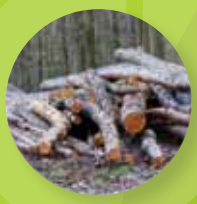
Arbor
Biomass for Energy

Biomass for Energy in the Northwest European region:
The ARBOR benchmark report



Improving ***sustainable biomass utilisation*** *in North West Europe*

Biomass for Energy

Summary

ARBOR (Accelerating Renewable Energies through valorisation of Biogenic Organic Raw Material) is a project partnership between six regions in the North West European area: Belgium, Germany, Ireland, Luxembourg, the Netherlands and the United Kingdom. This project has received European Regional Development Funding through INTERREG IVB. This report was set up to summarise, list and compare the current situation concerning bioenergy of these six countries. In 2012 the first version of the report was published and at the end of the project (2015) an update of this report will be carried out in order to evaluate the progress made.

In the first chapter an overview is given of current national statistics. In this chapter the current situation for renewable (bio-)energy is compared to the 2020 targets. It appears that Belgium and Germany are well on track in reaching these targets, while Ireland, Luxembourg and the Netherlands are more or less on track and the United Kingdom is not entirely on track. Except for Germany however, none of them have reached half of their 2020-targets. Biomass already accounts for more than 50% of renewable energy produced and according to plans will continue to cover a large share of renewable energy till 2020.

Chapter 2 gives an overview of the targets set out for the acceleration of bioenergy production and how these targets are to be reached, divided in three categories: renewable electricity, renewable heating and cooling and renewable transport. Except for Belgium and Ireland, all countries expect and plan their total national energy consumption to stagnate or even decrease. This chapter also lists how much biomass is expected to be locally available. Next to this some conclusions are made about the amounts of biomass that will have to be imported to be able to reach the targets.

In Chapter 3 the strategies documented in the national renewable energy action plans (NREAP) and national biomass action plans (nBAP) are listed. For the NREAP an overview is given of the potential mobilisation of new energy sources. Strategies concerning the assignment of land for energy crops, the inputs towards anaerobic digestion (AD), forest management techniques and policies promoting the production of biogas are very different amongst the six countries. The impact on other sectors is also subject of this chapter. A short overview of different existing nBAP is given.

In Chapter 4 the policy framework for the development of biomass strategies is described. Aspects that are dealt with are legislation, sustainability criteria and support measures.

In the last chapter countries were asked to give two or more case-studies that can serve as an innovative example of bioenergy in their country. A comprehensive table also was made of bioenergy projects in North-West Europe that are ongoing or already finished and that have a clear link with ARBOR.

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List of abbreviations

ABP	Animal-by-products
AD	Anaerobic digestion
ARBOR	Accelerating Renewable Energies through valorisation of Biogenic Organic Raw Material
Av. Red.	Aviation reduction
CAP	Common agricultural policy
CHP	Combined heat and power
DAFF	Department of Agriculture, Fisheries and Food (Ireland)
GEC	Green electricity certificates
HWRC	Household waste recycling centre
KGW	Kitchen and Garden Waste
Mio	Million
IPPC	Integrated Pollution Prevention Control
LNG	Liquified natural gas
LPG	Liquified petroleum gas
LoW	European List of waste
(n)BAP	National biomass action plan
NGO	Non governmental organisation
NREAP	National renewable energy action plan
NTA	Netherlands Technical Approach
ORC	Organic Rankine Cycle
PPO	Pure plant oil
Ref.	Reference scenario
SRC	Short Rotation Coppice
SRF	Solid recovered fuels
RED	Renewable Energy Directive 2009/28/EC
RES	Share of renewable energy
VLACO	Flemish Compost Organisation
VLAREA	Flemish Legislation for Waste Prevention and Management
VREG	Flemish Regulator of the Electricity and Gas market
WFQA	Wood Fuel Quality Assurance Certification

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Introduction

This document can be considered as a "starting point" for ARBOR, an Interreg IVB project for North-West Europe. ARBOR stands for Accelerating Renewable Energies through valorisation of Biogenic Organic Raw Material. It was approved in March 2011 as a strategic initiative for a duration of 4 years.

The different ARBOR-partners are:

- **From Belgium:** FlandersBio, Ghent University, Inagro, Provincial Development Agency West Flanders (POM West-Vlaanderen), Flemish Coordination Centre for Manure Processing (VCM)
- **From Germany:** Institute for Future Energy Systems (IZES) gGmbH
- **From Ireland:** University College Dublin (NUID - UCD)
- **From Luxembourg:** Public Research Centre Henri Tudor (CRTE)
- **From the Netherlands:** DLV Plant BV, Province of Utrecht, Wageningen University
- **From the UK:** Stoke-on-Trent city Council, Staffordshire University (lead partner)

Total budget for ARBOR is € 7 361 959.
The framework for ARBOR are the EU 20 20 20 targets in order to mitigate climate change and the fact that biomass accounts for 50% of the renewables in Europe. Although a lot of expertise concerning biomass is available, it is noted that this information is not disseminated in a coordinated way, nor is it related to commercial exploitations. That is why the ARBOR-mission is to accelerate the sustainable development and use of biomass in North West Europe, to facilitate the achievement of the EU 20 20 20 objectives and to realise a world-class utilisation of biomass.

The aim of this document, as a part of the total ARBOR-project, is to get a comprehensive state-of-the-art assessment on the use of biomass for bioenergy in the project regions. The document will be updated at the end of the project to determine the evolution in statistics and policy.
Data was gathered by means of a template that was filled out by the different partners. Another important source of information were the National Renewable Energy Action Plans (NREAP) that every Member State had to make to comply with article 4 of the renewable energy Directive (2009/28/EC). These plans provide detailed roadmaps of how each Member State expects to reach its legally binding 2020 target for the share of renewable energy in their final energy consumption. It was not compulsory to make a National Biomass Action Plan (nBAP), but out of the different ARBOR-partners, Luxembourg and Belgium are the only two without an nBAP.

Other frequently consulted documents/websites, were:

- Beurskens, L.W.M., Hekkenberg, M. & Vethman, P. (2011). Renewable Energy Projections as published in the National Renewable Energy Action Plans of the European Member States covering all 27 EU Member States with updates for 20 Member States. Version of 28th November 2011. European Environment Agency, 270p.
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- BAP Driver (2009). European best practice report. Comparative assessment of national bioenergy strategies & biomass action plans in 12 EU countries. Extended version. 143p.
- www.eubionet.net

The report was composed by Inagro (Greet Ghekiere, Anke De Dobbelaere) and POM West-Vlaanderen (Geert Dangreau, Viooltje Lebuf). FlandersBio (Willem Dhooge) took care of the final lay-out.



Chapter 1 - National statistics for biomass

1.1 State of the art: 2020 targets for renewable energy

In table 1 the targets for renewable energy from the renewable energy directive 2009/28/EC (RED) are shown, including the trajectories to be followed.

Table 1: Overall renewable energy targets from the RED (share renewable energy in gross final energy consumption (%)).[1]

	2005	2010	2015	2020
Belgium	2.2	4.4	7.1	13.0
Germany	5.8	8.2	11.3	18.0
Ireland	3.1	5.7	8.9	16.0
Luxembourg	0.9	2.9	5.4	11.0
the Netherlands	2.4	4.7	7.6	14.0
United Kingdom	1.3	4.0	7.5	15.0

In their National Renewable Energy Action Plan (NREAP) countries have specified till 2020 how much of the renewable energy will be coming from biomass. In table 2 these 'targets for bioenergy' are summarised.

Table 2: NREAP targets for bioenergy specified by countries to achieve the targets for renewable energy by 2020 (%).

	2005	2010	2015	2020
Belgium	1.7	3.1	5.2	8.9
Germany	4.5	6.9	7.8	9.9
Ireland	1.5	2.8	5.4	6.9
Luxembourg	0.5	1.6	3.2	6.7
the Netherlands	2.0	3.1	5.3	7.5
United Kingdom	0.9	1.7	3.3	7.3

Based on the most recent available national statistics for renewable energy and biomass, an overview can be made of what the situation is in reaching the national EU 2020 targets. Figure 1 gives such an overview. It is clear that bioenergy in the future will account for an important share of renewable energy.

[1] The targets shown for 2010 and 2015 are these calculated for the respective trajectory periods 2011-2012 and 2015-2016 following the equations defined in the RED: $S_{2005}+0.20*(S_{2020}-S_{2005})$ for 2011-2012 and $S_{2005}+0.45*(S_{2020}-S_{2005})$ for 2015-2016. The share of renewable energy is the amount of renewable energy in gross final energy consumption after a reduction for aviation is applied for some countries as defined in the RED.

[2] The targets for bioenergy, as we will call them here, are the amounts of bioenergy in final energy consumption according to the reference scenario without aviation reduction (when applicable) (reference: Beurskens et al. (2011)), since the data for the actual situation didn't include aviation reduction and are based on final energy consumption. When comparing the shares of renewable energy with those of bioenergy this means that for some countries the share of biomass in gross final energy consumption would be a bit smaller than the shares based on final energy consumption. In short: when comparing the shares of renewable energy with bioenergy, bioenergy can be a little underestimated for some countries. The Netherlands don't have a reference scenario so for the Netherlands numbers are based on the additional energy efficiency scenario.

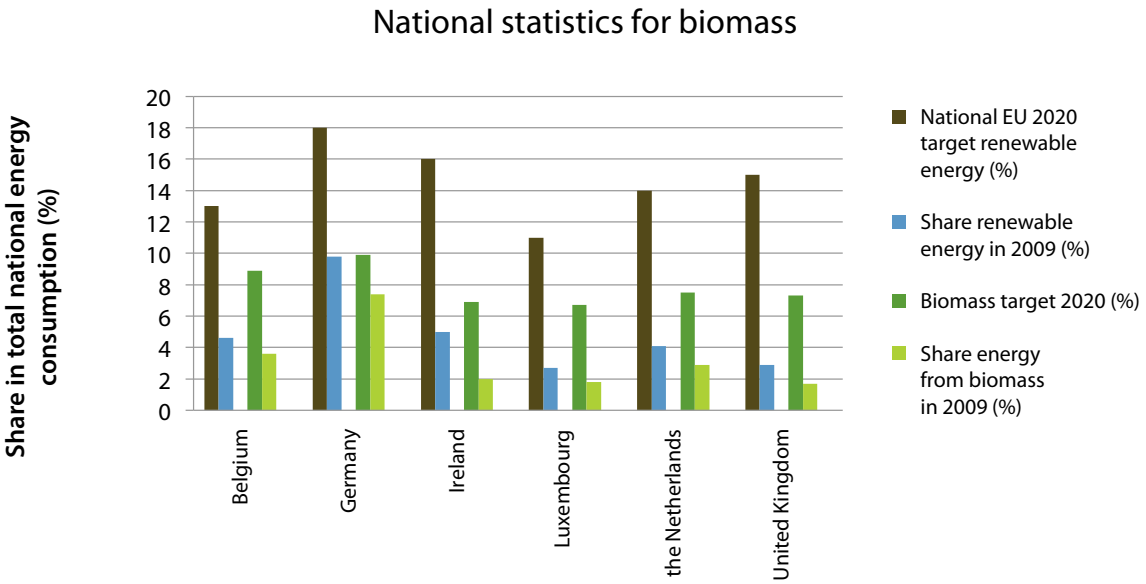


Figure 1: Representation of the share of renewable energy in total national energy consumption in 2009 (Eurostat, 2012) against the national EU 2020 target for renewable energy (%) and the share of energy from biomass in final energy consumption in 2009 (AEBIOM, 2011) against the NREAP 'targets for biomass'.

On the basis of the national statistics (figure 1) and the targets (table 1 and 2) it can be concluded that Belgium and Germany are well on track in reaching the targets, Ireland, Luxembourg and the Netherlands are more or less on track, while the United Kingdom is not entirely on track with the targets for renewable energy set out in the RED. For biomass it can be concluded that Belgium, Germany, Luxembourg and the United Kingdom are on track with the targets they specified for biomass in their NREAP while Ireland and the Netherlands are only more or less on track with these 'biomass targets'. From figure 1, based on what is achieved till 2009, it can be concluded that for renewable energy (from biomass) countries will still have to make the following efforts (table 3) to reach the targets till 2020.

Table 3: Efforts (presented as a factor=(target 2020)/(situation 2009)) still to be made by the countries till 2020.

Efforts	Belgium	Germany	Ireland	Luxembourg	the Netherlands	United Kingdom
Renewable energy	2.8	1.8	3.2	4.1	3.4	5.2
Renewable energy from biomass	2.5	1.3	3.5	3.7	2.6	4.3

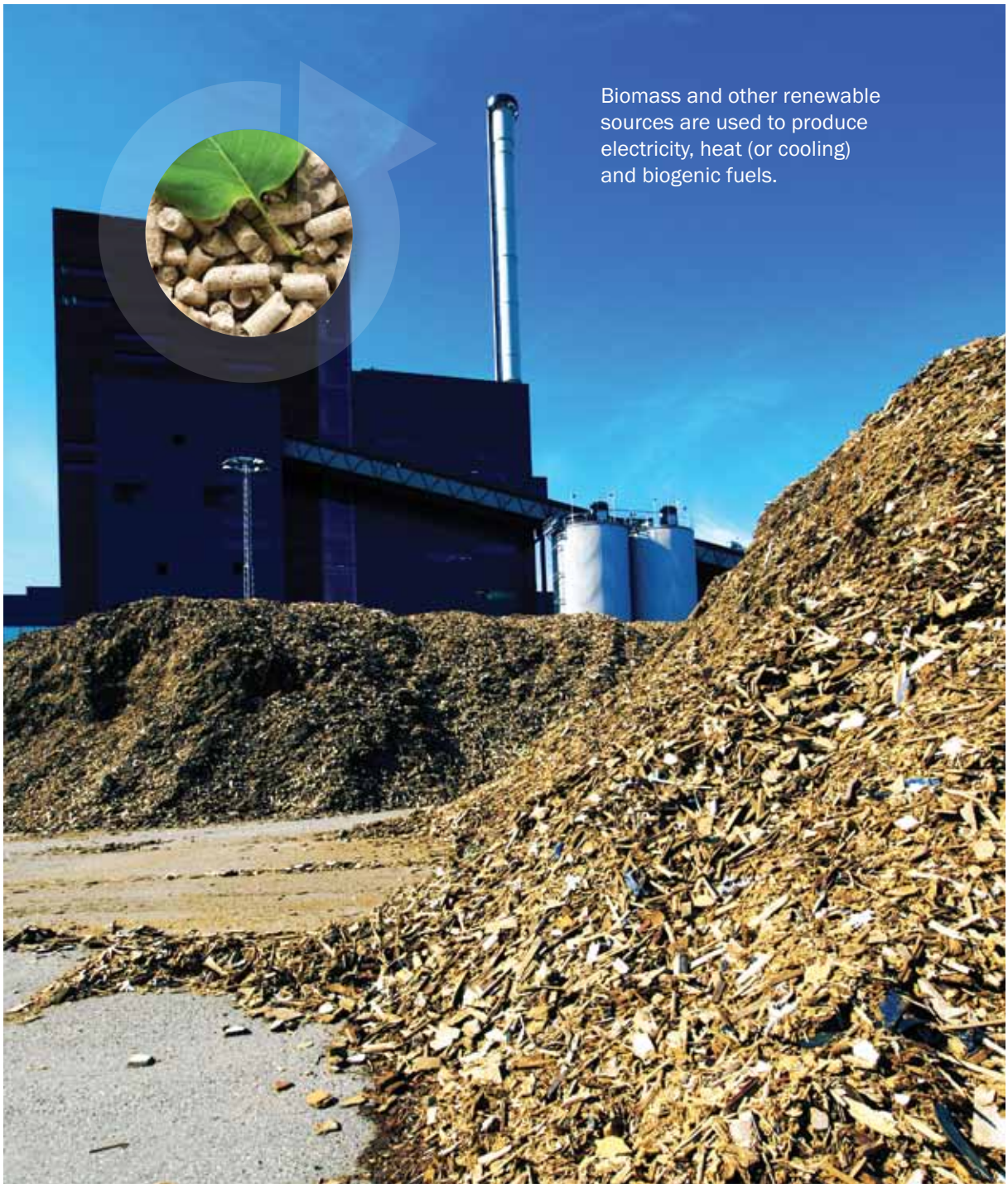
Looking at table 3 it can be concluded that the United Kingdom and Luxembourg will have to make the most efforts to reach the 2020 targets, while Germany has already made quite some efforts. Belgium, Ireland and the Netherlands are situated in between these categories. Except for Germany, five countries haven't reached half of their 2020-targets.

1.2 Most recent available data for: renewable (bio-)energy for electricity, heating or cooling and biogenic fuels

Biomass and other renewable sources are used to produce electricity, heat (or cooling) and biogenic fuels. In figure 2 it is shown how inputs are divided over these three categories[3] :

Figure 2: Production of renewable energy (from biomass (shaded areas)) for electricity (yellow), heating & cooling (red) and transport (blue) in Flanders (2010), Germany (2010), Luxembourg (2005), Ireland (2010), the Netherlands (2010) and the United Kingdom (2009).

