

Biomass role in achieving the Climate Change & Renewables EU policy targets.  
Demand and Supply dynamics under the perspective of stakeholders . **IEE 08  
653 SI2. 529 241**

## **The role of bioenergy in the National Renewable Energy Action Plans: a first identification of issues and uncertainties**

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November 2010

## Preface

This publication is part of the BIOMASS FUTURES project (Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders - IEE 08 653 SI2. 529 241, [www.biomassfutures.eu](http://www.biomassfutures.eu) ) funded by the European Union's Intelligent Energy Programme.

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## Executive Summary

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- The study represents a first evaluation of the proposed scale of deployment of bioenergy by the EU Member States in the period to 2020 as forecast in their National Renewable Energy Action Plans (NREAPs). The NREAPs specify how European governments plan to deliver their targets under the Renewable Energy Directive (RED). 23 NREAPs were available at the time of drafting and the analysis is based upon these.
- From the analysis of the 23 NREAPs it appears that the cumulative renewable energy share in gross final consumption will be between 20.2% and 22.4% by 2020 and the 20% target is expected to be met both by the European Union as a whole and by each Member State.
- For several Member States it will only be possible to meet the 20% target if they are able to attain a predicted improvement in energy efficiency and associated drop in gross final energy consumption. Other countries expect to meet the target on more pessimistic assumptions.
- Bioenergy (biomass, bioliquids and biofuels) accounts for almost 54.5% of the 2020 renewable energy target in the NREAPs examined, with a significant increase in absolute values anticipated. Bioenergy will remain the main contributor to the renewable energy sector. Overall, the bioenergy contribution to final energy consumption is expected to more than double, from 5.4% in 2005 to almost 12% (124Mtoe) in 2020.
- Solid biomass and forestry biomass in particular will continue to be the major source for bioenergy, and is estimated to represent 36% (83Mtoe) of the EU renewable energy target by 2020.
- Bioenergy's contribution to total renewable electricity supply in Europe will remain at low levels, but will increase to an estimated 17.7% (17,4Mtoe) by 2020. The importance of the more efficient combined heat and power plants (CHPs) is foreseen to grow slightly by 2020, but the cumulative contribution at the EU level will be not more than 10% of the renewable electricity target.
- Bioenergy will have a quasi-dominant role in the renewable portion of the EU heating and cooling sector, and is foreseen to contribute by more than 80% to the sectoral target. Solid biomass is expected to take around a 71% share in renewable heating & cooling gross final consumption, equivalent to up to 72Mtoe per annum.
- District Heating and Cooling (DHC) is expected to be further developed and to supply around 15.5% of the heat, but remains quite marginal in some EU countries, notably in the UK.
- By 2020, the individual use of biomass for heating in households will remain widespread with a share of up to 31% in renewable heating and cooling gross final consumption. Some countries count on the increased use of high caloric content biomass (i.e. pellets) rather than the direct combustion of forest biomass which seems to remain important in some other countries. The latter raises questions of sustainability and more careful monitoring will be required in terms of the technology used and the related combustion efficiency.
- From the analysis of the NREAPs, it appears that several countries such as Cyprus (5% by 2020), Bulgaria (8.3%) and Denmark (8%) will fall short of reaching the transport renewable target (RES-T). For several other NREAPs, meeting the RES-T target will be conditional on achieving the reported energy efficiency improvements by 2020.
- Several countries such as Denmark (100% by 2020), UK (87.7%), Ireland (70%), Greece (67%), the Netherlands (61.8%) and Germany (58.7%) already anticipate a significant dependency on biofuels imports. On the other hand, some other EU countries expect to have local potential and it remains to be seen how much the European Union as a whole can secure its supply needs from internal resources and how much will be imported from third countries.
- The technology for bioenergy generation must be carefully monitored in order to ensure that the biomass is used in an efficient way and with low associated greenhouse gas (GHG) emissions. An important role could be played by further research and development initiatives. Improving the technical efficiencies of the most promising bioenergy technologies and subsequently

increasing their market availability during the relatively short period remaining to 2020 will be critical in shaping the carbon profile of the sector and its contribution to a sustainable energy future.

## A short introduction to bioenergy

Bioenergy is energy produced from biomass and all major organisations and countries worldwide define it in a similar way. The UN's Food and Agriculture Organisation (FAO) defines bioenergy as 'all energy derived from biofuels' where biofuels are 'fuels produced directly or indirectly from biomass', considering biomass as 'material of biological origin excluding material embedded in geological formations and transformed to fossil'<sup>1</sup>. IEA and OECD consider bioenergy as the energy produced from 'material which is directly or indirectly produced by photosynthesis and which is utilised as a feedstock in the manufacture of fuels and substitutes for petrochemical and other energy intensive products'<sup>2</sup>. The US Department of Energy considers bioenergy as to be 'the energy derived from biomass' where biomass 'means any organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural crop wastes and residues, wood wastes and residues, and aquatic plants as well as animal, municipal, and other wastes'<sup>3</sup>.

The EU Renewable Energy Directive (Directive 2009/28/EC)<sup>4</sup> doesn't provide a definition for bioenergy as a whole, but defines separately biomass, bioliquids and biofuels as in the following:

- **biomass** means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste;
- **bioliquids** means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass;
- **biofuels** means liquid or gaseous fuel for transport produced from biomass.

The use of biomass can contribute to the reduction of greenhouse gas (GHG) emissions relative to fossil fuels. In theory, over the whole lifecycle of biomass use the carbon emissions from the energy production and consumption phases may be counterbalanced by the carbon amount absorbed during plant growth. In practice, the actual GHG reductions depend on how much land and energy are used to produce bioenergy and on whether excess process energy is generated.

As it is also indicated in the EU Renewable Energy Directive (RED), biomass for energy use is derived from different types of organic matter and can be supplied from varied resources such as:

- agricultural and fishery crops and residues including energy plants (oilseeds, plants containing sugar);
- forestry crops and residues including short rotation forestry as energy crops;
- industrial waste;
- municipal waste and sewage sludge.

For energy production, biomass is used in all its possible forms, according to different technologies and to different energy consumption needs (fuels for transport, electricity and/or heat generation): solid (wood, agricultural crops, plants, straw etc.), liquid (derived from oil crops, sugar and starchy crops or from lignocellulosic material) and gaseous (biogas derived from organic waste and landfill waste by anaerobic digestion or from solid biomass by gasification processes).

<sup>1</sup> FAO views on bioenergy: <http://www.fao.org/bioenergy/47280/en/>

<sup>2</sup> IEA Bioenergy: <http://www.ieabioenergy.com/IEABioenergy.aspx>

<sup>3</sup> US's Department of Energy: <http://www.energy.gov/energysources/bioenergy.htm>

<sup>4</sup> Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Official Journal of the European Union L 140/16 from 5.6.2009

Among a wide range of conversion processes, biomass can be used to produce varied forms of energy, from biofuels for transport to electricity or heating and cooling energy (figure 1). Moreover, there are different technologies for converting biomass into heat and/or power at different stages of market maturity and with different conversion efficiencies (table 1).

