Briefing for first stakeholder consultation on the role of biofuels in the EU27 transport sector

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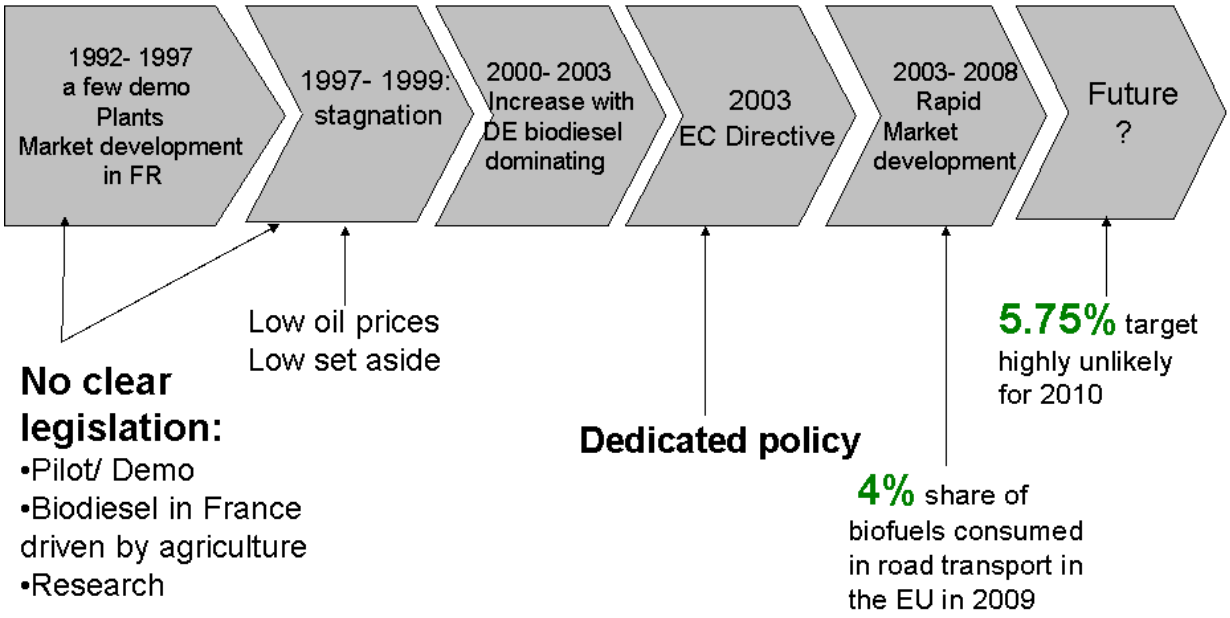
Imperial College London, September 2010

Market analysis for biofuels in the transport sector

The biofuels market in the EU27 has seen a rapid increase during the last eight years mainly due to policy driven demand following the Directive 2003/30/EC.

Biofuels consumption has grown by 70.9% between 2005 and 2006, 45.7% between 2006 and 2007 (reaching 8 Mtoe), 31.4% between 2007 and 2008 (10.5 Mtoe) and 18.7% between 2008 and 2009 (EurObserv'ER, 2010).

However, with the current development trends it is highly unlikely that the 5.75% target will be met in 2010.



Within the Biomass Futures project (www.biomassfutures.eu) we aim to ***assess the role that biomass can play in meeting EU RES-D targets for 2020 and inform policy makers at both the European and national levels***.

In the framework of the work on analysing the demand for biomass in the transport sectors this briefing aims to:
a) provide up-to-date information for the biofuels market in EU27 in terms of demand, market capabilities and consumer readiness for take-up, and
b) define & characterise market segments for future penetration of biofuels in transport
c) review the main key factors affecting future integration.

Policy driven demand

Dedicated biofuels policy was launched with the Directive 2003/30/EC as one of the means to tackle security of supply, reduction of GHG emissions and rural development through increased opportunities for the agricultural sector. The directive posed indicative, not mandatory, targets for all member states (MS), of 2% and 5.75% to be reached by 31 December 2005 and 31 December 2010 respectively, "calculated on the basis of energy content of all petrol and diesel for transport purposes placed on their markets" (European

Parliament, Article 3, p. 45). The respective shares achieved so far for the EU as a whole have up to now been: 1 % in 2005, 2.6% in 2007 and 4% in 2009. Based on the same trend the expected share for 2010 will not exceed 4.8% (EurObserv'ER, 2010).

