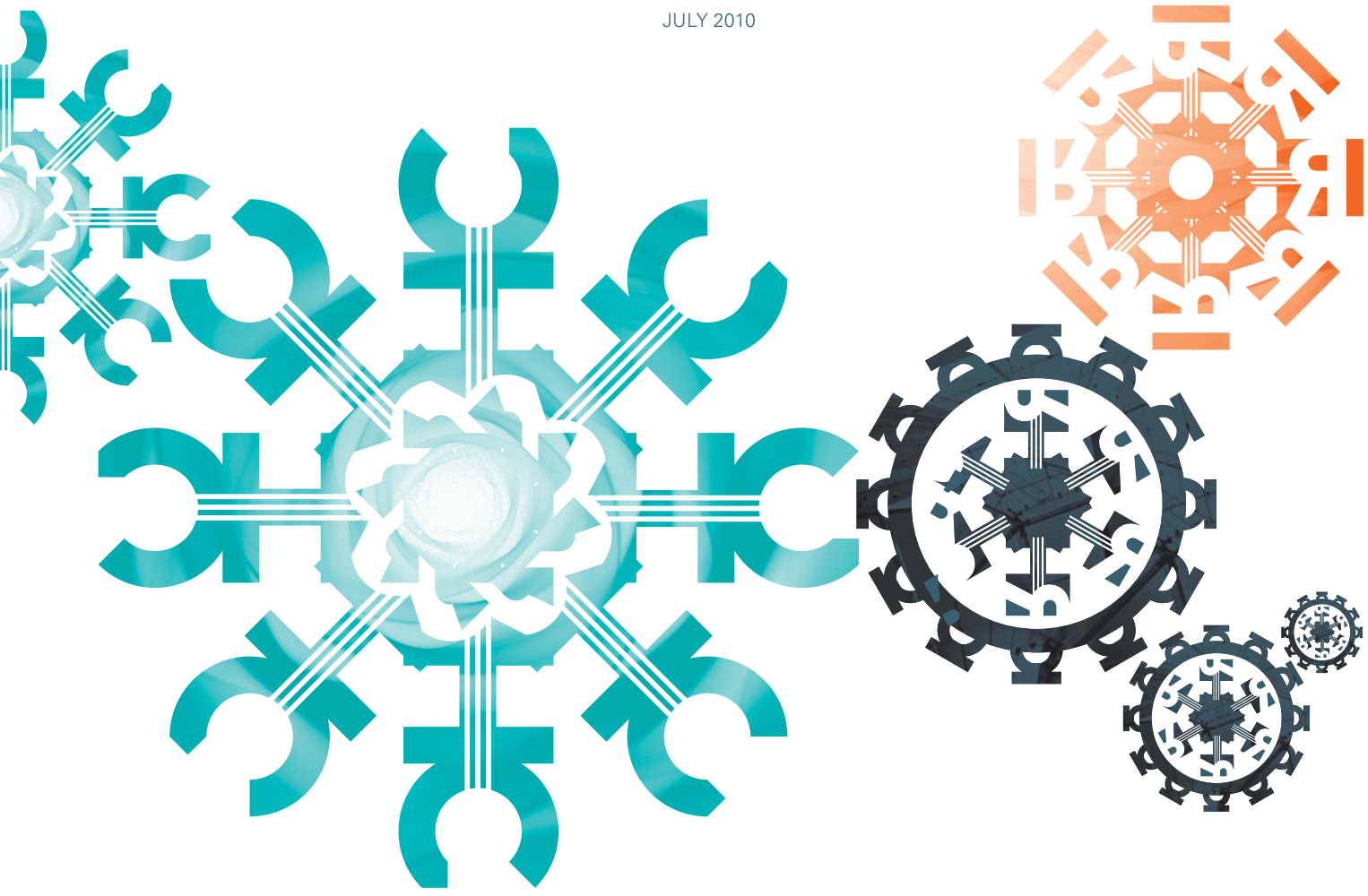
Biomass for heating & cooling

VISION DOCUMENT – EXECUTIVE SUMMARY

JULY 2010



RHC Renewable Heating & Cooling

European Technology Platform

www.rhc-platform.org

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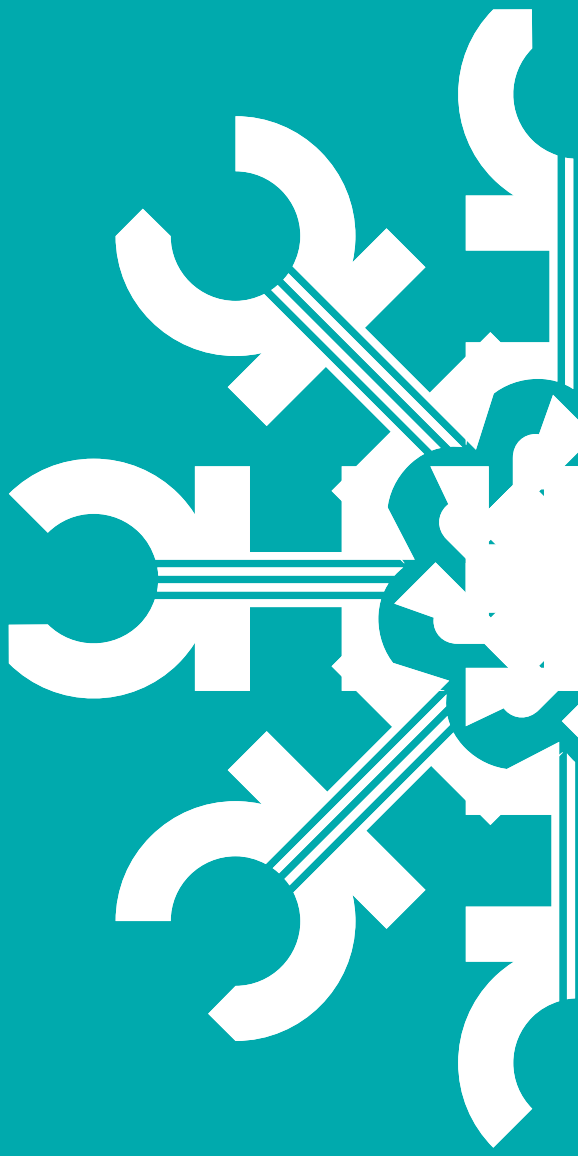
Foreword



