

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**

D2.2 Report on the main factors influencing biomass demand

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Preface

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1 Scope

The aim of this report is to analyse factors influencing potential uptake of biomass for heat, electricity/ CHP and biofuel technologies and examine how these factors may affect future market penetration. The analysis of key factors - technical, economic and organisational – has initially been based on literature review and then followed interactions with demand stakeholders i) during a dedicated workshop organised in Brussels (30th June 2010) and a separate set of interviews (that lasted from 1-2 hours each) and among other issues included discussion/ validation of the key factors.

The team intends to use the hereby presented report as the basis for future interactions with stakeholders where appropriate (both in the workshops planned within 2011 & in separate selected interviews) to ensure a broader & representative involvement prior to the final output.

Further to this, the work will feed into the scenarios & modelling work undertaken in the Biomass Futures project for defining the role biomass will play in the heat, electricity/ CHP and transport markets fro 2020.

2 Classification of key factors

The aim of this report was to analyse which key factors influencing potential uptake of biomass for heat, power and biofuel technologies and examine how these factors align or conflict with increasing demand for bio-materials. Key factors were classified into three categories - technical, economic and organisational factors - according to their likely greatest impact. Some key factors will be “showstoppers” that limit potential via “hard” constraints on biomass penetration.

Technical factors: determine whether biofuels are capable of meeting the demand for fuel on a technical basis. Examples are requirements to modify the refuelling infrastructure, and car manufacturers’ standards and safety requirements, with regards use of different blends of biofuel. The key technical factors will show where biomass technologies can or cannot fulfil a certain demand for technical reasons.

Economic factors: show where the ‘bio-carrier’ (e.g. heat, biodiesel, electricity) can be potentially more competitive than other ways of producing the same energy service. Applications where the ‘bio-carrier’ is a potentially competitive means of obtaining energy and fuels define the economic potential. This will be influenced by the willingness to pay for environmental or other added value services that bioenergy may provide. The economic effect of competing prices for biomass will be taken into account in the final prioritisation. An example is the conflicting demands that arises between energy crops and food.

Finally, the organisation / regulatory factors create positive and negative impacts on biomass implementation in Europe. More specifically, as the bioenergy/ biofuels and renewable energy targets set by the European Commission are influenced by political aspects, the reliability and uncertain continuity of incentives is a parameter that can impinge upon their uptake. Moreover, social awareness and public perception are also relevant factors that can cause either a positive or negative effect on market penetration of biomass-derived fuels.

2.1 Heat

2.1.1 Technical factors

The requirement for space (due to larger boiler size; the requirement for pellet stores etc.) is important in the domestic sector. This is particularly the case when the displaced fuel is natural gas. Space is of lesser importance for larger schemes, such as district heat. However, the importance of space varies with local factors. Existing coal-fired district heat plants will have large boiler rooms and coal storage facilities, so space is unlikely to be a primary concern when retrofit with biomass is being considered. On the other hand, new-build district heat schemes in urban areas will have a “space penalty” for selecting biomass in place of natural gas.

Modern biomass heat technologies offer substantial improvement of efficiency when used to displace old, inefficient technologies. In many rural areas, older boilers and furnaces are widespread and their displacement with more efficient modern biomass boilers represents a promising opportunity for biomass heat.

Air pollution and increased transport and noise associated with fuel deliveries may be constraints or concerns for biomass. These issues are important in urban areas. Air pollution may arise both directly from the emissions from the boilers and indirectly from the vehicles delivering fuel. Air quality regulations are likely to require flues to be above the height of surrounding buildings, and this can cause knock-on concerns about aesthetics.

2.1.2 Economic factors

Capital or investment costs for biomass heat are higher than for their fossil fuel equivalent. The impact is amplified if schemes have low availability factors, i.e. operated only in winter months. From the economic point of view, key barriers and drivers for biomass heat are impacted by several policy incentives and schemes seeking to stimulate the emergence of sustainable energy sources.

Capital grants and fiscal incentives are so far the most commonly used to specifically support biomass heat boilers. Emissions trading and renewable certificate schemes can also contribute to investments into biomass heat more attractive. However, grants and other incentives may only apply to specific segments of the market e.g. larger heat plants.

