Publishable Results Report

AGRI FOR ENERGY 2

Promoting and securing the production of biomass from forestry and agriculture without harming the food production

www.agriforenergy.com

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Table of contents

Executive Summary and Acknowledgments

At this point we would like to express our gratitude and respect for the engagement and support which was offered by all involved. We feel especially attached to all those who helped with the implementation of the project. The project development and performance was only possible through the close cooperation of the project partners and the help of the EACI project officer.

Particular thank goes to the organizations and enterprises which, through their involvement, made this project possible in the first place. We would be nothing without the others.

Therefore we had to identify and link the organisations and communication partners in the project regions, we have set up contacts with regional groups, organisations and institutions which are relevant to growth in the use of biomasses, biofuels and bio energies in the region and are therefore able to participate in the project. This had a very sustainable effect; because the A4E2-Partners may participate now in the inner circle of the cluster. Without these important connections much wouldn´t have been possible.

1. Objectives of the A4E2 project

The overall aim of the A4E2 project is to increase the use of bioenergy from the agriculture and forestry sectors in the EU. By doing so, it will contribute to the reduction of greenhouse gas emissions (thus contributing to the achievements of Kyoto targets) and strengthen the sustainable spatial development of rural areas. The project contributed to demonstrate that bioenergy can be an integral part of rural development and the use of renewable resources can create new economic activities. These activities were encouraged by connecting stakeholders from the supply and demand sides in order to fostering new bioenergy businesses in three specific sectors - where action from farmers & forest owners are seen to contribute most efficiently towards the EU bioenergy objectives:

Biomass heating - Pure Vegetable Oil - Biogas and Biomethane

- To facilitate and support **investments in new biomass heating** and wood-energy plants.
- To **promote decentralized PVO production** and use as a transport fuel mainly for farm self-consumption, and to contribute to implement the German quality standard DIN V 51605 in other countries.
- To promote **biogas production from agricultural wastes**, and to promote a relevant use of it, whether in direct combustion for heat/electricity production, or upgrading it to bio-methane to be used as a transport fuel.
- To enhance local coordination in the bioenergy sector**, establishing & training regional coordinators to be** able to promote & support coherent & efficient bioenergy business opportunities.
- To **disseminate project results** and good practices to regions with significant untapped bioenergy potential, across and beyond target countries and to **anchor farmers and forest owners** as **reliable producers of renewable energy** on local level

2. Mayor results achieved

Elaboration of 7 regional reports for the sectors Heat / PVO / Biogas&Biomethane and 3 international reports to assess the status quo for these sectors in 7 EU countries

3 Biomass info and training pack CD´s for Heat / PVO / Biogas&Biomethane with training materials, calculation tools, presentations and other relevant information

The consortium has edited a professional handbook on the use and production of Pure Vegetable Oil in seven languages which has been highly appreciated by market actors and target groups. These deliverables has been widely disseminated across pilot regions and at European level (> 3500 copies).

25 regional bioenergy coordinators were anchored as well known biomass experts

255 Heat WSO events with 4966 participants in the target regions across 7 countries were organised and >70 Heat feasibility studies were realised as professional negotiation base for concrete investments

53 new or enlarged Biomass heat projects with 26,45 MWth and an annual heat production of 118.081MWh were realised through the support of A4E2. The realisation of these 53 projects effects CO2 emission savings of more than 42.037 tons per year

27 new or national adopted biomass heat projects are presented via best practice folders and will be used as new project advisory tool across Europe

68 PVO WSO events with 1042 participants in the target regions across 7 countries were organised and >15 PVO feasibility studies were realised as professional negotiation base for potential investments

9 new PVO projects (CHP plants and mills) with 9,89 MWel, 5 MWth and an annual oil production of 12.105 tons were realised through the support of A4E2

The realisation of these projects effects CO2 savings of more than 3.127 tons per year

15 new or national adopted PVO projects are presented via best practice folders and will be used as new project advisory tool across Europe

135 Biogas&Biometane WSO events with 5617 participants in the target regions across 7 countries were organised and > 30 Biogas&Biometane feasibility studies were realised as professional negotiation base for potential investments

15 new Biogas&Biometane projects with an installed capacity of 9,92MWel and an annual production of 70.870 MWhel and 43.050 MWhth were realised through the support of A4E2. The realisation of these projects effects CO2 savings of more than 30.785 tons per year

27 new or national adopted Biogas&Biometane projects are presented via best practice folders and will be used as new project advisory tool across Europe

67 descriptions of Heat, PVO and Biogas&Biomethane projects are gathered in the 3 EU project advisory folders for dissemination on EU level

Total 458 WSO events organised by the consortium - 127 WSO events more than scheduled

11625 participants at WSO events - 6643 direct contacts more than scheduled

Presentation of the project at 14 fairs and poster exhibitions with total 650.000 participants at fairs and via www.agriforenergy.com with almost 55.300 visits in less than 3 years

The project deliverables and results have been widely and effectively disseminated at European and international level through the participation of the consortium at 14 international events. Furthermore, the main project deliverables have been disseminated by mean of 6 AEBIOM newsletters.

About 90 articles and advertisements have been published by the consortium in technical reviews with high reader ship across pilot regions

3. Main lessons learned

- The WSO model is an effective way to trigger investments but 3 years project running time is too short for showing a close connection between the events organised and realised investments, therefore many results of WSO activities will manifest their positive effects on the market after the end of the action.

- The feedback of WSO activities is very positive. The support we gave to several stakeholders to evaluate the pre-feasibility of investments was highly appreciated. The consortium is still receiving requests from stakeholders interested to evaluate the feasibility of biomass plants. The potential customers are municipalities, hotels and private house owners.

- The Biomass Heat sector has still a great developing potential, the availability of woody biomass is still very high in rural and mountain regions (wood exploitation ~ 30% of annual increment). The energy prices of wood fuels are highly competitive related to those of fossil fuels.

- Awareness of potential investors, both public and privates, is growing also thanks to promotional activities we did in the frame of the project and several successful and easily replicable show cases supported. In addition it’s getting more and more difficult for investors to get finance credits.

- The high investment costs for biomass projects still remains the most important barrier, even though the energy prices of wood fuels are highly competitive related to those of fossil fuels.

- Bioenergy coordinators had a significant influence in the development of biomass sector in the region, they are “our voice” on-side and help us to generate new projects, organizing workshops and study-tours and helped us removing some of the barriers mentioned above.

- The interest on PVO sector up to the middle of 2010 was quite high, especially in Italy. Therefore we were able to inspire and boost some interesting best cases. Afterwards the extremely high volatility of oilseeds and PVO prices hindered the further development of the market. The high prices created relevant economic problems to CHP supplied with PVO, as a consequence some plants have been turned off.

- The main lessons learned during the course of the project are linked to the economic and political backgrounds in the respective partner countries. Therefore, the lack of information about PVO leads to a very low acceptance of these products in the different partner countries. Moreover the fact that in some countries the legislation does not support the production or usage of PVO due to the taxes that are applied to them, has leaded to a significant decrease in the number and variety of groups interested in this field.

- Investing in a biogas plant requires a lot of paper work and several permits. Different stages of the project will take 1 - 3 years, depending on the size of the plant. Professional advisory help from the consortium is highly appreciated for the successful implementation of such projects.

- The best practices promoted in the frame of A4E2 were selected based on a qualitative assessment system for verifying the adherence of promoted plants to the position paper "the biogas done right" in term of sustainability and land-carbon efficiency. Despite the high participation of WS activities the contacts with farmers interested on "the biogas done right" were relatively low, this is in our opinion a clear "distorsion effect" created by the actual subsidies framework which needs to be reformed

- Biomethane (BM) sector still miss a proper legislative and subsidies framework for market development, therefore the WSO activities produced only few feasibility studies and no plant in operation. Never the less the interest of stakeholders in biomethane sector in some countries is very high and the activities and efforts done in the frame of A4E2 will play an important role to fill up in short term the legislative and subsidies gap.

- Through a consortium with a very balanced level of knowledge, we could almost be worked on a same (high) level. Technical, administrative or fiscal issues could be clarified quickly by phone or email, so experiences from the A4E2 partners could be implemented regionally and nationally.

- Biomasses are essential tools as complementary energy instruments, as well as an essential element in supporting energy self-sufficiency. At the same time emissions of greenhouse gases from biomass may show significant reductions in comparison with the use of fossil fuels. Particularly decentralized production systems (Wood heating Systems, PPO and biogas) have showed high energy efficiency and a high reduction of GHGs.

4. Bioenergy markets in partner countries

4.1 Biomass Heat market in the partner countries

Austria

Austria has a long tradition in heating with biomass. Up to 1970, single stoves were dominating domestic heating in Austria. Thereafter, single stoves were increasingly substituted with modern central heating systems. The number of dwellings with biomass heating systems (broken down by single stoves, one floor heating and central heating) is shown in Fig. 25. After the 1970ies, which were characterized by a decreasing number of dwellings equipped with biomass heating systems, there was a strong trend towards biomass-based central heating systems. In 1988 about 21% of all dwellings in Austria were heated with biomass. As a result of declining oil prices, there was a clearly decreasing trend from the beginning of the 1990ies until 2005. Thereafter, sales figures of modern biomass boilers rose significantly, resulting in an increasing importance of biomass in domestic heating[1].

Biomass district heating became increasingly popular during the 1990ies, partly due to investment grants of the "Länder" (provinces) and the Ministry of Agriculture. After the 1990ies the deployment of district heating plants declined, but district heat generation in CHP plants rapidly gained in importance. Fig. 26 shows the development of district heat generation broken down by plant types and the share of district heat originating from biomass plants. Since 2008, biomass heat and CHP plants account for more than one third of the total district production in Austria[2].

1 IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011
2 IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011

Research and development for renewables

According to an estimate of Statistik Austria, more than 8 billion Euro are expected to be spent on research and experimental development (R&D) in 2011. In comparison to 2010, the total sum of Austrian R&D expenditure will increase by 5.0% to 8.286 billion Euro and hence reach 2.79% of the Gross Domestic Product (GDP). The research intensity for 2010 is estimated to be 2.78%; thus, there will only be a small increase in 2011. The largest part of total R&D expenditure 2011 (44.6% or 3.70 billion Euro) will be financed by businesses. Funding from the business enterprise sector will rise by 5.9%, after a decrease in 2009 and only a minor increase in 2010. The public sector will contribute 38.7% approx. 3.21 billion Euro); of this share, the federal government will finance 2.73 billion Euro, the regional governments around 394 million Euro and other public funding from local governments, chambers or social security institutions will be about 87 million Euro.

This corresponds to an increase of public sector funding by 4.5% compared to 2010. 16.2% will be financed from abroad and 0.4% (approximately 35 million Euro) by the private non-profit sector. The funds from abroad (about 1.34 billion Euro) originate mostly from international enterprise groups whose domestic affiliates in Austria perform R&D and include backflows from the EU Framework Programmes for Research, Technological Development and Demonstration. Expenditures which can be solely attributed to “Support for production, storage and distribution of energy” amounted to 1.8% of federal expenditures. A strategy process called “e2050” was launched in 2005 with the aim to develop a long-term strategy for Austrian research on energy technologies. In late 2009 the Ministry for transport, innovation and technology presented the “energy research strategy Austria”. The government has developed different programmes for the energy sector to support R&D in renewable energy and energy efficiency and for market demonstration and deployment. The programme “Energy for the Future” was created in 2007 with a budget of 20 million Euro with the aim to support high-quality technology R&D projects.[3]

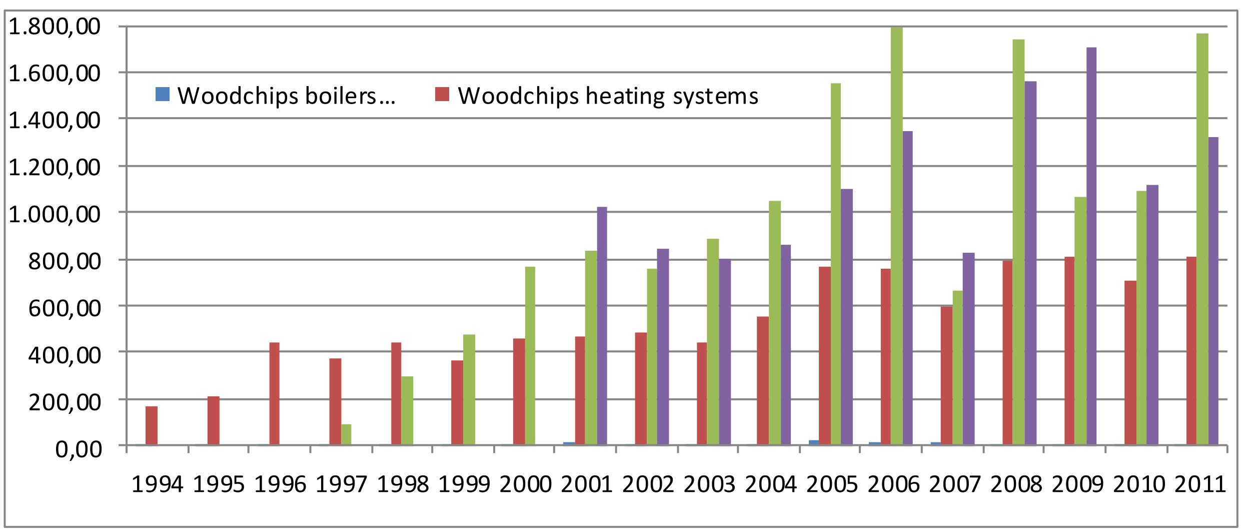
Since the beginning of the 80’s (after the second oil crisis) the Austrian government forced the use of bioenergy mainly to reduce the dependence of imports of coal and oil. There were a variety of measures to facilitate the marketing of renewable energy sources both at the federal and the provincial level, ranging from fiscal measures and subsidies to emission standards. With respect to biomass heating systems, investment subsidies are granted in every province but their amounts and conditions are different. In Carinthia and Vorarlberg, fixed amounts are paid out, whereas in other provinces, such as Burgenland or Styria, the subsidies account for certain proportions of the total investment costs. In some provinces there

3 IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011

are also additional requirements and restrictions and thus, a comparison between the different support schemes is not straightforward. In some regions, municipalities also grant subsidies for domestic biomass-fired heating systems and there are also support schemes for the installation of small-scale district and local heating systems in some provinces (e.g. Styria, Upper Austria, Carinthia).

Biomass fired combined heat and power systems and heating systems for agricultural purposes are subsidised both at federal and provincial level (see above). Austria has been very successful in recent years in developing sustainable energy technologies like solar water heating and biomass heating technologies. One reason for this is the promotion of the use of renewable energy with subsidies. The following figure illustrates the dynamic development of investment subsidies for domestic biomass heating systems in Austrian provinces during the period 1998 to 2005. In 1998, investment subsidies were granted only in Burgenland, Upper Austria, Carinthia and Vorarlberg. There were no direct subsidies in the other provinces but the installation of new heating systems was supported by the granting of soft loans. In the following years, direct investment subsidies were introduced in all provinces and in most of them the amounts were raised significantly[4].

The impact of these measures was the acceleration of substitution of old and inefficient stoves and boilers with modern low-emission systems:



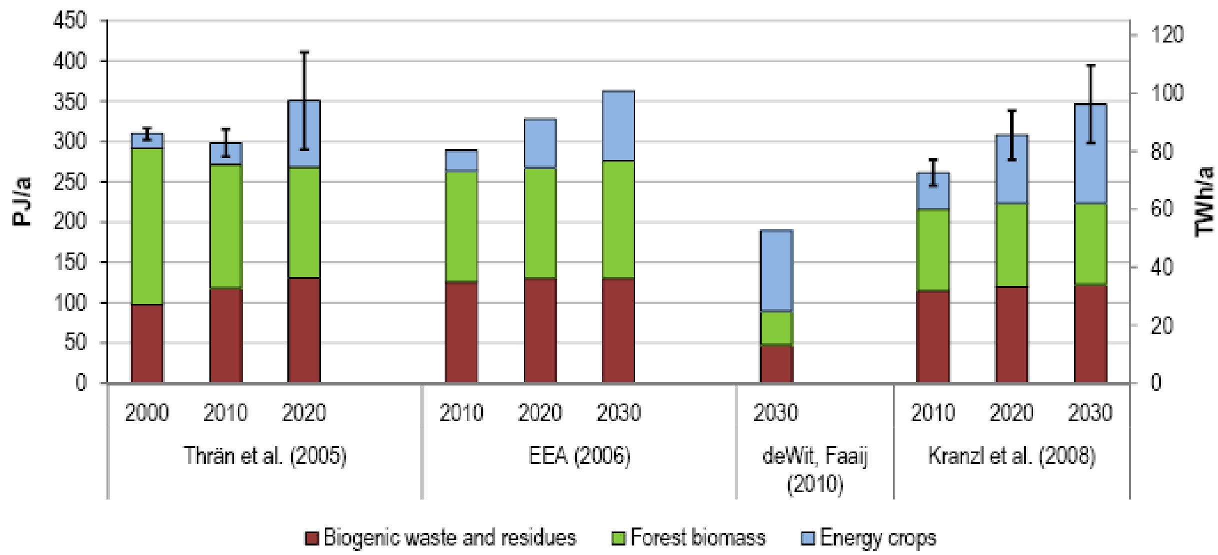
Development of wood fired heating systems[5]

4 IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011

5 Sources: Biomasseheizungserhebung 2011, Lk Niederösterreich

Biomass potentials in Austria:

Assessments of biomass potentials are numerous and the results vary widely. There are different concepts of potentials (e.g. theoretical, technical or environmentally compatible potentials). Usually potentials in literature are qualified according to these definitions. Yet methodological approaches, assumptions and constraints of potential assessments differ from study to study, and therefore results are often not directly comparable. The figure below shows the results of four studies assessing the biomass potentials in Austria.



Biomass Potentials in Austria[6]

Conclusions

The use of domestically supplied energy sources, especially wood, has a very long tradition in Austria and promotes the regional economy. More than 65 Austrian producers of biomass fired furnace and boiler systems have established themselves on the international market with their quality products and comprehensive range of know-how and experience. The latest developments focus on the generation of electricity and heat in small and medium-sized plants. The ever-increasing prices and the lack of supply security for fossil fuels have contributed to a tremendous upsurge in the use of pellets, wood chips and other biomass fuels. At present, the forest as a resource is not yet fully exploited in Austria. The growing enthusiasm for biomass must be combined with a determination to ensure that in future the forests continue to be cultivated in a sustainable manner and that wood as a raw material is used efficiently. Standards and norms should continue to safeguard the quality standards of biogenic fuels both in Austria and on the European level. As, at the present time, renewable energies are unable to compete in the market

6 Sources: Thrän et al. (2005), EEA (2006), de Wit & Faaij (2010), Kranzl et al. (2008)

with fossil energy systems, subsidising renewable technologies will continue to be a necessary and expedient approach. Using sustainable domestic resources secures jobs, creates added value to the regional economy, reduces dependency on fossil fuels and secures the world for our next generations

Slovenia

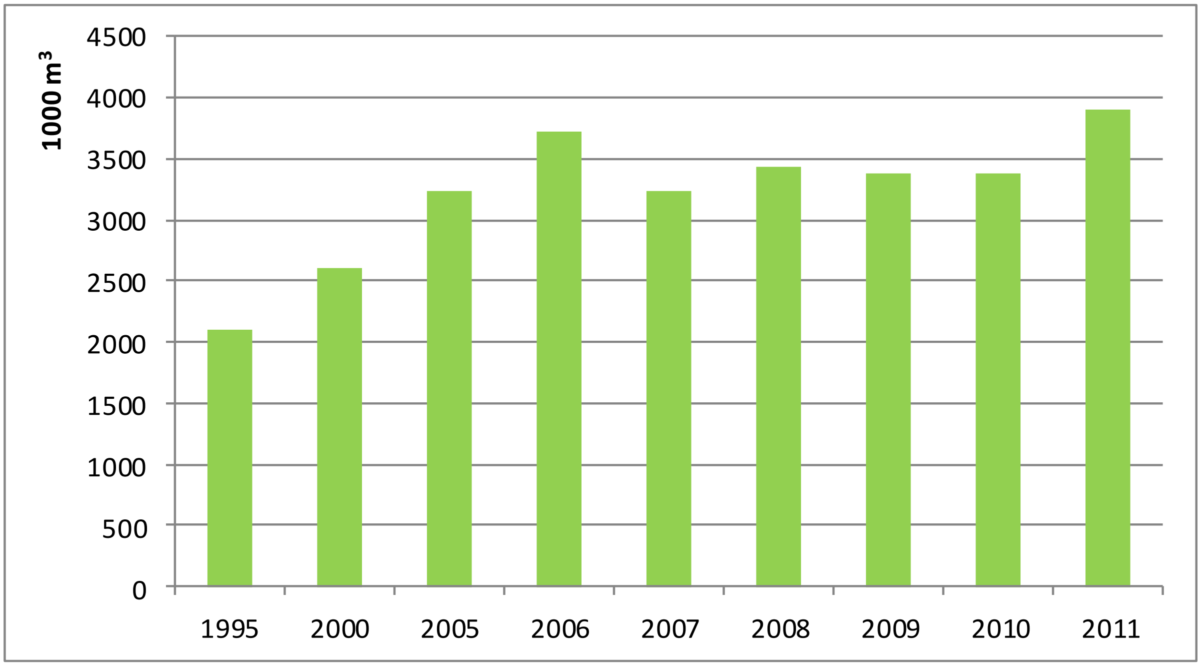
In Slovenia, wood is the most important renewable energy source. In 2006 more than 300,000 households used wood for heating. Now this number is still growing, in year 2009 it amounted to more than 330,000. Firewood is traditionally used for heating, in recent years the use of wood chips and pellets is growing. In addition to the use of wood in households there is also increase of district heating systems. Most of the wood consumed for heating comes from forests, while up to 20% of the total energy consumption of roundwood is from short rotation forestry, wood residues, wood wastes etc.

In Slovenia, the use of renewable energy is increasing; more than 80% of it comes from traditional sources, solid biomass and hydro energy. Within the framework of EU objectives, Slovenia should by 2020 reach at least a 25-percent share of renewable energy sources (RES) in gross final consumption. In year 2005 this share of RES in gross final energy consumption was 16.0%, in 2008 14.3% and 19.4% in year 2010 (Slovenian Environment Agency). The decrease of the share in 2008 is a consequence of the higher growth of gross final energy consumption in comparison with final consumption from RES. The gross final energy consumption in 2008 increased by more than 7%, while the final consumption from RES increased by more than 2%. The ratio of renewable energy sources increased between the years 2005 and 2010. Among RES, 54% represent wood biomass, which is mainly (95%) used for heating of households, followed by hydro energy with 36% and other renewable energy sources.

According to the Statistical Office of the Republic of Slovenia (SORS) data, the share of wood and other solid biomass on primary energy (PE) level was 19.8 PJ in 2006, which equals 6.5% of the total available PE, which was 307 PJ, while in 2007 this share amounted to 19.7 PJ (6.4%; total PE: 307 PJ), the share value in 2008 was 21.7 PJ (6.7%, total PE: 324 PJ), and in 2009, the share value was 20.9 PJ (7%, total PE: 292 PJ). According to temporary data available for 2010, the total PE was 300 PJ, while the share of wood and biomass amounted to 22.9 PJ or 7.6% (Country market statement 2011).

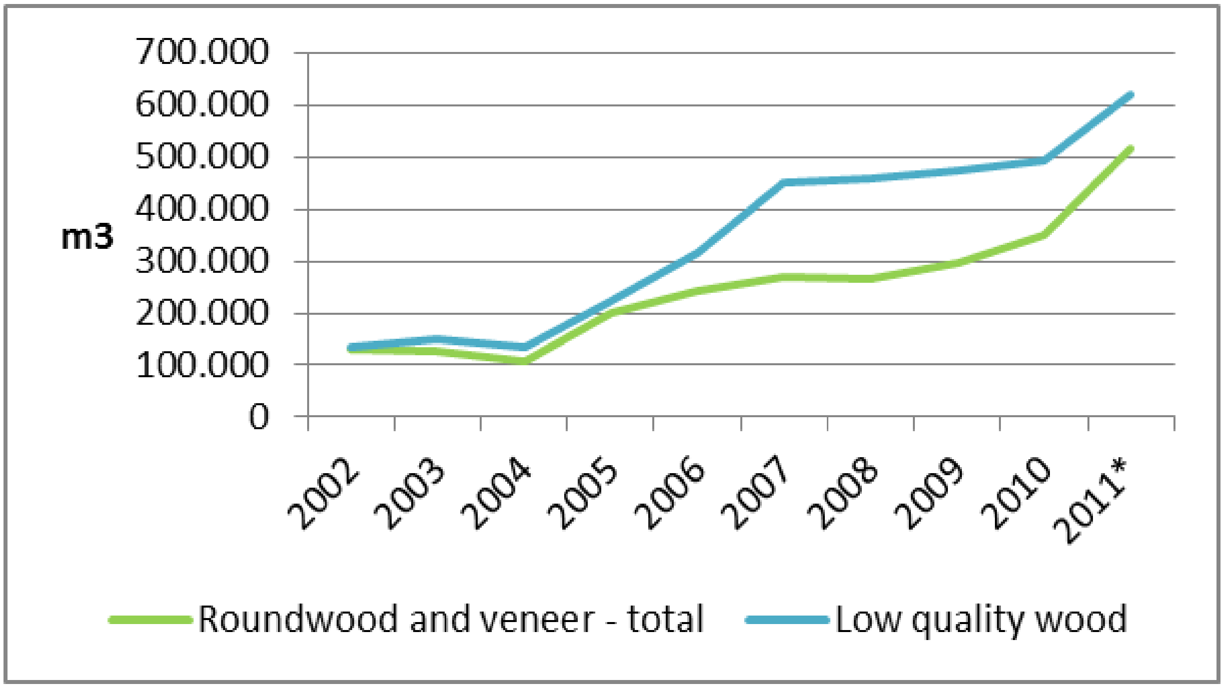
With 1,185,169 hectares, Slovenia is among the most forested countries in Europe. Forest covers more than half of the country (forest cover is 60%). The growing stock is approximately 330 million m^3. Annually increment is about 8.1 million m^3, but in the last few years the annual cut was from 3.0 to 3.7

million m^3. Increase of cutting was noticed in year 2011, when it was almost 4 million m^3. The difference between annual increment and annual cut shows that in Slovenia the potential of our forests is not exploited.



Annual cut in Slovenian forests

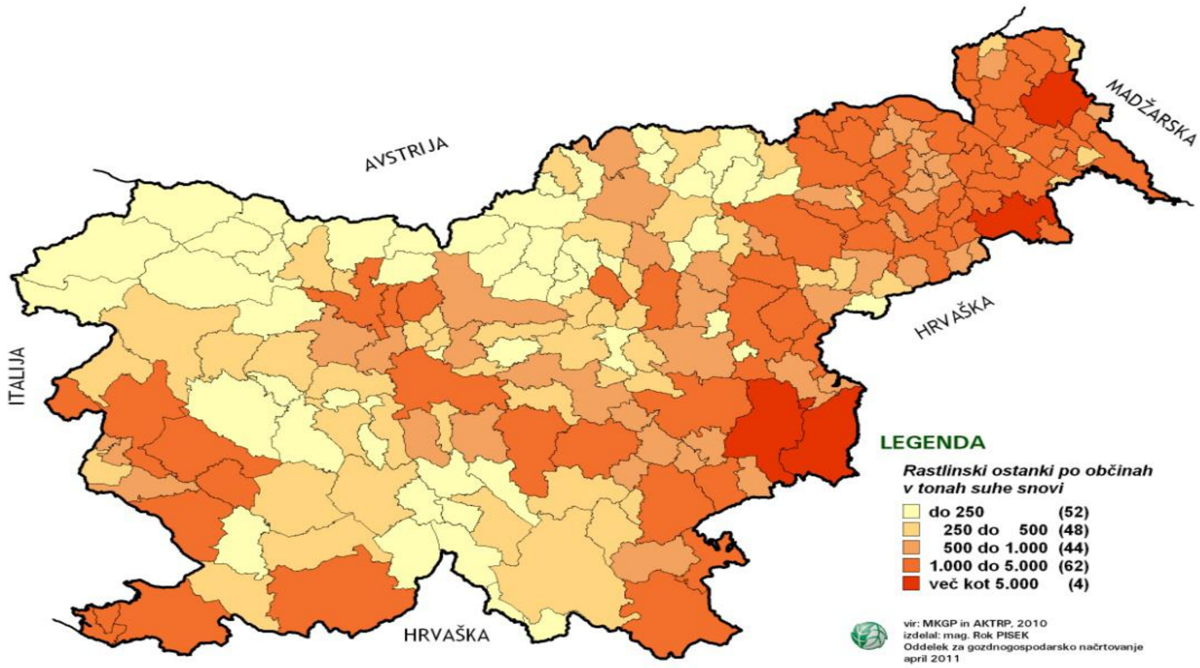
After the year 2004, the export of low quality wood has rapidly increased in 2007 we exported 450,000 t of it, in 2011 this amount was higher for 37% (618,000 t). On the other hand, import has also increased in these years; according to official data we imported 210,000 t in year 2007 and 390,000 t in 2011.