The European Union has set very ambitious targets for reach member state in the renewable energy directive. As more than half of renewable sources is biomass for heat applications and as heat covers more than half of the final energy consumption in Europe, biomass is obviously a key sector to meet the 2020 targets.

We also need to look beyond 2020 as many challenges are in front of us like the rising population and their needs for energy or the global warming threat.

Even if biomass for heat application is fully commercial now we need to continue more than ever to improve our efforts towards more efficient and environmentally sound technologies. That is the aim of this Vision. Together with industry and R&D community stakeholders we would like to pave the way to our future heat supply for 2020 and beyond. More concretely in the short term we would like to establish guidelines for future European support to R&D.

We are now living in a crucial period for biomass to heat development and we should not miss this opportunity offered by the Biomass Panel of this new European Technology Platform.

Join us!

Kari Mutka

Chairman of the Biomass Panel
European Technology Platform on Heating and Cooling

RHC Renewable Heating & Cooling
European Technology Platform

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European Technology Platform on Renewable Heating and Cooling

A European Technology Platform (ETP) is a European network bringing together industry, researchers and other relevant stakeholders in a particular technological field in order to foster European research and development in the concerned area. 36 ETPs have been created so far on various topics (http://cordis.europa.eu/technology-platforms/individual_en.html), including one on Renewable Heating and Cooling.

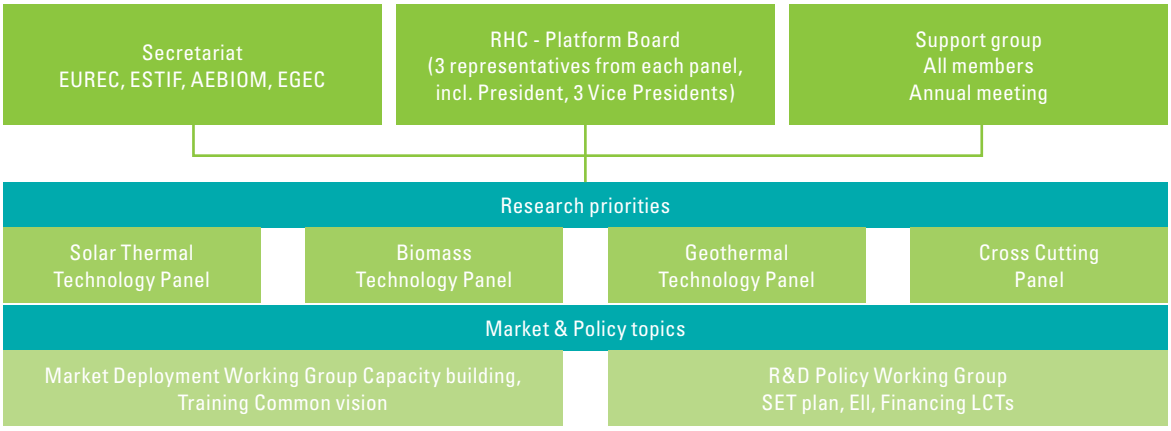
The policy objectives of the ETPs can be summarized as follows:

- Support the development and deployment of those key technologies in Europe that are vital to address major economic and societal challenges.
- Define a European vision and a Strategic Research Agenda (SRA) for the development and deployment of these technologies.
- Support the increase European private research investments by bringing research closer to industry and improving markets for innovative products.

The new European Technology Platform for Renewable Heating and Cooling (RHC-Platform, www.rhc-platform.org) has been recently endorsed by the European Commission. This Platform takes into account the main renewable heating sources (biomass, solar thermal and geothermal) and deals with strategic issues for growth, competitiveness and sustainability. The structure of this Platform can be seen at the diagram below.

The Biomass panel is composed of a general assembly (all persons that are registered on the web site – free of charge). It is managed by a Steering Committee of up to 20 persons headed by a chairman and 2 vice chair.

Figure 1: Structure of the Renewable Heating and Cooling platform.