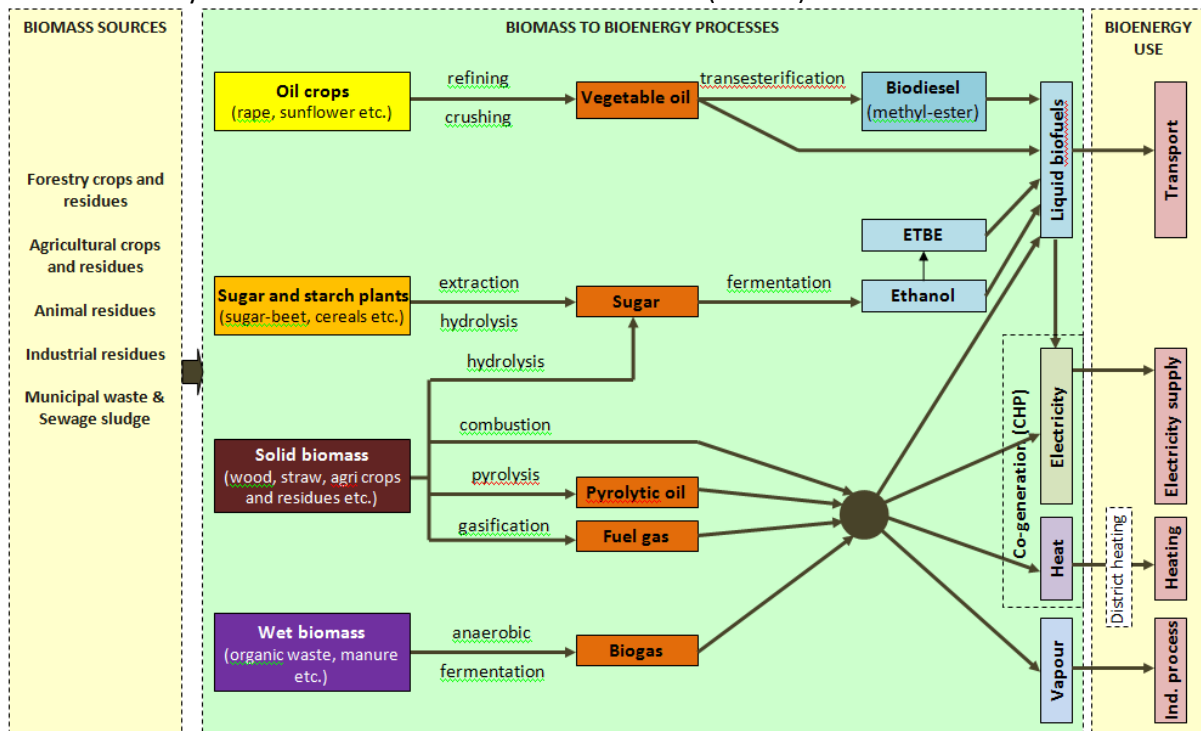


Fig. 1: Biomass pathways from resource to energy products<sup>5</sup>

Table 1: Major technologies in biomass to energy conversion<sup>6</sup>

Type of generated energy	Feedstock type	Conversion process	Technology maturity
Heat generation	Solid	Boiler	Yes
	Gaseous, liquid	Boiler	No
Combined heat and power (CHP)	Solid	Boiler-steam turbine	yes
		Pyrolysis reactor-diesel engine	No
		Pyrolysis reactor-gasifier	No
		Torrefaction reactor-boiler-steam turbine	No
	Solid and/or liquid	Gasifier-boiler-steam turbine	No
		Gasifier-gas engine	No
		Gasifier-gas turbine-boiler-steam turbine	No
		Digester-gas engine	Yes
	Liquid	Digester-gas turbine-boiler-steam turbine	No
		Liquid	Diesel engine
	Waste	Boiler-steam turbine	No
Landfill-gas engine		Yes	
Landfill-gas turbine-boiler-steam turbine		No	
Co-firing	Solid	Boiler (power plant)-steam turbine	Yes
		Gasifier (power plant)-gas turbine-boiler-steam turbine	Yes
	Liquid	Boiler (power plant)-steam turbine	Yes

## The EU Renewable Energy Directive and the National Renewable Energy Action Plans

<sup>5</sup> Based on the Blue Planet Energy diagram from <http://www.blueplanet-energy.com/>

<sup>6</sup> Evaluation of improvements in end-conversion efficiency for bioenergy production. Final report. Study commissioned by the EU Commission. Ecofys 2010

The EU Renewable Energy Directive (RED) on the promotion of the use of energy from renewable sources is a powerful measure at the heart of European energy and climate policy. The RED is part of the European Commission's Climate and Energy Package<sup>7</sup> from 2008, which lays out a strategy for the EU-27 Member States to reduce their collective greenhouse gas emissions by at least 20% and to increase the share of renewable energy to 20% of total consumption by 2020. The Climate and Energy Package reiterated also the energy efficiency indicative target of reducing primary energy consumption by 20% compared with a business-as-usual (BaU) scenario by 2020. Indeed all these three targets are interconnected and influence each other: a reduction in energy consumption makes it easier to reach the renewable energy target and both contribute to lowering GHG emissions (figure 2).

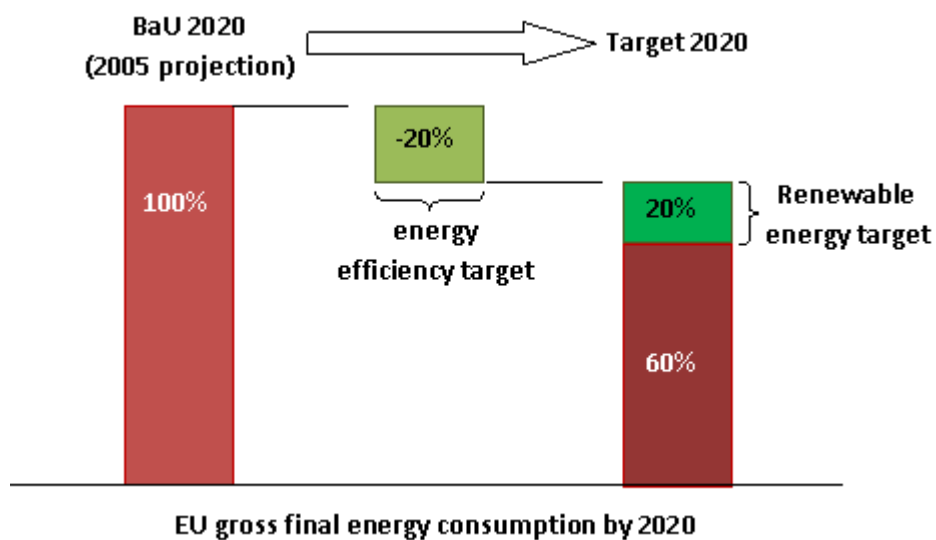


Figure 2: EU climate and energy targets and their interdependency

The RED sets out binding targets aimed at the promotion of renewable energy. The overall target requires the delivery of an EU-wide 20% share of renewable energy in gross final energy consumption by 2020, with the level of effort differentiated across Member States as specified in Annex A of the Directive. A sub-target specifically promotes the use of energy from renewable sources within the transport sector, requiring 10% of all transport fuels to be delivered from renewable sources by 2020 in every Member State. When the RED was adopted, it was unclear precisely which technologies and approaches would Member States choose in order to deliver these targets. Article 4 of the RED specifically requires Member States to produce and submit National Renewable Energy Action Plans (NREAPs) by 30 June 2010, outlining their national approaches and roadmaps in meeting the 2020 renewable targets. Consequently, the NREAPs are very important to understanding the anticipated consequences associated with meeting the EU RED targets.

By October 2010 (when this analysis was conducted) only 23 NREAPs had been submitted<sup>8</sup>, out of which only seven had been submitted on time. The still missing NREAPs are the ones from Poland, Belgium, Hungary and Estonia.

<sup>7</sup> Climate Action - Energy for a Changing world  
[http://ec.europa.eu/energy/strategies/2008/2008\\_01\\_climate\\_change\\_en.htm](http://ec.europa.eu/energy/strategies/2008/2008_01_climate_change_en.htm)

<sup>8</sup> Austria, Bulgaria, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK

The NREAPs were required to be based on a compulsory template<sup>9</sup>, showing the roadmap to 2020, the mix of renewable technology detailed for electricity, heating and cooling, and transport, explaining existing and foreseen support measures as well as measures for reducing administrative and regulatory barriers.

The RED encourages explicitly the implementation of energy efficiency measures as a way of fostering the renewable energy share by reducing final energy consumption. Moreover, the RED allows for statistical transfer between MSs as well as joint implementation of projects by two or more MSs or between MSs and third countries. These optional cooperation mechanisms provide flexibility by allowing Member States to engage in renewable generation in another Member State and to agree on the amount of energy produced from renewable sources that shall count towards the national target of one or the other.

The RED requires progress monitoring and reporting measures to ensure the implementation of the roadmaps put forward in the NREAPs. Among other things, RED requires Member States to prepare progress reports to the European Commission every two years. The Commission must in turn report to the European Parliament and to the Council. Moreover, by the end of 2010 the Commission shall prepare an analysis and an action plan on renewable energy sources focusing on the better use of existing EU funds (structural funds and framework programs, European Investment Bank), on better coordination between national and EU funds and on the feasibility of a 'risk sharing facility for investments in energy from renewable sources in the Community similar to the Global Energy Efficiency and Renewable Energy Fund initiative' (Article 23.7(c) of RED).

