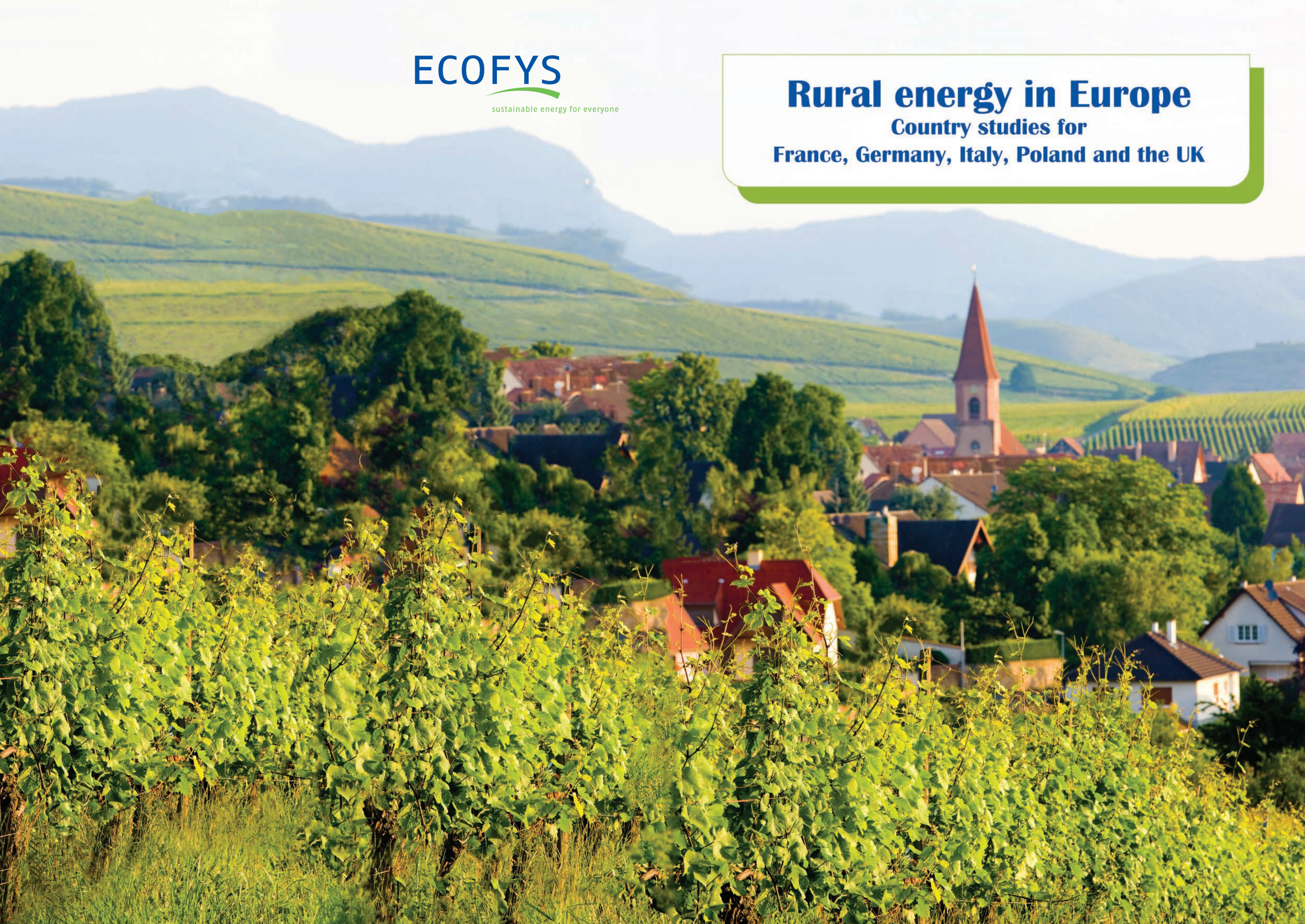
ECOFYS

sustainable energy for everyone

Rural energy in Europe

Country studies for France, Germany, Italy, Poland and the UK



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Design and layout
www.artnu.eu

By order of:
SHV Energy
within the framework of
the Future of Rural Energy in Europe (FREE) initiative

September 2011

Preface

Sustainable energy has attained a firm position on the agendas of policy makers in the European Union. It has been widely recognised as the key to reducing greenhouse gas emissions, and governments and industries have acknowledged the need for a transition to a sustainable energy system by the middle of this century.

At the same time, rural development is an important part of EU policies, since rural regions tend to be economically less advanced than urban regions. Energy can play a part here. Surprisingly, the role of sustainable energy for the development of rural areas in the EU has received little attention from policy makers to date.

If rural areas are to be included in the transition to a sustainable energy system, policy makers need quantified information to underpin any decision making on this. Sound information on differences in energy consumption patterns between rural and urban areas has been absent so far, and therefore the status of rural energy is unknown.

The Future of Rural Energy in Europe (FREE) initiative has taken action to address this need by commissioning this study. This report provides a wealth of information on energy demand in a variety of economic sectors in some of the largest EU Member States, focussing on the difference between rural and urban regions. It sheds light on differences in emissions per head of greenhouse gases and other air pollutants. It also pays attention to the effect of economic activity on these regional energy demand patterns.

There is a considerable scope for emissions reductions from energy consumption in the EU's rural regions and regions with limited economic activity. Targeted policies could help capitalise on this potential, through an increased use of renewable energy sources in these regions, a switch to low carbon fuels, and the improvement of a decentralised energy supply.

The analysis of sub-national energy data provides the main basis for the outcome of this project. However, we are grateful for the contributions provided by a series of national experts, who gave invaluable background information on differences in energy consumption patterns between rural and urban regions in their country. We would like to acknowledge Pierre Laurent, Régine Trotignon, and Anne Miquel from the Agency for the Environment and Energy Management (ADEME); Loïc le Quilleuc (ADEME Auvergne); Dr. Andrej Jentsch from Richtvert; Giovanni Cafiero (Studio Cafiero) and Gaetano Fasano (ENEA); Marek Hryniewicz and Prof. Anna Grzybek from the Polish Institute of Technology and Life; Dr. John Barrett (Leeds University) and Prof. dr. Roy Alexander (University of Chester). Their input was of great value.

