# *BIOENERGY COMPETENCY CENTRE*

## *Study of the bioenergy potential in the centre region of Portugal*

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Dissertation submitted in partial fulfilment of the requirements for the Degree of *Mestre em Ciência e Sistemas de Informação Geográfica*
(Master in Geographical Information Systems and Science)

Instituto Superior de Estatística e Gestão de Informação
da Universidade Nova de Lisboa

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Dissertation Supervised by

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&

Professor Doutor José Carlos Teixeira

November 2010

## ACKNOWLEDGMENTS

This section is dedicated to all that, directly or indirectly, helped me conclude the present study, to whom I would like to express my sincere gratitude.

Firstly, I would like to thank my supervisors, Professor Doutor Pedro Cabral and Professor Doutor José Carlos Teixeira for the stern, available and friendly way that they helped throughout the dissertation period, where their invaluable input aided in bettering this study.

To the CCB project (financed by iCentro – Programa Regional de Acções Inovadoras do Centro de Portugal) and all its coordinators, who provided all the needed information and support whenever needed.

To Professor Doutor António Dinis Ferreira, for being patient when I wasn't there.

To João Pinto. Without your tireless help and support, much of what was accomplished wouldn't have been possible.

To all the official organizations producers of the used information in this work, thank you for being so solicitous in attending my various requests.

To all my work colleagues and friends, Manuela, Marta, Érica, Célia, Carla, Ângela and Ana. Your friendship, support and suggestions given at every step of the way were of great importance. Our conversations undoubtedly helped out in the construction of this dissertation.

To Ricardo Martins, for turning me on to GIS. You opened up a whole new wonderful world for me.

To my ISEGI colleagues, for the exchange of ideas and experiences.

To Bruno Ribeiro. What can I say to express my gratitude for giving me strength and courage, when I had very little of my own?

To Paulo, who is always watching over me.

And last but certainly not least, to my family, especially to my own personal heroes, my dear parents. All your unquestionable support with every single decision I make turned me into whom I am today. I owe everything to you both.

***To you all, thank you so very much.***

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## ABSTRACT

The use of renewable energy is one of the most effective ways to achieve a sustainability much needed for the future of our planet. The continuous consumption of fossil fuels is rapidly depleting resources that are essential for Man's survival.

The bioenergy potential for the Centre region of Portugal is an important piece of information to attain, once this knowledge is very limited. To calculate this potential, several types of waste data was collected and treated. One of the advantages in allying Geographic Information Systems with multicriteria decision analysis, is the possibility to integrate alphanumerical and geographical data, turning these into perceptible information in the decision making process.

General results show that forest residues are the major contributors for the bioenergy potential in the Centre Region of Portugal, where the majority of this potential is located in the inland area of the study area. However, further analysis should be done as to verify if the use of energy crops are a viable possibility in this area.

The ideal location for the implementation of the Bioenergy Competency Centre is also determined. Results show that the most suitable areas for its implementation areas in the inland section of the study region.

**CENTRO DE COMPETÊNCIAS DE BIOENERGIA**

**Estudo do potencial bioenergético da região Centro de Portugal**

## RESUMO

O uso de energia renovável é uma das formas mais eficazes de atingir a sustentabilidade necessária para o futuro do nosso planeta. O consumo contínuo de combustíveis fósseis está rapidamente a esgotar recursos essenciais à existência do Homem.

O potencial bioenergético para a Região Centro de Portugal é uma informação importante a obter, dado que este conhecimento é muito limitado. De forma a calcular este potencial, dados de resíduos foram recolhidos e tratados. Uma das vantagens obtidas quando se aliam os Sistemas de Informação Geográfica com a análise multicritério, é a possibilidade de se integrarem dados alfanuméricos e geográficos, tornando-os em informação perceptível no processo de decisão.

Resultados gerais mostram que os maiores contribuidores para o potencial bioenergético da Região Centro de Portugal são os resíduos florestais, em que a sua maioria está localizada no interior da área de estudo. Contudo, estudos mais aprofundados deverão ser efectuados para se analisar a viabilidade da utilização de culturas energéticas nesta área.

A localização ideal para a implementação do Centro de Competências para a Bioenergia é igualmente estudada. Os resultados obtidos mostram que a maioria das áreas mais adequadas para a sua implementação se encontram no interior da Região Centro de Portugal.

**KEYWORDS**

Bioenergy potential

Bioenergy resources

Geographical Information System

Kyoto protocol

Land use

Optimal location

**PALAVRAS-CHAVE**

Potencial bioenergético

Recursos bioenergéticos

Sistemas de Informação Geográfica

Protocolo de Quioto

Ocupação do solo

Localização óptima

## ACRONYMS

**AFN** – *Autoridade Florestal Nacional* (Portuguese National Forest Authority)

**BCC** – Bioenergy Competency Centre

**CAOP** – *Carta Administrativa Oficial de Portugal* (Official Administrative Map of Portugal)

**$CH_4$** – Methane

**CGIAR-CSI** – CGIAR-Consortium for Spatial Information

**DRABL** – *Direcção Regional de Agricultura da Beira Litoral* (Agricultural Regional Service of Beira Litoral)

**EC** – European Commission

**EJ** – Exajoule

**ETRS89** – European Terrestrial Reference System 89

**EU** – European Union

**GDP** – Gross Domestic Product

**GHG** – Greenhouse gas

**GIS** – Geographical information system

**GJ** – Gigajoule

**GWh** – Gigawatt Hour

**ha** – Hectare

**ICNB** – *Instituto de Conservação da Natureza e da Biodiversidade* (Nature Conservation and Biodiversity Institute)

**IEA** – International Energy Agency

**IFAP** – *Instituto de Financiamento de Agricultura e Pescas* (Financing Institute for Agriculture and Fishery)

**IFN** – *Inventário Florestal Nacional* (National Forest Inventory)

**IGeoE** – *Instituto Geográfico do Exército* (Army Geographic Institute)

**IGP** – *Instituto Geográfico Português* (Portuguese Geographic Institute)

**INE** – *Instituto Nacional de Estatística* (Portuguese National Institute of Statistics)

**INGA** – *Instituto Nacional de Intervenção e Garantia Agrícola* (National Institute of Intervention and Agriculture Guarantee)

**INR** – *Instituto de Resíduos* (Waste Institute)

**IPA** – *Inovação e Projectos em Ambiente, Lda* (Environmental Innovation and Projects, Ltd)

**kcal** – Kilocalorie

**kg** – Kilogram

**kJ** – Kilojoules

**LHV** – Low heat value

**MADRP** – *Ministério da Agricultura, do Desenvolvimento Rural e das Pescas* (Agriculture, Rural Development and Fishery Portuguese Ministry)

**MSW** – Municipal solid waste

**Mtoe** – Million tons of oil equivalent

**MW** – Megawatt

**NUTS** – Nomenclature of Territorial Units for Statistics

**OECD** – Organisation for Economic Co-operation and Development

**PERSU II** – *Plano Estratégico para os Resíduos Sólidos Urbanos 2007 – 2016* (Strategic Plan for Municipal Solid Waste)

**PJ** – Petajoule

**REN** – *Rede Eléctrica Nacional* (National Electric Network)

**RGA** – *Recenseamento Geral da Agricultura* (General Agricultural Census)

**SAU** – *Superfície agrícola utilizada* (used agricultural area)

**S&GIS** – Science and Geographical Information Systems

**SRC** – Short rotation coppice

**SRF** – Short rotation forestry

**SWOT** – Strengths, Weaknesses, Opportunities and Threats

**toe** – Tonne of oil equivalent

**USA** – United States of America

**UVO** – Used vegetable oils

## CONVENTIONAL SIGNS

… Confidential data

- Null result

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*"Ever bigger machines, entailing ever bigger concentrations of economic power and exerting ever greater violence against the environment, do not represent progress: they are a denial of wisdom. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful."*

(Small is beautiful, E.F. Schumacher)

# 1. INTRODUCTION

What does the word *energy* mean? Initially, it emerged as based on a Greek word, which meant forceful or vigorous language. But in the early 1800s, this meaning was changed by scientists, due to their observations about the behaviour of such diverse phenomena as the transfer of heat, the motion of planets, the operation of machinery and the flow of electricity. Nowadays, the standard scientific definition is the *capacity to do work; that is, to move an object against a resisting force* (Boyle, et al., 2004). Energy presents itself as a complex process, once it is possible to convert it into different types, transport it, store it in variety of forms and use it in various end use modes in numerous places. Most of the energy sources are substitutable to each other due to fact that some form of energy can be converted to another form (Ramachandra, 2008).

Fossil fuels are extremely attractive as energy sources, once they are highly concentrated, enabling large amounts of energy to be stored in relatively small volumes. They are relatively easy to distribute, especially oil and gas which are fluids (Boyle, et al., 2004).

Figure 1.1: The Hibernia oil platform rig, one of the world's largest (Hibernia, 2009).

It is still unknown when cheap fossil fuels will end, but it is estimated that it may happen in just one generation, or even sooner. We currently live what may be considered as an oil crisis. Just recently, on the 3rd of July 2008, the price of the barrel of crude oil was above of 135 dollars, whereas in 2004, the price was located at around 35 dollars per barrel. In the ongoing year 2010, the current value can still be perceived as rather high, approximately 70 dollars/barrel of crude oil (U.S. Department of Energy, 2009). This substantial fluctuation of the oil price may cause serious worldwide economic disruption and lead to widespread protests, as seen recently all around the world (Boyle, et al., 2004).

Knowing that fossil fuels will become a rare commodity in the near future, and seeing that humanity is utterly dependant on energy, a new path needs to be traced as to support our energy consuming way of life. If not, serious consequences will outcome from this fact. Society's current use of fossil and nuclear fuels has many adverse environmental consequences. These include air pollution, acid rain, climate change, the depletion of natural resources and the dangers of nuclear radiation (Boyle, 2004). Other consequences from oil exploitation may also occur, that not only have environmental impacts, but also directly affects the loss of human life, such as coal mining accidents, fires on oil or gas drilling rigs, as well as oil spillages from tankers (Boyle, et al., 2004), as recently verified in the 2010 BP oil spill in the Gulf of Mexico, where the Deepwater Horizon well leaked around 5,000 barrels per day.

The term *sustainability* entered into common currency relatively recently, following the publication of the report *Our Common Future,* published by the United Nations' Brundtland Comission in 1987. The Commission defined sustainable development as the *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (Boyle, et al., 2004; World Comission on Environment and Development, 1990).

Sustainability is a key point in today's society, once it involves environmental, social and operational management strategies, an equilibrium that is not easy to control due to their interdependency. According to Boyle (2004), a sustainable energy source is ideally one that is not substantially depleted by continued use, does not entail significant pollutant emissions or other environmental problems, and also does not involve the perpetuation of substantial health hazards and/or social injustices. But only a few energy sources come close to this ideal, where the *renewables* appear generally more sustainable than fossil or nuclear fuels: they are essentially inexhaustible and their use usually entails much lower emissions of GHG or other pollutants, and fewer health hazards (Boyle, 2004). With the use of natural and renewable resources as an alternative to fossil fuels for the production of energy, a higher level of sustainability may be achieved by modern society (Richardson, et al., 2005).

The renewables are based on energy flows that are replenished by natural processes, not becoming depleted with use, as do fossil or nuclear fuels. The environmental impacts of renewable energy sources vary, but they are generally much lower than those of conventional fuels. However, the current costs of renewable energy sources are in many cases higher than those of conventional sources, and this has, until recently, retarded their deployment (Boyle, et al., 2004).

The core element of sustainable development is the integration of economic, social and environmental concerns in policy-making. Applying this mode of thinking - seeing climate change

through a sustainable development prism - is the only way in tackling the climate change and sharing efforts among countries (Streimikiene, et al., 2009).

A rather simple way to help achieve this goal is by regulating the implementation of bioenergy resources, where in comparison with the use of fossil fuels, the greenhouse gas (GHG) emissions are considerably lower. Moreover, in an economic point of view, they present a simpler know-how and technological investment and with less need to convert the existing energetic structures. This way, and with the use of these types of energies, we are aiming to achieve two major environmental goals: the use of cleaner energy and the contribution to minimize global warming.

Nevertheless, there are now factors taken into consideration that were inexistent before. On one hand, there is a larger society consciousness, particularly of the crucial actor *media*, that allows us to face with more seriousness questions related with energy consumption, climate change and sustainable development. In general, the scientific community agrees that the ongoing raise of GHG in the atmosphere, particularly $CO_2$, is causing the phenomena verified in the last years (temperature raise, higher frequency of extreme natural events, etc.) and that their intensity and frequency will rise. This aspect turns the reduction of GHG into an urgent matter (Netto, 2008). The Kyoto Protocol was an important advance in this sense, although debilitated by the long term absence of the United States of America (USA). However, the European Union (EU) has already assumed its leadership in this matter and aims to reduce emissions up to 20% until 2020, compared to 1990, considerably higher than the 8% foreseen in the Kyoto Protocol for the period of 2008 to 2012 (Commission of the European Communities, 2007). In December 2009, a follow up meeting of the Kyoto one was held in Copenhagen, Finland. Unfortunately, this wasn't a very successful summit, not having achieved the goals and expectations perceived; it didn't secure the future goals in a binding way, but only in an indicative way.

On the other hand, there are inherent reasons concerning the actual nature of these types of energy sources. Considering the fact that they are renewable allows us to state that their use would be a step towards sustainability, in the broader sense of the word. The oil exhaustion is a recurrent subject, with specialists indicating the year that production will reach its peak and when the major oil reserves will finally be depleted. Some specialists refer that, at the current consumption rates, world coal reserves should last for about 200 years, oil for approximately 40 years and natural gas for around 60 years. However, world production of liquid fuels, which include non-conventional as well as conventional sources, seems likely to reach a peak between 2005 and 2015. Peak production of natural gas is likely around 2030. From then on, although large quantities of oil and gas will remain, the overall resource will be in decline (Boyle, 2004).

We can also assume that it's quite possible the oil may never end. However, the harmful effect will still be felt: the market acts as though, sooner or later, a scarcity cost will be ascribed to the consumers. As time goes by, this fact will lead to the competitiveness of the renewable energies when compared with oil based energies. The case of natural gas and coal is a slight different one, due to the still enormous existent reserves, even though they are non-renewable finite resources for the human time scale. This way, the renewable energies have an inherent economical advantage (Netto, 2008).

## 1.1. The bioenergy problematic and its situation in Portugal

The price raise of the crude oil barrel has a series of consequences for all kinds of environmental, social and, especially, economical aspects in a given society. Countries with low or inexistent access to fossil fuels such as Portugal have an elevated price to pay for oil importation: in 2007 the consumption of primary energy from oil represented approximately 54% of the total (Direcção Geral de Energia e Geologia, 2005). Portugal has a final energy consumption per inhabitant that is still reduced when compared with other EU countries – 1,7 toe/inhabitant against an EU-25 mean of 2,5 toe/inhabitant (Agência Portuguesa do Ambiente, 2008). Nevertheless, the price raise of fossil fuels will represent an exit of a substantial amount of currency to foreign countries, with the consequent weakening of the economy. And this fact only regards oil importation. Remaining energy sources like natural gas and coal aren't taken into consideration. All together, these three forms of primary energy represent over 80% of the Portuguese national energetic balance (Direcção Geral de Energia e Geologia, 2005). Supply safety and energy independence is also important, once that the country is absolutely dependant on the volatility of the price of oil, natural gas and coal. This is one of the most important reasons that the majority of the countries are investing in renewable energies and energetic efficiency. If we take a look at the Swedish reality, this could have certainly been one of the most important reasons for the country to change their energy policy to a more sustainable one throughout the last 40 years (Regeringskansliet, 2009).

The renewable energy sector has been suffering a strong development, with a boost in the national electric energy production (APREN, 2010). In 2003, a preliminary target for 2010 was set for Portugal, where it had to produce 39% of electricity from renewable energy sources, the third highest goal of the EU 15 (European Parliament and of the Council, 2001). By early 2007, this aim had already been achieved, having these values been revised and set a new target of 45%, being presently one of the most ambitious targets of all EU member states (Direcção Geral de Energia e Geologia, 2005; European Commission, 2007). In order to achieve this new commitment, the target values in Table 1.1 have been set. In addition, the government plans to increase its biofuels

penetration target from 5.75% to 10% of the total road transport fuel placed in the market over the same time period (International Energy Agency, 2009).

When compared to 2005, the year 2007 presented a decrease around 10% in both consumption and importation of primary energy. Nowadays, the national production in Portugal is based exclusively on renewable energies. The contribution of this type of energy for the national energetic balance is already significant: in 2008, the amount of renewables in the total of primary energy supply was 18,15%, a higher value than 2007 (17,3%) and 1998 (15,5%). In this analysis, the variability and the high weight of the hydrological component should be taken into account, having 2007 been classified as an extremely dry year (Agência Portuguesa do Ambiente, 2009; International Energy Agency, 2009).

| Technology | 1997 | 2006 | 2010 targets |
|---|---|---|---|
| Hydro-power | 4.375 | 4.867 | 5.575 |
| Wind | 29 | 1.697 | 5.100 * |
| Biomass (without co-generation) | - | 24 | 250 |
| Photovoltaic | 0,53 | 3 | 150 |
| Wave/tide | - | - | 250 |
| Biogas | 1 | 9 | 100 |
| Biofuels | - | - | 10% of fuels for road transport use |
| Micro-generation | - | - | 50.000 systems |

* 2012 target

Table 1.1: Changes in installed renewable capacity (MW) and 2010 targets (adapted from (European Commission, 2007)).

The Directive 2001/77/CE of the European Parliament and of the Council, of 27 September, established the values for fixing of national indicative targets for electricity produced from renewable energy sources for several countries, including Portugal, having as a reference the year 1997. In 2008, 15.345 GWh of electric energy was produced from renewable energies. Of the total production, approximately 47,6% corresponded to hydroelectricity (Direcção Geral de Energia e Geologia, 2005).

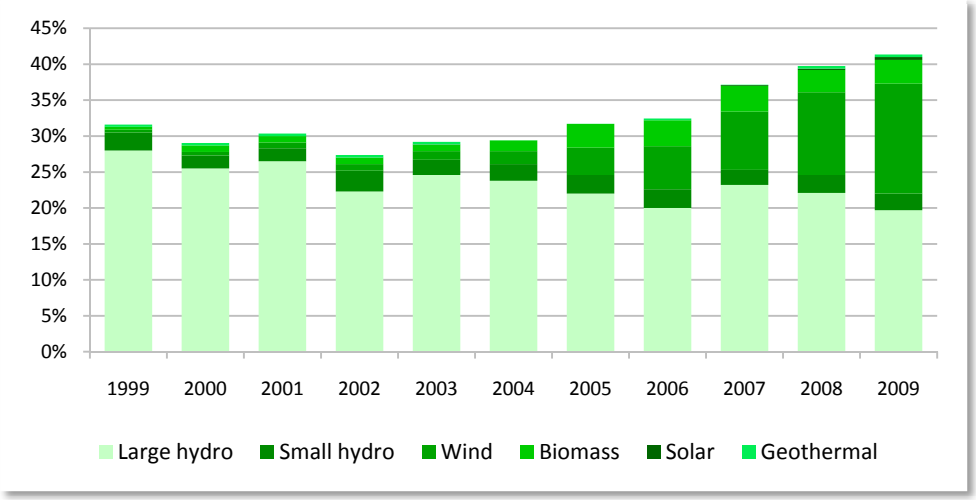


Figure 1.2: Renewable energy quota for the production of electric energy for each technology in Portugal, with hydraulicity correction (adapted from (APREN, 2010)).

Portugal was, in 2007, the fourth country of EU-27 with higher incorporation of renewable energies in the gross consumption of electric energy, being above the European average (21%) (Agência Portuguesa do Ambiente, 2009). The evolution of the penetration of the renewable energies for the production of electricity allows us to look at the 45% of renewable energy milestone in 2010 with optimism. However, this value may only be reached if 2010 continues with the tendency of a wet year, and if the withdrawing in electricity consumption tendency is maintained.

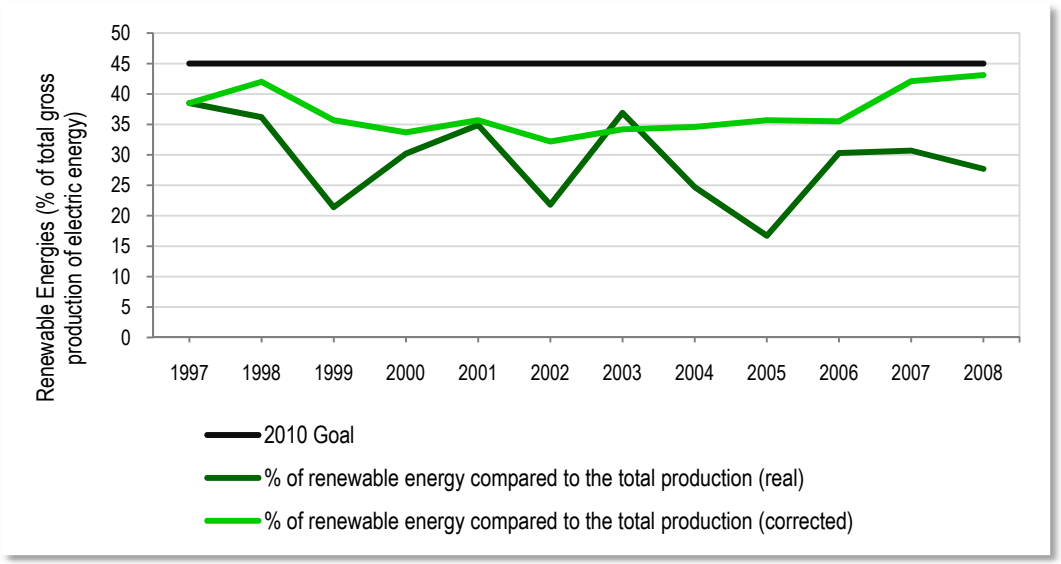


Figure 1.3: Production of electric energy originating from renewable energies (adapted from (Agência Portuguesa do Ambiente, 2009)).

By noticing the previous figure, renewable energy can be assumed as being real or corrected. Having into account the inclusion of the hydrological production values, these can differentiate widely on a yearly basis. Being this type of renewable energy particularly important in Portugal, these values need to be transformed and corrected by a methodology that takes into account the fact that the reference year defined by the Directive 2001/77/CE (European Parliament and of the Council, 2001), 1997, is one of high hydraulicity, which could not be easily repeated in the following years. Recently, a new Directive has emerged – Directive 2009/8/CE (European Parliament and of the Council, 2009) – as to alter (from April 1st, 2010) and fully revoke (from January 1st, 2012) the Directive 2001/77/CE.

Biomass dedicated power plants are of recognized importance for the global bioenergy balance. There are currently nine biomass plants working in a cogeneration regime in Portugal, generating a total of 308 MW of electric energy. The present government established 400 MW as the goal for the raise of production from electricity generated from forest biomass in dedicated power stations, from which 192 MW may be generated from this material, where 106 MW are already in production and 85,6 MW are foreseen to begin production in the years 2014, 2016 and 2018. Besides the previously mentioned biomass power plants, 15 invitations to tender were launched recently, from which a total of 96 MW are expected to be generated (APREN, 2010). The use of this material may articulate the relationship between forest and energy, simultaneously helping firefighting strategies. However, great attention has to be paid to the attribution of too much energy to the power plants of the forest biomass sector. The implication in having such power stations implies that there is enough material available for its proper functioning (APREN, 2010). Otherwise, alternate measures have to be taken to reach the full potential of biomass as a feedstock for energy, by creating a modern biomass energy framework. Its aim should be to maximise crop yields with minimum inputs; use and select adequate plant materials and processes; promote an optimum use of land, water and fertilisers; and create an adequate infrastructure and strong R&D base (Omer, A.M., 2008).

In terms of national municipal solid waste production, between 1995 and 2008 the increase of these residues accompanied the Gross Domestic Product (GDP) growth, being verified an increase of around 32% and 33%, respectively. These values mean a production of 5,059 million tonnes, a total higher than the one perceived in the Strategic Plan for Municipal Solid Waste 2007 – 2016 (Plano Estratégico para os Resíduos Sólidos Urbanos 2007 – 2016 – PERSU II) – 4,993 millon tones (Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional, 2007). In the continental area, the residue production raised to 4,787 million tonnes in 2008, which means an average production of 1,3 kg per inhabitant per day. Even so, this value is lower than the

current European capitation (1,4 kg per inhabitant per day), although it has been increasing since 2004 (1,2 kg per inhabitant per day) (Agência Portuguesa do Ambiente, 2009).

Landfills are still the main destination for municipal solid waste produced in Portugal. Around 65% of the total waste that is produced is deposited in these infra-structures, followed by incineration with energy valorisation (18%) and separate collection (9%). Only 8% of waste is conducted to organic valorisation. In what respects to separate collection, packaging waste has seen an increase in recycling, although its rate is only around 15%. The amount of packages subject to energetic valorisation has been increasing since 2003. As to paper and cardboard residues, these achieved the highest recycling rate in 2007 (82%), while woody waste packaging was of 71% and metal waste of 63% (Agência Portuguesa do Ambiente, 2009). In terms of glass waste, recycling rates values maintained when compared to 2006 (46%). The current installed capacity for the valorisation of all these recyclable residues is of 88 MW (APREN, 2010). They are currently already being valued in the two waste incineration plants that belong to Valorsul (Lisbon, with 50 MW) and Lipor (Porto, with 26 MW), and by Valor Ambiente (Madeira Island, with 8 MW) (Agência Portuguesa do Ambiente, 2009).

In 2008, from the 4,787 million tonnes of produced municipal solid waste, half of this value consisted of a biodegradable fraction. Most of these residues (67%) were conducted to landfills, 18% suffered anaerobic digestion, 8% was organically valued and 7% (paper and cardboard) were recycled. One of the aims proclaimed by PERSU II is the future valorisation of the total fraction of biodegradable municipal waste, by avoiding depositing these residues in a landfill and conducting them to anaerobic digestion, organic valorisation and mechanical and biological treatment units.

A more detailed analysis on most of the topics discussed in this section can be seen in the document produced by the International Energy Agency, which reviews in detail the Portuguese energy sector and provides sectoral critiques of existing policy and recommendations for further improvements (International Energy Agency, 2009).

In the following section, the main goals of the study work will be defined.

## 1.2. Main goals

With the elaboration of this thesis, it is intended to delineate strategies and tools as to realize the amount of renewable energies, residue-wise, that can be used to produce energy in order to study the viability of their use in an actual way.

Therefore, the first and utmost goal is to analyse the potential of bioenergy for the Centre Region of Portugal for several bioenergy sources, namely from energetic cultures, forest, agricultural and food residues and the biogas produced as by-product from some human activities. To achieve this goal, spatial and non-spatial data is collected, transformed into a comparable energy unit (tonne of oil equivalent - toe) and analysed in order to determine the costs of production/collection and processing of the raw material for the production of bioenergy.

Having the previously stated information, an analysis of the optimum location for the Bioenergy Competency Centre is made. This is an entity that includes a large range of services before and after bioenergy production, such as technical assistance during the production process, research, personnel training and product certification. The adequate implementation of this infra-structure in the terrain is essential for a flourishing development of the use of bioenergy in the study area.

After these analyses are made, key questions may be answered by the results, such as:

- What is the bioenergy potential in the Centre region of Portugal?
- Is the residue amount produced viable to be used in reality?
- Can we stop using fossil fuel-based energy?

Therefore, the two overall outcomes of the developed work will be a map of the bioenergy potential for the Centre region of Portugal and a map with recommendations for the optimum location of the implementation of the Bioenergy Competency Centre.

## 1.3. Thesis structure

The present thesis is organized in five chapters.

The first chapter introduces the bioenergy thematic. The motivation for the selection of the research theme is explained and the main goals are described.

The second chapter has an in-depth analysis of the research subject at hand, where the state of art, the explanation for the need of bioenergy, advantages and disadvantages of its use and its situation worldwide is described. In this chapter, the study area is also illustrated.

The third chapter defines the methodology to adequately reach the main goals that were proposed. A Geographical Information System (GIS) approach is used, where all the necessary resources (software, hardware and alphanumerical) are stated, collected and treated in order to calculate and attain the data necessary to comply with the proposed goals.

The fourth chapter presents the obtained results from the application of the specified methodology. It also has a critical analysis of these results, commenting on how the tool could be enhanced by visualising the weak points of the outcome.

The fifth chapter presents the main conclusions achieved during the elaboration of the present thesis, observing the main advantages and disadvantages of the use of a GIS system to obtain viable results as far as bioenergy potential in a certain area goes.

# 2. BIOENERGY IN THE CENTRE REGION OF PORTUGAL

This chapter presents the main considerations in the bioenergy study field, defining what bioenergy is, its sources, the current situation in the Centre Region of Portugal and the description of the study area.

## 2.1. Bioenergy

Europe is becoming extremely dependent on imported hydrocarbons (Figure 2.1). With "business as usual" the European Union's (EU) energy import dependence will jump from 50% of total EU energy consumption today to 65% in 2030. Reliance on imports of gas is expected to increase from 57% to 84% by 2030, and of oil from 82% to 93%. Being so, the EU is becoming gradually exposed to the effects of price volatility and rise on international energy markets and the consequences of the progressive concentration of hydrocarbons reserves in few hands. The potential effects are significant: if, for example, the oil price rose to 100$/barrel in 2030, the EU-27 energy total import bill would increase by around €170 billion, an annual increase of €350 for every EU citizen. Very little of this wealth transfer would result in additional jobs in the EU (Commission of the European Communities, 2007).

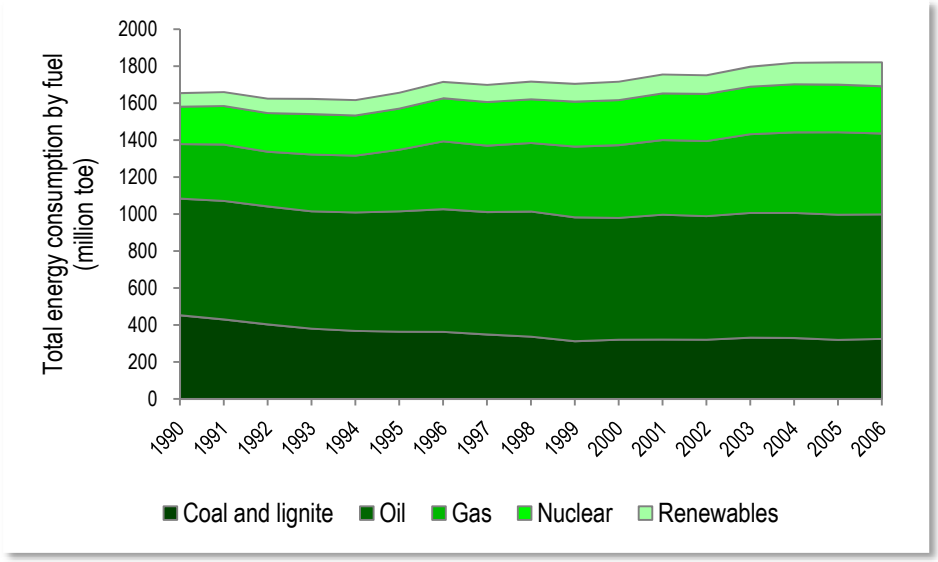


Figure 2.1: Total energy consumption by fuel in EU-27 (adapted from (European Environment Agency, 2008)).

Obtaining a reliable estimate of the total world-wide energy contribution from the many sources of bioenergy is a tough task. Unlike the fossil fuels, bioenergy has no global companies producing detailed reports on production and consumption. Indeed, the use of traditional biomass often involves no financial transaction at all, or the trading is local and unrecorded. In recent years, the International Energy Agency (IEA) has taken upon itself the task to collect national data based on aged categories of renewable energy. However, they warn their data is still subject to a great deal of uncertainty. (Boyle, 2004).

The potential for energy from sustainable technologies is huge. Technologically speaking, renewables have an obvious role to play, where there is no problem in terms of the technical potential for it to deliver energy. Moreover, there are very good opportunities for renewable energy technologies to help in reducing emissions of GHGs into the atmosphere, certainly far more than have been exploited so far. However, there are still some technical issues to address in order to cope with the intermittency of some renewables. Yet, the biggest problem with relying on renewables to deliver the necessary cuts in GHG emissions has more to do with politics and policy issues than with technical ones. For example, the single most important step governments could take to promote and increase the use of renewables is to improve their access to the energy market, one which would need to be under favourable conditions and, possibly, under favourable economic rates as well. What could help would be to acknowledge that there are environmental costs associated with other energy supply options and that these costs are not currently internalised within the market price of electricity or fuels. This could certainly make a significant difference, particularly if appropriate subsidies were applied to renewable energy in recognition of the environmental benefits it offers (Omer, 2008).

Rational decision-making at disaggregated levels is necessary to eliminate wasteful use of resources. Detailed planning should be required from National, to Regional, to District, to Municipality and Parish levels (Ramachandra, 2008). Knowing that in smaller scale systems it is not possible at times to explore the scale economies inherent to any industrial activity, it is also sure that this decentralized production may bring several advantages. From the get-go, its benefit is to diminish the overload in the transport infrastructures, allowing to reduce some investments in these facilities and reducing the losses in transport. Secondly, the decentralized production is, besides some exceptions, more work intensive than the centralized production. Decentralized production has, for this reason, a positive impact upon employment. Another advantage is that decentralized production technologies are usually easily internalized by the national production fabric, which brings benefits to the quality of the economic activity and, consequently, employment. Finally, the decentralized production has, in general, a smaller environmental impact for each unit of energy that is produced, due to the fact that it refers to the actual use of renewable energy and

because it allows a better use of the primary fuel, when using fossil fuels in multiple generation (electricity and/or heat and/or cooling) (APREN, 2010). The installation of small electroproduction units throughout the interior of the country may lead to the implantation and recuperation of a network of paths and roads to connect to the national road system, as to allow the installation, operation and maintenance operations. This routing activity for this end is frequently projected in articulation with the necessities of the local populations, promoting a significant improvement on their quality of life standards, as well as allowing greater safety to these populations and forest stands by the facilitation of the fire brigades' access to remote areas, otherwise inaccessible (Agência para a Prevenção de Incêndios Florestais, 2005). This way, the socio-economical benefits of this activity are a strong stimulus to the population settlement and, in the case of people owned estate, the maintenance of the traditional economies based on agriculture and agroforestry (Agência para a Prevenção de Incêndios Florestais, 2005).

This way, renewable energy technologies have the benefit of being environmentally benign when developed in a sensitive and appropriate way, with the full involvement of local communities. Additionally, they are diverse, secure, locally based and abundant. In spite of the enormous potential and the multiple benefits, the initially high development costs, concerns about local impacts, lack of research funding and poor institutional and economic arrangements hamper the ambitiously claimed contribution from renewable energy. Hence, an approach is needed to integrate these energies in a way that meets high performance requirements (Omer, 2008).

The use of bioenergy is not really new. It has only been given new perspectives and been the fruit of its economical and environmental growth. Actually, automobiles like the famous Ford T (produced between 1908 and 1927) were factory prepared to consume ethylic alcohol, derived from maize at the time (maybe due to the fact that Henry Ford was a son of farmers). The thermal machine, which we nowadays call Diesel motor, was designed to consume vegetable oils, not the diesel we use nowadays. It was actually the massive divulgation of the automobile and their internal combustion motors, associated to the huge amounts of necessity of liquid fuels, that guaranteed the rising fossil fuels to the title of the most important energetic source of the planet (Monteiro, 2008). There is actually a large variety of technologies for the production of electric energy, heat, heat and electric energy simultaneously (cogeneration) and even electric energy and/or heat and/or cooling (trigeneration) (Agência para a Prevenção de Incêndios Florestais, 2005).

As analysed, mankind cannot be exclusively dependent on fossil fuel energy much longer. Existing and new energy sources have to be further explored in order to guarantee a future not only for ourselves, the current generation, but also for our children and grandchildren.

An in-depth analysis will be done to the bioenergy subject in the following chapters.

### *2.1.1. What is bioenergy?*

Bioenergy is the general term for energy derived from biomass material, such as trees, plants, manure, and sometimes waste. Such materials can be processed through various transformation processes such as combustion, gasification and pyrolysis, where the biomass is either transformed into biofuels, bioheat or bioelectricity and used for energetic purposes. Charcoal and biodiesel, for example, are biofuels made from wood and plant seeds respectively (Boyle, 2004; AEBIOM, 2010).

The renewable energy directive (European Parliament and of the Council, 2009) defines biomass as being "the biodegradable fraction of products, wastes and residues from biological origin from agriculture (including vegetable and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste" (AEBIOM, 2010).

Material such as firewood, rice husks and other plant or animal residues can simply be burned to produce heat, and in many developing countries this traditional biomass continues to account for a large part of energy consumption. In recent decades, however, terms such as "new" biomass have come into use to characterize materials that are processed on a large, commercial scale, usually in the more industrialized countries. The input to these processes may be purpose-grown energy crops, but often they are organic wastes. The output may create heat, or any of a wide range solid, liquid or gaseous biofuels (Boyle, 2004).

Several conversion steps may be needed to transform raw biomass into consumable bioenergy products and services. As it grows, plant biomass proceeds to photosynthesize solar energy, converting it to chemical energy stored in the chemical bonds of its molecular constituents. This accumulated energy can be either directly released as heat via combustion (and subsequently transformed into power with an engine or turbine) or converted into an assortment of marketable intermediate chemical and energy products. The latter biomass-derived energy products may present themselves in the solid (chips, pellets, charcoal, etc.), liquid (biodiesel, bioethanol, etc.) or gaseous (biogas, synthesis gas, hydrogen, etc.) form that, in turn, can be used in a variety of energy applications, which include use as transport fuels (International Energy Agency Bioenergy, 2009).

A large amount of bioenergy sources are available nowadays. Several of the materials referred in the previously stated definitions are widely available. The next section describes some of these

energy sources, as well as several of particularities associated to each and every stated bioenergy source.

### *2.1.2. Bioenergy sources*

The details may be uncertain, but there is little doubt that biomass is a major energy provider over much of the world. It accounts for about a third of total primary energy consumptions in the developing countries (up to 90% in some of the poorest), and its total annual contribution continues to rise. Its percentage contribution to world primary energy is falling slightly as developing countries industrialize, but it remains important even in the more advanced of these, accounting for about 20% of primary energy in China and 40% in India (Boyle, 2004).

Even in the industrialized world, the energy contribution from biomass can be significant, particularly in countries with large forestry industries or well-developed technologies for processing residues and wastes. In Sweden and Finland, where biomass contributes about 20% of primary energy, the use of residues in the pulp and paper industries is important. Advanced systems for domestic heating, district heating and CHP (combined heat and power) have helped Sweden towards a 5-fold increase in the use of bioenergy over the past decade or so, reaching nearly 0,96 toe per head of population in 2001. In the UK, the bioenergy contribution rose at about 70% per year during the 1990's, and reached a total of 3,2M toe, or 0,05 toe per capita in 2002 (Boyle, 2004).

The yield, the tonnes of biomass produced per hectare per year, is obviously as important for energy crops as for food crops. Yields depend on many factors: the location, climate and weather, the nature of the soil, supplies of water, nutrients, etc., and the choice of plant. Even confining ourselves to energy crops, we find that the air-dry mass of plant matter produced annually on an area of one hectare can be as little as one tonne or, in favourable circumstances, as much as 30. In energy terms, this represents a range from perhaps 0,36 toe to 7,2 toe per hectare per year (Boyle, 2004).

However, attention has be to taken to the fact that agricultural productivity and changes to economic policies supporting agriculture may change in the future, as referred by Tuck, et al (2006). Their study reports that between the 1990s and the 2080s, considering precipitation requirements and minimum and maximum monthly temperatures at various times of the year, the potential range of most crops in Europe is predicted to extend further north and to retreat from the most southern parts of the territory. This way, most of the energy crops in the European territory will be selected due to the future climate. All model scenarios demonstrated that the southern

region will be most affected, being particularly vulnerable to climate change, where all temperate biofuel crops are predicted to decline considerably. This way, meeting demand for bioenergy crop production in southern Europe will be severely impaired by climate change. If these crops are to be viable in the vulnerable southern regions in the future, management efforts shall be required to allow bioenergy crop production to adapt to the challenges presented by climate change (Tuck, et al., 2006).

There are many bioenergy sources worldwide, from whom we shall consider in the next chapter the purpose grown energy crops (that include woody and agricultural crops) and wastes, the otherwise unwanted products of human activities (Boyle, 2004).

#### *2.1.2.1 Energy crops*

Boyle (2004) uses the term energy crop in its widest sense, where it includes any plant that is specifically grown to serve as fuel or for conversion into other biofuels. This category includes, for instance, wood for burning, plants for fermenting to ethanol and crops whose seeds are particularly rich in oils (obviously not including those that are grown primarily for food).

Similarly, Tuck, et al (2006) consider bioenergy or biofuel crops as being the annual and perennial species that are specifically cultivated to produce solid, liquid or gaseous forms of energy. The organic residues and wastes from food crops can also be used for producing energy (for example, cereal straw).

Recently, energy crops have been attracting increasing attention due to several different reasons, namely (Boyle, 2004):

- the need for alternatives to fossil fuels, to reduce net $CO_2$ emissions;
- the search for indigenous alternatives to imported oil;
- the problem of surplus and abandoned agricultural land.

The relative importance of these has been a major factor in determining the preferred crops in different country regions – subject of course to the constraints imposed by the local climate, soil, etc. (Boyle, 2004).

*Woody crops:*

About 60% of the wood removed worldwide is used for energy purposes, where in the developing countries this amount rises to 80% due to their use of this material for cooking, heating, and boiling water. Woodfuel is one of the main forest products, and it satisfies 7% of the world primary consumption. It plays an indubitable role as an energy source; nevertheless, its patterns of demand

and supply, and its associated social, economic and environmental impacts are still poorly understood (Masera, et al., 2006).

The patterns of woodfuel production and consumption and the associated social, economic and environmental impacts are complex and site specific. Broad generalizations about woodfuel use and availability at the regional, national and even subnational levels still commonly lead to biased assumptions and consequently to poor planning and ineffective action. Thorough local studies of woodfuel flows have sometimes been implemented, but they are expensive and time consuming, and they fail to provide the national perspective needed for the design of effective national policies (Drigo, et al., 2002).

In the environmental sector, forestry occupies an ambiguous position. One which is well managed can present itself as a sustainable fuel source, reducing atmospheric $CO_2$ as it grows and later providing substitute for fossil fuel. On the other hand, some types of "forestry" may lead to the decimation of the world's major natural forests, turning into a potential global environmental catastrophe. The wood in such cases is not cut primarily for fuel, although one might ask whether the residues of unsustainable forestry should be included as "renewables" in the woody wastes category (Boyle, 2004).

The uncontrolled removal of wood can bring not only environmental problems, but economic ones as well, by reducing productive capacity in countries where it contributes appreciably to industrial energy consumption (Boyle, 2004).

In conventional forestry, any energy production is incidental, often using wastes, as does the Spanish company FINSA. It produces chipboard and MDF material, where a sustainable resource generation is made by using several woody residues to feed their biomass power plant. In modified conventional forestry, the main part of the plan is to produce energy. Trees are planted at higher than usual density and vigorously thinned after a few years, using integrated harvesting techniques to produce chipped wood. The remaining trees grow to maturity in the normal way. There have been trials of this system, but the main developments in recent years have been with woody crops planted and harvested entirely for energy production, by using short rotation forestry (SRF). The "rotation" is periodic, and wood is cut every few years. In some regions (i.e., Europe), short rotation coppice (SRC) is a more usual technique, which uses the centuries-old practice of coppicing willow or other fast growing trees. In the modern version, cuttings are planted at 10-15.000 per hectare. Cut close to the ground after a year, they re-grow, either with multiple stems or as single-stem trees. The crop grows for 2 to 4 more years, after which the stems are cut close to the soil level. The stumps re-grow and the cycle is repeated, for approximately 30 years. Modern machinery can

reduce the stems locally to short lengths suitable for transporting, storage and future use (Boyle, 2004).

*Agricultural crops:*

Producing renewable energy and biomaterials is becoming a significant source of income for farmers in Europe. Due to changes in the food production and consumption in Europe, agriculture has shown to have potential to be a major contributor to bioenergy production in the EU 27, supporting the efforts to significantly increase the share of renewable energy sources in total energy production in the EU (European Environment Agency, 2007).

Renewable energy can be derived from a number of biomass feedstock, such as residues from agricultural crops (Bryan, et al., 2008). Globally the most widely grown crops for bioenergy purposes are sugar cane and maize. Both present high yields needed for a favourable energy balance, where their main interest lies in their potential for conversion to liquid fuels. Some crops are also used for their oily seeds, such as sunflowers, oilseed rape, soya beans, etc. This oil can be converted to a diesel substitute, known as biodiesel. Non-woody energy crops suitable for temperate climates have also received attention in some European and American countries. These include miscanthus, a grassy plant that originated in Asia and Africa, although some forms will grow in Northern Europe. The thick woody stems are suitable for direct combustion since they have very low water content (20-30%) when harvested (Boyle, 2004).

At the same time, attention has to be given to the fact that the shape and intensity of the agricultural sector determine the likely success in reaching environmental objectives of the European Union. Several key issues should be addressed when using agriculture crops for bioenergy production. In order to achieve a sustainable production of this type of bioenergy, all the economic, social and environmental aspects to it associated need to be taken into account. First and foremost, we should ask if the aim of substantially increasing bioenergy production from farmland can be achieved without compromising other environmental objectives at EU and national level. We also ought to consider what conditions need to be met for additional biomass production on farmland to remain environmentally compatible. Briefly, future biomass production on agricultural land should not impose any additional pressure on farmland biodiversity and environmental resources than is currently the case (European Environment Agency, 2007).

*Algae:*

Quite recently, algae have been presenting itself as a source of biomass for energy. Both microalgae and macroalgae are considered in this group. In terms of cultivation, the first can be

grown cost-effectively in open ponds on land, and in offshore reservoirs, where they potentially contain substantial concentrations of vegetable oil. Macroalgae could be cultivated in colonies in the open sea. The potential use for this product has not been studied as extensively as the land-based biomass, however studies indicate that they could reach up to several hundreds of EJ for microalgae and up to several thousands of EJ for macroalgae (International Energy Agency Bioenergy, 2009).

The downside of the use of algae is that they have relatively low dry matter content, which means that their applicability as a biomass feedstock is not straightforward. Other potential introduction barriers have not yet been fully explored (e.g. logistical issues for offshore cultivation). Therefore, it is still difficult to assess the sustainability and economic competitiveness of algae options (International Energy Agency Bioenergy, 2009).

Although Portugal is a littoral country with preferable hydrographical conditions for the production of algae, this material will not be taken into consideration in this work due to the limited knowledge and information associated to it at present. .

#### *2.1.2.2 Wastes*

There are several types of wastes that can be used to produce bioenergy, in which urban and industrial waste are included. With these residues, where much of it is organic material, they will release energy if burned. A main question remains, which is if this material should be regarded as a renewable resource. In recent years, it has become customary to treat only biodegradable wastes as renewables excluding, for instance, polymeric materials ("plastics") that do not degrade easily (Boyle, 2004).

*Wood residues:*

Operations such as thinning plantations and trimming felled trees generate large volumes of forest residues. What normally happens is that these residues are often left to rot on site. Although this fact has the environmental merit of retaining nutrients, they may enhance the forest fire risk in many regions. Recent technology has surpassed the difficulty of transporting this material, due to their bulk and inconvenient form, where transformation into a friendlier shape and size is made *in situ*. This aspect leads to the increase of some fraction of the residues for heat and/or power generation in many countries (Boyle, 2004).

*Temperate crop wastes:*

World-wide, more than half of the residues from crops in major cereal-growing regions may remain unused. Surplus in agricultural production may lead to burning in the field, but air pollution concerns and legislation creation restrain such practices (Boyle, 2004). As previously mentioned, these types of waste may be utilized for bioenergy generation.

*Animal wastes:*

With the massive consolidation of confined animal feeding operations over the past decades, there is a need for new, state-of-the-art waste management systems that make animal operations economically viable and environmentally benign (Cantrell, et al., 2008). Animal manure can be a major source of important pollutants, particularly methane ($CH_4$). Biogas is basically $CH_4$ produced through anaerobic fermentation (microbial process wherein the carbohydrates in the organic matter break down in the absence of oxygen) of dung and other organic wastes. Besides methane, biogas also contains carbon dioxide and traces of nitrogen, sulphur and moisture (Ramachandra, 2008).

The combination of intensive animal rearing and stricter environmental controls on odour and water pollution has led farmers to invest in anaerobic digestion as means of waste management, where the process generates useful biogas, and leaves an effluent that can be used (directly or dried) as a fertilizer (Boyle, 2004).

Bringing biofuel production to the farm-scale provides an opportunity for farmers to reduce their dependence on imported fossil fuels while concurrently improving the soil, water and air quality. The use of animal manure and other organic-based waste products as bioenergy feedstocks for waste-to-bioenergy conversion processes can allow farmers to take advantage of new markets for traditional waste products. In effect, livestock waste-to-bioenergy treatments have the potential to convert the treatment of livestock waste from a liability or cost component into a profit centre that can simultaneously generate annual revenues, moderate the impacts of commodity prices and diversify farm income (Cantrell, et al., 2008).

Another option exists for extracting energy from animal wastes, but only if the water content is low, is direct combustion for conventional power generation. Poultry litter, a mixture of chicken droppings and material such as straw, wood shavings, etc., has high energy content (0,22 – 0,36 $toe.t^{-1}$), depending on its moisture (Boyle, 2004).

*Municipal solid waste:*

MSW is considered in this work to include all kind of residues generated from homes, businesses, and the cleaning of public places such as streets, parks, beaches and other recreational areas.

Generally speaking, an average household in an industrialized country generates rather more than a tonne of solid waste per year, composed by an energy content of about 0,0052 toe per tonne (Boyle, 2004). As lots of many others, these residues can also be used to produce energy, where there are a number of technological options which include the recovery of landfill gas, incineration, gasification, production of $H_2$, pyrolysis and anaerobic digestion of the organic fraction (Gómez, et al., 2010). Each of these processes may be preceded by some form of initial treatment, from simple removal of metallic items to recycling. And each process may also be accompanied by some systems for extraction of useful energy (Boyle, 2004).

In this work, the energy potential of MSW is calculated considering three alternatives for its transformation: the recovery of landfill gas, incineration and anaerobic digestion.

*Landfill gas:*

As previously analysed, a large proportion of MSW is biological material and its anaerobic digestion reproduces the natural process of degradation of the organic matter in the landfill. This process produces methane, and, initially, systems were fitted to burn it off safely. However, currently this gas is collected by an array of interconnected perforated pipes at depths of up to 20 meters in the refuse. In a large well-established landfill there can be several kilometres of pipes. Compost is also an often by-product (Gómez, et al., 2010; Boyle, 2004).

Theoretically, the lifetime yield per tonne of wastes in a high-quality landfill site should lie between 150-300 $m^3$ of gas, with 50% to 60% by volume of methane which suggests a total energy of approximately 0,14 toe per tonne of refuse. In practice, yields are extremely variable and often unpredictable – a factor that tends to dissuade potential investors (Boyle, 2004).

The produced gas is viable to be used directly for kilns, furnaces or boilers operations. However, the output is increasingly used to generate electricity for local use or for sale, where the electricity generators are driven either by large internal combustion engines or by gas turbines. Assuming a gas-to-electricity energy efficiency of perhaps 35%, this brings the overall energy efficiency of the system below 10%. A site containing a million tonnes of MSW might support an electrical capacity of perhaps 2 MW over a 15-20 year generating lifetime. Despite the low energy conversion efficiency, landfill biogas plants have been amongst the most financially attractive of the existing systems (Boyle, 2004).

*Wastewater treatment plant gas:*

This is another extremely important source for bioenergy that can be found in large urban areas. For populations over 10 to 15.000 inhabitants, it is economically wise to install sludge drying

procedures with anaerobic digestion to produce biogas. Even small populations may benefit from this treatment, having only to create multi-municipal infrastructures for several small populations (Agência para a Energia, 2001).

The available potential that is yielded by cogeneration is around 157 GW/h of electric energy. The thermal energy is greatly used to heat the sludge in the anaerobic digestor, where an eventual surplus may be used to hygienise and dry the digested solids (Agência para a Energia, 2001).

Not only domestic effluents can be used to generate bioenergy. As with the solid component, effluent wastes from animal farms and several industrial sectors can also be yielded in this manner.

Due to fact that this topic is of such broad dimension, and feeling that it deserves an in-depth study that was incompatible for the present study, the author opted not to focus on it, although she recognizes its extreme importance to the current framework of the bioenergy study field.

### *2.1.3. The necessity of bioenergy use.*

Extra GHG have been added into the atmosphere since the industrial revolution. The main contributor to blame is the carbon dioxide emissions that come from the combustion of fossil fuels, the source of energy that is mainly used by Man. Serious consequences may arise from this fact, where the main one is the rise of the earth's mean global temperature. Scientists claim that, unless this increase isn't controlled, the surface temperature may climb up to 1,4 to 5,8 ºC by the end of the twenty-first century. This rise in temperature may lead to a series of severe climatic extremes, such as such as floods or droughts, serious disruption to agriculture and natural ecosystems and the rise of mean sea levels up to 0,5 m (Boyle, 2004).

These grave threats are the reason why Mankind needs to reduce such emissions, as to minimize or even prevent these unwanted consequences, once they interfere with Human well-being. Availability for food, access to energy for cooking, shelter and heating, health care, and cultural components like political rights, education, communication, transport, and material comfort may be compromised unless something is done (Buchholz, et al., 2007). Enhanced lifestyle and energy demand rise together and the wealthy industrialized economics, which contain 25% of the world's population, consume 75% of the world's energy supply. A World Energy Council study found that, if we resist in changing our current practice, the world energy demand in 2020 would be 50 to 80% higher than the 1990 levels. This ever increasing demand may place significant strain on the current infrastructure and potentially damage world environmental health with the concurrent emissions (Omer, 2008).

In the current discussion about the energy and environment policy, a great deal of importance is attributed to the renewable energy sector, where it appears to be one of the most efficient and effective solutions due to the intimate relationship between renewable energy and sustainable development. It is expected that their contribution shall be significant in the solution of many of the present and future problems (Staiss, et al., 2001; Omer, 2008). Alternative energies should substitute conventional energy such as fossil fuel, mineral charcoal and natural gas in order to avoid the referred increase of GHG in the atmosphere (Staiss, et al., 2001). We can say that renewables may even be able to shield a nation from the negative effect in the energy supply, price and related environmental concerns, being the fundamental inputs for any responsible energy policy.

Although the potential opportunities for bioenergy may be big, and its contribution to many of society's objectives (e.g. energy security, climate change mitigation, etc.) may be important, numerous challenges need to be addressed for its untapped potential to be used in a sustainable way (International Energy Agency Bioenergy, 2009).

### *2.1.4. Advantages and disadvantages of bioenergy use.*

The production of bioenergy is a subject much debated at present. As many others, this technology presents several advantages and disadvantages. It has to be properly regulated as not to create unbalances towards both human and animal feeding, as well as the environment. Ideally, there should be enough area to produce food for everybody, being the rest of the area occupied by bioresources. This would help to produce the necessary volume of bioenergy to substitute fossil fuels, securing the Earths' biosystems as well as the biodiversity (Santos, 2008).

In what refers to the advantages in using bioenergy, one can refer that (European Environment Agency, 2007; International Energy Agency Bioenergy, 2009; Omer, 2008; Omer, A.M., 2008; Ramachandra, 2008; Santos, 2008):

- There are very good opportunities for renewable energy technologies to play an important role in reducing emissions of GHGs into the atmosphere, certainly far more than have been exploited so far;
- If opportunities to reduce future emissions are taken in a timely manner, they should be less costly in the future;
- Biomass production costs are a key factor taken into account in most studies, where, typically, costs of € 2,3 – 3/GJ for primary biomass are perceived as a threshold to compete with fossil fuel prices. The positive aspect of this is that higher fossil fuel prices (especially

gasoline) and policy incentives in favour of bioenergy can substantially enlarge the economically viable potential;

- Biomass energy is experiencing a surge in interest stemming from a combination of factors, such as greater recognition of its current role and future potential contribution as a modern fuel, global environmental benefits, its development and entrepreneurial opportunities, etc;
- When correctly used, the use of biomass can be GHG neutral, presenting a closed cycle;
- Increasing the use of bioenergy offers significant opportunities for Europe to improve the security of its energy supply;
- The use of bioenergy technology would allow society to evolve scientific and technological knowledge, while gaining experience in designing policies to address climate change;
- In general, there is no problem in terms of the technical potential of renewables to deliver energy;
- Bioenergy from biomass can be stored and transported relatively easily in contrast to other renewable options such as wind and solar, which create intermittent electrical power that requires immediate consumption and a connection to the grid;
- Local production of energy and employment may increase immensely, leading to a local economy development;
- By producing bioenergy for domestic purposes, the depletion of natural resources like forests can be drastically reduced, which are otherwise the prominent and traditional source of energy.
- The dependence on forest is removed, leading to an improved environment;
- The amount and intensity of forest fires may be reduced due to the use of the forest fuel as biomass;
- A correct selection of the planted species will allow synergistic increases in food crop yields and decreased fertilizer applications;
- The landscape may improve greatly, once that previously abandoned agricultural areas for energy crops are reused for biomass production;
- The use of bioenergy can help solve some waste issues in some countries, by making the trash work for mankind;
- Space may be gained, once large commercial scale produced residues have a destination other than a waste landfill;
- Industrial residues such as e.g. woody residues can be used as biomass;

- The production of renewable energy and biomaterials is beginning to be a significant source of income for farmers in Europe.

Although several advantages are mentioned, there are also some disadvantages. In what concerns to this aspect, the following issues can be mentioned (European Environment Agency, 2007; International Energy Agency Bioenergy, 2009; Omer, 2008; Omer, A.M., 2008; Ramachandra, 2008; Santos, 2008):

- The inappropriate selection and site matching of species or management strategies can have adverse effects and lead to the degradation and abandonment of land;
- When assessing the biomass potential, one must distinguish between the technical potential, which is the unconstrained production potential limited only by the technology used and the natural circumstances, and the sustainable potential, which further considers a range of environmental and social constraints in order to guarantee sustainable feedstock production. The balance between these two aspects is a difficult one;
- The biogas dissemination programme can have many restraints, namely: technical (lack of quality control in raw materials, water scarcity in dry arid regions and lack of trained manpower); institutional (ineffective repair and maintenance strategy, poor service backup to handle the technical hiccups and delay in the payments); and economical (escalating installation and operation costs, inadequate government support – loans, subsidies – and government programs not reaching the needy).;
- There are too many agencies and organisations at many levels dealing simultaneously with the different aspects of energy;
- The current approach to planning in the energy sector does not offer any significant role to the district or local institutions. Furthermore, the coordination needed between the energy sector and the overall planning and development at the various territorial levels is missing;
- Currently, energy planning is not an integrated activity. Since there are many energy resources and end uses, many organisations and agencies deal with different aspects of energy. Although the forest department carries out forestry planning, only recently has it began to be interested in this recent topic that is biomass and bioenergy use;
- The equipment and infrastructure for energy supply and use are designed with long lifetimes, and the premature turnover of capital stock involves significant costs. Economic benefits may only occur if capital stock is replaced with more efficient equipment in step with its normal replacement cycle;

- Negative impacts on economic growth may only be avoided if energy at an acceptable cost is implemented;
- There are still some technical issues to address in order to cope with the intermittency of some renewables;
- The biggest problem with relying on bioenergy to deliver the necessary cuts in GHG emissions is more to do with politics and policy issues than with technical ones;
- Despite of the vast potential and the several benefits, the contribution from renewable energy still lags behind the ambitious claims for it, due to the initially high development costs, concerns about local impacts, lack of research funding and poor institutional and economic arrangements;
- Because renewable energy sources are stochastic and geographically diffuse, their ability to match demand is determined by the utilisation of a capture area greater than that occupied by the community to be supplied, or the reduction of the community's energy demands to a level commensurate with the locally available renewable resources;
- A major gap with biomass energy is that research has usually been aimed at obtaining supply and consumption data, with insufficient attention and resources being allocated to basic research, to production, harvesting and conservation process;
- Biomass production may be hindered by many problems such as those related to harvesting, collection, and transportation, besides the photo-sanitary control regulations;
- The substantial rise in the use of biomass from agriculture and other sectors for producing transport fuels and energy can put significant environmental pressures on farmland or forest biodiversity as well as on soil and water resources. Consequently, it may counteract current and potential future environmental policies and objectives, such as improving the quality of ground and surface waters or biodiversity protection;
- Local circumstances, pressures and possible solutions should be accounted for;
- Energy crops may compete with food crops;
- The possible particulate matter emission may be detrimental to environmental health;
- Unsustainable forest exploration for biomass may possibly occur, consequently leading to environmental and economical problems;
- Biomass fuel transformation energy is normally fairly low;
- Great amounts of transportation constraints emerge for the biomass;
- Large areas are necessary for biomass cultivation in order for its use to become economically viable.

Analysing the quoted advantages and disadvantages, one should opt cautiously to use one or the other kind of energy source – fossil fuels or bioenergy. Only with this pondered use can the aim of sustainability be achieved in an adequate manner. One has to take into account a large number of factors that influence where one lives, not only the environmental aspect. What good will a certain bioenergy source be to society if it is too expensive or inaccessible to the general public? Several questions such as this have to be asked as to proceed to a secure, better and cleaner future.

## 2.2. The use of bioenergy fuels worldwide

World total annual consumption of all forms of primary energy increased more than ten-fold during the twentieth century, and in the year 2006 it reached an estimated 10.800 Mtoe (Boyle, 2004; U.S. Energy Information Administration, 2009). The world population in 2006 was 6,5 billion (Population Reference Bureau, 2010), so the annual average energy consumption per person was about 1,65 toe. Projections indicate that in 2010, the consumption of this energy may reach 12.800 Mtoe (Boyle, 2004; U.S. Energy Information Administration, 2009) and in 2050 it is expected to achieve a range of 14.300 Mtoe to 23.900 Mtoe (International Energy Agency Bioenergy, 2009). However, major differences may be distinguished between the several countries. The average North American consumes nearly five times the world average, while people in Europe and the former Soviet Union use about half this amount, and those in the rest of the world only about one fifth.

Worldwide, approximately 3 billion people rely on traditional biomass for cooking and heating, and about 1,5 billion have no access to electricity. Up to a billion more have access only to unreliable electricity networks (United Nations, 2010).

In the future, the international community must unite in a common effort to transform the global energy system. Policy-makers and business leaders must also cooperate, where they must place greater emphasis on altering the performance of regional energy systems over the coming decades. The low, middle and high-income countries all face major, although different, transformational challenges, namely (United Nations, 2010):

- *Low-income countries* need to expand access to modern energy services substantially as to cover the needs of the several billion people who experience severe energy poverty in terms of inadequate and unreliable access to energy services and reliance on traditional biomass. This has to be done in a way that is economically viable, sustainable, affordable and efficient, while simultaneously releasing the least amount of GHGs.
- *Middle-income countries* need to face energy system development in such a way that enables them to progressively decouple growth from energy consumption through improved

energy efficiency and reduce energy-related GHG emissions through gradually shifting toward the deployment of low-GHG emission technologies.

- *High-income countries* face unique challenges. As the large infrastructure investments made in the 1960s and 1970s begin to reach the end of their economic lives, they present opportunities to further decarbonize their energy sectors through new investments in lower-carbon generation capacity. Additionally, they will need to reach a new level of performance in what respects to energy use.

The European Commission (EC) predicts that the production of renewable electricity may triple between 2004 and 2020, and that the increase of renewable energies will give way to important environmental benefits, avoiding hundreds of millions of tons of $CO_2$ emissions every year. This increase will impulse the development of new technologies, contributing for the creation of new jobs, innovation and competitiveness increase and help promote economic growth (Agência Portuguesa do Ambiente, 2009).

Currently, according to Eurostat data, the EU's total primary energy consumption from biomass is around 4% (69 Mtoe), making biomass by far one of the most important renewable energy sources, providing two thirds of the total energy produced from renewables (European Environment Agency, 2007). In the future, biomass could sustainably contribute between a quarter and a third of the future global energy mix (International Energy Agency Bioenergy, 2009). However, all countries presently underuse their domestic potential of sustainable bioenergy in a significant manner, and could also use it more efficiently in terms of costs, GHG reduction and social impacts. When taking in account the biodiversity needs and soil sustainability, the potential for extracting biomass residues and wastes in Organisation for Economic Co-operation and Development (OECD) countries is generally around 5-10% of the current overall energy supply. These values mainly depend on the share and structure of the agricultural/forest and food processing sectors, and the waste handling management (International Energy Agency Bioenergy, 2009).

Land availability is a major concern for all countries, but especially for those which export biomass and biofuels. The availability of land and land use are affected not only by bioenergy development, but also by national and global agricultural, food, forest, and trade policies (International Energy Agency Bioenergy, 2009).

This way, we can see that the worlds' energy consumption varies severely from region to region. In all these areas, bioenergy is used at different scales and intensities, being predicted that in the future, the amount of bioenergy may increase immensely. Different steps for different countries need to be taken in order to contribute to this augmentation in bioenergy production.

## 2.3. Characterization of the Centre Region of Portugal

Portugal is geographically located on the European west coast, in the Iberian Peninsula. Is has Spain as boundaries to the North and West and to its West and South, it encounters the Atlantic Ocean. Its frontiers are defined since the XIII century, including, beyond the continental area, the Autonomous Regions of Madeira and the Azores, archipelagos situated in the Atlantic Ocean. With a total area of 92.094 km$^2$, Portugal benefits from its privileged geographic location, being in a geo-strategic position between Europe, America and Africa (AICEP Portugal Global, 2008). The Tagus river divides the continental territory into the north (more mountainous), and south (more flat, with lower relief) areas. The littoral, generally more flat, is distinguished from the inland sloped areas. The higher altitudes are in the mountain range located in the Centre Region of the country. Serra do Açor, Gardunha, Lousã and Estrela compose this mountain range, where the last one, Serra da Estrela, constitutes the culminating element, with a total altitude of 1.993 m. In general, the weather is characterized by soft winters and mild summers. The rainiest months are November and December, while the driest period goes through April to September (AICEP Portugal Global, 2008; Instituto Nacional de Estatística, 2009).

By joining the EU, Portugal was divided into territorial units for statistics (Nomenclature of Territorial Units for Statistics – NUTS), where the country is at NUTS I level, divided into 7 NUTS II territories (Regions), in which the Centre Region of Portugal is included (AICEP Portugal Global, 2008).

The Centre Region of Portugal is divided into 12 NUTS III areas: Baixo Vouga; Baixo Mondego; Pinhal Litoral; Pinhal Interior Norte; Dão-Lafões; Pinhal Interior Sul; Serra da Estrela; Beira Interior Norte; Beira Interior Sul; Cova da Beira; Oeste and Médio Tejo. It occupies a total area of 28.200 km$^2$, 30,6% of the country. All these NUTS III areas comprise a total of 100 municipalities (25,2% of the countries' total) (AICEP Portugal Global, 2008) (Figure 2.2) (Annex 1, Table A1.1).

Its largest municipality is Castelo Branco, with a total area of 1.438,2 km$^2$ and the ones with higher altitude (1.993 m) are Seia, Manteigas and Covilhã. On the other hand, there are several municipalities with altitudes of 0 m, mainly the ones located in the coastal region (Instituto Nacional de Estatística, 2009).

There are several watersheds supplying this region, where the main ones are Douro and Tejo (international watersheds shared with Spain) and Vouga, Mondego, Lis and Amoia (national watersheds). Of the national ones, Mondego is the largest one, with a total area of 6.645 km$^2$ and an extension of 258 km (Instituto Nacional de Estatística, 2009).

In terms of protected areas, there are locations classified in the Natura 2000 network (456.031 ha), as well as protected areas (natural parks, national parks, natural reserves, protected landscapes,

natural monuments and classified sites) with a total area of 198.167 ha (Instituto Nacional de Estatística, 2009). Due to its landscape diversity and architectonic beauty, this region has registered a great development of the touristic activity (AICEP Portugal Global, 2008).

Temperature-wise, the annual mean varied for the different meteorological stations. Annex 2 (Table A2.1) summarizes what happened in 2008 in what regards to the meteorological aspect (Instituto Nacional de Estatística, 2009).

According to the 2001 Census, this region supports a population of 2.371.700 inhabitants, 22,6% of the Portuguese total, with a population density of 83,5 inhab/km$^2$ (AICEP Portugal Global, 2008). In what respects to the municipal urban waste produced in the Centre Region of Portugal, 2006 statistics show that 1.060.968 t of waste was created, from which 71.466 t came from selective collection (Instituto Nacional de Estatística, 2009).

Economically speaking, regional accounts indicators in 2006 and 2007 show that the study region contributed with 19,1% to the national GDP. In 2008, there were slightly more exported goods than imported ones (€ 7.630.410.000 *vs* € 7.058.840.000, respectively), where great part of these goods were exchanged in the EU territory (Instituto Nacional de Estatística, 2009).

Labor market indicators show that in 2008 there was a total unemployment rate of 5,4% (nation-wide, and in the same period, this rate was of 7,6%), from which 46,3% were long-term unemployment as a share of total unemployment (Instituto Nacional de Estatística, 2009).

This is one of the richest regions in Portugal, in terms of forest stands, where the olive groves, pine and eucalyptus trees forest stands are prominent (AICEP Portugal Global, 2008). A huge problem that occurs on a yearly basis are forest fires. These wildfires can be devastating to the rich forest areas that compose the regional landscape. In 2007 and 2008, a total of 4.482 wildfires occurred, having burnt 7.788 ha of land. 12.392 fire fighters were summoned to aid in this fight (Instituto Nacional de Estatística, 2009).

In agriculture, there was a variety of crops planted, ranging from wheat, to rice, to cherries. One that may have notability is the potato crop, having produced a total of 28.470 t in 2008, although the planted area was only of 15.208 ha. On the other hand, the crop with most planted area was maize (34.204 ha), although the total production reached a respectable 174.015 t. More information on these crops can be seen in Annex 2 (Table A2.2). Wine production is also very seen in this region. In 2008, a total of 1.507.444 hl of wine was produced. Olive oil production is also very popular, having produced a total of 144.743 hl of olive oil, from 309 olive oil mills (Instituto Nacional de Estatística, 2009).

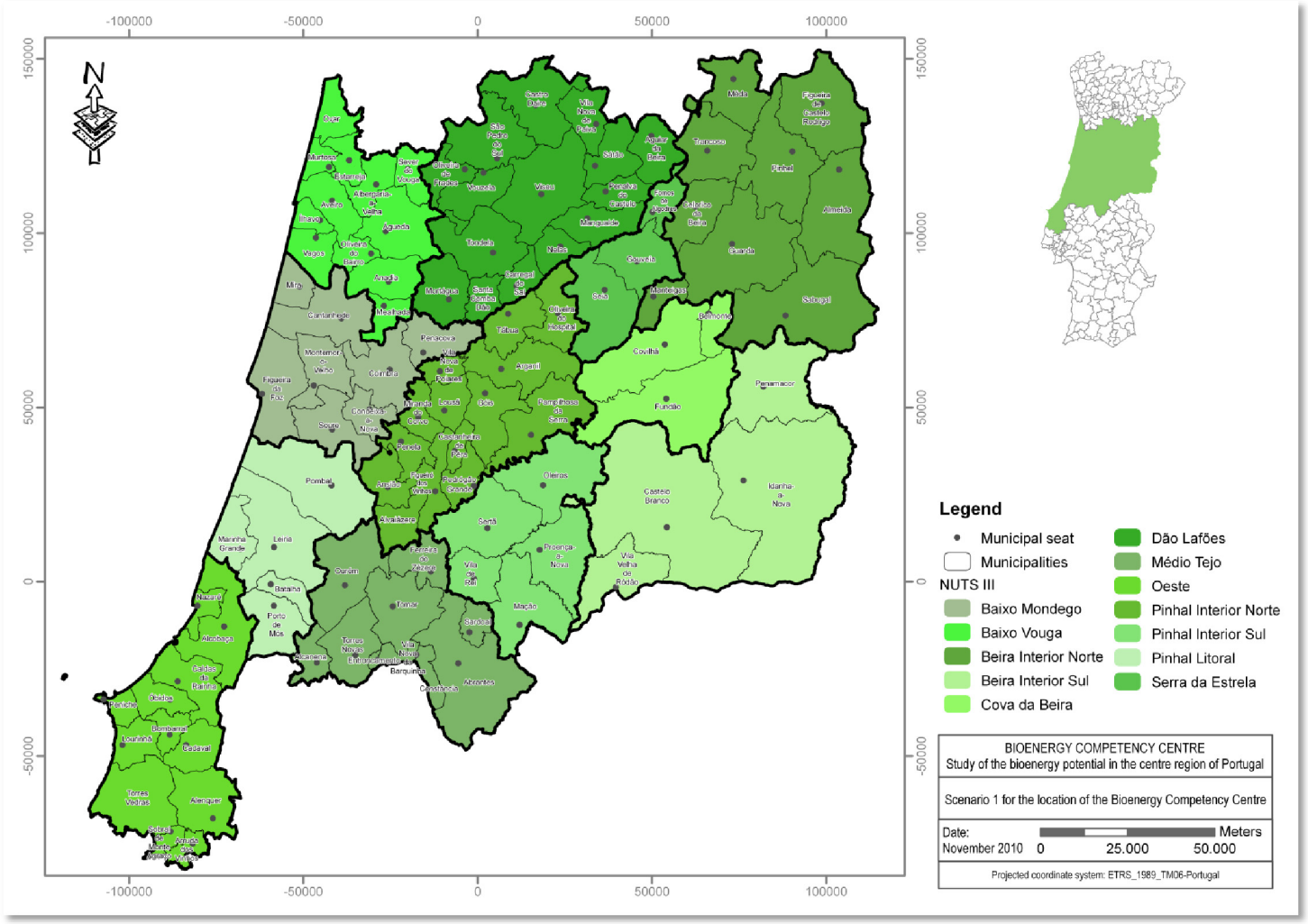


Figure 2.2: NUTS levels of the Centre Region of Portugal.

It has a rich industrial sector, mainly constituted from chemical industries, casting moulds for autos, paper and cellulose, textiles (woolen fabric), ceramics, agro-feeding (dairy, olive oil, meat), vitiviniculture and extracting industries (gold, lead, wolfram and tin). In 2005, it had 4.975 exporting industries, 21,2% of the total of Portugal. In this year (last known year with regional data), it was the only region in which the exportations surmounted the importations, having verified a slight strengthening of the coverage ratio (108%) in comparison with the previous year.

In what respects to energy consumption, and at a regional level, energy consumption can be broken down into the following categories: domestic, non-domestic, industrial, agriculture, lighting of public roads, inner lighting of State/public buildings and others. In 2007, the *industrial* sector is the one that used most energy (547.085,763 toe), in contrast with the *others* sector (12.157,364 toe). The domestic and agriculture sector spent 256.006,696 toe and 25.946,793 toe, respectively. An average inhabitant of the Centre Region of Portugal has a household consumption of electric energy per inhabitant of 0,107 toe, as opposed to the national average of 0,112 toe. As expected, the industrial sector is the one that mostly spends energy per consumer (15,239 toe), whilst the agriculture sector spends 0,201 toe and the domestic uses 0,361 toe (Instituto Nacional de Estatística, 2009).

When it comes to gross production of electricity, a total of 1.387.955,62 toe was produced, having 176.528,05 toe come from wind power, 123.427,47 toe from hydropower and 1.332 toe from photovoltaics. Thermal power was also produced (1.087.998,77 toe), from which 182.571,88 toe came from central cogeneration (Instituto Nacional de Estatística, 2009).

# 3. METHODOLOGY

The present chapter explains the methodology and techniques used to achieve the main goals proposed for this dissertation.

## 3.1. The Bioenergy Potential Map for the Centre Region of Portugal

A primordial step was to join all pertinent information to calculate the amount of the various residues that are passable to be transformed into bioenergy. This extensive research work consisted in using freely available information to the general public, having used no kind of purchased information whatsoever.

### *3.1.1. Input resource collection and treatment*

As mentioned previously, all the data used to create the base information for this map was obtained from several Portuguese organizations that aim to produce both numerical and statistical data for the general public, where great part of the information was obtained from the Portuguese National Institute of Statistics (*Instituto Nacional de Estatística – INE*). In what respects to the date of the available information, the most recent data was preferable in opposed to more dated records; nevertheless, some of the gathered information is rather old, for example, the 1999 agricultural census.

Regarding to the geographical data, only the Official Administrative Map of Portugal (Carta Administrativa Oficial de Portugal – CAOP) was used. The 2010 version can be found in the Portuguese Geographic Institute (Instituto Geográfico Português – IGP) website (Instituto Geográfico Português, 2009). This information uses the European Terrestrial Reference System 89 (ETRS89) coordinate system with a Transverse Mercator projection.

As for the description of the alphanumerical information, it will be made in sections 3.1.1.1. through 3.1.1.7.

The main activities conducted were as follows:

- Information collection: reports, statistics, diagnoses, telephonic contacts; meetings with key informants, namely INE, the Agricultural Regional Service of Beira Litoral (Direcção Regional de Agricultura da Beira Litoral – DRABL), the Portuguese National Forest Authority (Autoridade Florestal Nacional – AFN) and the Nature Conservation

and Biodiversity Institute (Instituto de Conservação da Natureza e da Biodiversidade – ICNB);

- Documental analysis: reading and triage of the relevant information;
- Data treatment.

Multiple information was collected and treated for a variety of sources, namely:

- Forest residue biomass;
- Agricultural residues biomass;
- Energetic cultures;
- Animal husbandry residues;
- Municipal solid waste;
- Used vegetable oils;
- Agricultural and food industries;

#### *3.1.1.1 Forest residue biomass*

In order to determine the forest biomass residue potential, data from the National Forest Inventory (Inventário Florestal Nacional – IFN) from the years 2005-2006 is used. The IFN is an information service provided by AFN, the national forest department, which aims to evaluate and monitor the extension and condition of national forest resources. It provides a series of statistical information on a variety of subjects, such as the evaluation of soil occupation in continental Portugal, forest stand structure analysis, evaluation of the vitality and sanity of the forest stands, as well as temporal analysis of forest modification. All of the provided information is produced from original data, collected in accordance with clearly defined methodologies, and with data collection being based on both aerial photography and field work (Autoridade Florestal Nacional, 2009).

According to this study, the Centre Region of Portugal has the following soil occupation (Table 3.1):

| Soil occupation | Area 1995/98 (ha) | Area 2005/06 (ha) |
|---|---|---|
| Forest | 993.664 | 937.600 |
| Forest shrubland | 590.600 | 668.900 |
| Agriculture | 627.883 | 572.400 |
| Social | 130.500 | 99.700 |
| Interior water | 24.244 | 29.000 |

Table 3.1: Soil occupation in the Centre Region of Portugal (adapted from (Agência Portuguesa do Ambiente, 2008)).

As can be observed by Table 3.1, the area occupied by forest stands has diminished in the past years. Within this forest area, the forest distribution is as follows:

| Forest occupation | Area 1995/98 (ha) | Area 2005/06 (ha) | % |
|---|---|---|---|
| Forest stands | 947.611 | 849.500 | 95 |
| Burned forest stands | 20.882 | 101.100 | 2,1 |
| Clear cutting | 15.032 | 16.700 | 1,5 |
| Other wooded areas | 10.139 | 6.300 | 1,0 |
| **Total** | **993.664** | **973.600** | **100** |

Table 3.2: Forest occupation of the Centre region of Portugal (adapted from (Autoridade Florestal Nacional, 2009)).

### *Bioenergy potential determination for forest stands*

The most disaggregated information was found at the parish level, although municipal information is used in order to comply with the rest of the collected data. As previously mentioned, the information is provided by the IFN report. The necessary information is the areas occupied by the various species whose biomass residues are passable to be used as biofuel. The species taken into consideration are maritime pines, cork oaks, eucalyptuses, holm oaks, Portuguese oak, stone pines, sweet chestnuts, other softwood trees and other hardwood trees.

According to Vieira, *et al* (2006), the residue annual production of the several species is as considered in Table 3.3. Not having found values for the other species, the following considerations are made:

- Portuguese oak, sweet chestnut and other hardwood trees: the residue annual production for these species was an intermediate value of the cork and holm oak species;
- other softwood trees: the same value as the one for maritime and stone pine was considered.

Having these two pieces of information, the amount of residues produced by each and every species in the NUTS III area is calculated:

$$Biomass\ residues\,(kg) = Occupied\ area\,(ha) \times Pr oduced\ residues\,(kg/ha.year)$$

Equation 3.1: Determination of the total biomass residue.

Another value that is needed is the Low Heat Value (LHV). Being water an inevitable combustion product of any fuel, it appears as a steam, and some extra heat can be obtained by cooling and condensing it. When this procedure is not done, the heat output per kilogram is called LHV (Boyle, 2004). This way, different types of woody residues will have different types of LHV, once ones

release more energy than others when combusted. This way, the different LHV values are considered (Vieira, et al., 2006) (Table 3.3):

| Forest stand | Residues (kg/ha.year) | LHV (kcal/kg) |
|---|---|---|
| Maritime pine | 1.060 | 4.000 |
| Cork oak | 1.350 | 3.400 |
| Eucalyptus | 875 | 3.500 |
| Holm oak | 875 | 3.400 |
| Stone pine | 1.060 | 4.000 |
| Portuguese oak | 900 | 3.400 |
| Sweet chestnut | 900 | 3.400 |
| Other hardwood trees | 900 | 3.400 |
| Other softwood trees | 1.060 | 4.000 |

Table 3.3: LHV values and residues per hectare per year for the different types of forest stands.

As before, the values for Portuguese oak, sweet chestnut, other hardwood trees and other softwood trees were not determined. Nevertheless, equal values to the cork and holm oak are considered for the first three types, whereas values equal to both the maritime and stone pine trees are adopted for the other softwood trees.

The next step is to calculate the energy potential in tonne of oil equivalent (toe). According to Portuguese regulation (Despacho n.º 17313/008 de 26 de Junho), 1 toe = 41.868 MJ. Also knowing that 1 kcal = $1x10^{-7}$ toe, we are now able to calculate this parameter:

$$Energy\ \ potential\ (toe) = Biomass\ \ residues\ (kg) \times LHV\ (kcal/kg) \times 1 \times 10^{-7}\ (toe)$$

Equation 3.2: Energy potential for a given residue from kcal/kg LHV unit.

If the LHV value is given in kJ/kg, and knowing that 1 kJ = $2,39x10^{-8}$ toe, the following calculation should be done:

$$Energy\ \ potential\ (toe) = Biomass\ \ residues\ (kg) \times LHV\ (kJ/kg) \times 2,39 \times 10^{-8}\ (toe)$$

Equation 3.3: Energy potential for a given residue from kJ/kg LHV unit.

Results for each one of the forest type residues are present in Annex 3 (Table A3.1 to A3.9; Figures A3.1 to A3.9).

*Bioenergy potential determination for burned areas*

In order to determine the bioenergy potential from burned areas, the total burned areas from the years from 1999 and 2009 is collected and analysed. For the production of the map, only 2009 values are used. This data is facilitated by the Portuguese National Forest Authority (AFN).

The respective information can be consulted in Annex 3 (Table A3.10).

With this information, the energy potential is calculated, by taking into account that a burned area produces roughly 5.000 kg/ha/year, according to Vieira, *et al* (2006). As done previously with the forest stand biomass residue (Equation 3.1), this value is multiplied by the amount of residue produced by each municipality, where we attain the total amount of biomass residues from burned area per municipality.

Knowing that the LHV for these types of residues is 4.780 kcal/kg (Vieira, et al., 2006), the potential energy value can be calculated as before (Equation 3.2).

The results can be viewed in Annex 3 (Table A3.11 and Figure A3.10).

*Bioenergy potential determination for shrublands*

Forest shrublands represent a large amount of area in the Portuguese terrain. The obtained data of these areas is determined at a municipal level and is facilitated by the IFN 2005-2006 database (Autoridade Florestal Nacional, 2009). The total occupied areas are determined for each and every municipality and, knowing that that these areas produce around 4.000 kg/ha/year (Vieira, et al., 2006), the total biomass value can be estimated (Equation 3.1). With a LHV of 3.344 kcal/kg (Vieira, et al., 2006), the potential energy value can be calculated as indicated in Equation 3.2.

These intermediate and final values can be viewed in Annex 3 (Table A3.12 and Figure A3.11).

#### *3.1.1.2 Agricultural residue biomass*

The calculation of the bioenergy potential for residues from agricultural infra-structures is done by using the temporary and permanent crops with most expression in the Centre Region of Portugal. The main base data that is used is the one from the 1999 General Agricultural Census (Recenseamento Geral da Agricultura – RGA, 1999) (Instituto Nacional de Estatística, 2001), a municipality levelled census that collected in 1999 the agricultural information of various types, such as the structure of the agricultural establishments and their economic dimension, the way they use their lands, their livestock and their machines and equipments, characterization of the labour

force and the agricultural population, the characteristics of the agricultural producers and the origin of their income (Instituto Nacional de Estatística, 2001; Instituto Nacional de Estatística, 2001). Although this information is rather aged, it is the most recent statistical publication presently available. The 2009 version of this census is currently in the making and is expected to be published in a few months.

In this study several kinds of agricultural residues are taken into consideration (Table 3.4).

| | | |
|---|---|---|
| **Permanent crops** | Fresh fruit | Apple, pear, peach, quince, cherry and plum trees, and other fresh fruit trees of minor expression (except citrons). |
| | Citron | Orange, lemon and tangerine trees, and other citron trees of minor expression. |
| | Nut | Almond, chestnut, walnut and hazel trees, and other nut trees of minor expression. |
| | Vineyard | Total of vineyards and vineyards mixed with other crops. |
| | Olive grove | All olive trees, for olive oil and table olives. |
| **Temporary crops** | Maize | Total areas of these cereal crops. |
| | Wheat | |
| | Barley | |
| | Rye | |
| | Sorghum | |
| | Oat | |
| | Rice | |

Table 3.4: Agricultural residues types for permanent and temporary crops.

### *Agricultural residues from permanent crops*

These crops are analysed one by one, where for each and every crop the occupied area value (ha) is collected, as aforementioned, from the 1999 RGA. Knowing how many residues (kg/ha.year) are produced by tree pruning (assuming a mean of 100 trees per hectare for fresh fruit, citron and nut trees; 2500 vines per hectare; and 50 olive trees per hectare with 6 or 7 years pruning) (Vieira, et al., 2006), the total amount of biomass is calculated (Equation 3.1). Having in attention the LHV values considered by Vieira, *et al* (2006) (Table 3.5), the total bioenergy potential is calculated for every permanent crop (Equation 3.3).

| Permanent crop | Residues (kg/ha.year) | LHV (kJ/kg) |
|---|---|---|
| Fresh fruit | 60 | 14.654 |
| Citron | 30 | 14.654 |
| Nut | 40 | 14.654 |
| Vineyard | 875 | 17.794 |
| Olive grove | 40 | 18.118 |

Table 3.5: LHV values and residues per hectare per year for the different types of permanent crops.

These results can be seen in Annex 4 (Table A4.1 to A4.5 and Figure A4.1 to A4.5).

*Agricultural residues from temporary crops*

The information from agricultural residues from temporary crops, just like the permanent ones, is collected from the 1999 RGA. The level of information for the considered crops (maize, wheat, barley, rye, sorghum, rice and oat) crops is at a municipal level.

Just as before, Equation 3.1 is used to calculate the amount of biomass (kg) produced annually per hectare. In order to calculate this amount, the following consideration is taken (Mourad, et al., 2004; Vieira, et al., 2006) (Table 3.6):

| Temporary crop | Residues (kg/ha.year) | LHV (kJ/kg) |
|---|---|---|
| Maize | 1.420 | 16.295 |
| Wheat | 1.420 | 17.112 |
| Barley | 1.420 | 16.144 |
| Rye | 1.420 | 16.144 |
| Sorghum | 1.420 | 16.295 |
| Oat | 1.420 | 16.550 |
| Rice | 1.315 | 16.295 |

Table 3.6: LHV values and residues per hectare per year for the different types of temporary crops.

Using LHV values considered by Vieira, *et al* (2006) and by using Equation 3.3, the final bioenergy potential values can be assessed.

Results are visible in Annex 4 (Tables A5.6 to A5.12; Figure A5.6 to A5.12).

#### *3.1.1.3 Energy crops biomass*

For the determination of the biomass of the energy crops, specific crops are considered as to maximize the collected energy yield in the Centre Region of Portugal. The amylaceous cereals that are thought to produce more energy are: maize, wheat, barley, rye and sorghum. Also potato and sugar beet crops are considered to be very energetic. Some oleaginous crops can also be considered, such as sunflower, rape seed and soy. But for this study, only sunflower crops were used, once the other two don't have much expression in the study area. The first kinds of crops are more specific to produce bioethanol, whilst the second are essentially used to produce biodiesel.

Once it would compete with food production, the total production of these crops isn't really viable to be used as a bioenergy resource, where the estimated potential should be reasonable when considering the present country's scenario for these crops.

In order to do so, the evolution of the Portuguese agriculture was analysed in the past two decades. According to a study done by INE (Instituto Nacional de Estatística, 2007), we can find that the country's Used Agricultural Area (Superfície Agrícola Utilizada – SAU) has been reduced

due to the abandonment of the agricultural activity. With data from the reduction of the SAU, the rate of reduction relative to the year of 1989 was calculated (Table 3.7):

| | 1989 | 1993 | 1995 | 1997 | 1999 | 2003 | 2005 | 2007 |
|---|---|---|---|---|---|---|---|---|
| SAU (ha) | 4.005.594 | 3.949.548 | 3.924.623 | 3.822.127 | 3.863.116 | 3.725.190 | 3.679.587 | 3.472.985 |
| Reduction rate relative to 1989 (%) | - | -1,4 | -2,0 | -4,6 | -3,6 | -7,0 | -8,1 | 13,3 |

Table 3.7: SAU reduction rate, having 1989 into account (adapted from (Instituto Nacional de Estatística, 2007; Instituto Nacional de Estatística, 2009).

From Table 3.7, we can see that the SAU has been reducing considerably along the years, where in 2007 the reduction rate achieved a staggering 13,3%. Taking this fact into consideration, it could be reasonable to assume that each crop area has reduced 13,3%. This way, we can also presume that that abandoned area is available to be dedicated to the aforementioned energy crops.

*Amylaceous crops*

Therefore, we can now calculate the bioenergy potential for amylaceous crops for the Centre Region of Portugal. Once again, the base data to use is from the 1999 RGA. By using the base data, 13,3% of the area is calculated, so that it can be multiplied by the productivity values obtained from Mateus (2006). These values have to be manipulated, once the information is not disaggregated by NUTS III area, but by Agricultural Region. This way, the Baixo Vougo, Baixo Mondego, Dão-Lafões, Pinhal Interior Norte and Pinhal Litoral sub-regions are considered as having the same productivity as the Beira Litoral Agricultural Region. The Beira Interior Norte, Beira Interior Sul, Cova da Beira, Pinhal Interior Sul and Serra da Estrela sub-regions have the same productivity value as the Beira Interior Agricultural Region. As for the Oeste and Médio Tejo NUTS III, the same productivity is considered as for the Ribatejo e Oeste Agricultural Region.

By multiplying these two values, the estimated production (kg) is obtained. According to the report created in 2005 by the Agriculture, Rural Development and Fishery Portuguese Ministry (Ministério da Agricultura, do Desenvolvimento Rural e das Pescas – MADRP) (Ministério da Agricultura, do Desenvolvimento Rural e das Pescas, 2005), different bioethanol energy conversion indexes for each crop type are considered. By using these values and multiplying them by the estimated production, we obtain the estimated potential for bioethanol production (l) for each municipality.

Knowing that 1l of bioethanol obtained from biomass corresponds to 21MJ (European Parliament and of the Council, 2009), the total amount of energy potential for energy crops (toe) can be calculated.

These calculations and respective results can be seen in Annex 5 (Tables A5.1 to A5.7; Figure A5.1 to A5.7).

*Oleaginous crops*

Oleaginous crops have a similar energy potential calculation as the latter crop type.

The base information was also from the 1999 RGA report at a municipality scale. This information was once again multiplied by 13,3%, which gave us the estimated area. Multiplying this result with the mean productivity value obtained from the 2006 crop production yearbook (GPP - Direcção de Serviços de Estatística, Metodologia e Estudos, 2006), the estimated production (kg) results. According to MADRP (2005), the energy conversion index for oleaginous crops is 400 l/kg. This value was multiplied by the estimated production and resulted in the estimated potential for biodiesel production (l) for each one of the study areas.

Taking into account that 1l of biodiesel obtained from vegetable oil corresponds to 33 MJ/l (European Parliament and of the Council, 2009), the total amount of energy potential for energy crops (toe) could be calculated (Annex 5 - Table A5.8; Figure A5.8).

#### *3.1.1.4 Energy potential from animal husbandry effluents*

For the animal husbandry topic, bovine, swine and poultry farming are considered to determine the energy potential. Only intensive farming infra-structures can be considered, otherwise it is very difficult, even impossible, to benefit from these excrement resources. The considered excrements are from dairy cattle, swine intensive breeding, as well as laying and breeding hens.

The excrements of each one of these animals have different daily biogas production rates, namely:

| Animal | Body weight (kg) | Daily excretion in proportion to its body weight (%) | Excretion (kg/day) | Total Solids (TS) (%) | Volatile solids (VS) (% of TS) | Biogas Yield (m3/kg VS) | Biogas ($m^3$/day.animal) |
|---|---|---|---|---|---|---|---|
| Bovine | 200 | 5 | 10 | 8,5 | 80 | 0,25 | 0,17 |
| Swine | 50 | 10 | 5 | 5,5 | 75 | 0,375 | 0,077 |
| Poultry | 1,5 | 4,5 | 0,0675 | 20 | 75 | 0,475 | 0,005 |

Table 3.8: Biomass for each animal type (adapted from (Steffen, et al., 1998; Werner, et al., 1989)).

### *Poultry effluents*

For poultry effluents energy potential, the 1999 RGA laying and breeding hens information is used. This document presents the number of farms and livestock in the centre region of Portugal. Knowing how many animals are available, as well as the amount ($m^3$) of biogas produced per animal on a daily basis, the amount of yearly produced biogas is known. With this value, the potential energy amount in toe can be calculated, by assuming the biogas LHV to be 21.600 $kJ/m^3$ (Mateus, 2006).

Results are visible in Annex 6 (Table A6.1; Figure A6.1).

### *Bovine effluents*

As the previous item, the bovine livestock base data for dairy cattle is also obtained from the 1999 RGA. With this information, it can be possible to calculate the amount of biogas ($m^3$) produced per animal daily. Having obtained this value, the energy potential (toe) can be estimated, taking in to consideration that the biogas' LHV is 21.600 $kJ/m^3$ (Mateus, 2006).

The resulting table can be seen in Annex 6 (Table A6.2; Figure A6.2).

Note that the viable harnessing of this type of energy for bovine effluents is only for farms with more than 50 animals (Ministério da Agricultura, do Desenvolvimento Rural e das Pescas, 2005). This way, the potential energy obtained is only theoretical, once that these values refer to the total of livestock in the municipality.

### *Swine effluents*

The number of swine in the centre region of Portugal was determined by the 1999 RGA. After this analysis, the amount of biogas ($m^3$) produced on a daily basis can be calculated. With this value, and considering that the LHV for biogas is 21.600 $kJ/m^3$ (Mateus, 2006), the potential energy potential (toe) can be estimated (Annex 6 - Table A6.3; Figure A6.3).

As for the bovines, harnessing of energy from swine effluents is only considered viable for farms with more than 200 pigs (Ministério da Agricultura, do Desenvolvimento Rural e das Pescas, 2005). As mentioned before, the potential energy obtained is only theoretical, once that these values refer to the total of livestock in the region.

#### *3.1.1.5 Energy potential from Municipal Solid Waste*

Municipal solid waste is a rich source for bioenergy. The waste generated at a municipal level can be transformed to produce bioenergy in various forms. For this study, the production of biogas from landfills, the direct combustion of the inorganic part of this waste and organic valorisation are considered.

In Annex 7 (Table A7.1), a table summarizes the amount of MSW collected per municipality, emphasizing the amount of waste that goes to recycling and that is organically valorised (practice used in only a few municipalities). Also notice that, according to INE statistics, no kind of energy valorisation of waste was done whatsoever in the Centre Region of Portugal. Being so, this parameter is not considered in this study.

This information is collected from the INE services, having used information relative to the year 2005.

*Landfill biogas*

During its decomposition and due to anaerobic processes, landfill waste produces a large amount of biogas. According to a methodology referred by Vieira, *et al* (2006), it is considered that the organic fraction of 1 tonne of MSW can, theoretically, generate a total of around 400 $m^3$ of biogas. In practice, we see that the degradation of more that 25% of that fraction is rare during the first fifteen years. The acquired experience allows us to consider that around 5 to 7$m^3$ of biogas can be obtained per tonne of MSW per year, during the first fifteen years. For this study, a value of 6 $m^3$/t.year is considered.

Taking into account the 2005 values obtained from the INE services, we know the amount of waste that is deposited in the landfills. By multiplying this value by the yearly amount of biogas produced per tonne (6 $m^3$/t.year), we obtain the total amount of biogas ($m^3$) that is produced every year per municipality. Knowing that the LHV value for landfill biogas is around 17.900 kJ/$m^3$ (Vieira, et al., 2006), the energy potential (toe) can be estimated (Annex 7 – (Table A7.2; Figure A7.1))

*Organic valorisation*

For the Centre Region of Portugal, the valorisation process that is presently used in most of the municipal associations for MSW disposal is generally composting. However, in the near future, four of the six waste management entities will transform their present organic treatment system into anaerobic digestion. From the two that aren't going to change their organic valorisation process,

one municipal association is going to re-structure soon and, possible plans for change may come with the new management. This way, and for this study, we will assume the future tendency and consider that all entities use anaerobic digestion and have energy harnessing technology that allows the biogas to be transformed into energy.

By using INE values from May 2007, the amount of residues that are used for organic valorisation is collected in tonnes. According to Alves, *et al.*, (2003), this technology has an average production of 100 to 150 $m^3$ of biogas per tonne of treated residue. For this study, an average value of 125 $m^3/t$ is considered. This way, by multiplying the amount of produced organic residue by the previously determined value, the yearly amount of produced biogas by anaerobic treatment is obtained ($m^3$/year). According to the same authors, the LHV for biogas from anaerobic combustion is 20 to 25 $MJ/m^3$. For this study, 22.500 $kJ/m^3$ is used. With this information, the final value of energy potential in toe may be obtained.

Results can be seen in Annex 7 (Table A7.3; Figure A7.2).

### *Direct combustion*

Some residues in MSW are not passable to be anaerobically digested. This way, direct combustion may be used to incinerate the inorganic part of the MSW. Taking into account that the typical composition of the MSW in Portugal is as stated in Table 3.9, the average composition of the MSW for each municipality can be estimated, as well as its energy potential (toe).

The materials considered for direct combustion are paper/cardboard, plastic, textile, fine matter and other material. By multiplying the percentage presented in the previous table of the respective material with the total values deposited in the landfill, we obtain the total amount of that material in the landfill that is passable to be combusted. Knowing that the LHV for paper/cardboard is 10.722 kJ/kg, for plastic is 23.643 kJ/kg, for textile is 7.827 kJ/kg, for fine matter is 13.593 kJ/kg and other material is 23.151 kJ/kg (Vieira, et al., 2006), the energy potential (toe) resulting from this combustion can be calculated.

Results are available in Annex 7 (Table A7.4; Figure A7.3 to A7.7).

| Component | % |
|---|---|
| Organic matter | 35,9 |
| Paper/cardboard | 23,7 |
| Plastic | 11,1 |
| Glass | 5,5 |
| Textile | 3,4 |
| Metal | 2,4 |
| Wood | 0,3 |
| Fine matter | 12,0 |
| Other material | 5,7 |

Table 3.9: Average composition of municipal solid waste in Portugal (Agência Portuguesa do Ambiente, 2008).

#### *3.1.1.6 Energy potential from Used Vegetable Oils*

To determine this potential, the amount of used vegetable oils (UVO) produced per municipality was analysed. According to a study done in 2004 by a private company named Environmental Innovation and Projects, Ltd (Inovação e Projectos em Ambiente, Lda – IPA), ordered by the then Waste Institute (Instituto de Resíduos – INR) (IPA -Inovação e Projectos, Lda, 2004), the yearly average per capita value in Portugal is 19,89 kg.

INE information about the population of the Centre Region of Portugal is only available until 2007 until the conclusion of this study. This way, knowing the population number in each municipality, we can multiply it by the average per capita of oil production above mentioned. This will give us the consumption per inhabitant per year in tonnes (t/inhab.year).

According to IPA (2004), from the totality of UVO produced, only 45% are actually considered as waste, once that, from the totality, 30% are incorporated in the food and the other 15% are losses (leaks, oil absorbed in paper filters, etc.). So, the consumption value previously calculated will be multiplied by 45% as to attain the amount of the actual oil waste amount (t/year).

Also taking into consideration the case study done on a Used Vegetable Oil Valorisation Unit (DieselBase – Energias Renováveis, Lda) (Rodrigues, 2006), from the total of the collected raw material only 60 – 70% of the oil is the amount that can actually suffer transesterification, once that the remaining material is water and residues withdrawn at the pre-treatment process. This way, we consider an average value of 65%, which is multiplied by the amount of the actual oil waste amount, obtaining the real amount of oil that can be transformed into biodiesel (t/year).

Rodrigues, Felizardo and Gomes (Rodrigues, 2006; Felizardo, 2003; Gomes, 2006) consider an average value of oil transformation into biodiesel yield of 95%, 62 – 92% and 77%, respectively. All these values are rather close together, so the biodiesel yield production value considered in this study is 77%, once that is seems like an intermediate value of all the consulted bibliographical

information. By multiplying the previous value by 77%, we obtain the amount of biodiesel produced per year in each municipality (t/year).

The latter value is transformed, so that it can be measured in toe to be comparable to other values. In order to do so, we use the LHV information referred in the Portuguese regulation document (Despacho n.º 17313/008 de 26 de Junho), 0,645 toe/t, and multiply it by the previously obtained value.

The resulting table can be seen in Annex 8 (Table A8.1; Figure A8.1).

#### *3.1.1.7 Energy potential from Agricultural and Food Industries*

For the determination of this potential, solid wastes from olive oil and wine mills are considered, once they are activities with great expression in the study area. In the first case, the estimate is based on the main produced waste of this activity, olive press-cake; while in the second case, the grape stems of when the grape is transformed into wine is the targeted residue.

##### *Olive oil production (olive press-cake)*

The first step is to verify how much produced olives and olive oil for each municipality of the Centre Region of Portugal, information which is retrieved from the then National Institute of Intervention and Agriculture Guarantee (Instituto Nacional de Intervenção e Garantia Agrícola – INGA), where the most recent available information is from the 2005/2006 campaign. This institute is now extinct, having dissolved into the Financing Institute for Agriculture and Fishery (Instituto de Financiamento de Agricultura e Pescas – IFAP). Beyond several other tasks, this Institute aims to validate and finance the several measures defined on a national and community level in what respects to agriculture, rural development, fishery and related sectors, reassuring an effective and rational management of the available resources (Instituto de Financiamento de Agricultura e Pescas, 2010).

In olive oil production, the secondary product olive press cake is created. This material is constituted from the olive pips, pulp and tegument of the fruit. This is the material which can be used for the production of bioenergy by combustion. Having the base information established, we can now determine the amount of olive press cake that is produced. According to a study realized in the Alentejo region, the amount of residue produced for each 100 kg of produced olives can vary, depending on the type of processing that exists in each olive press industry (traditional press system – 40 kg; two phased continuous system – 70 kg; three phased continuous system – 55 kg) (Freitas, 2007). Due to the difficulty involved in knowing which type of system exists in each and

every olive press in the Centre Region of Portugal, the value 40kg of olive press cake per 100 kg of produced olive is taken into consideration (i.e., 0,4 kg of olive press per kg of produced olive). This way, we can multiply the amount of produced olives with 0,4 kg. Knowing the LHV for olive press cake, 3.700 kcal/kg ( (Freitas, 2007), the value of potential energy can be calculated.

The results can be seen in Annex 9 (Table A9.1; Figure A9.1).