Export of round wood and veneer and low quality wood

According to official data and results of wood flow analysis we estimate that approximately 900,000 m^3 of roundwood from forests (mainly private) was used in 2008 for heating (mainly as firewood) of households. In years 2008 and 2009 a trend toward increasing use of wood biomass in public heat and power plants was noticed. The main reason was the implementation of a new scheme for green energy support and system of subsidies for investments in wood biomass boilers.

We estimate that the use of wood biomass in households has been slightly increasing, which is evident from the larger number of households using wood for heat production. Recent SORS data from 2011 show that households consume 1,137,000 tons of wood fuels with a predominance of wood logs (1,100,000 tons) households used about 1,500,000 m^3 of round wood in 2009 and 2010 for energy purposes (including bark). In year 2005, 38.9% of Slovenian households used wood for heating, 40.7% in year 2006, 41.9% in year 2007, 42.4% in year 2008 and 42.8% in year 2009. Besides biomass from forests, biomass from agricultural land is also a potential source for production of biomass. Slovenia Forest Service prepared the accessibility map (figure 3) of biomass residues in tones of dry matter for all municipalities in Slovenia.



Potential of wood biomass for energetic purposes from agricultural land[7]

Final energy consumption of different wood fuels		
	2009	**2010**
Firewood (t)	1,187,767	1,268,846
Wood chips (t)	11,879	12,690
Wood pellets (t)	4,272	4,563
Wood briquettes (t)	2,539	2,712
Wood residues (t)	23,438	25,037

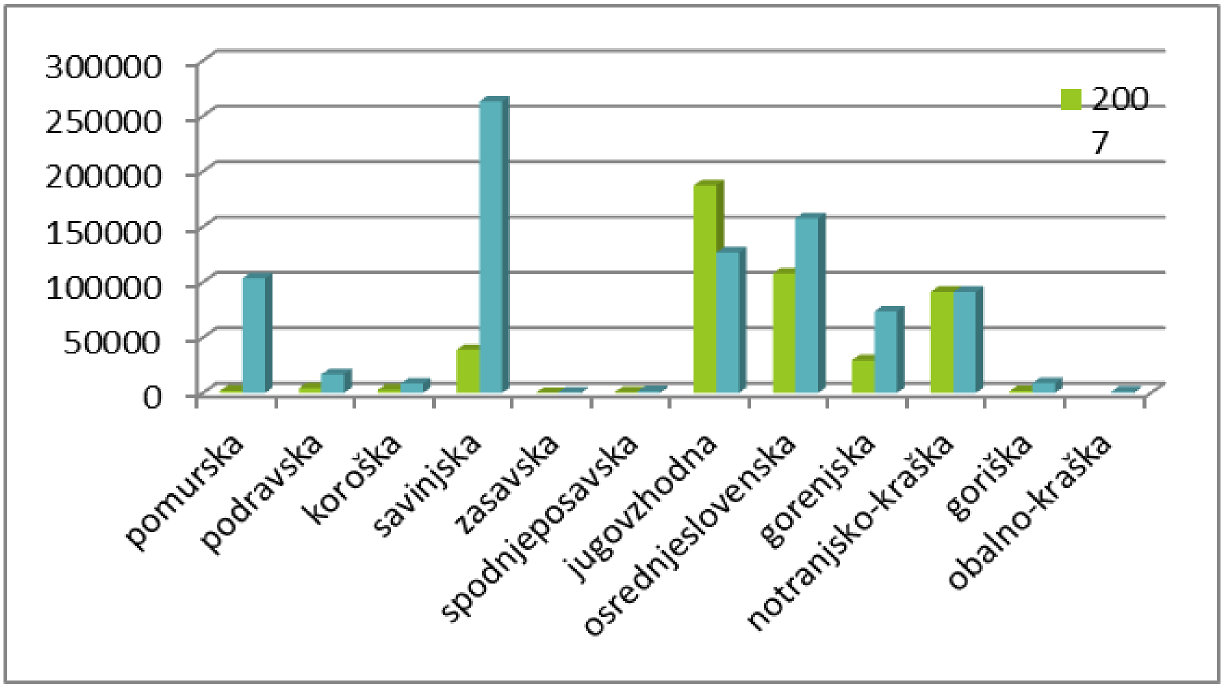
According to SORS and SFI (Slovenian forestry institute) estimates, some 177,977 tons of wood biomass, which is 30% less than in 2008, were used for energy and heat production for larger energy systems in 2009. In year 2010, this amount was 180,181 t. The main reasons for this decrease were reduced use of wood biomass in two largest thermal power plants in Slovenia (co-incineration of wood and coal) and reduced use of wood biomass in industry (predominantly the wood processing industry). We estimate that the decreasing trend of wood biomass use in the wood processing industry has stopped and shall remain on a similar level in years 2010, 2011 and 2012.

[7] (SFS, 2010)

In the Action Plan for Renewable Energy for the period 2010-2020 it is projected for Slovenia that the supply of wood biomass from forests and other wooded land for energy production will be 1,302,000 m^3 in year 2015 and 1,338,000 m^3 in 2020. Based on the analysis of timber flows and roundwood balances in Slovenia (KRAJNC / PIŠKUR 2006, KRAJNC / PIŠKUR 2008) we can conclude that around a quarter of roundwood, which comes directly from the forest, is used for energy purposes, but primarily to cover the needs of households. The market for all wood fuels in Slovenia is developing rapidly. The State has also contributed to this trend by co-financing the initial investments in modern boilers for central heating and support for the promotional projects. With the rising price of fossil fuels in recent years, wood as a domestic, renewable and affordable energy source has become important again.

According to SFI data, around 1,500,000 stock meters of wood logs are produced every year in Slovenia. This production is mainly linked to forest owners and their self-consumption or it is orientated to local markets. Production of wood chips for energy production started to grow in the last 10 years (subsidies for investments in wood chippers had a significant influence on this development). The most commonly used form of wood fuels is firewood, the use of wood chips and pellets has been increasing in the last decade. In the last years, some studies about state of the art of wood fuel production were performed. The first survey was performed in year 2006, when 35 wood chippers and 38 firewood processors were recorded. The highest capacity of wood chipper was 100 nm^3 of wood chips per hour. In figure 4 the distribution of wood chippers in Slovenia in years 2006 and 2011 is presented. In survey performed in year 2008 we collected data about wood fuel production in year 2007. We registered 62 wood chippers and 22 firewood processors. We divided wood chippers into three categories: small – capacity up to 5 nm^3 per hour, medium – capacity from 5 to 50 nm^3 per hour and large – capacity from 50 nm^3 and more. Small chippers presented 11%, medium 65% and large 24%. Their production was estimated to more than 460,000 loose m^3 of wood chips, most of which was produced by large chippers.

In summer of 2011, we performed another study on wood fuel production. We collected 122 wood chippers, 57 firewood processors and 58 firewood splitters. The number of wood chippers doubled between the years 2008 and 2011. Among wood chippers, middle size chippers present the majority. It is estimated that in Slovenia the number of wood chippers is higher, but their production is negligible and they are mainly used for production of wood fuel for domestic use. The whole production of wood chippers was estimated to more than 850,000 loose m^3, which means that the production of wood chips in year 2010 was 85% higher than in year 2007. Around 27% of produced wood chips are exported. Only 31% of wood chips are made of roundwood, other sources are wood residues, sawmill residues, forest residuals.



Production of wood chips in Slovenian regions in years 2007 and 2010

Production of wood chips from forest residues is not a common practice, the main barriers being economics and harvesting technology. In Slovenia, the use of chainsaw for harvesting is still the most common way, followed by tractor skidding. With such techniques, removal of harvesting residues is time-consuming and difficult. However, at present we are performing our own time studies and total cost estimations for producing green chips with these technologies. Results will be known in near future. In last years, harvesting with special machines was introduced and we are in the process of estimation of costs for green chips production. We already have some case studies for production of green wood chips at which cable-yards were used (alpine space). Measurements on test plots showed that we can produce up to 0.13 m^3 of forest residues (for wood chips production) per each m^3 of round wood harvested.

Production of wood pellets and briquettes has been relatively constant from the year 2006. According to the producers of pellets and briquettes, the annual production is from 55,000 to 60,000 t. A new pellet plant started to operate in 2011 (planned yearly production up to 6,000 t), in the year 2013 two new pellet plants in Šoštanj and in Krško (both with annual production of 60.000 t of wood pellets) will also start to operate. That means that the next year pellet production in Slovenia will triple.

In the year 2009 we had eight district heating systems. Their average annual biomass consumption was estimated to more than 25,000 t. Besides district heating systems we had more than 20 micro systems (for heating group of buildings). There were also 112 larger biomass systems, mainly in wood processing industries. Their average annual consumption of wood biomass was 280,000 tons. Use of wood biomass for energy production increased significant in the year 2008 mainly due to use of wood biomass for co-firing with coal (more than 200,000 tons were used for electricity production).

According to the available data for 2011 for Slovenia, more than 40 district heating systems in range of 85 kW to max 152 MW are currently installed. Total power installed in all district heating systems in Slovenia is estimated at 235 MW with the heat production of 212 GWh/a and electricity production of 31 GWh/a. The biggest producer is TE-TOL Ljubljana with installed biomass power of 152 MW. Its yearly production of the heat is 60 GWh/a, electricity production 31 GWh/a and the wood chips consumption 63,000 t/a. The programme of co-financing of district heating systems and the installation of boilers run on wood biomass is run within the framework of the Operational programme for environmental and transport infrastructure development for the period 2007-2013; the development priority »Sustainable Energy« and the priority orientations of innovative measures for local energy supply. In the last two years, two public tenders for co-financing the aforementioned systems run on wood biomass were published. In 2009 and 2010, 13 projects for district heating systems run on wood biomass were supported; combustion engines run on wood biomass were installed into 10 of these systems while 3 of these existing systems were expanded without the installation of combustion engines. State aid in the amount of EUR 6 million was used for the installation of combustion engines run on biomass with a total power of 15.6 MW and more than 31 km of pipelines with 777 connections. The expected sale of heat from renewable sources is 54 GWh. Due to various international and national commitments, wood biomass has been and remains an important energy source for Slovenia. In near future more emphasis should be given on promotion of modern technologies of wood biomass preparation and use. An important topic is also sustainability of wood biomass production and efficiency of its use. We should do more studies of alternative sources of wood biomass, like forest residues, wood from abandoned areas or small diameter wood from thinning operations. Estimation of all socioeconomic aspects of wood biomass production chains is also very important.

Italy

The agricultural Biomass Heat sector in Italy can be subdivided into six areas, based on the wooden source (fuel), the energy system scale and the related equipment. On behalf of the A4E2 Project, the work-field of AIEL has been mainly focused on energy systems based on chips as fuel, with the only exception of the “large size power plants”, which are relevant only for their influence on chip market due to the large amount of wood chips utilised in these power plants.

Feedstock	Energy system scale	Equipments
Logwood	Domestic heating	**Small scale boilers (<35 kWth)**
Pellets	Domestic heating	**Small scale boilers (<35 kWth)**
	Residential / commercial / industrial heating	**Medium scale boilers (15/20/35÷500/1,000 kWth)**
	Small scale district heating	**Medium scale boilers (50÷500/1,000 kWth)**
Chips	Residential / commercial / industrial heating	**Medium scale boilers (15/20/35÷500/1,000 kWth)**
	Small scale district heating	**Medium scale boilers (50÷500/1,000 kWth)**
	District heating	**Large scale boilers (>1 MWth)**
	CHP	**Maximum 1 MWel**
	Large size power plants	**Gas turbine**

Subdivision of the Italian Biomass Heat sector basing on wooden source (feedstock), energy system scale and equipment

As concern the sources of solid biomass feedstock, according to the National Forests and Carbon Inventory estimates, the Italian forest area amounts to 8.8 million hectares (Mha) located mainly in hilly-mountain areas (95%); 60% of forests are private and 40% are owned by local municipalities and communities (public authorities). The potential availability can be estimated being about 874 Mton (dry basis), having a yearly increase of 71,8 Mton. The second source is solid biomass import, which accounts to ~1.2 Mton yr-1 Lastly, according to 2008 data, the arable land under SRC is about 5,000 ha, cropped mainly with poplar plantation (2 years cutting cycle) which produces ~50,000 ton as dry matter of wood chips. In terms of feedstock types, on 2011 the logwood import accounted for 0.5 Mton yr-1 (among the pri~32% from Bosnia-Herzogovina and 29% from Croatia), whereas on 2009 the logwood from national forest withdrawal officially was 2.5÷3.0 Mton. This last data seems to be underestimated and uncertain, since the total logwood consumption has been recently estimated between 16 and 20 Mton, taking into account also the not recorded wood withdrawals and the wood recycling, in particular from the wood industry [Source: Favero and Pettenella, 2012 and Pettenella, 2009. As concern the wood pellet, on 2011 the consumption of pellet, mostly packaged in 15 kg bags, has been over 1.8 Mton yr-1, 520,000 ton arising from domestic production (23 Italian pellet producers) and 1.2 Mton imported, Italy being the most important European pellet consumer and a major net importer. [Source: Paniz, 2012]. Lastly, on 2011 the wood chips consumed was ~2 Mton yr-1: 0.7 Mton as imported chips,~1.2 Mton as fresh matter from internal production (estimates based on energy plants consumption and chips import) and ~50,000 ton as dry matter from SRC production [Source: Paniz, 2012].

Consumption of different types of solid biomass feedstock in Italy (Mt = Mton)

In terms of energy systems for the solid biomass feedstock, on 2011 the total energy consumption can be estimated at ~18÷22 Mton which generates ~78 MWh (6.7 MToe): • 16÷20 Mton are used for domestic heating (logwood and, in minor part, pellet); • 0.38 Mton of chips are used for small scale district heating and for small/medium scale boilers (up to 500 kWth); • 0.41 Mton of chips are consumed in district heating systems; • 1.80 Mton of chips are utilised in large size power plants.

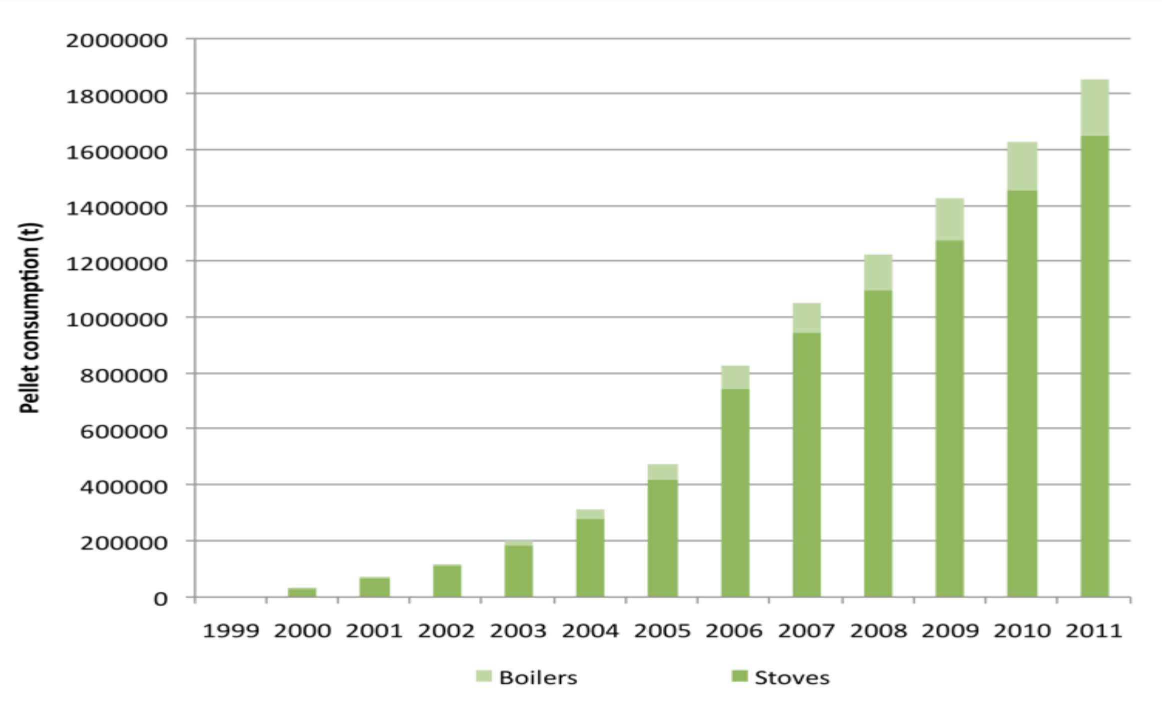
All the plants for domestic heating, for residential, commercial and/or industrial heating and for small scale district heating, when reaching an installed power up to 500 kWth, they can be considered in general as “small-scale heating systems”. Some data related to the investment costs and wood fuel consumption for these plants are reported in the following.

Equipments	Installed power	Investment costs (€)	**Wood fuel consumption (ton yr-1)**
Logwood boiler	<35 kWth	6,000÷15,000	**5÷10**
	35÷100 kWth	15,000÷30,000	**10÷25**
Pellet stove	<12 kWth	1,500÷4,000	**2÷3**
Pellet boiler	<35 kWth	7,000÷15,000	**5÷7**
Woodchips boiler	35÷150 kWth	18,000÷50,000	**30÷120**
	150÷300 kWth	50,000÷150,000	**120÷250**
	300÷500 kWth	**150,000÷250,000**	**250÷400**

Costs and wood fuels consumptions for small-scale heating systems[8]

The plants for domestic heating are mainly fuelled with logwood (87%) and wood pellets (11%), whereas only 2% of small scale boilers use wood chips. As concern domestic heating with logwood, 4.4 M of households use logwood as energy source. In particular, 73% of logwood is burnt in low-efficiency domestic heating systems (i.e. open fire places and tradition wood stoves), whereas only 7.5% is used in modern heating appliances (i.e. innovative stoves) [Source: APAT; 2008]. The domestic heating with pellet is steadily growing and the pellet sector is increasing its importance to the national economy: • Over 3,500 companies are entirely dedicated to this sector (>19,000 employed); • More than 1.8 million Mton of pellet have been consumed in 2011, corresponding to 470 M€ yr-1 [Fig. 3]; • According to CECED 2007, the annual turnover has exceed 10 M€ for the sole pellet stove segment.

[8] Source: Paniz, 2012



Annual consumption of pellet in single household stoves and small-scale heating networks (1999-2011)

Pellet consumption has increased by 56% per year (average rate) in the period 1999÷2011. On 2011, the overall pellet consumption has been equal to 1,85 Mton corresponding to 0.73 MToe, of which 89% (1.65 Mton) consumed by single household stoves and inserts and the remaining 11% (200,400 tons) utilised by small-scale heating networks In total, more than 1,.5 M of households are presently using pellet-fuelled domestic heating systems. The remarkable success of pellet stoves in Italy, as opposed to other European countries, was not due to specific subsidies but to the high price of traditional fossil fuels.

According to AIEL estimates, if the pellet stoves and boilers sales should settle at the levels of the last four years, the number of heating appliances installed by 2020 will exceed 3.67 M units, resulting in a pellet consumption higher than 4 Mton yr-1. The plants for residential, commercial and/or industrial heating as well as for small district heating are generally constituted of small/medium scale boilers (<500 kWth and up to 1,000 kWth) fuelled with pellet or chips. As regards the pellet boilers, on 2011 200,400 tons of pellet were used in centralized pellet boilers. In 2008 some thousands of boilers were estimated to be in operation, located mostly in the Northern regions of Italy (70%). This market shows a growing trend (grow rate of 70% in 2008).

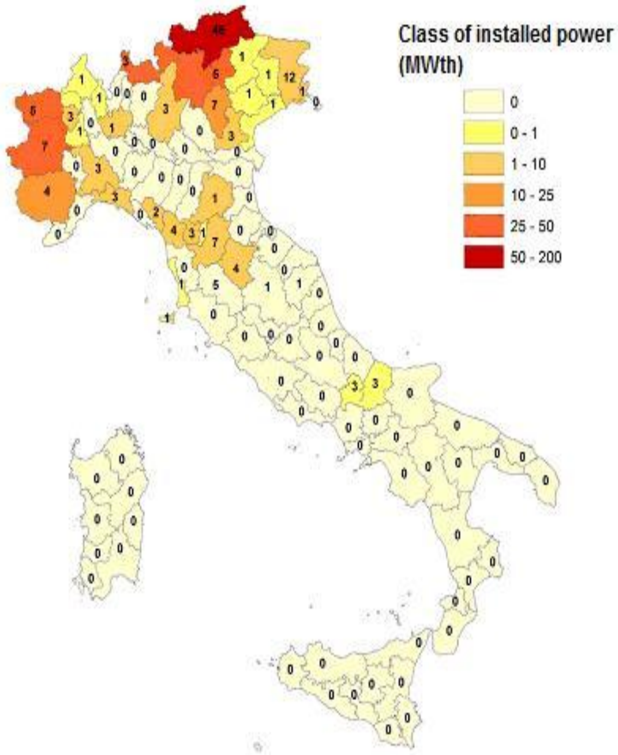
Regions/provinces	Nr. boilers	MWth	Feedstock (ton yr-1)
Bozen Province	7,000	295	**251,041**
Veneto	985	181.5	**154,275**
Piedmont	347	92.4	**78,540**
Tuscany	181	44.0	**35,184**
Friuli Venezia Giulia	191	15.3	**12,997**
Total	**8,704**	**628.2**	**532,037**

Logwood, pellet and chips boilers with capacity ranges from approximately 4 to 500 kWth in some Italian Regions[9]

.

As regards the plants for district heating, on 2010 there were ~200 plants, with a very variable installed thermal power (0.51÷20 MWth), mainly located in Northern Italy (in particular in Alto Adige Province) and in the Central Italian Regions [Fig. 5]. The total installed thermal power was >400 MWth and the network length is >1,000 km. The district heating plants were largely fuelled with wood chips (~450,000 ton yr-1) derived mainly from local forestry and wood industries [Fig. 2 and Tab. 2]. Lastly, as regards the plants for CHP and large size power plants (the latter being mainly based on gas turbine systems) on 2010 there were ~61 plants of which 32 constituted of CHP plants, with a total energy output of 436 MWel [Fig. 6]. When considering the Regional distribution of these plants in terms of EE produced, the two more important Regions are in the South (Calabria, in particular the Province of Crotone, 23% of the 2,260 GWh of EE produced in Italy on 2010) and in Northern Italy (Emilia-Romagna, in particular the Province of Ravenna, 14% of the 2,260 GWh of EE produced in Italy on 2010) [Figs. 6-7].

[9] Source: Francescato and Antonini, 2009



Number and nominal power output (MWth) of wood-fuelled district heating plants[10]

As regards the legislation on incentives, biomass heat has been supported since 1998 with the Financial Law 449/97 tax reduction scheme. Further tax credits were approved in 2000, although delayed to 2002 due to administrative complications. Moreover, for wood fuels it is applied a reduced VAT of 10% (Decree of the Republic President no. 633/1972 and following modifications and integrations).

For domestic heating and residential, commercial and/or industrial heating the existing support measures are almost exclusively investment focused [Tab. 5]. The “fiscal leverage” is the second economic instruments which has been applied to existing houses increasing the energy efficiency of the whole building by isolation and use of RES. By substituting a heating oil boilers with a woodlog, pellet or chip boilers together with some structural isolation works, it was possible to deduct 55% of the total investments (eligible expenses) within the next 10 year into the annual tax return declaration (36% for wood pellet stoves without any structural isolation works). This fiscal leverage has been presently substituted by a new system based on a 50% total investment deduction for any building work in an existing house (thus including domestic heating system changes). In the period 2000-2009, the previous and existing support and incentive measures (mainly tax deduction and credit) had led to an increase of

[10] Source: ITABIA, 2010

~220 kToe in the Gross Final consumption of RES for heating purposes [Source: www.ref-online.it]. This system will end in the middle of 2013. The general principles of the new support measures valid from 2013 are defined in Art. 28 of Legislative Decree no. 28/2011, but the Ministerial Decree has not enacted yet. As concern the district heating (small scale and "normal"), the existing support measures are partly those applied to the domestic heating systems and partly based on Energy Efficiency Certificates (TEE).

The latter, also known as White Certificate Scheme, is a market mechanism for reducing primary energy consumption in the industrial and residential sectors, by means of energy efficiency improvement and/or replacement of fossil fuels with RES (1 TEE = 1 Toe of saved energy). New requirements regarding the application of TEE were introduced on October 2011 by the Deliberation of Authority for Electricity Energy and Gas (EEN 9/11). In 2011 the medium value of Energy Efficiency Certificates (TEE) was around 105÷106 € for saved Toe. About 23% of TEE released in the last years is related to thermal purposes in the civil/private sector, in which the biomass district heating plants are included. The thermal energy produced by the district heating plants has contributed to the TEE with ~167,200 Toe (since August 2005) which corresponds to a contribution to the total reduction of primary energy consumption equal to 2.23%. The general principles of the new support measures valid from 2013 are defined in Art. 28 of Legislative Decree no. 28/2011, but the Ministerial Decree has not enacted yet. As regards the CHP plants based on solid biomass, the economic instruments can be subdivided into two categories. For the thermal energy production, the existing support measures are essentially those applied to the district heating systems, based on Energy Efficiency Certificates (TEE). For the EE production, the economic instruments are the same of these described for the biogas production (paragraph 3.3.3), i.e. feed-in-tariff system (280 €/MWh for EE fed into the grid) for 15-years applied to plants up to 1 MWel in operation from 01.01.2008 and which will come into operation by 31.12.2012.

Bulgaria

Agriculture and forestry are of strategic and economic importance in Bulgaria and central to the response to the challenges of today and tomorrow. Climate change, along with food and energy security should be seen as convergent drivers of sustainable agricultural and forestry production. The overall aim of the AGRIFORENERGY 2 project is to increase the use of bioenergy from the agriculture and forestry sectors in the EU. The more stable and active engagement of the agricultural sector into the bioenergy market, based on a sustainable forest and agricultural management contributes for:

- Stabilization of the agricultural markets and development of rural economy.

- Increase the farmers incomes
- New market possibilities for trade operators (producers, service companies, etc.) of RES installations, providing of new jobs;
- Sustainable energetic development and improvement of the environmental indices;

The energy balance in Bulgaria

- coal -37%
- mineral oil -25
- nuclear energy –20%,
- Natural gas –13 %.
- Share of wood and hydro energy - 4% and 1% resp.

60 % of the necessary primary energy resources are imported.

According the Ministry of economy, the consumption of renewable energy in Bulgaria reached just short of 10 per cent of the total energy produced in the country in 2009, Total production of energy from renewable sources was 3711GWh in 2009, or 8.7 per cent of the total energy output of Bulgaria. Bulgaria disposes with a large biomass potential with 5,5 Mio ha of agricultural land. 30% of the territory is covered by forests. According the Rural development plan the total annual estimations are: fuel wood - 2,146,761 tons; wood waste - 942,232 tons; agricultural solid waste - 4,912,000 tons; agricultural liquid waste is equated up to 494,860,000 m3 (as biogas). Biofuel is around 60,000 tons while the energy crops potential is estimated up to 2,000,000 tons. The use of RES has a real potential for GHG emissions with around 8 129 kt CO2 equivalent until 2015.

TYPE	POTENTIAL		
	TOTAL	NOT UTILIZED	
	ktoe	ktoe	%
Wood (forests)	1 110	510	46
Industrial waste	77	23	30
Agricultural waste	1 000	1000	100
Animal waste	320	320	100
Rapes oil	117	117	100
Total	2624	1970	76

Biomass potential in Bulgaria

The largest single use of renewable is household use of wood, which accounted 56% of all renewable energy in 2006 (EUROSTAT). In the table 2 a price comparison of heating energy for a house of 100 m² Data shows that wood energy has the cheapest price. The costs for pellets are closer to those for natural gas. The costs as well as the difficult access for credits are one of the main obstacles, indicated by the farmers in the framework of A4E2, for stronger penetration of modern installation based on wood pellets. Other obstacle that deserves more attention is the lack of awareness.