The dedication and enthusiasm of the Ecofys analysts underpins the quality of this study. I am confident that our readers will derive considerable benefit from the insights offered by this report.

Manon Janssen
Chief Executive Officer
Ecofys

Definitions of energy carriers

Coal	all primary coal (hard coal, lignite), derived fuels, and peat
Oil	crude oil, natural gas liquids (excl LPG), refinery feedstocks, as well as oil products, such as gasoline, jet fuels, kerosene, gas/diesel oil, fuel oil, etc.
LPG	liquefied petroleum gas
Gas	natural gas (excluding natural gas liquids) and gas works gas
Biomass	solid and liquid biomass, biogas, industrial waste and municipal waste. Biomass definitions may not be strictly comparable between countries
Heat	heat produced for sale, mostly derived from the combustion of fuels, but also from electrically powered heat pumps and boilers
Electricity	final consumption of electricity
Renewable energy sources (RES)	geothermal, solar, wind, tide/wave/ocean and hydroenergy, and the use of these energy forms for electricity and heat generation

Glossary

CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalents (a commonly used measure to express the amount of greenhouse gas emissions)
GHG	Greenhouse Gas
GVA	Gross Value Added
Mt	Megatonne (a million tonnes)
MW_e	Megawatt (a million Watts) electrical output from a power plant

1 Executive Summary

Background

A sustainable energy future for the European Union is important for all its citizens. Some areas within Europe are still deprived of access to a secure supply of clean and affordable energy. Gas and electricity networks are less well developed in rural areas and so the choice of fuels is more limited. Yet, there is a target to be reached - reducing greenhouse gas emissions in the EU by 20% by 2020 - and these rural areas have a significant role to play in reaching this.

To date, the role of energy in the development of rural areas in the EU has been less well considered in EU policies than other aspects. A better insight is required into energy consumption patterns in the areas, and in differences between areas, to provide an evidence base for developing regional policies on sustainable energy supply.

Objectives

This study presents energy mixes in rural, intermediate and urban areas, as well as GHG emissions per head.

In this summary report, we provide that insight based on the analysis of national and sub-national energy data, and on interviews with national energy experts. We present demand patterns for energy used by consumers in rural, intermediate, and urban areas. We also provide an insight into the way lower economic activity in rural areas plays a role in energy demand patterns. The study shows how differences in the fuels used in certain areas can lead to varying greenhouse gas emission levels. Differences in the fuel mix will also have an economic effect because of different fuel prices, although detailed consideration of this effect was outside the scope of this study.

For this study, the focus was on five of the larger EU Member States: France, Germany, Italy, Poland, and the United Kingdom. These countries represent 61% of the EU population, 61% of total final energy consumption in the EU, and 62% of CO_2 emissions from fossil fuel combustion.

In this study, the transport and industry sectors were not analysed in detail. There are very few differences in the fuel mix used in the transport sector in urban and rural areas. In industry, differences in fuel mix are due primarily to the nature of an industry rather than its location. For instance, the iron and steel industry typically uses a large amount of coal, whereas the aluminium industry relies mostly on electricity.

Conclusions

The findings in the study help to paint a picture of rural energy in Europe today. In general, across all five countries, energy consumption in households and services in rural areas relies less on natural gas than in urban areas. The share of oil in urban areas is lower than in intermediate and rural areas. Furthermore, there is a larger share of oil used in the agricultural sector due to the use of heavy equipment such as electricity generators and tractors.

In some countries, it is known that rural areas are associated with lower economic activity. To understand this better, we took the regions with the lowest economic activity (measured by gross value added or GVA) in each of the countries and calculated the share of that GVA realised in rural, intermediate and urban areas within that region. In France and Poland, the largest part of the low GVA region is in rural areas. In Germany, the largest part is in intermediate but the rest is in rural areas. Only in the UK do urban areas account for a significant part of the GVA realised in low GVA regions.

In the five countries studied, there are an estimated 26 million households in rural areas. These rural households emit about 27 Mt CO_2-eq from coal and heating oil. In the service sector, rural emissions amount to 8.3 Mt CO_2-eq. Together these emissions equal the greenhouse gas emissions from eight 600 MW_e coal plants, or from 3,500 small towns (10,000 inhabitants within 4,000 households) in the EU.

A switch from coal and oil to low carbon solutions in rural households and services could save the amount emitted by up to 8 coal plants.

2 Recommendations

There is great potential for lowering greenhouse gas emissions in rural areas. Three principle recommendations are formulated on the basis of this study.

Rural areas can greatly reduce GHG emissions by lowering the carbon intensity of the 80% non renewable energy.

1. Specific policies aimed at energy use in rural areas could bring environmental and economic benefits. Rural areas can contribute greatly to reducing greenhouse gas emissions. In principle, all of the emissions from households and services could be removed by a switch to renewable energy sources. Even a switch to lower carbon options such as gas could reduce the carbon intensity of a country overall. Although natural gas is a commonly used low carbon fuel, it can be expensive to extend natural gas distribution in rural areas and can be financially unattractive, particularly in the challenging economic situation in the EU today. To achieve the same effect, other low carbon alternatives that would not require major upfront investments could be considered. For instance, a full switch from coal and heating oil to LPG would result in a reduction of 7.7 Mt CO_2-eq in rural households and services, assuming there is no loss of efficiency in using LPG-based appliances. This roughly equals the emissions from 750 small towns in the EU (of 10,000 inhabitants or 4,000 households each). Regional support for a sustainable energy system in the EU regions could be considered in the debate on the 2014-2020 EU budget. In addition, funds already allocated to rural development could be focussed on the targeted support of low carbon and renewable energy in rural areas.

2. Within the European policy approach to lower the carbon intensity of regional energy mixes, there is good reason to give additional attention to low GVA regions including rural areas. Energy poverty is often associated with general poverty and addressing energy use specifically can help raise living standards. Better access to competitive, reliable energy sources will have a positive economic effect as well as an environmental one. In France and Poland, the largest part of the low GVA region is in rural areas. In Germany, the largest part is in intermediate but the rest is in rural areas. Only in the UK, do urban areas account for a significant part of the GVA realised in low GVA regions.