*Wine production (grape stems)*

Like the previous case, wine production also produces a residue of great value for bioenergy production. The 1999 RGA made the municipal values of wine production available. Having these values, the amount of gape stems can be calculated. Knowing that each hectare of vineyard origins around 250 kg of grape stems, the total amount of vineyard area was multiplied by 250 kg. Also taking into consideration that the LHV for grape stems is of 5.000 kcal/kg, the amount of potential bioenergy can be calculated.

The previous calculations can be seen in Annex 9 (Table A9.2; Figure A9.2).

### *3.1.2. Multicriteria decision analysis for bioenergy potential*

It is thought that 80% of the data used by managers and decision makers is somehow related to a geographical level. Decisions that involve geographical data are referred as to *geographical* or *spatial decision problems.* Normally, the input data is undigested unorganized and unevaluated material that can be processed to obtain information. In fact, data is of very little value for itself. To have some kind of significance, it must be transformed, organized, presented, analyzed and interpreted. The process of creating information adds extra value to the original data. As subsequent stages of the decision-making process, the original data is interpreted and analyzed to produce information useful to decision makers, once that successful decision making depends on the quality and quantity of information available to decision makers (Malczewski, 1999).

Accordingly, geographical information can be defined as georeferenced data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in the decision-making process (Malczewski, 1999). Spatial decision problems typically involve a large set of feasible alternatives and multiple, conflicting and incommensurate evaluation criteria, in which some are of the qualitative nature, while others may be quantitative (Malczewski, 1999; Malczewski, 2006). In order to solve these types of problems, multicriteria decision making can be a process to be adopted.

Multicriteria decision making problems involve a set of alternatives that are evaluated on the basis of conflicting and incommensurate criteria. In the spatial domain, it requires an articulation of the decision makers objectives and an identification of attributes useful for indicating the degree to which these attributes are achieved (Malczewski, 1999). The resulting alternatives are often evaluated by a number of individuals (decision-makers, managers, stakeholders, interest groups). These alternatives are normally characterized by unique preferences with respect to the relative importance of criteria on the basis of which the alternatives are evaluated (Malczewski, 2006).

Multicriteria analysis is a set of mathematical tools and methods allowing the comparison of different alternatives according to many criteria, often conflicting, to guide the decision maker towards a judicious choice. Multicriteria methods are used in spatial context to evaluate and compare spatial decision alternatives, often modelled through constraint-based suitability analysis and represented by point, line, and polygon features or their combination, and evaluated on several space-related criteria, to select a restricted subset for implementation (Chakhar, et al., 2008). This type of analysis grants a rich assortment of techniques and procedures for structuring decision problems, and designing, evaluating and prioritizing alternative decisions (Malczewski, 2006). The integration of multicriteria decision management techniques with GIS has considerably advanced the conventional map overlay approaches to the land-use suitability analysis (Malczewski, 2004).

Since the early 1990s, multicriteria analysis has been coupled with geographical information systems (GIS) for an enhanced spatial multicriteria decision making (Chakhar, et al., 2008). This way, a GIS-based multicriteria decision analysis can be thought of as a process that transforms and combines geographical data and value judgments (the decision-makers preferences) to obtain information for decision making, where its capability to perform an integrated analysis of spatial, aspatial and attributes data are key (Malczewski, 2004). By allying these two components, the ability of classic multi-layered analysis and process based models has significantly improved (Svoray, et al., 2010). Accordingly, two considerations of critical importance have to be given for spatial multicriteria decision management: (i) the GIS capabilities of data acquisition, storage, retrieval, manipulation and analysis, and (ii) the multicriteria decision management capabilities for combining the geographical data and the decision makers preferences into unidimensional values of alternative decisions (Malczewski, 2004).

GIS can be used not only for automatically producing maps, but it is unique in its capacity for integration and spatial analysis of multisource datasets such as data on land use, population, topography, hydrology, climate, vegetation, transportation network, public infrastructure, etc. (Malczewski, 2006; Malczewski, 2004). It may be applied in a wide variety of situations, such as ecological approaches for defining land suitability/habitant for animal and plant species, geological

favourability, suitability of land for agricultural activities, landscape evaluation and planning, environmental impact assessment, selecting the best site for the public and private sector facilities, and regional planning, where the aim is to explicitly identify the boundary of the best site (Malczewski, 2004). It works by subdividing the study area into a set of basic unit of observations such as polygons (areal units) or rasters. It involves classification of the units of observations according to their suitability for a particular activity, where the analysis defines an area in which a good site might exist. The explicit site search analysis determines not only the site suitability but also its spatial characteristics such as its shape, contiguity, and/or compactness by aggregating the basic units of observations according to some criteria (Malczewski, 2004).

ArcInfo software and its numerous extensions provide GIS capabilities to aid in GIS-based multicriteria decision analysis, such as data input, store, management, manipulation and analysis, and output (Malczewski, 2004). This software is designed to work with data that is referenced by spatial or geographic coordinates. The outputs reveal the spatial patterns that cannot be visualized by conventional methods (e.g., tables and histograms) and it is able to integrate common database operations (query and statistical analysis) with spatial data, characteristic that mainly distinguishes them from other information systems, making it valuable to a wide range of public and private enterprises for planning strategies and managing infrastructures in a region (Ramachandra, 2008). This software's capabilities are used for generating criterion maps and for identifying the set of feasible solutions (Malczewski, 2006). For this study, GIS software tool *ArcInfo 9.3,* produced by *ESRI* is used.

For the present study the data described in 3.1.1. is integrated into a geographic database. As referred, by using GIS technology, important results can emerge in order to visualise information that was initially difficult to perceive.

In particular, the *ModelBuilder* application of the software is used to create the model to process the input data. It is a geoprocessing tool that allows us to chain together sequences of tools, feeding the output of one tool into another (ESRI, 2010).

Several key processes are used. In general data is mostly treated the same way, by using the *dissolve*, *feature to raster, weighted sum* and *divide* tools. A short description of each one will be made subsequently.

The *merge* tool, combines input features from multiple input sources (of the same data type ) into a single, new, output feature class. The input data sources may be point, line, or polygon feature classes or tables (ESRI, 2010). For the present study, all input data is of the polygon type.

The *dissolve* tool aggregates features based on specified attributes (ESRI, 2010). Due to the fact that the previous tools created an input with several fields with the same value (e.g., several "Aveiro" fields), this information has to be summed up into one unique field.

The *feature to raster* tool converts input features into raster format (ESRI, 2010). This is to be able to use the next tool, *weighted overlay*. This allows us to overlay several rasters using a common measurement scale and weights, each according to its importance (ESRI, 2010).

At last, the *divide* tool allows us to obtain the amount of energy potential per area, by dividing the values of two rasters on a cell-by-cell basis (ESRI, 2010).

The ranges of values for each final and intermediate result are obtained using natural breaks (Jenks). ArcGis 9.3 Desktop Help describes that the classes are based on natural groupings inherent in the data. The software identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. The features are thus divided into classes whose boundaries are set where there are relatively big jumps in the data values (ESRI, 2010).

Combining the input data and the referred tools as shown in Annex 10 (Figure A10.1) will allow us to create a final output for the total bioenergy potential for the Centre Region of Portugal.

Intermediate results may also be saved, as to understand how each and every input party influences the final results. This information may also be consulted in Annex 10 (Figures A10.2 to A10.8 ).

## 3.2. Location of the Bioenergy Competency Centre

The Bioenergy Competency Centre (BCC) will not produce energy itself. Rather, it will have several critical functions for the further development of the bioenergy production area. In general, it is thought to constantly manage and update information produced in the first section of this work (evaluation of the bioenergy potential for the Centre Region of Portugal), and study the costs of production/collection and processing of the materials needed for the production of bioenergy, as well as the definition of the threshold of economic viability for this production. Its tasks shall also include product certification, research, development and innovation, consultancy, training and trials.

This Centre will have a logical integrated network with the main stakeholders in the Centre Region of Portugal, as to maximize the profitability of the various laboratorial, management and economical infra-structures and available knowledge. Information flow will be key in this organism's work processes.

The target group range of the BCC is varied, although it may be divided into three major groups: the first group is mainly connected to the production of raw materials (producers); the second group is focused on the enterprises that are dedicated or are interested in investing in the development of bioenergy production; and a third group aimed for the end users/consumers.

In the first group, the producers or raw materials origins are to be included, as aforementioned. These include sources such as: energy cultures, food organic waste, industrial organic waste, agricultural organic waste, forest organic waste, etc. This way, several types of entities can be included, such as agricultural and forest producers and their respective associations, industrial units that produce organic waste, canteens, municipal halls, waste collection companies and other producers of organic waste.

The second group includes some existing and future projects in Portugal, which include all those who intend to produce energy from renewable sources and that need assistance in doing so, particularly the ones located in the Centre Region of Portugal.

The third group integrates all the consumers, the Region and even the country. These will benefit from the existence of a structure that will guarantee that the products and the production processes based on renewable energies are done in accordance to norms that safeguard the security of the users and the equipments or vehicles. Besides, the BCC will guarantee that the products are in fact beneficial in what respects to the environment, translating themselves as an added benefit for the Region and the country, further developing the clean energy cluster. It will also allow to enhance Research, Development and Innovation in areas that have significant margin for expansion, seeking to accompany and not let go of an area that has gained increasing importance with the mounting rarefaction of other energy sources and the negative effects that are provoked by them.

Taking into consideration all the important functions that were previously described and that will be undertaken, the implementation for the location of the BCC is of utmost importance. Acknowledging the significance of its activities, it should be in a location that is of easy access to all the stakeholders.

### *3.2.1. Input resources*

For the implementation of the BCC, several suppositions have to be taken into consideration, some of common sense and others of environmental and legal restraints. As before, all the used information is freely available to the general public. Both alphanumerical and geographical information is used as to achieve the best possible results. This information is collected from

several national and international institutes, particularly the ones such as the ICNB (Instituto da Conservação da Natureza e da Biodiversidade, 2005), the Army Geographic Institute (Instituto Geográfico do Exército – IGeoE) (Instituto Geográfico do Exército, 2010), the Portuguese Geographic Institute (Instituto Geográfico Português – IGP) (Instituto Geográfico Português, 2009) and the CGIAR-Consortium for Spatial Information, (CGIAR – CSI) (CGIAR - Consortium for Spatial Information, 2008). Table 3.10 resumes the used geographical information and for what it is used for. Additionally, for the use of the Natural Gas Transport Network, the jpeg image available on the National Electric Network (Rede Eléctrica Nacional – REN) site is used as an input source to georeference this information for GIS use (REN, 2010).

Some alphanumerical information is also turned into geographical data, such as the location of existing and future biomass power plants in the Centre Region of Portugal. A list of these power plants is obtained from APREN (2010).

| Geographical data | Author | Use | Observations |
|---|---|---|---|
| National Network of Protected Areas, Site of Community Importance, Special Protection area | ICNB | Existing protected natural areas. | - Shapefiles. |
| Corine Land Cover 2006 for Portugal | IGP | Land use. | - Shapefile.<br>- Minimum mapping unit of 25 ha and a nomenclature with 44 classes. |
| Itinerary map for Portugal | IGeoE | Roads | - Original DGN file.<br>- Scale 1/500.000.<br>- Posterior transformation into featureclass with road information. |
| SRTM Digital Elevation Data | CGIAR – CSI | Slope calculation | - Raster.<br>- 90m pixel. |

Table 3.10: Main geographical information used for the location of the BCC.

### *3.2.2. Multicriteria decision analysis for the BCC implementation*

The use of the *ArcInfo* 9.3 *ModelBuilder* functionality is once again a valued resource to build this tool (Annex 11 – Figure A11.1).

In general, all the input information is at one point classified into five different classes, being 1 the least preferable condition and 5 the most preferable condition.

As mentioned previously, all road information from the IGeoE Itinerary map is retrieved and inserted into the prepared geodatabase as a line featureclass, having determined four types of main roads: high-ways; main and complementary routes; grade-separated roads; and main and secondary municipal roads. Three approaches for the use of this information are used.

For the first approach, the idea is to express and translate the importance of the types of roads that exist in each and every part of the study area. The aim of this procedure is to make sure that the BCC is easily accessible to all stakeholders, without having to travel long and troublesome routes to get there. To obtain this result, buffers are made around the different routes and the considerations in Table 3.11 are taken into account. Results from this procedure can be seen in Annex 11 (Figure A11.2).

| Road type | Buffer (m) | | | | |
|---|---|---|---|---|---|
| | 500 | 1000 | 1500 | 2000 | > 2000 |
| High-ways | 5 | 4 | 3 | 2 | 1 |
| Main and complementary routes | 4 | 3 | 2 | 1 | 1 |
| Grade-separated roads | 3 | 2 | 1 | 1 | 1 |
| Main and secondary municipal roads | 2 | 1 | 1 | 1 | 1 |

Table 3.11: Classification for different types of roads.

The second approach is to consider the distance to the roads. Buffers of 500 m, 1000 m, 1500 m and 2000 m are also used in order to express the preference of locating the BCC closer to the roads. Each buffer is classified in a scale from 1 to 5, as seen in Table 3.12. The final result is visible in Annex 11 (Figure A11.3)

| Buffer (m) | Classification |
|---|---|
| 500 | 5 |
| 1000 | 4 |
| 1500 | 3 |
| 2000 | 2 |
| > 2000 | 1 |

Table 3.12: Classification for road distance.

The final and last application for the road infrastructures is for the construction of service areas, by using the Network Analyst extension. The purpose is to express how easily the main stakeholders, namely the main biomass plant proprietors and managers, can access the BCC, expressed in time (hours). To do so, the points of the biomass plants in the study area are used as reference points to calculate the service area. Less travel time will mean a higher classification value, as can be observed in Table 3.13. The respective result can be found in Annex 11 (Figure A11.4).

| Travelling time (hours) | Classification |
|---|---|
| 0 - 0,5 | 5 |
| 0,5 - 1,5 | 4 |
| 1,5 - 2,5 | 3 |
| 2,5 - 3,5 | 2 |
| 3,5 - 7 | 1 |

Table 3.13: Time travel from biomass plant facilities and respective classification.

Another way to consider the stakeholders for this implementation is to use the previously obtained map, the Bioenergy Potential for the Centre Region of Portugal. This information influences the map in such a way that the BCC will be preferably located in areas with higher production of biomass. This way, the classification for the different classes of bioenergy potential is considered to be (Table 3.14):

| Bioenergy Potential (toe) | Classification |
|---|---|
| 1.847 – 9.432 | 1 |
| 9.432 – 15.119 | 2 |
| 15.119 – 25.732 | 3 |
| 25.732 – 43.935 | 4 |
| 43.935 – 98.912 | 5 |

Table 3.14: Classification of the bioenergy potential.

As before, these ranges of values were obtained using natural breaks (Jenks). The resulting map can be observed in Annex 11 (Figure A11.5).

Up to this point, the parameters discussed were the ideal conditions, i.e., the ones that are preferable for the location of the BCC. Contrarily, some parameters are of the restrictive nature, where an infrastructure such as the BCC cannot be located. This fact is due to a great deal of reasons, mainly legal ones. Other restrictions occur that are somewhat more obvious, such as, e.g., not locating the infrastructure on water surfaces. These restrictions will be further discussed in the following paragraphs.

In terms of legal restrictions, the most obvious one is the construction of any type of infrastructure in the various types of protected natural areas in the Centre Region of Portugal. These areas are taken into consideration and are entirely excluded from the possible locations to implement the BCC. Moreover, taking into consideration that constructing immediately around the limits of each protected area wouldn't be of good practice, a buffer of 500 m is considered. This value was considered once that no legal document was found as to justify this restriction.

As stated, there are also some restrictions of the territorial essence. Key features from the Corine Land Cover 2006 were selected as to remove some key features from the territory. These are:

i) Continuous urban fabric;
ii) Discontinuous urban fabric;
iii) Wetlands, which include all wet areas such as rice fields, water courses, estuaries, coastal lagoons, inland marshes, water bodies, salines and salt marshes, where a buffer of 100 m is used;
iv) Airports, with a 500 m buffer.

It is not desirable to build the BCC in already existing urban areas. That is why the continuous and discontinuous urban fabric is selected, as to exclude them from the influence area. In what concerns the various types of cited wetlands, Portuguese legislation (Decreto-Lei n.º 364/98, 1998) defines that a protection area of 100 m should be regarded in order to shield the cited areas. In what refers to the airports, there is no specific national legislation that determines the safety distances to obey. Despite this fact, the Municipal Master Plans have to consider these infrastructures. As the study area is composed of 100 municipalities, most of which with Municipal Master Plans that are under revision, only a few were consulted, which is enough to assume a safety distance of 500m around airports.

Although not being of legal nature, a 500 m buffer is constructed around the natural gas transportation lines, to guarantee safety conditions for implementation of the BCC.

Having considered the aforementioned restrictions, these are merged and transformed into a raster information layer, and a reclassification is done. The restricted areas are considered as NoData (to entirely exclude them from the final result) and the remaining area is classified as 5. The resulting map for the aforementioned restrictions can be seen in Annex 11 (Figure A11.6).

A final restriction is of the economical order. Slope plays a major role in the financial aspect of building a construction. The more sloped a given terrain is, a higher intervention has to be made as to prepare the terrain for construction, thus being less economical. Another way slope may influence is in the travelling aspect. Steeper roads provoke more difficulty in transportation (consequently more fuel consumption) than those ones that are more flat, being the latter a more desirable condition. This way, different classifications were taken into account when considering the different slopes of the Centre Region of Portugal, which are resumed in Table 3.15. Results can be found in Annex 11 (Figure A11.7).

| Slope (º) | Classification |
|---|---|
| 0 - 2 | 5 |
| 2 - 6 | 4 |
| 6 - 9 | 3 |
| 9 - 11 | 2 |
| 11 - 90 | 1 |

Table 3.15: Classification of the different degrees of slope.

Having classified all the inputs in a 1 to 5 layer, a weighted overlay is done to all the intervenient rasters. To do so, weights have to be given to these inputs. Three different scenarios are considered in order to verify the applicability of the tool and compare results. Table 3.16 sums the ponderations that are given to the tools' inputs:

| Inputs | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Restrictions | 5 | 5 | 5 | 5 |
| Road differentiation | 15 | 20 | 15 | 20 |
| Network analysis from biomass plants | 25 | 25 | 30 | 30 |
| Distance to roads | 20 | 15 | 20 | 15 |
| Slope | 10 | 10 | 10 | 10 |
| Bioenergy Potential | 25 | 25 | 20 | 20 |

Table 3.16: Weighting of different inputs for determination of the location of the BCC.

These scenarios are explained in the next paragraphs:

i) ***Scenario1:*** This will be considered as the base premise. This scenario considers that the *network analysis from the biomass plants* and the *bioenergy potential* will have the same weight in this classification (25%). This is due to the fact that both stakeholders may represent an important role for the BCC: on one hand, the biomass plants represented as bioenergy producers; on the other hand, the waste producer stakeholders, represented on the map by higher yields of biomass production. In what concerns the *road differentiation* and the *distance to road*, the first has a slightly lower value (15%) than the latter (20%). This will be one of the parameters tested in the following scenarios, in order to verify the influence that each one of these has in the final result. The parameter *slope* and *resrictions* will be the only ones that will remain fixed throughout all the tested scenarios (10% and 5%, respectively). The reason for this is because, in the *slope* case, this parameter is constant throughout the whole territory and will influence all other parameters in the same way (both the economical and road inclination characteristics, as previously mentioned). In what refers to the *restrictions*, the case is similar to the previous one. Its main goal is to exclude the impermissible areas from the study areas, so all remaining could be equally classified as 5.

*ii)* ***Scenario 2:*** In this scenario, all parameters have the same weight as the previous, except for the *road differentiation* and the *distance to roads* ones. These values are swapped, where in this scenario, *road differentiation* has now a higher weight (20%) than *distance to roads* (15%).

*iii)* ***Scenario 3:*** Here, all weights are the same as in the first case, except for *network analysis from the biomass plants* and the *bioenergy potential*. In this case, a contemplation is made where, being biomass plants more dependent on the success of their business (as opposed to farmers and other producer stakeholders, that face this more as a side business, by selling their residues), maybe they are more reliant on the services that the BCC can offer than the remaining stakeholders. Having this in mind, a change in the weights is made for these two parameters, where the *network analysis from the biomass plants* is slightly higher (30%) than in the *bioenergy potential* case (20%).

*iv)* ***Scenario 4:*** Here is where all weights are changed in respect to Scenario 1. Basically, the *network analysis from the biomass plants* and the *bioenergy potential* are the same as in the previous scenario. Another main alteration is to use the *road differentiation* and *distance to roads* weights as in Scenario 2. As previously stated, *slope* and *restrictions* are the same for all the scenarios.

For all the previous results, values equal to 4 and 5 are selected from the raster and subsequently transformed into feature classes. This alteration is made so it could be possible to calculate the areas of the resulting polygons and select ones with an area higher than 22.500 $m^2$, once that these are desirable (projected area that is necessary is 150 m x150 m).

Results are presented and discussed in the following chapter.

# 4. RESULT PRESENTATION AND DISCUSSION

This section will present and analyse the results obtained from the applied methodology and discuss pertinent matters associated to this issue.

## 4.1. The Bioenergy Potential Map for the Centre Region of Portugal

Before proceeding to the analysis and discussion of the bioenergy potential results, it should be noted that the displayed bioenergy potential does not fully represent reality. Currently, there is no method to fully yield 100% of the potential that is available by each and every considered residue. This consideration is taken, once that technology is constantly progressing and presenting new solutions, especially in an increasingly advancing field such as bioenergy studies. New techniques and procedures are frequently surpassing existing boundaries, so, whatever considered yield for bioenergy production in this work would rapidly be outdated.

By analyzing the intermediate information that resulted from the applied methodology (Annex 10 – (Figures A10.2 to A10.8), a great amount of remarks can be made. For the first presented map, the bioenergy from forest residues, we can see that the interior part of the country has the most amount of biomass production in the study area. By analyzing the respective tables (Annex 3 – Tables A3.1 to A3.12; Figures A3.1 to A3.11), some leads may help us understand why this happens. Figure 4.1 also has a graph as to aid in this explanation, where it shows the proportion between each forest biomass type for the entire study area. Note that in this chart, the category *Forest* includes a sum of all the forest stands used as input for this study (maritime pine, cork oak, eucalyptus, holm oak, Portuguese oak, stone pine, sweet chestnut and other hardwood and softwood trees).

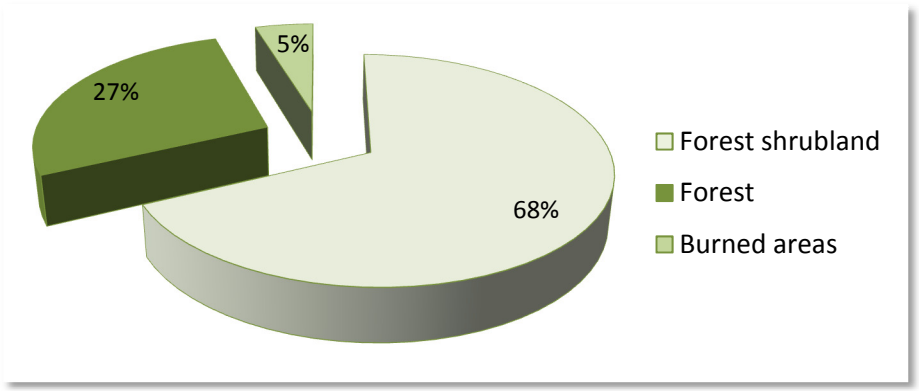


Figure 4.1: Contribution of bioenergy for each forest biomass for the Centre Region of Portugal.

When looking at the forest shrubland data, most of its higher values are present in the municipalities in the interior of the country. Being forest shrubland the category with higher proportion (68%), this may end up dominating the end result. Shrub areas are in great amount in the Portuguese landscape, frequently dominating other types of land use. Generally speaking, in most of the municipalities, this scenario is repeated. However, the forest stands also have a major dominance in the inland area, particularly species like holm oak, portuguese oak, cork oak, sweet chestnut and other softwood stands. Nonetheless, the remaining forest species (eucalyptus, maritime pine, stone pine and other hardwood stands) have a general influence throughout the whole territory, and not only in the inland region of the study area. In what respects to burned area residues, the values from 2009 are used. This was a year with no particularly great forest fires, in comparison with previous years. As before, the major occurrences are in the interior part of the Centre Region of Portugal, perhaps due to the high amount of forest areas that populate that particular region (Annex 10 – Figure A10.2).

Most municipalities have a production rate for forest higher than the remaining sources, in most cases, higher than 80% (mean of 72,90%). When comparing the different bioenergy sources, Pampilhosa da Serra is the municipality that yields most of its potential from forest biomass, with a total of 98,79% (highly rural area). The Entroncamento municipality is the one with lower bioenergy production yield from forest biomass (13,37%) (Annex 10 – Table A10.2).

In terms of actual bioenergy production, Sabugal municipality is the one with the highest value in the whole Centre Region of Portugal (96.272,44 toe). The municipality that has lowest production of bioenergy from forest biomass is Entroncamento, with a total production of 247,26 toe (Annex 10 – (Table A10.1).

Agricultural residue biomass yield is much lower than the forest one (mean of 5,96%). Montemor-o-Velho has 29,39% for the agricultural residue production, when comparing this value with other sources, as opposed to Pampilhosa da Serra, with 0,03% (Annex 10 – Table A10.2).

As can be seen in Figure 4.2, temporary crops contribute more for the production of biomass than permanent crops.

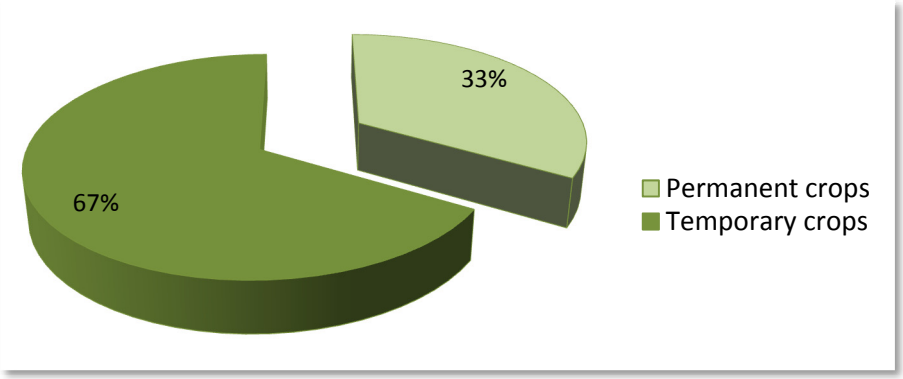


Figure 4.2: Contribution of bioenergy for each agricultural crop type for the Centre Region of Portugal.

Contrarily to what happened with the forest biomass, these crops can be found throughout the whole study region, equally dispersed. Some of them are more concentrated in some locations (e.g., rice production is restricted to the littoral area of Baixo Mondego). This may mean that the best physiographic conditions are at that setting in order to for them to prosper. A common fact to all types of crops is that in the middle of the study area, production yield is very low. This is where the mountain range is. Extreme temperatures and poor soil conditions verified in this area may result into a restriction and lead to poor agricultural production (Annex 10 – Figure A10.3).

The highest production yield from agricultural residues is in Alenquer, with a total of 3.632,79 toe (vineyards contribute heavily to this value). The lowest production rate is in Castanheira de Pêra, with 2,08 toe (Annex 10 – Table A10.1). As referred previously, this municipality is one located in the mountain range that crosses the Centre Region of Portugal.

Bioenergy crops aren't in great amount in the Centre Region of Portugal. In comparison to the other sources of bioenergy, it is significantly lower than the rest: 4,11% is the highest value for the Lourinhã municipality and 0,02% for Vila de Rei (Annex 10 – Table A10.2). A mean of 0,77% is verified for the production of bioenergy crops, in proportion to the rest.

In terms of actual bioenergy production, and looking at the respective intermediate map (Annex 10 – Figure A10.2), we can say that the bioenergy production is generally dispersed throughout the Centre Region of Portugal. However, the different types of crops aren't equally distributed throughout the territory. In fact, maize is the only crop that is generally disseminated in almost all areas of the study area. With rye, sunflower, wheat and sorghum crops, these are majorly situated in the inland part of the Centre Region of Portugal, although sorghum and wheat have some expression in the littoral and southern area too. Sugar beet and barley crops are more prominent in the southern part of the study area, while potato is more common in the southern, littoral and northern part of the territory. This may contribute to the homogeneity verified in the intermediate

map for bioenergy crops. Just as what happens with the agricultural biomass, the middle section of the study area is where less biomass is produced. Once again, this may be due to the physiographic conditions that are present in that section of the territory. The municipality with the highest amount of bioenergy production from bioenergy crops is Abrantes (375,15 toe), as opposed to Castanheira de Pêra, with a total production of 1,66 toe (Annex 10 – Table A10.1).

Animal husbandry effluents are of higher proportion than bioenergy crops, but lower than forest and agriculture biomass (mean of 2,05%). The municipality that proportionally extracts most animal biomass is Ferreira do Zêzere (12,81%), in contrast with Pampilhosa da Serra (0,01%) (Annex 10 – Table A10.2).

The animal production in the study area is disperse and depends on each species. As can be seen in Figure 4.3, swine effluents are the ones that mostly contribute for animal biomass, followed by poultry then bovine.

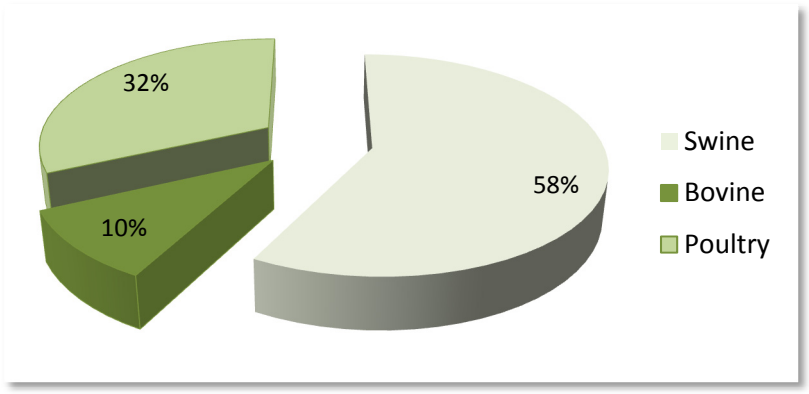


Figure 4.3: Contribution of bioenergy for each animal husbandry effluent for the Centre Region of Portugal.

Geographically, swine bioenergy production is dispersed throughout the whole territory, although major production occurs mainly in the Oeste and Pinhal Litoral NUTS III (Annex 6 – Figure A6.3). For bovine production, the northern part of the territory is where the production is dominant. Baixo Vouga, Baixo Mondego, Cova da Beira and Beira Interior Norte are where the most production potential is for these animals (Annex 6 – Figure A6.2). Poultry bioenergy production is not as disperse as the two other animals production. Its major contribution is in the Pinhal Litoral NUTS III area. The Tondela municipality also has a high value for this type of production (Annex 6 – Figure A6.1).

The final intermediate map for animal effluents is compliant with what was described above: most potential for bioenergy is in the Pinhal Litoral NUTS III area, followed by Oeste (Annex 10, Figure A10.6). Surrounding municipalities don't have as much production as these. The municipality with

most potential for bioenergy production (Leiria) is in the Pinhal Litoral region, with a total of 3.189,67 toe. On the other hand, Castanheira de Pêra is once again the municipality with least production potential (0,76 toe) (Annex 10, Table A10.1).

The animal and food industry is another sector considered in this study. As expected, the locations that have a higher amount of olive press cake are similar to those where olive groves are, namely the lower part of the study area (Médio Tejo, Pinhal Interior Sul, Cova da Beira and Beira Interior Sul) (Annex 9, Figure A9.1). The municipality of Castelo Branco is the one with most potential for production of bioenergy from olive press cake. In what respects to residues from grape stems, waste production is high exactly where large amounts of vineyards exist (Annex 6 – Figure A9.2).

In terms of waste proportion, these are the second lowest waste produced by the municipalities (mean of 1,42%). Alvaiázere is the municipality with most animal and food waste production (8,91%), while Ovar, Sever do Vouga, Murtosa, Ílhavo, Vila Nova de Paiva and Constância are the ones with no production whatsoever (Annex 10 – Table A10.2). As can be seen in Figure 4.4, olive oil industry contributes more for the potential production of bioenergy (60%) than wine industry (40%).

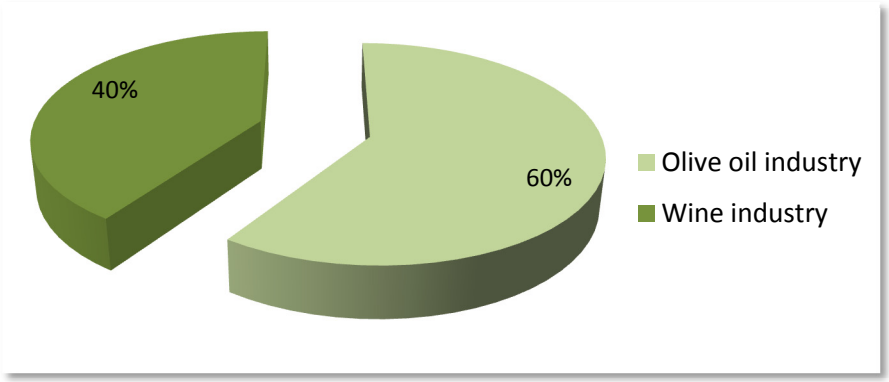


Figure 4.4: Contribution of bioenergy for each industrial biomass for the Centre Region of Portugal.

In the intermediate map for this section (Annex 10 – Figure A10.8), we can see that the Oeste, Pinhal Litoral, Médio Tejo, Beira Interior Sul, Cova da Beira and Beira Interior Norte are the dominant NUTS III, where, in most cases and for each NUTS III, only one municipality is where most potential is found. Castelo Branco is the municipality with higher potential of production of bioenergy, with a total of 1.061,14 toe, contrarily to Murtosa and Constância with absolutely no production of the sort. (Annex 10 – Table A10.1).

Being municipal solid waste a great part of the day to day reality, some advantages can be taken from its production. Entroncamento is the municipality that in proportion with the other residue

types, produces most municipal solid waste (84,59%). Mação is the municipality with the lowest value (0,70%). The mean for this parameter for all the municipalities is 16,97, far lower than the highest value (Annex 10 – Table A10.2).

Figure 4.5 illustrates the proportion between the types of residues and how they can be bioenergetically harnessed. As can be observed, direct combustion of inorganic material from MSW is one that dominates the rest (94%). Landfill biogas, organic valorisation and used vegetable oil are in much less amount than direct combustion (4%, 1% and 1%, respectively). This will mean that in the intermediate map for MSW, direct combustion will have more influence than the rest of the potential bioenergy sources.

For direct combustion, plastic is the material that can most contribute for the production of bioenergy (3.998,53 toe), closely followed by paper/cardboard, with a maximum production of 3.871,68 toe, both for Coimbra. Fine matter also contributes heavily in the final value, with a maximum of 2.485,26 toe and 2.010,57 toe, respectively, also for Coimbra. Textile is the MSW material that can less contribute for potential bioenergy: 405,46 toe for Coimbra. By analysing the tables and resulting maps, one can verify that major MSW production occurs mainly in great urban centres, e.g., such as Coimbra, Aveiro, Viseu, Leiria and Torres Vedras (Annex 7 – Table A7.4). More rural areas such as Belmonte, Manteigas and Vila de Rei have much less population, leading to a lesser production of MSW.

Materials that are deposited in landfills may also produce biogas which, as previously mentioned, can be harnessed for bioenergy. Following the same line of thinking as for direct combustion, more biogas will be produced in major urban centres, once that they are more densely populated, and a higher amount of residues will be produced at those locations. Once more, Coimbra is the municipality that most bioenergy potential has for this type of production, with a total of 163,53 toe. For the least amount of biogas production we find Vila de Rei, a more rural area, with 2,15 toe (Annex 7 – Table A7.2). Note that each municipality does not have a landfill to accommodate the residues for direct combustion nor the ones for landfill biogas. In most cases, residues are transported to a multi-municipal facility as a final destination. The data was treated at a municipal level as to facilitate the reading of the data and respective results.

As for the UVO, results are slightly different from the previous, although the same tendency for production in larger urban centres is maintained. Once again, Coimbra is the municipality with higher potential for bioenergy production from UVO – 396,46. Vila de Rei is also the municipality with least bioenergy potential, with 9,05 toe (Annex 8 – Figure A8.1).

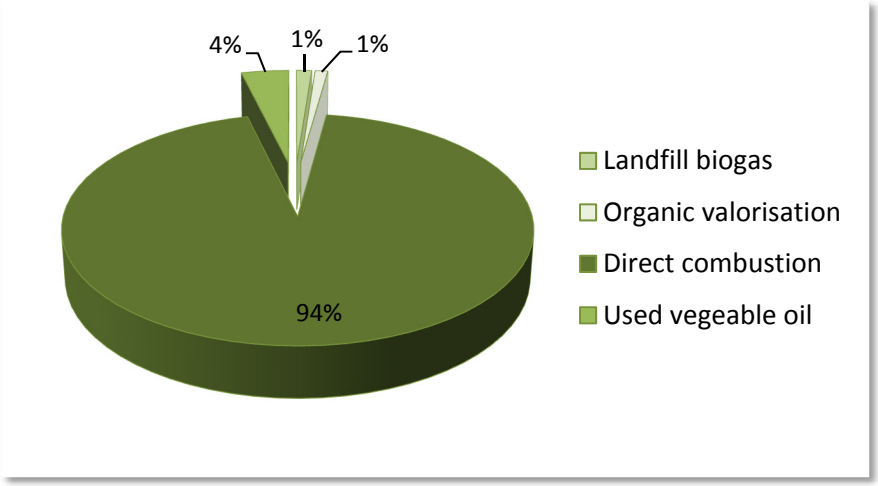


Figure 4.5: Contribution of bioenergy for each type of municipal waste for the Centre Region of Portugal.

Organic valorisation is a parameter that may not fully represent reality. According to the collected data from INE, only a few municipalities yield bioenergy from this resource (municipalities from the Serra da Estrela, Beira Interior Norte, Beira Interior Sul and Cova da Beira NUTS III areas). In the future, the tendency is to use most organic residues to produce this type of energy. However, it is difficult to predict how much organic material is produced per municipality, so only available information was used to simulate bioenergy production for this bioenergy source. From the fourteen municipalities that had available information, Covilhã is the one that most produces bioenergy (756,72 toe), closely followed by Fundão (615,61 toe). Sabugal and Penamacor are the ones with least bioenergy potential (1,52 toe and 1,71 toe, respectively) (Annex 7 – Figure A7.2).

As expected, the highest value or bioenergy potential is found throughout the major urban centres in the study region, being Coimbra the municipality with most potential: 13.331,50 toe. Mação has less capacity to produce bioenergy from MSW, with 179,04 toe (Annex10 – Table A10.1).

The resulting map from the methodology described in chapter 3.1.2. can be found in Figure 4.6. By its analysis, we can immediately verify that the most promising area in terms of bioenergy production is the northern inland area, Beira Interior Norte, by achieving a maximum of 98.912,40 toe in Sabugal. This fact is probably due to the combination of climatic factors (e.g., high water availability) with the high amount of agricultural and forest areas, leading to a higher yield of biomass. The more littoral part of the Centre Region of Portugal has significantly lower potential for the production of bioenergy. The municipality with less bioenergy potential is Entroncamento, with1.848,54 toe. The middle region of the study area is once again not very good for production of biomass for bioenergy. The amount of energy that is collected from this region is generally lower than 9.000 toe. The Oeste area is not particularly adequate for biomass potential either.

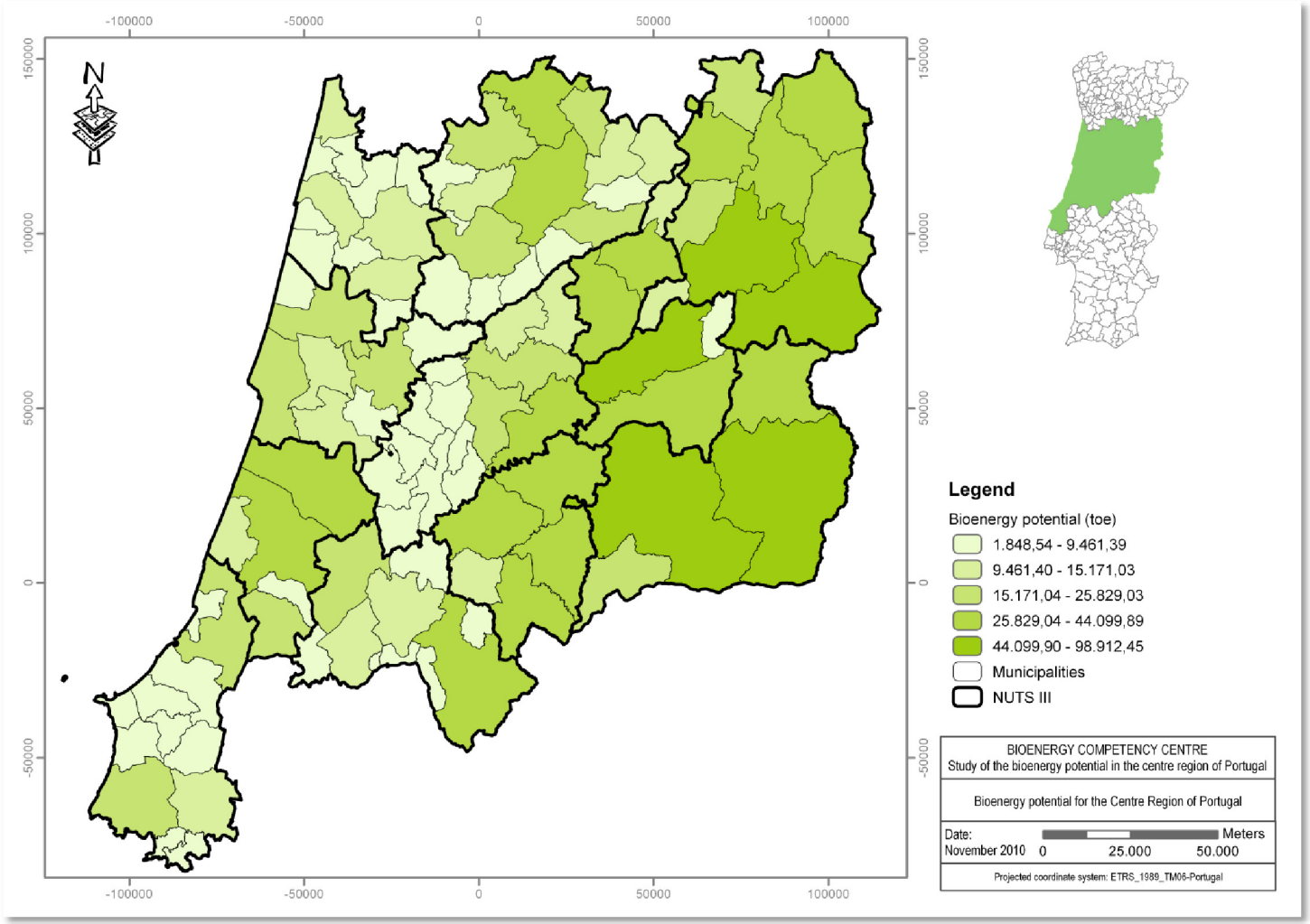


Figure 4.6: The bioenergy potential result for the Centre Region of Portugal.

By analyzing the intermediate maps previously discussed and presented in Annex 10 (Figure A10.2 to A10.8), we can verify that the component that most influences the final result is the forest waste biomass. The amount of bioenergy that this source is capable to produce actually overtakes the remaining sources, mainly due to the contribution that the forest shrublands make.

Still another type of analysis can be made from this final map and respective table. By dividing the total amount of potential bioenergy of each municipality by its area, very interesting results appear in the form of potential bioenergy per hectare (Annex 10 – Table A10.1). Looking at the highest value presented in the table and in Figure 4.7, we can see that it belongs to Entroncamento (1,35 toe/ha). This is a very curious fact because, as seen before, this municipality is several times the one with the least potential for bioenergy from the various waste sources. But when we look at the municipalities territorial dimension, we can see that is has a very small area (1.372,94 ha). We can compare this result with Sabugal (1,20 toe/ha). As seen previously, it is the municipality with highest potential for bioenergy production and has an area of 82.268,03 ha. Although Sabugal is almost sixty times larger than Entroncamento, the amount of potential bioenergy per hectare is still inferior. This result may mean that, while the actual value for bioenergy potential for Entroncamento is smaller than Sabugal, Entroncamento has a higher concentration of sources that leads to a superior production potential. Hence we may affirm that Entroncamento may be penalized by its' small territorial dimension. If it were larger, it might just surpass Sabugal's potential production. Beira Interior Norte, Serra da Estrela, Cova da Beira and Pinhal Interior Sul are the NUTS III regions that have the municipalities with higher production potential per hectare. Then there are some dispersed municipalities that have high production per hectare (Entroncamento, Vila Nova da Barquinha, Peniche and Arruda dos Vinhos), although the neighbouring municipalities don't have as high potential (Figure 4.7).

On the other tip of the scale are Murtosa and Tomar, both with 0,33 toe/ha. In general, most of the littoral municipalities are the ones with lowest bioenergy potential per hectare. Municipalities from Beira Interior Sul also have a rather low bioenergy potential per hectare, most of them around 0,5 toe/ha, which is curious, considering the vast available areas these municipalities probably have for agriculture and/or forest.

There are also a series of factors that may impede a correct estimation of the potential for bioenergy, ones that are difficult to estimate in a map, but have to be analysed and managed on a case to case basis. Some of these factors will be discussed formerly.

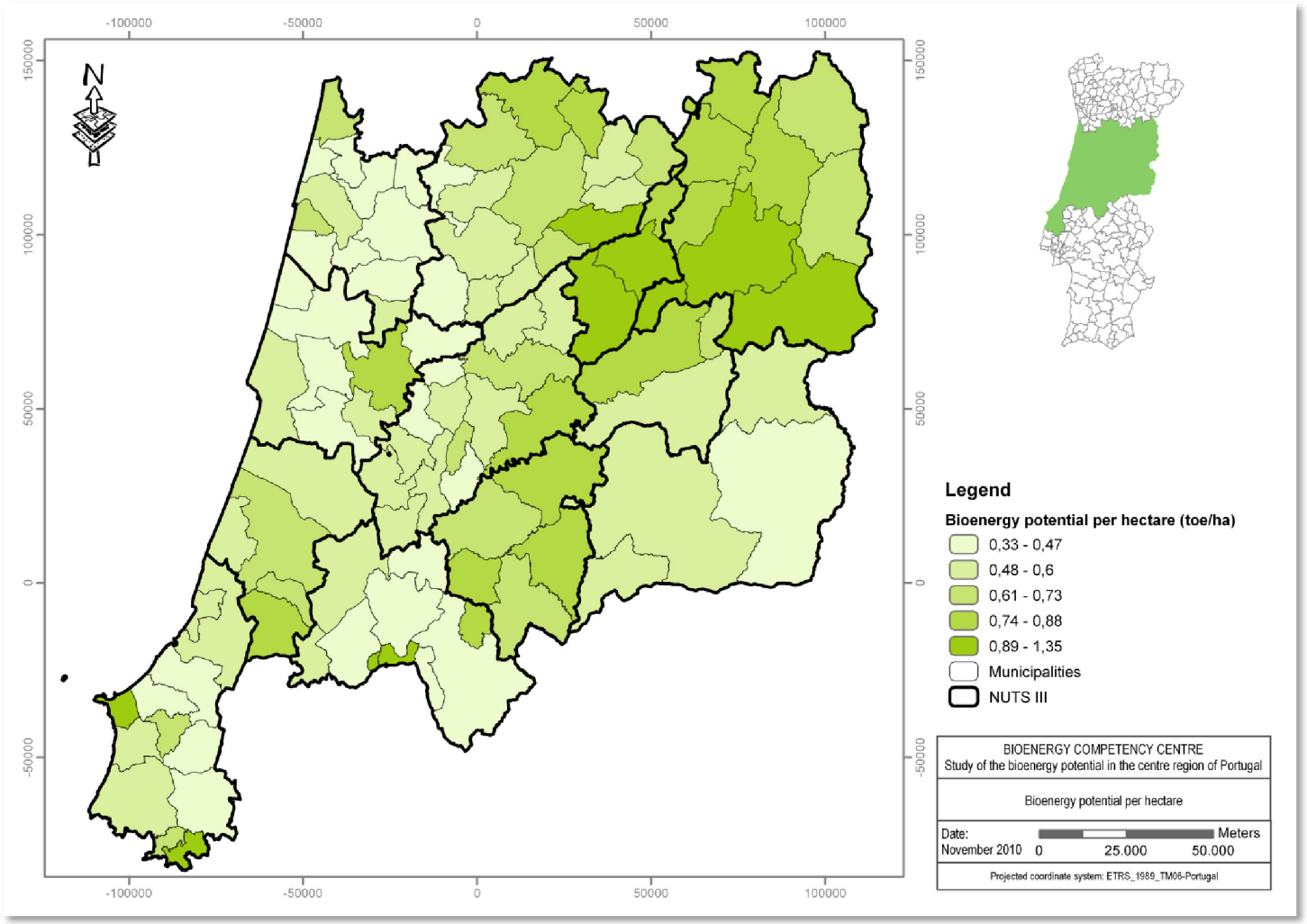


Figure 4.7: Spatial distribution for the potential bioenergy for the Centre Region of Portugal (toe/ha)

The confidentiality of the input information for some municipalities is a factor hampering the true potential analysis that this work does. Many of them have information for various waste sources that is presented as confidential data in the consulted bibliography. This could alter the presented results drastically, once that one or even several municipalities can produce enough waste to make a great difference in the final value for that/those municipality/municipalities, turning the final results presented in this work rapidly obsolete.

Other factors may hinder the potential for bioenergy. As can be verified in Table 3.1, forest, agriculture and social soil occupation have been decreasing along the years. This can certainly have an impact in the bioenergy production capacity for the region. However, in the same table, we can also verify that the amount of forest shrubland has been increasing over the years. As an input of major impact in the final result presented in this thesis, it would be a matter of performing an economical study to verify if the decrease in the amount of forest and agriculture waste could be compensated by the yield of bioenergy from forest shrubland. Another issue arises when using this type of material. Shrubland residues aren't correctly handled in most areas, remaining untouched and unmanaged in the terrain, hampering greatly the amount of biomass passable to be used for bioenergy production. In order to use this material, a proper management has to be made in order to guarantee that the full potential can be used for bioenergy, without damaging forest ecosystem equilibrium. Other than yielding bioenergy, another very important consequence would take place, which is the help in prevention for wildfires, helping to drastically reduce the risk. These ravage the country on a yearly basis leading to important environmental, social and economical losses.

Additionally, abnormal and occasional situations like forest and agriculture plagues may arise, consequently increasing or decreasing the final production. For example, from 2008 until now, Portugal had a grave problem with pinewood nematode, having to deplete more that 88.000 ha of forest in order to control this predicament. In 2009, 600.000 trees were identified and marked for felling because they were infected (CONFAGRI, 2010). This unbelievable amount of wood that had to be disposed of could have been used for bioenergy production, thus increasing the amount of biomass produced in a given year. However, consequences may arise from this boom in production: in subsequent years, it may fall drastically, once there are not the same amounts of forests producing waste as there were before (the trees that were substituted by the felled trees are still too little to produce great amounts of biomass).

Another consideration may be the analysis of the actual production of bioenergy from some sources. In some cases, we can almost positively say that actually using that energy source may be more expensive than not using it (in an energetic perspective). Certainly that the amount of energy used to produce, transport and transform a given energy source should not surpass the

amount of bioenergy that it is able to create. In this particular study, it is thought that energy crops are the essence of what is explained in this paragraph. If we look at the final amount of bioenergy that is produced from this bioenergy source, we find a respectable value of 9.479,32 toe. But if we take into account the different crops considered for bioenergy production and their bioenergy potential, we see very small values for some of them (e.g., 19,15 toe for sunflower; 34,08 toe for barley; and 19,92 toe for sorghum). It might just be that, due to these values being dependent solely on the amount of abandoned agriculture lands in the past years, they may not really translate what is actually happening. Nevertheless, these values would certainly not compensate the amount of energy used in the treatment process for some of these materials, being that its use would be simply impermissible.

## 4.2. Location of the Bioenergy Competency Centre

Properly locating the BCC is of great importance, because it will allow all stakeholders to have an easier access to the services to be provided by this institution. All inputs are considered key to the location of this institution, once they take into account different aspects that represent reality constraints and allowances. For this study, these are: road types, road distance, travel time, bioenergy potential and slope.

Four different scenarios are traced as to evaluate how different ponderations can affect the location of the BCC. For the final map, only values of 4 and 5 are selected. We also have to take into consideration that the inputs *slope* and *restrictions* have the same weight in each scenario.

First off, it's needed to say that the weighting of the different parameters is extremely difficult, due to the high amount of inputs. One cannot make large differentiations between two comparing values, due to the fact that, then, the other inputs will not have enough weight to be expressive and influence the final result. A delicate balance is used to consider the inputs, and overall, it is thought that the ponderations achieved are quite satisfying to construct viable outputs. These results can be seen in Figures 4.8 to 4.11. In these figures, and for the sake of legibility of the map, only the closest municipalities seats to the areas classified with 5 are labelled.

When looking at the results, at first glance we can verify that they are very similar between them. Most of the locations suggested in the different scenarios are coincident, although with visible changes in the area for every scenario. Another thing that is clearly visible is that there are more areas to implement the BCC with a classification of 4 than there are areas with a classification of 5.

Scenario 1 and 2 gives more weight to *network analysis for the biomass plants* and *bioenergy potential*, mainly focusing on both types of main clients that the BCC may have. These consider the

two types of clients equally important, giving them the same weight. The difference between these two scenarios is that they alternate in the *distance to roads* and the *road differentiation* parameters. Just by switching the weights of these two parameters, the maps vary considerably in terms of available area, both for classification 4 and 5. In Table 4.1 we can see that there is nearly a difference of 66.000 ha between the two scenarios, in terms of total area. It appears as that by constraining the distance to roads, less area is available for location of the BCC. We can also see that the amount of locations with classification 5 diminishes drastically in the second case, to nearly a third of the value for Scenario 1.

| Scenarios | Total area (ha) | Areas with classification 4 | | Areas with classification 5 | |
|---|---|---|---|---|---|
| | | Ha | % | ha | % |
| Scenario 1 | 578.021,15 | 567.981,87 | 98,26 | 10.039,28 | 1,77 |
| Scenario 2 | 512.315,38 | 508.802,14 | 99,31 | 3.513,24 | 0,69 |
| Scenario 3 | 645.172.95 | 635.514,89 | 98,50 | 9.658,06 | 1,50 |
| Scenario 4 | 593.636,41 | 586.909,87 | 98.87 | 6.726,55 | 1,15 |

Table 4.1: Summary of areas with classification 4 and 5.

Scenario 1 and 3 can also be compared, where the differentiation value is for *network analysis for the biomass plants* and *bioenergy potential* and the remaining are the same. Once again, these values are swapped between each other in both situations. As explained in the previous section, this is to verify if, by considering the biomass plants clients as more significant for business than the producer client, great changes will arise in the final result. By analysing Table 4.1, we verify a difference of nearly 68.000 ha between them, although the percentage of classification 4 and 5 are fairly approximate in both situations. Hence, we can say that there is no great impact in varying this factor because in proportion, results are similar, although more area for implementation of the BCC is found. This means that having into attention what kind of client may use the services of the BCC is barely relevant, once that the results are fairly similar between them.

When comparing Scenario 1 and 4 together, all parameters are different between them. Surprisingly enough, the difference between both settings is not as large as expected. There is clearly a large difference between the two total areas (around 49.000 ha), but it is still relatively lower when comparing Scenario 1 to the other two scenarios (66.000 and 68.000 ha). Main differences appear in classification 5, where much less of these areas appear in Scenario 4 than in Scenario 1.

By making a global analysis of all scenarios, we can say that Scenario 2 is the most limitative one, once a lower area with classification 5 is usable. Scenario 3 is the broadest of them, where a higher area is available, although the one with classification 5 is higher in Scenario 1.

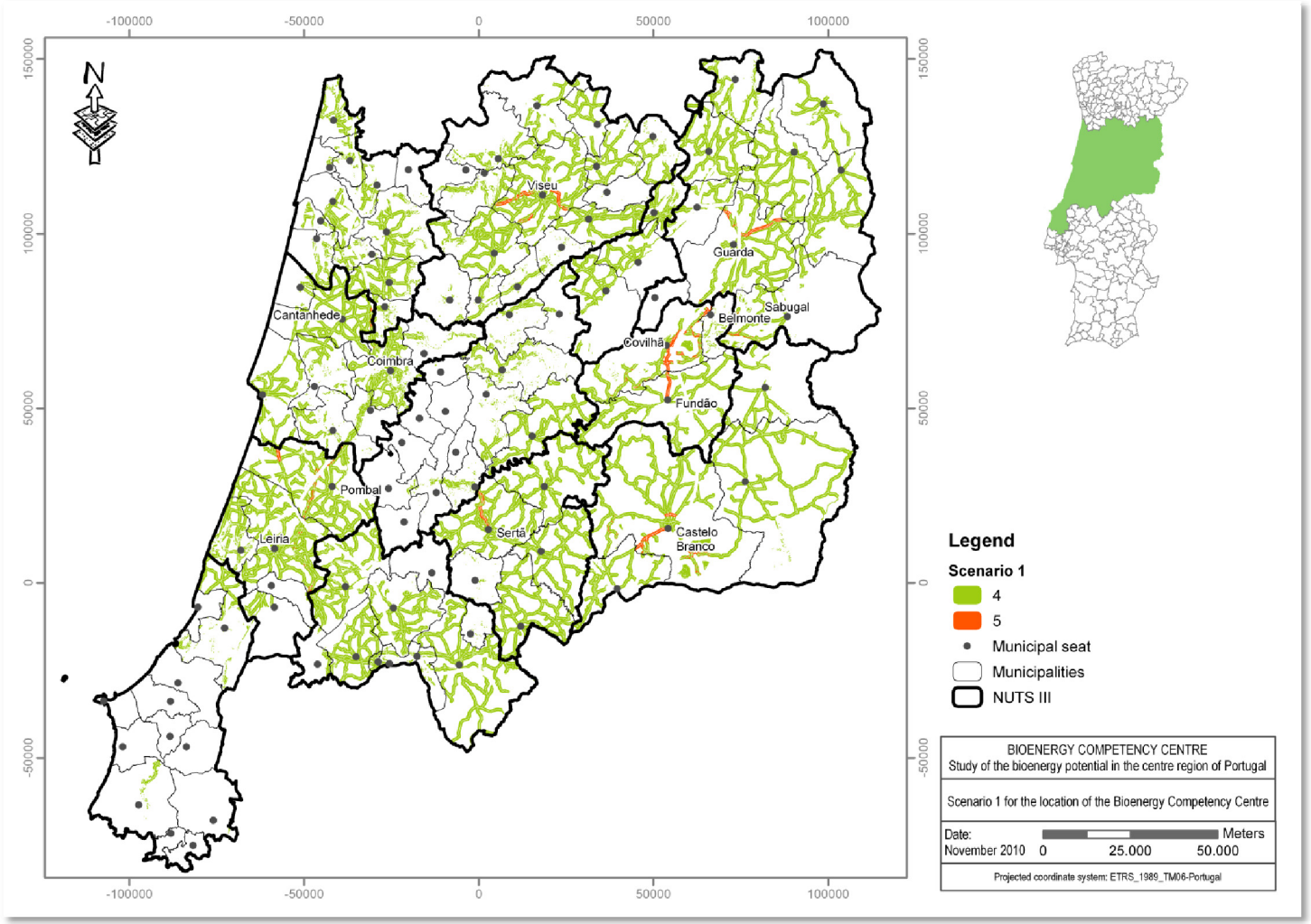


Figure 4.8: Possible locations for the Bioenergy Competency Centre – Scenario 1.

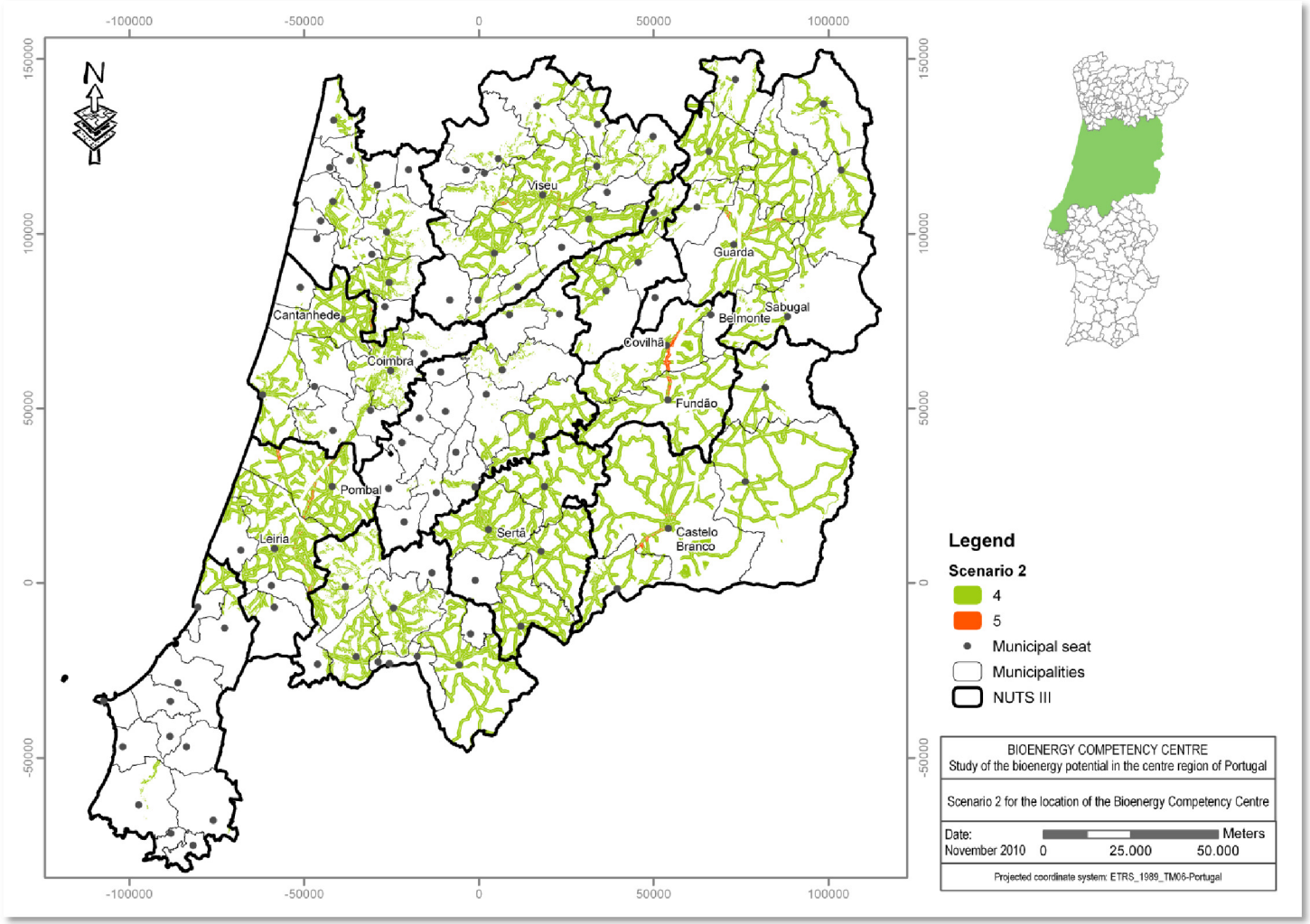


Figure 4.9: Possible locations for the Bioenergy Competency Centre – Scenario 2.

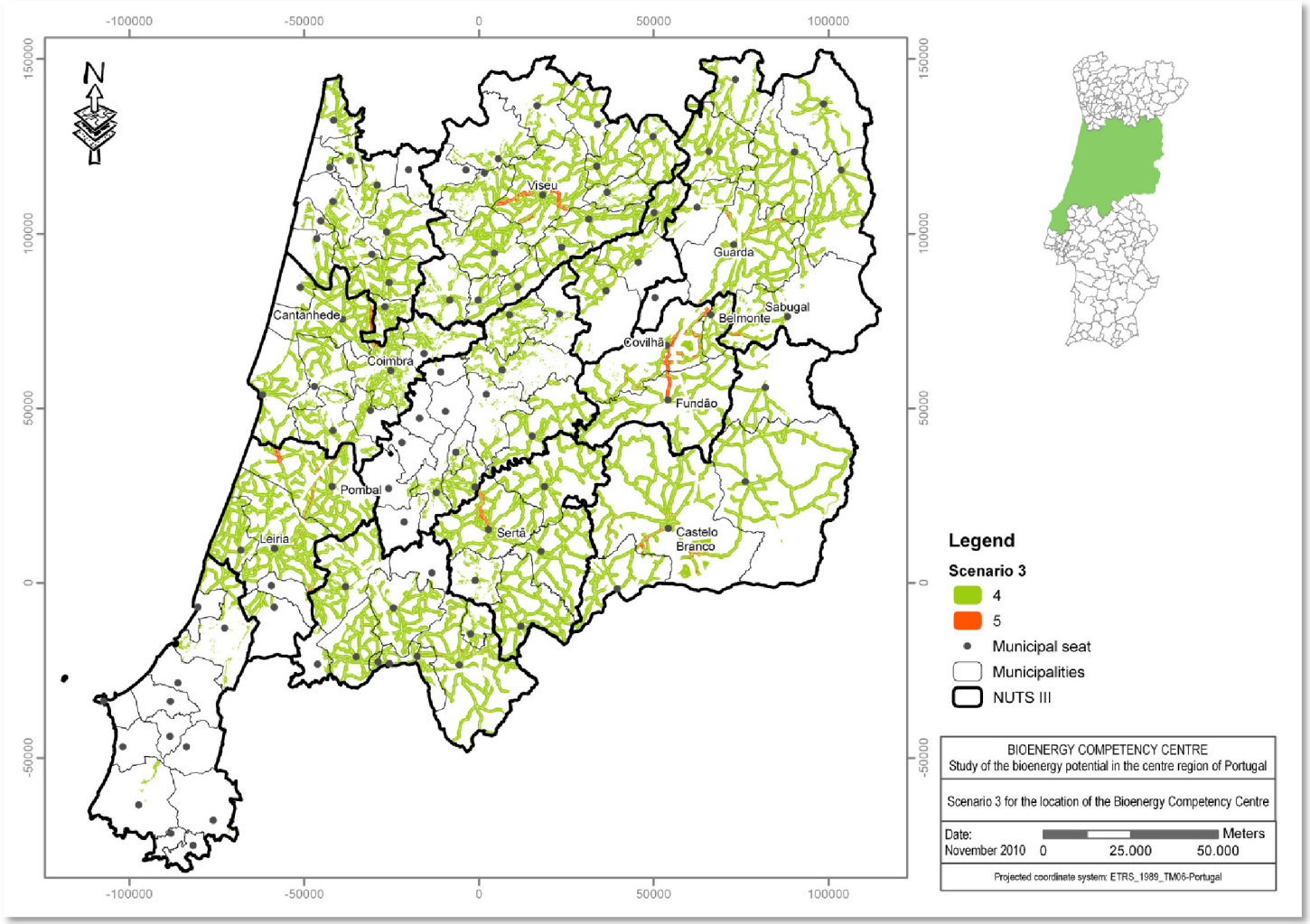


Figure 4.10: Possible locations for the Bioenergy Competency Centre – Scenario 3.

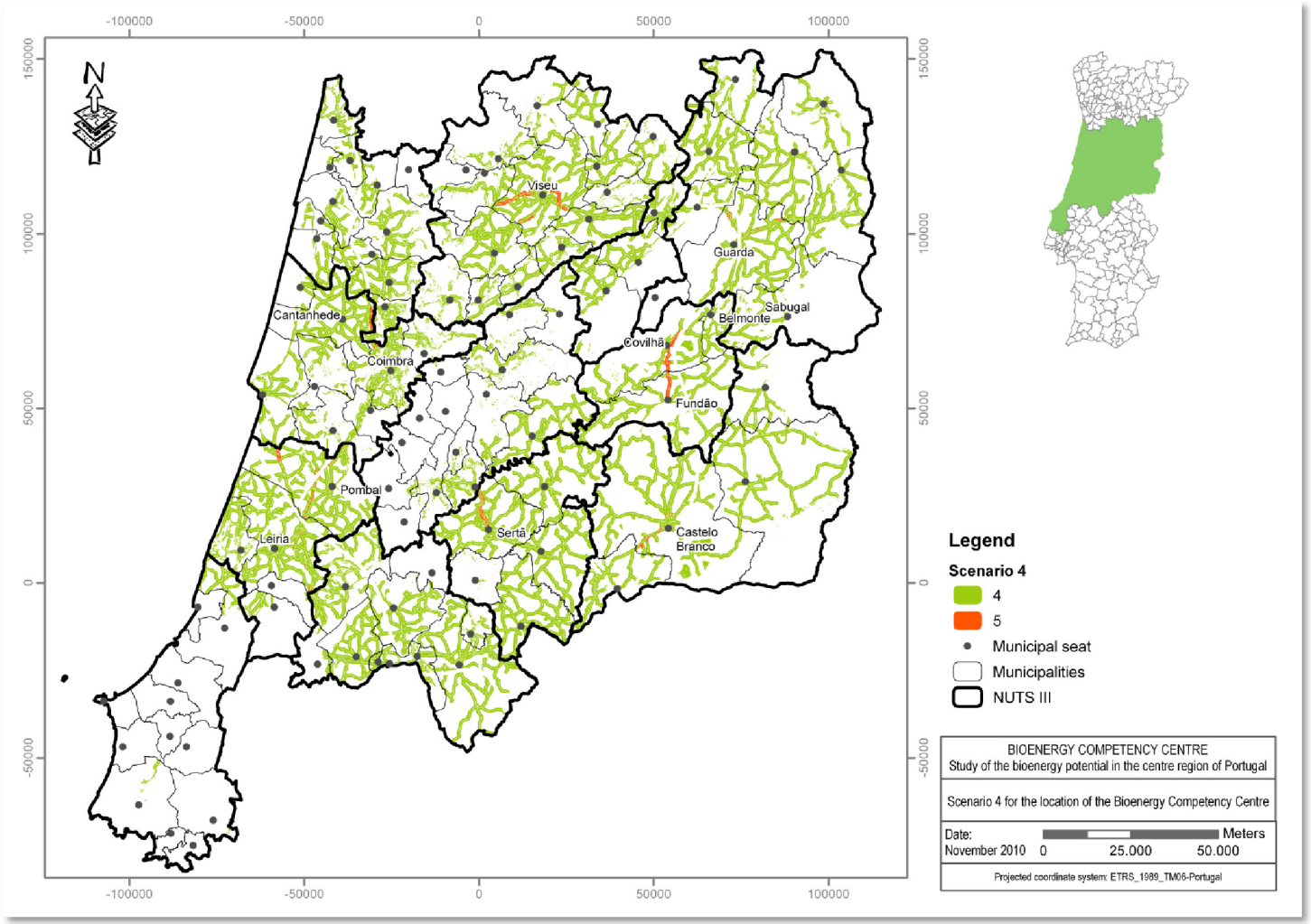


Figure 4.11: Possible locations for the Bioenergy Competency Centre – Scenario 4.

If it were preferable to use only locations with classification 5, the solution would be almost the same in all scenarios. In general, preferable locations would be situated in the Viseu, Covilhã, Guarda, Sabugal, Fundão, Castelo Branco, Sertã, Cantanhede, Coimbra, Pombal and Leiria municipalities. Table 4.2 illustrates the difference in the areas for each scenario and municipality. Only in Scenario 2 and for the municipalities of Belmonte and Sabugal haven't any adequate area for the location of the BCC. For the rest of the cases, values vary from scenario to scenario. In most cases, Scenario 3 has the most amount of area for all the municipalities, except for Covilhã, Guarda, Sabugal and Castelo Branco, where here the highest values are in Scenario 1.

| Municipalities | Areas with classification 5 (ha) | | | |
|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
| Viseu | 1.718,90 | 199,52 | 1.907,43 | 1.718,90 |
| Covilhã | 2.484,50 | 1.111,03 | 2.310,99 | 1.096,53 |
| Belmonte | 0,11 | - | 96,99 | - |
| Guarda | 1.494,89 | 352,75 | 541,82 | 352,75 |
| Sabugal | 282,56 | - | 281,94 | - |
| Fundão | 831,50 | 288,22 | 887,96 | 750,78 |
| Castelo Branco | 1.712,76 | 456,57 | 984,18 | 456,57 |
| Sertã | 593,78 | 15,73 | 631,08 | 593,78 |
| Cantanhede | 146,79 | 151,08 | 553,85 | 553,85 |
| Coimbra | 13,35 | 13.35 | 124,19 | 124,19 |
| Pombal | 624,26 | 746,73 | 1.146,02 | 887,59 |
| Leiria | 135,89 | 191,61 | 191,61 | 191,61 |

Table 4.2: Areas with classification 5 in the different municipalities.

It should be noted that after a final selection of the location for the BCC, this should be confronted with the Municipal Master Plans of the respective municipality. As previously referred, many of these documents are currently under revision, being the access to them and their respective information extremely limited. This is a parameter of extreme importance, once this legal document will determine the ability or inability to locate the BCC at a given location.

The pick of a determinate location for the BCC depends widely on what the directors and main stakeholders are looking for. Do they want more options? Do they want a lesser amount of optimum locations to pick from? Do they only want locations with classification 5? Is there no difference in using classification 4 or 5? Are they interested in a certain municipality? As like other technologies, GIS and its results are socially constructed via negotiations between various social groups such as developers, practitioners, planners, decision-makers, special interest groups, citizens, and others who may have interest in the planning and policy making process (Malczewski, 2004). All these questions have to been pondered by these key actors, mainly by the directors of the future BCC.

An interesting option for the location of the BCC could be the inland area of the country, in municipalities such as Viseu, Guarda, Covilhã, Belmonte, Sabugal, Fundão, Castelo Branco and Sertã. The aim of this suggestion is to give dynamism to this area, once that this population is increasingly fleeing to the littoral, looking for better life conditions. This migration pattern leads to the abandonment of the land, turning rich soils into inaccessible and unusable terrains for agriculture, forestry, or whichever activity over time. The location of the BCC in the inland area could very well mean local creation of more jobs, as well as the possibility of awakening the surrounding population to the possibility of this new business and delay (or even mitigate) the abandonment of land. A new local philosophy may emerge and doors may open to the population in general, when the potential of biomass waste yield is correctly explained to them.

# 5. CONCLUSIONS

This chapter will make an overall analysis of the presented work, discussing the key points, felt limitations and future work.

## 5.1. Discussion

The Centre Region of Portugal, just as the rest of the country and even the rest of the world, will soon face an energy problem with the potential to destroy civilizations. It is urgent to seek new energy sources and new management strategies in order to prevail, ones that are optimized and sustainable.

Sustainability has been a term repeatedly echoed in modern times. Mankind has become aware that, at the pace that natural resources are being destroyed, his survival is threatened. Having understood this fact, a new era emerges, one that is taking great steps in minimizing and mitigating all circumstances that menace his existence. One of the ways to do so is to endeavour in the use of bioenergy. Between several solutions presented to achieve this aim, one is to use waste from various sources as to yield energy from them. If disposable material is available and can be used to that sense, why not do so? This is the base premise of this work: taking material that has no further use, and maybe in some cases hazardous (forest residues when unmanaged intensify forest fires), and making it work for mankind.

In terms of the Bioenergy Potential for the Centre Region of Portugal, one can say that the use of several types of waste may heavily aid in reducing the importation of fossil fuel, leading to a better financial situation for the country. This work has no intention at all to say that these sources are enough to nullify the consumption of fossil fuels in Portugal. But what it does mean to say is that it is possible to substantially reduce the consumption of fossil fuels, by substituting them with greener energy, one that is produced locally. Hence, it may present itself as an invaluable tool in the decision support for local development.

Resources with great promise exist in the territory, ones such as forest wastes. As discussed in the previous section, these are a main contributor for the augmentation of the amount of bioenergy that the Centre Region of Portugal can produce. When compared to all other sources, it is generally the biomass that is most produced throughout the municipalities. Another advantage of the use of this material is that it is homogeneously distributed throughout the whole study area, in high amount. Some municipalities that have low production from other resources, generally have a high forest production rate. The use of this type of material in particular has a double function: the production

of bioenergy and the aid in the prevention of forest fires, an affliction that happens every summer on a yearly basis. These occurrences end up costing lives, material goods, ecosystems and, consequently money.

The use of agricultural residues is something that is unusual in the current context of bioenergy production from biomass in Portugal. The main type of biomass that is used is normally forest waste. With agricultural residues, a great amount of bioenergy may be produced, once Portugal is a country with high agricultural production. Yielding bioenergy from this source is of extreme interest and may greatly benefit the Centre Region of Portugal.

Municipal solid waste is another exceptionally attractive source for bioenergy. As time goes by, there is one fact that will remain constant: municipal waste will always be produced. This situation will probably remain invariable for a very long time. From this resource, not only bioenergy can be produced, but the amount of waste that is deposited in landfills would drastically reduce, an undeniable environmental plus. It is very important to further enhance municipal waste valorisation, once that it is a promising source of bioenergy, as can be seen in the presented results.

As for the other biomass sources presented in this work (animal husbandry effluents, agricultural and food industries and energy crops), they also assume an interesting role in bioenergy production, although not as an important one as the ones previously mentioned. These present a total of less that 5% in the total amount of bioenergy that is possible to be yielded in the Centre Region of Portugal. Nevertheless, over time their contribution may be dire to the total production of bioenergy.

The Centre Region of Portugal has, in general, great potential for the use of biomass for the production of bioenergy. As can be seen in the final results, the interior region of the study area is the one with higher bioenergy potential yield. This fact may bring several consequences to these areas, in which local richness may be enhanced. By yielding the available biomass, jobs will be created for the local population. This is an important factor, once that the inner region of Portugal is increasingly being abandoned by locals looking for employment in large, coastal cities. Reactivating these rural areas and giving them a sustainable way to earn money would greatly help the overall conditions of this population. It would also have the added bonus of fixing the remaining population in that area, once that secondary production from producers would render, hence promoting a secondary income. For example, a farmer that has his annual production and his normal revenue, may have another source of income from selling the produced residues from his crops.

An extremely important aspect has to be referred when taking into consideration the production of bioenergy. Caution must be taken in yielding these wastes, because the amount of energy that is used to produce, treat and transform the residues just might not compensate their use. In direct

reference to this particular study, this will probably be the case of the energy crops. Perhaps the problem is in how the final value was achieved and in how the model was created, where a new solution has to be explored as to make feasible the use of this source. Or, simply enough, this may possibly be a type of activity without great expression in the study area.

A way to overpass these types of problems and to fully yield the benefits that they bring, is by using inter-municipal or inter-stakeholder collaborations. These should certainly be done as to achieve some degree of sustainability. This way, the weight of the production costs would be distributed throughout the participating entities, whereas, if each entity had a treatment infrastructure of their own, costs would probably be sky high, and the transformation of these materials unviable. Another type of infra-structure that would help in minimizing costs, would be the creation of intermediate storage points throughout the study territory, as to simplify the trajectory for the collection vehicles. This would lead to fewer collection and transportation costs of the material.

Not only territorial issues influence the ability to produce bioenergy in a given location. Pertinent observations are made in the *Agência para a Energia* document – Fórum "Energias Renováveis em Portugal" (Agência para a Energia, 2001), where it points out that other political, economical and educational pressures may debilitate the use of biomass. Several relevant recommendations are made, from which this study will refer the ones found most pertinent. A major restraint nowadays in producing bioenergy is related with the price paid for this production. Biomass production in Portugal does not have a Green Tariff rate, as do the remaining renewable sources of energy. This rate valorises the environmental and social aspects, making the production of bioenergy through biomass more competitive with other sources of energy, be them fossil fuels or other renewable endogenous sources. An added constraint for this production is the unfamiliarity of the general public to these issues. A promotion and divulgation of these energies should be done next to the main stakeholders, mainly the producers, focussing on the environmental, economic and energetic benefits of these technologies. This education may be done through field campaigns, as well as with vocational training. And lastly, technological matters should also be considered, once local industries may not be adapted to the type of waste they are transforming. Due support has to be given to industries in order to promote a higher energetic yield from the various forms of biomass.

The location of the Bioenergy Competency Centre is the second result from the present study. This analysis is of great importance, once it will help all interested parts in easily reaching this Centre. Globally, the main results point to more adequate areas in the inland area. This result is highly desirable, where, once again, local development will be supported and the creation of more employment in the implementation area will occur. Varying the weights of the input information has

little influence in what respects to the actual location of the BCC. Normally favourable results landed pretty much in the same municipalities for all four scenarios. What varied greatly between these scenarios was the amount of available area in each classification. Being that the dimensions of the BCC are projected to be relatively small, a great amount of possible implementation area is available to be selected for the location of the Centre.

## 5.2. Limitations

Although being a greatly enticing study, at times it was felt that the hardships surpassed the gains. Several difficulties were felt, mainly throughout the data collection part of this work. The main difficulty started with the amount of information to collect: one hundred municipalities correspond to one hundred pieces of information multiplied by several sources of bioenergy. This fact wouldn't really be as discouraging if the information were easily accessible. On the contrary: most information was extremely hard to come upon and scattered throughout the various official organisms that create it. It is especially hard to come upon when we are looking for one that is freely available. Results of this research resulted in a rather complete dataset, although one that is very dated in some cases (e.g., INE values from the 1999 agricultural census). Another problem was collecting information at the same scale for the entire region and different data sources. Some would have information at a NUTS III level, other at a municipality level and still, other at a parish level. Combining, treating and transforming all these parameters for all municipalities was an especially hard and time consuming task. By having a rather large study area, several particularities of each and every municipality had to be overlooked. This study only presents an initial evaluation of the bioenergy potential, and not an in depth analysis for a given municipality. Regrettably, these small particularities may come to influence the final result of the potential for the municipality. That is why further studies have to be done in the future as to verify in detail the actual potential for a given municipality.

Another aspect that can be pointed out is the adaptability of the resulting models. In a fairly easy way, one can open the created tool and alter whatever needed parameters as to meet emerging requirements. All that would be needed afterwards would be to run the model, and in a brief moment, new results would emerge. This is an extremely important aspect of these tools. Knowing that reality today may not be the same as the one tomorrow, flexible tools have to be created in order to accompany the necessary changes. This was a consideration taken into great account when constructing the resulting tools.

## 5.3. Future work

As to enhance the presented results, some alterations/improvements are necessary in the future.

The first step would be to insert recent information into the model, as it is published by the several official entities. As referred before, INE is working on the recent agricultural census but, unfortunately, this information was not published before the conclusion of this work. Once that the previous information is 11 years old, certainly much has changed, so it would be very interesting to see how final results would alter with the entry of recent data. Other information such as forest fires changes constantly, where no year is alike. A regular update work has to be made as to keep information concurrent with what happens in the territory.

By inserting the transformations rates into the final results, these would present themselves as more realistic. Saying that a given area has a total bioenergy of, for example, 1.500 toe doesn't really represent the reality of that fact. Transformation yields for different technologies have to be taken into consideration in order to actually determine the potential for bioenergy. Nonetheless, we have to take into consideration that technology is rapidly changing, promoting ever higher transformation yields. This fact leads to the previous point: by constantly updating the information, it will represent what is really happening in the study area, in terms of bioenergy potential.

There are still various types of waste not considered in this work that would probably present themselves as a viable source for bioenergy. Biogas from sludge treatment from wastewater treatment plants is a key factor that would certainly influence the final result. Unfortunately, the solicited information to the due official office was not received in time to be included in this study. Thus, it would be extremely interesting to see in which way biogas from wastewater treatment plants effect in producing bioenergy in the Centre Region of Portugal. Other sources are available that weren't included in this study, such as industrial sources. Residues from factories that use materials such as bark, leather, wood, tyre fluff, ... are also passable to be used as a viable source of bioenergy. Being so, they can be included in this study in the future.

Close attention has to be paid to the municipal solid waste resource. In the close future, another type of facilities are going to be implemented in Portugal, where all municipal residues will be divided and duly treated, taking onto account the type of material (organic valorisation, recycling, ...). The aim is to drastically minimize inputs in landfills. This may mean a higher yield for bioenergy production. However, being that the landfills will start receiving lesser amount of residues (biodegradable and non-biodegradable), a change in its behaviour may occur in terms of biogas production. There is currently no bibliographical information as to explain or foresee what will

happen. This way, the only solution will be to accompany up close this situation and adapt the constructed model where necessary.

An important final step to validate the resulting information would be to make a Strengths, Weaknesses, Opportunities and Threats analysis (SWOT). The aim would be to analyse the feasibility of the use of the different types of biomass in order to make a well-founded decision. This is very important because we want our bioenergy production to have a positive energy balance, as well as to be profitable. Only after a study of this type may bioenergy production fully get underway in the Centre Region of Portugal.

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# ANNEXES

*Annex 1: List of the NUTS III and respective municipalities of the Centre region of Portugal*

Table A1.1: The Centre Region of Portugal: municipalities and NUTS III regions.

| NUTS III | Municipality | Area (ha) |
|---|---|---|
| *Baixo Vouga* (180.420,20ha) | Águeda | 33.527,44 |
| | Albergaria-a-Velha | 15.882,50 |
| | Anadia | 21.663,48 |
| | Aveiro | 19.746,72 |
| | Estarreja | 10.817,33 |
| | Ílhavo | 7.347,25 |
| | Mealhada | 11.065,66 |
| | Murtosa | 7.308,78 |
| | Oliveira do Bairro | 8.731,99 |
| | Ovar | 14.768,33 |
| | Sever do Vouga | 13.069,22 |
| | Vagos | 16.491,50 |
| *Baixo Mondego* (206.278,97ha) | Cantanhede | 39.088,02 |
| | Coimbra | 31.939,94 |
| | Condeixa-a-Nova | 13.867,47 |
| | Figueira da Foz | 37.904,94 |
| | Mira | 12.403,07 |
| | Montemor-o-Velho | 22.896,23 |
| | Penacova | 21.673,23 |
| | Soure | 26.506,07 |
| *Pinhal Litoral* (174.362,80ha) | Batalha | 10.341,20 |
| | Leiria | 56.506,97 |
| | Marinha Grande | 18.724,45 |
| | Pombal | 62.606,93 |
| | Porto de Mós | 26.183,20 |
| *Pinhal Interior Norte* (261.652,50ha) | Alvaiázere | 16.047,70 |
| | Ansião | 17.614,90 |
| | Arganil | 33.283,93 |
| | Castanheira de Pêra | 6.677,45 |
| | Figueiró dos Vinhos | 17.344,00 |
| | Góis | 26.330,19 |
| | Lousã | 13.840,01 |
| | Miranda do Corvo | 12.637,79 |
| | Oliveira do Hospital | 23.451,66 |
| | Pampilhosa da Serra | 39.646,24 |
| | Penela | 13.480,00 |
| | Tábua | 19.978,58 |
| | Vila Nova de Poiares | 8.445,30 |
| | Pedrógão Grande | 12.874,75 |
| *Dão Lafões* (348.893,30 ha) | Aguiar da Beira | 20.676,57 |
| | Carregal do Sal | 11.689,21 |
| | Castro Daire | 37.905,51 |
| | Mangualde | 21.925,56 |
| | Mortágua | 25.117,82 |
| | Nelas | 12.571,48 |
| | Oliveira de Frades | 14.534,62 |
| | Penalva do Castelo | 13.433,92 |
| | Santa Comba Dão | 11.194,77 |
| | São Pedro do Sul | 34.895,09 |
| | Sátão | 20.194,11 |
| | Tondela | 37.121,73 |
| | Vila Nova de Paiva | 17.553,28 |
| | Viseu | 50.710,14 |
| | Vouzela | 19.369,46 |

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| NUTS III | Municipality | Area (ha) |
|---|---|---|
| *Pinhal Interior Sul* (190.474,90 ha) | Mação | 40.000,72 |
| | Oleiros | 47.109,17 |
| | Proença-a-Nova | 39.537,97 |
| | Sertã | 44.672,55 |
| | Vila de Rei | 19.154,49 |
| *Serra da Estrela* (86.775,05 ha) | Fornos de Algodres | 13.145,05 |
| | Gouveia | 30.061,17 |
| | Seia | 43.568,83 |
| *Beira Interior Norte* (406.262,20 ha) | Almeida | 51.798,46 |
| | Celorico da Beira | 24.721,63 |
| | Figueira de Castelo Rodrigo | 50.857,46 |
| | Guarda | 71.209,57 |
| | Manteigas | 12.197,55 |
| | Mêda | 28.604,92 |
| | Pinhel | 48.452,12 |
| | Sabugal | 82.268,03 |
| | Trancoso | 36.152,47 |
| *Beira Interior Sul* (374.824,10 ha) | Castelo Branco | 143.818,64 |
| | Idanha-a-Nova | 141.633,64 |
| | Penamacor | 56.380,87 |
| | Vila Velha de Ródão | 32.990,90 |
| *Cova da Beira* (137.447,90 ha) | Belmonte | 11.875,91 |
| | Covilhã | 55.560,06 |
| | Fundão | 70.011,92 |
| *Oeste* (222.016,91 ha) | Alcobaça | 40.813,71 |
| | Bombarral | 9.128,12 |
| | Caldas da Rainha | 25.571,24 |
| | Nazaré | 8.243,64 |
| | Óbidos | 14.155,70 |
| | Peniche | 7.755,06 |
| | Alenquer | 30.422,16 |
| | Arruda dos Vinhos | 7.794,97 |
| | Cadaval | 17.491,47 |
| | Lourinhã | 14.717,38 |
| | Sobral de Monte Agraço | 5.209,69 |
| | Torres Vedras | 40.713,76 |
| *Médio Tejo* (230.600,51 ha) | Abrantes | 71.471,63 |
| | Alcanena | 12.733,36 |
| | Constância | 8.037,21 |
| | Entroncamento | 1.372,94 |
| | Ferreira do Zêzere | 19.038,58 |
| | Sardoal | 9.214,68 |
| | Tomar | 35.120,64 |
| | Torres Novas | 26.999,65 |
| | Vila Nova da Barquinha | 4.955,89 |
| | Ourém | 41.655,92 |

*Annex 2: Characterization information of the Centre Region of Portugal*

Table A2.1: Meteorological summary of the Centre Region of Portugal.

| Meteorological station | | | | Aveiro | Coimbra | Viseu | Penhas Douradas | Guarda | Leiria | Castelo Branco |
|---|---|---|---|---|---|---|---|---|---|---|
| Annual average temperature | Med. | | ºC | 15,3 | 15,5 | 13,2 | 9,2 | 11,7 | 15,0 | 15,7 |
| | Min. | | | 11,4 | 10,9 | 8,2 | 5,7 | 7,3 | 9,5 | 10,1 |
| | Max. | | | 19,1 | 20,1 | 18,2 | 12,7 | 15,4 | 20,5 | 21,3 |
| Warmest month | Month | | | Jul. | Jul./Aug. | Aug. | Aug. | Aug. | Aug. | Aug. |
| | Monthly average temperature | Med. | ºC | 19,7 | 21,0 | 20,1 | 17,0 | 19,2 | 20,0 | 24,1 |
| | | Min. | | 16,0 | 15,0 | 13,7 | 12,2 | 12,9 | 15,0 | 16,2 |
| | | Max. | | 23,4 | 27,1 | 26,5 | 21,7 | 25,4 | 24,9 | 31,9 |
| Coldest month | Month | | | Dec. | Dec. | Dec. | Dec. | Dec. | Nov./Dec. | Dec. |
| | Monthly average temperature | Med. | ºC | 9,6 | 9,3 | 6,8 | 3,2 | 4,1 | 9,4 | 8,4 |
| | | Min. | | 5,9 | 5,9 | 3,7 | 0,5 | 1,3 | 3,0 | 4,1 |
| | | Max. | | 13,2 | 12,6 | 9,9 | 5,9 | 6,8 | 14,1 | 12,6 |
| Precipitation | Annual | Total | mm | 849,7 | 801,5 | 1.049,5 | 1.212,7 | - | - | 568,2 |
| | | Rainless days | N.º | 250 | 227 | 230 | 260 | - | - | 266 |
| | Daily max. | | mm | 36,0 | 39,9 | 180,4 | 148,7 | - | - | 58,2 |
| | Month of highest precipitation | Month | | Apr. | Apr. | Apr. | Apr. | - | - | Apr. |
| | | Total | mm | 235,0 | 321,1 | 321,1 | 279,9 | - | - | 161,5 |
| | Month of lowest precipitation | Month | | Jul. | Jul. | Jul. | Jul. | - | - | Jul. |
| | | Total | mm | 6 | 6 | 5 | 5 | - | - | 0 |

*(Instituto Nacional de Estatística, 2009)*

Table A2.2: Main crops production in 2008.

| Crops | | | Crop area | Production | Production per hectare |
|---|---|---|---|---|---|
| | | | ha | t | |
| Temporary crops | Cereals | Wheat | 6.073 | 14.277 | 2,4 |
| | | Maize | 34.204 | 174.015 | 5,1 |
| | | Oat | 6.203 | 5.195 | 0,8 |
| | | Rye | 5.921 | 5.234 | 0,9 |
| | | Barley | 626 | 566 | 0,9 |
| | Others | Potato | 15.208 | 228.470 | 15,0 |
| | | Bean | 2.680 | 1.659 | 0,6 |
| Permanent crops | Citrus fruits | Orange | 2.125 | 9.731 | 4,6 |
| | | Tangerine | 95 | 364 | 3,8 |
| | Fresh fruits | Apple | 12.383 | 148.159 | 12.0 |
| | | Pear | 11.401 | 179.362 | 15,7 |
| | | Fig | 2.648 | 459 | 0,2 |
| | | Peach | 2.963 | 28.657 | 9,7 |
| | | Cherry | 2.466 | 6560 | 2,7 |
| | Nut fruits | Almond | 1.444 | 690 | 0,5 |
| | | Chestnut | 3.176 | 2.824 | 0,9 |
| | Others | Table olive | 2.838 | 1.306 | 0,5 |
| | | Dessert grapes | 2.145 | 19.855 | 9.3 |
| Other crops in the region | Rice | | 6.361 | 30.744 | 4,8 |
| | Sugar beet | | 112 | 10.444 | 93,3 |
| | Walnut | | 846 | 937 | 1,1 |
| | Tobacco | | 828 | 877 | 1,1 |
| | Tomato for industry | | 177 | 11.039 | 62,4 |

*(Instituto Nacional de Estatística, 2009)*

*Annex 3: Forest Biomass Residues:*

Table A3.1: Bioenergy potential (toe) for forest stands per municipality: Maritime pine.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 2.829,00 | 1.060 | 2.998,74 | 4.000 | **1.199,50** |
| | Albergaria-a-Velha | 1.034,00 | 1.060 | 1.096,04 | 4.000 | **438,42** |
| | Anadia | 1.541,00 | 1.060 | 1.633,46 | 4.000 | **653,38** |
| | Aveiro | 1.025,00 | 1.060 | 1.086,50 | 4.000 | **434,60** |
| | Estarreja | 571,00 | 1.060 | 605,26 | 4.000 | **242,10** |
| | Ílhavo | 1.130,00 | 1.060 | 1.197,80 | 4.000 | **479,12** |
| | Mealhada | 2.701,00 | 1.060 | 2.863,06 | 4.000 | **1.145,22** |
| | Murtosa | 918,00 | 1.060 | 973,08 | 4.000 | **389,23** |
| | Oliveira do Bairro | 565,00 | 1.060 | 598,90 | 4.000 | **239,56** |
| | Ovar | 4.572,00 | 1.060 | 4.846,32 | 4.000 | **1.938,53** |
| | Sever do Vouga | 2.040,00 | 1.060 | 2.162,40 | 4.000 | **864,96** |
| | Vagos | 5.351,00 | 1.060 | 5.672,06 | 4.000 | **2.268,82** |
| ***Baixo Mondego*** | Cantanhede | 14.860,00 | 1.060 | 15.751,60 | 4.000 | **6.300,64** |
| | Coimbra | 4.041,00 | 1.060 | 4.283,46 | 4.000 | **1.713,38** |
| | Condeixa-a-Nova | 4.157,00 | 1.060 | 4.406,42 | 4.000 | **1.762,57** |
| | Figueira da Foz | 12.243,00 | 1.060 | 12.977,58 | 4.000 | **5.191,03** |
| | Mira | 6.044,00 | 1.060 | 6.406,64 | 4.000 | **2.562,66** |
| | Montemor-o-Velho | 4.403,00 | 1.060 | 4.667,18 | 4.000 | **1.866,87** |
| | Penacova | 4.749,00 | 1.060 | 5.033,94 | 4.000 | **2.013,58** |
| | Soure | 6.172,00 | 1.060 | 6.542,32 | 4.000 | **2.616,93** |
| ***Pinhal Litoral*** | Batalha | 1.981,00 | 1.060 | 2.099,86 | 4.000 | **839,94** |
| | Leiria | 20.641,00 | 1.060 | 21.879,46 | 4.000 | **8.751,78** |
| | Marinha Grande | 11.648,00 | 1.060 | 12.346,88 | 4.000 | **4.938,75** |
| | Pombal | 22.230,00 | 1.060 | 23.563,80 | 4.000 | **9.425,52** |
| | Porto de Mós | 2.965,00 | 1.060 | 3.142,90 | 4.000 | **1.257,16** |
| ***Pinhal Interior Norte*** | Arganil | 11.078,00 | 1.060 | 11.742,68 | 4.000 | **4.697,07** |
| | Góis | 8.631,00 | 1.060 | 9.148,86 | 4.000 | **3.659,54** |
| | Lousã | 5.201,00 | 1.060 | 5.513,06 | 4.000 | **2.205,22** |
| | Miranda do Corvo | 2.900,00 | 1.060 | 3.074,00 | 4.000 | **1.229,60** |
| | Oliveira do Hospital | 7.712,00 | 1.060 | 8.174,72 | 4.000 | **3.269,89** |
| | Pampilhosa da Serra | 8.482,00 | 1.060 | 8.990,92 | 4.000 | **3.596,37** |
| | Penela | 4.163,00 | 1.060 | 4.412,78 | 4.000 | **1.765,11** |
| | Tábua | 4.704,00 | 1.060 | 4.986,24 | 4.000 | **1.994,50** |
| | Vila Nova de Poiares | 1.712,00 | 1.060 | 1.814,72 | 4.000 | **725,89** |
| | Alvaiázere | 2.906,00 | 1.060 | 3.080,36 | 4.000 | **1.232,14** |
| | Ansião | 5.267,00 | 1.060 | 5.583,02 | 4.000 | **2.233,21** |
| | Castanheira de Pêra | 2.585,00 | 1.060 | 2.740,10 | 4.000 | **1.096,04** |
| | Figueiró dos Vinhos | 3.924,00 | 1.060 | 4.159,44 | 4.000 | **1.663,78** |
| | Pedrógão Grande | 6.181,00 | 1.060 | 6.551,86 | 4.000 | **2.620,74** |
| ***Dão Lafões*** | Aguiar da Beira | 8.431,00 | 1.060 | 8.936,86 | 4.000 | **3.574,74** |
| | Carregal do Sal | 3.648,00 | 1.060 | 3.866,88 | 4.000 | **1.546,75** |
| | Castro Daire | 11.184,00 | 1.060 | 11.855,04 | 4.000 | **4.742,02** |
| | Mangualde | 6.101,00 | 1.060 | 6.467,06 | 4.000 | **2.586,82** |
| | Mortágua | 2.581,00 | 1.060 | 2.735,86 | 4.000 | **1.094,34** |
| | Nelas | 3.103,00 | 1.060 | 3.289,18 | 4.000 | **1.315,67** |
| | Oliveira de Frades | 3.588,00 | 1.060 | 3.803,28 | 4.000 | **1.521,31** |
| | Penalva do Castelo | 3.838,00 | 1.060 | 4.068,28 | 4.000 | **1.627,31** |
| | Santa Comba Dão | 2.564,00 | 1.060 | 2.717,84 | 4.000 | **1.087,14** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 13.289,00 | 1.060 | 14.086,34 | 4.000 | **5.634,54** |
| | Sátão | 8.223,00 | 1.060 | 8.716,38 | 4.000 | **3.486,55** |
| | Tondela | 11.354,00 | 1.060 | 12.035,24 | 4.000 | **4.814,10** |
| | Vila Nova de Paiva | 3.663,00 | 1.060 | 3.882,78 | 4.000 | **1.553,11** |
| | Viseu | 18.413,00 | 1.060 | 19.517,78 | 4.000 | **7.807,11** |
| | Vouzela | 6.250,00 | 1.060 | 6.625,00 | 4.000 | **2.650,00** |
| ***Pinhal Interior Sul*** | Oleiros | 14.606,00 | 1.060 | 15.482,36 | 4.000 | **6.192,94** |
| | Proença-a-Nova | 10.868,00 | 1.060 | 11.520,08 | 4.000 | **4.608,03** |
| | Sertã | 12.208,00 | 1.060 | 12.940,48 | 4.000 | **5.176,19** |
| | Vila de Rei | 3.047,00 | 1.060 | 3.229,82 | 4.000 | **1.291,93** |
| | Mação | 11.285,00 | 1.060 | 11.962,10 | 4.000 | **4.784,84** |
| ***Serra Estrela*** | Fornos de Algodres | 1.982,00 | 1.060 | 2.100,92 | 4.000 | **840,37** |
| | Gouveia | 2.611,00 | 1.060 | 2.767,66 | 4.000 | **1.107,06** |
| | Seia | 4.350,00 | 1.060 | 4.611,00 | 4.000 | **1.844,40** |
| ***Beira Interior Norte*** | Almeida | 3.845,00 | 1.060 | 4.075,70 | 4.000 | **1.630,28** |
| | Celorico da Beira | 2.366,00 | 1.060 | 2.507,96 | 4.000 | **1.003,18** |
| | Fig. Castelo Rodrigo | 2.248,00 | 1.060 | 2.382,88 | 4.000 | **953,15** |
| | Guarda | 5.592,00 | 1.060 | 5.927,52 | 4.000 | **2.371,01** |
| | Manteigas | 1.338,00 | 1.060 | 1.418,28 | 4.000 | **567,31** |
| | Meda | 2.459,00 | 1.060 | 2.606,54 | 4.000 | **1.042,62** |
| | Pinhel | 3.410,00 | 1.060 | 3.614,60 | 4.000 | **1.445,84** |
| | Sabugal | 5.252,00 | 1.060 | 5.567,12 | 4.000 | **2.226,85** |
| | Trancoso | 5.392,00 | 1.060 | 5.715,52 | 4.000 | **2.286,21** |
| ***Beira Interior Sul*** | Castelo Branco | 22.882,00 | 1.060 | 24.254,92 | 4.000 | **9.701,97** |
| | Idanha-a-Nova | 10.634,00 | 1.060 | 11.272,04 | 4.000 | **4.508,82** |
| | Penamacor | 12.459,00 | 1.060 | 13.206,54 | 4.000 | **5.282,62** |
| | Vila Velha de Ródão | 4.851,00 | 1.060 | 5.142,06 | 4.000 | **2.056,82** |
| ***Cova Beira*** | Belmonte | 595,00 | 1.060 | 630,70 | 4.000 | **252,28** |
| | Covilhã | 12.964,00 | 1.060 | 13.741,84 | 4.000 | **5.496,74** |
| | Fundão | 13.497,00 | 1.060 | 14.306,82 | 4.000 | **5.722,73** |
| ***Oeste*** | Alcobaça | 10.215,00 | 1.060 | 10.827,90 | 4.000 | **4.331,16** |
| | Bombarral | 222,00 | 1.060 | 235,32 | 4.000 | **94,13** |
| | Caldas da Rainha | 1.595,00 | 1.060 | 1.690,70 | 4.000 | **676,28** |
| | Nazaré | 4.275,00 | 1.060 | 4.531,50 | 4.000 | **1.812,60** |
| | Óbidos | 909,00 | 1.060 | 963,54 | 4.000 | **385,42** |
| | Peniche | 470,00 | 1.060 | 498,20 | 4.000 | **199,28** |
| | Alenquer | 542,00 | 1.060 | 574,52 | 4.000 | **229,81** |
| | Arruda dos Vinhos | 84,00 | 1.060 | 89,04 | 4.000 | **35,62** |
| | Cadaval | 342,00 | 1.060 | 362,52 | 4.000 | **145,01** |
| | Lourinhã | 181,00 | 1.060 | 191,86 | 4.000 | **76,74** |
| | Sobral de Monte Agraço | 87,00 | 1.060 | 92,22 | 4.000 | **36,89** |
| | Torres Vedras | 778,00 | 1.060 | 824,68 | 4.000 | **329,87** |
| ***Médio Tejo*** | Abrantes | 9.206,00 | 1.060 | 9.758,36 | 4.000 | **3.903,34** |
| | Alcanena | 741,00 | 1.060 | 785,46 | 4.000 | **314,18** |
| | Constância | 581,00 | 1.060 | 615,86 | 4.000 | **246,34** |
| | Entroncamento | 35,00 | 1.060 | 37,10 | 4.000 | **14,84** |
| | Ferreira do Zêzere | 2.078,00 | 1.060 | 2.202,68 | 4.000 | **881,07** |
| | Sardoal | 4.446,00 | 1.060 | 4.712,76 | 4.000 | **1.885,10** |
| | Tomar | 3.446,00 | 1.060 | 3.652,76 | 4.000 | **1.461,10** |
| | Torres Novas | 1.796,00 | 1.060 | 1.903,76 | 4.000 | **761,50** |
| | Vila Nova da Barquinha | 412,00 | 1.060 | 436,72 | 4.000 | **174,69** |
| | Ourém | 9.312,00 | 1.060 | 9.870,72 | 4.000 | **3.948,29** |
| | **Total** | **544.581,00** | **-** | **577.255,86** | **-** | **230.902,34** |

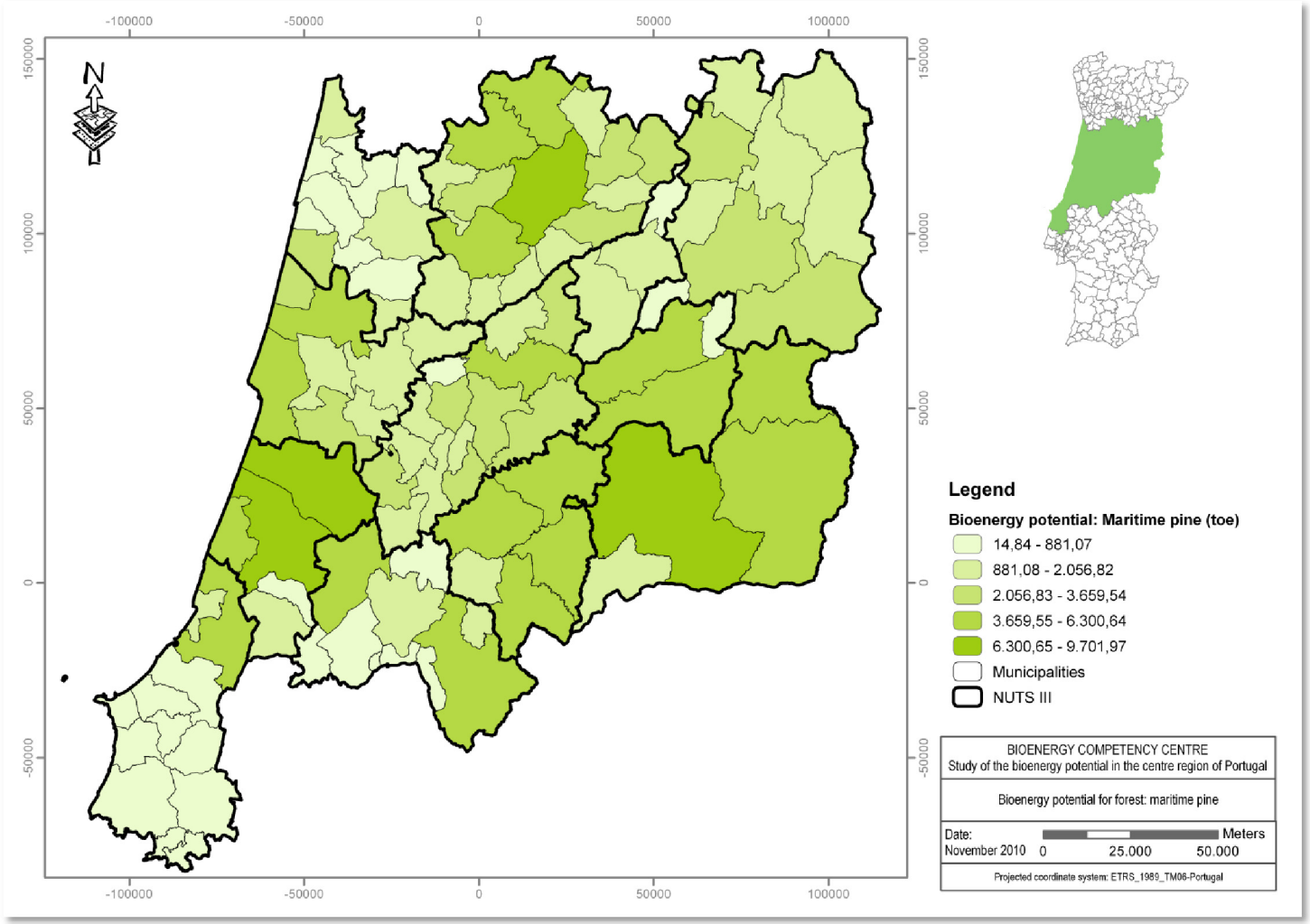


Figure A3.1: Map for the bioenergy potential for maritime pine stand residues.