Out of these diagrams it can be concluded for all six countries that biomass produces half or more of the renewable energy produced. In the United Kingdom biomass is mainly used for electricity production, while in Flanders, Luxembourg, Germany and Ireland it is mainly used for heating and cooling. In the Netherlands the share that goes to electricity is almost equal to the share of biomass for heating (or cooling). In Flanders and Ireland a substantial share of total biomass is also used to produce biofuels.



[3]These diagrams are based on most recent available estimates delivered by the partners from the ARBOR project: for Germany data are obtained from the Federal Ministry for the Environment (2011), for Ireland from SEAI (2011), for Luxembourg from NREAP (2010), for the Netherlands from Centraal Bureau voor de Statistiek (2011) and Ministerie van Economische Zaken (2010) and for the United Kingdom from Department of Energy and Climate Change (2011a). Since no recent data were yet available for Belgium, a diagram for Flanders is presented in which a provisional indication for these different categories is shown based on numbers from Jespers et al. (2011).

Chapter 2 - Plans and targets for energetic biomass acceleration

2.1 Overview biomass targets

2.1.1 Overview biomass targets in time

The evolution of total national energy consumption (also known as gross final energy consumption) that was planned in the NREAPs is shown in figure 3 and 4[4]. Figure 3 shows gross final energy consumption according to the reference scenario. Figure 4 shows the gross final energy consumption for the additional energy efficiency (and thus more optimistic) scenario. In both figures aviation reduction has been applied for certain countries as was prescribed for the calculation of the share of renewable energy (RES) by the RED. The choice of the scenario has a large impact on whether or not the RED targets are reached, table 4 gives an overview of the expected share renewable energy in 2020 based on the different scenarios. Background colours show if targets for 2020 (listed in table 1) are reached (green) or not (red). Most of the countries (here all six except Germany) calculated with the additional efficiency scenario in their NREAP to reach the targets set in the RED.

Table 4: NREAP targets for biomass specified by countries to achieve the targets for renewable energy by 2020 (%).

RES 2020 (%)	Belgium	Germany	Ireland	Luxembourg	the Netherlands	United Kingdom	Total 6 countries
Additional energy efficiency scenario	13.0	19.6	16.0	11.0	14.5	15	16.8
Reference scenario	12.7	18.2	14.8	9.8	(14.5)	14.4	16.0

Based on figures 3 and 4 it can be concluded that Belgium, Ireland and Luxembourg expect their energy consumption to rise, while the other countries expect their energy consumption to more or less stagnate (The Netherlands) or even decline (Germany and the United Kingdom).

Based on (gross) final energy consumption the share renewable energy and the share bioenergy planned over the years 2005, 2010, 2015 and 2020 are shown in the respective figures 5 and 6. Looking at the slope of these graphs, generally in all countries the greatest effort to be made in amounts of energy coming from renewable inputs is planned in the period of 2015 to 2020. This is not always the same for energy coming from biomass. For biomass the greatest efforts still to be delivered differ between countries: for Belgium, Luxembourg and United Kingdom greatest efforts are planned in 2015-2020. For Ireland and the Netherlands greatest efforts are planned in 2010-2015, while for Germany greatest efforts are planned in 2005-2010.

[4] Since data from the benchmark reports were not comparable between the different countries, NREAP and biomass targets were retrieved from Beurskens et al. (2011). No aviation reduction scenario is available for Belgium and Germany over the whole period and for Ireland for 2015-2020, so numbers for these countries are based on the same scenarios but without aviation reduction. The Netherlands don't have a reference scenario so for the Netherlands numbers are based on the additional energy efficiency scenario.

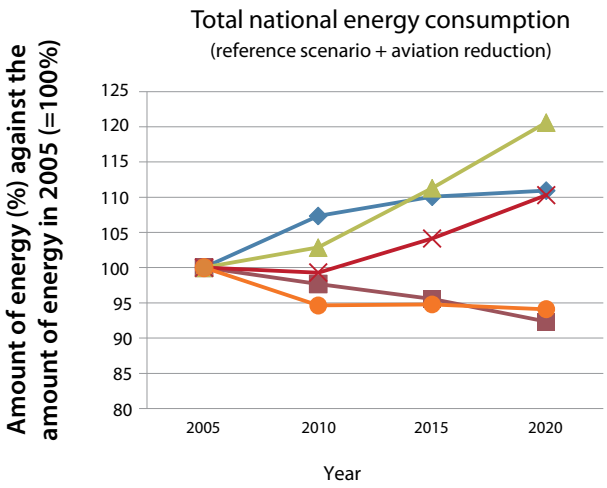


Figure 3: Evolution of gross final energy consumption in the reference scenario, incl. aviation reduction.

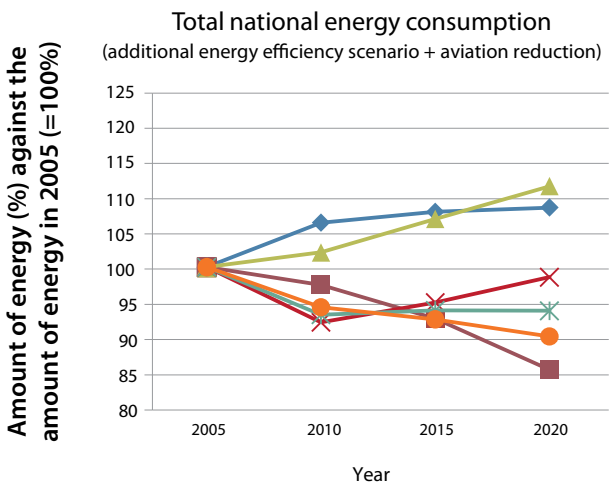


Figure 4: Evolution of gross final energy consumption in the additional energy efficiency scenario, incl. aviation reduction.

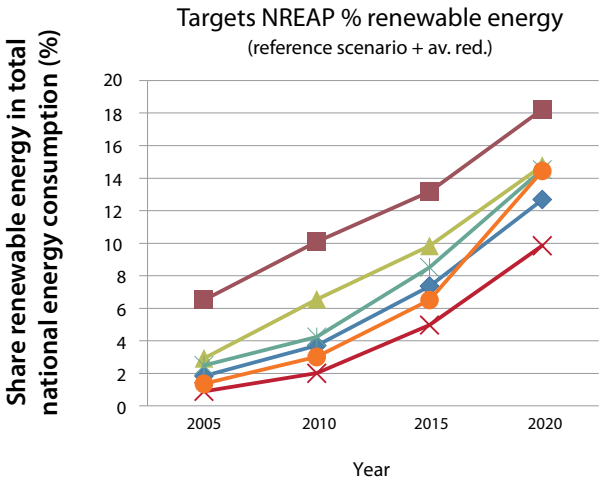


Figure 5: Evolution of the share renewable energy in gross final energy consumption (ref., incl. av.red.).

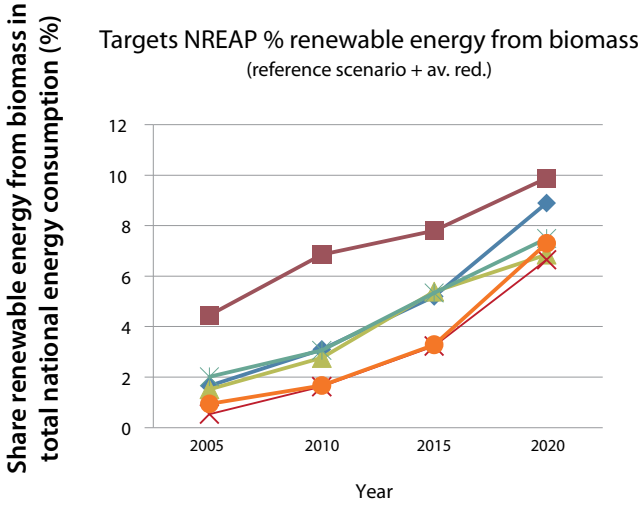
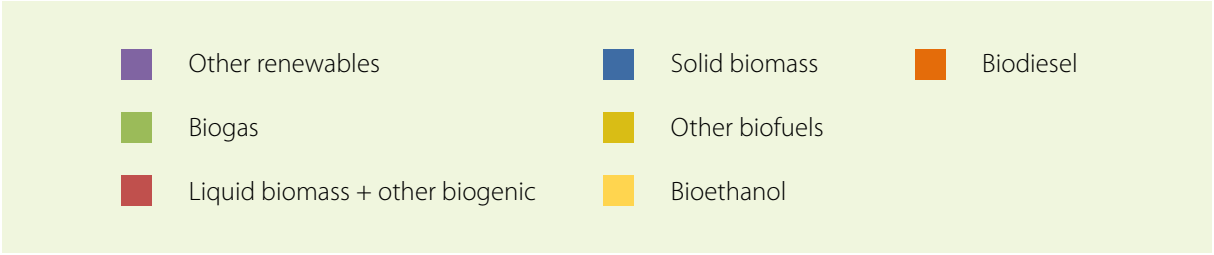


Figure 6: Evolution of the share of renewable energy from biomass in gross final energy consumption (ref., incl. av. red.).

2.1.2 Overview biomass targets divided in three categories: renewable electricity, renewable heating and cooling and renewable transport

In the following figures for the three categories (electricity, heating & cooling and transport) an overview[5] (for the six countries) is given of the evolution of the distribution of renewable energy coming from multiple inputs for the years 2005, 2010, 2015 and 2020. Again it can be concluded that biomass is expected to produce a large share of the renewable energy in the future. Next to the planned evolution the actual situation[6] (where available) is given to compare.



Belgium: planned distribution of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020.

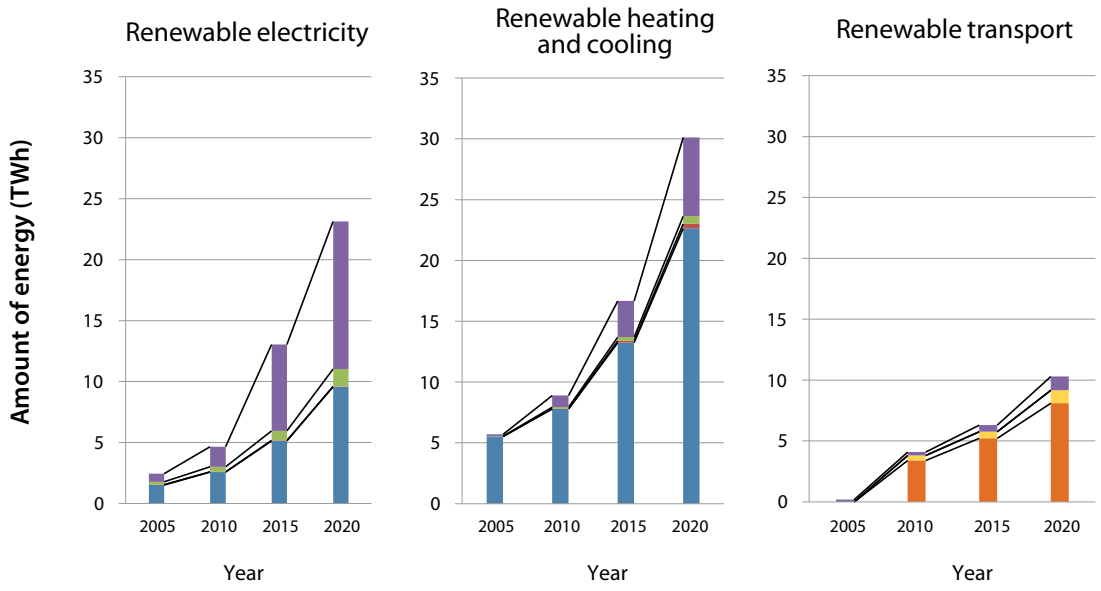


Figure 7: Planned distribution for Belgium of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020, divided over three categories: renewable electricity, renewable heating & cooling and renewable transport.

[5] Data are based on the data mainly coming from the NREAP according to: Beurskens et al. (2011).
[6] These data are based on most recent available estimates delivered by the partners from the Arbor project.

Germany: planned distribution of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020.

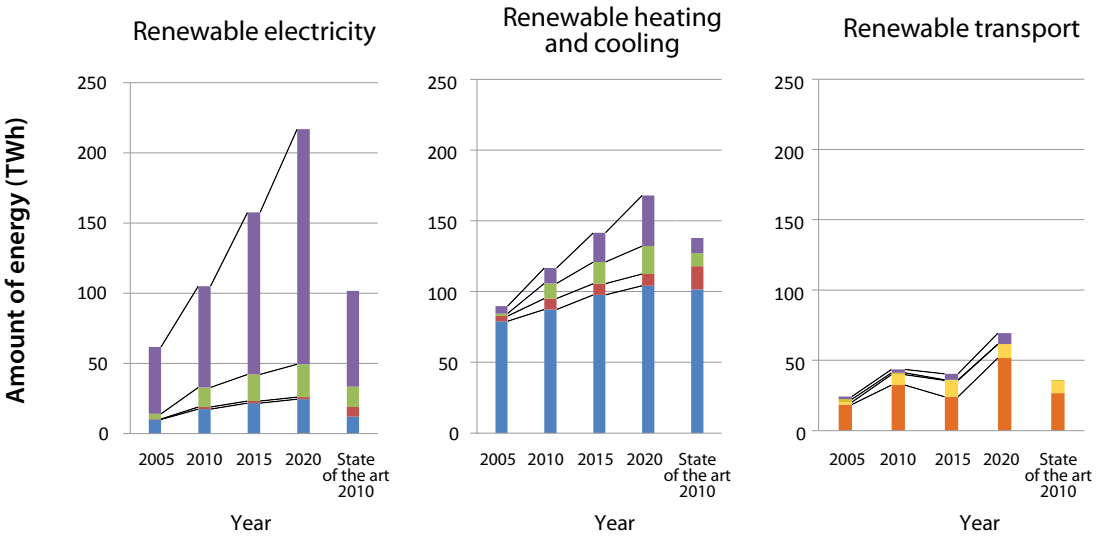


Figure 8: Planned distribution for Germany of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020, divided over three categories: renewable electricity, renewable heating & cooling and renewable transport. Comparison with state-of-the-art data from 2010.

Ireland: planned distribution of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020.

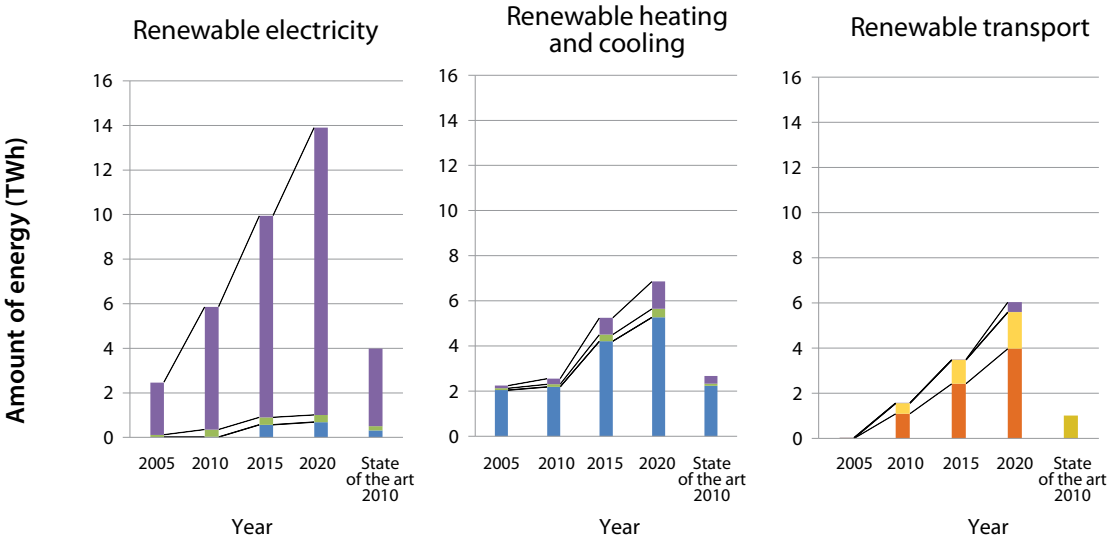


Figure 9: Planned distribution for Ireland of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020, divided over three categories: renewable electricity, renewable heating & cooling and renewable transport. Comparison with state-of-the-art data from 2010.

Luxembourg: planned distribution of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020.