Europe’s first trade-able certificate scheme for renewable heat will be launched in 2011. This is the UK’s Renewable Heat Incentive (RHI) scheme, which covers various technologies including biomass, solar thermal, air and ground source heat pumps. In the biomass sector, it covers all scales of technologies from domestic (though not traditional stoves or fires) to large-scale DH. The RHI will award actual generation of heat, with certificates awarded on a per mega watt hour basis. The RHI will not provide up-front support for schemes i.e. capital grants. Different technologies, and within those different scales, will attract levels of payment per mega watt hour. Also, the term for payments will differ, typically 15-25 years. This so-called “banding” is similar to that which now exists for the UK Renewables Obligation that supports electricity.

Fuel costs depend mostly on the specific biomass type considered and the related displaced fuel. Biomass is typically less costly than natural gas. Locally-produced coal is the fuel of choice for district heating in many European countries and this fuel continues to be relatively inexpensive compared to biomass though there are exceptions such as locally-available straw (Jablonski, 2008).

2.1.3 Organisation / regulation factors

Environmental concerns, particularly climate change, underlie policy efforts to promote renewable energy. The potential of biomass heat to displace carbon emissions is therefore an important driver.

Employment creation is invariably stressed as a key driver for biomass uptake but this is case-specific and it should be analysed as such in the different policy setting agendas.

2.2 Electricity/CHP

2.2.1 Technical factors

Cofiring provides a relatively low technical risk opportunity to increase biomass share in the European renewable electricity market. On-site blending of biomass with the primary fuel prior to co-milling has proved to be the least capital intensive approach and is currently the most popular method.

Existing fossil fuel-fired power stations can be modified quite rapidly for co-firing and achieve considerable levels of renewable generation, with lower capital costs and limited commercial risk. Logistics may be an issue since year-round secure supplies are important for large power plants.

CHP plants may be an attractive solution but require reliable heat demands in close proximity. Seasonality of heat demand may result in CHP plants operating only for part of the year. Heat demand is likely to also vary during the day, requiring investment in thermal storage. Intermittent heat demand reduces competitiveness, particularly in view of the fact that capital costs are relatively high.

Biomass is promising option for industries that are related or in close proximity to forest or agriculture based activities (forest products processing, sugar industries etc.). These industries benefit from biomass residues produced on-site and/or knowledge with the fuel.

Regarding micro and small scale- CHP, the key technical factor prohibiting its immediate market uptake is limited operational experience. Technologies at small scale, say below 3MWe, are not yet considered to be proven technically or commercially.

2.2.2 Economic factors

In both cofiring and CHP applications, for new efficient technologies, the plant scale has direct impacts on the capital and operational expenditure.

An immediate challenge for existing and future biomass cofiring and CHP units is to secure long term sustainable feedstock at reasonable prices.

Large scale co-firing is the least cost and lowest risk approach. Project risk does, however, increase as the co-firing ratio increases and / or the quality of the fuel decreases. For CHP installations, planning, design, authorisation, construction and commissioning of new plants can take a number of years. Significant up-front costs require a long-term view and the project developer must have resources for the period concerned.

Uncertainties in the markets for fuel prices prohibit new investments in CHP. Special premiums/favourable taxation measures for industry would enhance new investment.

Lenders including banks may be unwilling to commit capital for new build over entire project life. This increases the reliance of dedicated biomass schemes on renewables support mechanisms and associated capital grant schemes. The principal barriers to obtaining finance are:

- The use of technology which does not have a proven track record with reference plants. Because the new technologies are new they take a long time in planning and environmental permitting.
- Weak project sponsors lacking the human, technical and financial resource to see projects through to completion when development does not run entirely to plan.
- Absence of credible, contracted fuel supplies with a company of sound financial standing is a frequent barrier to raising finance for biomass projects. Such projects should be viewed as 'fuel supply projects' rather than 'electricity generating projects' because of the primacy of the fuel supply arrangements in the assessment of the financial viability.

2.2.3 Organisation/regulation factors

Planning, design, authorisation, construction and commissioning of new dedicated biomass power plants can take a number of years and involve significant costs. Barriers to achieve planning permission

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for a large biomass electricity plant are: time and cost for planning studies, no planning precedents, local opposition, politicians, lack of joined-up policies between government agencies, inexperience and lack of resources in the planning authorities.

Harmonised regulations and coherent policies are considered crucial to the future implementation of biomass CHP.

Environmental concern, particularly climate change, is an important driver for biomass. Although widely accepted that CO₂ released on combustion is balanced by CO₂ absorption by photosynthesis during growth, certain stakeholders consider that a more holistic approach should be taken. This would consider emissions related to storage and transportation of the biomass feedstock and emissions related to the fossil energy used in construction and operation of the power plant.