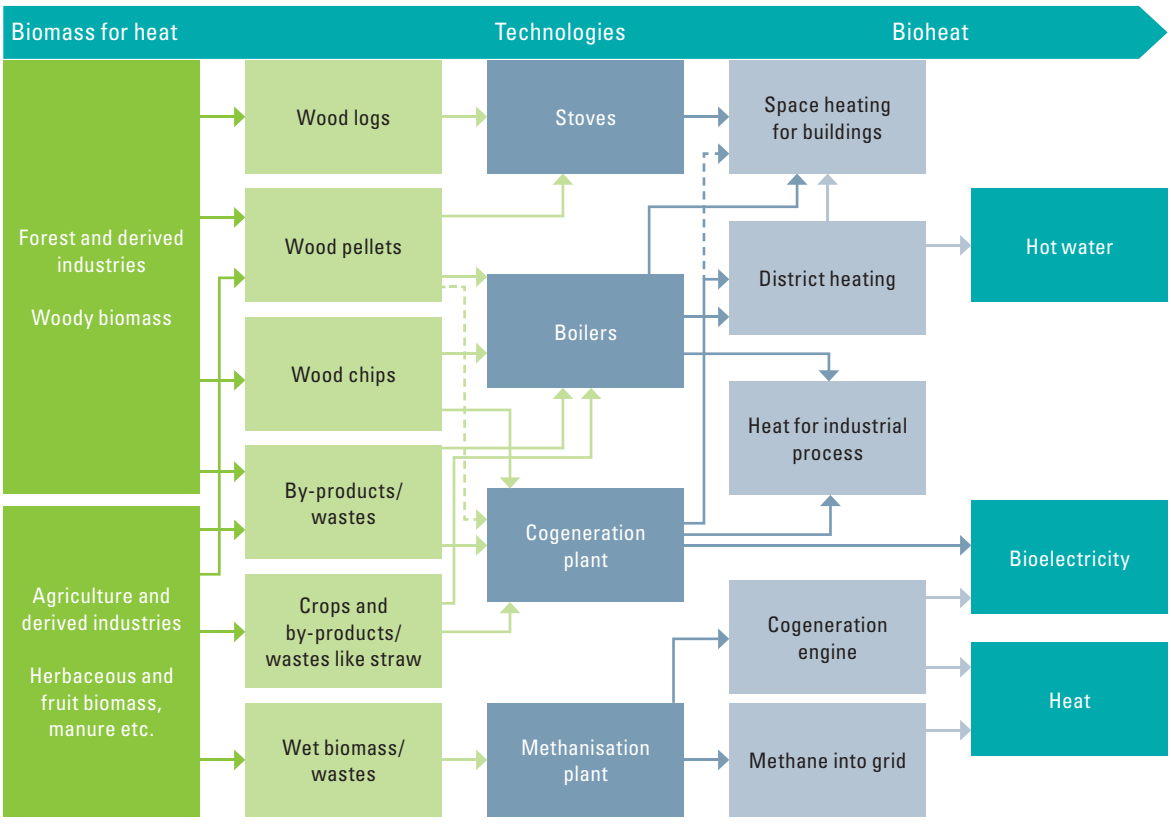
Biomass for heat

After coal, oil and natural gas, biomass is the largest energy source for fuel on Earth – it is the largest and most important renewable energy option at present and can be used to produce different forms of energy, potentially able to provide all the energy services required by society.

One of the main reasons for the large share of bioenergy within renewables is its important advantage that it can easily be stored, transported and used with flexible load and applications at the place and time of energy need. None of the other renewables is that flexible. This special property of biomass will also in future remain a special value and advantage which cannot be fully replaced by other renewable energies. The disadvantages of exhaust emissions from biomass use can be limited to non-harmful values almost as low as for natural gas applications. In addition, consumers traditionally value the enhanced level of comfort and well-being that comes together with certain types of small-scale appliances (e.g. stoves and tiled stoves.

Biomass routes to heat are manifold. Heat appliances arange from small scale stoves for room heating, to boilers of a few kW to heat houses, multi MW boilers for industry, district heating (DH) and in future even high temperature process heat. These large scale units can be combined with power cycles for combined production of heat and power (CHP). Novel technologies like Organic Rankine Cycle (ORC) and gasification also offer the possibility for efficient cogeneration. Fermentation to a combustible biogas is an alternative route for wet based raw materials. Biogas can be burned directly in a boiler for heat or an engine for cogeneration, while upgraded biogas (methane) can be injected in the natural gas grid and used directly by the consumer in boilers or small CHP systems.

Figure 2: Biomass routes to heat



Sector	Final energy in Mtoe	Hereof heat	
	Mtoe	%	Mtoe
Industry	323	55%	178
Households	285	86%	245
Commerce Services & Agriculture	173	76%	132
Transport	377	0%	0
Total	1158	48%	554

Table 1: Final energy consumption in EU27 in 2007 (Eurostat).