The target set by the EU biofuels Directive has been adopted by most Member States in their national biofuel objectives. As reported by Wiesenthal (2009) their focus has mainly been to stimulate market development through two instruments: a) fiscal incentives or b) prescription of a mandatory production.

a) Within fiscal incentives, biofuels are targeted to reduce the price level to that of fossil fuels (or below). This is implemented by a tax reduction scheme, which has proven successful although it causes important revenue losses for government. Tax exemptions were the most commonly used measure until 2006. Several countries adopted a full exemption approach until 2006: Cyprus, Estonia, Germany (for biodiesel only up to the first half of 2006), Greece (only biodiesel), Ireland, Italy (only biodiesel and only in 2006), Malta, Poland (practically a full exemption), Spain and Sweden.

b) Under the mandatory regime, fuel suppliers are obliged to achieve a certain biofuel share in their total sales. Fuel suppliers and ultimately the transport users carry the additional costs. In 2007 Germany, the Czech Republic, Luxemburg and the Netherlands adopted the obligation to blend as a policy to substitute the expensive measures of excise rates reduction (or abolition).

In the same time period other Member States such as Austria, Cyprus, Finland (from 2008), France, Italy, Lithuania, Portugal, Slovakia, Slovenia, Spain (from 2008), Sweden, United Kingdom (from 2008) adopted the combination of obligations to blend in addition to tax relief. As a result of previous efforts and in light of the targets set at European and national level, Member States have set out projections of biofuel deployment within their National Renewable Energy Action Plans. **Tables 1 and 2** show these projections (ECN, 2010).

It is Article 4 of Directive 2009/28/EC on the promotion of the use of energy from renewable sources that requires Member States to provide National Renewable Energy Action Plans (NREAP) by 30 June 2010.

The NREAPs shall illustrate according to a strict template published by the Commission how to achieve mandatory national 2020 RES targets as set out by that Directive. Part A of Annex I of the Directive specifies the national targets for the share of energy from renewable sources for the year 2020 and a reference value for the year 2005.

Part B of Annex I defines through formulae an indicative trajectory for each Member State, that must be attained in the reference years specified. Article 3.1 of the Directive states that mandatory national targets are consistent with a target of at least a 20% share of energy from renewable sources across the European Community's gross final energy consumption in 2020 (ECN, 2010).

Table 1: Projected total bioethanol in transport for the period 2005 - 2020

	2005 [ktoe]	2010 [ktoe]	2015 [ktoe]	2020 [ktoe]	2020 [%]
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.
Bulgaria	0	0	15	42	1
Czech Republic	n.a.	n.a.	n.a.	n.a.	n.a.
Denmark	0	13	95	94	2
Germany	144	639	996	857	14
Estonia	n.a.	n.a.	n.a.	n.a.	n.a.
Ireland	0	40	90	139	2
Greece	n.a.	43	256	414	7
Spain	113	232	301	400	7
France	75	550	550	650	11
Italy	0	148	374	600	10
Cyprus	0	0	3	15	0
Latvia	n.a.	n.a.	n.a.	n.a.	n.a.
Lithuania	1	13	30	36	1
Luxembourg	0	5	9	23	0
Hungary	n.a.	n.a.	n.a.	n.a.	n.a.
Malta	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	0	168	217	282	5
Austria	0	54	61	80	1
Poland	n.a.	n.a.	n.a.	n.a.	n.a.
Portugal	0	0	24	27	0
Romania	n.a.	n.a.	n.a.	n.a.	n.a.
Slovenia	0	4	8	19	0
Slovakia	n.a.	n.a.	n.a.	n.a.	n.a.
Finland	0	70	120	130	2
Sweden	144	251	358	465	8
United Kingdom	18	135	692	1743	29
All Member States (total)	495	2365	4199	6016	**100**