Bioenergy is expected to be the main contributor to the 2020 target, with an anticipated contribution of more than half of the 2020 renewable energy target<sup>10</sup>. The use of bioenergy raises a number of issues relating to sustainability and to their potential for reducing GHG emissions. Articles 16, 17, 18 of the RED set sustainability and compliance criteria for bioliquids and biofuels. Concerning the sustainability of solid biomass used for power and heat production, the RED asks for supplementary explanations from MSs, but the high share of direct wood and agriculture biomass identified in the NREAPs raises concerns about potential conflicts between bioenergy promotion and the limits on the resources available and bioenergy's ability to in reduce GHG emissions. In February 2010, the European Commission published a report on sustainability requirements for the use of solid and gaseous biomass for energy production<sup>11</sup>, fulfilling its obligation under Article 17(9) of the RED. Due to the wide variety of biomass feedstocks the Commission considered it infeasible for the moment to put forward a harmonised scheme and binding criteria at EU level.

## **Renewable energy targets and bioenergy implications by 2020**

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Analysing the roadmaps of the first 23 submitted NREAPs, it emerges that the cumulative renewable energy share in gross final consumption will be between 20.2% and 22.4% by 2020; the 20% target is expected to be met both by the European Union as a whole and by each Member State. Most of the NREAPs based the calculations of the renewable energy target on estimated energy efficiency improvements. This allows one to derive an implied reduction in energy consumption in 2020 compared to the Business as Usual scenario. From the analysis of the 23 NREAPs, the anticipated energy efficiency improvements will reduce energy consumption by 9.7% by the year 2020. This is

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<sup>9</sup> Commission Decision 2009/548/EC establishing a template for National Renewable Energy Action Plans under Directive 2009/28/EC of the European Parliament and of the Council

<sup>10</sup> Renewable Energy Road Map. Renewable energies in the 21st century: building a more sustainable future. COM(2006) 848 final

<sup>11</sup> Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling. COM(2010)11 final

well below the 20% indicative target for energy savings by 2020 identified by the 2006 EU Energy Efficiency Action Plan<sup>12</sup> and recalled by the 2008 Climate and Energy Package<sup>13</sup>.

Whether or not the renewable energy targets will be reached satisfactorily depends on the anticipated levels of total energy consumption in the Member States. Some countries like Austria, Germany and Spain secure the 2020 target with or without energy efficiency improvements. However, most countries (including Italy, UK, Sweden etc.) will fail to reach their 2020 target without achieving the assumed energy efficiency improvements.

Figure 3 illustrates the relationship between the declared energy efficiency improvement and the renewable energy target. The bars represent each Member State's renewable energy target, indicating also the renewable energy shares in 2005 and in 2010 (dark and light blue bars, respectively). The green lines show the estimated renewable energy shares according to gross energy consumption, including the foreseen energy efficiency improvements. The red lines indicate the estimated renewable energy shares according to gross energy consumption without the foreseen energy efficiency improvements.

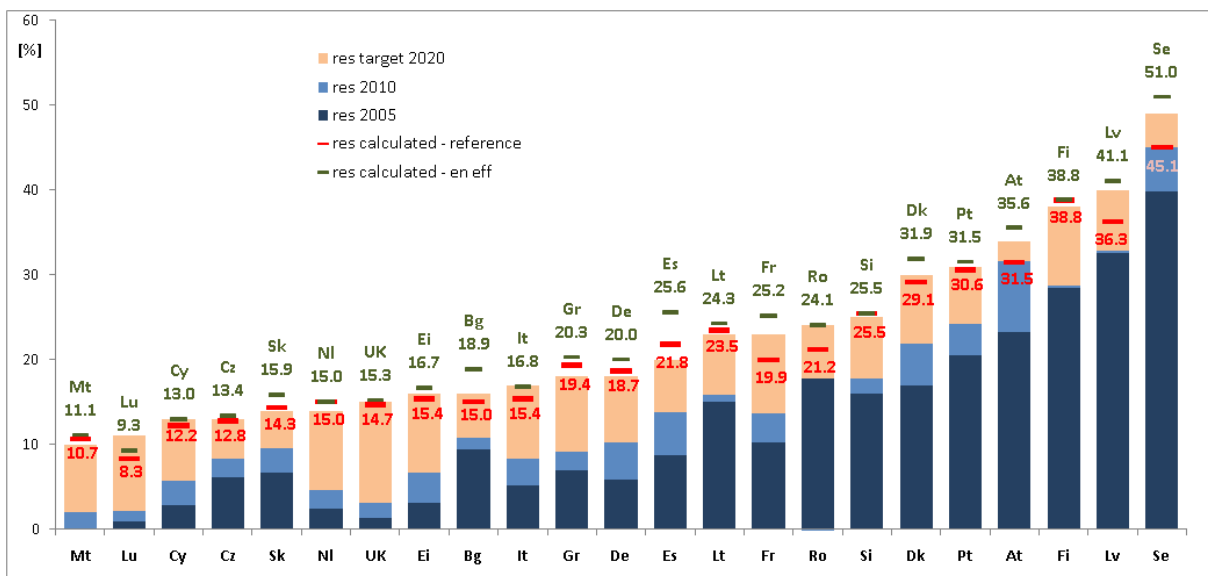


Fig. 3: Member States' 2020 RES targets in the reference scenario and considering the reported energy efficiency improvements in gross final consumption

Some countries like Italy and Luxemburg estimate that local resources will not be sufficient for meeting the 2020 target and thus anticipate using the cooperation mechanisms. Other countries like Bulgaria, Greece, Slovakia and Denmark anticipate exceeding their targets and have offered the surplus to other Member States.

Reaching the 2020 target will be a serious challenge for some countries with little current renewable deployment. In particular, the UK and the Netherlands have to improve their renewable energy shares from 3.1% and 4.6% in 2010 to 15% and 14%, respectively (figure 4). In figure 4, the bars indicate the 2020 renewable energy shares (on the left vertical axis) with the blue bars representing the renewable energy share in 2010 and the red bars representing the difference in renewable share to be reached by 2020. On the right vertical axis, the red dotted line shows the necessary effort (in percentage terms) for reaching the declared absolute amounts of renewable energy by 2020. The blue dotted line shows the necessary efforts (in percentage terms) for reaching the declared share of renewable energy by 2020.

<sup>12</sup> COM/2006/0545 final. Communication from the Commission - Action Plan for Energy Efficiency: Realising the Potential.

<sup>13</sup> Climate Action - Energy for a Changing world. January 2008

[http://ec.europa.eu/energy/strategies/2008/2008\\_01\\_climate\\_change\\_en.htm](http://ec.europa.eu/energy/strategies/2008/2008_01_climate_change_en.htm)



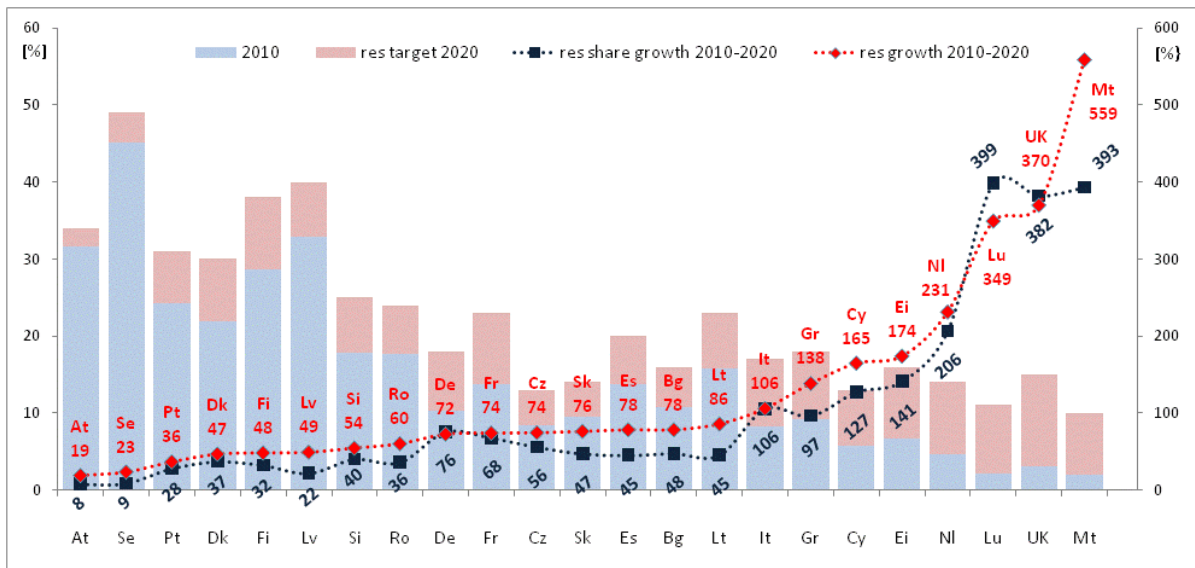


Fig. 4: The estimated efforts of the EU Member States in reaching the 2020 renewable energy target

Some NREAPs provide only partial evidence on how the targets will be reached, despite the fact that a number of them have to achieve challenging improvements. The Romanian NREAP, for instance, fails to complete the requested tables for the detailed breakdown of the renewable energy roadmaps in transport and heating & cooling. Another example is the Finnish NREAP, which contains mainly a brief description of major policy measures and the required tables describing the 2020 roadmap. There are also several NREAPs with differences between the figures declared for the renewable energy trajectory and the renewable energy figures shown in the detailed tables on electricity, heating & cooling and transport. Such discrepancies should be clarified and amended if necessary to ensure consistency with the declared roadmaps. Some countries such as Germany and the UK provide different scenarios; this is helpful for assessing the viability of the roadmaps but complicates the aggregate analysis as it diverges from the format of other NREAPs.

