Briefing Note on Biomass

SUSTAINABLE ENERGY IRELAND
(SEI)

9th DECEMBER 2002

Table of Contents

1. Introduction

This Briefing Note considers the issues in terms of the development of energy from biomass in Ireland. It looks at options based on available processes and proposes some initial actions to achieve early deployment of power and heat production from existing biomass resources. It is focused on short (to 2005) and medium (to 2010) term development measures for proven biomass to energy technologies.

Biomass as an energy source comes in diverse forms and its exploitation and conversion to useful energy has implications for a variety of sectors spanning energy, environment, agriculture and rural development. Biomass derived energy has the potential to contribute to security of supply and our obligations in terms of climate change agreements. While the impact in the medium term is limited by economic and technical factors its contribution beyond 2010 could, against a background of rising fuel prices, provide a major part of Ireland's response to the issue of climate change. Technologies for the efficient conversion of biomass to energy have been developed and applied across Europe and there is now an opportunity for its exploitation in Ireland based on the experience already gained.

This Note covers biomass for electricity and heat markets only. Biomass derived transport fuels will be dealt with in a separate paper.

2. What is biomass?

Biomass refers to cellular material from living or recently dead organisms. It is a widespread resource and can be divided into wastes and purpose grown material as follows;

- Wastes streams including residues from forestry and related industries, recycled wood, agricultural residues and agrifood effluents, manures, the organic fraction of municipal solid waste, separated household waste and sewage sludge[1].
- Purpose grown energy crops including short rotation forestry, miscanthus grass, etc.

The EU Directive on Sustainable Electricity from RES[2] defines biomass as including the biodegradable fraction of products, wastes and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

It is perhaps worth noting here, in terms of the cross sectoral nature of biomass as noted above, that The European Council Directive on Landfill of Waste (1999) requires Member States to devise a strategy for reducing the amount of biodegradable waste going to landfill. Under the Directive, landfill gas will have to be collected from all landfills receiving biodegradable waste and used to produce energy or be flared[3]. Irish targets outlined by the EPA over a fifteen year time-scale include a 65% reduction in biodegradable wastes consigned to landfill, as well as an 80% reduction in methane emissions from landfill. Therefore, this directive points towards the increased utilisation of landfill gas for energy in the near term while at the same time restricting its potential as a long term source of energy.

---

1 Woody Biomass as an Energy Source – Challenges in Europe, EFI proceedings No. 39, 2001.

2 EU Directive on the promotion of electricity produced from renewable energy sources in the internal electricity market 2000/0116 (COD), 2001.

3 Measures for existing landfills must be implemented within 8 years of the Directive being transposed into Irish legislation. Indications from the DoE are that Irish legislation is imminent.

3. Energy from biomass

Energy from biomass is a renewable indigenous source of fuel for heat and/or power generation. Conversion by currently proven technologies is based on combustion. Applications can include stand alone heat plants and individual heating boilers in buildings. Power production in Combined Heat and Power (CHP) plant, where heat and power are generated from fuel in a single process making optimum use of the energy from biomass, is becoming more common. Efficiencies of 70% or more in the case of CHP installations are in excess of that for separate heat and power production with typical generation efficiency of 30% to 40% and still significantly higher than the 55% attributed to combined cycle gas turbine (CCGT).

[Note: Under AER V, proposals in the biomass category were allowed to include plants where less than 10% of the fuel input was from fossil fuels (for start-up).]

4. Conversion Technologies and Current Status

Within the two categories of biomass i.e. biomass residues/wastes and purpose grown energy crops, material can be either: (a) dry combustible or (b) wet. Broadly speaking:

- dry combustible material includes energy crops, forestry wastes, straw and poultry litter, and
- wet material includes food processing waste and farm slurry.

The conversion technologies that can be used to generate energy from the biomass fuel supply include combustion, gasification, pyrolysis (for dry combustible material) and anaerobic digestion (for wet material). Descriptions of these are given in Annex A. In each case the output can be heat and/or power.

4.1 Power Generation

International and National status of development for power and heat from biomass fuels is presented in Tables 1 and 2 on following pages.

5. Cost of Electricity & Heat from Biomass

Table 3 shows projections of capital and operating costs for biomass energy generation for 2005. The most recent power purchase agreements awarded under the Non Fossil Fuel Obligation (NFFO) in the UK are included for comparison purposes. Gate fees should not be considered in the fuel cost figures, as 'wastes' will eventually become a valuable fuel, incurring a cost to the power generator. Inclusion of gate fees in the US in the past led to the failure of biomass plants as several States promoted recycling in preference to combustion[4]. The high price for heat or power produced by certain technologies reflects the scale of operation, with larger scale facilities having lower costs. Fuel costs for landfill gas and anaerobic digestion are taken as zero in Table 3.