Table A3.2: Bioenergy potential (toe) for forest stands per municipality: Cork Oak.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Anadia | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Aveiro | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Estarreja | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Ílhavo | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Mealhada | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Murtosa | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Oliveira do Bairro | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Ovar | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Sever do Vouga | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Vagos | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Coimbra | 25,00 | 1.350 | 33,75 | 3.400 | **11,48** |
| | Condeixa-a-Nova | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Figueira da Foz | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Mira | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Montemor-o-Velho | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Penacova | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Soure | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 1,00 | 1.350 | 1,35 | 3.400 | **0,46** |
| | Leiria | 202,00 | 1.350 | 272,70 | 3.400 | **92,72** |
| | Marinha Grande | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Pombal | 5,00 | 1.350 | 6,75 | 3.400 | **2,30** |
| | Porto de Mós | 80,00 | 1.350 | 108,00 | 3.400 | **36,72** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Góis | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Lousã | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Miranda do Corvo | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Oliveira do Hospital | 25,00 | 1.350 | 33,75 | 3.400 | **11,48** |
| | Pampilhosa da Serra | 1,00 | 1.350 | 1,35 | 3.400 | **0,46** |
| | Penela | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Tábua | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Alvaiázere | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Ansião | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Castanheira de Pêra | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Pedrógão Grande | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Carregal do Sal | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Castro Daire | 1,00 | 1.350 | 1,35 | 3.400 | **0,46** |
| | Mangualde | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Mortágua | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Nelas | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Oliveira de Frades | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Penalva do Castelo | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Santa Comba Dão | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Sátão | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Tondela | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Viseu | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Vouzela | 25,00 | 1.350 | 33,75 | 3.400 | **11,48** |
| ***Pinhal Interior Sul*** | Oleiros | 3,00 | 1.350 | 4,05 | 3.400 | **1,38** |
| | Proença-a-Nova | 2,00 | 1.350 | 2,70 | 3.400 | **0,92** |
| | Sertã | 2,00 | 1.350 | 2,70 | 3.400 | **0,92** |
| | Vila de Rei | 77,00 | 1.350 | 103,95 | 3.400 | **35,34** |
| | Mação | 27,00 | 1.350 | 36,45 | 3.400 | **12,39** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Gouveia | 26,00 | 1.350 | 35,10 | 3.400 | **11,93** |
| | Seia | 1,00 | 1.350 | 1,35 | 3.400 | **0,46** |
| ***Beira Interior Norte*** | Almeida | 155,00 | 1.350 | 209,25 | 3.400 | **71,15** |
| | Celorico da Beira | 72,00 | 1.350 | 97,20 | 3.400 | **33,05** |
| | Fig. Castelo Rodrigo | 147,00 | 1.350 | 198,45 | 3.400 | **67,47** |
| | Guarda | 176,00 | 1.350 | 237,60 | 3.400 | **80,78** |
| | Manteigas | 9,00 | 1.350 | 12,15 | 3.400 | **4,13** |
| | Meda | 137,00 | 1.350 | 184,95 | 3.400 | **62,88** |
| | Pinhel | 68,00 | 1.350 | 91,80 | 3.400 | **31,21** |
| | Sabugal | 181,00 | 1.350 | 244,35 | 3.400 | **83,08** |
| | Trancoso | 33,00 | 1.350 | 44,55 | 3.400 | **15,15** |
| ***Beira Interior Sul*** | Castelo Branco | 6.747,00 | 1.350 | 9.108,45 | 3.400 | **3.096,87** |
| | Idanha-a-Nova | 9.290,00 | 1.350 | 12.541,50 | 3.400 | **4.264,11** |
| | Penamacor | 3.432,00 | 1.350 | 4.633,20 | 3.400 | **1.575,29** |
| | Vila Velha de Ródão | 647,00 | 1.350 | 873,45 | 3.400 | **296,97** |
| ***Cova Beira*** | Belmonte | 15,00 | 1.350 | 20,25 | 3.400 | **6,89** |
| | Covilhã | 61,00 | 1.350 | 82,35 | 3.400 | **28,00** |
| | Fundão | 1.061,00 | 1.350 | 1.432,35 | 3.400 | **487,00** |
| ***Oeste*** | Alcobaça | 21,00 | 1.350 | 28,35 | 3.400 | **9,64** |
| | Bombarral | 3,00 | 1.350 | 4,05 | 3.400 | **1,38** |
| | Caldas da Rainha | 12,00 | 1.350 | 16,20 | 3.400 | **5,51** |
| | Nazaré | 2,00 | 1.350 | 2,70 | 3.400 | **0,92** |
| | Óbidos | 7,00 | 1.350 | 9,45 | 3.400 | **3,21** |
| | Peniche | 2,00 | 1.350 | 2,70 | 3.400 | **0,92** |
| | Alenquer | 1.201,00 | 1.350 | 1.621,35 | 3.400 | **551,26** |
| | Arruda dos Vinhos | 7,00 | 1.350 | 9,45 | 3.400 | **3,21** |
| | Cadaval | 6,00 | 1.350 | 8,10 | 3.400 | **2,75** |
| | Lourinhã | 7,00 | 1.350 | 9,45 | 3.400 | **3,21** |
| | Sobral de Monte Agraço | 2,00 | 1.350 | 2,70 | 3.400 | **0,92** |
| | Torres Vedras | 92,00 | 1.350 | 124,20 | 3.400 | **42,23** |
| ***Médio Tejo*** | Abrantes | 16.936,00 | 1.350 | 22.863,60 | 3.400 | **7.773,62** |
| | Alcanena | 263,00 | 1.350 | 355,05 | 3.400 | **120,72** |
| | Constância | 1.706,00 | 1.350 | 2.303,10 | 3.400 | **783,05** |
| | Entroncamento | 31,00 | 1.350 | 41,85 | 3.400 | **14,23** |
| | Ferreira do Zêzere | 177,00 | 1.350 | 238,95 | 3.400 | **81,24** |
| | Sardoal | 278,00 | 1.350 | 375,30 | 3.400 | **127,60** |
| | Tomar | 0,00 | 1.350 | 0,00 | 3.400 | **0,00** |
| | Torres Novas | 428,00 | 1.350 | 577,80 | 3.400 | **196,45** |
| | Vila Nova da Barquinha | 25,00 | 1.350 | 33,75 | 3.400 | **11,48** |
| | Ourém | 657,00 | 1.350 | 886,95 | 3.400 | **301,56** |
| | **Total** | **44.597,00** | **-** | **60.205,95** | **-** | **20.470,02** |

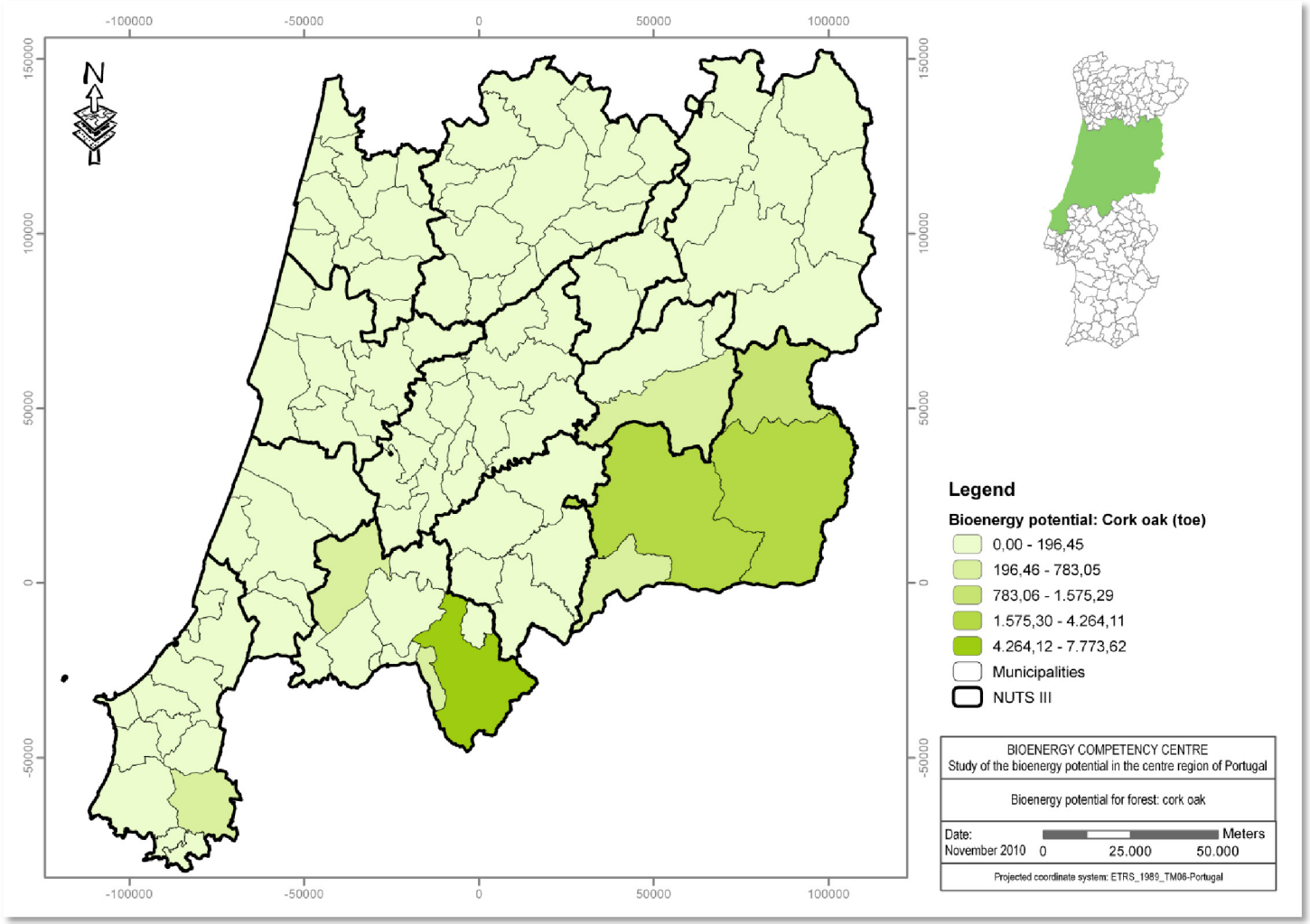


Figure A3.2: Map for the bioenergy potential for cork oak stand residues.

Table A3.3: Bioenergy potential (toe) for forest stands per municipality: Eucalyptus.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 16.833,00 | 875 | 14.728,88 | 3.500 | **5.155,11** |
| | Albergaria-a-Velha | 7.435,00 | 875 | 6.505,63 | 3.500 | **2.276,97** |
| | Anadia | 7.488,00 | 875 | 6.552,00 | 3.500 | **2.293,20** |
| | Aveiro | 2.256,00 | 875 | 1.974,00 | 3.500 | **690,90** |
| | Estarreja | 2.362,00 | 875 | 2.066,75 | 3.500 | **723,36** |
| | Ílhavo | 532,00 | 875 | 465,50 | 3.500 | **162,93** |
| | Mealhada | 2.344,00 | 875 | 2.051,00 | 3.500 | **717,85** |
| | Murtosa | 247,00 | 875 | 216,13 | 3.500 | **75,64** |
| | Oliveira do Bairro | 2.306,00 | 875 | 2.017,75 | 3.500 | **706,21** |
| | Ovar | 2.151,00 | 875 | 1.882,13 | 3.500 | **658,74** |
| | Sever do Vouga | 6.390,00 | 875 | 5.591,25 | 3.500 | **1.956,94** |
| | Vagos | 2.450,00 | 875 | 2.143,75 | 3.500 | **750,31** |
| ***Baixo Mondego*** | Cantanhede | 6.408,00 | 875 | 5.607,00 | 3.500 | **1.962,45** |
| | Coimbra | 5.211,00 | 875 | 4.559,63 | 3.500 | **1.595,87** |
| | Condeixa-a-Nova | 1.707,00 | 875 | 1.493,63 | 3.500 | **522,77** |
| | Figueira da Foz | 4.481,00 | 875 | 3.920,88 | 3.500 | **1.372,31** |
| | Mira | 1.149,00 | 875 | 1.005,38 | 3.500 | **351,88** |
| | Montemor-o-Velho | 2.842,00 | 875 | 2.486,75 | 3.500 | **870,36** |
| | Penacova | 9.648,00 | 875 | 8.442,00 | 3.500 | **2.954,70** |
| | Soure | 5.313,00 | 875 | 4.648,88 | 3.500 | **1.627,11** |
| ***Pinhal Litoral*** | Batalha | 867,00 | 875 | 758,63 | 3.500 | **265,52** |
| | Leiria | 6.462,00 | 875 | 5.654,25 | 3.500 | **1.978,99** |
| | Marinha Grande | 257,00 | 875 | 224,88 | 3.500 | **78,71** |
| | Pombal | 8.510,00 | 875 | 7.446,25 | 3.500 | **2.606,19** |
| | Porto de Mós | 994,00 | 875 | 869,75 | 3.500 | **304,41** |
| ***Pinhal Interior Norte*** | Arganil | 5.471,00 | 875 | 4.787,13 | 3.500 | **1.675,49** |
| | Góis | 8.280,00 | 875 | 7.245,00 | 3.500 | **2.535,75** |
| | Lousã | 1.869,00 | 875 | 1.635,38 | 3.500 | **572,38** |
| | Miranda do Corvo | 2.892,00 | 875 | 2.530,50 | 3.500 | **885,68** |
| | Oliveira do Hospital | 1.588,00 | 875 | 1.389,50 | 3.500 | **486,33** |
| | Pampilhosa da Serra | 5.338,00 | 875 | 4.670,75 | 3.500 | **1.634,76** |
| | Penela | 3.188,00 | 875 | 2.789,50 | 3.500 | **976,33** |
| | Tábua | 5.472,00 | 875 | 4.788,00 | 3.500 | **1.675,80** |
| | Vila Nova de Poiares | 2.267,00 | 875 | 1.983,63 | 3.500 | **694,27** |
| | Alvaiázere | 1.719,00 | 875 | 1.504,13 | 3.500 | **526,44** |
| | Ansião | 1.376,00 | 875 | 1.204,00 | 3.500 | **421,40** |
| | Castanheira de Pêra | 1.428,00 | 875 | 1.249,50 | 3.500 | **437,33** |
| | Figueiró dos Vinhos | 5.081,00 | 875 | 4.445,88 | 3.500 | **1.556,06** |
| | Pedrógão Grande | 3.089,00 | 875 | 2.702,88 | 3.500 | **946,01** |
| ***Dão Lafões*** | Aguiar da Beira | 412,00 | 875 | 360,50 | 3.500 | **126,18** |
| | Carregal do Sal | 1.574,00 | 875 | 1.377,25 | 3.500 | **482,04** |
| | Castro Daire | 944,00 | 875 | 826,00 | 3.500 | **289,10** |
| | Mangualde | 628,00 | 875 | 549,50 | 3.500 | **192,33** |
| | Mortágua | 16.533,00 | 875 | 14.466,38 | 3.500 | **5.063,23** |
| | Nelas | 565,00 | 875 | 494,38 | 3.500 | **173,03** |
| | Oliveira de Frades | 5.246,00 | 875 | 4.590,25 | 3.500 | **1.606,59** |
| | Penalva do Castelo | 296,00 | 875 | 259,00 | 3.500 | **90,65** |
| | Santa Comba Dão | 2.981,00 | 875 | 2.608,38 | 3.500 | **912,93** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 2.338,00 | 875 | 2.045,75 | 3.500 | **716,01** |
| | Sátão | 351,00 | 875 | 307,13 | 3.500 | **107,49** |
| | Tondela | 8.653,00 | 875 | 7.571,38 | 3.500 | **2.649,98** |
| | Vila Nova de Paiva | 302,00 | 875 | 264,25 | 3.500 | **92,49** |
| | Viseu | 1.920,00 | 875 | 1.680,00 | 3.500 | **588,00** |
| | Vouzela | 2.919,00 | 875 | 2.554,13 | 3.500 | **893,94** |
| ***Pinhal Interior Sul*** | Oleiros | 4.567,00 | 875 | 3.996,13 | 3.500 | **1.398,64** |
| | Proença-a-Nova | 4.210,00 | 875 | 3.683,75 | 3.500 | **1.289,31** |
| | Sertã | 4.560,00 | 875 | 3.990,00 | 3.500 | **1.396,50** |
| | Vila de Rei | 1.426,00 | 875 | 1.247,75 | 3.500 | **436,71** |
| | Mação | 5.870,00 | 875 | 5.136,25 | 3.500 | **1.797,69** |
| ***Serra Estrela*** | Fornos de Algodres | 28,00 | 875 | 24,50 | 3.500 | **8,58** |
| | Gouveia | 108,00 | 875 | 94,50 | 3.500 | **33,08** |
| | Seia | 661,00 | 875 | 578,38 | 3.500 | **202,43** |
| ***Beira Interior Norte*** | Almeida | 288,00 | 875 | 252,00 | 3.500 | **88,20** |
| | Celorico da Beira | 100,00 | 875 | 87,50 | 3.500 | **30,63** |
| | Fig. Castelo Rodrigo | 1.044,00 | 875 | 913,50 | 3.500 | **319,73** |
| | Guarda | 440,00 | 875 | 385,00 | 3.500 | **134,75** |
| | Manteigas | 20,00 | 875 | 17,50 | 3.500 | **6,13** |
| | Meda | 400,00 | 875 | 350,00 | 3.500 | **122,50** |
| | Pinhel | 190,00 | 875 | 166,25 | 3.500 | **58,19** |
| | Sabugal | 972,00 | 875 | 850,50 | 3.500 | **297,68** |
| | Trancoso | 193,00 | 875 | 168,88 | 3.500 | **59,11** |
| ***Beira Interior Sul*** | Castelo Branco | 16.594,00 | 875 | 14.519,75 | 3.500 | **5.081,91** |
| | Idanha-a-Nova | 13.581,00 | 875 | 11.883,38 | 3.500 | **4.159,18** |
| | Penamacor | 8.218,00 | 875 | 7.190,75 | 3.500 | **2.516,76** |
| | Vila Velha de Ródão | 8.092,00 | 875 | 7.080,50 | 3.500 | **2.478,18** |
| ***Cova Beira*** | Belmonte | 64,00 | 875 | 56,00 | 3.500 | **19,60** |
| | Covilhã | 1.072,00 | 875 | 938,00 | 3.500 | **328,30** |
| | Fundão | 4.687,00 | 875 | 4.101,13 | 3.500 | **1.435,39** |
| ***Oeste*** | Alcobaça | 4.480,00 | 875 | 3.920,00 | 3.500 | **1.372,00** |
| | Bombarral | 921,00 | 875 | 805,88 | 3.500 | **282,06** |
| | Caldas da Rainha | 5.862,00 | 875 | 5.129,25 | 3.500 | **1.795,24** |
| | Nazaré | 161,00 | 875 | 140,88 | 3.500 | **49,31** |
| | Óbidos | 3.725,00 | 875 | 3.259,38 | 3.500 | **1.140,78** |
| | Peniche | 568,00 | 875 | 497,00 | 3.500 | **173,95** |
| | Alenquer | 4.357,00 | 875 | 3.812,38 | 3.500 | **1.334,33** |
| | Arruda dos Vinhos | 99,00 | 875 | 86,63 | 3.500 | **30,32** |
| | Cadaval | 5.528,00 | 875 | 4.837,00 | 3.500 | **1.692,95** |
| | Lourinhã | 1.608,00 | 875 | 1.407,00 | 3.500 | **492,45** |
| | Sobral de Monte Agraço | 268,00 | 875 | 234,50 | 3.500 | **82,08** |
| | Torres Vedras | 7.583,00 | 875 | 6.635,13 | 3.500 | **2.322,29** |
| ***Médio Tejo*** | Abrantes | 17.983,00 | 875 | 15.735,13 | 3.500 | **5.507,29** |
| | Alcanena | 1.002,00 | 875 | 876,75 | 3.500 | **306,86** |
| | Constância | 2.236,00 | 875 | 1.956,50 | 3.500 | **684,78** |
| | Entroncamento | 75,00 | 875 | 65,63 | 3.500 | **22,97** |
| | Ferreira do Zêzere | 6.314,00 | 875 | 5.524,75 | 3.500 | **1.933,66** |
| | Sardoal | 1.338,00 | 875 | 1.170,75 | 3.500 | **409,76** |
| | Tomar | 7.001,00 | 875 | 6.125,88 | 3.500 | **2.144,06** |
| | Torres Novas | 1.089,00 | 875 | 952,88 | 3.500 | **333,51** |
| | Vila Nova da Barquinha | 2.171,00 | 875 | 1.899,63 | 3.500 | **664,87** |
| | Ourém | 4.681,00 | 875 | 4.095,88 | 3.500 | **1.433,56** |
| | **Total** | **357.798,00** | **-** | **313.073,25** | **-** | **109.575,64** |

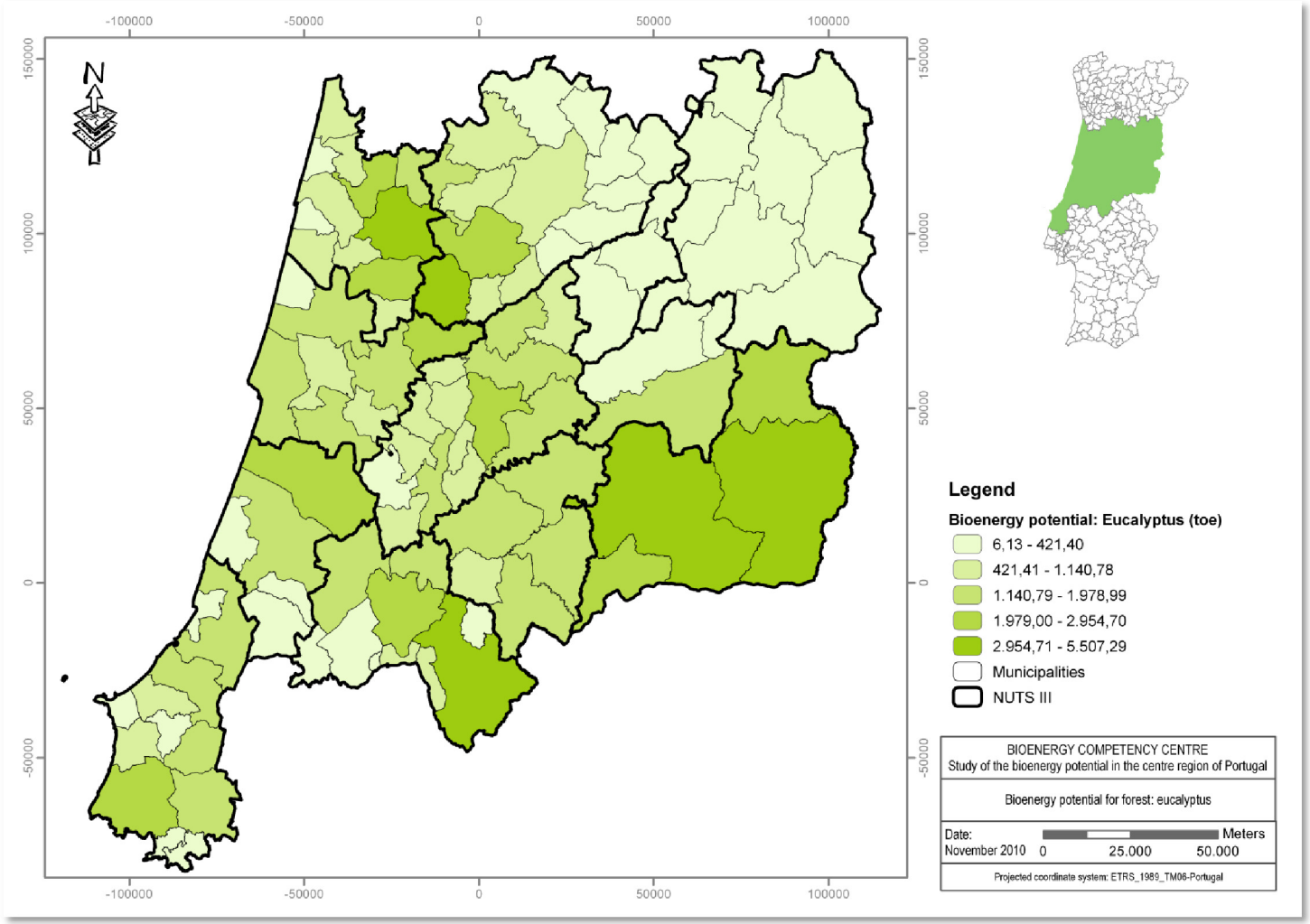


Figure A3.3: Map for the bioenergy potential for eucalyptus stand residues.

Table A3.4: Bioenergy potential (toe) for forest stands per municipality: Holm oak.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Anadia | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Aveiro | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Estarreja | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Ílhavo | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Mealhada | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Murtosa | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Oliveira do Bairro | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Ovar | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Sever do Vouga | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Vagos | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Coimbra | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Condeixa-a-Nova | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Figueira da Foz | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Mira | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Montemor-o-Velho | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Penacova | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Soure | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 25,00 | 875 | 21,88 | 3.400 | **7,44** |
| | Leiria | 26,00 | 875 | 22,75 | 3.400 | **7,74** |
| | Marinha Grande | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Pombal | 2,00 | 875 | 1,75 | 3.400 | **0,60** |
| | Porto de Mós | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Góis | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Lousã | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Miranda do Corvo | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Oliveira do Hospital | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Penela | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Tábua | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Alvaiázere | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Ansião | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Castanheira de Pêra | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Pedrógão Grande | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 25,00 | 875 | 21,88 | 3.400 | **7,44** |
| | Carregal do Sal | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Castro Daire | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| | Mangualde | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Mortágua | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Nelas | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Oliveira de Frades | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Penalva do Castelo | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Santa Comba Dão | 0,00 | 875 | 0,00 | 3.400 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| | Sátão | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Tondela | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Viseu | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| | Vouzela | 25,00 | 875 | 21,88 | 3.400 | **7,44** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Proença-a-Nova | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Sertã | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Vila de Rei | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Mação | 25,00 | 875 | 21,88 | 3.400 | **7,44** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Gouveia | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Seia | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| ***Beira Interior Norte*** | Almeida | 148,00 | 875 | 129,50 | 3.400 | **44,03** |
| | Celorico da Beira | 61,00 | 875 | 53,38 | 3.400 | **18,15** |
| | Fig. Castelo Rodrigo | 232,00 | 875 | 203,00 | 3.400 | **69,02** |
| | Guarda | 38,00 | 875 | 33,25 | 3.400 | **11,31** |
| | Manteigas | 53,00 | 875 | 46,38 | 3.400 | **15,77** |
| | Meda | 59,00 | 875 | 51,63 | 3.400 | **17,55** |
| | Pinhel | 204,00 | 875 | 178,50 | 3.400 | **60,69** |
| | Sabugal | 143,00 | 875 | 125,13 | 3.400 | **42,54** |
| | Trancoso | 18,00 | 875 | 15,75 | 3.400 | **5,36** |
| ***Beira Interior Sul*** | Castelo Branco | 8.145,00 | 875 | 7.126,88 | 3.400 | **2.423,14** |
| | Idanha-a-Nova | 10.760,00 | 875 | 9.415,00 | 3.400 | **3.201,10** |
| | Penamacor | 961,00 | 875 | 840,88 | 3.400 | **285,90** |
| | Vila Velha de Ródão | 1.022,00 | 875 | 894,25 | 3.400 | **304,05** |
| ***Cova Beira*** | Belmonte | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| | Covilhã | 4,00 | 875 | 3,50 | 3.400 | **1,19** |
| | Fundão | 103,00 | 875 | 90,13 | 3.400 | **30,64** |
| ***Oeste*** | Alcobaça | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Bombarral | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Caldas da Rainha | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Nazaré | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Óbidos | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Peniche | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Alenquer | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Cadaval | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Lourinhã | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Torres Vedras | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| ***Médio Tejo*** | Abrantes | 10,00 | 875 | 8,75 | 3.400 | **2,98** |
| | Alcanena | 2,00 | 875 | 1,75 | 3.400 | **0,60** |
| | Constância | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| | Entroncamento | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Ferreira do Zêzere | 26,00 | 875 | 22,75 | 3.400 | **7,74** |
| | Sardoal | 1,00 | 875 | 0,88 | 3.400 | **0,30** |
| | Tomar | 151,00 | 875 | 132,13 | 3.400 | **44,92** |
| | Torres Novas | 4,00 | 875 | 3,50 | 3.400 | **1,19** |
| | Vila Nova da Barquinha | 0,00 | 875 | 0,00 | 3.400 | **0,00** |
| | Ourém | 128,00 | 875 | 112,00 | 3.400 | **38,08** |
| | **Total** | **22.407,00** | **-** | **19.606,13** | **-** | **6.666,08** |

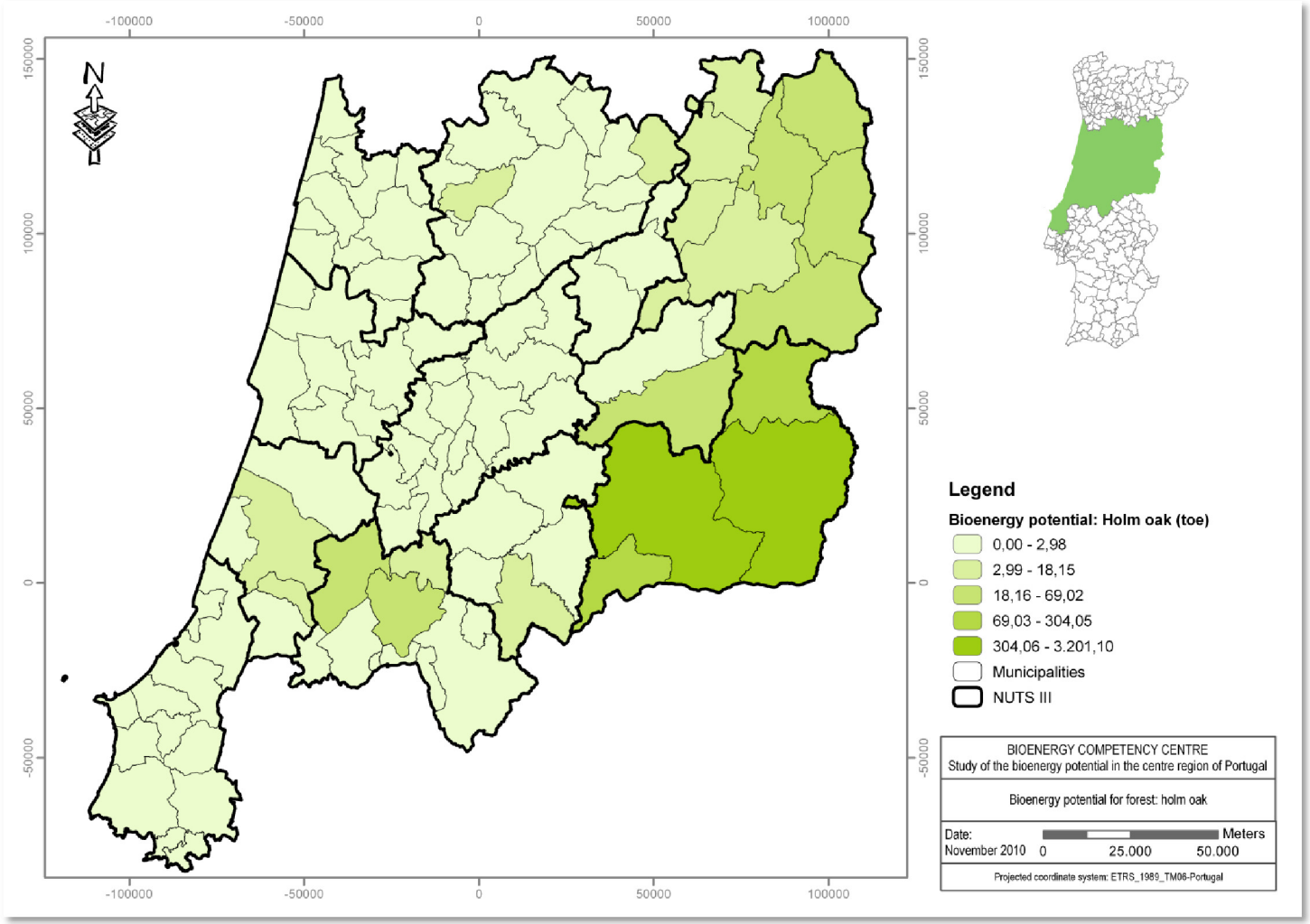


Figure A3.4: Map for the bioenergy potential for holm oak stand residues.

Table A3.5: Bioenergy potential (toe) for forest stands per municipality: Portuguese oak.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Albergaria-a-Velha | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Anadia | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Aveiro | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Estarreja | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ílhavo | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mealhada | 50,00 | 900 | 45,00 | 3.400 | **15,30** |
| | Murtosa | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Oliveira do Bairro | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ovar | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sever do Vouga | 101,00 | 900 | 90,90 | 3.400 | **30,91** |
| | Vagos | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Coimbra | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Condeixa-a-Nova | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| | Figueira da Foz | 50,00 | 900 | 45,00 | 3.400 | **15,30** |
| | Mira | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Montemor-o-Velho | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Penacova | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Soure | 175,00 | 900 | 157,50 | 3.400 | **53,55** |
| ***Pinhal Litoral*** | Batalha | 126,00 | 900 | 113,40 | 3.400 | **38,56** |
| | Leiria | 28,00 | 900 | 25,20 | 3.400 | **8,57** |
| | Marinha Grande | 26,00 | 900 | 23,40 | 3.400 | **7,96** |
| | Pombal | 603,00 | 900 | 542,70 | 3.400 | **184,52** |
| | Porto de Mós | 255,00 | 900 | 229,50 | 3.400 | **78,03** |
| ***Pinhal Interior Norte*** | Arganil | 387,00 | 900 | 348,30 | 3.400 | **118,42** |
| | Góis | 392,00 | 900 | 352,80 | 3.400 | **119,95** |
| | Lousã | 154,00 | 900 | 138,60 | 3.400 | **47,12** |
| | Miranda do Corvo | 4,00 | 900 | 3,60 | 3.400 | **1,22** |
| | Oliveira do Hospital | 361,00 | 900 | 324,90 | 3.400 | **110,47** |
| | Pampilhosa da Serra | 70,00 | 900 | 63,00 | 3.400 | **21,42** |
| | Penela | 57,00 | 900 | 51,30 | 3.400 | **17,44** |
| | Tábua | 258,00 | 900 | 232,20 | 3.400 | **78,95** |
| | Vila Nova de Poiares | 3,00 | 900 | 2,70 | 3.400 | **0,92** |
| | Alvaiázere | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ansião | 2.040,00 | 900 | 1.836,00 | 3.400 | **624,24** |
| | Castanheira de Pêra | 6,00 | 900 | 5,40 | 3.400 | **1,84** |
| | Figueiró dos Vinhos | 37,00 | 900 | 33,30 | 3.400 | **11,32** |
| | Pedrógão Grande | 5,00 | 900 | 4,50 | 3.400 | **1,53** |
| ***Dão Lafões*** | Aguiar da Beira | 371,00 | 900 | 333,90 | 3.400 | **113,53** |
| | Carregal do Sal | 78,00 | 900 | 70,20 | 3.400 | **23,87** |
| | Castro Daire | 1.687,00 | 900 | 1.518,30 | 3.400 | **516,22** |
| | Mangualde | 554,00 | 900 | 498,60 | 3.400 | **169,52** |
| | Mortágua | 125,00 | 900 | 112,50 | 3.400 | **38,25** |
| | Nelas | 173,00 | 900 | 155,70 | 3.400 | **52,94** |
| | Oliveira de Frades | 826,00 | 900 | 743,40 | 3.400 | **252,76** |
| | Penalva do Castelo | 394,00 | 900 | 354,60 | 3.400 | **120,56** |
| | Santa Comba Dão | 125,00 | 900 | 112,50 | 3.400 | **38,25** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1.208,00 | 900 | 1.087,20 | 3.400 | **369,65** |
| | Sátão | 620,00 | 900 | 558,00 | 3.400 | **189,72** |
| | Tondela | 727,00 | 900 | 654,30 | 3.400 | **222,46** |
| | Vila Nova de Paiva | 728,00 | 900 | 655,20 | 3.400 | **222,77** |
| | Viseu | 2.436,00 | 900 | 2.192,40 | 3.400 | **745,42** |
| | Vouzela | 836,00 | 900 | 752,40 | 3.400 | **255,82** |
| ***Pinhal Interior Sul*** | Oleiros | 2,00 | 900 | 1,80 | 3.400 | **0,61** |
| | Proença-a-Nova | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| | Sertã | 199,00 | 900 | 179,10 | 3.400 | **60,89** |
| | Vila de Rei | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| | Mação | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| ***Serra Estrela*** | Fornos de Algodres | 355,00 | 900 | 319,50 | 3.400 | **108,63** |
| | Gouveia | 833,00 | 900 | 749,70 | 3.400 | **254,90** |
| | Seia | 520,00 | 900 | 468,00 | 3.400 | **159,12** |
| ***Beira Interior Norte*** | Almeida | 5.149,00 | 900 | 4.634,10 | 3.400 | **1.575,59** |
| | Celorico da Beira | 698,00 | 900 | 628,20 | 3.400 | **213,59** |
| | Fig. Castelo Rodrigo | 2.654,00 | 900 | 2.388,60 | 3.400 | **812,12** |
| | Guarda | 5.593,00 | 900 | 5.033,70 | 3.400 | **1.711,46** |
| | Manteigas | 697,00 | 900 | 627,30 | 3.400 | **213,28** |
| | Meda | 1.863,00 | 900 | 1.676,70 | 3.400 | **570,08** |
| | Pinhel | 1.292,00 | 900 | 1.162,80 | 3.400 | **395,35** |
| | Sabugal | 7.214,00 | 900 | 6.492,60 | 3.400 | **2.207,48** |
| | Trancoso | 1.011,00 | 900 | 909,90 | 3.400 | **309,37** |
| ***Beira Interior Sul*** | Castelo Branco | 1.408,00 | 900 | 1.267,20 | 3.400 | **430,85** |
| | Idanha-a-Nova | 450,00 | 900 | 405,00 | 3.400 | **137,70** |
| | Penamacor | 346,00 | 900 | 311,40 | 3.400 | **105,88** |
| | Vila Velha de Ródão | 39,00 | 900 | 35,10 | 3.400 | **11,93** |
| ***Cova Beira*** | Belmonte | 535,00 | 900 | 481,50 | 3.400 | **163,71** |
| | Covilhã | 688,00 | 900 | 619,20 | 3.400 | **210,53** |
| | Fundão | 1.542,00 | 900 | 1.387,80 | 3.400 | **471,85** |
| ***Oeste*** | Alcobaça | 26,00 | 900 | 23,40 | 3.400 | **7,96** |
| | Bombarral | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Caldas da Rainha | 126,00 | 900 | 113,40 | 3.400 | **38,56** |
| | Nazaré | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Óbidos | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Peniche | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Alenquer | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Arruda dos Vinhos | 26,00 | 900 | 23,40 | 3.400 | **7,96** |
| | Cadaval | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Lourinhã | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Sobral de Monte Agraço | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Torres Vedras | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| ***Médio Tejo*** | Abrantes | 4,00 | 900 | 3,60 | 3.400 | **1,22** |
| | Alcanena | 51,00 | 900 | 45,90 | 3.400 | **15,61** |
| | Constância | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| | Entroncamento | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ferreira do Zêzere | 1.023,00 | 900 | 920,70 | 3.400 | **313,04** |
| | Sardoal | 1,00 | 900 | 0,90 | 3.400 | **0,31** |
| | Tomar | 3,00 | 900 | 2,70 | 3.400 | **0,92** |
| | Torres Novas | 2,00 | 900 | 1,80 | 3.400 | **0,61** |
| | Vila Nova da Barquinha | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ourém | 131,00 | 900 | 117,90 | 3.400 | **40,09** |
| | **Total** | **50.888,00** | **-** | **45.799,20** | **-** | **15.571,73** |

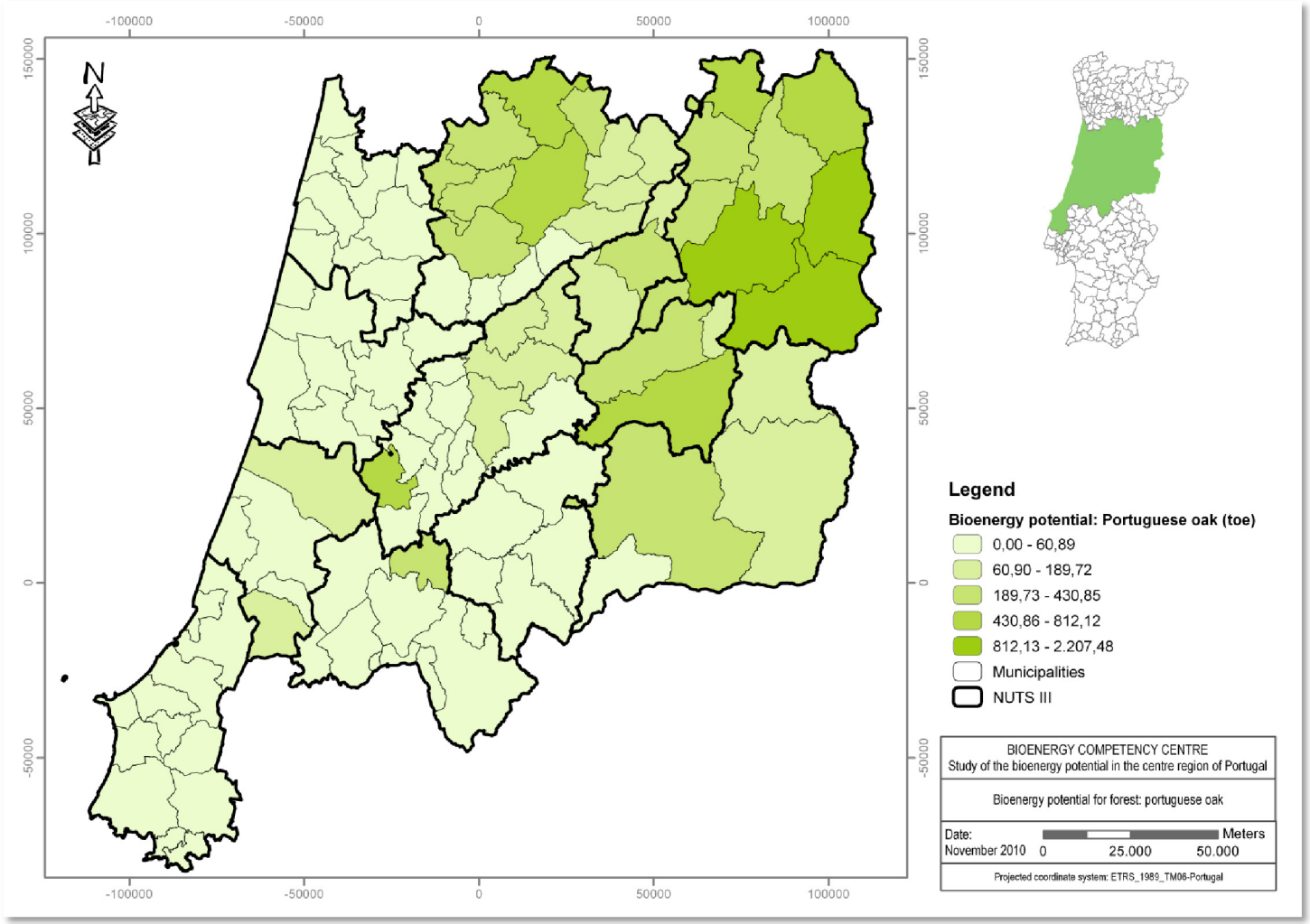


Figure A3.5: Map for the bioenergy potential for Portuguese oak stand residues.

Table A3.6: Bioenergy potential (toe) for forest stands per municipality: Stone pine.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Anadia | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Aveiro | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Estarreja | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ílhavo | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mealhada | 51,00 | 1.060 | 54,06 | 4.000 | **21,62** |
| | Murtosa | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Oliveira do Bairro | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ovar | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sever do Vouga | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Vagos | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Coimbra | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Condeixa-a-Nova | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Figueira da Foz | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Mira | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Montemor-o-Velho | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| | Penacova | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Soure | 150,00 | 1.060 | 159,00 | 4.000 | **63,60** |
| ***Pinhal Litoral*** | Batalha | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Leiria | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Marinha Grande | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Pombal | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Porto de Mós | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Góis | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Lousã | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Miranda do Corvo | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Oliveira do Hospital | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| | Pampilhosa da Serra | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Penela | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Tábua | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Vila Nova de Poiares | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Alvaiázere | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ansião | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Castanheira de Pêra | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Pedrógão Grande | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Carregal do Sal | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Castro Daire | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mangualde | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Mortágua | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Nelas | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| | Oliveira de Frades | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Penalva do Castelo | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Santa Comba Dão | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sátão | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Tondela | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Vila Nova de Paiva | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Viseu | 251,00 | 1.060 | 266,06 | 4.000 | **106,42** |
| | Vouzela | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Proença-a-Nova | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sertã | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Vila de Rei | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mação | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Gouveia | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Seia | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| ***Beira Interior Norte*** | Almeida | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Celorico da Beira | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Fig. Castelo Rodrigo | 151,00 | 1.060 | 160,06 | 4.000 | **64,02** |
| | Guarda | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Manteigas | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Meda | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Pinhel | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sabugal | 1,00 | 1.060 | 1,06 | 4.000 | **0,42** |
| | Trancoso | 100,00 | 1.060 | 106,00 | 4.000 | **42,40** |
| ***Beira Interior Sul*** | Castelo Branco | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Idanha-a-Nova | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Penamacor | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Vila Velha de Ródão | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Cova Beira*** | Belmonte | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Covilhã | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Fundão | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Oeste*** | Alcobaça | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Bombarral | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Caldas da Rainha | 101,00 | 1.060 | 107,06 | 4.000 | **42,82** |
| | Nazaré | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Óbidos | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| | Peniche | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Alenquer | 324,00 | 1.060 | 343,44 | 4.000 | **137,38** |
| | Arruda dos Vinhos | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Cadaval | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| | Lourinhã | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Sobral de Monte Agraço | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Torres Vedras | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| ***Médio Tejo*** | Abrantes | 275,00 | 1.060 | 291,50 | 4.000 | **116,60** |
| | Alcanena | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Constância | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Entroncamento | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ferreira do Zêzere | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Sardoal | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Tomar | 175,00 | 1.060 | 185,50 | 4.000 | **74,20** |
| | Torres Novas | 249,00 | 1.060 | 263,94 | 4.000 | **105,58** |
| | Vila Nova da Barquinha | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ourém | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | **Total** | **3.028,00** | **-** | **3.209,68** | **-** | **1.283,87** |

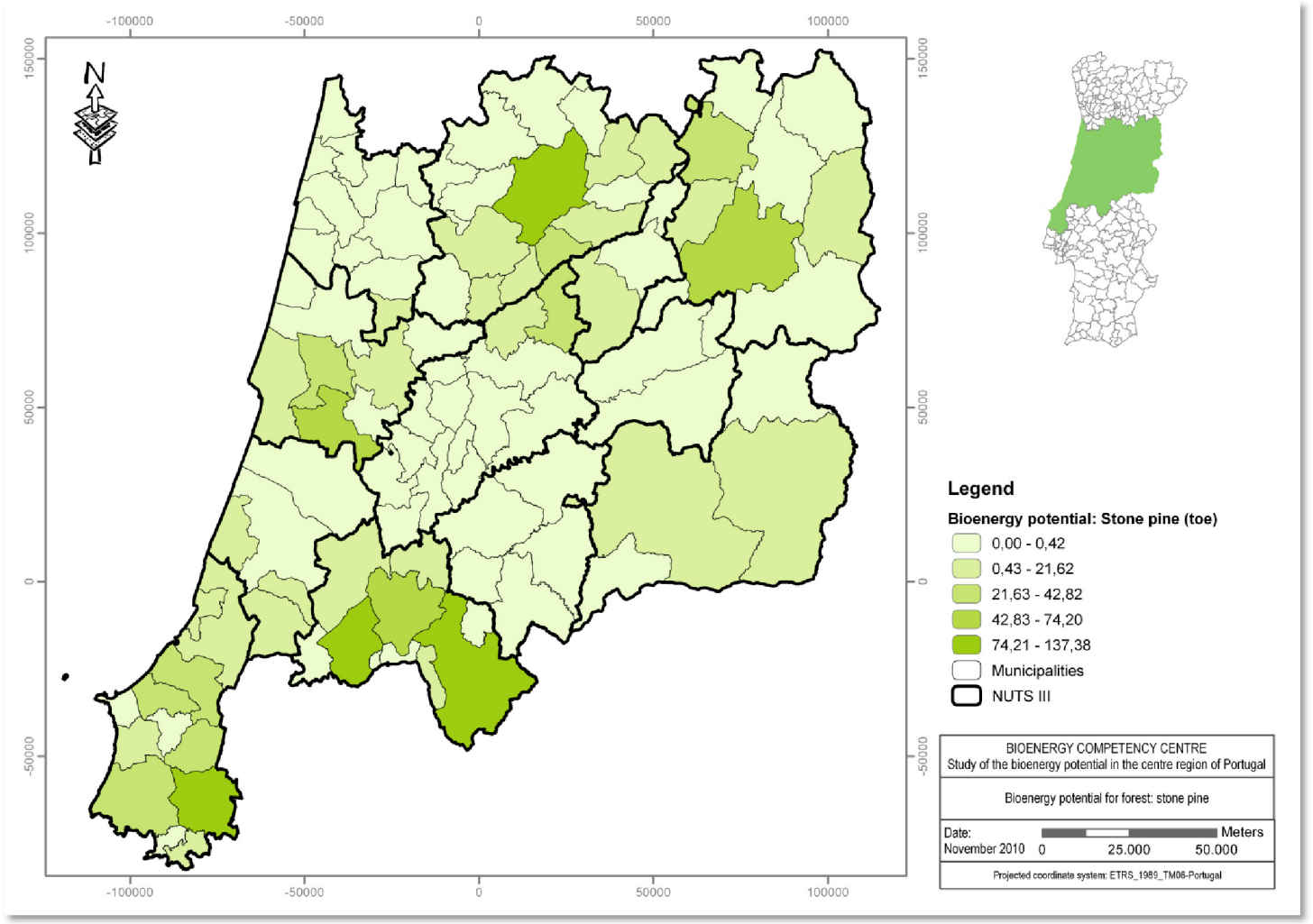


Figure A3.6: Map for the bioenergy potential for stone pine stand residues.

Table A3.7: Bioenergy potential (toe) for forest stands per municipality: Sweet chestnut.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Anadia | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Aveiro | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Estarreja | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ílhavo | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mealhada | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Murtosa | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Oliveira do Bairro | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ovar | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sever do Vouga | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Vagos | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Coimbra | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Condeixa-a-Nova | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Figueira da Foz | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mira | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Montemor-o-Velho | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Penacova | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Soure | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Leiria | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Marinha Grande | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Pombal | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Porto de Mós | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Góis | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Lousã | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Miranda do Corvo | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Oliveira do Hospital | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Penela | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Tábua | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Vila Nova de Poiares | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Alvaiázere | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ansião | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Castanheira de Pêra | 126,00 | 900 | 113,40 | 3.400 | **38,56** |
| | Figueiró dos Vinhos | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Pedrógão Grande | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Carregal do Sal | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Castro Daire | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mangualde | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mortágua | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Nelas | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Oliveira de Frades | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Penalva do Castelo | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Santa Comba Dão | 0,00 | 900 | 0,00 | 3.400 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sátão | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Tondela | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Vila Nova de Paiva | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Viseu | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Vouzela | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Proença-a-Nova | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sertã | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Vila de Rei | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mação | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Gouveia | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Seia | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| ***Beira Interior Norte*** | Almeida | 101,00 | 900 | 90,90 | 3.400 | **30,91** |
| | Celorico da Beira | 204,00 | 900 | 183,60 | 3.400 | **62,42** |
| | Fig. Castelo Rodrigo | 275,00 | 900 | 247,50 | 3.400 | **84,15** |
| | Guarda | 308,00 | 900 | 277,20 | 3.400 | **94,25** |
| | Manteigas | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Meda | 424,00 | 900 | 381,60 | 3.400 | **129,74** |
| | Pinhel | 225,00 | 900 | 202,50 | 3.400 | **68,85** |
| | Sabugal | 255,00 | 900 | 229,50 | 3.400 | **78,03** |
| | Trancoso | 677,00 | 900 | 609,30 | 3.400 | **207,16** |
| ***Beira Interior Sul*** | Castelo Branco | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Idanha-a-Nova | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Penamacor | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Vila Velha de Ródão | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Cova Beira*** | Belmonte | 76,00 | 900 | 68,40 | 3.400 | **23,26** |
| | Covilhã | 50,00 | 900 | 45,00 | 3.400 | **15,30** |
| | Fundão | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Oeste*** | Alcobaça | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Bombarral | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Caldas da Rainha | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Nazaré | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Óbidos | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Peniche | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Alenquer | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Cadaval | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Lourinhã | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Torres Vedras | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| ***Médio Tejo*** | Abrantes | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Alcanena | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Constância | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Entroncamento | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sardoal | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Tomar | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Torres Novas | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ourém | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | **Total** | **3.021,00** | **-** | **2.718,90** | **-** | **924,43** |

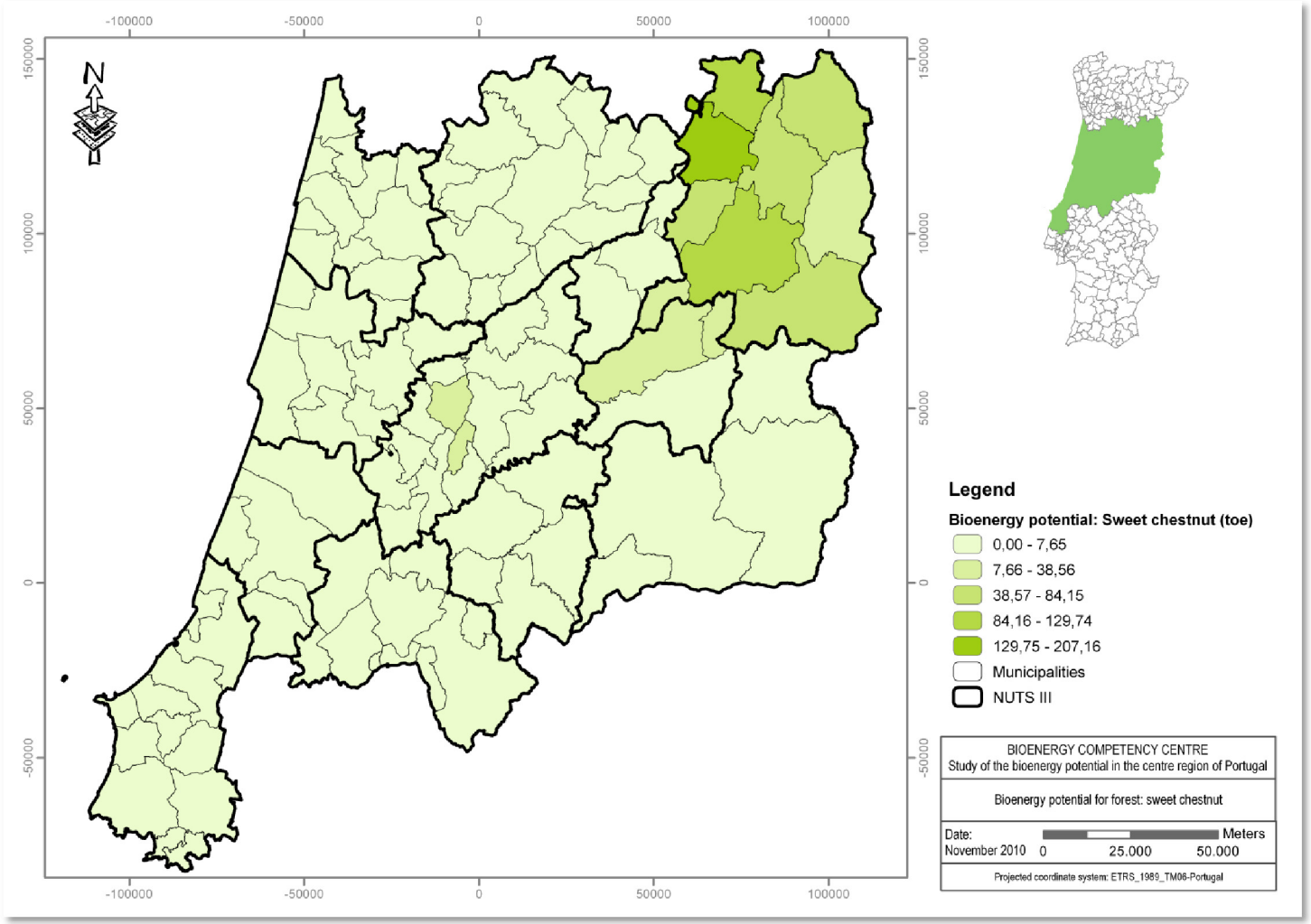


Figure A3.7: Map for the bioenergy potential for sweet chestnut stand residues.

Table A3.8: Bioenergy potential (toe) for forest stands per municipality: Other hardwood trees.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 695,00 | 900 | 625,50 | 3.400 | **212,67** |
| | Albergaria-a-Velha | 212,00 | 900 | 190,80 | 3.400 | **64,87** |
| | Anadia | 445,00 | 900 | 400,50 | 3.400 | **136,17** |
| | Aveiro | 304,00 | 900 | 273,60 | 3.400 | **93,02** |
| | Estarreja | 160,00 | 900 | 144,00 | 3.400 | **48,96** |
| | Ílhavo | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mealhada | 49,00 | 900 | 44,10 | 3.400 | **14,99** |
| | Murtosa | 23,00 | 900 | 20,70 | 3.400 | **7,04** |
| | Oliveira do Bairro | 165,00 | 900 | 148,50 | 3.400 | **50,49** |
| | Ovar | 69,00 | 900 | 62,10 | 3.400 | **21,11** |
| | Sever do Vouga | 595,00 | 900 | 535,50 | 3.400 | **182,07** |
| | Vagos | 118,00 | 900 | 106,20 | 3.400 | **36,11** |
| ***Baixo Mondego*** | Cantanhede | 339,00 | 900 | 305,10 | 3.400 | **103,73** |
| | Coimbra | 718,00 | 900 | 646,20 | 3.400 | **219,71** |
| | Condeixa-a-Nova | 191,00 | 900 | 171,90 | 3.400 | **58,45** |
| | Figueira da Foz | 121,00 | 900 | 108,90 | 3.400 | **37,03** |
| | Mira | 243,00 | 900 | 218,70 | 3.400 | **74,36** |
| | Montemor-o-Velho | 218,00 | 900 | 196,20 | 3.400 | **66,71** |
| | Penacova | 339,00 | 900 | 305,10 | 3.400 | **103,73** |
| | Soure | 238,00 | 900 | 214,20 | 3.400 | **72,83** |
| ***Pinhal Litoral*** | Batalha | 73,00 | 900 | 65,70 | 3.400 | **22,34** |
| | Leiria | 465,00 | 900 | 418,50 | 3.400 | **142,29** |
| | Marinha Grande | 97,00 | 900 | 87,30 | 3.400 | **29,68** |
| | Pombal | 294,00 | 900 | 264,60 | 3.400 | **89,96** |
| | Porto de Mós | 50,00 | 900 | 45,00 | 3.400 | **15,30** |
| ***Pinhal Interior Norte*** | Arganil | 588,00 | 900 | 529,20 | 3.400 | **179,93** |
| | Góis | 521,00 | 900 | 468,90 | 3.400 | **159,43** |
| | Lousã | 435,00 | 900 | 391,50 | 3.400 | **133,11** |
| | Miranda do Corvo | 212,00 | 900 | 190,80 | 3.400 | **64,87** |
| | Oliveira do Hospital | 574,00 | 900 | 516,60 | 3.400 | **175,64** |
| | Pampilhosa da Serra | 384,00 | 900 | 345,60 | 3.400 | **117,50** |
| | Penela | 166,00 | 900 | 149,40 | 3.400 | **50,80** |
| | Tábua | 382,00 | 900 | 343,80 | 3.400 | **116,89** |
| | Vila Nova de Poiares | 96,00 | 900 | 86,40 | 3.400 | **29,38** |
| | Alvaiázere | 46,00 | 900 | 41,40 | 3.400 | **14,08** |
| | Ansião | 140,00 | 900 | 126,00 | 3.400 | **42,84** |
| | Castanheira de Pêra | 49,00 | 900 | 44,10 | 3.400 | **14,99** |
| | Figueiró dos Vinhos | 140,00 | 900 | 126,00 | 3.400 | **42,84** |
| | Pedrógão Grande | 69,00 | 900 | 62,10 | 3.400 | **21,11** |
| ***Dão Lafões*** | Aguiar da Beira | 93,00 | 900 | 83,70 | 3.400 | **28,46** |
| | Carregal do Sal | 243,00 | 900 | 218,70 | 3.400 | **74,36** |
| | Castro Daire | 401,00 | 900 | 360,90 | 3.400 | **122,71** |
| | Mangualde | 186,00 | 900 | 167,40 | 3.400 | **56,92** |
| | Mortágua | 123,00 | 900 | 110,70 | 3.400 | **37,64** |
| | Nelas | 171,00 | 900 | 153,90 | 3.400 | **52,33** |
| | Oliveira de Frades | 398,00 | 900 | 358,20 | 3.400 | **121,79** |
| | Penalva do Castelo | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Santa Comba Dão | 197,00 | 900 | 177,30 | 3.400 | **60,28** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Sátão | 118,00 | 900 | 106,20 | 3.400 | **36,11** |
| | Tondela | 733,00 | 900 | 659,70 | 3.400 | **224,30** |
| | Vila Nova de Paiva | 160,00 | 900 | 144,00 | 3.400 | **48,96** |
| | Viseu | 809,00 | 900 | 728,10 | 3.400 | **247,55** |
| | Vouzela | 484,00 | 900 | 435,60 | 3.400 | **148,10** |
| ***Pinhal Interior Sul*** | Oleiros | 149,00 | 900 | 134,10 | 3.400 | **45,59** |
| | Proença-a-Nova | 25,00 | 900 | 22,50 | 3.400 | **7,65** |
| | Sertã | 270,00 | 900 | 243,00 | 3.400 | **82,62** |
| | Vila de Rei | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Mação | 123,00 | 900 | 110,70 | 3.400 | **37,64** |
| ***Serra Estrela*** | Fornos de Algodres | 26,00 | 900 | 23,40 | 3.400 | **7,96** |
| | Gouveia | 224,00 | 900 | 201,60 | 3.400 | **68,54** |
| | Seia | 374,00 | 900 | 336,60 | 3.400 | **114,44** |
| ***Beira Interior Norte*** | Almeida | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Celorico da Beira | 197,00 | 900 | 177,30 | 3.400 | **60,28** |
| | Fig. Castelo Rodrigo | 147,00 | 900 | 132,30 | 3.400 | **44,98** |
| | Guarda | 78,00 | 900 | 70,20 | 3.400 | **23,87** |
| | Manteigas | 199,00 | 900 | 179,10 | 3.400 | **60,89** |
| | Meda | 48,00 | 900 | 43,20 | 3.400 | **14,69** |
| | Pinhel | 97,00 | 900 | 87,30 | 3.400 | **29,68** |
| | Sabugal | 564,00 | 900 | 507,60 | 3.400 | **172,58** |
| | Trancoso | 173,00 | 900 | 155,70 | 3.400 | **52,94** |
| ***Beira Interior Sul*** | Castelo Branco | 124,00 | 900 | 111,60 | 3.400 | **37,94** |
| | Idanha-a-Nova | 393,00 | 900 | 353,70 | 3.400 | **120,26** |
| | Penamacor | 273,00 | 900 | 245,70 | 3.400 | **83,54** |
| | Vila Velha de Ródão | 99,00 | 900 | 89,10 | 3.400 | **30,29** |
| ***Cova Beira*** | Belmonte | 51,00 | 900 | 45,90 | 3.400 | **15,61** |
| | Covilhã | 469,00 | 900 | 422,10 | 3.400 | **143,51** |
| | Fundão | 542,00 | 900 | 487,80 | 3.400 | **165,85** |
| ***Oeste*** | Alcobaça | 321,00 | 900 | 288,90 | 3.400 | **98,23** |
| | Bombarral | 48,00 | 900 | 43,20 | 3.400 | **14,69** |
| | Caldas da Rainha | 273,00 | 900 | 245,70 | 3.400 | **83,54** |
| | Nazaré | 75,00 | 900 | 67,50 | 3.400 | **22,95** |
| | Óbidos | 73,00 | 900 | 65,70 | 3.400 | **22,34** |
| | Peniche | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Alenquer | 195,00 | 900 | 175,50 | 3.400 | **59,67** |
| | Arruda dos Vinhos | 172,00 | 900 | 154,80 | 3.400 | **52,63** |
| | Cadaval | 74,00 | 900 | 66,60 | 3.400 | **22,64** |
| | Lourinhã | 99,00 | 900 | 89,10 | 3.400 | **30,29** |
| | Sobral de Monte Agraço | 24,00 | 900 | 21,60 | 3.400 | **7,34** |
| | Torres Vedras | 148,00 | 900 | 133,20 | 3.400 | **45,29** |
| ***Médio Tejo*** | Abrantes | 463,00 | 900 | 416,70 | 3.400 | **141,68** |
| | Alcanena | 73,00 | 900 | 65,70 | 3.400 | **22,34** |
| | Constância | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Entroncamento | 0,00 | 900 | 0,00 | 3.400 | **0,00** |
| | Ferreira do Zêzere | 121,00 | 900 | 108,90 | 3.400 | **37,03** |
| | Sardoal | 98,00 | 900 | 88,20 | 3.400 | **29,99** |
| | Tomar | 295,00 | 900 | 265,50 | 3.400 | **90,27** |
| | Torres Novas | 98,00 | 900 | 88,20 | 3.400 | **29,99** |
| | Vila Nova da Barquinha | 24,00 | 900 | 21,60 | 3.400 | **7,34** |
| | Ourém | 438,00 | 900 | 394,20 | 3.400 | **134,03** |
| | **Total** | **21.971,00** | **-** | **19.773,90** | **-** | **6.723,13** |

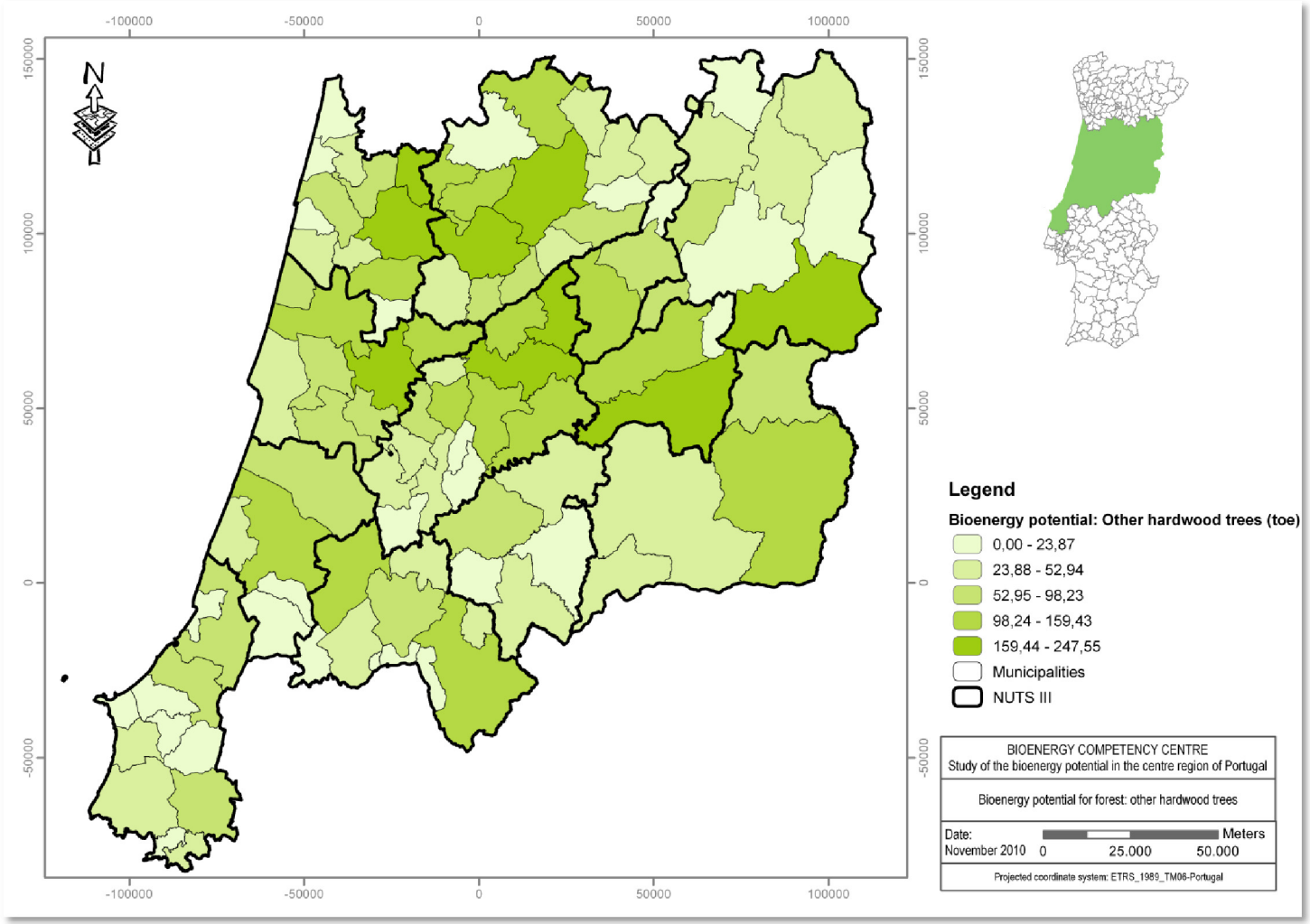


Figure A3.8: Map for the bioenergy potential for other hardwood trees stand residues.

Table A3.9: Bioenergy potential (toe) for forest stands per municipality: Other softwood trees.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Anadia | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Aveiro | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Estarreja | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ílhavo | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mealhada | 101,00 | 1.060 | 107,06 | 4.000 | **42,82** |
| | Murtosa | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Oliveira do Bairro | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ovar | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sever do Vouga | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Vagos | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Coimbra | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Condeixa-a-Nova | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Figueira da Foz | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mira | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Montemor-o-Velho | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Penacova | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Soure | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Leiria | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Marinha Grande | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Pombal | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Porto de Mós | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Góis | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Lousã | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Miranda do Corvo | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Oliveira do Hospital | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Penela | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Tábua | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Vila Nova de Poiares | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Alvaiázere | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ansião | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Castanheira de Pêra | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Figueiró dos Vinhos | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Pedrógão Grande | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Carregal do Sal | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Castro Daire | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mangualde | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mortágua | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Nelas | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Oliveira de Frades | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Penalva do Castelo | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Santa Comba Dão | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Sátão | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Tondela | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Viseu | 652,00 | 1.060 | 691,12 | 4.000 | **276,45** |
| | Vouzela | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Proença-a-Nova | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sertã | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| | Vila de Rei | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Mação | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Gouveia | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Seia | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| ***Beira Interior Norte*** | Almeida | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | Celorico da Beira | 29,00 | 1.060 | 30,74 | 4.000 | **12,30** |
| | Fig. Castelo Rodrigo | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Guarda | 1.010,00 | 1.060 | 1.070,60 | 4.000 | **428,24** |
| | Manteigas | 498,00 | 1.060 | 527,88 | 4.000 | **211,15** |
| | Meda | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Pinhel | 175,00 | 1.060 | 185,50 | 4.000 | **74,20** |
| | Sabugal | 429,00 | 1.060 | 454,74 | 4.000 | **181,90** |
| | Trancoso | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Beira Interior Sul*** | Castelo Branco | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Idanha-a-Nova | 50,00 | 1.060 | 53,00 | 4.000 | **21,20** |
| | Penamacor | 476,00 | 1.060 | 504,56 | 4.000 | **201,82** |
| | Vila Velha de Ródão | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Cova Beira*** | Belmonte | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Covilhã | 200,00 | 1.060 | 212,00 | 4.000 | **84,80** |
| | Fundão | 75,00 | 1.060 | 79,50 | 4.000 | **31,80** |
| ***Oeste*** | Alcobaça | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Bombarral | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Caldas da Rainha | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Nazaré | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Óbidos | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Peniche | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Alenquer | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Cadaval | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Lourinhã | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Torres Vedras | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| ***Médio Tejo*** | Abrantes | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Alcanena | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Constância | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Entroncamento | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Sardoal | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Tomar | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Torres Novas | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 1.060 | 0,00 | 4.000 | **0,00** |
| | Ourém | 25,00 | 1.060 | 26,50 | 4.000 | **10,60** |
| | **Total** | **4.295,00** | **-** | **4.552,70** | **-** | **1.821,08** |

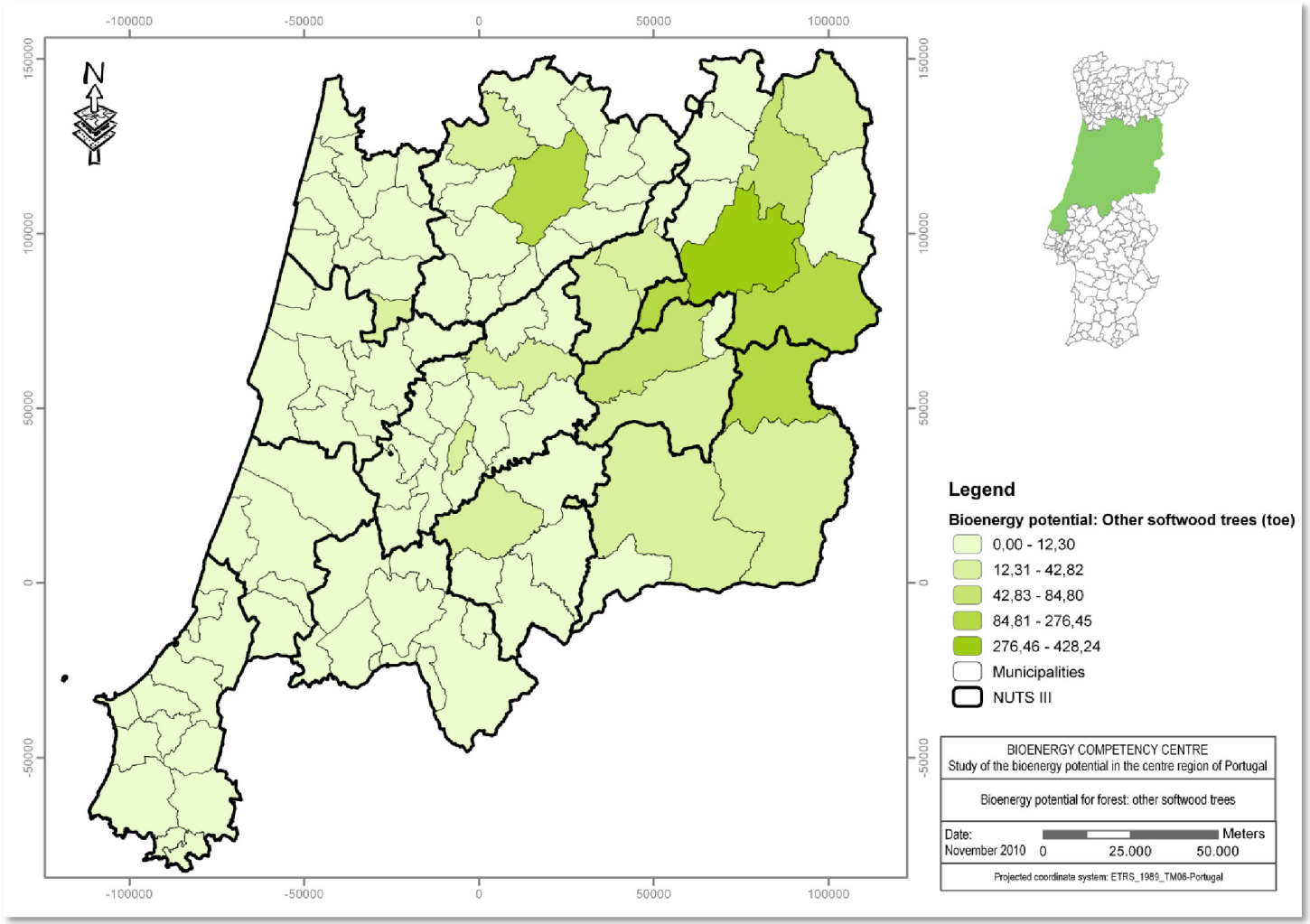


Figure A3.9: Map for the bioenergy potential for other softwood trees stand residues.

Table A3.10: Burned area (ha) from 1999 to 2009 per municipality.

| *NUTS III* | *Municipality* | *Years* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* | ***Total*** |
| ***Baixo Vouga*** | Águeda | 14,10 | 1.461,20 | 10,10 | 57,70 | 11,80 | 1.093,80 | 1.542,90 | 418,80 | 7,83 | 4,70 | 15,51 | **4.638,44** |
| | Albergaria-a-Velha | 15,50 | 18,40 | 63,70 | 18,50 | 49,70 | 41,10 | 1.864,80 | 15,60 | 21,85 | 3,65 | 19,28 | **2.132,08** |
| | Anadia | 6,10 | 5,60 | 12,00 | 51,00 | 86,40 | 28,70 | 2.504,90 | 14,10 | 2,17 | 2,09 | 8,49 | **2.721,55** |
| | Aveiro | 7,30 | 9,70 | 1,50 | 45,20 | 19,40 | 10,20 | 615,00 | 133,80 | 37,53 | 14,51 | 13,91 | **908,06** |
| | Estarreja | 15,70 | 8,70 | 2,10 | 43,80 | 10,10 | 12,80 | 69,40 | 3,50 | 35,04 | 22,90 | 28,98 | **253,02** |
| | Ílhavo | 0,80 | 2,70 | 1,00 | 3,80 | 1,40 | 2,50 | 2,90 | 1,30 | 2,01 | 11,79 | 0,82 | **31,02** |
| | Mealhada | 9,40 | 23,00 | 4,10 | 25,10 | 3,30 | 8,30 | 436,10 | 8,20 | 5,80 | 6,34 | 5,85 | **535,49** |
| | Murtosa | 0,70 | 0,20 | 1,40 | 3,70 | 0,30 | 1,20 | 13,20 | 1,70 | 1,58 | 1,41 | 1,73 | **27,11** |
| | Oliveira do Bairro | 1,10 | 2,00 | 1,70 | 5,00 | 3,30 | 2,70 | 20,40 | 5,90 | 2,79 | 9,66 | 6,94 | **61,50** |
| | Ovar | 28,70 | 25,80 | 21,90 | 67,50 | 53,20 | 40,20 | 215,90 | 13,00 | 9,41 | 3,33 | 43,29 | **522,24** |
| | Sever do Vouga | 33,60 | 40,50 | 9,10 | 41,70 | 5,00 | 712,20 | 32,10 | 905,10 | 93,57 | 47,05 | 372,98 | **2.292,90** |
| | Vagos | 3,50 | 8,70 | 1,50 | 2,20 | 2,60 | 18,10 | 257,20 | 247,30 | 4,89 | 4,17 | 6,14 | **556,30** |
| ***Baixo Mondego*** | Cantanhede | 8,70 | 11,80 | 6,10 | 43,70 | 9,80 | 16,50 | 440,10 | 57,90 | 20,45 | 355,16 | 18,15 | **988,37** |
| | Coimbra | 19,50 | 56,90 | 43,70 | 10,70 | 29,60 | 22,30 | 4.466,40 | 5,90 | 20,05 | 11,81 | 7,43 | **4.694,29** |
| | Condeixa-a-Nova | 6,10 | 72,90 | 1,90 | 0,80 | 1,30 | 0,10 | 86,70 | 142,10 | 0,87 | 3,46 | 2,50 | **318,74** |
| | Figueira da Foz | 28,00 | 63,20 | 11,20 | 36,60 | 33,10 | 46,10 | 2.285,70 | 46,30 | 46,1 | 2.285,7 | 46,3 | **2.603,54** |
| | Mira | 8,30 | 8,60 | 5,20 | 0,70 | 6,00 | 7,30 | 865,50 | 0,60 | 7,3 | 865,5 | 0,6 | **910,22** |
| | Montemor-o-Velho | 8,60 | 35,30 | 11,80 | 8,10 | 2,00 | 7,00 | 89,70 | 52,30 | 7,0 | 89,7 | 52,3 | **240,63** |
| | Penacova | 52,90 | 14,40 | 10,60 | 18,60 | 97,80 | 5,40 | 1.422,60 | 26,70 | 5,4 | 1.422,6 | 26,7 | **1.752,93** |
| | Soure | 103,00 | 39,80 | 7,10 | 1.728,30 | 101,40 | 180,90 | 2.574,40 | 29,50 | 180,9 | 2.574,4 | 29,5 | **6.792,54** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 1,50 | 0,10 | 0,90 | 2.730,60 | 1,10 | 9,20 | 5,80 | 1,1 | 9,2 | 5,8 | **2.900,94** |
| | Leiria | 97,90 | 67,60 | 33,80 | 93,80 | 19,50 | 107,50 | 4.429,00 | 83,10 | 107,5 | 4.429,0 | 83,1 | **5.148,50** |
| | Marinha Grande | 9,10 | 6,30 | 1,50 | 2,20 | 2.521,00 | 1,00 | 10,30 | 3,30 | 1,0 | 10,3 | 3,3 | **2.611,04** |
| | Pombal | 370,00 | 244,40 | 357,40 | 1.196,00 | 103,30 | 231,70 | 10.226,90 | 376,80 | 231,7 | 10.226,9 | 376,8 | **15.419,99** |
| | Porto de Mós | 10,00 | 993,10 | 390,60 | 32,60 | 2.897,40 | 805,90 | 226,60 | 3.479,10 | 805,9 | 226,6 | 3.479,1 | **8.925,43** |

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| NUTS III | Municipality | Years | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* | ***Total*** |
| ***Pinhal Interior Norte*** | Arganil | 11,40 | 962,90 | 1.376,90 | 45,80 | 154,40 | 0,30 | 4.525,20 | 23,20 | 8,03 | 12,64 | 5,60 | **7.126,37** |
| | Góis | 9,30 | 4.430,00 | 1.746,10 | 39,00 | 9,60 | 30,80 | 892,90 | 38,80 | 7,09 | 68,64 | 16,17 | **7.288,39** |
| | Lousã | 39,80 | 648,90 | 98,50 | 191,40 | 1,30 | 0,20 | 1.105,30 | 3,20 | 0,99 | 7,03 | 19,10 | **2.115,73** |
| | Miranda do Corvo | 290,20 | 1.196,20 | 227,70 | 248,20 | 12,10 | 6,70 | 4.390,20 | 21,60 | 1,45 | 25,62 | 143,93 | **6.563,90** |
| | Oliveira do Hospital | 128,90 | 45,00 | 103,40 | 1.224,70 | 149,80 | 22,70 | 2.094,90 | 12,10 | 14,46 | 15,40 | 43,31 | **3.854,66** |
| | Pampilhosa da Serra | 623,50 | 1.027,20 | 3.921,00 | 489,30 | 2.275,60 | 41,50 | 18.047,00 | 6,70 | 84,11 | 1,63 | 3,28 | **26.520,81** |
| | Penela | 58,10 | 12,00 | 14,50 | 1,50 | 1,90 | 51,30 | 1.953,70 | 14,40 | 0,39 | 2,55 | 7,53 | **2.117,88** |
| | Tábua | 310,60 | 533,70 | 87,80 | 352,20 | 15,60 | 15,40 | 1.007,30 | 449,00 | 8,11 | 3,51 | 11,08 | **2.794,30** |
| | Vila Nova de Poiares | 3,40 | 2,00 | 14,20 | 1.614,00 | 0,90 | 69,60 | 1.976,80 | 7,60 | 6,27 | 0,70 | 30,83 | **3.726,30** |
| | Alvaiázere | 655,30 | 725,90 | 13,40 | 316,30 | 297,70 | 21,20 | 1.470,90 | 1,50 | 1,97 | 25,73 | 4,39 | **3.534,29** |
| | Ansião | 4,70 | 3,80 | 1,00 | 3,30 | 8,50 | 5,80 | 372,80 | 8,70 | 1,35 | 3,54 | 4,64 | **418,13** |
| | Castanheira de Pêra | 1,80 | 0,50 | 0,60 | 2,60 | 0,30 | 0,60 | 0,50 | 0,60 | 10,13 | 5,51 | 223,87 | **247,01** |
| | Figueiró dos Vinhos | 114,70 | 454,10 | 246,10 | 643,50 | 46,80 | 69,80 | 7.475,50 | 357,80 | 0,82 | 4,82 | 1,28 | **9.415,22** |
| | Pedrógão Grande | 11,70 | 20,80 | 12,30 | 4,40 | 707,20 | 19,60 | 1.975,40 | 0,90 | 3,53 | 2,02 | 14,53 | **2.772,38** |
| ***Dão Lafões*** | Aguiar da Beira | 221,10 | 386,50 | 251,60 | 85,60 | 2.100,80 | 7,00 | 162,30 | 240,50 | 22,64 | 2,41 | 187,97 | **3.668,41** |
| | Carregal do Sal | 506,50 | 117,60 | 71,10 | 33,90 | 102,30 | 14,90 | 2.568,90 | 16,20 | 5,97 | 7,18 | 3,18 | **3.447,72** |
| | Castro Daire | 250,90 | 3.125,90 | 2.130,30 | 1.434,00 | 609,80 | 2.485,30 | 4.772,80 | 118,60 | 517,71 | 178,09 | 1.172,83 | **16.796,23** |
| | Mangualde | 183,80 | 669,30 | 640,50 | 1.833,00 | 308,90 | 239,20 | 2.224,80 | 118,30 | 105,14 | 177,37 | 1.556,14 | **8.056,45** |
| | Mortágua | 8,20 | 2,80 | 0,40 | 2,80 | 1,10 | 2,70 | 1.528,30 | 2,10 | 62,15 | 0,80 | 1,71 | **1.613,05** |
| | Nelas | 380,60 | 106,60 | 308,60 | 2.280,50 | 28,60 | 627,50 | 1.690,40 | 9,30 | 9,41 | 5,98 | 213,90 | **5.661,39** |
| | Oliveira de Frades | 26,20 | 60,20 | 49,40 | 92,30 | 21,80 | 374,60 | 218,50 | 1.036,00 | 10,93 | 10,28 | 21,41 | **1.921,61** |
| | Penalva do Castelo | 839,90 | 50,30 | 60,30 | 43,70 | 46,60 | 32,40 | 2.562,50 | 480,20 | 2,81 | 18,70 | 182,29 | **4.319,70** |
| | Santa Comba Dão | 80,10 | 48,00 | 38,60 | 69,50 | 7,40 | 11,00 | 130,00 | 5,70 | 7,32 | 5,01 | 2,63 | **405,26** |
| | São Pedro do Sul | 110,30 | 2.285,60 | 1.772,10 | 400,00 | 729,90 | 21,70 | 5.994,40 | 1.445,50 | 63,95 | 9,53 | 270,42 | **13.103,41** |
| | Sátão | 646,80 | 41,90 | 1.232,80 | 11,10 | 23,80 | 59,20 | 324,70 | 143,00 | 8,70 | 11,37 | 146,54 | **2.649,92** |
| | Tondela | 125,60 | 74,60 | 25,80 | 1.146,20 | 650,40 | 34,90 | 1.755,70 | 87,40 | 16.872,87 | 70,16 | 58,75 | **20.902,38** |
| | Vila Nova de Paiva | 110,50 | 396,60 | 159,10 | 569,20 | 142,40 | 67,90 | 2.804,40 | 106,40 | 145,35 | 83,60 | 294,52 | **4.879,97** |
| | Viseu | 221,50 | 877,00 | 594,00 | 1.088,20 | 482,40 | 93,40 | 2.773,60 | 382,30 | 50,10 | 15,48 | 148,25 | **6.726,23** |
| | Vouzela | 22,10 | 167,20 | 2.214,90 | 20,60 | 72,40 | 43,30 | 1.847,70 | 13,30 | 255,41 | 3,32 | 38,84 | **4.699,07** |

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| *NUTS III* | *Municipality* | *Years* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* | ***Total*** |
| ***Pinhal Interior Sul*** | Oleiros | 1.000,80 | 6.379,60 | 10,60 | 411,00 | 20.140,00 | 258,60 | 1.269,10 | 6,20 | 2,71 | 45,50 | 2,59 | **29.526,70** |
| | Proença-a-Nova | 674,60 | 588,60 | 9,00 | 102,80 | 13.958,20 | 5,90 | 430,10 | 1.028,00 | 7,18 | 23,22 | 0,96 | **16.828,56** |
| | Sertã | 165,30 | 5,10 | 6,20 | 3.265,70 | 15.105,30 | 38,20 | 5.274,40 | 262,50 | 5,75 | 2,77 | 8,88 | **24.140,09** |
| | Vila de Rei | 4,40 | 650,80 | 1.647,30 | 6,60 | 12.664,70 | 2,90 | 43,10 | 0,50 | 0,28 | 0,11 | 2,24 | **15.022,93** |
| | Mação | 778,50 | 265,70 | 14,20 | 172,10 | 19.534,10 | 15,40 | 2.378,00 | 300,50 | 7,81 | 6,28 | 5,17 | **23.477,75** |
| ***Serra Estrela*** | Fornos de Algodres | 988,50 | 985,10 | 1.585,20 | 473,10 | 1.286,00 | 225,90 | 479,30 | 375,10 | 38,78 | 171,44 | 63,17 | **6.671,59** |
| | Gouveia | 704,80 | 2.034,30 | 3.014,90 | 606,40 | 2.871,30 | 147,00 | 2.546,10 | 467,70 | 281,46 | 252,71 | 955,45 | **13.882,12** |
| | Seia | 543,50 | 6.627,50 | 3.966,70 | 1.304,10 | 4.227,20 | 23,20 | 8.087,70 | 68,60 | 149,01 | 62,23 | 193,31 | **25.253,06** |
| ***Beira Interior Norte*** | Almeida | 5.777,00 | 906,40 | 2.054,80 | 171,00 | 3.458,00 | 187,00 | 150,80 | 586,70 | 210,89 | 162,15 | 400,22 | **14.064,97** |
| | Celorico da Beira | 87,20 | 587,80 | 2.871,60 | 1.145,00 | 1.638,90 | 1.046,00 | 637,60 | 375,40 | 529,04 | 232,71 | 108,68 | **9.259,92** |
| | Fig. Castelo Rodrigo | 3.314,70 | 358,30 | 2.029,50 | 197,50 | 1.900,30 | 1.536,00 | 741,10 | 803,20 | 1.120,80 | 517,18 | 649,84 | **13.168,41** |
| | Guarda | 1.479,20 | 8.387,00 | 1.912,20 | 2.905,90 | 15.082,80 | 958,70 | 198,00 | 867,70 | 219,59 | 380,11 | 5.377,95 | **37.769,15** |
| | Manteigas | 8,70 | 63,50 | 44,50 | 462,50 | 17,00 | 3,00 | 2.937,00 | 9,00 | 4,85 | 10,02 | 5,23 | **3.565,30** |
| | Meda | 529,00 | 920,50 | 535,50 | 212,00 | 406,00 | 624,00 | 300,10 | 781,70 | 131,87 | 839,66 | 840,11 | **6.120,44** |
| | Pinhel | 2.214,30 | 434,50 | 904,10 | 498,80 | 4.389,50 | 1.882,80 | 3.544,10 | 352,70 | 513,15 | 540,48 | 1.255,02 | **16.529,44** |
| | Sabugal | 4.162,00 | 10.123,00 | 1.437,10 | 4.218,50 | 4.362,20 | 3.389,90 | 1.177,40 | 93,60 | 595,94 | 263,83 | 10.836,10 | **40.659,57** |
| | Trancoso | 1.844,00 | 2.857,70 | 1.197,50 | 515,10 | 3.477,20 | 182,50 | 2.344,70 | 462,20 | 423,23 | 481,54 | 962,02 | **14.747,69** |
| ***Beira Interior Sul*** | Castelo Branco | 3.902,70 | 289,70 | 265,20 | 6.720,90 | 8.652,70 | 6.140,30 | 5.269,90 | 378,50 | 118,36 | 1.157,76 | 100,87 | **32.996,89** |
| | Idanha-a-Nova | 976,70 | 664,10 | 3.879,50 | 5.117,10 | 8.570,20 | 534,40 | 51,60 | 49,70 | 273,79 | 242,00 | 187,50 | **20.546,60** |
| | Penamacor | 576,50 | 697,40 | 199,90 | 402,80 | 37,20 | 257,70 | 302,10 | 34,40 | 19,45 | 23,18 | 75,28 | **2.625,91** |
| | Vila Velha de Ródão | 3.163,70 | 8,00 | 73,10 | 2,00 | 5.002,60 | 7,80 | 189,20 | 39,00 | 29,76 | 21,82 | 15,77 | **8.552,75** |
| ***Cova Beira*** | Belmonte | 147,10 | 947,80 | 304,20 | 16,90 | 101,70 | 213,70 | 9,20 | 193,30 | 1,25 | 80,99 | 117,27 | **2.133,40** |
| | Covilhã | 385,00 | 8.587,00 | 4.867,80 | 752,50 | 1.837,50 | 119,60 | 3.818,00 | 317,30 | 44,56 | 45,11 | 101,04 | **20.875,41** |
| | Fundão | 497,70 | 470,20 | 1.002,40 | 1.221,00 | 4.157,80 | 133,60 | 3.467,80 | 457,50 | 49,72 | 375,64 | 107,15 | **11.940,51** |

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| *NUTS III* | *Municipality* | *Years* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1999* | *2000* | *2001* | *2002* | *2003* | *2004* | *2005* | *2006* | *2007* | *2008* | *2009* | ***Total*** |
| ***Oeste*** | Alcobaça | 137,80 | 102,20 | 76,00 | 111,40 | 139,80 | 52,40 | 91,40 | 17,90 | 45,26 | 23,34 | 15,36 | **812,86** |
| | Alenquer | 132,50 | 264,60 | 88,60 | 81,60 | 2.339,80 | 174,00 | 150,00 | 133,20 | 190,01 | 141,32 | 80,82 | **3.776,45** |
| | Arruda dos Vinhos | 57,80 | 193,20 | 42,30 | 36,10 | 53,10 | 80,10 | 171,20 | 70,50 | 92,03 | 83,84 | 86,49 | **966,66** |
| | Bombarral | 32,90 | 22,70 | 32,80 | 6,70 | 17,30 | 34,30 | 97,50 | 2,90 | 20,21 | 22,05 | 23,27 | **312,63** |
| | Cadaval | 22,70 | 45,30 | 11,30 | 26,60 | 15,60 | 22,30 | 71,30 | 15,70 | 47,99 | 6,35 | 27,10 | **312,23** |
| | Caldas da Rainha | 53,60 | 63,80 | 30,60 | 35,00 | 17,10 | 66,80 | 277,30 | 12,80 | 26,63 | 20,55 | 11,35 | **615,53** |
| | Lourinhã | 45,90 | 172,40 | 19,90 | 108,90 | 55,50 | 6,00 | 60,10 | 15,60 | 89,34 | 44,95 | 65,93 | **684,52** |
| | Nazaré | 31,40 | 13,10 | 62,50 | 25,40 | 0,70 | 8,90 | 10,20 | 5,30 | 6,32 | 18,22 | 2,08 | **184,13** |
| | Óbidos | 31,70 | 60,00 | 32,10 | 39,80 | 46,90 | 48,50 | 150,50 | 6,20 | 49,39 | 16,95 | 26,61 | **508,64** |
| | Peniche | 43,30 | 84,40 | 182,90 | 11,90 | 13,80 | 20,30 | 20,20 | 1,90 | 25,61 | 19,81 | 11,65 | **435,77** |
| | Sobral de Monte Agraço | 40,70 | 111,80 | 22,40 | 26,00 | 27,90 | 27,60 | 87,90 | 32,60 | 39,98 | 21,47 | 32,60 | **470,95** |
| | Torres Vedras | 84,40 | 232,20 | 111,00 | 215,40 | 533,60 | 197,40 | 118,00 | 28,30 | 97,89 | 55,86 | 25,16 | **1.699,21** |
| ***Médio Tejo*** | Abrantes | 847,50 | 381,20 | 217,70 | 82,70 | 14.052,90 | 1.069,30 | 6.837,80 | 31,60 | 39,10 | 53,57 | 33,39 | **23.646,76** |
| | Alcanena | 74,50 | 226,90 | 46,10 | 207,40 | 692,20 | 146,20 | 1.219,00 | 330,80 | 4,53 | 4,04 | 4,28 | **2.955,95** |
| | Constância | 223,80 | 6,60 | 93,90 | 15,90 | 1.069,60 | 101,70 | 144,60 | 7,00 | 10,97 | 4,83 | 0,21 | **1.679,11** |
| | Entroncamento | 0,30 | 3,90 | 0,10 | 0,30 | 0,00 | 0,50 | 1,50 | 0,00 | 0,02 | 0,12 | 0,53 | **7,27** |
| | Ferreira do Zêzere | 214,10 | 11,70 | 1.012,40 | 3,40 | 487,60 | 20,10 | 1.400,20 | 485,70 | 12,27 | 9,02 | 7,98 | **3.664,47** |
| | Ourém | 4,50 | 3,90 | 2,40 | 199,50 | 533,90 | 17,80 | 1.379,10 | 8,10 | 2.821,65 | 1,12 | 11,29 | **4.983,26** |
| | Sardoal | 499,80 | 907,00 | 156,30 | 2.339,90 | 336,10 | 1.173,80 | 2.687,30 | 109,80 | 279,83 | 41,58 | 31,11 | **8.562,53** |
| | Tomar | 20,80 | 52,00 | 17,70 | 619,40 | 2.015,70 | 549,20 | 341,30 | 15,30 | 57,16 | 29,02 | 10,01 | **3.727,58** |
| | Torres Novas | 16,00 | 2,50 | 1,50 | 44,60 | 55,60 | 33,60 | 917,60 | 66,40 | 8,08 | 4,31 | 3,08 | **1.153,27** |
| | Vila Nova da Barquinha | 657,70 | 603,00 | 54,30 | 653,60 | 1.244,00 | 1.083,50 | 9.351,40 | 959,60 | 33,19 | 688,16 | 21,52 | **15.349,97** |
| | **Total** | **44.055,70** | **79.099,40** | **54.571,90** | **53.617,80** | **194.436,70** | **30.743,50** | **184.587,10** | **21.896,80** | **29.972,79** | **10.779,71** | **28.440,55** | **732.201,95** |

Table A3.11: Bioenergy potential for burned areas (toe) per municipality.

| *NUTS III* | *Municipality* | *Burned areas (ha)* | *Burned residues (kg/ha.year)* | *Biomass residue (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 15,51 | 5.000 | 77,57 | 4.780 | **37,08** |
| | Albergaria-a-Velha | 19,28 | 5.000 | 96,40 | 4.780 | **46,08** |
| | Anadia | 8,49 | 5.000 | 42,43 | 4.780 | **20,28** |
| | Aveiro | 13,91 | 5.000 | 69,56 | 4.780 | **33,25** |
| | Estarreja | 28,98 | 5.000 | 144,90 | 4.780 | **69,26** |
| | Ílhavo | 0,82 | 5.000 | 4,11 | 4.780 | **1,96** |
| | Mealhada | 5,85 | 5.000 | 29,26 | 4.780 | **13,99** |
| | Murtosa | 1,73 | 5.000 | 8,64 | 4.780 | **4,13** |
| | Oliveira do Bairro | 6,94 | 5.000 | 34,72 | 4.780 | **16,60** |
| | Ovar | 43,29 | 5.000 | 216,47 | 4.780 | **103,47** |
| | Sever do Vouga | 372,98 | 5.000 | 1.864,90 | 4.780 | **891,42** |
| | Vagos | 6,14 | 5.000 | 30,68 | 4.780 | **14,66** |
| ***Baixo Mondego*** | Cantanhede | 18,15 | 5.000 | 90,75 | 4.780 | **43,38** |
| | Coimbra | 7,43 | 5.000 | 37,17 | 4.780 | **17,77** |
| | Condeixa-a-Nova | 2,50 | 5.000 | 12,52 | 4.780 | **5,98** |
| | Figueira da Foz | 29,78 | 5.000 | 148,90 | 4.780 | **71,18** |
| | Mira | 3,21 | 5.000 | 16,04 | 4.780 | **7,67** |
| | Montemor-o-Velho | 15,31 | 5.000 | 76,53 | 4.780 | **36,58** |
| | Penacova | 11,89 | 5.000 | 59,46 | 4.780 | **28,42** |
| | Soure | 12,44 | 5.000 | 62,18 | 4.780 | **29,72** |
| ***Pinhal Litoral*** | Batalha | 0,74 | 5.000 | 3,71 | 4.780 | **1,77** |
| | Leiria | 16,00 | 5.000 | 80,01 | 4.780 | **38,25** |
| | Marinha Grande | 5,90 | 5.000 | 29,48 | 4.780 | **14,09** |
| | Pombal | 17,90 | 5.000 | 89,52 | 4.780 | **42,79** |
| | Porto de Mós | 42,82 | 5.000 | 214,09 | 4.780 | **102,34** |
| ***Pinhal Interior Norte*** | Arganil | 5,60 | 5.000 | 27,99 | 4.780 | **13,38** |
| | Góis | 16,17 | 5.000 | 80,83 | 4.780 | **38,64** |
| | Lousã | 19,10 | 5.000 | 95,51 | 4.780 | **45,66** |
| | Miranda do Corvo | 143,93 | 5.000 | 719,63 | 4.780 | **343,98** |
| | Oliveira do Hospital | 43,31 | 5.000 | 216,54 | 4.780 | **103,50** |
| | Pampilhosa da Serra | 3,28 | 5.000 | 16,38 | 4.780 | **7,83** |
| | Penela | 7,53 | 5.000 | 37,66 | 4.780 | **18,00** |
| | Tábua | 11,08 | 5.000 | 55,40 | 4.780 | **26,48** |
| | Vila Nova de Poiares | 30,83 | 5.000 | 154,17 | 4.780 | **73,69** |
| | Alvaiázere | 4,39 | 5.000 | 21,96 | 4.780 | **10,50** |
| | Ansião | 4,64 | 5.000 | 23,19 | 4.780 | **11,09** |
| | Castanheira de Pêra | 223,87 | 5.000 | 1.119,37 | 4.780 | **535,06** |
| | Figueiró dos Vinhos | 1,28 | 5.000 | 6,39 | 4.780 | **3,05** |
| | Pedrógão Grande | 14,53 | 5.000 | 72,67 | 4.780 | **34,74** |
| ***Dão Lafões*** | Aguiar da Beira | 187,97 | 5.000 | 939,85 | 4.780 | **449,25** |
| | Carregal do Sal | 3,18 | 5.000 | 15,89 | 4.780 | **7,60** |
| | Castro Daire | 1.172,83 | 5.000 | 5.864,15 | 4.780 | **2.803,06** |
| | Mangualde | 1.556,14 | 5.000 | 7.780,69 | 4.780 | **3.719,17** |
| | Mortágua | 1,71 | 5.000 | 8,53 | 4.780 | **4,08** |
| | Nelas | 213,90 | 5.000 | 1.069,49 | 4.780 | **511,22** |
| | Oliveira de Frades | 21,41 | 5.000 | 107,05 | 4.780 | **51,17** |
| | Penalva do Castelo | 182,29 | 5.000 | 911,45 | 4.780 | **435,67** |
| | Santa Comba Dão | 2,63 | 5.000 | 13,16 | 4.780 | **6,29** |

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| *NUTS III* | *Municipality* | *Burned areas (ha)* | *Burned residues (kg/ha.year)* | *Biomass residue (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 270,42 | 5.000 | 1.352,12 | 4.780 | **646,31** |
| | Sátão | 146,54 | 5.000 | 732,72 | 4.780 | **350,24** |
| | Tondela | 58,75 | 5.000 | 293,73 | 4.780 | **140,40** |
| | Vila Nova de Paiva | 294,52 | 5.000 | 1.472,59 | 4.780 | **703,90** |
| | Viseu | 148,25 | 5.000 | 741,26 | 4.780 | **354,32** |
| | Vouzela | 38,84 | 5.000 | 194,20 | 4.780 | **92,83** |
| ***Pinhal Interior Sul*** | Oleiros | 2,59 | 5.000 | 12,96 | 4.780 | **6,19** |
| | Proença-a-Nova | 0,96 | 5.000 | 4,82 | 4.780 | **2,30** |
| | Sertã | 8,88 | 5.000 | 44,38 | 4.780 | **21,22** |
| | Vila de Rei | 2,24 | 5.000 | 11,19 | 4.780 | **5,35** |
| | Mação | 5,17 | 5.000 | 25,83 | 4.780 | **12,35** |
| ***Serra Estrela*** | Fornos de Algodres | 63,17 | 5.000 | 315,87 | 4.780 | **150,99** |
| | Gouveia | 955,45 | 5.000 | 4.777,23 | 4.780 | **2.283,52** |
| | Seia | 193,31 | 5.000 | 966,56 | 4.780 | **462,02** |
| ***Beira Interior Norte*** | Almeida | 400,22 | 5.000 | 2.001,11 | 4.780 | **956,53** |
| | Celorico da Beira | 108,68 | 5.000 | 543,38 | 4.780 | **259,74** |
| | Fig. Castelo Rodrigo | 649,84 | 5.000 | 3.249,20 | 4.780 | **1.553,12** |
| | Guarda | 5.377,95 | 5.000 | 26.889,76 | 4.780 | **12.853,30** |
| | Manteigas | 5,23 | 5.000 | 26,15 | 4.780 | **12,50** |
| | Meda | 840,11 | 5.000 | 4.200,56 | 4.780 | **2.007,87** |
| | Pinhel | 1.255,02 | 5.000 | 6.275,08 | 4.780 | **2.999,49** |
| | Sabugal | 10.836,10 | 5.000 | 54.180,48 | 4.780 | **25.898,27** |
| | Trancoso | 962,02 | 5.000 | 4.810,08 | 4.780 | **2.299,22** |
| ***Beira Interior Sul*** | Castelo Branco | 100,87 | 5.000 | 504,37 | 4.780 | **241,09** |
| | Idanha-a-Nova | 187,50 | 5.000 | 937,51 | 4.780 | **448,13** |
| | Penamacor | 75,28 | 5.000 | 376,42 | 4.780 | **179,93** |
| | Vila Velha de Ródão | 15,77 | 5.000 | 78,84 | 4.780 | **37,68** |
| ***Cova Beira*** | Belmonte | 117,27 | 5.000 | 586,34 | 4.780 | **280,27** |
| | Covilhã | 101,04 | 5.000 | 505,21 | 4.780 | **241,49** |
| | Fundão | 107,15 | 5.000 | 535,76 | 4780 | **256,09** |
| ***Oeste*** | Alcobaça | 15,36 | 5.000 | 76,79 | 4.780 | **36,70** |
| | Bombarral | 80,82 | 5.000 | 404,11 | 4780 | **193,16** |
| | Caldas da Rainha | 86,49 | 5.000 | 432,44 | 4.780 | **206,71** |
| | Nazaré | 23,27 | 5.000 | 116,35 | 4780 | **55,62** |
| | Óbidos | 27,10 | 5.000 | 135,50 | 4.780 | **64,77** |
| | Peniche | 11,35 | 5.000 | 56,76 | 4780 | **27,13** |
| | Alenquer | 65,93 | 5.000 | 329,65 | 4.780 | **157,57** |
| | Arruda dos Vinhos | 2,08 | 5.000 | 10,42 | 4780 | **4,98** |
| | Cadaval | 26,61 | 5.000 | 133,05 | 4.780 | **63,60** |
| | Lourinhã | 11,65 | 5.000 | 58,26 | 4780 | **27,85** |
| | Sobral de Monte Agraço | 32,60 | 5.000 | 163,02 | 4.780 | **77,92** |
| | Torres Vedras | 25,16 | 5.000 | 125,78 | 4780 | **60,12** |
| ***Médio Tejo*** | Abrantes | 33,39 | 5.000 | 166,97 | 4.780 | **79,81** |
| | Alcanena | 4,28 | 5.000 | 21,41 | 4780 | **10,23** |
| | Constância | 0,21 | 5.000 | 1,04 | 4.780 | **0,50** |
| | Entroncamento | 0,53 | 5.000 | 2,66 | 4780 | **1,27** |
| | Ferreira do Zêzere | 7,98 | 5.000 | 39,89 | 4.780 | **19,07** |
| | Sardoal | 11,29 | 5.000 | 56,47 | 4780 | **26,99** |
| | Tomar | 31,11 | 5.000 | 155,57 | 4.780 | **74,36** |
| | Torres Novas | 10,01 | 5.000 | 50,04 | 4780 | **23,92** |
| | Vila Nova da Barquinha | 3,08 | 5.000 | 15,39 | 4.780 | **7,36** |
| | Ourém | 21,52 | 5.000 | 107,61 | 4780 | **51,44** |
| | **Total** | **28.440,55** | **-** | **142.202,77** | **-** | **67.972,92** |

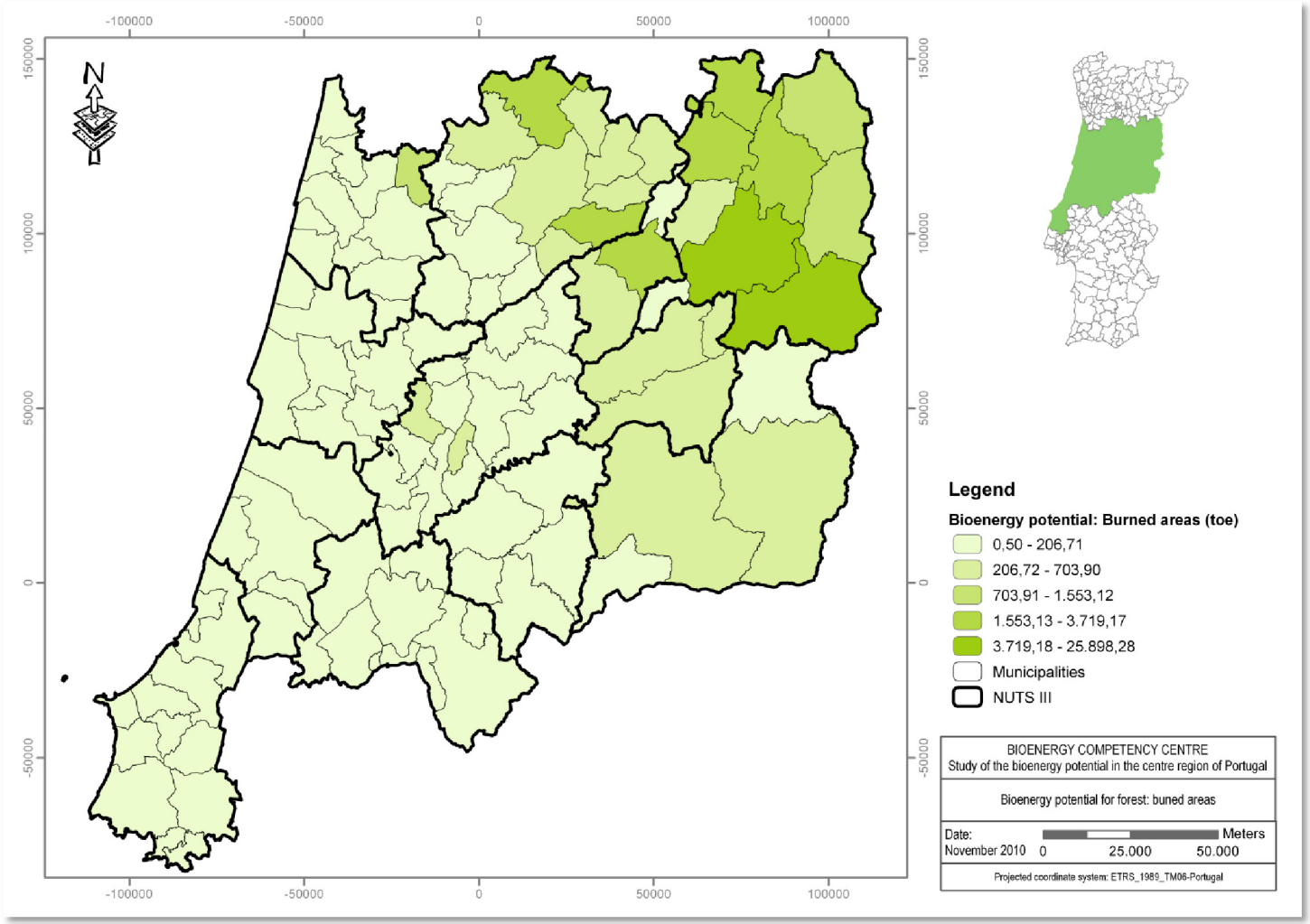


Figure A3.10: Map for the bioenergy potential for forest burned areas residues.