In addition to the greenhouse gas balance, other environmental impacts should be considered, in the overall environmental analysis, such as emissions from additional vehicle movements and the plant itself. The formation and emission of particulates (aerosols) and primary measures for NO_x reduction from biomass combustion has been a major issue. In some Member States, biomass combustion forms a major source of aerosols with significant health impacts.

As in the bio-heat segment, employment creation can be regarded as a key driver for future uptake but it should be analysed by case when designing policy and support schemes.

2.3 Cofiring plants

2.3.1 Technical factors

Type of co-firing technology: on-site blending of biomass with the primary fuel prior to co-milling has proved to be the lowest cost approach and is currently the most popular method.

Efficiency: it is known that higher steam temperatures give more efficient steam cycle, with conversion efficiencies of up to 35% achievable.

Fuel flexibility: co-firers are less exposed to fluctuations or even interruptions in biomass fuel supply, due to the ability to modify the ratio of biomass to fossil.

Lack of flexible and robust handling/ combustion technology and use. Though there are many advantages associated with co-firing biomass with coal, improper choices of fuels, boiler design, or operating conditions could minimise or even negate many of the advantages of burning biomass with coal and may, in some cases, lead to significant damage to equipment.

2.3.2 Economic factors

Large scale co-firing is a relatively low cost option, both from the perspective of investment and operating cost. Existing plants have written down their capital costs and the additional investment required for co-firing, in feedstock preparation etc., is relatively limited. Co-firing also benefits from relatively low O&M cost per kilo watt generated from biomass..

Cost of resources: low cost imported biomass are sought after by co-firers and enjoy larger share than local feedstocks.

2.3.3 Environment factors

Co-firing is inter-dependent with fossil fuels. Power plants continue to use large proportions of coal and are not renewable energy plants. Indeed, there is some debate about whether provision of incentives to co-fire provides indirect subsidies to fossil fuel, resulting in larger quantities of coal being combusted and / or extended life-span for plant.

Reduction of emissions: direct displacement of coal may contribute to high CO₂ reduction. However, note the debate mentioned above. Carbon impacts may not be great, or may be negated entirely, if coal use increases due to co-firing.

2.3.4 Organisation/ regulation factors

Regulatory limitations: a significant barrier for these plants are limits that the regulations set up in terms of biomass fuels origin and feed-in tariffs.

Concerns from Regulators: A key concern for the Regulator is the arrangements for the measurement and testing of the biomass fuel used. For commercial reasons, generators want the flexibility to purchase a variety of fuels including pre-blended material. Certification is a very important issue especially in the case of pre- blended imported biomass fuels.

Public acceptance: it is generally perceived that there are environmental benefits if coal fired stations use a proportion of biomass.

2.4 Small-scale CHP

2.4.1 Technical factors

The greatest issue at this scale is that the technology is not widely proven. Technologies such as gasification have been tested and demonstrated at this scale. However, there are many examples of failed schemes and limited evidence of sites with many trouble-free operating hours.

Implementers of small scale biomass CHP are likely to be enthusiasts and may be a stakeholder in the technology. The technology may require extensive attention and a “hands-on” approach to get it to work.

2.4.2 Economic factors

Biomass cost: in many cases the opportunity is to use resources that are produced on-site, which is a forest or agriculture-based industry. Hence, feedstocks are available at relatively low cost.

Cost per unit capacity for these small projects may be relatively high both because of the novelty of the technology and the lack of economies of scale. However, these are relatively small projects so overall investment is limited. The site-owner may be able to fund from their own balance sheet or access funds from lenders, using for example their facilities as security for the loan.

Grid connection and licensing costs have been documented as barriers for small scale biomass CHP plants, especially at scales below 100kW_e.

2.4.3 Environment factors

Emissions reduction: although there is a significant reduction of GHG emissions compared to a conventional power plant, the cost per tonne of CO₂ saved is high at small scale.

2.5 Medium-scale CHP plants

2.5.1 Technical factors

Both grate technology (fixed or vibrating) and fluidised bed combustion are widely proven, with several hundred commercial sites in Europe and further afield.

Efficiency: with high turbine inlet temperature maximise the efficiency of conversion to electrical energy. But also there are some technical difficulties, specifically due to deposits that fouled and ultimately blocked the heat exchangers.

