FOSTERING SUSTAINABLE FEEDSTOCK PRODUCTION FOR ADVANCED BIOFUELS ON UNDERUTILISED LAND IN EUROPE

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REPORT ON BEST PRACTICES FOR BIOENERGY POLICY, REGULATIONS AND SUPPORT SCHEMES WHICH ALLOW THE MOST SUSTAINABLE AND ENERGY EFFICIENT USE OF BIO-RESOURCES

GEONARDO

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Contents

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Fostering Sustainable Feedstock Production for Advanced Biofuels on underutilised land in Europe

The FORBIO project aims at developing a methodology to assess the sustainable bioenergy production potential on available "underutilized lands" in Europe (contaminated, abandoned, marginal, fallow land etc.) at local, site-specific level. Based on this methodology, the project will produce multiple feasibility studies in selected case study locations in three countries. The FORBIO project will also apply a series of innovative approaches in order to develop roadmaps for the removal of economic and non-economic barriers to sustainable bioenergy deployment and in order to promote and facilitate the formation of partnerships between farmers, bioenergy producers and local institutions. In addition, the project will carry out awareness raising and capacity building activities in order to share lessons learnt and good practices.

Objectives:

- Identification of social, economic, environmental and governance-related opportunities and challenges for advanced bioenergy deployment through a series of multi-stakeholder consultations
- Evaluation of the agronomic and techno-economic potential of the selected advanced bioenergy value chains in the case study sites of the target countries
- Assessment of the environmental, social and economic sustainability of the selected advanced bioenergy value chains in the target countries
- Analysis of the economic and non-economic barriers to the market uptake of the selected sustainable bioenergy technologies; and development of strategies to remove the aforementioned barriers, including identification of roles and responsibilities of relevant stakeholders
- Encourage European farmers to produce non-food bioenergy carriers and capacity building of economic actors and other relevant stakeholders for setting up sustainable bioenergy supply chains

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1 Introduction

The objective of this deliverable is to identify best practices for bioenergy policies, regulations and support schemes which allow the most sustainable and efficient use of bio-resources from under-utilized land in the target and outreach countries. This collaborative study that uses country specific information collected by FORBIO consortia partners is an outlook to the most recent EU and Member State examples on the legal and practical ("best practices") aspects of bioenergy projects.

In the FORBIO **target countries** (Germany, Italy, Ukraine) the importance of this work is to fuel the discussions with policy makers, both on national and regional levels, in order to identify potential site specific barriers that shall be overcome for supporting sustainable production and use of bio-resources. Knowledge exchange exercises in Task 4.4 could benefit subsequently.

In the FORBIO 5 **outreach countries** (Ireland, Belgium, Poland, Hungary, Romania) the collected information on best practices, policies and regulations can lead to conclude the current gap in legal (support schemes) and economical barriers and opportunities.

Three major strategies (Roadmaps) provide the framework to the EU approach to renewable energy. They determine specific targets and goals for the Member States to achieve until 2020, 2030 and 2050 respectively. A binding legislation has been adopted in the form of the Renewable Energy Directive which concluded that the Member States shall increase the proportion of renewable to conventional energy by 20% (10% in the transport sector) and a reduction of gas emissions to 20% from the baseline level of 1990. To achieve these goals, the Member States are bound to present a national action plan.

The biofuel legislation is based on the Directive 98/70/EC on the quality of petrol and diesel fuels. Its latest amendment of 2015 determines that „Member States are (...) to require suppliers of fuel or energy to reduce by at least 6 % by 31 December 2020 the life cycle greenhouse gas emissions per unit of energy of fuels used in the Union by road vehicles, non-road mobile machinery, agricultural and forestry tractors and recreational craft when not at sea." The biofuels directive 2003/30 further prescribes the substitution of conventional diesel and petrol with biofuels.

Another pillar to biofuels is the sustainability criteria laid down in Directives 98/70/EC and 2009/28/EC which requires the Member States and the Community to increase the use of biofuels in a way which brings a net benefit to the environment. Therefore the EU set out further objectives which anticipate a greenhouse gas emission saving of 35-60%. The relevant calculation method is to be applied by the Member States.

A White Paper from 2011 presented another relevant Roadmap which aims at achieving a resource efficient transport system. This strategy foresees a 60 % GHG reduction in the transport sector by 2050 and to halve the conventionally-fuelled cars in urban transport by 2030. The Commission released in 2013 a strategy on the use of alternative fuels which is non-binding. Directive 2014/94/EU sets forth a binding regulation on infrastructure to be offered by the Member States

Thanks to the above legislation measures in Europe there are **few initiatives of advanced biofuel projects** that are sustainable (environmental, social and techno-economical aspects) and utilize land that is marginal or under-utilized. These initiatives come from the industry or an EU

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research and development support. Examples of the mentioned projects are Clariant, Straubing (DE), Italian Bio Fuel, Crescentino (IT), etc. Additional examples can be found in Section 4.

This FORBIO study that is based on mainly literature available on-line (and off-line) will **point out the conditions that might enable to successfully implement a bioenergy project with a profile of advanced biofuels**. The collected best practices can be good examples therefore.

The collection of information in this deliverable also reveals the differences in several (9) European countries in terms of:

- policy implementation
- level (technical-innovative capacity) of bioenergy projects
- and regulations related to underutilized land e.g. contaminated/mining sites, fallow land etc.

The conclusions of this deliverable –along with other FORBIO findings in WP2 and 3 on agronomic, techno-economic potentials and established sustainability criteria for bioenergy value chains - can be carried to national stakeholder consultations to be implemented later in FORBIO project.

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2 FORBIO target countries

2.1 Germany

2.1.1 Relevant country-specific biomass feedstock types

In Germany, energy crops will have to make the greatest contribution to the planned expansion of energy production from biomass. Energy crops are mainly grown for the following purposes:

- Substrates for biogas production (e.g., maize, grass, cereals, and other crops etc.)
- Woody or lignocellulosic biomass for use as a solid fuel (e.g. SRC - fast growing tree species, miscanthus etc.)
- Sugar or starch or vegetable oils for the production of biofuels (e.g. rape, cereals, maize or sugar beet)

In Germany, several small scale SRC plantations exist. Most of them are driven and controlled by public research institutes, which are using the plantations for research purposes. In 2014, 20 hectare of experimental trials of poplars and 5 hectare of willows were grown in Germany [1]

In Germany biomass feedstocks are grown on more than 2.3 million hectare of arable land. Thereof energy crops account for about 2.1 million hectare. In addition, 11 million hectare of forestry contribute to the biomass production from forestry [2]

2.1.2 Relevant country-specific bioenergy production and processing technologies

Combustion and anaerobic digestion into biogas or ethanol are the most common conversion processes in Germany. A short summary is provided in the Table 1.

Energy source	**Conversion process**	**Yield Heating-oil equivalent l / (ha * a)**
Residues		
Forest waste wood	Combustion	434
Straw	Combustion	2390
Energy crops		
Maize silage	Anaerobic digestion into biogas	5280
Rapeseed oil	Combustion / transesterification into biodiesel	1528
Short-rotation coppice (e.g. poplars, willows)	Combustion	5120
Whole-plant grain silage	Anaerobic digestion into biogas	4013
Grain kernels	Combustion / anaerobic digestion into biogas / anaerobic digestion into ethanol	2232

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Grass silage (e.g. festuca arundinacea	Anaerobic digestion into biogas	3016
Miscanthus (miscanthus sinensis, from the 3rd year)	Combustion	6081

Table 1: Overview on the bioenergy sources, typical conversion processes and yields as heating-oil equivalent in litre per hectare and year (Source: Bioenergy - the multifaceted renewable energy, FNR)

2.1.3 Relevant EU legislation and policies for bioenergy

Directive 1998/70/EC

The EU Fuel Quality Directive specified a six percent decrease in greenhouse gas emissions of fuels by 2020, compared with 2010 [3]

Directive 2001/77/EC

The requirements of the directive 2001/77/EC were integrated into the German law based on the Act on Granting Priority to Renewable Energy Sources (Renewable Energy Sources Act / EEG) from the year 2000, which was amended first amendment in 2004. It was further enlarged for the scope of application of the Renewable Energy Sources Act, about what substances can be considered as biomass, what kind of technical processes for generating electricity from biomass fall within scope and what environmental standards should ne met to the generation of electricity from biomass. [4]

Biofuels Directive 2003/30/EC

The directive makes provisions for the mixture of bioethanol in petrol, which are in accordance with the EU directive on the promotion of the use of biofuels or other renewable fuels for transport. [4]

Directive 2009/28/EC

According to the National Action Plan under Directive 2009/28/EC the share of renewable energies in in the transport sector it will amount to 13.2 % by 2020 in Germany. The EU Commission and the German Federal Government are promoting the use of biofuels from non-food feedstocks.

In the transport sector, the European directives and regulations are implemented by the Federal Immission Protection Act (Bundesimmissionsschutzgesetz – BImSchG). Biofuel Sustainability Ordinance (Biokraftstoff-Nachhaltigkeitsverordnung – Biokraft-NachV) and the Biomass Power Sustainability Ordinance (Biomassestrom-Nachhaltigkeitsverordnung– Bioster-NachV) are is related to EU Renewable Energy Directive (RED, 2009/28/EC). Federal Immission Protection Ordinance (Bundesimmissionsschutzverordnung – BImSchV) is related to Fuel Quality Directive (FQD, 2009/30/ EC), and Energy Tax Act (Energiesteuergesetz – EnergieStG) is related to Energy Taxation Directive (2003/96/EC).

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RED established a minimum required greenhouse-gas-saving of 35% in comparison to fossil fuels. For instance, if a fuel fails to comply with this, its contribution cannot be credited against the required biofuel quota valid in Germany. This savings requirement risen to 50% in 2017.

In order to reduce the risk of indirect land use change and to prepare the transition towards advanced biofuels, Directive (EU 2015/1513) was issued in 2015. German government shall bring into force the laws, regulations and administrative provisions necessary to comply with this directive by September 2017. The following requirement will need to be implemented on the national level:

- the share of biofuels from crops grown on agricultural land that can be counted towards the 2020 renewable energy targets needs to be limited to 7%
- an indicative 0.5% target for advanced biofuels as a reference for national targets
- biofuels produced in new installations shall emit at least 60% fewer greenhouse gases than fossil fuels [5]

2.1.4 Relevant national legislations and policies for bioenergy

The National Policy Strategy on Bioeconomy

The strategy was issued by the Federal Ministry of Food and Agriculture in 2014. Bioeconomy is defined as an opportunity for the 21st century. With regard to biomass production, apart from the established energy crops such as maize, rape or cereals, as highly-promising alternatives for sourcing energy are mentioned Sorghum sudanense (Sudan grass), millet and Silphium perfoliatum. The strategy mentions SRC plantations as additional potential for wood not sourced in forests. It should ensured that appropriate support for the development of short rotation plantations, primarily on arable areas producing threshold-level yields and on degraded land areas (e.g. areas formerly used for mining), is in place. [6]

National Biomass Action Plan for Germany

The Biomass Action Plan highlights the areas of potential for bioenergy in Germany, what proportion of this is already being used, and which reserves can still be opened up. Building upon this, it presents the strategies which the German Government is pursuing for the expansion of the use of bioenergy in the areas of heat, electricity and fuel, and what measures are envisaged in this context.

Energy Concept for a reliable, affordable energy supply that spares the environment

The German Government declared its commitment to the expansion of the three areas – heat, electricity and fuel from sustainable use of biomass. The Energy Concept provides guidelines for an energy supply that is reliable and affordable and environmentally friendly. As part of this, a long term strategy, looking as far into the future as 2050, maps out the path for the far-reaching conversion to energy supply from renewable sources.

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The Mobility and Fuels Strategy of the German Government

In the 2010 the German government defined a reduction target for the transport sector, the energy consumption are meant to be decreased by around 10%by 2020 and by 40% by 2050, with a baseline at 2005. In addition to that, greenhouse gas emissions in Germany across all sectors are to be reduced by 40% by 2010 and at least 80% by 2050, with a baseline at 1990.

The strategy was launched in 2011 by the Ministry of Transport and Digital Infrastructure. The role of biofuels is to contribute to a diversification of the energy supply and lead to a reduction in CO_2. Biomethane is explicitly mentioned as an attractive option. Since 2011 biomethane volumes produced from residues and waste count twice towards the fulfilment of the quota.

Development and deployment of technology for supplying substantial amounts of liquid biofuels, for example from lignocellulose (in particular from thermochemical conversion and innovative biorefinery concepts with biofuels as a product) should be accelerated. In addition, obstacles in the area of facility investments for biorefineries need to be tackled.

From 2015, biofuels that have a particularly good greenhouse gas balance will count more heavily towards the greenhouse gas avoidance quota (greenhouse gas quota) that will apply as of then. If it transpires that certain particularly innovative biofuels require particular encouragement going beyond the general quota-based support, the German government will look into suitable measures.

The strategy also mentions advance biofuels. ("2nd or 3rd generation biofuels") and emphasises doubts about possible capacities for producing sufficient quantities of advanced biofuel options, based on lignocellulose, bioethanol, BtL fuels with the focus on diesel and kerosene, biomethane via SNG, hydrogen or algae fuels). The strategy forecasts the one cannot expect any breakthrough until after 2020 in Germany. [3]

Biorefineries Roadmap

The roadmap discusses a few particularly promising biorefinery paths, including lignocellulosic biorefinery, green biorefinery and biogas biorefinery. These concepts are discussed in more detail in terms of challenges in the establishment of innovative technologies in the market. [7]

German Renewable Energy Law (EEG 2017)

The legislative procedure for the enactment of the EEG 2017 was finalised with the new legal framework coming into force as of 1 January 2017. In EEG 2017 rates of renewables funding are determined by the market by means of dedicated auction schemes for electricity production from renewable energy sources.

Feed in tariffs, direct marketing, market premium and flexibility premium for electricity production from biomass is set in the EEG 2017. In Germany, the most important means to promote electricity from renewable sources is the feed-in tariff. The aim is to increase the proportion of electricity from renewable energy sources in total energy supply from at least 35% in 2020 to at least 80% by 2050 and to integrate these quantities of electricity in the electricity supply system.

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Gas Grid Ordinance

Following two amendments, this ordinance was launched to improve the infrastructural conditions of bio-methane feed into the natural gas grid. The target was to cover 6 billion Nm^3 of Germany's demand for natural gas with biomethane by 2020 and 10 billion Nm^3 by 2030. In 2009 the biomethane feed-in was around 0,18 billion Nm^3.

The Renewable Energies Heat Act – EEWärmeG (Since 2009)

The Heat Act foresees that by 2020 14% of Germany's heat must come from renewable energies. The Act was launched by the Federal Ministry for Environment, Nature Conservation and Nuclear Safety. The Act is intended to protect the environment and help reduce emissions of harmful greenhouse gases. Its aim is both to conserve resources and to ensure a secure and sustainable energy supply. There are three aspects to the Act and the second one details the financial support for renewable energies. The use of renewable energies will continue to be financially supported and the government will inject more money into the existing market incentive programme, increasing funding for this support instrument to as much as 500 million EUR per year, meaning better planning certainty for investors.

Biofuel Quota Act (Biokraftstoffquotengesetz - BioKraftQuG)

The Biofuels Quota Act sets a minimum level of biofuels that must be used in road transport in Germany. Since 2010, the total biofuels quota was at 6.25% based on energy content. As of 2015, this quota is to be replaced by a climate protection quota, which specifies the minimum net contribution that must be made by biofuels to the reduction of GHG emissions. This quota will be increased to 6% by 2020 [5]

In addition, different legal acts on sewage irrigation fields and reclamation areas exist.

Sewage irrigation fields and lignite reclamation sites:

- Federal Mining Act (BBergG, 1980)
- The German Federal Soil Protection Law (BBodSchG, 1998)
- The Environmental Impact Assessment Act (UVPG, 1990)
- Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV, 1999)
- Law on Regional Planning and Remediation Planning (RegBkPlG, 2002)
- Environmental Damage Act (USchadG, 2007)
- Federal Nature Conservation Act (BNatSchG, 2009)
- Federal Water Act (WHG, 2009)
- Regulation on the protection of groundwater (GrwV, 2010)

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2.1.5 Relevant national incentives and support schemes for bioenergy developments

BMU Environmental Innovation Programme (Since 1997)

The BMU Environmental Innovation Programme finances major industrial demonstration projects that are the first in their kinds of and can be realised to reduce environmental pollution and ecologically sound solutions can be applied. Loans and grants are provided for bioenergy and environmental projects with a demonstration character. A project usually can be financed if the proposed technology is not yet being used on a large scale or where an already known technology is to be utilised in a new procedural combination for the first time. Projects therefore must include an innovative character. Distinct characteristics of the programme is a relatively long-term financing at an attractive interest rate. Where applicable, investment grant can go up to the 30% of the eligible costs.

Bioenergy Demonstration Projects (Since 2005)

The Agency for Renewable Resources (FNR) is the central coordinating agency in Germany for the funding of R&D&I projects. In collaboration with the Federal Ministry for Food, Agriculture and Consumer Protection in December 2005 it was decided to launch support bioenergy demonstration projects. The scheme is concentrating on bioenergy plants and technologies where practice and proof of concept has already been proven at least at pilot stage. They also must be state of the art technology and expectedly to continue running on a commercial scale after the demonstration project is over. The financial support is given either as an investment grant or an allowance for operating costs, but not as a combination of both.

Joint Task of Improving Agricultural Structures and Coastal Protection (GAK) (2008)

The promotion of Investment into supply systems for heat an electricity produced from biomass was achieved by the German Federal Government. The government provided 60% of the funding for GAK activities and also bioenergy consultancy services.

BioEnergie2021 - Research for utilising biomass (2008-2013)

The "Bioenergy 2021" initiative was established by the Federal Ministry of Education and Research (BMBF) in a total amount of 50 million EUR. The main objective of the progamme was to increase the net energy yield per unit of area in terms of the efficient conversion of biomass. Projects consortiums couldapply with work programmes that could address the whole range of potential usage of biomass (fuel, electricity and heat), in particular the use of specific energy plants and the use of biological remainders and waste. The programme funding covered three different parts:

- Biorefinery of the future (module A),
- Energy crops (module B)
- Bioenergy idea contest (module C)

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The modules represented different approaches in terms of raw materials and conversion with different medium- and long-term objectives.

German Climate Initiative – „Promoting projects to optimise biomass energy use“ 2009-2011

The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has drawn up a program to promote projects to optimize biomass energy used in an amount of 30 million EUR. The program supported further development of heat and fuels from biomass, up to the preparation of a sustainable and supportable biomass strategy. The funding program also focused on the development and optimisation of climate-friendly and energy-efficient technologies for the utilisation of biomass for energy, taking into consideration their sustainability and climate protection aspects. Funding was provided for studies, pilots and demonstration projects in seven thematic areas: utilisation of residues, international cooperation (focus on non-EU Eastern Europe states), biomass gasification (combined heat and power, CHP), biomethane strategy, bioenergy strategy (biofuels), regional bioenergy (regional concepts, small-scale combustion plants), strategy development for biomass projects (strategic projects, service- and support projects etc.).

BAFA programme

The Federal Office for Economic Affairs and Export Control (BAFA) is involved in the promotion of further expansion of renewable energies in Germany. New highly efficient CHP plants can receive a fixed compensation for generated electricity (a CHP bonus) according to CHP Law (KWKG 2016). The bonus is applicable only if electricity is fed into the electricity network. For the plants between 1-50 MW the contract is determined via a tender procedure. Tenders are issued by the Federal Network Agency and are implemented by BAFA.

According to the CHP Law (KWKG 2016), the CHP bonus for plants over 2 MW is 3.1 EUR Cents per kWh. However, due to the new tendering procedure it is not possible to say if the bonus will remain the same in the future.

Market Incentive Programme (MAP):

This programme provides grants from the Federal Office for Economic Affairs and Export Control (BAFA) for smaller installations in private households and companies (e.g. roof-top solar thermal collectors or pellet heating systems in the cellar etc.). In addition, low-interest loans and repayment grants from the KfW are provided for larger systems, particularly those used for commercial purposes (e.g. municipal companies which are investing in process heat from renewables or building biomass cogeneration power plants and heating networks designed to run on renewables).

The KfW Renewable Energies Programme

The programme approves loans for electricity from biomass, biogas and heat from renewable energies, generated in combined heat and power stations. The conditions of the long-term and low-interest loans are attractive and for heat generated in large plants there is the possibility of

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repayment grants, where a part of loan sum is waived and small enterprises are preferred, they pay a lower interest rate than large enterprises.

KfW Banking Group offers different funding programs for new renewable energy projects. The Renewable Energy Premium funding program supports large-scale plants for the use of renewable energy sources in the heat market. It offers low interest rates and long-term financing of new renewable energy facilities. CHP biomass plants and biomass combustion plants are relevant for this program. The funding is provided in a form of a low interest loan. The loan can be provided up to 100% of the eligible investment costs, max. 10 million EUR for one project. Additional grants from federal funds can be provided in this program. The Renewable Energy Standard funding program aims at electricity production and CHP plants. This program offers low interest loans which can be up to 100% of the eligible investment costs, max. 50 million EUR for one project.

RENplus 2014-2020 funding program ILB (Investitionsbank des Landes Brandenburg)

With RENplus 2014-2020 funding program ILB (Investitionsbank des Landes Brandenburg) supports measures to increase energy efficiency and the use of renewable energy sources in the region. Highly efficient CHP plants can receive grants under this program. Depending on different criteria, max. 3 million EUR can be granted under this program.