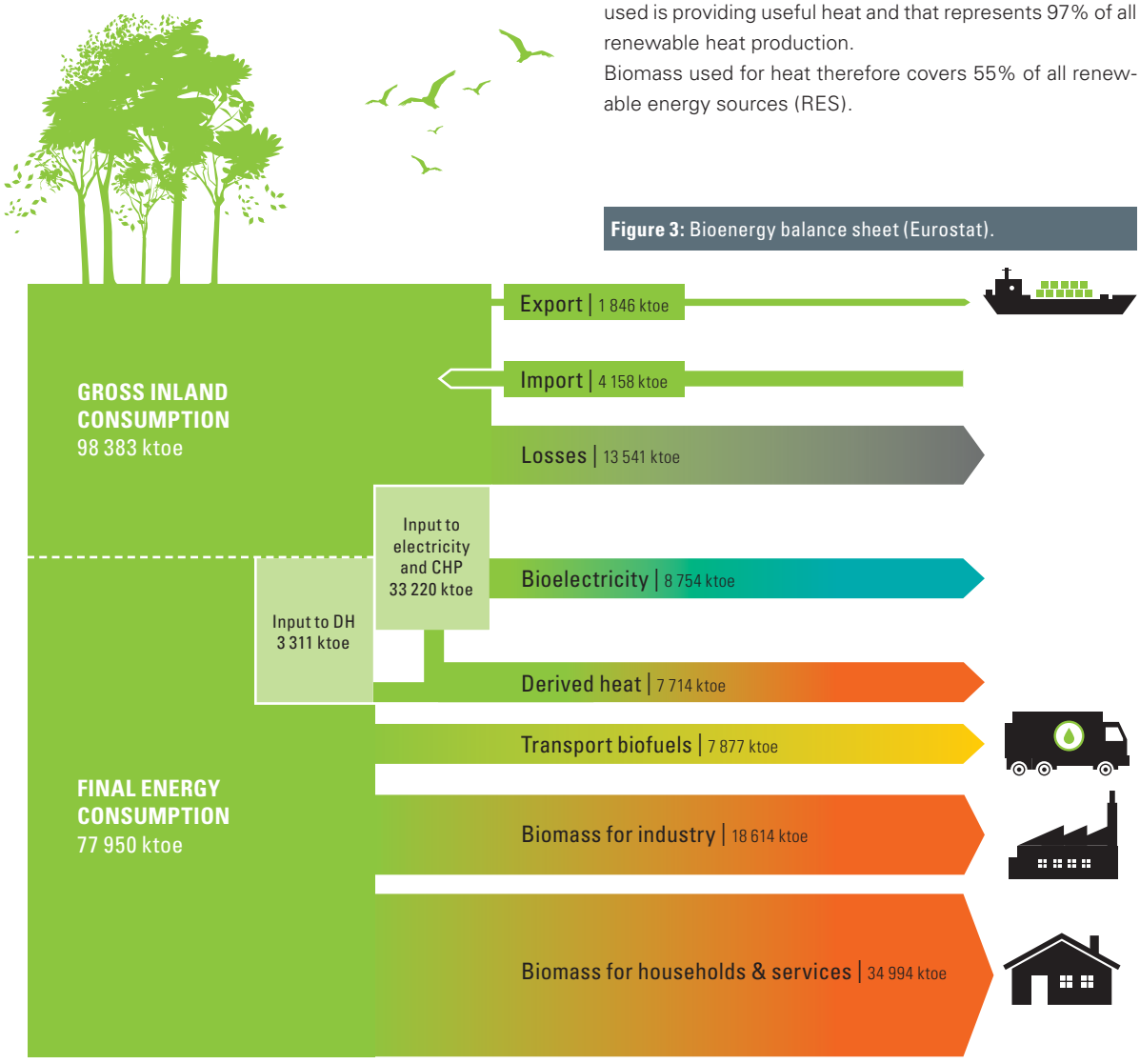
Heat represents roughly half of the final energy demand in Europe (see Table 1 below). A large part of electricity is used for heating and cooling purposes as well, through hot boiler, direct heating and air conditioning systems.

The Eurostat balance sheet (figure below) depicts the bioenergy balance sheet for 2007. The European Union consumes 98 Mtoe biomass. About 1/3 is fed to electricity, CHP and district heating (DH) plants, while the rest is consumed in private, commercial and industrial sector for heating purposes. Less than 8% is used as biofuels in the transport sector.

Allowing for heat recovered from CHP, 63% of the biomass used is providing useful heat and that represents 97% of all renewable heat production.

Biomass used for heat therefore covers 55% of all renewable energy sources (RES).

Figure 3: Bioenergy balance sheet (Eurostat).



Vision for 2020, 2030 and 2050

Ambitious targets

By 2020 renewable heat solutions as alternative to fossil based systems should be available for almost each type of consumer. These solutions should be technical reliable, environmental friendly and economically attractive.

The biomass market share should rise from 11% in 2007 to about 25% in 2020, even allowing for a reduction in heat demand.

By 2050 the energy needs will have radically shifted towards more electricity and less heat, and bioenergy will still play a key role in all markets. Sustainable land use and resource competition will be the key factors for the availability of bioenergy for heating and cooling. High conversion efficiency will be absolutely essential.

Bioenergy markets will be influenced by many driving forces from today to 2050, for example support policies, fossil fuel prices and the CO_2 emission costs. The uncertainty in the projections increases with time.

In the short term the RES Directive provides clear targets for 2020 for each Member State, defined as percentage of the gross final energy consumption. Members States have some room to favour some renewables and some energy sectors according to their RES potential, their market structure and their priorities. As bioenergy represents 2/3 of renewables today it is likely that bioenergy will still make a significant contribution to the targets. According to the European Renewable Energy Council (EREC) bioenergy will account for more than 60% of RES in 2020.

In the short term (up to 2020) it is essential to develop alternatives to fossil fuels for all markets of heat/cooling, electricity and transport. It is particularly critical for heat because private consumers, especially with lower incomes, will suffer as oil prices inevitably rise. Industries and district heating plants will also need to be prepared to diversify their energy supply towards more environmental friendly fuels. In all fields lowest emissions and ease of handling will be essential for high acceptance.

By 2030 biomass will be an outstanding solution for individual heating, dominated by (standardised and certified) pellets in urban areas and by wood chips, wood logs and pellets in rural areas. The boiler and stove markets will progressively shift from oil to biomass based systems. Heating oil will progressively become unaffordable.

CHP based on biomass will be progressively available in all sizes even at household level and for nearly all part load cases.