At the scale 5-30MWe, it is possible to have matching heat loads in close proximity, with either industrial, commercial and residential loads, or a combination. However, seasonality of these loads may be problematic, leading to lower use or uneconomic use in the non-heating season. This impact is great if there is no year-round industrial load. This has led to some plant operators to examine other uses of heat, such as production of ethanol from biomass feedstocks, or the provision of heat to drive absorption chillers and provide space cooling.

2.5.2 Economic factors

The initial investment cost for a biomass fired CHP plant is more than that for conventional plant.

Cost of fuel and location. With the exception of shipping, the transport of biomass over long distances is costly. Medium-scale CHP sites are unlikely to be adjacent to marine ports so fuel must be supplied from local sources by road vehicles. Typically, fuel must be available within 70km, enabling hauliers to make two or three return trips per day.

Investment risks are considered to be high. These sites are dependent upon non-conventional fuels, which are not yet widely traded, and for which there is not good price certainty, and limited opportunity to forward-contract. Also, notwithstanding the fact that the number of biomass CHP sites in Europe is growing, their extent is still very limited compared to conventional gas engine or gas turbine CHP.

2.5.3 Environmental factors

Significant reduction of CO₂ emissions comparing with a conventional power plant but the cost per tonne of CO₂ saved is relatively high (in comparison to, say, energy efficiency measures).

Impact on the environment: Noise and traffic pollution (when there is a long distance from the biomass resources), but in some cases reduction of wastes.

Formation of aerosols: the reduction of formation and emission of particulates (aerosols), during the biomass combustion, is an important factor

2.5.4 Organisation/regulation factors

While the role of grants and other support schemes are important, features of the design or implementation of these can prove problematic. This includes: complex and fragmented grant aid and support structure; short application deadlines; academic appraisal panels; levels of support varying between schemes; no link between grants and value of carbon saved.

There are barriers to getting planning permission; therefore most electricity generating plants in the planning phase are using conventional combustion / steam turbine technology. Also the new technologies are new they take a long time in planning and environmental permitting.

There may be limits for connection with the national grid, such that plants that are below this limit must use their own electricity.

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Lack of design rural development: The lack of incentive to develop non urban sites by the authorities and the big companies. Local development: Local employment at conversion plant and associated activities

Local opposition may be a problem, though this is specific to certain countries and sites. The environmental contributions of biomass may not be well understood at the local level. Local people see 'industrial-scale' biomass energy plants as a threat to the local environment. Lack of proper information and communication by local authorities and stakeholders with, in some case, media amplifying the real risks.

2.6 Large-scale CHP plants

2.6.1 Technical factors

Both grate technology (fixed or vibrating) and fluidised bed combustion are widely proven. Gasification is being trialled on large scale. Once there are some successful reference plants using advanced technology, it is likely there will be other similar schemes, since the advantage these will offer very high conversion efficiencies.

A key issue with large CHP plants is that heat loads in relatively close proximity will be small in relation to the plant. Linking the plant to larger loads will require very substantial investment in long distances of underground district heat pipework, which brings economic challenges. Seasonality of heat loads is also an issue, as described above for medium-scale.

2.6.2 Economic factors

Investment costs for wood fuelled plants are relatively high. Indicative comparative investment costs are as follows:

- Large IGCC power plant > €1,500/kWe
- Large coal fired power plant > €1,000/kWe
- Biomass stand alone power plant > €3,000- 5,000/kWe

Also there is a reliability or availability of plant coupled with the maintenance cost. So the economics of new plants are unattractive when considering future frameworks.

Difficulty to finance: Financing new technology is an equity risk to be handled either on the balance sheet of an appropriately sized corporate entity or by the way of high risk / high return speculative venture equity. Financing the development of new technology should not be attempted in the context of trying to finance a project employing that new technology. A biomass project will need to employ tried and tested technology if it is to be used in the financing plan. However there are some notable exceptions that are used gasification and manage to achieve bank finance. It seems that, in order to create real bankable projects, the conventional combustion / steam turbine technology is likely to continue as the preferred technology for some considerable time.

In general, dedicated plants have more barriers than the co-firing. Planning, design, authorisation, construction and commissioning of new stand-alone biomass power plants can take a number of years and involve significant costs. Also the initial cost is higher than for co-firing schemes of similar capacity and hence payback periods are significantly greater. In addition, existing fossil fuel-fired power stations can quickly be modified for co-firing and achieve considerable levels of renewable generation, and also higher CO₂ reduction benefits from each co-fired tonne of biomass. Technically, co-firing wood pellets with coal is feasible, and environmentally co-firing wood pellets is highly beneficial through the reduction of NO_x, SO₂ and CO₂. The co-firing of biomass also promises to kick start the biomass supply industry and help farmers and forests and at a much lower cost than with dedicated bioenergy plants.