CAP: German Rural Development Programmes (CAP 2014-2020)

In Germany, rural development is implemented through separate regional RDPs. Elements common to regional programmes are presented in a national framework established at federal level. In addition to this, a National Rural Network Programme provides the funding for the networking of rural development actors in Germany.

2.1.6 Best bioenergy practices in Germany

Different biorefinery concepts serving as best practice examples are implemented in Germany. The following examples are the most relevant for the FORBIO project:

CropEnergies Bioethanol

CropEnergies Bioethanol GmbH operates one of the largest bioethanol plants in Zeitz, with an annual capacity of 400,000 m^3 of bioethanol. It can process up to 750,000 ton of grain and sugar syrups from up to 1,000,000 ton of sugar beet per year. However, the plant in Zeitz, which was brought on stream in 2005, is not only impressive in size.

Figure 1: CropEnergies Bioethanol Plant (Source: www.cropenergies.com)

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Besides different cereals, such as wheat, maize, barley and triticale, it can also produce bioethanol from intermediate products from sugar production. Since October 2010, the bioethanol production is Zeitz has been certified as sustainable. [8]

Clariant SunLiquid

The SunLiquid plant converts lignocellulosic agricultural residues, such as cereal straw, into cellulosic ethanol or other biobased chemicals. The first plant opened in 2009 at the Clariant Biotech & Renewables Center in Münich and had a capacity of 1 ton of cellulosic ethanol per year. The 1000 ton of cellulosic ethanol/year capacity plant started its operation since 2012 in Straubing-Sand, Bavaria. The industrial sized plant is processing 50.000-150.000 ton of cellulosic ethanol per year from 2013.

Figure 2: Clariant SunLiquid Plant (Source: www.cropenergies.com)

The ethanol yield lies between 75% and 95% of the theoretical maximum. The entire process energy is generated from accumulated residues – mainly lignin and no fossil-based energy sources are used. [9]

Biowert Biorefinery

The Biowert production site in located in Brensbach, the Odenwald region, Hesse. The biorefinery is the centre of the Biowert technology that processes locally supplied meadow grass in several stages into biomaterials. The grass processing unit is directly coupled with a biogas plant. The grass is mixed with process water from the biogas plant and heated.

Figure 3: Biowert Biorefinery Plant (Source: https://biorrefineria.blogspot.hu/2016/04/biowert-biorefinery-biorrefineria-verde-green.html)

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The heated suspension is mechanically treated in a multistage process and then is gently dried in order to produce fibres. The separation runs completely mechanical without any application of chemicals or organic solvents. The specially developed two-step drying process is paramount for the production of high quality cellulosic fibres. These purified fibres are further processed to insulation material and composite granulate or profiles. In addition, nutrients from the digestate of the biogas plant are recovered and redistributed to farmers that have grown the grass.

All byproducts and waste materials are reused or supplied back to the production cycle in the closed-loop manufacturing process. All the water comes from meadow grass and biomass and is constantly reconditioned so that no water must be pumped in from the public water supply. The required process energy is provided by the affiliated biogas plant that runs on waste from the grass-refinery and sanitized food waste from the region. Biogas and waste heat from the production process are used for heating water, for drying processes and for generating green electricity. Stockpiling of raw material allows a year round production. The Biowert plant is designed for an annual capacity of 2,500 ton of fibers. [10]

2.1.7 Conclusions for Germany

There is no specific policy available for the development of bioenergy value chains on underutilized lands in Germany. Biomass feedstock production on underutilized land is mainly on the trial stage.

2.1.8 References

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2.2 Italy

2.2.1 Relevant country-specific biomass feedstock types

Arundo donax L. is a tall, erect, perennial cane and can grow to 2-10 m tall native of Eastern and Southern Asia. High resistance to drought with sterile seeds, tolerates saline soils. One of the most cost-effective energy crops, can be harvested annually for decades after planting. Yields of stem material (utilized for fibre) can reach 10-40 dry matter Mg ha-1 year-1 (~ 590 GJ ha-1) but with high variability across Europe and USA.

Triticale is a hybrid of wheat (Triticum) and rye (Secale) first bred in laboratories during the late 19th century in Scotland and Sweden. Annual growth cycle, combines the yield potential and grain quality of wheat with the disease and environmental tolerance of rye. It is grown mostly for forage or fodder. Yields can reach 10-20 Mg ha^{-1} $year^{-1}$.

Sorghum Bicolor L. is an annual warm season crop that belongs to the grass family, utilized for grain, fibre and fodder, is well adapted to growth in hot, arid or semi-arid areas. Yields can reach 10-40 Mg ha^{-1} $year^{-1}$ with 24–34% cellulose.

Cannabis sativa L (hemp) is an annual herbaceous plant and is one of the most versatile, valuable industrial plant that can serve as raw material for diverse products such as paper, construction materials, and fuels. Hemp exhibits optimal growth in a moderate climate at 13–22°C, it prefers deep, humus-rich, calcareous soils with a good water and nitrogen supply. Stem dry matter yields of 8–16 Mg ha^{-1} $year^{-1}$ and fibre yields of 2–4 ha^{-1} $year^{-1}$.

2.2.2 Relevant country-specific bioenergy production and processing technologies

Biomass power technologies convert renewable biomass fuels to heat and electricity using processes similar to those employed with fossil fuels. The primary approach for generating electricity from biomass is combustion direct-firing. Combustion systems for electricity and heat production are similar to most fossil-fuel fired power plants. The biomass fuel is burned in a boiler to produce high-pressure steam. This steam is introduced into a steam turbine, where it flows over a series of turbine blades, causing the turbine to rotate, connected to an electric generator.

Biogas fermentation is a commercially technology used for recycling and treating wet organic waste. It is a type of fermentation that converts organic material into biogas, which mainly consists of methane (approximately 60%) and carbon dioxide (approximately 40%). Gas from anaerobic digestion can be burned directly for cooking or heating. It can also be used in secondary conversion devices such as an internal combustion engine for producing electricity or shaft work.

Biorefinery involves the co-production of a spectrum of bio-based products (food, feed, materials, chemicals) and energy (fuels, power, heat), maximizing the value derived from the biomass feedstock. A biorefinery is a facility that integrates biomass conversion processes and equipment

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to produce fuels, power, and value-added chemicals from biomass. The biorefinery concept is analogous to today's petroleum refinery, which produces multiple fuels and products from petroleum.

Pyrolysis is the chemical decomposition of organic materials by heating in the absence of oxygen or any other reagents, except possibly steam. Three products are usually produced: gas, pyrolysis oil and charcoal, the relative proportions of which depend very much on the pyrolysis method, the characteristics of the biomass and the reaction parameters. Fast or flash pyrolysis is used to maximize either gas or liquid products according to the temperature employed.

2.2.3 Relevant EU legislation and policies for bioenergy

- Renewable Energy Directive 2009/28/EC. By 2020, 20% share of RES in final energy consumption, 20 % increase in energy efficiency; 10 % target for RES in transport in each Member State. No biofuel feedstock from carbon rich or biodiverse land.
- Amendment to the Fuel Quality Directive (2009/30/EC) Directive 2009/30/EC amending Directive 98/70/EC on environmental standards for fuel (Fuel Quality Directive). Further tightening environmental quality standards for a number of fuel parameters. Enabling more widespread use of ethanol in petrol. Reduction in life cycle GHG emissions from energy supplied. Binding target of 6% as first step while leaving open the possibility for increasing the future level of ambition to 10%. Incorporation of sustainability criteria for biofuels used to meet GHG reduction requirement. Increase of allowed biodiesel content in diesel to 7% by volume.
- Directive (EU) 2015/1513 – iLUC Directive. The contribution of biofuels produced from 'food' crops (to the 10 % renewables in transport target) is capped at 7%. The other 3% will come from a variety of multiple counted alternatives: biofuels from used cooking oil and animal fats; renewable electricity in rail; renewable electricity in electric vehicles; advanced biofuels. Member States have to transpose the directive into national legislation by mid-2017, and establish the level of their national indicative sub-targets for advanced biofuels.

2.2.4 Relevant national legislations and policies for bioenergy

- DECRETO LEGISLATIVO 3 Marzo 2011, n. 28. Attuazione Della Direttiva 2009/28/CE Sulla Promozione Dell'uso Dell'energia da Fonti Rinnovabili, Recante Modifica e Successiva Abrogazione Delle Direttive 2001/77/CE e 2003/30/CE defines the tools, mechanisms, incentives and institutional, financial and legal framework necessary for achieving the objectives up to 2020 as regards the overall share of energy from renewable sources in gross final consumption of energy and the share of energy from renewable sources in transport.
- DECRETO 10 ottobre 2014 MINISTERO DELLO SVILUPPO ECONOMICO Aggiornamento delle condizioni, dei criteri e delle modalità di attuazione dell'obbligo di immissione in consumo di biocarburanti compresi quelli avanzati. Update the conditions, criteria and procedures for mandatory conditions for the release for consumption of biofuels, establishing mandatory minimum national quantities of biofuels and advanced biofuels to

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be mixed with fossil fuels, following the formula BIO = Q%xBt, Where Q is the minimum mandatory percentage of biofuels to be mixed, Bt= is the calorific value expressed in Gcal of total gasoline and diesel.

	Q (%)	
Year	**Biofuels**	**Advanced Biofuels**
2015	5	0
2016	5,5	0
2017	6,5	0
2018	7,5	1,2
2019	9	1,2
2020	10	1,6
2021	10	1,6
2022	10	2

Table 2: National Q% of biofuel types (minimum mandatory percentage of biofuels to be mixed)

- Biofuels:
    - Dlgs 66/2005. Transposition of the fuel quality directive, on the quality of gasoline and diesel: it determines the objectives for the reduction of emissions of GHGs in biofuels per unit of energy in the transport sector, as well as sustainability that must be met by biofuels if they are to count towards the greenhouse gas intensity reduction obligation

2.2.5 Relevant national incentives and support schemes for bioenergy developments

- Ministerial Decree 23/06/2016. Incentives for electric energy production from renewables, except photovoltaic. Incentives are formed by a base number, increased by a combination of criteria like plant capacity, price difference with grey energy.
- Ministerial Decree 10/12/2014: Incentives for producing biofuels and advanced biofuels, based on mandatory production certificates which base value is the sanction value (750 euro in 2016).
- Ministerial Decree 05/12/2013 for Biomethane: Currently under revision. Incentives for purified biomethane used as automotive fuel, based on production certificates.

2.2.6 Best bioenergy practices in Italy

Biogasdoneright is a trademark developed by Italian Biogas producers consortium (CIB) which describe a technological platform that combines anaerobic digestion technologies and other industrial and agricultural practices that when applied synergistically are able to:

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- produce additional carbon both in already farmed land and in land that suffer desertification or lowered productivity, especially in dry lands,
- simultaneously increase the World Net Primary Production (NPP) of farmland and lower the negative externalities associated with modern conventional agricultural practices;
- continuous increase (until an equilibrium is reached) of the organic content of soils sequestering carbon at the required scale (> 1 Gton C per year) through a steady management of new organic matter input to the soils via green mulching and AD digestate spreading, thus also confirming and extending previous results obtained by organic farming to ameliorate soils health;
- realize this at very low cost, since the CO2 capture, transport and distribution costs could be paid off by services (the increase of soil fertility, soil water retention, soil biodiversity, etc) and sale of products (food/feed, energy, bio-based materials);
- contribute at the same time to an ecological agricultural intensification, to a capillary adoption of organic fertilization decoupled from the livestock industry growth, increasing the resilience of ranchers and farmers to ongoing climate change effects, improving the economics of farming, largely freeing farms from fossil fertilizers and fuels and thus transforming BECCS from a cost to an economically profitable opportunity scalable worldwide, able to attract more investment toward primary sector as we also need at least to increase food production.

Beta Renewables operates a small-scale fermentation pilot plant in Rivalta Scrivia based on lignocellulosic materials with a yearly output of 50 t ethanol. The pilot is in TRL 4 and operates since 2009. (http://demoplants.bioenergy2020.eu/)

Another plant that is owned by BETA renewables is a joint venture of Mossi & Ghisolfi Chemtex division with TPG and operates as IBP – Italian Bio Fuel since 2013 near the city of Crescentino in Piedmont The plant is a TRL 8 commercial demo site based on the fermentation of lignocellulosic crops such as wheat straw, rice straw and energy trees like arundo donax and poplar. Around 40.000 ton of ethanol is produced yearly by enzymatic conversion of selected biomasses. The technology consist of pretreatment, handling of pre-treated material and hydrolysis done in equipment specifically designed. (http://demoplants.bioenergy2020.eu/)

2.2.7 Conclusions for Italy

In agriculture, the role played by bioenergies is very relevant, specifically solid biomass (including biodegradable fraction of waste), biogas and bioliquids. In the electricity sector (mainly energy produced from biogas plants) with 1.62 Mtoe of 21:14, bioenergies account for 9% of the gross power consumption from RES, whereas in the thermal sector (wood and pellets) can cover 7.69 Mtoe of 10.59 overall, 72.6%.

Agriculture, therefore, while it has a marginal role in the budget of national energy consumption, at around 2%, it has a growing importance in emerging sectors of excellence, due in particular to the potential for using agricultural products and waste for the production of energy.

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This is precisely the case of the biogas sector, which achieved extremely positive results, and is moving towards an evolutionary path, essentially by dismissing the production of electricity, switching to biomethane. In Italy there are more than 1500 biogas plants, of which 1200 are fully operational, with an installed capacity of about 1,200 MW, equivalent to a potential production of biomethane of 2.4 billion cubic meters a year. This shows an important capability to adapt to the changed framework conditions (particularly with regards to the incentive system for energy production and to the technological development in place) and the strategic role of agriculture in achieving the objectives of the "de-carbonization" set agreed the Paris Conference on Climate Change (COP21).

2.2.8 References

Dlgs 28/2011 – "Attuazione della direttiva 2009/28/CE sulla promozione dell'uso dell'energia da fonti rinnovabili, recante modifica e successiva abrogazione delle direttive 2001/77/CE e 2003/30/CE".

DM 29 aprile 2008, n. 110 – "Regolamento recante criteri, condizioni e modalità per l'attuazione dell'obbligo di immissione in consumo nel territorio nazionale di una quota minima di biocarburanti, ai sensi dell'articolo 1, comma 368, punto 3, della legge n. 296/2006".

DM 10 Ottobre 2014 – "Aggiornamento delle condizioni, dei criteri e delle modalità di attuazione dell'obbligo di immissione in consumo di biocarburanti compresi quelli avanzati".

DM 5 dicembre 2013 – c.d. "DM biometano"

Dm 20 gennaio 2015 – "Sanzioni amministrative per il mancato raggiungimento dell'obbligo di immissione in consumo di una quota minima di biocarburanti, ai sensi del comma 2, dell'articolo 30 –sexies del decreto-legge 24 giugno 2014, n. 91, convertito in legge 11 agosto 2014, n. 116".

Dlgs 66/2005. Recepimento fuel quality directive

DM 6 luglio 2012 – c.d. "DM FER elettriche diverse dal fotovoltaico".

DM 23 giugno 2016. Incentiva la produzione di energia elettrica da impianti a fonti rinnovabili, diversi dal fotovoltaico, entrati in esercizio dal 1°gennaio 2013

www.gse.it

www.cib.it

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2.3 Ukraine

2.3.1 Relevant country-specific biomass feedstock types

Ukraine has relatively limited area of forests and lacks its own forest resources. Forests cover 9.6 million ha of lands. Forest coverage in relation to land area is only 15.9%. Over the last 50 years the forest area has increased by 21% and the volume of wood in almost three times. The total volume of timber comes to 2.1 billion m^3. Ukraine has about 30 species of wood. The highest concentration of forests is in north and west Ukraine (predominately pine 33%, oak 24%, spruce 8%, beech 7%, and birch 6%). The forests play a considerable role in soil and water conservation, as well as areas for recreation [1].

Ukraine has a huge potential to cultivate energy crops (such as Sorgum, Miascanthus, Switchgrass) and run short rotation energy plantations (Populus spp., Salix spp., Robinia pseudoacacia L.) but it is on the initial stage. There are a few companies that do it on a commercial level, some other companies are going to enter the business. According to UABio's conception [2], the total area under energy crops may come to about 200 thousand ha in 2020 and 1 million ha in 2030. The respective harvest of the crops will be 1 Mtce in 2020 and about 5 Mtce in 2030.

The agricultural sector plays a major role in the Ukrainian economy. Ukraine has approximately 43 million ha of agricultural land, including 32 million ha of arable land. Half of it is black soil, the highest productive soil type in the world. In 2015, Ukraine produced 60 million t of grains. It is the third largest world exporter of grain after the US and the EU. Ukraine is also the largest producer and exporter of sunflower, the third largest exporter of maize, the fourth of barley [3]. Wheat, barley and maize represent 60% of the crop area. Crop production has doubled over the last decade. Agricultural residues such as wheat and barley straw, corn stover, sunflower residues are partly used with energy purpose. Maize silage can be used as a raw material for biogas production. Rape has a wide range of applications both in Ukraine and abroad. Natural and climatic conditions of the most regions of Ukraine are suitable for rape growing (in 2015 its yield was 1.7 million t [4]). According to the estimations, in Ukraine the potential of rape growing with an average yield of 2.8-3.0 t/ha is up to 6 million t. This is sufficient for domestic processing capacity and the formation of the export potential [5]. In the current situation, rapeseed is mainly exported due to the lack of processing capacity.

2.3.2 Relevant country-specific bioenergy production and processing technologies

From the technical point of view, Ukraine has all needed equipment to collect and process wood and agro-biomass for heat and electricity production. The same goes to biogas production technologies. There is always choice for people involved in such activity whether to use domestic cheaper service and equipment or more expensive imported one but with higher quality and productivity (there are many foreign producers at Ukrainian market).

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2.3.3 Relevant EU legislation and policies for bioenergy

Relevant EU strategies that have significant effect on national bioenergy legislation

The Action Plan on the implementation of the European Parliament and Council Directive 2009/28/EU of April 23, 2009 on the promotion of energy use, produced from renewable energy sources, whereby amendments and further repealing of Directives 2001/77/EU and 2003/30/EU [6].

The Decree of the Cabinet of Ministers of Ukraine No. 791-p of September 3, 2014 approved the Action Plan, which consists of 17 points on preparation, implementation and coverage of the relevant activities in order to promote energy usage from the renewable energy sources by corresponding state authorities. These activities are developed and approved according to stringent requirements to the criteria of sustainable biofuels production and greenhouse gas emissions reduction. The following specified measures highlighted:

- The development and further disclosure of the calculating methodology of the greenhouse gas emissions' reduction indicators for biofuels and bioliquids;

- The development of the technical requirements for biofuels and bioliquids production and usage though the greenhouse gas emissions reduction;

- The development of the sustainability criteria for liquid and gas fuel, produced from biomass and used for transport, as well as for liquid fuel, produced from biomass and intended for energy use, not for transport, considering electricity and heat production, as well as energy for cooling.

Relevant EU policies that have significant effect on national bioenergy legislation

Following EU policy aimed at the development of RES, Ukrainian Government made a resolve to update the current Energy Strategy. That was reflected in Decree of the Cabinet of Ministers of Ukraine No. 1014-p of October 16, 2014 "On approval of the plan of short- and medium-term measures for natural gas consumption reduction for the period up to 2017" (with amendments). According to the Decree, there must be elaborated amendments to the "Energy Strategy of Ukraine for the period up to 2030" aiming to reduce natural gas consumption and to increase the use of energy, produced from renewable energy sources and alternative fuels.

EU bioenergy targets harmonized with national bioenergy objectives

EU bioenergy targets have considerable influence on the national bioenergy objectives. Now they are not harmonized with the European targets and are not reflected in the Energy Strategy of Ukraine until 2030. Nevertheless, the Strategy is now under revision with the purpose to consider EU bioenergy targets as much as possible. The revised Strategy is expected to be much better than the present one regarding RES targets.

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2.3.4 Relevant national legislations and policies for bioenergy

Relevant national renewable energy programmes and legislation

National Action Plan on Renewable Energy for the period up to 2020, approved by the Decree of the Cabinet of Ministers of Ukraine No. 902-p of October 1, 2014 [7].

The document describes the current state of the energy sector in Ukraine, emphasizing the considerable potential of the renewable energy use as one of the prior directions of the energy policy of Ukraine.

National Action Plan sets indicative sectoral targets overall in bioenergy and in energy, produced from renewable energy sources, and used in the transport sector, as well as the pathway to achieve them. The indicative targets of the renewable energy in gross final energy consumption in 2020 within heating and cooling systems, electricity production and transport sector, as well as estimated growth curve of energy from renewable sources share in gross final energy consumption are set.

National Action Plan lays on the achievement of such national indicative targets:

- An indicative target for the share of energy from renewable sources in gross final energy consumption up to 2020 is 11%;

- An expected adjusted energy consumption up to 2020 – 78.080 toe;

- An expected amount of energy, produced from renewable sources, corresponding to the indicative target up to 2020 – 8.590 toe;

- An expected electricity production from biomass, corresponding to the indicative target up to 2020 is 4.220 GWh, including 2.950 GWh from solid biomass and 1.270 GWh from biogas;

- An expected thermal energy production from biomass, corresponding to the indicative target up to 2020 is 5.000 ktoe, including 4.850 ktoe form solid biomass and 150 ktoe from biogas;

- An expected liquid biofuels production for further use in the transport sector, according to the indicative target of the National Action Plan up to 2020 is 320 ktoe of bioethanol (or ethyl tert-butyl ether from bioethanol) and 70 ktoe of biodiesel.