The analysis of the 23 NREAPs shows that bioenergy (biomass, biogas, bioliquids and biofuels) is anticipated to contribute almost 54.5% to the 2020 renewable energy target. This will in fact be a decrease in relative terms from a 58.9% contribution in 2010 due to a stronger development of other renewable energy sources but an increase in absolute values. Consequently, bioenergy will remain the main contributor to the renewable energy sector. The relative importance of bioenergy in the renewable energy target (figure 5) is largest in the Czech Republic (85.4%), Lithuania (85.2%), Latvia (81.7%), Finland (77%), Denmark (72%) and Bulgaria (68.9%).

Overall, the share of bioenergy in final energy consumption is expected to more than double, from 5.4% in 2005 to almost 12% in 2020.

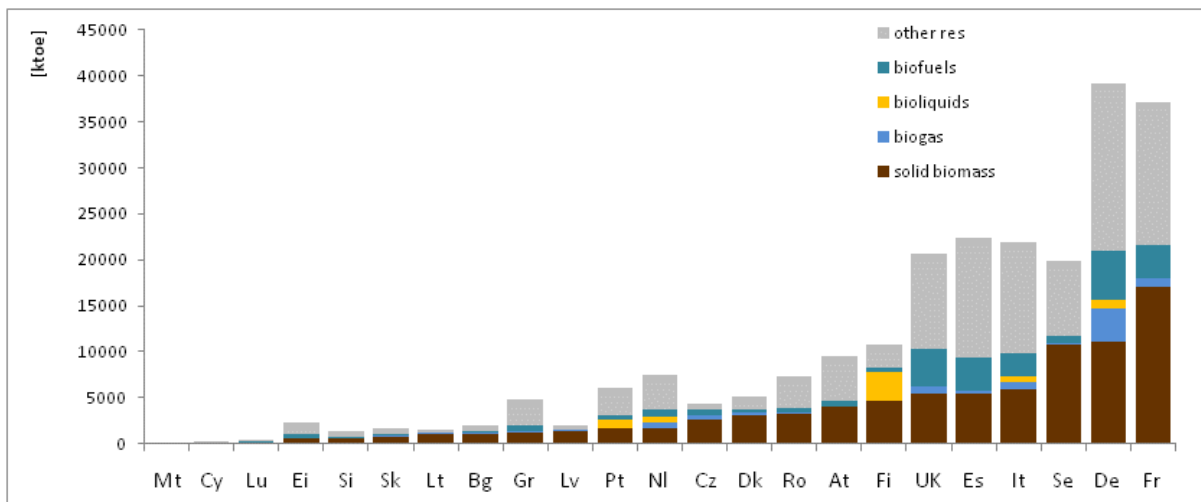


Fig.5: Bioenergy contribution to the 2020 target

Solid biomass is by far the most important bioenergy source representing 36% (83Mtoe) out of the total renewable energy supply anticipated in 2020, with its share in gross final consumption increasing from 4.9% in 2010 to 8% by 2020. The use of biogas and bioliquids is also foreseen to increase within the EU over the next decade, but with a marginal contribution to the 2020 renewable energy target in the large majority of Member States. Finland (11% in gross final energy consumption, consisting of 83ktoe biogas and 3021ktoe bioliquids) Portugal (5.2% consisting in 82ktoe biogas and 932ktoe bioliquids) and Germany (2.3% consisting of 3707ktoe biogas and 836ktoe bioliquids) are among relatively few Member States to forecast a significant contribution from biogas and bioliquids by 2020.

## Biomass feedstocks: current status and 2020 estimation

The large majority of NREAPs indicate that solid biomass and forestry biomass in particular will continue to be the major source for bioenergy within the European Union and this raises issues about the sustainability of biomass usage. Several NREAPs, such as that for the UK estimate large local potentials for woody energy crops derived from sustainable forestry. However, the NREAPs don't provide details on how this forestry resource will be collected or the forests managed and there is not enough evidence to evaluate the potential impacts of increased use of forestry products for energy generation. Other plans estimate that domestic resources will not be sufficient and thus anticipate imports of solid biomass and/or biofuels<sup>14</sup>.

One mechanism by which Member States could rapidly increase domestic production of biomass would be to make use of short rotation coppice (e.g. willows, poplars) and high yielding grasses such as reed canary grass, switch grass or miscanthus.

Data from NREAPs on biomass supply show that there was little usage of short rotation coppice at the EU level in 2006. There is still an intensive debate on the benefits of short rotation coppice, mainly in terms of their potential drawbacks<sup>15</sup> for biodiversity and water resources and because they may be alien species depending on where they are planted.

However, the cultivation of short rotation coppice may contribute to the reduction of GHG emissions by producing large quantities of carbon-rich biomass that can be harvested and used as an

<sup>14</sup> I.e. in the UK NREAP it is anticipated that 'biomass, specifically woody biomass, will increasingly become a globally traded commodity. Imported biomass products are likely to continue to play a role in the UK's use of bioenergy'.

<sup>15</sup> For a correct account of the carbon impact of the short rotation energy crops one also has to consider all the associated carbon emissions from planting, farming, use of fertilizers etc.

alternative to fossil fuels in heat and power generation and by sequestering the carbon in soil through deposition of litter and roots mass.

Only few NREAPs provided indications on the land area used in 2006 for energy crops, amounting to an overall area of 997,026ha allocated for short rotation coppice and 149,240ha for other advanced energy crops such as grasses. However, there is a lot of confusion in estimating the area of land devoted to these crops, partially due to the lack of a more exact explanation in the NREAP template, and figures reported by several countries are questionable. As an example, the Czech NREAP reported 970,000ha used for short rotation forestry which seems to be overestimated given the aggregate figure above.

In the NREAPs, the extent of bioenergy feedstocks required is estimated in different units such as the area (ha) of feedstocks, weight (t), volume (m<sup>3</sup> and solid m<sup>3</sup>); without having more details on the feedstock type it is difficult to make a more comprehensive analysis. Moreover, bioenergy feedstocks are distinguished as follows:

- Direct supply of wood biomass from forests and other wooded land for energy generation
- Indirect supply of wood biomass for energy generation
- Agricultural crops and fishery products directly provided for energy generation
- Agricultural by-products / processed residues and fishery by-products for energy generation
- Biodegradable fraction of municipal solid waste including biowaste (biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants) and landfill gas
- Biodegradable fraction of industrial waste (including paper, cardboard, pallets)
- Sewage sludge

However, the conversion of feedstock units into a quantity of primary energy generated (ktoe) offers a common reference and facilitates a first general analysis.

In terms of primary energy, the NREAPs estimate a 100% increase in the EU-wide domestic feedstock potential between 2006 and 2020 (figure 6). The greatest anticipated increases are in Portugal (with an over 3000% estimated increase in local feedstock exploitation), the Netherlands (1379%), Ireland (636%), Italy (389%) and Slovenia (201%).

The direct wood supply from forest and wooded lands and the indirect supply of wood biomass for energy generation together are expected to increase by 25% at the EU level, with an important estimated growth in Italy (354%), Slovenia (201%) and Ireland (111%). The Finish NREAP (with a high actual level of biomass utilisation for energy production) anticipates a decreased use of solid biomass in favour of bioliquids but lacks in details on this issue (see Annex 1).