Most district heating and cooling systems will be retrofitted with solar thermal, biomass and geothermal and many new small heat, cool and biogas networks will appear.

In the longer term (up to 2050) several trends will shape the energy picture, e.g. like:

- High demands on energy efficiency;
- High probability of very high prices of oil, and subsequently natural gas;
- With the scarcity of sources, high probability of geopolitical tensions and increasing importance of energy independence;
- High probability of climate change crisis;
- Globalisation of the world economy will continue with Brazil, Russia, India and China exerting much greater influence.

Therefore the challenge for Europe is to maintain our high standard of living during the transition to a sustainable climate safe society.

all figures in Mtoe	2007	2020	2030	2050
Primary biomass	96.2	200	270	330
Imports	4.2	20	30	40
Exports	1.9	-	-	-
Gross inland consumption	98.4	220	300	370
Input to Electricity and CHP	33.3	65	80	95
Input to DHC	3.3	10	20	15
Input to Biofuels 2G/Biorefineries	0	5	10	30
Biomass use by households and services	35.0	80	115	130
Biomass use by industries	18.6	30	35	45
Total electricity (in TWh)	8.8 (102)	20 (227)	35 (404)	56 (645)
Total biomass for heat	53.6	110	150	175
Total bioheat (or derived heat)	7.7	14	32	56
Total biofuels	7.9	32	45	70
Total final energy consumption from biomass	78.0	175	261	357

Table 2 : Summary of biomass/bioenergy targets (source : RHC platform, biomass panel).

The energy picture will look differently in 2050 with different proportions for heat, electricity and transport fuels. High oil prices will lead to an efficient use of energy. The heat demand will decrease in the residential and tertiary sectors thanks to better insulation and low energy consumption buildings. Bioenergy will be intelligently coupled with other RES technologies like solar thermal and geothermal technologies. Decarbonisation of high temperature process heat in cement and iron production will largely depend on using biomass. Liquid transport fuels will compete with electric cars in the private sector but heavy vehicles, ships and planes will need the same volume even if train transport increases. Within the whole final energy consumption electricity will become proportionally more important.

An extremely important driving force for future energy production projects will be efficiency. It will have several effects:

- Industrial waste heat will be recovered as much as possible;
- Power production without cogeneration will be restricted. Biomass will have a special value, as it can be used for peak load and participates in load regulation;
- Heat generation without cogeneration of power will be restricted in the same way;
- District Heating and Cooling (DHC) networks will be developed even in many rural villages;
- Electricity for direct heating applications (hot water and space heating) will be banned.

In 2050 renewables will cover most of the energy needs and Europe will lead in know-how and technology developments. Different RES resources will be combined, taking full account of their individual advantages/constraints and costs. Biomass will be recognised for its multiple facets:

- Local fuel, but can be transported and, crucially, stored;
- The stimulation of the regional economy;
- Various outlets through biorefinery applications.

Increased biomass mobilisation

By 2020 the biomass supply in Europe should double with a very significant increase of energy crops, by-products from agriculture and the use of forest logging residues.

In the long run biomass resources should be mobilized intensively and efficiently, from agriculture, forest and waste streams.

The biomass supply should be increased significantly to meet the demand of all sectors of heat, electricity, and transport biofuels. None of these sectors can be isolated from the others because they can all tap on the same potentials and supply chains. 98 Mtoe of biomass were used in 2007 in Europe and this amount can be fourfoldly increased in the longer term thanks to a higher contribution from the agriculture, forest and waste streams. Such developments in the biomass supply should be realised taking into account the need for other sectors like food as the priority for agriculture and materials production. Biomass is the only renewable carbon source and bio-based industries will grow for many different applications, towards future bio refineries producing products and energy.

Table 3 shows the expectation availability of future biomass as derived by the biomass experts in the RHC-Platform. Agriculture should especially play a key role by mobilizing 20 million hectares in 2020 for different kinds of energy crops to produce transport fuels, biogas and solid biomass. This area will increase progressively after 2020 as well as the yield from these energy crops.

By-products from agriculture and agro-food industries will increasingly be used as bioenergy in the future as well, driven by the ban of organic matters in landfill. There is a large untapped potential for biogas production as well from manure and various kinds of organic wastes.

Table 3: Expectation of biomass supply in 2020 – 2030 – 2050 (source : expert view of RHC platform, biomass panel).

		2007		2020		2030		2050	
		Surface (Mha)	Biomass (Mtoe)	Surface (Mha)	Biomass (Mtoe)	Surface (Mha)	Biomass (Mtoe)	Surface (Mha)	Biomass (Mtoe)
Agriculture	Energy crops	5.2	10	20	43	25	75	30	129
	By-products		4		20		30		30
	Other						5		15
Forestry	Residues		18		40		55		55
	Industry by-products		54		65		65		66
Waste			10		32		40		35
Imports			2		20		30		40
Total		5.2	98	20	220	25	300	30	370

After 2020 intensive cultivation of biomass in the form of algae for example will develop commercially, eventually also for various applications in the biofuels sector.

Forest based industries (pulp&paper, board industry, sawmills, etc.) are currently providing most of the biomass and there is a potential to increase it but the expansion of the bioenergy use is limited by competition aspects with other sectors. The forest growth is currently higher than the exploitation in Europe and the forest area is continuously growing. This gives the chance to better exploit our forests with thinnings and by using the logging residues, while always keeping sustainability aspects into account. This increase of the forest area should be accompanied by an improvement in logistics (machinery and field pretreatment, methods of collection, transport and storage) to become truly useful.