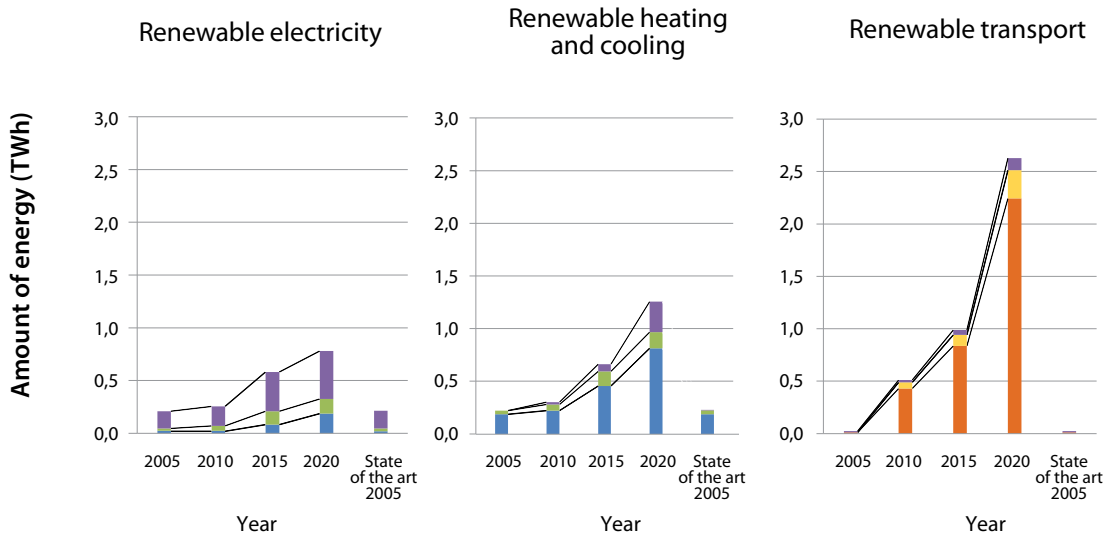


Figure 10: Planned distribution for Luxembourg of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020, divided over three categories: renewable electricity, renewable heating & cooling and renewable transport. Comparison with state-of-the-art data from 2005.

the Netherlands: planned distribution of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020.

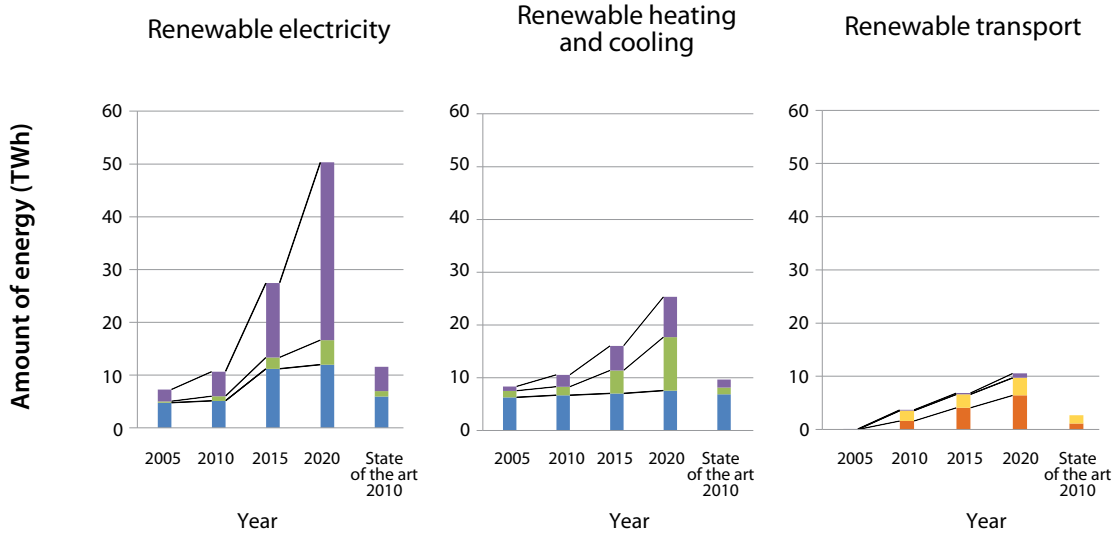


Figure 11: Planned distribution for the Netherlands of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020, divided over three categories: renewable electricity, renewable heating & cooling and renewable transport. Comparison with state-of-the-art data from 2010.

United Kingdom: planned distribution of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020.

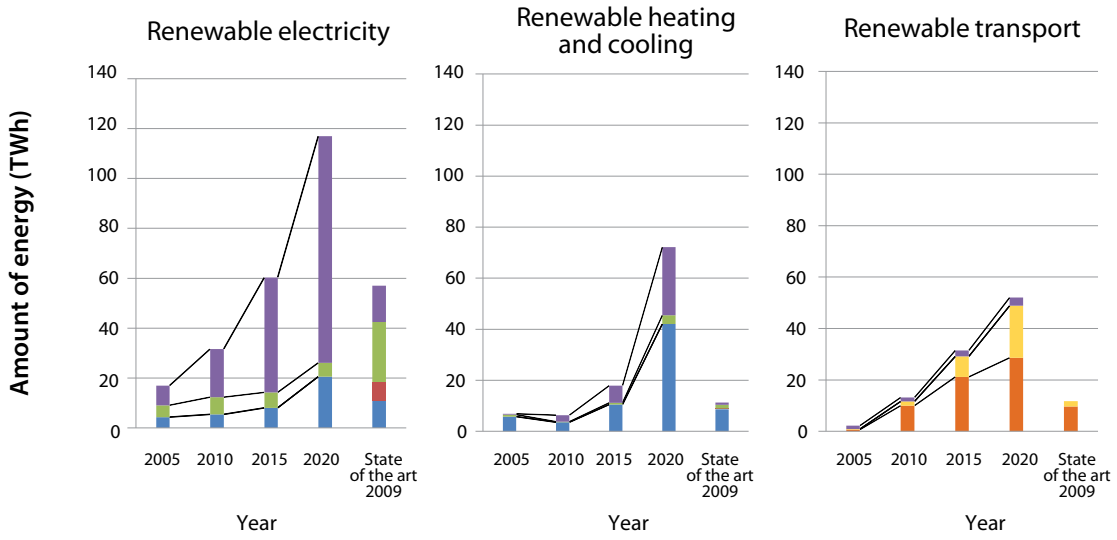


Figure 12: Planned distribution for the United Kingdom of multiple inputs for renewable energy in 2005, 2010, 2015 and 2020, divided over three categories: renewable electricity, renewable heating & cooling and renewable transport. Comparison with state-of-the-art data from 2009.

Biomass is expected to produce a large share of the renewable energy in the future.

2.2. Local available biomass today and in the future [7]

Table 5: Domestic resource in 2006 (ktoe)

	Belgium	Germany	Ireland	Luxembourg	the Netherlands	United Kingdom
Woody biomass	455	9 425	NA	34	640	557
Agriculture and fisheries	92	5 566	NA	10	450	412
Waste	260	743	NA	16	1 348	2 011

Table 6: Domestic resource in 2009 (ktoe)

	Belgium	Germany [8]	Ireland	Luxembourg	the Netherlands	United Kingdom
Woody biomass	NA	9 425	149	NA	828	1 087
Agriculture and fisheries	NA	5 566	NA	NA	NA	476
Waste	NA	743	60	NA	1 157	4 029

Table 7: Domestic resource in 2010 (ktoe)

	Belgium	Germany	Ireland	Luxembourg	the Netherlands	United Kingdom
Woody biomass	NA	9 425	159	NA	808	1 224
Agriculture and fisheries	NA	5 566	NA	NA	NA	439
Waste	NA	743	64	NA	1 168	4 139

[7] References:
- Beurskens, 2011
- Progress report Ireland, the Netherlands & the UK, 2012
- Bundesrepublik Deutschland, 2012

[8] In the progress report for 2009-2010 of the NREAP for Germany it is mentioned that there has been no substantial change to the availability of biomass in Germany in 2009 and 2010 in comparison to the detailed information provided in the NREAP for 2006.

Table 8: Expected amount of domestic resource in 2015 (ktoe)

	Belgium	Germany	Ireland	Luxembourg	the Netherlands	United Kingdom
Woody biomass	738	12 237	NA	59	370	1 063
Agriculture and fisheries	198	NA	NA	45	4 414	1 874
Waste	336	1 440	NA	25	2 155	9 055

* Best possible scenario and worst possible scenario

Table 9: Expected amount of domestic resource in 2020 (ktoe)

	Belgium	Germany[8]	Ireland	Luxembourg	the Netherlands	United Kingdom
Woody biomass	869	11 985	NA	85	573	1 567
Agriculture and fisheries	443	NA	NA	72	7 787	6 967
Waste	452	1391	NA	29	2 615	12 945

Summary

In 2006 Germany possessed the largest amount of domestic resources of woody biomass, as well as biomass from agriculture and fisheries. The UK possessed the largest domestic resource of biomass coming from waste.

Other trends that catch the eye are the very large increases expected for biomass from agriculture and fisheries in Belgium, Luxembourg, the Netherlands and the UK, mainly between 2006 and 2015. Also for waste a large increase is expected in the UK (2006-2015). In Germany a slight decrease of woody biomass and biomass from waste after 2015 is expected.

For the Netherlands figures are very variable: a huge, almost impossible, increase of biomass from agriculture and fisheries is expected, whilst woody biomass is expected to decrease with 40% between 2006 and 2015. This trend is not coherent with available data for 2009 and 2010.

Table 10: Land used in 2006-2009-2010 for low impact energy crops

	Land for short rotation coppice (ha)			Land for other energy crops (ha) *(reed canary grass, switch grass, Miscanthus, sorghum, ...)*		
	2006	**2009**	**2010**	**2006**	**2009**	**2010**
Belgium	0	NA	NA	0	NA	NA
Germany	1 200	2 300	3 600	1 100	1 800	2 100
Ireland	63	360	548	617	2 101	2 266
Luxembourg	0	NA	NA	0	NA	NA
the Netherlands	0	12	8	10 000	NA	NA
United Kingdom	4 196	NA	NA	5 316	NA	NA

2.2.1 Developments after 2006-2007

Germany:

The Progress report from Germany states that there has been no substantial change to the availability of biomass in Germany in 2009 and 2010 in comparison to the NREAP for 2006 and 2007. There has been an increase in area under cultivation for biogas substrates, in particular maize. Well over a quarter of the area planted with maize is used for energy in Germany at the present time.

Ireland:

The largest single stream, forest based biomass, although increasing in absolute terms, remained at a consistent 45% of total biomass for bioenergy over the period 2008-2010. The contribution from liquid biofuels has increased from 20% of total biomass in 2008 to 26% in 2010.

the Netherlands:

Most biomass for electricity generation and heating comes from waste from the Dutch domestic market. In addition, a great deal of waste wood is made available for energy purposes, for use both in the Netherlands and in other EU States. Another important stream is the importation of wood pellets for co-incineration in power stations. A large proportion of these comes from North America.
For 2009 and 2010, no data are available on the origin and nature of raw materials for the production of biofuels for transport.

UK:

The single largest feedstock for renewable energy in UK transport in 2009 and 2010 was soy with 1 120 and 907 ktoe supplied, respectively. This was all imported from outside the EU. Sugar cane, primarily from Brazil also contributed a significant proportion of the energy. Oilseed rape is the largest EU feedstock with over 200 ktoe supplied in each year. The largest UK feedstock was sugar beet with 92 and 129 ktoe supplied in 2009 and 2010, respectively. There was a significant increase in the amount of used cooking oil (UCO) reported from all sources in 2010 reflecting the removal of the duty differential for all biofuels except those derived from UCO in April that year.

2.3. Share of local biomass & share of imported biomass[9]

In the NREAP there is little information available on the share of imported biomass today and in the future. That is why in this chapter we make some assumptions for the future, deducted from 2.1. and 2.2.

From 2.1. it can be concluded that all 6 partners expect a serious increase between 2005 and 2020 in renewable electricity, renewable heating and cooling and renewable transport. Mainly for renewable heating and cooling and renewable transport a large share will be bioenergy. Biomass resources will thus have to increase, in combination with the increase in energy efficiency.

In Germany domestic resources more or less seem to stagnate after 2015. From the statistics in 2.1. we can deduce that they expect a small increase in bioenergy in this period. Time will tell how much import will be necessary to meet these targets.

In the Netherlands, Belgium, Luxembourg and the UK large increases in domestic biomass are expected between 2006-2020. In the near future it will become clear if this increase will be enough to reach the expected bioenergy targets. Because of the fact that Ireland, Luxembourg and Belgium are relatively small countries, it seems inevitable that they will have to import quite a large share of biomass.

The expectations for 2020 in the NREAP and the information provided by the project partners more or less matches these conclusions:

- **Belgium:** Currently 1/3rd of biomass is being imported. The quantity of biomass which will have to be imported in 2020 is estimated at 3100 ktoe. The question of possible import countries depends on developments on the international biomass market. Belgium currently imports wood pellets from Canada, United States, Germany, the Netherlands, Portugal, Estonia, Latvia, Lithuania and South Africa.

- **Germany:** gap of 9 500 ktoe between domestic supply and demand, however this will primarily be mobilised domestically by e.g. energy yield increases and increased energy use of forest wood. A "timber gap" however is expected. Also the import of biomethane over the gas grid might be realistic if policy and market situation will be adapted.

- **Ireland:** two scenarios are presented. The first one estimates that imported biomass will account for about 350 ktoe of total required biomass supply of 1 100 ktoe or 32%. The second one estimates that imported biomass will account for 510 ktoe of the total required biomass supply of 1 260 ktoe or 40%. The imported biomass is foreseen as coming from Canada (wood biomass), USA (wood biomass), Brazil (biofuels) and Russia (wood biomass).

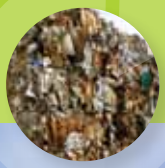
- **Luxembourg:** imports of biomass, in particular in the category 'indirect supply of wood biomass for energy generation' are expected to reach 45 ktoe by 2020. A large share of the renewable energy targets will be obtained by biofuel imports. Also around 35% of woody biomass for burning will have to be imported.

- **the Netherlands:** the expected required biomass is approximately 8 Mtoe in 2020. In the Netherlands -depending on the scenario - approximately 5 Mtoe will be available for energy applications in 2020. Sectors which will almost certainly have to import large amounts of biomass are combined burning in coal-fired power stations and biofuels for transport.

- **UK:** at present the UK imports the majority of its biofuels, this may change over the decade as there are currently large ethanol refineries under construction in the UK. The UK also expects to have sufficient biomass resource potential to meet the demand for heat and power.

[9] NREAP, 2011

Chapter 3 - Overview of the different National Renewable Energy Action Plans and National Biomass Action Plans



3.1. NREAP[10]

In this chapter we will focus on the content of the different NREAP's and make a comparison between different strategies proposed by the member states. As ARBOR only deals with bioenergy aspects, strategies concerning other renewables such as wind and geothermal energy will not be mentioned here. The main aim of this chapter is to compare the different measures taken by the member states to increase their biomass availability and what impact these measures may have on other sectors.

All the NREAPs were released in 2010.

3.1.1 NREAP targets

The different renewable energy and bioenergy targets mentioned in the NREAPs won't be stated here as they are fully in line with the targets from the EU directive 2009/28/EC that are mentioned in table 1 in chapter 1.

3.1.2 Mobilisation of new biomass sources

3.1.2.1 Perennial energy crops on degraded land and unused arable land

The amount of degraded land that is available for energy purposes:

- Belgium, United Kingdom, Luxembourg, the Netherlands, Ireland: no noteworthy amount mentioned in the NREAP, although in the ARBOR project special attention is given to SRC on industrial sites in Belgium and perennial energy crops on set aside lands in the Netherlands
- Germany: partly sealed, undeveloped brownfield and urban recycling areas that could be available for biomass production

The amount of unused arable land, available for energy purposes:

- Belgium: 2 600 ha in the Flemish Region (2009), 12 319 ha in the Walloon Region (2008)
- Ireland: 3 589 ha
- the Netherlands, Germany and Luxembourg: no significant reserves of unused arable land
- United Kingdom: 255 000 ha

Support measures for the establishment of perennial energy crops:

- Belgium: demonstration projects on SRC and phyto-remediation of degraded land
- Ireland: Bioenergy Scheme (establishment grants to farmers for up to 50% of the costs associated with establishing Miscanthus and willow) & Afforestation Grant Schemes (The scheme is open to farmers and non-farmers. Forests established under this scheme must meet full silvicultural standards and must be managed as a commercial crop for the realisation of a profit, 75% of the costs associated with the establishment of a forest)
- the Netherlands, Luxembourg, Germany: no support measures for energy crops on degraded land or unused arable land
- United Kingdom: grant rate is 50% of the actual establishment costs (2007-2013 Rural Development Programme for England's Energy Crops Scheme)

Summary

The NREAP states that perennial energy crops can be grown on degraded land or unused arable land. Germany is the only partner where degraded land is available and the UK is the only one with a significant amount of unused arable land. It is clear that the UK and Ireland put most effort into promoting the establishment of perennial energy crops through grants.

[10] NREAP, 2011

3.1.2.2 Energy use of available primary material

How will the available primary material be used:

- **Belgium:** focus on improved collection of waste flows, usage for anaerobic digestion (AD), together with manure and compost, through support for investments and green certificates

- **Germany:** former priority on accelerating biogas production from energy crops is still existent but with restrictions on mass percentage (maize max. 60%) and changes in tariffs. Focus on small scale manure digestion. Current policy headlines the fermentation of organic residues such as municipal organic waste or other organic residues that currently are not valorised, e.g. landscape material, flower stripes, straw, horse-cow-pig manure, clover, etc (Personal communication, Weiler K., Izes).