Table A3.12: Bioenergy potential for forest shrubland (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 2.136,00 | 4.000 | 8.544,00 | 3.344 | **2.857,11** |
| | Albergaria-a-Velha | 399,00 | 4.000 | 1.596,00 | 3.344 | **533,70** |
| | Anadia | 1.626,00 | 4.000 | 6.504,00 | 3.344 | **2.174,94** |
| | Aveiro | 882,00 | 4.000 | 3.528,00 | 3.344 | **1.179,76** |
| | Estarreja | 154,00 | 4.000 | 616,00 | 3.344 | **205,99** |
| | Ílhavo | 239,00 | 4.000 | 956,00 | 3.344 | **319,69** |
| | Mealhada | 1.160,00 | 4.000 | 4.640,00 | 3.344 | **1.551,62** |
| | Murtosa | 493,00 | 4.000 | 1.972,00 | 3.344 | **659,44** |
| | Oliveira do Bairro | 424,00 | 4.000 | 1.696,00 | 3.344 | **567,14** |
| | Ovar | 763,00 | 4.000 | 3.052,00 | 3.344 | **1.020,59** |
| | Sever do Vouga | 660,00 | 4.000 | 2.640,00 | 3.344 | **882,82** |
| | Vagos | 757,00 | 4.000 | 3.028,00 | 3.344 | **1.012,56** |
| ***Baixo Mondego*** | Cantanhede | 3.082,00 | 4.000 | 12.328,00 | 3.344 | **4.122,48** |
| | Coimbra | 3.077,00 | 4.000 | 12.308,00 | 3.344 | **4.115,80** |
| | Condeixa-a-Nova | 2.598,00 | 4.000 | 10.392,00 | 3.344 | **3.475,08** |
| | Figueira da Foz | 2.566,00 | 4.000 | 10.264,00 | 3.344 | **3.432,28** |
| | Mira | 725,00 | 4.000 | 2.900,00 | 3.344 | **969,76** |
| | Montemor-o-Velho | 1.113,00 | 4.000 | 4.452,00 | 3.344 | **1.488,75** |
| | Penacova | 1.756,00 | 4.000 | 7.024,00 | 3.344 | **2.348,83** |
| | Soure | 3.234,00 | 4.000 | 12.936,00 | 3.344 | **4.325,80** |
| ***Pinhal Litoral*** | Batalha | 2.572,00 | 4.000 | 10.288,00 | 3.344 | **3.440,31** |
| | Leiria | 6.206,00 | 4.000 | 24.824,00 | 3.344 | **8.301,15** |
| | Marinha Grande | 1.105,00 | 4.000 | 4.420,00 | 3.344 | **1.478,05** |
| | Pombal | 10.288,00 | 4.000 | 41.152,00 | 3.344 | **13.761,23** |
| | Porto de Mós | 11.341,00 | 4.000 | 45.364,00 | 3.344 | **15.169,72** |
| ***Pinhal Interior Norte*** | Arganil | 11.061,00 | 4.000 | 44.244,00 | 3.344 | **14.795,19** |
| | Góis | 6.438,00 | 4.000 | 25.752,00 | 3.344 | **8.611,47** |
| | Lousã | 2.222,00 | 4.000 | 8.888,00 | 3.344 | **2.972,15** |
| | Miranda do Corvo | 1.064,00 | 4.000 | 4.256,00 | 3.344 | **1.423,21** |
| | Oliveira do Hospital | 5.375,00 | 4.000 | 21.500,00 | 3.344 | **7.189,60** |
| | Pampilhosa da Serra | 18.613,00 | 4.000 | 74.452,00 | 3.344 | **24.896,75** |
| | Penela | 2.037,00 | 4.000 | 8.148,00 | 3.344 | **2.724,69** |
| | Tábua | 3.025,00 | 4.000 | 12.100,00 | 3.344 | **4.046,24** |
| | Vila Nova de Poiares | 835,00 | 4.000 | 3.340,00 | 3.344 | **1.116,90** |
| | Alvaiázere | 4.354,00 | 4.000 | 17.416,00 | 3.344 | **5.823,91** |
| | Ansião | 2.617,00 | 4.000 | 10.468,00 | 3.344 | **3.500,50** |
| | Castanheira de Pêra | 1.537,00 | 4.000 | 6.148,00 | 3.344 | **2.055,89** |
| | Figueiró dos Vinhos | 3.255,00 | 4.000 | 13.020,00 | 3.344 | **4.353,89** |
| | Pedrógão Grande | 1.291,00 | 4.000 | 5.164,00 | 3.344 | **1.726,84** |
| ***Dão Lafões*** | Aguiar da Beira | 6.956,00 | 4.000 | 27.824,00 | 3.344 | 9.304,35 |
| | Carregal do Sal | 1.872,00 | 4.000 | 7.488,00 | 3.344 | 2.503,99 |
| | Castro Daire | 15.176,00 | 4.000 | 60.704,00 | 3.344 | 20.299,42 |
| | Mangualde | 7.184,00 | 4.000 | 28.736,00 | 3.344 | 9.609,32 |
| | Mortágua | 1.100,00 | 4.000 | 4.400,00 | 3.344 | 1.471,36 |
| | Nelas | 2.854,00 | 4.000 | 11.416,00 | 3.344 | 3.817,51 |
| | Oliveira de Frades | 1.128,00 | 4.000 | 4.512,00 | 3.344 | 1.508,81 |
| | Penalva do Castelo | 2.577,00 | 4.000 | 10.308,00 | 3.344 | 3.447,00 |
| | Santa Comba Dão | 1.218,00 | 4.000 | 4.872,00 | 3.344 | 1.629,20 |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced forest residues (kg/ha.year)* | *Biomass Residues (t)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 10.333,00 | 4.000 | 41.332,00 | 3.344 | 13.821,42 |
| | Sátão | 4.203,00 | 4.000 | 16.812,00 | 3.344 | 5.621,93 |
| | Tondela | 4.218,00 | 4.000 | 16.872,00 | 3.344 | 5.642,00 |
| | Vila Nova de Paiva | 8.763,00 | 4.000 | 35.052,00 | 3.344 | 11.721,39 |
| | Viseu | 7.585,00 | 4.000 | 30.340,00 | 3.344 | 10.145,70 |
| | Vouzela | 4.037,00 | 4.000 | 16.148,00 | 3.344 | 5.399,89 |
| ***Pinhal Interior Sul*** | Oleiros | 24.456,00 | 4.000 | 97.824,00 | 3.344 | 32.712,35 |
| | Proença-a-Nova | 18.889,00 | 4.000 | 75.556,00 | 3.344 | 25.265,93 |
| | Sertã | 17.302,00 | 4.000 | 69.208,00 | 3.344 | 23.143,16 |
| | Vila de Rei | 8.870,00 | 4.000 | 35.480,00 | 3.344 | 11.864,51 |
| | Mação | 13.562,00 | 4.000 | 54.248,00 | 3.344 | 18.140,53 |
| ***Serra Estrela*** | Fornos de Algodres | 6.239,00 | 4.000 | 24.956,00 | 3.344 | 8.345,29 |
| | Gouveia | 18.253,00 | 4.000 | 73.012,00 | 3.344 | 24.415,21 |
| | Seia | 27.421,00 | 4.000 | 109.684,00 | 3.344 | 36.678,33 |
| ***Beira Interior Norte*** | Almeida | 20.448,00 | 4.000 | 81.792,00 | 3.344 | 27.351,24 |
| | Celorico da Beira | 11.602,00 | 4.000 | 46.408,00 | 3.344 | 15.518,84 |
| | Fig. Castelo Rodrigo | 20.222,00 | 4.000 | 80.888,00 | 3.344 | 27.048,95 |
| | Guarda | 36.723,00 | 4.000 | 146.892,00 | 3.344 | 49.120,68 |
| | Manteigas | 7.969,00 | 4.000 | 31.876,00 | 3.344 | 10.659,33 |
| | Meda | 11.707,00 | 4.000 | 46.828,00 | 3.344 | 15.659,28 |
| | Pinhel | 21.914,00 | 4.000 | 87.656,00 | 3.344 | 29.312,17 |
| | Sabugal | 48.657,00 | 4.000 | 194.628,00 | 3.344 | 65.083,60 |
| | Trancoso | 16.673,00 | 4.000 | 66.692,00 | 3.344 | 22.301,80 |
| ***Beira Interior Sul*** | Castelo Branco | 36.547,00 | 4.000 | 146.188,00 | 3.344 | 48.885,27 |
| | Idanha-a-Nova | 33.180,00 | 4.000 | 132.720,00 | 3.344 | 44.381,57 |
| | Penamacor | 13.536,00 | 4.000 | 54.144,00 | 3.344 | 18.105,75 |
| | Vila Velha de Ródão | 8.962,00 | 4.000 | 35.848,00 | 3.344 | 11.987,57 |
| ***Cova Beira*** | Belmonte | 4.559,00 | 4.000 | 18.236,00 | 3.344 | 6.098,12 |
| | Covilhã | 24.910,00 | 4.000 | 99.640,00 | 3.344 | 33.319,62 |
| | Fundão | 19.009,00 | 4.000 | 76.036,00 | 3.344 | 25.426,44 |
| ***Oeste*** | Alcobaça | 6.952,00 | 4.000 | 27.808,00 | 3.344 | **9.299,00** |
| | Bombarral | 475,00 | 4.000 | 1.900,00 | 3.344 | **635,36** |
| | Caldas da Rainha | 3.115,00 | 4.000 | 12.460,00 | 3.344 | **4.166,62** |
| | Nazaré | 846,00 | 4.000 | 3.384,00 | 3.344 | **1.131,61** |
| | Óbidos | 1.610,00 | 4.000 | 6.440,00 | 3.344 | **2.153,54** |
| | Peniche | 682,00 | 4.000 | 2.728,00 | 3.344 | **912,24** |
| | Alenquer | 3.158,00 | 4.000 | 12.632,00 | 3.344 | **4.224,14** |
| | Arruda dos Vinhos | 1.876,00 | 4.000 | 7.504,00 | 3.344 | **2.509,34** |
| | Cadaval | 2.173,00 | 4.000 | 8.692,00 | 3.344 | **2.906,60** |
| | Lourinhã | 1.073,00 | 4.000 | 4.292,00 | 3.344 | **1.435,24** |
| | Sobral de Monte Agraço | 793,00 | 4.000 | 3.172,00 | 3.344 | **1.060,72** |
| | Torres Vedras | 3.669,00 | 4.000 | 14.676,00 | 3.344 | **4.907,65** |
| ***Médio Tejo*** | Abrantes | 5.786,00 | 4.000 | 23.144,00 | 3.344 | **7.739,35** |
| | Alcanena | 3.059,00 | 4.000 | 12.236,00 | 3.344 | **4.091,72** |
| | Constância | 956,00 | 4.000 | 3.824,00 | 3.344 | **1.278,75** |
| | Entroncamento | 145,00 | 4.000 | 580,00 | 3.344 | **193,95** |
| | Ferreira do Zêzere | 2.019,00 | 4.000 | 8.076,00 | 3.344 | **2.700,61** |
| | Sardoal | 959,00 | 4.000 | 3.836,00 | 3.344 | **1.282,76** |
| | Tomar | 4.208,00 | 4.000 | 16.832,00 | 3.344 | **5.628,62** |
| | Torres Novas | 3.867,00 | 4.000 | 15.468,00 | 3.344 | **5.172,50** |
| | Vila Nova da Barquinha | 515,00 | 4.000 | 2.060,00 | 3.344 | **688,86** |
| | Ourém | 9.971,00 | 4.000 | 39.884,00 | 3.344 | **13.337,21** |
| | **Total** | **731.801,00** | **-** | **2.927.204,00** | **-** | **978.857,02** |

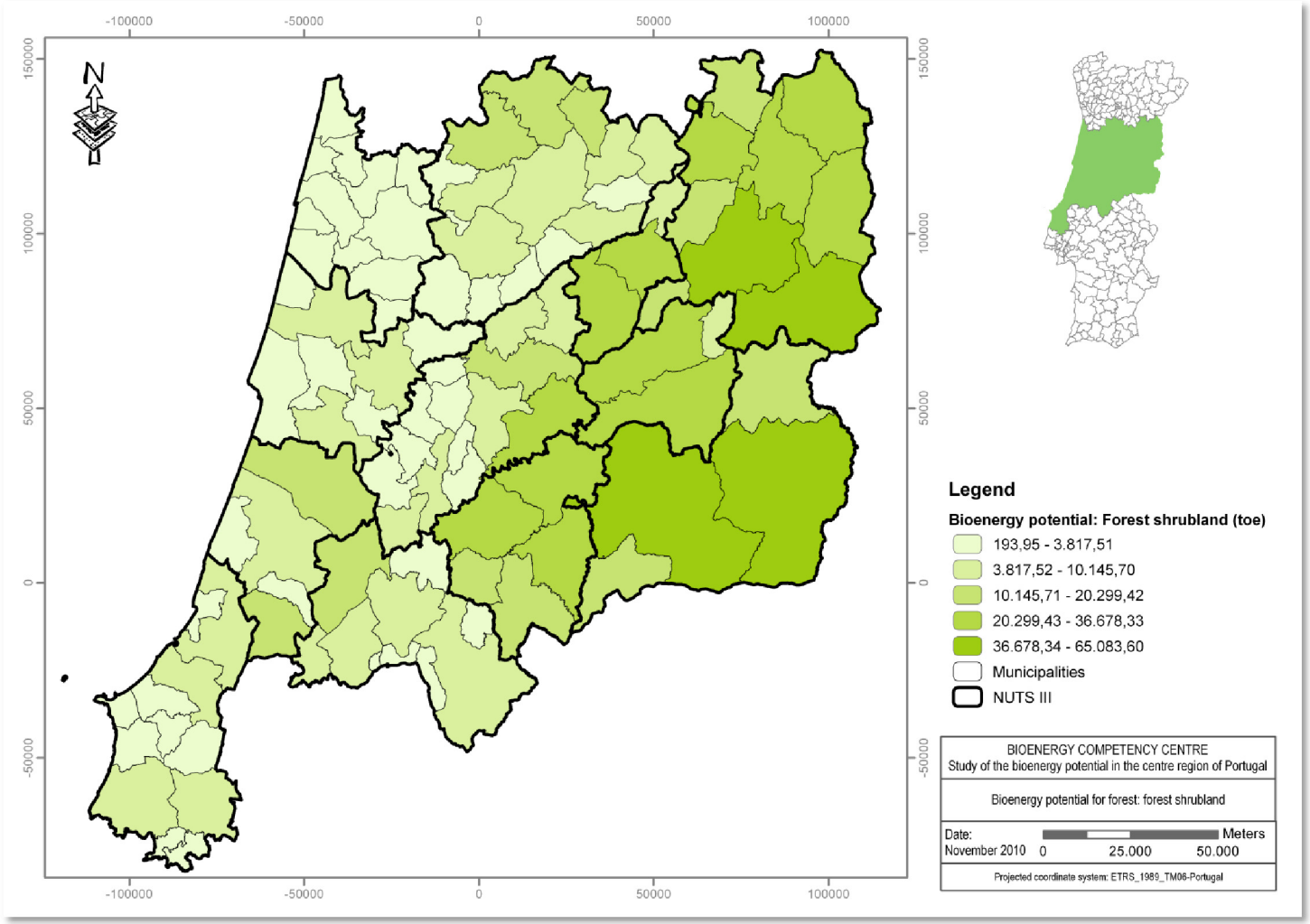


Figure A3.11: Map for the bioenergy potential for forest shrubland residues.

## *Annex 4: Agricultural Biomass Residues*

Table A4.1: Bioenergy potential for fresh fruit permanent crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced fresh fruit residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 36,27 | 60 | 2.176,20 | 14.654 | **0,76** |
| | Albergaria-a-Velha | 4,60 | 60 | 276,00 | 14.654 | **0,10** |
| | Anadia | 30,16 | 60 | 1.809,60 | 14.654 | **0,63** |
| | Aveiro | 4,58 | 60 | 274,80 | 14.654 | **0,10** |
| | Estarreja | 3,66 | 60 | 219,60 | 14.654 | **0,08** |
| | Ílhavo | ... | 60 | 0,00 | 14.654 | **0,00** |
| | Mealhada | 35,92 | 60 | 2.155,20 | 14.654 | **0,75** |
| | Murtosa | 0,33 | 60 | 19,80 | 14.654 | **0,01** |
| | Oliveira do Bairro | 17,71 | 60 | 1.062,60 | 14.654 | **0,37** |
| | Ovar | 7,34 | 60 | 440,40 | 14.654 | **0,15** |
| | Sever do Vouga | 8,97 | 60 | 538,20 | 14.654 | **0,19** |
| | Vagos | 6,86 | 60 | 411,60 | 14.654 | **0,14** |
| ***Baixo Mondego*** | Cantanhede | 59,41 | 60 | 3.564,60 | 14.654 | **1,25** |
| | Coimbra | 114,16 | 60 | 6.849,60 | 14.654 | **2,40** |
| | Condeixa-a-Nova | 28,56 | 60 | 1.713,60 | 14.654 | **0,60** |
| | Figueira da Foz | 30,93 | 60 | 1.855,80 | 14.654 | **0,65** |
| | Mira | 21,72 | 60 | 1.303,20 | 14.654 | **0,46** |
| | Montemor-o-Velho | 14,19 | 60 | 851,40 | 14.654 | **0,30** |
| | Penacova | 10,88 | 60 | 652,80 | 14.654 | **0,23** |
| | Soure | 101,08 | 60 | 6.064,80 | 14.654 | **2,12** |
| ***Pinhal Litoral*** | Batalha | 291,30 | 60 | 17.478,00 | 14.654 | **6,12** |
| | Leiria | 645,86 | 60 | 38.751,60 | 14.654 | **13,57** |
| | Marinha Grande | 14,12 | 60 | 847,20 | 14.654 | **0,30** |
| | Pombal | 84,93 | 60 | 5.095,80 | 14.654 | **1,78** |
| | Porto de Mós | 546,74 | 60 | 32.804,40 | 14.654 | **11,49** |
| ***Pinhal Interior Norte*** | Arganil | 24,76 | 60 | 1.485,60 | 14.654 | **0,52** |
| | Góis | 4,11 | 60 | 246,60 | 14.654 | **0,09** |
| | Lousã | 9,50 | 60 | 570,00 | 14.654 | **0,20** |
| | Miranda do Corvo | 38,34 | 60 | 2.300,40 | 14.654 | **0,81** |
| | Oliveira do Hospital | 24,53 | 60 | 1.471,80 | 14.654 | **0,52** |
| | Pampilhosa da Serra | 5,32 | 60 | 319,20 | 14.654 | **0,11** |
| | Penela | 8,02 | 60 | 481,20 | 14.654 | **0,17** |
| | Tábua | 20,76 | 60 | 1.245,60 | 14.654 | **0,44** |
| | Vila Nova de Poiares | 9,34 | 60 | 560,40 | 14.654 | **0,20** |
| | Alvaiázere | 13,40 | 60 | 804,00 | 14.654 | **0,28** |
| | Ansião | 7,76 | 60 | 465,60 | 14.654 | **0,16** |
| | Castanheira de Pêra | ... | 60 | 0,00 | 14.654 | **0,00** |
| | Figueiró dos Vinhos | 10,06 | 60 | 603,60 | 14.654 | **0,21** |
| | Pedrógão Grande | 7,63 | 60 | 457,80 | 14.654 | **0,16** |
| ***Dão Lafões*** | Aguiar da Beira | 157,69 | 60 | 9.461,40 | 14.654 | **3,31** |
| | Carregal do Sal | 34,97 | 60 | 2.098,20 | 14.654 | **0,73** |
| | Castro Daire | 10,60 | 60 | 636,00 | 14.654 | **0,22** |
| | Mangualde | 115,43 | 60 | 6.925,80 | 14.654 | **2,43** |
| | Mortágua | 3,98 | 60 | 238,80 | 14.654 | **0,08** |
| | Nelas | 45,07 | 60 | 2.704,20 | 14.654 | **0,95** |
| | Oliveira de Frades | 3,47 | 60 | 208,20 | 14.654 | **0,07** |
| | Penalva do Castelo | 154,34 | 60 | 9.260,40 | 14.654 | **3,24** |
| | Santa Comba Dão | 30,93 | 60 | 1.855,80 | 14.654 | **0,65** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced fresh fruit residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 86,51 | 60 | 5.190,60 | 14.654 | **1,82** |
| | Sátão | 68,78 | 60 | 4.126,80 | 14.654 | **1,45** |
| | Tondela | 71,19 | 60 | 4.271,40 | 14.654 | **1,50** |
| | Vila Nova de Paiva | 12,03 | 60 | 721,80 | 14.654 | **0,25** |
| | Viseu | 340,71 | 60 | 20.442,60 | 14.654 | **7,16** |
| | Vouzela | 123,31 | 60 | 7.398,60 | 14.654 | **2,59** |
| ***Pinhal Interior Sul*** | Oleiros | 28,45 | 60 | 1.707,00 | 14.654 | **0,60** |
| | Proença-a-Nova | 108,66 | 60 | 6.519,60 | 14.654 | **2,28** |
| | Sertã | 59,43 | 60 | 3.565,80 | 14.654 | **1,25** |
| | Vila de Rei | 7,14 | 60 | 428,40 | 14.654 | **0,15** |
| | Mação | 33,39 | 60 | 2.003,40 | 14.654 | **0,70** |
| ***Serra Estrela*** | Fornos de Algodres | 32,55 | 60 | 1.953,00 | 14.654 | **0,68** |
| | Gouveia | 104,64 | 60 | 6.278,40 | 14.654 | **2,20** |
| | Seia | 129,14 | 60 | 7.748,40 | 14.654 | **2,71** |
| ***Beira Interior Norte*** | Almeida | 13,44 | 60 | 806,40 | 14.654 | **0,28** |
| | Celorico da Beira | 88,60 | 60 | 5.316,00 | 14.654 | **1,86** |
| | Fig. Castelo Rodrigo | 44,43 | 60 | 2.665,80 | 14.654 | **0,93** |
| | Guarda | 436,90 | 60 | 26.214,00 | 14.654 | **9,18** |
| | Manteigas | 38,89 | 60 | 2.333,40 | 14.654 | **0,82** |
| | Meda | 178,77 | 60 | 10.726,20 | 14.654 | **3,76** |
| | Pinhel | 431,08 | 60 | 25.864,80 | 14.654 | **9,06** |
| | Sabugal | 121,04 | 60 | 7.262,40 | 14.654 | **2,54** |
| | Trancoso | 241,22 | 60 | 14.473,20 | 14.654 | **5,07** |
| ***Beira Interior Sul*** | Castelo Branco | 335,97 | 60 | 20.158,20 | 14.654 | **7,06** |
| | Idanha-a-Nova | 98,34 | 60 | 5.900,40 | 14.654 | **2,07** |
| | Penamacor | 65,45 | 60 | 3.927,00 | 14.654 | **1,38** |
| | Vila Velha de Ródão | 41,70 | 60 | 2.502,00 | 14.654 | **0,88** |
| ***Cova Beira*** | Belmonte | 479,52 | 60 | 28.771,20 | 14.654 | **10,08** |
| | Covilhã | 1.153,73 | 60 | 69.223,80 | 14.654 | **24,24** |
| | Fundão | 2.496,07 | 60 | 149.764,20 | 14.654 | **52,45** |
| ***Oeste*** | Alcobaça | 3.935,99 | 60 | 236.159,40 | 14.654 | **82,71** |
| | Bombarral | 2.812,28 | 60 | 168.736,80 | 14.654 | **59,10** |
| | Caldas da Rainha | 3.390,24 | 60 | 203.414,40 | 14.654 | **71,24** |
| | Nazaré | 178,18 | 60 | 10.690,80 | 14.654 | **3,74** |
| | Óbidos | 1.983,94 | 60 | 119.036,40 | 14.654 | **41,69** |
| | Peniche | 100,13 | 60 | 6.007,80 | 14.654 | **2,10** |
| | Alenquer | 588,00 | 60 | 35.280,00 | 14.654 | **12,36** |
| | Arruda dos Vinhos | 147,17 | 60 | 8.830,20 | 14.654 | **3,09** |
| | Cadaval | 2.533,82 | 60 | 152.029,20 | 14.654 | **53,25** |
| | Lourinhã | 1.129,66 | 60 | 67.779,60 | 14.654 | **23,74** |
| | Sobral de Monte Agraço | 18,26 | 60 | 1.095,60 | 14.654 | **0,38** |
| | Torres Vedras | 1.660,67 | 60 | 99.640,20 | 14.654 | **34,90** |
| ***Médio Tejo*** | Abrantes | 344,65 | 60 | 20.679,00 | 14.654 | **7,24** |
| | Alcanena | 158,88 | 60 | 9.532,80 | 14.654 | **3,34** |
| | Constância | 23,05 | 60 | 1.383,00 | 14.654 | **0,48** |
| | Entroncamento | 18,92 | 60 | 1.135,20 | 14.654 | **0,40** |
| | Ferreira do Zêzere | 227,26 | 60 | 13.635,60 | 14.654 | **4,78** |
| | Sardoal | 23,00 | 60 | 1.380,00 | 14.654 | **0,48** |
| | Tomar | 189,48 | 60 | 11.368,80 | 14.654 | **3,98** |
| | Torres Novas | 1.299,14 | 60 | 77.948,40 | 14.654 | **27,30** |
| | Vila Nova da Barquinha | 7,65 | 60 | 459,00 | 14.654 | **0,16** |
| | Ourém | 131,68 | 60 | 7.900,80 | 14.654 | **2,77** |
| | **Total** | **31.233,42** | **-** | **1.874.005,20** | **-** | **656,33** |

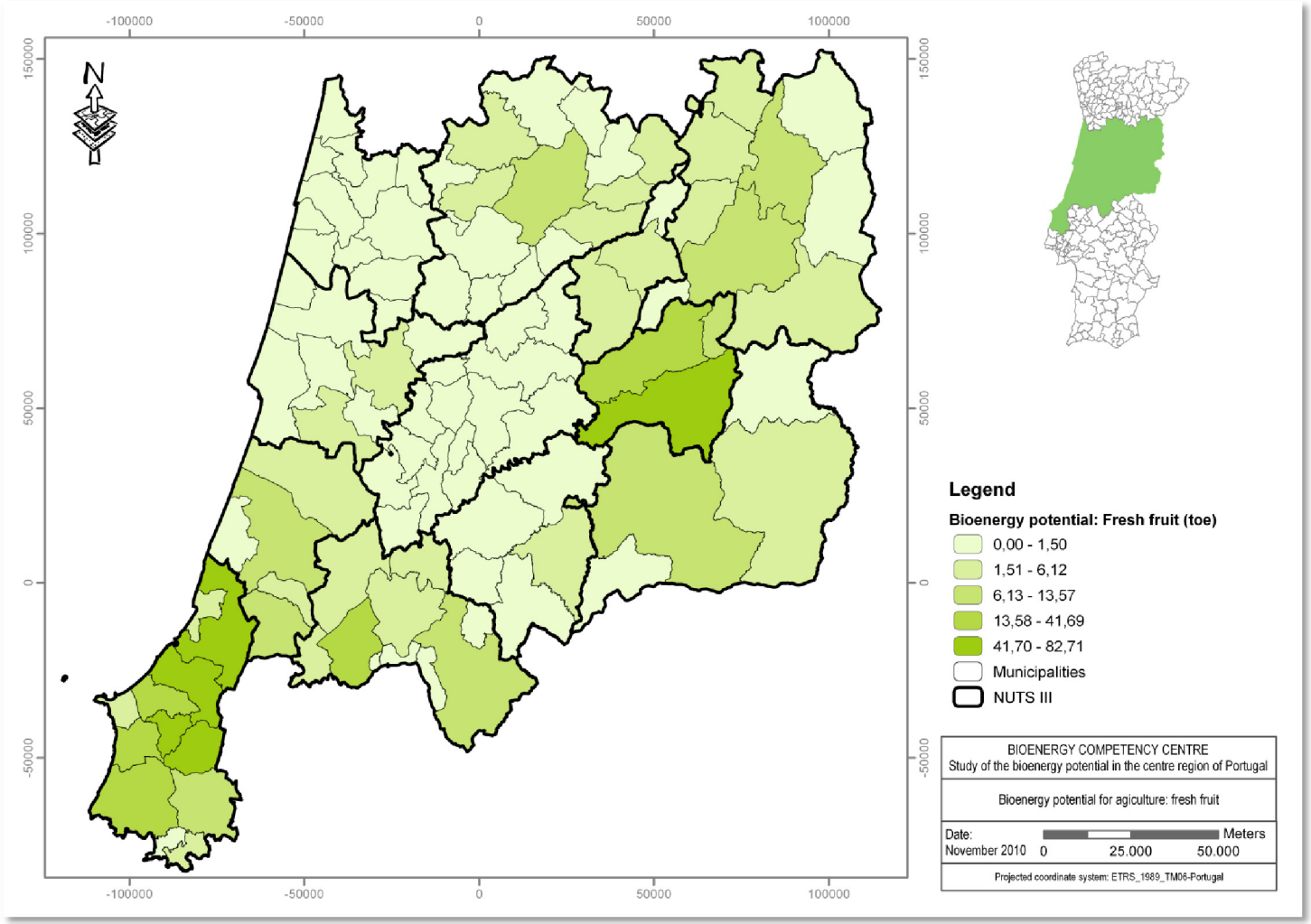


Figure A4.1: Map for the bioenergy potential for fresh fruit residues.

Table A4.2: Bioenergy potential for citron permanent crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced citron residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 12,69 | 30 | 380,70 | 14.654 | **0,13** |
| | Albergaria-a-Velha | 3,06 | 30 | 91,80 | 14.654 | **0,03** |
| | Anadia | 19,32 | 30 | 579,60 | 14.654 | **0,20** |
| | Aveiro | 3,67 | 30 | 110,10 | 14.654 | **0,04** |
| | Estarreja | 2,02 | 30 | 60,60 | 14.654 | **0,02** |
| | Ílhavo | 1,49 | 30 | 44,70 | 14.654 | **0,02** |
| | Mealhada | 25,45 | 30 | 763,50 | 14.654 | **0,27** |
| | Murtosa | 0,00 | 30 | 0,00 | 14.654 | **0,00** |
| | Oliveira do Bairro | 11,01 | 30 | 330,30 | 14.654 | **0,12** |
| | Ovar | 4,65 | 30 | 139,50 | 14.654 | **0,05** |
| | Sever do Vouga | 5,4 | 30 | 162,00 | 14.654 | **0,06** |
| | Vagos | 17,38 | 30 | 521,40 | 14.654 | **0,18** |
| ***Baixo Mondego*** | Cantanhede | 90,92 | 30 | 2.727,60 | 14.654 | **0,96** |
| | Coimbra | 93,02 | 30 | 2.790,60 | 14.654 | **0,98** |
| | Condeixa-a-Nova | 9,73 | 30 | 291,90 | 14.654 | **0,10** |
| | Figueira da Foz | 27,76 | 30 | 832,80 | 14.654 | **0,29** |
| | Mira | 54,07 | 30 | 1.622,10 | 14.654 | **0,57** |
| | Montemor-o-Velho | 15,77 | 30 | 473,10 | 14.654 | **0,17** |
| | Penacova | 1,18 | 30 | 35,40 | 14.654 | **0,01** |
| | Soure | 25,3 | 30 | 759,00 | 14.654 | **0,27** |
| ***Pinhal Litoral*** | Batalha | 4,99 | 30 | 149,70 | 14.654 | **0,05** |
| | Leiria | 31,9 | 30 | 957,00 | 14.654 | **0,34** |
| | Marinha Grande | 3,18 | 30 | 95,40 | 14.654 | **0,03** |
| | Pombal | 46,82 | 30 | 1.404,60 | 14.654 | **0,49** |
| | Porto de Mós | 7,13 | 30 | 213,90 | 14.654 | **0,07** |
| ***Pinhal Interior Norte*** | Arganil | 0,08 | 30 | 2,40 | 14.654 | **0,00** |
| | Góis | 0,00 | 30 | 0,00 | 14.654 | **0,00** |
| | Lousã | 1,59 | 30 | 47,70 | 14.654 | **0,02** |
| | Miranda do Corvo | 6,62 | 30 | 198,60 | 14.654 | **0,07** |
| | Oliveira do Hospital | 2,69 | 30 | 80,70 | 14.654 | **0,03** |
| | Pampilhosa da Serra | 1,69 | 30 | 50,70 | 14.654 | **0,02** |
| | Penela | 2,54 | 30 | 76,20 | 14.654 | **0,03** |
| | Tábua | 1,56 | 30 | 46,80 | 14.654 | **0,02** |
| | Vila Nova de Poiares | 2,18 | 30 | 65,40 | 14.654 | **0,02** |
| | Alvaiázere | 2,38 | 30 | 71,40 | 14.654 | **0,03** |
| | Ansião | 1,84 | 30 | 55,20 | 14.654 | **0,02** |
| | Castanheira de Pêra | ... | 30 | 0,00 | 14.654 | **0,00** |
| | Figueiró dos Vinhos | 3,91 | 30 | 117,30 | 14.654 | **0,04** |
| | Pedrógão Grande | 1,14 | 30 | 34,20 | 14.654 | **0,01** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 30 | 0,00 | 14.654 | **0,00** |
| | Carregal do Sal | 1,01 | 30 | 30,30 | 14.654 | **0,01** |
| | Castro Daire | 0,33 | 30 | 9,90 | 14.654 | **0,00** |
| | Mangualde | 2,39 | 30 | 71,70 | 14.654 | **0,03** |
| | Mortágua | 2,39 | 30 | 71,70 | 14.654 | **0,03** |
| | Nelas | 0,87 | 30 | 26,10 | 14.654 | **0,01** |
| | Oliveira de Frades | 3,48 | 30 | 104,40 | 14.654 | **0,04** |
| | Penalva do Castelo | ... | 30 | 0,00 | 14.654 | **0,00** |
| | Santa Comba Dão | 1,29 | 30 | 38,70 | 14.654 | **0,01** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced citron residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 8,74 | 30 | 262,20 | 14.654 | **0,09** |
| | Sátão | ... | 30 | 0,00 | 14.654 | **0,00** |
| | Tondela | 56,77 | 30 | 1.703,10 | 14.654 | **0,60** |
| | Vila Nova de Paiva | 0,00 | 30 | 0,00 | 14.654 | **0,00** |
| | Viseu | 6,08 | 30 | 182,40 | 14.654 | **0,06** |
| | Vouzela | 0,27 | 30 | 8,10 | 14.654 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,19 | 30 | 5,70 | 14.654 | **0,00** |
| | Proença-a-Nova | 22,02 | 30 | 660,60 | 14.654 | **0,23** |
| | Sertã | 4,89 | 30 | 146,70 | 14.654 | **0,05** |
| | Vila de Rei | 0,85 | 30 | 25,50 | 14.654 | **0,01** |
| | Mação | 29,25 | 30 | 877,50 | 14.654 | **0,31** |
| ***Serra Estrela*** | Fornos de Algodres | 0,7 | 30 | 21,00 | 14.654 | **0,01** |
| | Gouveia | 0,69 | 30 | 20,70 | 14.654 | **0,01** |
| | Seia | 0,55 | 30 | 16,50 | 14.654 | **0,01** |
| ***Beira Interior Norte*** | Almeida | 0,00 | 30 | 0,00 | 14.654 | **0,00** |
| | Celorico da Beira | ... | 30 | 0,00 | 14.654 | **0,00** |
| | Fig. Castelo Rodrigo | 8,2 | 30 | 246,00 | 14.654 | **0,09** |
| | Guarda | 0,58 | 30 | 17,40 | 14.654 | **0,01** |
| | Manteigas | 0,00 | 30 | 0,00 | 14.654 | **0,00** |
| | Meda | 0,59 | 30 | 17,70 | 14.654 | **0,01** |
| | Pinhel | ... | 30 | 0,00 | 14.654 | **0,00** |
| | Sabugal | 0,45 | 30 | 13,50 | 14.654 | **0,00** |
| | Trancoso | ... | 30 | 0,00 | 14.654 | **0,00** |
| ***Beira Interior Sul*** | Castelo Branco | 123,99 | 30 | 3.719,70 | 14.654 | **1,30** |
| | Idanha-a-Nova | 85,27 | 30 | 2.558,10 | 14.654 | **0,90** |
| | Penamacor | 11,9 | 30 | 357,00 | 14.654 | **0,13** |
| | Vila Velha de Ródão | 46,64 | 30 | 1.399,20 | 14.654 | **0,49** |
| ***Cova Beira*** | Belmonte | 0,43 | 30 | 12,90 | 14.654 | **0,00** |
| | Covilhã | 1,81 | 30 | 54,30 | 14.654 | **0,02** |
| | Fundão | 74,43 | 30 | 2.232,90 | 14.654 | **0,78** |
| ***Oeste*** | Alcobaça | 27,46 | 30 | 823,80 | 14.654 | **0,29** |
| | Bombarral | 4,93 | 30 | 147,90 | 14.654 | **0,05** |
| | Caldas da Rainha | 38,32 | 30 | 1.149,60 | 14.654 | **0,40** |
| | Nazaré | 1,60 | 30 | 48,00 | 14.654 | **0,02** |
| | Óbidos | 13,65 | 30 | 409,50 | 14.654 | **0,14** |
| | Peniche | 2,33 | 30 | 69,90 | 14.654 | **0,02** |
| | Alenquer | 11,61 | 30 | 348,30 | 14.654 | **0,12** |
| | Arruda dos Vinhos | 1,32 | 30 | 39,60 | 14.654 | **0,01** |
| | Cadaval | 3,20 | 30 | 96,00 | 14.654 | **0,03** |
| | Lourinhã | 8,26 | 30 | 247,80 | 14.654 | **0,09** |
| | Sobral de Monte Agraço | 3,87 | 30 | 116,10 | 14.654 | **0,04** |
| | Torres Vedras | 18,38 | 30 | 551,40 | 14.654 | **0,19** |
| ***Médio Tejo*** | Abrantes | 169,55 | 30 | 5.086,50 | 14.654 | **1,78** |
| | Alcanena | 6,46 | 30 | 193,80 | 14.654 | **0,07** |
| | Constância | 13,14 | 30 | 394,20 | 14.654 | **0,14** |
| | Entroncamento | 8,89 | 30 | 266,70 | 14.654 | **0,09** |
| | Ferreira do Zêzere | 18,76 | 30 | 562,80 | 14.654 | **0,20** |
| | Sardoal | 20,61 | 30 | 618,30 | 14.654 | **0,22** |
| | Tomar | 44,90 | 30 | 1.347,00 | 14.654 | **0,47** |
| | Torres Novas | 156,65 | 30 | 4.699,50 | 14.654 | **1,65** |
| | Vila Nova da Barquinha | 7,96 | 30 | 238,80 | 14.654 | **0,08** |
| | Ourém | 27,00 | 30 | 810,00 | 14.654 | **0,28** |
| | **Total** | **1.652,03** | **-** | **49.560,90** | **-** | **17,36** |

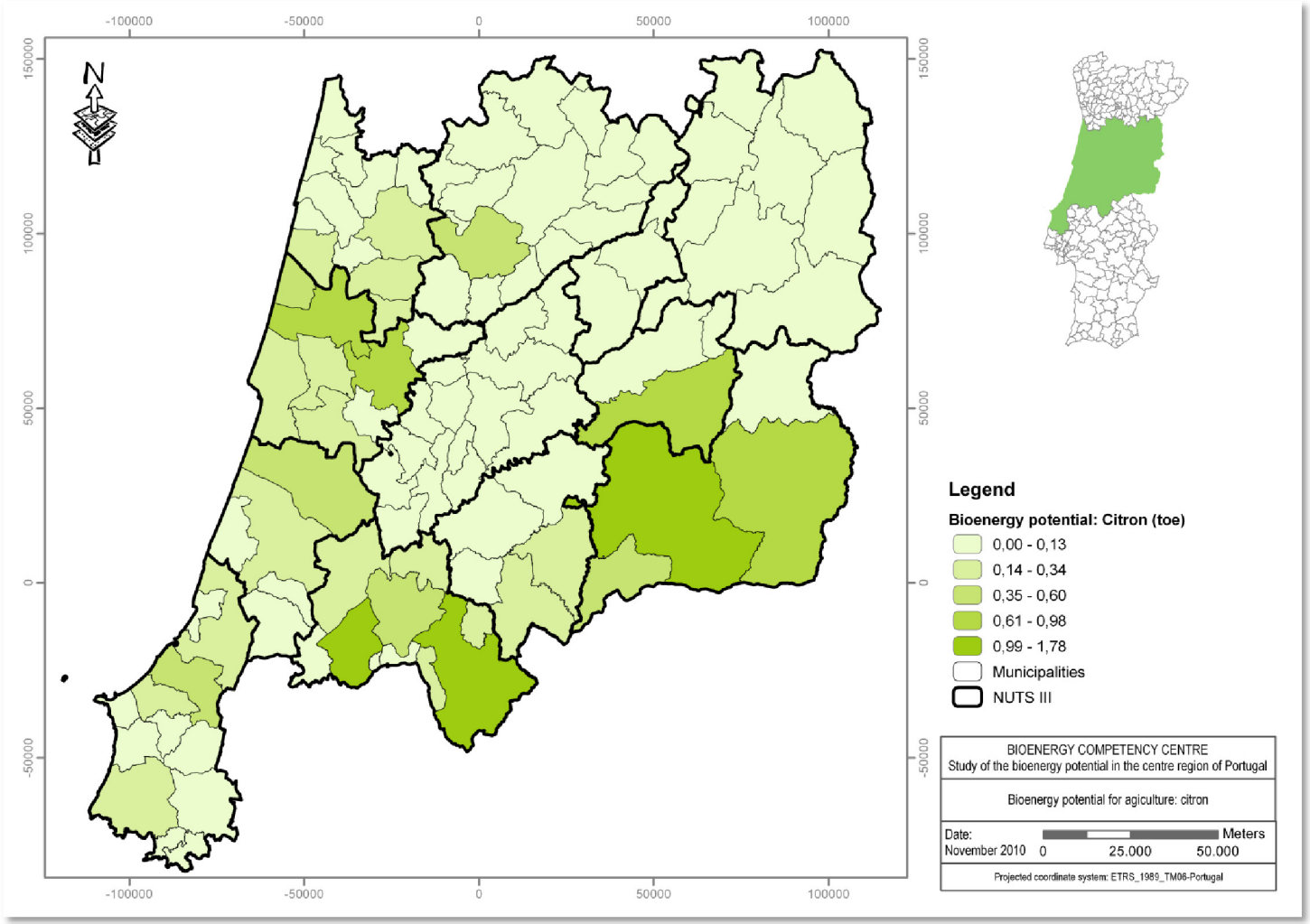


Figure A4.2: Map for the bioenergy potential for citron residues.

Table A4.3: Bioenergy potential for nut permanent crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced nut residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 14,61 | 40 | 584,40 | 14.654 | **0,20** |
| | Albergaria-a-Velha | 7,81 | 40 | 312,40 | 14.654 | **0,11** |
| | Anadia | 16,15 | 40 | 646,00 | 14.654 | **0,23** |
| | Aveiro | ... | 40 | 0,00 | 14.654 | **0,00** |
| | Estarreja | ... | 40 | 0,00 | 14.654 | **0,00** |
| | Ílhavo | 0,00 | 40 | 0,00 | 14.654 | **0,00** |
| | Mealhada | 7,45 | 40 | 298,00 | 14.654 | **0,10** |
| | Murtosa | 0,00 | 40 | 0,00 | 14.654 | **0,00** |
| | Oliveira do Bairro | 8,74 | 40 | 349,60 | 14.654 | **0,12** |
| | Ovar | 0,00 | 40 | 0,00 | 14.654 | **0,00** |
| | Sever do Vouga | 2,71 | 40 | 108,40 | 14.654 | **0,04** |
| | Vagos | 2,71 | 40 | 108,40 | 14.654 | **0,04** |
| ***Baixo Mondego*** | Cantanhede | 26,59 | 40 | 1.063,60 | 14.654 | **0,37** |
| | Coimbra | 23,86 | 40 | 954,40 | 14.654 | **0,33** |
| | Condeixa-a-Nova | 6,39 | 40 | 255,60 | 14.654 | **0,09** |
| | Figueira da Foz | 3,71 | 40 | 148,40 | 14.654 | **0,05** |
| | Mira | 1,9 | 40 | 76,00 | 14.654 | **0,03** |
| | Montemor-o-Velho | 0,92 | 40 | 36,80 | 14.654 | **0,01** |
| | Penacova | 0,41 | 40 | 16,40 | 14.654 | **0,01** |
| | Soure | 13,71 | 40 | 548,40 | 14.654 | **0,19** |
| ***Pinhal Litoral*** | Batalha | 8,12 | 40 | 324,80 | 14.654 | **0,11** |
| | Leiria | 34,55 | 40 | 1.382,00 | 14.654 | **0,48** |
| | Marinha Grande | 0,00 | 40 | 0,00 | 14.654 | **0,00** |
| | Pombal | 18,75 | 40 | 750,00 | 14.654 | **0,26** |
| | Porto de Mós | 14,89 | 40 | 595,60 | 14.654 | **0,21** |
| ***Pinhal Interior Norte*** | Arganil | 10,4 | 40 | 416,00 | 14.654 | **0,15** |
| | Góis | 20,08 | 40 | 803,20 | 14.654 | **0,28** |
| | Lousã | 3,49 | 40 | 139,60 | 14.654 | **0,05** |
| | Miranda do Corvo | 15,96 | 40 | 638,40 | 14.654 | **0,22** |
| | Oliveira do Hospital | 60,9 | 40 | 2.436,00 | 14.654 | **0,85** |
| | Pampilhosa da Serra | 12,85 | 40 | 514,00 | 14.654 | **0,18** |
| | Penela | 16,83 | 40 | 673,20 | 14.654 | **0,24** |
| | Tábua | 23 | 40 | 920,00 | 14.654 | **0,32** |
| | Vila Nova de Poiares | 9,24 | 40 | 369,60 | 14.654 | **0,13** |
| | Alvaiázere | 8,67 | 40 | 346,80 | 14.654 | **0,12** |
| | Ansião | 8,06 | 40 | 322,40 | 14.654 | **0,11** |
| | Castanheira de Pêra | 2,14 | 40 | 85,60 | 14.654 | **0,03** |
| | Figueiró dos Vinhos | 5,98 | 40 | 239,20 | 14.654 | **0,08** |
| | Pedrógão Grande | ... | 40 | 0,00 | 14.654 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 69,08 | 40 | 2.763,20 | 14.654 | **0,97** |
| | Carregal do Sal | 20,15 | 40 | 806,00 | 14.654 | **0,28** |
| | Castro Daire | 23,11 | 40 | 924,40 | 14.654 | **0,32** |
| | Mangualde | 61,8 | 40 | 2.472,00 | 14.654 | **0,87** |
| | Mortágua | 1,24 | 40 | 49,60 | 14.654 | **0,02** |
| | Nelas | 11,34 | 40 | 453,60 | 14.654 | **0,16** |
| | Oliveira de Frades | 12,79 | 40 | 511,60 | 14.654 | **0,18** |
| | Penalva do Castelo | 10,38 | 40 | 415,20 | 14.654 | **0,15** |
| | Santa Comba Dão | 9,55 | 40 | 382,00 | 14.654 | **0,13** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced nut residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 34,95 | 40 | 1.398,00 | 14.654 | **0,49** |
| | Sátão | 96,43 | 40 | 3.857,20 | 14.654 | **1,35** |
| | Tondela | 58,43 | 40 | 2.337,20 | 14.654 | **0,82** |
| | Vila Nova de Paiva | 58,61 | 40 | 2.344,40 | 14.654 | **0,82** |
| | Viseu | 106,27 | 40 | 4.250,80 | 14.654 | **1,49** |
| | Vouzela | 8,03 | 40 | 321,20 | 14.654 | **0,11** |
| ***Pinhal Interior Sul*** | Oleiros | 26,88 | 40 | 1.075,20 | 14.654 | **0,38** |
| | Proença-a-Nova | 8,6 | 40 | 344,00 | 14.654 | **0,12** |
| | Sertã | 34,78 | 40 | 1.391,20 | 14.654 | **0,49** |
| | Vila de Rei | 3,07 | 40 | 122,80 | 14.654 | **0,04** |
| | Mação | 4,56 | 40 | 182,40 | 14.654 | **0,06** |
| ***Serra Estrela*** | Fornos de Algodres | 25,5 | 40 | 1.020,00 | 14.654 | **0,36** |
| | Gouveia | 60,79 | 40 | 2.431,60 | 14.654 | **0,85** |
| | Seia | 173,56 | 40 | 6.942,40 | 14.654 | **2,43** |
| ***Beira Interior Norte*** | Almeida | 22,75 | 40 | 910,00 | 14.654 | **0,32** |
| | Celorico da Beira | 76,93 | 40 | 3.077,20 | 14.654 | **1,08** |
| | Fig. Castelo Rodrigo | 718,08 | 40 | 28.723,20 | 14.654 | **10,06** |
| | Guarda | 587,03 | 40 | 23.481,20 | 14.654 | **8,22** |
| | Manteigas | 6,32 | 40 | 252,80 | 14.654 | **0,09** |
| | Meda | 883,75 | 40 | 35.350,00 | 14.654 | **12,38** |
| | Pinhel | 168,18 | 40 | 6.727,20 | 14.654 | **2,36** |
| | Sabugal | 278,57 | 40 | 11.142,80 | 14.654 | **3,90** |
| | Trancoso | 883,29 | 40 | 35.331,60 | 14.654 | **12,37** |
| ***Beira Interior Sul*** | Castelo Branco | 27,51 | 40 | 1.100,40 | 14.654 | **0,39** |
| | Idanha-a-Nova | 11,17 | 40 | 446,80 | 14.654 | **0,16** |
| | Penamacor | 52,58 | 40 | 2.103,20 | 14.654 | **0,74** |
| | Vila Velha de Ródão | 3,51 | 40 | 140,40 | 14.654 | **0,05** |
| ***Cova Beira*** | Belmonte | 11,83 | 40 | 473,20 | 14.654 | **0,17** |
| | Covilhã | 51,73 | 40 | 2.069,20 | 14.654 | **0,72** |
| | Fundão | 155 | 40 | 6.200,00 | 14.654 | **2,17** |
| ***Oeste*** | Alcobaça | 25,72 | 40 | 1.028,80 | 14.654 | **0,36** |
| | Bombarral | 2,23 | 40 | 89,20 | 14.654 | **0,03** |
| | Caldas da Rainha | 37,54 | 40 | 1.501,60 | 14.654 | **0,53** |
| | Nazaré | 0,80 | 40 | 32,00 | 14.654 | **0,01** |
| | Óbidos | 8,83 | 40 | 353,20 | 14.654 | **0,12** |
| | Peniche | ... | 40 | 0,00 | 14.654 | **0,00** |
| | Alenquer | 20,59 | 40 | 823,60 | 14.654 | **0,29** |
| | Arruda dos Vinhos | 17,51 | 40 | 700,40 | 14.654 | **0,25** |
| | Cadaval | 8,49 | 40 | 339,60 | 14.654 | **0,12** |
| | Lourinhã | 4,20 | 40 | 168,00 | 14.654 | **0,06** |
| | Sobral de Monte Agraço | 23,16 | 40 | 926,40 | 14.654 | **0,32** |
| | Torres Vedras | 27,94 | 40 | 1.117,60 | 14.654 | **0,39** |
| ***Médio Tejo*** | Abrantes | 19,52 | 40 | 780,80 | 14.654 | **0,27** |
| | Alcanena | 4,98 | 40 | 199,20 | 14.654 | **0,07** |
| | Constância | ... | 40 | 0,00 | 14.654 | **0,00** |
| | Entroncamento | 0,22 | 40 | 8,80 | 14.654 | **0,00** |
| | Ferreira do Zêzere | 30,06 | 40 | 1.202,40 | 14.654 | **0,42** |
| | Sardoal | 3,89 | 40 | 155,60 | 14.654 | **0,05** |
| | Tomar | 52,67 | 40 | 2.106,80 | 14.654 | **0,74** |
| | Torres Novas | 112,79 | 40 | 4.511,60 | 14.654 | **1,58** |
| | Vila Nova da Barquinha | 2,45 | 40 | 98,00 | 14.654 | **0,03** |
| | Ourém | 13,78 | 40 | 551,20 | 14.654 | **0,19** |
| | **Total** | **5.687,08** | **-** | **227.483,20** | **-** | **79,67** |

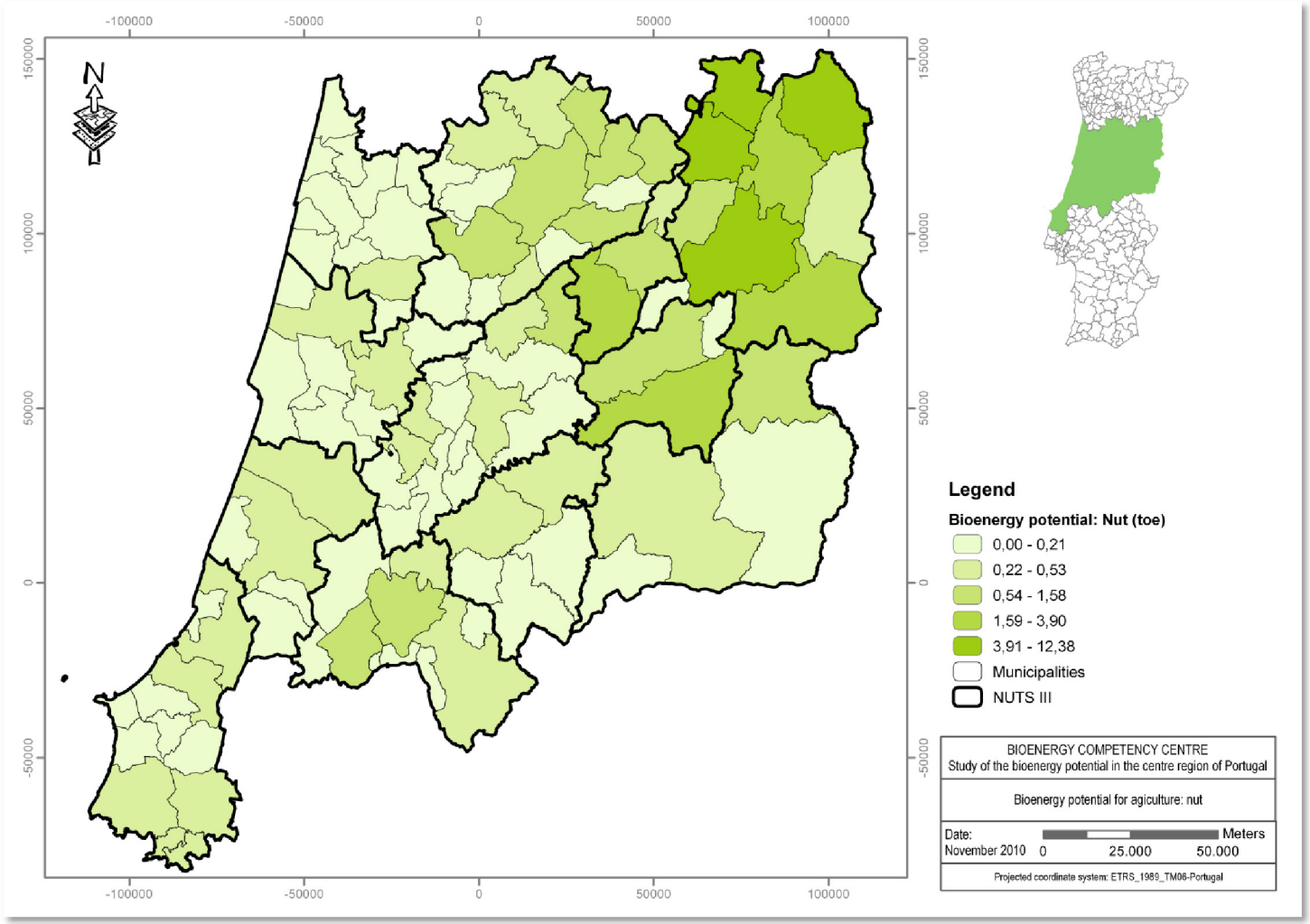


Figure A4.3: Map for the bioenergy potential for nut residues.

Table A4.4: Bioenergy potential for vineyard permanent crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced vineyard residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 292,75 | 875 | 256.156,25 | 17.794 | **108,94** |
| | Albergaria-a-Velha | 58 | 875 | 50.750,00 | 17.794 | **21,58** |
| | Anadia | 2723,78 | 875 | 2.383.307,50 | 17.794 | **1.013,56** |
| | Aveiro | 61,86 | 875 | 54.127,50 | 17.794 | **23,02** |
| | Estarreja | 23,42 | 875 | 20.492,50 | 17.794 | **8,71** |
| | Ílhavo | 0,95 | 875 | 831,25 | 17.794 | **0,35** |
| | Mealhada | 1158,18 | 875 | 1.013.407,50 | 17.794 | **430,98** |
| | Murtosa | 0,00 | 875 | 0,00 | 17.794 | **0,00** |
| | Oliveira do Bairro | 748,7 | 875 | 655.112,50 | 17.794 | **278,60** |
| | Ovar | 2,76 | 875 | 2.415,00 | 17.794 | **1,03** |
| | Sever do Vouga | 1,22 | 875 | 1.067,50 | 17.794 | **0,45** |
| | Vagos | 69,83 | 875 | 61.101,25 | 17.794 | **25,98** |
| ***Baixo Mondego*** | Cantanhede | 3101,69 | 875 | 2.713.978,75 | 17.794 | **1.154,19** |
| | Coimbra | 1140,91 | 875 | 998.296,25 | 17.794 | **424,55** |
| | Condeixa-a-Nova | 391,35 | 875 | 342.431,25 | 17.794 | **145,63** |
| | Figueira da Foz | 194,72 | 875 | 170.380,00 | 17.794 | **72,46** |
| | Mira | 24,56 | 875 | 21.490,00 | 17.794 | **9,14** |
| | Montemor-o-Velho | 178,31 | 875 | 156.021,25 | 17.794 | **66,35** |
| | Penacova | 120,46 | 875 | 105.402,50 | 17.794 | **44,83** |
| | Soure | 531,49 | 875 | 465.053,75 | 17.794 | **197,78** |
| ***Pinhal Litoral*** | Batalha | 660,14 | 875 | 577.622,50 | 17.794 | **245,65** |
| | Leiria | 1583,48 | 875 | 1.385.545,00 | 17.794 | **589,24** |
| | Marinha Grande | 20,33 | 875 | 17.788,75 | 17.794 | **7,57** |
| | Pombal | 974,86 | 875 | 853.002,50 | 17.794 | **362,76** |
| | Porto de Mós | 230,56 | 875 | 201.740,00 | 17.794 | **85,80** |
| ***Pinhal Interior Norte*** | Arganil | 40,4 | 875 | 35.350,00 | 17.794 | **15,03** |
| | Góis | 4,08 | 875 | 3.570,00 | 17.794 | **1,52** |
| | Lousã | 24,07 | 875 | 21.061,25 | 17.794 | **8,96** |
| | Miranda do Corvo | 152,26 | 875 | 133.227,50 | 17.794 | **56,66** |
| | Oliveira do Hospital | 407,29 | 875 | 356.378,75 | 17.794 | **151,56** |
| | Pampilhosa da Serra | 14,72 | 875 | 12.880,00 | 17.794 | **5,48** |
| | Penela | 227,14 | 875 | 198.747,50 | 17.794 | **84,52** |
| | Tábua | 150,12 | 875 | 131.355,00 | 17.794 | **55,86** |
| | Vila Nova de Poiares | 31,73 | 875 | 27.763,75 | 17.794 | **11,81** |
| | Alvaiázere | 197,5 | 875 | 172.812,50 | 17.794 | **73,49** |
| | Ansião | 349,06 | 875 | 305.427,50 | 17.794 | **129,89** |
| | Castanheira de Pêra | 3,65 | 875 | 3.193,75 | 17.794 | **1,36** |
| | Figueiró dos Vinhos | 93,89 | 875 | 82.153,75 | 17.794 | **34,94** |
| | Pedrógão Grande | 22,78 | 875 | 19.932,50 | 17.794 | **8,48** |
| ***Dão Lafões*** | Aguiar da Beira | 136,5 | 875 | 119.437,50 | 17.794 | **50,79** |
| | Carregal do Sal | 345,61 | 875 | 302.408,75 | 17.794 | **128,61** |
| | Castro Daire | 100,31 | 875 | 87.771,25 | 17.794 | **37,33** |
| | Mangualde | 886,11 | 875 | 775.346,25 | 17.794 | **329,74** |
| | Mortágua | 160,15 | 875 | 140.131,25 | 17.794 | **59,59** |
| | Nelas | 1201,17 | 875 | 1.051.023,75 | 17.794 | **446,98** |
| | Oliveira de Frades | 87,16 | 875 | 76.265,00 | 17.794 | **32,43** |
| | Penalva do Castelo | 734,47 | 875 | 642.661,25 | 17.794 | **273,31** |
| | Santa Comba Dão | 263,82 | 875 | 230.842,50 | 17.794 | **98,17** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced vineyard residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 174,64 | 875 | 152.810,00 | 17.794 | **64,99** |
| | Sátão | 413,6 | 875 | 361.900,00 | 17.794 | **153,91** |
| | Tondela | 1757,84 | 875 | 1.538.110,00 | 17.794 | **654,12** |
| | Vila Nova de Paiva | 2,37 | 875 | 2.073,75 | 17.794 | **0,88** |
| | Viseu | 2093,45 | 875 | 1.831.768,75 | 17.794 | **779,01** |
| | Vouzela | 123,68 | 875 | 108.220,00 | 17.794 | **46,02** |
| ***Pinhal Interior Sul*** | Oleiros | 41,65 | 875 | 36.443,75 | 17.794 | **15,50** |
| | Proença-a-Nova | 167,8 | 875 | 146.825,00 | 17.794 | **62,44** |
| | Sertã | 126,15 | 875 | 110.381,25 | 17.794 | **46,94** |
| | Vila de Rei | 25,33 | 875 | 22.163,75 | 17.794 | **9,43** |
| | Mação | 178,94 | 875 | 156.572,50 | 17.794 | **66,59** |
| ***Serra Estrela*** | Fornos de Algodres | 133,93 | 875 | 117.188,75 | 17.794 | **49,84** |
| | Gouveia | 1197,83 | 875 | 1.048.101,25 | 17.794 | **445,73** |
| | Seia | 741,96 | 875 | 649.215,00 | 17.794 | **276,10** |
| ***Beira Interior Norte*** | Almeida | 773,37 | 875 | 676.698,75 | 17.794 | **287,78** |
| | Celorico da Beira | 231,67 | 875 | 202.711,25 | 17.794 | **86,21** |
| | Fig. Castelo Rodrigo | 2873,67 | 875 | 2.514.461,25 | 17.794 | **1.069,34** |
| | Guarda | 664,18 | 875 | 581.157,50 | 17.794 | **247,15** |
| | Manteigas | 41,1 | 875 | 35.962,50 | 17.794 | **15,29** |
| | Meda | 2822,55 | 875 | 2.469.731,25 | 17.794 | **1.050,32** |
| | Pinhel | 4750,27 | 875 | 4.156.486,25 | 17.794 | **1.767,66** |
| | Sabugal | 482,15 | 875 | 421.881,25 | 17.794 | **179,42** |
| | Trancoso | 1153,49 | 875 | 1.009.303,75 | 17.794 | **429,23** |
| ***Beira Interior Sul*** | Castelo Branco | 1082,87 | 875 | 947.511,25 | 17.794 | **402,95** |
| | Idanha-a-Nova | 326,63 | 875 | 285.801,25 | 17.794 | **121,54** |
| | Penamacor | 317,54 | 875 | 277.847,50 | 17.794 | **118,16** |
| | Vila Velha de Ródão | 51,83 | 875 | 45.351,25 | 17.794 | **19,29** |
| ***Cova Beira*** | Belmonte | 752,38 | 875 | 658.332,50 | 17.794 | **279,97** |
| | Covilhã | 940,4 | 875 | 822.850,00 | 17.794 | **349,94** |
| | Fundão | 1270,18 | 875 | 1.111.407,50 | 17.794 | **472,66** |
| ***Oeste*** | Alcobaça | 560,42 | 875 | 490.368 | 17.794 | **208,54** |
| | Bombarral | 1.460,04 | 875 | 1.277.535 | 17.794 | **543,31** |
| | Caldas da Rainha | 1.571,67 | 875 | 1.375.211 | 17.794 | **584,85** |
| | Nazaré | 17,43 | 875 | 15.251 | 17.794 | **6,49** |
| | Óbidos | 491,73 | 875 | 430.264 | 17.794 | **182,98** |
| | Peniche | 90,09 | 875 | 78.829 | 17.794 | **33,52** |
| | Alenquer | 6.377,86 | 875 | 5.580.628 | 17.794 | **2.373,31** |
| | Arruda dos Vinhos | 1.335,84 | 875 | 1.168.860 | 17.794 | **497,09** |
| | Cadaval | 2.345,05 | 875 | 2.051.919 | 17.794 | **872,63** |
| | Lourinhã | 816,19 | 875 | 714.166 | 17.794 | **303,72** |
| | Sobral de Monte Agraço | 583,51 | 875 | 510.571 | 17.794 | **217,13** |
| | Torres Vedras | 6.072,69 | 875 | 5.313.604 | 17.794 | **2.259,75** |
| ***Médio Tejo*** | Abrantes | 276,07 | 875 | 241.561 | 17.794 | **102,73** |
| | Alcanena | 29,62 | 875 | 25.918 | 17.794 | **11,02** |
| | Constância | 0,50 | 875 | 438 | 17.794 | **0,19** |
| | Entroncamento | 6,17 | 875 | 5.399 | 17.794 | **2,30** |
| | Ferreira do Zêzere | 379,64 | 875 | 332.185 | 17.794 | **141,27** |
| | Sardoal | 77,96 | 875 | 68.215 | 17.794 | **29,01** |
| | Tomar | 907,65 | 875 | 794.194 | 17.794 | **337,75** |
| | Torres Novas | 553,61 | 875 | 484.409 | 17.794 | **206,01** |
| | Vila Nova da Barquinha | 18,41 | 875 | 16.109 | 17.794 | **6,85** |
| | Ourém | 1.218,59 | 875 | 1.066.266 | 17.794 | **453,46** |
| | **Total** | **70.832,49** | **-** | **61.978.428,75** | **-** | **26.357,98** |

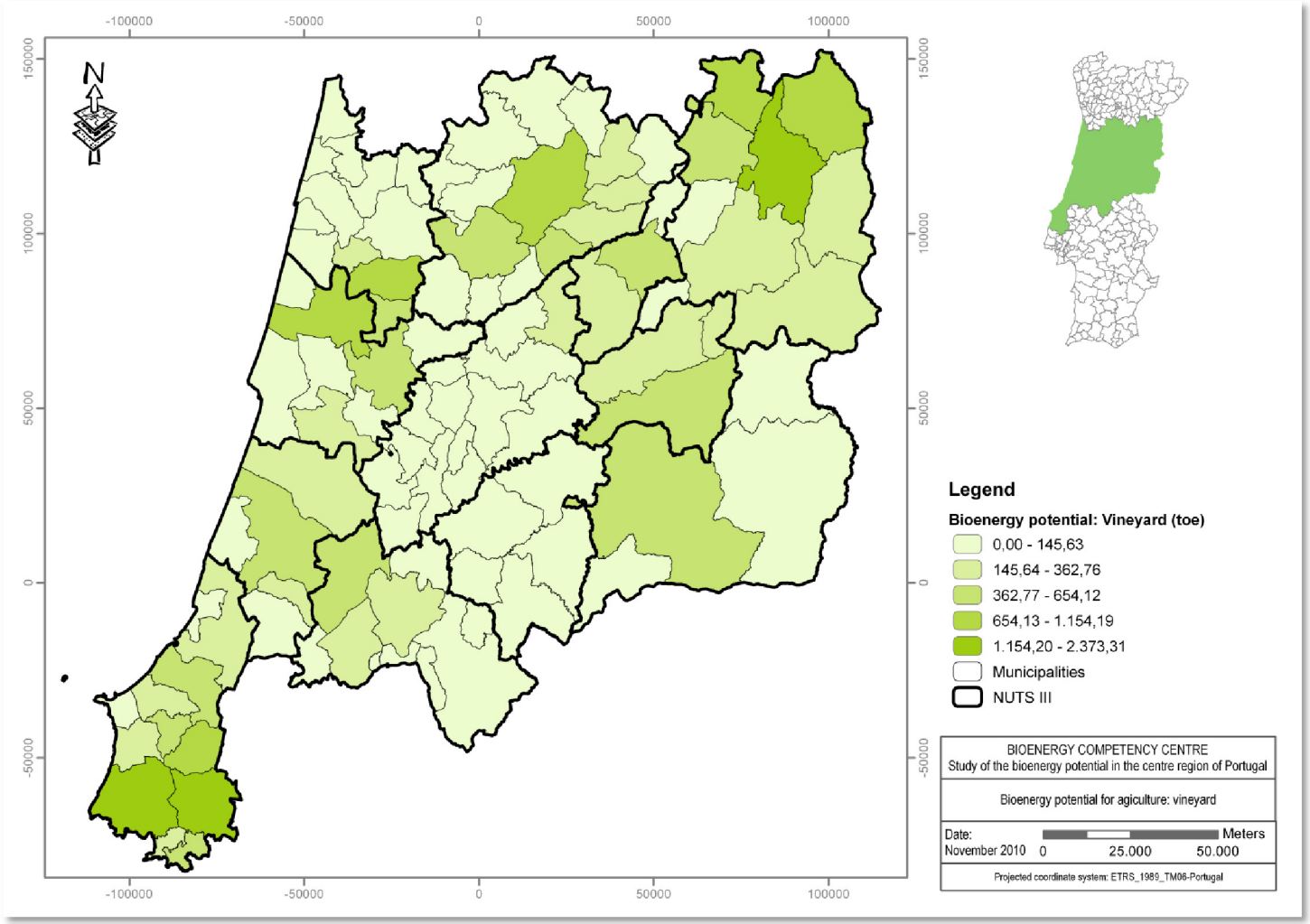


Figure A4.4: Map for the bioenergy potential for vineyard residues.

Table A4.5: Bioenergy potential for olive grove permanent crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced olive grove residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 3,78 | 40 | 151,20 | 18.117 | **0,07** |
| | Albergaria-a-Velha | ... | 40 | 0,00 | 18.117 | **0,00** |
| | Anadia | 82,54 | 40 | 3.301,60 | 18.117 | **1,43** |
| | Aveiro | - | 40 | 0,00 | 18.117 | **0,00** |
| | Estarreja | - | 40 | 0,00 | 18.117 | **0,00** |
| | Ílhavo | - | 40 | 0,00 | 18.117 | **0,00** |
| | Mealhada | 235,77 | 40 | 9.430,80 | 18.117 | **4,08** |
| | Murtosa | - | 40 | 0,00 | 18.117 | **0,00** |
| | Oliveira do Bairro | 1,39 | 40 | 55,60 | 18.117 | **0,02** |
| | Ovar | - | 40 | 0,00 | 18.117 | **0,00** |
| | Sever do Vouga | - | 40 | 0,00 | 18.117 | **0,00** |
| | Vagos | - | 40 | 0,00 | 18.117 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 245,60 | 40 | 9.824,00 | 18.117 | **4,25** |
| | Coimbra | 522,98 | 40 | 20.919,20 | 18.117 | **9,06** |
| | Condeixa-a-Nova | 788,39 | 40 | 31.535,60 | 18.117 | **13,65** |
| | Figueira da Foz | 13,65 | 40 | 546,00 | 18.117 | **0,24** |
| | Mira | ... | 40 | 0,00 | 18.117 | **0,00** |
| | Montemor-o-Velho | 110,21 | 40 | 4.408,40 | 18.117 | **1,91** |
| | Penacova | 115,58 | 40 | 4.623,20 | 18.117 | **2,00** |
| | Soure | 1.380,52 | 40 | 55.220,80 | 18.117 | **23,91** |
| ***Pinhal Litoral*** | Batalha | 331,23 | 40 | 13.249,20 | 18.117 | **5,74** |
| | Leiria | 721,61 | 40 | 28.864,40 | 18.117 | **12,50** |
| | Marinha Grande | ... | 40 | 0,00 | 18.117 | **0,00** |
| | Pombal | 1.498,27 | 40 | 59.930,80 | 18.117 | **25,95** |
| | Porto de Mós | 2.029,80 | 40 | 81.192,00 | 18.117 | **35,16** |
| ***Pinhal Interior Norte*** | Arganil | 494,54 | 40 | 19.781,60 | 18.117 | **8,57** |
| | Góis | 89,04 | 40 | 3.561,60 | 18.117 | **1,54** |
| | Lousã | 65,54 | 40 | 2.621,60 | 18.117 | **1,14** |
| | Miranda do Corvo | 251,58 | 40 | 10.063,20 | 18.117 | **4,36** |
| | Oliveira do Hospital | 786,24 | 40 | 31.449,60 | 18.117 | **13,62** |
| | Pampilhosa da Serra | 184,17 | 40 | 7.366,80 | 18.117 | **3,19** |
| | Penela | 794,68 | 40 | 31.787,20 | 18.117 | **13,76** |
| | Tábua | 541,33 | 40 | 21.653,20 | 18.117 | **9,38** |
| | Vila Nova de Poiares | 59,99 | 40 | 2.399,60 | 18.117 | **1,04** |
| | Alvaiázere | 1.237,04 | 40 | 49.481,60 | 18.117 | **21,43** |
| | Ansião | 1.837,35 | 40 | 73.494,00 | 18.117 | **31,82** |
| | Castanheira de Pêra | 39,69 | 40 | 1.587,60 | 18.117 | **0,69** |
| | Figueiró dos Vinhos | 258,59 | 40 | 10.343,60 | 18.117 | **4,48** |
| | Pedrógão Grande | 500,02 | 40 | 20.000,80 | 18.117 | **8,66** |
| ***Dão Lafões*** | Aguiar da Beira | 46,89 | 40 | 1.875,60 | 18.117 | **0,81** |
| | Carregal do Sal | 451,58 | 40 | 18.063,20 | 18.117 | **7,82** |
| | Castro Daire | 39,74 | 40 | 1.589,60 | 18.117 | **0,69** |
| | Mangualde | 195,15 | 40 | 7.806,00 | 18.117 | **3,38** |
| | Mortágua | 23,80 | 40 | 952,00 | 18.117 | **0,41** |
| | Nelas | 311,23 | 40 | 12.449,20 | 18.117 | **5,39** |
| | Oliveira de Frades | 11,31 | 40 | 452,40 | 18.117 | **0,20** |
| | Penalva do Castelo | 296,04 | 40 | 11.841,60 | 18.117 | **5,13** |
| | Santa Comba Dão | 67,08 | 40 | 2.683,20 | 18.117 | **1,16** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced olive grove residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 67,58 | 40 | 2.703,20 | 18.117 | **1,17** |
| | Sátão | 85,83 | 40 | 3.433,20 | 18.117 | **1,49** |
| | Tondela | 127,51 | 40 | 5.100,40 | 18.117 | **2,21** |
| | Vila Nova de Paiva | 0,45 | 40 | 18,00 | 18.117 | **0,01** |
| | Viseu | 614,49 | 40 | 24.579,60 | 18.117 | **10,64** |
| | Vouzela | 23,68 | 40 | 947,20 | 18.117 | **0,41** |
| ***Pinhal Interior Sul*** | Oleiros | 1.928,08 | 40 | 77.123,20 | 18.117 | **33,39** |
| | Proença-a-Nova | 2.973,20 | 40 | 118.928,00 | 18.117 | **51,50** |
| | Sertã | 2.567,73 | 40 | 102.709,20 | 18.117 | **44,47** |
| | Vila de Rei | 366,05 | 40 | 14.642,00 | 18.117 | **6,34** |
| | Mação | 1.962,09 | 40 | 78.483,60 | 18.117 | **33,98** |
| ***Serra Estrela*** | Fornos de Algodres | 450,24 | 40 | 18.009,60 | 18.117 | **7,80** |
| | Gouveia | 1.062,69 | 40 | 42.507,60 | 18.117 | **18,41** |
| | Seia | 1.801,13 | 40 | 72.045,20 | 18.117 | **31,20** |
| ***Beira Interior Norte*** | Almeida | 251,13 | 40 | 10.045,20 | 18.117 | **4,35** |
| | Celorico da Beira | 1.062,54 | 40 | 42.501,60 | 18.117 | **18,40** |
| | Fig. Castelo Rodrigo | 4.553,73 | 40 | 182.149,20 | 18.117 | **78,87** |
| | Guarda | 798,97 | 40 | 31.958,80 | 18.117 | **13,84** |
| | Manteigas | 23,44 | 40 | 937,60 | 18.117 | **0,41** |
| | Meda | 1.818,12 | 40 | 72.724,80 | 18.117 | **31,49** |
| | Pinhel | 2.119,39 | 40 | 84.775,60 | 18.117 | **36,71** |
| | Sabugal | 412,81 | 40 | 16.512,40 | 18.117 | **7,15** |
| | Trancoso | 1.088,31 | 40 | 43.532,40 | 18.117 | **18,85** |
| ***Beira Interior Sul*** | Castelo Branco | 12.021,52 | 40 | 480.860,80 | 18.117 | **208,21** |
| | Idanha-a-Nova | 8.065,32 | 40 | 322.612,80 | 18.117 | **139,69** |
| | Penamacor | 3.454,73 | 40 | 138.189,20 | 18.117 | **59,84** |
| | Vila Velha de Ródão | 4.021,36 | 40 | 160.854,40 | 18.117 | **69,65** |
| ***Cova Beira*** | Belmonte | 412,32 | 40 | 16.492,80 | 18.117 | **7,14** |
| | Covilhã | 1.550,07 | 40 | 62.002,80 | 18.117 | **26,85** |
| | Fundão | 5.559,96 | 40 | 222.398,40 | 18.117 | **96,30** |
| ***Oeste*** | Alcobaça | 494,60 | 40 | 19.784,00 | 18.117 | **8,57** |
| | Bombarral | 3,17 | 40 | 126,80 | 18.117 | **0,05** |
| | Caldas da Rainha | 55,70 | 40 | 2.228,00 | 18.117 | **0,96** |
| | Nazaré | 0,38 | 40 | 15,20 | 18.117 | **0,01** |
| | Óbidos | 4,73 | 40 | 189,20 | 18.117 | **0,08** |
| | Peniche | - | 40 | 0,00 | 18.117 | **0,00** |
| | Alenquer | 81,77 | 40 | 3.270,80 | 18.117 | **1,42** |
| | Arruda dos Vinhos | 12,13 | 40 | 485,20 | 18.117 | **0,21** |
| | Cadaval | 36,91 | 40 | 1.476,40 | 18.117 | **0,64** |
| | Lourinhã | 1,84 | 40 | 73,60 | 18.117 | **0,03** |
| | Sobral de Monte Agraço | 20,63 | 40 | 825,20 | 18.117 | **0,36** |
| | Torres Vedras | 5,63 | 40 | 225,20 | 18.117 | **0,10** |
| ***Médio Tejo*** | Abrantes | 7.007,97 | 40 | 280.318,80 | 18.117 | **121,38** |
| | Alcanena | 2.719,36 | 40 | 108.774,40 | 18.117 | **47,10** |
| | Constância | 716,04 | 40 | 28.641,60 | 18.117 | **12,40** |
| | Entroncamento | 28,18 | 40 | 1.127,20 | 18.117 | **0,49** |
| | Ferreira do Zêzere | 1.718,64 | 40 | 68.745,60 | 18.117 | **29,77** |
| | Sardoal | 1.045,68 | 40 | 41.827,20 | 18.117 | **18,11** |
| | Tomar | 2.961,06 | 40 | 118.442,40 | 18.117 | **51,29** |
| | Torres Novas | 4.142,35 | 40 | 165.694,00 | 18.117 | **71,74** |
| | Vila Nova da Barquinha | 189,01 | 40 | 7.560,40 | 18.117 | **3,27** |
| | Ourém | 3.012,17 | 40 | 120.486,80 | 18.117 | **52,17** |
| | **Total** | **102.166,36** | **-** | **4.086.654,40** | **-** | **1.769,51** |

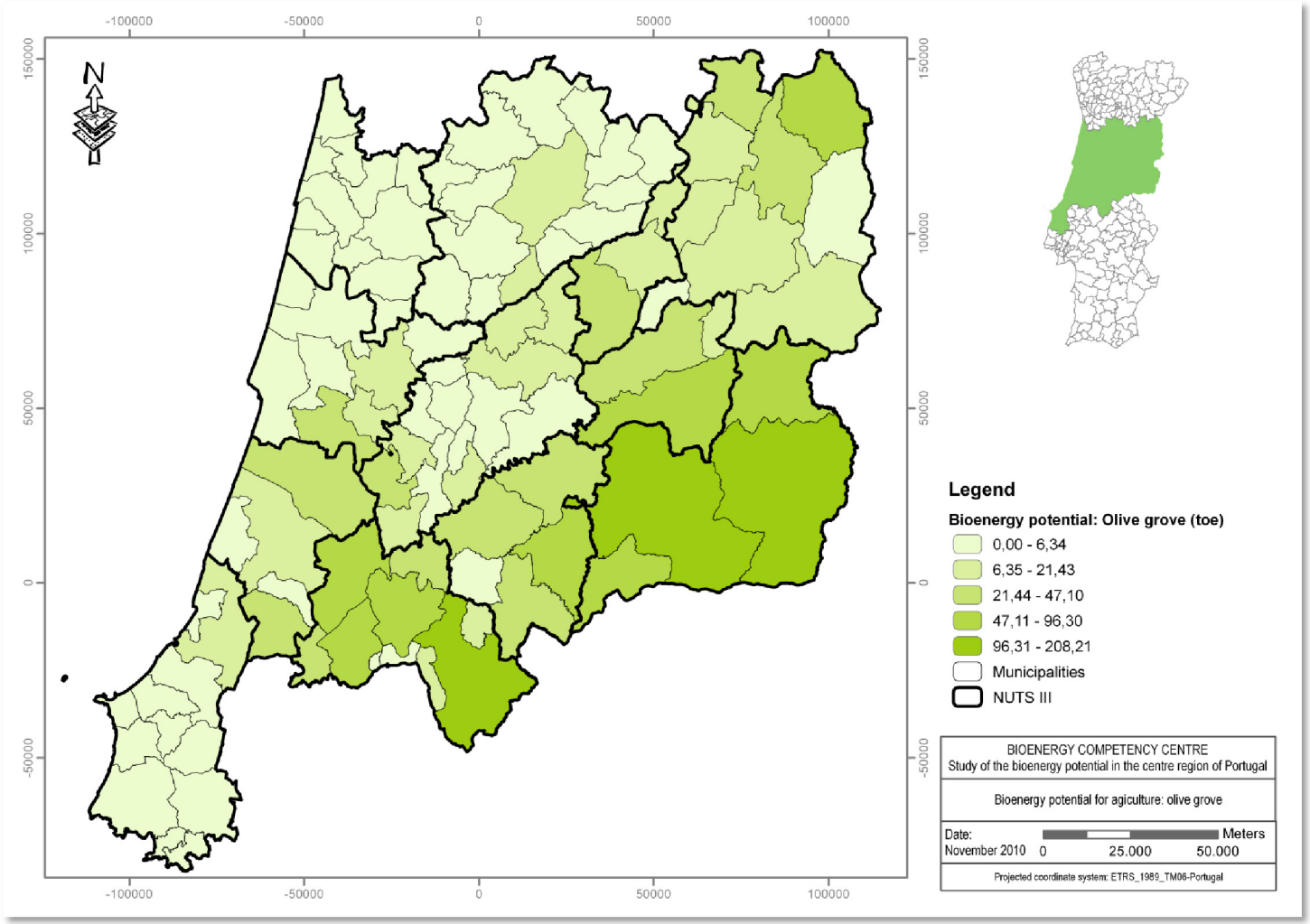


Figure A4.5: Map for the bioenergy potential for olive grove residues.