[4] Critical Success Factors for Bioenergy Technology Implementation, Swedish National Energy Administration, 1998.

Table 1: **International and national status of development of power generation from biomass fuels using various technologies.**

	World-wide	Fuel Type	Ireland	Fuel Type
Conventional Steam Cycle	Technologically & commercially demonstrated. Widespread deployment of CHP generation plant in USA & Scandinavia.	Wood wastes, forest residues, Agri-residues, refuse derived fuels	Burning of peat[5] in large-scale condensing power stations is well advanced, but is an inefficient process. Conventional steam cycle CHP is more efficient and can be used for different fuel types. An economic scale for wood CHP is 1 – 30MW and wood fuel can be sourced within a radius of 50km. Wood is a well-dispersed and local fuel source, whereas peat has a limited distribution in Ireland.	Fossil fuels -peat
Gasification	Early stages of development - not yet commercially demonstrated. 6MWe BIGCC technology demonstration plant at Värnamo, Sweden. 3 gasification projects awarded NFFO 3 contracts in UK – none yet operational in fully integrated mode.	Wood wastes, forest residues, Agri-residues, refuse derived fuels	Two downdraft gasifiers in Northern Ireland. Micro-scale: 100-200 kWe This technology is still at development stage and is not a suitable starting point for Irish conditions.	Wood wastes
Pyrolysis	Early stages of development - not yet commercially demonstrated. 7 pyrolysis projects awarded NFFO 4 contracts in UK - none yet commercially operational.	Solid biomass e.g. wood, energy crops	None. This technology is still developing and much work is needed to make it viable.	None
Anaerobic Digestion	Commercially demonstrated in sewage treatment. Technologically demonstrated for other residues. By 1999: Germany: 1500+ biogas plants *(German Biogas Assoc.)*; Denmark: 20 centralised & 25 farm plants *(University of S. Denmark)*; England: 25 farm plants *(IrBEA Proposal, 1999)*	Wet agricultural residues (slurry, manure etc), industrial food-processing residues, organic household waste, sewage sludge	3 Micro-scale CHP plants with an installed capacity of 0.23 MWe. More widespread application of AD is possible with AER support.	Industrial food-processing residues, sewage sludge
Landfill gas	Technologically & commercially demonstrated. By December 2000, 161 operational projects generating 349MWe in UK.	Organic household waste, organic fraction of other landfill wastes	15 MWe commissioned in Ireland (4 sites in Dublin, 1 site in Cork). Additional 8 MWe awarded in AER V. All sites supported through AER PPA. LFG is the most cost-effective greenhouse gas abatement technology and requires continued AER support. However, the long term potential is limited.	Household waste, organic fraction of other landfill wastes

[5] Peat takes thousands of years to form and is therefore not regarded as a renewable source of energy

Table 2: International and national status of development of heat generation from biomass fuels using various technologies.

	World-wide	Fuel Type	Ireland	Fuel Type
Industrial Application Direct Combustion	Technology is well proven. Industrial wood-fuelled heat market is advanced in France, Austria and Scandinavia. Considerable growth in wood pellet market in USA, Canada, Scandinavia & Austria.	Industrial wood wastes, forest residues, energy crops, crop residues	Combustion in: - Sawmills (30 MWth) - Boardmills (185 MWth) - Joineries (30 MWth) Direct combustion is a less risky, simple technology with a more rapid development time (lead time of 1 – 2 yrs) than power technology.	Wood chips, bark & sawdust
Anaerobic Digestion	Biogas CHP from anaerobic digestion is well advanced in countries such as Germany, Denmark & Sweden.	Agricultural residues, industrial residues, household waste	- 3 Farm-based anaerobic digesters - 4 Industrial AD units - 10 Wastewater treatment AD units More widespread application of AD and direct combustion is possible – e.g with a 10 year demonstration programme.	Agricultural residues, industrial residues, sewage sludge
Domestic Application	Widespread deployment of wood heating on household scale. Efficient use of wood in specially designed domestic wood stoves has advanced considerably in countries such as France, Germany, Austria, Sweden and Denmark.	Wood logs, chips and pellets	Burning of wood logs in open fireplaces and stoves (~250,000m^3/year) Traditional use of wood for domestic heating is poor in Ireland. Therefore, demonstration of wood heating systems is required with a 10-year development plan put in place.	Wood logs, blocks

Table 3: Projections of capital and operating costs for biomass energy generation for 2005; (*Source: EU Atlas Report, 1997; EC Biomass Conversion Technologies, 1998*).