A significant EU-wide increase is forecast for agricultural crops and fishery products directly used for energy generation, from 19.6% in 2006 to 31% by 2020. The use of agricultural and fishery by-products for energy generation is expected to more than triple in all 23 Member States. Portugal (4557%), Ireland (1078%), Czech Republic (1018%) and Italy (530%) have the most optimistic forecasts, while Sweden estimated a 33% decrease in the use of domestic agricultural resources for energy purposes.

With regard to biodegradable municipal and industrial waste and sewage sludge, Ireland (5337%) and Italy (230%) plan the greatest increases<sup>16</sup>.

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<sup>16</sup> The biodegradable municipal and industrial waste and sewage sludge are usually converted into biogas by the anaerobic digestion process. The anaerobic digestion is a well proven renewable energy and waste management technology. It produces biogas from organic materials such as manure and slurry, food waste and sewage sludge.

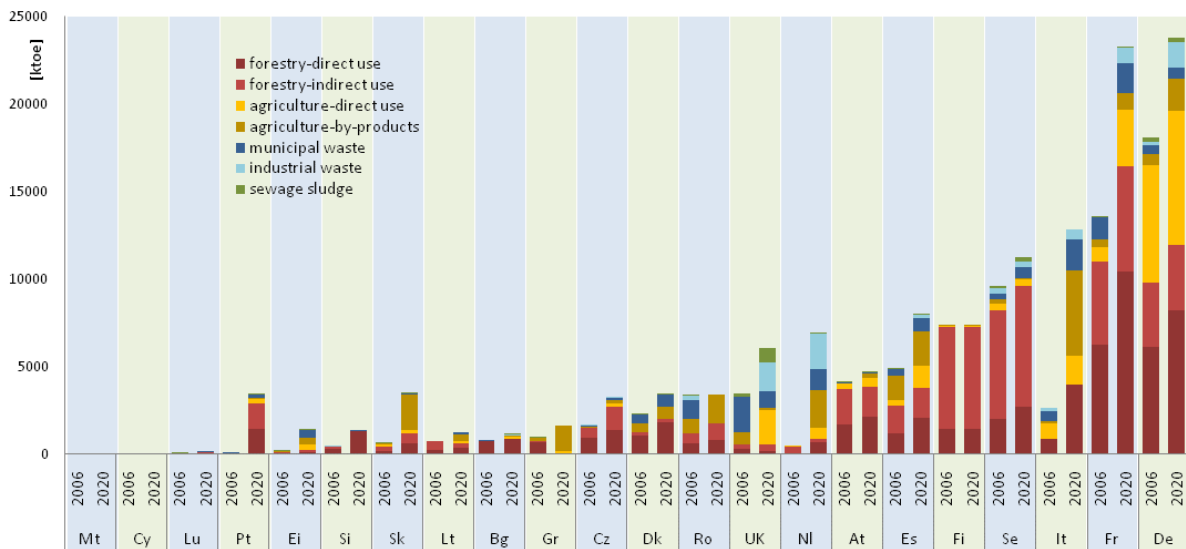


Fig. 6: Biomass feedstock in 2006 and the NREAPs estimations by 2020

## Bioelectricity

Bioenergy will contribute 17.7% (17.2 Mtoe) to renewable electricity by 2020, with biomass and biogas as the most important bioenergy resources (figure 7). Bioelectricity is foreseen to take a significant share of the renewable target in Czech Republic (52.8%), Denmark (43%), Lithuania (41.7%), Finland (38.6%), Germany (22.8% with a balanced contribution of biomass and biogas), UK (22.6%), and the Netherlands (33%).

Highly efficient combined heat and power generation (CHP) is important in the context of biomass use for energy generation because the same amount of resources can cover simultaneously electricity and heating and cooling needs, offering considerable flexibility at the fuel side and having very promising perspectives for the improvement in conversion efficiency. However, one important condition for promoting highly efficient CHPs plants is the existence of a properly developed district heating system or close collaboration with the industrial processes requiring heating, steam and/or hot water.

The large majority of countries linked biomass usage to CHP, most notably Finland, France, Denmark, Sweden, Austria, Slovenia and Romania. The UK is the only major EU country which foresees an increase in bioelectricity generation with only very limited deployment of CHP by 2020. However, the UK Renewable Obligation Scheme<sup>17</sup> considers CHP among the most desirable technologies, offering the maximum incentives for CHP with biomass (2 renewable obligation certificates per 1 MWh).

The CHP share in the RES electricity target is estimated to increase from 7.4% in 2010 to almost 10% by 2020, a significant share but with important potential remaining unexploited.

<sup>17</sup> The Renewables Obligation, the Renewables Obligation (Scotland) and the Northern Ireland Renewables Obligation are designed to incentivise renewable generation as part of the wider electricity market. Generators are attributed Renewables Obligation Certificates (ROCs) for every megawatt hour (MWh) of eligible renewable electricity they produce. Generators can sell their ROCs to suppliers or traders to receive a premium on top of the wholesale price of their electricity. ROCs can be sold with or without the electricity they represent.

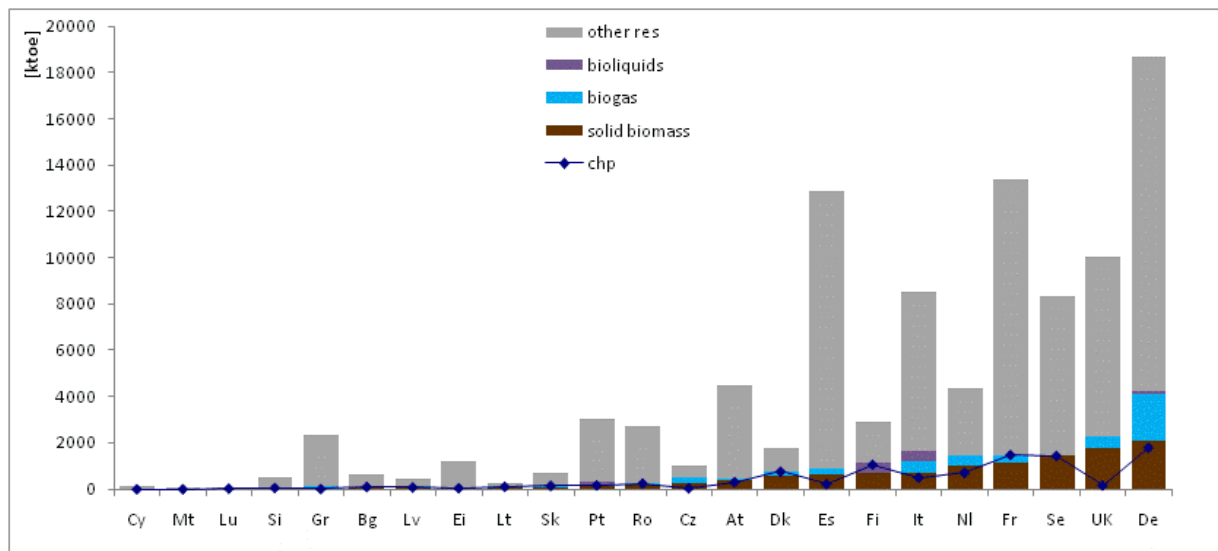


Fig 7: Bioelectricity share by 2020

## Bioenergy for heating and cooling

According to the NREAPs, bioenergy will remain the most important renewable resource in the EU for heating and cooling, and is foreseen to contribute more than 80% to the sectoral target, despite the fact that its overall share will reduce from 90% in 2010 (figure 8). Solid biomass is expected to take the highest share in renewable heating and cooling generation (71,4%), most notably in Bulgaria (95.4%), Lithuania (92.6%), Sweden (89%) and the Czech Republic (88%).

District Heating and Cooling (DHC) has proved to be advantageous in reducing GHG emissions, due to the fact that it is a flexible technology which can make use of any fuel, including renewable energy, and it aligns well with the application of combined heat and power (CHP).

From the NREAPs analysis, district heating<sup>18</sup> is expected to be further developed and to deliver around 15.5% of heating supply in the 23 reporting countries. District heating from renewable energy generation is foreseen to cover 49% of the heating supply in Denmark, 44% in Luxemburg and the Slovak Republic, 30% in Sweden, 22% in Ireland, 17.7% in Germany, 17.3% in Finland, 16.8% in Austria and 16.2% in France. District heating will remain marginal in the UK (3.7%) and in Spain (0.7%). The Romanian NREAP failed to complete the detailed table for the heating & cooling sector (table 11 of the NREAP template).