Table A4.6: Bioenergy potential for maize temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced maize residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 1.333,02 | 1.420 | 1.892.888,40 | 16.295 | **737,19** |
| | Albergaria-a-Velha | 783,60 | 1.420 | 1.112.712,00 | 16.295 | **433,35** |
| | Anadia | 858,43 | 1.420 | 1.218.970,60 | 16.295 | **474,73** |
| | Aveiro | 894,17 | 1.420 | 1.269.721,40 | 16.295 | **494,49** |
| | Estarreja | 729,48 | 1.420 | 1.035.861,60 | 16.295 | **403,42** |
| | Ílhavo | 297,75 | 1.420 | 422.805,00 | 16.295 | **164,66** |
| | Mealhada | 433,19 | 1.420 | 615.129,80 | 16.295 | **239,56** |
| | Murtosa | 258,22 | 1.420 | 366.672,40 | 16.295 | **142,80** |
| | Oliveira do Bairro | 530,44 | 1.420 | 753.224,80 | 16.295 | **293,34** |
| | Ovar | 343,28 | 1.420 | 487.457,60 | 16.295 | **189,84** |
| | Sever do Vouga | 412,52 | 1.420 | 585.778,40 | 16.295 | **228,13** |
| | Vagos | 850,44 | 1.420 | 1.207.624,80 | 16.295 | **470,31** |
| ***Baixo Mondego*** | Cantanhede | 1.613,73 | 1.420 | 2.291.496,60 | 16.295 | **892,42** |
| | Coimbra | 2.525,47 | 1.420 | 3.586.167,40 | 16.295 | **1.396,63** |
| | Condeixa-a-Nova | 475,85 | 1.420 | 675.707,00 | 16.295 | **263,15** |
| | Figueira da Foz | 1.230,15 | 1.420 | 1.746.813,00 | 16.295 | **680,30** |
| | Mira | 454,86 | 1.420 | 645.901,20 | 16.295 | **251,55** |
| | Montemor-o-Velho | 3.219,26 | 1.420 | 4.571.349,20 | 16.295 | **1.780,31** |
| | Penacova | 326,21 | 1.420 | 463.218,20 | 16.295 | **180,40** |
| | Soure | 1.736,12 | 1.420 | 2.465.290,40 | 16.295 | **960,11** |
| ***Pinhal Litoral*** | Batalha | 175,39 | 1.420 | 249.053,80 | 16.295 | **96,99** |
| | Leiria | 2.267,71 | 1.420 | 3.220.148,20 | 16.295 | **1.254,09** |
| | Marinha Grande | 99,03 | 1.420 | 140.622,60 | 16.295 | **54,77** |
| | Pombal | 2.082,57 | 1.420 | 2.957.249,40 | 16.295 | **1.151,70** |
| | Porto de Mós | 120,93 | 1.420 | 171.720,60 | 16.295 | **66,88** |
| ***Pinhal Interior Norte*** | Arganil | 335,72 | 1.420 | 476.722,40 | 16.295 | **185,66** |
| | Góis | 65,96 | 1.420 | 93.663,20 | 16.295 | **36,48** |
| | Lousã | 120,76 | 1.420 | 171.479,20 | 16.295 | **66,78** |
| | Miranda do Corvo | 128,28 | 1.420 | 182.157,60 | 16.295 | **70,94** |
| | Oliveira do Hospital | 601,49 | 1.420 | 854.115,80 | 16.295 | **332,64** |
| | Pampilhosa da Serra | 56,77 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penela | 111,43 | 1.420 | 158.230,60 | 16.295 | **61,62** |
| | Tábua | 475,24 | 1.420 | 674.840,80 | 16.295 | **262,82** |
| | Vila Nova de Poiares | 114,35 | 1.420 | 162.377,00 | 16.295 | **63,24** |
| | Alvaiázere | 124,90 | 1.420 | 177.358,00 | 16.295 | **69,07** |
| | Ansião | 251,44 | 1.420 | 357.044,80 | 16.295 | **139,05** |
| | Castanheira de Pêra | 5,29 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Figueiró dos Vinhos | 92,27 | 1.420 | 131.023,40 | 16.295 | **51,03** |
| | Pedrógão Grande | 126,81 | 1.420 | 180.070,20 | 16.295 | **70,13** |
| ***Dão Lafões*** | Aguiar da Beira | 711,30 | 1.420 | 1.010.046,00 | 16.295 | **393,36** |
| | Carregal do Sal | 389,82 | 1.420 | 553.544,40 | 16.295 | **215,58** |
| | Castro Daire | 1.012,43 | 1.420 | 1.437.650,60 | 16.295 | **559,89** |
| | Mangualde | 770,01 | 1.420 | 1.093.414,20 | 16.295 | **425,83** |
| | Mortágua | 328,09 | 1.420 | 465.887,80 | 16.295 | **181,44** |
| | Nelas | 244,22 | 1.420 | 346.792,40 | 16.295 | **135,06** |
| | Oliveira de Frades | 781,13 | 1.420 | 1.109.204,60 | 16.295 | **431,98** |
| | Penalva do Castelo | 633,81 | 1.420 | 900.010,20 | 16.295 | **350,51** |
| | Santa Comba Dão | 295,70 | 1.420 | 419.894,00 | 16.295 | **163,53** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced maize residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1.192,06 | 1.420 | 1.692.725,20 | 16.295 | **659,23** |
| | Sátão | 844,66 | 1.420 | 1.199.417,20 | 16.295 | **467,11** |
| | Tondela | 1.299,84 | 1.420 | 1.845.772,80 | 16.295 | **718,84** |
| | Vila Nova de Paiva | 439,95 | 1.420 | 624.729,00 | 16.295 | **243,30** |
| | Viseu | 1.626,00 | 1.420 | 2.308.920,00 | 16.295 | **899,21** |
| | Vouzela | 739,71 | 1.420 | 1.050.388,20 | 16.295 | **409,07** |
| ***Pinhal Interior Sul*** | Oleiros | 196,59 | 1.420 | 279.157,80 | 16.295 | **108,72** |
| | Proença-a-Nova | 232,57 | 1.420 | 330.249,40 | 16.295 | **128,62** |
| | Sertã | 400,86 | 1.420 | 569.221,20 | 16.295 | **221,68** |
| | Vila de Rei | 41,61 | 1.420 | 59.086,20 | 16.295 | **23,01** |
| | Mação | 113,86 | 1.420 | 161.681,20 | 16.295 | **62,97** |
| ***Serra Estrela*** | Fornos de Algodres | 581,93 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Gouveia | 234,91 | 1.420 | 333.572,20 | 16.295 | **129,91** |
| | Seia | 667,43 | 1.420 | 947.750,60 | 16.295 | **369,10** |
| ***Beira Interior Norte*** | Almeida | 39,95 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Celorico da Beira | 340,11 | 1.420 | 482.956,20 | 16.295 | **188,09** |
| | Fig. Castelo Rodrigo | 58,96 | 1.420 | 83.723,20 | 16.295 | **32,61** |
| | Guarda | 559,89 | 1.420 | 795.043,80 | 16.295 | **309,63** |
| | Manteigas | 38,34 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Meda | 248,62 | 1.420 | 353.040,40 | 16.295 | **137,49** |
| | Pinhel | 323,66 | 1.420 | 459.597,20 | 16.295 | **178,99** |
| | Sabugal | 401,57 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Trancoso | 394,79 | 1.420 | 560.601,80 | 16.295 | **218,33** |
| ***Beira Interior Sul*** | Castelo Branco | 986,50 | 1.420 | 1.400.830,00 | 16.295 | **545,55** |
| | Idanha-a-Nova | 2.834,38 | 1.420 | 4.024.819,60 | 16.295 | **1.567,47** |
| | Penamacor | 808,24 | 1.420 | 1.147.700,80 | 16.295 | **446,97** |
| | Vila Velha de Ródão | 57,97 | 1.420 | 82.317,40 | 16.295 | **32,06** |
| ***Cova Beira*** | Belmonte | 304,25 | 1.420 | 432.035,00 | 16.295 | **168,26** |
| | Covilhã | 842,89 | 1.420 | 1.196.903,80 | 16.295 | **466,13** |
| | Fundão | 1.913,64 | 1.420 | 2.717.368,80 | 16.295 | **1.058,28** |
| ***Oeste*** | Alcobaça | 276,59 | 1.420 | 392.757,80 | 16.295 | **152,96** |
| | Bombarral | 25,73 | 1.420 | 36.536,60 | 16.295 | **14,23** |
| | Caldas da Rainha | 200,77 | 1.420 | 285.093,40 | 16.295 | **111,03** |
| | Nazaré | 40,27 | 1.420 | 57.183,40 | 16.295 | **22,27** |
| | Óbidos | 180,23 | 1.420 | 255.926,60 | 16.295 | **99,67** |
| | Peniche | 223,51 | 1.420 | 317.384,20 | 16.295 | **123,61** |
| | Alenquer | 805,33 | 1.420 | 1.143.568,60 | 16.295 | **445,36** |
| | Arruda dos Vinhos | 61,30 | 1.420 | 87.046,00 | 16.295 | **33,90** |
| | Cadaval | 50,09 | 1.420 | 71.127,80 | 16.295 | **27,70** |
| | Lourinhã | 316,08 | 1.420 | 448.833,60 | 16.295 | **174,80** |
| | Sobral de Monte Agraço | 183,00 | 1.420 | 259.860,00 | 16.295 | **101,20** |
| | Torres Vedras | 489,88 | 1.420 | 695.629,60 | 16.295 | **270,91** |
| ***Médio Tejo*** | Abrantes | 1.545,59 | 1.420 | 2.194.737,80 | 16.295 | **854,74** |
| | Alcanena | 132,02 | 1.420 | 187.468,40 | 16.295 | **73,01** |
| | Constância | 93,80 | 1.420 | 133.196,00 | 16.295 | **51,87** |
| | Entroncamento | 43,63 | 1.420 | 61.954,60 | 16.295 | **24,13** |
| | Ferreira do Zêzere | 92,55 | 1.420 | 131.421,00 | 16.295 | **51,18** |
| | Sardoal | 31,76 | 1.420 | 45.099,20 | 16.295 | **17,56** |
| | Tomar | 422,68 | 1.420 | 600.205,60 | 16.295 | **233,75** |
| | Torres Novas | 1.369,25 | 1.420 | 1.944.335,00 | 16.295 | **757,22** |
| | Vila Nova da Barquinha | 83,37 | 1.420 | 118.385,40 | 16.295 | **46,11** |
| | Ourém | 678,66 | 1.420 | 963.697,20 | 16.295 | **375,31** |
| | **Total** | **57.940,87** | **-** | **80.680.168,40** | **-** | **31.420,93** |

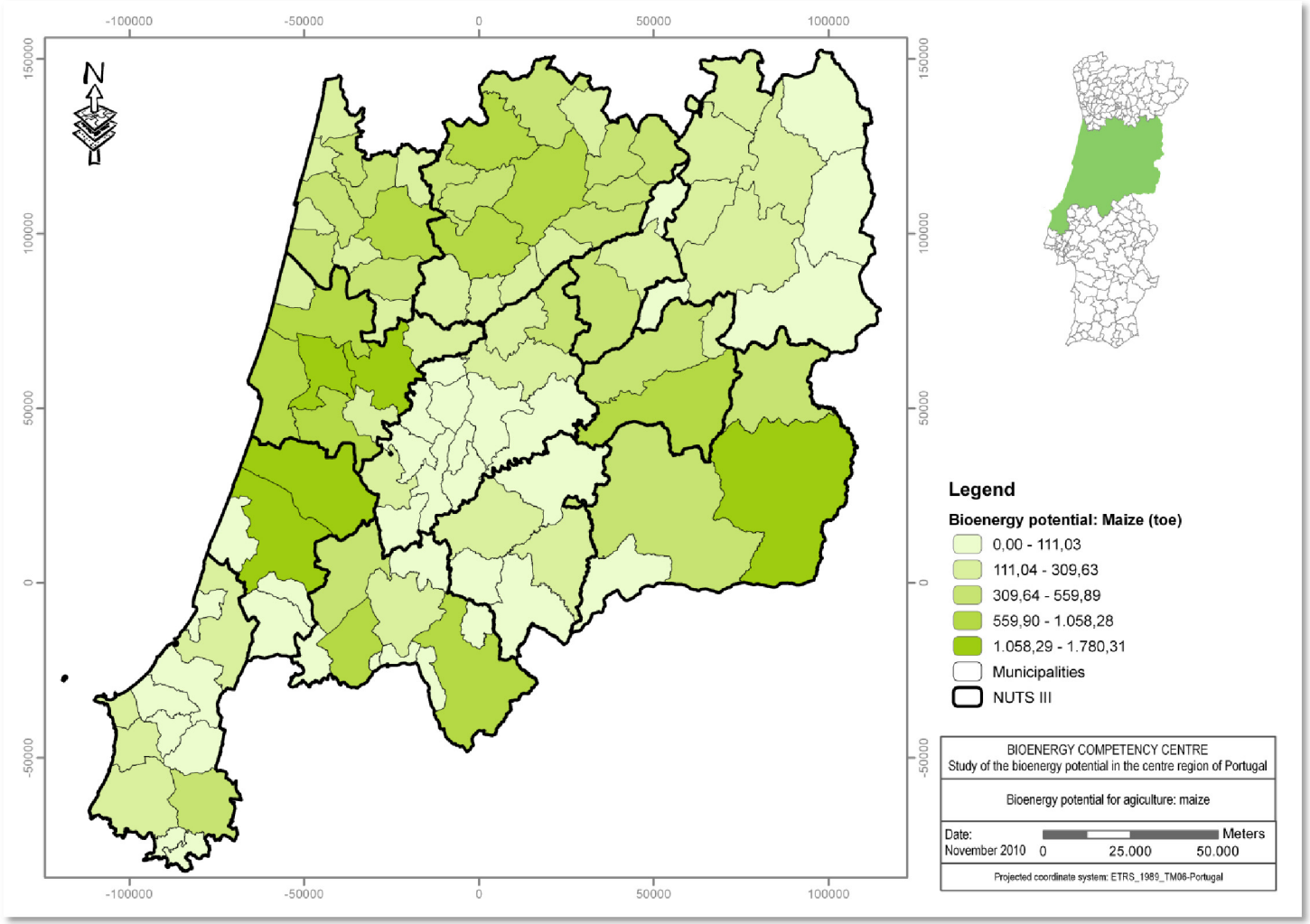


Figure A4.6: Map for the bioenergy potential for maize residues.

Table A4.7: Bioenergy potential for wheat temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced wheat residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 15,82 | 1.420 | 22.464,40 | 17.112 | **9,19** |
| | Albergaria-a-Velha | 18,22 | 1.420 | 25.872,40 | 17.112 | **10,58** |
| | Anadia | 12,44 | 1.420 | 17.664,80 | 17.112 | **7,22** |
| | Aveiro | 8,68 | 1.420 | 12.325,60 | 17.112 | **5,04** |
| | Estarreja | 10,64 | 1.420 | 15.108,80 | 17.112 | **6,18** |
| | Ílhavo | 13,34 | 1.420 | 18.942,80 | 17.112 | **7,75** |
| | Mealhada | 7,95 | 1.420 | 11.289,00 | 17.112 | **4,62** |
| | Murtosa | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Oliveira do Bairro | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Ovar | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Sever do Vouga | 0,18 | 1.420 | 255,60 | 17.112 | **0,10** |
| | Vagos | 3,69 | 1.420 | 5.239,80 | 17.112 | **2,14** |
| ***Baixo Mondego*** | Cantanhede | 73,62 | 1.420 | 104.540,40 | 17.112 | **42,75** |
| | Coimbra | 28,36 | 1.420 | 40.271,20 | 17.112 | **16,47** |
| | Condeixa-a-Nova | 54,19 | 1.420 | 76.949,80 | 17.112 | **31,47** |
| | Figueira da Foz | 22,09 | 1.420 | 31.367,80 | 17.112 | **12,83** |
| | Mira | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Montemor-o-Velho | 15,72 | 1.420 | 22.322,40 | 17.112 | **9,13** |
| | Penacova | 79,36 | 1.420 | 112.691,20 | 17.112 | **46,09** |
| | Soure | 83,16 | 1.420 | 118.087,20 | 17.112 | **48,29** |
| ***Pinhal Litoral*** | Batalha | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Leiria | 46,00 | 1.420 | 65.320,00 | 17.112 | **26,71** |
| | Marinha Grande | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Pombal | 269,87 | 1.420 | 383.215,40 | 17.112 | **156,73** |
| | Porto de Mós | 43,32 | 1.420 | 61.514,40 | 17.112 | **25,16** |
| ***Pinhal Interior Norte*** | Arganil | 37,93 | 1.420 | 53.860,60 | 17.112 | **22,03** |
| | Góis | 1,22 | 1.420 | 1.732,40 | 17.112 | **0,71** |
| | Lousã | 5,37 | 1.420 | 7.625,40 | 17.112 | **3,12** |
| | Miranda do Corvo | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Oliveira do Hospital | 1,58 | 1.420 | 2.243,60 | 17.112 | **0,92** |
| | Pampilhosa da Serra | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Penela | 61,54 | 1.420 | 87.386,80 | 17.112 | **35,74** |
| | Tábua | 40,38 | 1.420 | 57.339,60 | 17.112 | **23,45** |
| | Vila Nova de Poiares | 20,36 | 1.420 | 28.911,20 | 17.112 | **11,82** |
| | Alvaiázere | 17,50 | 1.420 | 24.850,00 | 17.112 | **10,16** |
| | Ansião | 194,88 | 1.420 | 276.729,60 | 17.112 | **113,18** |
| | Castanheira de Pêra | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Figueiró dos Vinhos | 0,81 | 1.420 | 1.150,20 | 17.112 | **0,47** |
| | Pedrógão Grande | 7,30 | 1.420 | 10.366,00 | 17.112 | **4,24** |
| ***Dão Lafões*** | Aguiar da Beira | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Carregal do Sal | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Castro Daire | 2,63 | 1.420 | 3.734,60 | 17.112 | **1,53** |
| | Mangualde | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Mortágua | 52,00 | 1.420 | 73.840,00 | 17.112 | **30,20** |
| | Nelas | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Oliveira de Frades | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Penalva do Castelo | 1,76 | 1.420 | 2.499,20 | 17.112 | **1,02** |
| | Santa Comba Dão | 1,53 | 1.420 | 2.172,60 | 17.112 | **0,89** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced wheat residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1,42 | 1.420 | 2.016,40 | 17.112 | **0,82** |
| | Sátão | 19,60 | 1.420 | 27.832,00 | 17.112 | **11,38** |
| | Tondela | 13,21 | 1.420 | 18.758,20 | 17.112 | **7,67** |
| | Vila Nova de Paiva | 7,16 | 1.420 | 10.167,20 | 17.112 | **4,16** |
| | Viseu | 11,36 | 1.420 | 16.131,20 | 17.112 | **6,60** |
| | Vouzela | … | 1.420 | 0,00 | 17.112 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Proença-a-Nova | 14,95 | 1.420 | 21.229,00 | 17.112 | **8,68** |
| | Sertã | 17,96 | 1.420 | 25.503,20 | 17.112 | **10,43** |
| | Vila de Rei | 13,53 | 1.420 | 19.212,60 | 17.112 | **7,86** |
| | Mação | 15,57 | 1.420 | 22.109,40 | 17.112 | **9,04** |
| ***Serra Estrela*** | Fornos de Algodres | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Gouveia | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Seia | 0,45 | 1.420 | 639,00 | 17.112 | **0,26** |
| ***Beira Interior Norte*** | Almeida | 126,53 | 1.420 | 179.672,60 | 17.112 | **73,48** |
| | Celorico da Beira | 3,11 | 1.420 | 4.416,20 | 17.112 | **1,81** |
| | Fig. Castelo Rodrigo | 461,51 | 1.420 | 655.344,20 | 17.112 | **268,02** |
| | Guarda | 32,22 | 1.420 | 45.752,40 | 17.112 | **18,71** |
| | Manteigas | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Meda | 116,75 | 1.420 | 165.785,00 | 17.112 | **67,80** |
| | Pinhel | 236,43 | 1.420 | 335.730,60 | 17.112 | **137,31** |
| | Sabugal | 144,37 | 1.420 | 205.005,40 | 17.112 | **83,84** |
| | Trancoso | 43,79 | 1.420 | 62.181,80 | 17.112 | **25,43** |
| ***Beira Interior Sul*** | Castelo Branco | 88,58 | 1.420 | 125.783,60 | 17.112 | **51,44** |
| | Idanha-a-Nova | 812,20 | 1.420 | 1.153.324,00 | 17.112 | **471,68** |
| | Penamacor | 115,42 | 1.420 | 163.896,40 | 17.112 | **67,03** |
| | Vila Velha de Ródão | 9,15 | 1.420 | 12.993,00 | 17.112 | **5,31** |
| ***Cova Beira*** | Belmonte | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Covilhã | 100,50 | 1.420 | 142.710,00 | 17.112 | **58,37** |
| | Fundão | 149,67 | 1.420 | 212.531,40 | 17.112 | **86,92** |
| ***Oeste*** | Alcobaça | 126,83 | 1.420 | 180.098,60 | 17.112 | **73,66** |
| | Bombarral | 12,66 | 1.420 | 17.977,20 | 17.112 | **7,35** |
| | Caldas da Rainha | 64,30 | 1.420 | 91.306,00 | 17.112 | **37,34** |
| | Nazaré | 4,21 | 1.420 | 5.978,20 | 17.112 | **2,44** |
| | Óbidos | 23,48 | 1.420 | 33.341,60 | 17.112 | **13,64** |
| | Peniche | 66,26 | 1.420 | 94.089,20 | 17.112 | **38,48** |
| | Alenquer | 1.021,20 | 1.420 | 1.450.104,00 | 17.112 | **593,06** |
| | Arruda dos Vinhos | 428,79 | 1.420 | 608.881,80 | 17.112 | **249,02** |
| | Cadaval | 34,93 | 1.420 | 49.600,60 | 17.112 | **20,29** |
| | Lourinhã | 251,05 | 1.420 | 356.491,00 | 17.112 | **145,80** |
| | Sobral de Monte Agraço | 516,42 | 1.420 | 733.316,40 | 17.112 | **299,91** |
| | Torres Vedras | 801,30 | 1.420 | 1.137.846,00 | 17.112 | **465,35** |
| ***Médio Tejo*** | Abrantes | 379,50 | 1.420 | 538.890,00 | 17.112 | **220,39** |
| | Alcanena | 92,21 | 1.420 | 130.938,20 | 17.112 | **53,55** |
| | Constância | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Entroncamento | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Ferreira do Zêzere | 7,96 | 1.420 | 11.303,20 | 17.112 | **4,62** |
| | Sardoal | … | 1.420 | 0,00 | 17.112 | **0,00** |
| | Tomar | 189,68 | 1.420 | 269.345,60 | 17.112 | **110,16** |
| | Torres Novas | 363,96 | 1.420 | 516.823,20 | 17.112 | **211,37** |
| | Vila Nova da Barquinha | 0,00 | 1.420 | 0,00 | 17.112 | **0,00** |
| | Ourém | 16,49 | 1.420 | 23.415,80 | 17.112 | **9,58** |
| | **Total** | **8.210,11** | **-** | **11.658.356,20** | **-** | **4.768,00** |

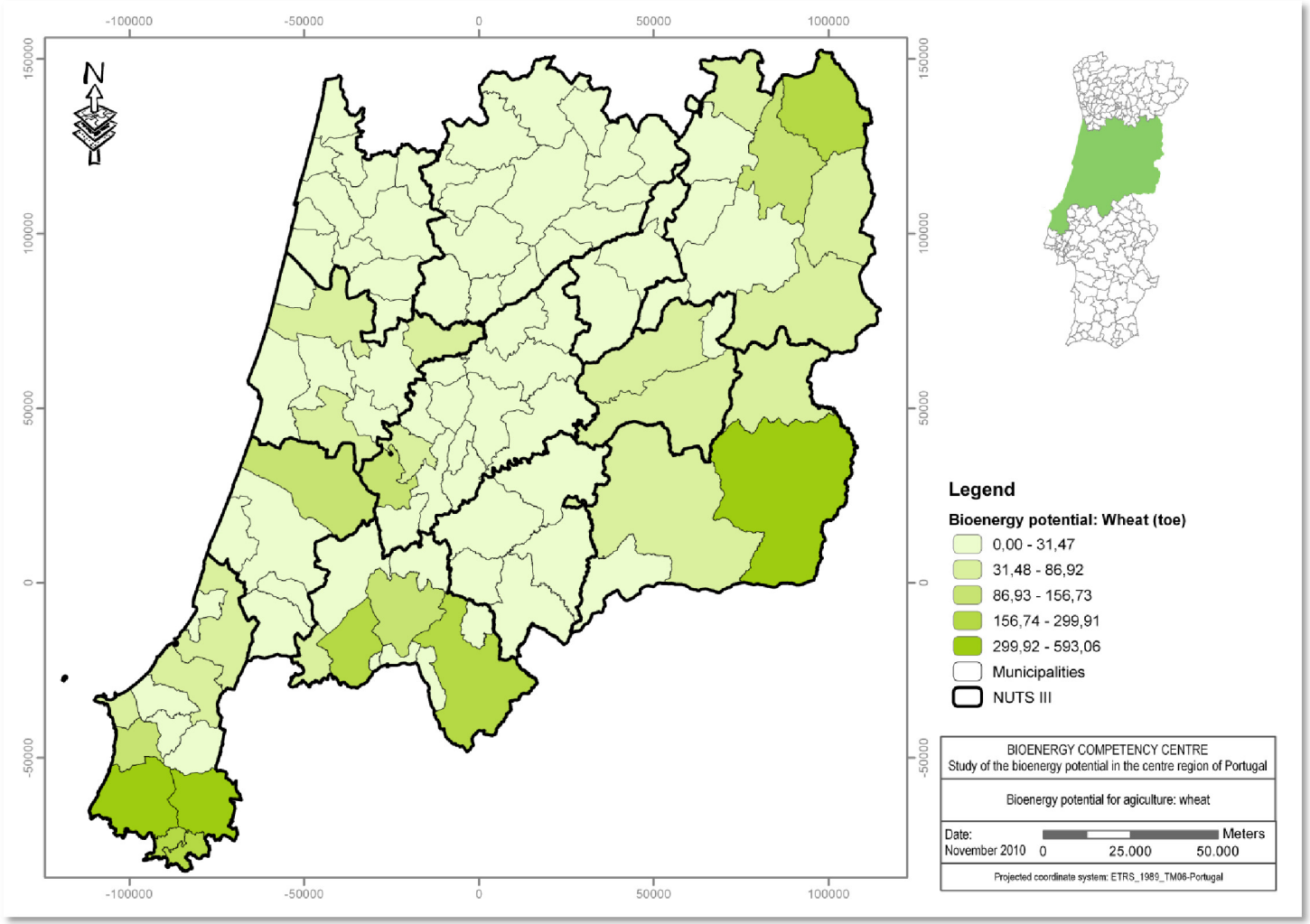


Figure A4.7: Map for the bioenergy potential for wheat residues.

Table A4.8: Bioenergy potential for barley temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced barley residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Albergaria-a-Velha | 0,70 | 1.420 | 994,00 | 16.144 | **0,38** |
| | Anadia | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Aveiro | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Estarreja | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Ílhavo | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Mealhada | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Murtosa | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Oliveira do Bairro | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Ovar | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Sever do Vouga | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Vagos | 27,00 | 1.420 | 38.340,00 | 16.144 | **14,79** |
| ***Baixo Mondego*** | Cantanhede | 1,28 | 1.420 | 1.817,60 | 16.144 | **0,70** |
| | Coimbra | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Condeixa-a-Nova | 5,05 | 1.420 | 7.171,00 | 16.144 | **2,77** |
| | Figueira da Foz | 3,94 | 1.420 | 5.594,80 | 16.144 | **2,16** |
| | Mira | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Montemor-o-Velho | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Penacova | 1,22 | 1.420 | 1.732,40 | 16.144 | **0,67** |
| | Soure | 4,23 | 1.420 | 6.006,60 | 16.144 | **2,32** |
| ***Pinhal Litoral*** | Batalha | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Leiria | 1,30 | 1.420 | 1.846,00 | 16.144 | **0,71** |
| | Marinha Grande | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Pombal | 15,38 | 1.420 | 21.839,60 | 16.144 | **8,43** |
| | Porto de Mós | 1,60 | 1.420 | 2.272,00 | 16.144 | **0,88** |
| ***Pinhal Interior Norte*** | Arganil | 3,58 | 1.420 | 5.083,60 | 16.144 | **1,96** |
| | Góis | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Lousã | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Miranda do Corvo | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Oliveira do Hospital | 3,24 | 1.420 | 4.600,80 | 16.144 | **1,78** |
| | Pampilhosa da Serra | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Penela | 0,72 | 1.420 | 1.022,40 | 16.144 | **0,39** |
| | Tábua | 2,24 | 1.420 | 3.180,80 | 16.144 | **1,23** |
| | Vila Nova de Poiares | 1,20 | 1.420 | 1.704,00 | 16.144 | **0,66** |
| | Alvaiázere | 4,26 | 1.420 | 6.049,20 | 16.144 | **2,33** |
| | Ansião | 11,48 | 1.420 | 16.301,60 | 16.144 | **6,29** |
| | Castanheira de Pêra | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Figueiró dos Vinhos | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Pedrógão Grande | 0,53 | 1.420 | 752,60 | 16.144 | **0,29** |
| ***Dão Lafões*** | Aguiar da Beira | 6,87 | 1.420 | 9.755,40 | 16.144 | **3,76** |
| | Carregal do Sal | 0,54 | 1.420 | 766,80 | 16.144 | **0,30** |
| | Castro Daire | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Mangualde | 14,26 | 1.420 | 20.249,20 | 16.144 | **7,81** |
| | Mortágua | 0,93 | 1.420 | 1.320,60 | 16.144 | **0,51** |
| | Nelas | 2,19 | 1.420 | 3.109,80 | 16.144 | **1,20** |
| | Oliveira de Frades | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Penalva do Castelo | 1,25 | 1.420 | 1.775,00 | 16.144 | **0,68** |
| | Santa Comba Dão | … | 1.420 | 0,00 | 16.144 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced barley residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Sátão | 2,00 | 1.420 | 2.840,00 | 16.144 | **1,10** |
| | Tondela | 0,28 | 1.420 | 397,60 | 16.144 | **0,15** |
| | Vila Nova de Paiva | 5,28 | 1.420 | 7.497,60 | 16.144 | **2,89** |
| | Viseu | 0,62 | 1.420 | 880,40 | 16.144 | **0,34** |
| | Vouzela | 0,59 | 1.420 | 837,80 | 16.144 | **0,32** |
| ***Pinhal Interior Sul*** | Oleiros | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Proença-a-Nova | 9,45 | 1.420 | 13.419,00 | 16.144 | **5,18** |
| | Sertã | 2,63 | 1.420 | 3.734,60 | 16.144 | **1,44** |
| | Vila de Rei | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Mação | 3,83 | 1.420 | 5.438,60 | 16.144 | **2,10** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Gouveia | 12,28 | 1.420 | 17.437,60 | 16.144 | **6,73** |
| | Seia | 0,69 | 1.420 | 979,80 | 16.144 | **0,38** |
| ***Beira Interior Norte*** | Almeida | 1,79 | 1.420 | 2.541,80 | 16.144 | **0,98** |
| | Celorico da Beira | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Fig. Castelo Rodrigo | 28,96 | 1.420 | 41.123,20 | 16.144 | **15,87** |
| | Guarda | 5,18 | 1.420 | 7.355,60 | 16.144 | **2,84** |
| | Manteigas | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Meda | 18,48 | 1.420 | 26.241,60 | 16.144 | **10,13** |
| | Pinhel | 4,08 | 1.420 | 5.793,60 | 16.144 | **2,24** |
| | Sabugal | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Trancoso | 5,50 | 1.420 | 7.810,00 | 16.144 | **3,01** |
| ***Beira Interior Sul*** | Castelo Branco | 10,51 | 1.420 | 14.924,20 | 16.144 | **5,76** |
| | Idanha-a-Nova | 7,87 | 1.420 | 11.175,40 | 16.144 | **4,31** |
| | Penamacor | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Vila Velha de Ródão | … | 1.420 | 0,00 | 16.144 | **0,00** |
| ***Cova Beira*** | Belmonte | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Covilhã | 2,34 | 1.420 | 3.322,80 | 16.144 | **1,28** |
| | Fundão | 4,12 | 1.420 | 5.850,40 | 16.144 | **2,26** |
| ***Oeste*** | Alcobaça | 29,35 | 1.420 | 41.677,00 | 16.144 | **16,08** |
| | Bombarral | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Caldas da Rainha | 2,04 | 1.420 | 2.896,80 | 16.144 | **1,12** |
| | Nazaré | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Óbidos | 24,65 | 1.420 | 35.003,00 | 16.144 | **13,51** |
| | Peniche | 137,19 | 1.420 | 194.809,80 | 16.144 | **75,17** |
| | Alenquer | 180,76 | 1.420 | 256.679,20 | 16.144 | **99,04** |
| | Arruda dos Vinhos | 209,60 | 1.420 | 297.632,00 | 16.144 | **114,84** |
| | Cadaval | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Lourinhã | 143,74 | 1.420 | 204.110,80 | 16.144 | **78,75** |
| | Sobral de Monte Agraço | 57,56 | 1.420 | 81.735,20 | 16.144 | **31,54** |
| | Torres Vedras | 440,30 | 1.420 | 625.226,00 | 16.144 | **241,24** |
| ***Médio Tejo*** | Abrantes | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Alcanena | 4,39 | 1.420 | 6.233,80 | 16.144 | **2,41** |
| | Constância | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Entroncamento | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Ferreira do Zêzere | 1,46 | 1.420 | 2.073,20 | 16.144 | **0,80** |
| | Sardoal | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Tomar | 6,73 | 1.420 | 9.556,60 | 16.144 | **3,69** |
| | Torres Novas | 10,58 | 1.420 | 15.023,60 | 16.144 | **5,80** |
| | Vila Nova da Barquinha | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Ourém | 3,72 | 1.420 | 5.282,40 | 16.144 | **2,04** |
| | **Total** | **1.493,54** | **-** | **2.120.826,80** | **-** | **818,30** |

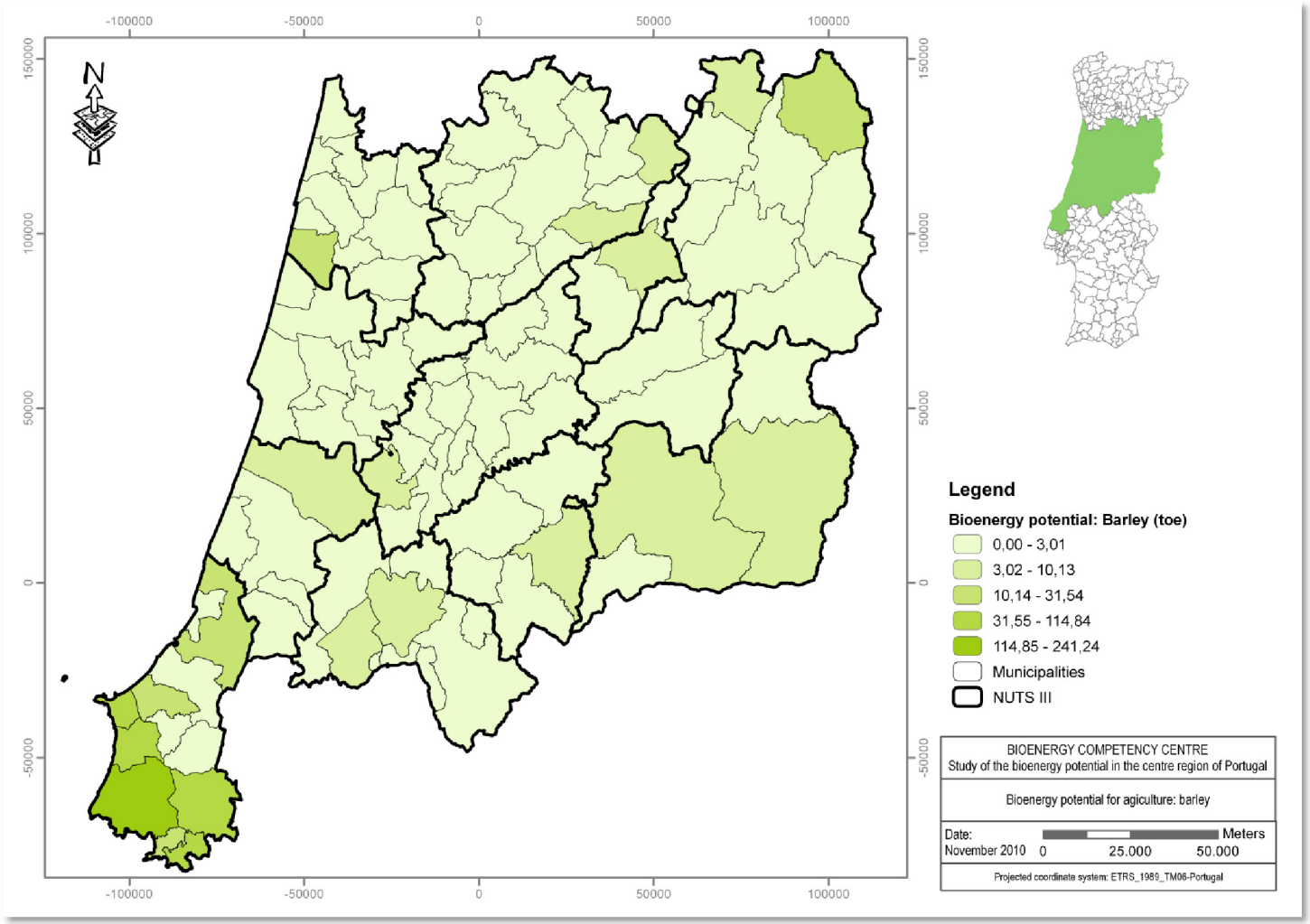


Figure A4.8: Map for the bioenergy potential for barley residues.

Table A4.9: Bioenergy potential for rye temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced rye residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 8,07 | 1.420 | 11.459,40 | 16.144 | **4,42** |
| | Albergaria-a-Velha | 7,50 | 1.420 | 10.650,00 | 16.144 | **4,11** |
| | Anadia | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Aveiro | 8,53 | 1.420 | 12.112,60 | 16.144 | **4,67** |
| | Estarreja | 0,99 | 1.420 | 1.405,80 | 16.144 | **0,54** |
| | Ílhavo | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Mealhada | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Murtosa | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Oliveira do Bairro | 13,17 | 1.420 | 18.701,40 | 16.144 | **7,22** |
| | Ovar | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Sever do Vouga | 1,90 | 1.420 | 2.698,00 | 16.144 | **1,04** |
| | Vagos | … | 1.420 | 0,00 | 16.144 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 4,57 | 1.420 | 6.489,40 | 16.144 | **2,50** |
| | Coimbra | 1,10 | 1.420 | 1.562,00 | 16.144 | **0,60** |
| | Condeixa-a-Nova | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Figueira da Foz | 2,85 | 1.420 | 4.047,00 | 16.144 | **1,56** |
| | Mira | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Montemor-o-Velho | 3,24 | 1.420 | 4.600,80 | 16.144 | **1,78** |
| | Penacova | 13,48 | 1.420 | 19.141,60 | 16.144 | **7,39** |
| | Soure | … | 1.420 | 0,00 | 16.144 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Leiria | 4,47 | 1.420 | 6.347,40 | 16.144 | **2,45** |
| | Marinha Grande | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Pombal | 2,75 | 1.420 | 3.905,00 | 16.144 | **1,51** |
| | Porto de Mós | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 15,31 | 1.420 | 21.740,20 | 16.144 | **8,39** |
| | Góis | 0,64 | 1.420 | 908,80 | 16.144 | **0,35** |
| | Lousã | 0,20 | 1.420 | 284,00 | 16.144 | **0,11** |
| | Miranda do Corvo | 0,15 | 1.420 | 213,00 | 16.144 | **0,08** |
| | Oliveira do Hospital | 49,63 | 1.420 | 70.474,60 | 16.144 | **27,19** |
| | Pampilhosa da Serra | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Penela | 2,25 | 1.420 | 3.195,00 | 16.144 | **1,23** |
| | Tábua | 13,43 | 1.420 | 19.070,60 | 16.144 | **7,36** |
| | Vila Nova de Poiares | 6,57 | 1.420 | 9.329,40 | 16.144 | **3,60** |
| | Alvaiázere | 0,31 | 1.420 | 440,20 | 16.144 | **0,17** |
| | Ansião | 0,19 | 1.420 | 269,80 | 16.144 | **0,10** |
| | Castanheira de Pêra | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Figueiró dos Vinhos | 2,36 | 1.420 | 3.351,20 | 16.144 | **1,29** |
| | Pedrógão Grande | 3,34 | 1.420 | 4.742,80 | 16.144 | **1,83** |
| ***Dão Lafões*** | Aguiar da Beira | 423,47 | 1.420 | 601.327,40 | 16.144 | **232,02** |
| | Carregal do Sal | 12,91 | 1.420 | 18.332,20 | 16.144 | **7,07** |
| | Castro Daire | 285,06 | 1.420 | 404.785,20 | 16.144 | **156,18** |
| | Mangualde | 92,50 | 1.420 | 131.350,00 | 16.144 | **50,68** |
| | Mortágua | 9,08 | 1.420 | 12.893,60 | 16.144 | **4,97** |
| | Nelas | 11,50 | 1.420 | 16.330,00 | 16.144 | **6,30** |
| | Oliveira de Frades | 11,94 | 1.420 | 16.954,80 | 16.144 | **6,54** |
| | Penalva do Castelo | 117,50 | 1.420 | 166.850,00 | 16.144 | **64,38** |
| | Santa Comba Dão | 13,01 | 1.420 | 18.474,20 | 16.144 | **7,13** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced rye residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 59,89 | 1.420 | 85.043,80 | 16.144 | **32,81** |
| | Sátão | 325,75 | 1.420 | 462.565,00 | 16.144 | **178,48** |
| | Tondela | 50,34 | 1.420 | 71.482,80 | 16.144 | **27,58** |
| | Vila Nova de Paiva | 349,26 | 1.420 | 495.949,20 | 16.144 | **191,36** |
| | Viseu | 198,09 | 1.420 | 281.287,80 | 16.144 | **108,53** |
| | Vouzela | 56,63 | 1.420 | 80.414,60 | 16.144 | **31,03** |
| ***Pinhal Interior Sul*** | Oleiros | 2,58 | 1.420 | 3.663,60 | 16.144 | **1,41** |
| | Proença-a-Nova | 110,34 | 1.420 | 156.682,80 | 16.144 | **60,45** |
| | Sertã | 13,84 | 1.420 | 19.652,80 | 16.144 | **7,58** |
| | Vila de Rei | 5,51 | 1.420 | 7.824,20 | 16.144 | **3,02** |
| | Mação | 14,87 | 1.420 | 21.115,40 | 16.144 | **8,15** |
| ***Serra Estrela*** | Fornos de Algodres | 274,30 | 1.420 | 389.506,00 | 16.144 | **150,29** |
| | Gouveia | 438,13 | 1.420 | 622.144,60 | 16.144 | **240,05** |
| | Seia | 71,79 | 1.420 | 101.941,80 | 16.144 | **39,33** |
| ***Beira Interior Norte*** | Almeida | 589,13 | 1.420 | 836.564,60 | 16.144 | **322,78** |
| | Celorico da Beira | 1.367,38 | 1.420 | 1.941.679,60 | 16.144 | **749,18** |
| | Fig. Castelo Rodrigo | 603,87 | 1.420 | 857.495,40 | 16.144 | **330,86** |
| | Guarda | 2.774,95 | 1.420 | 3.940.429,00 | 16.144 | **1.520,38** |
| | Manteigas | 69,81 | 1.420 | 99.130,20 | 16.144 | **38,25** |
| | Meda | 953,67 | 1.420 | 1.354.211,40 | 16.144 | **522,51** |
| | Pinhel | 1.354,41 | 1.420 | 1.923.262,20 | 16.144 | **742,07** |
| | Sabugal | 2.045,79 | 1.420 | 2.905.021,80 | 16.144 | **1.120,88** |
| | Trancoso | 1.027,35 | 1.420 | 1.458.837,00 | 16.144 | **562,88** |
| ***Beira Interior Sul*** | Castelo Branco | 249,15 | 1.420 | 353.793,00 | 16.144 | **136,51** |
| | Idanha-a-Nova | 718,10 | 1.420 | 1.019.702,00 | 16.144 | **393,44** |
| | Penamacor | 350,11 | 1.420 | 497.156,20 | 16.144 | **191,82** |
| | Vila Velha de Ródão | 2,86 | 1.420 | 4.061,20 | 16.144 | **1,57** |
| ***Cova Beira*** | Belmonte | 1.079,50 | 1.420 | 1.532.890,00 | 16.144 | **591,45** |
| | Covilhã | 1.383,38 | 1.420 | 1.964.399,60 | 16.144 | **757,95** |
| | Fundão | 683,27 | 1.420 | 970.243,40 | 16.144 | **374,36** |
| ***Oeste*** | Alcobaça | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Bombarral | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Caldas da Rainha | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Nazaré | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Óbidos | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Peniche | 1,50 | 1.420 | 2.130,00 | 16.144 | **0,82** |
| | Alenquer | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Cadaval | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Lourinhã | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Torres Vedras | … | 1.420 | 0,00 | 16.144 | **0,00** |
| ***Médio Tejo*** | Abrantes | 5,65 | 1.420 | 8.023,00 | 16.144 | **3,10** |
| | Alcanena | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Constância | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Entroncamento | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Ferreira do Zêzere | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Sardoal | 0,63 | 1.420 | 894,60 | 16.144 | **0,35** |
| | Tomar | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Torres Novas | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 1.420 | 0,00 | 16.144 | **0,00** |
| | Ourém | … | 1.420 | 0,00 | 16.144 | **0,00** |
| | **Total** | **18.375,80** | | **26.093.636,00** | | **10.068,01** |

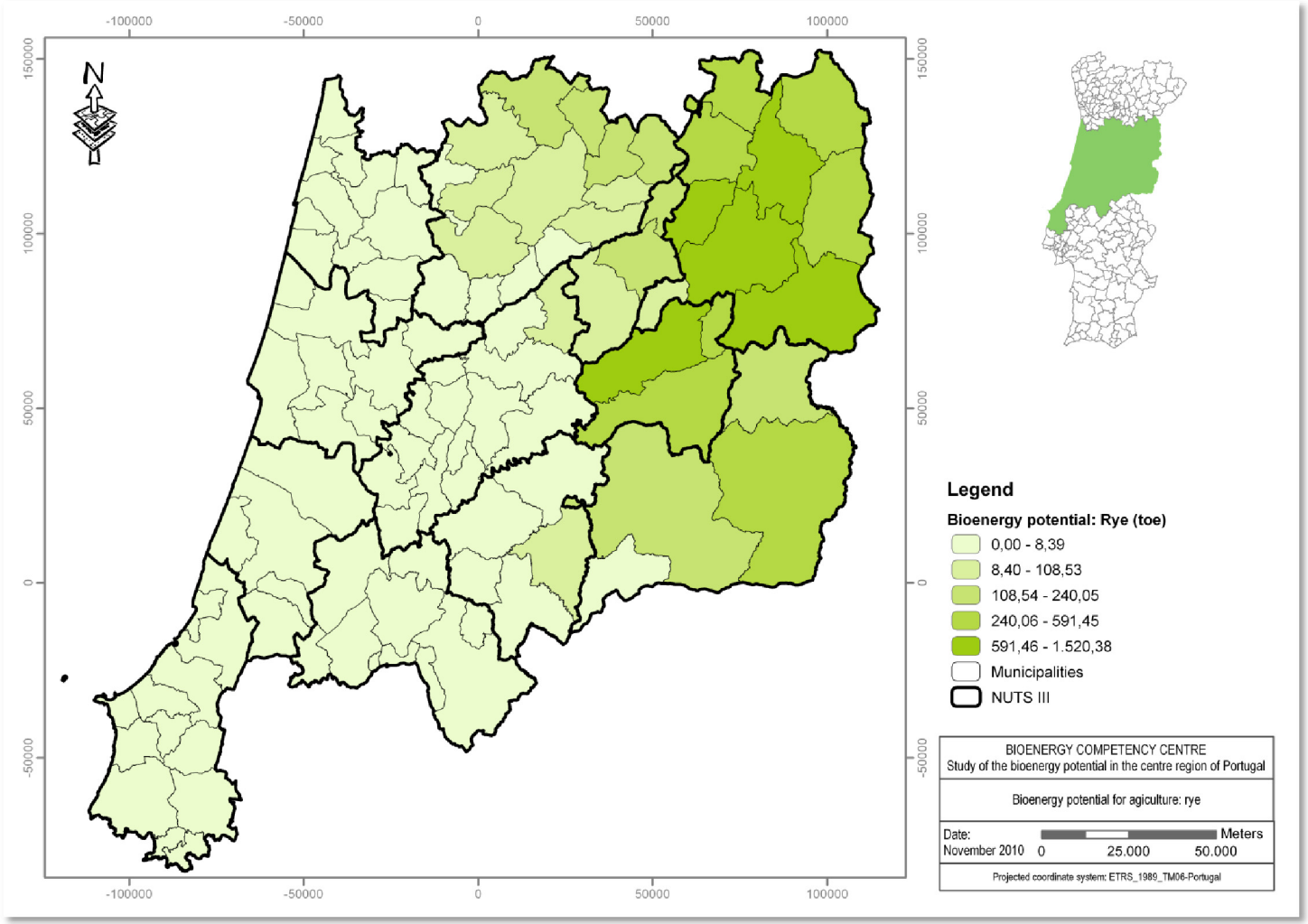


Figure A4.9: Map for the bioenergy potential for rye residues.

Table A4.10: Bioenergy potential for sorghum temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced sorghum residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,67 | 1.420 | 951,40 | 16.295 | **0,37** |
| | Albergaria-a-Velha | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Anadia | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Aveiro | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Estarreja | 1,24 | 1.420 | 1.760,80 | 16.295 | **0,69** |
| | Ílhavo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mealhada | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Murtosa | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira do Bairro | 1,76 | 1.420 | 2.499,20 | 16.295 | **0,97** |
| | Ovar | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sever do Vouga | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vagos | … | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 10,14 | 1.420 | 14.398,80 | 16.295 | **5,61** |
| | Coimbra | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Condeixa-a-Nova | 5,99 | 1.420 | 8.505,80 | 16.295 | **3,31** |
| | Figueira da Foz | 6,68 | 1.420 | 9.485,60 | 16.295 | **3,69** |
| | Mira | 3,01 | 1.420 | 4.274,20 | 16.295 | **1,66** |
| | Montemor-o-Velho | 5,67 | 1.420 | 8.051,40 | 16.295 | **3,14** |
| | Penacova | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Soure | 8,33 | 1.420 | 11.828,60 | 16.295 | **4,61** |
| ***Pinhal Litoral*** | Batalha | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Leiria | 11,85 | 1.420 | 16.827,00 | 16.295 | **6,55** |
| | Marinha Grande | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pombal | 5,87 | 1.420 | 8.335,40 | 16.295 | **3,25** |
| | Porto de Mós | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Góis | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Lousã | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Miranda do Corvo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira do Hospital | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penela | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Tábua | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Alvaiázere | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ansião | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Castanheira de Pêra | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pedrógão Grande | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Carregal do Sal | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Castro Daire | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mangualde | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mortágua | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Nelas | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira de Frades | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penalva do Castelo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Santa Comba Dão | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced sorghum residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sátão | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Tondela | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Viseu | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vouzela | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Proença-a-Nova | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sertã | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila de Rei | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mação | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Gouveia | 4,15 | 1.420 | 5.893,00 | 16.295 | **2,30** |
| | Seia | … | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Beira Interior Norte*** | Almeida | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Celorico da Beira | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Fig. Castelo Rodrigo | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Guarda | 14,30 | 1.420 | 20.306,00 | 16.295 | **7,91** |
| | Manteigas | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Meda | 0,30 | 1.420 | 426,00 | 16.295 | **0,17** |
| | Pinhel | 6,97 | 1.420 | 9.897,40 | 16.295 | **3,85** |
| | Sabugal | 4,80 | 1.420 | 6.816,00 | 16.295 | **2,65** |
| | Trancoso | 0,82 | 1.420 | 1.164,40 | 16.295 | **0,45** |
| ***Beira Interior Sul*** | Castelo Branco | 25,62 | 1.420 | 36.380,40 | 16.295 | **14,17** |
| | Idanha-a-Nova | 49,53 | 1.420 | 70.332,60 | 16.295 | **27,39** |
| | Penamacor | 6,40 | 1.420 | 9.088,00 | 16.295 | **3,54** |
| | Vila Velha de Ródão | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Cova Beira*** | Belmonte | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Covilhã | 5,94 | 1.420 | 8.434,80 | 16.295 | **3,28** |
| | Fundão | 14,02 | 1.420 | 19.908,40 | 16.295 | **7,75** |
| ***Oeste*** | Alcobaça | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Bombarral | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Caldas da Rainha | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Nazaré | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Óbidos | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Peniche | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Alenquer | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Arruda dos Vinhos | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Cadaval | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Lourinhã | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Torres Vedras | … | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Médio Tejo*** | Abrantes | 39,00 | 1.420 | 55.380,00 | 16.295 | **21,57** |
| | Alcanena | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Constância | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Entroncamento | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sardoal | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Tomar | 44,11 | 1.420 | 62.636,20 | 16.295 | **24,39** |
| | Torres Novas | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ourém | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | **Total** | **277,17** | **-** | **393.581,40** | **-** | **153,28** |

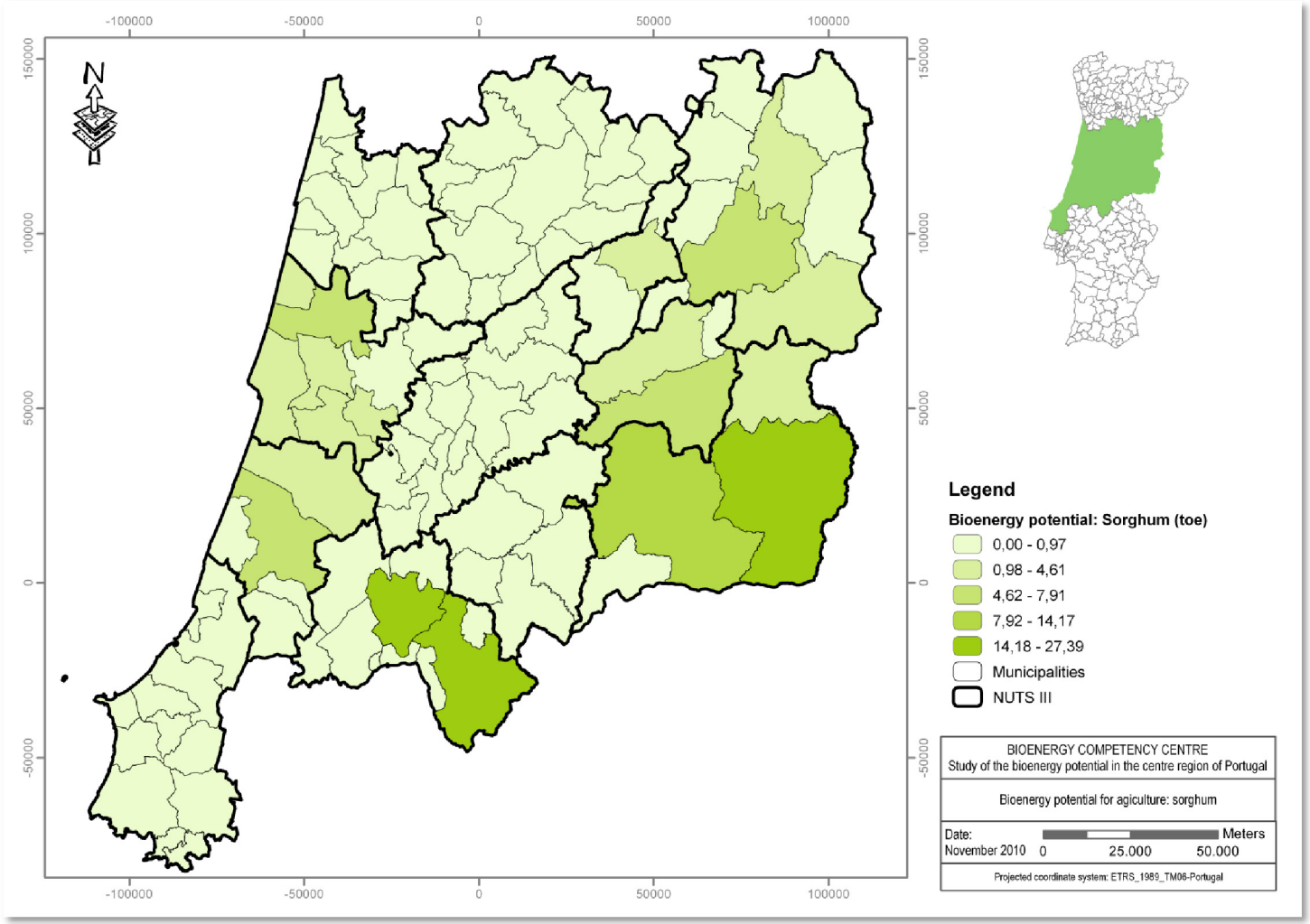


Figure A4.10: Map for the bioenergy potential for sorghum residues.

Table A4.11: Bioenergy potential for oat temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced oat residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 119,32 | 1.420 | 169.434,40 | 16.295 | **65,99** |
| | Albergaria-a-Velha | 80,81 | 1.420 | 114.750,20 | 16.295 | **44,69** |
| | Anadia | 91,30 | 1.420 | 129.646,00 | 16.295 | **50,49** |
| | Aveiro | 48,40 | 1.420 | 68.728,00 | 16.295 | **26,77** |
| | Estarreja | 21,55 | 1.420 | 30.601,00 | 16.295 | **11,92** |
| | Ílhavo | 81,63 | 1.420 | 115.914,60 | 16.295 | **45,14** |
| | Mealhada | 138,50 | 1.420 | 196.670,00 | 16.295 | **76,59** |
| | Murtosa | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira do Bairro | 11,68 | 1.420 | 16.585,60 | 16.295 | **6,46** |
| | Ovar | 2,25 | 1.420 | 3.195,00 | 16.295 | **1,24** |
| | Sever do Vouga | 6,62 | 1.420 | 9.400,40 | 16.295 | **3,66** |
| | Vagos | 40,19 | 1.420 | 57.069,80 | 16.295 | **22,23** |
| ***Baixo Mondego*** | Cantanhede | 270,96 | 1.420 | 384.763,20 | 16.295 | **149,85** |
| | Coimbra | 107,09 | 1.420 | 152.067,80 | 16.295 | **59,22** |
| | Condeixa-a-Nova | 155,84 | 1.420 | 221.292,80 | 16.295 | **86,18** |
| | Figueira da Foz | 163,32 | 1.420 | 231.914,40 | 16.295 | **90,32** |
| | Mira | 7,28 | 1.420 | 10.337,60 | 16.295 | **4,03** |
| | Montemor-o-Velho | 227,15 | 1.420 | 322.553,00 | 16.295 | **125,62** |
| | Penacova | 172,96 | 1.420 | 245.603,20 | 16.295 | **95,65** |
| | Soure | 287,70 | 1.420 | 408.534,00 | 16.295 | **159,10** |
| ***Pinhal Litoral*** | Batalha | 2,26 | 1.420 | 3.209,20 | 16.295 | **1,25** |
| | Leiria | 49,96 | 1.420 | 70.943,20 | 16.295 | **27,63** |
| | Marinha Grande | 2,00 | 1.420 | 2.840,00 | 16.295 | **1,11** |
| | Pombal | 386,87 | 1.420 | 549.355,40 | 16.295 | **213,95** |
| | Porto de Mós | 19,05 | 1.420 | 27.051,00 | 16.295 | **10,54** |
| ***Pinhal Interior Norte*** | Arganil | 42,97 | 1.420 | 61.017,40 | 16.295 | **23,76** |
| | Góis | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Lousã | 3,37 | 1.420 | 4.785,40 | 16.295 | **1,86** |
| | Miranda do Corvo | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira do Hospital | 39,50 | 1.420 | 56.090,00 | 16.295 | **21,84** |
| | Pampilhosa da Serra | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penela | 80,61 | 1.420 | 114.466,20 | 16.295 | **44,58** |
| | Tábua | 142,97 | 1.420 | 203.017,40 | 16.295 | **79,07** |
| | Vila Nova de Poiares | 82,05 | 1.420 | 116.511,00 | 16.295 | **45,38** |
| | Alvaiázere | 26,70 | 1.420 | 37.914,00 | 16.295 | **14,77** |
| | Ansião | 152,56 | 1.420 | 216.635,20 | 16.295 | **84,37** |
| | Castanheira de Pêra | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Figueiró dos Vinhos | 7,68 | 1.420 | 10.905,60 | 16.295 | **4,25** |
| | Pedrógão Grande | 16,53 | 1.420 | 23.472,60 | 16.295 | **9,14** |
| ***Dão Lafões*** | Aguiar da Beira | 8,34 | 1.420 | 11.842,80 | 16.295 | **4,61** |
| | Carregal do Sal | 3,47 | 1.420 | 4.927,40 | 16.295 | **1,92** |
| | Castro Daire | 24,59 | 1.420 | 34.917,80 | 16.295 | **13,60** |
| | Mangualde | 59,02 | 1.420 | 83.808,40 | 16.295 | **32,64** |
| | Mortágua | 201,22 | 1.420 | 285.732,40 | 16.295 | **111,28** |
| | Nelas | 0,74 | 1.420 | 1.050,80 | 16.295 | **0,41** |
| | Oliveira de Frades | 2,81 | 1.420 | 3.990,20 | 16.295 | **1,55** |
| | Penalva do Castelo | 8,59 | 1.420 | 12.197,80 | 16.295 | **4,75** |
| | Santa Comba Dão | 75,76 | 1.420 | 107.579,20 | 16.295 | **41,90** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced oat residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 29,78 | 1.420 | 42.287,60 | 16.295 | **16,47** |
| | Sátão | 39,84 | 1.420 | 56.572,80 | 16.295 | **22,03** |
| | Tondela | 29,63 | 1.420 | 42.074,60 | 16.295 | **16,39** |
| | Vila Nova de Paiva | 4,04 | 1.420 | 5.736,80 | 16.295 | **2,23** |
| | Viseu | 57,53 | 1.420 | 81.692,60 | 16.295 | **31,82** |
| | Vouzela | 6,12 | 1.420 | 8.690,40 | 16.295 | **3,38** |
| ***Pinhal Interior Sul*** | Oleiros | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Proença-a-Nova | 41,40 | 1.420 | 58.788,00 | 16.295 | **22,90** |
| | Sertã | 4,02 | 1.420 | 5.708,40 | 16.295 | **2,22** |
| | Vila de Rei | 7,46 | 1.420 | 10.593,20 | 16.295 | **4,13** |
| | Mação | 22,91 | 1.420 | 32.532,20 | 16.295 | **12,67** |
| ***Serra Estrela*** | Fornos de Algodres | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Gouveia | 39,17 | 1.420 | 55.621,40 | 16.295 | **21,66** |
| | Seia | 18,51 | 1.420 | 26.284,20 | 16.295 | **10,24** |
| ***Beira Interior Norte*** | Almeida | 45,65 | 1.420 | 64.823,00 | 16.295 | **25,25** |
| | Celorico da Beira | 227,84 | 1.420 | 323.532,80 | 16.295 | **126,00** |
| | Fig. Castelo Rodrigo | 1.225,58 | 1.420 | 1.740.323,60 | 16.295 | **677,77** |
| | Guarda | 195,47 | 1.420 | 277.567,40 | 16.295 | **108,10** |
| | Manteigas | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Meda | 208,68 | 1.420 | 296.325,60 | 16.295 | **115,40** |
| | Pinhel | 122,33 | 1.420 | 173.708,60 | 16.295 | **67,65** |
| | Sabugal | 66,65 | 1.420 | 94.643,00 | 16.295 | **36,86** |
| | Trancoso | 179,47 | 1.420 | 254.847,40 | 16.295 | **99,25** |
| ***Beira Interior Sul*** | Castelo Branco | 489,16 | 1.420 | 694.607,20 | 16.295 | **270,52** |
| | Idanha-a-Nova | 1.562,89 | 1.420 | 2.219.303,80 | 16.295 | **864,31** |
| | Penamacor | 827,80 | 1.420 | 1.175.476,00 | 16.295 | **457,79** |
| | Vila Velha de Ródão | 11,70 | 1.420 | 16.614,00 | 16.295 | **6,47** |
| ***Cova Beira*** | Belmonte | 108,06 | 1.420 | 153.445,20 | 16.295 | **59,76** |
| | Covilhã | 483,44 | 1.420 | 686.484,80 | 16.295 | **267,35** |
| | Fundão | 1.048,83 | 1.420 | 1.489.338,60 | 16.295 | **580,02** |
| ***Oeste*** | Alcobaça | 101,23 | 1.420 | 143.746,60 | 16.295 | **55,98** |
| | Bombarral | 29,10 | 1.420 | 41.322,00 | 16.295 | **16,09** |
| | Caldas da Rainha | 37,63 | 1.420 | 53.434,60 | 16.295 | **20,81** |
| | Nazaré | 2,27 | 1.420 | 3.223,40 | 16.295 | **1,26** |
| | Óbidos | 24,84 | 1.420 | 35.272,80 | 16.295 | **13,74** |
| | Peniche | 24,64 | 1.420 | 34.988,80 | 16.295 | **13,63** |
| | Alenquer | 195,00 | 1.420 | 276.900,00 | 16.295 | **107,84** |
| | Arruda dos Vinhos | 237,56 | 1.420 | 337.335,20 | 16.295 | **131,38** |
| | Cadaval | 52,11 | 1.420 | 73.996,20 | 16.295 | **28,82** |
| | Lourinhã | 106,95 | 1.420 | 151.869,00 | 16.295 | **59,15** |
| | Sobral de Monte Agraço | 130,08 | 1.420 | 184.713,60 | 16.295 | **71,94** |
| | Torres Vedras | 367,99 | 1.420 | 522.545,80 | 16.295 | **203,51** |
| ***Médio Tejo*** | Abrantes | 316,54 | 1.420 | 449.486,80 | 16.295 | **175,05** |
| | Alcanena | 11,80 | 1.420 | 16.756,00 | 16.295 | **6,53** |
| | Constância | 7,75 | 1.420 | 11.005,00 | 16.295 | **4,29** |
| | Entroncamento | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ferreira do Zêzere | 10,85 | 1.420 | 15.407,00 | 16.295 | **6,00** |
| | Sardoal | 10,95 | 1.420 | 15.549,00 | 16.295 | **6,06** |
| | Tomar | 65,88 | 1.420 | 93.549,60 | 16.295 | **36,43** |
| | Torres Novas | 154,62 | 1.420 | 219.560,40 | 16.295 | **85,51** |
| | Vila Nova da Barquinha | … | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ourém | 55,34 | 1.420 | 78.582,80 | 16.295 | **30,60** |
| | **Total** | **12.521,26** | **-** | **17.780.189,20** | **-** | **6.924,50** |

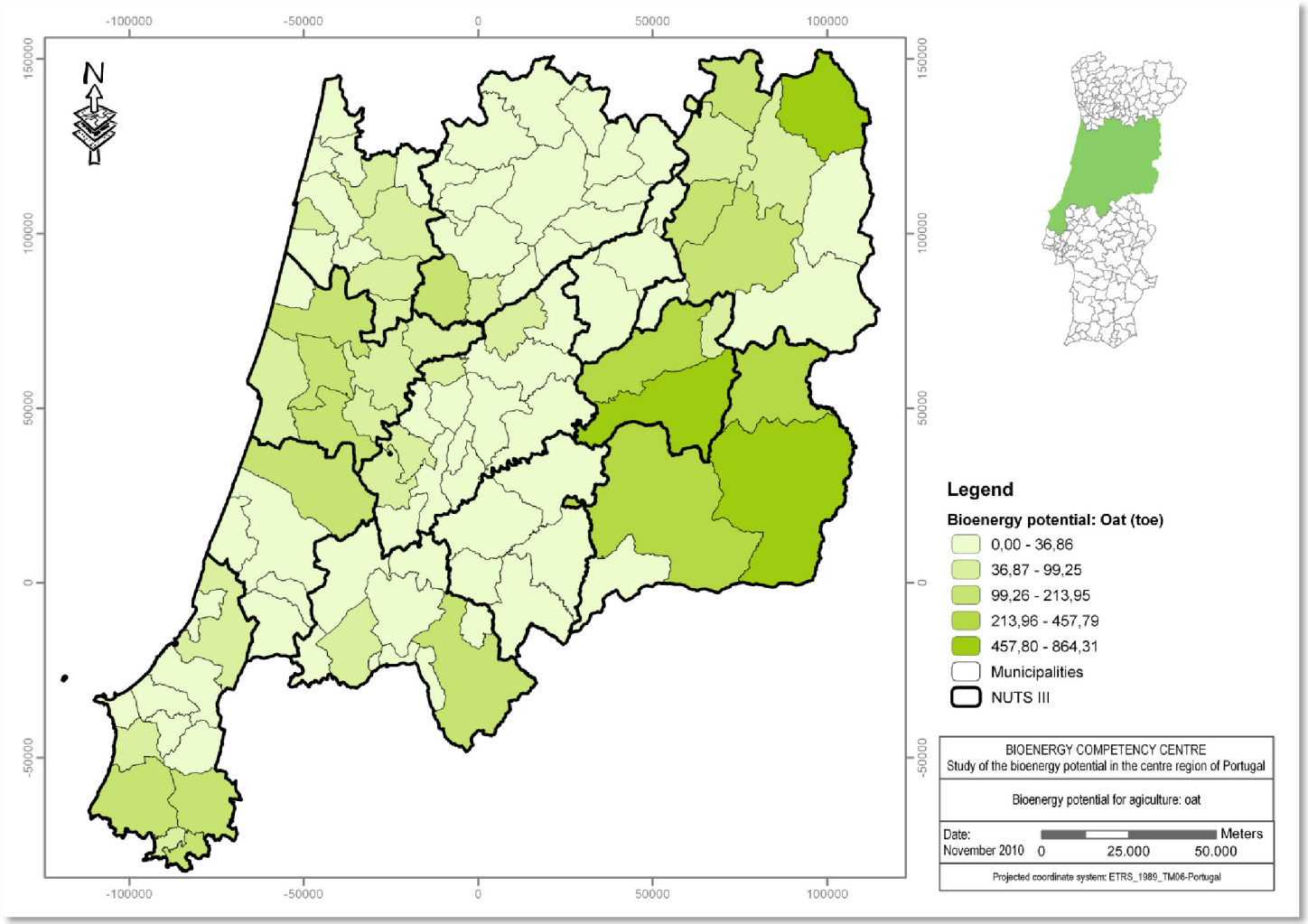


Figure A4.11: Map for the bioenergy potential for oat residues.

Table A4.12: Bioenergy potential for rice temporary crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced oat residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 95,97 | 1.420 | 136.277,40 | 16.295 | **53,07** |
| | Albergaria-a-Velha | 2,93 | 1.420 | 4.160,60 | 16.295 | **1,62** |
| | Anadia | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Aveiro | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Estarreja | 98,04 | 1.420 | 139.216,80 | 16.295 | **54,22** |
| | Ílhavo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mealhada | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Murtosa | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira do Bairro | 112,35 | 1.420 | 159.537,00 | 16.295 | **62,13** |
| | Ovar | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sever do Vouga | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vagos | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 11,14 | 1.420 | 15.818,80 | 16.295 | **6,16** |
| | Coimbra | 522,03 | 1.420 | 741.282,60 | 16.295 | **288,69** |
| | Condeixa-a-Nova | ... | 1.420 | 0,00 | 16.295 | **0,00** |
| | Figueira da Foz | 2.702,65 | 1.420 | 3.837.763,00 | 16.295 | **1.494,62** |
| | Mira | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Montemor-o-Velho | 1.665,46 | 1.420 | 2.364.953,20 | 16.295 | **921,03** |
| | Penacova | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Soure | 778,92 | 1.420 | 1.106.066,40 | 16.295 | **430,76** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Leiria | 128,00 | 1.420 | 181.760,00 | 16.295 | **70,79** |
| | Marinha Grande | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pombal | 266,13 | 1.420 | 377.904,60 | 16.295 | **147,18** |
| | Porto de Mós | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Góis | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Lousã | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Miranda do Corvo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira do Hospital | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penela | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Tábua | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Alvaiázere | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ansião | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Castanheira de Pêra | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pedrógão Grande | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Carregal do Sal | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Castro Daire | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mangualde | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mortágua | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Nelas | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Oliveira de Frades | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penalva do Castelo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Santa Comba Dão | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |

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| *NUTS III* | *Municipality* | *Occupied area (ha)* | *Produced oat residues (kg/ha.year)* | *Biomass Residues (kg)* | *LHV (kJ/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sátão | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Tondela | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Viseu | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vouzela | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Proença-a-Nova | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sertã | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila de Rei | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Mação | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Gouveia | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Seia | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Beira Interior Norte*** | Almeida | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Celorico da Beira | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Fig. Castelo Rodrigo | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Guarda | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Manteigas | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Meda | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Pinhel | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sabugal | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Trancoso | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Beira Interior Sul*** | Castelo Branco | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Idanha-a-Nova | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Penamacor | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Velha de Ródão | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Cova Beira*** | Belmonte | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Covilhã | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Fundão | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Oeste*** | Alcobaça | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Bombarral | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Caldas da Rainha | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Nazaré | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Óbidos | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Peniche | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Alenquer | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Cadaval | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Lourinhã | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Torres Vedras | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| ***Médio Tejo*** | Abrantes | 27,35 | 1.420 | 38.837,00 | 16.295 | **15,13** |
| | Alcanena | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Constância | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Entroncamento | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Sardoal | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Tomar | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Torres Novas | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | Ourém | 0,00 | 1.420 | 0,00 | 16.295 | **0,00** |
| | **Total** | **6.410,97** | **-** | **9.103.577,40** | **-** | **3.545,39** |

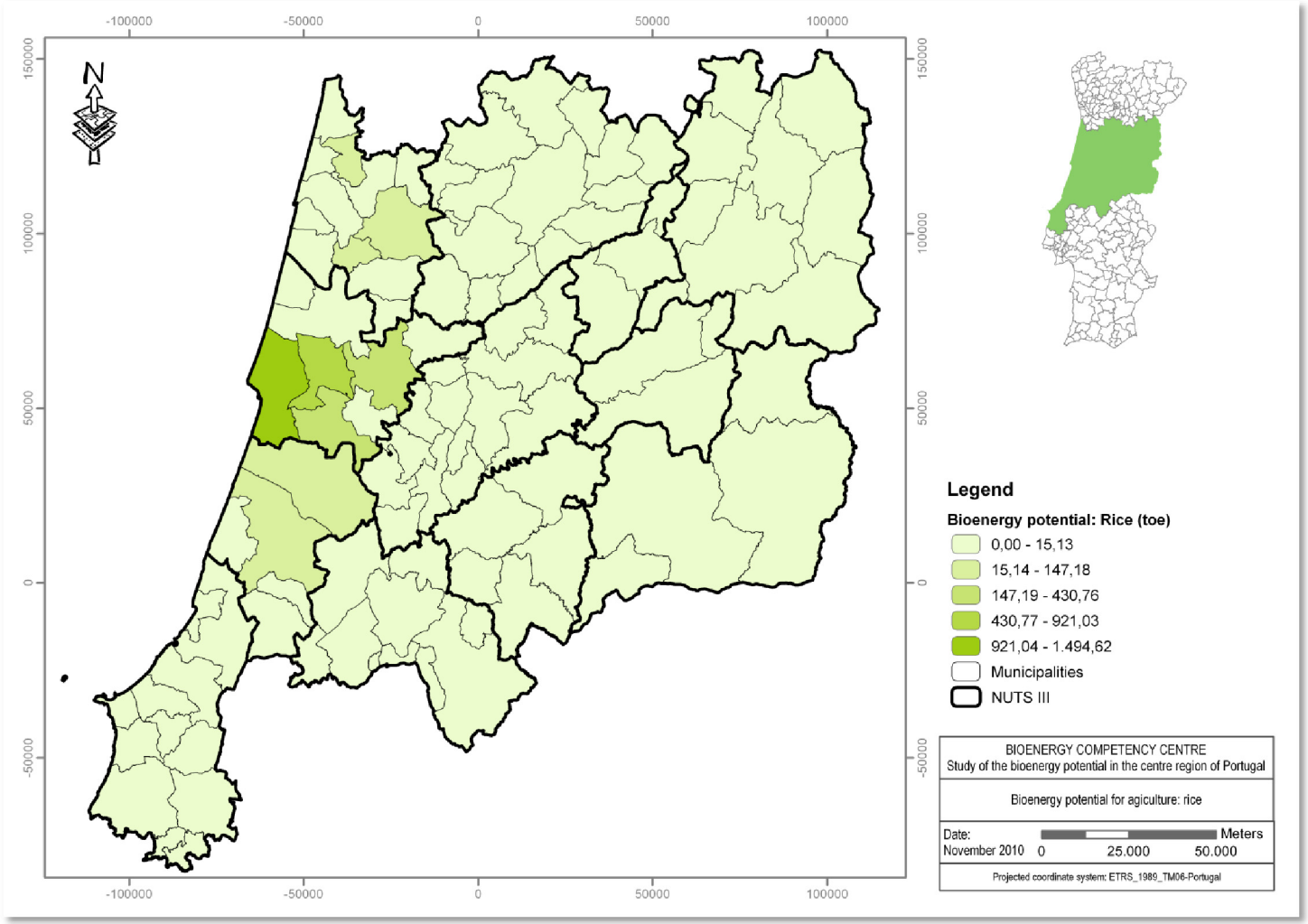


Figure A4.12: Map for the bioenergy potential for rice residues.

## *Annex 5: Bioenergy Crops Biomass*

Table A5.1: Bioenergy potential for amylaceous maize energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 1.333,02 | 177,29 | 3.907 | 692,68 | 388 | 268.759,26 | **134,81** |
| | Albergaria-a-Velha | 783,60 | 104,22 | 3.907 | 407,18 | 388 | 157.986,95 | **79,24** |
| | Anadia | 858,43 | 114,17 | 3.907 | 446,07 | 388 | 173.073,93 | **86,81** |
| | Aveiro | 894,17 | 118,92 | 3.907 | 464,64 | 388 | 180.279,72 | **90,43** |
| | Estarreja | 729,48 | 97,02 | 3.907 | 379,06 | 388 | 147.075,44 | **73,77** |
| | Ílhavo | 297,75 | 39,60 | 3.907 | 154,72 | 388 | 60.031,41 | **30,11** |
| | Mealhada | 433,19 | 57,61 | 3.907 | 225,10 | 388 | 87.338,39 | **43,81** |
| | Murtosa | 258,22 | 34,34 | 3.907 | 134,18 | 388 | 52.061,50 | **26,11** |
| | Oliveira do Bairro | 530,44 | 70,55 | 3.907 | 275,63 | 388 | 106.945,63 | **53,64** |
| | Ovar | 343,28 | 45,66 | 3.907 | 178,38 | 388 | 69.211,02 | **34,72** |
| | Sever do Vouga | 412,52 | 54,87 | 3.907 | 214,36 | 388 | 83.170,97 | **41,72** |
| | Vagos | 850,44 | 113,11 | 3.907 | 441,91 | 388 | 171.463,02 | **86,00** |
| ***Baixo Mondego*** | Cantanhede | 1.613,73 | 214,63 | 3.907 | 838,54 | 388 | 325.355,12 | **163,19** |
| | Coimbra | 2.525,47 | 335,89 | 3.907 | 1.312,31 | 388 | 509.177,25 | **255,40** |
| | Condeixa-a-Nova | 475,85 | 63,29 | 3.907 | 247,27 | 388 | 95.939,37 | **48,12** |
| | Figueira da Foz | 1.230,15 | 163,61 | 3.907 | 639,22 | 388 | 248.018,94 | **124,40** |
| | Mira | 454,86 | 60,50 | 3.907 | 236,36 | 388 | 91.707,43 | **46,00** |
| | Montemor-o-Velho | 3.219,26 | 428,16 | 3.907 | 1.672,83 | 388 | 649.056,99 | **325,56** |
| | Penacova | 326,21 | 43,39 | 3.907 | 169,51 | 388 | 65.769,43 | **32,99** |
| | Soure | 1.736,12 | 230,90 | 3.907 | 902,14 | 388 | 350.031,01 | **175,57** |
| ***Pinhal Litoral*** | Batalha | 175,39 | 23,33 | 3.907 | 91,14 | 388 | 35.361,58 | **17,74** |
| | Leiria | 2.267,71 | 301,61 | 3.907 | 1.178,37 | 388 | 457.208,50 | **229,33** |
| | Marinha Grande | 99,03 | 13,17 | 3.907 | 51,46 | 388 | 19.966,11 | **10,01** |
| | Pombal | 2.082,57 | 276,98 | 3.907 | 1.082,17 | 388 | 419.881,16 | **210,61** |
| | Porto de Mós | 120,93 | 16,08 | 3.907 | 62,84 | 388 | 24.381,52 | **12,23** |
| ***Pinhal Interior Norte*** | Arganil | 335,72 | 44,65 | 3.907 | 174,45 | 388 | 67.686,80 | **33,95** |
| | Góis | 65,96 | 8,77 | 3.907 | 34,27 | 388 | 13.298,65 | **6,67** |
| | Lousã | 120,76 | 16,06 | 3.907 | 62,75 | 388 | 24.347,25 | **12,21** |
| | Miranda do Corvo | 128,28 | 17,06 | 3.907 | 66,66 | 388 | 25.863,41 | **12,97** |
| | Oliveira do Hospital | 601,49 | 80,00 | 3.907 | 312,55 | 388 | 121.270,51 | **60,83** |
| | Pampilhosa da Serra | 56,77 | 7,55 | 3.907 | 29,50 | 388 | 11.445,79 | **5,74** |
| | Penela | 111,43 | 14,82 | 3.907 | 57,90 | 388 | 22.466,16 | **11,27** |
| | Tábua | 475,24 | 63,21 | 3.907 | 246,95 | 388 | 95.816,38 | **48,06** |
| | Vila Nova de Poiares | 114,35 | 15,21 | 3.907 | 59,42 | 388 | 23.054,88 | **11,56** |
| | Alvaiázere | 124,90 | 16,61 | 3.907 | 64,90 | 388 | 25.181,94 | **12,63** |
| | Ansião | 251,44 | 33,44 | 3.907 | 130,66 | 388 | 50.694,54 | **25,43** |
| | Castanheira de Pêra | 5,29 | 0,70 | 3.907 | 2,75 | 388 | 1.066,55 | **0,53** |
| | Figueiró dos Vinhos | 92,27 | 12,27 | 3.907 | 47,95 | 388 | 18.603,18 | **9,33** |
| | Pedrógão Grande | 126,81 | 16,87 | 3.907 | 65,89 | 388 | 25.567,03 | **12,82** |
| ***Dão Lafões*** | Aguiar da Beira | 711,30 | 94,60 | 3.907 | 369,61 | 388 | 327.828,96 | **164,43** |
| | Carregal do Sal | 389,82 | 51,85 | 3.907 | 202,56 | 388 | 149.137,98 | **74,81** |
| | Castro Daire | 1.012,43 | 134,65 | 3.907 | 526,09 | 388 | 28.172,19 | **14,13** |
| | Mangualde | 770,01 | 102,41 | 3.907 | 400,12 | 388 | 33.328,28 | **16,72** |
| | Mortágua | 328,09 | 43,64 | 3.907 | 170,49 | 388 | 57.444,96 | **28,81** |
| | Nelas | 244,22 | 32,48 | 3.907 | 126,90 | 388 | 5.962,89 | **2,99** |
| | Oliveira de Frades | 781,13 | 103,89 | 3.907 | 405,90 | 388 | 16.316,63 | **8,18** |
| | Penalva do Castelo | 633,81 | 84,30 | 3.907 | 329,35 | 388 | 83.393,08 | **41,83** |
| | Santa Comba Dão | 295,70 | 39,33 | 3.907 | 153,65 | 388 | 33.663,61 | **16,89** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1.192,06 | 158,54 | 3.907 | 619,43 | 388 | 95.645,59 | **47,97** |
| | Sátão | 844,66 | 112,34 | 3.907 | 438,91 | 388 | 5.725,01 | **2,87** |
| | Tondela | 1.299,84 | 172,88 | 3.907 | 675,44 | 388 | 48.739,23 | **24,45** |
| | Vila Nova de Paiva | 439,95 | 58,51 | 3.907 | 228,61 | 388 | 8.449,22 | **4,24** |
| | Viseu | 1.626,00 | 216,26 | 3.907 | 844,92 | 388 | 80.234,65 | **40,24** |
| | Vouzela | 739,71 | 98,38 | 3.907 | 384,38 | 388 | 5.494,29 | **2,76** |
| ***Pinhal Interior Sul*** | Oleiros | 196,59 | 26,15 | 2.777 | 72,61 | 388 | 35.628,32 | **17,87** |
| | Proença-a-Nova | 232,57 | 30,93 | 2.777 | 85,90 | 388 | 46.381,87 | **23,26** |
| | Sertã | 400,86 | 53,31 | 2.777 | 148,05 | 388 | 57.546,71 | **28,86** |
| | Vila de Rei | 41,61 | 5,53 | 2.777 | 15,37 | 388 | 56.575,11 | **28,38** |
| | Mação | 113,86 | 15,14 | 2.777 | 42,05 | 388 | 141.369,70 | **70,91** |
| ***Serra Estrela*** | Fornos de Algodres | 581,93 | 77,40 | 2.777 | 214,93 | 388 | 406.178,86 | **203,73** |
| | Gouveia | 234,91 | 31,24 | 2.777 | 86,76 | 388 | 115.824,27 | **58,10** |
| | Seia | 667,43 | 88,77 | 2.777 | 246,51 | 388 | 8.307,35 | **4,17** |
| ***Beira Interior Norte*** | Almeida | 39,95 | 5,31 | 2.777 | 14,76 | 388 | 43.600,34 | **21,87** |
| | Celorico da Beira | 340,11 | 45,23 | 2.777 | 125,62 | 388 | 120.789,77 | **60,59** |
| | Fig. Castelo Rodrigo | 58,96 | 7,84 | 2.777 | 21,78 | 388 | 274.232,86 | **137,55** |
| | Guarda | 559,89 | 74,47 | 2.777 | 206,79 | 388 | 327.828,96 | **164,43** |
| | Manteigas | 38,34 | 5,10 | 2.777 | 14,16 | 388 | 149.137,98 | **74,81** |
| | Meda | 248,62 | 33,07 | 2.777 | 91,83 | 388 | 28.172,19 | **14,13** |
| | Pinhel | 323,66 | 43,05 | 2.777 | 119,54 | 388 | 33.328,28 | **16,72** |
| | Sabugal | 401,57 | 53,41 | 2.777 | 148,32 | 388 | 57.444,96 | **28,81** |
| | Trancoso | 394,79 | 52,51 | 2.777 | 145,81 | 388 | 5.962,89 | **2,99** |
| ***Beira Interior Sul*** | Castelo Branco | 986,50 | 131,20 | 2.777 | 364,35 | 388 | 16.316,63 | **8,18** |
| | Idanha-a-Nova | 2.834,38 | 376,97 | 2.777 | 1.046,85 | 388 | 83.393,08 | **41,83** |
| | Penamacor | 808,24 | 107,50 | 2.777 | 298,52 | 388 | 33.663,61 | **16,89** |
| | Vila Velha de Ródão | 57,97 | 7,71 | 2.777 | 21,41 | 388 | 95.645,59 | **47,97** |
| ***Cova Beira*** | Belmonte | 304,25 | 40,47 | 2.777 | 112,37 | 388 | 5.725,01 | **2,87** |
| | Covilhã | 842,89 | 112,10 | 2.777 | 311,31 | 388 | 48.739,23 | **24,45** |
| | Fundão | 1.913,64 | 254,51 | 2.777 | 706,79 | 388 | 8.449,22 | **4,24** |
| ***Oeste*** | Alcobaça | 276,59 | 36,79 | 7.667 | 282,04 | 388 | 109.432,24 | **54,89** |
| | Bombarral | 25,73 | 3,42 | 7.667 | 26,24 | 388 | 10.180,02 | **5,11** |
| | Caldas da Rainha | 200,77 | 26,70 | 7.667 | 204,73 | 388 | 79.434,22 | **39,84** |
| | Nazaré | 40,27 | 5,36 | 7.667 | 41,06 | 388 | 15.932,74 | **7,99** |
| | Óbidos | 180,23 | 23,97 | 7.667 | 183,78 | 388 | 71.307,62 | **35,77** |
| | Peniche | 223,51 | 29,73 | 7.667 | 227,92 | 388 | 88.431,25 | **44,36** |
| | Alenquer | 805,33 | 107,11 | 7.667 | 821,20 | 388 | 318.627,10 | **159,82** |
| | Arruda dos Vinhos | 61,30 | 8,15 | 7.667 | 62,51 | 388 | 24.253,21 | **12,17** |
| | Cadaval | 50,09 | 6,66 | 7.667 | 51,08 | 388 | 19.818,00 | **9,94** |
| | Lourinhã | 316,08 | 42,04 | 7.667 | 322,31 | 388 | 125.056,38 | **62,73** |
| | Sobral de Monte Agraço | 183,00 | 24,34 | 7.667 | 186,61 | 388 | 72.403,56 | **36,32** |
| | Torres Vedras | 489,88 | 65,15 | 7.667 | 499,54 | 388 | 193.819,98 | **97,22** |
| ***Médio Tejo*** | Abrantes | 1.545,59 | 205,56 | 7.667 | 1.576,06 | 388 | 611.509,39 | **306,72** |
| | Alcanena | 132,02 | 17,56 | 7.667 | 134,62 | 388 | 52.233,43 | **26,20** |
| | Constância | 93,80 | 12,48 | 7.667 | 95,65 | 388 | 37.111,77 | **18,61** |
| | Entroncamento | 43,63 | 5,80 | 7.667 | 44,49 | 388 | 17.262,12 | **8,66** |
| | Ferreira do Zêzere | 92,55 | 12,31 | 7.667 | 94,37 | 388 | 36.617,21 | **18,37** |
| | Sardoal | 31,76 | 4,22 | 7.667 | 32,39 | 388 | 12.565,78 | **6,30** |
| | Tomar | 422,68 | 56,22 | 7.667 | 431,01 | 388 | 167.232,44 | **83,88** |
| | Torres Novas | 1.369,25 | 182,11 | 7.667 | 1.396,24 | 388 | 541.740,84 | **271,73** |
| | Vila Nova da Barquinha | 83,37 | 11,09 | 7.667 | 85,01 | 388 | 32.985,16 | **16,54** |
| | Ourém | 678,66 | 90,26 | 7.667 | 692,04 | 388 | 268.510,38 | **134,68** |
| | **Total** | **57.940,87** | **7.706,14** | **-** | **31.884,32** | **-** | **12.371.114,64** | **6.205,17** |

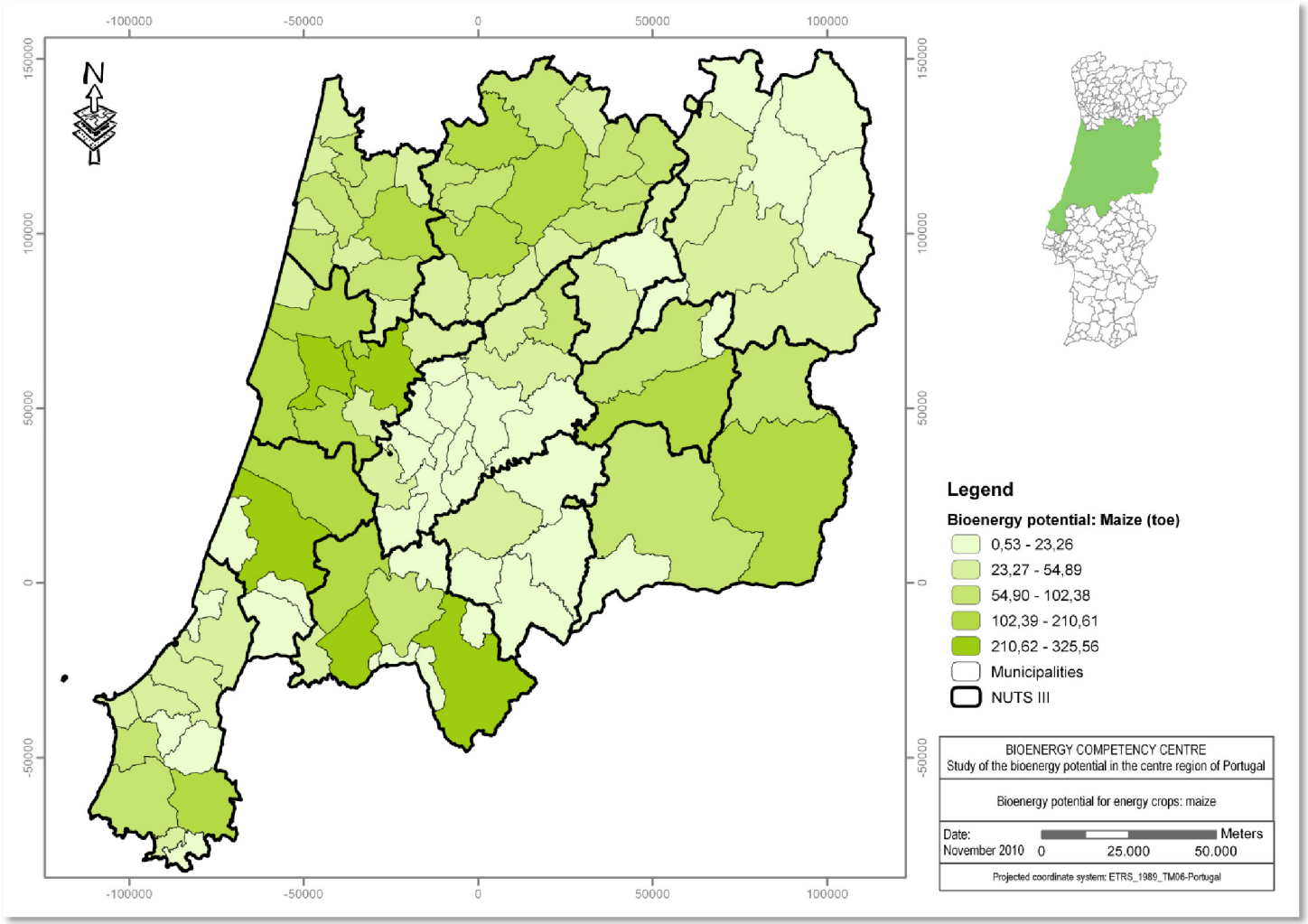


Figure A5.1: Map for the bioenergy potential for maize energy crops.

Table A5.2: Bioenergy potential for amylaceous wheat energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 15,82 | 2,10 | 1.518 | 3,19 | 385 | 1.229,68 | **0,62** |
| | Albergaria-a-Velha | 18,22 | 2,42 | 1.518 | 3,68 | 385 | 1.416,23 | **0,71** |
| | Anadia | 12,44 | 1,65 | 1.518 | 2,51 | 385 | 966,95 | **0,49** |
| | Aveiro | 8,68 | 1,15 | 1.518 | 1,75 | 385 | 674,69 | **0,34** |
| | Estarreja | 10,64 | 1,42 | 1.518 | 2,15 | 385 | 827,04 | **0,41** |
| | Ílhavo | 13,34 | 1,77 | 1.518 | 2,69 | 385 | 1.036,91 | **0,52** |
| | Mealhada | 7,95 | 1,06 | 1.518 | 1,61 | 385 | 617,95 | **0,31** |
| | Murtosa | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Oliveira do Bairro | … | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Ovar | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Sever do Vouga | 0,18 | 0,02 | 1.518 | 0,04 | 385 | 13,99 | **0,01** |
| | Vagos | 3,69 | 0,49 | 1.518 | 0,74 | 385 | 286,82 | **0,14** |
| ***Baixo Mondego*** | Cantanhede | 73,62 | 9,79 | 1.518 | 14,86 | 385 | 5.722,42 | **2,87** |
| | Coimbra | 28,36 | 3,77 | 1.518 | 5,73 | 385 | 2.204,40 | **1,11** |
| | Condeixa-a-Nova | 54,19 | 7,21 | 1.518 | 10,94 | 385 | 4.212,14 | **2,11** |
| | Figueira da Foz | 22,09 | 2,94 | 1.518 | 4,46 | 385 | 1.717,04 | **0,86** |
| | Mira | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Montemor-o-Velho | 15,72 | 2,09 | 1.518 | 3,17 | 385 | 1.221,90 | **0,61** |
| | Penacova | 79,36 | 10,55 | 1.518 | 16,02 | 385 | 6.168,59 | **3,09** |
| | Soure | 83,16 | 11,06 | 1.518 | 16,79 | 385 | 6.463,96 | **3,24** |
| ***Pinhal Litoral*** | Batalha | … | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Leiria | 46,00 | 6,12 | 1.518 | 9,29 | 385 | 3.575,54 | **1,79** |
| | Marinha Grande | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Pombal | 269,87 | 35,89 | 1.518 | 54,49 | 385 | 20.976,78 | **10,52** |
| | Porto de Mós | 43,32 | 5,76 | 1.518 | 8,75 | 385 | 3.367,23 | **1,69** |
| ***Pinhal Interior Norte*** | Arganil | 37,93 | 5,04 | 1.518 | 7,66 | 385 | 2.948,27 | **1,48** |
| | Góis | 1,22 | 0,16 | 1.518 | 0,25 | 385 | 94,83 | **0,05** |
| | Lousã | 5,37 | 0,71 | 1.518 | 1,08 | 385 | 417,41 | **0,21** |
| | Miranda do Corvo | … | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Oliveira do Hospital | 1,58 | 0,21 | 1.518 | 0,32 | 385 | 122,81 | **0,06** |
| | Pampilhosa da Serra | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Penela | 61,54 | 8,18 | 1.518 | 12,42 | 385 | 4.783,45 | **2,40** |
| | Tábua | 40,38 | 5,37 | 1.518 | 8,15 | 385 | 3.138,70 | **1,57** |
| | Vila Nova de Poiares | 20,36 | 2,71 | 1.518 | 4,11 | 385 | 1.582,57 | **0,79** |
| | Alvaiázere | 17,50 | 2,33 | 1.518 | 3,53 | 385 | 1.360,26 | **0,68** |
| | Ansião | 194,88 | 25,92 | 1.518 | 39,35 | 385 | 15.147,86 | **7,60** |
| | Castanheira de Pêra | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | 0,81 | 0,11 | 1.518 | 0,16 | 385 | 62,96 | **0,03** |
| | Pedrógão Grande | 7,30 | 0,97 | 1.518 | 1,47 | 385 | 567,42 | **0,28** |
| ***Dão Lafões*** | Aguiar da Beira | … | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Carregal do Sal | … | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Castro Daire | 2,63 | 0,35 | 1.518 | 0,53 | 385 | 204,43 | **0,10** |
| | Mangualde | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Mortágua | 52,00 | 6,92 | 1.518 | 10,50 | 385 | 4.041,92 | **2,03** |
| | Nelas | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Oliveira de Frades | 0,00 | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| | Penalva do Castelo | 1,76 | 0,23 | 1.518 | 0,36 | 385 | 136,80 | **0,07** |
| | Santa Comba Dão | 1,53 | 0,20 | 1.518 | 0,31 | 385 | 118,93 | **0,06** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1,42 | 0,19 | 1.518 | 0,29 | 385 | 110,38 | **0,06** |
| | Sátão | 19,60 | 2,61 | 1.518 | 3,96 | 385 | 1.523,49 | **0,76** |
| | Tondela | 13,21 | 1,76 | 1.518 | 2,67 | 385 | 1.026,80 | **0,52** |
| | Vila Nova de Paiva | 7,16 | 0,95 | 1.518 | 1,45 | 385 | 556,54 | **0,28** |
| | Viseu | 11,36 | 1,51 | 1.518 | 2,29 | 385 | 883,00 | **0,44** |
| | Vouzela | … | 0,00 | 1.518 | 0,00 | 385 | 0,00 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | … | 0,00 | 1.084 | 0,00 | 385 | 0,00 | **0,00** |
| | Proença-a-Nova | 14,95 | 1,99 | 1.084 | 2,16 | 385 | 829,82 | **0,42** |
| | Sertã | 17,96 | 2,39 | 1.084 | 2,59 | 385 | 996,89 | **0,50** |
| | Vila de Rei | 13,53 | 1,80 | 1.084 | 1,95 | 385 | 751,00 | **0,38** |
| | Mação | 15,57 | 2,07 | 1.084 | 2,24 | 385 | 864,23 | **0,43** |
| ***Serra Estrela*** | Fornos de Algodres | … | 0,00 | 1.084 | 0,00 | 385 | 0,00 | **0,00** |
| | Gouveia | … | 0,00 | 1.084 | 0,00 | 385 | 0,00 | **0,00** |
| | Seia | 0,45 | 0,06 | 1.084 | 0,06 | 385 | 24,98 | **0,01** |
| ***Beira Interior Norte*** | Almeida | 126,53 | 16,83 | 1.084 | 18,24 | 385 | 7.023,20 | **3,52** |
| | Celorico da Beira | 3,11 | 0,41 | 1.084 | 0,45 | 385 | 172,62 | **0,09** |
| | Fig. Castelo Rodrigo | 461,51 | 61,38 | 1.084 | 66,54 | 385 | 25.616,68 | **12,85** |
| | Guarda | 32,22 | 4,29 | 1.084 | 4,65 | 385 | 1.788,41 | **0,90** |
| | Manteigas | … | 0,00 | 1.084 | 0,00 | 385 | 0,00 | **0,00** |
| | Meda | 116,75 | 15,53 | 1.084 | 16,83 | 385 | 6.480,35 | **3,25** |
| | Pinhel | 236,43 | 31,45 | 1.084 | 34,09 | 385 | 13.123,34 | **6,58** |
| | Sabugal | 144,37 | 19,20 | 1.084 | 20,81 | 385 | 8.013,43 | **4,02** |
| | Trancoso | 43,79 | 5,82 | 1.084 | 6,31 | 385 | 2.430,62 | **1,22** |
| ***Beira Interior Sul*** | Castelo Branco | 88,58 | 11,78 | 1.084 | 12,77 | 385 | 4.916,74 | **2,47** |
| | Idanha-a-Nova | 812,20 | 108,02 | 1.084 | 117,10 | 385 | 45.082,15 | **22,61** |
| | Penamacor | 115,42 | 15,35 | 1.084 | 16,64 | 385 | 6.406,53 | **3,21** |
| | Vila Velha de Ródão | 9,15 | 1,22 | 1.084 | 1,32 | 385 | 507,88 | **0,25** |
| ***Cova Beira*** | Belmonte | … | 0,00 | 1.084 | 0,00 | 385 | 0,00 | **0,00** |
| | Covilhã | 100,50 | 13,37 | 1.084 | 14,49 | 385 | 5.578,38 | **2,80** |
| | Fundão | 149,67 | 19,91 | 1.084 | 21,58 | 385 | 8.307,62 | **4,17** |
| ***Oeste*** | Alcobaça | 126,83 | 16,87 | 2.229 | 37,60 | 385 | 14.475,86 | **7,26** |
| | Bombarral | 12,66 | 1,68 | 2.229 | 3,75 | 385 | 1.444,96 | **0,72** |
| | Caldas da Rainha | 64,30 | 8,55 | 2.229 | 19,06 | 385 | 7.338,94 | **3,68** |
| | Nazaré | 4,21 | 0,56 | 2.229 | 1,25 | 385 | 480,51 | **0,24** |
| | Óbidos | 23,48 | 3,12 | 2.229 | 6,96 | 385 | 2.679,91 | **1,34** |
| | Peniche | 66,26 | 8,81 | 2.229 | 19,64 | 385 | 7.562,65 | **3,79** |
| | Alenquer | 1.021,20 | 135,82 | 2.229 | 302,74 | 385 | 116.555,63 | **58,46** |
| | Arruda dos Vinhos | 428,79 | 57,03 | 2.229 | 127,12 | 385 | 48.940,35 | **24,55** |
| | Cadaval | 34,93 | 4,65 | 2.229 | 10,36 | 385 | 3.986,77 | **2,00** |
| | Lourinhã | 251,05 | 33,39 | 2.229 | 74,43 | 385 | 28.653,83 | **14,37** |
| | Sobral de Monte Agraço | 516,42 | 68,68 | 2.229 | 153,10 | 385 | 58.942,08 | **29,56** |
| | Torres Vedras | 801,30 | 106,57 | 2.229 | 237,55 | 385 | 91.457,13 | **45,87** |
| ***Médio Tejo*** | Abrantes | 379,50 | 50,47 | 2.229 | 112,51 | 385 | 43.314,59 | **21,73** |
| | Alcanena | 92,21 | 12,26 | 2.229 | 27,34 | 385 | 10.524,48 | **5,28** |
| | Constância | … | 0,00 | 2.229 | 0,00 | 385 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | 2.229 | 0,00 | 385 | 0,00 | **0,00** |
| | Ferreira do Zêzere | 7,96 | 1,06 | 2.229 | 2,36 | 385 | 908,52 | **0,46** |
| | Sardoal | … | 0,00 | 2.229 | 0,00 | 385 | 0,00 | **0,00** |
| | Tomar | 189,68 | 25,23 | 2.229 | 56,23 | 385 | 21.649,31 | **10,86** |
| | Torres Novas | 363,96 | 48,41 | 2.229 | 107,90 | 385 | 41.540,92 | **20,84** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 2.229 | 0,00 | 385 | 0,00 | **0,00** |
| | Ourém | 16,49 | 2,19 | 2.229 | 4,89 | 385 | 1.882,10 | **0,94** |
| | **Total** | **8.210,11** | **1.091,94** | **-** | **1.929,31** | **-** | **742.782,50** | **372,57** |

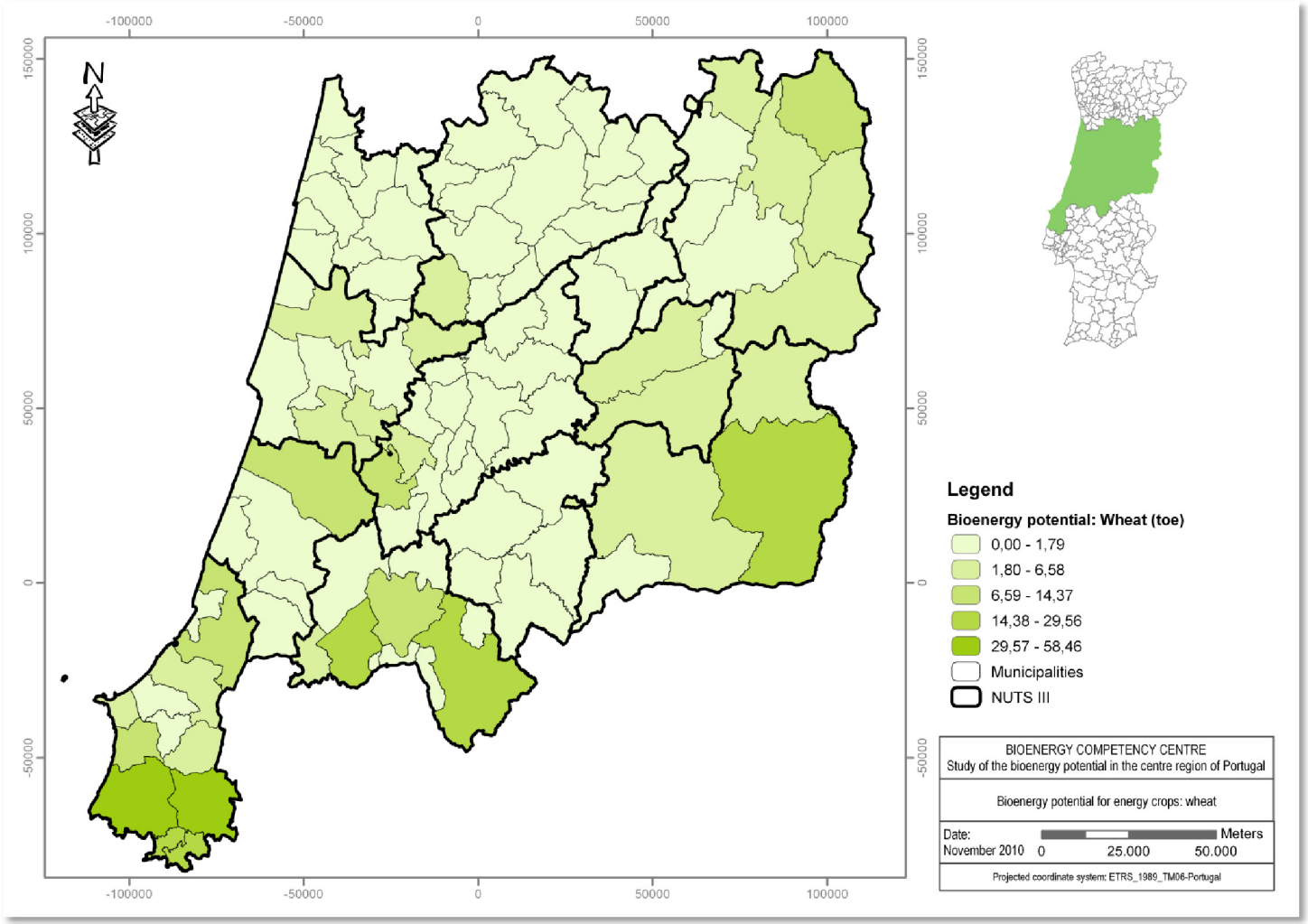


Figure A5.2: Map for the bioenergy potential for wheat energy crops.