3. In general, more focus on energy mix in policies for the agricultural sector would bring substantial greenhouse gas emission reductions. Emissions related to energy use in agriculture in the five countries amount to around 78 Mt CO_2-eq. This equals the emissions of 22 coal plants of 600 MW_e, or the emissions of over 7,500 small towns in the EU. In principle, the use of carbon intensive fuels in this sector could be reduced through a switch to renewable and low carbon options. One example of where this is already taking place has been in dual fuel use which has emerged as a promising alternative, with biogas being used in diesel-based equipment. The potential contribution of this option could be considered more in the discussions on new energy policies for agriculture.

3 France

Energy in households

In France, clear differences exist between the energy mix used by households in rural and urban areas. French households in rural areas use more biomass and oil than in urban areas where more natural gas is used. Gas networks are more limited in rural areas, and LPG is used more often than in urban areas (Figure 3 - 1).

"In France rural households use more fuel oil and les natural gas intensive fuels than urban households."
(Loïc Le Quilleuc)

Figure 3 - 1
Energy mix in French households

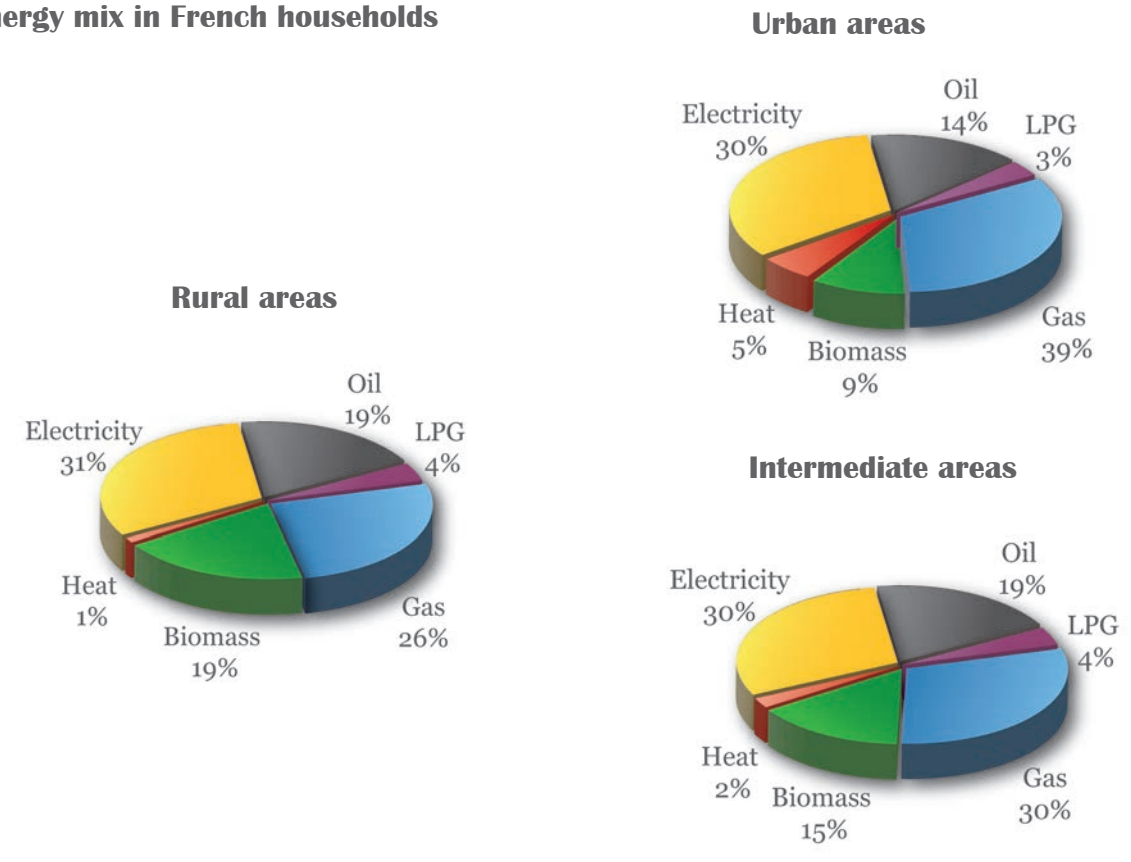
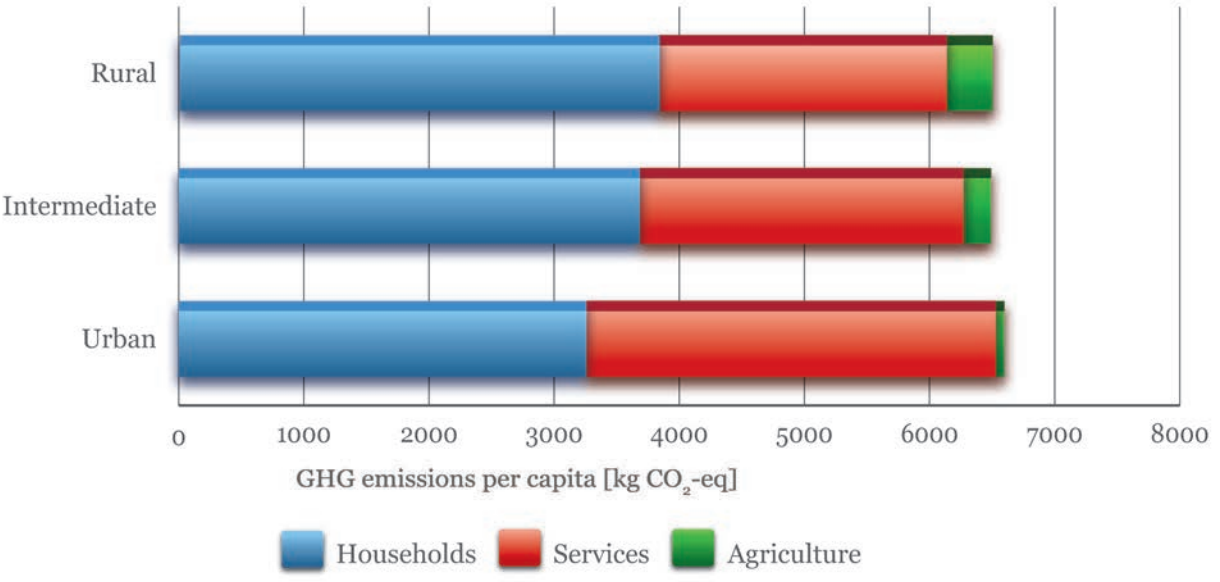


Figure 3 - 2 Greenhouse gas emissions per head



Energy in agriculture

The French agricultural sector produces a large share of the agricultural output in the EU. In 2010 as much as 20% of crop output and 16% of animal output were produced in France, with wine, cattle and cereals as the most important products. Hence, it is important to include the sector in approaches for a more sustainable energy in rural areas. Currently, the dominant fuel in the French agricultural sector is oil, mostly used for electric generators and tractors. Oil makes up around three quarters of energy consumption in agriculture. The remaining quarter is covered by LPG, electricity and natural gas, which have similar shares in the energy mix.