Relevant national forest and agriculture development programmes and legislations

1. CMU Resolution No. 977 of September 16, 2009 “On approval of the State targeted programme “Forests of Ukraine” 2010-2015” [8], aimed to determine the main directions of sustainable forest development to strengthen environmental, social and economic functions of forests. The strategic task was further increasing of the area, sustainability and productivity of forests. The programme ended, but “The concept of State targeted programme “Forests of Ukraine” for the period from 2016 to 2020” has been under discussion. It has not been approved yet because of the lack of funding. At oblasts level, similar programs were approved. For example, “Regional ecology programme “Forests of Kirovogradska oblast” 2016-2020” [9], “Regional programme

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"Development of forests management in Lvivska oblast" 2017-2021" [10], "Regional target programme of "Forest management" [11].

2. CMU Resolution No. 1158 of September 19, 2007 "On approval of the State target programme of the Ukrainian village development until 2015" (with amendments) [12] with the purpose to ensure the sustainability in agriculture, competitiveness in domestic and foreign markets, food security ensuring, protection of the peasantry as a carrier of Ukrainian identity, culture and spirituality. The programme ended, and CMU approved the concept of the development of the agricultural sector of economy.

3. CMU Resolution No. 1437 of December 30, 2015 "On approval of the State target program of the development of the agricultural sector of economy until 2020" [13]. The aim of the Strategy is to create organizational and economic conditions for efficient, socially oriented development of the agricultural sector, sustainable supply of agricultural raw materials to the industry and high-quality and safe domestic agricultural products to the population, to increase production with high added value, strengthening Ukraine's presence on world markets of agricultural products and food.

4. CMU Resolution No. 806 of October 10, 2013 "On approval of the Strategy of the agricultural sector development until 2020" [14]. The aim of the Strategy is to create organizational and economic conditions for the effective development of the agricultural sector by ensuring the unity of economic, social and environmental interests of society to ensure a stable providing population with high-quality, healthy, affordable domestic agricultural products and the industry with agricultural raw materials.

2.3.5 Relevant national incentives and support schemes for bioenergy developments

Direct international and EU funds

U.S. Agency for International Development (USAID) devotes funds for the energy sector development in Ukraine, in particular for bioenergy, promoting energy efficiency improvement of the Ukrainian economy and the reduction of imported energy dependence. Among the pilot bioenergy projects are (in the frame of "Municipal energy reform in Ukraine" (MERP) project [15]):

Development of Draft Sustainability Criteria for Biofuels and Bioliquids for Ukraine. The key points of the project are the best European practices base, development of sustainability criteria for liquid biofuels and for biogas intended for transport, followed by the elaboration of the draft legal documents for introduction of the sustainability criteria into Ukraine's legislation.

Development of legislative package for competitive heat market establishment in Ukraine. The key points of the project are analysis of world and EU examples of competitive heat energy market, overview of the existing regulatory and law field in the district heating sector in Ukraine, development of the concept strategy with further development of the legislation package

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addressing specific technical and organizational details of competitive heat market functioning in Ukraine.

EU funds through local administrations

East Europe Foundation[16] is an International charitable organization that invests in projects, aimed at efficient solutions in the different sectors of economy of Ukraine, including in the bioenergy. An example of such activity is a project of international technical support "Clean Energy: Partnership for the future of the Dnipro region", intended to energy potential assessment of biomass in the Dnipro region and to analysis of its further use directions.

Loan programmes

There are a number of international institutions and structures in Ukraine providing loans for projects implementation on renewable energy and energy efficiency:

1. World Bank:

International Finance Corporation (IFC)

Ukraine Sustainable Energy Finance Program[17] works to encourage investments in energy efficiency projects across the country. The Project helps financial institutions and companies to assess modernization projects, and supports banks in building their internal capacity to develop new financial products to develop the market for energy-efficiency financing. By participating in public information campaigns, the Project also works to raise general awareness about the need for greater energy efficiency in Ukraine.

Ukraine Resource Efficiency Program[18] launched to increase the use of and investment in resource efficient technologies. Best practice in resource efficiency has proven benefits in reducing costs and improving profitability, as well as delivering tangible environmental benefits, most notably the reduction of GHG emissions. The wider implementation of resource efficiency in Ukraine could have significant and immediate benefits for individual enterprises, the country's economy, and the environment.

2. European Bank of Reconstruction and Development (EBRD):

Ukraine Energy Efficiency Programme (UKEEP) [19] targets Ukrainian private companies in all sectors looking to invest in energy efficiency or renewable energy projects. Loans distributed via partner banks for the projects on:

- Rehabilitation and expansion of production facilities using energy efficient equipment;

- Usage of renewable energy sources for own needs.

Ukraine Sustainable Energy Lending Facility (USELF) [20] is part of the EBRD's Sustainable Energy Initiative (SEI) addressing the challenges of climate change and energy efficiency. USELF provide financing directly from the EBRD for small and medium projects with a simplified and rapid approval process, so reducing transaction costs.

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Target projects include all forms of power generation from renewable energy sources, including hydro, wind, biomass, biogas and solar. Biomass and input for biogas production would come from sustainable sources and/or organic waste.

Eastern Europe Energy Efficiency and Environmental Partnership Fund (E5P) [21] designed to promote energy efficiency investments in Ukraine and other eastern European countries. Grants under E5P allocated to district heating, other energy efficiency projects, and environment projects.

3. Regional financial corporations:

- Nordic Environment Finance Corporation (NEFCO) intends to finance district heating projects under the E5P programme.

DemoUkraine programme, received loan from the Swedish International Development Cooperation Agency (Sida) [22], to finance local district heating projects, including consulting and sourcing professional district heating expertise by NEFCO.

Small grants

German Society for International Cooperation (**GIZ**) provides grants for the research of bioenergy facilities in Ukraine. One of such projects is **"Estimation of local biomass potential in Odessa oblast"** (in the frame of the project "Establishment of Energy Agencies in Ukraine" [23]) with the following key points as an assessment of biomass potential within two districts of Odessa oblast; identification of the potential biomass suppliers; identification of up to three most promising bioenergy projects in each district.

Bioenergy production incentives

The Law of Ukraine No. 575/97-BP, approved by the Verhovna Rada of Ukraine of October 16, 1997, valid in the current edition of November 26, 2016 [24].

The Law regulates relations during production, transmission, supply and use of energy, state monitoring over the safety of work performance at the electric power facilities, regardless of ownership form, the safe operation of power equipment and state supervision over use conditions of electricity and heat energy.

The Law of Ukraine "On Electricity" consists of 7 chapters and 30 articles. Article 17^1 is devoted to stimulation of electricity production from alternative energy sources, establishing the conditions for feed-in tariff setting for each economic entity.

Feed-in tariff for economic entities, generating electricity from biomass, is set at the retail tariff level for the second voltage class consumers as of January 2009, multiplied by the feed-in tariff index for electricity, produced from biomass.

Feed-in tariff for economic entities, producing electricity from biogas, is set at the retail tariff level for the second voltage class consumers as of January 2009, multiplied by the feed-in tariff index for electricity, generated from biogas.

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Categories of power facilities with the feed-in tariff	Feed-in tariff's ration for objects or queues/startup complexes, put into operation							
	up to and including 31.03.13	from 01.04.13 to 31.12.14	from 01.01.15 to 30.06.15	from 01.07.15 to 31.12.15	from 01.01.16 to 31.12.16	from 01.01.17 to 31.12.19	from 01.01.20 to 31.12.24	from 01.01.25 to 31.12.29
On the electricity from biomass	2,30	2,30	2,07	2,30			2,07	1,84
On the electricity from biogas	-	2,30	2,07	2,30			2,07	1,84

Table 3: The feed-in tariff index for electricity, generated from alternative energy sources

The Law of Ukraine "On Electricity" establishes an allowance to the feed-in tariff for the level compliance of the Ukrainian equipment used, and it is applicable for its entire validity period.

State supported loans

The Decree of the Cabinet of Ministers of Ukraine No. 1056 of October 17, 2011 "Some issues on funds use in energy efficiency and conservation" (with amendments according to the Decree of the Cabinet of Ministers of Ukraine No. 589 of July 27, 2016) [25].

The Decree provides funds reimbursement for energy saving measures implementation, namely:

1. Reimbursement of the partial loan amount, raised by associations of apartment buildings owners and cooperative housing for purchasing energy efficient equipment and materials:

- 40% of the loan amount, but not more than 14.000 UAH per flat of an apartment building on one credit agreement.

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2. Reimbursement of the partial loan amount, raised by population for purchasing boilers, operating on all fuels and energy types (except natural gas), including appropriate additional equipment and materials to them:

- 20% of the loan amount, but not more than 12.000 UAH on one credit agreement.

3. Reimbursement of the partial loan amount, raised by population for purchasing energy efficient equipment and materials:

- 30% of the loan amount, but not more than 14.000 UAH on one credit agreement.

4. Fund receiver being natural entity, who is prescribed a subsidy for housing and utilities services will be reimbursed by 70% of the loan amount, but not more than 12.000 UAH on one credit agreement for purchasing boilers, equipment and materials to them; no more than 14.000 UAH for one credit agreement to other energy-saving equipment and materials.

R&D programmes for bioenergy developments

Since 2007, an integrated target program "Biological resources and the modern technologies of bioenergy conversion" [26] (in 2007-2012 "Biomass as fuel") has been carrying out at the National Academy of Sciences of Ukraine. The main objectives of the program are:

- Increasing significantly the efficiency of the various types of biofuels by expanding the resource base with new (alternative) crops and advance crops, which are already used, by means of selection, genomics and molecular biotechnology;

- Development and improvement of technologies for obtaining liquid biofuels from different crops, agricultural and forest residues; to develop and improve technologies for energy from biomass production.

2.3.6 Best bioenergy practices in Ukraine

Best practices for direct wood burning

A modern project of a 7 MW woodchip boiler house (2 boilers of 3.5 MW each [27]) in Kniazhychi village (Brovarskyi region, Kyivska oblast) showed that a turn-key greenfield biomass plant with the implementation of the concept of a full cycle of production and supply of thermal energy was the right design choice. The boiler house provides heat energy to greenhouses where flowers are grown (11 ha area). Biomass storage located close to the boilers, woodchips are delivered from nearby sawmills, ash is partly used in the greenhouses as fertilizer. The feature of the boiler house is that the owner ("Kamelia" ltd [28]) decided to use local equipment and components for its construction.

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Figure 4 – Woodchip boiler in Kniazhychi

Best practices for biogas fermentation

Among other similar modern projects, the first oldest biogas project in Ukraine (since 2003) demonstrates successful implementation of anaerobic digestion technologies. Biogas project implemented within the Holland-Ukrainian cooperation and realized in Olenivka village in Dnipro oblast (agriculture company "Agro-Oven" Ltd. [29]). Two biogas reactors of 1000 m^3 each with mesophilic temperature regime treat 80 ton of pig manure and fat waste from a poultry plant every day. Biogas yield is 3300 m^3/day; the content of methane in the biogas is 55-60%. Installed electricity and thermal capacity of cogeneration units is 160 and 320 kW respectively. Electricity is used for own needs.

Figure 5 – Biogas fermentation in Olenivka

Best practices for direct straw burning

The first straw batch-fired boiler in Ukraine was installed in Drozdy village (Bilotserkivskyi region, Kyivska oblast) within the frame of Dutch-Ukrainian technical assistance project in 2001 (agricultural company "Dim") [30]. Though being the first, it was a very successful project that served as an example for replication. Boiler RAU-2-1210 of 980 kW capacity supplies heat to a community center, a secondary school, a kindergarten, administrative buildings and four two-stored buildings connected to a heat network. Baled straw consumption over a heating season is 1100 ton and the volume of replaced natural gas is 385000 m^3/year.

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Figure 6 – Straw batch firing boiler in Drozdy

2.3.7 Conclusions for Ukraine

The political and economic situation in Ukraine contributes to the rapid development of bioenergy. The country has not only great potential but also wood biomass, agriculture residues, corn silage for biogas production or rapeseed for biodiesel production, energy crops on land not used for agriculture have already been practical used for energy purposes. From the technical point of view, Ukraine have all needed equipment to collect and process wood and agro-biomass for heat and electricity production. The same goes to biogas production technologies. The new Ukrainian legislation and harmonized with the European legislation along with the supporting schemes and financial mechanisms encourage public/companies to use biomass instead of traditional fossil fuels. Experts believe that the development of bioenergy in Ukraine in short- and medium terms will be at high level.

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3 FORBIO outreach countries

3.1 Poland

3.1.1 Relevant country-specific biomass feedstock types

The most important biofuel used in Poland is solid forestry biomass, among oak, fagus fagus, carpinus, robinia pseudoacacia l., pine, spruce and populus spp. It is generally fed into power plants, local heating plants, home boilers and fireplaces. Power plants and local heating centers usually apply wood chips, while home boilers and fireplaces use wood in pieces and briquettes. Bio pellets are rarely used due to higher cost. Solid fuels are mainly prepared from energy crop plants (Miscanthus, Populus spp., Salix spp.) and with agricultural residues (wheat straw and corn stover). The price of biomass depends on its heating value and water content and in commercial transactions, the price is related to 1 GJ of energy contained in biomass. Recently the price of biomass was directly linked with a state support system of green energy production in the form of certificates. The collapse of the green certificates market system at the turn of 2012-2013 significantly reflected on the biomass market. The average biomass from forest price was decreasing as 2012-7.35 EUR/GJ, 2013-6.59 EUR/GJ, 2014-5.858 EUR/GJ, 2015-7.45 EUR/GJ, 2016-4,11 EUR/GJ. Similar trend shows agro-biomass market with following prices fluctuating as of 2012-7,59 EUR/GJ, 2013-6,59 EUR/GJ, 2014-6,11 EUR/GJ, 2015-5,49 EUR/GJ, 2016-4,52 EUR/GJ and price drop has not been stabilized up to now. For liquid biofuels production, rape seeds are implemented for biodiesel production and potatoes or corn (rarely) for bioethanol production. Current rape seed price is around 429,2 EUR/t. For biogas production the main base material is corn silage, grass, residues and wastes from agricultural and food production together with livestock byproducts.

3.1.2 Relevant country-specific bioenergy production and processing technologies

Collection and process of wood biomass for heat production

The local biomass market is directly effecting the situation of boiler production and development, as mainly these are available in areas covered with forests. This is enhanced by the locally available and relatively inexpensive biomass raw materials and also supported by investments co-financed by local environment protection funds.

Collection and process of wood biomass for electricity production

Similarly processes could be observed during technological line construction for biomass co-firing at electric power plant stations. However logistical preparation of resource base for big units was more difficult and the profitability started to declined from 2012. From one side investments were co-financed from environment protection funds, while on other side the relatively high price of certificates origin of green energy caused biomass import from distant countries. The dedicated installations of biomass firing plants started in 2012.

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Biogas fermentation

Biogas production takes place on sewage treatment plants, landfills and agricultural biogas stations. The produced biogas is processed into electrical energy and heat. From 2010, special attention was given to agricultural biogas stations development. Due to some unfavorable conditions (the lack of stable law and low profitability), biogas production was not profitable without co-financing. The Agricultural Market Agency have a collection of registered 85 biogas producers. The total annual agricultural biogas production is 387.955.352 (m^3 / year) with a total installed electrical power 101 MW.

Collection and processing of straw for heat production

Straw as biofuel is commonly used in local spots and individual boilers. Local heating boilers with power up to a few MW were constructed in 2005, thanks to useful co-financing conditions, while individual boilers are still constructed.

3.1.3 Relevant EU legislation and policies for bioenergy

The most important and acknowledged renewable energy based development of the European Commission is the Energy and Climate Package launched in March 2007. The package defined three most important energy and climate change targets until 2020. Twenty percent share of renewable energy sources from the total EU energy consumption is forecasted by then. Directive 2009/28/WE was adopted for promoting of utilization of energy from renewable energy sources, replacing Directive 2001/77/WE for the support of energy production from renewable energy sources at internal market and also Directive 2003/30/WE (for the support of biofuels or other renewable energy use in transport). Directive 2009/28/WE fits in 3x20 Package realization as it is assuming a 20% increase of energy from renewable energy sources in the total energy balance of the EU. Other EU member states should increase up to 10% until 2020 in the transport sector, while the increase is predicted for 15% in Poland.

3.1.4 Relevant national legislations and policies for bioenergy

The objectives of Directive 28/2009/WE were implemented in the strategic „Polish energy policy up to 2030 year" [1] and the „Polish energy policy up to 2050 year" [2] legislative documents. According to Polish Energy Policy, the share of renewable energy sources in the total energy consumption of Poland should increase to 15% in 2020 year and to 20% in 2030 year. In parallel, energy efficiency measures should also take place and renewable energy utilization should occur, mainly based on bioenergies. The Polish Ministry Council approved an important document "National activities plan at the framework of energy from RES" [3] in 2010. It presents the path of reaching 15% renewable energy share in the total energy production in Poland, describing the share of electrical energy, heat, cold and renewables in transport until 2020. Up to date, the growth path of renewable energy sources share at electrical energy consumption was achieved and renewable energy share was even higher than expected. The strategic document also predicts

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co-firing maintenance as an important method of RES implementation with limits for forest biomass until 2020.

The below figure presents the predicted renewable sector share in Poland, also appearing in the national energy policy up to 2030.

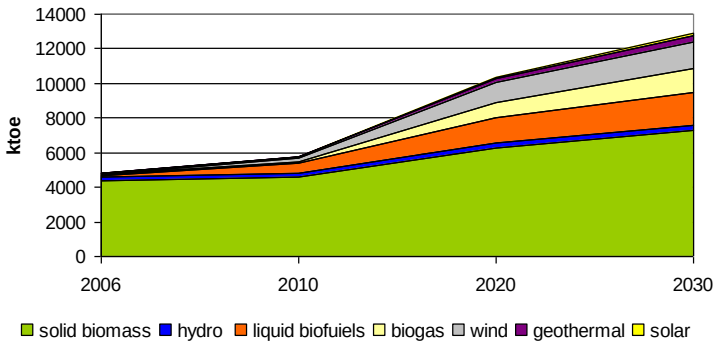

Figure 7: Demand of total energy in Poland according to RES production structure (Source: „Polish energy policy up to 2030 year")

According to the predictions biomass will have significant share fulfilling the requirements of Directive 28/2009/WE in the heating, cooling, transport and electrical energy production sectors. and the „Polish energy policy up to 2050 year" document was elaborated by the Ministry of Economy in that relation. It assumes an operational support for electrical energy producers from RES and predicts about 150 ktoe increase of renewable energy sources per year.

The basic normative act which describes the mechanism and support instruments of the electrical energy production from renewables is the "Act about RES" [4] signed by the Polish President in 2016. The Act is now the substitution of the "Energy Law" [5]. set up in 1997.

The "Act about RES" determines principles and conditions of activities linked with:

a. electrical energy production from renewable energy sources, mechanisms and instruments for production support,
b. heat production,
c. issuing rules of certificates of origin for energy produced from renewable energy sources installations.

The Ministry of Economy launched its disposition for the verification of biomass and wood other than standard sterling and the documentation requirement of their origin for the support system in 2015. [6] as it is detailed in article 119 of the 2016 Act about renewable energy sources.

The Minister of Economy defined detailed duties for the issue of certificates of origin, substitution fee payment, electrical energy and heat purchase produced in renewable energies and confirmation data of electrical energy produced. The Minister ordered that a producer should document the origin of biomass fuel by the preparation of fuel chart for each fuel part separately.

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The producer is also obliged to describe the life cycle of the biomass from the first fuel obtaining, through processing (mechanical, thermal, biological or chemical) until the supplement to heat, electrical or combined energy production.

Producers owning a concession for electrical energy production in renewable energy installation are requested to provide a qualification of fuel composites by biomass marking, based on characterization, type and quantity. Biomass derived from energy crops are additionally marked with age, plantation surface and annual biomass growth per hectare. A description for each biomass type should be supplied on processing technologies (mechanical, thermal, biological or chemical) for their full life cycle. In case there is a doubt on the origin of the biomass the producer is enabled to receive proofing support from independent and certified laboratories.

The Information of URE Chairman document was published in 2013 according to wood and wooden material qualification at supporting system. The paper recommends that biomass producers and suppliers implement and use the estimation and qualification system based on the EU Parliament Regulation no 995/2010 establishing duties for units for commercial wood and wooden products.

The "Regulation of Minister of Economy 2015" law act linked the reference price of electrical energy produced from renewable energy sources in 2016. The reference price for biomass fueled (or hybrid) power plants with the total installed power no higher than 50 MW was 96,28 EUR/MWh, while in high-performance co-generation installations, the reference price was set to 100,92 EUR/MWh. In installations with total power higher than 50 MW and heat power achieved in cogeneration not higher than 150MW, the reference price was set to 97,44 EUR/MWh.