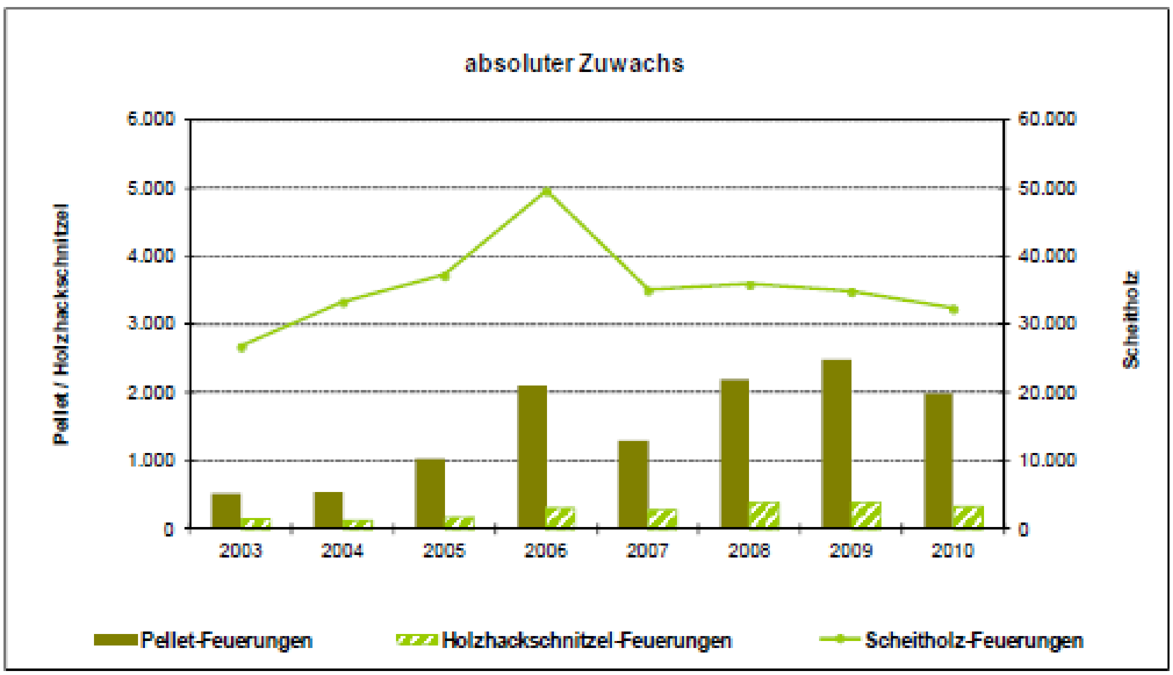
Type of heating energy	Calories	Unit price in BGN	Price/heating unit (BGN)	Costs for heating per month
Coal	6KWh/kg	260/t	0,060 /KWh	208
Wood	3,14KWh/kg	145/m3	0,066 /KWh	180,3
Electricity	1 KWh	0,171	0,172/KWh	470,6
Diesel	11,63KWh/kg	2057/t	0,201 /KWh	548,4
Gasoil	10,98KWh/kg	1900t	0,197/KWh	536,6
Wooden pellets	4,88 KWh/kg	380t	0,088/KWh	241,2
Mineral gas	9,01KWh/m3	804 /1000 m3	0,099/KWh	270,5

Comparison of the prices of heating energy for a house of 100 m²

The high price of pellets and the existing demand for export explain the interests for pellet plants. A financial support in provided in the rural development plan. As regards the use of renewable energy sources for heating and cooling, the regulatory framework is underdeveloped and does not provide significant incentives. Support for the development of the use of renewable energy sources in this respect comes mainly from funds and programmes supporting the initial investment in these technologies.

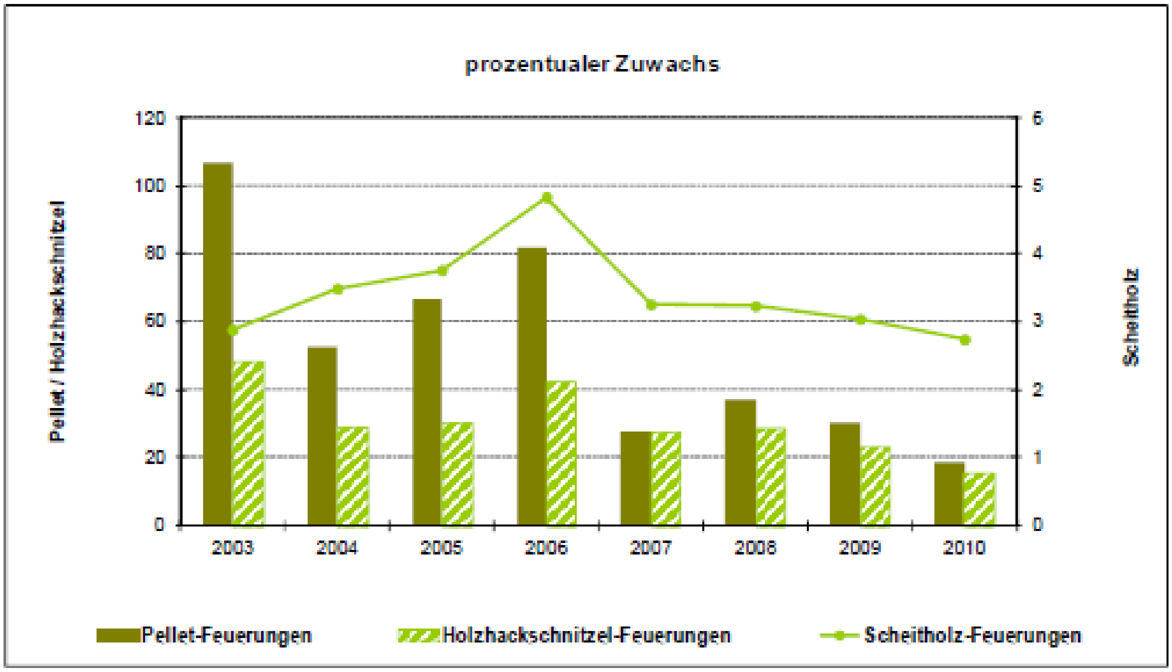
Germany

For all boiler plants, there has in recent years been a clear decline in the growth of new installations compared to previous years. In the case of pellet burners, the increase of 1,997 new installations in 2010 was well under the level of the previous year. Also for woodchip burners, there were only 336 new installations, well below the year before. For split log burners also, with a growth of 32,379 new installations, the numbers were down on the previous year. Figure 1 below shows the yearly change in the number of installations for all three categories since statistics were first collected in 2003.



Absolute growth in the numbers of installations in all categories

The number of split log burners in 2010 amounted to about 1.217 million. The yearly growth since the start of the recording of numbers amounts to between 3% and 5% per year. However, in 2010, this figure dropped to 2.73%, the lowest level since 2003. The number of pellet burners increased to 12,662 installations, although the percentage growth of 18.72% was significantly lower than the previous year and was the lowest value since the start of counting. The number of woodchip burners increased in 2010 to 2,517 installations but the percentage growth of 15.41% was well below the previous year's level and was the lowest value over the period.



Yearly percentage increase for wood burners < 1 MW in Lower Saxony

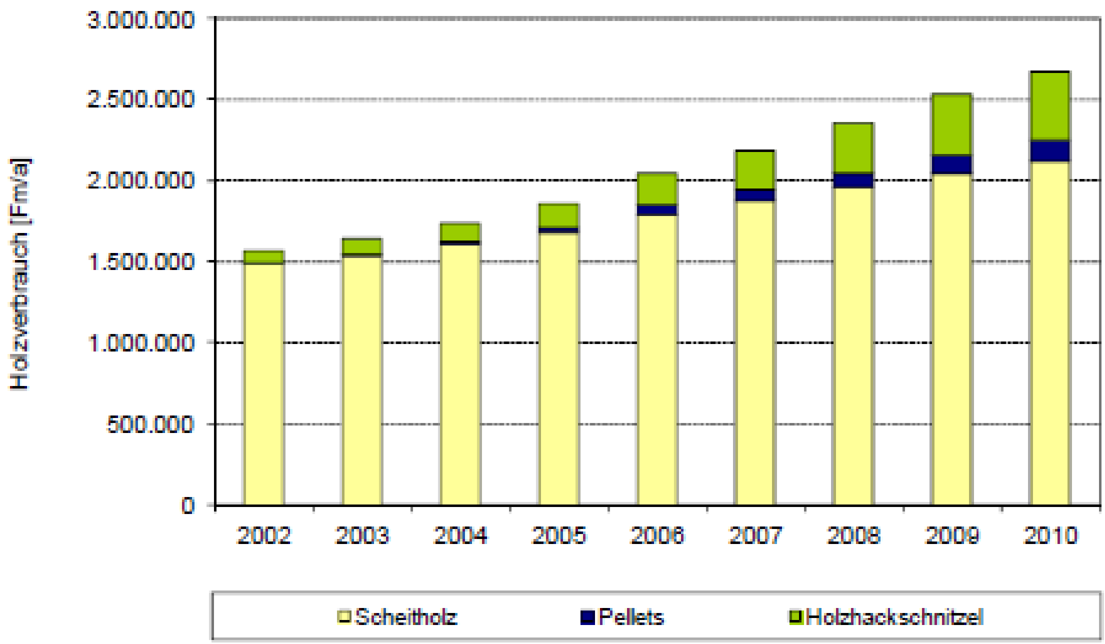
Split log burners

The number of split log burners in 2010 amounted to 1,217,031 installations. Most of these installations – about 1.179 million – are individual burners and these showed an increase of 2.64% (30,375 new installations). The percentage growth for split log individual burners was therefore the lowest over the counting period. The number of split log central heating units < 15 kW increased by 5.33%. There was an increase of 869 burners to a total of 17,177. For split log central heating units > 15 kW, the numbers increased by 5.9%, that is, by 1,135 to 20,365 installations. In 2010 there were a total of 12,662 pellet burners. With a percentage growth of 20.14%, individual installations showed the lowest increase since combustion units were first counted. In 2010, the numbers increased by 892 installations to 5,321. For pellet central heating units < 15 kW, the numbers only increased by 14.71%. The percentage growth therefore was the lowest in the counting period. Numbers grew by 484 installations to 3,774. In the case of pellet central heating units > 15 kW, there was a growth of 21.08%. The percentage growth in this category achieved its lowest value. The number of installations grew by 621 to 3,567. In comparison to the previous year and the other two installation categories, pellet burners show the best growth results.

Woodchip burners

In 2010 there were a total of 2,517 woodchip burners. For woodchip-fired central heating units < 50 kW, there was a growth of 19.42%. The number increased by 236 installations to a total of 1,451. The absolute growth was below that of the previous two years. The percentage growth also shows a decrease.

For woodchip-fired central heating units > 50 kW, there was only a small increase of 10.35%. Numbers increased by 100 installations to a total of 1,066. The absolute growth was therefore the lowest of the last five years. As a percentage, this was clearly below the growth rate of the previous year and was the lowest value over the counting period. The following illustrations show the figures for installations and growth rates as well as percentage increases on the previous year for the two woodchip burner categories.



Wood consumption for burners under 1 MW in Lower Saxony, scm/yr

In Lower Saxony, about 12 million solid cubic metres of wood grows each year and from this, about 9.5 million scm is available for harvesting. In 2010, the wood consumption of the wood-fired plants under 1 MW was at about 2.68 million scm. This amount can be broken down to give 79% for split log burners, 16% for woodchip burners and 5% for pellet burners. It must be taken into account that for split log and woodchip burners, wood briquettes, sawmill waste, wood from gardens and landscape management as well as naturally occurring timber are also used, meaning that the share of forestry wood in the calculation is reduced.

Substitution of fossil fuels

The consumption of 2.68 million solid cubic metres of wood gives an energy output of about 6.14 million MWh. Considering the typical utilisation levels of the various wood combustion systems, a useful energy output of about 4.61 MWh can be determined. However, as no data is available on which energy sources are replaced by the wood fuel, it is assumed for the calculation that 70% natural gas and 30% heating oil is substituted. This corresponds to the approximate distribution of natural gas and heating oil in the sector 'households, industry, commerce and services' in Lower Saxony. In order to supply the same useful energy with natural gas and heating oil systems, a total of 5.43 million MWh must be provided. The difference to the energy content in the wood fuel consumption is largely explained by the fact that the level of plant utilisation for fossil fuel installations is higher than for split log burners, where most of the wood fuel goes. Also, in the case of energy supplied from wood fuels, a small amount of fossil fuel energy is used, e.g. for the fuel manufacturing and transport.

In the case of wood fuel use, there is a climate-friendly heat production effect. The use of wood energy is virtually CO2 neutral. When wood is combusted, only so much CO2 is produced as the vegetation had taken up in its growth phase. Small amounts of fossil fuels are used only for fuel processing, transport and the use of electricity to operate the plant. In 2010, the wood burners < 1MW in Lower Saxony reduced the output of carbon dioxide by about 1.24 million tonnes. The emissions of the pollutants NOx and particulates are raised in comparison to natural gas and heating oil and the level of sulphur dioxide (SO2) is reduced. In the evaluation of the particulates emissions, it should be noted that the heat energy provision from biogenic solid fuels contributes only about 4% of the total particulates emissions and about 7% of the respirable particles, compared to the main pollution sources from road traffic, industry, power stations and agriculture.

Sweden

The Southeast of Sweden consists of three counties (län), the county of Kalmar, the county of Kronoberg and the county of Blekinge. There are 21 counties in Sweden. Län (County) is the Swedish language term for an administrative division used in Sweden. Counties in Sweden are an executive power of the national government and have neither autonomy nor legislative power. The data for the region is mainly collected from Statistics Sweden (SCB) and reports from the Linnaeus University. Both regional and national data is used. Furthermore data was supplemented with data from other sources as the for example energy suppliers and county administrative boards etc. Energy supplied from biomass combustion accounts for about 60 % in the Southeast of Sweden. Preconditions and frameworks to use biomass for energy purposes from agriculture as well as forestry are very favourable in the southeast of Sweden. This is due to positive legal frameworks and policies with regard to the use of bioenergy as well as the good conditions regarding the resources and well developed infrastructure. The whole of Sweden has today well established biomass chains for forest products but even for agricultural products due to well organised infrastructure within the wood working industries and the highly organised forest owners and farmers.

Swedish counties and regions

Facts and figures - what kind of solid biomass is used

The biomass chain has come a long way. Energy from biomass is used in all sectors in Sweden. The size of plants using biomass ranges from small pellet boilers supplying one family houses with energy up to big scale combined heat and power plants supplying major part of cities with heat and electricity.

The following solid biofuels are available and used:

- Forest wood, Forest residues
- Landscape management wood
- Wood residues from the wood working industries
- Recycling wood

- Renewable primary products, which are cultivated targeted on energy usage
- By-products from agricultural productions
- Waste

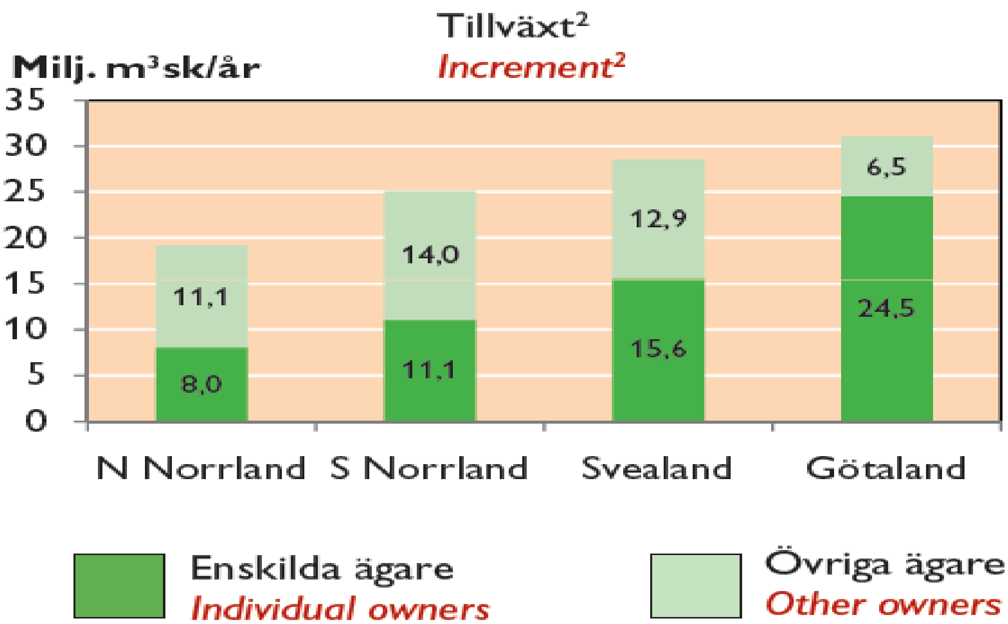
The most common biomass energy sources are residues both from the forest and the wood working industries. Whereas energy recovery of wooden fuels is well established und used in many places are renewable primary products as straw, grain or fast growing woods (for example salix) is not as much established yet. Logs and pellets are mainly used in the smaller range of performance (10 – 50 kW). Wood chips have the biggest application range (50 – 5.000 kW).

Wood chips are usually produced of wood residues. The wood residues are coming from pulpwood harvesting, thinnings and landscape management, sawmill residues as well as used wood. It is chipped in stationary or in mobile chippers. The availability is good. Forest wood chips are extracted from thinning material (small dimensioned wood), forest residues (leftovers from the harvesting) or wood residues from the wood working industries.

CHP plant sandviksverket in Växjö

Potential of renewable resources

Approximately 45% of the total harvest from the Swedish forests is used in energy generation. Of this, large quantities come from the by-products of the forest industry, e.g., bark, shavings and wood substances. Roughly 10 % of felling residues, i.e., tops and branches from harvesting, is used today for energy generation purposes.

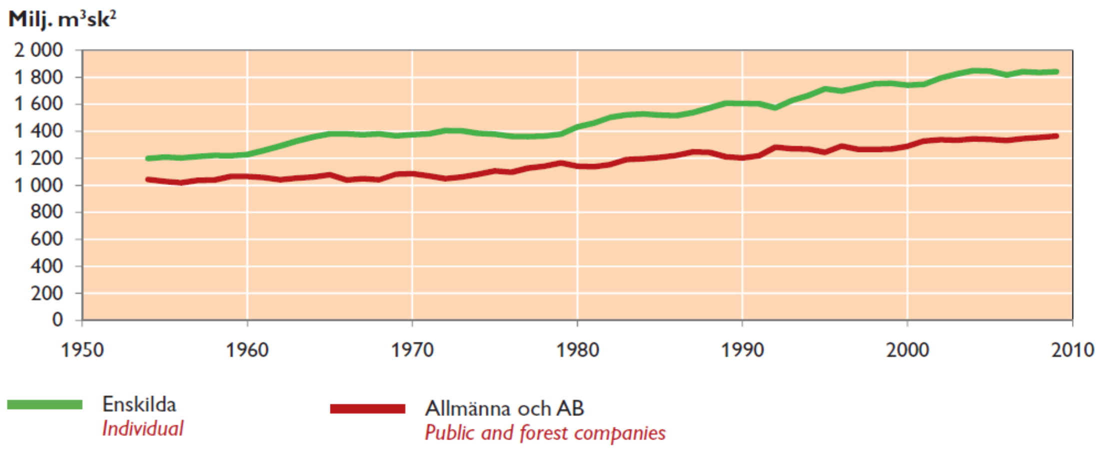


Annual increment (forest) in different regions of Sweden the southeast of Sweden is included in Götaland 11 12

As show is the share in growing stock and increment among the highest in Sweden in the region of Götaland. The following chart, shows the development of standing volume from 1950 to 2010.

[12] Increment: Increment excl. increment felled trees

Trend for standing volume for all land use categories¹ 3 years-average, by ownership categories



¹ Se fotnot figur 3.8.
See footnote, Figure 3.8.
² Här redovisas även mindre volymer med obestämd ägare (nästan uteslutande växande på jordbruksmark).
Includes even small volumes, nearly all from agricultura land, with unspecified owners.

Källa: Riksskogstaxeringen.
Source: Swedish National Forest Inventory.

Trend for standing volume since 1950, the southeast of Sweden is included in Götaland[13]

Growing stock and increment as well as trend for the standing volume reflect the good availability of wood as energy source in the county. But not only the natural resources but also the infrastructure is an important basic condition for an effective and running biomass chain. In total there are about 350 000 private forest owners in Sweden, of which 70 % live on their properties. The share in private forest owners varies and is higher in the south (78 %) than in the north (41 %) of Sweden. The high level of organisation/grouping of private forest owners, the positive forest legislation, advanced wood working industry as well as the goals set by the Swedish government regarding bioenergy contribute to the extensive use of wooden biomass for energy purposes in Sweden. It is difficult to estimate exact figures for the wooden biomass potential in the southeast Sweden. Taking the development of the last years and the current policy instruments into account the share in biomass for heating and electricity production will increase by 30-50 %.

The total amount of energy supplied to Swedish society during year 2007 was 625 TWh (incl. conversion losses in nuclear power (124 TWh). Biofuels accounted for 19 % of the total (national level). Such energy sources were used to generate 124 TWh during 2007. Of that amount, 53 % was used for industrial purposes (including electricity generation), 38 % for district heating and 9 % to heat detached houses. Wood fuel was used to generate 21 TWh for district heating in 2007. The current annual use of wood to heat detached houses is estimated at circa 7 million m³ (stacked dimension).

Biomass supply: both domestic and trade

The proportion of biofuels used in Sweden has steadily increased, from a little over 10 % of the total energy supply in the 1980s to 19 % in 2007. Most of the biofuels, peat and waste used in Sweden are indigenous, consisting mainly of:

- Wood fuels, unprocessed (bark, chips, return timber, felling waste and energy forests and plantations), and processed (briquettes and pellets).
- Black liquors and tall oil (intermediate and by-products in chemical pulp mills)
- Cereals, energy grasses and straw (biofuels from agriculture)
- Peat
- Combustible waste (from industries, domestic waste etc.)
- Ethanol (100 % for use in industry, as admixture in 95 octane petrol and the main ingredient in E85 and E 92 motor fuels)
- FAME, an umbrella name for fatty and acid methyl esters, of which RME (rapeseed methyl ester) is the most common
- Biogas

Although most of the biofuels used in the Swedish energy system are of indigenous origin, there is also an extensive import of biofuels, such as ethanol, wood pellets and peat. It is estimated that about 80 % of the ethanol used in or as motor fuel is imported. As far as pellets are concerned, it is estimated that almost a fifth of the quantity used consists of net imports, with about 358,000 tonnes in 2007. Unfortunately no reliable import or export statistics are collected at present. It is difficult to estimate quantities. However, imports are included in the country's energy balance as indigenously produced, calculated from statistics of use. Investigations that have been carried out into the import quantities indicate figures in the range 5 – 9 TWh, which means that the import of biofuels represents a significant raw material contribution. Most of the imported material is used for the supply of district heating.[14] A survey of the Swedish biomass association SVEBIO shows that there is a big potential to increase the Swedish biomass supply from today 124 TWh up to 248 TWh per year during the next years. According to the survey supplies could be increased up to 390 TWh in the longer term. The biggest potentials are predicted for the forestry sector: increased increment due to more efficient forestry and climate change and fast growing tree species. The potential for forest biomass is estimated for 130 TWh and 190 in the future. But even wood working industries and agriculture have the potential to increase their shares in biomass supply in the near future and longer-term.[15]

Description of the current situation of agricultural land used for dedicated energy production

The agricultural sector contributes with about 1 TWh to the biomass supply. About 1 percent of the total energy supply in Sweden. Agriculture contributes with straw for combustion, grain for the production of ethanol as well as salix and grain for combustion. Even smaller amounts of manure and ley for biogas production and oil plants for the production of RME are provided by agriculture. About two percent of the total agricultural area in Sweden is used for the production of bioenergy. Even within agriculture there are big potentials to increase the share in biomass supply. The "comission against oil dependence" published a report in June 2006 including a scenario with how much agriculture could contribute to a renewable energy system. The commission estimated a potential of about 10 TWh until 2020. In 2050 the share could be 32 TWh[16]. Even the Swedish farmers association (LRF) has estimated potentials for the agricultural sector. They estimate that agriculture can contribute with 22 TWh until 2020. Another survey "Bioenergi från jordbruket – en växande resurs" [17]compiled by the Swedish government estimates that agriculture could contribute with 34 TWh bioenergy from agriculture, always depending on alternative possible applications and sources of income.

Future developments for renewable on the raw materials market

Development and improvement of today's technique will lead to lower costs and higher effectiveness within the biofuel production chain. This will stimulate the supply and will bring down the price. An increased biomass production can at the same time lead to usage of more expansive sources. That could result in a price increase.

Planned measures to improve forest management techniques in order to maximise the extraction of biomass from the forest in a sustainable way

- Implementation of new technique (supported by the Swedish energy agency through research and development projects)
- More efficient and intensive usage of forest residues and thinning wood (in line with the guidelines and recommendations of the Swedish forest agency)

[15] Potentialen för bioenergi, SVEBIO, 2008-03-31

- Better regeneration material and more efficient regeneration methods (in line with the guidelines and recommendations of the Swedish forest agency)
- Increased fertilization, among others by recovering ash from biomass combustion (in line with the guidelines and recommendations of the Swedish forest agency)
- Usage of stumps (in line with the guidelines and recommendations of the Swedish forest agency)
- Intensive cultivation of short rotation wood on forest soil (longer turn-round than short rotation plantations on agricultural soil)

Investment costs for technologies

Investment costs	small scale heating systems	district heating	CHP Heat and power production
€/kW installed	0,57 – 0,85 €/kW	0,66 – 0,95 €/kW	0,95 – 1,23 €/kW
Public contribution: either €/kW installed or % of the investment cost	Varying during the years, at the moment no public contribution available (exception: plants with new technique)		

Conditions and frameworks for biomass from agriculture as well as forestry are very favourable in Sweden and the southeast region. This is due to positive legal frameworks and policies with regard to the use of bioenergy as well as the good conditions regarding sources and well developed infrastructure. The Southeast of Sweden has today a well-established biomass chain for forest products but even for agricultural products with regard to well organised infrastructure within the wood working industries and the highly organised forest owners and farmers.

Finland

The area of Central Finland has a population of 270,000 it covers nearly 20,000 km^2; lakes comprise nearly 3,000 km^2. The most remarkable biomass resources are forests, in total almost 1.4 million hectares (14,000 km^2). The strongest branches of economic activity are pulp and paper, wood products, forestry and production of machineries and equipment. Central Finland is very advanced in the use of bioenergy for heat and electricity. However, the renewable energy target for 2015 is very challenging. The bioenergy production should be increased by 14.4 PJ. Wood energy from forests plays a crucial role in this, accounting for 5.8 PJ increase by 2015. The increase in the use of agro biomasses is estimated to be 2.5 PJ. In Central Finland alone, 1,000 new employees are needed in different tasks in the bioenergy sector by 2015. Additionally over 200 new forest machines are needed to produce forest chips by 2015. Forest offers great job opportunities. In Finland, majority of forest workers are older than 50 years, which means many of them will retire during the next ten years. If not enough qualified and skillful forest workers are trained and employed, the required quantities of high-quality material for energy plants all year round cannot be guaranteed.

Figure: Target regions

Another critical point is lack of energy plant investments. According to several studies there are about 4,000 oil-heated large buildings in Central Finland. If half of these buildings (2,000 buildings) were retrofitted to biomass-based heating (equals 1.9 PJ), the value of the produced heat would be 42,000,000 €/year. This means that 30,000,000 €/year which is now used for heating oil would stay in the county. The size of these investments would be totally 100 million €. This would mean a large amount of jobs; in heat production 200 man-years, during the construction 550 man-years, indirect jobs 250 man-years. Because most of these larger buildings are owned by municipalities (23 municipalities in Central Finland) the decision-making process for investments takes time – too much time, considering the target year of 2015.

Western Finland (South Ostrobothnia)

South Ostrobothnia is a province located in Western Finland and home to approximately 194,000 inhabitants. The province consists of 19 municipalities. Its central city is Seinäjoki with a population of

56,000. The area covered by South Ostrobothnia is approximately 14,000 square kilometres. The province is specifically known for its entrepreneurs, fertile countryside and versatile culture. South Ostrobothnia is quite dependent on fossil fuels (mostly oil and electricity produced outside the province). At the moment the share of renewable energy is about 15% of the whole consumption while on national level it is 28 %. In the future South Ostrobothnia plans to increase its energy independency and the use of renewable energy. In this scenario woody biomass, peat and also agricultural biomass will play a significant role. South Ostrobothnia plans also to increase the use of solar and wind energy and also the use of heat pumps but their role will stay quite minimal in the near future. (Thermopolis Ltd. 2007) South Ostrobothnia should be 75% self-sufficient in energy by 2020, compared to 42% in 2010. In order to reach this target all energy excluding fuels used in traffic should be generated from local energy sources. Naturally bioenergy plays an important role in energy production. There is a regional goal to generate 35% all energy from renewable sources by 2020. This means an increase of 1,200 GWh of renewable energy compared to the use in 2005, assuming that the total energy consumption remains at the same level. Furthermore there is a goal to create 1,200 new jobs in the energy sector by 2020 (compared to 2,100 jobs in 2005). Most of these people would be employed by machine and appliance industry of bioenergy. (Etelä-Pohjanmaa 2012)

Consumption of woody biomass

The most common solid biomasses used for energy generation in Finland are wood and peat. Agrobiomasses play only a marginal role. Most of the woody biomass comes from supply chains of the Finnish forest industry including wood residues from paper, pulp and wood industry and logging residues from loggings. The amount of wood residues has been quite steady during the past a couple of decades because most of them are already in use. On the other hand, the use of logging residues has been increasing since early 90’s.