Greenhouse gas emissions

The greater share of oil in rural households leads to relatively high greenhouse gas emissions per capita (Figure 3 - 2). Greenhouse gas emissions from heating oil in the residential and commercial/public sectors in rural areas are around 10 Mt CO_2-eq. This equals the emissions of around 1,000 small towns in the EU. If these fuels were replaced by renewable energy, these emissions could be reduced entirely. Substantial reductions in emissions are also possible if these fuels were to be replaced by available low carbon alternatives such as natural gas or LPG. Not all rural areas however, have access to natural gas infrastructures, and some may never have in view of financial and geographical limitations. If there is no loss of efficiency in using LPG-based appliances, a full switch from coal and heating oil to LPG would result in a reduction of 1.6 Mt CO_2-eq, equal to the emissions of around 150 small EU towns.

4 Germany

Energy in households

In Germany, rural areas are scattered fairly evenly across the country, as are business and industry centres. The gas network is well developed and covers large parts of rural areas. German households in rural, intermediate and urban areas show very little difference in the fuel mix used (Figure 4 - 1).

The relationship between the relative wealth and the energy mix in regions is also relevant in this respect. Households in more well-to-do areas, i.e. areas with a high economic activity, measured by GVA, tend to use more natural gas and electricity. Homes in areas with the lowest economic activity appear less well connected to the gas and electricity networks. Heating oil and particularly biomass are more important in these areas. This is important, since in Germany the largest part of low GVA regions is in intermediate regions, but the rest is in rural areas.

"Rural homes in Germany tend to use more heating oil than urban ones."
(Dr. Andrej Jentsch)

Figure 4 - 1
Energy mix in German households

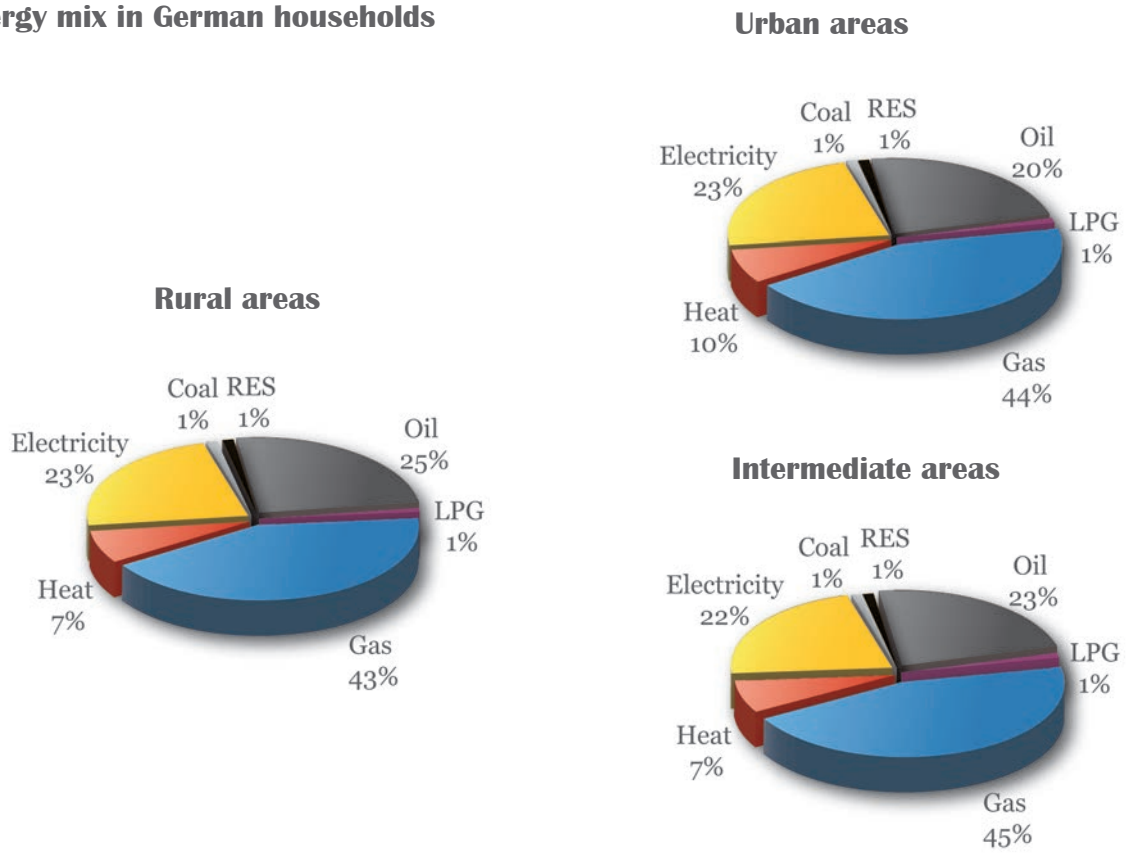
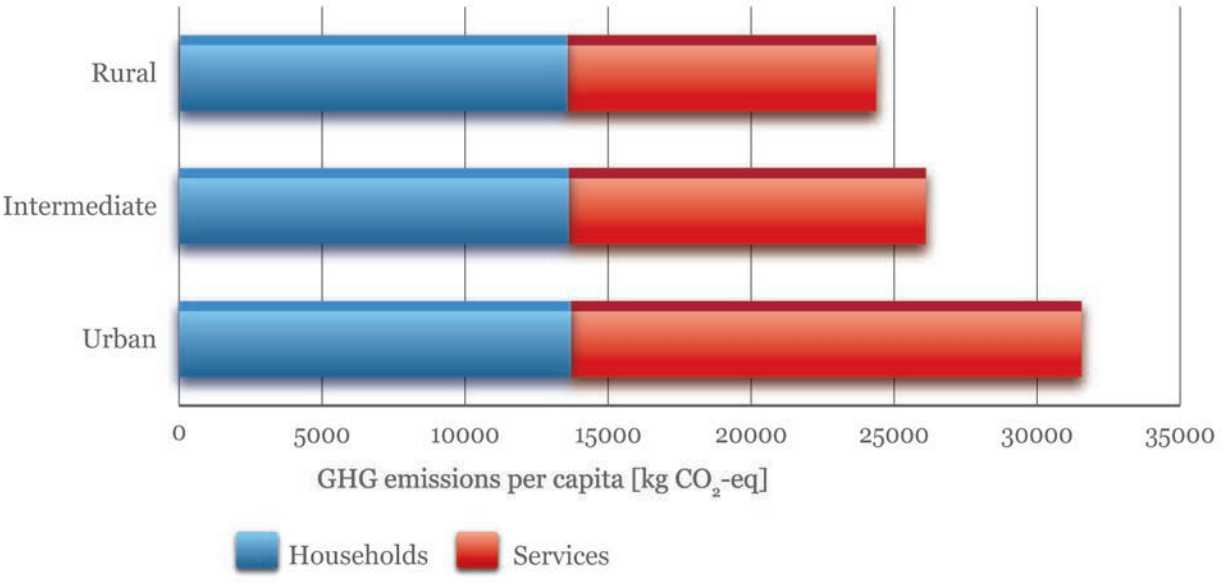