- **Ireland:** focus on anaerobic digestion CHP through a number of capital grant aid schemes + a special tariff for AD to make use of animal manure and other wastes from secondary processing of agricultural products. Also focus on biomass co-fired with peat and use of wood coming from forests in heating through a number of capital grant aid schemes and a tariff to support the use of materials from the forestry sector (thinning and waste from sawmills)

- **Luxembourg:** energy wood, old and scrap wood, manure, biogenic organic residue and sludge are the available primary materials already being used for energy, focus on the improvement and suitability of the current incentives (investment and feed-in tariffs) for the collection of organic waste as well as use of old and scrap wood

- **the Netherlands:** focus on facilitating manure fermentation through financial support and by improving the legislative framework for the use of digestate as fertilizer and mineral concentrates as inorganic fertilizer substitutes

  UK: focus on anaerobic digestion of manure and slurry through financial incentive mechanisms for renewable energy, capital grant schemes, advice workshops for farmers and online advice services

Summary

All partners agree on the importance of AD for the energy use of their available primary material and would like to focus on manure as input material for AD. Ireland, Belgium and Luxembourg stress the importance of an improved collection of waste flows. Germany also considers crop residues as an important source for AD. Ireland is the only partner mentioning co-firing with peat and the exploitation of forests.

3.1.2.3 Policies promoting the production and use of biogas

Specific measures for biogas:

- Germany
  - Gas Grid Access Ordinance: facilitate feed-in of 6 billion m^3 per year by 2020 and 10 billion m^3 per year by 2030
  - Integration of biogas plants in micro-grids
  - Energy concept 2050: targets for higher use of biomethane in transport sector
  - Biogas feed-in tariff law (see pg. 48)

- Luxembourg
  - "Reglement grand-ducal" on the promotion and the development of the biogas production and the injection of the biogas into the natural gas grid

- United Kingdom
  - AD Implementation Plan: actions to increase the production of biogas (published 25th of March 2010), *http: //archive.defra.gov.uk/environment/waste/ad/implementation-plan.htm*
  - Government's Coalition Agreement: the Government committed to 'a huge increase in waste to energy through anaerobic digestion'
  - AD Demonstration Program: five projects will be built to demonstrate the 'state of the art' of AD (£ 10 million)
  - Quality protocol for production and use of digestate. The Anaerobic Digestate Quality Protocol was published in England and Wales in 2009. In July 2010 it was updated to enable use in Northern Ireland. Contains end-of-waste-criteria for digestate.
  - Feasibility study on the use of biogas in local transport (dating from 2006): *http: //www.environmental-protection.org.uk/assets/library/documents/biogas_as_transport_fuel_june06.pdf*

- Others
  - No specific measures for biogas

Summary

The United Kingdom, Luxembourg and Germany are the only partners with clear biogas promoting policies.

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

- Belgium
  - Limited additional energetic potential of domestic forests

  Germany
  - Performance bonus for the independent industry-wide marketing of wood supply through a forestry association

- Ireland
  - Tools that show the location and size of forest biomass resources available from privately owned forests over a period till 2029
  - Programme for wood energy research that aims to investigate forest management techniques that maximise the level of sustainable biomass production
  - Funding to encourage private forest owners to work collectively in the marketing of forest products
  - Roading grants to assist the early thinning of plantations

- Luxembourg
  - The forest mobilisation, especially of private forests, is planned with a focus on the efficient management, e.g. management plans, reforestation, maintenance of younger plants, replacement of coniferous forests, and on the improvement and development of the forest infrastructure
  - In general, sustainability criteria apply for each type of forestation (Programme forestier national)

- the Netherlands
  - Clean & Efficient Work Programme: tasks set out for forestry sector
    - Promote more intensive landscape management
    - Conclude multi-annual agreements with energy companies for a constant take-up of biomass from the forestry sector

- United Kingdom
  - Forestry apprenticeship scheme to improve skills
  - Felling licences
  - Biomass Energy Centre (http: //www.biomassenergycentre.org.uk)
  - Forestry Standard: UK's requirements for sustainable forest management is being revised
  - Roading grants to assist the early thinning of plantations

Summary

The United Kingdom and Ireland have the most support mechanisms to maximise extraction of biomass through the improvement of forest management in place. Both aspire to do this through research, education and funding. Both Germany and the Netherlands will try to promote marketing of wood supply and a constant take-up of biomass from the forestry sector. Luxembourg will try to increase the sustainable extraction from private forests by improving forest infrastructure. In Belgium there is no significant potential for extraction of biomass from domestic forests.

3.1.3 Impact on other sectors

3.1.3.1 Monitoring of the impact of energy use of biomass on other sectors

- Belgium
  - No green electricity certificates for flows that are reserved for industrial application or for recycling
- Germany
  - Keeps track of number of biomass plants and capacities
  - Assesses import and export of relevant material flows
- Ireland
  - Monitors the effect of feed-in tariffs on prices for raw material
- Luxembourg
  - Preparation of analysis of the interactions between the different uses of biomass and area
- the Netherlands
  - Yearly update of the prices for agricultural products for the last 10 years to analyse the impact of the promotion of bioenergy
  - Green Feedstock Platform to promote biomass in various sectors in the most balanced way possible
- United Kingdom
  - Statistics on the area of non-food crops and roundwood and sawmill product deliveries to wood processing sectors, to wood fuel and to export
  - Focus on bioenergy supplies from purpose-grown energy crops and non-wood waste material to reduce the competition for wood feedstocks

3.1.3.2 Expected development in other sectors that could have an impact on the energy use of biomass

- Belgium
  - Improved use of residual flows
  - Improved use of wood residues from road shoulders, parks, nature reserves and gardens
- Germany
  - Increased global food and feed demand > increased land use competition
  - Conservation targets for preservation of landscapes and habitats > restricted forest biomass use
  - Result: other potentials: forest wood residues, residues from landscape management, organic waste + integrated approach to energy and material use (cascade)
- Ireland
  - Concentration of livestock produce > availability of animal wastes
  - Higher landfill levies > increased supply of waste
  - Wood production will grow by 80% by 2029 > significant proportion used for energy
- Luxembourg
  - No developments mentioned in the NREAP

- the Netherlands
  - Revision of CAP may impact manure availability in the Netherlands. The emerging biorefinery business is not yet expected to impact biomass availability.

- United Kingdom
  - Increased yields of existing energy crops
  - Development of new energy crops

Summary

Germany expects an increasing global food & feed demand and increasing conservation targets. Both will lead to a decrease in biomass availability. That is why Germany suggests an increasing use of wood residues and landscape material and also Belgium stresses the importance of these two streams. In the UK much is expected from new and existing energy crops and Ireland expects an increasing availability of wastes and a big growth of wood production. The Netherlands mention the revision of the Common Agricultural Policy. For Luxembourg no significant developments that could have an impact on the energy use of biomass are mentioned.

3.1.3.3 Recent developments [11]

- Germany
  Timber prices have risen in recent years due to strong demand. This strong demand follows from an improved economic situation and an increasing demand for wood for energy. Stronger competition internationally is also expected in the future for solid fuels.
  The influence of bioenergy use in Germany on international trade prices for cereals is estimated as being extremely low. The growth of biogas plants has led to increased rental prices for arable land in certain regions of Germany.

- Ireland
  In 2009 and 2010 biomass feedstocks had no detectable influence on commodity prices or land-use.

- the Netherlands
  In the case of woody biomass, there is no indication that demand from energy applications in 2009-2010 has led to changes in commodity prices. The price for energy maize however has risen about 25% over the last 6 years. The increase in the use of maize for fermenting has not led to an increase in the area of maize or a change in land use.

- United Kingdom
  Although the demand for biofuels has risen dramatically over recent years, in the UK it will have had a very limited impact on food prices. Biofuels still represent a very small proportion of total agricultural commodity usage within the UK, and furthermore, the prices of agricultural commodities are largely set at a global level.

[11] Progress reports of Ireland, the Netherlands, the UK (2012) & Bundesrepublik Deutschland (2012).

3.2 nBAP[12]

Out of the different partners, Belgium and Luxembourg are the only countries without a BAP. Because the different BAP were not written in the same year, and do not have a fixed structure (unlike the NREAP), it is hard to make a comparison between them. That is why in the following only the aspects that the partners of ARBOR highlighted, when asked about the main targets of their nBAP, are mentioned.

- Germany (2009)
  - Increased share biofuels to a net greenhouse gas reduction of 7% by 2020
  - Increase of biomethane to 6% of gas demand

- Ireland (2006)
  - 30% co-firing in peat stations with biomass by 2015
  - 10% biofuel for road transport by 2020 (Biofuel Obligation Scheme)
  - Bioheat scheme: supports the installation of wood chip and wood pellet boilers in the commercial, industrial, public, voluntary and community sectors

- the Netherlands (2005)
  - A full-grown BAP was concluded in 2005 as one of the first in Europe. It was adopted by BERK (the bioenergy realisation forum) consisting of government, main market players and NGO's. The end date of the BAP was 2010. No further update is foreseen.
  - The BAP dates back to 2005 and is no longer actively pursued.

- United Kingdom (2007)
  - Expanding supply of biomass by sourcing an additional 1 million dry tonnes of wood per annum from currently unmanaged woodland in England
  - Expanding supply of biomass by increasing the amount of perennial energy crops up to a further 350 000 hectares across the UK by 2020
  - Expanding supply of biomass by increasing supply from organic waste materials such as manures and slurries, certain organic wastes, source separated waste biomass and waste derived Solid Recovered Fuels (SRF)

[12] National Biomass Action Plans from Germany, Ireland, the Netherlands and the UK.

Chapter 4 - Instruments for the development of biomass strategies

Legislation is necessary to reassure sustainability and preserve the environment. To reassure sustainability of biomass, sustainability criteria are being set out and are, starting from the EU level, already imposed for biofuels and bioliquids. The conducted policies worked out in legislation and support measures however have a large impact on the realisation of bioenergy projects.

4.1 Legislation

To indicate the large influence of legislation on bioenergy practices, a legislative overview was made based on the templates[13] that have been filled out by the partners in the ARBOR project. Below an overview of some points of interest is given, based on the information given in the templates. This overview contains information about permits, inputs, outputs and incentives for wood boilers, anaerobic digesters and biofuels.

4.1.1 Wood boilers

4.1.1.1 Permits

- Belgium
  - Small scale installations do not require an environmental permit unless treated wood waste or untreated non-massive wood waste is burned.
  - Large scale installations require an environmental permit.
  - A building permit is not necessary if the wood boiler is placed inside an existing building or if it is a mobile construction (no fundaments in the soil)

- Germany
  - Waste wood and wood burning until 1 MW threshold need a simplified building permit
  - Waste wood and wood boiler > 1 MW need a permit which is issued according to the Federal Immission Control Act ("BImSchG"). The permit procedure is either run in a small or big procedure depending on the type of waste wood used.
  - For waste wood categories A III and A IV (organic halogen compounds or wood preservatives) an environmental permit is necessary. Waste wood Category A II (treated or processed wood) and Wood category I (untreated, mechanically processed scrap wood that was not contaminated with foreign substances when used) need a location oriented Pr-evaluation to assess whether an environmental permit is necessary. Within the emission control permit other permits are integrated if applicable (planning and construction permission, environmental impact assessment, public hearings, safety and health related requirements, water law: substances hazardous to water, waste woodlaw: analysis of waste in plants, nature conservation law: offset mechanisms, etc., disposal and use of fertilizers regulations, removal of animal by-products: hygienic requirements.

- Ireland
  - Integrated Pollution Prevention Control (IPPC) licences

- Luxembourg
  - Small scale installations (100 kW) do not require permits
  - Large scale installations or wood boilers >1 MW are classified by the "Commodo" law as "class 1" objects for environmental permitting. However, the permission of large-scale wood boilers is decided from case to case since the legal requirements in Luxembourg are not restrictive. Reference levels for emissions are adopted from the neighbouring countries.
  - The permission of the installation of wood boilers includes the same permits for all commercially or agriculturally used buildings:
    - waste permit for the disposal of the ash: the ash is defined as waste according to the European List of Waste (LoW) (2000/532/EG & 2011/118/EG); the waste permit is provided by the "Administration de l'Environnement" of the Ministère de l'Environnement (The Department of Environment),
    - building permits for the wood boiler: by the local council under the "Commodo" law,
    - building permits for an exterior wood storage with a capacity >300 m^3 and interior wood storages (100- 300 m^3) in industrial, commercial or agricultural zones (Commodo law).

[13] Templates filled out by the countries can be consulted on the ARBOR website (www.arbornwe.eu).

- General regulations apply for the installation of large scale wood boilers in industrial zones and in the "green belt"(permit from the "Administration de la Nature et des Forêts" or Regulatory Body for Nature and Forests).

- the Netherlands
  - Small scale installations (<130 kW) do not require any permits
  - Large scale installations, environmental permit is needed for:
    - CHP installation with untreated wood, often including conditions on heat production.
    - Combustion of waste wood. Relevant authority depends on whether the waste is produced by the organisation itself and to what extent it is treated.
    - Wood pellets/chips installation for industrial use from 20 kW on, for private use from 130 kW on.
    - Combustion installations for waste wood (industrial) also require a construction permit
    - Wood chip installations for professional use also require a construction permit

- United Kingdom
  - Regional (Regional Spatial Strategies) and local (Local Development Frameworks) plans must be developed in accordance with Government planning guidance. For biomass, relevant guidance is provided by:
    - Renewable Energy – PPS 22 (England), SPP 6 & PAN 45 (Scotland) and TAN 8 (Wales), draft PPS 18 (Northern Ireland)
    - Climate Change – PPS 1 (England)
    - Pollution Control – PPS 23 (England) and PAN 51 (Scotland)

4.1.1.2 Inputs (excl. UK)

- Belgium
  - Wood waste that is available for re-use, such as wood waste coming from gardens or urban parks, collected in household waste recycling centres (HWRC) or coming from nature reserves without an approved management plan, can't be burnt. These two streams should be composted and mulched instead. Wooden packaging can't be burnt either, because this stream is going to the chipboard industry.
  - Selectively collected waste which is eligible for material recycling or unsorted industrial and domestic waste cannot be burned. Exceptions which can be combusted, provided that their calorific content > 11 500 kJ/kg: vegetable waste from agriculture and forestry, vegetable waste from food industry, fibrous vegetable waste originating from sorting, sifting and washing in the production of raw pulp, paper and cork waste.
  - Biomass which is not considered as waste (e.g. manure, energy crops) can be combusted at all times, given that the emission standards for the flue gases are fulfilled.

- Germany
  - Waste:
    - Waste wood of categories III and IV are independent of their size and other functions defined as thermal waste for treatment plants according to the Federal Immission Control Act (8.1., Annex 4. BImSchV). An environmental permit is obligatory. The construction and operation follows the regulations of the 17. BImSchV for plants burning waste. Further the German TA Air Regulation applies.
  - Burning energy crops is according to the amended 1. BImSchV (01/2010) allowed if: crops are marked as not for food production, crops meet specified quality aspects, emission thresholds under working conditions are met (by burning no higher emissions than are allowed for dioxins, furans and polycyclic aromatic hydrocarbon: annual monitoring is required).

- Ireland
  - Ireland has launched the Wood Fuel Quality Assurance Certification system (WFQA) in April 2010 to assure good wood fuel quality. Slowly, companies have started taking WFQA certificate for wood fuel supply. Wood wastes or by-products come from wood processing industries e.g. chips, bark and sawdust. These residues are used in board mills as feedstock for production and within sawmills and board mills to provide heat for drying or space heating and to produce steam for the manufacturing process. Additional residues are available from forestry and industrial processes for the generation of high quality wood fuels. High quality wood fuels such as wood chips and wood pellets can be used for domestic buildings, commercial sized buildings and to drive process heat in industry.

- When Miscanthus is burned, the boilers warranty should cover Miscanthus as a fuel.

- Luxembourg
  - The utilisation of each type of waste (amount and type, according to the European List of Waste (LoW) and national regulations) is subject to authorisation from case to case meaning that operators may not react fast to the market conditions.
  - Burning of non-treated waste from wood chips and sawdust, but also waste from treated wood (painted and/or glued) is allowed, but only if the wood is not treated with neither preservatives nor halogens. When wood waste produced in the same type of industry, i.e. carpentries, is combusted; regulations regarding emissions and minimal distance have to be respected.

- the Netherlands
  - An electrostatic filter is required for CHP installations with untreated wood of 5 MWth and larger, combustion installations for waste wood (industry) ≥ 0,5MW and wood pellets/chips installations for industrial use ≥ 0,5MW. For installations <0,5 MW a multi-cyclone is required.