Waste is the third sector with a potential for expansion in the short term. Landfill gas must be collected more intensively and organic wastes will be used more and more efficiently for energy as long as they will be progressively banned from landfill. Novel solid biofuels will be introduced mainly in the large-scale installations, such as Solid Recovered Fuel (SRF) derived from the municipal waste treatment, which could be considered partially as biogenic, i.e. up to 60% on weight basis. Also sewage sludge with increasing amounts from the steady growth of the number of waste water treatment plants will be utilized with higher energy recovery rates.

Finally, imports will increase significantly in the future in the form of transport biofuels (ethanol and biodiesel) and upgraded solid biomass (pellets, pyrolysis oil, etc.). As the world population will increase the agriculture food production will follow together with the availability of its by-products. Development of efficient (global) systems for food, feed and fuel production will be necessary. Recultivation of degraded lands around the world with adapted energy crops will be a big challenge.

Ensure sustainability

Bioenergy will progressively take sustainability criteria into account in an important manner to maximise benefits and ensure confidence of the public.

An increasing production of biomass in agriculture and forest and a mobilization of by-products and wastes and its conversion and use should be done in a sustainable way, considering the environmental, social and economic aspects (Figure 4).

Sustainable use of biomass for heating and cooling will consider the whole chain from biomass production and supply over conversion to use. While economic sustainability is necessary for a market success the sustainability of land use for production of biomass is one of the most crucial parts. Priority of food production of agriculture, taking into account the increasing world population as well as competition of biomass by other sectors like pulp and paper or biofuels will result in increasing pressure on land use. In order not to damage biodiversity areas for nature and wildlife protection will have to be preserved and production of biomass will find new ways of sustainable, diverse cultivation.

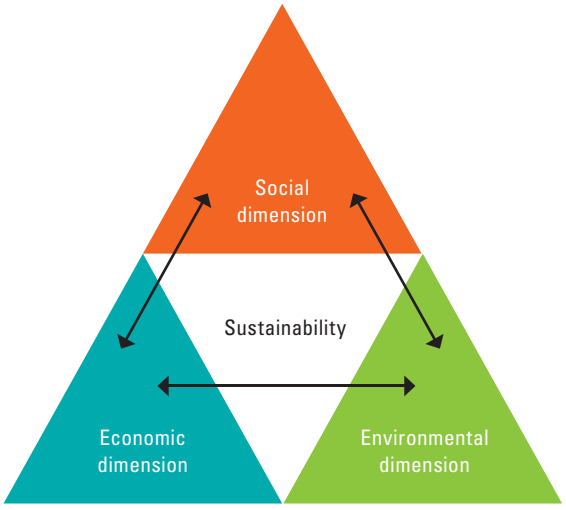
Under sustainable raw material production and use conditions bioenergy will always have a sufficiently low CO_2 emission and fossil energy fraction in its production as well as high CO_2 savings per toe biomass or per hectare land used. Also the conservation of soil and its organic fraction will be a very important factor that might lead to limitations of intense land use for bioenergy or even residue utilization from fields and forests. Social factors include the creation of jobs in production areas or access to biomass and bioenergy.

Emissions of dust, hydrocarbons, CO, NOx and heavy metals can in the future be reduced with new primary and secondary measures to extremely low values that will not have a significant impact on sustainability.

There will be better methods in future to fulfil sustainability requirements in production, conversion and use of biomass. New rules for sustainability of heating and cooling from biomass will be developed and integrated into normal practise. All three aspects of sustainability – environmental, social, economic – together also limit the biomass potential. Based on detailed analyses down to local areas in future there will be better clarity which is the limit and appropriate potential in which region, which type of biomass and cultivation and which kind of use.

A special focus on imports will be needed as the controls we can have on third country agriculture and forestry will always be lower compared to the management of EU forest and agriculture land.

Figure 4: Dimensions of the term sustainability (source: DBFZ).



Increasing competitiveness

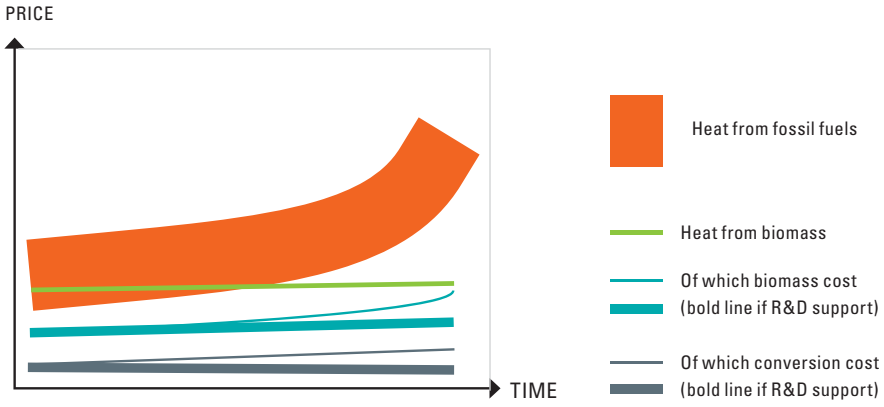
R&D plays a key role in making bioheat competitive with fossil heat without subsidies. R&D should maintain biomass prices reasonable, taking into account an increasing demand, and should decrease investment costs for conversion technologies.

Generally speaking, biomass fuels are cheaper than fossil alternatives while conversion technologies are quite more expensive, partly due to lack of economy of scale in production.