Figure 4 - 2 Greenhouse gas emissions per head



Energy in agriculture

While not as large as France, agriculture in Germany also produces substantial shares of the EU crop and animal outputs. 12% of EU crops come from Germany, while 15% of EU animal output originates here. Milk, pigs and vegetables are key products. Although its relative weight is smaller than the importance of, for instance, French agriculture, the contribution from German agriculture to the EU agricultural production is significant. According to the International Energy Agency, electricity and natural gas are currently dominant energy carriers in this sector.

Greenhouse gas emissions

Greenhouse gas emissions per head in the residential sector are similar in urban, intermediate and rural areas (Figure 4 - 2). Currently, rural greenhouse gas emissions from heating oil and coal in the residential and commercial/public sectors are estimated at around 10 Mt CO_2-eq. This equals the emissions of more than 1,000 small towns in the EU. These emissions could be reduced if these fuels were replaced by low carbon solutions, such as renewable energy or gas. A switch to renewable energy could, in principle, remove all of the emissions. A full switch from coal and heating oil to LPG would result in a reduction of 1.6 Mt CO_2-eq, provided that there is no loss in efficiency from using LPG-based appliances. This is close to the emission level of around 150 small EU towns.

5 Italy

Energy in households

Italian households use mostly natural gas with very little difference between rural and urban areas. As in Germany, natural gas is clearly the dominant energy carrier, while electricity ranks second. Other significant fuels used in the residential sector are gas/diesel oil, LPG and biomass/waste. This pattern does not differ between urban, intermediate and rural areas (Figure 5 - 1). The most remote rural areas however are reported as exceptions to this, and have much less in the way of centralised energy supplies.

In Italy, there is a clear distinction in energy use between households in areas with a low economic activity and other areas. Households in areas with the lowest GVA tend to have a greater share of electricity in their energy mix. These areas are located mostly towards the south and there may be a mix of reasons to explain the difference, such as a greater use of electrical heating in winter and/or air-conditioning systems in summer. The use of older, less efficient appliances could also contribute to this.

Very remote rural areas, such as mountainous regions, are most deprived of a centralized energy supply.