Table A5.3: Bioenergy potential for amylaceous barley energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Albergaria-a-Velha | 0,70 | 0,09 | 1.167 | 0,11 | 216 | 23,47 | **0,01** |
| | Anadia | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Aveiro | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Estarreja | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Ílhavo | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Mealhada | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Murtosa | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Oliveira do Bairro | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Ovar | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Sever do Vouga | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Vagos | 27,00 | 3,59 | 1.167 | 4,19 | 216 | 905,19 | **0,45** |
| ***Baixo Mondego*** | Cantanhede | 1,28 | 0,17 | 1.167 | 0,20 | 216 | 42,91 | **0,02** |
| | Coimbra | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Condeixa-a-Nova | 5,05 | 0,67 | 1.167 | 0,78 | 216 | 169,30 | **0,08** |
| | Figueira da Foz | 3,94 | 0,52 | 1.167 | 0,61 | 216 | 132,09 | **0,07** |
| | Mira | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Montemor-o-Velho | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Penacova | 1,22 | 0,16 | 1.167 | 0,19 | 216 | 40,90 | **0,02** |
| | Soure | 4,23 | 0,56 | 1.167 | 0,66 | 216 | 141,81 | **0,07** |
| ***Pinhal Litoral*** | Batalha | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Leiria | 1,30 | 0,17 | 1.167 | 0,20 | 216 | 43,58 | **0,02** |
| | Marinha Grande | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Pombal | 15,38 | 2,05 | 1.167 | 2,39 | 216 | 515,62 | **0,26** |
| | Porto de Mós | 1,60 | 0,21 | 1.167 | 0,25 | 216 | 53,64 | **0,03** |
| ***Pinhal Interior Norte*** | Arganil | 3,58 | 0,48 | 1.167 | 0,56 | 216 | 120,02 | **0,06** |
| | Góis | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Lousã | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Miranda do Corvo | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Oliveira do Hospital | 3,24 | 0,43 | 1.167 | 0,50 | 216 | 108,62 | **0,05** |
| | Pampilhosa da Serra | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Penela | 0,72 | 0,10 | 1.167 | 0,11 | 216 | 24,14 | **0,01** |
| | Tábua | 2,24 | 0,30 | 1.167 | 0,35 | 216 | 75,10 | **0,04** |
| | Vila Nova de Poiares | 1,20 | 0,16 | 1.167 | 0,19 | 216 | 40,23 | **0,02** |
| | Alvaiázere | 4,26 | 0,57 | 1.167 | 0,66 | 216 | 142,82 | **0,07** |
| | Ansião | 11,48 | 1,53 | 1.167 | 1,78 | 216 | 384,87 | **0,19** |
| | Castanheira de Pêra | 0,00 | 0,00 | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | … | … | 1.167 | 0,00 | 216 | 0,00 | **0,00** |
| | Pedrógão Grande | 0,53 | 0,07 | 1.167 | 0,08 | 216 | 17,77 | **0,01** |
| ***Dão Lafões*** | Aguiar da Beira | 6,87 | 0,91 | | 1,07 | 1.167 | 230,32 | **0,12** |
| | Carregal do Sal | 0,54 | 0,07 | | 0,08 | 1.167 | 18,10 | **0,01** |
| | Castro Daire | … | … | | 0,00 | 1.167 | 0,00 | **0,00** |
| | Mangualde | 14,26 | 1,90 | | 2,21 | 1.167 | 478,07 | **0,24** |
| | Mortágua | 0,93 | 0,12 | | 0,14 | 1.167 | 31,18 | **0,02** |
| | Nelas | 2,19 | 0,29 | | 0,34 | 1.167 | 73,42 | **0,04** |
| | Oliveira de Frades | 0,00 | 0,00 | | 0,00 | 1.167 | 0,00 | **0,00** |
| | Penalva do Castelo | 1,25 | 0,17 | | 0,19 | 1.167 | 41,91 | **0,02** |
| | Santa Comba Dão | … | … | | 0,00 | 1.167 | 0,00 | **0,00** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | … | … | | 0,00 | 1.167 | 0,00 | **0,00** |
| | Sátão | 2,00 | 0,27 | | 0,31 | 1.167 | 67,05 | **0,03** |
| | Tondela | 0,28 | 0,04 | | 0,04 | 1.167 | 9,39 | **0,00** |
| | Vila Nova de Paiva | 5,28 | 0,70 | | 0,82 | 1.167 | 177,02 | **0,09** |
| | Viseu | 0,62 | 0,08 | | 0,10 | 1.167 | 20,79 | **0,01** |
| | Vouzela | 0,59 | 0,08 | | 0,09 | 1.167 | 19,78 | **0,01** |
| ***Pinhal Interior Sul*** | Oleiros | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| | Proença-a-Nova | 9,45 | 1,26 | | 0,93 | 739 | 200,62 | **0,10** |
| | Sertã | 2,63 | 0,35 | | 0,26 | 739 | 55,83 | **0,03** |
| | Vila de Rei | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| | Mação | 3,83 | 0,51 | | 0,38 | 739 | 81,31 | **0,04** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 0,00 | | 0,00 | 739 | 0,00 | **0,00** |
| | Gouveia | 12,28 | 1,63 | | 1,21 | 739 | 260,70 | **0,13** |
| | Seia | 0,69 | 0,09 | | 0,07 | 739 | 14,65 | **0,01** |
| ***Beira Interior Norte*** | Almeida | 1,79 | 0,24 | | 0,18 | 739 | 38,00 | **0,02** |
| | Celorico da Beira | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| | Fig. Castelo Rodrigo | 28,96 | 3,85 | | 2,85 | 739 | 614,82 | **0,31** |
| | Guarda | 5,18 | 0,69 | | 0,51 | 739 | 109,97 | **0,06** |
| | Manteigas | 0,00 | 0,00 | | 0,00 | 739 | 0,00 | **0,00** |
| | Meda | 18,48 | 2,46 | | 1,82 | 739 | 392,33 | **0,20** |
| | Pinhel | 4,08 | 0,54 | | 0,40 | 739 | 86,62 | **0,04** |
| | Sabugal | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| | Trancoso | 5,50 | 0,73 | | 0,54 | 739 | 116,76 | **0,06** |
| ***Beira Interior Sul*** | Castelo Branco | 10,51 | 1,40 | | 1,03 | 739 | 223,13 | **0,11** |
| | Idanha-a-Nova | 7,87 | 1,05 | | 0,77 | 739 | 167,08 | **0,08** |
| | Penamacor | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| | Vila Velha de Ródão | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| ***Cova Beira*** | Belmonte | … | … | | 0,00 | 739 | 0,00 | **0,00** |
| | Covilhã | 2,34 | 0,31 | | 0,23 | 739 | 49,68 | **0,02** |
| | Fundão | 4,12 | 0,55 | | 0,40 | 739 | 87,47 | **0,04** |
| ***Oeste*** | Alcobaça | 29,35 | 3,90 | 1.704 | 6,65 | 216 | 1.436,76 | 0,72 |
| | Bombarral | … | … | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Caldas da Rainha | 2,04 | 0,27 | 1.704 | 0,46 | 216 | 99,86 | 0,05 |
| | Nazaré | 0,00 | 0,00 | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Óbidos | 24,65 | 3,28 | 1.704 | 5,59 | 216 | 1.206,68 | 0,61 |
| | Peniche | 137,19 | 18,25 | 1.704 | 31,09 | 216 | 6.715,80 | 3,37 |
| | Alenquer | 180,76 | 24,04 | 1.704 | 40,97 | 216 | 8.848,66 | 4,44 |
| | Arruda dos Vinhos | 209,60 | 27,88 | 1.704 | 47,50 | 216 | 10.260,45 | 5,15 |
| | Cadaval | … | … | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Lourinhã | 143,74 | 19,12 | 1.704 | 32,58 | 216 | 7.036,43 | 3,53 |
| | Sobral de Monte Agraço | 57,56 | 7,66 | 1.704 | 13,04 | 216 | 2.817,71 | 1,41 |
| | Torres Vedras | 440,30 | 58,56 | 1.704 | 99,79 | 216 | 21.553,79 | 10,81 |
| ***Médio Tejo*** | Abrantes | … | … | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Alcanena | 4,39 | 0,58 | 1.704 | 0,99 | 216 | 214,90 | 0,11 |
| | Constância | 0,00 | 0,00 | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Entroncamento | 0,00 | 0,00 | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Ferreira do Zêzere | 1,46 | 0,19 | 1.704 | 0,33 | 216 | 71,47 | 0,04 |
| | Sardoal | … | … | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Tomar | 6,73 | 0,90 | 1.704 | 1,53 | 216 | 329,45 | 0,17 |
| | Torres Novas | 10,58 | 1,41 | 1.704 | 2,40 | 216 | 517,92 | 0,26 |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 1.704 | 0,00 | 216 | 0,00 | 0,00 |
| | Ourém | 3,72 | 0,49 | 1.704 | 0,84 | 216 | 182,10 | 0,09 |
| | **Total** | **1.493,54** | **198,64** | **-** | **314,54** | **-** | **67.940,08** | **34,08** |

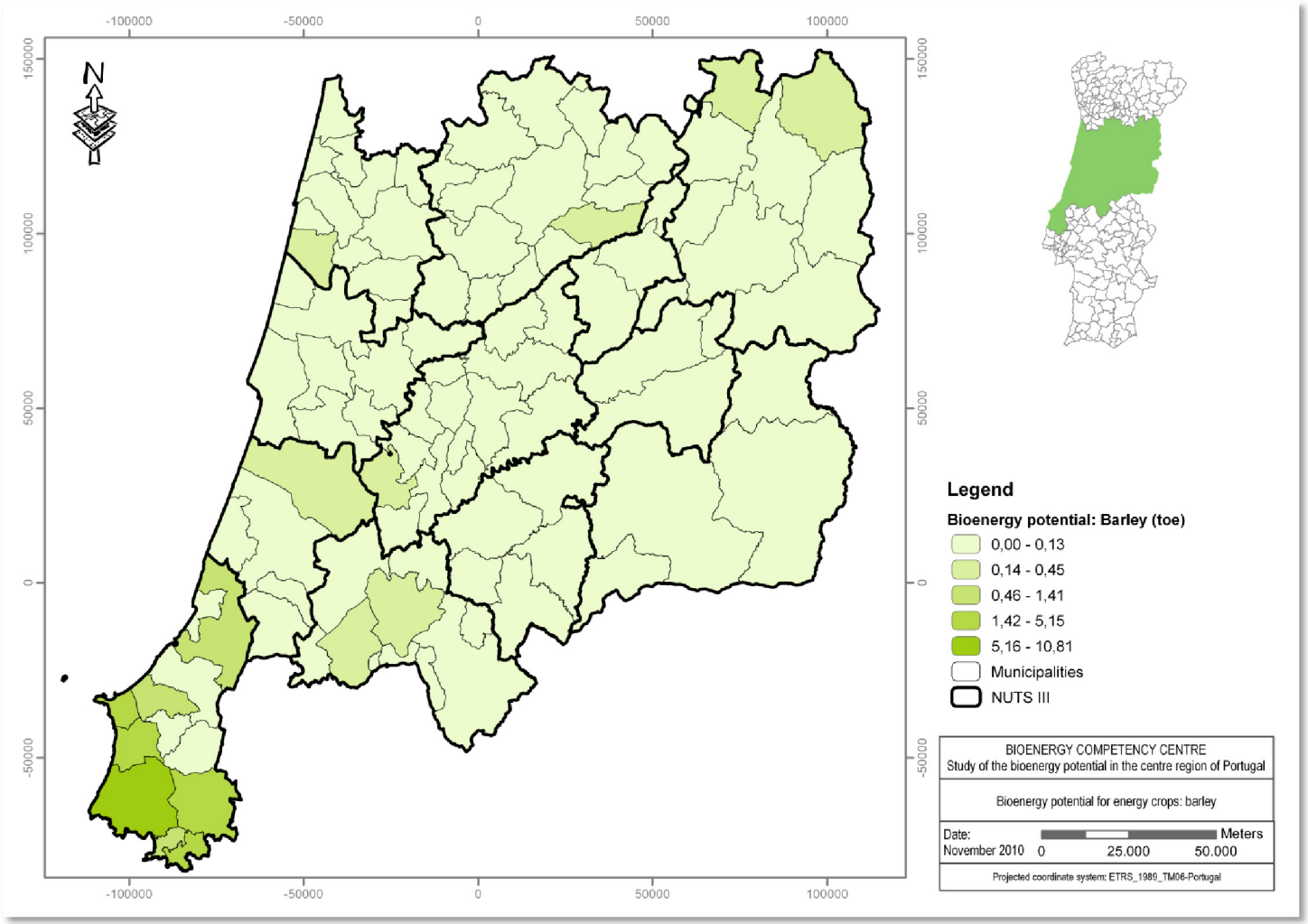


Figure A5.3: Map for the bioenergy potential for barley energy crops.

Table A5.4: Bioenergy potential for amylaceous rye energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 8,07 | 1,07 | 924 | 0,99 | 216 | 214,22 | **0,11** |
| | Albergaria-a-Velha | 7,50 | 1,00 | 924 | 0,92 | 216 | 199,09 | **0,10** |
| | Anadia | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Aveiro | 8,53 | 1,13 | 924 | 1,05 | 216 | 226,43 | **0,11** |
| | Estarreja | 0,99 | 0,13 | 924 | 0,12 | 216 | 26,28 | **0,01** |
| | Ílhavo | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Mealhada | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Murtosa | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Oliveira do Bairro | 13,17 | 1,75 | 924 | 1,62 | 216 | 349,59 | **0,18** |
| | Ovar | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Sever do Vouga | 1,90 | 0,25 | 924 | 0,23 | 216 | 50,43 | **0,03** |
| | Vagos | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 4,57 | 0,61 | 924 | 0,56 | 216 | 121,31 | **0,06** |
| | Coimbra | 1,10 | 0,15 | 924 | 0,14 | 216 | 29,20 | **0,01** |
| | Condeixa-a-Nova | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Figueira da Foz | 2,85 | 0,38 | 924 | 0,35 | 216 | 75,65 | **0,04** |
| | Mira | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Montemor-o-Velho | 3,24 | 0,43 | 924 | 0,40 | 216 | 86,00 | **0,04** |
| | Penacova | 13,48 | 1,79 | 924 | 1,66 | 216 | 357,82 | **0,18** |
| | Soure | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Leiria | 4,47 | 0,59 | 924 | 0,55 | 216 | 118,65 | **0,06** |
| | Marinha Grande | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Pombal | 2,75 | 0,37 | 924 | 0,34 | 216 | 73,00 | **0,04** |
| | Porto de Mós | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 15,31 | 2,04 | 924 | 1,88 | 216 | 406,40 | **0,20** |
| | Góis | 0,64 | 0,09 | 924 | 0,08 | 216 | 16,99 | **0,01** |
| | Lousã | 0,20 | 0,03 | 924 | 0,02 | 216 | 5,31 | **0,00** |
| | Miranda do Corvo | 0,15 | 0,02 | 924 | 0,02 | 216 | 3,98 | **0,00** |
| | Oliveira do Hospital | 49,63 | 6,60 | 924 | 6,10 | 216 | 1.317,41 | **0,66** |
| | Pampilhosa da Serra | … | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Penela | 2,25 | 0,30 | 924 | 0,28 | 216 | 59,73 | **0,03** |
| | Tábua | 13,43 | 1,79 | 924 | 1,65 | 216 | 356,49 | **0,18** |
| | Vila Nova de Poiares | 6,57 | 0,87 | 924 | 0,81 | 216 | 174,40 | **0,09** |
| | Alvaiázere | 0,31 | 0,04 | 924 | 0,04 | 216 | 8,23 | **0,00** |
| | Ansião | 0,19 | 0,03 | 924 | 0,02 | 216 | 5,04 | **0,00** |
| | Castanheira de Pêra | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | 2,36 | 0,31 | 924 | 0,29 | 216 | 62,65 | **0,03** |
| | Pedrógão Grande | 3,34 | 0,44 | 924 | 0,41 | 216 | 88,66 | **0,04** |
| ***Dão Lafões*** | Aguiar da Beira | 423,47 | 56,32 | 924 | 52,04 | 216 | 11.240,87 | **5,64** |
| | Carregal do Sal | 12,91 | 1,72 | 924 | 1,59 | 216 | 342,69 | **0,17** |
| | Castro Daire | 285,06 | 37,91 | 924 | 35,03 | 216 | 7.566,82 | **3,80** |
| | Mangualde | 92,50 | 12,30 | 924 | 11,37 | 216 | 2.455,38 | **1,23** |
| | Mortágua | 9,08 | 1,21 | 924 | 1,12 | 216 | 241,03 | **0,12** |
| | Nelas | 11,50 | 1,53 | 924 | 1,41 | 216 | 305,26 | **0,15** |
| | Oliveira de Frades | 11,94 | 1,59 | 924 | 1,47 | 216 | 316,94 | **0,16** |
| | Penalva do Castelo | 117,50 | 15,63 | 924 | 14,44 | 216 | 3.119,00 | **1,56** |
| | Santa Comba Dão | 13,01 | 1,73 | 924 | 1,60 | 216 | 345,35 | **0,17** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 59,89 | 7,97 | 924 | 7,36 | 216 | 1.589,76 | **0,80** |
| | Sátão | 325,75 | 43,32 | 924 | 40,03 | 216 | 8.646,93 | **4,34** |
| | Tondela | 50,34 | 6,70 | 924 | 6,19 | 216 | 1.336,26 | **0,67** |
| | Vila Nova de Paiva | 349,26 | 46,45 | 924 | 42,92 | 216 | 9.270,99 | **4,65** |
| | Viseu | 198,09 | 26,35 | 924 | 24,34 | 216 | 5.258,23 | **2,64** |
| | Vouzela | 56,63 | 7,53 | 924 | 6,96 | 216 | 1.503,22 | **0,75** |
| ***Pinhal Interior Sul*** | Oleiros | 2,58 | 0,34 | 924 | 0,32 | 216 | 68,49 | **0,03** |
| | Proença-a-Nova | 110,34 | 14,68 | 924 | 13,56 | 216 | 2.928,94 | **1,47** |
| | Sertã | 13,84 | 1,84 | 924 | 1,70 | 216 | 367,38 | **0,18** |
| | Vila de Rei | 5,51 | 0,73 | 924 | 0,68 | 216 | 146,26 | **0,07** |
| | Mação | 14,87 | 1,98 | 924 | 1,83 | 216 | 394,72 | **0,20** |
| ***Serra Estrela*** | Fornos de Algodres | 274,30 | 36,48 | 924 | 33,71 | 216 | 7.281,20 | **3,65** |
| | Gouveia | 438,13 | 58,27 | 924 | 53,84 | 216 | 11.630,02 | **5,83** |
| | Seia | 71,79 | 9,55 | 924 | 8,82 | 216 | 1.905,64 | **0,96** |
| ***Beira Interior Norte*** | Almeida | 589,13 | 78,35 | 924 | 72,40 | 216 | 15.638,26 | **7,84** |
| | Celorico da Beira | 1.367,38 | 181,86 | 924 | 168,04 | 216 | 36.296,65 | **18,21** |
| | Fig. Castelo Rodrigo | 603,87 | 80,31 | 924 | 74,21 | 216 | 16.029,53 | **8,04** |
| | Guarda | 2.774,95 | 369,07 | 924 | 341,02 | 216 | 73.660,14 | **36,95** |
| | Manteigas | 69,81 | 9,28 | 924 | 8,58 | 216 | 1.853,08 | **0,93** |
| | Meda | 953,67 | 126,84 | 924 | 117,20 | 216 | 25.314,86 | **12,70** |
| | Pinhel | 1.354,41 | 180,14 | 924 | 166,45 | 216 | 35.952,37 | **18,03** |
| | Sabugal | 2.045,79 | 272,09 | 924 | 251,41 | 216 | 54.304,82 | **27,24** |
| | Trancoso | 1.027,35 | 136,64 | 924 | 126,25 | 216 | 27.270,67 | **13,68** |
| ***Beira Interior Sul*** | Castelo Branco | 249,15 | 33,14 | 924 | 30,62 | 216 | 6.613,61 | **3,32** |
| | Idanha-a-Nova | 718,10 | 95,51 | 924 | 88,25 | 216 | 19.061,73 | **9,56** |
| | Penamacor | 350,11 | 46,56 | 924 | 43,03 | 216 | 9.293,56 | **4,66** |
| | Vila Velha de Ródão | 2,86 | 0,38 | 924 | 0,35 | 216 | 75,92 | **0,04** |
| ***Cova Beira*** | Belmonte | 1.079,50 | 143,57 | 924 | 132,66 | 216 | 28.654,97 | **14,37** |
| | Covilhã | 1.383,38 | 183,99 | 924 | 170,01 | 216 | 36.721,37 | **18,42** |
| | Fundão | 683,27 | 90,87 | 924 | 83,97 | 216 | 18.137,18 | **9,10** |
| ***Oeste*** | Alcobaça | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Bombarral | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Caldas da Rainha | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Nazaré | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Óbidos | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Peniche | 1,50 | 0,20 | 924 | 0,18 | 216 | 39,82 | **0,02** |
| | Alenquer | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Cadaval | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Lourinhã | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Torres Vedras | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| ***Médio Tejo*** | Abrantes | 5,65 | 0,75 | 924 | 0,69 | 216 | 149,98 | **0,08** |
| | Alcanena | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Constância | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Ferreira do Zêzere | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Sardoal | 0,63 | 0,08 | 924 | 0,08 | 216 | 16,72 | **0,01** |
| | Tomar | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Torres Novas | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | Ourém | … | … | 924 | 0,00 | 216 | 0,00 | **0,00** |
| | **Total** | **18.375,80** | **2.443,98** | **-** | **2.258,24** | **-** | **487.779,58** | **244,66** |

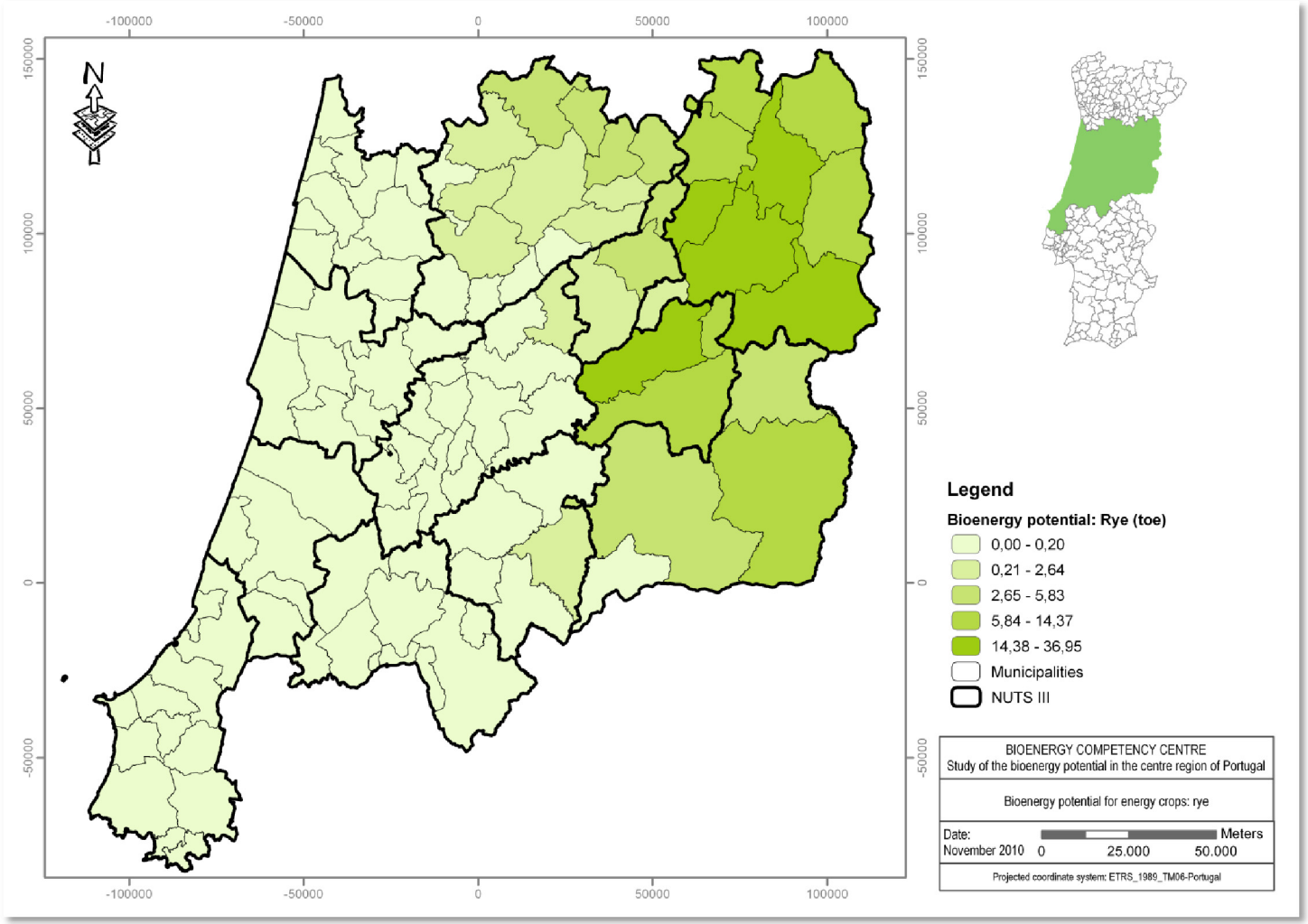


Figure A5.4: Map for the bioenergy potential for rye energy crops.

Table A5. 5: Bioenergy potential for amylaceous sorghum energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,67 | 0,09 | 2.777 | 0,25 | 388 | 96,01 | **0,05** |
| | Albergaria-a-Velha | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Anadia | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Aveiro | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Estarreja | 1,24 | 0,16 | 2.777 | 0,46 | 388 | 177,70 | **0,09** |
| | Ílhavo | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Mealhada | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Murtosa | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Oliveira do Bairro | 1,76 | 0,23 | 2.777 | 0,65 | 388 | 252,22 | **0,13** |
| | Ovar | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Sever do Vouga | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Vagos | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 10,14 | 1,35 | 2.777 | 3,75 | 388 | 1.453,11 | **0,73** |
| | Coimbra | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Condeixa-a-Nova | 5,99 | 0,80 | 2.777 | 2,21 | 388 | 858,39 | **0,43** |
| | Figueira da Foz | 6,68 | 0,89 | 2.777 | 2,47 | 388 | 957,27 | **0,48** |
| | Mira | 3,01 | 0,40 | 2.777 | 1,11 | 388 | 431,35 | **0,22** |
| | Montemor-o-Velho | 5,67 | 0,75 | 2.777 | 2,09 | 388 | 812,54 | **0,41** |
| | Penacova | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Soure | 8,33 | 1,11 | 2.777 | 3,08 | 388 | 1.193,72 | **0,60** |
| ***Pinhal Litoral*** | Batalha | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Leiria | 11,85 | 1,58 | 2.777 | 4,38 | 388 | 1.698,16 | **0,85** |
| | Marinha Grande | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Pombal | 5,87 | 0,78 | 2.777 | 2,17 | 388 | 841,20 | **0,42** |
| | Porto de Mós | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Góis | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Lousã | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Miranda do Corvo | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Oliveira do Hospital | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Penela | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Tábua | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Alvaiázere | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Ansião | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Castanheira de Pêra | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Pedrógão Grande | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Carregal do Sal | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Castro Daire | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Mangualde | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Mortágua | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Nelas | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Oliveira de Frades | … | 0,00 | 2.777 | 1,53 | 388 | 594,71 | **0,30** |
| | Penalva do Castelo | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Santa Comba Dão | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Sátão | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Tondela | … | … | 2.777 | 5,28 | 388 | 2.049,25 | **1,03** |
| | Vila Nova de Paiva | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Viseu | 0,00 | 0,00 | 2.777 | 0,11 | 388 | 42,99 | **0,02** |
| | Vouzela | 0,00 | 0,00 | 2.777 | 2,57 | 388 | 998,83 | **0,50** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 0,00 | 2.777 | 1,77 | 388 | 687,86 | **0,35** |
| | Proença-a-Nova | … | … | 2.777 | 0,30 | 388 | 117,51 | **0,06** |
| | Sertã | … | … | 2.777 | 9,46 | 388 | 3.671,46 | **1,84** |
| | Vila de Rei | … | … | 2.777 | 18,29 | 388 | 7.097,86 | **3,56** |
| | Mação | 0,00 | 0,00 | 2.777 | 2,36 | 388 | 917,15 | **0,46** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Gouveia | 4,15 | 0,55 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Seia | … | … | 2.777 | 2,19 | 388 | 851,23 | **0,43** |
| ***Beira Interior Norte*** | Almeida | … | … | 2.777 | 5,18 | 388 | 2.009,13 | **1,01** |
| | Celorico da Beira | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Fig. Castelo Rodrigo | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Guarda | 14,30 | 1,90 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Manteigas | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Meda | 0,30 | 0,04 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Pinhel | 6,97 | 0,93 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Sabugal | 4,80 | 0,64 | 2.777 | 1,53 | 388 | 594,71 | **0,30** |
| | Trancoso | 0,82 | 0,11 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| ***Beira Interior Sul*** | Castelo Branco | 25,62 | 3,41 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Idanha-a-Nova | 49,53 | 6,59 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Penamacor | 6,40 | 0,85 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Vila Velha de Ródão | 0,00 | 0,00 | 2.777 | 5,28 | 388 | 2.049,25 | **1,03** |
| ***Cova Beira*** | Belmonte | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Covilhã | 5,94 | 0,79 | 2.777 | 0,11 | 388 | 42,99 | **0,02** |
| | Fundão | 14,02 | 1,86 | 2.777 | 2,57 | 388 | 998,83 | **0,50** |
| ***Oeste*** | Alcobaça | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Bombarral | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Caldas da Rainha | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Nazaré | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Óbidos | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Peniche | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Alenquer | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Arruda dos Vinhos | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Cadaval | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Lourinhã | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Torres Vedras | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| ***Médio Tejo*** | Abrantes | 39,00 | 5,19 | 2.777 | 14,40 | 388 | 5.588,87 | **2,80** |
| | Alcanena | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Constância | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Sardoal | … | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Tomar | 44,11 | 5,87 | 2.777 | 16,29 | 388 | 6.321,15 | **3,17** |
| | Torres Novas | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | Ourém | … | … | 2.777 | 0,00 | 388 | 0,00 | **0,00** |
| | **Total** | **277,17** | **36,86** | **-** | **102,37** | **-** | **39.719,66** | **19,92** |

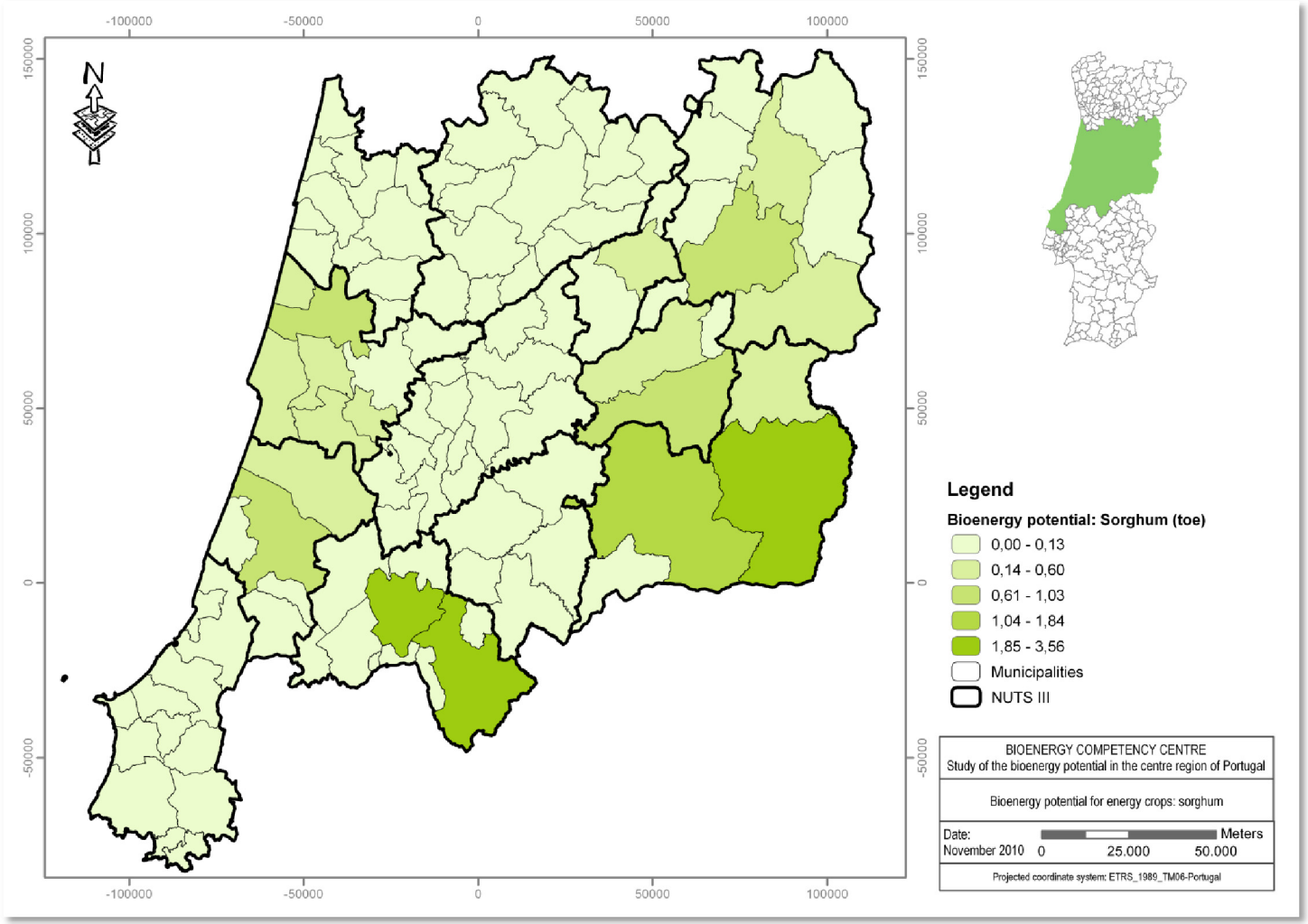


Figure A5.5: Map for the bioenergy potential for sorghum energy crops.

Table A5.6: Bioenergy potential for amylaceous potato energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 199,26 | 26,50 | 17.836 | 472,68 | 118 | 55.776,50 | **27,98** |
| | Albergaria-a-Velha | 113,33 | 15,07 | 17.836 | 268,84 | 118 | 31.723,13 | **15,91** |
| | Anadia | 488,64 | 64,99 | 17.836 | 1.159,15 | 118 | 136.779,22 | **68,61** |
| | Aveiro | 157,63 | 20,96 | 17.836 | 373,93 | 118 | 44.123,50 | **22,13** |
| | Estarreja | 64,06 | 8,52 | 17.836 | 151,96 | 118 | 17.931,56 | **8,99** |
| | Ílhavo | 70,83 | 9,42 | 17.836 | 168,02 | 118 | 19.826,60 | **9,94** |
| | Mealhada | 125,03 | 16,63 | 17.836 | 296,59 | 118 | 34.998,17 | **17,55** |
| | Murtosa | 15,87 | 2,11 | 17.836 | 37,65 | 118 | 4.442,30 | **2,23** |
| | Oliveira do Bairro | 283,58 | 37,72 | 17.836 | 672,71 | 118 | 79.379,20 | **39,82** |
| | Ovar | 40,58 | 5,40 | 17.836 | 96,26 | 118 | 11.359,08 | **5,70** |
| | Sever do Vouga | 38,29 | 5,09 | 17.836 | 90,83 | 118 | 10.718,07 | **5,38** |
| | Vagos | 660,04 | 87,79 | 17.836 | 1.565,74 | 118 | 184.757,20 | **92,67** |
| ***Baixo Mondego*** | Cantanhede | 854,31 | 113,62 | 17.836 | 2.026,58 | 118 | 239.136,90 | **119,95** |
| | Coimbra | 113,68 | 15,12 | 17.836 | 269,67 | 118 | 31.821,10 | **15,96** |
| | Condeixa-a-Nova | 67,64 | 9,00 | 17.836 | 160,45 | 118 | 18.933,67 | **9,50** |
| | Figueira da Foz | 153,74 | 20,45 | 17.836 | 364,70 | 118 | 43.034,62 | **21,59** |
| | Mira | 398,88 | 53,05 | 17.836 | 946,22 | 118 | 111.653,77 | **56,00** |
| | Montemor-o-Velho | 104,36 | 13,88 | 17.836 | 247,56 | 118 | 29.212,26 | **14,65** |
| | Penacova | 155,86 | 20,73 | 17.836 | 369,73 | 118 | 43.628,05 | **21,88** |
| | Soure | 98,20 | 13,06 | 17.836 | 232,95 | 118 | 27.487,97 | **13,79** |
| ***Pinhal Litoral*** | Batalha | 68,13 | 9,06 | 17.836 | 161,62 | 118 | 19.070,83 | **9,57** |
| | Leiria | 141,69 | 18,84 | 17.836 | 336,12 | 118 | 39.661,61 | **19,89** |
| | Marinha Grande | 8,28 | 1,10 | 17.836 | 19,64 | 118 | 2.317,72 | **1,16** |
| | Pombal | 109,84 | 14,61 | 17.836 | 260,56 | 118 | 30.746,21 | **15,42** |
| | Porto de Mós | 30,92 | 4,11 | 17.836 | 73,35 | 118 | 8.655,07 | **4,34** |
| ***Pinhal Interior Norte*** | Arganil | 128,43 | 17,08 | 17.836 | 304,66 | 118 | 35.949,89 | **18,03** |
| | Góis | 25,89 | 3,44 | 17.836 | 61,42 | 118 | 7.247,08 | **3,64** |
| | Lousã | 42,97 | 5,72 | 17.836 | 101,93 | 118 | 12.028,08 | **6,03** |
| | Miranda do Corvo | 43,09 | 5,73 | 17.836 | 102,22 | 118 | 12.061,67 | **6,05** |
| | Oliveira do Hospital | 542,71 | 72,18 | 17.836 | 1.287,41 | 118 | 151.914,40 | **76,20** |
| | Pampilhosa da Serra | 24,13 | 3,21 | 17.836 | 57,24 | 118 | 6.754,43 | **3,39** |
| | Penela | 30,10 | 4,00 | 17.836 | 71,40 | 118 | 8.425,54 | **4,23** |
| | Tábua | 206,68 | 27,49 | 17.836 | 490,28 | 118 | 57.853,49 | **29,02** |
| | Vila Nova de Poiares | 51,56 | 6,86 | 17.836 | 122,31 | 118 | 14.432,58 | **7,24** |
| | Alvaiázere | 18,25 | 2,43 | 17.836 | 43,29 | 118 | 5.108,51 | **2,56** |
| | Ansião | 41,68 | 5,54 | 17.836 | 98,87 | 118 | 11.666,99 | **5,85** |
| | Castanheira de Pêra | 8,03 | 1,07 | 17.836 | 19,05 | 118 | 2.247,74 | **1,13** |
| | Figueiró dos Vinhos | 65,68 | 8,74 | 17.836 | 155,81 | 118 | 18.385,03 | **9,22** |
| | Pedrógão Grande | 8,08 | 1,07 | 17.836 | 19,17 | 118 | 2.261,74 | **1,13** |
| ***Dão Lafões*** | Aguiar da Beira | 619,80 | 82,43 | 17.836 | 1.470,28 | 118 | 173.493,29 | **87,02** |
| | Carregal do Sal | 155,44 | 20,67 | 17.836 | 368,73 | 118 | 43.510,48 | **21,82** |
| | Castro Daire | 394,28 | 52,44 | 17.836 | 935,31 | 118 | 110.366,14 | **55,36** |
| | Mangualde | 486,80 | 64,74 | 17.836 | 1.154,78 | 118 | 136.264,17 | **68,35** |
| | Mortágua | 168,08 | 22,35 | 17.836 | 398,72 | 118 | 47.048,65 | **23,60** |
| | Nelas | 220,47 | 29,32 | 17.836 | 523,00 | 118 | 61.713,56 | **30,95** |
| | Oliveira de Frades | 46,61 | 6,20 | 17.836 | 110,57 | 118 | 13.046,99 | **6,54** |
| | Penalva do Castelo | 439,81 | 58,49 | 17.836 | 1.043,31 | 118 | 123.110,82 | **61,75** |
| | Santa Comba Dão | 110,62 | 14,71 | 17.836 | 262,41 | 118 | 30.964,55 | **15,53** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 67,36 | 8,96 | 17.836 | 159,79 | 118 | 18.855,29 | **9,46** |
| | Sátão | 245,19 | 32,61 | 17.836 | 581,64 | 118 | 68.633,14 | **34,43** |
| | Tondela | 350,47 | 46,61 | 17.836 | 831,38 | 118 | 98.102,93 | **49,21** |
| | Vila Nova de Paiva | 137,81 | 18,33 | 17.836 | 326,91 | 118 | 38.575,52 | **19,35** |
| | Viseu | 609,88 | 81,11 | 17.836 | 1.446,75 | 118 | 170.716,50 | **85,63** |
| | Vouzela | 124,42 | 16,55 | 17.836 | 295,15 | 118 | 34.827,42 | **17,47** |
| ***Pinhal Interior Sul*** | Oleiros | 39,82 | 5,30 | 10.917 | 57,82 | 118 | 6.822,42 | **3,42** |
| | Proença-a-Nova | 6,47 | 0,86 | 10.917 | 9,39 | 118 | 1.108,51 | **0,56** |
| | Sertã | 28,50 | 3,79 | 10.917 | 41,38 | 118 | 4.882,94 | **2,45** |
| | Vila de Rei | 2,17 | 0,29 | 10.917 | 3,15 | 118 | 371,79 | **0,19** |
| | Mação | 6,24 | 0,83 | 10.917 | 9,06 | 118 | 1.069,11 | **0,54** |
| ***Serra Estrela*** | Fornos de Algodres | 240,44 | 31,98 | 10.917 | 349,11 | 118 | 41.194,92 | **20,66** |
| | Gouveia | 94,97 | 12,63 | 10.917 | 137,89 | 118 | 16.271,34 | **8,16** |
| | Seia | 285,98 | 38,04 | 10.917 | 415,23 | 118 | 48.997,35 | **24,58** |
| ***Beira Interior Norte*** | Almeida | 189,60 | 25,22 | 10.917 | 275,29 | 118 | 32.484,43 | **16,29** |
| | Celorico da Beira | 225,64 | 30,01 | 10.917 | 327,62 | 118 | 38.659,22 | **19,39** |
| | Fig. Castelo Rodrigo | 110,52 | 14,70 | 10.917 | 160,47 | 118 | 18.935,55 | **9,50** |
| | Guarda | 786,39 | 104,59 | 10.917 | 1.141,81 | 118 | 134.733,30 | **67,58** |
| | Manteigas | 23,62 | 3,14 | 10.917 | 34,30 | 118 | 4.046,85 | **2,03** |
| | Meda | 282,51 | 37,57 | 10.917 | 410,19 | 118 | 48.402,83 | **24,28** |
| | Pinhel | 599,93 | 79,79 | 10.917 | 871,07 | 118 | 102.786,85 | **51,56** |
| | Sabugal | 375,29 | 49,91 | 10.917 | 544,91 | 118 | 64.298,96 | **32,25** |
| | Trancoso | 582,13 | 77,42 | 10.917 | 845,23 | 118 | 99.737,15 | **50,03** |
| ***Beira Interior Sul*** | Castelo Branco | 28,87 | 3,84 | 10.917 | 41,92 | 118 | 4.946,34 | **2,48** |
| | Idanha-a-Nova | 11,26 | 1,50 | 10.917 | 16,35 | 118 | 1.929,19 | **0,97** |
| | Penamacor | 29,77 | 3,96 | 10.917 | 43,22 | 118 | 5.100,54 | **2,56** |
| | Vila Velha de Ródão | 2,94 | 0,39 | 10.917 | 4,27 | 118 | 503,71 | **0,25** |
| ***Cova Beira*** | Belmonte | 99,69 | 13,26 | 10.917 | 144,75 | 118 | 17.080,03 | **8,57** |
| | Covilhã | 139,03 | 18,49 | 10.917 | 201,87 | 118 | 23.820,20 | **11,95** |
| | Fundão | 79,02 | 10,51 | 10.917 | 114,73 | 118 | 13.538,61 | **6,79** |
| ***Oeste*** | Alcobaça | 617,71 | 82,16 | 15.103 | 1.240,79 | 118 | 146.413,63 | **73,44** |
| | Bombarral | 196,29 | 26,11 | 15.103 | 394,29 | 118 | 46.525,93 | **23,34** |
| | Caldas da Rainha | 290,24 | 38,60 | 15.103 | 583,00 | 118 | 68.794,57 | **34,51** |
| | Nazaré | 94,32 | 12,54 | 15.103 | 189,46 | 118 | 22.356,34 | **11,21** |
| | Óbidos | 315,75 | 41,99 | 15.103 | 634,25 | 118 | 74.841,11 | **37,54** |
| | Peniche | 238,65 | 31,74 | 15.103 | 479,38 | 118 | 56.566,37 | **28,37** |
| | Alenquer | 286,72 | 38,13 | 15.103 | 575,93 | 118 | 67.960,23 | **34,09** |
| | Arruda dos Vinhos | 24,18 | 3,22 | 15.103 | 48,57 | 118 | 5.731,30 | **2,87** |
| | Cadaval | 135,57 | 18,03 | 15.103 | 272,32 | 118 | 32.133,68 | **16,12** |
| | Lourinhã | 2.121,81 | 282,20 | 15.103 | 4.262,08 | 118 | 502.925,16 | **252,26** |
| | Sobral de Monte Agraço | 86,43 | 11,50 | 15.103 | 173,61 | 118 | 20.486,20 | **10,28** |
| | Torres Vedras | 1.140,02 | 151,62 | 15.103 | 2.289,96 | 118 | 270.214,93 | **135,54** |
| ***Médio Tejo*** | Abrantes | 58,31 | 7,76 | 15.103 | 117,13 | 118 | 13.821,01 | **6,93** |
| | Alcanena | 2,85 | 0,38 | 15.103 | 5,72 | 118 | 675,53 | **0,34** |
| | Constância | ... | … | 15.103 | 0,00 | 118 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | 15.103 | 0,00 | 118 | 0,00 | **0,00** |
| | Ferreira do Zêzere | 7,69 | 1,02 | 15.103 | 15,45 | 118 | 1.822,73 | **0,91** |
| | Sardoal | 7,88 | 1,05 | 15.103 | 15,83 | 118 | 1.867,77 | **0,94** |
| | Tomar | 8,99 | 1,20 | 15.103 | 18,06 | 118 | 2.130,87 | **1,07** |
| | Torres Novas | 2,96 | 0,39 | 15.103 | 5,95 | 118 | 701,60 | **0,35** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 15.103 | 0,00 | 118 | 0,00 | **0,00** |
| | Ourém | 11,93 | 1,59 | 15.103 | 23,96 | 118 | 2.827,73 | **1,42** |
| | **Total** | **19.896,09** | **2.646,18** | **-** | **41.214,07** | **-** | **4.863.259,74** | **2.439,34** |

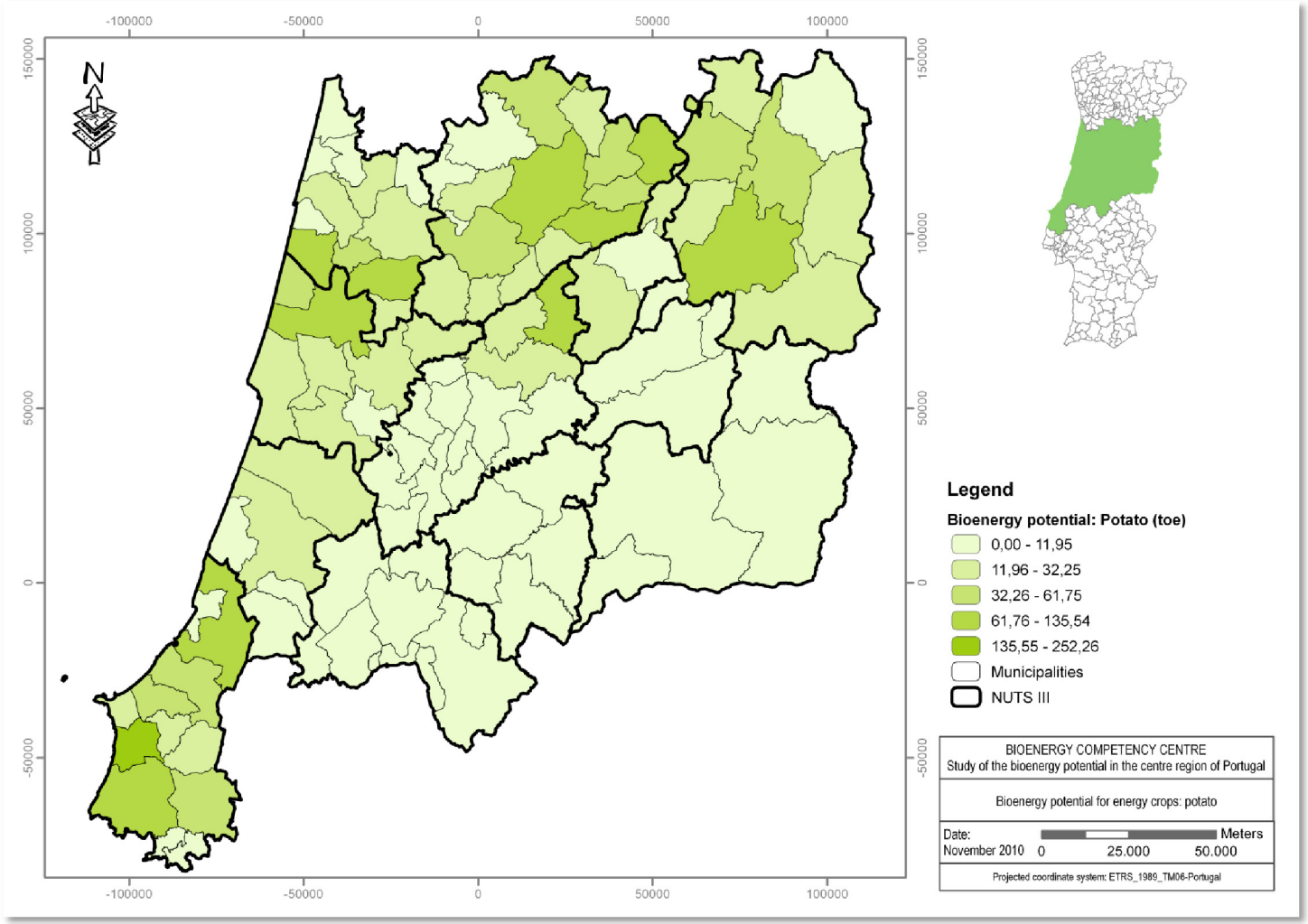


Figure A5.6: Map for the bioenergy potential for potato energy crops.

Table A5.7: Bioenergy potential for amylaceous sugar beet energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | ... | … | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Anadia | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Aveiro | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Estarreja | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Ílhavo | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Mealhada | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Murtosa | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Oliveira do Bairro | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Ovar | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Sever do Vouga | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Vagos | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | ... | … | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Coimbra | 25,49 | 3,39 | 39.798 | 134,92 | 97 | 13.087,43 | **6,56** |
| | Condeixa-a-Nova | ... | … | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Figueira da Foz | ... | … | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Mira | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Montemor-o-Velho | 40,44 | 5,38 | 39.798 | 214,05 | 97 | 20.763,27 | **10,41** |
| | Penacova | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Soure | 26,18 | 3,48 | 39.798 | 138,57 | 97 | 13.441,70 | **6,74** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Leiria | 91,54 | 12,17 | 39.798 | 484,53 | 97 | 46.999,75 | **23,57** |
| | Marinha Grande | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Pombal | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Porto de Mós | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Góis | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Lousã | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Miranda do Corvo | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Oliveira do Hospital | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Penela | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Tábua | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Alvaiázere | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Ansião | ... | … | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Castanheira de Pêra | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Pedrógão Grande | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Carregal do Sal | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Castro Daire | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Mangualde | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Mortágua | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Nelas | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Oliveira de Frades | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Penalva do Castelo | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Santa Comba Dão | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Sátão | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Tondela | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Viseu | 0,00 | 0,00 | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| | Vouzela | ... | … | 39.798 | 0,00 | 97 | 0,00 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Proença-a-Nova | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Sertã | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Vila de Rei | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Mação | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Gouveia | ... | … | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Seia | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| ***Beira Interior Norte*** | Almeida | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Celorico da Beira | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Fig. Castelo Rodrigo | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Guarda | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Manteigas | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Meda | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Pinhel | ... | … | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Sabugal | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Trancoso | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| ***Beira Interior Sul*** | Castelo Branco | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Idanha-a-Nova | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Penamacor | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Vila Velha de Ródão | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| ***Cova Beira*** | Belmonte | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Covilhã | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| | Fundão | 0,00 | 0,00 | 16.986 | 0,00 | 97 | 0,00 | **0,00** |
| ***Oeste*** | Alcobaça | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Bombarral | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Caldas da Rainha | ... | … | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Nazaré | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Óbidos | ... | … | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Peniche | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Alenquer | 57,53 | 7,65 | 59.695 | 456,76 | 97 | 44.305,30 | **22,22** |
| | Arruda dos Vinhos | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Cadaval | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Lourinhã | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Torres Vedras | ... | … | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| ***Médio Tejo*** | Abrantes | 86,40 | 11,49 | 59.695 | 685,97 | 97 | 66.538,82 | **33,37** |
| | Alcanena | ... | … | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Constância | ... | … | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Sardoal | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Tomar | ... | … | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Torres Novas | 107,54 | 14,30 | 59.695 | 853,81 | 97 | 82.819,26 | **41,54** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | Ourém | 0,00 | 0,00 | 59.695 | 0,00 | 97 | 0,00 | **0,00** |
| | **Total** | **435,12** | **57,87** | **-** | **2.968,61** | **-** | **287.955,54** | **144,43** |

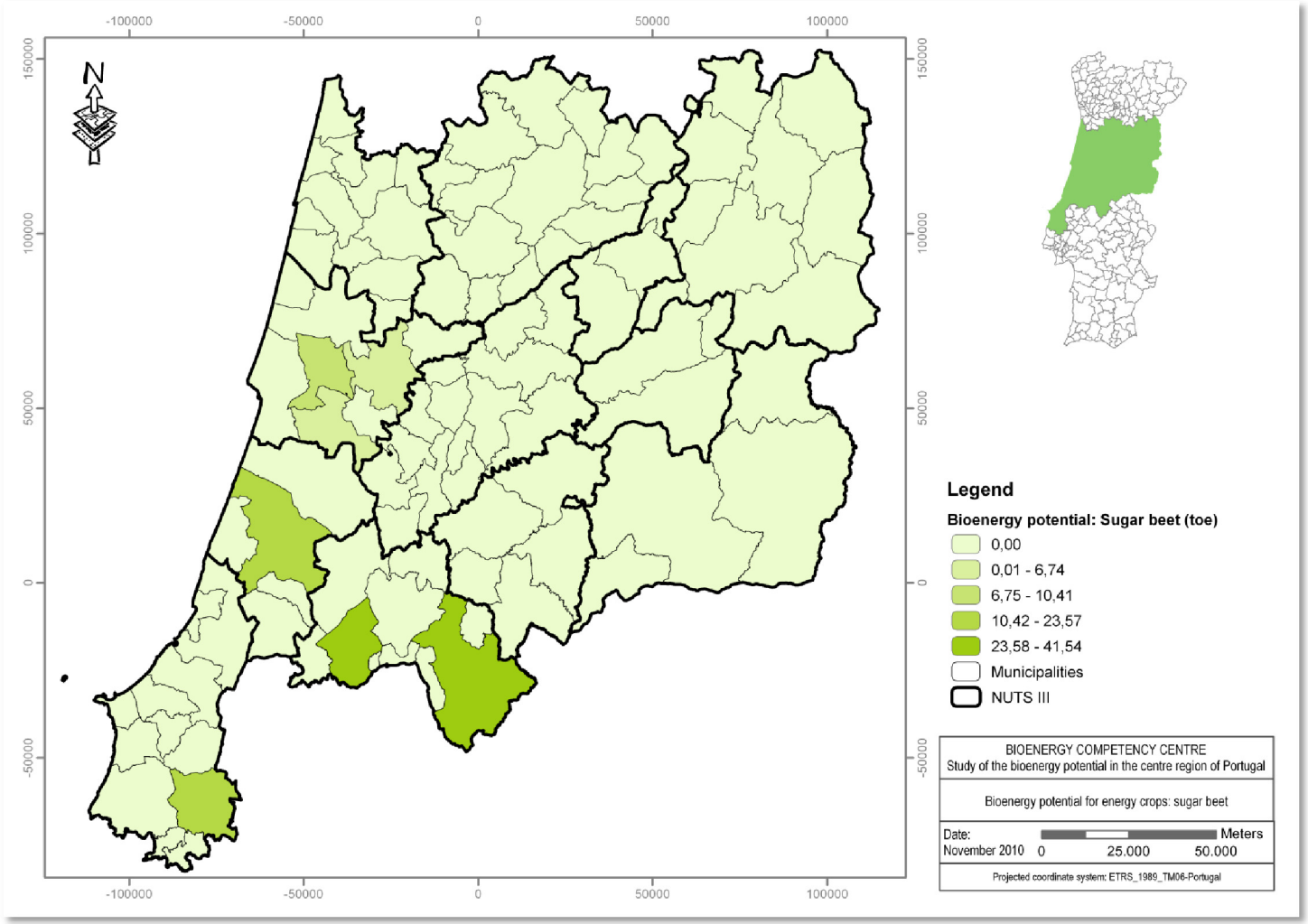


Figure A5.7: Map for the bioenergy potential for sugar beet energy crops.

Table A5.8: Bioenergy potential for oleaginous sunflower energy crops (toe) per municipality.

| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Anadia | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Aveiro | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Estarreja | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Ílhavo | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Mealhada | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Murtosa | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Oliveira do Bairro | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Ovar | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Sever do Vouga | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Vagos | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Coimbra | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Condeixa-a-Nova | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Figueira da Foz | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Mira | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Montemor-o-Velho | 6,01 | 0,80 | 550 | 0,44 | 400 | 175,85 | **0,09** |
| | Penacova | 0,32 | 0,04 | 550 | 0,02 | 400 | 9,36 | **0,00** |
| | Soure | 29,84 | 3,97 | 550 | 2,18 | 400 | 873,12 | **0,44** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Leiria | 27,91 | 3,71 | 550 | 2,04 | 400 | 816,65 | **0,41** |
| | Marinha Grande | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Pombal | 0,69 | 0,09 | 550 | 0,05 | 400 | 20,19 | **0,01** |
| | Porto de Mós | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Góis | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Lousã | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Miranda do Corvo | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Oliveira do Hospital | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Penela | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Tábua | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Alvaiázere | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Ansião | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Castanheira de Pêra | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Pedrógão Grande | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Carregal do Sal | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Castro Daire | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Mangualde | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Mortágua | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Nelas | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Oliveira de Frades | 0,70 | 0,09 | 550 | 0,05 | 400 | 20,48 | **0,01** |
| | Penalva do Castelo | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Santa Comba Dão | 0,14 | 0,02 | 550 | 0,01 | 400 | 4,10 | **0,00** |

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| *NUTS III* | *Municipality* | *Total occupied area (ha)* | *Estimated area (ha)* | *Productivity (kg/ha)* | *Estimated production (t)* | *Energy conversion index (l/t)* | *Estimated potential for Bioethanol production (l)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Sátão | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Tondela | 0,87 | 0,12 | 550 | 0,06 | 400 | 25,46 | **0,01** |
| | Vila Nova de Paiva | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Viseu | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Vouzela | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Proença-a-Nova | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Sertã | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Vila de Rei | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Mação | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Gouveia | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Seia | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Beira Interior Norte*** | Almeida | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Celorico da Beira | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Fig. Castelo Rodrigo | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Guarda | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Manteigas | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Meda | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Pinhel | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Sabugal | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Trancoso | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Beira Interior Sul*** | Castelo Branco | 52,37 | 6,97 | 550 | 3,83 | 400 | 1.532,35 | **0,77** |
| | Idanha-a-Nova | 767,65 | 102,10 | 550 | 56,15 | 400 | 22.461,44 | **11,27** |
| | Penamacor | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Vila Velha de Ródão | 32,47 | 4,32 | 550 | 2,38 | 400 | 950,07 | **0,48** |
| ***Cova Beira*** | Belmonte | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Covilhã | 16,05 | 2,13 | 550 | 1,17 | 400 | 469,62 | **0,24** |
| | Fundão | 26,00 | 3,46 | 550 | 1,90 | 400 | 760,76 | **0,38** |
| ***Oeste*** | Alcobaça | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Bombarral | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Caldas da Rainha | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Nazaré | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Óbidos | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Peniche | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Alenquer | 87,71 | 11,67 | 550 | 6,42 | 400 | 2.566,39 | **1,29** |
| | Arruda dos Vinhos | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Cadaval | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Lourinhã | ... | … | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Torres Vedras | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| ***Médio Tejo*** | Abrantes | 239,38 | 31,84 | 550 | 17,51 | 400 | 7.004,26 | **3,51** |
| | Alcanena | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Constância | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Sardoal | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Tomar | 8,69 | 1,16 | 550 | 0,64 | 400 | 254,27 | **0,13** |
| | Torres Novas | 7,83 | 1,04 | 550 | 0,57 | 400 | 229,11 | **0,11** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | Ourém | 0,00 | 0,00 | 550 | 0,00 | 400 | 0,00 | **0,00** |
| | **Total** | **1.304,63** | **173,52** | **-** | **95,43** | **-** | **38.173,47** | **19,15** |

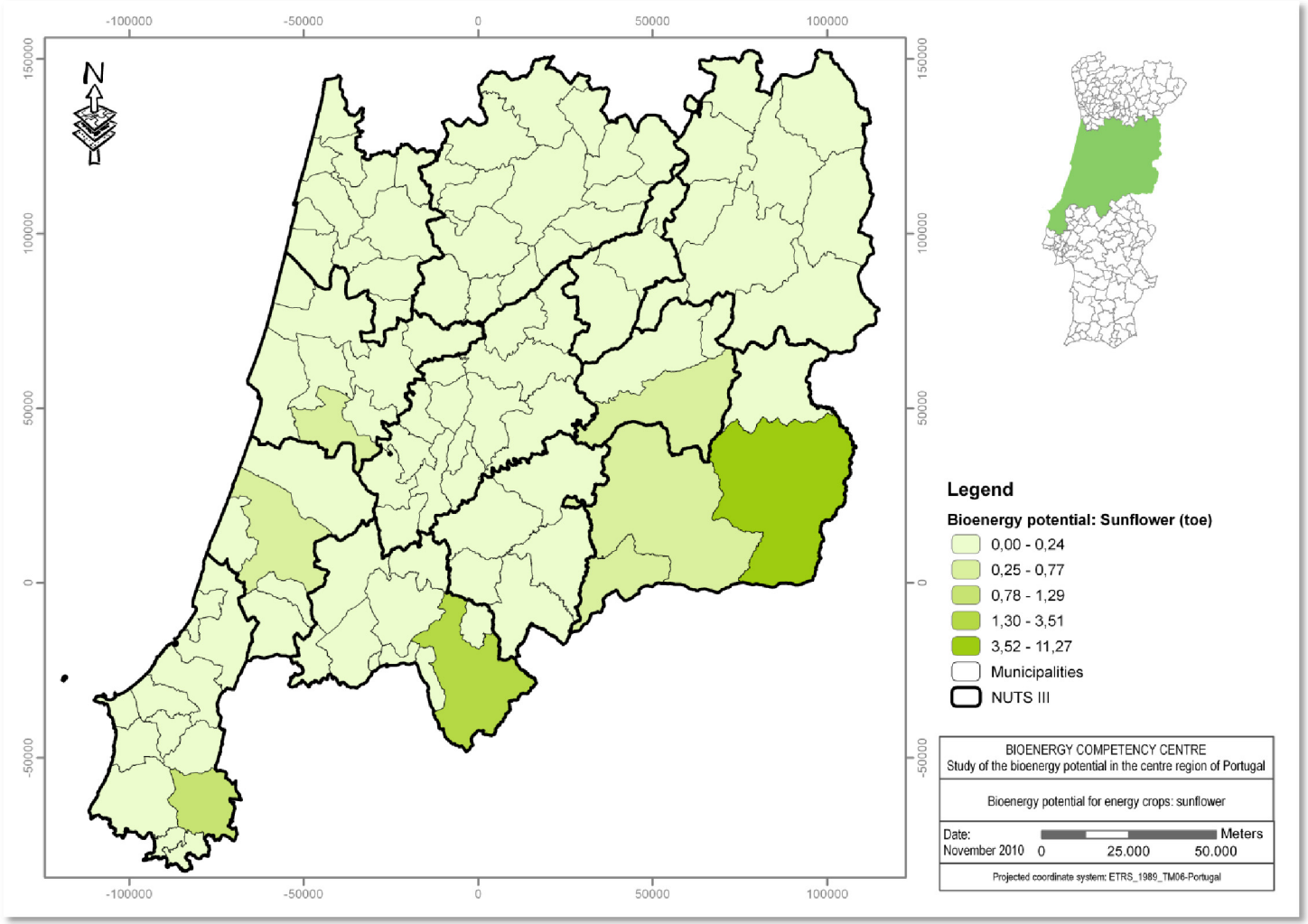


Figure A5.8: Map for the bioenergy potential for sunflower energy crops.

## *Annex 6: Animal husbandry effluents*

Table A6.1: Bioenergy potential for poultry effluents (toe) per municipality.

| *NUTS III* | *Municipality* | *N.º farms* | *Livestock* | *Biogas (1000 m³/year)* | *LHV (kJ/m³)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 1.740 | 14.070 | 25,68 | 21.600 | **13,25** |
| | Albergaria-a-Velha | 706 | 179.117 | 326,89 | 21.600 | **168,64** |
| | Anadia | 1.914 | 34.801 | 63,51 | 21.600 | **32,77** |
| | Aveiro | 791 | 7.397 | 13,50 | 21.600 | **6,96** |
| | Estarreja | 605 | 6.622 | 12,09 | 21.600 | **6,23** |
| | Ílhavo | 197 | 1.998 | 3,65 | 21.600 | **1,88** |
| | Mealhada | 1.013 | 355.199 | 648,24 | 21.600 | **334,43** |
| | Murtosa | 290 | 3.669 | 6,70 | 21.600 | **3,45** |
| | Oliveira do Bairro | 1.035 | 8.010 | 14,62 | 21.600 | **7,54** |
| | Ovar | 426 | 79.255 | 144,64 | 21.600 | **74,62** |
| | Sever do Vouga | 481 | 37.897 | 69,16 | 21.600 | **35,68** |
| | Vagos | 1.340 | 95.888 | 175,00 | 21.600 | **90,28** |
| ***Baixo Mondego*** | Cantanhede | 3.176 | 43.717 | 79,78 | 21.600 | **41,16** |
| | Coimbra | 2.024 | 16.855 | 30,76 | 21.600 | **15,87** |
| | Condeixa-a-Nova | 905 | 7.114 | 12,98 | 21.600 | **6,70** |
| | Figueira da Foz | 1.762 | 157.461 | 287,37 | 21.600 | **148,25** |
| | Mira | 755 | 6.396 | 11,67 | 21.600 | **6,02** |
| | Montemor-o-Velho | 2.267 | 18.085 | 33,01 | 21.600 | **17,03** |
| | Penacova | 698 | 22.465 | 41,00 | 21.600 | **21,15** |
| | Soure | 1.880 | 15.728 | 28,70 | 21.600 | **14,81** |
| ***Pinhal Litoral*** | Batalha | 710 | 86.623 | 158,09 | 21.600 | **81,56** |
| | Leiria | 3.459 | 958.704 | 1.749,63 | 21.600 | **902,65** |
| | Marinha Grande | 128 | 56.319 | 102,78 | 21.600 | **53,03** |
| | Pombal | 3.488 | 455.799 | 831,83 | 21.600 | **429,15** |
| | Porto de Mós | 904 | 6.027 | 11,00 | 21.600 | **5,67** |
| ***Pinhal Interior Norte*** | Arganil | 766 | 47.242 | 86,22 | 21.600 | **44,48** |
| | Góis | 237 | 2.581 | 4,71 | 21.600 | **2,43** |
| | Lousã | 187 | 2.077 | 3,79 | 21.600 | **1,96** |
| | Miranda do Corvo | 627 | 4.960 | 9,05 | 21.600 | **4,67** |
| | Oliveira do Hospital | 1.180 | 58.627 | 106,99 | 21.600 | **55,20** |
| | Pampilhosa da Serra | 288 | 2.322 | 4,24 | 21.600 | **2,19** |
| | Penela | 568 | 3.137 | 5,73 | 21.600 | **2,95** |
| | Tábua | 759 | 23.237 | 42,41 | 21.600 | **21,88** |
| | Vila Nova de Poiares | 219 | 1.941 | 3,54 | 21.600 | **1,83** |
| | Alvaiázere | 871 | 5.314 | 9,70 | 21.600 | **5,00** |
| | Ansião | 1.302 | 174.349 | 318,19 | 21.600 | **164,15** |
| | Castanheira de Pêra | 56 | 423 | 0,77 | 21.600 | **0,40** |
| | Figueiró dos Vinhos | 413 | 2.878 | 5,25 | 21.600 | **2,71** |
| | Pedrógão Grande | 362 | 3.157 | 5,76 | 21.600 | **2,97** |
| ***Dão Lafões*** | Aguiar da Beira | 784 | 4.961 | 9,05 | 21.600 | **4,67** |
| | Carregal do Sal | 678 | 6.068 | 11,07 | 21.600 | **5,71** |
| | Castro Daire | 1.473 | 9.298 | 16,97 | 21.600 | **8,75** |
| | Mangualde | 1.168 | 10.620 | 19,38 | 21.600 | **10,00** |
| | Mortágua | 741 | 194.470 | 354,91 | 21.600 | **183,10** |
| | Nelas | 798 | 6.305 | 11,51 | 21.600 | **5,94** |
| | Oliveira de Frades | 842 | 288.747 | 526,96 | 21.600 | **271,86** |
| | Penalva do Castelo | 844 | 23.021 | 42,01 | 21.600 | **21,67** |
| | Santa Comba Dão | 626 | 5.535 | 10,10 | 21.600 | **5,21** |

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| *NUTS III* | *Municipality* | *N.º farms* | *Livestock* | *Biogas (1000 m³/year)* | *LHV (kJ/m³)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1.373 | 12.159 | 22,19 | 21.600 | **11,45** |
| | Sátão | 1.301 | 35.232 | 64,30 | 21.600 | **33,17** |
| | Tondela | 2.202 | 845.273 | 1.542,62 | 21.600 | **795,85** |
| | Vila Nova de Paiva | 489 | 9.511 | 17,36 | 21.600 | **8,95** |
| | Viseu | 3.102 | 57.783 | 105,45 | 21.600 | **54,40** |
| | Vouzela | 1.026 | 91.976 | 167,86 | 21.600 | **86,60** |
| ***Pinhal Interior Sul*** | Oleiros | 1.345 | 11.905 | 21,73 | 21.600 | **11,21** |
| | Proença-a-Nova | 1.446 | 12.453 | 22,73 | 21.600 | **11,72** |
| | Sertã | 2.101 | 19.034 | 34,74 | 21.600 | **17,92** |
| | Vila de Rei | 407 | 32.223 | 58,81 | 21.600 | **30,34** |
| | Mação | 1.194 | 9.993 | 18,24 | 21.600 | **9,41** |
| ***Serra Estrela*** | Fornos de Algodres | 522 | 4.506 | 8,22 | 21.600 | **4,24** |
| | Gouveia | 769 | 33.257 | 60,69 | 21.600 | **31,31** |
| | Seia | 1.477 | 57.190 | 104,37 | 21.600 | **53,85** |
| ***Beira Interior Norte*** | Almeida | 640 | 4.030 | 7,35 | 21.600 | **3,79** |
| | Celorico da Beira | 720 | 5.988 | 10,93 | 21.600 | **5,64** |
| | Fig. Castelo Rodrigo | 404 | 3.115 | 5,68 | 21.600 | **2,93** |
| | Guarda | 2.012 | 73.238 | 133,66 | 21.600 | **68,96** |
| | Manteigas | 96 | 1.022 | 1,87 | 21.600 | **0,96** |
| | Meda | 696 | 5.271 | 9,62 | 21.600 | **4,96** |
| | Pinhel | 1.580 | 9.830 | 17,94 | 21.600 | **9,26** |
| | Sabugal | 1.846 | 10.481 | 19,13 | 21.600 | **9,87** |
| | Trancoso | 1.271 | 7.509 | 13,70 | 21.600 | **7,07** |
| ***Beira Interior Sul*** | Castelo Branco | 3.389 | 29.474 | 53,79 | 21.600 | **27,75** |
| | Idanha-a-Nova | 1.360 | 11.201 | 20,44 | 21.600 | **10,55** |
| | Penamacor | 1.008 | 7.037 | 12,84 | 21.600 | **6,63** |
| | Vila Velha de Ródão | 719 | 4.977 | 9,08 | 21.600 | **4,69** |
| ***Cova Beira*** | Belmonte | 679 | 4.578 | 8,35 | 21.600 | **4,31** |
| | Covilhã | 1.996 | 16.802 | 30,66 | 21.600 | **15,82** |
| | Fundão | 3.263,00 | 25.982,00 | 47,42 | 21.600 | **24,46** |
| ***Oeste*** | Alcobaça | 1.830 | 14.533 | 26,52 | 21.600 | **13,68** |
| | Bombarral | 192 | 2.034 | 3,71 | 21.600 | **1,92** |
| | Caldas da Rainha | 332 | 2.004 | 3,66 | 21.600 | **1,89** |
| | Nazaré | 175 | 1.302 | 2,38 | 21.600 | **1,23** |
| | Óbidos | 396 | 2.216 | 4,04 | 21.600 | **2,09** |
| | Peniche | 922 | 305.833 | 558,15 | 21.600 | **287,95** |
| | Alenquer | 448 | 451.138 | 823,33 | 21.600 | **424,76** |
| | Arruda dos Vinhos | 1.312 | 158.334 | 288,96 | 21.600 | **149,08** |
| | Cadaval | 489 | 3.542 | 6,46 | 21.600 | **3,33** |
| | Lourinhã | 803 | 98.134 | 179,09 | 21.600 | **92,40** |
| | Sobral de Monte Agraço | 376 | 2.540 | 4,64 | 21.600 | **2,39** |
| | Torres Vedras | 1.155 | 197.461 | 360,37 | 21.600 | **185,92** |
| ***Médio Tejo*** | Abrantes | 807 | 8.437 | 15,40 | 21.600 | **7,94** |
| | Alcanena | 348 | 3.253 | 5,94 | 21.600 | **3,06** |
| | Constância | 46 | 505 | 0,92 | 21.600 | **0,48** |
| | Entroncamento | 27 | 183 | 0,33 | 21.600 | **0,17** |
| | Ferreira do Zêzere | 898 | 691.769 | 1.262,48 | 21.600 | **651,32** |
| | Sardoal | 1.328 | 410.787 | 749,69 | 21.600 | **386,77** |
| | Tomar | 945 | 7.041 | 12,85 | 21.600 | **6,63** |
| | Torres Novas | 43 | 448 | 0,82 | 21.600 | **0,42** |
| | Vila Nova da Barquinha | 2.319 | 1.270.575 | 2.318,80 | 21.600 | **1.196,29** |
| | Ourém | 465 | 3.421 | 6,24 | 21.600 | **3,22** |
| | **Total** | **104.107,0** | **8.641.585,0** | **15.770,9** | **-** | **8.136,3** |

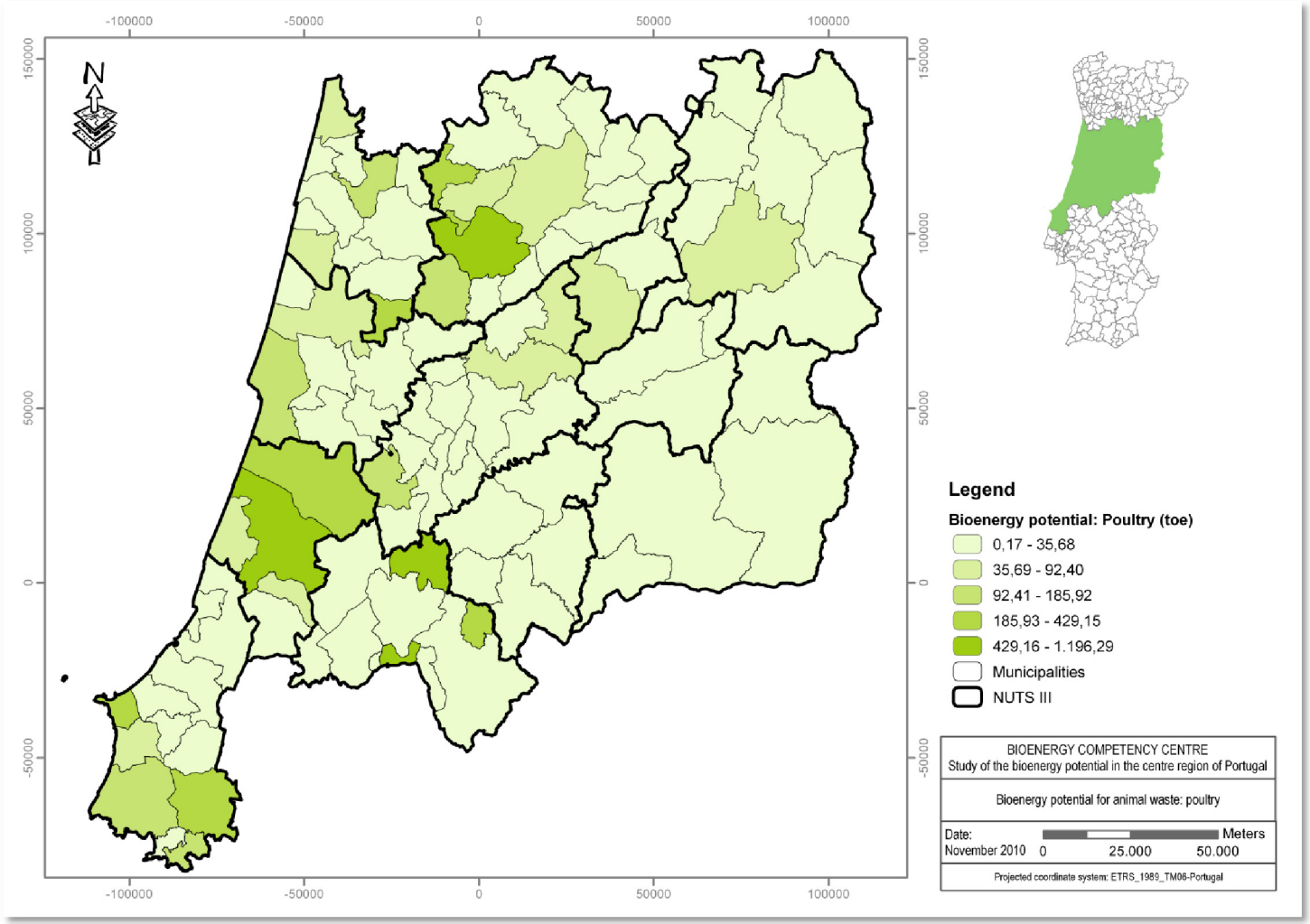


Figure A6.1: Map for the bioenergy potential for animal husbandry waste, poultry.

Table A6.2: Bioenergy potential for bovine effluents (toe) per municipality.

| *NUTS III* | *Municipality* | *N.º farms* | *Livestock* | *Biogas (1000 $m^3$/year)* | *LHV ($kJ/m^3$)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 122 | 836 | 51,87 | 21.600 | **26,76** |
| | Albergaria-a-Velha | 268 | 2.102 | 130,43 | 21.600 | **67,29** |
| | Anadia | 29 | 761 | 47,22 | 21.600 | **24,36** |
| | Aveiro | 149 | 1.168 | 72,47 | 21.600 | **37,39** |
| | Estarreja | 514 | 5.668 | 351,70 | 21.600 | **181,44** |
| | Ílhavo | 65 | 575 | 35,68 | 21.600 | **18,41** |
| | Mealhada | 11 | 412 | 25,56 | 21.600 | **13,19** |
| | Murtosa | 163 | 2.816 | 174,73 | 21.600 | **90,15** |
| | Oliveira do Bairro | 76 | 731 | 45,36 | 21.600 | **23,40** |
| | Ovar | 288 | 4.830 | 299,70 | 21.600 | **154,62** |
| | Sever do Vouga | 401 | 883 | 54,79 | 21.600 | **28,27** |
| | Vagos | 731 | 4.058 | 251,80 | 21.600 | **129,90** |
| ***Baixo Mondego*** | Cantanhede | 824 | 6.685 | 414,80 | 21.600 | **214,00** |
| | Coimbra | 71 | 483 | 29,97 | 21.600 | **15,46** |
| | Condeixa-a-Nova | 49 | 362 | 22,46 | 21.600 | **11,59** |
| | Figueira da Foz | 565 | 4.858 | 301,44 | 21.600 | **155,51** |
| | Mira | 209 | 1.782 | 110,57 | 21.600 | **57,05** |
| | Montemor-o-Velho | 773 | 7.400 | 459,17 | 21.600 | **236,89** |
| | Penacova | 2 | ... | 0,00 | 21.600 | **0,00** |
| | Soure | 67 | 613 | 38,04 | 21.600 | **19,62** |
| ***Pinhal Litoral*** | Batalha | 43 | 393 | 24,39 | 21.600 | **12,58** |
| | Leiria | 105 | 1.448 | 89,85 | 21.600 | **46,35** |
| | Marinha Grande | 4 | 16 | 0,99 | 21.600 | **0,51** |
| | Pombal | 79 | 786 | 48,77 | 21.600 | **25,16** |
| | Porto de Mós | 245 | 2.530 | 156,99 | 21.600 | **80,99** |
| ***Pinhal Interior Norte*** | Arganil | 2,00 | ... | 0,00 | 21.600 | **0,00** |
| | Góis | 2,00 | ... | 0,00 | 21.600 | **0,00** |
| | Lousã | 3,00 | 4,00 | 0,25 | 21.600 | **0,13** |
| | Miranda do Corvo | 4,00 | 14,00 | 0,87 | 21.600 | **0,45** |
| | Oliveira do Hospital | 12,00 | 22,00 | 1,37 | 21.600 | **0,70** |
| | Pampilhosa da Serra | 0,00 | 0,00 | 0,00 | 21.600 | **0,00** |
| | Penela | 23,00 | 71,00 | 4,41 | 21.600 | **2,27** |
| | Tábua | 5,00 | 7,00 | 0,43 | 21.600 | **0,22** |
| | Vila Nova de Poiares | 4,00 | 25,00 | 1,55 | 21.600 | **0,80** |
| | Alvaiázere | 4,00 | 10,00 | 0,62 | 21.600 | **0,32** |
| | Ansião | 47,00 | 95,00 | 5,89 | 21.600 | **3,04** |
| | Castanheira de Pêra | 0,00 | 0,00 | 0,00 | 21.600 | **0,00** |
| | Figueiró dos Vinhos | 3,00 | 3,00 | 0,19 | 21.600 | **0,10** |
| | Pedrógão Grande | 3,00 | 7,00 | 0,43 | 21.600 | **0,22** |
| ***Dão Lafões*** | Aguiar da Beira | 335 | 812 | 50,38 | 21.600 | **25,99** |
| | Carregal do Sal | 10 | 10 | 0,62 | 21.600 | **0,32** |
| | Castro Daire | 318 | 667 | 41,39 | 21.600 | **21,35** |
| | Mangualde | 27 | 64 | 3,97 | 21.600 | **2,05** |
| | Mortágua | 25 | 101 | 6,27 | 21.600 | **3,23** |
| | Nelas | 4 | 8 | 0,50 | 21.600 | **0,26** |
| | Oliveira de Frades | 439 | 1.067 | 66,21 | 21.600 | **34,16** |
| | Penalva do Castelo | 63 | 91 | 5,65 | 21.600 | **2,91** |
| | Santa Comba Dão | 9 | 31 | 1,92 | 21.600 | **0,99** |

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| NUTS III | Municipality | N.º farms | Livestock | Biogas (1000 $m^3$/year) | LHV ($kJ/m^3$) | **Energy potential (toe)** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 395 | 849 | 52,68 | 21.600 | **27,18** |
| | Sátão | 316 | 617 | 38,28 | 21.600 | **19,75** |
| | Tondela | 269 | 544 | 33,76 | 21.600 | **17,41** |
| | Vila Nova de Paiva | 250 | 648 | 40,21 | 21.600 | **20,74** |
| | Viseu | 94 | 345 | 21,41 | 21.600 | **11,04** |
| | Vouzela | 204 | 674 | 41,82 | 21.600 | **21,58** |
| ***Pinhal Interior Sul*** | Oleiros | 4,00 | 6,00 | 0,37 | 21.600 | **0,19** |
| | Proença-a-Nova | 6,00 | 7,00 | 0,43 | 21.600 | **0,22** |
| | Sertã | 139,00 | 302,00 | 18,74 | 21.600 | **9,67** |
| | Vila de Rei | 4,00 | 8,00 | 0,50 | 21.600 | **0,26** |
| | Mação | 6,00 | 10,00 | 0,62 | 21.600 | **0,32** |
| ***Serra Estrela*** | Fornos de Algodres | 55 | 136 | 8,44 | 21.600 | **4,35** |
| | Gouveia | 14 | 21 | 1,30 | 21.600 | **0,67** |
| | Seia | 18 | 48 | 2,98 | 21.600 | **1,54** |
| ***Beira Interior Norte*** | Almeida | 215 | 1.466 | 90,97 | 21.600 | **46,93** |
| | Celorico da Beira | 51 | 167 | 10,36 | 21.600 | **5,35** |
| | Fig. Castelo Rodrigo | 45 | 457 | 28,36 | 21.600 | **14,63** |
| | Guarda | 669 | 2.593 | 160,90 | 21.600 | **83,01** |
| | Manteigas | 3 | 4 | 0,25 | 21.600 | **0,13** |
| | Meda | 65 | 232 | 14,40 | 21.600 | **7,43** |
| | Pinhel | 456 | 1.594 | 98,91 | 21.600 | **51,03** |
| | Sabugal | 587 | 1.656 | 102,75 | 21.600 | **53,01** |
| | Trancoso | 436 | 1.457 | 90,41 | 21.600 | **46,64** |
| ***Beira Interior Sul*** | Castelo Branco | 43 | 148 | 9,18 | 21.600 | **4,74** |
| | Idanha-a-Nova | 43 | 664 | 41,20 | 21.600 | **21,26** |
| | Penamacor | 58 | 421 | 26,12 | 21.600 | **13,48** |
| | Vila Velha de Ródão | 5 | 75 | 4,65 | 21.600 | **2,40** |
| ***Cova Beira*** | Belmonte | 89 | 490 | 30,40 | 21.600 | **15,69** |
| | Covilhã | 205 | 1.447 | 89,79 | 21.600 | **46,32** |
| | Fundão | 308 | 1.617 | 100,33 | 21.600 | **51,76** |
| ***Oeste*** | Alcobaça | 74 | 895 | 55,53 | 21.600 | **28,65** |
| | Bombarral | 11 | 454 | 28,17 | 21.600 | **14,53** |
| | Caldas da Rainha | 7 | 78 | 4,84 | 21.600 | **2,50** |
| | Nazaré | 6 | 195 | 12,10 | 21.600 | **6,24** |
| | Óbidos | 14 | 603 | 37,42 | 21.600 | **19,30** |
| | Peniche | 17 | 859 | 53,30 | 21.600 | **27,50** |
| | Alenquer | 6 | 165 | 10,24 | 21.600 | **5,28** |
| | Arruda dos Vinhos | 13 | 507 | 31,46 | 21.600 | **16,23** |
| | Cadaval | 11 | 182 | 11,29 | 21.600 | **5,83** |
| | Lourinhã | 7 | 84 | 5,21 | 21.600 | **2,69** |
| | Sobral de Monte Agraço | 31 | 594 | 36,86 | 21.600 | **19,02** |
| | Torres Vedras | 68 | 1.773 | 110,01 | 21.600 | **56,76** |
| ***Médio Tejo*** | Abrantes | 19 | 143 | 8,87 | 21.600 | **4,58** |
| | Alcanena | 44 | 621 | 38,53 | 21.600 | **19,88** |
| | Constância | 2 | ... | 0,00 | 21.600 | **0,00** |
| | Entroncamento | 0 | 0 | 0,00 | 21.600 | **0,00** |
| | Ferreira do Zêzere | 3 | 5 | 0,31 | 21.600 | **0,16** |
| | Sardoal | 21 | 201 | 12,47 | 21.600 | **6,43** |
| | Tomar | 31 | 213 | 13,22 | 21.600 | **6,82** |
| | Torres Novas | 0 | 0 | 0,00 | 21.600 | **0,00** |
| | Vila Nova da Barquinha | 26 | 177 | 10,98 | 21.600 | **5,67** |
| | Ourém | 3 | 7 | 0,43 | 21.600 | **0,22** |
| | **Total** | **12.658** | **81.757,00** | **5.073,02** | **-** | **2.617,21** |

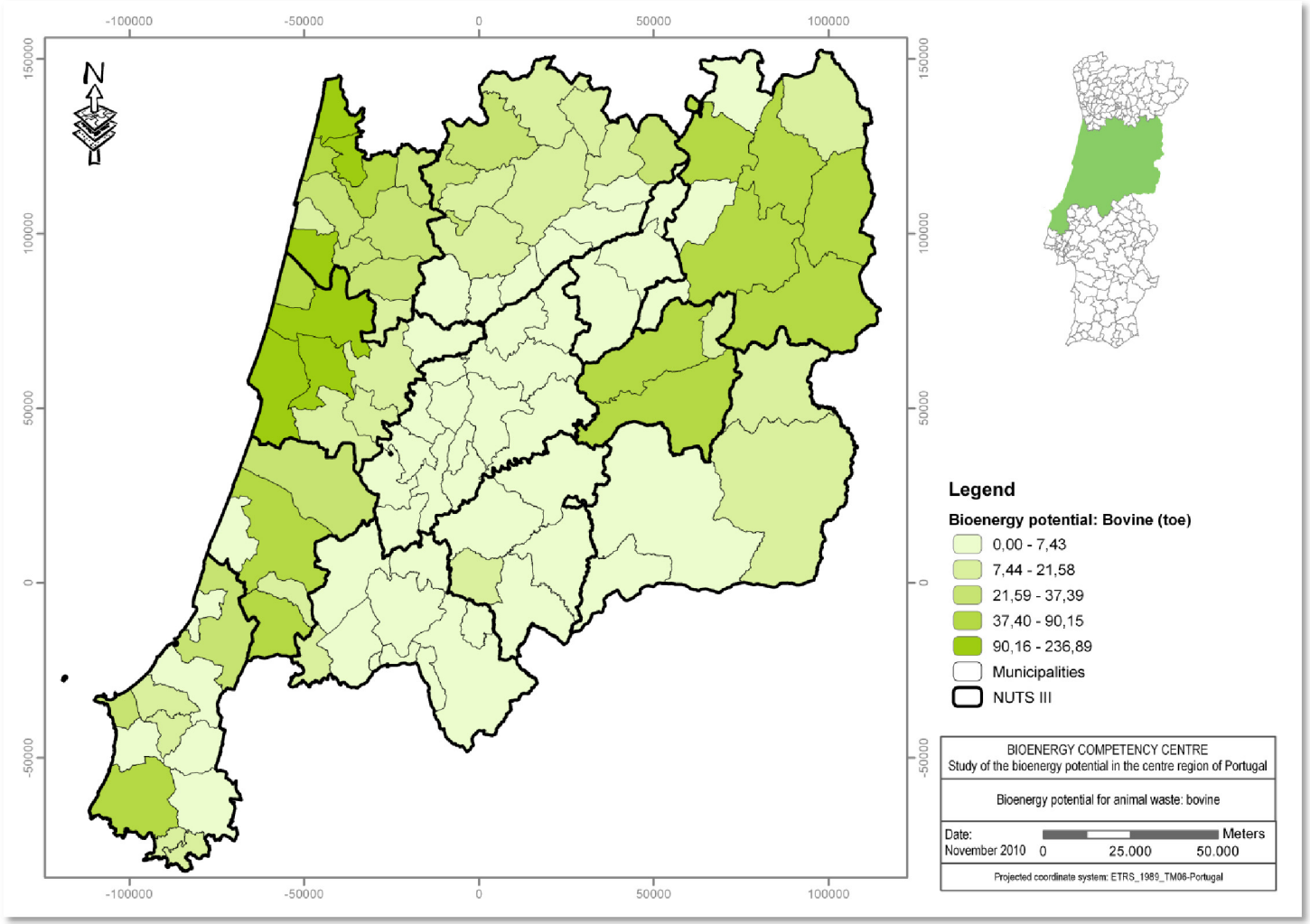


Figure A6.2: Map for the bioenergy potential for animal husbandry waste, bovine.

Table A6.3: Bioenergy potential for swine effluents (toe) per municipality.

| *NUTS III* | *Municipality* | *N.º farms* | *Livestock* | *Biogas (1000 $m^3$/year)* | *LHV ($kJ/m^3$)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 1.943 | 6.848 | 192,46 | 21.600 | **99,29** |
| | Albergaria-a-Velha | 895 | 4.443 | 124,87 | 21.600 | **64,42** |
| | Anadia | 2.010 | 10.169 | 285,80 | 21.600 | **147,45** |
| | Aveiro | 947 | 3.640 | 102,30 | 21.600 | **52,78** |
| | Estarreja | 983 | 4.107 | 115,43 | 21.600 | **59,55** |
| | Ílhavo | 176 | 746 | 20,97 | 21.600 | **10,82** |
| | Mealhada | 955 | 12.435 | 349,49 | 21.600 | **180,30** |
| | Murtosa | 340 | 1.428 | 40,13 | 21.600 | **20,71** |
| | Oliveira do Bairro | 1.303 | 5.503 | 154,66 | 21.600 | **79,79** |
| | Ovar | 404 | 4.623 | 129,93 | 21.600 | **67,03** |
| | Sever do Vouga | 569 | 4.778 | 134,29 | 21.600 | **69,28** |
| | Vagos | 1.695 | 11.792 | 331,41 | 21.600 | **170,98** |
| ***Baixo Mondego*** | Cantanhede | 3.281 | 21.959 | 617,16 | 21.600 | **318,40** |
| | Coimbra | 1.527 | 5.051 | 141,96 | 21.600 | **73,24** |
| | Condeixa-a-Nova | 484 | 2.171 | 61,02 | 21.600 | **31,48** |
| | Figueira da Foz | 1.551 | 10.426 | 293,02 | 21.600 | **151,17** |
| | Mira | 735 | 8.057 | 226,44 | 21.600 | **116,82** |
| | Montemor-o-Velho | 2.179 | 11.334 | 318,54 | 21.600 | **164,34** |
| | Penacova | 504 | 1.354 | 38,05 | 21.600 | **19,63** |
| | Soure | 1.295 | 5.222 | 146,76 | 21.600 | **75,72** |
| ***Pinhal Litoral*** | Batalha | 436 | 17.107 | 480,79 | 21.600 | **248,04** |
| | Leiria | 2.800 | 161.430 | 4.536,99 | 21.600 | **2.340,67** |
| | Marinha Grande | 130 | 3.909 | 109,86 | 21.600 | **56,68** |
| | Pombal | 3.624 | 40.704 | 1.143,99 | 21.600 | **590,19** |
| | Porto de Mós | 605 | 28.341 | 796,52 | 21.600 | **410,93** |
| ***Pinhal Interior Norte*** | Arganil | 258 | 811 | 22,79 | 21.600 | **11,76** |
| | Góis | 75 | 1.966 | 55,25 | 21.600 | **28,51** |
| | Lousã | 105 | 698 | 19,62 | 21.600 | **10,12** |
| | Miranda do Corvo | 354 | 1.165 | 32,74 | 21.600 | **16,89** |
| | Oliveira do Hospital | 382 | 1.170 | 32,88 | 21.600 | **16,96** |
| | Pampilhosa da Serra | 75 | 147 | 4,13 | 21.600 | **2,13** |
| | Penela | 339 | 1.114 | 31,31 | 21.600 | **16,15** |
| | Tábua | 324 | 678 | 19,06 | 21.600 | **9,83** |
| | Vila Nova de Poiares | 129 | 337 | 9,47 | 21.600 | **4,89** |
| | Alvaiázere | 480 | 2.371 | 66,64 | 21.600 | **34,38** |
| | Ansião | 882 | 7.464 | 209,78 | 21.600 | **108,22** |
| | Castanheira de Pêra | 16 | 25 | 0,70 | 21.600 | **0,36** |
| | Figueiró dos Vinhos | 217 | 2.369 | 66,58 | 21.600 | **34,35** |
| | Pedrógão Grande | 145 | 300 | 8,43 | 21.600 | **4,35** |
| ***Dão Lafões*** | Aguiar da Beira | 616 | 4.633 | 130,21 | 21.600 | **67,18** |
| | Carregal do Sal | 365 | 1.785 | 50,17 | 21.600 | **25,88** |
| | Castro Daire | 1.329 | 6.573 | 184,73 | 21.600 | **95,31** |
| | Mangualde | 362 | 4.671 | 131,28 | 21.600 | **67,73** |
| | Mortágua | 681 | 1.740 | 48,90 | 21.600 | **25,23** |
| | Nelas | 305 | 1.463 | 41,12 | 21.600 | **21,21** |
| | Oliveira de Frades | 868 | 5.091 | 143,08 | 21.600 | **73,82** |
| | Penalva do Castelo | 590 | 1.443 | 40,56 | 21.600 | **20,92** |
| | Santa Comba Dão | 447 | 12.143 | 341,28 | 21.600 | **176,07** |

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| *NUTS III* | *Municipality* | *N.º farms* | *Livestock* | *Biogas (1000 m³/year)* | *LHV (kJ/m³)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 922 | 5.645 | 158,65 | 21.600 | **81,85** |
| | Sátão | 1.122 | 4.972 | 139,74 | 21.600 | **72,09** |
| | Tondela | 1.970 | 5.605 | 157,53 | 21.600 | **81,27** |
| | Vila Nova de Paiva | 406 | 1.095 | 30,77 | 21.600 | **15,88** |
| | Viseu | 2.090 | 6.069 | 170,57 | 21.600 | **88,00** |
| | Vouzela | 994 | 4.300 | 120,85 | 21.600 | **62,35** |
| ***Pinhal Interior Sul*** | Oleiros | 555 | 941 | 26,45 | 21.600 | **13,64** |
| | Proença-a-Nova | 705 | 1.685 | 47,36 | 21.600 | **24,43** |
| | Sertã | 1.136 | 10.275 | 288,78 | 21.600 | **148,98** |
| | Vila de Rei | 198 | 1.028 | 28,89 | 21.600 | **14,91** |
| | Mação | 479 | 4.849 | 136,28 | 21.600 | **70,31** |
| ***Serra Estrela*** | Fornos de Algodres | 146 | 276 | 7,76 | 21.600 | **4,00** |
| | Gouveia | 217 | 1.175 | 33,02 | 21.600 | **17,04** |
| | Seia | 329 | 1.341 | 37,69 | 21.600 | **19,44** |
| ***Beira Interior Norte*** | Almeida | 200 | 5.737 | 161,24 | 21.600 | **83,18** |
| | Celorico da Beira | 177 | 680 | 19,11 | 21.600 | **9,86** |
| | Fig. Castelo Rodrigo | 123 | 583 | 16,39 | 21.600 | **8,45** |
| | Guarda | 867 | 6.147 | 172,76 | 21.600 | **89,13** |
| | Manteigas | 45 | 102 | 2,87 | 21.600 | **1,48** |
| | Meda | 136 | 261 | 7,34 | 21.600 | **3,78** |
| | Pinhel | 389 | 885 | 24,87 | 21.600 | **12,83** |
| | Sabugal | 728 | 2.539 | 71,36 | 21.600 | **36,81** |
| | Trancoso | 364 | 828 | 23,27 | 21.600 | **12,01** |
| ***Beira Interior Sul*** | Castelo Branco | 984 | 13.200 | 370,99 | 21.600 | **191,39** |
| | Idanha-a-Nova | 520 | 1.590 | 44,69 | 21.600 | **23,05** |
| | Penamacor | 361 | 1.118 | 31,42 | 21.600 | **16,21** |
| | Vila Velha de Ródão | 246 | 2.075 | 58,32 | 21.600 | **30,09** |
| ***Cova Beira*** | Belmonte | 282 | 731 | 20,54 | 21.600 | **10,60** |
| | Covilhã | 751 | 6.963 | 195,70 | 21.600 | **100,96** |
| | Fundão | 806 | 6.038 | 169,70 | 21.600 | **87,55** |
| ***Oeste*** | Alcobaça | 1.482 | 178.265 | 5.010,14 | 21.600 | **2.584,77** |
| | Bombarral | 111 | 3.691 | 103,74 | 21.600 | **53,52** |
| | Caldas da Rainha | 328 | 12.763 | 358,70 | 21.600 | **185,06** |
| | Nazaré | 38 | 10.325 | 290,18 | 21.600 | **149,71** |
| | Óbidos | 229 | 19.883 | 558,81 | 21.600 | **288,29** |
| | Peniche | 473 | 47.184 | 1.326,11 | 21.600 | **684,15** |
| | Alenquer | 212 | 2.416 | 67,90 | 21.600 | **35,03** |
| | Arruda dos Vinhos | 888 | 61.639 | 1.732,36 | 21.600 | **893,74** |
| | Cadaval | 278 | 1.691 | 47,53 | 21.600 | **24,52** |
| | Lourinhã | 233 | 7.665 | 215,42 | 21.600 | **111,14** |
| | Sobral de Monte Agraço | 68 | 10.496 | 294,99 | 21.600 | **152,19** |
| | Torres Vedras | 529 | 62.412 | 1.754,09 | 21.600 | **904,95** |
| ***Médio Tejo*** | Abrantes | 210 | 3.819 | 107,33 | 21.600 | **55,37** |
| | Alcanena | 86 | 1.795 | 50,45 | 21.600 | **26,03** |
| | Constância | 5 | 3.438 | 96,62 | 21.600 | **49,85** |
| | Entroncamento | 14 | 45 | 1,26 | 21.600 | **0,65** |
| | Ferreira do Zêzere | 278 | 29.537 | 830,14 | 21.600 | **428,27** |
| | Sardoal | 217 | 6.210 | 174,53 | 21.600 | **90,04** |
| | Tomar | 216 | 3.925 | 110,31 | 21.600 | **56,91** |
| | Torres Novas | 6 | 39 | 1,10 | 21.600 | **0,57** |
| | Vila Nova da Barquinha | 990 | 4.737 | 133,13 | 21.600 | **68,68** |
| | Ourém | 106 | 231 | 6,49 | 21.600 | **3,35** |
| | **Total** | **65.854** | **1.018.442** | **28.623,31** | **-** | **14.766,97** |

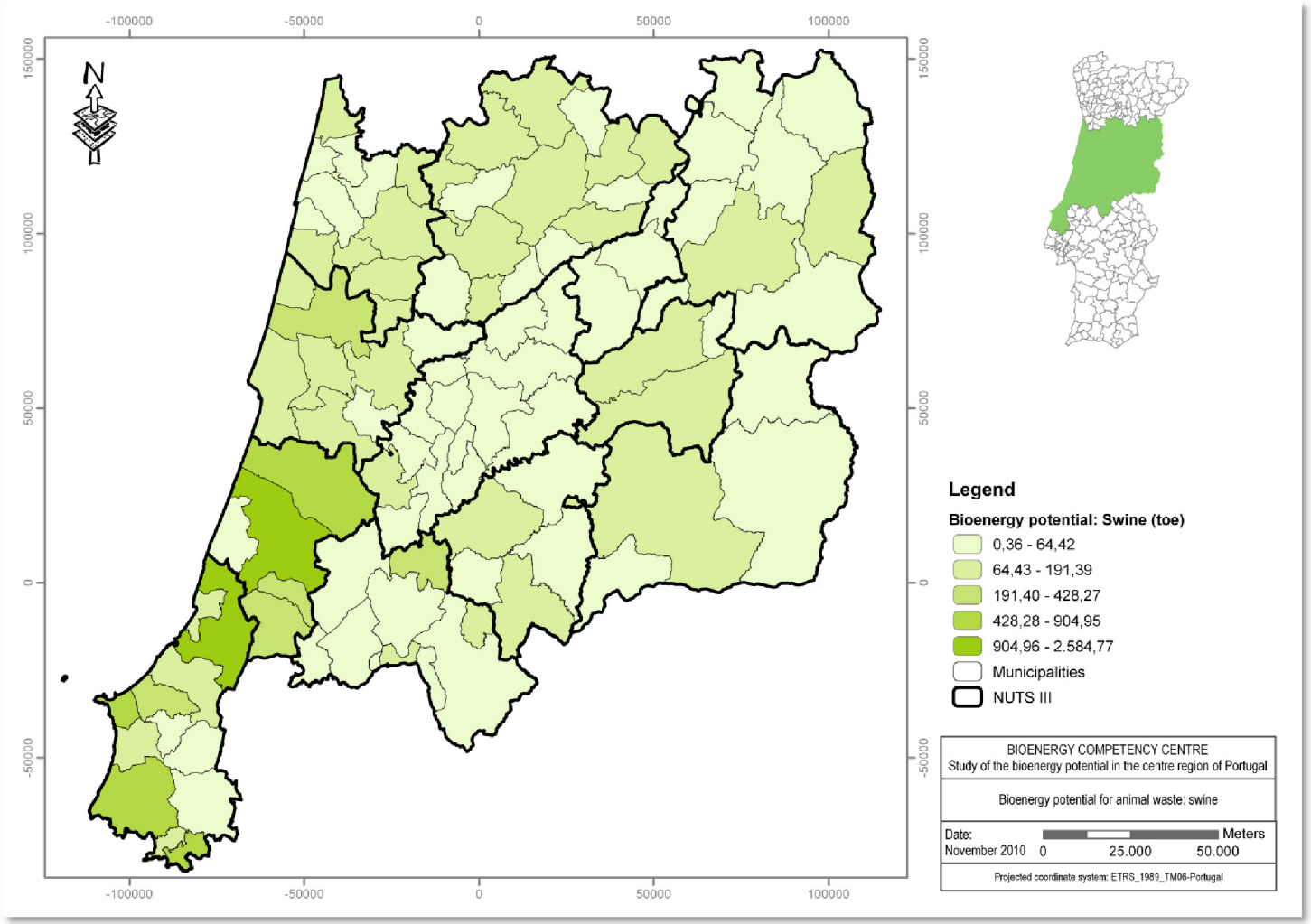


Figure A6.3: Map for the bioenergy potential for animal husbandry waste, swine.