	Chips from wood residues	Saw dust	Bark	Wood chips from logging residues	Other woody biomass	Total
Region			**1000 m^3**			
Finland	762	1,606	7,089	4,032	847	**14,335**
Central Finland	115	143	688	588	41	**1,576**
Western Finland	**21**	**84**	**93**	**201**	**31**	**430**

* Western Finland = South Ostrobothnia

The use of solid woody biomass in heat and CHP plants in Finland in 2008

The table shows how much solid wood was used in heating plants and combined heat and power plants (CHP) in Finland and target regions in 2008. In addition, another 0.6 million solid-m^3 of wood chips were used in domestic heating in residential buildings and farms. 5.5 million solid-m^3 of firewood, e.g. logs and billets, were used in residential heating also. Two target regions used about 10 % each of this additional firewood. Other woody biomass includes for example wood pellets. In 2008 the total production of wood pellets in Finland amounted to 373,000 tonnes (1.7 TWh) of which about 60 % were exported. There are only small pellet mills in the target regions. Exacts quantities of wood pellets used in the target regions in not known. Estimates vary between 20.000 to 30.000 t per region. All energy produced from wood chips in Central and Western Finland was used in the same regions. Although wood based energy production is always local, particularly in Central Finland where there are many large CHPs, the procurement area of wood fuels is larger than the region of central Finland.

Wood fuel harvesting is highly mechanized in Finland

A former WRC rally driver, Mr. Mäkinen, champions also wood heating.

It should be noticed that wood chip markets of small and medium-sized heating plants are much more local. An average road transport distance seldom exceeds 50 km. Also the particle size and quality of wood chips are different from those used in large CHPs. Small boilers usually require dryer chips and more homogeneous particles. Needles and bark are not desired in large quantities. The national target for using forest wood chips in energy production is 5 million solid-m^3 (10 TWh) annually by 2010 and a new target for 2020 is 12 million solid-m^3 (24 TWh) forest chips (Kansallinen metsäohjelma 2015). In addition, according to the same target energy plants should use wood residues 10 million solid-m^3 (20 TWh). However, reaching these goals depends very much on the development of the forest industry of Finland because a vast majority of wood fuels comes as a by-product of timber harvesting. Another important factor is the future energy wood markets develop. These markets can be easily affected by incentives, directives and taxes. About 1million solid-m^3 of forest chips should be used annually for energy production in both target regions by 2015. The use of wood residues should remain about the same as it is nowadays. The use of wood pellets should increase significantly, being even 800 GWh per year by 2015 (e.g. Paananen 2007).

Biomass heating well known, yet some challenges remain

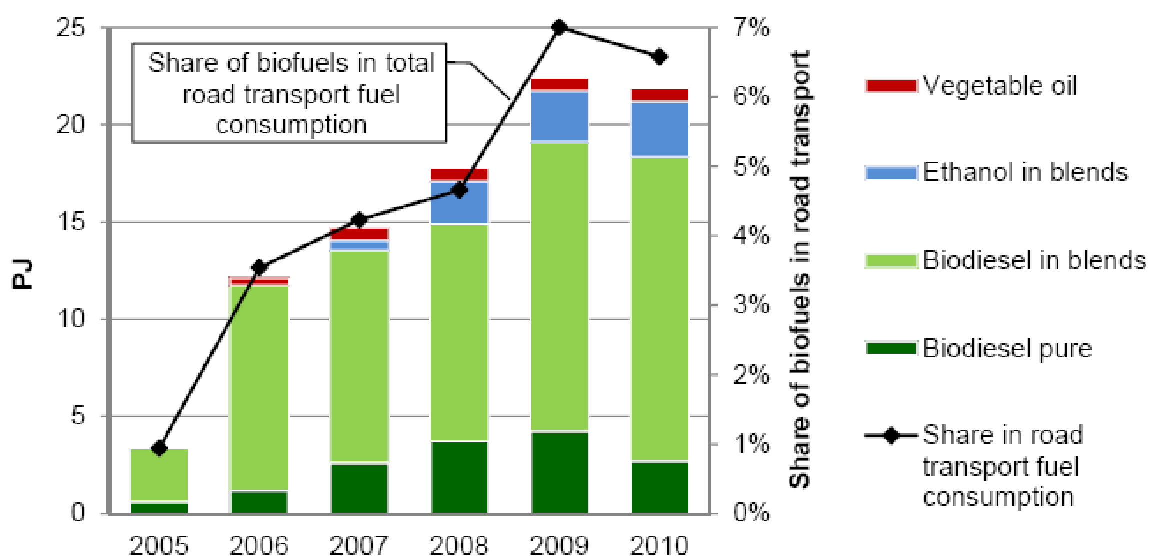
Finland has a long tradition in using wood for heating. Also central and district heating are a common form to provide heat for households, public buildings and industry. A contemporary heating entrepreneurship and small and medium scale district heating started already in early 90’s in Finland. Over 20 year experience and development has given a solid foundation to start such heating business everywhere in the country. The benefits and challenges of choosing wood heat are commonly known. So are the risks of becoming such an entrepreneur. Because there are already so many good examples of successful installations, it is much easier to start a new enterprise or enlarge existing heating business. It is nowadays also easier for municipalities and other public authorities to outsource heating of public buildings to a private enterprise because many well-functioning models are available. There are still definite challenges, however. For example, Western Finland is the most entrepreneurial province in Finland. Because of this most heating entrepreneurs are in this region. Nowadays this causes competition for wood fuel among entrepreneurs as they supply their heating plants. The most potential customers have already been mapped and involved in wood heat business. Therefore it is quite difficult to find new customers and build more heating capacity. Nevertheless, there are still public buildings, e.g. schools, that are heated with fossil fuels but replacing their heating systems face administrative obstacles like bureaucracy and inadequate decision making. Most rural bioenergy investments receive some regional subsidies in Finland. However, policies and application processes have not always been consistent. Also the subsidy levels have often changed. The whole investment process requires a lot of paper work and it is easy to get overwhelmed by bureaucracy. Public projects are hindered by a lack of knowledge and/or inadequacy/willingness to make decisions.

A typical Finnish heating plant with boiler room and chip store in the same building

4.2 PVO market in partner countries

Austria

The increasing use of biofuels for transport was one of the most dynamic developments in the Austrian bioenergy sector in the last decades. The next figure shows the development of the consumption of biogenic transport fuels broken down by types of biofuels as well as the share in the total fuel consumption in road transport. The figure illustrates that this share increased from about 1% in 2005 to 7% in 2009. From 2009 to 2010, a slight reduction in the consumption of biofuels occurred. The figure also illustrates that the largest contribution comes from biodiesel in blends (66% in 2009), followed by pure biodiesel (19%), ethanol in blends (12%) and vegetable oil (3%). The current use of E85 (a blend that contains 85% ethanol and 15% gasoline) and biomethane (cleaned and conditioned biogas), is negligible.[18]



Development of the consumption of biofuels for transport in Austria from 2005 to 2010[19]

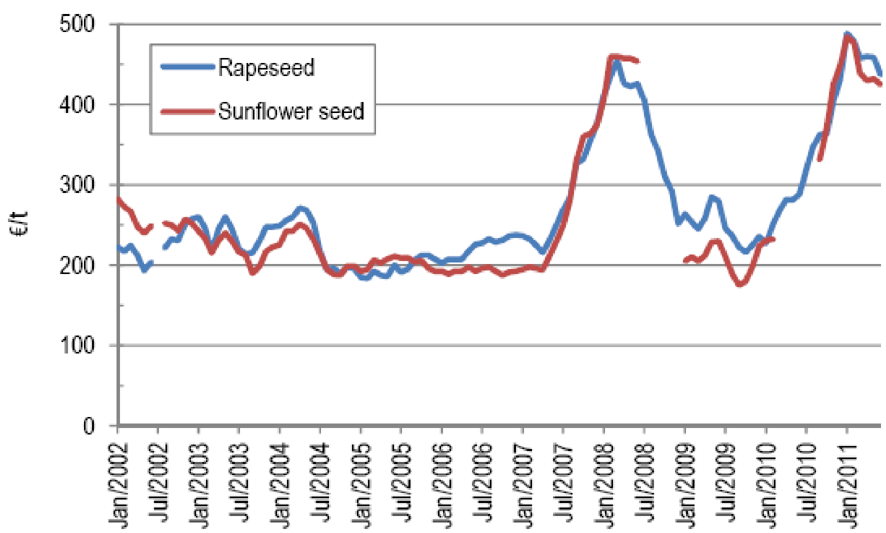
The use of liquid biomass represents the third largest sector in the renewable energy sources in Austria in 2008 and contributes with 5.9% for renewable End-energy amount in Austria. Under liquid biomass, biodiesel, bioethanol and vegetable oil are combined. The produced vegetable oils and their transformation products can be used as fuels for internal combustion engines in mobile and stationary block heating plants or used as fuel exclusively for furnaces for heat. Vegetable oils have a lot of potential as a fuel of the future. In particular, the agricultural sector can enjoy additional sources of income. In

18 IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011

19 IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011

Austria, the production of sunflower and rapeseed is mainly confined to the provinces of Upper Austria, Lower Austria and Burgenland. Where the agricultural land for oil seeds has increased in recent years and there is enormous potential in this area. Pure vegetable oil is produced from oil plants through cold pressing and filtering and is crude or refined but chemically unmodified. It can be used as biofuel when compatible with the type of engine involved and the corresponding emission requirements. It has been tested in vehicle fleets with controversial results. For rapseed pure vegetable oil exists a pre-norm (DIN V 51605) stating Requirements and test methods for the use of rapseed oil". Plant oils are extracted by pressing the plants, and it is particularly the seeds that have the highest oil contents. The best-known plant oils come from rapeseed, sunflower, corn, soybean, palm, olive, linseed and peanut, among others. The uses and the qualities of plant oils are determined through their fatty acid compositions. The decentralized oil mill sector has developed in recent years in the preparation of seeds very positive. In 2007 alone, there was a rise of more than 25 tonnes of rapeseed per year.

The following figure shows the price development of the two most important types of oilseeds that are traded at the Vienna Agricultural Commodities Market: rapeseed and sunflower seed. The main feedstock for the production of biodiesel in Austria is rapeseed. The figure shows that the prices for oilseeds remained relatively constant at about 200 €/t from 2004 to 2006. As a consequence of a surge in demand as well as the strong increase in fossil fuel prices from the beginning of 2007, the prices for oilseeds rose to more than 400 €/t. After a decline in mid-2008 and a short stabilization at about original price levels, prices went back up to close to 500 €/t at the end of 2010.

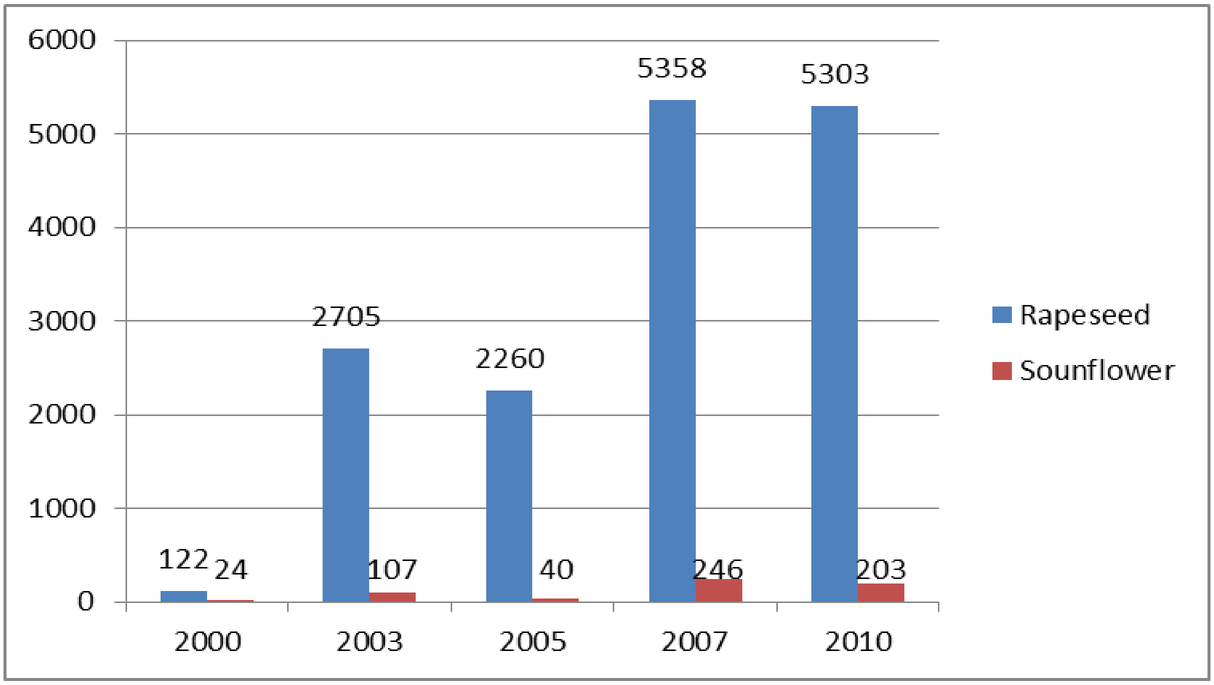


Nominal price developments of oilseeds at the Vienna Agricultural Commodities[20]

[20] IEA BIOENERGY – TASK 40 Sustainable International Bioenergy Trade: Securing supply and demand Country Report Austria 2011

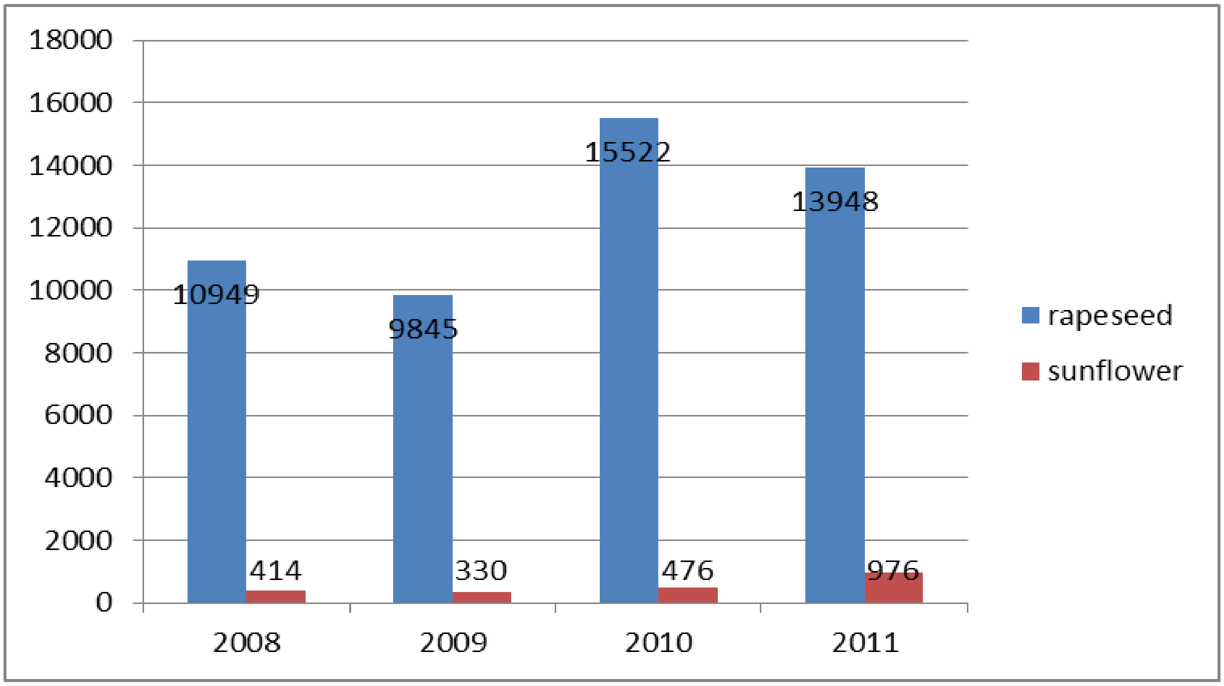
Slovenia

Slovenia obliged itself to reach 5.2% share on biofuels in transport. As a Central Europe country it covers approx. 2 million hectares of territory. There are different types of climatic conditions from Submediterranean, Continental, Alpine to Subpannonian which influence agriculture and land use. Land cover and use depends also on climatic, geographical and socioeconomic conditions. 60% of land is covered by forests and 25% covered by farm land. In the category of farm land, there is 10% of land available for crops production. At this moment, liquid biofuel production in Slovenia is based on conventional agriculture plants. The most common plant for PVO production is rapeseed as can be seen from the figures presented in the document.



Graph in the picture presents ha of rapeseed and ha of sunflower cultivated

As we can see, there is a growing trend of rapeseed cultivation present in the last years and it is to continue also in the year 2011.



Graph in the picture presents rapeseed and sunflower production in tons in different years.

Average annual production of rapeseed is 12,566 tons/year. It was reported (Lesjak 2008) that average harvest in Slovenia, based on five harvesting years amounted to 2.3 t/ha. If we have a good season and we meet all recommended agriculture provisions, it is expected that we will harvest from 3 to 4.5 t/ha of rapeseed. From that data and calculation that from 3 tons of rapeseed seeds we can get 1,000 litres of PVO, we can say that average production of PVO in Slovenia could be around 5 million litre of PVO, which is a fictitious share (0.32 %) of diesel consumed in Slovenia in the recent years. Potential of rapeseed production depends on different factors. There are more methodologies calculating potential crop land availability for rapeseed production in Slovenia. The Slovenian Agriculture Institute estimates that there are 18,000 hectares of crop land where rapeseed production is possible, others are mentioning 15,000 (Tajnišek) or 7,000 (Panvita). According to potentials and realisation we can say that possible production has not been reached yet.

There are also more analyses made about potential PVO consumption. If we take into account Slovenian obligation to reach a 5.4% share of befuels in the transport, for which also others biofuels (biomethane, biodiesel, blinding diesel and biodiesel) can be used, 34,000 hectares are needed. An interesting analysis was made in 2008 (Lesjak), which analysed production of PVO for tractors. According to that analysis it was calculated that more than 20,000 hectares are needed to fulfil Slovenian tractor fuel consumption, which is estimated at 19,104 tons of biodiesel. In the last decade, crop land was exposed to pressures from construction sector; therefore thousands of hectares were lost for infrastructure (highways) and settlement projects until the collapse of building industry in Slovenia during the economical crises. These data together with some not very good examples of biogas plants running mainly on crops have lead to public debates about food self-supply, which has one of the lowest rates (35 %) among the EU countries. For these reasons some political and legislative decisions were made to protect farm land and to use it for food production. Because all of that, energy production from the crop land is not a well communicated idea in the public.

Another important factor which affects PVO use is economy, on which excise tax, tractor adapting costs, rapeseed seed price, fossil fuels price and other factors have a great influence.

PVO as a fuel is not free of excise tax. If one uses PVO for a fuel, they have to register their production and pay excise tax which equals the tax for normal diesel. Farmers can get the excise tax back for fuel (diesel, PVO, petrol) used on their farm, but the amount of eligible consumption is regulated. Paying excise tax is also obligatory if one uses PVO for energy production (heating, cogeneration), which equals the amount for heating oil. Excise tax policy negatively affects the interest to use PVO as an energy product as it is related to extra bureaucracy and costs that drive away potential PVO users. In Slovenia, adapting the tractor engine to run on PVO costs around EUR 1,000 EUR and depends on the type of engine and adapting.

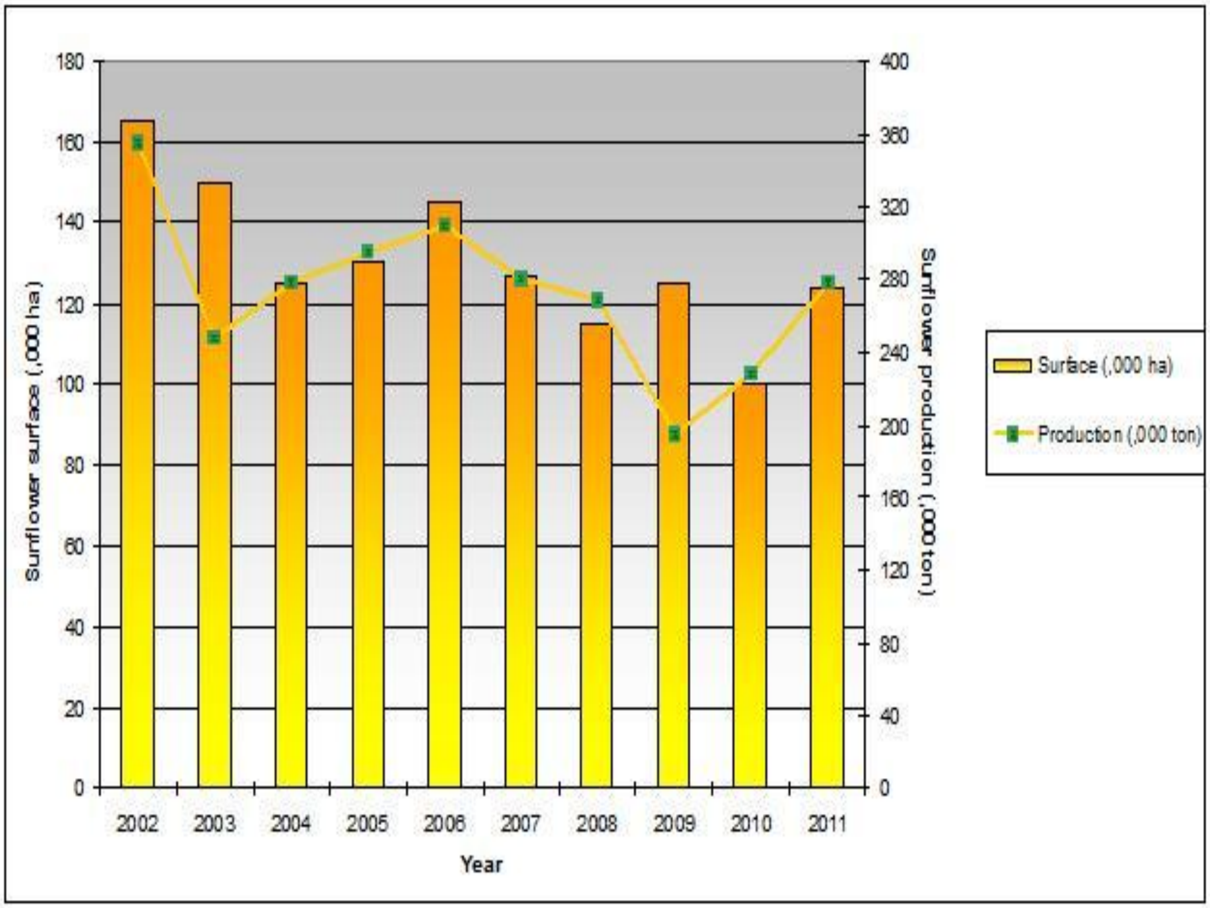
PVO is a contribution to biodiesel production. Governments in the EU decided to fulfil their biofuel quotas with diesel and biodiesel blending. This decision influences the rapeseed and PVO market, which have to compete with biodiesel. The result is that the price of rapeseed seeds has almost double in the last four years (from 0.25 EUR/kg in 2009 to 0.48 EUR/kg in 2012). Majority of the produced rapeseed (3/4) goes for biodiesel production and seeds are often exported as the biggest PVO producer in Slovenia closed its mill in the last year. Therefore not a lot of production is left for other uses of rapeseed oil. Rapeseed oil can be used also for alimentary purposes where the price can exceed 6 EUR/l compared to the price of PVO for fuel which is less than 1 EUR/l. Economy of PVO reflects present situation of PVO development in Slovenia. Until now perhaps a dozen of different vehicles in Slovenia have been adapted and approx. a dozen of PVO users blend PVO with diesel in different proportions. In general, PVO or used vegetable oil is used in older vehicles. As we don’t have data on such kind of production in Slovenia we consider that the production is more in experimental and enthusiast phase, where technology and quality of product are quite questionable.

However, there are also individuals who are interested in PVO production and PVO use in their vehicles and we have met them during AGRIFORENERGY2 project. Good examples are PVO mill Brece and oil mill Jabel, which produce quality oil in a modern process. There are some individuals who own small pressing machines and produce also PVO to use it in their tractors, although they mainly produce alimentary oil. Some of the users adapted their tractor engines, others are simply adding PVO to the diesel. There is also domestic oil pressing machine producer who mainly produces small scale pressing machines and sells it to the framers. In the last years, he has sold dozens of pressing machines to farmers who produce mainly alimentary oil, with exemption of 2 or 3 who produce also PVO. To foster small scale or farmers' PVO use in Slovenia some of impending factors coming from government policies have to be abandoned. One of them is excise tax for PVO, which should be excise free; the second one is more global and perhaps more difficult to reach because the influences on world energy and environment policy are included. In the open market different EU member states which obliged themselves to reach some of the environment targets are competing for resources, including rapeseed to produce biodiesel to be added to fossil diesel. The prices formed according to the supply and demand in the market influence the farmers' decision to grow rapeseed for production of alimentary oil, for production of PVO for self-consumption or to sell it for biodiesel production.

The above mention situations have lead to the present situation and foresee future expectations. In generally we can say that PVO market is not developed and expansion of PVO use is limited. What is the future of PVO in Slovenia? Talking to experts and analysing the present situation regarding PVO leads us to conclusion that PVO has a chance to be developed on farms where farmers see the PVO use in the context of energy self-supply. Using PVO also has a positive externality as it is eco-friendly and the rapeseed cake as a by-product can be used for feeding animals. Questions about using agriculture land to produce fuel can have an answer in the history. Once it was a common practice and completely understandable that farmers produced fodder on their fields for their working animals (horse, ox ...); nowadays, animals are replaced by tractors and energy for their operation is obtained from diesel. So why not use PVO as energy product from the farm, since technology allows us to?

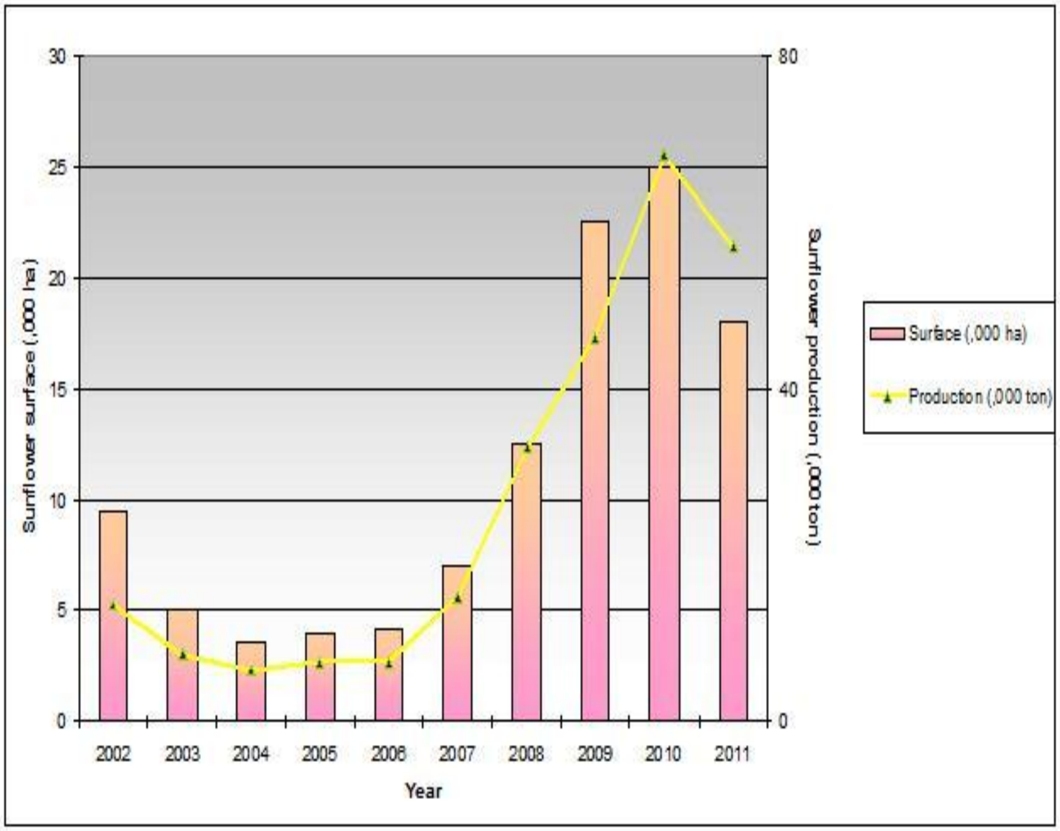
Italy

The **main local crops for PVOs production in Italy** are rapeseeds and sunflower oil seeds, whose harvested surface and production are relatively limited at a national level [**Fig. 1-2**]. On 2008 the Italian pure vegetable oils (PVOs) and the biodiesel have been produced mainly from 12,000 ha rapeseed crops (corresponding to 100% of the total national surface devoted to this crop) and 3,000 ha sunflower (2.5% of the total national surface cropped with sunflower). In the same year (2008) the biodiesel national production has been equal to 660,000 ton yr^{-1} of which 250,000 ton yr^{-1} are used internally for blending Diesel. On 2009 the potential production of PVOs has been estimated equal to approximately 1,700 ton yr^{-1}.