Figure 5 - 1
Energy mix in Italian households

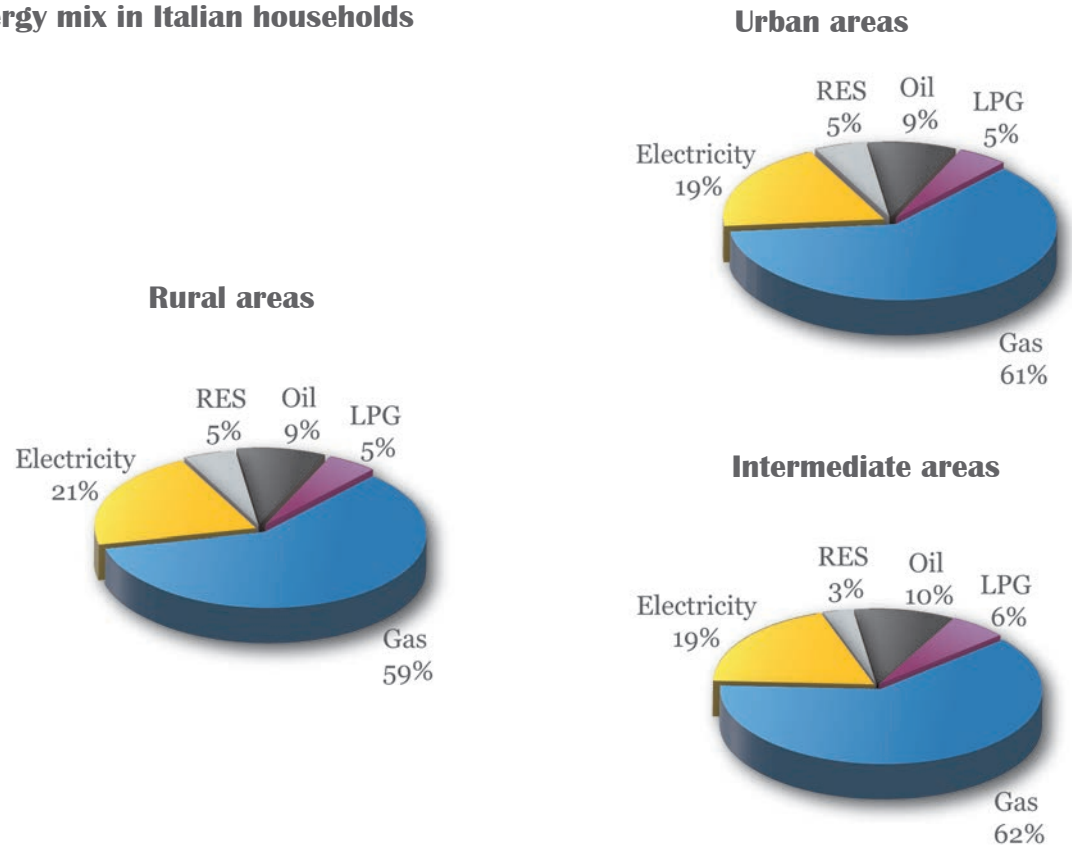
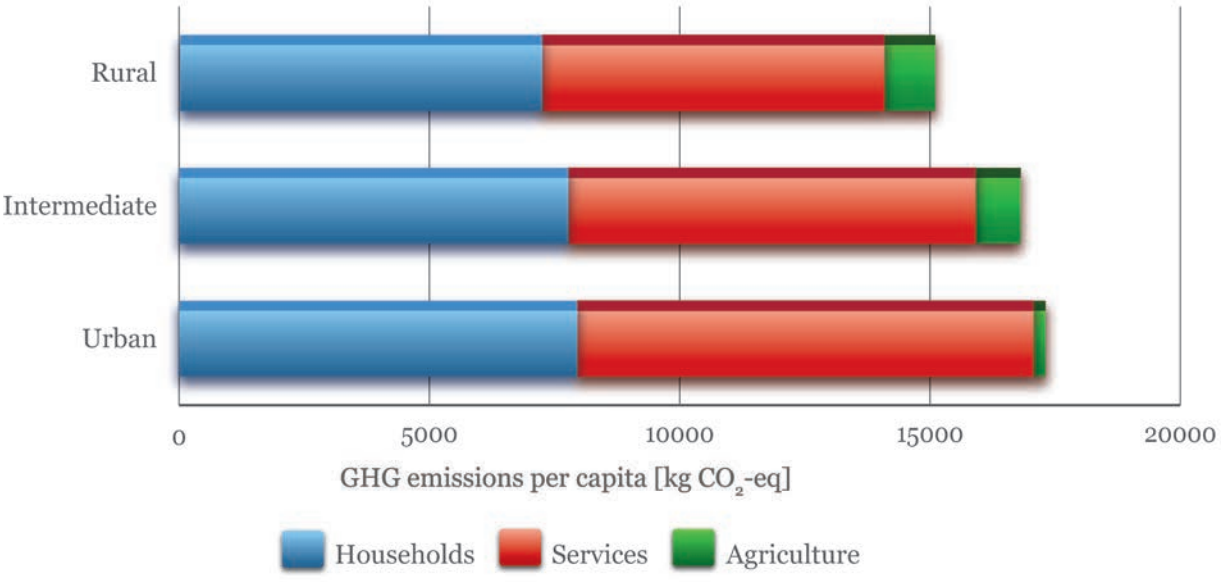


Figure 5 - 2 Greenhouse gas emissions per head



Energy in agriculture

Italian agriculture produces 14% of the EU crop output and 10% of the animal output. The principal products are vegetables, fruits and wine. The agricultural sector could benefit from a more sustainable energy system in Italy's regions, considering its present energy use pattern. Currently, the fuel of choice for most activities in Italian agriculture is oil, which makes up more than three quarters of the energy mix in this sector. Total energy related emissions in this sector amount to 40 Mt CO_2-eq. This is on the same order of magnitude as the joint emissions from 4,000 small EU towns.

Greenhouse gas emissions

In Italy, greenhouse gas emissions per head from households do not differ much between rural and urban areas (Figure 5 - 2). Currently, rural greenhouse gas emissions from heating oil and coal in the residential and commercial/public sectors are estimated to be on the order of 2.3 Mt CO_2-eq. This equals the emissions of more than 200 small towns in the EU. These emissions could be reduced if these fuels were replaced by low carbon solutions, such as renewable energy, natural gas or LPG. If there is no loss in efficiency from using LPG-based appliances, a full switch from coal and heating oil to LPG would result in a reduction of 0.3 Mt CO_2-eq, equal to the emissions of more than 30 small EU towns.

6 Poland

Energy in households

In Poland, coal is the dominant energy carrier in the residential sector, followed by heat from district heating systems. There are few differences between the energy mixes in urban and rural homes (Figure 6 - 1), although some rural areas, especially in mountainous parts of the country, are deprived of access to a centralised energy supply. For these areas coal, LPG and wood are important.

In Poland, households in areas with a high economic activity are better connected to the natural gas network. In areas with a low economic activity the use of coal and LPG is higher, while district heating systems are used slightly less than in medium and high GVA areas. This is important, because the greater part of low GVA regions in Poland is in rural areas.

"Polish households predominantly rely on coal and municipal heat – which is also generated using coal." (Marek Hryniewicz)