## *Annex 7: Municipal Solid Waste*

Table A7.1: Municipal solid waste produced in the Centre Region of Portugal per municipality.

| *NUTS III* | *Municipality* | *Total* | *Bulk collection* | | *Selective collection* | *Energy valorisation of waste* |
|---|---|---|---|---|---|---|
| | | | *Landfill* | *Organic valorisation* | | |
| ***Baixo Vouga*** | Águeda | 15.452,60 | 14.565,16 | 0,00 | 887,44 | 0,00 |
| | Albergaria-a-Velha | 7.199,42 | 6.812,30 | 0,00 | 387,12 | 0,00 |
| | Anadia | 9.991,64 | 9.259,46 | 0,00 | 732,18 | 0,00 |
| | Aveiro | 37.125,19 | 35.029,60 | 0,00 | 2.095,59 | 0,00 |
| | Estarreja | 9.017,68 | 8.485,90 | 0,00 | 531,78 | 0,00 |
| | Ílhavo | 19.044,18 | 18.158,22 | 0,00 | 885,96 | 0,00 |
| | Mealhada | 7.583,49 | 7.037,02 | 0,00 | 546,47 | 0,00 |
| | Murtosa | 4.868,37 | 4.642,28 | 0,00 | 226,09 | 0,00 |
| | Oliveira do Bairro | 7.487,51 | 7.113,78 | 0,00 | 373,73 | 0,00 |
| | Ovar | 26.055,16 | 24.762,88 | 0,00 | 1.292,28 | 0,00 |
| | Sever do Vouga | 3.196,78 | 2.905,40 | 0,00 | 291,38 | 0,00 |
| | Vagos | 6.865,86 | 6.452,04 | 0,00 | 413,82 | 0,00 |
| ***Baixo Mondego*** | Cantanhede | 11.269,26 | 10.096,50 | 0,00 | 1.172,76 | 0,00 |
| | Coimbra | 68.574,06 | 63.749,56 | 0,00 | 4.824,50 | 0,00 |
| | Condeixa-a-Nova | 5.610,17 | 5.384,10 | 0,00 | 226,07 | 0,00 |
| | Figueira da Foz | 33.649,41 | 32.225,19 | 0,00 | 1.424,22 | 0,00 |
| | Mira | 6.224,93 | 5.877,38 | 0,00 | 347,55 | 0,00 |
| | Montemor-o-Velho | 8.778,12 | 8.353,90 | 0,00 | 424,22 | 0,00 |
| | Penacova | 4.156,43 | 3.925,22 | 0,00 | 231,21 | 0,00 |
| | Soure | 6.311,66 | 6.004,92 | 0,00 | 306,74 | 0,00 |
| ***Pinhal Litoral*** | Batalha | 6.097,10 | 5.699,82 | 0,00 | 397,28 | 0,00 |
| | Leiria | 49.821,33 | 46.575,02 | 0,00 | 3.246,31 | 0,00 |
| | Marinha Grande | 19.279,36 | 17.949,64 | 0,00 | 1.329,72 | 0,00 |
| | Pombal | 15.392,86 | 14.389,88 | 0,00 | 1.002,98 | 0,00 |
| | Porto de Mós | 8.222,42 | 7.686,65 | 0,00 | 535,77 | 0,00 |
| ***Pinhal Interior Norte*** | Arganil | 4.012,86 | 3.821,22 | 0,00 | 191,64 | 0,00 |
| | Góis | 1.506,13 | 1.418,48 | 0,00 | 87,65 | 0,00 |
| | Lousã | 5.832,87 | 5.547,51 | 0,00 | 285,36 | 0,00 |
| | Miranda do Corvo | 4.381,99 | 4.234,24 | 0,00 | 147,75 | 0,00 |
| | Oliveira do Hospital | 6.916,43 | 6.713,58 | 0,00 | 202,85 | 0,00 |
| | Pampilhosa da Serra | 1.636,68 | 1.586,90 | 0,00 | 49,78 | 0,00 |
| | Penela | 1.773,28 | 1.682,32 | 0,00 | 90,96 | 0,00 |
| | Tábua | 4.200,95 | 4.130,34 | 0,00 | 70,61 | 0,00 |
| | Vila Nova de Poiares | 2.477,59 | 2.387,12 | 0,00 | 90,47 | 0,00 |
| ***Dão Lafões*** | Alvaiázere | 1.749,24 | 1.643,32 | 0,00 | 105,92 | 0,00 |
| | Ansião | 3.467,91 | 3.297,36 | 0,00 | 170,55 | 0,00 |
| | Castanheira de Pêra | 1.037,33 | 975,26 | 0,00 | 62,07 | 0,00 |
| | Figueiró dos Vinhos | 1.846,17 | 1.754,12 | 0,00 | 92,05 | 0,00 |
| | Pedrógão Grande | 1.168,08 | 1.104,76 | 0,00 | 63,32 | 0,00 |
| | Aguiar da Beira | 1.700,31 | 1.659,08 | 0,00 | 41,23 | 0,00 |
| | Carregal do Sal | 3.859,25 | 3.748,30 | 0,00 | 110,95 | 0,00 |
| | Castro Daire | 4.087,54 | 4.004,64 | 0,00 | 82,90 | 0,00 |
| | Mangualde | 7.344,36 | 7.172,28 | 0,00 | 172,08 | 0,00 |
| | Mortágua | 2.948,97 | 2.810,00 | 0,00 | 138,97 | 0,00 |
| | Nelas | 5.643,35 | 5.524,74 | 0,00 | 118,61 | 0,00 |
| | Oliveira de Frades | 3.032,70 | 2.985,10 | 0,00 | 47,60 | 0,00 |
| | Penalva do Castelo | 2.077,28 | 2.038,32 | 0,00 | 38,96 | 0,00 |
| | Santa Comba Dão | 4.402,45 | 4.274,30 | 0,00 | 128,15 | 0,00 |

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| NUTS III | Municipality | Total | Bulk collection | | Selective collection | Energy valorisation of waste |
|---|---|---|---|---|---|---|
| | | | Landfill | Organic valorisation | | |
| ***Dão Lafões*** | São Pedro do Sul | 5.685,23 | 5.547,27 | 0,00 | 137,96 | 0,00 |
| | Sátão | 3.455,11 | 3.392,74 | 0,00 | 62,37 | 0,00 |
| | Tondela | 9.925,46 | 9.647,84 | 0,00 | 277,62 | 0,00 |
| | Vila Nova de Paiva | 1.467,32 | 1.437,34 | 0,00 | 29,98 | 0,00 |
| | Viseu | 37.721,51 | 36.074,44 | 0,00 | 1.647,07 | 0,00 |
| | Vouzela | 3.087,95 | 3.003,23 | 0,00 | 84,72 | 0,00 |
| ***Pinhal Interior Sul*** | Oleiros | 1.460,44 | 1.433,24 | 0,00 | 27,20 | 0,00 |
| | Proença-a-Nova | 2.524,42 | 2.476,08 | 0,00 | 48,34 | 0,00 |
| | Sertã | 4.050,30 | 3.753,16 | 0,00 | 297,14 | 0,00 |
| | Vila de Rei | 837,80 | 837,80 | 0,00 | 0,00 | 0,00 |
| | Mação | 2.312,73 | 2.312,73 | 0,00 | 0,00 | 0,00 |
| ***Serra Estrela*** | Fornos de Algodres | 1.704,58 | 1.532,91 | 135,570,00 | 36,10 | 0,00 |
| | Gouveia | 5.415,07 | 5.268,38 | 0,00 | 146,69 | 0,00 |
| | Seia | 9.019,29 | 8.648,42 | 0,00 | 370,87 | 0,00 |
| ***Beira Interior Norte*** | Almeida | 2.804,17 | 2.691,75 | 50,14 | 62,28 | 0,00 |
| | Celorico da Beira | 2.709,13 | 2.438,29 | 215,64 | 55,20 | 0,00 |
| | Fig. Castelo Rodrigo | 2.387,64 | 2.300,94 | 42,84 | 43,86 | 0,00 |
| | Guarda | 16.511,06 | 11.645,78 | 4.381,40 | 483,88 | 0,00 |
| | Manteigas | 1.260,63 | 882,26 | 318,32 | 60,05 | 0,00 |
| | Meda | 1.617,57 | 1.448,93 | 128,74 | 39,90 | 0,00 |
| | Pinhel | 3.609,06 | 3.504,07 | 65,23 | 39,76 | 0,00 |
| | Sabugal | 4.512,24 | 4.408,28 | 22,70 | 81,26 | 0,00 |
| | Trancoso | 2.800,53 | 2.518,81 | 222,94 | 58,78 | 0,00 |
| ***Beira Interior Sul*** | Castelo Branco | 22.885,23 | 21.955,65 | 0,00 | 929,58 | 0,00 |
| | Idanha-a-Nova | 4.816,88 | 4.698,48 | 0,00 | 118,40 | 0,00 |
| | Penamacor | 1.969,52 | 1.881,22 | 25,40 | 62,90 | 0,00 |
| | Vila Velha de Ródão | 1.368,44 | 1.323,96 | 0,00 | 44,48 | 0,00 |
| ***Cova Beira*** | Belmonte | 2.162,22 | 904,46 | 1.193,39 | 64,37 | 0,00 |
| | Covilhã | 16.929,90 | 5.665,12 | 11.264,78 | 0,00 | 0,00 |
| | Fundão | 11.795,04 | 2.259,02 | 9.164,26 | 371,76 | 0,00 |
| ***Oeste*** | Alcobaça | 24.707,90 | 23.613,18 | 0,00 | 1.094,72 | 0,00 |
| | Bombarral | 6.163,76 | 19.024,84 | 0,00 | 317,92 | 0,00 |
| | Caldas da Rainha | 24.580,37 | 5.091,76 | 0,00 | 1.048,92 | 0,00 |
| | Nazaré | 11.178,55 | 5.845,84 | 0,00 | 326,38 | 0,00 |
| | Óbidos | 5.927,54 | 6.007,79 | 0,00 | 239,23 | 0,00 |
| | Peniche | 19.270,48 | 23.531,45 | 0,00 | 939,72 | 0,00 |
| | Alenquer | 19.550,32 | 10.549,35 | 0,00 | 525,48 | 0,00 |
| | Arruda dos Vinhos | 5.309,66 | 10.852,17 | 0,00 | 217,90 | 0,00 |
| | Cadaval | 6.304,89 | 5.688,31 | 0,00 | 297,10 | 0,00 |
| | Lourinhã | 11.122,56 | 18.330,76 | 0,00 | 573,21 | 0,00 |
| | Sobral de Monte Agraço | 4.410,62 | 4.257,18 | 0,00 | 153,44 | 0,00 |
| | Torres Vedras | 35.336,48 | 33.389,95 | 0,00 | 1.946,53 | 0,00 |
| ***Médio Tejo*** | Abrantes | 15.535,73 | 15.535,73 | 0,00 | 0,00 | 0,00 |
| | Alcanena | 5.119,04 | 4.913,78 | 0,00 | 205,26 | 0,00 |
| | Constância | 2.187,11 | 2.067,74 | 0,00 | 119,37 | 0,00 |
| | Entroncamento | 7.786,33 | 7.402,47 | 0,00 | 383,86 | 0,00 |
| | Ferreira do Zêzere | 2.841,06 | 2.708,66 | 0,00 | 132,40 | 0,00 |
| | Sardoal | 1.310,20 | 14.041,08 | 0,00 | 0,00 | 0,00 |
| | Tomar | 16.632,65 | 1.310,20 | 0,00 | 621,11 | 0,00 |
| | Torres Novas | 15.135,65 | 16.011,54 | 0,00 | 438,81 | 0,00 |
| | Vila Nova da Barquinha | 3.413,30 | 14.696,84 | 0,00 | 109,11 | 0,00 |
| | Ourém | 15.019,75 | 3.304,19 | 0,00 | 978,67 | 0,00 |
| | **Total** | **922.029,13** | | **27.231,35** | **43.075,26** | **0,00** |

Table A7.2: Bioenergy potential for landfill biogas (toe) per municipality.

| *NUTS III* | *Municipality* | *MW in landfills (t)* | *Produced biogas ($m^3$/year)* | ***Energy potential (toe)*** |
|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 14.565,16 | 87.390,96 | **37,36** |
| | Albergaria-a-Velha | 6.812,30 | 40.873,80 | **17,47** |
| | Anadia | 9.259,46 | 55.556,76 | **23,75** |
| | Aveiro | 35.029,60 | 210.177,60 | **89,86** |
| | Estarreja | 8.485,90 | 50.915,40 | **21,77** |
| | Ílhavo | 18.158,22 | 108.949,32 | **46,58** |
| | Mealhada | 7.037,02 | 42.222,12 | **18,05** |
| | Murtosa | 4.642,28 | 27.853,68 | **11,91** |
| | Oliveira do Bairro | 7.113,78 | 42.682,68 | **18,25** |
| | Ovar | 24.762,88 | 148.577,28 | **63,52** |
| | Sever do Vouga | 2.905,40 | 17.432,40 | **7,45** |
| | Vagos | 6.452,04 | 38.712,24 | **16,55** |
| ***Baixo Mondego*** | Cantanhede | 10.096,50 | 60.579,00 | **25,90** |
| | Coimbra | 63.749,56 | 382.497,36 | **163,53** |
| | Condeixa-a-Nova | 5.384,10 | 32.304,60 | **13,81** |
| | Figueira da Foz | 32.225,19 | 193.351,14 | **82,66** |
| | Mira | 5.877,38 | 35.264,28 | **15,08** |
| | Montemor-o-Velho | 8.353,90 | 50.123,40 | **21,43** |
| | Penacova | 3.925,22 | 23.551,32 | **10,07** |
| | Soure | 6.004,92 | 36.029,52 | **15,40** |
| ***Pinhal Litoral*** | Batalha | 5.699,82 | 34.198,92 | **14,62** |
| | Leiria | 46.575,02 | 279.450,12 | **119,47** |
| | Marinha Grande | 17.949,64 | 107.697,84 | **46,04** |
| | Pombal | 14.389,88 | 86.339,28 | **36,91** |
| | Porto de Mós | 7.686,65 | 46.119,90 | **19,72** |
| ***Pinhal Interior Norte*** | Arganil | 3.821,22 | 22.927,32 | **9,80** |
| | Góis | 1.418,48 | 8.510,88 | **3,64** |
| | Lousã | 5.547,51 | 33.285,06 | **14,23** |
| | Miranda do Corvo | 4.234,24 | 25.405,44 | **10,86** |
| | Oliveira do Hospital | 6.713,58 | 40.281,48 | **17,22** |
| | Pampilhosa da Serra | 1.586,90 | 9.521,40 | **4,07** |
| | Penela | 1.682,32 | 10.093,92 | **4,32** |
| | Tábua | 4.130,34 | 24.782,04 | **10,60** |
| | Vila Nova de Poiares | 2.387,12 | 14.322,72 | **6,12** |
| | Alvaiázere | 1.643,32 | 9.859,92 | **4,22** |
| | Ansião | 3.297,36 | 19.784,16 | **8,46** |
| | Castanheira de Pêra | 975,26 | 5.851,56 | **2,50** |
| | Figueiró dos Vinhos | 1.754,12 | 10.524,72 | **4,50** |
| | Pedrógão Grande | 1.104,76 | 6.628,56 | **2,83** |
| ***Dão Lafões*** | Aguiar da Beira | 1.659,08 | 9.954,48 | **4,26** |
| | Carregal do Sal | 3.748,30 | 22.489,80 | **9,62** |
| | Castro Daire | 4.004,64 | 24.027,84 | **10,27** |
| | Mangualde | 7.172,28 | 43.033,68 | **18,40** |
| | Mortágua | 2.810,00 | 16.860,00 | **7,21** |
| | Nelas | 5.524,74 | 33.148,44 | **14,17** |
| | Oliveira de Frades | 2.985,10 | 17.910,60 | **7,66** |
| | Penalva do Castelo | 2.038,32 | 12.229,92 | **5,23** |
| | Santa Comba Dão | 4.274,30 | 25.645,80 | **10,96** |

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| *NUTS III* | *Municipality* | *MW in landfills (t)* | *Produced biogas ($m^3$/year)* | ***Energy potential (toe)*** |
|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 5.547,27 | 33.283,62 | **14,23** |
| | Sátão | 3.392,74 | 20.356,44 | **8,70** |
| | Tondela | 9.647,84 | 57.887,04 | **24,75** |
| | Vila Nova de Paiva | 1.437,34 | 8.624,04 | **3,69** |
| | Viseu | 36.074,44 | 216.446,64 | **92,54** |
| | Vouzela | 3.003,23 | 18.019,38 | **7,70** |
| ***Pinhal Interior Sul*** | Oleiros | 1.433,24 | 8.599,44 | **3,68** |
| | Proença-a-Nova | 2.476,08 | 14.856,48 | **6,35** |
| | Sertã | 3.753,16 | 22.518,96 | **9,63** |
| | Vila de Rei | 837,80 | 5.026,80 | **2,15** |
| | Mação | 2.312,73 | 13.876,38 | **5,93** |
| ***Serra Estrela*** | Fornos de Algodres | 1.532,91 | 9.197,46 | **3,93** |
| | Gouveia | 5.268,38 | 31.610,28 | **13,51** |
| | Seia | 8.648,42 | 51.890,52 | **22,18** |
| ***Beira Interior Norte*** | Almeida | 2.691,75 | 16.150,50 | **6,90** |
| | Celorico da Beira | 2.438,29 | 14.629,74 | **6,25** |
| | Fig. Castelo Rodrigo | 2.300,94 | 13.805,64 | **5,90** |
| | Guarda | 11.645,78 | 69.874,68 | **29,87** |
| | Manteigas | 882,26 | 5.293,56 | **2,26** |
| | Meda | 1.448,93 | 8.693,58 | **3,72** |
| | Pinhel | 3.504,07 | 21.024,42 | **8,99** |
| | Sabugal | 4.408,28 | 26.449,68 | **11,31** |
| | Trancoso | 2.518,81 | 15.112,86 | **6,46** |
| ***Beira Interior Sul*** | Castelo Branco | 21.955,65 | 131.733,90 | **56,32** |
| | Idanha-a-Nova | 4.698,48 | 28.190,88 | **12,05** |
| | Penamacor | 1.881,22 | 11.287,32 | **4,83** |
| | Vila Velha de Ródão | 1.323,96 | 7.943,76 | **3,40** |
| ***Cova Beira*** | Belmonte | 904,46 | 5.426,76 | **2,32** |
| | Covilhã | 5.665,12 | 33.990,72 | **14,53** |
| | Fundão | 2.259,02 | 13.554,12 | **5,79** |
| ***Oeste*** | Alcobaça | 23.613,18 | 141.679,08 | **60,57** |
| | Bombarral | 19.024,84 | 114.149,04 | **48,80** |
| | Caldas da Rainha | 5.091,76 | 30.550,56 | **13,06** |
| | Nazaré | 5.845,84 | 35.075,04 | **15,00** |
| | Óbidos | 6.007,79 | 36.046,74 | **15,41** |
| | Peniche | 23.531,45 | 141.188,70 | **60,36** |
| | Alenquer | 10.549,35 | 63.296,10 | **27,06** |
| | Arruda dos Vinhos | 10.852,17 | 65.113,02 | **27,84** |
| | Cadaval | 5.688,31 | 34.129,86 | **14,59** |
| | Lourinhã | 18.330,76 | 109.984,56 | **47,02** |
| | Sobral de Monte Agraço | 4.257,18 | 25.543,08 | **10,92** |
| | Torres Vedras | 33.389,95 | 200.339,70 | **85,65** |
| ***Médio Tejo*** | Abrantes | 15.535,73 | 93.214,38 | **39,85** |
| | Alcanena | 4.913,78 | 29.482,68 | **12,60** |
| | Constância | 2.067,74 | 12.406,44 | **5,30** |
| | Entroncamento | 7.402,47 | 44.414,82 | **18,99** |
| | Ferreira do Zêzere | 2.708,66 | 16.251,96 | **6,95** |
| | Sardoal | 14.041,08 | 84.246,48 | **36,02** |
| | Tomar | 1.310,20 | 7.861,20 | **3,36** |
| | Torres Novas | 16.011,54 | 96.069,24 | **41,07** |
| | Vila Nova da Barquinha | 14.696,84 | 88.181,04 | **37,70** |
| | Ourém | 3.304,19 | 19.825,14 | **8,48** |
| | **Total** | **851.722,52** | **5.110.335,12** | **2.184,84** |

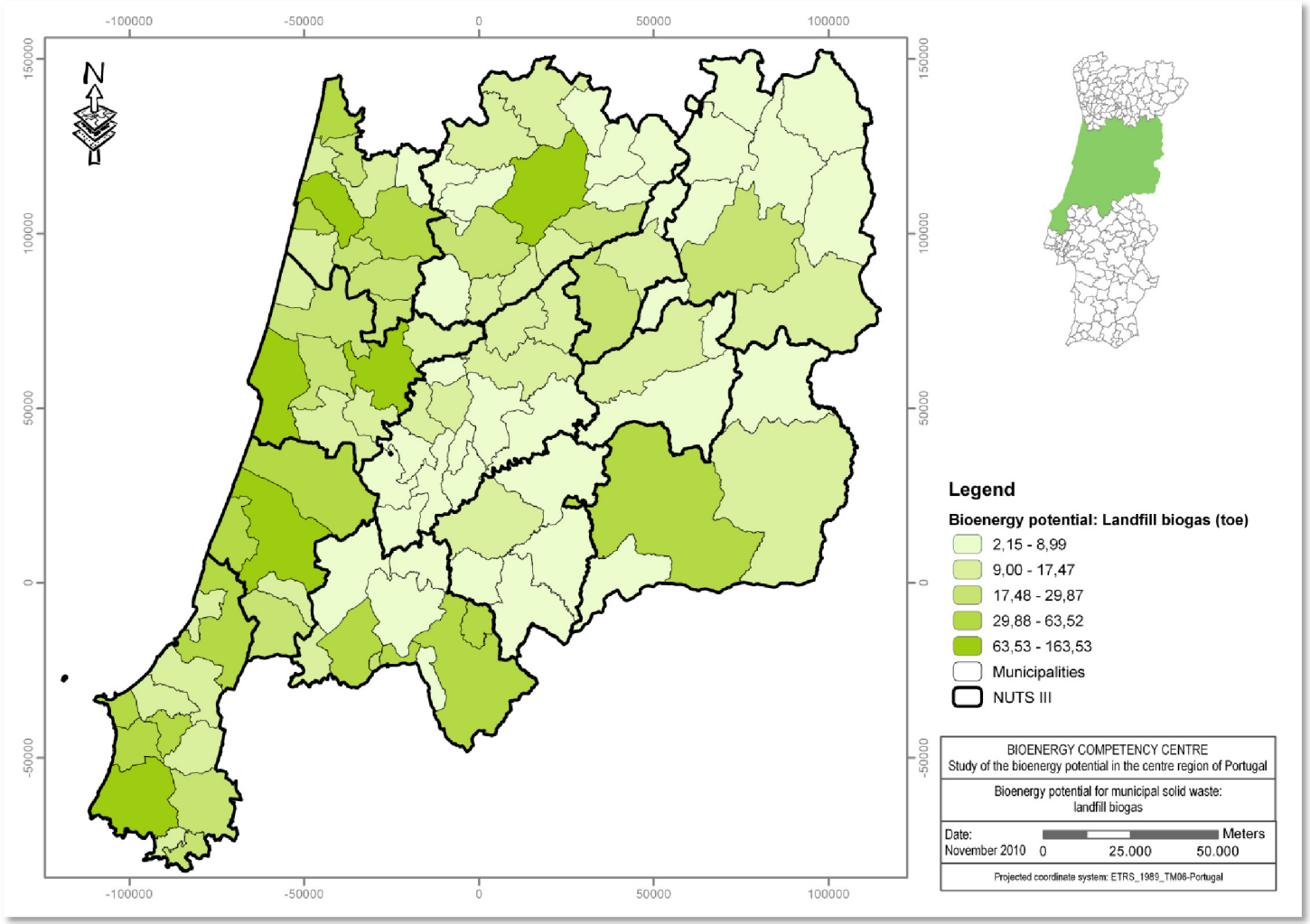


Figure A7.1: Map for the bioenergy potential for landfill biogas.

Table A7.3: Bioenergy potential for organic valorisation (toe) per municipality.

| *NUTS III* | *Municipality* | *Organic matter (t)* | *Produced biogas ($m^3$/year)* | ***Energy potential (toe)*** |
|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0,00 | 0,00 | **0,00** |
| | Albergaria-a-Velha | 0,00 | 0,00 | **0,00** |
| | Anadia | 0,00 | 0,00 | **0,00** |
| | Aveiro | 0,00 | 0,00 | **0,00** |
| | Estarreja | 0,00 | 0,00 | **0,00** |
| | Ílhavo | 0,00 | 0,00 | **0,00** |
| | Mealhada | 0,00 | 0,00 | **0,00** |
| | Murtosa | 0,00 | 0,00 | **0,00** |
| | Oliveira do Bairro | 0,00 | 0,00 | **0,00** |
| | Ovar | 0,00 | 0,00 | **0,00** |
| | Sever do Vouga | 0,00 | 0,00 | **0,00** |
| | Vagos | 0,00 | 0,00 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 0,00 | 0,00 | **0,00** |
| | Coimbra | 0,00 | 0,00 | **0,00** |
| | Condeixa-a-Nova | 0,00 | 0,00 | **0,00** |
| | Figueira da Foz | 0,00 | 0,00 | **0,00** |
| | Mira | 0,00 | 0,00 | **0,00** |
| | Montemor-o-Velho | 0,00 | 0,00 | **0,00** |
| | Penacova | 0,00 | 0,00 | **0,00** |
| | Soure | 0,00 | 0,00 | **0,00** |
| ***Pinhal Litoral*** | Batalha | 0,00 | 0,00 | **0,00** |
| | Leiria | 0,00 | 0,00 | **0,00** |
| | Marinha Grande | 0,00 | 0,00 | **0,00** |
| | Pombal | 0,00 | 0,00 | **0,00** |
| | Porto de Mós | 0,00 | 0,00 | **0,00** |
| ***Pinhal Interior Norte*** | Arganil | 0,00 | 0,00 | **0,00** |
| | Góis | 0,00 | 0,00 | **0,00** |
| | Lousã | 0,00 | 0,00 | **0,00** |
| | Miranda do Corvo | 0,00 | 0,00 | **0,00** |
| | Oliveira do Hospital | 0,00 | 0,00 | **0,00** |
| | Pampilhosa da Serra | 0,00 | 0,00 | **0,00** |
| | Penela | 0,00 | 0,00 | **0,00** |
| | Tábua | 0,00 | 0,00 | **0,00** |
| | Vila Nova de Poiares | 0,00 | 0,00 | **0,00** |
| | Alvaiázere | 0,00 | 0,00 | **0,00** |
| | Ansião | 0,00 | 0,00 | **0,00** |
| | Castanheira de Pêra | 0,00 | 0,00 | **0,00** |
| | Figueiró dos Vinhos | 0,00 | 0,00 | **0,00** |
| | Pedrógão Grande | 0,00 | 0,00 | **0,00** |
| ***Dão Lafões*** | Aguiar da Beira | 0,00 | 0,00 | **0,00** |
| | Carregal do Sal | 0,00 | 0,00 | **0,00** |
| | Castro Daire | 0,00 | 0,00 | **0,00** |
| | Mangualde | 0,00 | 0,00 | **0,00** |
| | Mortágua | 0,00 | 0,00 | **0,00** |
| | Nelas | 0,00 | 0,00 | **0,00** |
| | Oliveira de Frades | 0,00 | 0,00 | **0,00** |
| | Penalva do Castelo | 0,00 | 0,00 | **0,00** |
| | Santa Comba Dão | 0,00 | 0,00 | **0,00** |

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| *NUTS III* | *Municipality* | *Organic matter (t)* | *Produced biogas ($m^3$/year)* | ***Energy potential (toe)*** |
|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 0,00 | 0,00 | **0,00** |
| | Sátão | 0,00 | 0,00 | **0,00** |
| | Tondela | 0,00 | 0,00 | **0,00** |
| | Vila Nova de Paiva | 0,00 | 0,00 | **0,00** |
| | Viseu | 0,00 | 0,00 | **0,00** |
| | Vouzela | 0,00 | 0,00 | **0,00** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 0,00 | **0,00** |
| | Proença-a-Nova | 0,00 | 0,00 | **0,00** |
| | Sertã | 0,00 | 0,00 | **0,00** |
| | Vila de Rei | 0,00 | 0,00 | **0,00** |
| | Mação | 0,00 | 0,00 | **0,00** |
| ***Serra Estrela*** | Fornos de Algodres | 135,57 | 16.946,25 | **9,11** |
| | Gouveia | 0,00 | 0,00 | **0,00** |
| | Seia | 0,00 | 0,00 | **0,00** |
| ***Beira Interior Norte*** | Almeida | 50,14 | 6.267,50 | **3,37** |
| | Celorico da Beira | 215,64 | 26.955,00 | **14,49** |
| | Fig. Castelo Rodrigo | 42,84 | 5.355,00 | **2,88** |
| | Guarda | 4.381,40 | 547.675,00 | **294,32** |
| | Manteigas | 318,32 | 39.790,00 | **21,38** |
| | Meda | 128,74 | 16.092,50 | **8,65** |
| | Pinhel | 65,23 | 8.153,75 | **4,38** |
| | Sabugal | 22,70 | 2.837,50 | **1,52** |
| | Trancoso | 222,94 | 27.867,50 | **14,98** |
| ***Beira Interior Sul*** | Castelo Branco | 0,00 | 0,00 | **0,00** |
| | Idanha-a-Nova | 0,00 | 0,00 | **0,00** |
| | Penamacor | 25,40 | 3.175,00 | **1,71** |
| | Vila Velha de Ródão | 0,00 | 0,00 | **0,00** |
| ***Cova Beira*** | Belmonte | 1.193,39 | 149.173,75 | **80,17** |
| | Covilhã | 11.264,78 | 1.408.097,50 | **756,72** |
| | Fundão | 9.164,26 | 1.145.532,50 | **615,61** |
| ***Oeste*** | Alcobaça | 0,00 | 0,00 | **0,00** |
| | Bombarral | 0,00 | 0,00 | **0,00** |
| | Caldas da Rainha | 0,00 | 0,00 | **0,00** |
| | Nazaré | 0,00 | 0,00 | **0,00** |
| | Óbidos | 0,00 | 0,00 | **0,00** |
| | Peniche | 0,00 | 0,00 | **0,00** |
| | Alenquer | 0,00 | 0,00 | **0,00** |
| | Arruda dos Vinhos | 0,00 | 0,00 | **0,00** |
| | Cadaval | 0,00 | 0,00 | **0,00** |
| | Lourinhã | 0,00 | 0,00 | **0,00** |
| | Sobral de Monte Agraço | 0,00 | 0,00 | **0,00** |
| | Torres Vedras | 0,00 | 0,00 | **0,00** |
| ***Médio Tejo*** | Abrantes | 0,00 | 0,00 | **0,00** |
| | Alcanena | 0,00 | 0,00 | **0,00** |
| | Constância | 0,00 | 0,00 | **0,00** |
| | Entroncamento | 0,00 | 0,00 | **0,00** |
| | Ferreira do Zêzere | 0,00 | 0,00 | **0,00** |
| | Sardoal | 0,00 | 0,00 | **0,00** |
| | Tomar | 0,00 | 0,00 | **0,00** |
| | Torres Novas | 0,00 | 0,00 | **0,00** |
| | Vila Nova da Barquinha | 0,00 | 0,00 | **0,00** |
| | Ourém | 0,00 | 0,00 | **0,00** |
| | **Total** | **27.231,35** | **3.403.918,75** | **1.829,28** |

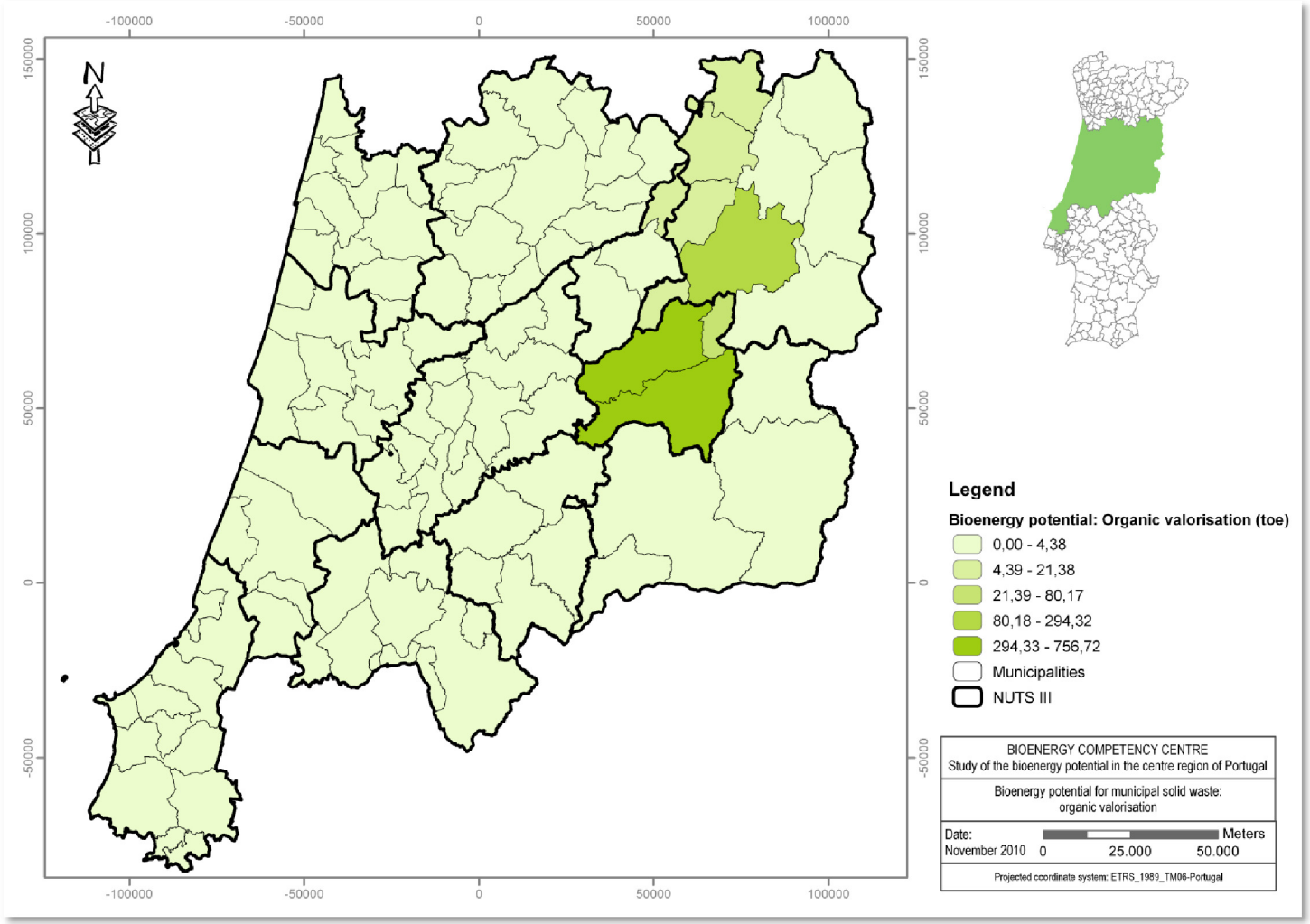


Figure A7.2: Map for the bioenergy potential for organic valorisation.

Table A7.4: Bioenergy potential for direct combustion (toe) per municipality.

| *NUTS III* | *Municipality* | *MW in landfills (t)* | *Paper/cardboard (t)* | ***Energy potential (toe)*** | *Plastic (t)* | ***Energy potential (toe)*** | *Textile (t)* | ***Energy potential (toe)*** | *Fine matter (t)* | ***Energy potential (toe)*** | *Other material (t)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 14.565,16 | 3.451,943 | **885** | 1.617 | **914** | 495 | **93** | 1.747,819 | **568** | 830,214 | **459** |
| | Albergaria-a-Velha | 6.812,30 | 1.614,515 | **414** | 756 | **427** | 232 | **43** | 817,476 | **266** | 388,301 | **215** |
| | Anadia | 9.259,46 | 2.194,492 | **562** | 1.028 | **581** | 315 | **59** | 1.111,135 | **361** | 527,789 | **292** |
| | Aveiro | 35.029,60 | 8.302,015 | **2.127** | 3.888 | **2.197** | 1.191 | **223** | 4.203,552 | **1.366** | 1.996,687 | **1.105** |
| | Estarreja | 8.485,90 | 2.011,158 | **515** | 942 | **532** | 289 | **54** | 1.018,308 | **331** | 483,696 | **268** |
| | Ílhavo | 18.158,22 | 4.303,498 | **1.103** | 2.016 | **1.139** | 617 | **115** | 2.178,986 | **708** | 1.035,019 | **573** |
| | Mealhada | 7.037,02 | 1.667,774 | **427** | 781 | **441** | 239 | **45** | 844,442 | **274** | 401,110 | **222** |
| | Murtosa | 4.642,28 | 1.100,220 | **282** | 515 | **291** | 158 | **30** | 557,074 | **181** | 264,610 | **146** |
| | Oliveira do Bairro | 7.113,78 | 1.685,966 | **432** | 790 | **446** | 242 | **45** | 853,654 | **277** | 405,485 | **224** |
| | Ovar | 24.762,88 | 5.868,803 | **1.504** | 2.749 | **1.553** | 842 | **157** | 2.971,546 | **965** | 1.411,484 | **781** |
| | Sever do Vouga | 2.905,40 | 688,580 | **176** | 322 | **182** | 99 | **18** | 348,648 | **113** | 165,608 | **92** |
| | Vagos | 6.452,04 | 1.529,133 | **392** | 716 | **405** | 219 | **41** | 774,245 | **252** | 367,766 | **203** |
| ***Baixo Mondego*** | Cantanhede | 10.096,50 | 2.392,871 | **613** | 1.121 | **633** | 343 | **64** | 1.211,580 | **394** | 575,501 | **318** |
| | Coimbra | 63.749,56 | 15.108,646 | **3.872** | 7.076 | **3.999** | 2.167 | **405** | 7.649,947 | **2.485** | 3.633,725 | **2.011** |
| | Condeixa-a-Nova | 5.384,10 | 1.276,032 | **327** | 598 | **338** | 183 | **34** | 646,092 | **210** | 306,894 | **170** |
| | Figueira da Foz | 32.225,19 | 7.637,370 | **1.957** | 3.577 | **2.021** | 1.096 | **205** | 3.867,023 | **1.256** | 1.836,836 | **1.016** |
| | Mira | 5.877,38 | 1.392,939 | **357** | 652 | **369** | 200 | **37** | 705,286 | **229** | 335,011 | **185** |
| | Montemor-o-Velho | 8.353,90 | 1.979,874 | **507** | 927 | **524** | 284 | **53** | 1.002,468 | **326** | 476,172 | **263** |
| | Penacova | 3.925,22 | 930,277 | **238** | 436 | **246** | 133 | **25** | 471,026 | **153** | 223,738 | **124** |
| | Soure | 6.004,92 | 1.423,166 | **365** | 667 | **377** | 204 | **38** | 720,590 | **234** | 342,280 | **189** |
| ***Pinhal Litoral*** | Batalha | 5.699,82 | 1.350,857 | **346** | 633 | **358** | 194 | **36** | 683,978 | **222** | 324,890 | **180** |
| | Leiria | 46.575,02 | 11.038,280 | **2.829** | 5.170 | **2.921** | 1.584 | **296** | 5.589,002 | **1.816** | 2.654,776 | **1.469** |
| | Marinha Grande | 17.949,64 | 4.254,065 | **1.090** | 1.992 | **1.126** | 610 | **114** | 2.153,957 | **700** | 1.023,129 | **566** |
| | Pombal | 14.389,88 | 3.410,402 | **874** | 1.597 | **903** | 489 | **92** | 1.726,786 | **561** | 820,223 | **454** |
| | Porto de Mós | 7.686,65 | 1.821,736 | **467** | 853 | **482** | 261 | **49** | 922,398 | **300** | 438,139 | **242** |

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| *NUTS III* | *Municipality* | *MW in landfills (t)* | *Paper/cardboard (t)* | ***Energy potential (toe)*** | *Plastic (t)* | ***Energy potential (toe)*** | *Textile (t)* | ***Energy potential (toe)*** | *Fine matter (t)* | ***Energy potential (toe)*** | *Other material (t)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Pinhal Interior Norte*** | Arganil | 3.821,22 | 905,629 | **232** | 424 | **240** | 130 | **24** | 458,546 | **149** | 217,810 | **121** |
| | Góis | 1.418,48 | 336,180 | **86** | 157 | **89** | 48 | **9** | 170,218 | **55** | 80,853 | **45** |
| | Lousã | 5.547,51 | 1.314,760 | **337** | 616 | **348** | 189 | **35** | 665,701 | **216** | 316,208 | **175** |
| | Miranda do Corvo | 4.234,24 | 1.003,515 | **257** | 470 | **266** | 144 | **27** | 508,109 | **165** | 241,352 | **134** |
| | Oliveira do Hospital | 6.713,58 | 1.591,118 | **408** | 745 | **421** | 228 | **43** | 805,630 | **262** | 382,674 | **212** |
| | Pampilhosa da Serra | 1.586,90 | 376,095 | **96** | 176 | **100** | 54 | **10** | 190,428 | **62** | 90,453 | **50** |
| | Penela | 1.682,32 | 398,710 | **102** | 187 | **106** | 57 | **11** | 201,878 | **66** | 95,892 | **53** |
| | Tábua | 4.130,34 | 978,891 | **251** | 458 | **259** | 140 | **26** | 495,641 | **161** | 235,429 | **130** |
| | Vila Nova de Poiares | 2.387,12 | 565,747 | **145** | 265 | **150** | 81 | **15** | 286,454 | **93** | 136,066 | **75** |
| | Alvaiázere | 1.643,32 | 389,467 | **100** | 182 | **103** | 56 | **10** | 197,198 | **64** | 93,669 | **52** |
| | Ansião | 3.297,36 | 781,474 | **200** | 366 | **207** | 112 | **21** | 395,683 | **129** | 187,950 | **104** |
| | Castanheira de Pêra | 975,26 | 231,137 | **59** | 108 | **61** | 33 | **6** | 117,031 | **38** | 55,590 | **31** |
| | Figueiró dos Vinhos | 1.754,12 | 415,726 | **107** | 195 | **110** | 60 | **11** | 210,494 | **68** | 99,985 | **55** |
| | Pedrógão Grande | 1.104,76 | 261,828 | **67** | 123 | **69** | 38 | **7** | 132,571 | **43** | 62,971 | **35** |
| ***Dão Lafões*** | Aguiar da Beira | 1.659,08 | 393,202 | **101** | 184 | **104** | 56 | **11** | 199,090 | **65** | 94,568 | **52** |
| | Carregal do Sal | 3.748,30 | 888,347 | **228** | 416 | **235** | 127 | **24** | 449,796 | **146** | 213,653 | **118** |
| | Castro Daire | 4.004,64 | 949,100 | **243** | 445 | **251** | 136 | **25** | 480,557 | **156** | 228,264 | **126** |
| | Mangualde | 7.172,28 | 1.699,830 | **436** | 796 | **450** | 244 | **46** | 860,674 | **280** | 408,820 | **226** |
| | Mortágua | 2.810,00 | 665,970 | **171** | 312 | **176** | 96 | **18** | 337,200 | **110** | 160,170 | **89** |
| | Nelas | 5.524,74 | 1.309,363 | **336** | 613 | **347** | 188 | **35** | 662,969 | **215** | 314,910 | **174** |
| | Oliveira de Frades | 2.985,10 | 707,469 | **181** | 331 | **187** | 101 | **19** | 358,212 | **116** | 170,151 | **94** |
| | Penalva do Castelo | 2.038,32 | 483,082 | **124** | 226 | **128** | 69 | **13** | 244,598 | **79** | 116,184 | **64** |
| | Santa Comba Dão | 4.274,30 | 1.013,009 | **260** | 474 | **268** | 145 | **27** | 512,916 | **167** | 243,635 | **135** |
| | São Pedro do Sul | 5.547,27 | 1.314,703 | **337** | 616 | **348** | 189 | **35** | 665,672 | **216** | 316,194 | **175** |
| | Sátão | 3.392,74 | 804,079 | **206** | 377 | **213** | 115 | **22** | 407,129 | **132** | 193,386 | **107** |
| | Tondela | 9.647,84 | 2.286,538 | **586** | 1.071 | **605** | 328 | **61** | 1.157,741 | **376** | 549,927 | **304** |
| | Vila Nova de Paiva | 1.437,34 | 340,650 | **87** | 160 | **90** | 49 | **9** | 172,481 | **56** | 81,928 | **45** |

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| *NUTS III* | *Municipality* | *MW in landfills (t)* | *Paper/cardboard (t)* | ***Energy potential (toe)*** | *Plastic (t)* | ***Energy potential (toe)*** | *Textile (t)* | ***Energy potential (toe)*** | *Fine matter (t)* | ***Energy potential (toe)*** | *Other material (t)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | Viseu | 37.721,51 | 8.549,642 | **2.191** | 4.004 | **2.263** | 1.227 | **229** | 4.328,933 | 1.406 | 2.056,243 | **1.138** |
| | Vouzela | 3.087,95 | 711,766 | **182** | 333 | **188** | 102 | **19** | 360,388 | 117 | 171,184 | **95** |
| ***Pinhal Interior Sul*** | Oleiros | 1.460,44 | 339,678 | **87** | 159 | **90** | 49 | **9** | 171,989 | 56 | 81,695 | **45** |
| | Proença-a-Nova | 2.524,42 | 586,831 | **150** | 275 | **155** | 84 | **16** | 297,130 | 97 | 141,137 | **78** |
| | Sertã | 4.050,30 | 889,499 | **228** | 417 | **235** | 128 | **24** | 450,379 | 146 | 213,930 | **118** |
| | Vila de Rei | 837,80 | 198,559 | **51** | 93 | **53** | 28 | **5** | 100,536 | 33 | 47,755 | **26** |
| | Mação | 2.312,73 | 548,117 | **140** | 257 | **145** | 79 | **15** | 277,528 | 90 | 131,826 | **73** |
| ***Serra Estrela*** | Fornos de Algodres | 1.704,58 | 363,300 | **93** | 170 | **96** | 52 | **10** | 183,949 | 60 | 87,376 | **48** |
| | Gouveia | 5.415,07 | 1.248,606 | **320** | 585 | **330** | 179 | **34** | 632,206 | 205 | 300,298 | **166** |
| | Seia | 9.019,29 | 2.049,676 | **525** | 960 | **542** | 294 | **55** | 1.037,810 | 337 | 492,960 | **273** |
| ***Beira Interior Norte*** | Almeida | 2.804,17 | 637,945 | **163** | 299 | **169** | 92 | **17** | 323,010 | 105 | 153,430 | **85** |
| | Celorico da Beira | 2.709,13 | 577,875 | **148** | 271 | **153** | 83 | **16** | 292,595 | 95 | 138,983 | **77** |
| | Fig. Castelo Rodrigo | 2.387,64 | 545,323 | **140** | 255 | **144** | 78 | **15** | 276,113 | 90 | 131,154 | **73** |
| | Guarda | 16.511,06 | 2.760,050 | **707** | 1.293 | **730** | 396 | **74** | 1.397,494 | 454 | 663,809 | **367** |
| | Manteigas | 1.260,63 | 209,096 | **54** | 98 | **55** | 30 | **6** | 105,871 | 34 | 50,289 | **28** |
| | Meda | 1.617,57 | 343,396 | **88** | 161 | **91** | 49 | **9** | 173,872 | 56 | 82,589 | **46** |
| | Pinhel | 3.609,06 | 830,465 | **213** | 389 | **220** | 119 | **22** | 420,488 | 137 | 199,732 | **111** |
| | Sabugal | 4.512,24 | 1.044,762 | **268** | 489 | **276** | 150 | **28** | 528,994 | 172 | 251,272 | **139** |
| | Trancoso | 2.800,53 | 596,958 | **153** | 280 | **158** | 86 | **16** | 302,257 | 98 | 143,572 | **79** |
| ***Beira Interior Sul*** | Castelo Branco | 22.885,23 | 5.203,489 | **1.333** | 2.437 | **1.377** | 746 | **140** | 2.634,678 | 856 | 1.251,472 | **692** |
| | Idanha-a-Nova | 4.816,88 | 1.113,540 | **285** | 522 | **295** | 160 | **30** | 563,818 | 183 | 267,813 | **148** |
| | Penamacor | 1.969,52 | 445,849 | **114** | 209 | **118** | 64 | **12** | 225,746 | 73 | 107,230 | **59** |
| | Vila Velha de Ródão | 1.368,44 | 313,779 | **80** | 147 | **83** | 45 | **8** | 158,875 | 52 | 75,466 | **42** |
| ***Cova Beira*** | Belmonte | 2.162,22 | 214,357 | **55** | 100 | **57** | 31 | **6** | 108,535 | 35 | 51,554 | **29** |
| | Covilhã | 16.929,90 | 1.342,633 | **344** | 629 | **355** | 193 | **36** | 679,814 | 221 | 322,912 | **179** |
| | Fundão | 11.795,04 | 535,388 | **137** | 251 | **142** | 77 | **14** | 271,082 | 88 | 128,764 | **71** |

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| *NUTS III* | *Municipality* | *MW in landfills (t)* | *Paper/cardboard (t)* | ***Energy potential (toe)*** | *Plastic (t)* | ***Energy potential (toe)*** | *Textile (t)* | ***Energy potential (toe)*** | *Fine matter (t)* | *Energy potential (toe)* | *Other material (t)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Oeste*** | Alcobaça | 23.613,18 | 5.596,32 | **1.434,09** | 2.621,06 | **1.481,08** | 802,85 | **150,19** | 2.833,58 | **920,55** | 1.345,95 | **744,73** |
| | Bombarral | 19.024,84 | 4.508,89 | **1.155,43** | 2.111,76 | **1.193,29** | 646,84 | **121,00** | 2.282,98 | **741,68** | 1.084,42 | **600,02** |
| | Caldas da Rainha | 5.091,76 | 1.206,75 | **309,24** | 565,19 | **319,37** | 173,12 | **32,38** | 611,01 | **198,50** | 290,23 | **160,59** |
| | Nazaré | 5.845,84 | 1.385,46 | **355,03** | 648,89 | **366,67** | 198,76 | **37,18** | 701,50 | **227,90** | 333,21 | **184,37** |
| | Óbidos | 6.007,79 | 1.423,85 | **364,87** | 666,86 | **376,82** | 204,26 | **38,21** | 720,93 | **234,21** | 342,44 | **189,48** |
| | Peniche | 23.531,45 | 5.576,95 | **1.429,13** | 2.611,99 | **1.475,95** | 800,07 | **149,67** | 2.823,77 | **917,37** | 1.341,29 | **742,15** |
| | Alenquer | 10.549,35 | 2.500,20 | **640,69** | 1.170,98 | **661,68** | 358,68 | **67,10** | 1.265,92 | **411,26** | 601,31 | **332,71** |
| | Arruda dos Vinhos | 10.852,17 | 2.571,96 | **659,08** | 1.204,59 | **680,68** | 368,97 | **69,02** | 1.302,26 | **423,07** | 618,57 | **342,26** |
| | Cadaval | 5.688,31 | 1.348,13 | **345,47** | 631,40 | **356,79** | 193,40 | **36,18** | 682,60 | **221,76** | 324,23 | **179,40** |
| | Lourinhã | 18.330,76 | 4.344,39 | **1.113,28** | 2.034,71 | **1.149,75** | 623,25 | **116,59** | 2.199,69 | **714,62** | 1.044,85 | **578,13** |
| | Sobral de Monte Agraço | 4.257,18 | 1.008,95 | **258,55** | 472,55 | **267,02** | 144,74 | **27,08** | 510,86 | **165,96** | 242,66 | **134,27** |
| | Torres Vedras | 33.389,95 | 7.913,42 | **2.027,86** | 3.706,28 | **2.094,30** | 1.135,26 | **212,37** | 4.006,79 | **1.301,70** | 1.903,23 | **1.053,07** |
| ***Médio Tejo*** | Abrantes | 15.535,73 | 3.681,97 | **943,53** | 1.724,47 | **974,44** | 528,21 | **98,81** | 1.864,29 | **605,66** | 885,54 | **489,98** |
| | Alcanena | 4.913,78 | 1.164,57 | **298,43** | 545,43 | **308,20** | 167,07 | **31,25** | 589,65 | **191,56** | 280,09 | **154,97** |
| | Constância | 2.067,74 | 490,05 | **125,58** | 229,52 | **129,69** | 70,30 | **13,15** | 248,13 | **80,61** | 117,86 | **65,21** |
| | Entroncamento | 7.402,47 | 1.754,39 | **449,57** | 821,67 | **464,30** | 251,68 | **47,08** | 888,30 | **288,58** | 421,94 | **233,46** |
| | Ferreira do Zêzere | 2.708,66 | 641,95 | **164,50** | 300,66 | **169,89** | 92,09 | **17,23** | 325,04 | **105,60** | 154,39 | **85,43** |
| | Sardoal | 14.041,08 | 3.327,74 | **852,75** | 1.558,56 | **880,69** | 477,40 | **89,30** | 1.684,93 | **547,39** | 800,34 | **442,84** |
| | Tomar | 1.310,20 | 310,52 | **79,57** | 145,43 | **82,18** | 44,55 | **8,33** | 157,22 | **51,08** | 74,68 | **41,32** |
| | Torres Novas | 16.011,54 | 3.794,73 | **972,42** | 1.777,28 | **1.004,28** | 544,39 | **101,84** | 1.921,38 | **624,21** | 912,66 | **504,98** |
| | Vila Nova da Barquinha | 14.696,84 | 3.483,15 | **892,58** | 1.631,35 | **921,82** | 499,69 | **93,48** | 1.763,62 | **572,95** | 837,72 | **463,52** |
| | Ourém | 3.304,19 | 783,09 | **200,67** | 366,77 | **207,25** | 112,34 | **21,02** | 396,50 | **128,81** | 188,34 | **104,21** |
| | **Total** | **851.722,52** | **201.858,24** | **51.727,34** | **94.541,20** | **53.422,18** | **28.958,57** | **5.417,14** | **102.206,70** | **33.204,17** | **48.548,18** | **26.862,14** |

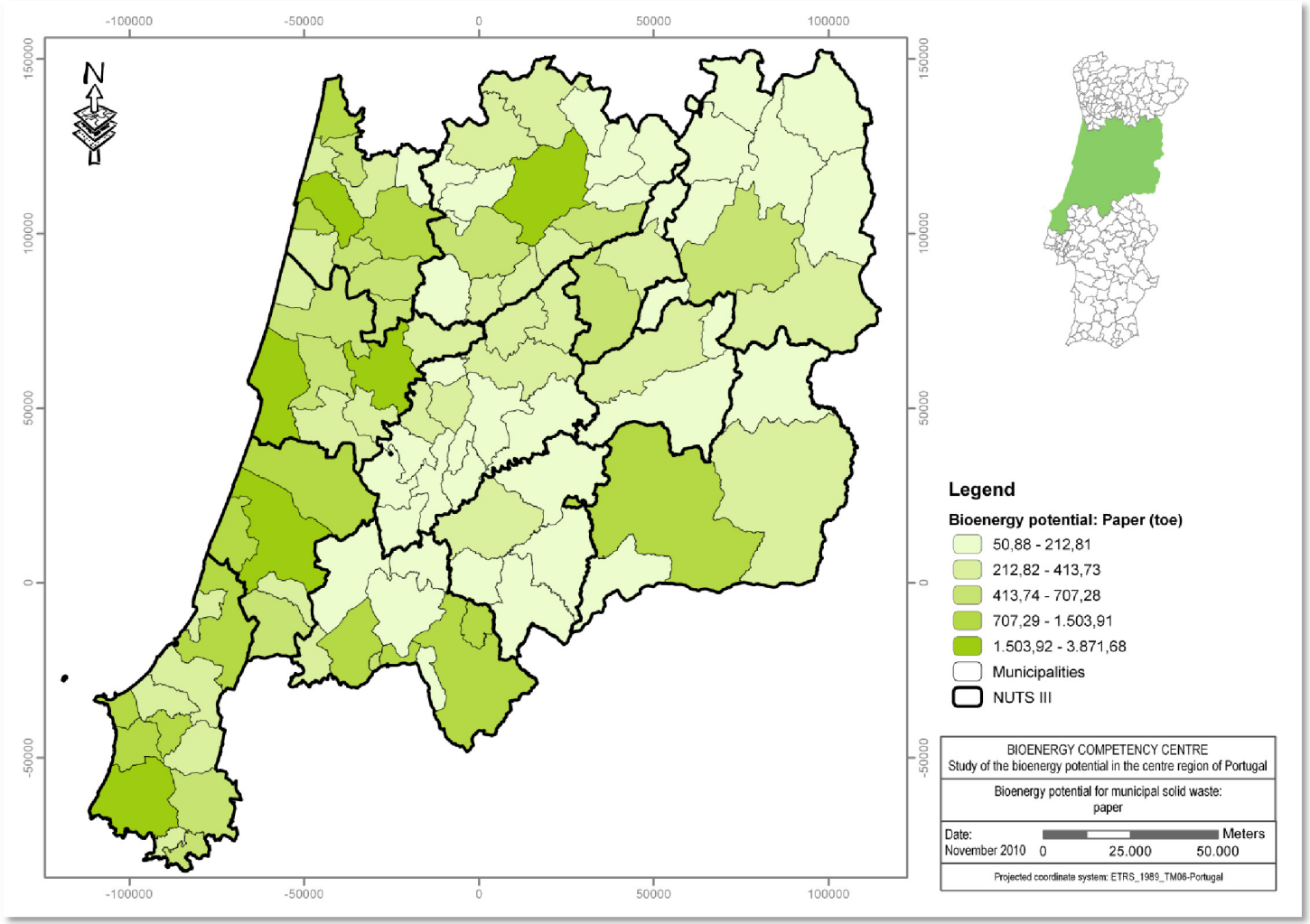


Figure A7.3: Map for the bioenergy potential from direct combustion (paper).

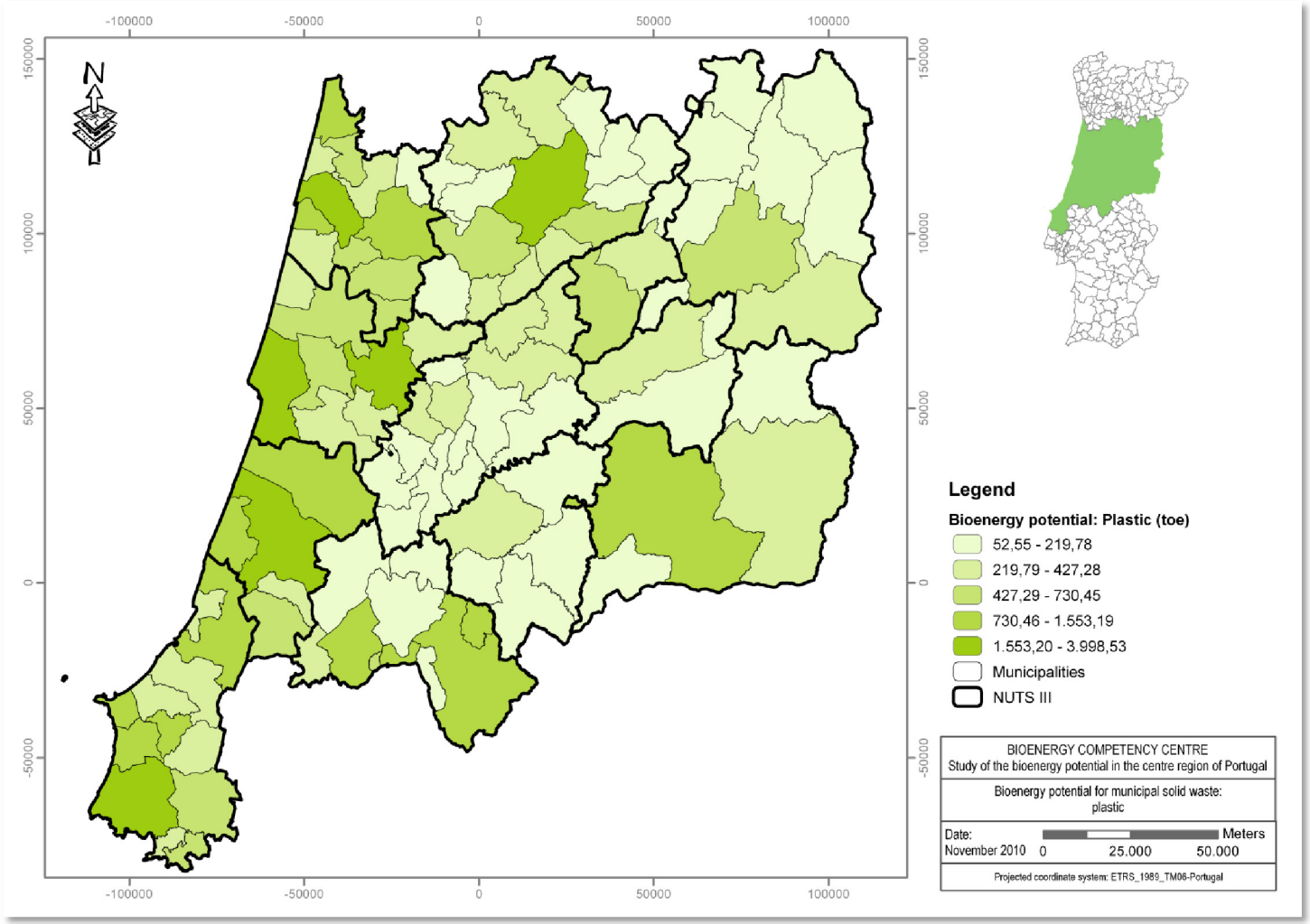


Figure A7.4: Map for the bioenergy potential from direct combustion (plastic).

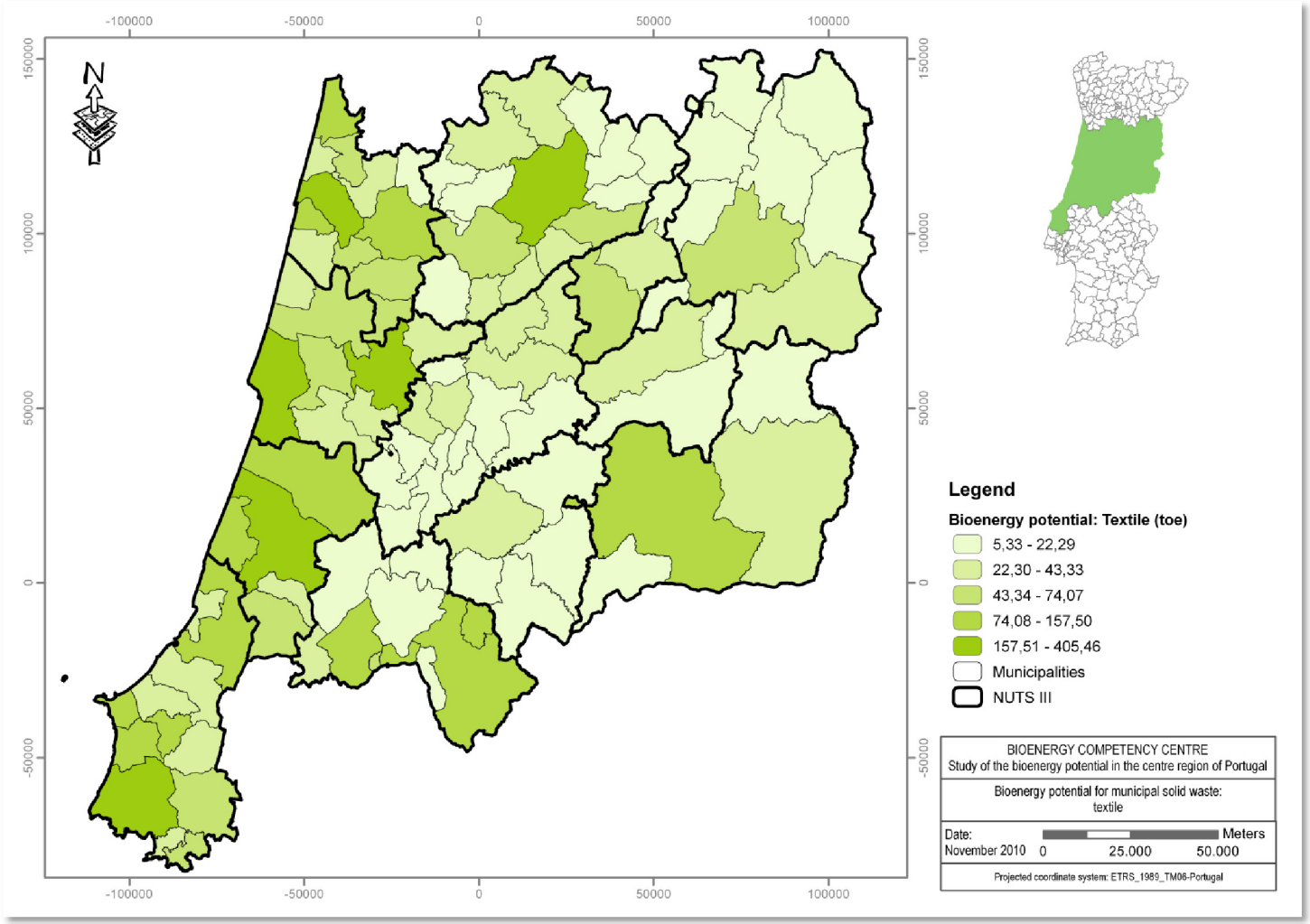


Figure A7.5: Map for the bioenergy potential from direct combustion (textile).

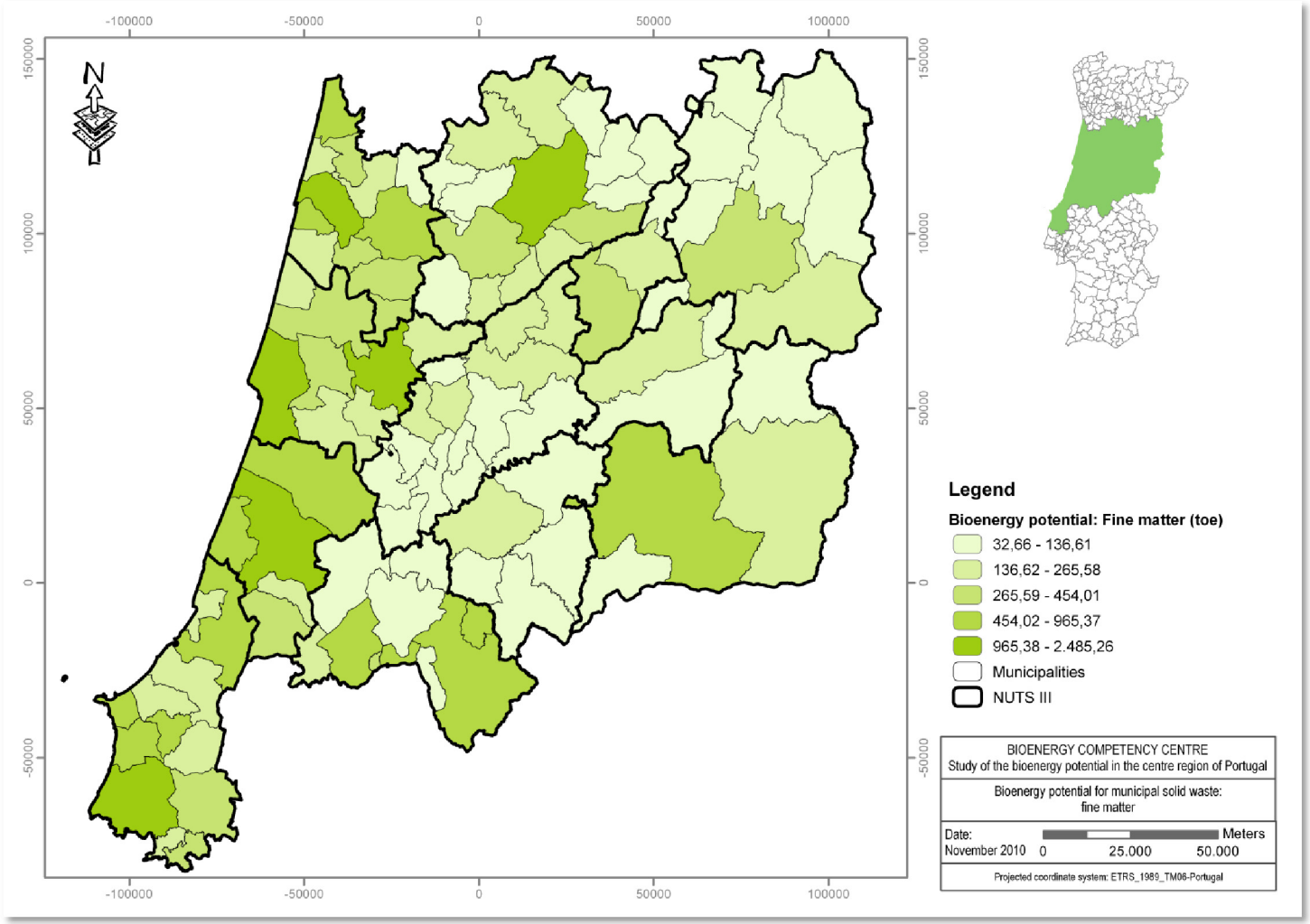


Figure A7.6: Map for the bioenergy potential from direct combustion (fine matter).

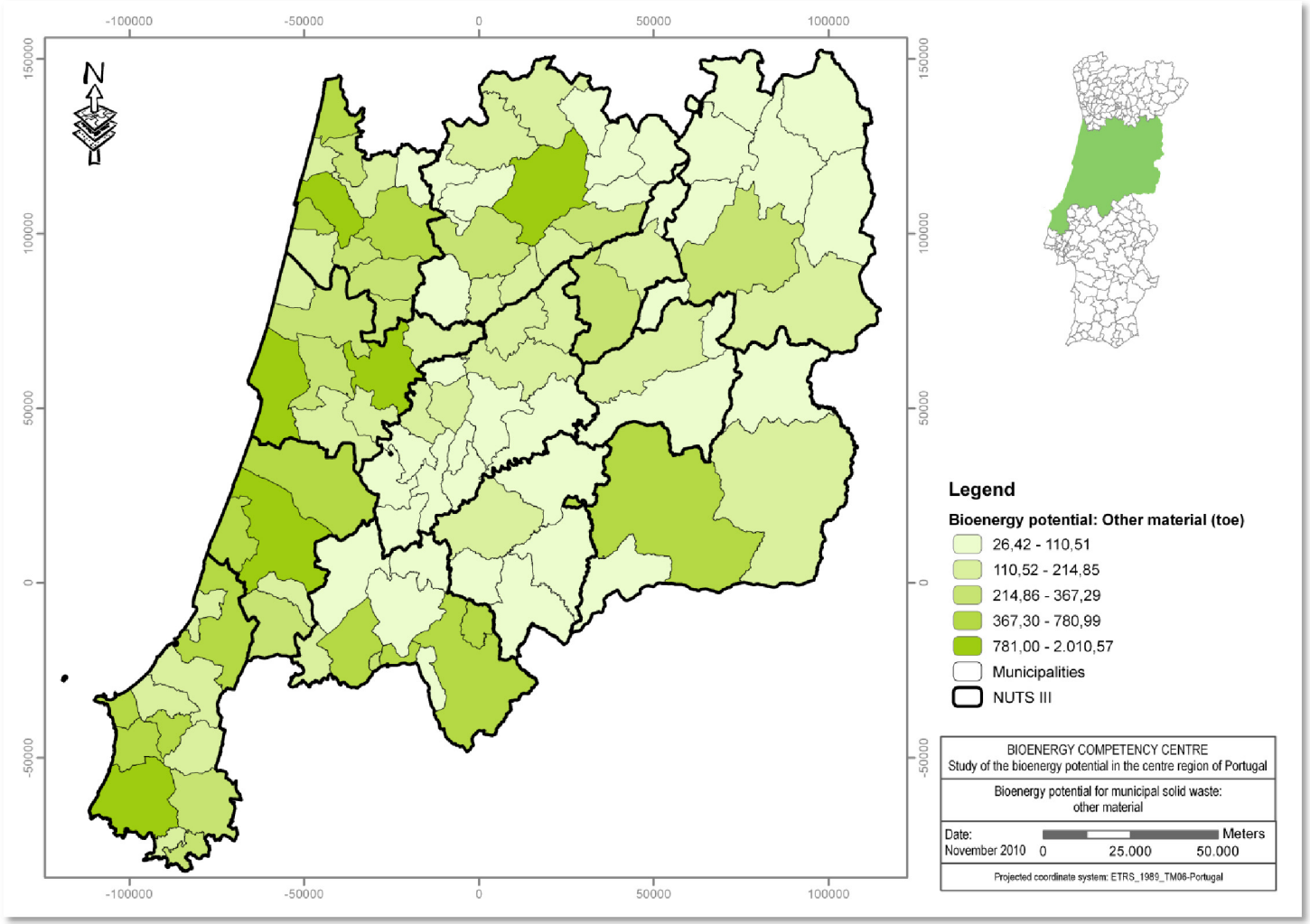


Figure A7.7: Map for the bioenergy potential from direct combustion (other material).

## *Annex 8: Used Vegetable Oil*

Table A8.1: Bioenergy potential for used vegetable oil (toe) per municipality.

| *NUTS III* | *Municipality* | *Population* | *Consumption (t/hab/year)* | *Waste amount (ton/year)* | *Oil for biodiesel (t/year)* | *Biodiesel (t/year)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 49.892,00 | 992,35 | 446,56 | 290,26 | 223,50 | **144,16** |
| | Albergaria-a-Velha | 26.101,00 | 519,15 | 233,62 | 151,85 | 116,93 | **75,42** |
| | Anadia | 31.559,00 | 627,71 | 282,47 | 183,60 | 141,38 | **91,19** |
| | Aveiro | 73.347,00 | 1.458,87 | 656,49 | 426,72 | 328,57 | **211,93** |
| | Estarreja | 28.300,00 | 562,89 | 253,30 | 164,64 | 126,78 | **81,77** |
| | Ílhavo | 40.819,00 | 811,89 | 365,35 | 237,48 | 182,86 | **117,94** |
| | Mealhada | 22.099,00 | 439,55 | 197,80 | 128,57 | 99,00 | **63,85** |
| | Murtosa | 9.850,00 | 195,92 | 88,16 | 57,31 | 44,13 | **28,46** |
| | Oliveira do Bairro | 23.244,00 | 462,32 | 208,05 | 135,23 | 104,13 | **67,16** |
| | Ovar | 57.730,00 | 1.148,25 | 516,71 | 335,86 | 258,61 | **166,81** |
| | Sever do Vouga | 12.733,00 | 253,26 | 113,97 | 74,08 | 57,04 | **36,79** |
| | Vagos | 23.933,00 | 476,03 | 214,21 | 139,24 | 107,21 | **69,15** |
| ***Baixo Mondego*** | Cantanhede | 38.931,00 | 774,34 | 348,45 | 226,49 | 174,40 | **112,49** |
| | Coimbra | 137.212,00 | 2.729,15 | 1.228,12 | 798,28 | 614,67 | **396,46** |
| | Condeixa-a-Nova | 17.422,00 | 346,52 | 155,94 | 101,36 | 78,05 | **50,34** |
| | Figueira da Foz | 63.229,00 | 1.257,62 | 565,93 | 367,86 | 283,25 | **182,70** |
| | Mira | 13.269,00 | 263,92 | 118,76 | 77,20 | 59,44 | **38,34** |
| | Montemor-o-Velho | 24.820,00 | 493,67 | 222,15 | 144,40 | 111,19 | **71,72** |
| | Penacova | 16.893,00 | 336,00 | 151,20 | 98,28 | 75,68 | **48,81** |
| | Soure | 20.579,00 | 409,32 | 184,19 | 119,73 | 92,19 | **59,46** |
| ***Pinhal Litoral*** | Batalha | 15.918,00 | 316,61 | 142,47 | 92,61 | 71,31 | **45,99** |
| | Leiria | 127.919,00 | 2.544,31 | 1.144,94 | 744,21 | 573,04 | **369,61** |
| | Marinha Grande | 38.533,00 | 766,42 | 344,89 | 224,18 | 172,62 | **111,34** |
| | Pombal | 59.764,00 | 1.188,71 | 534,92 | 347,70 | 267,73 | **172,68** |
| | Porto de Mós | 25.089,00 | 499,02 | 224,56 | 145,96 | 112,39 | **72,49** |
| ***Pinhal Interior Norte*** | Arganil | 7.827,00 | 155,68 | 70,06 | 45,54 | 35,06 | **22,62** |
| | Góis | 13.591,00 | 270,32 | 121,65 | 79,07 | 60,88 | **39,27** |
| | Lousã | 12.799,00 | 254,57 | 114,56 | 74,46 | 57,34 | **36,98** |
| | Miranda do Corvo | 3.250,00 | 64,64 | 29,09 | 18,91 | 14,56 | **9,39** |
| | Oliveira do Hospital | 6.901,00 | 137,26 | 61,77 | 40,15 | 30,91 | **19,94** |
| | Pampilhosa da Serra | 4.446,00 | 88,43 | 39,79 | 25,87 | 19,92 | **12,85** |
| | Penela | 18.786,00 | 373,65 | 168,14 | 109,29 | 84,16 | **54,28** |
| | Tábua | 13.686,00 | 272,21 | 122,50 | 79,62 | 61,31 | **39,54** |
| | Vila Nova de Poiares | 21.714,00 | 431,89 | 194,35 | 126,33 | 97,27 | **62,74** |
| | Alvaiázere | 4.416,00 | 87,83 | 39,53 | 25,69 | 19,78 | **12,76** |
| | Ansião | 4.111,00 | 81,77 | 36,80 | 23,92 | 18,42 | **11,88** |
| | Castanheira de Pêra | 6.287,00 | 125,05 | 56,27 | 36,58 | 28,16 | **18,17** |
| | Figueiró dos Vinhos | 12.331,00 | 245,26 | 110,37 | 71,74 | 55,24 | **35,63** |
| | Pedrógão Grande | 7.491,00 | 149,00 | 67,05 | 43,58 | 33,56 | **21,64** |
| ***Dão Lafões*** | Aguiar da Beira | 6.225,00 | 123,82 | 55,72 | 36,22 | 27,89 | **17,99** |
| | Carregal do Sal | 10.633,00 | 211,49 | 95,17 | 61,86 | 47,63 | **30,72** |
| | Castro Daire | 16.618,00 | 330,53 | 148,74 | 96,68 | 74,44 | **48,02** |
| | Mangualde | 21.220,00 | 422,07 | 189,93 | 123,45 | 95,06 | **61,31** |
| | Mortágua | 10.217,00 | 203,22 | 91,45 | 59,44 | 45,77 | **29,52** |
| | Nelas | 14.719,00 | 292,76 | 131,74 | 85,63 | 65,94 | **42,53** |
| | Oliveira de Frades | 10.630,00 | 211,43 | 95,14 | 61,84 | 47,62 | **30,71** |
| | Penalva do Castelo | 8.571,00 | 170,48 | 76,71 | 49,86 | 38,40 | **24,77** |
| | Santa Comba Dão | 12.310,00 | 244,85 | 110,18 | 71,62 | 55,15 | **35,57** |

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| *NUTS III* | *Municipality* | *Population* | *Consumption (t/hab/year)* | *Waste amount (ton/year)* | *Oil for biodiesel (t/year)* | *Biodiesel (t/year)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 19.224,00 | 382,37 | 172,06 | 111,84 | 86,12 | **55,55** |
| | Sátão | 13.556,00 | 269,63 | 121,33 | 78,87 | 60,73 | **39,17** |
| | Tondela | 30.852,00 | 613,65 | 276,14 | 179,49 | 138,21 | **89,14** |
| | Vila Nova de Paiva | 6.399,00 | 127,28 | 57,27 | 37,23 | 28,67 | **18,49** |
| | Viseu | 98.619,00 | 1.961,53 | 882,69 | 573,75 | 441,79 | **284,95** |
| | Vouzela | 11.723,00 | 233,17 | 104,93 | 68,20 | 52,52 | **33,87** |
| ***Pinhal Interior Sul*** | Oleiros | 7.253,00 | 144,26 | 64,92 | 42,20 | 32,49 | **20,96** |
| | Proença-a-Nova | 5.872,00 | 116,79 | 52,56 | 34,16 | 26,30 | **16,97** |
| | Sertã | 8.977,00 | 178,55 | 80,35 | 52,23 | 40,21 | **25,94** |
| | Vila de Rei | 15.841,00 | 315,08 | 141,78 | 92,16 | 70,96 | **45,77** |
| | Mação | 3.131,00 | 62,28 | 28,02 | 18,22 | 14,03 | **9,05** |
| ***Serra Estrela*** | Fornos de Algodres | 5.317,00 | 105,76 | 47,59 | 30,93 | 23,82 | **15,36** |
| | Gouveia | 15.505,00 | 308,39 | 138,78 | 90,21 | 69,46 | **44,80** |
| | Seia | 27.082,00 | 538,66 | 242,40 | 157,56 | 121,32 | **78,25** |
| ***Beira Interior Norte*** | Almeida | 7.213,00 | 143,47 | 64,56 | 41,96 | 32,31 | **20,84** |
| | Celorico da Beira | 8.643,00 | 171,91 | 77,36 | 50,28 | 38,72 | **24,97** |
| | Fig. Castelo Rodrigo | 6.638,00 | 132,03 | 59,41 | 38,62 | 29,74 | **19,18** |
| | Guarda | 44.191,00 | 878,96 | 395,53 | 257,10 | 197,96 | **127,69** |
| | Manteigas | 3.714,00 | 73,87 | 33,24 | 21,61 | 16,64 | **10,73** |
| | Meda | 5.788,00 | 115,12 | 51,81 | 33,67 | 25,93 | **16,72** |
| | Pinhel | 10.009,00 | 199,08 | 89,59 | 58,23 | 44,84 | **28,92** |
| | Sabugal | 13.533,00 | 269,17 | 121,13 | 78,73 | 60,62 | **39,10** |
| | Trancoso | 10.422,00 | 207,29 | 93,28 | 60,63 | 46,69 | **30,11** |
| ***Beira Interior Sul*** | Castelo Branco | 54.254,00 | 1.079,11 | 485,60 | 315,64 | 243,04 | **156,76** |
| | Idanha-a-Nova | 10.352,00 | 205,90 | 92,66 | 60,23 | 46,37 | **29,91** |
| | Penamacor | 5.783,00 | 115,02 | 51,76 | 33,64 | 25,91 | **16,71** |
| | Vila Velha de Ródão | 3.534,00 | 70,29 | 31,63 | 20,56 | 15,83 | **10,21** |
| ***Cova Beira*** | Belmonte | 7.735,00 | 153,85 | 69,23 | 45,00 | 34,65 | **22,35** |
| | Covilhã | 52.553,00 | 1.045,28 | 470,38 | 305,74 | 235,42 | **151,85** |
| | Fundão | 31.062,00 | 617,82 | 278,02 | 180,71 | 139,15 | **89,75** |
| ***Oeste*** | Alcobaça | 55.643,00 | 1.106,74 | 498,03 | 323,72 | 249,27 | **160,78** |
| | Bombarral | 13.858,00 | 275,64 | 124,04 | 80,62 | 62,08 | **40,04** |
| | Caldas da Rainha | 52.587,00 | 1.045,96 | 470,68 | 305,94 | 235,58 | **151,95** |
| | Nazaré | 14.581,00 | 290,02 | 130,51 | 84,83 | 65,32 | **42,13** |
| | Óbidos | 11.332,00 | 225,39 | 101,43 | 65,93 | 50,76 | **32,74** |
| | Peniche | 28.595,00 | 568,75 | 255,94 | 166,36 | 128,10 | **82,62** |
| | Alenquer | 45.687,00 | 908,71 | 408,92 | 265,80 | 204,67 | **132,01** |
| | Arruda dos Vinhos | 12.064,00 | 239,95 | 107,98 | 70,19 | 54,04 | **34,86** |
| | Cadaval | 14.595,00 | 290,29 | 130,63 | 84,91 | 65,38 | **42,17** |
| | Lourinhã | 25.377,00 | 504,75 | 227,14 | 147,64 | 113,68 | **73,32** |
| | Sobral de Monte Agraço | 10.346,00 | 205,78 | 92,60 | 60,19 | 46,35 | **29,89** |
| | Torres Vedras | 77.203,00 | 1.535,57 | 691,01 | 449,15 | 345,85 | **223,07** |
| ***Médio Tejo*** | Abrantes | 40.349,00 | 802,54 | 361,14 | 234,74 | 180,75 | **116,59** |
| | Alcanena | 14.699,00 | 292,36 | 131,56 | 85,52 | 65,85 | **42,47** |
| | Constância | 3.775,00 | 75,08 | 33,79 | 21,96 | 16,91 | **10,91** |
| | Entroncamento | 21.329,00 | 424,23 | 190,91 | 124,09 | 95,55 | **61,63** |
| | Ferreira do Zêzere | 9.170,00 | 182,39 | 82,08 | 53,35 | 41,08 | **26,50** |
| | Sardoal | 3.858,00 | 76,74 | 34,53 | 22,45 | 17,28 | **11,15** |
| | Tomar | 42.295,00 | 841,25 | 378,56 | 246,06 | 189,47 | **122,21** |
| | Torres Novas | 37.101,00 | 737,94 | 332,07 | 215,85 | 166,20 | **107,20** |
| | Vila Nova da Barquinha | 8.122,00 | 161,55 | 72,70 | 47,25 | 36,38 | **23,47** |
| | Ourém | 50.606,00 | 1.006,55 | 452,95 | 294,42 | 226,70 | **146,22** |
| | **Total** | **2.385.911** | **47.455,77** | **21.355,10** | **13.880,81** | **10.688,23** | **6.893,91** |

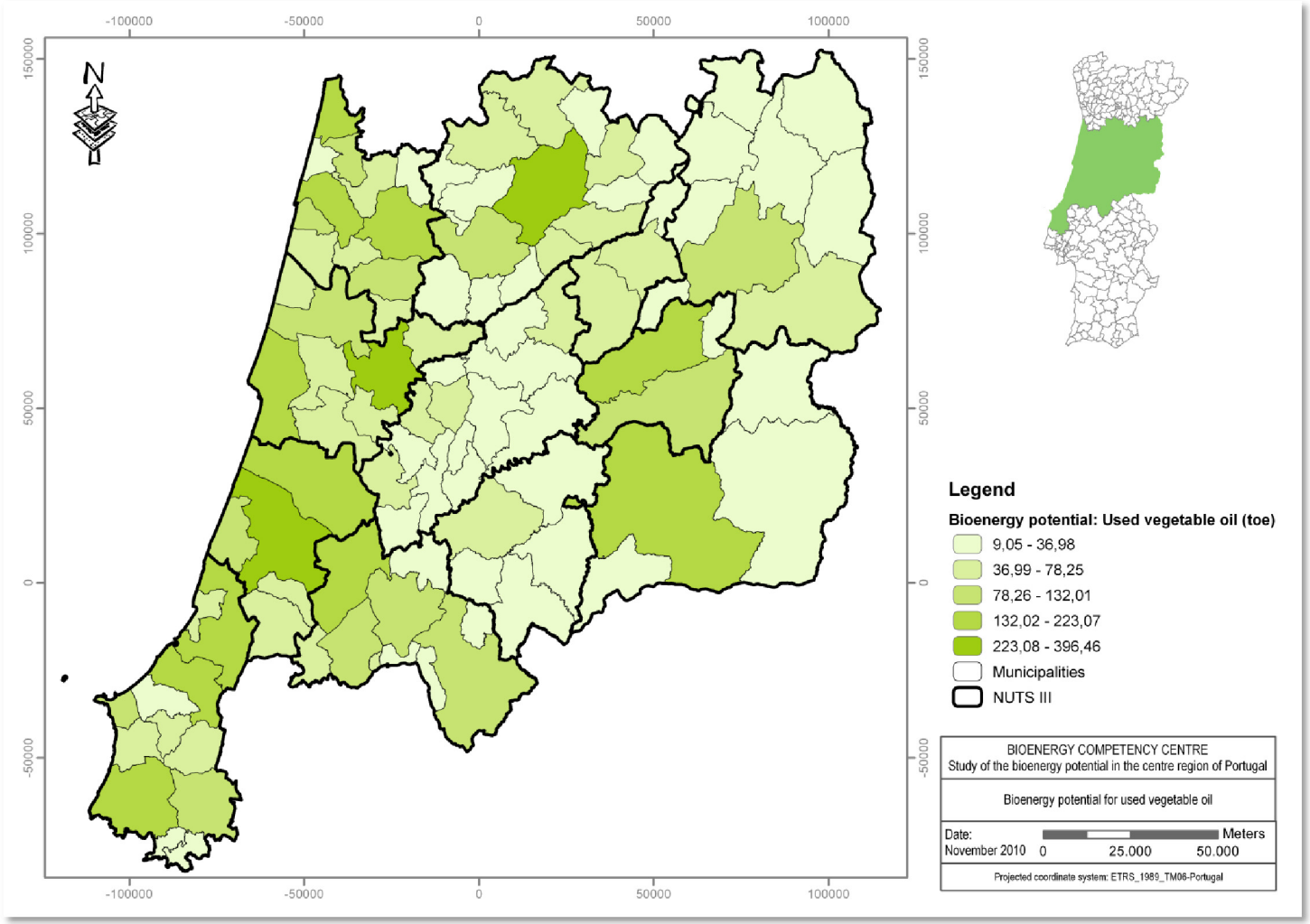


Figure A8.1: Map for the bioenergy potential for used vegetable oil.

*Annex 9: Agricultural and Food Industries*

Table A9.1: Bioenergy potential for olive press-cake (toe) per municipality.

| *NUTS III* | *Municipality* | *Olive Press industries (N.º)* | *Produced olives (kg)* | *Produced olive oil (kg)* | *Olive press cake (kg)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Albergaria-a-Velha | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Anadia | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Aveiro | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Estarreja | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Ílhavo | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Mealhada | 1 | 776.255,00 | 80.523,00 | 310.502,00 | 3.700 | **114,89** |
| | Murtosa | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Oliveira do Bairro | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Ovar | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Sever do Vouga | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Vagos | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| ***Baixo Mondego*** | Cantanhede | 2 | 646.256,00 | 75.093,00 | 258.502,40 | 3.700 | **95,65** |
| | Coimbra | 3 | 1.203.095,00 | 144.582,00 | 481.238,00 | 3.700 | **178,06** |
| | Condeixa-a-Nova | 1 | 148.674,00 | 20.969,00 | 59.469,60 | 3.700 | **22,00** |
| | Figueira da Foz | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Mira | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Montemor-o-Velho | 1 | 366.117,00 | 53.351,00 | 146.446,80 | 3.700 | **54,19** |
| | Penacova | 3 | 883.773,00 | 101.461,00 | 353.509,20 | 3.700 | **130,80** |
| | Soure | 2 | 793.618,00 | 93.383,00 | 317.447,20 | 3.700 | **117,46** |
| ***Pinhal Litoral*** | Batalha | 2 | 583.918,00 | 64.930,00 | 233.567,20 | 3.700 | **86,42** |
| | Leiria | 2 | 388.057,00 | 43.772,00 | 155.222,80 | 3.700 | **57,43** |
| | Marinha Grande | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Pombal | 6 | 2.668.790,00 | 290.196,00 | 1.067.516,00 | 3.700 | **394,98** |
| | Porto de Mós | 6 | 1.133.317,00 | 128.291,00 | 453.326,80 | 3.700 | **167,73** |
| ***Pinhal Interior Norte*** | Arganil | 1 | 48.722,00 | 6.347,00 | 19.488,80 | 3.700 | **7,21** |
| | Góis | 1 | 30.686,00 | 3.827,00 | 12.274,40 | 3.700 | **4,54** |
| | Lousã | 1 | 214.972,00 | 24.933,00 | 85.988,80 | 3.700 | **31,82** |
| | Miranda do Corvo | 2 | 420.707,00 | 54.065,00 | 168.282,80 | 3.700 | **62,26** |
| | Oliveira do Hospital | 4 | 1.907.491,00 | 251.363,00 | 762.996,40 | 3.700 | **282,31** |
| | Pampilhosa da Serra | 4 | 352.887,00 | 47.430,00 | 141.154,80 | 3.700 | **52,23** |
| | Penela | 3 | 932.897,00 | 110.735,00 | 373.158,80 | 3.700 | **138,07** |
| | Tábua | 3 | 2.723.804,00 | 337.881,00 | 1.089.521,60 | 3.700 | **403,12** |
| | Vila Nova de Poiares | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Alvaiázere | 14 | 5.247.754,00 | 659.700,00 | 2.099.101,60 | 3.700 | **776,67** |
| | Ansião | 9 | 2.642.324,00 | 317.932,00 | 1.056.929,60 | 3.700 | **391,06** |
| | Castanheira de Pêra | 1 | 152.587,00 | 24.020,00 | 61.034,80 | 3.700 | **22,58** |
| | Figueiró dos Vinhos | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Pedrógão Grande | 2 | 747.843,00 | 86.307,00 | 299.137,20 | 3.700 | **110,68** |
| ***Dão Lafões*** | Aguiar da Beira | 1 | 103.553,00 | 14.452,00 | 41.421,20 | 3.700 | **15,33** |
| | Carregal do Sal | 3 | 573.970,00 | 59.723,00 | 229.588,00 | 3.700 | **84,95** |
| | Castro Daire | 1 | 126.588,00 | 16.596,00 | 50.635,20 | 3.700 | **18,74** |
| | Mangualde | 4 | 1.829.051,00 | 214.561,00 | 731.620,40 | 3.700 | **270,70** |
| | Mortágua | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Nelas | 1 | 509.058,00 | 58.498,00 | 203.623,20 | 3.700 | **75,34** |
| | Oliveira de Frades | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Penalva do Castelo | 3 | 698.845,00 | 84.532,00 | 279.538,00 | 3.700 | **103,43** |
| | Santa Comba Dão | 1 | 424.478,00 | 47.980,00 | 169.791,20 | 3.700 | **62,82** |

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| *NUTS III* | *Municipality* | *Olive Press industries (N.º)* | *Produced olives (kg)* | *Produced olive oil (kg)* | *Olive press cake (kg)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 1 | 164.476,00 | 18.996,00 | 65.790,40 | 3.700 | **24,34** |
| | Sátão | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Tondela | 3 | 1.372.542,00 | 156.264,00 | 549.016,80 | 3.700 | **203,14** |
| | Vila Nova de Paiva | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Viseu | 4 | 1.001.882,00 | 124.576,00 | 400.752,80 | 3.700 | **148,28** |
| | Vouzela | 1 | 102.366,00 | 13.377,00 | 40.946,40 | 3.700 | **15,15** |
| ***Pinhal Interior Sul*** | Oleiros | 9 | 964.339,00 | 131.423,00 | 385.735,60 | 3.700 | **142,72** |
| | Proença-a-Nova | 29 | 2.371.229,00 | 287.222,00 | 948.491,60 | 3.700 | **350,94** |
| | Sertã | 15 | 2.550.201,00 | 296.361,00 | 1.020.080,40 | 3.700 | **377,43** |
| | Vila de Rei | 1 | 133.581,00 | 11.545,00 | 53.432,40 | 3.700 | **19,77** |
| | Mação | 21 | 1.965.387,00 | 225.720,00 | 786.154,80 | 3.700 | **290,88** |
| ***Serra Estrela*** | Fornos de Algodres | 4 | 719.138,00 | 106.860,00 | 287.655,20 | 3.700 | **106,43** |
| | Gouveia | 3 | 321.391,00 | 45.044,00 | 128.556,40 | 3.700 | **47,57** |
| | Seia | 5 | 1.801.482,00 | 233.638,00 | 720.592,80 | 3.700 | **266,62** |
| ***Beira Interior Norte*** | Almeida | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Celorico da Beira | 5 | 568.298,00 | 84.522,00 | 227.319,20 | 3.700 | **84,11** |
| | Fig. Castelo Rodrigo | 7 | 1.617.464,00 | 192.116,00 | 646.985,60 | 3.700 | **239,38** |
| | Guarda | 3 | 529.551,00 | 68.886,00 | 211.820,40 | 3.700 | **78,37** |
| | Manteigas | 1 | 389.274,00 | 44.973,00 | 155.709,60 | 3.700 | **57,61** |
| | Meda | 5 | 575.777,00 | 84.147,00 | 230.310,80 | 3.700 | **85,21** |
| | Pinhel | 6 | 2.114.149,00 | 305.431,00 | 845.659,60 | 3.700 | **312,89** |
| | Sabugal | 1 | 101.688,00 | 10.704,00 | 40.675,20 | 3.700 | **15,05** |
| | Trancoso | 5 | 1.241.050,00 | 189.438,00 | 496.420,00 | 3.700 | **183,68** |
| ***Beira Interior Sul*** | Castelo Branco | 34 | 6.262.214,00 | 743.446,00 | 2.504.885,60 | 3.700 | **926,81** |
| | Idanha-a-Nova | 2 | 192.719,00 | 24.031,00 | 77.087,60 | 3.700 | **28,52** |
| | Penamacor | 3 | 1.956.467,00 | 234.300,00 | 782.586,80 | 3.700 | **289,56** |
| | Vila Velha de Ródão | 12 | 1.357.300,00 | 158.675,00 | 542.920,00 | 3.700 | **200,88** |
| ***Cova Beira*** | Belmonte | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Covilhã | 4 | 583.895,00 | 79.172,00 | 233.558,00 | 3.700 | **86,42** |
| | Fundão | 16 | 4.518.577,00 | 612.221,00 | 1.807.430,80 | 3.700 | **668,75** |
| ***Oeste*** | Alcobaça | 2 | 159.655,00 | 20.657,00 | 63.862,00 | 3.700 | **23,63** |
| | Bombarral | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Caldas da Rainha | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Nazaré | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Óbidos | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Peniche | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Alenquer | 1 | 128.990,00 | 13.119,00 | 51.596,00 | 3.700 | **19,09** |
| | Arruda dos Vinhos | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Cadaval | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Lourinhã | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Sobral de Monte Agraço | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| ***Médio Tejo*** | Torres Vedras | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Abrantes | 12 | 2.046.201,00 | 234.408,00 | 818.480,40 | 3.700 | **302,84** |
| | Alcanena | 3 | 760.974,00 | 84.410,00 | 304.389,60 | 3.700 | **112,62** |
| | Constância | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Entroncamento | 0 | 0,00 | 0,00 | 0,00 | 3.700 | **0,00** |
| | Ferreira do Zêzere | 5 | 3.265.081,00 | 352.782,00 | 1.306.032,40 | 3.700 | **483,23** |
| | Sardoal | 4 | 772.958,00 | 84.813,00 | 309.183,20 | 3.700 | **114,40** |
| | Tomar | 11 | 3.210.167,00 | 375.176,00 | 1.284.066,80 | 3.700 | **475,10** |
| | Torres Novas | 11 | 3.026.629,00 | 349.677,00 | 1.210.651,60 | 3.700 | **447,94** |
| | Vila Nova da Barquinha | 1 | 469.443,00 | 76.569,00 | 187.777,20 | 3.700 | **69,48** |
| | Ourém | 12 | 5.363.225,00 | 597.615,00 | 2.145.290,00 | 3.700 | **793,76** |
| | **Total** | **350,00** | **83.959.847,00** | **10.189.747,00** | **33.583.938,80** | **-** | **12.426,06** |

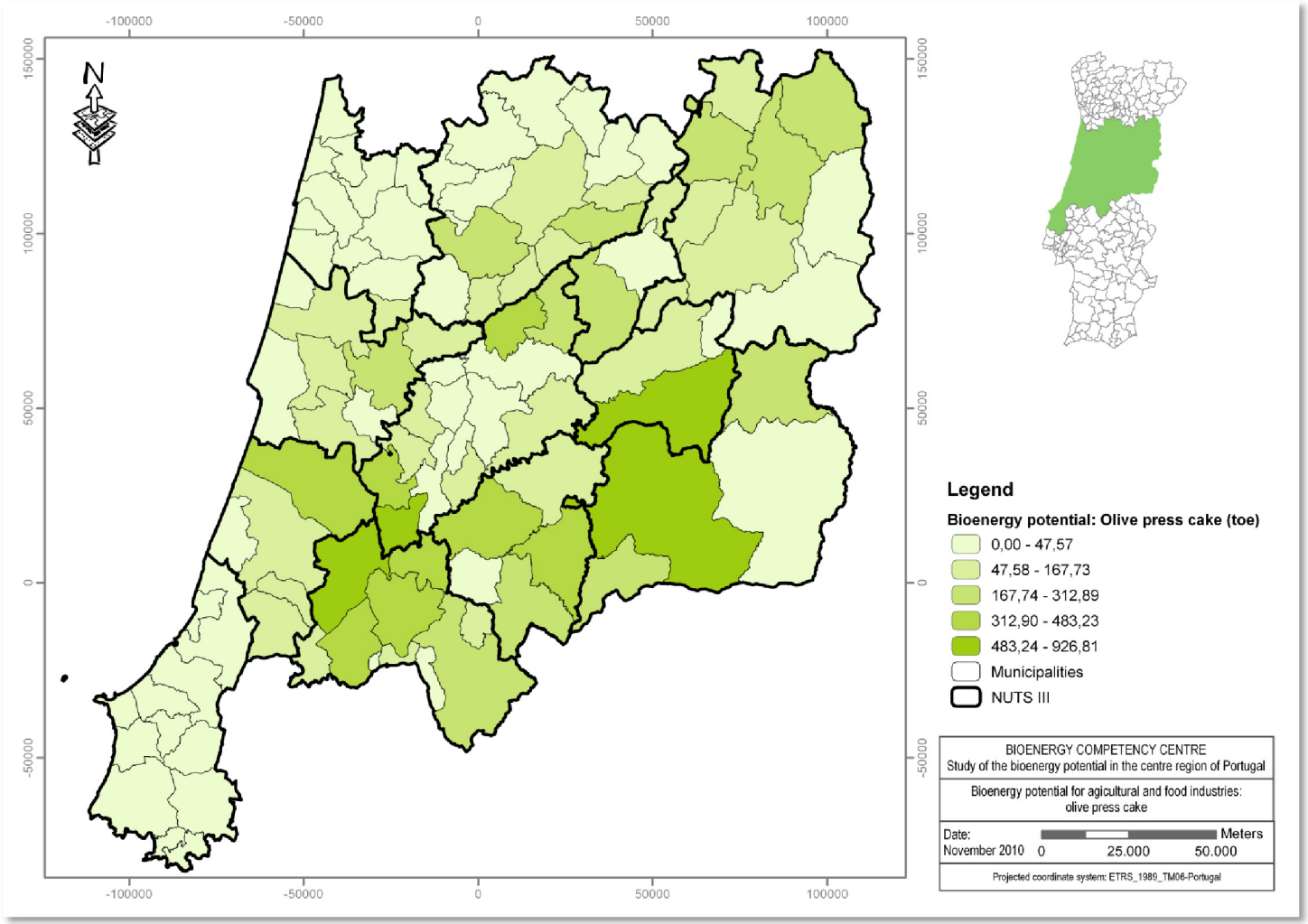


Figure A9.1: Map for the bioenergy potential from olive press cake.