4.1.1.3 Outputs (excl. IRL)

- Belgium
  - Emissions:
    - Small scale installations (<300 kW): measurements required when burning wood waste
    - Large scale: measurements are always required
    - When wood waste is burned the frequency of measurements depends on the type of waste
  - Ashes:
    - Ashes remaining after combustion of biomass can be spread out on the field.
    - Ashes remaining after combustion of waste are always considered as waste. They are eligible for use as "secondary raw material" as a building material or as a soil fertilizer when certain VLAREA-criteria are met (VLAREA = Flemish Regulation on Waste Prevention and Management). When used as a soil fertilizer a utility certificate is required from the Department of Environment.

- Germany
  - Emissions:
    - Emission control according to German TA Air from 1 MW, 1. BImSchV for plants under 1 MW; 17. BImSchV requirements for waste wood over 1 MW.
  - Ashes:
    - Fine fly ash and cyclone ash need to be deposed cost intensively. Coarse ash is defined in German AVV as specially monitored wastes. If certain dangerous parameters are under those thresholds, the authority can announce a deviant determination. A reuse of the coarse ash is nearly impossible.
  - As an additive to fertilizers according to German Fertilizer Law a reuse is newly possible if the coarse ash comes from mono-burning of nature wood out of the combustion chambers. No other ashes for fertilizer use are allowed.

- Luxembourg
  - Emissions:
    - No measurements required for small scale installations.
    - Maximum emissions and the minimum distance (100 m from living area) are regulated for wood combustion systems being installed in carpentries and apply also for large scale wood boilers. Limitations for the fumes of installations ≥1 MW are (at 11 %vol. oxygen) max. 250 mg/m^3 CO, 500 mg/m^3 NOx, and max. 50 mg/m^3 VOC's (volatile organic compounds).
    - Prior to construction of the system, an emission declaration is required from the operator.
    - For all large-scale combustion plants (>50 MW), the emissions have to be measured either continuously or if not continuously then every six months.
    - Reference values for emissions were adopted from the German "TA Luft" (Technische Anleitung zur Reinhaltung der Luft, Bundes-Immisionsschutzgesetz, Germany).
  - Ashes:
    - The same regulations as for waste (European List of Waste LoW and national regulation) apply for the ash, especially for the ash from burning treated wood.

- If ash originates from wood which is grown only for energy production then the ash may be used as fertiliser on the fields with respect to the agricultural practice, but has to meet the requirements for land application of organic fertilisers.

- the Netherlands
  - Emissions:
    - CHP installation with untreated wood: specific emission regulation. Maintenance check once every 2 years.
    - Combustion installation for waste wood (industry), wood pellets/chips installation for professional use: several emission regulations apply to certain installations (depends on the capacity of the installation)

- United Kingdom
  - Emissions:
    - Measurements required, emission limits depend on: manual/automatic stoking, nominal heat output (≤50 kW, 50-150 kW, 150-300 kW) and emission class.

4.1.2 Anaerobic digestion (excl. NL)

4.1.2.1 Permits

- Belgium
  - Building permit only for large installations and small non-mobile installations
  - Environmental permit of the lowest risk class (announce to local authority) for digesters with maximum production of 10 Nm^3 biogas/h, highest risk class for digesters with higher biogas production

- Germany
  - Installations:
    - <10 MW: single building permit
    - >10 & <50MW: simplified emission control permit without public involvement
    - >50 MW: emission control permit incl. public involvement
  - Emission control permits integrate other necessary permits
  - Installations are only permissible within municipal development plans located in certain areas (special area for renewable energy usage, housing area when agricultural/forest holding, other industrial undertaking in housing/mixed area, industrial undertaking in trading estate area, not essential impacting industrial undertaking in core area) and in certain outside areas (when it concerns biomass on a holding with livestock + for public power supply + local input (incl. neighbours) + 1 plant/holding + <0,5 MW)

- Ireland
  - Building permit
  - Approval from Department of Agriculture, Fisheries and Food (DAFF)
  - Environmental Impact Statement is needed when feedstock is deemed as waste and when annual intake >25 000 tonnes
  - Focus on proximity towards inputs, access to infrastructure and potential users and on suitable distance from residential areas

- Luxembourg
  - No difference between large & small scale
  - Building permit
  - Case to case decisions for permitting by 'Administration de l'Environnement'
  - Additional permit for installation in non-agricultural areas (e.g. green belt)

- United Kingdom
  - Building permit for large scale
  - Environmental permit exemption for very low risk small operations
  - Environmental Impact Assessment is required if input >50 000 tonnes waste or in a sensitive location, but can also be requested in other cases depending on local council authority

4.1.2.2 Inputs

- Belgium
  - In agricultural areas:
    - max. 60 000 tonnes input/year,
    - min. 60% of input streams has to originate directly from agriculture/horticulture (animal manure & products coming from plants not considered as waste)
  - Some provinces with high manure production require minimum manure input (e.g. 33%)
  - Installations processing waste streams need a VLACO quality certificate
  - Requirements for processing animal by-products according to EC No 1069/2009
  - Large installations also need to be recognised by the Flemish Public Waste Agency when other animal by-products than manure are used

- Germany
  - Waste:
    - <10 tonnes/day: single building permit
    - >10 & <50 tonnes/day: simplified emission control permit without public involvement
    - >50 tonnes/day: emission control permit incl. public involvement
  - Animal by-products: hygienic and phyto-hygienic pre-treatment necessary when outputs are used as fertiliser

- Ireland
  - Categorisation of waste allowed for digestion

- Luxembourg:
  - Authorisation is needed for each type of waste used for digestion

- United Kingdom
  - Waste:
    - A list of biowaste types suitable for AD can be found in Appendix B of the Quality Protocol for Anaerobic Digestate.
    - Bioplastics must comply with the quality standard BS EN 13432 or either of the similar standards DIN V 54900 or ASTM D6400.
    - 'Home compostable' are only allowed if they meet the requirements by the Environment Agency
  - High risk (Category 2) animal by-products (ABP) cannot be used as feedstock in biogas plants, except where they have first been rendered to the 133°C/3 bar/20 minute EU pressure-rendering standard.
  - Manure and digestive tract content are classified as a category 2 ABP, but they can be used without processing as raw material in a biogas plant. (plant must be approved first)

4.1.2.3 Outputs

- Belgium
  - <u>Digestate:</u>
    - When manure is co-digested, digestate is considered as 100% manure and has to be applied following the fertilisation restrictions for animal manure. When no manure is used for digestion: fertilisation can occur following restrictions for other fertilisers
    - When animal by-products are used as input, digestate needs to be pasteurised when exported (Regulation EC No 1069/2009).
  - <u>Biogas:</u>
    - No injection of biogas into the grid for the moment
    - Flanders: technical recommendations for biomethane
    - Walloon region: decree about labels of origin for biomethane

- Germany
  - <u>Digestate:</u>
    - German fertiliser ordinances
    - Biowaste ordinance
    - Sewage sludge ordinance

- Biogas:
  - Technical minimum requirements in "Arbeitsblätter G260a und G262".
  - The grid operator is obliged to an economically feasible grid extension, also in relation to pressure rise in terms of gas recovery for a continuous annual injection

- Ireland
  - Digestate:
    - Animal by-products regulation
  - Biogas:
    - Biogas can be injected into the grid after compression to pipeline pressure
    - 1 unit (0,5 MW) is contracted for connection

- Luxembourg
  - Digestate:
    - Digestate has to be analysed for a number of parameters including fermentation status according to the German requirements (Gütesicherung Kompost)
  - Biogas:
    - Biogas can be injected into the grid after compression to pipeline pressure
    - Injection is possible, biogas must have the same quality as natural gas (amendment of LPG (<10%))

- United Kingdom
  - Digestate:
    - Certification of outputs through PAS110 quality control
  - Biogas:
    - Biogas can be injected into the grid after compression to pipeline pressure
    - For biomethane to cease being a waste, the producer currently has to apply for an end of waste test through the Environment Agency
    - Currently a regulatory position on biomethane is being prepared

4.1.3 Biofuels (excl. D, NL)

4.1.3.1 Permits

- Belgium
  - An environmental permit is needed for an oil press, starting from 5 kW. Stocking more than 10 tonnes PPO requires an environmental permit
  - A building permit is not necessary if the oil press is placed inside an existing building or if it is a mobile construction (no fundaments in the soil).

- Ireland
  - Integrated Pollution Prevention Control (IPPC) is required
  - Waste Collection Permit to collect the oil from the restaurants

- Luxembourg
  - Construction and operation of biofuel plants are regulated by the Commodo law. The installation of biofuel producing facilities needs the permits from both the Departmentsof Labour and the Environment.
  - The installation of large scale biofuel plants includes further permits:
    - waste permit: according to the European List of Waste (LoW), the permit is provided by the "Administration de l'Environnement" of the Ministère de l'Environnement (Department of Environment)
    - water permit: taking into account the sealing of surface areas, discharge & treatment of waste water and surface water from the buildings, the permit is provided by the "Administration de la Gestion de l'Eau" (Regulatory Body for Water)
    - building permit: by the council.

- United Kingdom
  - Depending on the quantity and the method of production an environmental permit or registering an exemption from environmental permitting may be needed.

- Producing biodiesel or bioethanol by chemical means from waste or virgin vegetable oils requires:
  - a PPC permit if you make more than 5 000 litres per year
  - a waste management licence if you make less than 5 000 litres per year
- Animal by-product legislation when using animal by-products

4.2 Sustainability criteria

According to the renewable energy directive (RED) 2009/28/EC sustainability of biofuels is obliged and is checked using the sustainability criteria. These criteria consider:

- Greenhouse gas savings from the use of biofuels should be at least 35%, 50% by 2017 and 60% for installations starting in 2018 or later.
- Raw materials cannot be obtained from land with high biodiversity or land with high carbon stock.
- Cross compliance rules under the CAP must be met.

Member states have the responsibility to verify if companies are implementing the sustainability criteria. Verification happens in three ways: 1) companies report to EU member states about sustainability of their biofuels, 2) bilateral and multilateral agreements are organised between EU and other countries on these sustainability criteria and 3) voluntary national and international certification schemes can be set up, which the European Commission accredits as sufficient proof to verify sustainability (Martikainen & van Dam, 2010).

A report on requirements for a sustainability scheme for biomass other than bioliquids and biofuels was published accompanied by an impact assessment (COM, 2010) in which it was concluded that binding criteria could cause substantial costs and that it would be better at that stage to develop national schemes that take into account the national market and the targets for renewable energy. It is important that national sustainability schemes are not a disguised restriction on trade and also do not disturb the internal market. These schemes should use similar criteria as the criteria mandated for biofuels and bioliquids. The situation will be reviewed at the end of 2011 (European Commission, 2012; Martikainen & van Dam, 2010; Mertens et al., 2011).

At the moment efforts for sustainability in bioenergy production have already been made at national and regional levels. An overview of some of these efforts is given below for the different countries working on the ARBOR project. Where progress reports of 2012 were yet available some primary conclusions from these reports were added as well.

4.2.1 Belgium[14]

4.2.1.1 Sustainability criteria for green electricity from biomass

The supporting system for green electricity in Belgium is situated at the regional level. In Flanders the supporting system, with VREG (Flemish Regulator of the Electricity and Gas market) as its issuing body, is based on the assignation and selling of green electricity certificates: one certificate equals the net production of 1 MWh green electricity. Sustainability criteria within this system are mainly focused on ecological and economical sustainability. Not all types of biomass generate green certificates, for example: specific types of wood that can be used in industrial processes and for recycling. The certificates are based on the net energy production. Energy needed for transport and pre-treatment of biomass is subtracted from the net energy production of the plant. Transport over long distances is disadvantaged this way. VREG also uses a certification system for imported biomass flows. Except for good environmental practices, sustainability during energy-crop production is not considered.

[14] References:
- BAP Driver (2009).
- Communication with Accoe, F., Dangreau, G., De Dobbelaere, A., Dhooghe, W., Ghekiere, G., Lebuf, V., Meers, E. and Michels E. (2011) from VCM, POM West-Vlaanderen, Inagro and Universiteit Gent, 11/10/2011.

4.2.1.2 Sustainability criteria for biofuels

Since the 1st of January 2008, the binding requirements for energy crop production for biofuels and bioliquids within the directive 2009/EC/28 are applicable. Production of biofuels in Belgium is regulated using quota which give the right to a tax exemption. In the solicitation procedure for the production quota important criteria were the sustainability of the resourcing and production of the biofuels: minimisation of pesticides and fertilisers, minimisation of the distance between the location of the raw material and the location where the biofuel is produced. CO_2-balance of final products and energy efficiency of the plant were also important criteria. In Belgium seven companies were approved.

4.2.1.3 Focus on sustainabilityin policy frameworks

According to the Flemish Energy Agency the Flemish waste policy is based on the 'Ladder of Lansink': minimise the use of non-renewable sources, optimise the use of renewable sources, maximise the prevention of waste production, maximise the use of waste as a secondary resource and minimise the environmental impact while processing waste products (BAP Driver, 2009).
Belgium expects prescriptions and certification systems to be made uniformly for all countries at EU level, since a multitude of certification systems can cause double counting and make administration more complicated. In this context Belgium participates in the CEN TC 383 working groups (NREAP, 2010).

Progress report 2012:

Not yet available.

4.2.2 Germany[15]

The sustainable generation of biomass for energetic utilisation is regulated by European law under the directive 2009/28/EC. So far, this directive is only implemented into national law through two ordinances since 2010.[16]

The verification for sustainable produced biomass for energetic utilisation is a pre-requirement for certain compensation, tax relief or quota fulfilment. The verification is so far only valid for liquid biomass.[17] According to a report from the Commission of the European Union from the 25th of February 2010, the sustainability criteria for biofuels and liquid fuels can be readily adopted to other types of biomass. At the moment, legal binding or even contractual penalties are not in place due to the risk to the European economy.

The use of biomass for biogas plants is defined through the classification of approved biomass by the biomass ordinance. So far no additional sustainable criteria are integrated. In the amendment of the EEG 2012, coming into effect on the 1st of January 2012, the biomass ordinance will be amended and will have no further requirements with regard to additional sustainability criteria.

Progress report 2012[18]:

- Greenhouse gases:

Net saving of GHG emission by use of renewable energy (t CO_2 eq)	2009	2010
Renewable electricity	69 Mio.	75 Mio.
Renewable heating & cooling	33 Mio.	40 Mio.
Renewable transport	5 Mio.	5 Mio.

[15] References: • Communication with Baur, F., Weiler, K. and Speck, M. (2011) from the IZES gGmbH organization, 31/08/2011.
• NREAP (2010).

[16] Ordinance for the requirements of a sustainable production of liquid biomass for the electricity generation (Biomassestrom- Nachhaltigkeitsverordnung - BioSt-NachV) and ordinance for the requirements of a sustainable production of biofuels (Biokraftstoff- Nachhaltigkeitsverordnung-Biokraft-NachV)

[17] If in the biogas plant a dual fuel engine with canola oil is operated, the operation of the interface has to be certified, but not for the substrates which are grown for the digestion in the biogas plant.

[18] Bundesrepublik Deutschland (2012).

- Biodiversity, water resources, water quality and soil quality

Multiple research projects have been carried out to evaluate the impact of bioenergy production.

- Land use:

In 2010, 12% of agricultural area was used for biomass (for energy) production. From 2010 to 2011 the area of biomass grown for energy production increased by 7.7%. A quarter of the total maize area is used for energy production. Biomass for biogas production is grown on 650 000 ha (2010). Biomass for bioethanol and biodiesel/plant oil is grown on respectively 240 000 (2010) and 940 000 ha (2010). The area of biomass for biodiesel/plant oil is estimated to have decreased slightly.

4.2.3 Luxembourg[19]

The document with further information on the NREAP for Luxembourg states that: "provisions in the Directive on the sustainability criteria were transposed into national law by the Grand-Ducal Regulation of 27 February laying down the sustainability criteria for biofuels and bioliquids (Memorial A No 41 of 2 March 2011, p. 590)."

Progress report 2012:

Not yet available.

4.2.4 Ireland[20]

The legal basis for the Biofuel Obligation is the Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010. The Obligation, which came into force on 1 July 2010, is operated by the National Oil Reserves Agency (NORA) (NREAP, 2010). According to the National Oil Reserves Agency (Ó Cléirigh & McGrath, 2011) implementation of the sustainability criteria for biofuels from the renewable energy directive 2009/28/EC (RED) was expected in January 2012.According to NORA (2012) information about complying with sustainability criteria at the moment is not yet required.

Ireland does not intend to develop voluntary schemes for sustainability of biofuels and bioliquids (NREAP 2010).

Progress report 2012[21]:

- Green house gases:

Net saving of GHG emission by use of renewable energy (t CO_2 eq)	2009	2010
Renewable electricity	2 032 700	1 856 870
Renewable heating & cooling	767 414	824 780
Renewable transport	216 650	259 020

- Biodiversity, water resources, water quality and soil quality

Because of the mix of feedstocks there was no detectable impact on these subjects.

- Land use:

The increased use of biomass did not have detectable influence on land use.