The Regulation of the Polish Ministry Council from 2015 defines a maximum amount and value of electrical energy which can be produced in renewable energy installations with the degree of power utilization less than 4.000 MWh/MW/year. The regulation also defines the maximum amount of electrical energy produced from renewable energies can be sold at the auction in the amount of 4.736.044 MWh. The maximum sold value of electrical energy can be as of 418.606 EUR.

3.1.5 Relevant national incentives and support schemes for bioenergy developments

The fourth chapter of the 2016 "Act about RES" is entitled as "Supportive mechanisms and instruments of electrical energy production from RES, agricultural biogas and heat in RES installations". The legislation predicted that auction systems will be a target model of renewable energy support. The basic criteria for an auction winning is the standard price on which energy producers from renewables are ready to supply and the proposed price cannot overcome the maximum reference price level. The Act also defined the new renewable energy support system in conjunction with auctions on energy from large-scale installations (above 1 MW). The law stated that sterling wood is a type of biomass which fulfils quality standards of high volume, while medium volume of hardwood and softwood mixed with fragmented material cannot be considered as renewable.

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The main institution which financially supports renewable energy and bioenergy is the National Fund for Environmental Protection and Water Management. One priority of the Fund is to limit or avoid of CO_2 emissions by the increase of energy production from renewable energy sources. The other priority is the promotion of energy efficiency and renewable energy utilization in the corporate level. The bioenergy development and renewable energy investment support can be obtained from the Fund in the framework of "Support of distributed RES" sub-program in the forms of support loan and donation.

Each Polish region owns own Regional Fund for Environmental Protection and Water Management. All regional funds support educational activities for renewable energies. At regional and local level, finances can be received from Regional Operational Programmes for the support of renewable energy production and implementation, infrastructure construction or accommodation to energy distribution from renewables, installation construction for the production of bio-components or biofuels of 2nd or 3rd generation. Investments in the construction or modernization of units for electrical energy production or heat production from renewable energies can be also applied for. Bioenergy related research and development activities are conducted at different project framework levels. They are financed from national structural funds such as Innovative Economy, Infrastructure and Environment and from international funds such as European Funds, Norwegian Financial Mechanism or European Space Agency. Research and development activities are also financed by the National Centre for Research and Development by different programs, for example the BIOSTRATEG program or Small Grants program. Loans for investments in bioenergy can be achieved from the Environmental Protection Bank. There are special programs for agriculture and rural areas for the support of bioenergy production and utilization at farm level realized as Rural Areas Development Program and Agriculture-Environment Program. For the forestry sector the National Forestry Program offers funding possibilities. It should create a vision for Polish Forestry at perspective to 2030 and further to 2080. It is a strategical program for forests and forestry economy development and environment protection in forests.

3.1.6 Best bioenergy practices in Poland

Best practice for direct wood burning

Heating plant in Pisz town is presented below.

Figure 8: General view of Pisz heating plant,

Figure 9: Wood chips storage

(Source: Henryk Poslednik, piszpec@wp.pl)

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Different types of woody biomass are used in this district heating plants, such as chopped biomass, wood chips, plywood chips, shavings and sawdust.

Technical data:

- 21 MW biomass district heating plant
- 4x POLYTECHNIK boilers: 3 x 6 MW, 1 x 3 MW
- rated capacity ~26 MW
- boilers efficiency 87,4 %
- medium moisture of biomass 35% w.
- allowed quantity of ash 1,5 %
- fuel granulation up to 5 cm

Biomass storage

- Biomass is stored on two open yards with 2200 m^2 surface each.
- Bales, stumps and edgings are gathered on area of 3 ha.
- Covered shed 6,5 m height is foreseen for dry chips (3000 m^3) and staves (500 m^3) storage.

Best practice for biogas fermentation

The biogas station in Klempsk has an installed capacity of 0,93 MW of electrical power, being a unique station in Poland by having assembled with gas turbines. The installation is also taking advantage of a pig farm with 1.100 pcs. of livestock. In the fermentation chambers mesophil fermentation process is conducted at 32-38°C. Dry matter content in substrates is less than 15%. After the fermentation process the residues are used as fertilizer for corn for silo crop with a content of 5-6% of dry matter. The fertilizer enriches the soil with organic matter being more valuable than the same crop residues of corn and provides food for soil microorganisms. Fig. 10 presents the general view of station and a picture with the owner.

Figure 10: General view of biogas station and a picture with the owner.

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Best practices for direct straw burning

Figure 11 presents a typical boiler on straw for farms heating used in Poland with a usual thermal power of 100 kW. The boilers are usually installed in batches with periodic operation. Due to this feature a storage tank for hot water is usually implemented to secure heat supply for heated buildings. To heat a residential building with 200 m^2 surface, the biomass consumption is 8 ton of straw per season harvested from 3 hectare.

Figure 11: Straw boilers

3.1.7 Conclusions for Poland

According to the „Polish energy policy up to 2030 year" legislation paper, biomass will have a dominant position in renewable energy production structure. The "Act about RES" law emphasized that the transport distance of biomass to any energy unit should be maximum 300 km. The exact distance value is going to be clarified by the future Regulation of the Minister of Agriculture. In connection with the entry into force of the "Act about RES" and due to the lack of some regulations to it, the situation for bioenergy production is not yet stable in Poland and some of the regulations are still in the preparation phase. From a commercial point of view the utilization of energy crops for solid fuels became unprofitable because of higher coal application and higher level of emission. The general public knowledge about bioenergy policy is not high, while government administration sometimes miss the necessary background information. The national support system for bioenergy use can be considered as insufficient, especially for biomass producers and with the current lack of profitability for biomass crops, it is difficult to forecast that there will be changes in the application of unused and underutilized land in the short and medium term.

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3.2 Romania

3.2.1 Relevant country-specific biomass feedstock types

Romania has a variety of renewable energy sources, but the capacity to fully capitalize on them what concern the renewables for heat, is reduced due to market immaturity for advanced technologies and to low financial incentives. Biomass carries the highest potential for green energy production. According to Ministry of Agriculture, the country's biomass energy potential is of approximately 7.6 million ton of equivalent oil per year, out of which: biogas (7.7%), lumber and firewood waste (15.5%), wood waste (6.4%), agricultural waste from cereals, corn stalk, vineyards (63.2%) and urban household waste (7.2%)

Other estimation [1] for the period 2012-2025, taking into account the sustainability criteria mainly for agricultural waste, gives:

Resource	PJ/year	Percentage
Forestry and wood waste	90	34.5%
Agricultural waste	100	39%
Biogas (animal waste, food industry, sewage sludge, landfill)	30	11 %
MSW	6	2.5 %
Dedicated energy crops	35	13 %

Table 4: Sustainability criteria estimation for agricultural was for the period 2012-2025

Since 2011 energy crops are eligible for a direct payment scheme granted for agriculture. As a result, the number of farmers cultivating energy plants increased year by year. Thus, from 2015 to 2014 their number increased to 442, from 320 in 2014, and the total area required to pay in 2015 was about 5,000 ha. Cca 70% from total is represented by Salix. [Ministry for Agriculture and Rural Development - MARD)

Main residues	Residues production t/ha	Area cultivated ha	Total residues t x 10^3
Wheat straw	4-6	5463570	21854...32781
Corn Stover	4-6	2604475	10418...15627
Sunflower Stalks	4-6	1011523	4046...6069
Sugar beet	5-6	26591	133...160

Table 5: Agricultural residues [MARD, 2]

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3.2.2 Relevant country-specific bioenergy production and processing technologies

The production of energy from renewable sources from agriculture and forestry is around 3,700 ktoe. The production and use of energy from renewable sources in the agricultural sector are still low, so that only 2.5% of the total production of renewable energy at national level came in 2011 from agriculture, compared to 9.8% in the EU27. Instead, about 69.1% of renewable energy (mainly heat) at national level in 2011 came from the forestry sector, compared with 48.3% in the EU 27 [3].

Biomass for energy is mainly used for heat, with a large consumption of woody biomass and agricultural waste in rural households, but in low efficiency (c.a.17%) traditional stoves. Heat consumption from solid biomass in 2015 was in total 3.495 Mtoe 3.431, but only 0.064 Mtoe in DH systems [7].

Pellets and briquettes production increased in Romania mostly after the country inclusion in EU. This was and still is mostly related with the new markets in Europe. Currently, there are many pellet producers in Romania, but information about their production capacities is scarcely accessible. In general, most of the production of large companies is sold on western European markets. Small producers sell also on the Romanian market in the limit of their stocks (most of the production is realized from wood processing residues), based on pre-established contracts [4].

According to the Romanian Regulatory Authority for Energy (ANRE), with approximately only 106 MW installed capacity in power plants using biomass or its derivatives (such as biogas) as fuels at the end of 2015, the sector has a significant potential for medium term growth in Romania. As a number, at the end of 2015, there were 70 operators licensed for biomass and biogas for electricity projects. According to [5], the gross electricity production from solid biomass of Romania in 2015 was only 0.454 TWh.

3.2.3 Relevant EU legislation and policies for bioenergy

The European Union has promoted renewable energy through legislative frameworks since the first renewable electricity directive from 2001 and the 2003 directive on renewable energy use in transport. These directives were repealed by the Renewable Energy Directive adopted in 2009, which set out legally binding targets for each Member State for 2020, and a trajectory to reach them, bringing the EU as a whole to 20% of renewable energy in final energy consumption by 2020.

According to the DIRECTIVE 2009/28/EC Romania has a target of 24% for share of energy from renewable sources in gross final consumption of energy till 2020. The Directive 2009/28/CE was adopted in Romania partially through the Law no. 220/2008 regarding the system of promotion for the production of energy from renewable sources amended by Government Ordinance no. 29/2010

On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the target of at least

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27% renewables in the final energy consumption in the EU by 2030 is met. Romania will probably assume a higher target than the European (average) one. A NREAP to guide the target fulfilment is also asked by the European legislation and Romania produced its NREAP on 2010 with Progress Reports in 2012 and 2014.

3.2.4 Relevant national legislations and policies for bioenergy

Energy Strategy 2016-2030 with an outlook to 2050

A new Energy Strategy was launched at the end of 2016 by the Ministry of Energy for public consultation.

The Strategy has five key strategic goals: energy security, competitive energy markets, and clean energy, along with good governance in the energy sector and affordable energy supplies, which entails the reduction of energy poverty and better protection of vulnerable consumers.

The third key area of strategic intervention addresses the prevalent role of biomass in household heating in rural areas. Almost 90% of dwellings in rural areas and 45% at national level are mainly using firewood for heating. These dwellings are often only partially heated, by burning wood in traditional stoves with incomplete combustion. The comfort level is low and the cost high. Biomass will preserve a key role in heating rural dwellings. The Government will support the use of efficient and less polluting equipment, as well as biomass and biogas based cogeneration systems in semi-urban areas which are suitable for the development of small district heating networks.

Basic law: Law No. 220/2008

Since 2005, Romania has adopted a support system with mandatory quotas combined with transactions of GCs. The number of GCs received for each 1 MW delivered is different depending on the type of renewable sources. In 2015 the number of GCs by type of renewable sources was reduced.

The Law 220 regarding the establishment of a system for promoting the production of energy from renewable sources of energy was (too) often subsequently amended and supplemented, as following:

by (i) Law No. 139/2010 ("Law 139/2010"); (ii) Emergency Ordinance No. 88/2011 ("EO 88/2011"), as approved with amendments by Law No. 134/2012 ("Law 134/2012"); (iii) Emergency Ordinance No. 57/2013 ("EO 57/2013") as approved with amendments by Law No. 23/2014; (iv) Emergency Ordinance No. 79/2013 ("EO 79/2013"); and (v) Law No. 122/2015 ("Law 122/2015").

In accordance with Law 122/2015, RES-Electricity producers with power production facilities below 0.5 MW will be able to choose between the RES Support Scheme and a FiT system. The RES-Electricity producers opting for the FiT will no longer be entitled to receive GCs. The Government decision establishing the mechanism for the FiT has not yet been adopted, although the deadline set by Law 122/2015 has expired. According to a new proposed law, this scheme was postponed.

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National Renewable Energy Action Plan (NREAP)

The target of energy from RES in gross final energy consumption for 2020 is 24%, whereas the target for the RES share to the gross final consumption of heating and cooling is 22.05%. The target for the share of solid biomass to the gross final consumption of heating and cooling is 20.99% in 2020.

According to the 2nd progress report (2014), the actual contribution of solid biomass for the RES share in heating and cooling in 2011 and 2012 exceeds the estimated targets according to the NREAP. However, the target on DH has not been achieved.

The biomass heating target is on track only because that a large part of rural population burns fire wood for household heating.

Total actual contribution (final energy consumption) from biomass technology in Romania to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in heating and cooling (ktoe) [6].

	2013	**2014**
Biomass	3813.8 ktoe	3823.0 ktoe
Of which biomass in households	3108.9 ktoe	3118.9 ktoe

Table 6: Indicative interim trajectory for the shares of energy from renewable resources in heating and cooling (ktoe)

2014-2020 Rural Development Programme (RDP) for Romania was formally adopted by the European Commission on 26 May 2015. The RDP for Romania focuses mainly on 3 priority areas: promoting competitiveness and restructuring in Romania's large agricultural sector; environmental protection & climate change; and stimulating economic development, job creation and a better quality of life in Romanian villages. According to RDP, EUR 1.95 million total investment is foreseen in renewable energy production.

Under the priority "Restoring, preserving and enhancing ecosystems related to agriculture and forestry", more than 1.3 million ha (over 10%) of agricultural land and more than 800 000 ha (12%) of forests will benefit from payments to support biodiversity and promote environmentally-friendly land management practices. A further 4.7 million ha will receive support in order to prevent land abandonment and soil erosion.

According to **the new Government Programme,** in Romania, the total area of over 490,000 hectare of land in poor condition, can be used for energy crops. For the use of the land which is in the process of desertification and degradation, as well as for a new scheme for afforestation, new national targets will be set, together with incentives for mitigating GHG emissions and investments in alternative fuels, biofuels, biomass and bio-economy.

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Emergency Government Ordinance No 125/2006 approving the direct payment and complementary national direct payment schemes granted for agriculture starting from 2007.

MEF Order no. 1341/2012 for approving the procedure for issuing certificates of origin for biomass from forestry and related industries.

3.2.5 Relevant national incentives and support schemes for bioenergy developments

RES Support Scheme based on Green Certificates

In principle, the scheme, in operation since 2011, awards green certificates (GC) to accredited plants using renewable energy sources (RES) for each MW of generation from RES for a period of up to 15 years from first generation under the scheme. The number of certificates awarded is dependent on technology. GCs are sold to suppliers at a price within a maximum and minimum range; suppliers redeem the certificates to discharge a quota obligation based on their share of total sales. The cost of the scheme is therefore borne by electricity consumers, a concern witch led recently to the decrease of the initially foreseen level of incentive. The power generated by these projects is sold on a commercial basis.

During the first years the generosity of the support scheme for electricity production resulted in an explosive development of wind and PV farms. Biomass use for electricity, requiring higher capital costs and a secure biomass supply chain was neglected, even biomass projects are granted to 3 Green Certificates per MW if produced by efficient cogeneration or energy crops and to 2 GCs if produced by bio-waste.

As mentioned the rules of the GC market changed during the game:

- E.g. the diminishing of the RES quota for the 2016 year from an initially 17% to 12.15%. This induced the dissatisfaction of the RES investors claiming the instability of the market legislation.
- GCs number was reduced, a share of them were postponed for transaction. Biomass was the only RES resource which not undertook a reduction of the granted number of GCs.
- Exemption of large consumers from payment of GCs
- Taxation of GCs at the date of granting not upon sale (in 2015 RES investors financed the state with more than 2 Mio Euro through taxes paid in account of GCs [Source: Association of RES producers-PATRES]

As a result there was a surplus of unsold GCs on the market (PATRES assumption: 7 Mio at the end of 2016) and an increased return of investment 25-30 yrs. Based on a recent proposed Emergency Ordinance aimed to amend the Law 220/2008, the European Commission authorised at 16 December 2016, some changes to the Support Scheme with Green Certificates for energy from renewable sources.

The main changes are related to:

- method of calculating the rate of CV (the new method of calculation will result in a more even distribution of impact on final consumer);

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- increasing the duration of validity of the certificates (GC issued from January 1, 2017 will be valid until December 31, 2031)
- extending the period of deferral and the recovery of deferred CV;
- CV value will be recorded only when their trading;
- the transaction (this will be restricted transactions to be made on a centralized market CV);
- transfer mode with CV costs to final consumers;
- the minimum and maximum CV (minimum 29.4 EUR / CV and maximum 35 EUR / CV);
- insert a maximum acceptable impact on final consumer amounting to 11.1 euros / MWh.

Structural and rural development funds (2014-2020)

Grants provided by the European Union by its structural and rural development funds (EAFRD) are an attractive alternative means of financing biomass and biogas projects.

Projects are funded from two main sources:

- Cohesion Fund and the European Fund for Rural Development (Structural Instruments)
- Common Agricultural Policy (European Agricultural Fund for Rural Development)

Funding Program	Type of project
OP Large Infrastructure	•Waste to Energy (Axis 4, Investment Priority 2, Specific Objective 4.2.1) •Development of power plants and cogeneration plants for supply network (Axis 7, Investment Priority 1, Specific Objective 7.1.1)
Regional OP	•Acquisition of thermal and power plants for communities and buildings (Axis 4, Investment Priority 1).
OP Competitiveness	•Foreign staff for research (Axis1.2.4) •Creation, modernization and equipment research laboratories (Axis 1.2.1).
NRDP -National Rural Development Programme	Measure 4 (Investments in physical assets) - installations for production and use of renewable energy within the farm, including energy efficiency and production (sub measure 1) - Investments in processing and marketing of agricultural products (sub measure 2) Measure 6 (Developing farms and enterprises) - Support for non-agricultural activities in rural areas, produce energy for use on the farm (sub-measure 2) - Activities producing biofuels from biomass (sub-measure 4) Measure 19 LEADER (Support for LEADER local development) - Biomass cogeneration projects for Local Action Groups –LAGs

Table 7: Main bioenergy funding sources in Romania

Supporting Scheme for Agriculture

As other crops, starting from 2011, energy crops are eligible for direct payments scheme both from European funds and the transitional national aid financed from the national budget. Amount/ha of these payments is set annually by Government Decision, after determining the

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areas eligible for payment by the Agency for Payments and Intervention in Agriculture by the end of March.

Also from national budget, energy crop growers are entitled to reimbursement of sums representing the difference between standard and reduced rate of excise 21 euros / 1000 liter of fuel used for agricultural works.

Scheme of the Single Area Payment Scheme (SAPS), defined by art. 36 para. (1) of Regulation (EU) no. 1307/2013 and art. 10 of GEO. 3/2015. For 2015, the amount paid SAPS was established in the amount of 77.42 Euro / ha, equivalent. Redistributive payment, defined by art. 41, para. (1) of Regulation (EU) no. 1307/2013 and article 14 of GEO 3/2015. Redistributive payment represents an annual payment for farmers who are entitled to the single area payment and shall be granted gradually to the first 30 hectare of the farm.

The amount of redistributive payment and areas shall be established annually by Government decision. For 2015 for redistributive payment was set an amount of 5 Euro / ha for farms between 1-5 hectare and 46.75 Euro / ha for those between 6-30 hat. Payment for agricultural practices beneficial for the climate and environment defined by art. 43 para. (1) Reg. (EU). 1307/2013 and article 17 of GEO. 3/2015.

Farmers entitled to the SAPS, are obliged to apply applied on all of their eligible holdings the following agricultural practices beneficial for the climate and the environment:

- crop diversification;
- maintain existing permanent grassland;
- presence of an area of ecological interest on their agricultural area .

For 2015, the amount of payments for greening and ecological practices has been established in the amount of 53.90 Euro / ha (for holdings between 5-30 ha).

3.2.6 Best bioenergy practices in Romania

Biogas co-generation plant in Filipestii de Padure

Figure 12: Biogas co-generation plant in Filipestii de Padure (Source: http://www.energyreport.ro)

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Genesis Biopartner put in operation in 2013 the first Romanian biogas cogeneration plant in Filipestii de Padure, Prahova County. The project has an electric capacity of 1 MW and a thermal capacity of 1.2 MW, processing a daily amount of 49 ton of organic substrate. The project required an investment of approximately EUR 5 million. From a technical point of view, the project was implemented by AB Energy şi MT Energie, which supplied equipment for the CHP,

The first beneficiary of the resulted heat is the local cold cuts producer Cris-Tim. By the partnership with the Cris-Tim it was provided a large part of the needed raw material for the plant and therefore a long term secure supply chain, a key factor the project success. CHP station uses green corn recovered from cultures situated at a distance of 5-10 km, but also animal waste from the cold cuts producer Cris-Tim , which will lead to better management animal waste.

High efficiency biomass cogeneration plant in Huedin city

Figure 13: Biomass cogeneration plant in Huedin city (Source: ARBIO – Bioenergy4Business Project)

The Company, Paulownia GreenE International SRL took over the public DH service of Huedin city, Cluj County in 01.02.2015. The old DH system, which has been refurbished, consists of a 4 MW sawdust boiler. The plant supplies all the heat produced to natural persons and legal entities in the area of Huedin city The installation of a new cogeneration system using biomass through gasification process is foreseen for the year of 2017. The capacity of the CHP unit is 1.4 MW (heat) and 1 MW (electricity), with an investment 2.8 mil. Euro.