Cultivated surface (ha) and national production (t yr^{-1}) of sunflower oil seeds[21]

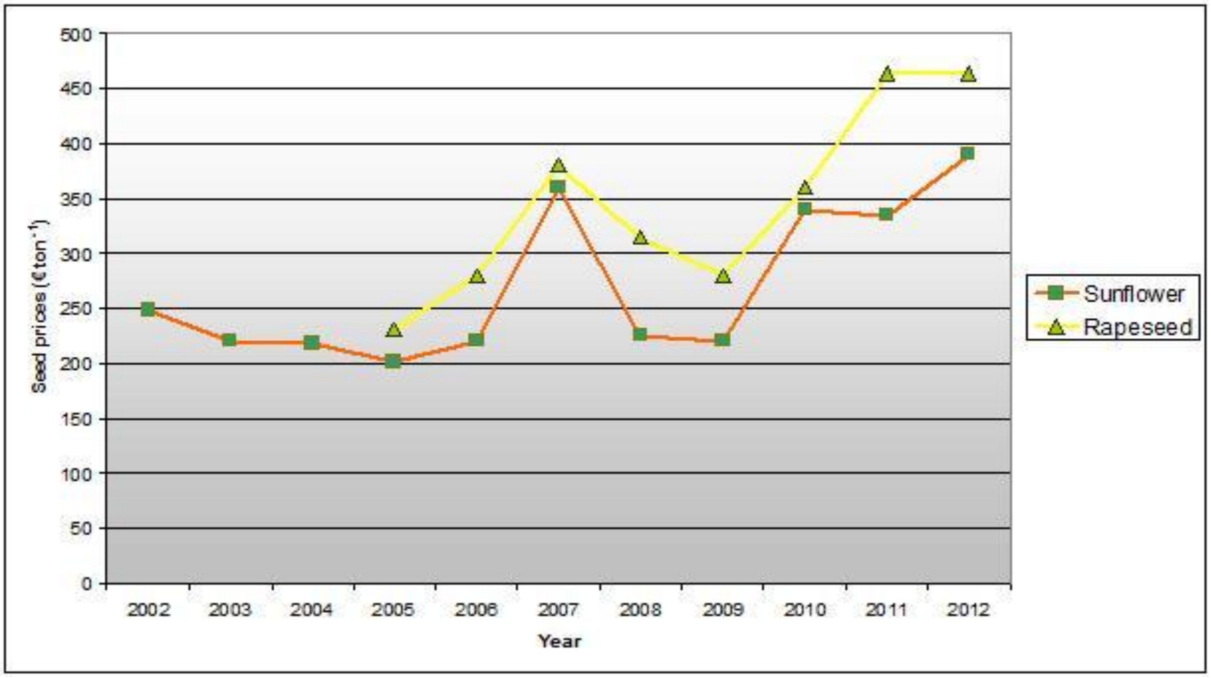
[21] Source: AIEL elaboration, 2012 from Borsa Merci Bologna



Cultivated surface (ha) and national production (t yr-1) of rapeseeds[22]

The prices of the oilseeds crops are subjected to significant fluctuations. Remarkable increases in oilseeds prices (i.e. crops, seeds, rapeseed oil, sunflower oil, rapeseed cakes, sunflower cakes) were recorded during the 2006-2008 triennium and again from 2009, increase that is still ongoing. Within the period 2009-2010, the number of CHP plants supplied with PVOs has increased from 35 to 86 (+145%), whereas the installed electrical power has increased from 302.5 to 510 MWel (+68.6%). In the same period, the electrical energy (EE) produced from PVOs has increased from 1,049.5 to 2,681.6 GWh (+155.5% 2010/2009). It is important to note that this tremendous increase in EE production from PVOs has been due not only to the increase in the number of CHP plants fuelled with PVOs, but also to the introduction of a new accounting system which has decoupled the bio-liquids from other biomasses

[22] Source: AIEL elaboration, 2012 from Assoziazione Nazionale Bieticoltori-ANB

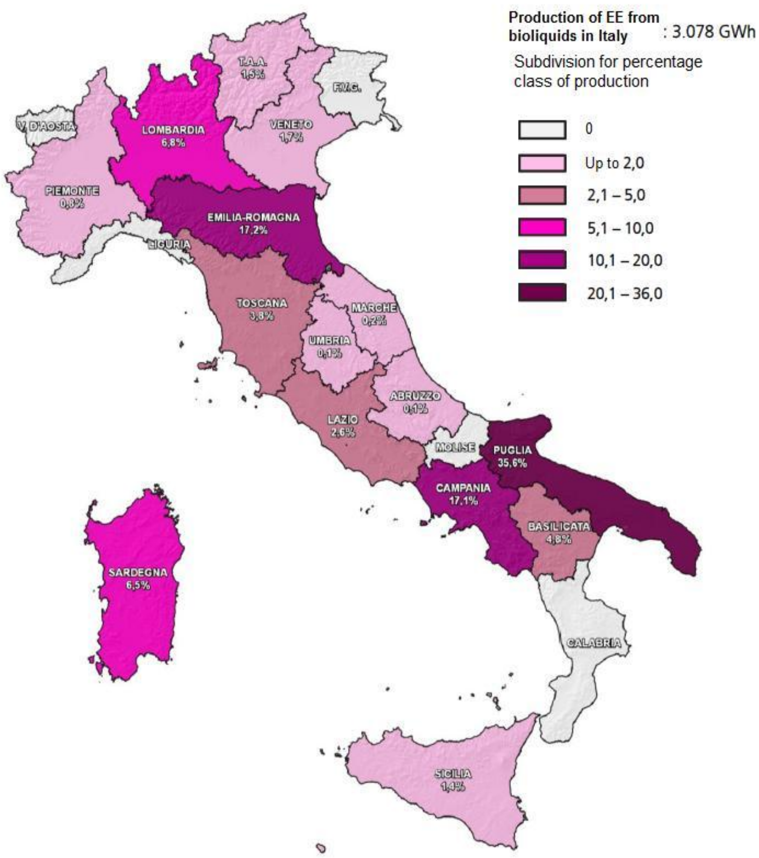


Prices of rapeseed and sunflowers seeds (2002-2012)[23]

When considering the number and the installed electrical power of the CHP plants supplied with *other bio-liquids*, the increase has been less pronounced: from 7 to 11 plants (+57% in 2010 in comparison to 2009) and from 82 to 91 MW_{el} (+10.6% 2010/2009). The corresponding EE produced from *other bio-liquids* has had a slight decrease from 398 to 397 GWh (-0.4% 2010/2009). When considering the regional distribution of the overall EE produced by CHP plants fuelled with bio-liquids (i.e. PVOs and *other bio-liquids*), it can be concluded that the Region where is concentrated the production of EE from this RES is Puglia (35.6%, Province of Bari), followed by Emilia Romagna (17.2%, Province of Ravenna) and Campania (17.1%, Province of Naples). It is significant to note that Bari, Ravenna and Naples are Provinces facing the sea and characterized by relevant port infrastructures. As a matter of fact, almost all the bio-liquids used as fuel in the Italian CHP plants are transported by ship, imported from abroad and mostly constituted by palm oil. In 2010 there were no. 4 PVOs plants in operation at a farm scale with 5,040 t yr-1 of seed capacity (ranging from 780 to 2,700 t yr-1) corresponding to 2,500 ha devoted to oil seed crops. The PVOs final use was agriculture (no. 1 plant) and tractors or public sector. A significant CHP plant (420 kWel + 200 kWth) which is fuelled also by PVO locally produced and processed (short supply chain), is located in Ancona, Marche Region and it came into operation on 2009. The entire PVO

[23] [Source: AIEL elaboration, 2012 on data from Energie Pflanzen, Ufop (Union for promoting oil and protein plants), Ismea (Istituto di servizi per il mercato agricolo alimentare), IlSole24ore]

energy chain is managed by a local farmer cooperative, which acts as an energy seller in the frame of a contracting model. The fuel utilised by the CHP consists for 55% of sunflower oil produced in a local decentralized oil mill (seeds capacity: 450 kg hr-1) and whose oil seeds are cropped locally, and the remaining 45% palm oil which is bought on the market. In Italy at the moment there are 4 tractors running with PVOs. All of them are included in demonstrative projects.



Regional distribution (%) of EE produced from bio-liquids in 2010[24]

As regards the legislation on incentives, it is necessary to differentiate between legislation on EE from CHP and legislation on fuels. The economic instruments for EE production are the same of these described for the biogas production (paragraph 3.3.3), i.e. feed-in-tariff system (280 €/MWh for EE fed into the grid) for 15-years applied to plants up to 1 MWel in operation from 01.01.2008 and which will come into operation by 31.12.2012. This feed-in-tariff has not been applied to the PVO sector for some years due to the lack of the criteria for defining the traceability of the oil seeds according to the European legislation. Hence for several years, the CHP plants in operation before 15th of August 2009 it has been in force the previous “All-inclusive feed-in tariff” corresponding to 220 €/MWh. Moreover, if the CHP plant is not able to demonstrate that the PVO could be traceable, the “All inclusive feed-in-tariffs” has been further reduced to 180 €/MWh.

As concern the ***economic instruments for PVOs to be used as fuels*** (e.g. agricultural tractors), the PVOs have been recognized as fuels by a Ministerial Decree enacted on May 2005 that has transposed the Directive 2003/30/CE into the Italian legislative system. The main barrier for the development of the PVOs sector was then the heavy burden on fuels, since in Italy taxes determine almost half of the fuel prices at the filling stations. The National Financial Law in force since 1st January 2008 stated that an amount of PVOs can be used, corresponding to 1 M€ avoided tax yield (*no-taxation-area*). This tax relief is however valid for self-consumption within farmers' purposes only. Among the heavy burden of fuels it must be noticed that the Italian fuel producers must respect the principle of the so called "*fiscal storage*", i.e. a taxation applied to fuel producers on their production. Another Ministerial Decree in force since November 2007 (tansposition of the Directive 2003/96/EC) permits for oil-mills owners not to respect this fiscal obligation for oil production <5 t yr^{-1} of oil to be used at farm level for internal use only. This amount is actually quite low.

As concern the national priorities related to the **PVOs sector** the economic instruments above mentioned have tried at stimulating the sector in order to reach the targets for EE, heat and fuel production which have been set by the National Action Plan for Renewable Energies (PAN, "*Piano di azione nazionale per le energie rinnovabili dell'Italia*"). This has surely happened for the EE production, whereas these instruments have been not sufficient for reaching the targets for heat and fuel production from PVOs.

Bulgaria

The agricultural land in Bulgaria amounts at 5,5 Mio ha of which the uses arable land (UAA)is around 3,7 Mio ha. On the table below is shown the area of the main energy crops.

Y/ha	2004	2005	2006	2007	2008	2009	2010
Maize	383 217	298 713	350 291	214 367	348 402	303 881	360 046
Rape seeds	11 300	11 000	15 800	54 000	102 000	115 013	209 347
Sunflower	592 765	635 003	750 521	602 398	723 962	687 209	734 314
Rye	8 500	8 800	7 400	5 100	7 000	17 034	16 116
Sugar beet	1083	1294	1356	994	n.a.	n.a.	n.a.
Wheat	1039679	1101807	970392	1087996	1112045	1254151	1095703

[24] Source: GSE, 2011

Area of main energy crops

The area of main crops that are considered and are utilized in the biomass and biofuel productions shows a considerable change in the rapeseed, which size soared up from 9 500 ha in the year 2000 to 102 000 ha in 2008.According to the EUROSTAT, the average yield of rape conceived as the main energy crop in Bulgaria in 2007 was 1,72 t/ha, while in EU-27, it was evaluated up to 2,8 t/ha, a discrepancy by 62%. Regardless, the national rape average yield increased in 2008 up to 2,28 t/ha, it is still at the level of 81% of the EU average level .

The oleic crops are ranging on the second place after the cereals.

According to the Ministry of Economy, in the biofuel sector, Bulgaria will need 509 001 ha of oilseeds which is about 16.3% of the arable land in order to be able reach the national target of 10% in 2020.

Bulgaria is self-supporter in pure vegetable oil. According the data collected in the framework of AGRIFORENERGY 2 the total production of oleic seeds during 2008-2010 varies from 1 532 000 to 1 892 000 t or the average production is about 1 712 000t/year. The internal consumption for food is about 130 000 t of pure vegetable oil and for industrial needs – around 20 000 t. These quantities are produced from 400 - 450 000 t of seeds the rest of the quantity which is about 1250000 per year is exported. The EU is the main client, followed by Turkey with 35-40% and Western Balkan countries. The data shows that the production of oil seed is enough to cover the needs of fuel for the agricultural sector which is estimated at approximately 450 000 tons. The use of PVO as a fuel will contribute improvement of the competitivity of the agricultural sector and the decrease of import of mineral oils (Angelov, 2010). An integration of policy areas is necessary to create synergy effects between agriculture, environment, energy and transport is needed and boost stimulate the use of PVO as a fuel. PVO as a fuel could have a good market niche in Turkey where the possibilities for energy crops are limited (Alkara, 2010).

Promotion activities within A4E2 for PVO

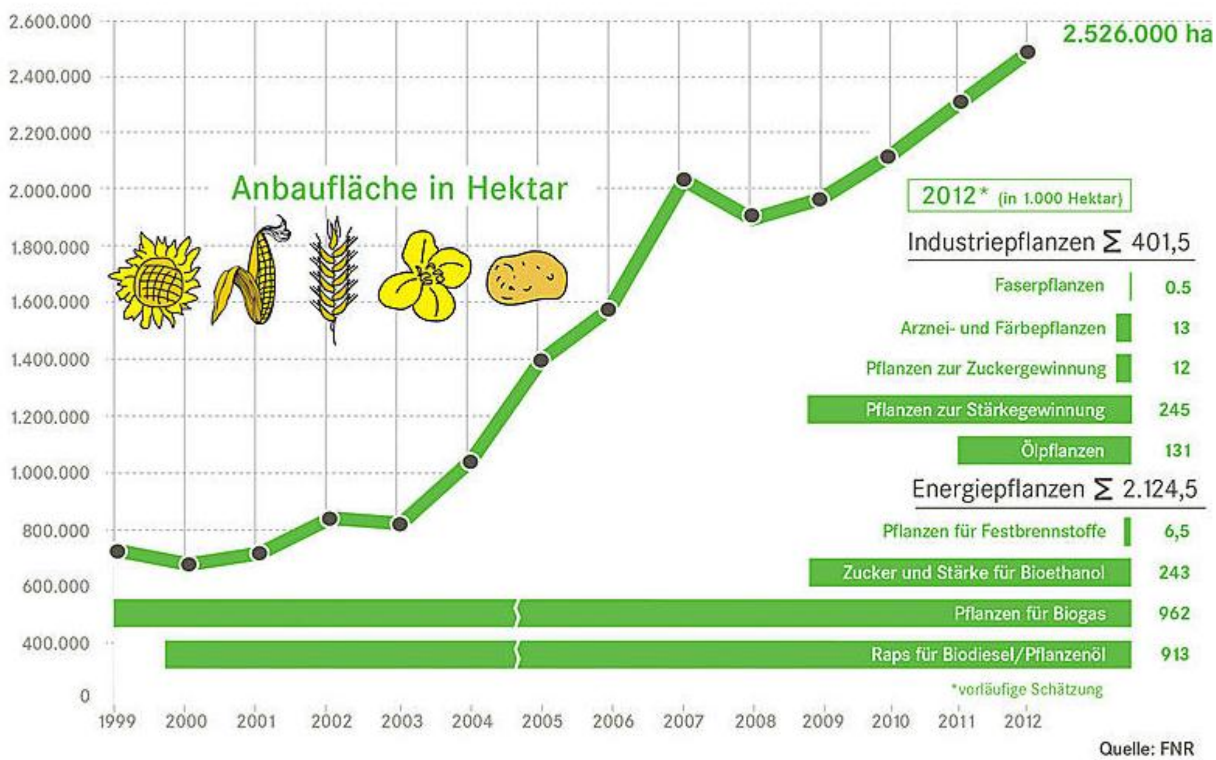
Besides the PVO, as a by-product over 720 000 t of cake for animal feeding could be produced which will guarantee the sustainable development of the agriculture and will contribute to the increase of the competitvity of the sector (Stanchev, 2010). The PVO is not used as fuel. The high prices of cereals and the lack of incentives and tax exemptions are considered by farmers as the main burdens. In 2009 due to the record prices of mineral fuels the diesel was mixed with PVO (up to 20 %). Furthermore additional investments are needed for motors conversion - 5 000 to 7 000 €. (PVO handbook A4E2)

An integration of policy areas to create synergy effects between agriculture, environment, energy, transport, nature is needed in order to boost etc. The PVO is used as a row material for biodiesel production. The biodiesel production is limited up to the quota obligation (5,75%). The Renewable and Alternative Energy Sources and Biofuels Act set tax warehouses in accordance with the Excise Duties and Tax Warehouses Act. The Excise Duties and Tax Warehouses Act provides for the implementation of the following financial incentives for the use of biofuels:

- A zero rate of excise duty for pure biodiesel falling within CN code 3824 90 99
- A reduced rate of excise duty for unleaded petrol when bioethanol falling within CN code 2207 20 00 with 4 % to 5 % of volume has been added
- A reduced rate of excise duty for gas oil when biodiesel falling within CN code 3824 90 99 with 4 % to 5 % of volume has been added

Germany

Increasing fuel prices, uncertainty in the supply situation of fossil fuels because of political instability and the chaotic state of some of the producer countries, the constantly increasing consumption world-wide of resources which are becoming ever more scarce – all these factors are making alternatives increasingly interesting. The main driver of the rise in prices is the increases in the price of crude oil and this does not just influence production costs, it also has an effect on the demand for biofuels and to this extent, the prices of renewable resources. In Germany, the area of energy crops has increased by about 8% to 2.12 million hectares in 2012.



Cultivation of Renewable Resources in Germany

In the light of this situation, it is of particular interest to agricultural concerns to be able to assure a comparatively favorable, sustainable and decentralized energy supply. One answer may be for enterprises to produce vegetable oil from their own resources. The use of vegetable oil offers agriculture and forestry in particular the opportunity to once again achieve energy independence. In contrast to biodiesel or bioethanol, vegetable oil can be produced on the farm without expensive resources and in small units. If the byproduct, press cake, is used as a feedstuff, then the natural cycle is completed. Strict sustainability criteria mean that these days, production is carried out in an environmentally friendly way. By establishing a local protein production as assurance against high feedstuff costs in the case of imports from Brazil and Argentina, a small part of the output consists of vegetable oil which can be used as an agricultural fuel.

Cultivation of sun flowers in Lower Saxony

Vegetable oil is a valuable niche fuel which can stand up to any discussion on the ethics of biofuel production. About 4% of the fuel requirement within German agriculture and forestry could be produced on native ground. However, because of the political and fiscal framework conditions, the low price difference with diesel and the regulations on the use of agricultural diesel, the production and use of pure biofuels is currently not economic and many of the decentralized oil seed processing plants have been closed down. However, there are still some operating oil mills processing rapeseed fuel within agricultural enterprises, as they are well-integrated into the normal production routines and are there mainly to produce protein feeds and achieve independence from market prices. In addition, these decentralized concepts have the advantage that transport routes are short and the technical requirements are basic. Rapeseed fuel produced in this way achieves comparably good greenhouse gas balance values and this is shown in the standard values for each stage of processing prescribed for biofuels in the directive on biomass sustainability. The consumption of agricultural diesel by German farmers stands at around two million t per year. In consideration of the output of protein cake which is a byproduct of the fuel production and is used as an animal feed, meaning that neither foreign nor domestic land is required, there is then a cultivation requirement of about 4% of the domestic arable land available. This means that in view of the above values, a farmer needs less than 10% of his land in order to be fully independent as far as fuel supply goes.

An opportunity lost to reduce greenhouse gas emissions by 13 milliont

The emission of 13 million t of greenhouse gases (GHG) could have been avoided if the output of pure biofuels had remained at the 2007 level. In 2007 there was an output of 2.7 million t of rapeseed oil fuel and biodiesel but in 2011 this was down to only 0.1 million t. This is according to the latest publication from the Federal Office of Economics and Export Control (BAFA). While biodiesel and pure vegetable oil fuel have a very favourable GHG saving potential, the greenhouse gas reduction potential for 2011 was reduced by almost 96% compared to 2007. The Federal Association of decentralized Oil Mills is therefore demanding better framework conditions to revive the market in pure biofuels. A potential field of action here is the German agricultural and forestry industries because of its level of fuel requirement and the potential for ecological and sustainable cultivation. The sale of pure biodiesel has decreased since 2007 from 1.9 million t to 90,000 t today; for pure vegetable oil over the same period, the decrease is from 800,000 to 20,000 t. Günter Hell, President of the BDOel, has explained the situation thus: “In the future also, however, pure biofuels will play an important role in the renewable energy mix. They contribute considerably to the reduction targets for GHG emissions set down by the EU“. The EU directive 2009/28/EC provides that these should be reduced by 40% by the year 2020 (based on 1990 levels) and the share of biogenic fuel admixtures to be increased to 10%. The collapsing market for pure biofuels has brought with it a large reduction in the number of decentralized oil mills. From a peak of 600 mills, there are now only 274 in production and even these are operating at an average capacity of 45%. “We regret this development very much as this will result in the loss of a regional value creation factor and an important part of the small company sector“, according to Günter Hell. The pure biofuels produced in decentralized oil mills could also profit from quota trading, if the tax system was used to promote this. While two-thirds of the crop grown for oil goes to produce a protein-rich animal feed, this means that at the same time as supporting domestic fuel production, imports from abroad are replaced and there is again a saving in GHG emissions.

New possibilities in the use of vegetable oils

However, there are also new possibilities in the use of vegetable oils. The manufacturer John Deere has started a new project to develop a competitive tractor complying with the EU Stage IV emissions standard but operating on 100% vegetable oil fuel. PraxTrak follows on from the very successful EU project 2ndVegOil (www.2ndvegoil.eu) which was led by John Deere and which demonstrated compliance with EU Stages 3a and 3b in the case of vegetable oil fuels and laid down the basis of EU Stage IV. In the recently completed EU project 2ndVegOil, it could be demonstrated that a greenhouse gas reduction potential of 60% and more could be achieved for agricultural uses. In the case of the use of vegetable oils outside of agriculture, the CO2 reduction potential declines. Because vegetable oil production is tied to the manufacture of animal feeds (about 2/3 of the mass yield is protein-rich press cake), the production of feedstuffs is supported (and with that, food production for human nutrition). Today, necessary feedstuff imports can be replaced in part as a result of the increased use of vegetable oils as an agricultural fuel in the EU. The PraxTrak project is among other things targeted at reducing fuel consumption, an optimized design of the exhaust gas treatment system and an increase in engine efficiency when operating with vegetable oil fuel. Alongside the research and testing efforts in the field, there is to be a comprehensive evaluation of the impacts on the climate and environment, including also the effects of non-limited exhaust gas constituents. Within the framework of the project, a wide range of usable vegetable oil fuels (including cameline oil) will be analyzed, thus creating greater opportunities for value creation, increased biodiversity and more jobs. The project is supported by the German Federal Ministry for Food, Agriculture and Consumer Protection (BMELV). The project leader for the BMELV is the Agency for Renewable Resources e.V. (FNR) in Gülzow. JD is developing PraxTrak together with the project partner technology and Support Centre (TFZ), Straubing, along with the University of Kaiserslautern (TU KL) and also including long-term research partners such as regineering GmbH, Denkendorf, B.A.U.M Consult GmbH and the Institute for Energy and Environmental Technology, both in Munich. The first meeting of the consortium took place on 16 July 2012 in Kaiserslautern.

Sweden

In the last year cultivation of oil crops has increased steadily in Sweden. From 2003 to 2008 the area where rape and turnip rape are cultivated has increased by more than 50 per cent. Many evaluators mean that the demand for rape for biofuel use will continue to increase, largely due to the investments in production of RME (rapeseed oil methyl ester), biodiesel produced from rapeseed oil, that are being made both in Sweden and abroad. To produce 1 cubic meter of RME about 1.1 cubic meters of rapeseed oil is used, which corresponds to 3 tonnes of rapeseed. If all diesel sold in Sweden would be mixed with 5 per cent RME produced only from rape grown in Sweden, more than 170,000 hectares of oil crop would be required (the need for rape for food and fodder uncounted), according to the interest organization Svensk raps. In 2008 almost 91,000 hectares of rape and turnip rape were grown in Sweden.

In May 2006 the production of RME started at Lantmännen Ecobränsle in Karlshamn. To begin with 40,000 tonnes of RME per year were produced, and there were plans for an increased production. The rape price had a large impact on profitability and the production was stopped during 2008. In the beginning of 2007 there was one more RME-plant ready in Perstorp near Stenungsund. The production will be 60,000 tonnes per year to start with. Ecobränsle uses rapeseed oil from the nearby rapeseed oil plant to a large extent. Perstorp uses only imported oil.

Biooil producing 1,309 GWh was delivered to district heating plants for heat production in Sweden in 2009. There are no exact figures for southeast Sweden. There are currently no direct subsidues for biofuels. There are however national and international research and development as well as projects with information and knowledge transfer supporting the development of the biofuel sector.

Some examples of national support programmes:

The Swedish Energy Agency supports for example research and development for sustainable supply and refining of biofuels with 160 million Swedish kronor from 2007 to 2010 through the Fuel programme, Bränsleprogrammet15. Bio Oil and other liquid biofuels could replace part of the fossil heating oil in Sweden ahead and contribute to break the dependence on fossil heating oil and at the same time contribute to counteract climate change. At the same time it is important to carefully examine the best field of use for biooil/liquid biofuel: *Oil for energy purposes is okay, but it could be an idea to use biooil for production of chemicals, materials and transport fuels instead*, says Sten Stymne at Swedish University of Agricultural Sciences, Alnarp. We can agree on this, and that biooils in the first place should be used as Sten Stymne suggests, but also as a raw material for biogas production. The need for secure handling and standardization is however large for use as a small scale bioenergy alternative.

Finland

The target region included Central and Western Finland. Some rape seeds are produced in the area but the main production areas are located in Southern Finland, however. In 2011 the total production of rape seeds in Finland was 115 million kg of which about 2 million kg were produced in Central Finland. Crops in Southern Finland were 1,300 to 1,400 kg/ha and in Central Finland 950 kg/ha. Figures are relatively low compared to other agricultural crops. For 2012 the estimated crop will be only 70 million kilos of rape seeds.

Consumption of pure vegetable oil

Using pure vegetable oil as a fuel is very rare in Finland. It is considered much more useful and economic for food or biodiesel. Most of the locally produced oil is used for food in the form of cold-pressed oil, as raw material of biodiesel (not very popular) or sold as seeds to the industry, which press these more effectively. Such an industry company is Raisio Oy, which is the most important company in the Finland pressing and using rape seeds.