Figure 6 - 1
Energy mix in Polish households

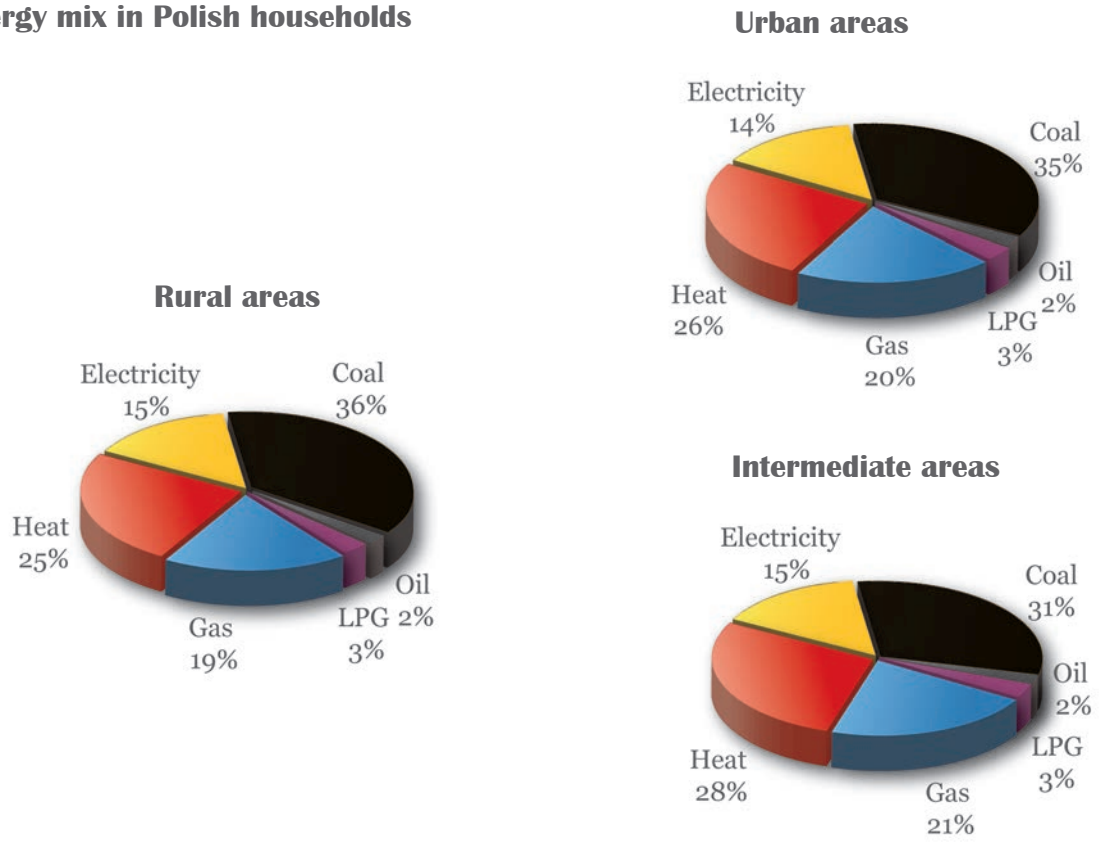
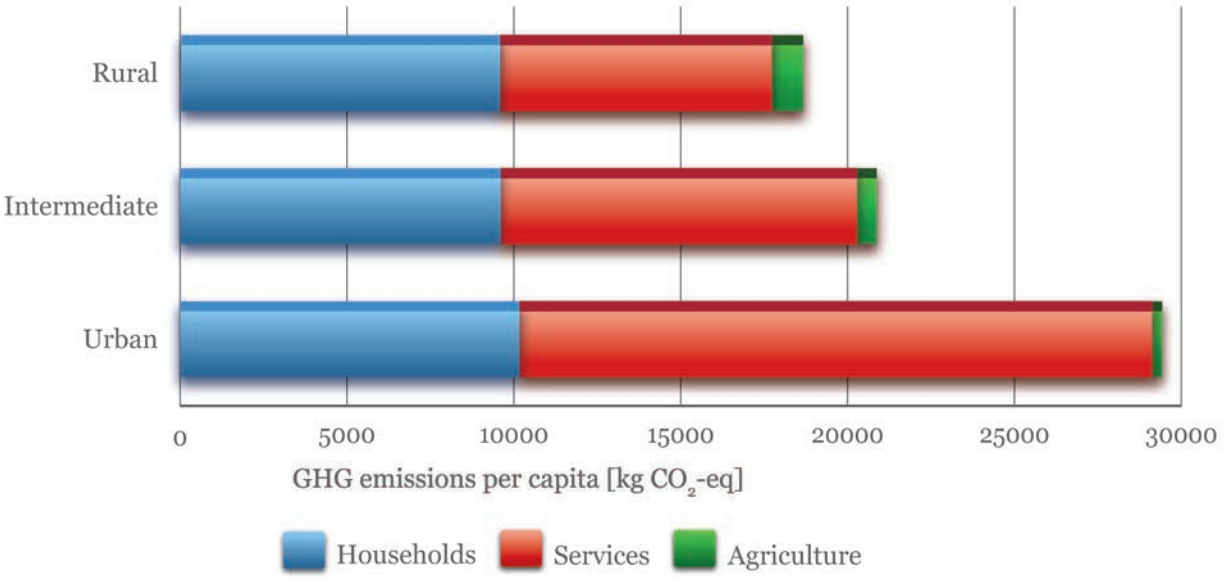


Figure 6 - 2 Greenhouse gas emissions per head



Energy in agriculture

The Polish agricultural sector yields 5% of EU crop output and 6.5% of animal outputs. The chief products include milk, pigs, and cereals. The energy mix in Polish agriculture is very carbon intensive. According to regional energy statistics, coal is the dominant fuel, and other important energy carriers include oil and electricity. Data from the International Energy Agency point at gas/diesel oil as the principal energy carrier in this sector. Either way, there is ample scope in Polish agriculture to use more low carbon fuels.

Greenhouse gas emissions

Greenhouse gas emissions per capita is higher in urban areas in Poland (Figure 6 - 2). Currently, rural greenhouse gas emissions from heating oil and coal in the residential and commercial/public sectors are estimated at around 11 Mt CO_2-eq. This equals the emissions of more than 1,000 small towns in the EU. These emissions could be reduced considerably if these fuels were replaced by renewable energy, natural gas or LPG. If there was no loss in efficiency in using LPG-based appliances, a full switch from coal and heating oil to LPG would result in a reduction of 3.8 Mt CO_2-eq, equal to the emissions of more than 350 small EU towns.

7 United Kingdom

Energy in households

Differences in the energy mix between urban and rural homes in the UK are very pronounced. Rural homes tend to rely more on heating oil and coal, whereas urban households use more natural gas (Figure 7 - 1). This results in higher residential emissions per capita in rural areas, both for greenhouse gases and other gases.

A similar difference becomes apparent when distinguishing areas along the lines of economic activity. In areas with a relatively low total gross value households use more coal and heating oil than natural gas.

Households in rural areas in the UK tend to use more carbon intensive fuels than in urban areas.