[14] Permanent Representation of the Grand Duchy of Luxembourg to the European Union (2011).
[20] References:
- Communication with Thampi, R. (2011) from the University College Dublin.
- NREAP (2010); NORA (2012); Ó Cléirigh & McGrath (2011).

[21] Progress report Ireland (2012).

4.2.5 the Netherlands[22]

The criteria and indicators of sustainability in the Netherlands are divided into six categories: 'greenhouse gas balance', 'competition with food, local energy supply, medicines and building materials', 'biodiversity', 'prosperity', 'welfare' and 'environment'. According to the NL Agency (2011) the criteria from the renewable energy directive 2009/28/EC (RED) were implemented in the Dutch policy for biofuels in 2011. A lot of initiatives have commenced to develop sustainability systems also called 'voluntary schemes' for biomass and biofuel. According to the Dutch biofuels legislation (1/1/2011) only the systems approved by the European Commission or the Dutch government are allowed. Most involve certification systems although there are exemptions in which ex post verification is used or where only the chain of custody is covered. NL Agency (2011) also states: 'In the Netherlands, the Netherlands Technical Approach (NTA) 8080 on sustainability criteria for sustainable biomass for energy applications was developed in order to allow certification of sustainable produced biomass for energy applications. The NTA 8080 contains details of the sustainability criteria for solid, liquid and gaseous biomass. In the NTA 8081 Certification scheme for sustainable produced biomass for energy applications the regulations for certification with NTA 8080 criteria are defined. The NTA8080/8081 is meant to be applied by organisations producing, processing, trading or using biomass for energy application, and wishes to prove that the biomass was produced in a sustainable manner, so that this may be sold or used as sustainable produced biomass.' According to the NREAP (2010) certification is carried out for and by industry, the government helps to set up the certification.

Progress report 2012[23]:

- Greenhouse gases:

Net saving of GHG emission by use of renewable energy (t CO_2 eq)	2009	2010
Renewable electricity	6359	6883
Renewable heating & cooling	1458	1511
Renewable transport	730	518

- Biodiversity, water resources, water quality and soil quality

In 2009 and 2010 biofuels have mainly been produced with residues from industry (frying oil, animal fats, glycerine). Only 1 factory for the production of ethanol has been started up at the end of 2010. Since almost no crops are grown for biofuel use, impact on these aspects will be small.

- Land use:

The increased use of biomass did not have significant influence on land use. The total area of maize has decreased from 2009 to 2010 (-5%), while the area of energy maize has increased (+67%). 6% of biodiesel was produced from rapeseed, which was mainly imported from Belgium and the United Kingdom. The surface of rapeseed grown in the Netherlands has stayed more or less the same in 2009 and 2010.

[22] References:
- Communication with Wubben, E., Isakhanyan, G., Van Oers, C., de Vries, S. (2011) from Wageningen University and Research Centre, DLV, Province of Utrecht, 9/10/2011.
- NL Agency (2011); NREAP (2010).

[23] Progress report the Netherlands (2012).

4.2.6 United Kingdom [24]

Reporting on sustainability criteria for solid biomass and biogas is mandatory under the Renewables Obligation (a support mechanism in the UK for renewable electricity projects). According to the Department of Energy and Climate change (2011b) mandatory sustainability criteria for solid biomass and biogas exist since the first of April 2011 for biomass electricity generators over 50 kW. These have to report against the following criteria:

- minimum 60% greenhouse gas emission savings relative to fossil fuel;
- restrictions using material from land with high biodiversity or high carbon stock.

From April 2013 on, generators starting from 1 MW capacity will have to meet these criteria to be able to receive Renewables Obligation Certificates. For biofuels and bioliquids the RED sustainability criteria also have to be met. Ofgem (Office of the Gas and Electricity Markets) gives guidance in complying with the criteria.

Progress report 2012 [25]:

- Greenhouse gases:

Net saving of GHG emission by use of renewable energy (t CO_2 eq)	2009	2010
Renewable electricity	9 300 535	10 449 675
Renewable heating & cooling	n.a.	n.a.
Renewable transport	1 823 690	1 917 385

- Biodiversity, water resources, water quality and soil quality

In 2009 and 2010 respectively 99% and 85% of biofuels complied with a voluntary scheme or originated from by-products. The ACCS (now Red Tractor Farm Assurance) requires compliance with the UK Government code of practice for protection of water, soil and air by farmers, growers and land managers. It also requires compliance with the UK's Environmental Impact Assessment Regulations. No additional data relating to the impacts of the production of bioliquids on biodiversity, water resources, water quality and soil quality are available. Since electricity generated from crop derived bioliquids was estimated to be extremely low in 2009 and 2010, impacts are likely to be negligible.

- Land use:

There was an increase (+147%) in the land used for oilseed rape and sugar beet as biofuel feedstock between 2009 and 2010. There are large increases in the land used for wheat for biofuel production. 2% of the total UK wheat crop in 2010 is used for biofuel production. In the past few years the project EUBIONET III has made an overview of certification systems (forest, agriculture, heat & power and transport) in different countries. In this overview different existing certification systems were analysed to see how well they could serve as a certification system covering all sustainability criteria. The conclusion was that only the recently developed certification systems RTFO, NTA8080, ISCC and RSB cover all sustainability requirements (Martikainen & van Dam, 2010).
On 19th July 2011, the European Commission approved seven voluntary schemes:

1. **ISCC** (International Sustainability and Carbon Certification)
2. **Bonsucro EU**
3. **RTRS EU RED** (Round Table on Responsible Soy EU RED)
4. **RSB EU RED** (Roundtable of Sustainable Biofuels EU RED)
5. **2BSvs** (Biomass Biofuels voluntary scheme)
6. **RBSA** (Abengoa RED Bioenergy Sustainability Assurance)
7. **Greenergy** (Greenergy Brazilian Bioethanol verification programme)

[24] References:
- Department of Energy and Climate change (2011b).

[25] Progress report UK (2012).

4.3 Support measures

4.3.1 Overview

	Belgium (see 4.3.2. for further info)	Germany (see 4.3.3. for further info)	Ireland (see 4.3.4. for further info)	Luxembourg (see 4.3.5. for further info)	the Netherlands (see 4.3.6. for further info)	UK (see 4.3.7. for further info)
Incentives for investments						
Tax incentives	Y	N	Y	N	Y	Y
Investment grants	Y	Y	Y	Y	Y	Y
Low interest loans	Y	Y	Y	N	Y	Y
Support measures per unit green electricity produced						
Certification system	Y	N	N	N	N	Y
Feed-in tariffs	N	Y	Y	Y	N	Y
Other	CHP Certificate System	Y	Y	Y	SDE+	Y
Support measures per unit green heat produced						
Any existing?	Y	N*	N	Y	Y	Y
Support measures per unit biomethane produced						
Any existing?	N	Y	N	Y	Y	N[26]
Support measures for biofuels						
Reduction in excise duty	Y	Y	N	Y	Y	Y
Other				Investment incentives	TAB – Filling stations for alternative fuels IBB: Innovative Biofuels	Renewable Transport Fuel Certificates
Others						
		Demonstration support: KlimaPlusSaar, Future Energy Program Technology. * EEWärmeG: accelerate RE heating/ cooling in buildings by certain quotas. Target of making public buildings an example of how to use renewables for heating and cooling; obligation to use RES to heat a part of new buildings / old buildings undergoing major renovations. EEG: obligation for heat recovery in biogas plants built since 01/2012	Obligation to use RES to heat new buildings Revised simplified application procedures for authorisations to construct and licenses to generate (< 40 MW) Renewable Energy R&D Programme Renewable Energy Information Office	Investment incentives	Green deal Energy Innovation Agenda	

[26] Biogas is eligible for Renewable Transport Fuel Certificates provided that it is dutiable and produced wholly from biomass.

4.3.2 Belgium

Incentives for investments

Tax incentives: Fiscal deduction for individuals when investing in a wood boiler and a reduction of the taxable profits for companies that invest in renewable energy.

Investment grants: VLIF: investment support for farmers (28% of the total investment).

Ecological Investment Support: for SME & large enterprises, only in case of extra-costs due to ecological investments.

Low interest loans: 'Green loans' for individuals when investing in a wood boiler (stops in 2012).

Support measures per unit green electricity produced

Green electricity certificates: for every MWh produced a green electricity certificate is handed out to the producer. It is possible to sell these certificates on the market to an electricity supplier. Electricity suppliers have an obligation to supply a certain percentage of their total amount of electricity as "green" electricity (6% in 2011, 7% in 2012, 8% in 2013 and up to 13% in 2021). If they fail to do so they have to pay a €110 fine in 2012. In 2013 this fine will be reduced to €100.

Distribution companies also have a procurement duty for these certificates at a minimal guaranteed price. This guaranteed price depends on the type of technology used.

CHP certificates: Same system as for GEC. For every MWh of primary energy that was saved one certificate is handed out. The minimal guaranteed price is set at €27 and the fine to be paid by electricity suppliers is €41.

Support measures per unit green heat produced

Green Heat Energy Action Plan starts in 2012. The highlight of the Green Heat Energy Action Plan is a new support mechanism for large industrial plants. Twice a year companies can submit projects with a capacity over 1 MW. The selected projects get a fixed price per unit green heat produced during 10 years. The maximum support is € 6 per MWh. In 2012, 2013 and 2014 there is 4 million EUR available for new projects.

Support measures for biofuels

PPO is exempt from taxes. Also 7 producers of biofuels get an annual quotum for the production of a certain volume of biofuel that is exempt from taxes. In 2011 the total quotum was 250 million liters for bio-ethanol and 380 million liters for biodiesel. These biofuels can be added to normal diesel (max 7% of biodiesel) and gasoline (max 5% of bio-ethanol).

[26] References:
- Communication with Baur, F., Weiler, K. and Speck, M. (2011) from the IZES gGmbH organization, Germany
- Communication with Accoe, F., Dangreau, G., De Dobbelaere, A., Dhooghe, W., Ghekiere, G., Lebuf, V., Meers, E. and Michels E. (2011) from VCM, POM West-Vlaanderen, Inagro and Universiteit Gent, Belgium
- Communication with Koster, D. & Arenz, M. (2011) from the CRTE (Centre de Recherche Public Henri Tudor), Luxembourg
- Communication with Thampi, R. (2011) from the University College Dublin, Ireland Communication with Wubben, E., Isakhanyan, G., Van Oers, C., de Vries, S. (2011) from Wageningen University and Research Centre, DLV, Province of Utrecht, the Netherlands
- Communication with Al-Shemmeri, T., Danneels, S., Jones, N., Oberweis, S., Phair, K. (2011) from Staffordshire University and Stoke-on-Trent City Council, UK

4.3.3 Germany

Incentives for investments

Market Incentive Programme (MAP): Capital grants for small scale (max 100 kW) pellet boilers and stoves, wood chip plants, log and pellet gasification boilers, for biogas plants with max 70 kW_{el} and biogas purification plants. Low interest loans for small scale bioenergy installations, up to 5 million EUR + units for combustion/gasification of solid biomass (> 100 kW).

GAK: Promotion under the Joint Task of Improving Agricultural Structures and Coastal Protection. Since 2008 investment in supply systems for heat and electricity generated from biomass has been promoted with funding provided under the heading of integrated rural development.

Support measures per unit green electricity/biomethane produced

EEG 2009/Feed-In Tariff Law: capacity oriented basic tariff system plus cumulative boni when using innovative techniques, energy crops, CHP.

Amendment EEG 2012/ New Feed-In Tariff System for biogas plants operated since 01.01.2012:

- Basic Fee for mainly agro-industrial side products
  - E.g. Waste bread, backery residues, potatoes, rape cake, food residues; road greeneries, etc.
- Cumulative tariff from biomass input category I: former energy crop bonus
  - E.g. maize, corn crops, sugar plants, etc.
  - But limitation of maize and corn crop input to 60 mass percent
- Cumulative tariff from biomass input category II: no sufficient energetic utilisation
  - E.g. straw, manure, agricultural grass, landscape conservation material etc.
- Cumulative tariff for injection of biomethane into the gas grid
- Degression of 2% on basic tariff but no degression on cumulative input-based tariffs due to raw material price development
- Extra high (non cumulative) tariff for organic wastes, if at least 90% waste input
- Input combination and proportional input related tariffs
- Special tariffs for small agricultural plants (75kW) with a minimum of 80 mass percent manure
- No tariffs for waste wood, forest wood or liquid biomass
- Obligation for minimum heat recovery of 60% (annual balance)!
- Market and flexibility bonus for direct power sales to third parties (private market)

Support measures for biofuels

2^{nd} generation biofuels, fuels with an ethanol share of 70-90% as well as biogas are exempt from taxes.

4.3.4 Ireland

Incentives for investments

Wood biomass Harvesting Machinery Scheme: The Department of Agriculture and Food has introduced a special scheme of support for biomass harvesting machinery, such as harvesters and chippers for processing of forest biomass. The funding being provided is 1.2 million EUR, and the scheme has attracted significant attention to date.

Energy Crops Premium Scheme: The Department of Agriculture and Food has also introduced a new Bioenergy Scheme (since 2007) providing establishment grants to farmers for up to 50% of the costs associated with establishing Miscanthus and willow.

Accelerated Capital Allowance: A tax incentive scheme for companies to purchase specified energy-efficient equipment, e.g. biomass boilers, thereby improving the overall energy efficiency of Irish businesses.

Low-interest long-term loans are used for financing biogas plant projects.

Support measures per unit green electricity/biomethane produced

REFIT 3 offers new support tariffs for biomass technologies. The expected result of REFIT 3 is 310 MW of biomass technologies (anaerobic digestion, high efficiency CHP and biomass combustion and co-firing). REFIT 3 was planned to be implemented in January 2012. Significant higher tariffs will be awarded for high efficiency CHP and for anaerobic digestion when compared with biomass combustion and biomass co-firing.

It is intended that the REFIT scheme will also incentivise renewable heat production, although payable on exported electricity.

Support measures for biofuels

The Biofuel Obligation Scheme is new since 2010 and replaced the MOTR Scheme (Mineral Oil Tax Relief). Biofuels Obligation Certificates are awarded for the supply of one litre of biofuel. These certificates may then be traded amongst account holders.

To encourage the development and use of second generation biofuels, the Biofuel Obligation Scheme awards double certificates for each litre of second generation biofuel placed on the market.

Other

Part L of the Second Schedule of Building Regulations: a reasonable proportion of the energy consumption of the dwellings should be provided by renewable energy sources.

Renewable Energy R&D Programme: Financial support for demonstration and R&D, targeted at developers of renewable energy technologies.

Renewable Energy Information Office: This is an information service on renewable energy that provides the public with a service whereby they can easily obtain practical information on renewable energy.

4.3.5 Luxembourg

Incentives for investments

- On private household level for wood firing systems (25-30% of the investment costs). Condition: combination with a power and combustion control, and automatic feeding and ignition. In order to receive investment subsidies for the installation of a wood pellet oven coupled to the heating system, >50% of the heat has to be fed into the central system
- On private household level for connection to a district heating grid (€50/kW)
- For companies investment incentives are provided for the installation of wood boilers.
- On agricultural level for wood heating systems (35% of the investment costs)
- On agricultural level for biogas production and CHP or feed into the natural gas grid (35% of the investment costs)

Support measures per unit green electricity produced

Feed-in tariffs: Different classes depending on capacity and technology. Some tariffs are degressive.

Support measures per unit green heat produced

Since January 2008, a so-called *"heat premium"* (prime de chaleur) has been introduced. This premium differs according to technologies (solid biomass, biogas and waste wood) and is granted for each MWh commercialised.

For example for a wood boiler a heating bonus of 30 €/ MWh commercially used energy is paid if the proportion of the commercialised heat is min. 35% from the total produced heat in the first three years of the installation and min. 75% from the fourth year onwards.

Support measures per unit biomethane produced

Feed-in tariffs: Reglement grand-ducal du 15 décembre 2011


Supplying innovative biofuels
to the transport sector.

4.3.6 the Netherlands

Incentives for investments

Tax incentives:

MIA: Environmental Investment Scheme, up to 36% of the investment costs for an environmentally friendly investment can be deducted from the fiscal profits of a business.

With ***Vamil: Random Depreciation & Control Environmental Investments,*** there is freedom of choice with regards to the depreciation of the investment.

EIA: Energy Investment Deduction, 41.5% of the investment costs can be deducted from the fiscal profit of a business.

Investment grants:

Subsidy Innovative Biofuels: Subsidy for investment projects that develop innovative biofuels.

MEI & IRE: Subsidies for the greenhouse horticultural sector. Companies that invest in energy saving e.g. biomass-based boilers get an investment grant. Some provinces also give subsidies for investments related to renewable energy.

Low interest loans: for business & non-profit organisations, to finance their 'green' projects.

Support measures per unit green electricity produced

SDE+: Renewable Energy Production Incentive, subsidises renewable energy in the sectors of electricity, heat and gas. Biomass projects receive a subsidy amount per MWh or per m^3 of biogas injected in the natural gas grid, which is annually set and amended according to actual electricity/natural gas prices, during 12 years independent from the technology. The difference between market price for fossil fuel and break-even price for RES is supported by the scheme (between a minimum and a maximum). In 2012 it's the first time that renewable heat projects are eligible for SDE+ support.