Challenges and development of PVO

In Finland rape oil is usually used for food in different products, mainly produced by Raisio Oy. Surplus oil is sold to Neste Oil for biodiesel production. Rape cakes, the main byproduct, are used for cattle feed because of their high protein content. Little pure rape oil is used for heating. A good example of this would be the heating of a grain dryer. On the other hand, the users of pure rape oil are skeptical about using it as a fuel because the viscosity creates troubles in the motor especially in winter time. A mill is needed for pressing seeds to rape oil, and the oil requires a special burner with preheating of rape oil. In the equipment markets, there is a lack of special small-scale burners for rape oil. Present burners are rather effective but they are designed in most cases for heavy heating oil. In general, rape oil burner markets are very small and therefore burner manufacturers are not interested in this fuel. On the other hand, if rape oil turned to biodiesel it can be used in regular light oil burners. From the economic point of view PVO fuel is an expensive solution for a farm, but in cooperation and with other products, for example cold pressed food oil and rape cakes, it might be an economically sound solution

Rape oil burner for heating a grain dryer

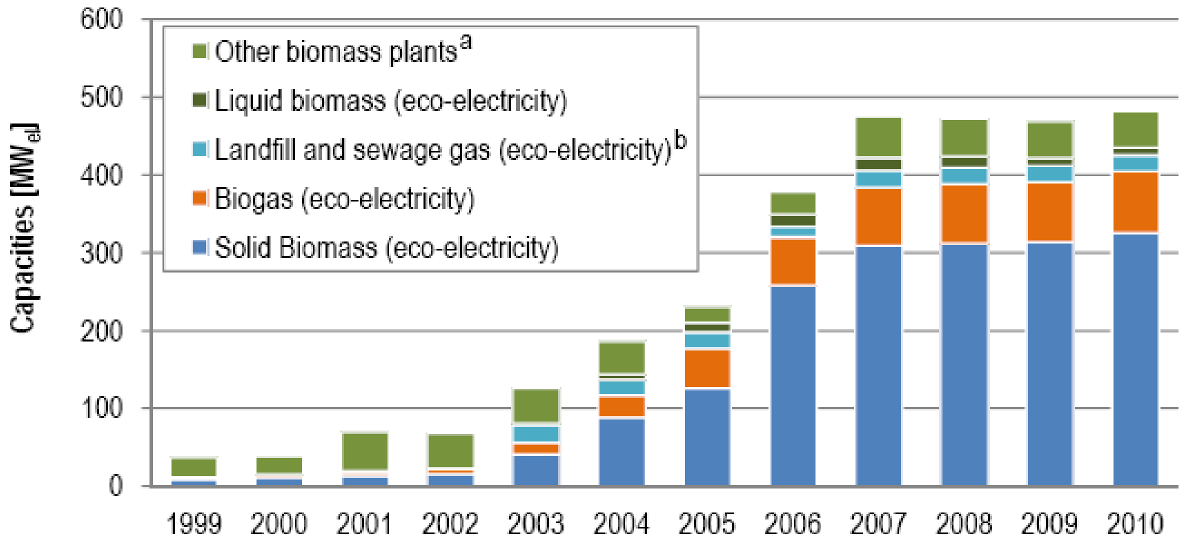
Mr. Kotta is pressing rape oil to rape cakes and oil with two small scale presses

The project A4E2 prepared a very comprehensive and useful handbook of PVO. Nothing similar has ever been created in Finland. Copies were distributed among the participants of seminars and workshops, and to other stakeholders like agricultural organizations and the Ministry of Agriculture and Forestry. The handbook provides basic information about PVO production and will serve as a useful reference for potential projects in the future Pure vegetable oil will only play a marginal role in the biofuel markets in Finland. Most of the pure rape oil will be used in food industry and the rest will be upgraded to biodiesel. Biodiesel is much easier to use in heating and as a vehicle fuel. The objective of the Ministry of the Agriculture and Forestry is to get the production of rape seeds as high as possible, because of the protein content of rape cakes used for cattle feed.

4.3 Biogas and Biomethane market in partner countries

Austria

The installed capacities of biomass electricity and CHP plants shown in Fig. 32 are based on official data on eco-electricity plants as well as estimated capacities of plants not supported within the Green Electricity Act (primarily autoproducer plants of the wood processing industries; waste liquor plants are excluded here). The installed capacities of eco-electricity plants using solid biomass exceed 300 MWel and are by far the most important category,followed by biogas plants (about 80 MWel).



Development of installed capacities for electricity generation from biomass[25]

The energetic use of the renewable energy source biogas plays an important role in the Austrian climate and energy strategy. At the moment 344 plants are in operation with an installed electric power of 92 megawatts. The production of electric power amounts to 650 GWh and covers approximately 1 % of the whole annual electricity acquirement of Austria. 200.000 Austrian households can be well provided with green electric power. The biggest share comes from agricultural plants which use energy crops – mainly silage maize - and slurry for the biogas production. The average electric plant size amounts to 300 kW. A large part of the biogas plants was installed in the years from 2002 to 2006 with the implementation of the first Eco-power law (feed –in tariffs). Numerous changes of the Eco-power law have led a decline of the

[25] *a) Bioenergy plants not supported as eco-electricity plants; estimated capacites based on energy balance (6,000 annual full load hours assumed); excluding waste liquor and MSW plants).*
b) No data available for the years before 2003 Sources: E-control (2011b), Statistik Austria (2011c), own calculations

feed-in tariffs. The consequence was a decline during the last years. In February 2010 the government has decided new feed-in tariffs. The tariffs depend on the size of the plant and range between 18,50 ct/kWh (< 250 kW) to 13,00 ct/kWh (>1000 kW). The tariffs are guaranteed for 15 years. A use of non-agricultural substrates reduces the tariff by 20%. A minimum overall efficiency of 60% for electricity and heat production is required. The use of more than 70 % of process heat is rewarded with 2 ct/kWh. In 2008, an additional bonus of 4 ct/kWh due the high prices for agricultural substrates was granted for existing plants. The heat can be sold freely on the market. A feeding in of biogas into the gas grid is possible with many restrictions. However, for economic incentives feed-in tariffs between 28 to 20 ct/kWh are necessary. Therefore, a new "biogas-boom" during the next years will not be expected.

Higher prices for raw material, low feed-in tariffs and the insufficient usage of waste heat have led that numerous biogas plants struggle for their economic existence. As a consequence the biogas operators explored for new options to enter the energy market. New fields on the biogas sector are the decentralised feed-in in gas grids and the usage as fuel for cars. In Austria there are 4 plants installed which produce biomethane for feeding in gas grids. Two plants produce biomethane as use fuel for vehicles (substitution for petrol). The biomethane market in Austria is negligible because the plants produce only 918.000 cubic meter biomethane per year - that is 0,01 % of the annual natural gas consumption. In 2009 the natural gas consumption in Austria was 9.5 billions cubic meters. A higher potential for the future are the regional, decentralised usage of biomethane in micro nets and the usage of waste heat for cooling. New political and technical incentives are necessary for the future development of the biogas sector in Austria. Biogas plants have to become a future key technology because the provided energy services are multi-talented. The decentralised energy supply plays an important role for the regional development. Regional energy supply reduces the dependence on energy-imports and raises the regional added value by the creation of new jobs.

Slovenia

Domestic production in Slovenia covers 45% of energy consumption. The rest has to be covered by import. In the year 2006, consumption of electricity from renewable energy sources in Slovenia was 24.4%. The main percent of “green electricity” was obtained from hydroelectric power plants (97%), 2% were produced from biomass, and 0.9% (11.9 ktoe) was produced from all biogas electric power plants. In the Pre-Accession Treaty, Slovenia has committed itself to reach 25% of energy from RES until 2020 and 36.6% of electricity produced from renewable energy sources (RES) until 2012. In 2010, the share of RES in gross consumption has reached 19.9 % and 30% in electricity from RES.

One of the RES is also biogas coming from biogas power plants. In the project we focused only on biogas coming from agriculture wastes and landfill; others sources of biogas were not discussed. In 2010, a study was made (Pašker P., 2010), which estimated the biogas potential from agriculture. It included the potential of animal manure and green biomass from agriculture. The study presupposes three scenarios regarding different availability of crop land for green biomass production. According to the scenarios, tree different yields of biogas were calculated and different electricity potentials were presented.

	Scenario I	Scenario II	Scenario III
installed engine power (kW)	86,082	115,892	147,425
electricity production (GWh)	688.7	927.1	1,179.4

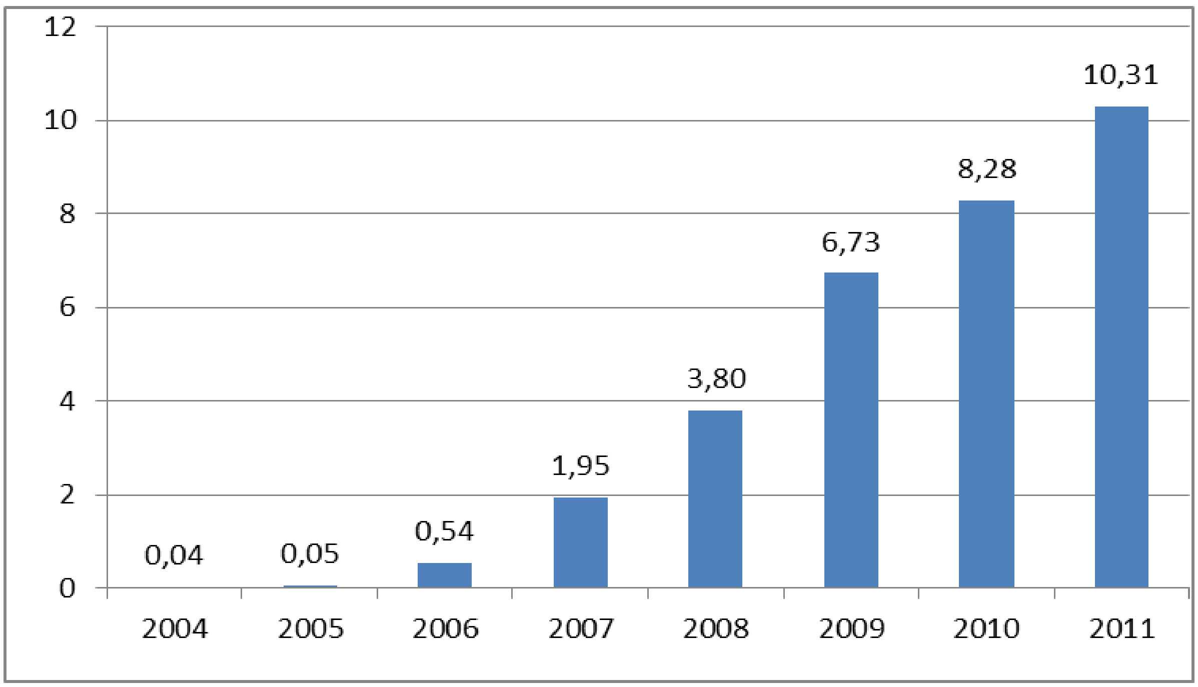
Potentials of installed engine power and electricity production in Slovenia

Before 2002, the interest in biogas production was low because of different reasons and only one biogas plant on the pig farm was operating. Now, there is a support scheme for biogas electricity production or subsidies for investments. There was also a lack of information about biogas among potential investors and prices of fossil fuels were competitive. After the year 2002, when regulation about repurchasing electrical power from qualified producers was adopted, development took place. This regulation assured repurchase and higher premium of green electricity. In 2007, there were already 5 biogas plants in operation with total installation electric power of 3.6 MW. There was a fast development between 2009 and 2011 as investors see considerable gains due to very high green electricity prices. In 2011, 12 biogas plants got a declaration which allows them to trade in the green electricity market. With that number of biogas plants the peak annual growth in Slovenia was reached. Nowadays, 23 biogas plants are operating and there are four or five which are going to start in 2012. The biggest biogas plant in Slovenia has a power of 7.1 MW and it was built in 2011. The smallest biogas plant in Slovenia has a power of 0.11 MW and was built in 2003.

Distribution of biogas plants and livestock density in Slovenia[26]

In Slovenia there are regions with no biogas plants and regions where the number of biogas plant exceeds resources. Biogas operators cope with a lack of resources in this region by importing them.

As presented above, the feeding tariff is an important policy tool to foster development. This scheme has 3 different classes according to the power size of biogas plants: micro less than 50 kW, small less than 1 MW and middle less than 10 MW. Because of the financial benefits operators invested in biogas plants of less than 1 MW, which can be classified as smaller biogas plants, but in reality they look more like industrial biogas plants as one investor often operates more < 1MW biogas plants. There are 12 biogas power plants with power size of 999 kW, which belong in the category less than 1 MW; 8 of them are located in the same 3 destinations. The majority of biogas plants were build by Slovenian company Ketter Organica, which has developed its own biogas plant model and offers the complete background and support system, so the investors usually decided to buy turnkey biogas plants from them.



Annual electricity production from biogas in ktoe[27]

Production of electricity started with 0.04 ktoe in 2004 and reached 10.31 ktoe in 2011. With some new installations (four) starting to operate in 2012, production is going to rise. Net power from all biogas plants in operation in 2011 amounted to 27.92 MW (EnGIS, 2012), which equals 1/3 of theoretical installed engine power potential.

[26] Geopedia, 2012
27 Borzen 2011, Poje 2012

According to presented data we can say that a great development of biogas plant has been made in the last 3 or 4 years. Interests of the potential investors and public were great and many newspaper articles about biogas plant were published. There were events organised with a lot of participants - farmers, investors, politicians, and environmentalists. Among positive aspects of biogas production there were also issues on the conflict with food production and environment risks stressed in the media. Negative aspects are coming from large expansion of biogas plants which mainly use corn silage; this has lead to a negative campaign in the public which rises the question whether to use farm land for production of energy or food. There were also some conflicts with local communities which were against biogas plants in their environment because of possible environment risks.

At the moment, the main question regards potentials for new plants in Slovenia and changes of the Green electricity low in December 2010. This regulation lowers feeding tariffs for new biogas plants installations. From now on, only plants using less than 40 % of silage corn or cereals are entitled to get fixed price of green electricity. Therefore, interest in new biogas plant has decreased. It is expected that only investors in biogas plants who already have the necessary permission and could operate according to the old feeding tariff are going to realize the investment and start producing electricity from biogas. Biogas plants trade mainly with electrical energy, while heat as secondary product was usually used only for heating production process. In Slovenia, biogas as motor fuel is not used yet and the biomethane production is not present here yet. The new biomass strategy which includes also biogas is now in the phase of public debate. There are more issues opened about further biogas development, which are probably going to change today’s biogas practice and give more chances to micro biogas plants situated on the farm, to biogas plants which are going to use heat as a secondary product more efficiently, and biogas plants which are going to use more manure and not a silage, which harms food production. This new approach to biogas has a good chance to encourage development and to contribute to the RES and RDP targets.

Italy

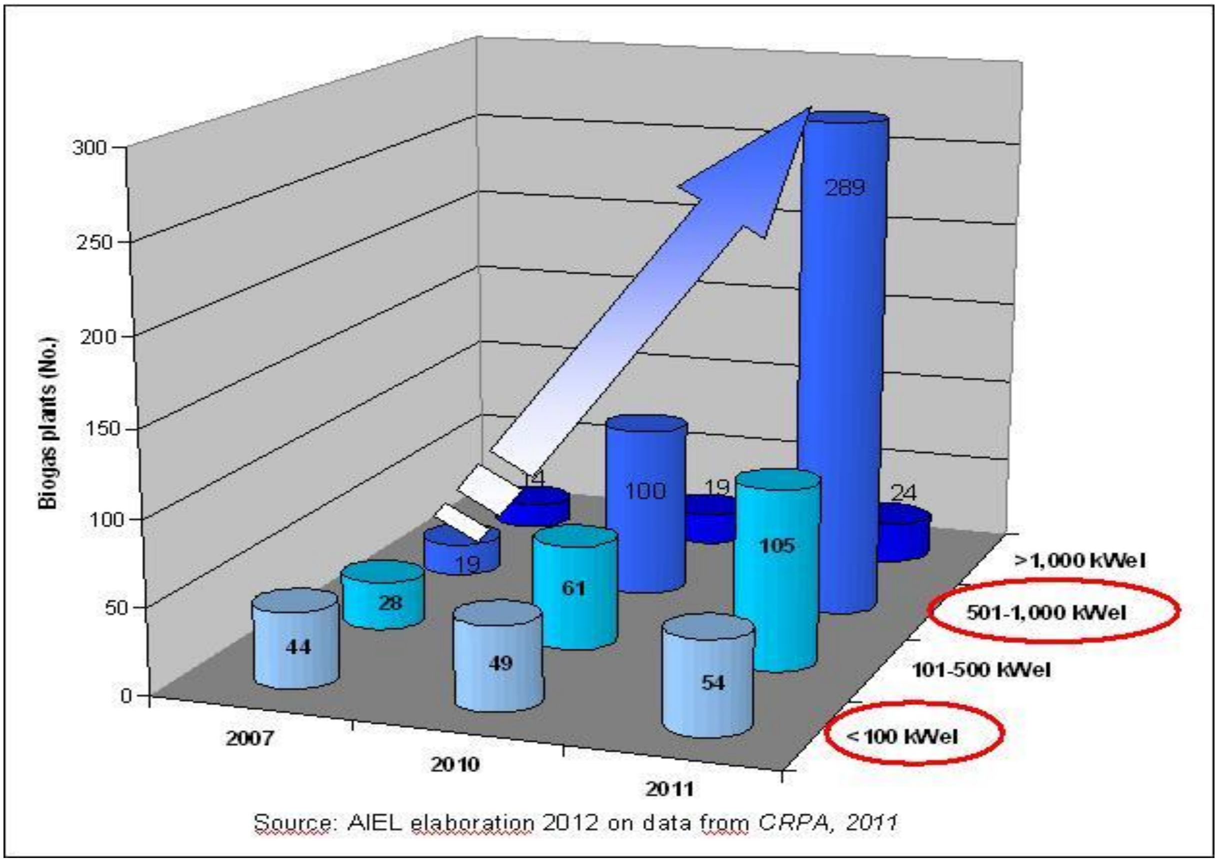
The development of the **agricultural biogas sector** in Italy can be clearly understood in the light of the following two features. Firstly, the legislation on incentives is the economic instrument which acts as the main driving force for this sector. Secondly, Italian agriculture is characterized by wide differences among geographical areas, particularly between the North and the South of the country. Animal husbandry, as well as cereal production, are concentrated in the Po Valley Regions in Northern Italy, i.e. Lombardy, Veneto, Piedmont, Emilia-Romagna and Friuli Venezia Giulia. Thus, biogas has had a first diffusion especially in these Regions at the end of the ’70, mainly due to its role in the reduction of environmental impacts (i.e. odours) caused by animal manures, in particular from pig slurries. A second biogas development phase occurred from 1992 due to the Provision no. 6/1992 enacted by the Interministerial Committee of Prices, which introduced an incentive system based on the so called “*green certificates*”. Such a system had a limited role in the development of the sector because of the low level of incentives. The result has been a limited diffusion of agricultural biogas plants, mostly being characterized by a “*simplified*” technology (air-tight cover over the slurry storage tank) constructed by Italian companies, plug-flow systems, psicrophilic conditions and hence low biogas productivity and small CHP units. These plants have operated mainly on manures, sometimes having small integrations with other by-products (e.g. whey from cheese factories annexes to the pig breeding units)

Diffusion of agricultural biogas plants in Italian Regions on 2007[28]

This situation has radically changed with the introduction of an all-in-one *feed-in-tariff* system (Law no. 99/2009, 23 July 2009) which has established a very high incentive value for electric energy (EE) fed into the EE grid, corresponding to 280 €/MWh. This incentive has a 15-years duration for biogas plants up to 1 MW_{el} in operation from 01.01.2008 and which will come into operation by 31.12.2012. The result has been a wide diffusion of “*industrial*” biogas plants, constructed mostly by South Tyrol subsidiaries of German companies. These plants are characterized by Completely Stirred Tank Reactor (CSTR),

[28] Source: CRPA, 2007

mesophilic conditions, high biogas productivity and large CHP units (typical 0.999 MW_{el}). On 2011, 92% of the installed electric power has been localized in the Po Valley Regions, particularly in farm with enough arable land where cultivating energy crops and spreading the digestate, since the energy produced by these more powerful agricultural biogas plants derives mostly from energy crops (maize silage over all)



Number of agricultural biogas plants from 2007 to 2011 per class of CHP unit size (<100 kWel, 101÷500 kWel, 501÷1,000 kWel, >1,000 kWel

It must be noticed that the sophisticated equipments and technologies adopted in these plants have implied very high investment costs, corresponding to approximately to 4.5÷5.0 M €/MW_{el}. The investment costs probably have increased also as a consequence of the very high incentive value for the electricity produced (incentives as a leverage for extra-profits by the biogas plant construction firms). This kind of development model where the all-in-one *feed-in-tariff* system has played the major role, has had some positive and some negative consequences (pros and *cons*), as it can be summarised in the following

Regarding the development of the biomethane from agricultural sources (BMAgr), there is still a lack in Italian legislation concerning BMAgr production and use (vehicle fuel or gas injection into the gas grid), regarding in particular the incentives for BMAgr, the repartition of costs for BMAgr treatment and injection, the technical rules for BMAgr as a vehicle fuel and for BMAgr injection into the gas grid. Moreover, the high incentive for EE production from biogas (feed-in-tariff = 280 €/MWh lasting for 15 years) has pushed many investor farmers to produce biogas to be used in CHP plants rather than to be upgraded and purified in order to obtain BMAgr. Pending the specific legislation on BMAgr, no upgrading & purification plant is presently in operation in Italy. As concern the national priorities related to the agricultural biogas sector the economic instruments above mentioned, i.e. the previous Law no. 99/2009 and the new Ministerial Decree enacted on the 6th of July 2012, should allow to reach the targets for biogas in EE and heat production which have been set by the National Action Plan for Renewable Energies (PAN, "Piano di azione nazionale per le energie rinnovabili dell'Italia").

Bulgaria

Bulgaria has a large potential for biogas. According to the calculations done in the NLTPPUB 2008-2020, taking into account the waste resources left from the livestock, the energy potential of the biogas might be used for electricity generation of about 470 GWh, which is about 14% out of the total current supply of RES (ME, 2008).

Type of farms	Nr of animals	Average quantity of manure in kg dry matter/day	Average quantity of manure in kg dry matter/year	Energy equivalent biogas/year
Cattle and buffalo	127 205	4,0	92 860	20 000
Pigs	462 070	0,6	101 193	21 800
Poultry	12 000 000	0,03	131 400	28 200
TOTAL			**325 453**	**70 000**

Agricultural waste as a row material for biogas production

The Danish experience, shared in the framework of A4E2 demonstrated the use of agricultural waste for biogas production could be a win-win solution for Bulgarian farmers concerning the implementation of the "Nitrate Directive". Bioenergy currently contributes more than 70 % of total renewable energy production in Denmark. The 21 centralized biogas plants and 60 farm scale biogas plants contribute not only for not only for production of renewable energy, but this is rather a multifunctional technology securing the sustainable development of agriculture, environmental protection and the creation of new jobs in the rural area.(Nielsen,2010)

The necessity of stimulation the small scale enterprises for electricity production, bases on RES as well as the advantages for Bulgarian economy and environment is pointed out. The production of 1 kW electricity in the heat energy plant on coal means: 0,014 kg slag; 0,080 kg ash; 1,00 kg CO_2; 0,014 kg SO_2 while the micro enterprises on RES with capacity of efficiency the green gas emission are 70 -100% lower. (Jeliazkov, 2009)

The high potential for biogas is not utilized, so far in Bulgaria there is not even an installation for production of biogas using the livestock wastes. Without financial incentives it is not economically vital to invest in biogas plants. Contrary to biogas sector, the share of the electricity from solar and wind park marked an intensive growth as a result of high feed – in tariffs and long contracts.

An increased interest towards biogas plants is demonstrated since 2011 when a new Law for stimulation production and use of RES (the transposition of EU Directive 2009/30EC). The preferential feed-in tariff is provided. A co-financing up to 70% for the establishment of biogas plants is available under the rural development plan. Agriculture should not only supply biomass for the energy sector, but must play a greater role in development, operation and ownership of bioenergy plants. To benefit from this opportunity is a real challenge that cattle breeders in Bulgaria are facing, who are obliged to make considerable investments for the implementation of the EU hygiene standards. The recapitalization of the sector and the difficult access to financial instruments are the main problems, indicated by the farmers in the framework of A4E2.

Germany

In the year 2011, about 18 billion kWh of electricity were produced from biogas in Germany, representing approximately 18% of all power produced from renewable energy sources and about 3.5% of the entire power consumption in the country. Also in 2011, the heat energy arising from electricity production amounted to about 18 billion kWh in Germany. Biogas which is processed to methane can be used as a transport fuel, and in 2011, more than 90,000 vehicles were licensed which operate on natural gas in Germany. About 200 of the 1000 natural gas filling stations offer fuel with a biomethane content varying from 5% - 100%. By the end of 2011, about 60 biogas plants were feeding around 205 million standard cubic metres of biomethane into the German natural gas grid. In 2011, there was a saving of about 12 million tonnes of the harmful greenhouse gas CO_2 through the substitution of heat and electricity production from fossil fuels with the use of biogas. A further positive effect is that through the use of slurry and manure for biogas production, methane emissions from slurry storage and spreading are largely avoided. In 2011, the financial turnover in the industry amounted to about 6 billion euros and is an important economic factor in regional value creation. German biogas companies were able to generate 500 million euros turnover (10%) through business in foreign countries in 2011. In 2011, about 40,000 people were employed directly or indirectly in connection with biogas plants – through construction, servicing and operation, maintenance and the cultivation of energy crops.

Biogas in Lower Saxony

With regard to the production of regenerative energies in Lower Saxony, bioenergy supplied the greatest contribution with a share of over 20%. In 2012, there were 1,500 biogas plants with about 700 MW electrical output, which covered about 11% of the demand for electricity in Lower Saxony. In particular, the production of biogas from renewable resources has developed in Lower Saxony within only a few years to become a major economic factor in the state. As with wind and solar energy, biogas has become a key component in the production of regenerative electricity. In the meantime, however, numerous waste heat energy concepts have been put into practice and now supply communities, companies and private households with heat energy. By 2020, it is reckoned that there will be a doubling of the current biogas capacity about over 1.000 MW of electrical output. The energetic output from biogas would therefore increase to about 8 billion kWh. Alongside measures to increase efficient biogas production, the required arable and grassland areas will increase by an estimated 60,000 ha to 300,000 ha and will make up a share of about 10% of the agricultural land in Lower Saxony.

Substrate	CO2 reduction in 1000t	Share of the substrates on greenhouse gas savings	Share of the substrates in a fresh matter	Share of the substrates electricity production
Liquid manure	424	14%	35%	7%
By-products	29	1%	1%	1%
Energy crop	2.062	67%	51%	79%
Bio-waste	376	12%	7%	4%
Solid manure	207	7%	6%	9%
	3.097	**100%**	**100%**	**100%**

The increase in the cultivation of biomass correlates with the output of biogas plants in the regions. There are therefore clear regional differences in Lower Saxony. The land requirement for the supply of raw material to a biogas plant, operating on renewable resources and with an output of 500 kWel amounts to 150 to 230 ha, according to the potential yield.

With an average land requirement of 0.36 to 0.4 ha per kWh, about 10% of arable land or 8% of all agricultural land is needed to supply the basic substrate, averaged across the state. A large proportion of the biogas plants use slurry as well as energy crops and this reduces the land requirement. At present, maize and cereals are the most efficient crops used in biogas production. Because of the high yields and financial attractiveness, energy maize as the main crop for biogas production had a share of about 25% of all maize cultivation in Lower Saxony in 2009. By 2010, the cultivation of energy maize had increased to about 35% of the whole maize-growing area in the state, with clear regional differences at administrative district level.

In areas with high biogas plant numbers and livestock densities, for example in the Weser-Ems region, the increasing cultivation of maize for biogas production and the necessary processing work has meant that in some communities, over 50% of the arable land is planted with maize. This has led to a change in the agricultural landscape and species diversity. It is particularly in these regions that energy crop cultivation should be carried out with targeted measures to expand crop rotation methods and improve the habitat conditions for game animals, flora and fauna. Such measures include the laying of flowering plant strips along maize field edges, undersown crops, mixed crops to avoid large mono-cultures and the increased use of alternative cultures in crop rotation systems.

Large fluctuations in the market price of agricultural raw materials has led to heated discussions over the use of agricultural produce to supply the 'plate or the tank'. Particularly in times of high prices, bioenergy has been given the blame as the main reason for price of foods increasing. The current fall in the prices of agricultural raw materials and the fact that worldwide only about 3 – 5% of the raw materials are used in bioenergy production has quite clearly defused these claims. In regions with a high livestock density and lots of biogas plants, the increased demand for land can influence the leasing prices regionally. The places most affected are in the meat production regions in which the leasing price is already above the average level. In other regions, the leasing price has remained clearly lower despite a relatively high number of biogas plants and a high share of energy crop cultivation.

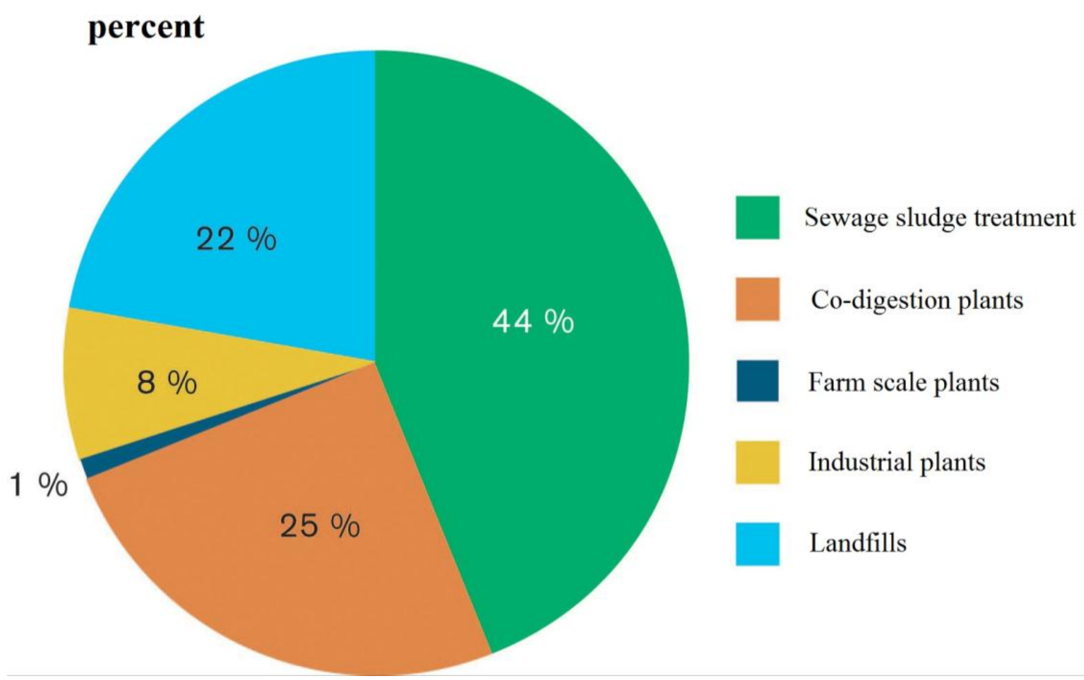
Next to the optimisation of energy crop cultivation, a further important factor is the increase in efficiency of biogas production and the better utilisation of the output. For a number of biogas plants, there are waste heat concepts in practice to improve the efficiency of the plants and therefore to achieve a more productive and profitable operation. These concepts include supplying communal buildings, industrial and commercial centres with heat and the provision of processing heat for agricultural drying operations. Through the inclusion of biogas in the energy concepts, numerous new 'energy communities' have arisen in Lower Saxony. The aim of these communities is to source a high proportion of their heat and power requirements from decentralised and regenerative energy providers. The energy concepts involving decentralised supply require the building of special biogas pipework and the construction of individual cogeneration plants in the vicinity of the customers and may include the supply of entire district networks with biogas waste heat.