The use of biomass in individual households will remain significant in 2020, representing around 31% of the heating and cooling renewable energy target. Countries such as Bulgaria (91.75%), Austria (69.5%), Slovenia (63%), the Czech Republic (51.8%) and Germany (41%) are counting on a high degree of biomass usage in private households. Some countries such as Austria and Sweden count on the use of pellets with a higher caloric value than the direct combustion of the forest biomass which seems to remain important in some countries such as Bulgaria and Romania.

<sup>18</sup> District heating and cooling is a system for distributing heat generated in a centralized location providing space (and water) heating/cooling for residential and commercial consumers.

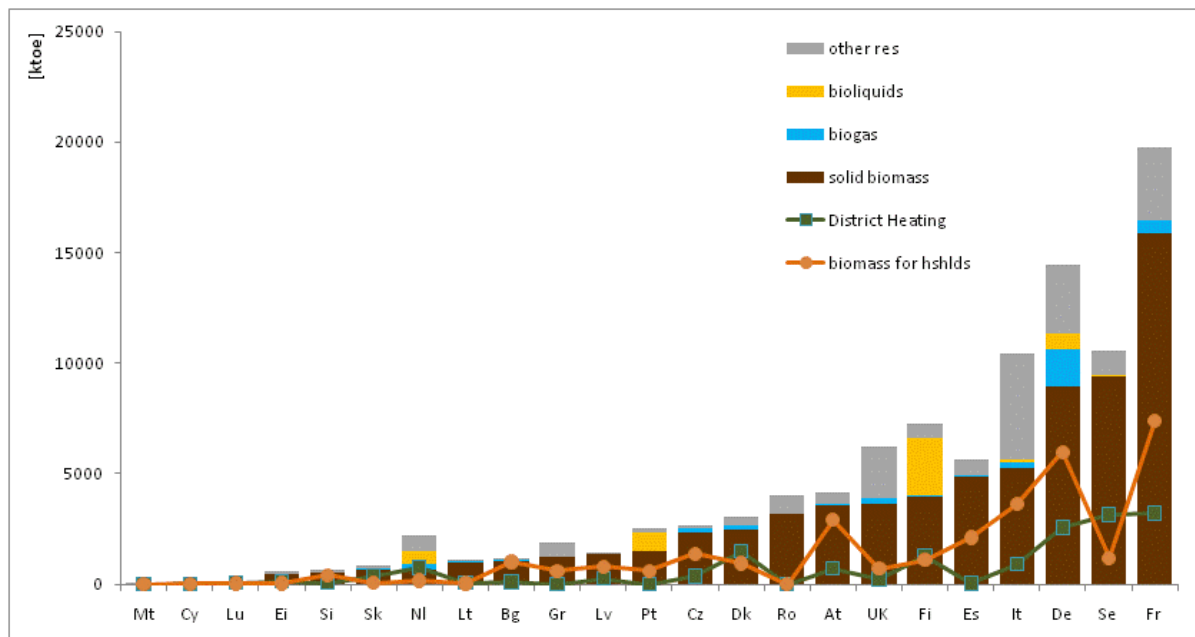


Fig. 8: Bioenergy for heating and cooling by 2020

## Biofuels in transport

The RED obliges all Member States to reach a specific 10% share of renewable energy in transport gross energy consumption by 2020. From the NREAP analysis, it appears that several countries such as Cyprus (5% by 2020), Bulgaria (8.3%) and Denmark (8%) will fall short in reaching the transport renewable target. The capacity of several other Member States to meet the renewable transport (RES-T) target is conditional on their achievement of anticipated energy efficiency improvements by 2020. A number of other Member States will secure the RES-T target with or without reaching the assumed energy efficiency improvements, notably Finland, Germany and Sweden.

Article 21.2 of the RED specifically encourages the contribution of biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material by double counting them in the calculation of funds eligible to meet the renewable energy target. Some of the 23 NREAPs have significant discrepancies between the anticipated level of use of these more advanced biofuels in the calculation table for the share of the RES-T (table 4.b. of the NREAP template) and the sum of the detailed contribution of different (?) biofuels from table 12 of the NREAP template. Given their double weighting under Article 21.2, the exact level of use of these more advanced biofuels will potentially influence the achievement of the RES-T target (and consequently the RES target) rather significantly. Further details and clarifications from the Member States will be necessary on this issue. As it is difficult to predict the development of these rather new biofuel technologies precisely, further adjustments of the roadmaps during the monitoring process are to be expected.

Figure 9 shows on the left axis the estimated amount of Article 21.2 biofuels to be consumed by 2020 for the renewable trajectories (table 4b of the NREAPs) (in ktoe, represented by the colored bars) and the declared contribution of Article 21.2. biofuels resulting from the detailed roadmaps for renewable energy in transport (in ktoe, represented by pink diamonds). On the right axis, the RES-T share by 2020 in case of counting the Article 21.2. biofuels declared in table 4.b (in %, represented by the blue line) and in table 12 (in %, represented by the red bullets) from the NREAPs are represented.

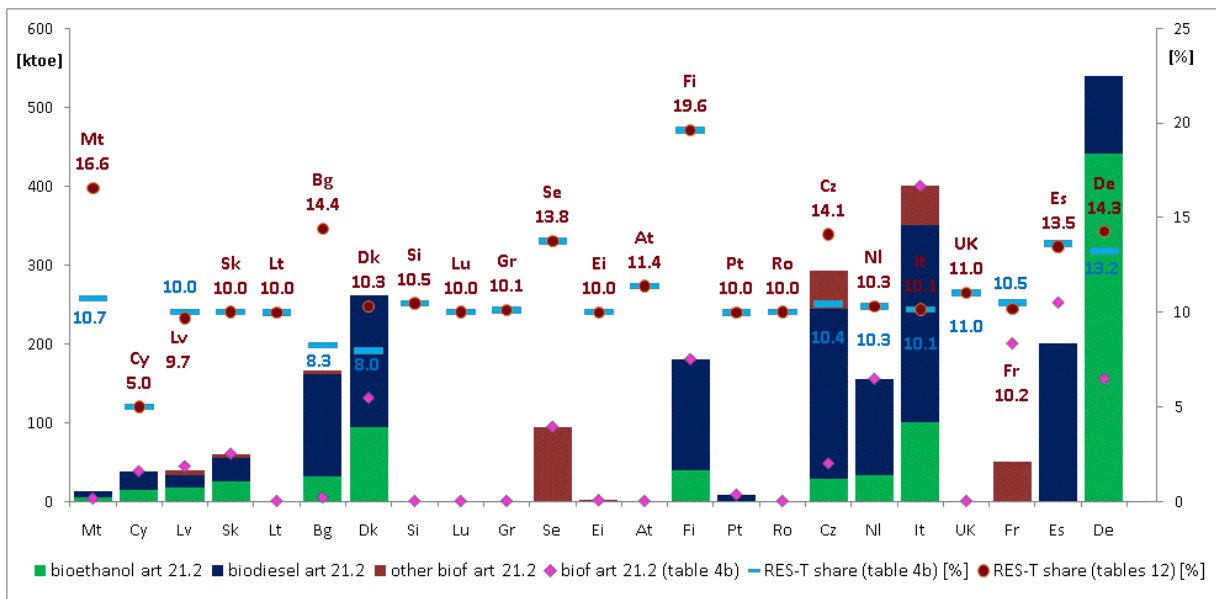


Fig. 9: The Implication of biofuel art.21.2 on the RES-T target

Because of the inconsistencies in accounting for Article 21.2 biofuels, the analysis of the NREAPs biofuels implication detailed below does not take these biofuels into account.

According to the NREAPs, the RES-T target will stimulate a major increase in the use of conventional biofuels up to 2020, contributing up to 90% of total predicted biofuel use in 2020.

According to the 23 NREAPs, biodiesel is expected to contribute with around 66% to the renewable energy share in transport by 2020; bioethanol and biodiesel together are expected to deliver 89% (figure 9). A particular high use of bioethanol is foreseen in Greece (65.3% of renewable energy in transport) followed by Malta (42.9%), Cyprus (38.3%) and the UK (39%). Lithuania does not consider bioethanol use at all, which also seems to be the case for Romania (the detailed table 12 for the renewable energy roadmap in the transport sector is not provided). Portugal (5%), Slovenia (9.1%), and Austria (9.35%), anticipate a low demand of bioethanol in the transport sector of up to 10% of renewable energy in transport.