Support measures for biofuels

TAB: A subsidy can be applied to set up a filling point for alternative fuels such as natural gas/green gas, E85 (bioethanol) and/or B30 (biodiesel).

IBB: This subsidy programme supports projects that improve or renew the process for supplying innovative biofuels to the transport sector.

Other

Green Deal: The Green Deal offers governmental support for sustainable projects that have difficulties getting off the ground. It aims to eliminate statutory and regulatory problems, and to ensure effective information provision and bring about effective cooperation. The Green Deal covers specific projects in areas such as energy saving, sustainable energy, sustainable mobility and sustainable use of raw materials and water. The Green Deal does not include any subsidies.

Energy Innovation Agenda: This includes a large number of support measures aimed at the acceleration phase of the energy innovation chain. Renewable energy forms a large part of this package.

4.3.7 United Kingdom

Incentives for investments

Enhanced Capital Allowance: Businesses can write off the whole of the capital cost of their investment in energy-saving technologies (e.g. combined heat and power) against their taxable profits of the period during which they make the investment.

Woodland Improvement Grant: Access infrastructure and preparation for harvesting can be funded up to 60% of the costs.

English Woodland Grant Scheme provides a range of other grant support for landowners wanting to create new woodland or to carry out sustainable woodland management. Also grants for harvesting machinery and supply chain activity may be available on a regular basis.

Energy Crops Scheme offers grants to farmers in England for the establishment of energy crops such as Miscanthus and short rotation coppice (£1000 per hectare for short rotation coppice and £800 per hectare for Miscanthus).

Rural Development Programme for England: Rural Development Agency grants are available to develop energy projects or small scale on-farm renewable energy technologies, including AD, biomass boilers and CHP, and hydro or wind turbines. Rural Development Programme can also support alternative agriculture such as growing the feedstock for use in low carbon renewable materials and fuel. It includes the ECS.

Forestry Micro-enterprise grant: Grants between £2 500 and £25 000 will be available towards buying new machinery or equipment, building, handling or storage facilities or installing woodfuel systems.

Community Sustainable Energy Programme has been set up to help non-profit community based organisations in England to reduce their energy bills and environmental impact. Both capital and project development grants are available under this scheme. Capital grants are available for the purchase and installation of a range of low carbon technologies such as solar water heating, photovoltaics or wood fuelled boilers, along with various energy efficiency measures such as cavity wall insulation. Project development grants are available for feasibility studies.

WRAP AD Loan Fund: The Anaerobic Digestion Loan Fund (ADLF) is a £10 Mio fund designed to support the development of new AD capacity in England in conjunction with investments from the private sector. Interests will be charged at UK Reference Rate plus a margin based on the level of risk taken by WRAP.

Green Investment Bank: Financial support to mobilise private sector investment into green infrastructure.

Support measures per unit green electricity produced

Renewables Obligation: obligation on electricity suppliers to source an increasing proportion of electricity from renewable sources. In 2011-2012 this proportion is 12.4%, it will be 15% by 2015 and it is likely to be extended to 20% by 2020. If they do not comply with this amount they have to pay a financial penalty called the buy-out.

Renewables Obligation Certificates: normally supply and demand regulate the price of a ROC (2011-2012: £38.69/MWh), but there is also a fixed floor price (= the buy-out price).
The expected result from the Renewables Obligation is to increase the generation of renewable electricity from a range of technologies. The targeted group are primarily licensed large scale renewable electricity generators. The Renewables Obligation started in 2002 and the scheme will remain open to new projects until 31st of March 2017. Support is provided to renewable deployment projects for up to 20 years from time of accreditation.

Feed-in Tariffs (FiTs): Intended for households, communities and small businesses investing in projects up to 5 MW. FiTs were introduced on 1st April 2010 and new entrants will be eligible for 10-25 years, dependent upon the technology.

Support measures per unit green heat produced

Renewable Heat Incentive: a fixed price per kWh produced, when connected to a heat network you get an additional payment for exporting surplus heat. Individuals, communities and businesses all profit from these measures. Open for applications from the non-domestic sector at the end of November 2011. The Government intends that the scheme remains open to new applications until at least 2020. Once in the scheme, support lasts for 20 years.

Renewable Heat Premium Payment: Financial support to encourage the deployment of renewables. Runs from August 2011 to March 2012.

Support measures for biofuels

HM Revenue & Customs: Waste cooking oil benefits from a 20 pence per litre duty differential for a period of 2 years.

Chapter 5 - Regional strategies and case studies

As mentioned in the introduction, ARBOR has 13 different partners from 6 different countries. Each partner works in a certain region, which often also has its own regional bioenergy strategy. These regional strategies are revealed in this chapter, as well as some interesting innovative concepts that were developed in this region.

5.1 Belgium – Flanders[27]

5.1.1 Regional strategy

The Flemish government stated in its PACT 2020 that it wants a leading position among the best performing European regions in 2020. They will do this by stabilising their access to energy sources, by making efficient use of energy and materials and by lowering the emissions of greenhouse gases and fine dust particles. On a provincial level the Province of Limburg is committed to becoming climate neutral by 2020. Also different Flemish cities (Ghent, Antwerp, Genk, Hasselt, Ostend and Leuven) have signed the EU initiative 'Covenant of Mayors'. Flanders prepares a Flemish Renewable Energy Action Plan.

5.1.2 Innovative case 1: Biogas Boeye - co-digestion in agricultural areas

Biogas Boeye is a co-digestion plant which processes manure, biodegradable waste and energy crops. The plant was brought into service in 2008. Total input amounts to 60 000 tonnes per year. The digestion process is thermophilic , because this leads to a higher biogas production than a mesophilic process, however the process should be followed up more strictly. The digestate is separated into a solid and a liquid fraction. The solid fraction is dried and exported. The liquid fraction is filtrated, which leads to a concentrate of the nutrients and a permeate which can be ejected on surface water.

Three CHP installations produce each 716 kWh electricity and 1000 kWh heat per year. Electricity is put into the grid, while heat is used locally for the digestion process, drying of the solid fraction of the digestate, heating of the stables (chicken farm) and buildings.

More information: **www.biogasboeye.be.**

5.1.3 Innovative case 2: Ecowerf - digestion before composting

Ecowerf is an intermunicipal cooperation of 27 municipalities in the province of Vlaams-Brabant. The cooperation's main goals are to prevent, collect and process waste in this region. The energy demand of the cooperation is about 60 000 GJ, mainly for the aeration during the composting process. If their input materials (50 000 t/a: KGW, garden waste from HWRC, organic-biological waste, waste from road shoulders) were to be put in a digester before composting, 97 000 GJ of energy could be produced, so this process would make them self-sufficient. At the moment they are still performing an energy study to estimate the capacity that should be installed. If they decide to sell electricity/heat to surrounding companies, they could increase their capacity and include other input streams, such as sewage sludge from a surrounding water treatment plant.

More information: **www.ecowerf.be.**

5.1.4 Innovative case 3: small digestion at Hendrickx dairy farm

The Hendrickx farm was the first one in Belgium to install a small-scale manure digester in cooperation with Biolectric, who developed this technology in Flanders. Only manure produced on-farm by 65 dairy cows is digested. The heat and electricity produced is sufficient for the energy supply of the whole farm plus the

[27] References:
- Communication with Baur, F., Weiler, K. and Speck, M. (2011) from the IZES gGmbH organization, Germany
- Communication with Accoe, F., Dangreau, G., De Dobbelaere, A., Dhooghe, W., Ghekiere, G., Lebuf, V., Meers, E. and Michels E. (2011) from VCM, POM West-Vlaanderen, Inagro and Universiteit Gent, Belgium
- Communication with Koster, D. & Arenz, M. (2011) from the CRTE (Centre de Recherche Public Henri Tudor), Luxembourg
- Communication with Thampi, R. (2011) from the University College Dublin, Ireland
- Communication with Wubben, E., Isakhanyan, G., Van Oers, C., de Vries, S. (2011) from Wageningen University and Research Centre, DLV, Province of Utrecht, the Netherlands
- Communication with Al-Shemmeri, T., Danneels, S., Jones, N., Oberweis, S., Phair, K. (2011) from Staffordshire University and Stok-on-Trent City Council, UK

adjacent bed and breakfast, run by the farmer and his wife. The capacity is 2000 tonnes of manure per year and the plant produces 64 MWh electricity. This is an excellent example of decentralized energy production which leads to self-sufficiency.

5.2 Germany – Saarland

5.2.1 Regional strategy

Amongst the sixteen federal states of Germany, Saarland came in second last place in the ranking of renewable energy production[28], carried out by the "Agency of Renewable Energies". Current Saarland policies address the acceleration of renewable energy utilization. A set of governmental strategy planning papers have been published to provide a scientific base for future decision makings. The Framework Masterplan "New Energy for Future Location Saarland (2011)", written by IZES gGmbH, portrays the targets and measures for a future oriented energy supply in Saarland considering the sustainable criteria of resource management, environmental and climate protection, social acceptability, security of supply and profitability. Against the background of the so called "Energy and Industry Location Saarland", the priority of renewable energies, the security of the high energy demand at producing business as well as the price stability at consumer's site are analysed and transferred into an Action program until 2050. Main target is the CO_2 reduction of 80% until 2050. Further designated Partial Plans for Biomass, Solar and Geothermal Energy, which portray the available potentials for mobilisation, have been published in 2011 and 2012. The available potential is the result after the reduction of technical, ecological and economical restraints of the general theoretical potential. The biomass potential was elaborated under consideration of essential restrictions, as sustainability criteria (Conservation areas, cross compliance, allowable cut levels by forest management, etc), utilisation concurrences, social aspects (recreation areas, food supply) as well as effects by increasing land efficiency. All data have been matched with relevant local stakeholders.

5.2.2 Saarland innovative case 1: Bioenergie Merzig gGmbH

A biogas plant using input of arable renewable raw materials coming from local farmers: corn input, grass, triticale, whole plant silage and arable crops. The average distance is 15 km to the plant. Inputs are also coming from neighbouring French farmers. The produced biogas is processed into suitable biomethane for injection into the local gas grid. A gas treatment plant is located on site at the biogas plant. 60% of the methane is consumed locally. The plant has a sound eco balance with 1kWh biomethane equal to 250g CO_2 reduction.

The plant became operational on the 28th of June 2011. The capacity of the plant is 2 MW and 51 million kWh of biomethane is produced every year.

More information: **http: //www.enovos.eu/index.php?id=41&L=0**

5.2.3 Saarland innovative case 2: Biomass cogeneration plant Warndt

STEAG New Energies GmbH installed the first ORC plant and the first biomass-CHP-plant based on untreated woodscraps in Saarland. Its input material comes from local forests. The plant is situated in the direct surrounding of a wood storage and wood logs processing plant, re-using the area of an old coal mine and thus demonstrating a successful industrial conversion project. The plant generates 13.4 GWh_{el} and 51 GWh_{therm} to supply about 3350 households with electricity and about 2833 households with heating in a district heating grid.

More information: **http: //www.steag-newenergies.com/fileadmin/user_upload/steag-newenergies.com/info_service/medien/broschueren/pdf/STEAG_Broschuere_Biomasse_warndt_web.pdf**

[28] 55 Criteria's as policy, installed capacities, research projects, green company settlement, number of patent application

5.2.4 France/Saarland interregional innovative case 3: Methavalor

Sydeme (Syndicat Mixte de Transport et de Traitement des déchets Ménagers de Moselle-est) is responsible for the transport and the treatment of the municipal solid waste in the East-Moselle area. In order to manage this task under efficiency and ecological aspects, SYDEME decided to implement a whole new waste collection system involving colour coded bags (orange for recyclables, green for organic waste, blue for residuals). The three bag colours are collected simultaneously in one and the same bin. The three material flows are then separated in an innovative optical sorting pant, where a camera recognises the bag colours and redirects them to the appropriate valorisation path. The green fraction is conveyed into the biogas plant "Methavalor", based on a dry fermentation process, producing electricity, heat, biofuel and/or natural gas (grid injection).

The construction started in June 2009 and the plant became operational in October 2011. The capacity of the plant is 42 000 ton/a household waste.

More information: **http: //www.sydeme.fr/site/index.php**

5.2.5 Bavaria innovative case 4: Greenery residues fermentation plant Regen

Zweckverband Abfallwirtschaft Donau-Wald started up this plant in 2007. It is part of a regional disposal and recycling centre, where the existing composting plants had to be extended due to rising amounts of greenery residues. The leafy and fibrous fraction between 15 mm and 60 mm is fermented together with renewable resources. The solid digestate is further processed together with the sandy fraction to a high-value compost (ca. 18 000 t/a). The resting press-water is used in agriculture as a certified liquid fertilizer. The annual energy production of ca 5 000 MWh_{el} is used to supply 1 500 inhabitants. The waste heat is used in the plant itself, in the facilities of a connected recycling centre and at a nearby situated hotel.

More information: **http: //www.lpv.de/themen/energie-und-klimaschutz/energie-aus-landschaftspflege/best-practice/karte-mit-praxisbeispielen/gruengutvergaerungsanlage-regen-gva-regen.html**
or
http: //www.awg.de/?content_id=aktuelles/vga_regen&menu_id=7

5.3 Ireland – South East Region

5.3.1 Regional strategy

The South-East regional plan covers the counties of Carlow, Kilkenny, South Tipperary, Waterford and Wexford as well as Waterford city. The objective of the plan is to make this region leader for the use and promotion of bioenergy in Ireland. This plan is the only regional plan implemented in Ireland. The South-East Regional Authority (SERA) has developed the plan with the local authorities and local energy agencies in the region such as the Environmental Protection Agency, Teagacs and Sustainable Energy Ireland (SEI). SEI also partly funds the project. The main objectives of the project are to analyse the scope and potential for bioenergy development in the region, to identify and reduce the barriers to the development of the bioenergy sector and harmonise the planning requirements for the bioenergy development in the region.

5.3.2 Innovative case 1: Inchydoney Island Lodge and Spa

Inchydoney Island Lodge and Spa is a luxury 4 star, 67 bed hotel, conference, spa and leisure centre, located near Clonakilty, West Cork, Ireland. The hotel recently converted from a LPG gas system to a wood pellet and solar heating system and is Ireland's largest commercial renewable heating system.

Inchydoney Lodge and Spa has a very considerable (and increasing) heating demand both in terms of space heating for the hotel and spa facilities and the hot water demand. A 50% cost reduction for heating and hot water has been achieved with the solar and wood heating system when compared to the old LPG system. The savings are generated by the reduced fuel costs of wood pellets, a highly efficient boiler and hot water preparation system and the energy from the solar thermal installation.

Facts:

- Boiler size: 450kW (3 X 150kW)
- Wood pellet consumption: 360 tonnes per year
- Solar system: 80m^2 of flat plate collectors
- Payback/fuel savings: €50 000 per year
- Investment: €300 000
- Wood boiler manufacturer: www.kwb.at
- Wood pellet fuel supplier: www.balcas.com

This project was supported by the SEI Bioheat Programme.

5.3.3 Innovative case 2: Teagasc Crops Research Centre

An automatic wood heating system has been installed and commissioned by Natural Power Supply (NPS) Ltd. at Teagasc, the Agriculture and Food Development Authority, at its Crops Research Centre at Oak Park, Carlow. The 100 kW KWB boiler is currently powered by wood chips made from short rotation willow crops but the unit will also be used for trials with fuels such as cereal straws, a by-product of arable farms, rape straw and Miscanthus. The new boiler heats nearly 1 000 m^2 of office, laboratory and workshop space. Teagasc at Oak Park have been pioneers in researching and testing sources of sustainable and renewable energy for several decades. Oak Park is recognised as one of the leading research establishments in this particular field.

This wood chip fuelled boiler was installed by John Wills and Damien Dolan of Complete Corporate Support Services, Dublin with Christian Luttenberger, of Conness, distributors of Austrian- manufactured KWB wood heating boilers. The boiler is a KWB USV 100, with an output capacity of 100kW and has an efficiency of over 90% at rated output and 90% on part load.

5.3.4 Innovative case 3: Gartan Outdoor Education Centre

Gartan Outdoor Education Centre is located on the shores of Gartan Lough close to Letterkenny, Co Donegal. Over 6 000 people visit Gartan each year and take part in a range of water sport and mountaineering courses. The Centre is owned by Donegal Vocational Education Committee (VEC) and caters for the needs of primary, secondary and third level education, as well as the tourism and private sectors.

Recently the Gartan Centre decided to install a wood chip heating system in a new boathouse building they were developing on their 35 ha property. Ursula McPherson, the Centre's director, comments: "Wood heating was a sustainable choice but also makes economic sense for us as we are making fuel savings in the order of €2 600 per year". The new boathouse incorporates shower and changing facilities, a meeting room, coffee shop, boat and equipment storage, work shop and a drying room. The boiler is fuelled with willow wood chip and caters for the full heating and hot water needs.