Table 2: Projected total biodiesel in transport for the period 2005 - 2020

	2005 [ktoe]	2010 [ktoe]	2015 [ktoe]	2020 [ktoe]	2020 [%]
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.
Bulgaria	0	30	100	154	1
Czech Republic	n.a.	n.a.	n.a.	n.a.	n.a.
Denmark	0	18	152	167	1
Germany	1598	2790	2074	4443	24
Estonia	n.a.	n.a.	n.a.	n.a.	n.a.
Ireland	1	94	209	342	2
Greece	1	64	130	203	1
Spain	145	1471	2169	3100	17
France	328	2165	2375	2850	16
Italy	179	868	1374	1880	10
Cyprus	0	15.7	19.8	23.2	0
Latvia	n.a.	n.a.	n.a.	n.a.	n.a.
Lithuania	3	42	79	131	1
Luxembourg	1	37	72	193	1
Hungary	n.a.	n.a.	n.a.	n.a.	n.a.
Malta	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	0	139	350	552	3
Austria	35	276	309	410	2
Poland	n.a.	n.a.	n.a.	n.a.	n.a.
Portugal	0	281	405	450	2
Romania	n.a.	n.a.	n.a.	n.a.	n.a.
Slovenia	0	37	72	174	1
Slovakia	n.a.	n.a.	n.a.	n.a.	n.a.
Finland	0	150	300	430	2
Sweden	9	89	170	251	1
United Kingdom	57	861	1818	2462	14
All Member States (total)	2357	9427.7	12177.8	18215.2	**100**

Source: ECN, 2010

During the first four years since the enactment of the Biofuels Directive (2003/30/EC), policy was coherent globally including the US and Latin America and several initiatives for international collaboration were established. Nevertheless biofuels were the target of severe criticism during 2007/2008 as one of the major reasons for the food-price increases and their potential contribution to the reduction of GHG emissions became a field for 'debate' among the international scientific and political community.

In March 2007, in addition to the overall goal of the Directive 2003/30/EC, the European Council agreed on a 10 % binding minimum target to be achieved by all Member States for the share of biofuels in overall EU transport petrol and diesel consumption by 2020.

Market capabilities

According to the SET plan, almost 4% of current EU gross energy demand is covered by biomass resources. Nearly two-thirds of all renewable energy sources (RES) used in Europe comes from biomass. In 2005, about 5% of biomass consumption for energy purposes was dedicated to biofuel production, which corresponded to a total production of biofuels of about 4 Mt. By 2030, the Biofuels European Technology Platform considers that up to one quarter of the EU transport fuel consumption could be met by biofuels (www.biofuelstp.eu). The market share of biofuels in the overall EU-27 transport petrol and diesel consumption, with respect to the baseline are projected to be 7.5% in 2020 and 9.5% in 2030. The maximum market share of biofuels in the EU-27 is estimated to reach 14% in 2020 and 20% in 2030.

If the maximum market shares are achieved, biofuels could potentially avoid 40 Mt/year CO_2 in 2020 and 75 Mt/year CO_2 in 2030 compared to the baseline. The corresponding maximum cumulative avoided CO_2 emissions for the period 2010 to 2030 would be up to 0.81 $GtCO_2$. Moreover, achieving the maximum market share for biofuels could lead to the use of up to 25 Mtoe of biofuels in 2020 and 40 Mtoe in 2030, displacing roughly the same amount of oil, with a maximum cumulative fossil fuel avoidance of 450 Mtoe, for the period 2010 to 2030. At present the most significant market capabilities for biodiesel are located in a handful of countries as shown in **table 3.**

Table 3: EU27 Biodiesel production capabilities

Country	Firms	Number of plants	Production capacity (Million tonnes per year)
France	Diester Industry	9	2
Germany	ADM Biodiesel, Verbio and Cargill	7	1.8
Spain	Infinita, Entaban and Acciona	7	1.7
Switzerland	Biopetrol	3	0.75
Italy	Marseglia Group and Novaol	4	0.7

Bioethanol production firms are part of agri-food markets, and mainly sugar and starch industries. The most significant market capabilities are shown in **Table 4**.

In addition, a number of countries such as Austria, Hungary, Poland, Czech Republic and the UK are known to host one bioethanol plant.