In the future heat from biomass has a chance to become definitely competitive, even without subsidies if prices of fossil fuels rise stronger than those of biomass. The future cost of biomass can only be guessed and will be influenced by many factors, including the global biomass market, the higher transport distances, and even climate change might have an impact. However, as demand and competition of all kinds of biomass will increase it is likely that prices of biomass will increase as well. Such price increase is not perceived as a significant barrier for the market if adequate measures are taken in the short term that will drive more investments for biomass mobilisation and create a strong infrastructure for biomass procurement. Also political signals on bioenergy use will influence biomass prices.

Significant R&D support can help to develop and mobilize new sources of biomass at competitive cost by improving the efficiency of the whole supply chain, thus contributing to secure the increasing biomass demand whilst reducing the biomass costs and a proper fuel quality. Such improvements will drive more investments for biomass mobilisation and creates a strong infrastructure for biomass procurement for the bioenergy markets. However, to keep heating and cooling from biomass competitive with possibly rising biomass prices the investment costs for conversion technologies need to be addressed. R&D support will play a key role here as well.

Figure 5: Competitiveness of bioheat vs heat from fossil fuels.



Create markets in the short term

Renewables in the heat sector should become a priority for Member States by 2020.

By 2020 renewable energy sources in the heat market should be considered as a priority in many members states, coupled with many efficiency measures (insulation, etc.). Support schemes will be benchmarked taking into account key criteria like:

- Amount of final energy produced for each ton oil equivalent (toe) biomass
- Amount of CO_2 emission reduction per hectare land or per toe biomass and cost of each ton CO_2 saved
- Costs and benefits for the final consumers
- Efficiency in using biomass
- Sustainability issues (land use, cultivation methods, bio-diversity, supply chain,…)

Renewables should become the fashion way of producing heat/cool for households and a valuable fuel diversification for industries and district heating/cooling.

Plumbers and installers of boilers will be competent thanks to dedicated and mandatory training courses and accreditation schemes.

Benefits for Europe

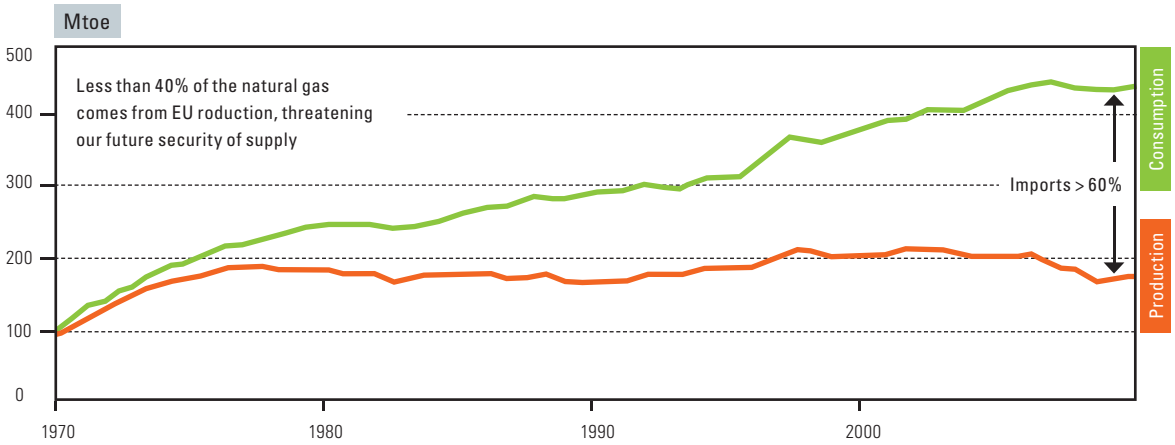
Bioenergy in 2020:
- 800.000 people employed in the bioenergy sector
- Europe is worldwide technology leader
- Increased security of supply
- € 60 billion less spent for fossil fuel imports
- 379 million ton CO_2 from fossil fuels avoided through bioheat

Our current use of fossil energy is not secure, it is expensive for our economies and it damages our environment. Europe is already seeking to change this trend and has to consider paving the way for a new energy paradigm: 100% renewables. Changes should start now and lies in the hand of the policy makers. Europe should keep its position as world leader in renewable energies, and the heat sector, as the main contributor to global renewables, should be a corner stone of this strategy.

Using biomass diversifies our energy supplies and increases energy security.

Bioenergy brings economic growth. If we assume that investment costs for heat appliances range from 200 to 600 €/kW installed, and biomass costs range from 10 to 50 €/MWh, we can calculate a rough estimation of the turnover of the biomass heat sector. Based on the objectives mentioned such a turnover reaches € 80 billion in 2020 and € 115 billion in 2050. New companies will be created for the whole value chain, starting from biomass collection, treatment (crushing, drying, etc.), logistics, boiler production, accessories (piping, software, etc.), installations, maintenance, etc.

Figure 6: Production and consumption of natural gas in the European Union.