Figure 7 - 1
Energy mix in households in the UK

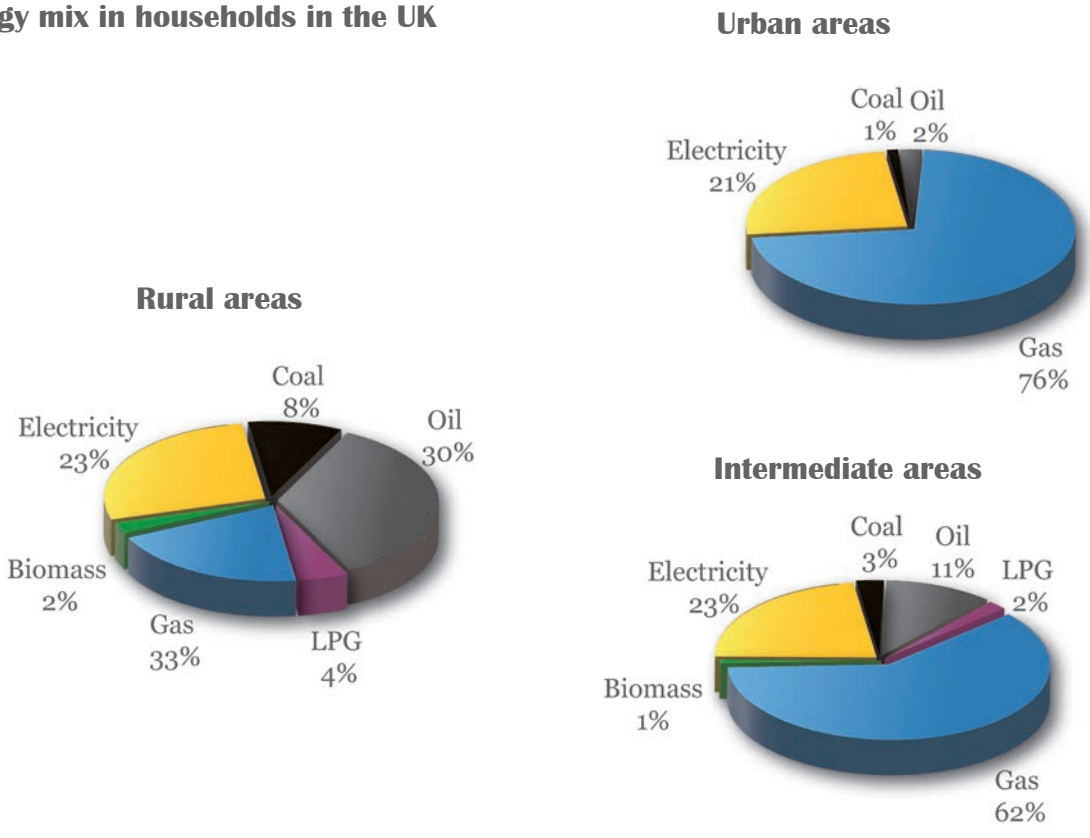
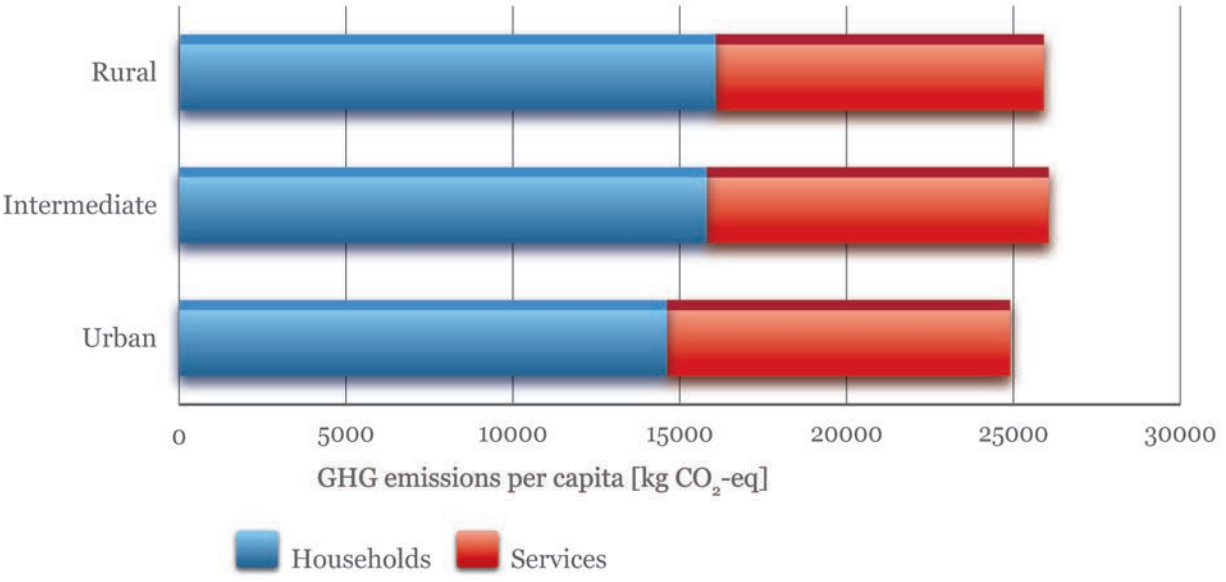


Figure 7 - 2 Greenhouse gas emissions per head



Energy in agriculture

In the UK, agriculture produces 5% of crop output and 9% of animal output in the EU. Milk, cattle and cereals are the dominant products. The energy mix in this sector consists of electricity, natural gas, gas/diesel oil and LPG. There is scope for a reduction of greenhouse gas emissions, by including the sector in regional policies to promote a more sustainable energy system.

Greenhouse gas emissions

The greater use of coal and heating oil causes higher greenhouse gas emission levels per capita in rural areas (Figure 7- 2). Currently, rural greenhouse gas emissions from heating oil and coal in the residential and commercial/public sectors are estimated to be on the order of 2.3 Mt CO_2-eq. This equals the emissions of more than 200 small towns in the EU. These emissions could be reduced if these fuels were replaced by low carbon energy solutions, such as renewable energy, natural gas or LPG. If there was no loss in efficiency from LPG-based appliances, a full switch from coal and heating oil to LPG would result in a reduction of 0.4 Mt CO_2-eq, equal to the emissions of more than 40 small EU towns.

Data sources

INSEE	Institut national de la statistique et des études économiques (www.insee.fr)
LAK	Länderarbeitskreis Energiebilanzen (www.lak-energiebilanzen.de)
ENEA	Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (www.enea.it)
GUS	Central Statistical Office Poland (www.stat.gov.pl)
DECC	Department of Energy and Climate Change (www.decc.gov.uk)
Eurostat	www.ec.europa.eu/eurostat