Table 4: EU27 Bioethanol production capabilities

Country	Firms	Number of plants	Production capacity (Million tonnes per year)
France	Tereos, Abengoa, Crop Energies, Cristanol	12	1.7
Spain	Abengoa	4	0.55
Germany	Crop Energies, Verbio	3	0.5
Belgium	Tereos, Crop Energie	2	0.4

Consumer readiness for take-up

Light Vehicles

Bioethanol can be used at *a low blend, 5-10%, in all petrol vehicles without modification*. When bioethanol is *blended into fuel at levels above 10% of volume, some engine modifications may be necessary*. High-percentage blended bioethanol, e.g. E85, is used in adapted petrol vehicles. These are *flexi-fuel*, which means that they can run on either petrol or a blend of petrol and bioethanol up to 85 percent.

During the past few years, several major car manufacturers have developed **flexible fuel vehicles (FFVs)**. *The main differences between bioethanol FFVs and petrol vehicles are the materials used in the fuel management system, metallic and rubber based materials are replaced with bioethanol compatible substitutes. Modifications to the engine calibration system are also made.* The corrosive effect of the fuel rises when the bioethanol content is increased. 15% petrol is added to the bioethanol fuel because bioethanol has a lower vapour pressure than petrol at low temperatures, making cold starts more difficult. Bioethanol cars have only one fuel tank, which can be filled with either E85 or petrol. The amount of bioethanol in the fuel is detected by a sensor that analyses the content of the fuel tank as mixture of bioethanol and petrol.

Maintenance needs

Compared to conventional petrol cars, *bioethanol cars need more frequent service*. The manufacturers recommend service every 10,000 km (or once a year), compared to every 20,000 km (or once a year) for new petrol cars. The reason for this is that engine oil and the oil filter have to be changed more often in a bioethanol car, as the bioethanol fuel is not lubricating the engine as much as petrol does and the oil gets worn out faster.

Driving range

Bioethanol fuel contains approximately 35% less energy compared to petrol. This means that the consumption of bioethanol is higher than petrol and thus the driving range is shorter. A bioethanol car that uses 0.7 litres petrol/10 km needs 1.0 litre E85/10 km. Conversely, *bioethanol fuel has a higher octane number (104) and can be used with a higher compression ratio, resulting in higher energy efficiency*. This means that engines optimised for bioethanol can be more energy efficient than engines that are currently optimised for petrol. As bioethanol has a higher octane number than petrol, *it offers increased torque and higher power,* especially when used in combination with turbo-technology.

Blends of ethanol in gasoline are commonly used in vehicles designed to operate on gasoline, although vehicle modification is required for alcohol fuelling because its properties are different from those of gasoline.

Market Segments

EU27 transport market segmentation

This section provides the initial market segmentation for discussion with the stakeholders.

The segmentation of the transport market is considered according to the type of vehicles, as it can be illustrated from the **Figure 1** below. **Tables 5 and 6** represent in more detail the exact meaning of each segment, as well as the size of each one according to available data for 2008.