Several NREAPs anticipate the need for significant imports from other EU Member States or from third countries for reaching the 10% renewable energy share in transport (figure 10). Denmark (mainly from outside EU), Luxemburg and Cyprus forecast a 100% dependency on biofuel imports. UK (87.7% by 2020), Ireland (70%), Greece (67%), the Netherlands (61.8%) and Germany (58.7%) also estimate high shares of bioethanol and biodiesel imports. Other countries such as Slovenia, Romania and Portugal estimate that their domestic resources will cover all biofuel needs. Romania notably declared by far the biggest unused arable land area (around 3 million ha), which represents a large potential resource for future biomass production.

However, at the moment it is difficult to clearly estimate from the NREAPs which are the anticipated shares of biofuel imports from third countries versus imports from inside the European Union.

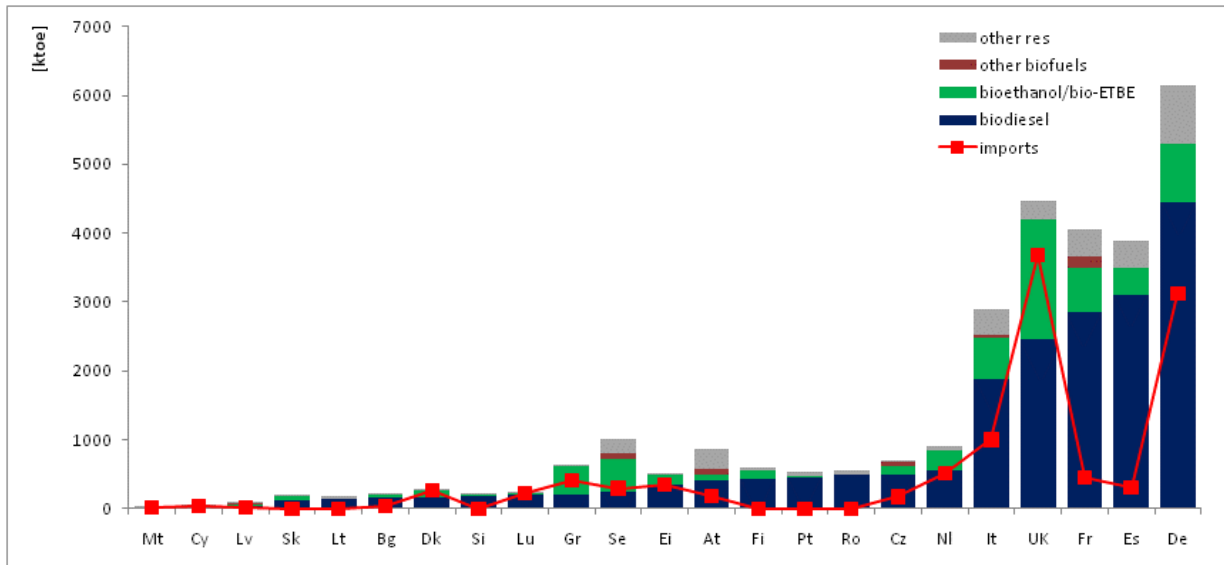


Fig. 10: Breakdown of biofuels in transport by 2020 and estimated import dependency.

## Conclusions

The RED's binding targets of an EU-wide 20% renewable energy share in gross final consumption and a 10% renewable energy share in transport in each Member State provide a clear objective and timeframe and thus a strong driver for future deployment of renewable energy in Europe.

The National Renewable Energy Action Plans provide for the very first time detailed commitments and roadmaps with interim targets. A regular monitoring process will contribute significantly to their implementation as well as assisting in making adjustments in the light of initial experience.

Some NREAPs provide only partial information on how the 2020 renewable energy target will be reached, and others include partially diverging and inconsistent figures for the renewable energy trajectory and the sum of the declared renewable energy figures in the detailed tables on electricity, heating & cooling and transport. This is not necessarily a problem, but it must be clarified in order to provide consistency and greater confidence in the official roadmaps.

From the analysis based on 23 NREAPs it appears that the cumulative renewable energy share in gross final consumption at the EU level will be between 20.2% and 22.4% by 2020 and the 20% target is expected to be met both by the European Union as a whole and by each Member State.

For several Member States it will only be possible to meet the 20% target if they are able to attain a predicted improvement in energy efficiency and associated drop in gross final energy consumption. Other countries expect to meet the target on more pessimistic assumptions.

The cooperation mechanisms between EU countries are likely to be used with some NREAPs anticipating an excess in renewable energy by 2020 and others already estimating a scarcity of domestic resources.

The implementation of the NREAPs will entail a significant effort for some countries with little present renewable deployment; this is particularly the case for the UK and the Netherlands.

Bioenergy (biomass, bioliquids and biofuels) would account for almost 54.5% of the overall 2020 renewable energy target in the 23 Member States, with an estimated increase in absolute amounts deployed and remaining the main contributor to the renewable energy sector. Overall, the bioenergy contribution to final energy consumption is expected to more than double, from 5.37% in 2005 to almost 12% in 2020. Solid biomass and forestry biomass in particular will continue to be the major sources for bioenergy, being estimated to represent 36% (83Mtoe) of the EU RES target by 2020.



Bioenergy's contribution to renewable electricity will remain at relatively low levels, but will increase to an estimated 17.7% (17.4Mtoe) by 2020. The importance of CHP is foreseen to grow slightly by 2020, but the cumulative contribution at the EU level will not be more than 10% of the RES electricity target.

Bioenergy will preserve a quasi-dominant role in the renewable heating and cooling sector, being foreseen to contribute more than 80% to the sectoral target. Solid biomass is expected to account for around 71% of renewable heating & cooling energy by 2020, equivalent to up to 72Mtoe.

District Heating and Cooling (DHC) is expected to be further developed by 2020 and to supply around 15.5% of heating needs, but remains marginal in some countries, notably the UK.

From the analysis of the NREAPs it seems that whereas a combination of CHP and DHC would be one of the most efficient ways of utilizing biomass, few Member States plan to exploit this option on a significant scale. As noted above, a continuing large scale use of biomass, notably wood and high calorific content pellets is expected in the private household heating sector. It is less clear where these will be sourced, raising questions about sustainability or what combustion technologies will be employed. This is an area where particularly careful monitoring will be required.

Although it will not be met in every country and in some depends on real steps forward in energy efficiency, the RES-T target is anticipated to stimulate a major increase in the use of conventional biofuels up to 2020, contributing up to 90% of total predicted biofuel use in 2020. The relatively modest expectations for use of more advanced biofuels in most Member States is notable.

Trade issues will be important. Several NREAPs anticipate a significant dependence on biofuel imports. Some other EU countries seems to have sufficient domestic potential and it remains to be established how much the European Union at a whole can secure its supply needs from internal resources and how much will be imported from third countries or from within the Union.

Leaving aside climate change considerations, promoting bioenergy can contribute to diversifying and securing energy supply in Europe. However, progress in the latter depends to a considerable degree on a capacity to source a large proportion of biomass domestically; otherwise the import dependency on fossil fuels merely will be shifted to biofuels. Given the large volumes, ensuring the sustainability of bioenergy use will be one of the major challenges in the coming decade. The RED already includes sustainability criteria for bioliquids and biofuels and it requires supplementary explanations from Member States in relation to the sustainability of biomass use for energy production. This will require serious attention in a number of areas for example in relation to the high estimated shares of dedicated woody and agricultural biomass that some Member States appear to be relying on.

Early in 2010, the European Commission published a report on sustainability requirements for the use of biomass for energy production, fulfilling the obligation under Article 17(9) of the RED. However, due to the wide variety of biomass feedstocks likely to be deployed, the Commission considered it unsuitable to put forward a harmonised scheme or binding criteria on sustainability at the EU level.

The sustainability challenge relates to the whole supply chain, not only at the feedstock stage but also including the conversion efficiency of the technologies for utilising biomass which need to be developed in order to meet demanding standards for reduced greenhouse gas emissions. This can be expected to be an important theme in the planning of research and the related support foreseen to come from the EU SET-Plan<sup>19</sup> and the European Industrial Bioenergy Initiative<sup>20</sup>. They could make a significant contribution for defining bioenergy's role in a low-carbon energy future.