On the other hand dedicated plants present an advantage over co-firing biomass on an existing plant, where the plant design and systems will have been optimised for the primary fuel and there are a lot of available technological options. Such plants help the development of local communities, independent of the fossil fuel and if the projects observe the principles of sustainable development, there are a lot of environmental benefits. The most significant advantage is that they will have an extended life of maybe 35 years, while coal power plants' life is limited both technically and via regulations.

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In conclusion for the economic point of view, the co-firing biomass stations continue to be the best investment for a short period of time, but the stand-alone biomass plants will be rather investment for a long period of time. Also, for the social and environmental point of view, stand-alone plants have more benefits and any improvement in regulation sector and more efficient use of technology will make them the best practice.

2.7 Transport

2.7.1 Technical factors

EU 27 transport sector's development should be based on alternative liquid fuels so as to achieve a minimized climate changing gases emitted into the atmosphere and secure the supply of fuels in the near future. However, the production chain of biofuels is still linked with several environmental and social impacts, compared to fossil fuels, requesting the launch of certain criteria for fuels produced through biomass. Even if biofuels can provide a response to emerging issues like the security of energy supply, the warming of the planet or the rural areas upgrade, there is a variety of published reviews commenting on the extent of indirect effects of biofuels production, which has created concerns about the future growth of the sector.

Introducing biofuel in transport fuel will impact the quality of the final transport fuel and therefore will impact vehicles. This will have an impact on market acceptance and importance of quality standards

Developing new cars is possible but lead time is necessary and introduction of higher biofuels blending (>E10 or >B7) must happen in a harmonised and simultaneous way across the EU. Backward compatibility for older engines to higher biofuel blending is in most cases not a possible option.

Different biofuel types have different side effects on conventional cars, so it is very important for end users to have very clear quality statements when they are requested to use the biofuel or invest in a new car.

Labelling is an important issue in the future penetration, especially in private users. Unclear indication of bio-content at the pump causes confusion to consumers and increases the risk of mis-fuelling

2.7.2 Economic factors

The costs of fossil derived fuels compared to biofuels, taking into account at the same time the growth in prices of oil and gas and the costs of tonne of carbon avoided, are considered as an important factor influencing the potential for biofuels uptake in transport sector.

A variety of factors, including crop feedstock costs, processes, land and labour costs, raw material costs, credits for bio-products, agricultural subsidies, food (sugar) and oil market, investment costs, operation and maintenance costs, taxation (tax exception of biofuels), is affecting the cost of biofuels, whereas the plant size is an important factor which can significantly reduce the operating costs.

The investment cost for biofuels along with the continuously changing subsidies and taxes that exist in national and European levels are of significant importance as well, as they can be either a strong opportunity or a delay, for the promotion of biofuels. Indeed, in many Member States the financial system can be characterized as being in favour of biofuels due to lower taxes and incentives for their quicker market integration. However, in some other leading countries, as in Germany for example, a quota system is implemented and tax exemptions for biofuels are reduced.

2.7.3 Organisation/regulation factors

As a result of the Biofuels Directive in all European Member States, large investments were made in the production of biodiesel and bioethanol. Nevertheless, lately, due to the policy followed by particular member states to diversify their targets, namely Germany and the UK, that took the decision to lower their goals, and combined with the rising costs of agricultural commodities and the increased amounts of imports, both the European biodiesel and bioethanol industries are facing a harsh reality.

As the targets that the European Commission has posed for biofuels and renewable energy for transportation in general, are influenced by several aspects, the reliability of directives and incentives is a parameter that can affect the uptake of biofuels in transportation in a dubious manner.

Not all Member States are aligned with EU27 standardisation rules and this creates a complex market both for the fuel/ refineries and car manufactures to meet different specifications at different countries.

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Developing a new car takes approximately 5-7 years and is rather costly, so consistency in policy and respective regulations is an important issue for future planning in the car- manufacturing industry.

Public acceptance of biomass/ biofuels can be a barrier for people with little knowledge of biomass and the associated technologies and benefits, there have been prejudices and limited perceptions of the benefits of bioenergy. Especially for biofuels, the debate over the sustainability has directly impacted on the social acceptability of the biomass field overall.

Finally, the perceived lack of infrastructure necessary to support biomass fuel supply can be a barrier to the realisation of biofuel plants.