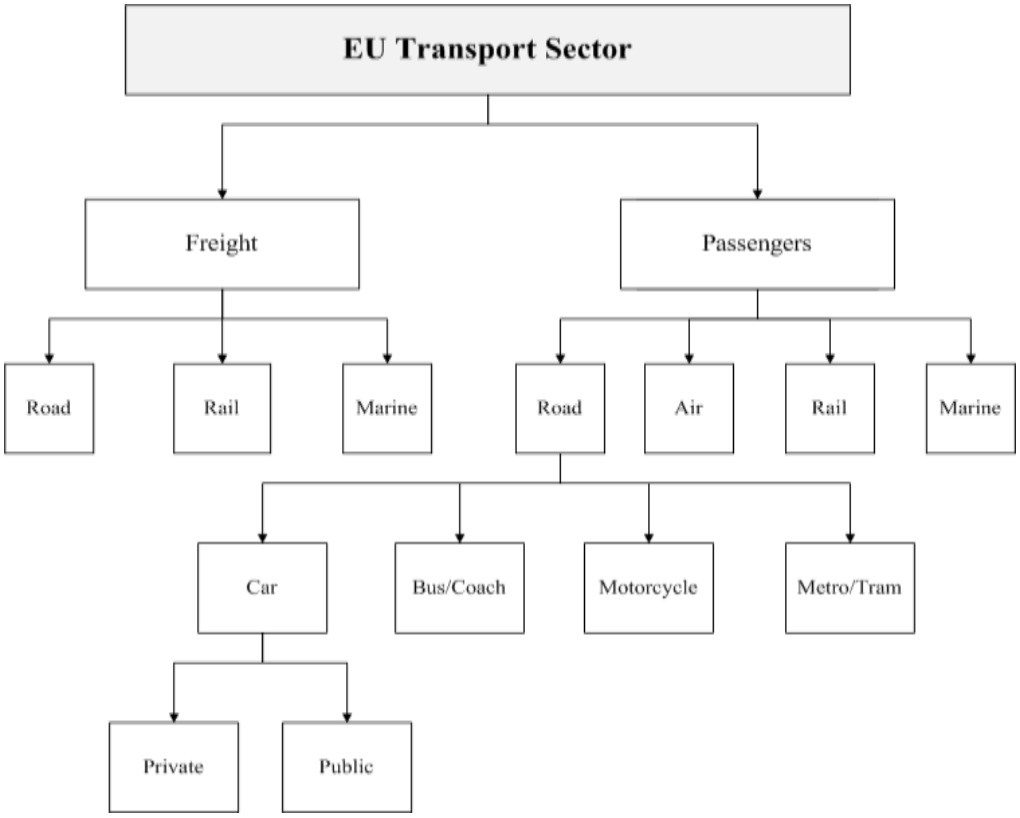


Figure 1: Segmentation Tree of the EU 27 transport market by vehicle type

The different types of energy technologies that exist both for passengers and freight transport consist of internal combustion engines, electric motors and hybrids, fuel cells and gas turbines, and CNG, as stated in PRIMES Energy Model. Among the enormous variety of biomass-derived alternative fuels that exist at present, biodiesel and bioethanol are the ones consumed more, however, they have to remain compatible with vehicle engine characteristics to replace diesel or petrol. The blends that are most suitable for diesel replacement are B30, B100, ED95 (95% hydrous bioethanol and 5% additives), BTL, HVO (hydrotreated vegetable oils) and PVO (pure vegetable oils). Blends suitable for petrol replacement are E85 (85% bioethanol and 15% petrol) and biogas (Biofuels Cities 2008).

Table 5: Passengers transport segments

Segments	Description/ Comments	Market Size (2008) *thousand mio pkm*
Air	Estimates of domestic and intra-EU-27 transport	561
Rail		409
Sea	Estimates of domestic and intra-EU-27 transport	41
Metro/ Tram	Not fully comparable data across countries.	89
Road(total)		5427
Road-Bus	Data are not fully comparable, while many data for 2008 are provisional.	547
Road- Motorcycles		155
Road Cars	Data are not harmonised and hence not fully comparable, while many data for 2008 are provisional.	4725

Table 6: Freight transport segments

Segments	Description/ Comments	Market Size (2008) *thousand mio tkm*
Air	Estimates of domestic and intra-EU-27 transport	2.7
Rail		443
Sea	Estimates of domestic and intra-EU-27 transport	1498
Road	National and international haulage by vehicles registered in the EU-27	1878
Inland Water Navigation		145
Oil pipelines	Data are not harmonised and hence not fully comparable. In most countries, only pipelines longer than 40 km are included.	124

Depending on the different Member States, the conversion rates from weight or volume (litre or m^3) to tonne of oil equivalent (toe) may vary. New coefficients and conversion rates to calculate the energy density of transport fuels proposed by the European Commission can be used to avoid discrepancies. The coefficients are 27 MJ/kg (equivalent to 0.6449 toe per ton) and 21 MJ/l (equivalent to 0.5016 toe per m^3) for pure 100% bioethanol, 37 MJ/kg (0.8837 toe per ton) and 33 MJ/l (0.7882 toe per m^3) for pure 100% biodiesel, and 37 MJ/kg (0.8837 toe per ton) and 34 MJ/l (0.8121 toe per m^3) and for pure vegetable oil (Biofuels barometer 2010). The conversion rates are 1 tonne of bioethanol = 0.64 toe, 1 tonne of biodiesel = 0.86 toe, 1 m^3 of biodiesel = 0.78 toe, and 1 m^3 of bioethanol = 0.51 toe (Biofuels barometer 2009).