A further development in the industry is the processing of biogas to achieve natural gas quality. Preconditions for the setting up of processing facilities include sufficient pipe pressure, a satisfactory feed-in efficiency and appropriate load conditions in the natural gas network. Because the gas supply network in Lower Saxony is well developed and with an average distance to the feed-in stations of about 20 km, there are good access conditions, for example in static cogeneration plants, in filling stations as transport fuels and as 'bio natural gas' for gas-fired heating installations.

The advantages over the direct use of gas close to a biogas plant are a result of the temporal and spatial separation of production and consumption. In the meantime, a total of 10 biogas plants in Lower Saxony have the necessary technology or are planning to install it. There is also a number of projects under way to bundle smaller plants and connect them to shared processing installations. Each year, the biogas plants in Lower Saxony save about 3,5 million tonnes of CO2 and in this way make an important contribution to climate protection (see the table above). Across the flat Lower Saxony landscape with its highly productive agricultural industry, the biogas technology is of major importance. In comparison to the use of fossil fuels or liquid biofuels such as biodiesel, bioethanol or BtL fuel, the local and regional value creation for biogas use is very high. When one considers the various financial streams arising from the construction and operation of a biogas plant, it can be seen that the major part of this remains in the rural area. Just the so-called "maize problem" and the production of "new" energy crops, the development of local heat networks and the upgrading of biogas were the key points that 3N and the A4E co-ordinators in the project increasingly employed.

Sweden

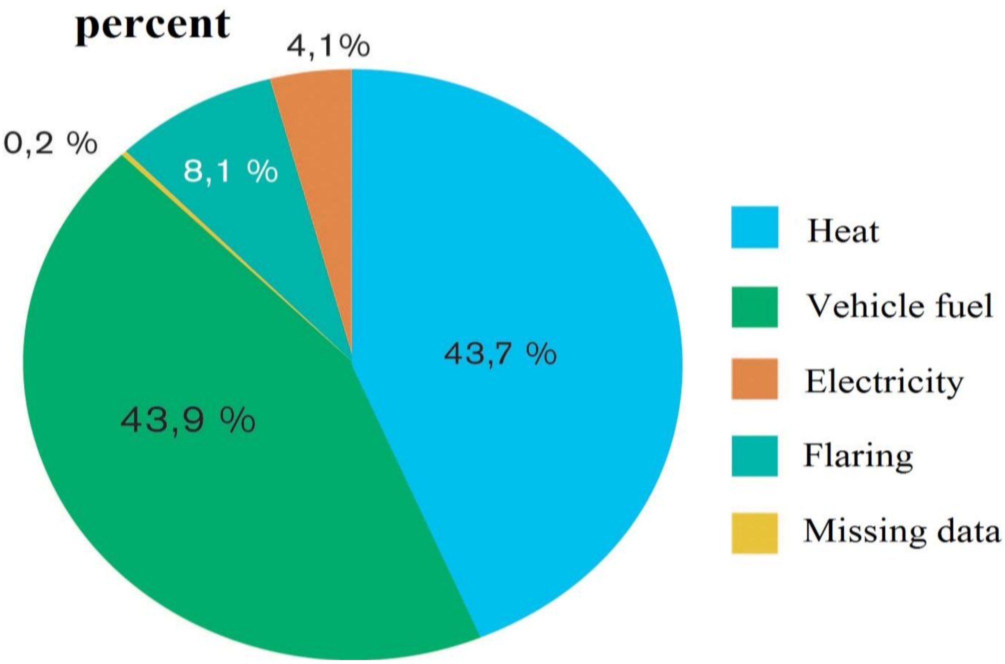
Sweden today has come a long way concerning biogas use and is a forerunner concerning cleaning of biogas to vehicle gas quality. The investment in biogas plants has been going on for several years, but still, in several regions, demand for biogas is larger than supply.



Production of Biogas in Sweden

About 1 387 GWh biogas was produced in Sweden in 2010. The biggest share came from sewage water treatment plants. Approximately 44% or 610 GWh biogas was produced in sewage water treatment plants, circa 22% or 298 GWh was produced from landfills, 25% or 344 GWh in co-digestion plants and 8% or 114 GWh was produced in industrial plants. Small scale biogas production (farm scale) stands for about 1% or 16 GWh of the total biogas production in Sweden.

The production of biogas has increased by 24 GWh in 2010. Growth can be seen for all kinds of plants, but above all for co-digestion plants and industrial plants, where three and one plants respectively have been taken into use. Reduced production output from landfills is expected in the future, due to the prohibition to deposit organic waste since 2005. At the same time an increase is predicted for co-digestion plants, industrial plants and farm scale biogas plants. Today there are about 20 biogas plants in the southeast of Sweden (counties of Kalmar, Kronoberg and Blekinge). Currently, mainly waste and sewage is digested in biogas plants in this region. In the counties of Kalmar and Kronoberg there are upgrading plants (small scale).



Use of Biogas in Sweden

The biogas produced in Sweden today is mainly used for heat production. The heat is delivered to customers or used by the producer for heating of their own premises or as process heat. Of the biogas produced 2008, 53% or 720 GWh was used for heating purposes, 4% or 59 GWh for electricity production, 26% or 355 GWh was upgraded to vehicle gas, 14% or 195 GWh was burnt off, and for 2% or 30 GWh the use is unknown. Vehicle gas increased by 7% compared to 2006, which was the largest increase among the sectors of use. The total volume of upgraded biogas injected into the natural gas grid was 133 GWh. Injection into the natural gas grid takes place at Laholm, Falkenberg, Helsingborg, Malmö, Bjuv and Göteborg. Also in the southeast region the main part of the biogas produced was used for heat production.

Biogas can play an important role to decrease the impact of transports on climate and create more jobs locally and regionally. Swedish Energy Agency after consultation with Swedish Board of Agriculture and Swedish Environmental Protection Agency will develop a long-term strategy covering all sectors and suggest measures which both in the short term and in the long term contribute to increased biogas use.
The suggestions for measures together will constitute a common platform for the future development concerning production, distribution and use of biogas in Sweden. The strategy and the common priorities should particularly consider cost efficiency and energy efficiency, the transport sector's dependency on

fossil fuels, the environmental goals, the development of relevant initiatives within the EU and internationally and the Swedish industry's competitive force.

Different reports show there is a potential for as much as a ten times higher production, or about 14 TWh per year in Sweden. In this potential is assumed for example that about 10% of the agricultural area is used for growing crops for digestion. If also the possibility to produce methane from cellulose rich wood materials, so called biomethane, is considered the potential for production of methane from domestic raw materials will be nearly 100 TWh.

Biogas plant in Kalmar

In the Southeast of Sweden there is one project that is waiting for the final financing to be realized. The biogas plant that is to be developed by a group of farmers in the county of Kalmar is planned to have a capacity of about 20GWh of upgraded biogas (methane). Another project in the county of Kronoberg is also planning a similar project with a capacity of 9 GWh of biomethane. This project is also waiting to solve the financing issue, and as soon as this is solved, the project will be started. The most important issue for an increase of small biogas plants is the ongoing discussion about financial support. This have been discussed for several years and is still not solved, although a few new interesting suggestions have come up lately, that can, if accepted by the government, boost the production of biogas on the farmscale level significantly.

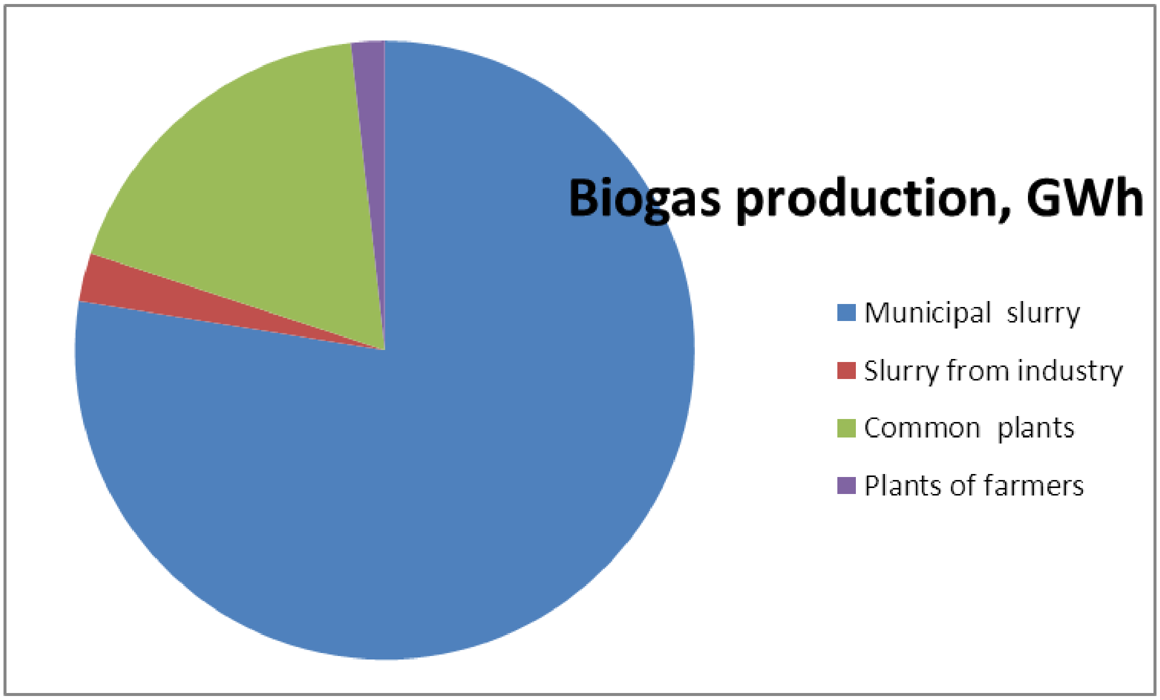
Food production versus energy production

In the potential mentioned for future Swedish biogas production is included, besides biogas from organic waste, also digestion of various crops. If land today lying fallow (10–15% of cultivated area) is used for energy production there will be no direct competition with food production. Also rest products from food production can be used for biogas production. A possible situation of competition might come up if this area should be used for production of some other energy source. Sweden today has come a long way concerning biogas use and is a forerunner concerning cleaning of biogas to vehicle gas quality. The investment in biogas plants has been going on for several years, but still, in several regions, demand for biogas is larger than supply.

Finland

The area of Central and Western Finland was chosen for the action area in the beginning of the project. A general description of the region can be found under 3.1.7. In Central Finland there are plenty of forests, lakes, bogs, and small scattered farms. Therefore it is difficult to create large biogas plants corresponding to national feed-in tariffs. In Southern Finland there are more fields and community waste, and therefore more raw materials resources for a biogas plant. On the other one hand, there are fewer cattle. The Finnish biogas production by different production plants is presented in figure 1. Biogas from landfills is excluded, however. In 2010 production of thermal, electrical and mechanical energy amounted to 180 GWh. There was a fair increase in the total amount of biogas and generated energy compared to the previous year (Huttunen & Kuittinen 2010).

A reasonably large biogas plant was constructed in Kouvola with contribution of Gasum Oy during the project period. Other supported large private biogas plants in Southern Finland include Envor Oy and VamBio Oy, which was described in the case studies. Two large companies, Gasum Oy and Taalerintehdas Oy, started looking for funding in 2011 for the construction of larger biogas plants. The number of this kind of large projects will grow in the future.



Finnish biogas production is dominated by municipal plants

In practice, small farm scale plants were not constructed during the Agriforenergy2 project period. The total number of small farm scale biogas plants is less than 20 plants in Finland. One reason for this is a long waiting for determining the feed-in the tariff and the disappointment caused by the level and conditions of the new tariff. On the other hand, the government is interested in supporting investments in biogas plants, and subsidies are granted for these investment. Much information has been disseminated and good contacts with main actors and even with the ministry of Ministry of Agriculture and Forestry have been established. Stakeholders from industry and from the ministry always participated in the workshops and study tours. However, only a few plans for building new plants were made. At the moment, one plant is being constructed in Joutsa, the Southern part of Central Finland. The basic idea is to produce methane for vehicle fuel. The plant should start in 2013.

In the workshops many farmers and local authorities obtained information on biogas and biomethane. It is likely that new plants will be constructed in the near future. In practice the public has a very good view of biogas because waste materials are turned to electricity, heat, vehicle fuel and soil improvement materials in the process. There is also a lot of idle land and plenty of resources for food production, and therefore biogas production is not considered to risk self-sufficiency of domestic food.

Layout of the biogas plant of Joutsa[29]

National conditions and priorities

Finnish authorities would like to see more biogas plants in Finland. Subsidies are available for investments and there is a tariff for electricity and heat generate with biogas. The tariff requirement of electricity production, 100 kVA, is usually too high for a farm. Farmers are afraid of high costs and long pay back times. It usually takes many years before the biogas plant becomes profitable. Many farmers are already in debts because of other farm investments. The investment subsidy from the Ministry of Employment and the Economy (TEM) has been more popular than the tariff for biogas construction. This subsidy is normally 20 - 30% of the total investment. In Finland there are several possibilities to build a biogas plant and make it economically profitable as shown in figure 3. The image was created on the basis of the results of a report of Kalmari & Luostarinen 2007. Example table for the calculation of figure 3 is shown in the table 1. The profitability of a farm-scale biogas plant without gate charge for waste materials is low. Investment subsidies do not significantly improve the profitability due to the high operating costs. The feed-in tariff does not improve the economy sufficiently either. Production of bio-methane for transportation purposes is not a profitable alternative due to high investment costs and relatively low production.

[29] Source: Erkki Kalmari, Metener Oy

The profitability will be improved if some amount of gate-charged food waste is included in the raw material feed. Taking waste materials in the feedstock of a biogas plant increases profitability but it does not make the market price electricity and heat production profitable alone. The feed-in tariff is still needed. Biomethane production for transport fuel is profitable with a number of raw material feed combinations, even without subsidies. Calculations based on assumptions that the number of users of the fuel is about 80 - 100 cars and a normal driving distance of a car is about 20 000 km/year show that upgrading of biogas to fuel is profitable in several options of figure 3 (cases with a light green color).

If the price of biogas is equivalent to the price of natural gas or liquefied petroleum gas, the supply of biogas to customers using biogas fuel is profitable. Biogas cannot compete with solid biomass in mere heat production.

Why small biogas plants are missing?

- The demand of tariff of 100 kVA electricity is usually too large for one farmer.
- On the other hand a large plant is cheaper to build and it is more effective.
- The co-operation of several farms is hampered by long transport distances, at least in Central and Northern Finland. At biogas plant in Juva there is ten suppliers of raw materials. The suppliers are mainly located in a radius of ten kilometers from the plant.
- Farmers often have loans to pay back or/and their income is low. A 0.5 - 1.5 million euro biogas plant is a very expensive investment.
- Prior to the construction of a biogas plant there is a great deal of paperwork to do in which a professional could assist.
- For maximum profitability revenues from electricity, heat and gate fees should be gained. It is not, however, always easy to find a customer for all of them.

A4E2 had an important role and also good impact on biogas promotion in Finland even though the number of constructed biogas plants was small. Workshops were important for spreading practical know-how of biogas. Articles of biogas and methane in newspapers provided information for a larger audience. At the moment there is a growing interest to upgrade biogas to fuel for cars, figure 4. A plant for biomethane production has already been constructed in Joutseno and farm scale experiments have been carried out also in Haapajärvi and Nivala in existing biogas plants.

Biomethane for a car Source: YLE Keski-Suomi

In Finland farmers are interested in biogas plants and have a positive view of the production method. Because plants are very expensive, only a few biogas plants operated by farmers are built annually. Just recently Metaenergia Oy in Northern Central Finland has developed a module-based biogas plant in order to decrease investment costs of a biogas plant. Marketing of this new system is just starting.

5 "WSO Working model" of A4E2

Each of the 3 main WPs of A4E2 presents a similar approach based on three sequential steps, and designated as **"WSO key market start up actions"**, WSO standing for Workshop, Study tours and One-to-One meetings:

1. The first step consists in workshops where e.g. local farmers/forest owners and potential costumers/investors (hotels owners, building planners, small industry, other farmers etc.) can meet.

2. The second step is the organization of study tours (mainly locally) showing to potential customers/investors some best practice examples in the region (i.e. woodchips contracting plant, decentralised oil mills, biogas/biomethane plants).

3. The third step is the organization of one-to-one meetings between bioenergy suppliers and potential costumer/investors to further discuss business cases. Participants to these meetings are expected to be the committed and interested actors identified in the workshops and study tours. Project partners will support these business matchmaking meetings by preparing simplified technical-economical pre-feasibility study (3-5 pages), thus providing technical support and acting as a catalyst to encourage promising businesses.

To sum-up, workshops will allowed supply and demand side to meet, study tours increased actors' confidence by visiting real, working bioenergy installations, while one-to-one meetings between committed bioenergy suppliers and interested potential end-users allowed pushing forward the most promising business cases.

Partners have choosen different approaches to implement the WSO model in their partner regions. The table below illustrates the very efficient and sophisticated approach of AIEL the Italian project partners.

Actions	Target groups	Instruments
I Analyse technically and economically single solid biomass plants	Potential investors	One-to-one meeting Pre-feasability studies Study tours
II Choose single solid biomass plants as best practice case studies, analyse technically and economically these plants	Potential investors Solid biomass plant owners/ managers Policy makers	Advisory folders Workshops Study Tours
III Analyze technically and economically general market trends (including new technologies, equipments and managements)	Potential investors Solid biomass plant owners/managers Policy makers	Workshops Study tours One-to-one meeting

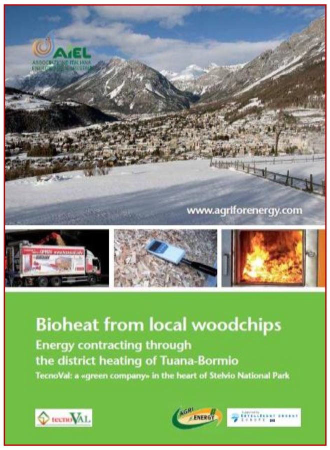
Impacts and Results per action:

I Rationalization of the solid biomass plant from an energetic and environmental point of view: stimulating a rational use of biomasses (short supply chain, valorising the local productions), re-orienting the plant size towards a plant tailored to the farm/firm size and needs, adopting the best available techniques (technologies and management strategies) for heat and EE production from solid biomass

II Rationalization of the solid biomass plant from an energetic and environmental point of view, spreading the knowledge of advantages from the solid biomass plants among all the parties involved, improving the social acceptability of energy produced by solid biomass plants

III Rationalization of the solid biomass plant from an energetic and environmental point of view: adopting the best available techniques (technologies and management strategies) for energy produced by solid biomass plants

When an idea starts to grow



Advisory folder

Workshop

Feasibility study

Study tour

One to one meeting

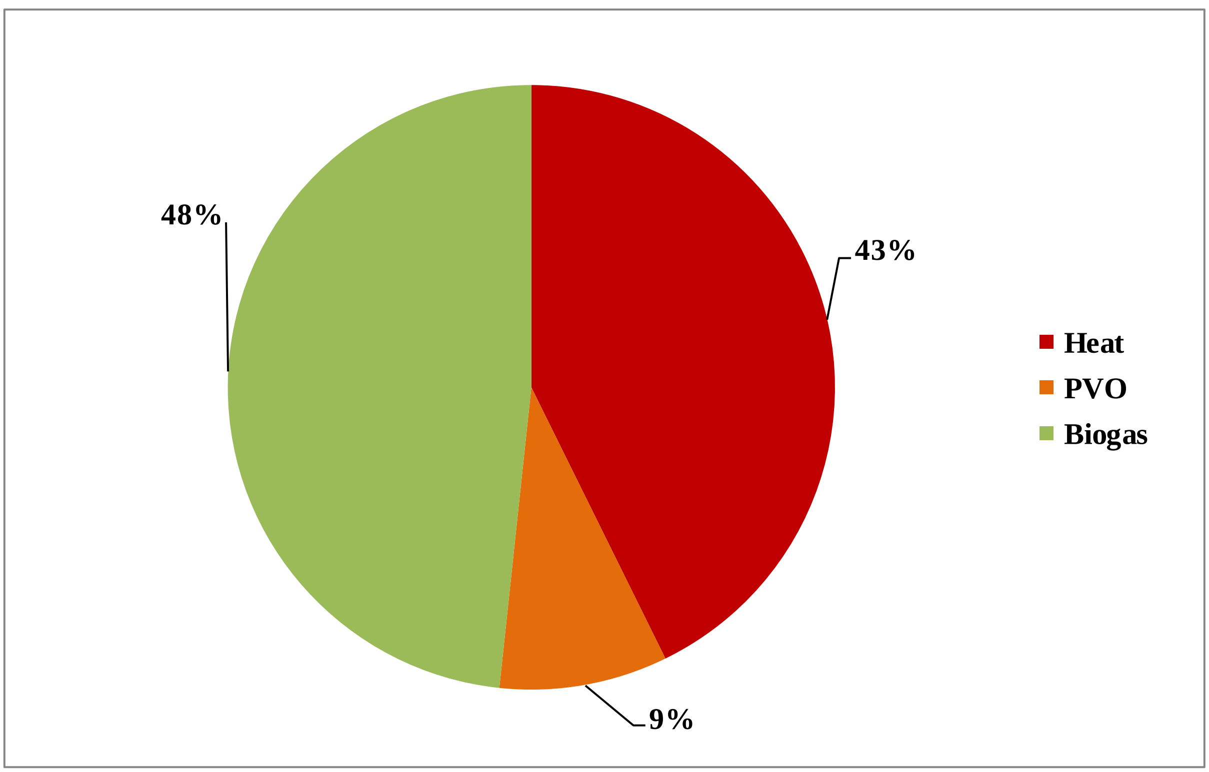
biomass plant

WSO implementation in practical

As described even in the separate WSO monitoring files the WSO model can´t be implemented always step by step, as scheduled in theory, to reality. Advisers, partners and coordinators are facing potential investors on different levels of their project realization. Sometimes only a short technical advise is needed and WSO model starts with a study tour or a short OTO meeting. A technic-economic feasibility study is not required at this stage. However the support is highly appreciated by the potential investors. Sometimes the project starts with an OTO meeting about legal framework and subsidies. Within a Workshop potential investors and customers from more regions are informed about potential next steps. A study tour is very useful but not always appreciated by the investors. However the WSO model stands for a support of potential investments with advisory folders delivered by regional bioenergy coordinators acting very often as shoehorn for Workshops, Study tours, One to One meetings and hopefully results in a final expertise through techno-economic feasibility studies and/or concrete project management.

Partner	Country	WS done	ST done	OTO done	people reached
Lk	Austria	25	9	42	939
SFI	Slovenia	9	9	26	722
AIEL	Italy	31	23	49	3150
CBA	Bulgaria	11	4	24	651
3N	Germany	27	14	43	3782
ESS	Sweden	19	12	30	1619
VTT	Finland	12	13	26	762
Total		**134**	**84**	**240**	**11625**

WSO events organized and number of participants



Share of participants per sector at WSO events

Impressions from Workshops:

Impressions from Study tours:

6 PVO Handbook

Frontpage and reverse of A4E2 PVO handbook available on www.agriforenergy.com

Many authors provided articles to different topics (mainly technical, economical and fiscal aspects). It has been also performed a survey by the main EU Associations and PPO groups of interest which are involved in the pure plant oil sector in order to better know the state of the art in their respective countries concerning the real PPO situation in the transport sector under authoritative and fiscal conditions. All texts collected have been translated and adapted into English. We also inserted the recently developed biofuels legislation regarding e.g. the new certification process schemes and sustainability criteria which in some EU countries are also in force. 500 copies of the booklet were printed in English language. Often it has been pointed out that we have given for the first time a detailed European overview about the use of PVO. Beside the technical data, especially the comparison of legal and fiscal aspects in different countries was appreciated. The PVO handbook is available in 7 languages:

Slovenian, German, Italian, Swedish, Finnish, Bulgarian and English

Italian PVO handbook was illustrated as special issue of the periodical AIEL agriforenergy review

7 New project advisory folders

67 national advisory folders - representing good practice examples from seven EU countries - were prepared and mainly already disseminated to our target groups. Additionally three international advisory folders with English versions of all gathered national best practice examples were prepared for dissemination on EU level and beyond participating countries. Advisory folders cover a wide range of different biomass projects and represent a large pool of knowledge that can be used by potential biomass users and investors.

Advisory folders are providing to potential investors a first idea about the technical equipment, feasibility, raw material supply and legal aspects of a potential biomass plant. Based on this info the potential investors can go further in developing the project idea or in gathering additional information. The presented national best practice examples can be visited by potential plant operators in order to exchange know how and benefit from existing know how and expert knowledge. Biomass projects in RES advanced countries are acting very often as lighthouses. Therefore some partners illustrated projects from other countries and adopted them for the special national conditions.

Advisory folders can be ordered or downloaded via www.agriforenergy.com in national or international version. E.g. the national Austrian new project advisory folder consists of three best practice examples on Heat, three best practice examples on PVO and three best practice examples on Biogas in German language.

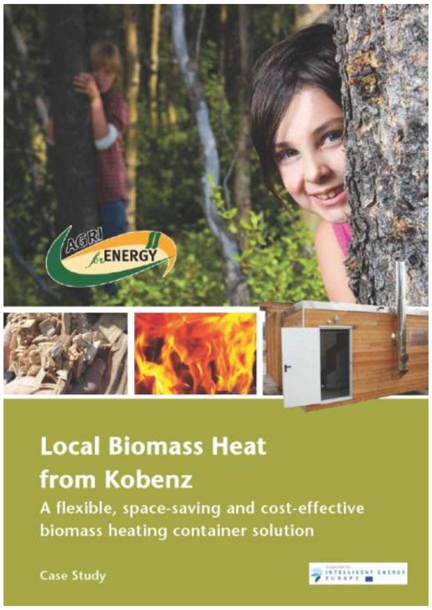
On the other hand e.g. the international advisory folder for heat consists **of > 20 best practice biomass heat examples**, successful implemented within Agri for Energy 2.