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Stakeholders (interviewed)

Biofuels for transport

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Appendix 1 – Key factors (Heat, Electricity/ CHP)

Technical Key Factors	
1. Technology availability	<p>Biomass heat, electricity/ CHP combustion technologies are commercially available at most scales with technical reliability comparable to fossil fuels (Oberberger & Biedermann, 2005).</p> <p>Smaller CHP plants are less mature and reliable, and gasification technologies are still at demonstration scale (DTI, 2007).</p>
2. Heat/power demand	<p>All temperature/pressure characteristics of hot gas and steam for heat production can technically be achieved with different biomass heat / CHP technology.</p> <p>In addition, for CHP technologies, the heat-to-power ratio of the demand has to be suitable to the type of technology used (Biomass Energy Centre, 2008).</p>
3. System response time	<p>Biomass heat producing technologies have a slower response than gas or oil fired systems, but comparable to coal systems. However in practice, the gap is closed by installing buffer vessels with the biomass system.</p>
4. Fuel supply logistics	<p>Recent improvements in supply logistics have meant that biomass quantities needed for almost all scales of heat and power applications can technically be sourced, managed and/or delivered. However, biomass quantities needed for larger scale applications can still appear difficult to source, manage and/or deliver without jeopardising security of supply.</p>
5. Fuel quality	<p>Historically, micro/small scale heat boilers have been able to accommodate only low moisture content (MC) biomass, while technologies for accommodating high MC were available for medium/large scale applications (e.g. moving grate). Recently some modern biomass technologies have emerged at the small scale to accommodate high MC and various types of biomass feedstock (Davis, 2006), but they are not yet widespread. Older boilers/furnaces technologies tend to be more flexible (but exhibit low efficiencies).</p>
6. Space requirement	<p>Bioenergy heat and power systems require more room than alternative fossil fuels for the boiler itself (with its buffer vessel if relevant), as well as for fuel storage, and for fuel delivery vehicles' access (RETScreen International, 2005). This is especially an issue where space is a premium, but can be reduced by using energy intensive fuels such as bio-oil or pellets, or when the displaced fuel also requires on-site storage.</p>
7. Conversion efficiency	<p>Modern biomass heat and power systems generally have lower conversion efficiencies than fossil fuels (Kavalov & Peteves, 2004), but the difference is small or negligible.</p> <p>In some cases, co-firing of biomass and fossil fuels in large power plants can improve the overall performance of the plant.</p>
Economic Key Factors	

8. Capital costs	Capital costs for installing biomass heat and/or power systems are higher than the coal/oil/gas equivalent systems (DTI, 2007, RETscreen International, 2005). This is especially penalising for bioenergy investments with low capacity factors.
9. Operating and Maintenance (O&M) costs	Bioenergy heat and power systems require slightly more maintenance than oil and gas ones (including for ash disposal and fuel supply), and about the same than with coal systems. This is due to the biomass fuel handling requirements, and depends on the technology considered.
10. Fuel costs (versus fossil cost)	Biomass fuels can sometimes be "cheap" alternatives to fossil fuels depending on the local availability of fuel and the geographical location (Nilsson et al., 2006). This contributes to making bioenergy systems operating costs much cheaper than fossil fuel systems. This is especially the case when biomass "at negative cost" is available via a waste stream which otherwise would have to be disposed of (Biomass Task Force, 2005).
11. Heat sales revenues	To date there have only been discussions surrounding the possibilities of designing policy instruments for renewable heat based on a feed-in tariff system (International Energy Agency, 2007)
12. Electricity sales revenues	In certain instances the value of electricity produced with renewable energy sources can be entitled to a higher selling price to be paid from the Distribution System Operator (DSO) when compared to fossil fuels produced power which makes biomass power production more competitive (feed-in tariffs). This is not the case in the UK or in Poland.
13. Operation grants / payments	Operation grants provide cash payments based on an energy generation basis (typically by MWh) for the production of electricity. Targeting the energy product of heat is also a possibility. However, the distributed nature of heat supply complicates the implementation of operation grants due to a lack of effective metering and monitoring procedures often only effective and practical for larger systems (International Energy Agency, 2007).
14. Emissions trading scheme revenues	Revenues from specifically designed mechanisms improve the attractiveness of investing in bioenergy.
15. Access to / Cost of capital	Banks often hesitate to provide loans for equipment which is still developing a market presence (International Energy Agency, 2007b), but when "bankability" by established institutions is assured, then this may pave the way forward for project developers. Bioenergy systems are still considered risky investments, and the cost of capital for such projects is thus higher than for other fossil fuel systems (i.e. including a risk premium) (Rosch & Kaltschmitt, 1999).
16. Eligibility for favourable loans	Financial assistance in the form of low-interest or no-interest loans, long-term loans, and / or loan guarantees effectively lowers the cost of capital. Since the high u-front costs is often an important consideration for potential renewable heat (and bio-heat) investors, lowering it can effectively bring does the average cost per unit and hence reduce the investment risks.