Definitions/ Other

Biofuel types

Table 7: Biofuel types

Bioethanol	E85	85% bioethanol + 15% petrol, frequently used in Europe	1 litre E85 →0,73 litre petrol
	E100	Pure bioethanol fuel can be used in warmer climates where cold start problems are not a factor	
	ED95	95%bioethanol + 5 additives	1 litre ED95 →0,60 litre diesel
Biodiesel	B30	30% biodiesel + 70% diesel	1 litre B30 →0,98 litre diesel
	B100	100% biodiesel	1 litre B100 →0,92 litre diesel
	PVO	Pure Vegetable Oil	1 litre PVO →0,90 litre diesel
Biogas	BG	Gas with high methane content	1 litre Biogas →1 litre natural gas

Table 8: Modifications required to use biofuel blends

VEHICLE MODIFICATIONS REQUIRED			
	Modification required?	OEMs Available	Retrofitting possible
E85	Yes	Yes	Yes(LD), No(HD)
E95	Yes	Yes	No
B30	1	1	Yes
B100	1	1	Yes
BTL	No	n/a	n/a
HVO	No	n/a	n/a
PPO	Yes	No	Yes
Biogas	No	Yes	Yes

"Biofuels Cities - March 2009"

1: depends on manufacturer and warranty

OEM: original equipment manufacturer

Retrofit: modified after delivery

LD: Light Duty

HD: Heavy Duty

References

1. Biofuels Cities 2008. "Running your fleet of vehicles on biofuels, an overview of the latest options", Available online www.biofuel-cities.eu, Assessed on 30th July 2010.

2. ECN. 2010 Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States. Assessed on 28th September 2010.

3. European Biofuels Platform. www.biofuelsplatform.eu Assessed on 24th September 2010.

4. EurObserv'ER, Biofuels Barometer 192. 2009. http://www.eurobserv-er.org/pdf/baro192.pdf. Assessed on 28th September 2010.

5. Panagiotakopoulou P. 2010. Market Segment Analysis of the Transport Sector in the EU 27. Master Thesis. Imperial College London.

6. Wiesenthal et al., 2009 T. Wiesenthal et al., Biofuel support policies in Europe: lessons learnt for the long way ahead, Renewable and Sustainable Energy Reviews 13 (4) (2009), pp. 789–800.

Key factors

BIOMASS FUTURES project (www.biomassfutures.eu)

Name:
Company:
Email address (if you wish to receive info from the Biomass Futures project):

Questionnaire *on key factors affecting the deployment of biofuels in the transport sector*
You can also download the form from our site and email it to: a.castillo@imperial.ac.uk
We are interested in your comments and suggestions. Please take a few minutes to complete the following table.

Please rate the importance of the below described factors using 1-5.

1	2	3	4	5
Very low	Low	Average	High	Very high

KEY FACTORS AFFECTING BIOFUEL PLANTS (Transport)		
Technical	Current high technology reliability and full maturity for 1st generation (medium term prospect of maturity of 2nd generation)	
	Good conversion efficiency	
	High GHG savings from full chain	
	Stringent on-board storage requirements	
	Extensive refuelling infrastructure requirements	
	Safety and standardization	
	Financing new technology is an equity risk	
Economic	Growth in prices of oil and gas	
	Variable Subsidies and grants	
	Investment and development costs	
	Operating and maintenance costs	
	Biomass vs fossil fuel costs	
	Access to loans-cost of capital	
	Competitive/expensive cost per tonne of CO2 saved?	

Organisational	Variable reliability of incentives	
	The targets for renewables 2010 and 2020, respectively.	
	Lacks of joining-up in Government/Regulator – Different ministries within a country have different agendas and policy objectives.	
	Biofuel security of supply	
	Relatively good biofuel price volatility	
	Good organizational capability	
	Administrative issues and planning	
	Challenge of balancing short-term consumer interests and environmental agenda	
	Favourable policy for bio-waste to energy fuels	
	Biomass quality standards	
	Grant schemes that subside new plants	
	Complex and fragmented grant aid and support structure, short application deadlines, academic appraisal panels, rates vary between schemes	
	No link between grants and value of carbon saved	
	Planning procedures require careful coordination among different authorities.	
	Planning – the impact of public perception on planning applications.	

Thank you!
The BIOMASS FUTURES team