The willow chips are supplied by Rural Generation Ltd by trailer with the capacity to blow the fuel chip directly into the store, to avoid manual handling. This is a practical solution in cases where access to the fuel store is difficult as such systems can blow chips a distance of 30 metres.

Gartan OEC is the first outdoor education centre in the Republic of Ireland to venture down the wood heating road, and will continue to pursue this policy, with plans to use wood chip from its own estate. "We are satisfied that the technology works and are now planning to investigate using wood chip from the woodlands and hedges of our own estate and locally to fuel the system in the future" said Ms. McPherson.

This boiler is fuelled by willow chip and was installed by Rural Generation, Derry, N. Ireland; Carr & Co., Ballybofey, Co. Donegal and Delap and Waller, Derry, N. Ireland.

The boathouse development was also supported by the Department of Education and Science and Failte Ireland.

5.4 Luxembourg

5.4.1 Regional strategy

Specific plans on a regional level are not applicable for Luxembourg.

5.4.2 Innovative case 1: Naturgas Kielen

Naturgas Kielen is an association of 30 agricultural enterprises who operate a biogas plant and upgrade and inject biomethane into the natural gas grid since 2009. The biogas plant produces 2.8 Mio m^3 of gas (equalling the consumption of 1000 houses) per year with a fermentation capacity of 50 000 tonnes per year. The input materials are: agricultural residues (mainly manure), energy crops (maize silage, other whole plant silage and sunflowers), bio waste and other commercial organic wastes.

5.4.3 Innovative case 2: Ecogen

Enovos, the main energy supplier in Luxembourg and Kronospan, a producer of wood products such as particleboards, oriented strand boards and medium density fibreboards started up the Ecogen project. On the site of the company Kronospan, a wood based cogeneration unit with 5 MW electrical power should generate electricity and heat in order to raise the level of self supply of the company from 50 to 97%. Part of the heat will be used for the drying processes of the production site. Furthermore, pellet production is planned. This project is currently in the phase of the preparation of the permit procedure. The commissioning of the installation is planned for the end of 2013. It is a new phenomenon that large companies as Kronospan invest substantial funds in renewable energy facilities in order to become self-sufficient.

More information: **www.kronospan.lu** or **www.enovos.lu**

5.4.4 Innovative case 3: Kiowatt (Luxembourg)

A convention between the Department of Sustainable Development and Infrastructure, the Ministry of the Economy and Foreign Trade and the company Kiowatt was signed July 25th, 2011, for the construction of a combined heat, cold and power plant (tri-generation) and a wood pellet production unit. The construction is planned for 2012 and the full operation modus is expected in 2015. This project involves three aspects:
1) use of 32 000 tonnes of wood residues for the production of 21 GWh electricity which will be fed into the electricity grid and 93 GWh heat which will be connected to the local district heating grid, 2) generate cooling power for the data centre in Roost nearby, and 3) production of 35 000 tonnes of wood pellets. Heat production power will be 17 MW and electricity power will be 2.6 MW.

More information: **www.mywort.lu/bissen/news/10092839.html**

5.5 the Netherlands – regions Utrecht and Gelderland

5.5.1 Regional strategy

The 'keuzenotitie energiebeleid' (2003) set out 2010-targets for Gelderland, for example a target of 10.5 PJ bioenergy. The targets for the organic fraction in waste incineration and co-firing of biomass in coal-fired plants in Gelderland were collectively 6.5 PJ. These targets were set by the planned capacity of the plants and the agreements by the government for waste generators and processors.

The 'Gelders klimaatprogramma 2008-2012', called 'Aanpakken en aanpassen', strives for climate neutrality in 2050. The province functions as producer, and offers some subsidies. One of the targets is to raise biomass availability from the countryside by 300 000 tonnes wood and grass by 2020.

The 'Notitie Kansen voor biomassa en bio-energie in de Provincie Utrecht' sets out the ambitions of the Province of Utrecht for biomass and bioenergy. The Province of Utrecht is committed to improve the law and regulations for the utilisation of biomass, optimisation of the use of biomass, innovating and strengthening the regional economy by matching supply and demand of biomass.

5.5.2 Innovative case 1: A. van de Groep en Zonen

Van de Groep is a company active in the fish industry (catch to consumer market). The idea for a co-digestion plant started when they were searching for a more sustainable and economically acceptable use for their waste products. To be able to maintain the digestion process different sources of input where found. At the moment the digestion process is more or less manageable with very diverse input products arriving at irregular intervals.

The plant became operational in January 2010. The capacity of the plant is 5.5 million m^3 of input material per year.

More information: **http: //www.energieconsultant.nl/nieuws/2011/Groen-gas-uit-vissenkoppen-en-stroopwafels** (in Dutch)

5.5.3 Innovative case 2: Simon Zwarts

Simon Zwarts is a breeder of ornamental flowers who gasifies wood and water reed (*Phragmites australis*) and uses the gas for a CHP. Research was performed to determine the technical possibilities and the economical feasibility.

There were three suppliers who could install a gasifier with CHP that can use side streams such as reed, next to wood. Main benefit of these side streams is the low price compared to wood. The recovery of CO_2 from this process is not economically feasible. The investment for the gasifier-CHP-installation is 5 to 10 times higher than a natural gas CHP. The investment for the gasifier was only feasible with subsidies for the energy produced and subsidies for the investment.

5.5.4 Innovative case 3: region Arnhem - Nijmegen

Public transport in Arnhem, Nijmegen and the surroundings, in particular 225 buses, will switch to biogas, ideally Bio-LNG. For such a large project 12 million m^3 (Bio)-LNG per year should be produced. Waste processor ARN already invested in a digester to produce over 6 million m^3 biogas per year to be injected in the national gas grid. This was partially enabled by subsidies. Another investor is currently collaborating with Imtech to prepare a 2012-investment for a digester, producing over 6 million m^3 green gas per year.

5.5.5 Innovative case 4: municipality Nijmegen

The huge paper mill NSP in Renkum strives to reduce running costs and transform to a biobased oriented company. Green deals are agreed upon to process biomass from water purification stations in the region to be processed in a CHP. Furthermore, woody biomass and recycled paper processed into pulp is to be used for various biobased activities such as a biorefinery testing site, and fish farming.

5.6 UK – Stoke-on-Trent and Staffordshire

5.6.1 Regional strategy

All Regional Development Agencies (RDAs) will close by March 2012, so the responsibility for economic development and regeneration in England is passed to successor bodies, including Local Enterprise Partnerships (LEPs) and central Government departments. This has led to the creation of a combined LEP for Stoke-on-Trent and Staffordshire.

Stoke-on-Trent City Council has a Sustainability and Environmental Policy (2011) which outlines the City Council's commitment to dealing with its environmental responsibilities but this has not been finalised. They also have a Sustainability and Planning Supplementary Planning Document (2011) which, amongst others, sets out Building Regulations.

There's also a Core Spatial Strategy in which strategic aim 17 is to minimise the adverse impacts of climate change through energy efficiency.

5.6.2 Innovative case 1: John Pointon and Sons Ltd

John Pointon and Sons Ltd (JPS) in Staffordshire have announced plans to construct a £12 million, 60 000 tonnes per annum Food Waste Anaerobic Digestion and renewable energy facility at their site in Cheddleton, Staffordshire. The scheme has been granted planning permission and will be co-funded by a £1.44 million capital grant fund from WRAP and Advantage West Midlands (AWM).

The facility should have been completed in October 2011. It has the capacity to process 60 000 tonnes of food waste with a generating capacity of 2MW of renewable energy per annum, saving 85 000 tonnes of CO_2. In total, it is estimated that 195 000 tonnes of combined commercial and industrial waste will be diverted from landfill in the first five years of operation.

It is the first of its kind in the region of the West Midlands, primarily put in place to use as convincing argument that biomass is a feasible substitution to fossil fuel. Policy makers in the UK still believe that the natural resources of fossil fuel are enough for UK's energy demand. The biomass market is only recently launching and there is a severe lack of know-how among retailers.

More information: **http: //www.pointon.co.uk/digestionplant.htm**.

5.6.3 Innovative case 2: Staffordshire County Council

A green heating system – which will cut costs and carbon emissions – will be keeping staff at Staffordshire County Council warm at the new state-of-the-art Tipping Street development. The building will be heated mainly through biomass, leading to a huge reduction in the use of fossil fuels as well as creating financial savings. The biomass wood fuel supply will also be used to generate the majority of Tipping Street's hot water including the 12 showers that are being provided to encourage staff to leave their cars at home and cycle, walk or even run to work. The new biomass system will contribute to reducing CO2 emissions by 1 750 tonnes each year, saving thousands of pounds for the tax payer. It will also improve Staffordshire County Council's ranking on the government's Carbon Reduction Commitment Energy Efficiency scheme, meaning more money is returned to the council from the central CRC pot. All the wood chips used are produced locally in the area of Cannock Chase.

Just like the food waste anaerobic digester of John Pointon, this is also the first of its kind in the region of the West Midlands.

More information: **http: //www.staffordshire.gov.uk/environment/woodfuel/home.aspx** and **http: //www.staffordshire.gov.uk/Resources/Documents/p/Poweringyourlocalauthority.pdf.**

Appendices

Appendix 1: Overview of relevant biomass projects.

	Focus	Project region	Project period
Graskracht	AD	Flanders	2010-2012
Optibiogaz	AD	North-West Europe	2008-2012
Prograss	AD + Combustion	Herbstein – Hessen & SW Germany	2009-2012
Biomass use from nature reserves	AD + Combustion	Saarland	2004-?
VerKOHt	Combustion	Flanders	2009-2011
Pilot Miscanthus to Energy	Combustion	Rhenen	2008-2010
Wood chips on a dairy farm	Combustion	Oudewater	2008-2010
Analysis of wood species for use as biomass	Combustion	Ireland	?
Novel Solid Biofuel	Combustion	Ireland	?
MABFUEL	Biofuels	Ireland	2009-2013
IKEBANA	Energy Crops	Flanders	2010-2011
Innovation in Miscanthus	Energy Crops	Zeeland	2010-2012
Energy crops trial	Energy Crops	Zeeland/ Noord-Brabant	2008-2010
Energy from Miscanthus	Energy Crops	Noord-Holland	2006-2010
Energy crops for wastelands in the Netherlands	Energy Crops	the Netherlands	In development
Energy from bufferstrips	Energy Crops	Zeeland, Zuid-Holland, West-Brabant	2011-2014
Energy Conversion Parks	Supply biomass	Flanders, the Netherlands	2010-2013

Brief description	Weblink
Evaluation of the potential of mowed grass for energy.	www.graskracht.be
Optimisation of biomass conversion to biogas by supporting of process and use of optimised feeding doses. Regional inventory and material flow/efficiency analysis for exemplary biogas plants in the greater region. Identification of new ways of utilisation and valorisation for the side-products of biogas-production, evaluation of their environmental compatibility (heat, digests, organic fertilizers). Creation of a competence network in the field of biogas technology in the greater region.	
The University of Kassel developed a technological and process orientated approach (PROGRASS) to produce bioenergy (electricity and solid fuel) also from mature grasslands. Conservation of NATURA-grassland area through decentralised energy production.	www.prograss.eu
Study on the potential of the energetic use of biomass from nature reserves in Saarland. Use of the grassy biomass for AD and the woody biomass for heating.	www.lpv.de
Demonstration project on short rotation coppice for farmers. Focus on local applications and biodiversity.	www.energiehout.be
Use of Miscanthus in an advanced combustion installation, for heating water needed in the stables where calves are reared for meat.	www.adbrevio.nl/projecten-verbrandingmiscanthus.html
Use of wood chips and other wooden residues as a result of clearing and pruning. The heat is used directly in the production process of making yoghurt.	www.zuivelboerderij.nl
Chemical and physical analysis of different wood species and assortments from various geographical locations. Assessing suitability as a solid biofuel with respect to ash content, energy values, major and minor elements.	www.wit.ie/research/ResearchGroups Centres/Groups/Forestry/Projects
Development of an energy efficient and environmentally safe novel solid biofuel from forest and sawmill residues mixed with solid pig manure.	www.wit.ie/researchReaseach/Groups Centres/Groups/Forestry/Projects
Investigate the feasibility of using algae as a feedstock for producing biofuels in Turkey and Ireland.	www.dommrc.com/project-mabfuel.html
Stimulate scientific research on environmental aspects when cultivating bamboo, stimulate Good Agricultural Practices, create a network of stakeholders and cultivators.	www.ikebana-bamboo.eu
Optimisation of the cultivation of Miscanthus.	www.dlvplant.nl www.babg.nl
Testing different energy crops.	
Testing, growing and processing Miscanthus (burning).	www.oostwaardhoeve.nl
Using low input crops in abandoned industrial areas and wastelands.	
Looking for new possibilities for the use of buffer strips as an energy source and as an improvement of water quality.	www.duurzameakkerrand.nl
An Energy Conversion Park combines several sources of biomass and applies a highly integrated set of conversion technologies. The Energy Conversion Park project will demonstrate the economic advantages, develop 5 parks, develop a knowledge platform and disseminate the concept.	www.ecp-biomass.eu

Appendices

Appendix 1, part two

	Focus	Project region	Project period
Nature Management Residues	Supply biomass	Flanders	2009-2011
BioMob	Supply biomass	Ireland	2009-2011
WoodEnergy and ForestEnergy	Supply biomass	Ireland	?
EnAlgae (Energetic Algae)	Supply biomass	North West Europe	2011-2015
RUBIN Biomass	Supply biomass	North West Europe	2005-2008
Regional concepts for the expansion of bioenergy-generation from wood	Supply biomass	Saarland	2009-2012
BioRegio	Supply biomass	Saar-Hunsrück, Südlicher Oberrhein, Emscher-Lippe, Nordostvorpommern, Mittelsachsen, K.E.R.N.-Region (all in Germany)	2005-2008
Energy-conscious farming	Other	Flanders	2010-2012
ELKE	Other	Germany	2007-?
The Energyfarm	Other	Limburg (NL)	2009-?
Social and economic feasibility of bioenergy regions in Flanders	Other	Flanders	2010-2011
LUCAS	Other	Luxembourg	2010-2013
SEDIS	Other	Saarland	2003-2007

Brief description	Weblink
Demonstration of how woody and grassy residues of nature management can be used to produce bioenergy. Bring supply and demand sides of these residues in contact with each other.	www.enerpedia.be
Development of research-driven clusters for biomass mobilisation.	http: //cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=10990987
Public demonstration and workshops on harvesting first thinning. The project also determines a number of parameters relevant to fuel quality: moisture content, bulk density, ash content etc.	www.wit.ie/research/ResearchGroups Centres/Groups/Forestry/Projects
Accelerated development of sustainable technologies for algal biomass production, bioenergy and greenhouse gas mitigation.	http: //www.enalgae.eu/index.html
Regional strategy for the sustainable usage of biomass (wood, biogas from animal manure, grass and straw) by the establishment of a network of different actors in the biomass sector on a regional level to initiate and support biomass projects and to develop a strategic master plan for the biomass production in this region.	www.rubin-biomass.deepwe.de
Promotion and support of biomass networks in the Federal State of Saarland, analysis of existing increasing potentials of wood energy, mobilisation of wood fractions which are difficult to access.	http://www.energetische-biomassenutzung.de/de/vorhaben/liste-aller-vorhaben/details/projects/75.html
Development of an optimised biomass utilisation strategy for each model region. Development of concrete regional biomass scenarios and strategies, investigation of the potentials of regional added value-creation resulting from the bioenergy projects. Identification of possible hindering factors in the regional project implementation. Development of a tool for technology assessment.	www.bioregio.info
Project aims to raise awareness among farmers and to assist them in investing in innovations that are energy efficient or that make use of renewable energy.	www.enerpedia.be
Evaluate the environmental effects of certain extensive land-use systems for the production of renewable resources. The major points of interest are effects on biodiversity and protection of abiotic resources (e.g. soil conservation and fertility, avoidance of erosion, water protection…).	www.landnutzungsstrategie.de
All aspects of energy saving and the implementation of renewable energy on arable farms.	www.energieboerderij.nl
Feasibility study and development of possible scenarios for the development of a Flemish "bioenergy village".	http: //www.mipvlaanderen.be/nl/webpage/106/bio-energieregios.aspx
LCA method development for the integration of indirect land use change effects into the life cycle assessment of bioenergy. Case study: indirect land use change effects caused by the expected increase of the biogas production in Luxembourg according to the set of aims in the framework of NREAP.	www.crte.lu
Researching and realising the so-called ETVS process (producing drainage-drying-gasification-electricity). This procedure is for the decentralised processing of liquid, and also paste-like and solid biological waste materials, such as e.g. sewage sludge and matured timber, and its conversion into electrical energy and mineral ashes directly at the place where these wastes arise. The process was analysed by the example of sewage sludge.	http: //cordis.europa.eu/fetch?CALLER=PROJ_ICT_TEMP&ACTION=D&CAT=PROJ&RCN=71342

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