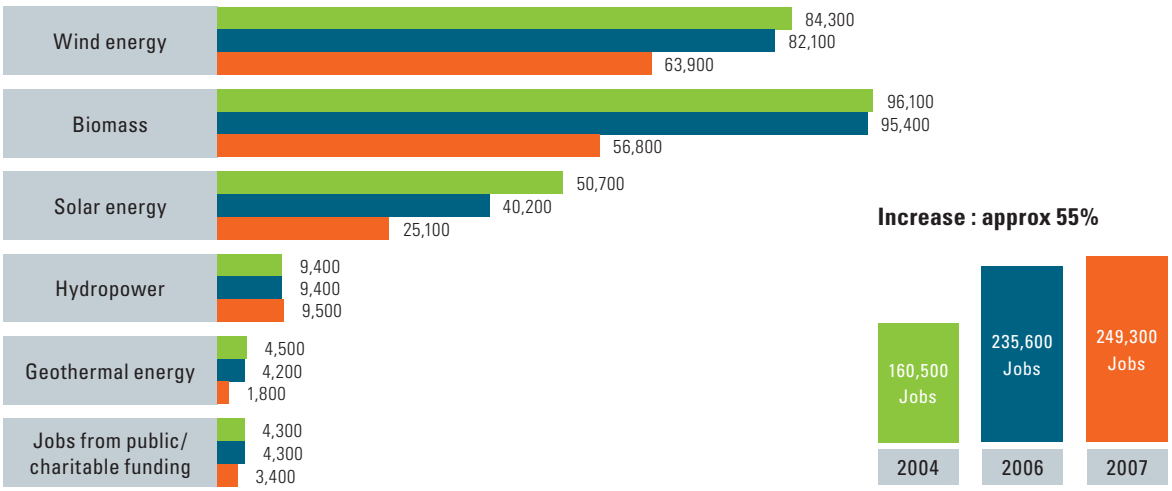
Bioenergy development in Europe also means cooperation with third countries/continents, like Canada, Russia, Africa, etc. where sourcing has started already because of their huge resources of biomass that are still potentially exploitable. The cooperation should however be followed up closely and regulated to ensure sustainability, and to maximize benefits to their economies and populations.
Such high investments to renovate our energy system require a substantial mobilization of public and private funds, and support from the bank sector.

Making an assumption that € 100 000 turnover generates one job, we can evaluate the total employment need to 800 000 jobs in 2020 in Europe. Both small enterprises and large heat services companies will hire personnel of various qualifications, ranging from drivers, craftsmen, etc.) to engineers, traders, project developers, etc. Biomass for heat is by nature a decentralised market, both for biomass production in forest and agriculture as well as for heat use. It therefore entails a large potential for rural development. The vast majority of jobs related to the bioenergy cannot be centralised.

Converting our energy demand from imported fossil resource to European domestic biomass will save more than € 60 billion in 2020 of import expenses, taking into account a 500€/toe cost of fossil fuels. This money will be invested in our economy in turn, creating welcome leverage effects. The same applies for smaller geographical areas like regions and villages, having people earning salaries from the biomass to heat sector, these earnings being themselves reinvested for other goods in a virtuous cycle.

Biomass for heat replaces fossil fuels and therefore reduces greenhouse gas (GHG) emissions. Taking into account the Eurostat GHG emission intensity of 3 tons GHG per toe, biomass to heat would avoid the total emission of 370 Mt GHG in 2020, equivalent to 7% of the 2005 emissions. This reduction would apply mainly be realised in the non ETS (Emission Trading Scheme) sector where mandatory targets are not so easy to enforce. In addition the public costs for reducing GHG by replacing fossil fuels by biomass is rather low, typically lower than € 20 per ton CO_2 equivalent.

Figure 7: Jobs in the RES sector in Germany.



Outlook on the Strategic Research Agenda

In the next step the RHC-platform will develop the Strategic Research Agenda with detailed biomass priorities. Over all system analysis on covering the whole process chain from biomass production to use must accompany the research programs and should also analyze combinations with other systems and check the best options of biomass use also in competing sectors. Some of the most important provisional topics are listed below.

Technical and logistic issues

- Development of agricultural and forest practices of biomass produced from crops and other additional unexploited biomass sources.
- Studies of production and market potential with sustainability criteria.
- Development of cost-efficient, high quality and high energy content fuels from various biomass sources – e.g. via pretreatment (biochar for example), blending, compacting etc.
- Develop regional bioenergy concepts for the whole chain (e.g. biomass village)
- Development of sustainable agro-to-energy and forest-to-energy chains (improvement of logistics – machinery, methods of collection, transport and storage- and their associated processes to supply biomass plants).

- Development of solutions to increase system efficiency and reduce emission factors (e.g. particles) from stoves and boilers by primary and secondary measures
- Development of reliable and efficient micro and small scale CHP plants
- High reliability, high load and fuel flexibility, high efficiency in large CHP
- CO_2 reduction and development of carbon negative solutions

Policy issues

- Study/analysis of a certification system for raw materials, products and co-products.
- Information campaign for biomass producers and other stakeholders in biomass supply chain
- Training of key actors in the buildings sector (architects, civil engineers, manufacturers of pre-fabricated buildings, planners, end user)
- Training of plumbers/installers of new biomass and combined systems (other RES sources, climatisation of buildings, etc.)
- Social perception of the sector in society
- Simplifying and streamlining authorization procedures
- Development of effective and efficient support mechanisms for bioheat

AEBIOM

EUROPEAN BIOMASS ASSOCIATION

The European Biomass Association (AEBIOM) is in charge of the Biomass Panel of the RHC-Platform and edited the input of the platform stakeholders for this vision document.

For the current list of stakeholders and information on how to get involved in the RHC-Platform, please visit **www.rhc-platform.org**

AEBIOM is the voice of the European bioenergy sector in Brussels. For information about membership benefits visit **www.aebiom.org** or contact **info@aebiom.org**

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