The company is in the process of setting up a 130 ha plantation of Paulownia hybrids that will be exploited both for timber and biomass to provide the necessary biomass for own production plant, to reduce operating costs and reduce energy price. The heat produced will be used by the enhanced network of consumers in Huedin city, while the electricity generated during the process shall be delivered to the national grid, by means of a conversion unit placed in the vicinity of the plant.

Holzindustrie Schweighofer (Austria) – opened two cogeneration power plants using biomass in May 2009 in Radauti, Suceava County and then another two cogeneration power plants in Sebes, Alba County. In Romania, first biomass cogeneration plant was at Radauţi, owned by the Austrian company Holzindustrie Schweighofer. The power plant, launched by 2008, has a capacity of 29 MW total, of which 24 MW heat and 5 MW electric-power, and the investment was about 20 million EUR. Further at Sebes another biomass cogeneration plant with a power half that of Radauti, which will have a capacity of 8.5 MW of electricity was opened. The cogeneration plant operating at Radauti consumes biomass sterile 40 m3/h, and the heat produced is currently used to dry timber in the self-owned factory (also Holzindustrie Schweighofer), but also to heat the 7000 flats in Radauti, the electric electricity being supplied to the national energy system.

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Nevertheless it is worth to mention here that biomass projects encounter serious risks and barriers. A known failure was the Suceava municipality biomass plant. The plant was finalized in 2013 as a private investment (Adrem Invest Company) to supply additional heat to municipal district heating. The equipment supplier is Austrian company URBAS. The plant was designed for an electrical capacity of 29.65 MW and a thermal capacity available in the heat exchanger for district heating of 71.43 MW. The biomass consumption is approx. 154,800 t/year. But problems occurred related to the availability and price stability of the fuel supply chain and to the payment capacity of the population and the plant was shut down after 2 years.

3.2.7 Conclusions for Romania

Viable biomass supply models are to be identified and promoted as the security of supply chain is the one of the main barriers for a larger penetration of biomass projects in Romania. The key obstacles to affect the supply security are:

- uncertainty on farmers business
- cost volatility of the biomass fuel
- fluctuation of available biomass resource
- low experience to use agricultural waste or to grow energy crops

Another barrier is the lack of consistency and continuity in the biomass for energy policy:

- The National Biomass Action Plan is not recognized and is not implemented in practice, although several draft versions have been formulated. Neither a Biomass Law to create a transparent and stable framework for investors was yet promoted.
- National renewables obligations are to fulfilled by power from wind and solar and by heat produced in traditional and inefficient ways, therefore no political interest to promote modern biomass for energy technologies
- Under above mentioned circumstances, there is a low interest in promoting underutilised land for energy from biomass, except some measures under Operational Programmes.

Nevertheless positive steps are expected on the biomass for energy development as the Romanian authorities have stated lately in strategic documents (e.g. New Energy Strategy) their intention to focus on the neglected Biomass potential use.

- The main areas of interventions should be agricultural waste (from crops and animal farming sector) and dedicated energy crops on unused land rather than on biomass from forest wood. In light of some unsustainable and aggressive use of the forests wood in the last period in Romania the forestry and wood use for power production become a sensitive issue for public opinion and policy makers perception. Also security of supply of forestry resources is questionable in the medium and long term, given the alternative uses as new materials in furniture and construction industries
- Local authorities, which own a good share of under-utilised land, are aware and ready to be involved and to develop business on these categories of land. There is a clear trend on local level to build consensus on the most appropriate local solutions, including collection of fuels.

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3.3 United Kingdom

3.3.1 Relevant country-specific biomass feedstock types

Investigations performed by Forestry Commission of United Kingdom have defined potential energy grasses with high yields. These grasses are following [1]:

- Switchgrass (Panicum virgatum);
- Miscanthus species;
- Reed canary grass (Phalaris arundinacea);
- Rye (Secale cereale);
- Giant reed (Arundo donax).

Short rotation coppice (SRC) [2] as energy biomass includes such species as willows and poplars. Yields of wheat in United Kingdom reach 7.5-8 ton of grain per ha [3]. In addition there is 3.5-5 ton per ha of straw which can be burned to produce heat. Forestry Commission has proposed wood of following tress as energy biomass [4]:

- Eucalyptus
- Nothofagus (southern beech)
- Poplar
- Sycamore
- Ash

3.3.2 Relevant country-specific bioenergy production and processing technologies

There are different ways to convert raw biomass feedstock into a final product. Some technologies are even adapted to the different physical nature and chemical composition of the feedstock and to the energy service that is required for the moment , as heat, power, transport fuel etc. The production of heat by the direct combustion of biomass is the leading bioenergy application throughout the world.

According to UK Energy Strategy [5] there are following technologies to use biomass:

- biomass burning for heat and electricity production,
- production of biofuels.

Development of bioenergy technologies is needed mainly to improve first of all the efficiency, reliability and then the sustainability of bioenergy chains. In the heat sphere - more cleaner and reliable systems; electricity creation of the smaller electricity systems; in the transport sphere - higher quality and sustainable biofuels production.

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3.3.3 Relevant EU legislation and policies for bioenergy

Following EU legislation in sphere of biomass use are applied to UK:

Renewables Directive - Directive 2009/28/EC of April 2009 on the promotion of the use of energy from renewable sources (amending the previous Renewables Directive 2001/77/EC). The Directive sets an overall EU community target for 20% of energy and 10% of transport fuels to be produced from renewable sources by 2020. Each Member State has its own legally binding individual targets in order to contribute to this, based on existing renewable capacity and relative GDP per capita; the UK's target is to produce 15% of our energy requirements from renewable sources by 2020 [11].

50 by 50: Global Fuel Economy Initiative - Launched in 2009, the "50 by 50" initiative, led by a consortium including the International Energy Agency and United Nations Environment Programme (UNEP), sets the global auto industry and governments a target of halving emissions from cars by 2050. The initiative requires an improvement in average fuel economy (reduction in fuel consumption per kilometer) of 50% worldwide by 2050, which would make an important contribution to meeting the CO_2 targets identified by the International Panel on Climate Change (IPCC) **[**11**].**

Emissions Trading System (EU ETS) - The system began operation in 2005 as an international CO_2 Trading System, based on EU Directive 2003/87/EC. It covers over 11,500 energy-intensive installations across the EU, including combustion plants, oil refineries, coke ovens, iron and steel plants, and factories making cement, glass, lime, brick, ceramics, pulp and paper. Participating companies can buy or sell emission allowances, with the price depending on supply and demand. National Allocation Plans (NAPs) determine the total quantity of CO_2 emissions that Member States grant to their companies [11].

Energy Performance Building Directive - The EPBD (directive 2002/91/EC) made a legal requirement for the energy certification of buildings in domestic, commercial and some industrial sectors. Any building that is built, sold or rented in the UK must now have an Energy Performance Certificate (EPC). Public buildings must also have a Display Energy Certificate (DEC) to give information about their energy efficiency. Energy practitioners involved in energy reporting or energy assessing buildings need to register as "Accredited Energy Assessors" through an approved accreditation body such as ECMK or CIBSE [11].

3.3.4 Relevant national legislations and policies for bioenergy

The Renewable energy Strategy is a key document regulating issues on renewable energy production and reducing of CO_2 emissions [5].

The UK Bioenergy Strategy provides a holistic view of biomass uses in setting bioenergy policy and will inform policy decisions on electricity, heat and transport [6].

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The Rural Development Programme for England provides money for projects to improve agriculture, the environment and rural life [7].

The United Kingdom Forestry Standard (UKFS) is the reference standard for sustainable forest management in the UK. The UKFS, supported by its series of Guidelines, outlines the context for forestry in the UK, sets out the approach of the UK governments to sustainable forest management, defines standards and requirements, and provides a basis for regulation and monitoring – including national and international reporting [17].

The Rural Economy and Land Use Programme enabled researchers to work together to investigate the social, economic, environmental and technological challenges faced by rural areas. It was an unprecedented collaboration between the Economic and Social Research Council (ESRC), the Biotechnology and Biological Sciences Research Council (BBSRC) and the Natural Environment Research Council (NERC). It had a budget of £24 million, with additional funding provided by the Scottish Government and the Department for Environment, Food and Rural Affairs [9].

The Standard Rule Permit SR2012 No12 "Anaerobic digestion facility including use of the resultant biogas" applies to England and Wales, and enables anaerobic digester operators (processing no more than 100 ton per day) to carry out anaerobic digestion of wastes and also combustion of the resultant biogas in gas engines. The rules also allow use of gas turbines, boilers, fuel cells and treatment and/or upgrading the biogas to biomethane. Permitted wastes include those controlled by the Animal-By-Products Regulations but do not include hazardous wastes [10].

3.3.5 Relevant national incentives and support schemes for bioenergy developments

The Energy Entrepreneurs Fund is a competitive funding scheme to support the development and demonstration of state of the art technologies, products and processes in the areas of energy efficiency, power generation, heat and electricity storage and carbon capture and storage (CCS) [12].

The Department of Energy & Climate Change (DECC), BBSRC and the Technology Strategy Board are part of a European consortium that, supported by the European Commission, aims to encourage generation of bioenergy through a single collaborative funding call. The objective of the call is to fund several collaborative bioenergy demonstration projects. Department of Energy & Climate Change (DECC) [12].

Carbon Trust interest free loans – The Carbon Trust offer government funded, unsecured 0% business loans for energy saving projects, up to a maximum loan limit of £100,000. Available for small, medium and large companies that don't fall under the Carbon Reduction Commitment [11].

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Carbon Trust survey – The Carbon Trust offers free carbon surveys to sites and organisations with an energy bill greater than £50,000 per year. Telephone support is available for smaller organisations [11].

The Domestic Renewable Heat Incentive (Domestic RHI) is a government financial incentive to promote the use of renewable heat. Switching to heating systems that use eligible energy sources can help the UK reduce its carbon emissions and meet its renewable energy targets. People who join the scheme and stick to its rules receive quarterly payments for seven years for the amount of clean, green renewable heat it's estimated their system produces [13].

The Energy Company Obligation (ECO) is a government energy efficiency scheme in Great Britain to help reduce carbon emissions and tackle fuel poverty. Under the scheme, larger energy suppliers have to deliver energy efficiency measures to homes in Great Britain. Suppliers are given targets based on their share of the domestic gas and electricity market. The scheme focuses on the installation of insulation and heating measures and supports vulnerable consumer groups [14].

The Climate Change Levy (CCL) Exemption is now closed for renewables. Renewable electricity generated from 1 August 2015 will not be eligible to receive Levy Exemption Certificates (LECs). The CCL is a tax on UK business energy use, charged at the time of supply. Energy use refers to electricity, gas, liquid petroleum gas and solid fuel [15].

The Renewables Obligation (RO) is one of the main support mechanisms for large-scale renewable electricity projects in the UK. Smaller scale generation is mainly supported through the Feed-In Tariffs (FIT scheme). The RO came into effect in 2002 in England and Wales, and Scotland, followed by Northern Ireland in 2005. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources [8].

3.3.6 Best bioenergy practices in the UK

In UK biomass is usually burned in adapted traditional coal-fired power stations (so-called 'co-firing') or in specialised biomass facilities designed for the production of electricity, heat, or combined heat and power [16].

Currently there are two primary types of biofuels in commercial production. Bioethanol made from fermenting agricultural crops such as sugar cane, sugar beet or wheat; and biodiesel produced from oily crops such as soy and oilseed rape or by processing oily wastes such as used cooking oil and animal fats.

Biogas can be produced from the decomposition of biomass in the absence of oxygen, a process known as anaerobic digestion (AD). AD can be used on farms to process animal slurries and other agricultural residues; by the water industry to process sewage sludge; and to process food waste that would otherwise go to landfill. In all cases it produces a valuable methane-rich gas which can be used like natural gas to generate energy for electricity, heat and transport. The process of gasification or pyrolysis (high temperature treatment in the presence of little or no oxygen)

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produces a range of products including a gas that can be converted and used in a similar way to biogas. It is often referred to as 'syngas' and, where the feedstock is biomass, this gas is renewable [5, page 95].

Co-firing of biomass: Drax is a large coal-fired power station in North Yorkshire, England, capable of co-firing biomass and petcoke. The station tested co-firing biomass in the summer of 2004, and in doing so was the first power station in the UK to be fueled by wood. The initial trial of 14,100 ton of willow was locally sourced from nearby Eggborough. Since the trial, the station's use of biomass has continued. It uses direct injection for firing the biomass, whereby it bypasses the pulverising mills and is either injected directly into the boiler or the fuel line, for greater throughput. In 2009 a target was set for 12.5% of the station's energy to be sourced from biomass, and the shift to biomass was intended to contribute to the aim of cutting CO_2 emissions by 15%. The station burns a large range of biomass, mostly wood pellets, sunflower pellets, olive, peanut shell husk and rape meal [18].

Figure 14: Wood-pellets co-firing on Drax power station

Straw burning plant: Elean power station is a straw-fired biomass power station in Cambridgeshire, England. At a capacity of 38 MW, it was the largest straw-fired power plant in the world at the time of its completion. The power station was constructed between 1998 and 2000 by FLS Miljo and is operated by EPR Ely Ltd. It generates 270 GWh of electricity from 200,000 ton of biomass annually, supplied by Anglian Straw Ltd. Straw is the major fuel of the plant, but oilseed rape and the energy crop Miscanthus are also used, as well as some natural gas. [19].

Figure 15: Elean power station

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Figure 16 Fuel for Elean power station

Burning of poultry litter

Thetford is largest power station in Britain running on poultry litter, consuming 420,000 ton of litter (a mixture of straw, wood chips and poultry droppings) annually. It has a capacity of 38.5MW and generates enough electricity for some 93,000 homes. A valuable by-product of the process is high quality fertiliser [20].

Fig 17: Fuel for Thetford power station

Figure 18: Thetford power station

3.3.7 Conclusions for the UK

High biomass potential is determined by presence of numerous species of trees, grass and bushes with great ability to produce biomass. In addition here are other sources of biomass, except energy cultures, such as grain straw residuals and agriculture residuals. Unfortunately, there are not so many ways of biomass usage in the UK. Biomass is primarily burned to receive heat and electricity, other way of biomass usage – is production of biofuels and biogas. Country's government tries to support bioenergy developers through loans, tax incentives, grants, paybacks and support schemes and this sector is only developing and even is trying to spread as far as new ways and possibilities are open, for instance to grow valuable energy crop on under-utilized lands that can be more beneficial. Growing on under- utilized land will free more agricultural lands that are good for food production. But farmers should be prepared and aware of different possibilities as for now in the country is observed active competition for agricultural land, which are suitable for

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growing bioenergy crops. People started to come to the understanding that there is a future in this segment of the energy market and with the time it will be only developing. As to the vision of the country's bio-energy market until 2050 that it can be generated 44 percent of all electricity consumed by the United Kingdom. At the same time to achieve such figures, the country has a sufficient volume of own raw materials and imports of biomass will not be necessary. Also can be seen the huge potential of the United Kingdom in terms of energy production from biomass, as the economy of the country produces it in excess, at the moment

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3.4 Hungary

3.4.1 Relevant country-specific biomass feedstock types

The total area of Hungary is almost 10 million acres, out of which vegetation covers almost the three-quarter. The total available biomass potential in Hungary is approximately 350-360 million ton, out of which 105-110 million ton of biomass is regenerating every year (approximately 9 million ton of forests per year) in a total energy potential of 1185 PJ. Forests are estimated to cover more than 1.5 million acres (with a total of 250 million ton of biomass potential), while arable lands account almost the half of the total country area. According to estimations, the theoretical low-worth area of Hungary that is considered as under utilised and capable of energy related plantation cultivation is more than 1,79 million acres. On this total area of low-worth land a total production of 14–25 million ton of biomass would possible per year. In theory this amount is equal to 150-250 PJ of energy with a maximal biomass gain. All over from the regenerating 105-110 million ton of biomass, 38-43 million ton could be used for energy production. In case the under utilised and out-of-cultivation area is concerned in an approximate area of 1,1 million Ha, a total production of 8-14 million ton of biomass could be produced, equaling to 80-150 PJ energy which is almost equivalent to 10% of Hungary's total energy demand. The most popular energy plants in Hungary are the following: Robinia pseudoacacia L., Salix, Poplar, Robinia, Tree of heaven, Energy grasses, Miscanthus, Rapeseed, Hemp, Tritikale, Arundo. [1]

3.4.2 Relevant country-specific bioenergy production and processing technologies

The most relevant biomass production technology in Hungary is still relating to conventional forestry logwoods. Collection and process of timber wood biomass for heat and electricity production is the major source for bioenergy developments. This means in the first place direct wood burning in heat and electricity production plants, very frequently in co-firing with black/brown coal and lignite. The second most usual bioenergy development is biomass burning in district heating boilers (without co-firing). Individual logwood burning in home stoves for residential use is getting more and more frequent, even with the steady increase of logwood prices. Direct biogas fermentation is also quite relevant in Hungary, mostly in connection with wastewater treatment plants, where the sewage leftover is processed biologically and the produced bio-methane is burned in gas motors. Biomethane is also collected and burned from municipal solid waste but only at a few landfills. Latest technologies are in development to inject the cleaned biogas backwards into the existing natural gas grid. Biomass pyrolysis from wood and plantation material is not very common in Hungary although the amount of available base material would make it possible, however the investment costs for such technology yet are too high. First generation bioethanol is produced in two large factories (Győr and Szabdszállás) usually from corn and maize. However, the residential consumption of bioethanol is limited only to the amount that is blended into petrol fuel by national standards (4,4 v/v %), while E85 consumption is practically non-existent. The number of E85-ready cars (special Saab, Ford, etc.

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types) running on Hungarian roads are negligible. Biodiesel is blended into regular diesel fuel also in a rate of 4,4 v/v % since 1 January 2008. [2]

3.4.3 Relevant EU legislation and policies for bioenergy

Legislation

Three major strategies (Roadmaps) provide the framework to the EU approach to renewable energy. They determine specific targets and goals for the Member States to achieve until 2020 [3], 2030[4] and 2050 [5] respectively. These documents served as a compass for the Hungarian legislation in this field as well. A binding legislation has been adopted in the form of the Renewable Energy Directive which concluded that the Member States shall increase the proportion of renewable to conventional energy by 20% (10% in the transport sector) and a reduction of gas emissions to 20% from the baseline level of 1990[6]. The country-specific target for Hungary regarding the share of energy from renewable sources in gross final consumption of energy by 2020 is 13%. [7] To achieve these goals, the Member States are bound to present a national action plan.

1257/1999 EC provides the general framework for supporting and intervening in lands that are under utilised.

The biofuel legislation is based on the Directive 98/70/EC on the quality of petrol and diesel fuels. Its latest amendment of 2015 determines that „Member States are (...) to require suppliers of fuel or energy to reduce by at least 6 % by 31 December 2020 the life cycle greenhouse gas emissions per unit of energy of fuels used in the Union by road vehicles, non-road mobile machinery, agricultural and forestry tractors and recreational craft when not at sea." [8] The biofuels directive 2003/30 further prescribes the substitution of conventional diesel and petrol with biofuels. [9]

Another pillar to biofuels is the sustainability criteria laid down in Directives 98/70/EC and 2009/28/EC which requires the Member States and the Community to increase the use of biofuels in a way which brings a net benefit to the environment. Therefore the EU set out further objectives which anticipate a greenhouse gas emission saving of 35-60%. The relevant calculation method is to be applied by the Member States. The use of land is closely related matter which has been addressed in the 2015 Directive: it is necessary to harmonize measures on the EU-level in order to prevent an environmentally harmful competition between the use of land for food production and fuel production (indirect land-use). A specific calculation methodology for land carbon stock has been developed by the Commission. [10]

A White Paper from 2011 presented another relevant Roadmap which aims at achieving a resource efficient transport system. This strategy foresees a 60 % GHG reduction in the transport sector by 2050 and to halve the conventionally-fueled cars in urban transport by 2030. [11] The Commission released in 2013 a strategy on the use of alternative fuels which is non-binding. [12] Directive 2014/94/EU sets forth a binding regulation on infrastructure to be offered by the Member States that enables the use of alternative fuels. To this end, Member States ought to

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develop a national policy framework. [13] The Directive 443/2009/EC further determines standards for CO_2 emission of new passenger cars which is binding for Hungary as well.

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market. - The directive had major impact on Hungarian bioenergy developments, as many power plants were switching from conventional fuels into solid biomass based fuel material. Pure solid biomass burning is now ongoing in power plants of Pécs, Ajka, Oroszlány and Kazincbarcika, while biomass-coal co-firing technology was developed in the Mátra Power Plant. Although switching from conventional fuels into biomass at large power plants were not without techno-economic problems, the sustainable, environment friendly and highly efficient latest technologies could be successfully implemented and installed after all. [14]

Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. – This directive had an indirect effect on national policies, as by 2007 the share of renewable energies of the total energy consumption reached 5,1%, however it should be noted that this increase was partly generated by the stable increase of fossil fuel prices too.

Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport. – The most important effect of this directive was to increase the rate of liquid and solid fuels for a total of 90% by 2007. However it should be noted that the larger part of this was consisting of solid biomass.

The Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC [15]

The most important EU legislation that has a direct and significant effect on Hungarian bioenergy legislation is the Action Plan on the implementation of the European Parliament and Council Directive 2009/28/EU of April 23, 2009 on the promotion of energy use, produced from renewable energy sources. Amending and replacing of Directives 2001/77/EU and 2003/30/EU, the „RED" Directive foresees at least 13% of renewable energy share form the full Hungarian energy mix until 2020. This 13% share should be equivalent with at least 129-135 PJ/year and the Directive also expects that the energy share for solely transport reasons should exceed 10% of the total national energy mix. The objectives were to be set in the Hungarian National Renewable Energy Action Plan [16]

Relevant EU strategies that have significant effect on national bioenergy legislation

The EC 2020 package is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020. The package sets three key targets: 20% cut in greenhouse gas emissions (from 1990 levels), 20% of EU energy from renewables and 20% improvement in energy efficiency. The targets were set by EU leaders in 2007 and enacted in legislation in 2009. They are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth.

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3.4.4 Relevant national legislations and policies for bioenergy

Relevant national renewable energy programmes and legislation

In compliance with the EU-legislation, the Member States are obliged to develop a National Action Plan on Renewable Energy (NAP). The Hungarian document (titled „Hungary's Renewable Energy Utilisation Action Plan", 2010) thus serves as the official framework of national policies which respond directly to EU requirements. The Hungarian Government decided to surpass the demanded share of renewable energy of 13 % and aspires to achieve a share of 14,65 %. Furthermore, the NAP also identifies five key areas of the Hungarian renewable energy policy:

- Security of supply
- Environmental sustainability and climate protection
- Agriculture and rural development: due to Hungary's favourable agro-ecological conditions, the country is a fitting candidate for increased investment in the biogas and biofuels sector. According to a calculation in the NAP, more than 10% of the estimated energy consumption can be covered by first generation biofuels, with further expansion potential via second generation biofuels.
- Development of a green economy
- Contribution to Community goals

Biofuels ought to receive two types of economic support: indirect incentives (eg. tax benefits) and green financing. Moreover, the share of alternative fuels is planned to exceed the Community goal of 10 % by setting out a goal 11,18 %. In connection with this, the NAP recognizes a window of opportunity in the public transport sector, as the fleet of vehicles might be replaced by a new one based on biofuels.

Apart from the NAP on Renewable Energy, there is a set of other frameworks which are related to the use of alternative fuels and biofuels among them.

- The „New Széchenyi Plan" (2011): This is the national overall development framework for Hungary. One chapter is dedicated to green energy with emphasis on agricultural opportunities (restructuring the sector to accommodate the production of biofuels), decentralized production of alternative energy and green transport. [17]
- „National Energy Strategy 2030" (2012): one chapter on transport, similar content to the one above. [18]
- „National Transport Strategy" on the energy efficiency of transport (2013): here they propose ideas on f.e. imposing green taxes on fuels (per liter) and to found an institution dedicated to energy efficiency. They stress that great energy efficiency savings cannot be expected in the transport sector due to lack of capital. Instead, a reduction of GHG emission may be pursued. [19]
- The „Hungary's National Energy Efficiency Action Plan until 2020" (2015): includes a section on development plans in the transport sector (infrastructure, research, procurement, licensing, etc.). It also mentions the necessity of research in the field of second-generation biofuels in order to overcome the sustainability conflict of first-generation biofuels. [20]

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Legislative acts related to the topic:

- 137 and 151/2004 (IX. 18.) FVM Minister Decree on under utilised lands and their financial intervention [21] [22]
- 49/2005. (V. 31.) FVM Minister Decree on amendment of 151/2004 (IX. 18.) [23]
- 25/2007. (IV. 17.) FVM Minister Decree on under utilised lands compensation rules [24]
- 343/2010. (XII. 28.) Government Decree on the requirements and verification of sustainable biofuels-production [25]
    - Includes a list of definitions for biomaterial
    - This law prescribes the national sustainability criteria for biofuels
    - It also determines how they have to be licensed
    - Transparency criteria for traders of biomaterial
- 2010. CXVII. Act on the promotion of the use of renewables and the reduction of greenhouse gases in the transport sector [26]:
    - This law determines how biofuels should be used in the transport sector.
- 30/2011. (VI. 28.) NFM Decree on the quality standards of engine fuels [27]
- 1002/2011. (I.14.) Government Decree on the tasks regarding the NAP: sets deadlines for the relevant ministers and authorities. [28]
- 2015. LVII. Act on energy efficiency (energy audits, energy efficiency network, energy experts assigned to businesses) [29]

3.4.5 Relevant national incentives and support schemes for bioenergy developments

State incentives framework for biomass utilisation on under-utilised lands:

A) Hungarian funds operated through national institutions

National Energy Conservation Programme (NEP)

Green Investment System (ZBR)

B) EU funds operated through national institutions:

Environmental and Infrastructure Operative Programme (KIOP)

Environment and Energy Operative Programme (KEOP)

C) Energy Efficiency Loan Base (EHA)

EU funds through local administrations

2007 - KEOP-4.1.0 – Production of heat and electrical energy from renewable materials

2007 - GOP-2.1.1 – Increasing the competitiveness of small- and medium sized enterprises with growth potential through technical development

2009 - GOP-2.1.1-09/A – Production of wood chips from wood process industry byproducts

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2009 - KEOP – 2009-7. 4. 3. 0 – Renewable based regional development

2009 - KEOP – 2009-4. 2. 0 – Provision of local heat and cooling energy based on renewables

2009 - KEOP – 2009-4. 4. 0 – Production of electrical energy based on renewables

2009 - KEOP – 2009-4. 6. 0 – Bioethanol production

2011 - KEOP-2011-4.2.0/B – Local heat production from renewable energies

2011 - Biomass heated furnace replacement programme for pellet or biomass

2012 - KEOP-2012-4.10.0/C – Production of biomethane from renewable sources

2013 - KMOP-3.3.3-13 – Increasing the share of renewable energy applications

2016 - ZFR-CSH/2016 – Energy saving developments for family houses, based on biomass for heat production

2016 - VP3-4.2.2-16 – Vineyard support for biomass utilisation development

2016 - TOP-6.5.2-15 – Renewable energy developments for county municipalities

2016 - TOP-3.2.2-15 – Municipality building developments based on renewable energies

2016 - VP5- 8.1.1-16 - Supporting energy forestation activities

Regional incentives for biomass utilisation in Hungary for under-utilised lands

LEADER Programme – example: (Bükk-MAK)

INTERREG South-East Europe Programme – examples with Hungarian relevancies and participants:

- ENER - SUPPLY - ENergy Efficiency and Renewables - SUPporting Policies in Local level for EnergY
- M2RES - FROM MARGINAL TO RENEWABLE ENERGY SOURCES SITES Recovering marginal territories, making them regain their lost value by pursuing sustainable development programs

INTERREG Central-Europe Programme – examples with Hungarian relevancies and participants:

- RUBIRES - Rural Biological Resources
- SEBE - Sustainable and Innovative European Biogas Environment
- GOVERNEE - Good Governance in Energy Efficiency
- URBAN-SMS - Urban Soil Management Strategy
- CIRCUSE - Circular flow land use management
- MANERGY - Paving the way for self-sufficient regional energy supply based on sustainable energy concepts and renewable energy sources

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Direct international and EU funds

International incentives for biomass utilisation in Hungary on under-utilised lands – examples with Hungarian relevancies and participants:

- PROBIO - Production of biogas and fertilisers out of wood and straw (FP6)
- OPTIMA - Optimization of Perennial Grasses for Biomass Production (FP7)
- BIOSURF - BIOmethane as SUstainable and Renewable Fuel (H2020)

3.4.6 Best bioenergy practices in Hungary

Szarvas Agricultural Research and Development Non-profit Ltd. utilises energy grass on under utilised lands since the 2000s. The Szarvasi-1 energy grass came into existence by the cross-fertilization of plant materials collected in the "szik" soil areas of the Great Plain and in the arid areas of Middle-Asia. The genotype peculiar to the class is the result of a 10 year improving work. The biggest biogas production of the "Szarvasi-1" energy grass is at 350 degrees C. At 325 degrees C, an exothermic reaction can be detected with intensive gas production. The second peak during the gas production process was detected at 500 and 700 degrees C pyrolisis temperature. [30]

Figure 19: Energy grass plantation in Hungary (Source: http://www.energiafu.hu/nemesit.html)

Komló Heat Plant Co Ltd. developed a woodchip biomass fired plant in Komló municipality in a total project cost of 4.433.000 EUR, out of which the EU contribution was 1.666.666 EUR. The 18 MW heat boiler is operating since 2010, satisfying at least two third of the city's heat demand is produced from biomass. [31]

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Figure 20: Komló Biomass Heat Plant (Source: http://www.pert.hu/en/recultivation/komlo-zobak)

Green Energy Storage Consulting, n.o. lead the Consortium of one of the few Hungarian biomass pryrolisis technology development project between 2012 and 2015. The total project budget was 999.920.00 EUR, out of which ERDF awarded 810.102 EUR in a bilateral Hungarian-Slovakian project. The objective was to develop and install a plant for energy production by pyrolysis using municipal, agricultural and forestry by-products and waste. [32]

Figure 21: Biomass Pyrolisis Demo Plant (Source: http://www.envirovid.eu/wp-content/uploads/2016/01/Toroczkay-J..pdf)

Pannonpower Co. Ltd (as part of the Veolia Group) is operating two bio-based power plant blocks in the city of Pécs since 2005. One of the blocks is fueled by dried straw that is collected from nearby agricultural communities and farms, the other block is fueled by woodchips. The wood material f(mainly mischantus) or the chips is collected first from the Mecsek mountains, nowadays from all around South-Hungary.

The power plant produces energy in a rate of 30-35% for the district heating and 65-70% for electricity. The plant has FSC certification for sustainable collection and use of wood biomass. The district heating of Pécs is now fully covered from renewable sources. Drone video about the biomass fuelled power plant is available at: https://www.youtube.com/watch?v=o_-lijv2d5s [33]

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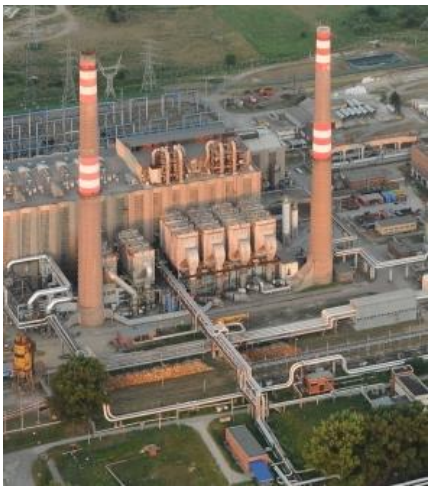

Figure 22: Pannonpower Plant (Source: http://www.pannonpower.hu/tagvallalatok/pannon-hoeromu-zrt)

3.4.7 Conclusions for Hungary

Since the end of the 19th century, the under utilised area in Hungary increased from 530.000 acres to 1.596.000 hectare, which equals to an increase from 6 % to 17 % of the total area. It also meant a 9500 hectare per year decrease of crop-land area, but in the past decades the process escalated. As a result of the overdriven industrialisation era, the under utilised area increased with 350.000 hectar only between 1945 and 1985. Even after the system change in 1990, the process is slowing down only at a minor rate and the loss of useful lands are tend to stagnate around 5-6000 hectare per year. The biggest decrease impacted the arable lands, while grasslands suffered only smaller losses. A Hungarian specialty is that even marked as arable land, a considerable percentage of that is considered as out-of crop area nowadays, without any kind of utilisation since ~1990. This is explained with the extremely delayed privatisation process, which resulted several unclarified propriatorship of many areas. Without a legally confirmed owner, these lands turned from arable lands into under utilised and out-of crop areas with wild flora. Another important Hungarian relevance is that even if the useful areas decreased since a long time, interestingly the area of woodlands increased thanks to the focused forestation activities after the system change. In summary it can be stated that because of unclarified propriety reasons the economic utilization of these lands for bioenergy developments are yet to be seen.

In Hungary, at most of the cases the system change did not automatically resulted in a more reasonable and conceptualised land use. In order to maximize crop gains and agricultural profits, arable lands were still forced to be applied on slopes and hills, which increased water erosion and resulted in several out of use surfaces. State and EU supported interventions on these type of area for remediation would be welcome, mostly with flora that can apply to the special slope conditions and micro-climate.

Another chance for bioenergy investments on under utilised lands in Hungary are the remaining military grounds that were actively used until the early 1990s. These soviet military grounds were left usually heavily contaminated with petrol chemicals and need further in-situ remediation.

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Most of these areas are usually completely out of exploitation, but thanks to some state level incentives, preliminary activities already started for utilisation.

Current bioenergy developments in Hungary are still relating to the direct burning of logwoods, straw, agricultural solid plant residues or in better cases the utilization of biomass chip. Co-firing of biomass with conventional energy sources (coal, lignite) is still very relevant in larger power plants. The production of cellulosic ethanol is negligible in Hungary, while 3rd generation biofuel developments are still in research and development stage. Still, first generation biofuel production is quite relevant rom maize and corn, as there are several industries active in that field. Biomass gasification and pyrolysis in plant scale currently is almost non-existent in Hungary.

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3.5 Belgium

3.5.1 Relevant country-specific biomass feedstock types

Nowadays forest covers over 600.000 ha in Belgium and almost all forests are managed as high forest. Major forest stand types and extent in Flanders and Wallonia (after Waterinckx and Roelandt (2001) and Lecomte et al. (2003))

National forest types	Forest types for biodiversity assessment (FTBA, BEAR)	Flanders		Wallonia	
		Area (ha)	(%)	Area (ha)	(%)
Oak forests	Mixed oak and oak hornbeam forests	11.500	8%	84.800	18%
Beech forests	Lowland and sub-montane beech forest	5.000	4%	42.300	9%
	Idem	25.000	17%	9.900	2%

Table 8: Forest types and distributions in Wallonia and Flanders

By a decree of the Flemish Government of June 20th 2006 short rotation forestry, defined as the cultivation of fast growing woody plants, from which the above ground biomass is periodically harvested with a maximum of 8 years after planting or previous harvest, is no longer considered as subjected to the Forest Decree, except in some land use categories which are considered to be vulnerable. This means that SRF can be considered as an agricultural crop. Until then, areas stocked with trees or shrubs were considered as forest, meaning that establishment of a SRF - plantation on agricultural land turned it into forest land, and was lost for agriculture for the future. In Flanders poplar and willow are used in short rotation forestry. Biomass streams that are also large and still relatively under utilised are manure, common sludges, some agricultural crop residues, and landscape care residues.

Biomass from the forest sector remains large, but once a further mobilisation of the primary residues will start the available amount will decline but still remain significant. Primary forestry residues are however difficult to mobilise, but still they are interesting as they can reduce the pressure of markets on secondary forestry residues.

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Cropped biomass shows a clear growth both for sugar, starch and oil crops and particularly for woody and lignocellulosic crops. The growth in the first category of crops is an immediate result of the expectation that the NREAP targets set for biofuels in 2020, and kept stable for 2030, are to be partly based on domestic crops, particularly sugar beet. This crop is likely to be attractive as it provides a very high sugar yield per hectare and current sugar beet production levels can only be maintained after reform of the sugar market when they are used to satisfy the domestic biofuel targets or new biochemical feedstock markets. As for the expected growth in the perennial and woody biomass crops group it is based on the expectation that more land will be released from agriculture because of the declining demand for food and feed crops produced in Belgium. Wood waste, MSW and animal / mixed food waste are already largely exploited for energy generation so the opportunity is mainly to improve resource efficiency. Growth in waste categories is expected to be limited. The same applies to Municipal Solid Wastes (MSW) of which the organic fraction is already largely used for compost and energy generation. It is worth noting here that MSW potential is relatively small in Belgium (as compared to many other EU countries) since only a limited amount of waste ends up in the mixed waste stream. Belgium is a front-runner together with a couple of other EU countries in waste separation.

3.5.2 Relevant country-specific bioenergy material production and processing technologies

Feedstocks	Selected value chain	Motivation
Organic waste	Separately collected organic waste: • Anaerobic digestion (medium scale) & local CHP • Anaerobic digestion (medium scale) & upgrading to SNG	Good experience in separate collection of green waste. AD needs to be promoted in this sector. Utilisation of biogas (CHP or SNG upgrading) depends on the local situation (heat demand).
Primary forest residues		Potential is mainly situated in the Walloon Region.
Industrial wood residues / wood waste	Combustion (medium scale CHP), heat driven.	Important wood processing industry in Flanders. Lot of focus on recycling and cascading principles.
Biomass crops		Intensive agriculture with high productive land.

Table 9: Feedstocks and value chain motivation in Belgium

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3.5.3 Relevant EU legislation and policies for bioenergy

The Renewable Energy Directive establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the target of at least 27% renewables in the final energy consumption in the EU by 2030 is met.

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

Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources

3.5.4 Relevant national legislation and policies for bioenergy

Forest Decree of 13 June 1990 - The forest decree is the legal basis for the management and policy of forests in Flanders. It is applicable on public, as well as private forests. It is mainly focused on the protection and the sustainable use of the forest. The decree also recognizes the different functions that a forest can fulfil.

Decree of 27/06/2003 for establishing the criteria for sustainable forest management for forests situated in the Flemish Region - The management of public forests and forests situated in the VEN (Flemish Ecological Network) should be done according to the criteria for sustainable forest management.

Decree of 11 March 2004 on incentives intended to promote environmental protection and sustainable use of energy - The Walloon Region provides investment assistance for companies which develop projects aiming at developing the sustainable use of energy, including investments in renewable energy plants. The production of heat and electricity through biogas CHP plants with an electrical power less than 10 kW is eligible. Heat production through biomass heating plants as well as heat and electricity production through biomass CHP plants are eligible, except solid biomass CHPs with electric power >1 MW, or plants using liquid biomass.

Decree of 6 May 2004 on the promotion of green electricity and cogeneration quality: green certificates - A quota system to increase the proportion of renewable energy in total energy generation; green certificates are allocated by the Brussels regulatory authority Brugel. The number of certificates depends on the amount of electricity generated (in kWh) in proportion with the CO_2 saved: one certificate is issued for every 217 kg of CO_2 saved.

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Green certificates - Decree of the Walloon Government of 30 November 2006 on Support for Renewable Energy and Combined Heat and Power Generation - In the Walloon region, renewable electricity generation is promoted through quota obligations. Electricity suppliers are obliged to prove, by submitting certificates, that a certain statutory and continuously increasing proportion (quota) of the electricity they supply was generated from renewable sources.

Forest Code of 15 July 2008 - The decree is the legal basis for the management and policy of forests in Wallonia. It is applicable on public, as well as private forests. It is mainly focused on the protection and the sustainable use of the forest. The decree also recognizes the different functions that a forest can fulfil.

Energy Decree - Decree of 8 May 2009 concerning general provisions related to energy - The Energy Decree bundles all prior energy related decrees, e.g. electricity and gas decree, and stipulates general conditions for energy policy in Flanders. The following relevant parts can be identified: - Green power certificates - CHP certificates - Grid injection tariffs - Green heat support - Renewable heating in buildings obligation

Royal Decree of 12 October 2010 on efficiency and emission levels of small scale heating installations - The goal of this decree is to secure the conditions of bringing heat generators powered by solid fuel to the market and sets minimum requirements for efficiency and emission levels of small scale heating systems operating on solid fuel.

Royal Decree of 5 April 2011 on requirements for wood pellets in non-industrial heating installations - In a royal decree the minimum requirements for wood pellets to be used in non-industrial heating installations are regulated. Pellets should be produced from chemically uncontaminated wood, and should come from sustainable forest management (FSC, PEFC or equivalent).

Royal Decree of 26 November 2011 on product norms for biofuels, including sustainability criteria - Sets out the product standards for biofuels and lays down the provisions in terms of the national certification plan demonstrating the sustainability applying to biofuels in accordance with European Renewable Energy Directive (2009/28/EC) & Fuel Quality Directive (2009/30/EC)

Material decree - Decree of 23 December 2011 concerning the sustainable management of material chains and waste streams - The decree anchors sustainable materials management in Flanders. It implements the European Framework Directive (EC) 2008/98 on waste management in Flanders. VLAREMA, a complementary decision of the Flemish Government (made 17th February 2012), runs parallel with the material decree and contains more detailed prescriptions concerning special waste streams, raw materials, selective collection transport, registration duty and the extended producer responsibility.

Law of 17 July 2013 on the mandatory nominal blending of sustainable biofuels - The Law specifies that any registered company marketing petrol products and/or diesel products for general use is also obliged to market, during the same calendar year, 6% of sustainable biofuels.

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Decree of 21 Nov 2013 of the Brussels Capital Region concerning integrated pollution prevention and control of pollution from industrial emissions - This Decree lays down rules on integrated prevention and control of pollution by industrial activities and complements the provisions of the Ordinance of 5 June 1997 concerning the environmental permits that apply to it. In line with European Industrial Emissions Directive.

3.5.5 Relevant national incentives and support schemes for bioenergy developments

Common Agricultural Policy implementation (Since 1992) - In line with EU Common Agricultural Policy; provides a framework for financial support to farmers (Pillar 1 - Direct Payments), and national rural development programmes (Pillar 2 - Rural Development)

Act of 6 May 1999 to promote the development of forest groups - The system of Forest Groups has reinforced the legal arsenal available in the Walloon Region in order to optimize forest management by grouping forest owners. The Act of May 6, 1999 was to halt the process of fragmentation observed in the Walloon forest, and allow for a more coordinated management of the forest. Forest groups can enjoy specific fiscal incentives through grants.