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17. Other administrative costs (grid connection, licensing)	Transaction costs linked to power grid connection, and the power production licensing process, can be a burden for smaller scale or decentralised projects, where they represent a higher percentage of the investment costs. As decentralised energy mainly relates to renewables, this can be seen as an obstacle to bio-electricity.
18. Other incentives (based on decentralised energy production, like “embedded benefits”)	In some countries (such as the UK), the provision of decentralised smaller scale energy can be incentivised by valuing their contribution to the overall network. As decentralised energy mainly relates to renewables, this can be seen as an opportunity for bioenergy.
Organisational Key Factors	
19. Potential for carbon displacement	Bioenergy has lower carbon content than alternative fuels, and can help mitigate climate change. This effect can be enhanced or reduced depending on the carbon content of the displaced fuel.
20. Employment creation	A very popular argument supporting bioenergy is that it creates employment. Various regions of the globe have documented various experiences, and the ambiguity of terminologies used makes it impossible to draw straightforward conclusions. Among other renewables, bioenergy has the highest employment-creation potential. Ultimately, the level at which it can contribute depends on local demographic and economic conditions (Domac et al., 2005).
21. Social acceptability (tradition, confidence with biomass fuel, conversion technology)	There is a broad acceptance of renewable energies (and associated technologies) by the public at present, to which the climate change debate has contributed (Rosch & Kaltschmitt, 1999). However, people who are not familiar with the opportunities and benefits of using biomass for energy, and with little knowledge of biomass conversion technologies tend to have prejudices, which can reduce or annihilate the relative advantage of bioenergy.
22. Educational policy instruments	Education to promote bio-heat aims to enhance the awareness of the public (and the bioenergy consumers) by information campaigns and providing training to increase installer knowledge. This type of support may take the form of technical assistance, financial advice, labelling of appliances, or information distribution (International Energy Agency, 2007).
23. Amenity issues (fuel delivery and energy production)	<p>Concentration of small scale biomass heat boilers impacts on local gaseous / particulate emission levels (especially in urban areas) with potential consequences on public health (Carbon Trust, 2009).^c At the same time, the replacement of old inefficient boilers with high emissions levels can be seen as an opportunity for bioenergy.</p> <p>In the case of large quantities of biomass needed, the fuel delivery can also create issues of amenities, such as additional traffic-induced noise and emissions (notably when compared to gas). This is especially the case for such a plant built near a population area or within a urban or industrialised area (Rosch & Kaltschmitt, 1999).</p>

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<p>24. Organisational capability (skilled personnel availability, know-how) and management of complexity</p>	<p>Planning, realisation and operation of biomass plants, including the provision and delivery of biomass feedstock is more difficult to handle compared to fossil fuels (Rosch & Kaltschmitt, 1999). Implementation of a bioenergy plant thus requires more organisational capability than with other fuels. However this challenge can be eased by the use of a third party dealing with this task (e.g. an Energy Services Company - ESCO, or IPP), and who has the required bioenergy expertise (including skilled personnel availability and know how) for fuel supply and/or operation of the plant.</p>
<p>25. Fuel infrastructure availability</p>	<p>Despite the recent progresses made, the perceived lack of infrastructure necessary to support the biomass fuel supply can be a barrier to the realisation of biomass energy plants.</p>
<p>26. Security of fuel supply</p>	<p>Energy security is a factor of increasing importance in EU27. For smaller scale applications, because it can often be produced locally (either on site or in the vicinity of the application), biomass is perceived as a more secure fuel than gas or oil from the supply point of view. This is less true in the case of larger scale energy plants, where biomass quantities required leads to the sourcing of (at least part of) biomass fuel from other regions/countries where it is available at low cost.</p>
<p>27. Fuel price stability</p>	<p>In the past biomass fuel prices have been seen as more stable than other fossil fuels commodity prices. However this has recently changed, as competition on biomass resources has increased. Concerns have already been expressed for some commodities such as vegetable oils, woodchips, but also food products.</p>
<p>28. Regulations (as policy instruments)</p>	<p>Generally implemented by means of regulation, governments can intervene in the market by placing requirements on specified sectors. This type of instruments forces bio-heat deployment by directly requiring the development of specified technologies. In this context biomass can appear as an attractive option in many cases.</p>
<p>29. Administrative issues (planning, grid connection, power export option etc.)</p>	<p>Obtaining and respecting all administrative permissions, pre-conditions and requirements to construct and operate a bioenergy plant are often seen as unattractive or too complex for project developers (Rosch & Kaltschmitt, 1999).</p>