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<sup>19</sup> Strategic Energy Technology Plan (SET Plan): [http://ec.europa.eu/energy/technology/set\\_plan/set\\_plan\\_en.htm](http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm)

<sup>20</sup> European Industrial Bioenergy Initiative (EIBI): <http://www.biofuelstp.eu/eibi.html>

## Acknowledgements

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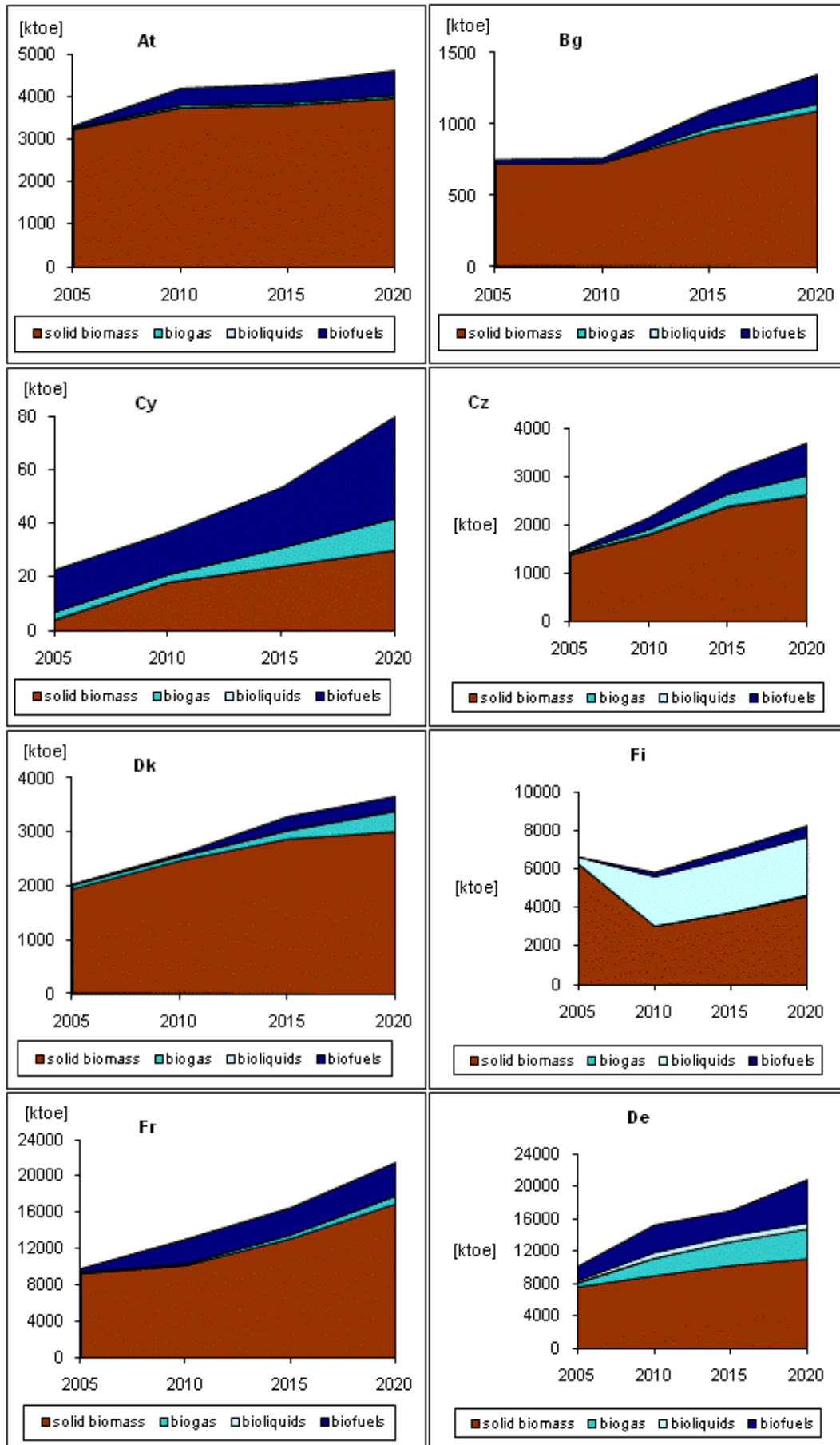
The author would like to thank Bettina Kretschmer, Pernille Schiellerup and David Baldock for their support in peer reviewing this report to ensure its quality and accuracy.



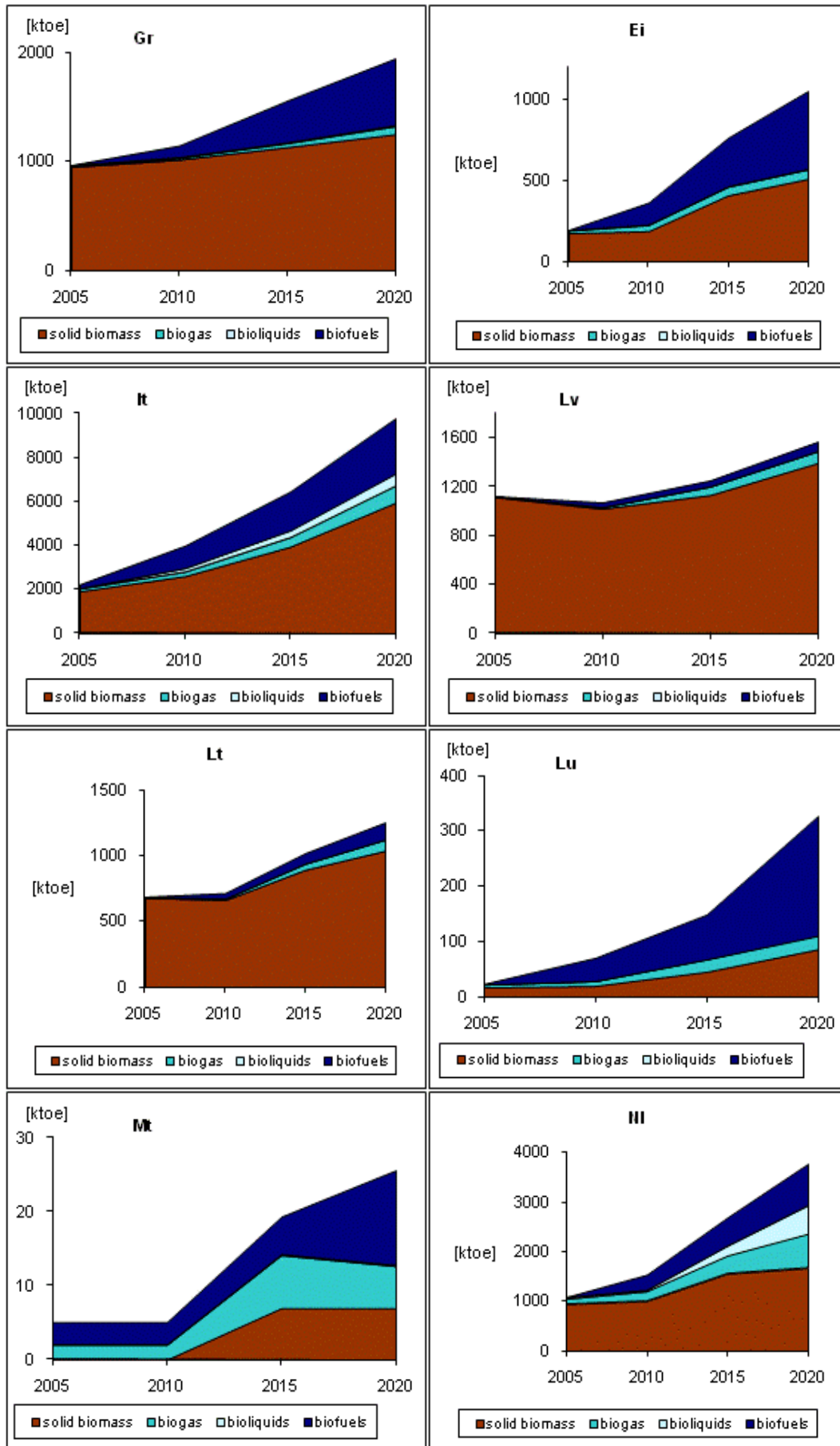
The paper is prepared under the *Biomass Futures* project funded by the Intelligent Energy Europe Programme.

**Annex 1**  
**EU National Renewable Energy Action Plans**  
**Bio-energy roadmaps by 2020**

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# BIOMASS FUTURES



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