Subsidies for afforestation and forest management - Subsidies for: - purchase of land for afforestation - afforestation of agricultural land - ecological function of forests - reforestation or afforestation with native tree species - opening of private forests - preparation of a forest management plan

Decision of 27 June 2003 on the recognition and subsidizing of forest groups (Since 2003) - Subsidies are provided to forest groups. Forest groups are voluntary cooperations between different forestry owners (public, as well as private). The main goal is to organize joint forest management and wood sales.

Circular P&O/DD/2 (November 18, 2005) on the purchasing policy of the federal government to promote the use of sustainably exploited wood - The Federal Council of Ministers has decided that the consumption of wood from Federal Governmental Departments should only come from sustainable forestry. This applies to purchase, hire and leasing of products in which wood is processed.

BELSPO – SSD (2005-2009) - Federal research programme "Science for a Sustainable Development". The programme SSD is composed of 8 priority research areas: Energy, Transport and mobility, Agrofood, Health and environment, Climate, Biodiversity, Atmosphere and terrestrial and marine ecosystems and Transversal Research.

Royal decree of 10 March 2006 regarding the use of rapeseed oil as biofuel - Biofuel from rapeseed oil produced by a natural or legal person who directly sells its production to the end consumer without intermediary can be exempted from excise duty. These limitations don't apply for public transport using pure rapeseed oil.

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Budget Act of the 10 June 2006 - Tax exempt quotas for sustainable biofuels - Introduces a reduced excise rate for petrol and diesel products containing a minimum share of biofuel (minimum 7%vol bio-ethanol in petrol; minimum 3,37%vol FAME in diesel). The biofuels should be produced by production units authorised by the Belgian Government. The selection of these parties is based on a tender process, taking into account supply distance, CO_2 balance, energy efficiency and production cost. From 2014 these units need to report on a monthly basis on the sustainability character of the supplied biofuels.

Decree of 2 April 2009 on aid for energy saving and energy production from renewable energy sources - Investment assistance for companies which develop environmental projects, including investments in renewable energy plants; investments in biogas or biomass CHP and trigeneration plants are eligible under condition that CO_2 savings of the plant are at least 5 % compared with conventional installations producing separately heating, cooling and electricity.

Innoviris support for scientific research and innovation (Since 2010) - Innoviris funds scientific research and technological innovation. Businesses, universities and colleges in the Brussels-Capital Region can apply for financial support for research.

Decision of the Flemish Government of 17 December 2010 granting aid to companies for ecological investments in the Flemish Region: Ecology Premium Plus / Support for Strategic Ecological Projects - In general, companies are stimulated to invest in environmental friendly and energy efficient technologies via a subsidy scheme consisting of the Ecologic Premium Plus (EP-PLUS) and Strategic Ecologic Support (EP-STRES). An ecologic premium plus (EP-PLUS) is paid to technologies registered within a limited technology list (LTL). Technologies not singled out in LTL may apply for strategic ecologic support (EP-STRES).

Energy premiums (2012-2013) - The installation of heating plants through biomass, shallow geothermal energy (heat pumps) and solar thermal energy (solar water heaters) is eligible for the energy premiums. Moreover, CHP plants using biogas or biomass are also eligible

FISCH - Flanders Innovation Hub for Sustainable Chemistry (2012-2015) - FISCH strives for the realization of new value chains based on the application of sustainable chemistry: micro-algae, valorisation of secondary flows, separation Technology, renewable chemicals, microprocess technology, polymer cycles, knowledge Tools.

Energy Premiums (2013-2014) for residential, industrial and service sector buildings - Provides energy subsidies for residential, industrial as well as service sector buildings located in the Brussels region. Subsidies can also apply for renovation works in buildings older than 10 years. Devices needed for the installation of biogas or biomass CHP plants as well as the installation itself are eligible under certain conditions. The energy subsidies are defined each year and apply from 1 January to 31 December.

UREBA - Decree of 28 March 2013 on the granting of subsidies to public bodies as well as non-commercial bodies for projects aiming at improving the energy performance of their buildings - Walloon region provides UREBA subsidies, which aim at supporting public bodies such as towns and provinces in their initiatives to reduce the energy consumption of their

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buildings. Projects using renewable energy sources are subsidised. The material as well as the installation of renewable energy plants for the production of heat for the exclusive use of the building are eligible. The subsidy amounts to 30 % of the investment costs.

IWT Innovation Support - IWT is the government agency for Innovation by Science and Technology. They help Flemish companies and research centres in realizing their research and development projects, offering them financial funding, advice and a network of potential partners in Flanders and abroad.

3.5.6 Best bioenergy practices in Belgium

Biogas fermentation on the farm: Biolectric
http://www.biolectric.be

On a farm with 80 cows the yearly CH_4 emission of manure is equal to the CO_2 equivalent of 110 ton per year (that's about 110 cars on the road). By placing a Biolectric biogas installation on your farm this waste and its CH_4 emission are converted into green energy and heat, which can be used on the farm. The residual manure can be used as fertiliser.

The Biolectric biogas installation daily pumps a fixed quantity of manure from the reactor to the digestate storage and repletes the discharged volume with fresh manure from the manure pit. This process is fully automated and is done under supervision. Biogas is formed in the reactor through anaerobic fermentation. The gas is then purified and in the combustion engine it converts to green energy. This energy can be used on the farm in the form of electricity and heat.

Figure 23: Biogas Installation (Source: Bioelectric, Belgium)

ALCO BIO FUEL Bioethanol Plant, Belgium (www.alcobiofuel.com)

Customer	Alco Bio Fuel - Ghent - Belgium
General contractor	De Smet Engineers & Contractors
Scope of works	Turn-key supply of a complete wheat based bioethanol production plant
Industrial operation	2008
Plant capacity	150,000 m^3 per year of bioethanol
Processing units	• Wheat milling • Mash preparation, liquefaction, saccharification

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	• Mash fermentation • Alcohol distillation • Alcohol dehydration • Stillage separation • Stillage concentration • DDGS drying
Utilities	• Water cooling • Steam production • Electricity transformation and distribution network • Compressed air production • Effluent water treatment plant • Fire fighting system
Auxiliaries	• Chemicals and enzymes storage • Ethanol buffer storage • Ethanol pipeline • DDGS pelletizing unit • Laboratory • Control room • Administration building

Ghent Bio-Energy Valley (www.fbbv.be)

Ghent Bio-Energy Valley was founded at the initiative of Wim Soetaert in July 2005 as a Public Private Partnership between Ghent University, the City of Ghent, the Port of Ghent, the Development Agency East-Flanders and a number of industrial companies related to the Ghent region, active in the fields of generation, distribution, storage and use of bio-energy.

The driving force for the establishment of GBEV was mainly of a political nature. By joining forces, companies were hoping to obtain an as large as possible production quotum for biofuels from the Belgian government. In addition, the partnership should help them to tackle common problems related to production, feedstock or infrastructure. Finally, GBEV also provided a platform to inform the general public on these new products and technologies in a concerted way.

GBEV finally succeeded in acquiring 80% of the Flemish quotum for biofuels in October 2006, representing an investment of 120 million EURO in the port of Ghent. Production at Bioro and Alco Bio Fuel started in the spring of 2008.

Also In 2008, GBEV obtained a legal identity by transforming into a non-profit organization. In spite of what the name suggested, GBEV has always supported the development of all biobased activities, including bioenergy.

In order to better cover our scope of activities, a name change was inevitable in 2013: Ghent Bio-Economy Valley. Where indeed it all started with bioenergy activities originally, a whole new range of activities have been introduced over the last few years. The new name “Ghent Bio-Economy Valley”, is therefore a better reflection of the current activity range.

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3.5.7 Conclusions for Belgium

Biomass from the forest sector remains large. Belgian forest covers over 600.000 ha and almost all forests are managed as high forest. Poplar and willow are used in short rotation forestry. Biomass streams that are also large and still relatively under utilised are manure, common sludges, some agricultural crop residues, and landscape care residues. Cropped biomass shows a clear growth both for sugar, starch and oil crops and particularly for woody and lignocellulosic crops.

The large potential in manure is not surprising as Belgium has high density of cows, pigs and chicken. The potential in some waste categories is also large as there is a relatively large food and agricultural processing industry in Belgium.
Wood waste, MSW and animal / mixed food waste are already largely exploited for energy generation so the opportunity is mainly to improve resource efficiency. Growth in waste categories is expected to be limited.

The same applies to Municipal Solid Wastes (MSW) of which the organic fraction is already largely used for compost and energy generation. It is worth noting here that MSW potential is relatively small in Belgium (as compared to many other EU countries) since only a limited amount of waste ends up in the mixed waste stream. Belgium is a front-runner together with a couple of other EU countries in waste separation.

EU regulation is fully translated into national legislation and European targets are applied to the Belgian market. National legislation is complicated as energy is a regionalized topic so each of the regions adapted EU-legislation in a similar but different way leading to a multitude of legislation and incentives.

A lot of innovation in the field of biomass is ongoing. Research is led by universities and some outstanding research institutes such as VIB (Flemish Institute for Biotechniology) and VITO (Flemish Institute for Technology Research). Ghent University is bringing together academic research, innovators and private companies together in Ghent Bio-Economy Valley, a large area in the Ghent harbor area where experimental sites are developed.

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3.6 Ireland

3.6.1 Relevant country-specific biomass feedstock types

Ireland's renewable thermal energy requirement in the industrial sector is dominated by biomass, particularly in the wood products sector where wood is used extensively for process heat. In 2009, the wood products sector accounted for 65% of industrial renewable thermal energy use and 43% of total renewable thermal energy use. Wood biomass from Irish forests is a sustainable, renewable, carbon-neutral and indigenous source of energy. It is predominantly used to generate thermal energy (heat) but is also used to generate electricity, or both heat and electricity, in Combined Heat and Power (CHP) plants. In the residential sector, which accounted for 25% of total renewable thermal energy use in 2009, wood biomass also dominates.

The total estimated demand for wood energy in 2011 is 0.95 million m^3 and it is anticipated that will increase to 1.67 m^3 by 2028. A recent COFORD study estimated that up to 1.45 million m^3 of wood fibre will potentially be available for the renewable energy sector by 2020, increasing to 1.81 million m^3 by 2027. The estimate assumes, inter alia, that increased volumes of small roundwood from thinning operations in the private sector, downgrade material from large assortments and wood residues from the processing sector will be available over the forecast period. It should be emphasised that these volumes are potentially available - wood energy will have to compete with other end uses in order to secure the volumes indicated. [1]

3.6.2 Relevant country-specific bioenergy material production and processing technologies

In Ireland the main source material for bioenergy developments is woody biomass. Ireland's forests provide a range of roundwood assortment sizes used for board manufacture, wood energy, stake production and for the sawmill sector. The Irish wood processing sector is well-developed and, in recent years, has shown that it can adapt to changing market conditions. Total roundwood harvest available for processing in 2009 was 2.421 m^3, a small reduction (c. 3%) on the 2008 harvest. The reduction was primarily due to reduced demand for sawn timber and wood-based panels, linked to the reduction in construction activity. The harvest was broken down as 66% sawlog, 30% pulpwood and 4% stakewood.

Total wood fibre available in the Republic of Ireland in 2009 amounted to 3.553 m^3, including 932,000m^3 processing residue and 200,000m^3 post-consumer recovered wood. Of the wood available for processing 1.602 m^3 was used by the sawmilling sector, 1.286 m^3 by the wood-based panel sector and 0.431 m^3 for process drying, heat and power in the processing sector. The balance was used for a variety of products including round stakes (88,000 m^3), horticultural bark mulch (54,000 m^3) and woodchip (55 m^3). [2]

3.6.3 Relevant EU legislation and policies for bioenergy

Under the EU Renewable Energy Directive, all Member States are obliged to achieve a minimum target of 10% renewable energy in the transport sector by 2020.

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In order to meet the EU obligations of Ireland the Government has introduced the Biofuel Obligation Scheme to ensure that a proportion of the transport fuel used in the state consists of environmentally sustainable biofuels. Details of the sustainability criteria are available on Statutory Instrument 483 of 2014 European Union (Renewable Energy) Regulations 2014. The scheme is administered by the National Oil Reserves Agency.

The scheme places an obligation on suppliers of mineral oil to ensure that 6% (by volume) of the motor fuels (generally Gasoline and Motor Diesel) they place on the market in Ireland is produced from renewable sources, e.g. Ethanol and Biodiesel. The obligation was increased from the 1st January, 2013. It was previously 4%.

This means that at the end of each year an obligated road transport fuel supplier must hold six biofuel obligation certificates for every 94 litres of petroleum based fuel it has placed on the market. Certificates are issued for biofuels that have been demonstrated to have complied with the sustainability criteria of the Directive. Biofuels must not be made from feedstock's sourced from certain categories of land, and must achieve certain greenhouse gas emissions reductions.

It is intended that the biofuel obligation will be incrementally increased on a sustainable basis to 2020 to meet the renewable transport target of 10% in 2020. The incremental increases will have to take cognisance of technical and other developments.

Following consultations in October 2015 and February 2016, on 3 May 2016 Minister Alex White signed the National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2016 to increase the rate of biofuel obligation to 8.695 per cent from 1 January 2017. From 2017, an obligated party will be required to hold eight biofuel obligation certificates for every 92 litres of petroleum based fuel it has placed on the market, which equates to an 8% obligation in volume terms. [3]

3.6.4 Relevant national legislation and policies for bioenergy

The Energy White Paper in 2007 the government set a target of 30% co-firing with wood biomass, at the three state-owned peat power stations, to be achieved progressively by 2015, beginning with Edenderry Power Station. Trials commenced at Edenderry in 2008. In 2009, 66,000 ton of wood biomass were co-fired at the plant. It is estimated that wood biomass use at Edenderry Power could reach 300,000 ton by 2016. In 2006, a Green Paper on energy policy was published by the Irish government. Following a consultation process, the White Paper on energy policy was introduced in early 2007. This outlined energy policy for the period 2007-2020. Its primary objectives are security of supply, environmental sustainability and economic competitiveness. From a forestry perspective, the sustainable energy sub–programme outlines how the renewable energy sector is to be developed. The White Paper also set a target of 12% of thermal energy to come from renewable sources by 2020. [4] [5]

National Climate Change Strategy (2007 – 2012) - The Irish forestry sector has a key role to play in addressing climate change, through carbon sequestration and through the development of renewable energy resources. Forest areas established as a result of grant aid under State/European Union (EU) funded afforestation schemes since 1990 are expected to contribute an annual average emission reduction of 2.074 million ton of carbon dioxide (CO_2) over the Kyoto first commitment period (2008 – 2012). There is also a significant potential for wood fuel to

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displace fossil fuel, particularly in the generation of heat in industrial, commercial, domestic and institutional markets. [6]

Biomass and the National Development Plan (NDP) - Between 2007 and 2013 the NDP invested 184 billion EUR in the Irish economy. Areas in which the NDP influenced the Irish biomass sector included:

- Provision of support for the cultivation of fast-growing species, for the purposes of biomass production;
- The mitigation of climate change;
- Investment in sustainable energy with a view to meeting the target of 15% of electricity produced from renewable sources by 2010.

  - By 2015, a target has been set to achieve 30% co-firing with biomass in the three peat-fired power stations.
  - A target has been set for biomass to supply 12% of the renewable heat market by 2020

The Sustainable Energy Sub-Programme invested at least 276 million EUR in the Irish sustainable energy sector over the period of the NDP. This is in support of the targets for sustainable energy, including the promotion of renewable energy, improved energy efficiency and innovation. Key objectives included a commitment to delivering significant growth in the use of renewable energy in power generation. A target of producing 33% of electricity consumption from renewable sources by 2020 has been set. The ESB and Bord na Móna will work with the biomass sector to develop the potential of co-firing (with biomass) at the three state owned peat-fired stations. Biomass firing is set to commence at the Moneypoint generating station by 2010. [7]

Biomass power generation projects will be supported through the **Renewable Energy Feed-in Tariff (REFIT) scheme**. Under this scheme, the tariff price for biomass generated electricity is set at 7.2 c per kWh compared to 5.7 c per kWh for wind. The use of biomass in power generation will also be supported by means of technology transfer, by investment in specific research and development programmes and by tackling supply issues. The need to develop Combined Heat and Power (CHP) and District Heating Schemes has been identified as an area where energy efficiency could be improved. [8]

The Green Paper on Energy Policy in Ireland was launched on 12 May 2014, it commenced a public consultation process on the future of energy policy in Ireland for the medium to long-term. The purpose of the consultation was to invite interested parties to tease out the most important points highlighted, express any other views and identify policy points for consideration. The consultation finished on 31 July 2014 and 1,200 submissions were received. [9]

The National BioEnergy Action Plan aims to increase the use of renewable energy in three key sectors, namely transport, heat generation and electricity. The objective is that by 2020, a third of the electricity consumed in Ireland should be generated from renewable sources. Another objective is that by 2015, all peat fired power generation stations will be co-fired with 30% biomass. The aim is to reduce carbon dioxide emissions by 900,000 ton per year. Another element of the plan includes the introduction of additional 'top up' payments of 80 EUR per hectare for energy crops. This is in addition to the EU energy crops premium payment of 45 EUR per hectare. The additional payment of 80 EUR applied for three years.

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Item/year	2010	2020
Target for biomass generated electricity	400 MW	800 MW
Target for biomass generated heat	5%	12%

Table 10: Ireland targets for biomass CHP output (Source: Energy White Paper)

Other elements include:

- The introduction of a bioenergy scheme to encourage farmers to plant new energy crops such as miscanthus and willow
- A Research Stimulus Fund Programme will fund research into biofuels and energy crops.
- The introduction of a grant scheme for wood biomass harvesting machinery to include wood chippers and forest residue bundlers.
- The encouragement of a rate of afforestation that is sufficient to meet increased market demand for wood fibre in the medium to long term.
- The development of an efficient wood energy supply chain to facilitate the delivery of quality wood fuel at competitive prices. [10] [11] [12] [13] [14]

The Draft Bioenergy Plan was published by the Department in 2014. The draft Plan recognises that meeting the demand for biomass from indigenous sources could deliver significant economic and employment benefits. [15]

3.6.5 Relevant national incentives and support schemes for bioenergy developments

SEAI Greener Homes Scheme - In the residential sector, which accounted for 25% of total renewable thermal energy use in 2009, wood biomass also dominates. This is primarily due to grants under the SEAI Greener Homes Scheme for the installation of domestic renewable heating systems fueled by woodchip, wood pellets and other renewable fuels. Between 2004 and 2009 use of renewable thermal energy in homes increased from 15 ktoe to 49 ktoe.