Appendix 2 – Key factors (Transport)

<i>Technical Key factors</i>	Comments
1. Current high technology reliability and full maturity for 1 st generation (medium term prospect of maturity of 2 nd generation)	Technology is considered very reliable for first generation biofuels, while there is some reluctance to the maturity of the production capabilities for second generation biofuels up to 2020.
2. Biofuel content in mass market	The current blending (E5, E10, B7) is easily used in the current infrastructure & fleets but it is not enough to meet policy targets. Increasing bio- content in mass markets could be an outlet to meeting the 2020 targets.
3. GHG savings from full chain	When considering future biofuel penetration it is important to consider their full chain GHG balances and take into account their respective performance. The 2017 increase in the overall sustainability threshold, may be a limiting factor for biofuel availability in the market.
4. Extensive refuelling infrastructure requirements	Specialised infrastructure requirements require attention in planning the future biofuel industry, especially for high blends.
5. Safety and standardization	Standardisation and safety issues should be carefully taken into account for any biofuel development in the future, especially for niche fuels that are for dedicated power-train and dedicated fuel infrastructures (eg E85 or B30). It is important to avoid non-harmonised introduction of future biofuels in EU27 by using CEN rules
6. Ensure compatibility of new cars in higher blends	Careful tests in different fuel parts in the cars should be undertaken.
7. Labelling	Unclear indication of bio-content at the pump causes confusion to consumers and increases the risk of mis fuelling
<i>Economic Key factors</i>	
8. Financing new technology	Adaptation of car engines is rather costly & time consuming for the industry so the fuel specifications need to be consistent for a long term
9. Capital costs	Capital costs are substantially high and increase the risk for second generation facilities, especially due to large scale of the plants. First generation biofuels are considered commercially viable options with many installations in Europe and worldwide.
10. Variable subsidies and grants	The target set by the EU biofuels Directive has been adopted by most Member States in their national biofuel objectives. As reported by Weisenthal (2009) their focus has mainly been to stimulate market development through two instruments: a) fiscal incentives or b)

	prescription of a mandatory production.
11. Oil and gas price increases	As biofuels are directly compared with their fossil counterparts, the recent price increases of the latter make the bioenergy carriers more competitive.
11. Operating and maintenance costs	Biofuel production systems require slightly more maintenance than oil and gas ones due to the biomass fuel handling requirements, and this certainly depends on the technology considered.
12. Access to loans-cost of capital	Financial assistance in the form of low-interest or no-interest loans, long-term loans, and / or loan guarantees effectively lowers the cost of capital. Since the high u-front costs is often an important consideration for potential biofuel investors, lowering it can effectively bring down the average cost per unit and hence reduce the investment risks.
Organisational Key factors	
13. Variable reliability of incentives	EU-wide there is great variability in terms of financial mechanisms and incentives and their duration is mostly 'short to medium' term. This creates instability for new market developments. In addition, complex and fragmented grant and support structure, short application deadlines, academic appraisal panels, rates vary between schemes
14. Lack of joined-up Government policy across different ministries	Due to the variety of policy/ regulation issues involved across the biofuels value chain there are several ministries involved and they are not always well coordinated.
15. Security of feedstock supply	Security of feedstock supply for biofuels is a risk for two main reasons: i) the competition of first generation feedstocks with food & feed, and ii) the lack of security in supplying the large quantities required to support the second generation biofuel facilities.
16. Good organizational capability	Well organised infrastructure and refuelling stations will increase further biofuel market penetration.
17. Administrative issues and planning:	Planning procedures require careful coordination among different authorities.
18. Challenge of balancing short-term interests and environmental agenda	Society is prepared to undertake a share of the costs for eco-friendly fuels. However, during economic crisis this may be modified. So policies, have to ensure long term support in order to counterpart the financing risks for the industry.
19. Favourable policy for bio-waste to fuels	This helps in producing cheaper biofuels due to lower feedstock costs.