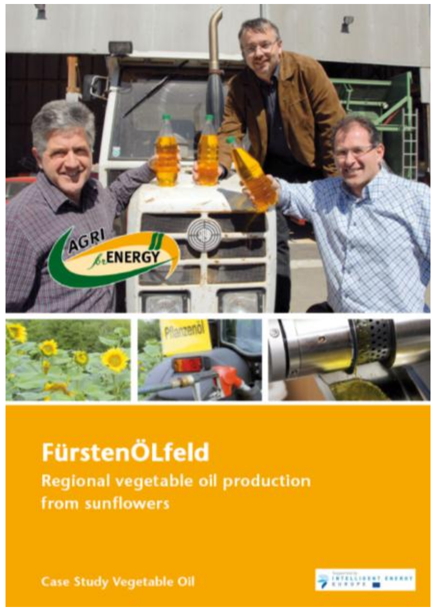
	Austria	Slovenia	Italy	Bulgaria	Germany	Sweden	Finland	Total
Heat	3	4	4	5	3	4	4	27
PVO	3	3	3	1	1	2	2	15
BG/BM	3	3	4	4	6	2	3	25
Total	**9**	**10**	**11**	**8**	**10**	**8**	**9**	**67**

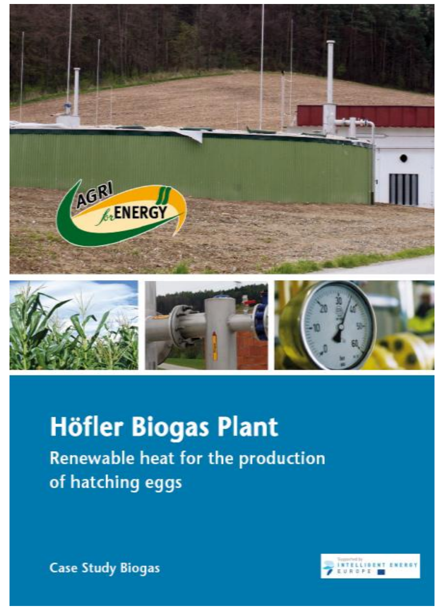
National Advisory folders prepared by the A4E2 consortium

Hereafter we are presenting a selection of advisory folders from all sectors and partners:

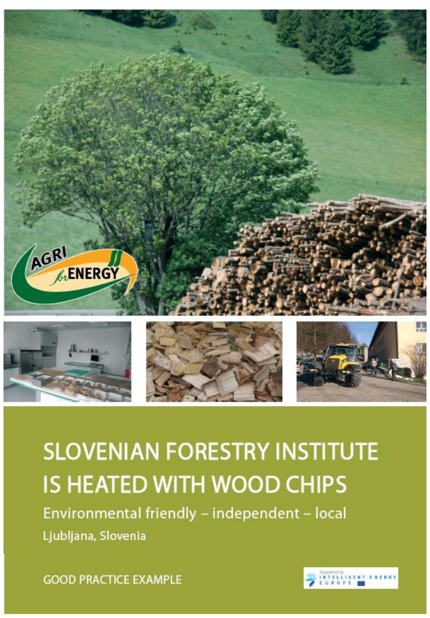
Austria

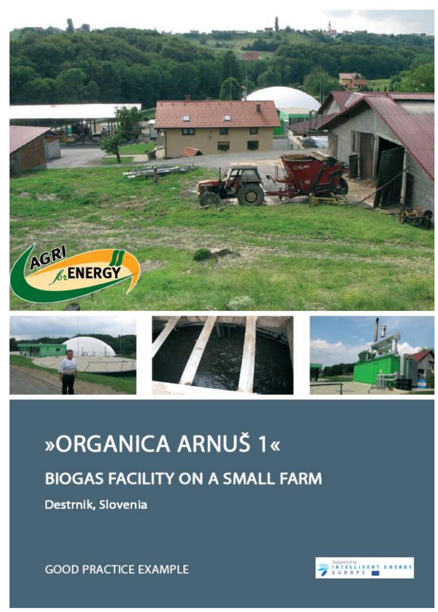




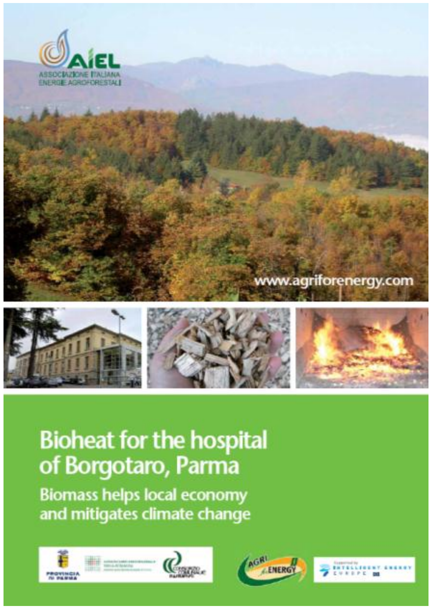


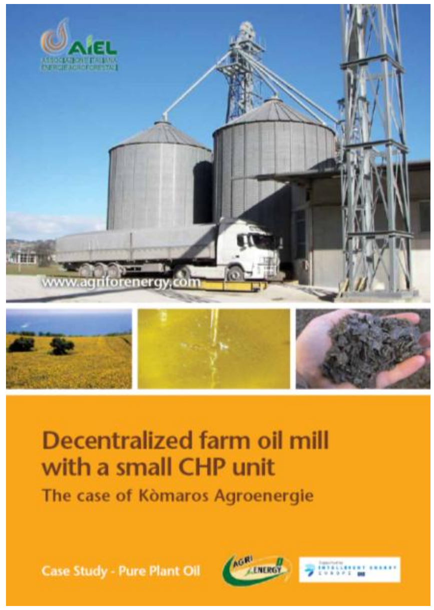
Slovenia

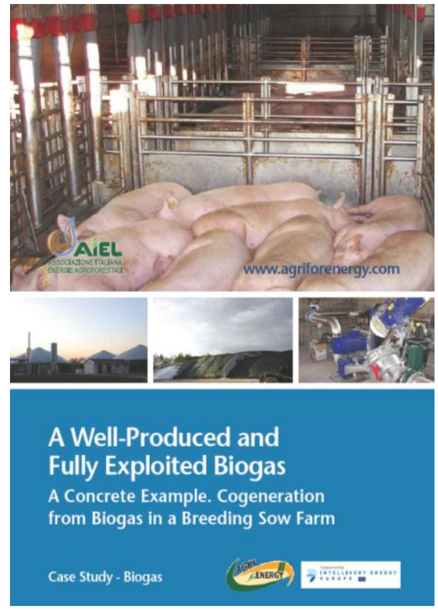




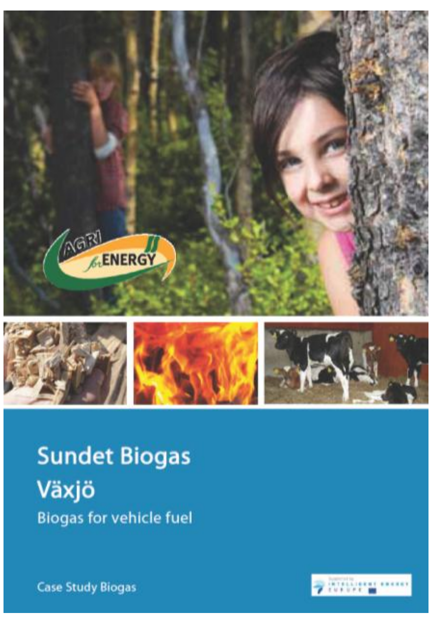
Italy

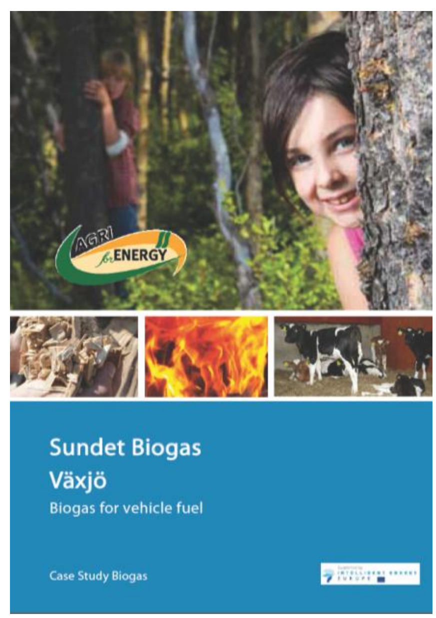






Sweden





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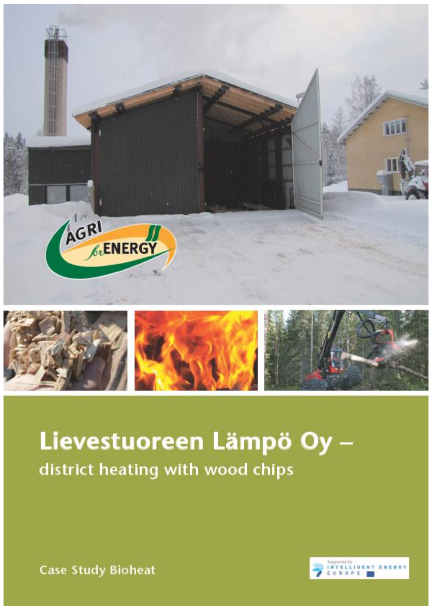

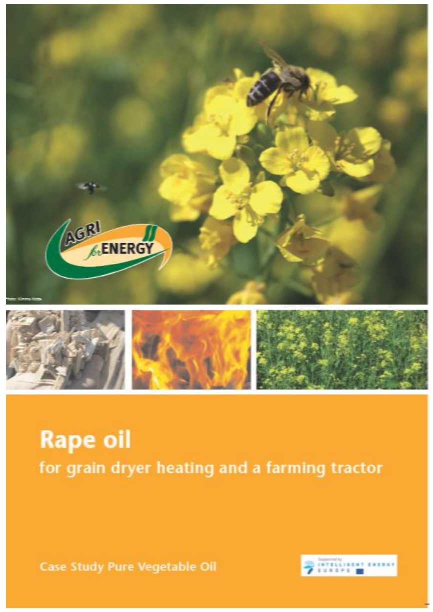

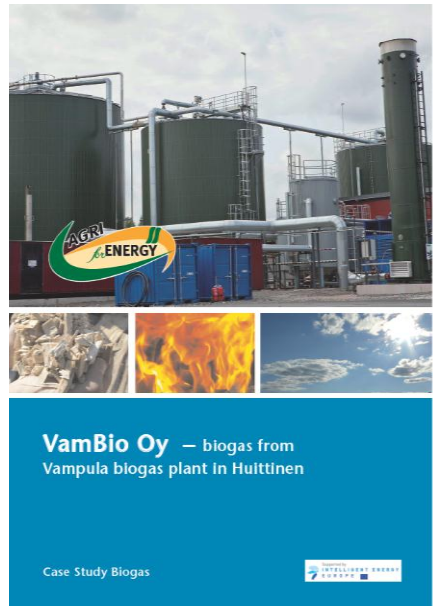

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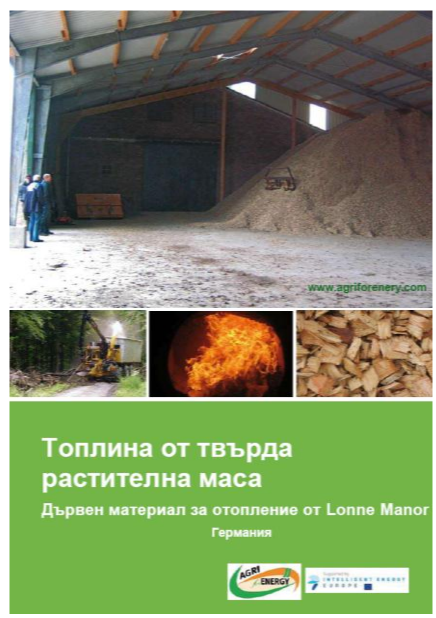

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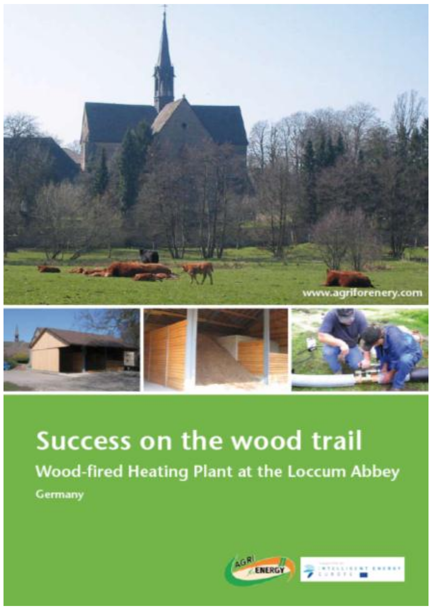

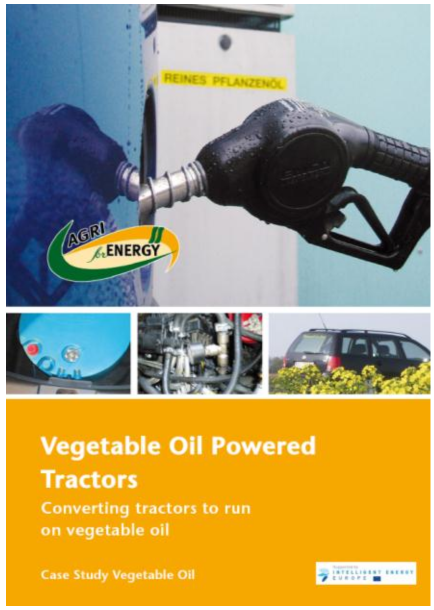

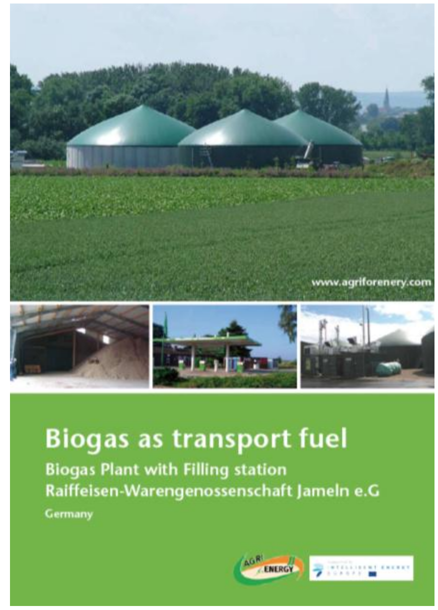

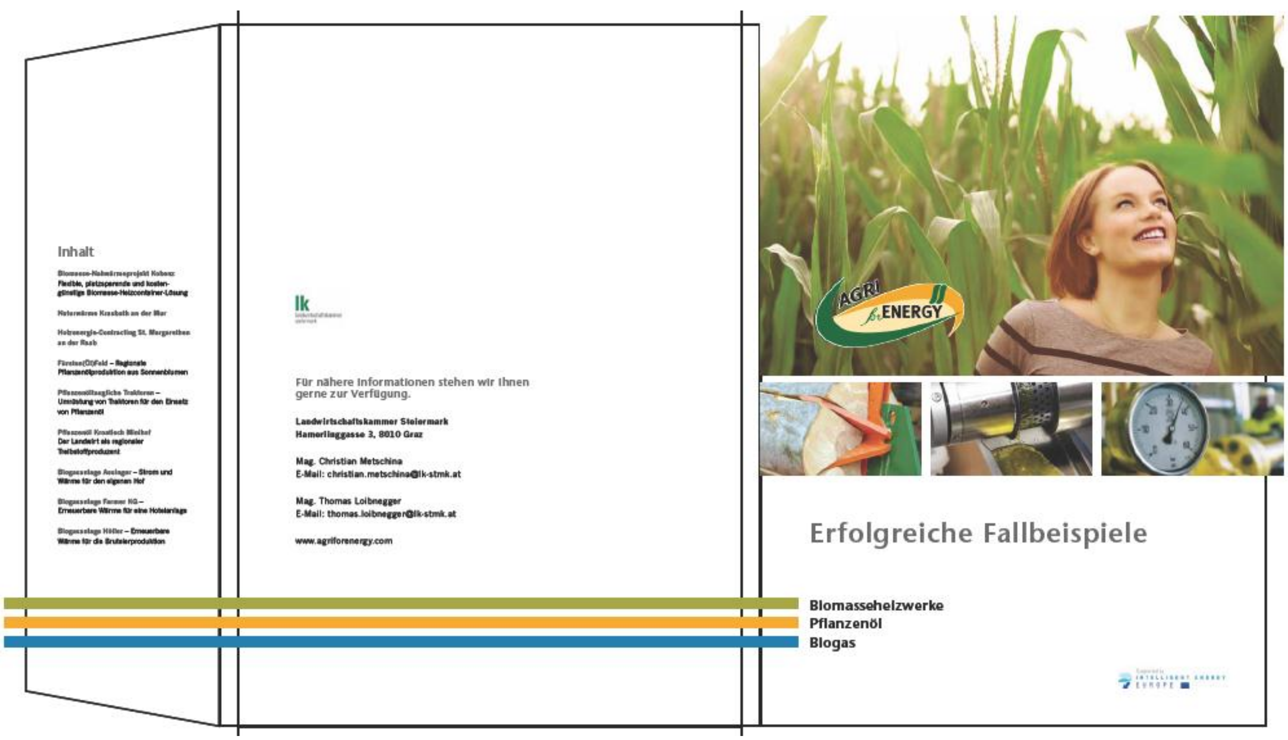

Folders are available in an envelope and can be ordered on www.agriforenergy.com

8 Regional Bioenergy Coordinators

Within A4E2 project running time 25 regional bioenergy coordinators were active and anchored in the seven pilot regions. They provided information to potential investors in the sectors HEAT, PVO and BG/BM where a significant lack of information and knowledge occurred. The number of active coordinators per country is listed below.

Coordinators	Austria	Slovenia	Italy	Bulgaria	Germany	Sweden	Finland
Active in the region	5	3	3	3	3	4	4

Regional bioenergy coordinators

In a first step partners selected synergies with existing services in the region to avoid competition with already established energy services. Based on this outcome the consortium selected target areas in which the regional bioenergy coordinators were active. Building on the experience of the predecessor project Agri for Energy Italian, Slovenian and Austrian partners advised the other partners in the consortium about the experience and lessons learned with regional bioenergy coordinators. The support was given within the first and second project meeting but also via e-mail and phone. Lk-Stmk as WP leader provided a training schedule for the selected regional bioenergy coordinators as it is in use in Austria. Partners used this training schedule and adopted it to their specific needs.

The situation variegates in the partner countries. Some partners already extended the collaboration with the regional bioenergy coordinators beyond the end of the official project running time. In other countries like in Central and Western Finland or Sweden regional networks of experts advising biomass projects has been developing over many years it is likely that stakeholders already know whom to contact in their region. It was a natural choice e.g. for Scandinavian partners to involve these already known coordinators to collaborate with A4E2. People already trust them and they already have such a good network of important contacts for further help. The success in regional wood heat promotion in Finland has shown how crucial it is to have continuity in promotional activity. As the results of our project indicate, A4E2 supported this continuity in a great way. In Germany even the national television broadcasted a report with a regional bioenergy coordinator of 3N LWK. http://www.ndr.de/fernsehen/sendungen/hallo_niedersachsen/media/hallonds10823.html.

Impressions of regional bioenergy coordinators activities in the regions:


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Intelligent Energy Europe

9 Concrete projects realised and selected success stories from partners

New Biomass Heat plants						
	planned	realised	MWth planned	MWth realised	MWh/y	CO2 savings in t: (356 kgCO2 eq/MWh)
Lk	10	13	-	12,34	29005	9455
SFI	8	3	-	5,29	10060	3581
AIEL	10	17	-	9,58	43969	15653
CBAO	5	4	-	1,91	3052	1087
3N	6	3	-	0,5	750	267
ESS	5	1	-	2	7500	2670
VTT	6	12	-	7,17	23745	8453
Total	**50**	**52**	**16**	**24,45**	**108136**	**38496**

Representative for the whole consortium we are presenting here three success stories from our mains sectors HEAT / PVO / BIOGAS&BIOMETHANE. More best practice examples are presented in our advisory folders and are available as free download on www.agriforenergy.com.

Heat: Tommi Mäkinen racing Oy (Finland)

Tommi Mäkinen Racing Oy Ltd was established by Tommi Mäkinen in 2004 after a highly successful World Rally Championship career. After spending the last two years of his career with the Subaru World Rally Team a move to become a partner of Subaru Technical International (STI) for the development and building of Subaru Group N cars was a natural progression. The company was started in the small but practical workshops just outside of Puuppola near Jyväskylä, the well-known home of the WRC Rally Finland. With numerous rally victories in Finland and around the world, the company quickly began to expand and today employs more than ten people. The aim of the company is to continue to produce the best Group N and R4 car options available and to provide its current and future clients with unrivalled levels of service and support. (http://www.tommimakinen.net/company.htm)

Heating plant of Tommi Mäkinen Racing Oy

At first the regional bioenergy coordinator was a real asset when first contacts were made with different equipment manufacturers and system designers. Later on, A4E2 provided regular help for calling for and evaluating tenders when the system was being purchased, and later gave some technical advice with

When Mr. Mäkinen built his new car workshop in 2009, he had to decide how to heat this large building with 11,000 m3 of space. As a farm and woodland owner it was natural to him to consider wood heating options. Having contacted some wood energy specialists including Agriforenergy2 (A4E2), it became obvious that heating with wood chips would be the best solution for him. A wood heating system was installed in 2010. Regard to the system. A feasibility study was also provided when Mr. Mäkinen decided to offer heat to a nearby school and day care. A4E2 also helped to determine a competitive price for heat to be offered to a nearby school and day care. Many one-to-one meetings took place in 2009 and 2010, mostly by phone. Mr. Mäkinen also took part of an A4E2 study tour in Central Finland. This is a prime example of a successful project where a network of experts included in A4E2 was effectively involved to give confidence and provide practical support for an entrepreneur who did not have previous experience of such business. Good examples, reliable system manufacturers and professional help were the means to help the entrepreneur move on quickly and decisively. The heat plant has proved to work faultlessly and therefore Mr. Mäkinen gained enough confidence to offer heat to a nearby school and day care. A separate heating company has already been established for such heating business.

New PVO plants (CHP, PVO)						
	planned	realised	MWel realised	MWth realised	Produced oil [t/year]	CO2 savings in t: (198 kgCO2 eq/Mwhe)
Lk	2	-	-	-	-	-
SFI	2	1	-	-	105	58
AIEL	3	7	9,89	5	9000	3069
CBAO	1	1	-	-	3000	-
3N	2	-	-	-	-	-
ESS	2	-	-	-	-	-
VTT	1	-	-	-	-	-
Total	13	**9**	**9,89**	**5**	**12105**	**3127**

Pure Vegetable Oil: Kòmaros Agroenergie Srl (Italy)

The company «Kòmaros Agroenergie» (www.komarosagroenergie.it) is located in Osimo (Ancona, Italy) and started its activities in February 2007, as initiative of a group of farmers and entrepreneurs active in the local agriculture sector with the aim of producing renewable energy from agricultural products using the local expertise and entrepreneurial skills. The company is owned for about a third by a farming cooperative of about hundred farmers and two thirds belongs to technicians and single farmers. The company's core business is the combined production of electricity and heat from agricultural biomass, and was created primarily to give an answer to the difficulties of local agriculture – like the sugar beet sector's crisis - trying to give farmers new business opportunities inspired by good agricultural practice (e.g. crop rotation, minimal tillage). The agricultural energies chains are considered by Kòmaros as a new development model that can offer real solutions to the local socio-economic and employment issues, relying on the activities of production of renewable energy from agriculture as a response to the need to replace the fossil energy sources and keeping the added value of their replacement into the local economy. In 2008 Kòmaros has carried out a decentralised oil mill feed with sunflower oil seeds purchased by members and by local farmers.

The oil is cold-extracted with presses in series with an average production capacity of approx. 1,200 kg/hour of seed (approx. 780 kg of cake + 380 kg of oil). The oil is used for supplying a 420 kWel. CHP installed by the company at the public Sport Hall of Ancona. The power goes into the public grid and the heat is sold to the Sport Hall (contracting). The protein-rich cake, produced in the form of flakes, is temporarily stored and sold to some local livestock (cattle, sheep and pigs), both for beef and dairy. The oil mill is 50% independent from the energy point of view since on the roof of the hall has been installed a photovoltaic system with 20 kWel peak. In Aril 2011 they asked us to support them to carry out an economic feasibility study for installing a new CHP. They were interested to create a demonstrative site by the oil mill for having the possibility to show to local farmers the whole PVO value chain. This company is since long-time member of AIEL and Massimiliano Mazzoni, because his skill and experience in the field of PVO production, has been selected to be our Regional coordinator in the frame of Agriforenergy2 project. In the frame of A4E2 project, we worked together to find out the best technological solution, we visited together some companies offering small PVO adapted CHP unit, considering also the application of a Li-Br absorber for cooling purposes. Based on the results of the pre-feasibility techno-economic analysis and scenarios, they decided to install an internal combustion MAN engine with electric output of 200 kWel+100 kWth adapted to the use of pure plant oil with a two tank system and installed into a plug&play container. On 30 March 2012 the plant was inaugurated in the frame of an event organised by Kòmaros (see http://www.komarosagroenergie.it/index.php/eventi.html) in which AIEL was invited to present the A4E2 advisory folder (also downloadable by Kòmaros web site). This plant, realised with the support of the A4E2 project and thanks to motivation of the bioenergy coordinator M. Mazzoni, is playing an important role for transferring know-how and best practices to farmers, orienting them to develop local and sustainable PVO value chain based on farm decentralised oil mill.

New BG/BM plants						
	planned	realised	MWel realised	MWhel/year	MWhth/y	CO2 savings in t: (270 kgCO2 eq/Mwhe)
Lk	3	4	2,19	12934	21750	9365
SFI	1	2	1,89	15700	17500	8964
AIEL	6	5	1,54	12300		3321
CBAO	2	-	-	-	-	-
3N	2	2	2,8	18936	3800	6139
ESS	2	-	-	-	-	-
VTT	3	2	1,5	11000		2970
Total	**19**	**15**	**9,92**	**70870**	**43050**	**30758**

Biogas: Biogas examples from innovative communities Eickenrode and Vrees

The use of waste heat from biogas plants presents us with a challenge: the distance between gas production and the user of the heat energy is large because of separation criteria and it would be necessary to install an extensive pipework system in order to reach a sufficient number of users. This was the situation in Eickenrode, in the Peine district. The newly-established operating company had already considered the use of waste heat at the start of their planning process and wanted local residents to be able to participate in the benefits of biogas production. They planned for the installation of a cogeneration plant in the centre of the community which would be connected to the biogas plant through a 700 metre long crude gas pipeline.

The majority of the residents decided in favour of a complete heat delivery service, by which their own heating boilers would no longer be needed. The operating company therefore installed an oil-fired peak load boiler which would work alongside the biogas cogeneration plant and which could only cover 20% of the annual heat energy requirement. A woodchip-fired boiler would not have been economical for such a low output.

The project in Eickenrode shows a typical situation concerning the development of a district heating supply system with biogas plants. From the standpoint of the cogeneration plant, the connection with as high a user base as possible is desirable in order to achieve a high proportion of electricity production in the cogeneration operation. From the standpoint of the supply network, a low investment and a high heating density is desirable, so that lower transmission costs can be achieved. The heat energy consumers, on the other hand, hope for a high level of affordable heat from the cogeneration plant or peak load boiler. To reconcile these interests within residential areas with a low heat density, it is necessary to concentrate on population centres. Despite the very favourable conditions for establishing the pipeline system, the major investment costs are in the setting up of the supply network. The use of waste heat from the biogas cogeneration plant is compensated by bonus payments for electricity fed into the grid. The 3N Centre of Experts has supported the Eickenrode scheme within the framework of the A4E project by assisting with the feasibility study and the development of a pricing model and has provided an outline heat supply contract. The first section of the network was constructed in summer 2011 in time to supply the town with heat from biogas by the following heating season.

Vrees extends its district heating network

As one of the first bioenergy villages in Lower Saxony, Vrees belongs to the pioneers of the use of regenerative energies. Here, regionally produced biomass is used locally. Vrees therefore not only makes an important contribution to climate protection, it also contributes to value creation in the region through the generation of new jobs. Since 1997, a central woodchip boiler (400 kW) has supplied CO2 neutral heat energy for initially 75 households in the neighbouring housing estate. A district heating network brings the heat energy to the individual houses. In the first years of the scheme, the main supply was covered by the woodchip boiler and a natural gas boiler covered peak load periods. In 2011, however, the concept was extended and optimised through the inclusion of the local biogas plant. The independent electricity and heat production based on biomass is reliant today on the two biogas plants which supply other heating networks via cogeneration plants in the locality.

Biogas plant Büter Heymann in Vrees

In this way, the proportion of heat energy produced from biomass is currently over 90% and the annual capacity utilisation of the wood-fired boiler has been increased to nearly 98%. In future, over 200 households and public buildings will be supplied with heat via four networks. The woodchip plant with its output of 650 kWh works in combination with a biogas cogeneration plant so that today, 90 houses and public buildings are supplied. The wood-fired plant covers peak load in the winter months (November to March). The base supply is met by a satellite cogeneration plant (250kWel./298 kWth.) connected to the system. A total of seven cogeneration plants have been installed in operation with the biogas plants and these supply public buildings and residential areas. Through the continuous extension of the district heating network, the annual utilisation of the biogas-cogeneration system has been gradually optimised. In the summer months, the operation of a woodchip drying system (7000 solid cubic metres) at the Biogas Plant Büter-Heymann and the supply of two agricultural enterprises (poultry stalls and fish farming) and two industrial concerns assures the maximum use of the heat energy produced. In order to optimise the development of heat energy supply based on bioenergy within the framework of regional building regulations which apply in Vrees, the 3N Centre of Experts carried out a feasibility study in the development stage of the project. The A4E2-regional bioenergy coordinator Jan Wulkotte helped by the implementation of legal requirements, regulations and general standards such as the implementation of the German building regulations.

Savings of CO_2emissions per year through A4E2 activities[30]

	Wood energy	PVO	BG/BM	Total
CO_2-eq savings planned	7.800 t CO_2-eq	10.000 t CO_2-eq	11.000 t CO_2-eq	28.800 t CO_2-eq
CO_2-eq savings realised	**38.496 t** CO_2-eq	**3.127 t** CO_2-eq	**30.758 t** CO_2-eq	**72.381 t** CO_2-eq

[30] All plants in full operation in 2013

10 Unique consortium of Agri for Energy 2

THANKS TO ALL

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