The **ReHeat Programme** provides support to the commercial, public and industrial sectors for the installation of wood chip and wood pellet boilers. By June 2010, some 163 biomass projects had received support under the scheme, with a combined installed capacity of 67.6 MW. [16]

The Combined Heat and Power Programme provided grant-aid for the installation of CHP units. It aimed to develop small-scale CHP units (up to 1 MW) fired by fossil fuels, which can be deployed in buildings having a substantial heat requirement. A second strand, yet to be launched, covers grant aid for biomass fired CHP. This programme aims to deliver 10-15 MW Biomass CHP, and 10-20 MW of electricity from small-scale fossil fuel CHP. There is no limit on the size of installations

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that can be grant-aided if they are fueled by biomass. To date, no biomass CHP projects have been commissioned under this scheme. However, a number are in the early stages of development. [17]

The **Pilot Bioheat Boiler Deployment Programme** is a sub-programme of measured support under the Renewable Energy RD&D Programme that stimulates the biomass heat market. The Programme is aimed at accelerating the uptake of biomass boilers for space heating in Ireland by providing capital grant support for the installation of a number of biomass boilers, for large buildings and small industrial sites, around the country. The programme is supporting qualifying boiler systems typically rated between 60kW and 1,000kW that are fueled by wood pellets and/or wood chip fuel. It is proposed to offer support of 25% of the capital costs involved in biomass boiler and fuel storage purchase and installation. To stimulate interest and to help ensure good quality projects it is also proposed to support feasibility studies by suitably qualified contractors at 45% of the external costs, up to a maximum of EUR 5000 in each case. This support will be made available for a limited period only, and not after 2006. The total fund available for feasibility study grant support is EUR 50,000. The following suggested range of investment costs are provided as a guide to applicants and are intended as general guidelines only. For qualifying boilers rated at 60kW, the investment cost is estimated to be up to EUR 500/kW, including fuel storage. For qualifying boilers rated at 1000kW, the investment cost is expected to be up to EUR 250/kW, including fuel storage. For qualifying boilers between these sizes a linear interpolation will be used to assess investment cost. [18]

The Forest Service of Ireland promotes afforestation as a viable land use for farmers through the provision of planting grants and payment of annual premiums. In 2010, over 107 million EUR of capital expenditure was invested in afforestation grants and premia, mainly comprising 27.6 million EUR on afforestation 1st instalment grants, 7.4 million EUR on afforestation 2nd instalment grants and 72.3 million EUR on afforestation premium payments. An additional 6.6 million EUR was spent on other forestry support schemes for forestry and woodland development projects. A total of 114.5 million EUR in funding for capital and current expenditure has been allocated for the overall forestry programme in 2011. This should facilitate payment for between 7,500 and 8,000 hectare of new planting. [19]

Year	Total Expenditure	Total Afforestation Programme	1st Grant (million EUR)	2nd Grant (million EUR)	Premia (million EUR)	Forestry support schemes (million EUR)
2005	110,8	97,0	26,9	12,0	58,1	13,8
2006	111,0	93,6	22,7	10,9	60,0	17,4
2007	117,1	103,2	21,1	10,5	71,6	13,9
2008	115,7	103,7	19,8	9,5	74,3	12,0
2009	111,0	102,3	22,1	8,7	70,5	8,7
2010	114,4	107,8	27,6	7,4	72,3	6,6

Table 11: Annual expenditure on forest schemes in Ireland between 2005-2010 (Source: COFORD)

3.6.6 Best bioenergy practices in Ireland

The first commercial wood-fuelled CHP plant in Ireland is operated by **Grainger Sawmills Ltd.** This demonstration project is a joint venture between two companies - Grainger Sawmills Limited and SWS Group who have come together to develop the project from concept to an operational

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plant generating green energy (heat and electricity) from wood byproducts such as sawdust, bark, peelings and forest thinnings. This development means that in addition to having a plentiful supply of hot water at a fixed cost, the sawmill also has a guaranteed market for its low-grade residues, protection from fluctuating energy costs, a new revenue stream from 'green' electricity which is sold to the national grid and the satisfaction of knowing that it has reduced lorry journeys from the sawmill by an expected 1,500 per year. By investing in a biomass CHP plant the company has added as much value as possible to the timber processed from the mill while keeping the cost base as low as possible and improving environmental performance. The CHP plant, designed to burn sawmill co-products, is a Wartsila BioPower 2 Hot Water CHP plant with a Bio Grate bio fuel combustion chamber, steam boiler and steam turbine, as well as an extensive 450 meter long fuel conveyor system for transporting fuel in the form of wood by products from the sawmill. The plant is designed to ensure the sawmill's own thermal requirements in the form of kiln drying capacity are met and electricity produced sold to the national grid. By consuming these products on site rather than transporting them to often distant markets, energy is saved and CO_2 emissions reduced. [20]

Figure 24: Wood-fuelled CHP plant by Grainger Sawmills Ltd. (Source: http://www.seai.ie/Renewables/Bioenergy/Graingers,_Ireland's_first_biomass_CHP_plant.pdf)

The use of local biofuels increases energy independency and minimizes environmental emissions due to the high total efficiency, which may exceed 90%. Fuel is collected from five different locations at the sawmill. The bark and peelings are crushed in a crusher before feeding into the conveying system. The conveyor system is a completely enclosed belt conveyor line taking the fuel to the covered active fuel storage area. The capacity of the main fuel storage is 600 m^3. From the storage the fuel is fed further to the boiler using a drag chain conveyor and stoker screw. The plant has also an enclosed passive storage area located beside the main storage making it possible to store the additional fuel required for periods when the sawmill is not in operation. The critical requirements for this project were the Power Purchase Agreement, the Grid connection and ensuring a long-term fuel contract. The project developers, IBS identified two key priority areas for the successful uptake of biomass CHP in Ireland. The project was supported at both feasibility and capital stage through SEI's Renewable Energy Research Development and Demonstration Programme. Financing options include 100% capital investment (including bank financing) or third party financing from the equipment supplier or an energy contracting company. [20]

The other most important CHP facility in Ireland is operating at **Munster Joinery Ltd** and was developed by Fingleton White & Co. Ltd. It is designed to burn wood chip and saw dust, up to a maximum of 2 t/h sawdust and 2 t/h of wood chip. Two separate feed systems are used; sawdust is combusted in suspension, blown in from the sides of the furnace, while wood chip is delivered directly to the air cooled reciprocating grate, where combustion takes place. The joinery is fitted with dust extraction units that transport sawdust from the individual saws in the joinery to two fuel storage bunkers with movingfloors. Off cuts from the joinery are brought

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by forklift to the chipping area, where they are chipped and transported via a combination of conveyors and augers to a chip storage bunker. [21]

Figure 25: Wood-fueled boiler at Munster Joinery (Source: http://www.seai.ie/Renewables/Bioenergy/Munster_Joinery_Case_Study.pdf)

Each of the three fuel storage bunkers have a capacity for 700m^3 of fuel. This is enough storage to run the plant for 15 days. The boiler is supplied by Lambion and is a reciprocating grate, single pass shell and tube type, with refractory lined wet walls and two stages of super heaters. An induced draught fan maintains a negative pressure in the furnace, while combustion air is delivered by primary and secondary air fans, designed to ensure good quality combustion, ensuring full and efficient burnout of woodchip and sawdust. The boiler produces 15 t/h of steam at 400^{o}C and 25 barG, which is supplied to the condensing steam turbine with controlled extraction. The flow rate of steam to the turbine is controlled based on boiler pressure. Three hydraulic control valves modulate to maintain the boiler pressure at 25 barG. The project started in May 2005 and commissioned by October 2008 with a project capital cost of ~ 10 million EUR, funded by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union, in collaboration with the Sustainable Energy Authority of Ireland. [21]

3.6.7 Conclusions for Ireland

The Government White Paper on Energy Policy set a target of 12% of thermal energy to come from renewable sources by 2020. However, the renewable heat sector remains largely under developed. Today's economic climate, Irish businesses cannot afford to ignore the high cost of energy. Ireland's dependence on imported fossil fuel has left energy consumers vulnerable in terms of energy security, energy price volatility and exposure to carbon taxes. The Irish biomass resource plays an important role in contributing to the reduction in greenhouse gas emissions for Ireland. Forestry acts as a sink for the removal for CO_2 from the atmosphere. Biomass can substitute for fossil fuels and be used to produce process heat and steam for industry, or in power production through combined heat and power technologies. Switching to biomass renewable heat would not only reduce the cost base of Irish companies but would protect them from the price volatility associated with traditional fossil fuels. [22]

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http://www.seai.ie/Renewables/Bioenergy/Graingers,_Ireland's_first_biomass_CHP_plant.pdf

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4 European best practices outlook

In addition to target and outreach countries, a desk-based research was also implemented in a wider European scale in order to identify the best practices for bioenergy policies, regulations and support schemes. Those countries were investigated where relevant progress in bioenergy utilization could be identified, preferably with non-research operating bioenergy plants with at least a technology readiness level of 4.

4.1 Austria

In Guessing an innovative process for combined heat and power production based on steam gasification has been successfully demonstrated. Biomass is gasified in a circulating dual fluidised bed reactor. The producer gas is cooled, cleaned in two stages and used in a gas engine. Wood chips from forestry are the main fuel for the demonstration plant. The wood trunks are dried naturally by storage of about 1-2 years in the forest. Then they are delivered to the CHP-plant and chipped there. When the biomass is used, it has a water content of about 25-40%. The heat produced in the process is partly used internal, e.g. for air preheating, steam production, etc., and the rest is delivered to an existing district heating system. The net electricity produced is delivered to the electrical grid. The feed in rate in Austria is regulated by law and depends on the type of biomass used and on the size of the plant (13-16 EUR Cents/kWh). (http://demoplants.bioenergy2020.eu)

In 2009 Renet Austria and the Austrian Bioenergy Centre merged together and formed BIOENERGY2020+, a centre of excellence, funded by the COMET programme from Austria. With the support of BIOENERGY2020+ a new Technikum was erected, where now R&D on FT, mixed alcohols or hydrogen is done as well. (www.ficfb.at)

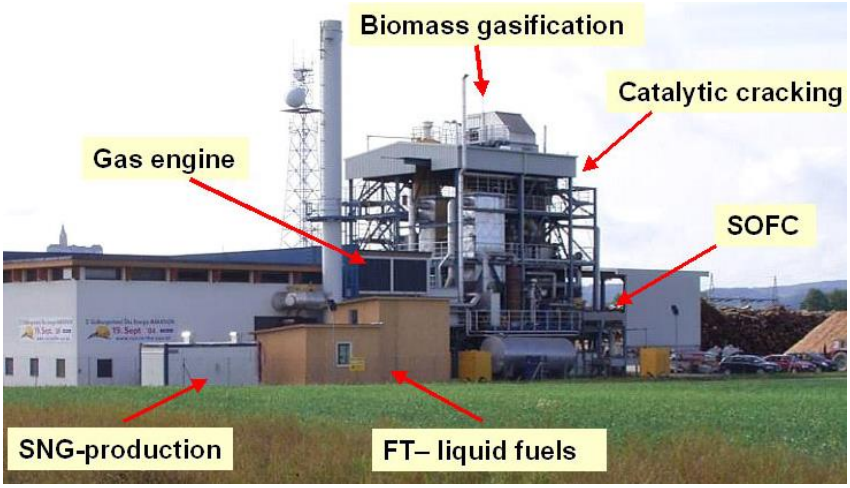

Figure 21: The Guessing plant (Source: www.ficfb.at)

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4.2 France

The Futurol Project was initiated in 2011 by the member of the Procetol 2G consortium: Agro industrie Recherches et Développements (ARD), Confédération Générale des Betteraviers (CGB), VIVESCIA, Crédit Agricole du Nord-Est, IFP New energies, Institut National de la Recherche Agronomique (INRA), Lesaffre, Office National des Forêts (ONF), Tereos, Total and Unigrains. The plant is based on woody and agricultural by products, residues and energy crops, producing around 2700 ton of cellulosic ethanol yearly. The plant is located near the city Pomacle and was the result of a private investment of 76.400.000 EUR. (http://demoplants.bioenergy2020.eu)

Figure 22: Futurol Project (Source: http://www.projetfuturol.com/Espace-Presse_a42.html)

4.3 The Netherlands

ECN initiated a fuel synthesis pilot plant in the city of Petten since 2008. The technology produces substitute natural gas from woody biomass using MILENA gasification, gas cleaning, gas upgrading and methanation, based on lignocellulosic raw material such as clean wood and demolition wood, in a total yearly stream of 1800 ton. http://demoplants.bioenergy2020.eu/

Figure 23: The ECN pilot (Source: http://www.jasperlensselink.com)

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4.4 Denmark

Aalborg University, the Danish government and private entities invested more than 2.000.000 EUR to set up a continuous bench scale site in Aalborg that is operating since 2013. The investment is based on hydrothermal liquefaction technology that is producing 24 ton bio-oil per year from DDGS, hardwood, softwood, peat, woody biomass and forest residues, mainly aspen. (http://demoplants.bioenergy2020.eu)

Renewable oil yields of 40% (dry weight), oxygen content of 5-12 wt% and higher heating value (HHV) of 36-40 MJ/kg; and, energy conversion of 80% and carbon conversion ratios above 60%. (http://steeperenergy.com/projects/pilot-plant)

A similar technology is operated since 2015 at the Center for Biorefinery Technologies at the Aarhaus University. It is also based on hydrothermal liquefaction from lignocellulosic crops, but has a smaller yield of 1 ton / year. (http://demoplants.bioenergy2020.eu)

4.5 Finland

Fortum is operating a TRL 7 demo site in the city of Joensuu since 2015. The fast pyrolysis technology applies lignocellulosic crops and wood residues to produce 50.000 ton of bio-oil per year.

Chempolis Ltd. is operating a biorefining plant in Oulu that is using non-wood and non-food lignocellulosic biomass such as straw, reed, empty fruit bunch, bagasse, corn stalks, as well as wood residues (25,000 ton/year) to produce 5.000 ton cellulosic ethanol per year and also other type of chemical outputs.

Figure 24: Biorefinery plant in Oulus (Source: www.chempolis.com)

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4.6 Sweden

SP/EPAP operates a TRL 7 demo biorefinery plant in Ornskoldsvik since 2004, being it one of the long-time running cellulosic plant in Sweden. EPAP is owned by University of Umea, the Technical University of Lulea, and SEKAB E-technology AB. SEKAB E-Technology runs the plant, and was responsible for the development as well. The plant operates during 24 hours, 7 days a week and since the first start-up and it accumulated more than 30.000 hours of operating time. The technology consists of two steps diluted acid and enzyme hydrolysis process, utilizing sugarcane bagasse, wheat, corn stover and energy grass to produce around 160 ton of cellulosic ethanol per year.

Figure 25: Ethanol Pilot Plant in Ornskoldsvik (Source: http://www.nyteknik.se/energi/etanolpiloten-far-nytt-liv-i-ornskoldsvik-6403905)

Preem Petroleum operates a TRL 8 "first-of-a-kind" commercial hydro-treatment biorefinery plant in Gothenburg. The plant uses oil crops, vegetable oils, tall oil and fats to produce 20.000 ton of diesel type of hydrocarbons per year. It should be noted that the processing of the tall oil takes place within the fossil oil refinery, and the product is diesel with only a renewable content of 1/3.

Figure 26: Preem Biorefinery Plant in Gothenburg (Source: https://www.preem.se/en/in-english/about/refineries/)

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5 Conclusions

The main objective of Deliverable 4.1 was to identify and reveal successfully applied bioenergy policies that resulted in value chain oriented bioenergy developments and biofuel installations within Europe. The desk-based research attempted to collect and list all available relevant information about national, regional and European incentives and support schemes that could facilitate the development and uptake of bioenergies as best examples based on country specific biomass feedstock types and material processing technologies.

Twelve FORBIO target and outreach partners were performing an investigation within their countries to collect all the knowledge about how EU legislation changed national bioenergy strategies and policies to make sustainable bioenergy production feasible locally. In most of the cases this is not possible without the introduction of public funds, therefore the most relevant national incentives and support schemes were categorised to provide a list of good examples in each related countries.

Deliverable 4.1 also intended to screen and map successful bioenergy installations that could be launched and operated as successful results of different policies and support schemes. Several best practices were presented in the study per FORBIO target and outreach countries and also with an outlook into other European countries. The main conclusion of this activity is that most of these installations are still first generation biofuel plants based on conventional value chain biomass feedstocks (woodlog biomass, woodchips) and technologies (biomass co-firing with different type of non-renewable materials).

The other main experience gained is that only a few number of second generation biofuel plants are operating in Europe as large scale plants. Many of them are still in design phase, or under construction, while others were launched as very small-scale or demo plants. Many of these plants were opened and operated for a while, but closed afterwards. It seems from the collected information that the still operating plants were built at least in some share of private funds and investments and therefore they can be operated on a feasible close-to-commercial basis without major state subsidies or other larger policy supporting mechanisms that tend to cease after some times.

Although the collection of available information provided a comprehensive and exhaustive list of several bioenergy related legislations, policies and support mechanisms that in theory could contribute to the bioenergy developments in several regions of Europe, the authors of this deliverable came to realise that policy and decision making for underutilised lands in favor of bioenergy developments is something that is not yet really elaborated on European or national policy and decision making level. It turned out from the desk-based research, that there is almost no such legislation available on country level that directly support bioenergy developemts on underutilised lands. This is an important conclusion that would need further consideration throughout the further development and progress of the FORBIO project's capacity building phases.

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6 Annex 1 – Country specific bioenergy value chain questionnaire

Most relevant country-specific biomass feedstock types, yields and raw materials	Germany	Italy	Ukraine	Romania	Hungary	Poland	Ireland	UK	Belgium
Wood biomass	Target country	Target country	Target country	Outreach country	Outreach country	Outreach country	Outreach country	Outreach country	Outreach country
➢ Oak	(x)	x	x	x	x	x			x
➢ Fagus	x	x	x	x	x	x		x	x
➢ Carpinus		x				x			
➢ Ailanthus altissima		x							
➢ Any other (please specify shortly)	pine, spruce	Robinia pseudoacacia L.	pine, birch	Coniferous	Robinia pseudoacacia L.	Robinia pseudoacacia L.		Ash, sycamore	
(You can insert additional rows here, if necessary)						pine, spruce			
Short rotation energy plantations									
➢ Populus spp.	x	x	x	x	x	x		x	x
➢ Salix spp.	(x)		x	x		x		x	x
➢ Robinia pseudoacacia L.	(x)		x	x	x				
➢ Any other (please specify shortly)									
(You can insert additional rows here, if necessary)					Paulownia tomentosa				
Energy grasses									
➢ Sudangrass	(x)								
➢ Miscanthus	(x)		x	x		x		x	x
➢ Hemp		x						x	
➢ Kenaf									
➢ Tritikale	x	x							
➢ Arundo		x						x	
➢ Any other (please specify shortly)	Corn sillage, rye				Szarvasi energy grass (C	canary grass			
(You can insert additional rows here, if necessary)	Grass cuttings								
Energy crops									
➢ Alfalfa	x								
➢ Sorghum	x	x	x	x					x
➢ Arundo donax		x						x	
➢ Miascanthus	x		x	x		x		x	x
➢ Switchgrass			x					x	
➢ Any other (please specify)	x							Brassica napus,	Helianthus annuus, s
(You can insert additional rows here, if necessary)	Sudan grass, mixed silphie								
Agricultural residues									
➢ Wheat straw	x	x	x	x	x	x		x	x
➢ Corn stover	(x)	x	x	x	x	x			x
➢ Any other (please specify shortly)			Sunflower residues (s	Vineyard chords, sunf					
(You can insert additional rows here, if necessary)			Barley straw						
➢ **Maize**	corn sillage		x	x		x			x
➢ **Rapeseed**	x		x	x	not anymore	x		x	x
➢ **Forages**				x	x				
Most relevant country-specific production and processing technologies									
➢ Collection and process of wood biomass for heat production	x	x	x	x	x	x		x	
➢ Collection and process of wood biomass for electricity production	x	x	x	x	x	x		x	x
➢ Solid biomass pyrolisis	(x)	x						x	
➢ Biogas fermentation	x	x	x	x	x	x			x
➢ Biomethane upgrade for transport fuel	x	x							
➢ 2nd generation bioethanol production	It is under discussion in the Ge	x			only experimental			x	x
➢ Lignocellulosic bio-refinery for non-food products (cosmetics, health, etc.)	x	x			algae R&D developmen				
➢ Any other (please specify shortly)	Grass biorefinery		Collection and proces	1st generation biofue		Collection and processing			
(You can insert additional rows here, if necessary)	Biochemical - levulinic acid (it								
National legislation and policies									
➢ Relevant national bioenergy policies and strategies	x	x		x	x			x	x
➢ Relevant national renewable energy programmes and legislations	x	x	x	x	x	x		x	x
➢ Relevant national rural development programmes and legislations	x	x		x	x	x		x	x
➢ Relevant national programmes and legislations about under-utilised lands		x		x	x				
➢ Relevant national forest and agriculture development programmes and legislations	x	x	x	x	x	x		x	x
➢ Other relevant national programmes and legislations (mining, land use, health, etc.)	x				x			x	
➢ If yes, please specify shortly	Federal mining and planning ac				KAT			RELUP	
(You can insert additional rows here, if necessary)									
➢ Specific legislation about wood biomass for heating and/or electricity production	x	x			x	x			x
➢ Specific legislation about biogas production	x	x			x	x		x	
➢ Specific legislation for 2nd generation ethanol production		x							
➢ Strategies for non-food biorefinery development	Attached to email								
➢ Bioenergy pricing programmes	e.g. feed in tariff, in RES Law	x			x				
➢ Bioenergy purchasing policies	Direct marketing, market pren	x			x				
➢ Any other (please specify shortly)									
(You can insert additional rows here, if necessary)									
EU legislation and policies									
➢ Relevant EU strategies that have significant effect on national bioenergy legislation	x	x	x	x	x			x	x
➢ Relevant EU policies that have significant effect on national bioenergy legislation	x	x	x	x	x			x	x
➢ EU bioenergy targets harmonised with national bioenergy objectives	x	x	x	x	x				x
Incentives and support for bioenergy developments									
➢ Direct international and EU funds	x	x	x	x	x	x		x	x
➢ EU funds through local administrations	x	x	x	x	x	x			x
➢ Regional funds through local administrations	x	x			x	x		x	
➢ National funds through local administrations	x	x		x	x	x		x	
➢ Municipality-level support programmes	x	x			x	x			
➢ Tax credits	(x) not for biofuels								x
➢ Tax incentives	(x) not for biofuels								x
➢ Loan programmes		x	x		x	x		x	
➢ Cooperative programmes or services									
➢ Small grants	Market Incentive Programme (	x	x	x	x	x		x	
➢ Bioenergy production incentives	x	x	x	x	x	x		x	x
➢ Debt financing with state supported rates and terms									
➢ State supported loans	Market Incentive Programme (		x			x		x	
➢ State subsidies and subventions	Feed in tariff								x
➢ Bioenergy portfolio standards									
➢ Tax increment financings									
➢ Tax exemption initiatives								x	
➢ Tax or VAT reduction support									
➢ Bioenergy rebates									
➢ Individual incentives (for natural persons)	x (MAP)			x				x	
➢ R&D pogrammes for bioenergy developments	x	x	x	x	x	x			x
➢ Any other type of available incentives (please specify shortly)				x					
(You can insert additional rows here, if necessary)									
Best practices									
➢ Best practices for direct wood burning	x	x	x	x	x	x		x	
➢ Best practices for biomass pyrolisis	(x)	x						x	
➢ Best practices for biogas fermentation	x	x	x	x	x	x			x
➢ Best practices for biomethane production	x								
➢ Best practices for lignocellulosic ethanol production	(x)	x						x	x
➢ Best practices for lignocellulosic bio-refinery for non-food purposes	For example biorefinery, which								x
➢ Best practices for any other country specific application (please specify shortly)			Best practices for dire			Best practices for direct s			
(You can insert additional rows here, if necessary)									

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