Table A9.2: Bioenergy potential for grape stems (toe) per municipality.

| *NUTS III* | *Municipality* | *V.Q.P.R.Q.* vineyards (ha)* | *Other vineyards (ha)* | *Total vineyards (ha)* | *Grape stems (kg)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 192,02 | 100,14 | 292,16 | 73.040,00 | 5.000 | **36,52** |
| | Albergaria-a-Velha | 0,00 | 57,91 | 57,91 | 14.477,50 | 5.000 | **7,24** |
| | Anadia | 2.599,31 | 0,00 | 2.599,31 | 649.827,50 | 5.000 | **324,91** |
| | Aveiro | ... | 61,14 | 61,14 | 15.285,00 | 5.000 | **7,64** |
| | Estarreja | ... | 23,39 | 23,39 | 5.847,50 | 5.000 | **2,92** |
| | Ílhavo | 0,00 | 0,95 | 0,95 | 237,50 | 5.000 | **0,12** |
| | Mealhada | 1.106,52 | 0,00 | 1.106,52 | 276.630,00 | 5.000 | **138,32** |
| | Murtosa | 0,00 | 0,00 | 0,00 | 0,00 | 5.000 | **0,00** |
| | Oliveira do Bairro | 736,85 | ... | 736,85 | 184.212,50 | 5.000 | **92,11** |
| | Ovar | ... | 2,74 | 2,74 | 685,00 | 5.000 | **0,34** |
| | Sever do Vouga | ... | 1,02 | 1,02 | 255,00 | 5.000 | **0,13** |
| | Vagos | 45,50 | 24,14 | 69,64 | 17.410,00 | 5.000 | **8,71** |
| ***Baixo Mondego*** | Cantanhede | 2.922,09 | 66,65 | 2.988,74 | 747.185,00 | 5.000 | **373,59** |
| | Coimbra | 232,43 | 884,13 | 1.116,56 | 279.140,00 | 5.000 | **139,57** |
| | Condeixa-a-Nova | 0,00 | 388,17 | 388,17 | 97.042,50 | 5.000 | **48,52** |
| | Figueira da Foz | 0,00 | 187,31 | 187,31 | 46.827,50 | 5.000 | **23,41** |
| | Mira | 0,82 | 23,74 | 24,56 | 6.140,00 | 5.000 | **3,07** |
| | Montemor-o-Velho | 3,99 | 173,52 | 177,51 | 44.377,50 | 5.000 | **22,19** |
| | Penacova | 2,29 | 118,10 | 120,39 | 30.097,50 | 5.000 | **15,05** |
| | Soure | ... | 526,23 | 526,23 | 131.557,50 | 5.000 | **65,78** |
| ***Pinhal Litoral*** | Batalha | 656,99 | ... | 656,99 | 164.247,50 | 5.000 | **82,12** |
| | Leiria | 1.421,35 | 117,89 | 1.539,24 | 384.810,00 | 5.000 | **192,41** |
| | Marinha Grande | ... | 18,93 | 18,93 | 4.732,50 | 5.000 | **2,37** |
| | Pombal | 518,65 | 452,29 | 970,94 | 242.735,00 | 5.000 | **121,37** |
| | Porto de Mós | 227,39 | 1,50 | 228,89 | 57.222,50 | 5.000 | **28,61** |
| ***Pinhal Interior Norte*** | Arganil | 37,53 | 2,86 | 40,39 | 10.097,50 | 5.000 | **5,05** |
| | Góis | 0,00 | 4,08 | 4,08 | 1.020,00 | 5.000 | **0,51** |
| | Lousã | 0,00 | 24,03 | 24,03 | 6.007,50 | 5.000 | **3,00** |
| | Miranda do Corvo | 0,00 | 150,19 | 150,19 | 37.547,50 | 5.000 | **18,77** |
| | Oliveira do Hospital | 400,61 | 0,92 | 401,53 | 100.382,50 | 5.000 | **50,19** |
| | Pampilhosa da Serra | 0,00 | 14,72 | 14,72 | 3.680,00 | 5.000 | **1,84** |
| | Penela | 0,00 | 222,85 | 222,85 | 55.712,50 | 5.000 | **27,86** |
| | Tábua | 143,81 | 1,48 | 145,29 | 36.322,50 | 5.000 | **18,16** |
| | Vila Nova de Poiares | 0,00 | 31,71 | 31,71 | 7.927,50 | 5.000 | **3,96** |
| | Alvaiázere | 0,00 | 197,21 | 197,21 | 49.302,50 | 5.000 | **24,65** |
| | Ansião | 0,00 | 346,96 | 346,96 | 86.740,00 | 5.000 | **43,37** |
| | Castanheira de Pêra | 0,00 | 3,65 | 3,65 | 912,50 | 5.000 | **0,46** |
| | Figueiró dos Vinhos | 0,00 | 93,89 | 93,89 | 23.472,50 | 5.000 | **11,74** |
| | Pedrógão Grande | 0,00 | 22,78 | 22,78 | 5.695,00 | 5.000 | **2,85** |
| ***Dão Lafões*** | Aguiar da Beira | 131,04 | 0,45 | 131,49 | 32.872,50 | 5.000 | **16,44** |
| | Carregal do Sal | 339,93 | 0,77 | 340,70 | 85.175,00 | 5.000 | **42,59** |
| | Castro Daire | 0,00 | 99,84 | 99,84 | 24.960,00 | 5.000 | **12,48** |
| | Mangualde | 857,52 | ... | 857,52 | 214.380,00 | 5.000 | **107,19** |
| | Mortágua | 121,48 | 37,86 | 159,34 | 39.835,00 | 5.000 | **19,92** |
| | Nelas | 1.163,80 | ... | 1.163,80 | 290.950,00 | 5.000 | **145,48** |
| | Oliveira de Frades | 9,12 | 77,84 | 86,96 | 21.740,00 | 5.000 | **10,87** |
| | Penalva do Castelo | 728,12 | 0,00 | 728,12 | 182.030,00 | 5.000 | **91,02** |
| | Santa Comba Dão | 250,01 | 10,97 | 260,98 | 65.245,00 | 5.000 | **32,62** |

* V.P.Q.R.D. – Wine of Quality Produced in a Determined Region (designation that is given by managing institutions to the wines whose quality and individuality connects them in an unmistakable way to the region in which they are produced).

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| *NUTS III* | *Municipality* | *V.Q.P.R.Q. vineyards (ha)* | *Other vineyards (ha)* | *Total vineyards (ha)* | *Grape stems (kg)* | *LHV (kcal/kg)* | ***Energy potential (toe)*** |
|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 124,85 | 48,52 | 173,37 | 43.342,50 | 5.000 | **21,67** |
| | Sátão | 393,47 | 12,79 | 406,26 | 101.565,00 | 5.000 | **50,78** |
| | Tondela | 1.666,19 | 70,66 | 1.736,85 | 434.212,50 | 5.000 | **217,11** |
| | Vila Nova de Paiva | 0,00 | 2,29 | 2,29 | 572,50 | 5.000 | **0,29** |
| | Viseu | 1.880,19 | 168,43 | 2.048,62 | 512.155,00 | 5.000 | **256,08** |
| | Vouzela | 88,98 | 34,67 | 123,65 | 30.912,50 | 5.000 | **15,46** |
| ***Pinhal Interior Sul*** | Oleiros | 0,00 | 41,65 | 41,65 | 10.412,50 | 5.000 | **5,21** |
| | Proença-a-Nova | 19,58 | 143,93 | 163,51 | 40.877,50 | 5.000 | **20,44** |
| | Sertã | 0,00 | 125,32 | 125,32 | 31.330,00 | 5.000 | **15,67** |
| | Vila de Rei | ... | 24,80 | 24,80 | 6.200,00 | 5.000 | **3,10** |
| | Mação | ... | 169,63 | 169,63 | 42.407,50 | 5.000 | **21,20** |
| ***Serra Estrela*** | Fornos de Algodres | 132,86 | 0,98 | 133,84 | 33.460,00 | 5.000 | **16,73** |
| | Gouveia | 1.128,88 | 42,89 | 1.171,77 | 292.942,50 | 5.000 | **146,47** |
| | Seia | 675,30 | 51,67 | 726,97 | 181.742,50 | 5.000 | **90,87** |
| ***Beira Interior Norte*** | Almeida | 211,82 | 561,05 | 772,87 | 193.217,50 | 5.000 | **96,61** |
| | Celorico da Beira | 119,25 | 111,29 | 230,54 | 57.635,00 | 5.000 | **28,82** |
| | Fig. Castelo Rodrigo | 2.701,86 | 99,21 | 2.801,07 | 700.267,50 | 5.000 | **350,13** |
| | Guarda | 198,60 | 463,36 | 661,96 | 165.490,00 | 5.000 | **82,75** |
| | Manteigas | ... | 40,73 | 40,73 | 10.182,50 | 5.000 | **5,09** |
| | Meda | 1.862,41 | 941,71 | 2.804,12 | 701.030,00 | 5.000 | **350,52** |
| | Pinhel | 4.656,20 | 45,49 | 4.701,69 | 1.175.422,50 | 5.000 | **587,71** |
| | Sabugal | 112,12 | 369,50 | 481,62 | 120.405,00 | 5.000 | **60,20** |
| | Trancoso | 1.032,96 | 117,63 | 1.150,59 | 287.647,50 | 5.000 | **143,82** |
| ***Beira Interior Sul*** | Castelo Branco | 364,60 | 710,06 | 1.074,66 | 268.665,00 | 5.000 | **134,33** |
| | Idanha-a-Nova | 69,92 | 226,33 | 296,25 | 74.062,50 | 5.000 | **37,03** |
| | Penamacor | 47,79 | 267,10 | 314,89 | 78.722,50 | 5.000 | **39,36** |
| | Vila Velha de Ródão | 1,85 | 49,25 | 51,10 | 12.775,00 | 5.000 | **6,39** |
| ***Cova Beira*** | Belmonte | 371,97 | 342,18 | 714,15 | 178.537,50 | 5.000 | **89,27** |
| | Covilhã | 855,85 | 73,66 | 929,51 | 232.377,50 | 5.000 | **116,19** |
| | Fundão | 917,81 | 341,37 | 1.259,18 | 314.795,00 | 5.000 | **157,40** |
| ***Oeste*** | Alcobaça | 2,01 | 543,50 | 545,51 | 136.377,50 | 5.000 | **68,19** |
| | Bombarral | 258,64 | 1.155,03 | 1.413,67 | 353.417,50 | 5.000 | **176,71** |
| | Caldas da Rainha | 100,57 | 1.401,03 | 1.501,60 | 375.400,00 | 5.000 | **187,70** |
| | Nazaré | 0,00 | 17,27 | 17,27 | 4.317,50 | 5.000 | **2,16** |
| | Óbidos | 98,06 | 389,75 | 487,81 | 121.952,50 | 5.000 | **60,98** |
| | Peniche | 0,62 | 89,19 | 89,81 | 22.452,50 | 5.000 | **11,23** |
| | Alenquer | 400,10 | 4.454,65 | 4.854,75 | 1.213.687,50 | 5.000 | **606,84** |
| | Arruda dos Vinhos | 126,42 | 769,12 | 895,54 | 223.885,00 | 5.000 | **111,94** |
| | Cadaval | 341,01 | 1.934,20 | 2.275,21 | 568.802,50 | 5.000 | **284,40** |
| | Lourinhã | 8,59 | 794,43 | 803,02 | 200.755,00 | 5.000 | **100,38** |
| | Sobral de Monte Agraço | 15,18 | 516,82 | 532,00 | 133.000,00 | 5.000 | **66,50** |
| ***Médio Tejo*** | Torres Vedras | 546,26 | 5.269,24 | 5.815,50 | 1.453.875,00 | 5.000 | **726,94** |
| | Abrantes | 38,86 | 224,06 | 262,92 | 65.730,00 | 5.000 | **32,87** |
| | Alcanena | 6,43 | 22,53 | 28,96 | 7.240,00 | 5.000 | **3,62** |
| | Constância | 0,00 | ... | 0,00 | 0,00 | 5.000 | **0,00** |
| | Entroncamento | 0,00 | 6,17 | 6,17 | 1.542,50 | 5.000 | **0,77** |
| | Ferreira do Zêzere | 3,07 | 373,68 | 376,75 | 94.187,50 | 5.000 | **47,09** |
| | Sardoal | ... | 71,28 | 71,28 | 17.820,00 | 5.000 | **8,91** |
| | Tomar | 76,39 | 825,11 | 901,50 | 225.375,00 | 5.000 | **112,69** |
| | Torres Novas | 10,33 | 503,47 | 513,80 | 128.450,00 | 5.000 | **64,23** |
| | Vila Nova da Barquinha | 0,00 | 18,16 | 18,16 | 4.540,00 | 5.000 | **2,27** |
| | Ourém | 20,40 | 1.197,47 | 1.217,87 | 304.467,50 | 5.000 | **152,23** |
| | **Total** | **36.537,42** | **30.849,26** | **67.386,68** | **16.846.670,00** | **-** | **8.423,34** |

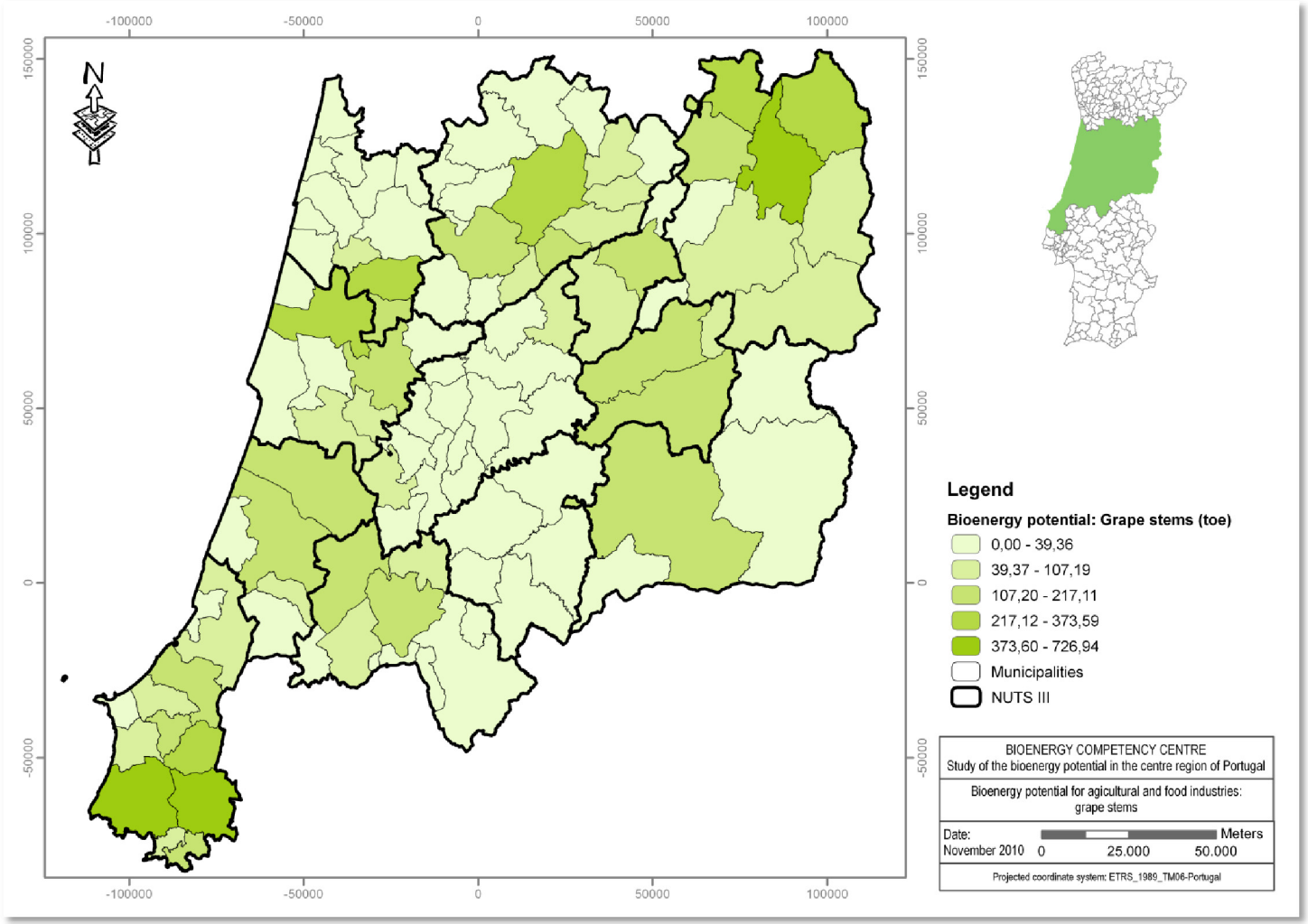


Figure A9.2: Map for the bioenergy potential from grape stems.

*Annex 10: Bioenergy Potential tool and intermediate results*

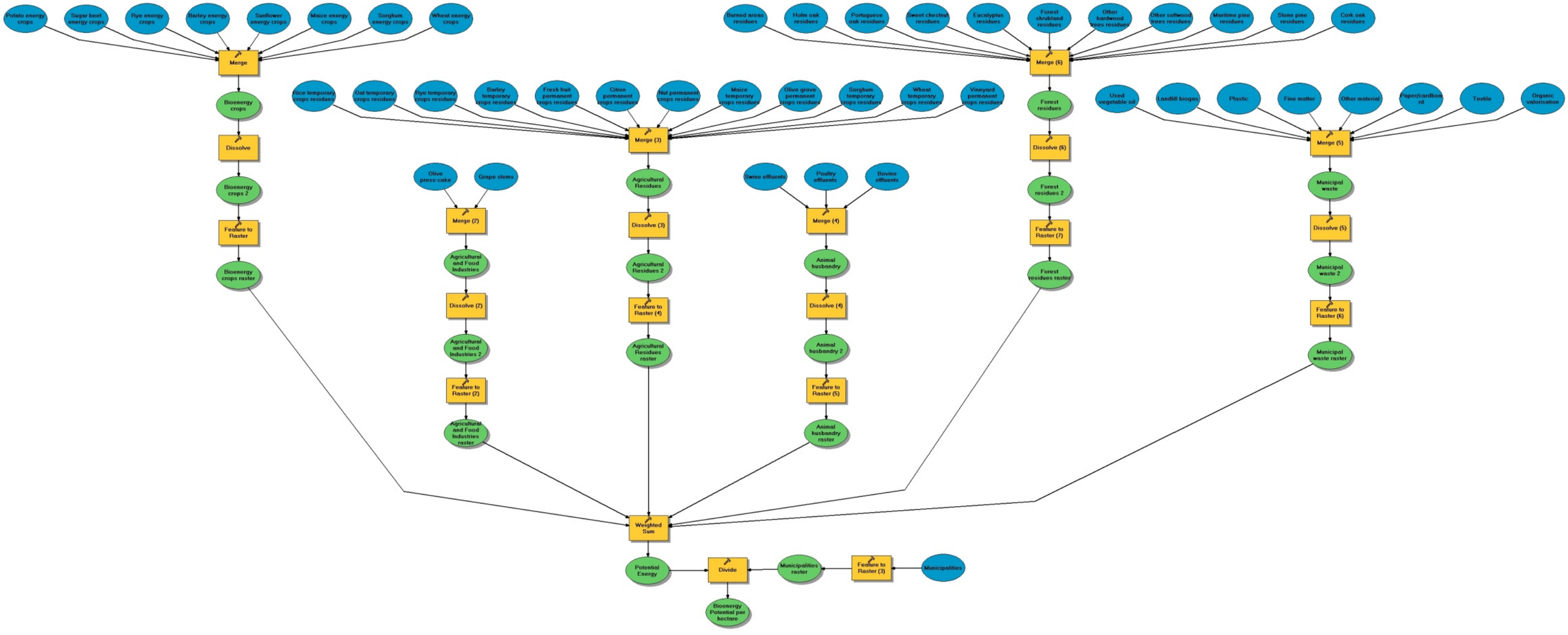


Figure A10.1: Bioenergy Potential tool.

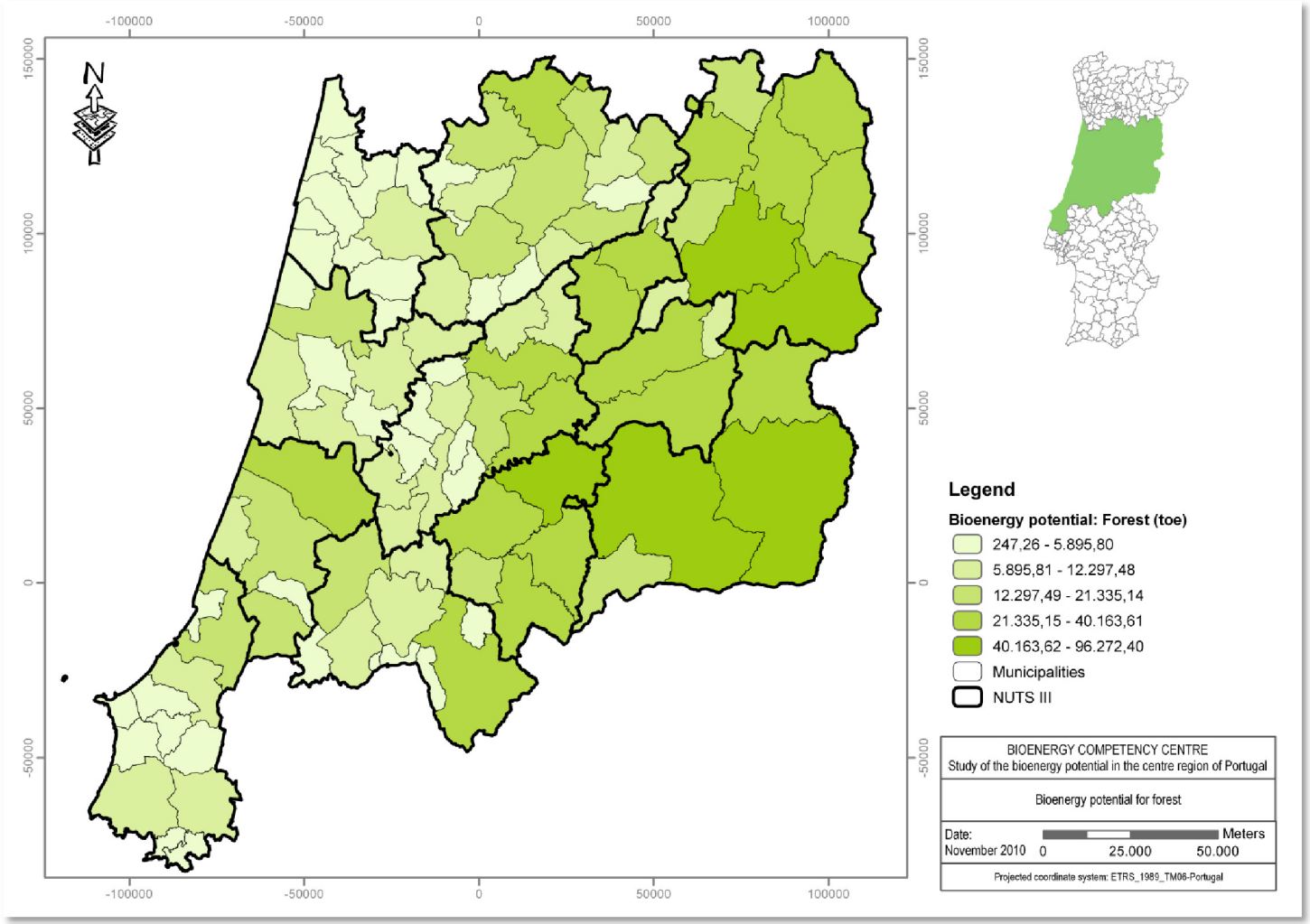


Figure A10.2: Potential bioenergy from forest waste.

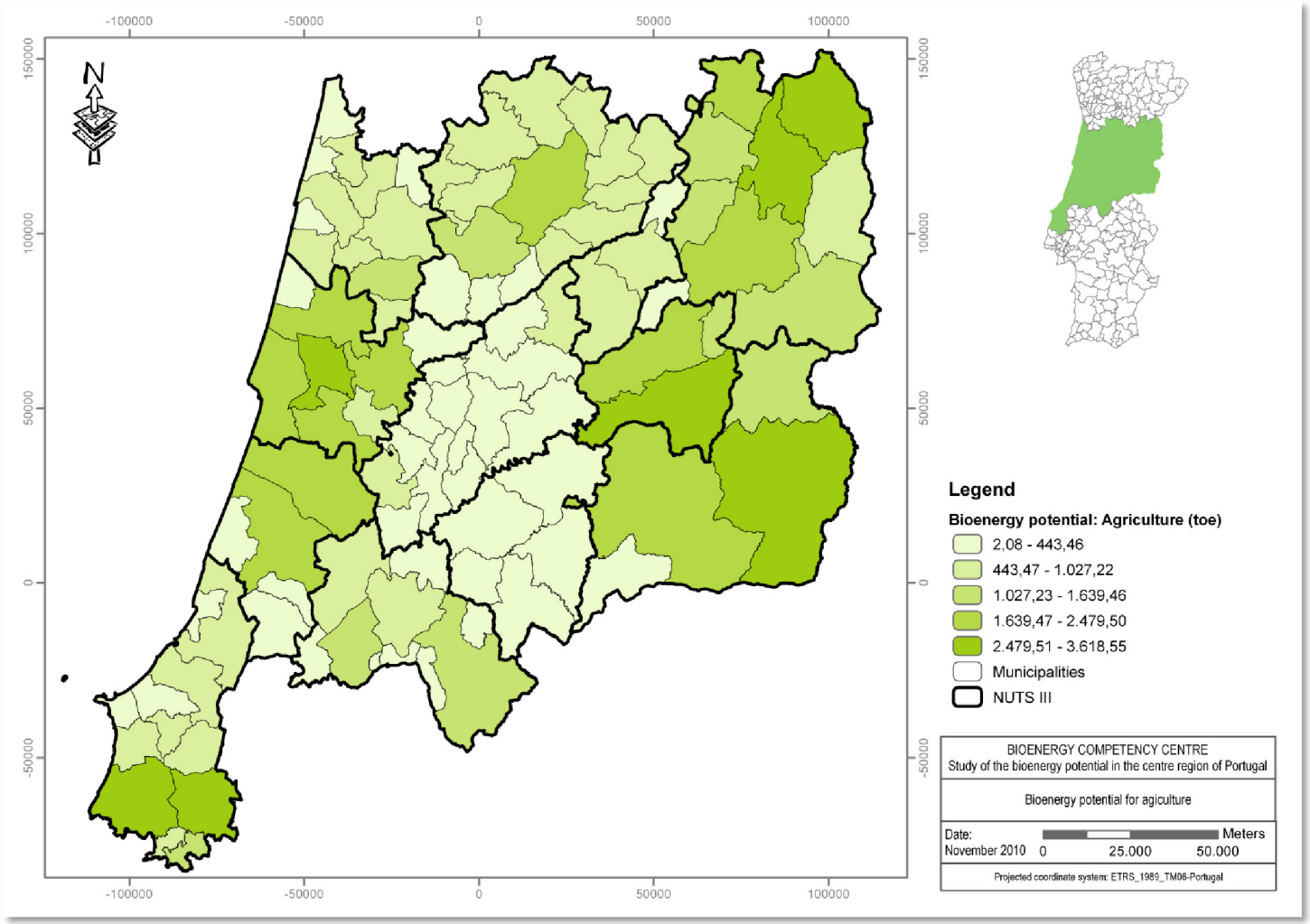


Figure A10.3: Potential bioenergy from agricultural waste.

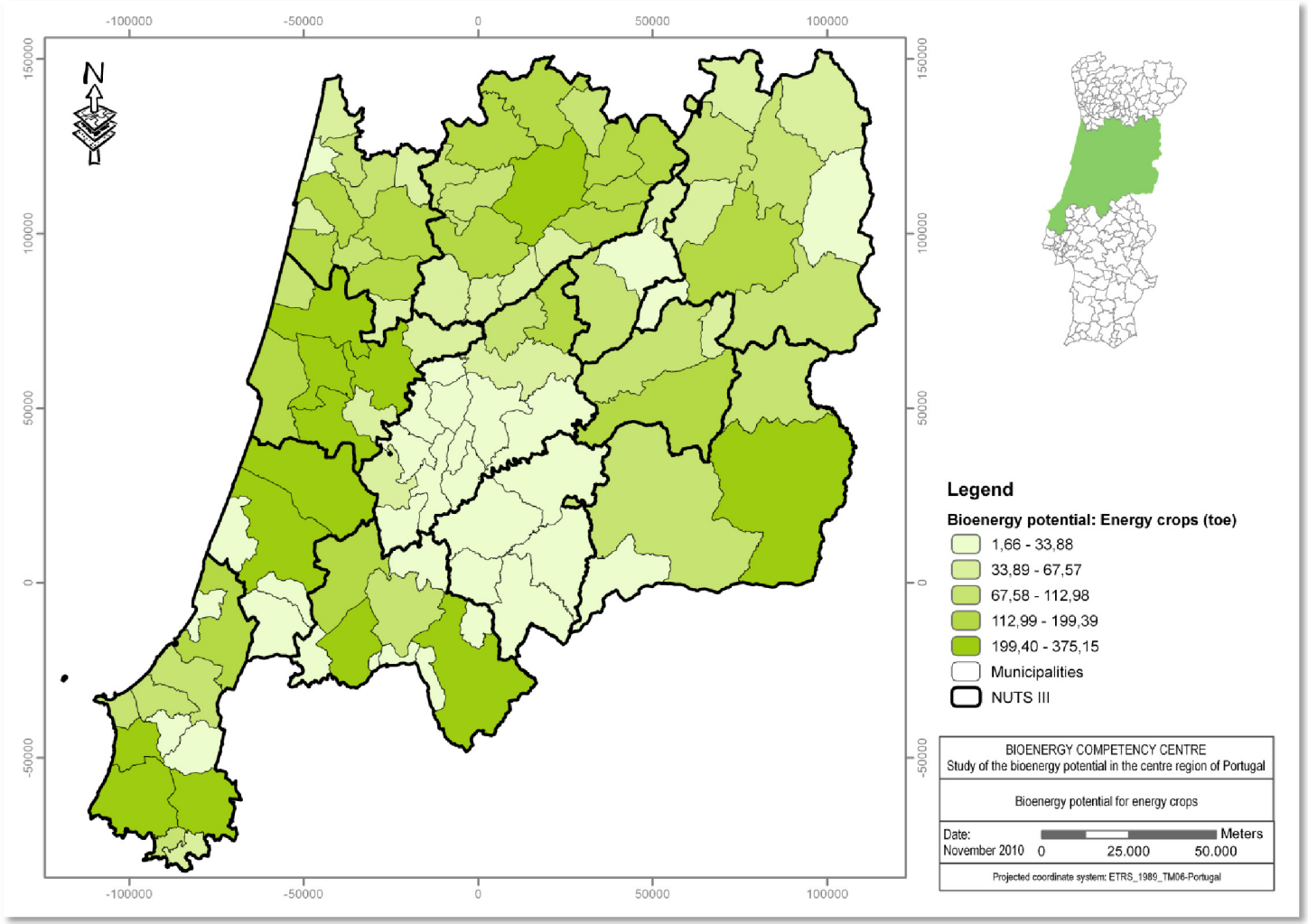


Figure A10.4: Potential bioenergy from energy crops.

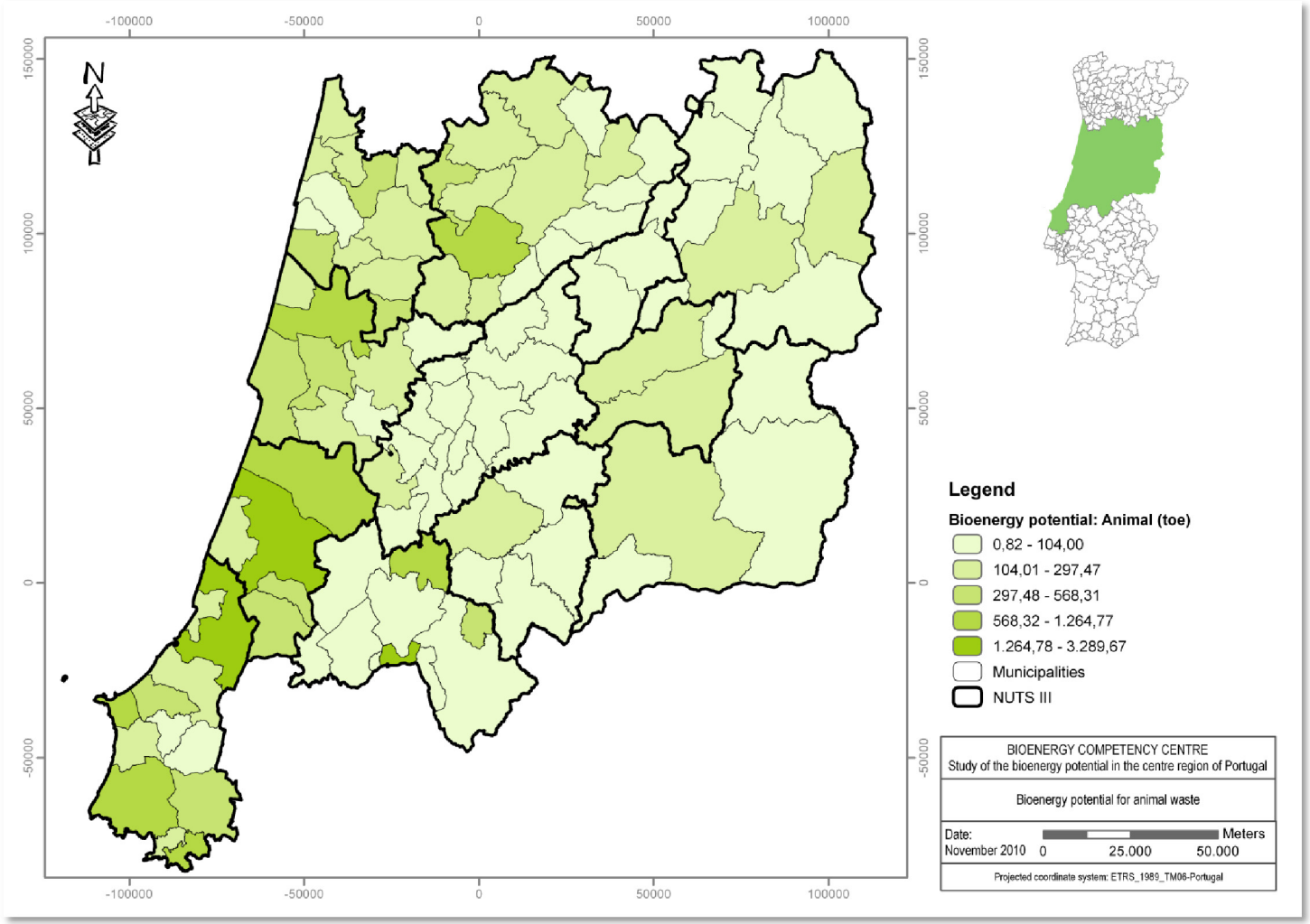


Figure A10.5: Potential bioenergy from animal husbandry waste.

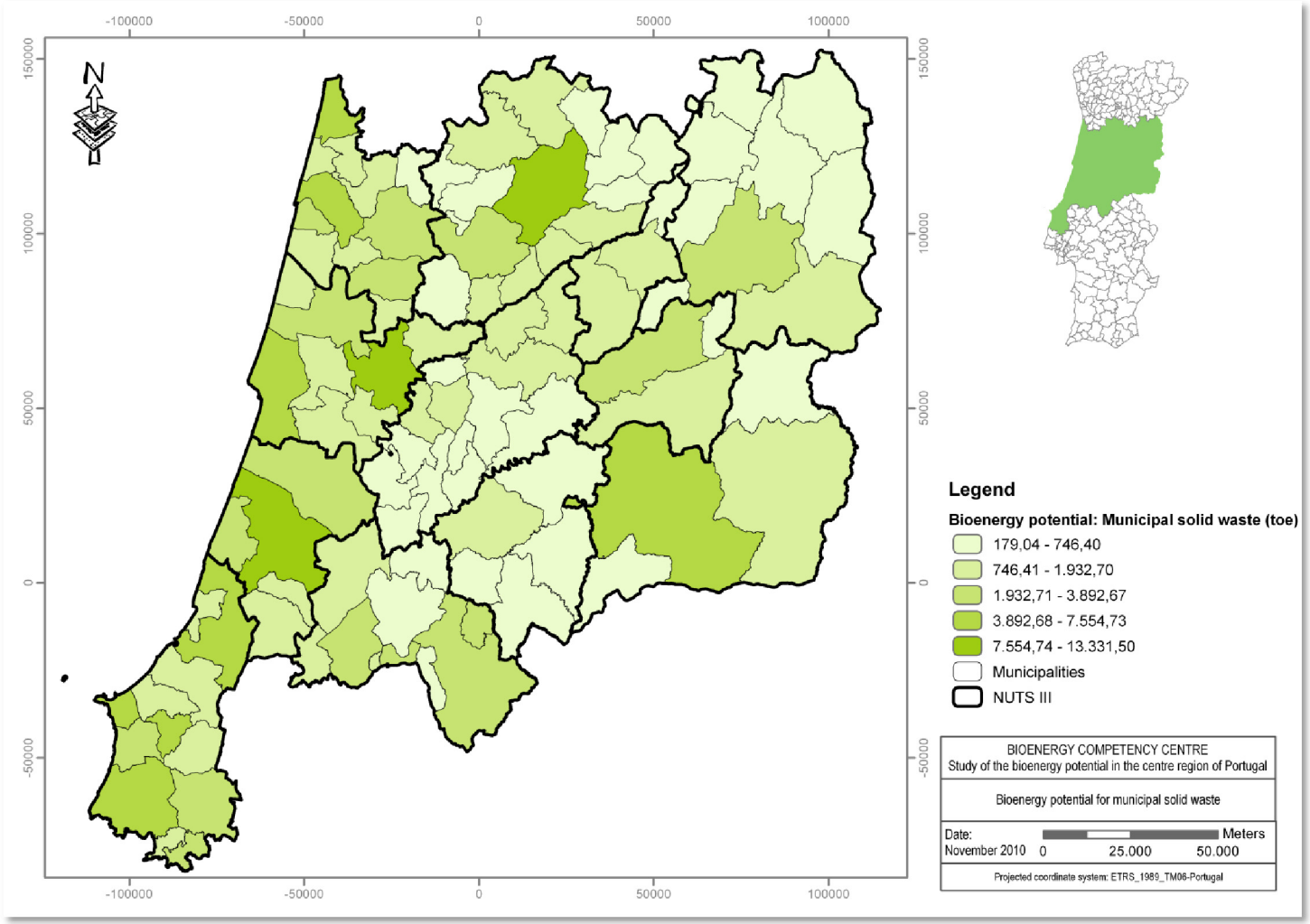


Figure A10.6: Potential bioenergy from municipal solid waste.

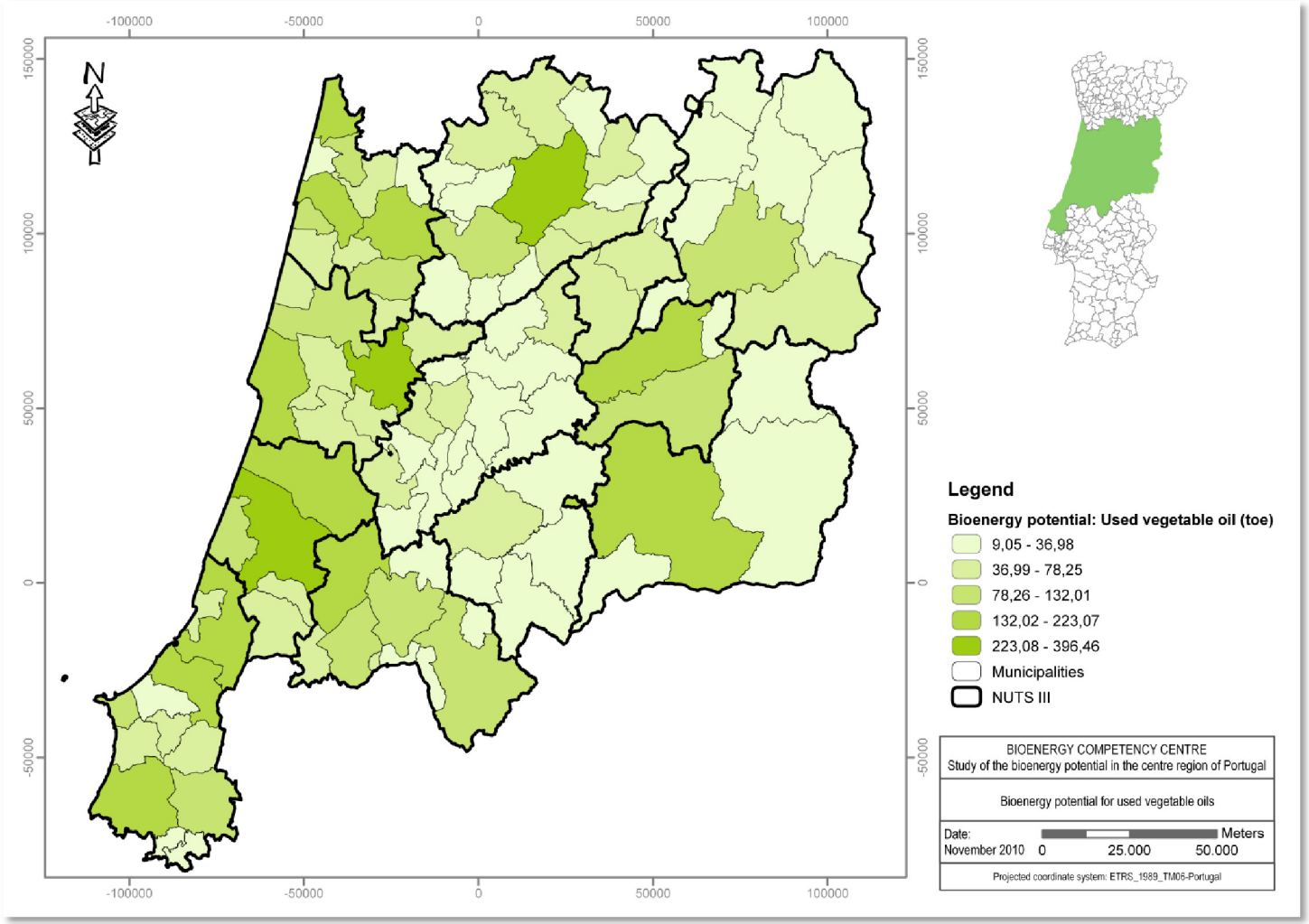


Figure A10.7: Potential bioenergy from used vegetable oil.

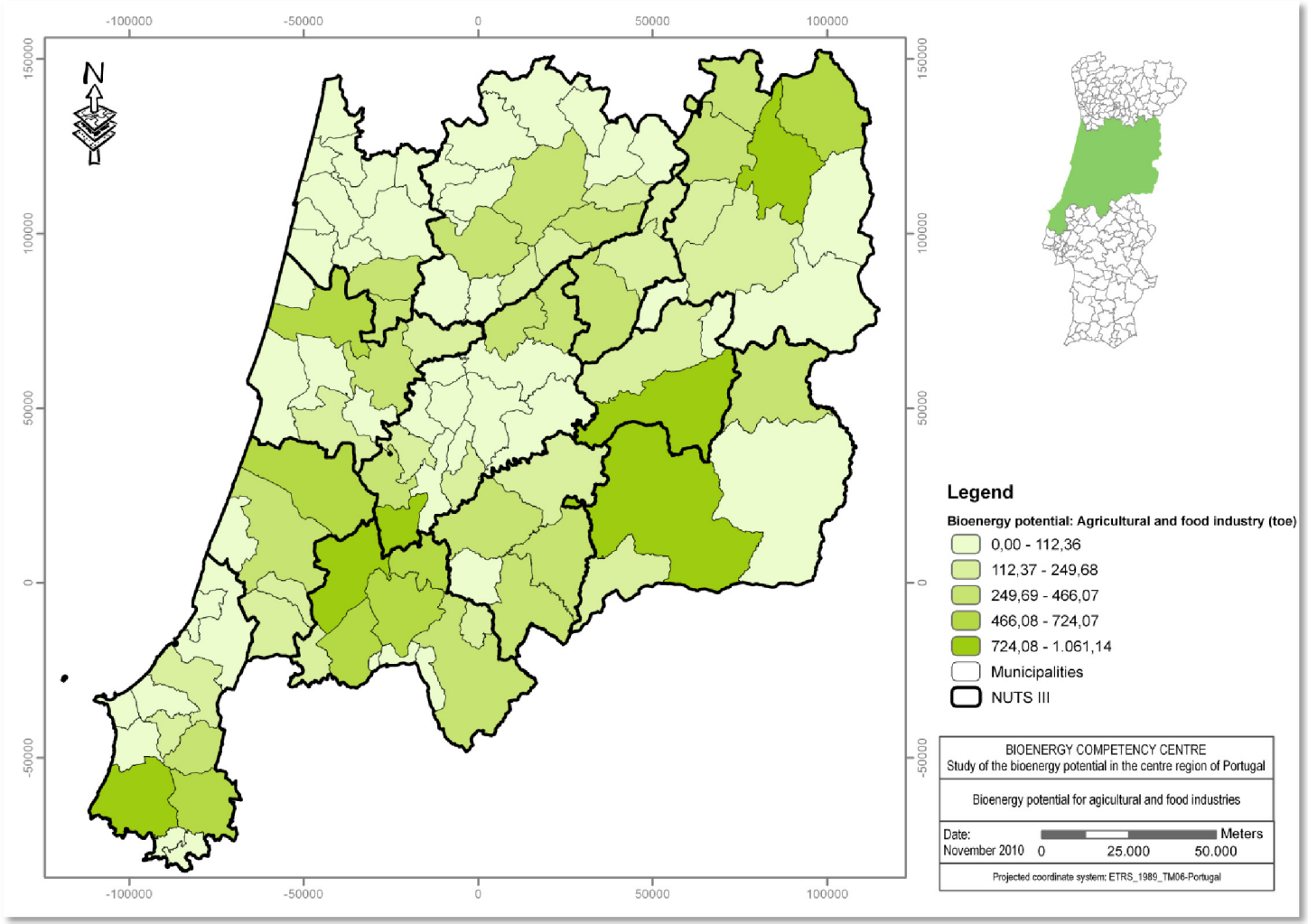


Figure A10.8: Potential bioenergy from industrial waste.

Table A10.1: Global results for bioenergy potential per type (toe).

| *NUTS III* | *Municipality* | *Forest (toe)* | *Agriculture residues (toe)* | *Bioenergy crops (toe)* | *Animal husbandry effluent (toe)* | *Agricultural and food industries (toe)* | *Municipal waste (toe)* | ***Total (toe)*** | ***Bioenergy potential per hectare (toe/ha)*** |
|---|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 9.469,11 | 980,33 | 163,55 | 139,30 | 36,52 | 3.099,49 | **13.888,31** | **0,41** |
| | Albergaria-a-Velha | 3.360,04 | 516,55 | 95,98 | 300,36 | 7,24 | 1.457,66 | **5.737,82** | **0,36** |
| | Anadia | 5.300,92 | 1.548,50 | 155,90 | 204,57 | 324,91 | 1.969,97 | **9.504,78** | **0,44** |
| | Aveiro | 2.431,54 | 554,13 | 113,01 | 97,13 | 7,64 | 7.319,57 | **10.523,02** | **0,53** |
| | Estarreja | 1.289,68 | 485,77 | 83,28 | 247,23 | 2,92 | 1.803,59 | **3.912,48** | **0,36** |
| | Ílhavo | 963,70 | 217,92 | 40,58 | 31,10 | 0,12 | 3.802,32 | **5.055,73** | **0,69** |
| | Mealhada | 3.523,42 | 756,96 | 61,67 | 527,92 | 253,20 | 1.491,69 | **6.614,87** | **0,60** |
| | Murtosa | 1.135,48 | 142,81 | 28,34 | 114,31 | 0,00 | 970,40 | **2.391,33** | **0,33** |
| | Oliveira do Bairro | 1.580,00 | 649,36 | 93,76 | 110,73 | 92,11 | 1.510,58 | **4.036,54** | **0,46** |
| | Ovar | 3.742,45 | 192,32 | 40,41 | 296,27 | 0,34 | 5.191,29 | **9.463,08** | **0,64** |
| | Sever do Vouga | 4.809,11 | 233,68 | 47,13 | 133,23 | 0,13 | 626,31 | **5.849,58** | **0,45** |
| | Vagos | 4.082,47 | 535,82 | 179,27 | 391,17 | 8,71 | 1.378,30 | **6.575,73** | **0,40** |
| ***Baixo Mondego*** | Cantanhede | 12.550,94 | 2.261,02 | 286,82 | 573,56 | 469,24 | 2.161,11 | **18.302,68** | **0,47** |
| | Coimbra | 7.718,15 | 2.198,94 | 279,04 | 104,57 | 317,63 | 13.331,50 | **23.949,83** | **0,75** |
| | Condeixa-a-Nova | 5.825,16 | 546,96 | 60,25 | 49,76 | 70,53 | 1.142,79 | **7.695,45** | **0,55** |
| | Figueira da Foz | 10.129,72 | 2.359,17 | 147,43 | 454,94 | 23,41 | 6.721,31 | **19.835,99** | **0,52** |
| | Mira | 3.966,32 | 267,43 | 102,22 | 179,89 | 3,07 | 1.230,88 | **5.749,81** | **0,46** |
| | Montemor-o-Velho | 4.379,32 | 2.909,74 | 351,78 | 418,25 | 76,37 | 1.766,75 | **9.902,23** | **0,43** |
| | Penacova | 7.449,26 | 377,27 | 58,17 | 40,78 | 145,85 | 845,25 | **8.916,58** | **0,41** |
| | Soure | 8.789,53 | 1.829,46 | 200,45 | 110,15 | 183,23 | 1.277,88 | **12.390,71** | **0,47** |
| ***Pinhal Litoral*** | Batalha | 4.626,93 | 355,92 | 27,30 | 342,18 | 168,54 | 1.202,51 | **6.723,39** | **0,65** |
| | Leiria | 19.321,47 | 2.005,06 | 275,93 | 3.289,67 | 249,84 | 9.819,87 | **34.961,84** | **0,62** |
| | Marinha Grande | 6.557,84 | 63,77 | 11,18 | 110,22 | 2,37 | 3.753,39 | **10.498,75** | **0,56** |
| | Pombal | 26.113,10 | 2.073,98 | 237,28 | 1.044,50 | 516,35 | 3.092,45 | **33.077,65** | **0,53** |
| | Porto de Mós | 16.974,58 | 236,17 | 18,29 | 497,60 | 196,34 | 1.632,14 | **19.555,12** | **0,75** |

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| ***NUTS III*** | *Municipality* | *Forest (toe)* | *Agriculture residues (toe)* | *Bioenergy crops (toe)* | *Animal husbandry effluent (toe)* | *Agricultural and food industries (toe)* | *Municipal waste (toe)* | ***Total (toe)*** | ***Bioenergy potential per hectare (toe/ha)*** |
|---|---|---|---|---|---|---|---|---|---|
| ***Pinhal Interior Norte*** | Arganil | 21.500,69 | 266,07 | 53,73 | 56,24 | 12,26 | 356,05 | **22.245,03** | **0,67** |
| | Góis | 15.135,38 | 40,96 | 10,36 | 30,94 | 5,05 | 708,32 | **15.931,01** | **0,61** |
| | Lousã | 6.009,19 | 82,23 | 18,46 | 12,20 | 34,82 | 812,32 | **6.969,23** | **0,50** |
| | Miranda do Corvo | 3.956,21 | 133,14 | 19,02 | 22,01 | 81,04 | 207,27 | **4.418,69** | **0,35** |
| | Oliveira do Hospital | 11.378,70 | 550,94 | 137,80 | 72,87 | 332,50 | 375,86 | **12.848,67** | **0,55** |
| | Pampilhosa da Serra | 30.275,09 | 8,98 | 9,13 | 4,32 | 54,07 | 300,66 | **30.652,24** | **0,77** |
| | Penela | 5.552,37 | 242,29 | 17,94 | 21,38 | 165,93 | 1.179,89 | **7.179,78** | **0,53** |
| | Tábua | 7.978,31 | 439,93 | 78,87 | 31,93 | 421,28 | 898,69 | **9.849,01** | **0,49** |
| | Vila Nova de Poiares | 2.641,04 | 137,89 | 19,70 | 7,51 | 3,96 | 1.424,95 | **4.235,06** | **0,50** |
| | Alvaiázere | 7.607,07 | 191,85 | 15,95 | 39,70 | 801,32 | 334,75 | **8.990,64** | **0,56** |
| | Ansião | 6.833,27 | 505,00 | 39,07 | 275,42 | 434,43 | 236,04 | **8.323,24** | **0,47** |
| | Castanheira de Pêra | 4.200,90 | 2,08 | 1,66 | 0,76 | 23,04 | 359,52 | **4.587,95** | **0,69** |
| | Figueiró dos Vinhos | 7.630,93 | 96,79 | 18,62 | 37,16 | 11,74 | 873,69 | **8.668,92** | **0,50** |
| | Pedrógão Grande | 5.350,97 | 102,94 | 14,30 | 7,55 | 113,53 | 506,00 | **6.095,28** | **0,47** |
| ***Dão Lafões*** | Aguiar da Beira | 13.614,53 | 689,64 | 164,71 | 97,84 | 31,76 | 354,62 | **14.953,11** | **0,72** |
| | Carregal do Sal | 4.659,80 | 362,32 | 61,43 | 31,92 | 127,54 | 791,27 | **6.034,27** | **0,52** |
| | Castro Daire | 28.773,28 | 769,77 | 161,64 | 125,41 | 31,22 | 860,57 | **30.721,89** | **0,81** |
| | Mangualde | 16.344,68 | 853,40 | 147,69 | 79,78 | 377,89 | 1.516,60 | **19.320,02** | **0,88** |
| | Mortágua | 7.708,90 | 388,54 | 58,94 | 211,56 | 19,92 | 599,68 | **8.987,54** | **0,36** |
| | Nelas | 5.954,49 | 596,45 | 55,84 | 27,41 | 220,82 | 1.163,52 | **8.018,53** | **0,64** |
| | Oliveira de Frades | 5.062,43 | 472,99 | 85,71 | 379,84 | 10,87 | 636,40 | **6.648,24** | **0,46** |
| | Penalva do Castelo | 5.744,14 | 703,17 | 127,50 | 45,51 | 194,44 | 438,35 | **7.253,12** | **0,54** |
| | Santa Comba Dão | 3.744,69 | 313,57 | 45,67 | 182,27 | 95,45 | 902,84 | **5.284,49** | **0,47** |
| | São Pedro do Sul | 21.209,43 | 777,90 | 130,86 | 120,48 | 46,01 | 1.181,11 | **23.465,79** | **0,67** |
| | Sátão | 9.810,30 | 838,29 | 124,98 | 125,02 | 50,78 | 727,57 | **11.676,94** | **0,58** |
| | Tondela | 13.711,49 | 1.429,87 | 181,86 | 894,53 | 420,24 | 2.046,73 | **18.684,72** | **0,50** |
| | Vila Nova de Paiva | 14.342,61 | 445,91 | 68,86 | 45,58 | 0,29 | 310,13 | **15.213,37** | **0,87** |
| | Viseu | 20.271,27 | 1.844,86 | 253,15 | 153,45 | 404,36 | 7.604,60 | **30.531,68** | **0,60** |
| | Vouzela | 9.459,50 | 492,95 | 93,04 | 170,52 | 30,61 | 643,24 | **10.889,85** | **-** |

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| NUTS III | Municipality | Forest (toe) | Agriculture residues (toe) | Bioenergy crops (toe) | Animal husbandry effluent (toe) | Agricultural and food industries (toe) | Municipal waste (toe) | Total (toe) | Bioenergy potential per hectare (toe/ha) |
|---|---|---|---|---|---|---|---|---|---|
| Pinhal Interior Sul | Oleiros | 40.357,71 | 160,00 | 17,59 | 25,05 | 147,93 | 490,22 | **41.198,49** | **0,87** |
| | Proença-a-Nova | 31.174,45 | 342,40 | 19,26 | 36,38 | 371,38 | 307,78 | **32.251,64** | **0,82** |
| | Sertã | 29.913,29 | 336,56 | 31,98 | 176,57 | 393,09 | 528,34 | **31.379,84** | **0,70** |
| | Vila de Rei | 13.634,15 | 53,98 | 3,63 | 45,50 | 22,87 | 807,30 | **14.567,43** | **0,76** |
| | Mação | 24.793,18 | 196,57 | 9,39 | 80,04 | 312,08 | 179,04 | **25.570,30** | **0,64** |
| Serra Estrela | Fornos de Algodres | 9.461,80 | 208,97 | 66,14 | 12,60 | 123,16 | 335,50 | **10.208,18** | **0,78** |
| | Gouveia | 28.195,44 | 867,84 | 31,31 | 49,02 | 194,04 | 1.113,78 | **30.451,43** | **1,01** |
| | Seia | 39.511,25 | 731,75 | 73,53 | 74,83 | 357,49 | 1.833,05 | **42.581,90** | **0,98** |
| Beira Interior Norte | Almeida | 31.769,13 | 715,22 | 30,55 | 133,91 | 96,61 | 570,38 | **33.315,80** | **0,64** |
| | Celorico da Beira | 17.222,77 | 1.172,63 | 62,13 | 20,84 | 112,93 | 534,20 | **19.125,49** | **0,77** |
| | Fig. Castelo Rodrigo | 31.037,91 | 2.484,41 | 34,93 | 26,02 | 589,52 | 488,93 | **34.661,72** | **0,68** |
| | Guarda | 66.829,65 | 2.245,97 | 146,75 | 241,09 | 161,12 | 2.784,98 | **72.409,56** | **1,02** |
| | Manteigas | 11.773,45 | 54,85 | 5,72 | 2,57 | 62,70 | 211,13 | **12.110,42** | **0,99** |
| | Meda | 19.627,21 | 1.951,45 | 58,32 | 16,17 | 435,73 | 319,37 | **22.408,25** | **0,78** |
| | Pinhel | 34.475,67 | 2.947,89 | 99,98 | 73,11 | 900,61 | 744,29 | **39.241,55** | **0,81** |
| | Sabugal | 96.272,44 | 1.437,25 | 92,72 | 99,69 | 75,25 | 935,08 | **98.912,44** | **1,20** |
| | Trancoso | 27.578,70 | 1.374,88 | 93,42 | 65,72 | 327,50 | 556,17 | **29.996,39** | **0,83** |
| Beira Interior Sul | Castelo Branco | 69.941,44 | 1.643,86 | 81,90 | 223,88 | 1.061,14 | 4.611,65 | **77.563,87** | **0,54** |
| | Idanha-a-Nova | 61.260,31 | 3.592,96 | 251,78 | 54,86 | 65,55 | 983,25 | **66.208,72** | **0,47** |
| | Penamacor | 28.337,48 | 1.347,39 | 68,99 | 36,31 | 328,92 | 400,12 | **30.519,22** | **0,54** |
| | Vila Velha de Ródão | 17.203,50 | 135,76 | 5,19 | 37,17 | 207,27 | 278,85 | **17.867,74** | **0,54** |
| Cova Beira | Belmonte | 6.860,02 | 1.116,83 | 44,81 | 30,60 | 89,27 | 286,03 | **8.427,56** | **0,71** |
| | Covilhã | 39.869,48 | 1.956,14 | 94,44 | 163,10 | 202,61 | 2.058,04 | **44.343,80** | **0,80** |
| | Fundão | 34.027,80 | 2.733,95 | 159,04 | 163,77 | 826,15 | 1.163,73 | **39.074,44** | **0,56** |

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| *NUTS III* | *Municipality* | *Forest (toe)* | *Agriculture residues (toe)* | *Bioenergy crops (toe)* | *Animal husbandry effluent (toe)* | *Agricultural and food industries (toe)* | *Municipal waste (toe)* | ***Total (toe)*** | ***Bioenergy potential per hectare (toe/ha)*** |
|---|---|---|---|---|---|---|---|---|---|
| ***Oeste*** | Alcobaça | 15.165,28 | 599,15 | 136,31 | 2.627,10 | 91,82 | 4.951,98 | **23.571,64** | **0,58** |
| | Bombarral | 1.220,77 | 640,21 | 29,17 | 465,07 | 176,71 | 3.900,26 | **6.432,19** | **0,66** |
| | Caldas da Rainha | 7.015,27 | 828,28 | 78,08 | 1.059,05 | 187,70 | 1.185,08 | **10.353,46** | **0,37** |
| | Nazaré | 3.083,60 | 36,24 | 19,45 | 69,97 | 2,16 | 1.228,27 | **4.439,68** | **0,55** |
| | Óbidos | 3.801,85 | 365,57 | 75,26 | 33,68 | 60,98 | 1.251,75 | **5.589,08** | **0,41** |
| | Peniche | 1.313,52 | 287,35 | 79,91 | 189,44 | 11,23 | 4.857,25 | **6.738,70** | **0,97** |
| | Alenquer | 6.717,11 | 3.632,79 | 280,32 | 206,22 | 625,93 | 2.272,51 | **13.734,89** | **0,46** |
| | Arruda dos Vinhos | 2.665,25 | 1.029,78 | 44,73 | 157,18 | 111,94 | 2.236,81 | **6.245,69** | **0,92** |
| | Cadaval | 4.865,36 | 1.003,47 | 28,06 | 309,68 | 284,40 | 1.196,35 | **7.687,33** | **0,42** |
| | Lourinhã | 2.084,04 | 786,13 | 332,89 | 999,60 | 100,38 | 3.792,71 | **8.095,74** | **0,50** |
| | Sobral de Monte Agraço | 1.265,87 | 722,83 | 77,57 | 173,59 | 66,50 | 893,69 | **3.200,05** | **0,61** |
| | Torres Vedras | 7.739,56 | 3.476,34 | 289,44 | 1.147,62 | 726,94 | 6.998,02 | **20.377,92** | **0,50** |
| ***Médio Tejo*** | Abrantes | 25.265,91 | 1.523,38 | 375,15 | 67,90 | 335,70 | 3.268,85 | **30.836,88** | **0,43** |
| | Alcanena | 4.882,25 | 197,09 | 31,93 | 48,97 | 116,24 | 1.039,50 | **6.315,98** | **0,50** |
| | Constância | 3.004,62 | 69,37 | 18,61 | 50,32 | 0,00 | 430,46 | **3.573,39** | **0,44** |
| | Entroncamento | 247,26 | 27,41 | 8,66 | 0,82 | 0,77 | 1.563,62 | **1.848,54** | **1,35** |
| | Ferreira do Zêzere | 5.984,06 | 239,04 | 19,77 | 1.079,76 | 530,33 | 576,09 | **8.429,04** | **0,44** |
| | Sardoal | 3.762,81 | 71,84 | 7,25 | 6,79 | 123,31 | 2.860,14 | **6.832,14** | **0,79** |
| | Tomar | 9.518,45 | 802,65 | 99,27 | 483,25 | 587,79 | 388,05 | **11.879,46** | **0,33** |
| | Torres Novas | 6.625,25 | 1.368,17 | 334,83 | 70,36 | 512,17 | 3.356,00 | **12.266,78** | **0,45** |
| | Vila Nova da Barquinha | 1.554,60 | 56,51 | 16,54 | 0,99 | 71,75 | 3.005,51 | **4.705,90** | **1,21** |
| | Ourém | 19.305,45 | 926,40 | 137,13 | 1.270,64 | 945,99 | 816,66 | **23.402,27** | **0,53** |
| | **Total** | **1.440.768,26** | **86.579,26** | **9.479,32** | **25.527,29** | **20.849,39** | **181.541,00** | **1.764.744,52** | **-** |

Table A10.2: Global results for bioenergy potential per type (%).

| *NUTS III* | *Municipality* | *Forest (%)* | *Agriculture residues (%)* | *Bioenergy crops (%)* | *Animal husbandry effluents (%)* | *Agricultural and food industries (%)* | *Municipal waste (%)* | ***Total (%)*** |
|---|---|---|---|---|---|---|---|---|
| ***Baixo Vouga*** | Águeda | 68,18 | 7,06 | 1,18 | 1,00 | 0,26 | 22,32 | **100,00** |
| | Albergaria-a-Velha | 58,56 | 9,00 | 1,67 | 5,23 | 0,13 | 25,40 | **100,00** |
| | Anadia | 55,77 | 16,29 | 1,64 | 2,15 | 3,42 | 20,73 | **100,00** |
| | Aveiro | 23,11 | 5,27 | 1,07 | 0,92 | 0,07 | 69,56 | **100,00** |
| | Estarreja | 32,96 | 12,42 | 2,13 | 6,32 | 0,07 | 46,10 | **100,00** |
| | Ílhavo | 19,06 | 4,31 | 0,80 | 0,62 | 0,00 | 75,21 | **100,00** |
| | Mealhada | 53,27 | 11,44 | 0,93 | 7,98 | 3,83 | 22,55 | **100,00** |
| | Murtosa | 47,48 | 5,97 | 1,19 | 4,78 | 0,00 | 40,58 | **100,00** |
| | Oliveira do Bairro | 39,14 | 16,09 | 2,32 | 2,74 | 2,28 | 37,42 | **100,00** |
| | Ovar | 39,55 | 2,03 | 0,43 | 3,13 | 0,00 | 54,86 | **100,00** |
| | Sever do Vouga | 82,21 | 3,99 | 0,81 | 2,28 | 0,00 | 10,71 | **100,00** |
| | Vagos | 62,08 | 8,15 | 2,73 | 5,95 | 0,13 | 20,96 | **100,00** |
| ***Baixo Mondego*** | Cantanhede | 68,57 | 12,35 | 1,57 | 3,13 | 2,56 | 11,81 | **100,00** |
| | Coimbra | 32,23 | 9,18 | 1,17 | 0,44 | 1,33 | 55,66 | **100,00** |
| | Condeixa-a-Nova | 75,70 | 7,11 | 0,78 | 0,65 | 0,92 | 14,85 | **100,00** |
| | Figueira da Foz | 51,07 | 11,89 | 0,74 | 2,29 | 0,12 | 33,88 | **100,00** |
| | Mira | 68,98 | 4,65 | 1,78 | 3,13 | 0,05 | 21,41 | **100,00** |
| | Montemor-o-Velho | 44,23 | 29,38 | 3,55 | 4,22 | 0,77 | 17,84 | **100,00** |
| | Penacova | 83,54 | 4,23 | 0,65 | 0,46 | 1,64 | 9,48 | **100,00** |
| | Soure | 70,94 | 14,76 | 1,62 | 0,89 | 1,48 | 10,31 | **100,00** |
| ***Pinhal Litoral*** | Batalha | 68,82 | 5,29 | 0,41 | 5,09 | 2,51 | 17,89 | **100,00** |
| | Leiria | 55,26 | 5,74 | 0,79 | 9,41 | 0,71 | 28,09 | **100,00** |
| | Marinha Grande | 62,46 | 0,61 | 0,11 | 1,05 | 0,02 | 35,75 | **100,00** |
| | Pombal | 78,94 | 6,27 | 0,72 | 3,16 | 1,56 | 9,35 | **100,00** |
| | Porto de Mós | 86,80 | 1,21 | 0,09 | 2,54 | 1,00 | 8,35 | **100,00** |
| ***Pinhal Interior Norte*** | Arganil | 96,65 | 1,20 | 0,24 | 0,25 | 0,06 | 1,60 | **100,00** |
| | Góis | 95,01 | 0,26 | 0,07 | 0,19 | 0,03 | 4,45 | **100,00** |
| | Lousã | 86,22 | 1,18 | 0,26 | 0,18 | 0,50 | 11,66 | **100,00** |
| | Miranda do Corvo | 89,53 | 3,01 | 0,43 | 0,50 | 1,83 | 4,69 | **100,00** |
| | Oliveira do Hospital | 88,56 | 4,29 | 1,07 | 0,57 | 2,59 | 2,93 | **100,00** |
| | Pampilhosa da Serra | 98,77 | 0,03 | 0,03 | 0,01 | 0,18 | 0,98 | **100,00** |
| | Penela | 77,33 | 3,37 | 0,25 | 0,30 | 2,31 | 16,43 | **100,00** |
| | Tábua | 81,01 | 4,47 | 0,80 | 0,32 | 4,28 | 9,12 | **100,00** |
| | Vila Nova de Poiares | 62,36 | 3,26 | 0,47 | 0,18 | 0,09 | 33,65 | **100,00** |
| | Alvaiázere | 84,61 | 2,13 | 0,18 | 0,44 | 8,91 | 3,72 | **100,00** |
| | Ansião | 82,10 | 6,07 | 0,47 | 3,31 | 5,22 | 2,84 | **100,00** |
| | Castanheira de Pêra | 91,56 | 0,05 | 0,04 | 0,02 | 0,50 | 7,84 | **100,00** |
| | Figueiró dos Vinhos | 88,03 | 1,12 | 0,21 | 0,43 | 0,14 | 10,08 | **100,00** |
| | Pedrógão Grande | 87,79 | 1,69 | 0,23 | 0,12 | 1,86 | 8,30 | **100,00** |
| ***Dão Lafões*** | Aguiar da Beira | 91,05 | 4,61 | 1,10 | 0,65 | 0,21 | 2,37 | **100,00** |
| | Carregal do Sal | 77,22 | 6,00 | 1,02 | 0,53 | 2,11 | 13,11 | **100,00** |
| | Castro Daire | 93,66 | 2,51 | 0,53 | 0,41 | 0,10 | 2,80 | **100,00** |
| | Mangualde | 84,60 | 4,42 | 0,76 | 0,41 | 1,96 | 7,85 | **100,00** |
| | Mortágua | 85,77 | 4,32 | 0,66 | 2,35 | 0,22 | 6,67 | **100,00** |
| | Nelas | 74,26 | 7,44 | 0,70 | 0,34 | 2,75 | 14,51 | **100,00** |
| | Oliveira de Frades | 76,15 | 7,11 | 1,29 | 5,71 | 0,16 | 9,57 | **100,00** |
| | Penalva do Castelo | 79,20 | 9,69 | 1,76 | 0,63 | 2,68 | 6,04 | **100,00** |
| | Santa Comba Dão | 70,86 | 5,93 | 0,86 | 3,45 | 1,81 | 17,08 | **100,00** |

*(continues on next page)*

*(continued from previous page)*

| *NUTS III* | *Municipality* | *Forest (%)* | *Agriculture residues (%)* | *Bioenergy crops (%)* | *Animal husbandry effluents (%)* | *Agricultural and food industries (%)* | *Municipal waste (%)* | ***Total (%)*** |
|---|---|---|---|---|---|---|---|---|
| ***Dão Lafões*** | São Pedro do Sul | 90,38 | 3,32 | 0,56 | 0,51 | 0,20 | 5,03 | **100,00** |
| | Sátão | 84,01 | 7,18 | 1,07 | 1,07 | 0,43 | 6,23 | **100,00** |
| | Tondela | 73,38 | 7,65 | 0,97 | 4,79 | 2,25 | 10,95 | **100,00** |
| | Vila Nova de Paiva | 94,28 | 2,93 | 0,45 | 0,30 | 0,00 | 2,04 | **100,00** |
| | Viseu | 66,39 | 6,04 | 0,83 | 0,50 | 1,32 | 24,91 | **100,00** |
| | Vouzela | 86,87 | 4,53 | 0,85 | 1,57 | 0,28 | 5,91 | **100,00** |
| ***Pinhal Interior Sul*** | Oleiros | 97,96 | 0,39 | 0,04 | 0,06 | 0,36 | 1,19 | **100,00** |
| | Proença-a-Nova | 96,66 | 1,06 | 0,06 | 0,11 | 1,15 | 0,95 | **100,00** |
| | Sertã | 95,33 | 1,07 | 0,10 | 0,56 | 1,25 | 1,68 | **100,00** |
| | Vila de Rei | 93,59 | 0,37 | 0,02 | 0,31 | 0,16 | 5,54 | **100,00** |
| | Mação | 96,96 | 0,77 | 0,04 | 0,31 | 1,22 | 0,70 | **100,00** |
| ***Serra Estrela*** | Fornos de Algodres | 92,69 | 2,05 | 0,65 | 0,12 | 1,21 | 3,29 | **100,00** |
| | Gouveia | 92,59 | 2,85 | 0,10 | 0,16 | 0,64 | 3,66 | **100,00** |
| | Seia | 92,79 | 1,72 | 0,17 | 0,18 | 0,84 | 4,30 | **100,00** |
| ***Beira Interior Norte*** | Almeida | 95,36 | 2,15 | 0,09 | 0,40 | 0,29 | 1,71 | **100,00** |
| | Celorico da Beira | 90,05 | 6,13 | 0,32 | 0,11 | 0,59 | 2,79 | **100,00** |
| | Fig. Castelo Rodrigo | 89,55 | 7,17 | 0,10 | 0,08 | 1,70 | 1,41 | **100,00** |
| | Guarda | 92,29 | 3,10 | 0,20 | 0,33 | 0,22 | 3,85 | **100,00** |
| | Manteigas | 97,22 | 0,45 | 0,05 | 0,02 | 0,52 | 1,74 | **100,00** |
| | Meda | 87,59 | 8,71 | 0,26 | 0,07 | 1,94 | 1,43 | **100,00** |
| | Pinhel | 87,86 | 7,51 | 0,25 | 0,19 | 2,30 | 1,90 | **100,00** |
| | Sabugal | 97,33 | 1,45 | 0,09 | 0,10 | 0,08 | 0,95 | **100,00** |
| | Trancoso | 91,94 | 4,58 | 0,31 | 0,22 | 1,09 | 1,85 | **100,00** |
| ***Beira Interior Sul*** | Castelo Branco | 90,17 | 2,12 | 0,11 | 0,29 | 1,37 | 5,95 | **100,00** |
| | Idanha-a-Nova | 92,53 | 5,43 | 0,38 | 0,08 | 0,10 | 1,49 | **100,00** |
| | Penamacor | 92,85 | 4,41 | 0,23 | 0,12 | 1,08 | 1,31 | **100,00** |
| | Vila Velha de Ródão | 96,28 | 0,76 | 0,03 | 0,21 | 1,16 | 1,56 | **100,00** |
| ***Cova Beira*** | Belmonte | 81,40 | 13,25 | 0,53 | 0,36 | 1,06 | 3,39 | **100,00** |
| | Covilhã | 89,91 | 4,41 | 0,21 | 0,37 | 0,46 | 4,64 | **100,00** |
| | Fundão | 87,08 | 7,00 | 0,41 | 0,42 | 2,11 | 2,98 | **100,00** |
| ***Oeste*** | Alcobaça | 64,34 | 2,54 | 0,58 | 11,15 | 0,39 | 21,01 | **100,00** |
| | Bombarral | 18,98 | 9,95 | 0,45 | 7,23 | 2,75 | 60,64 | **100,00** |
| | Caldas da Rainha | 67,76 | 8,00 | 0,75 | 10,23 | 1,81 | 11,45 | **100,00** |
| | Nazaré | 69,46 | 0,82 | 0,44 | 1,58 | 0,05 | 27,67 | **100,00** |
| | Óbidos | 68,02 | 6,54 | 1,35 | 0,60 | 1,09 | 22,40 | **100,00** |
| | Peniche | 19,49 | 4,26 | 1,19 | 2,81 | 0,17 | 72,08 | **100,00** |
| | Alenquer | 48,91 | 26,45 | 2,04 | 1,50 | 4,56 | 16,55 | **100,00** |
| | Arruda dos Vinhos | 42,67 | 16,49 | 0,72 | 2,52 | 1,79 | 35,81 | **100,00** |
| | Cadaval | 63,29 | 13,05 | 0,36 | 4,03 | 3,70 | 15,56 | **100,00** |
| | Lourinhã | 25,74 | 9,71 | 4,11 | 12,35 | 1,24 | 46,85 | **100,00** |
| | Sobral de Monte Agraço | 39,56 | 22,59 | 2,42 | 5,42 | 2,08 | 27,93 | **100,00** |
| | Torres Vedras | 37,98 | 17,06 | 1,42 | 5,63 | 3,57 | 34,34 | **100,00** |
| ***Médio Tejo*** | Abrantes | 81,93 | 4,94 | 1,22 | 0,22 | 1,09 | 10,60 | **100,00** |
| | Alcanena | 77,30 | 3,12 | 0,51 | 0,78 | 1,84 | 16,46 | **100,00** |
| | Constância | 84,08 | 1,94 | 0,52 | 1,41 | 0,00 | 12,05 | **100,00** |
| | Entroncamento | 13,38 | 1,48 | 0,47 | 0,04 | 0,04 | 84,59 | **100,00** |
| | Ferreira do Zêzere | 70,99 | 2,84 | 0,23 | 12,81 | 6,29 | 6,83 | **100,00** |
| | Sardoal | 55,08 | 1,05 | 0,11 | 0,10 | 1,80 | 41,86 | **100,00** |
| | Tomar | 80,13 | 6,76 | 0,84 | 4,07 | 4,95 | 3,27 | **100,00** |
| | Torres Novas | 54,01 | 11,15 | 2,73 | 0,57 | 4,18 | 27,36 | **100,00** |
| | Vila Nova da Barquinha | 33,04 | 1,20 | 0,35 | 0,02 | 1,52 | 63,87 | **100,00** |
| | Ourém | 82,49 | 3,96 | 0,59 | 5,43 | 4,04 | 3,49 | **100,00** |

*Annex 11: Location of the Bioenergy Competency Centre*

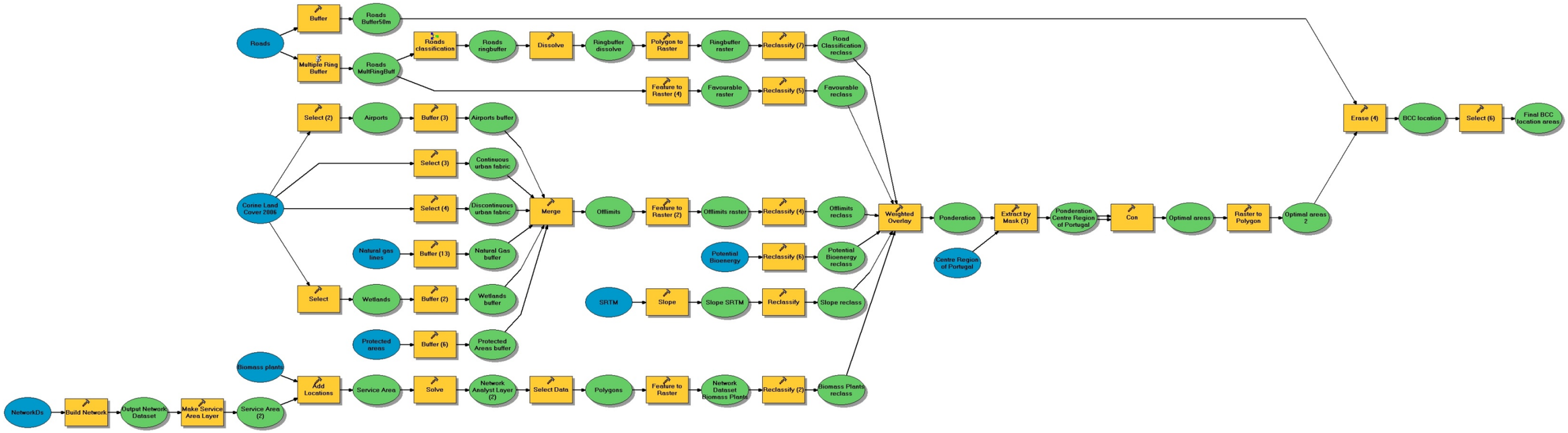


Figure A11.1: Bioenergy Competency Centre location tool.

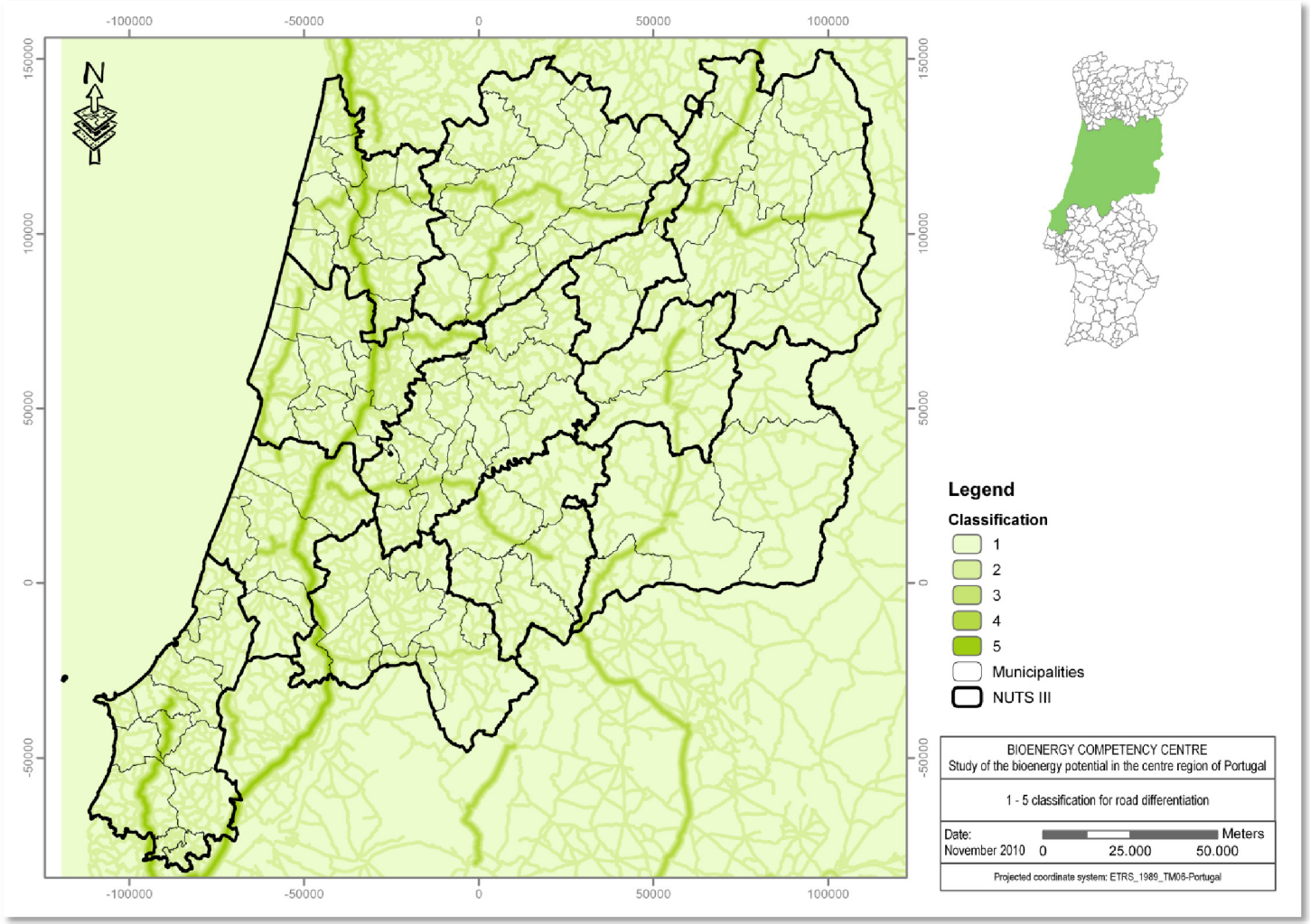


Figure A11.2: Classification for road differentiation.

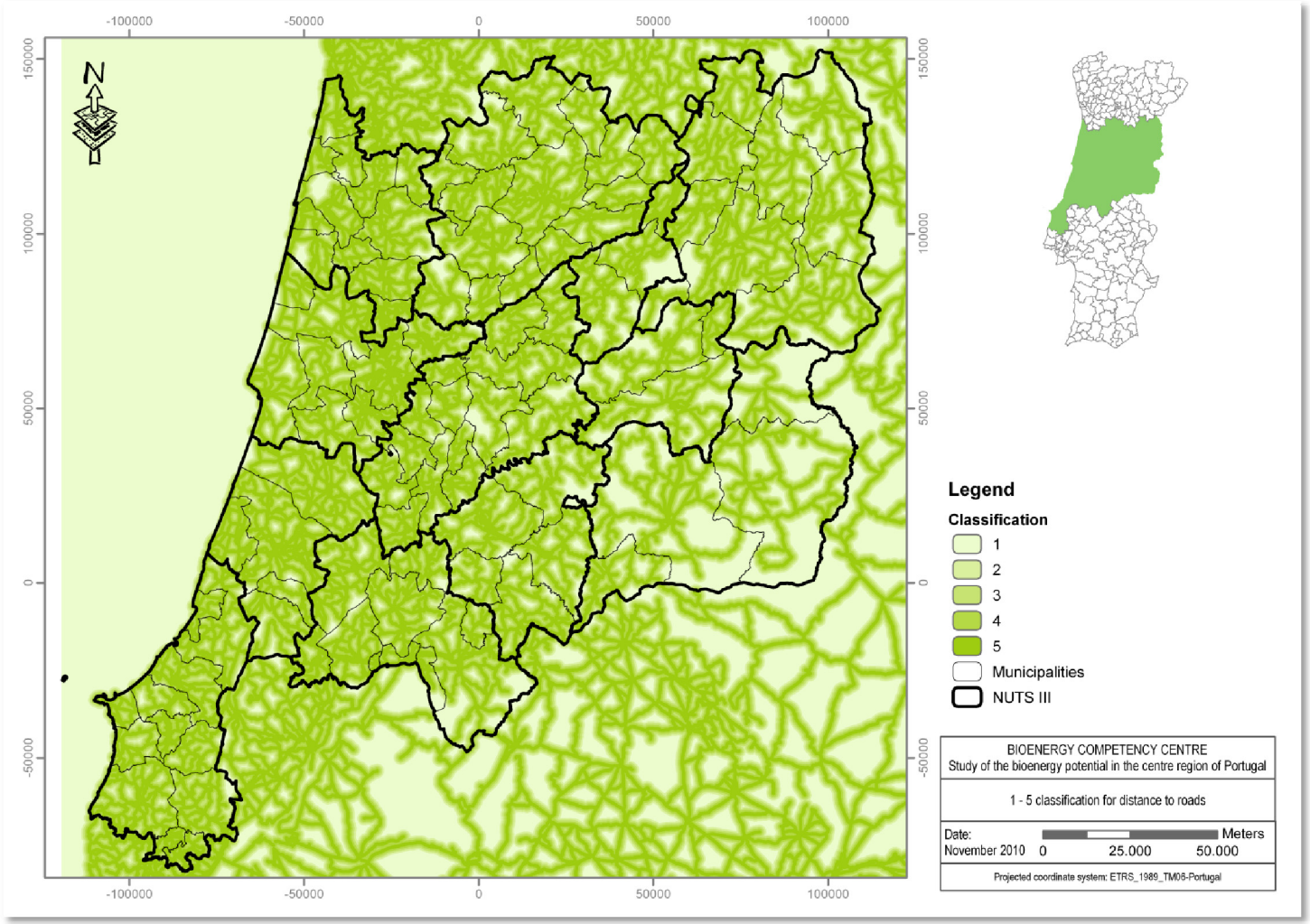


Figure A11.3: Classification for distance to roads.

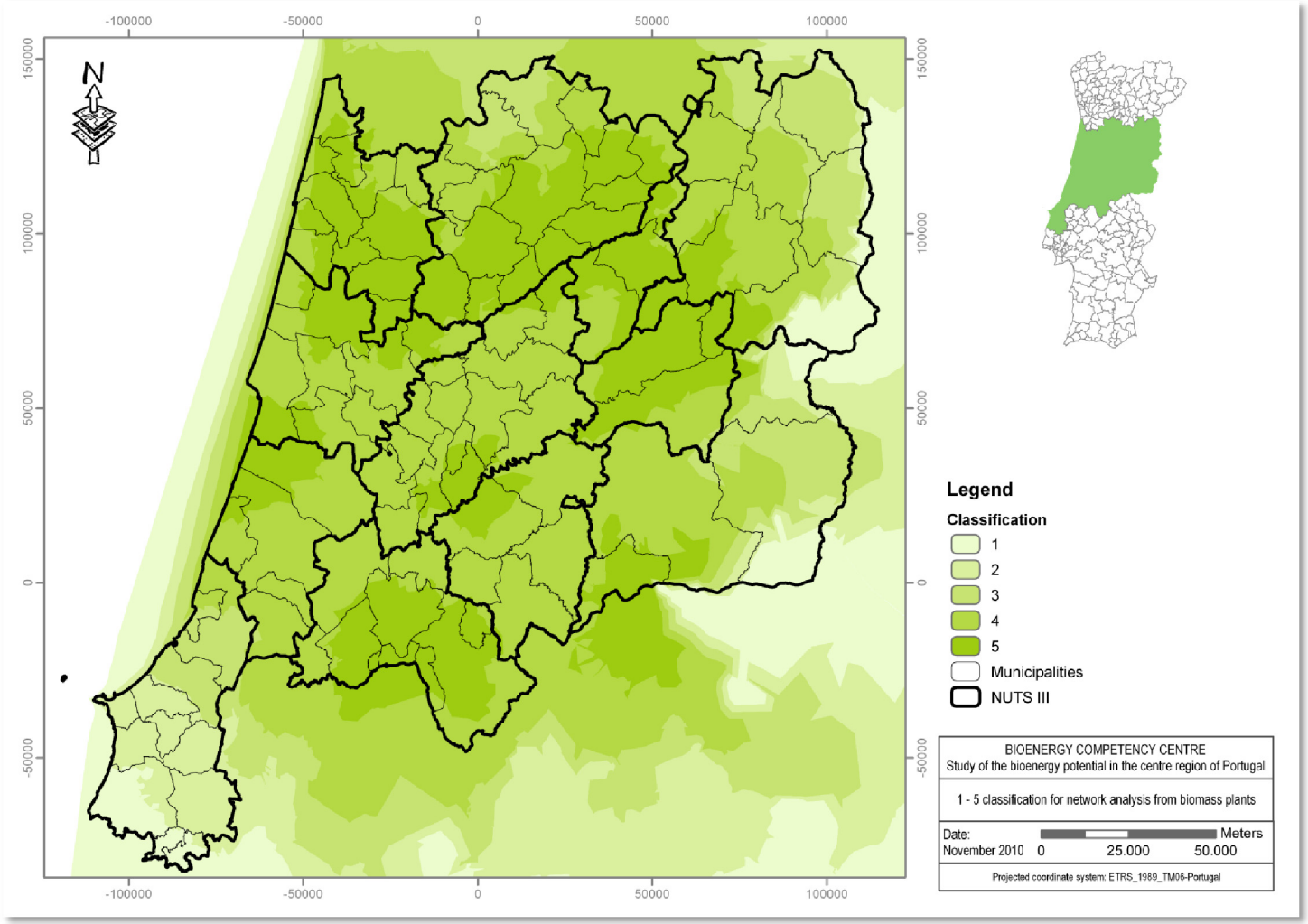


Figure A11.4: Classification for network analysis from biomass plants.

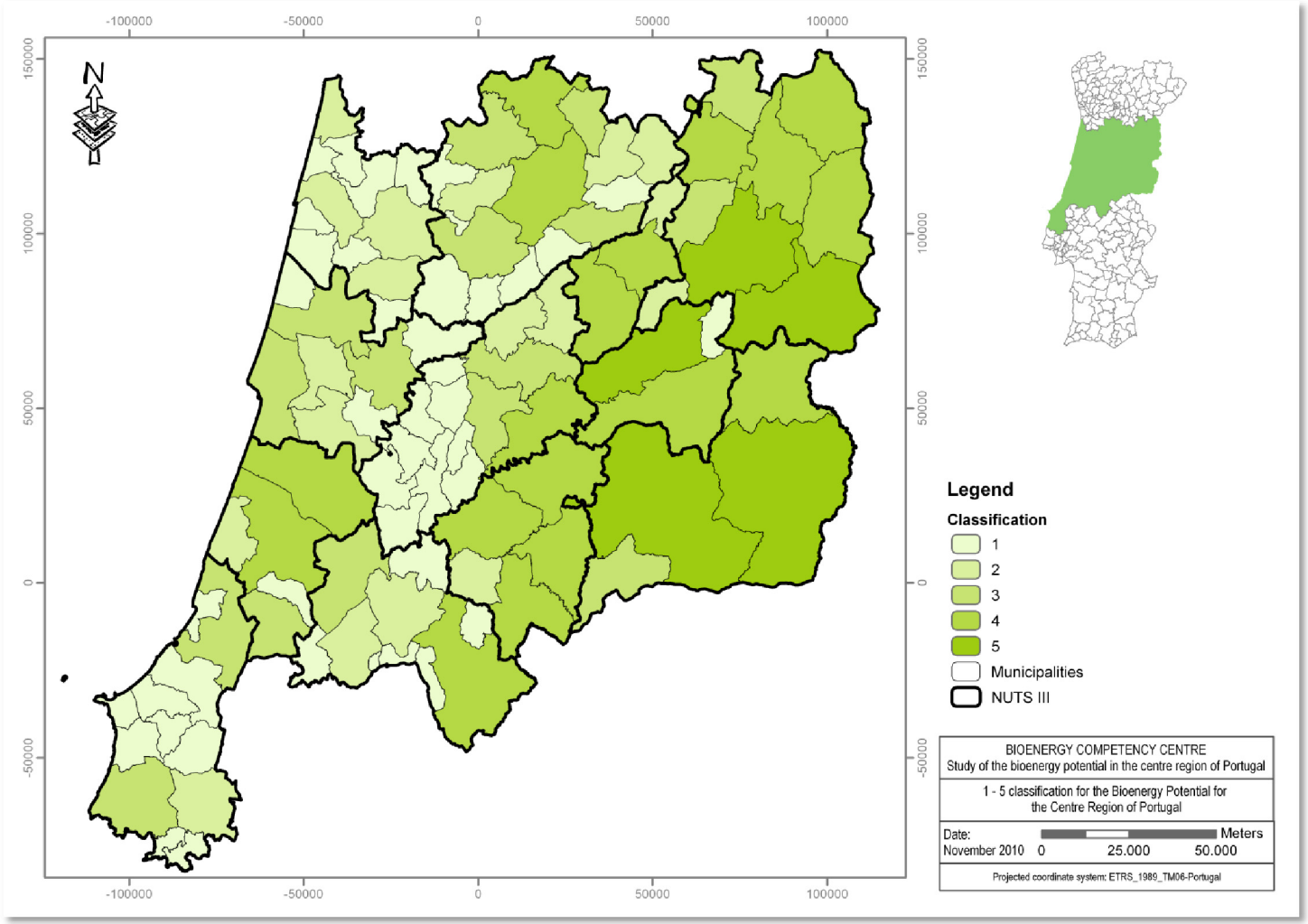


Figure A11.5: Classification for the Bioenergy Potential for the Centre Region of Portugal.

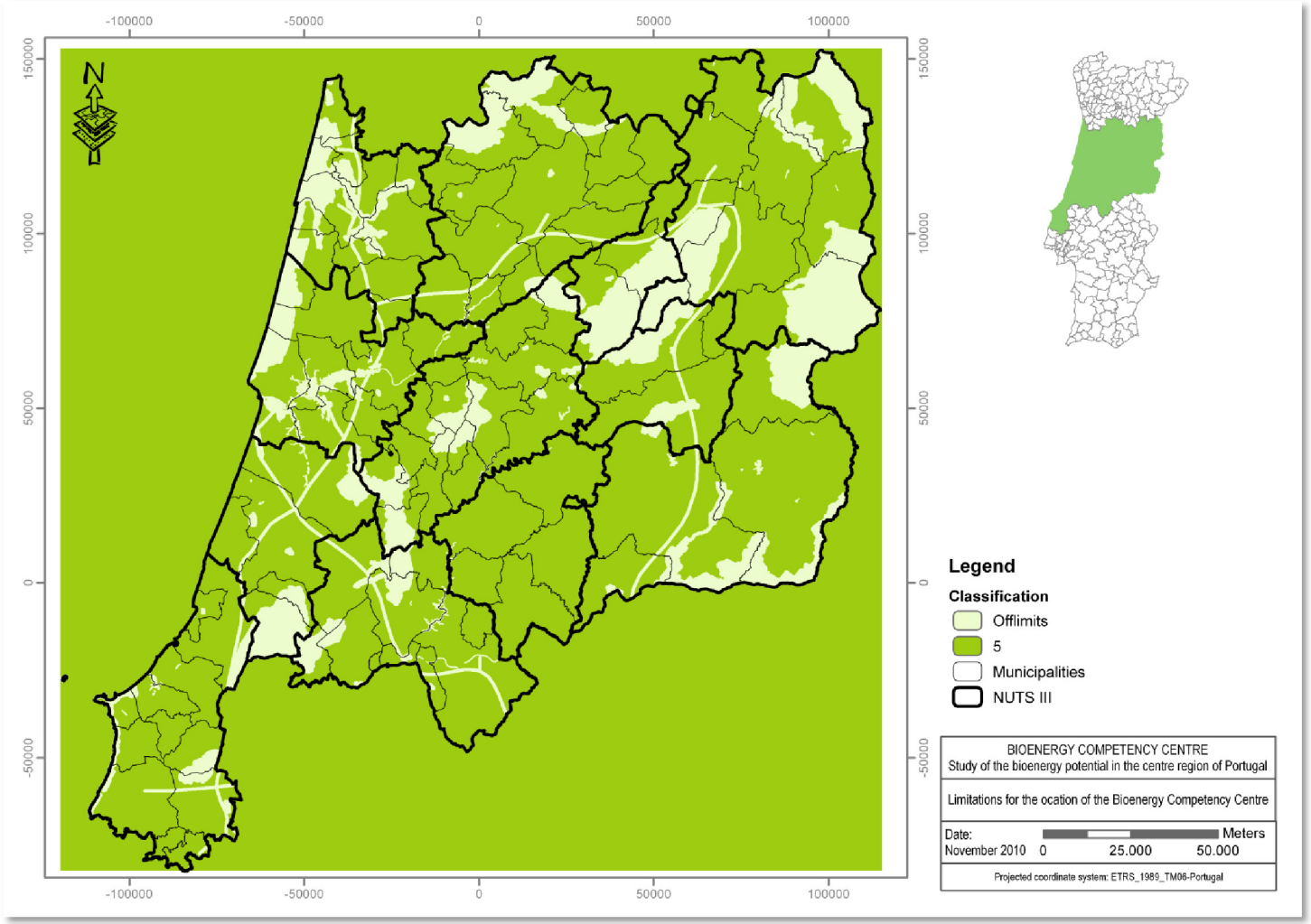


Figure A11.6: Restrictions for the location of the Bioenergy Competency Centre.

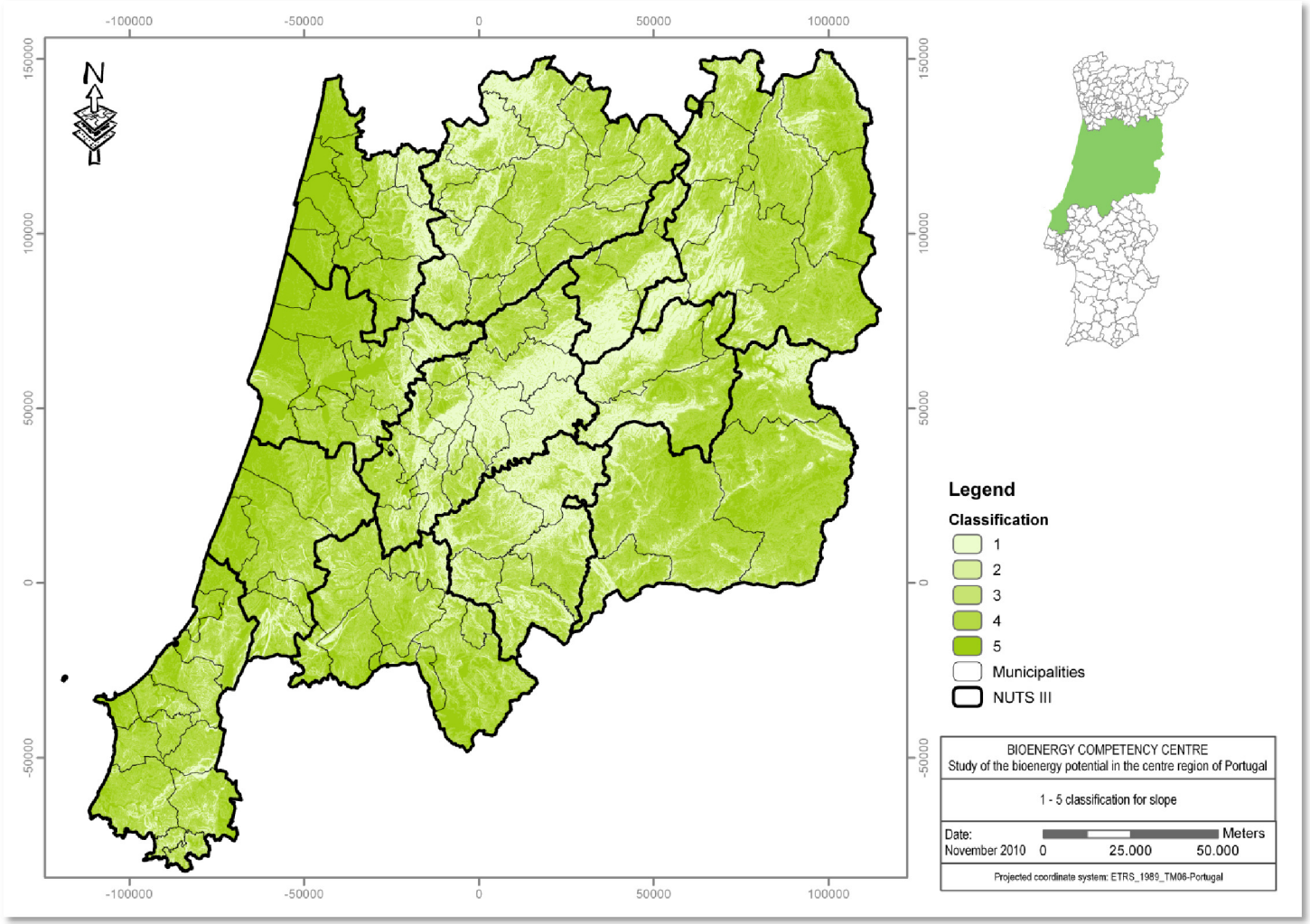


Figure A11.7: Classification for slope.