		Capital Cost (Euro/kW)	O&M Costs (Euro/kW)	Fuel Costs (Eurocent/kWh)	Cost of electricity (Eurocent/kWh)		Cost of Heat (Eurocent/kWh)
Biomass Heating							
Proven Technologies	*Industrial System: 5MW*	600	12	0.4			2.8
	Commercial Systems:						
	Wood chips (100kW)	300	6	2.1			8.4 – 9.0
	Wood pellets (45kW)	511	7.7	4.5			10 – 10.6
	Domestic Systems:						
	Wood chips (15kW)	800	13	2.1			9.1 – 10.9
	Wood pellets (15kW)	665	13	4.5			11.4 – 12.7
	Wood logs (5kW)	500	20	4.9			17.1 – 19.7
Fossil Fuel Heating							
		(unit cost)					
	Oil furnace (15kW)	600	13	3.3			9.0 – 9.5
	Gas furnace (15kW)	500	13	3.6			8.7 – 8.9
Biomass Electricity							
					Atlas (2005)	*NFFO (1994-1998)*	
Proven Technologies	<u>*Landfill Gas*</u>	925	146	0	3.3 – 6.6	4.2-5.1[3]	
	<u>*Steam Cycle*</u>	1,500	145	1 – 2.2	5.8 – 9.4	7.9-8.4[5]	
	Wood industry residues				5.8		
	Forest residues				6.8		
	Agricultural residues				5.8 – 8.3		
	Energy crops				9.4		
	<u>*Anaerobic Digestion*</u>	4,000	350	0 – 2.2	5 - 10	8.2-8.4[4]	
	Sewage						
	Agricultural residues						
	Organic wastes						
Developing Technologies	<u>*Gasification*</u>	1,470	60	1 - 1.8	5.1 –7.5	13.6-14.1[5]	
	Wood industry residues				5.1		
	Forest residues				5.8		
	Agricultural residues				5.1 - 6.8		
	Energy crops				7.5		
Fossil Fuel Electricity							
	Pulverised Combustion Coal	1,000	50	0.5	3.3 - 5.1		
	Gas Turbine Cycle Gas	330	25	1.35	3.5 - 5.2		

Cost of energy is calculated using 8% discount rate. All costs are corrected to 1990 ECUs.

3 NFFO 5 power purchase agreements (1998)

4 NFFO 4 power purchase agreements (1997)

5 NFFO 3 power purchase agreements (1994 - most recent NFFO round that conventional steam cycle could bid into).

6. Advantages and Potential of Biomass Development for Ireland

Biomass is an indigenous resource that can provide a sustainable source of heat and/or power and has many environmental, economic and social benefits:

- Biomass is carbon neutral and could reduce annual CO_2 emissions in Ireland significantly by 2010. The average CO_2 emissions for fossil fuels and biomass are given in Figure 1 (Annex A).
- Ireland currently imports over 86% of its total primary energy requirement. Increased levels of biomass deployment would reduce this level and the associated risk of fuel supply interruptions due to events overseas.
- Increased levels of biomass deployment could reduce our economic externalities through
  - fuel mix diversification (currently over 50% of our energy comes from oil)
  - savings on electricity transmission and distribution network investment
- Biomass developments would provide a source of employment in the following fields: fuel supply, energy conversion, engineering consultancy, environmental services, construction, legal/financing, manufacturing, maintenance, servicing & administration. Projected increases in European employment for the different biomass technologies are presented in Figure 2 (Annex A).
- Biomass is sustainable and does not deplete future resources. Careful design of energy crops can help to enhance local landscapes, provide recreational facilities and support a diversity of flora and fauna.
- Useful bioenergy can be recovered from wood residues (e.g. from sawmills), forest residues, household and agricultural residues and be used to generate heat and electricity, while at the same time contributing solutions to the problem of waste disposal.

Due to the fact that it is 'carbon dioxide neutral', biomass has the potential to reduce greenhouse gas emissions in compliance with our commitments under the Kyoto Protocol (1997). In this context the European Commission in its White Paper for a Communiy Strategy and Action Plan (1997)[6] has set a target to double the use of renewable energy in the generation of electricity from 6% to 12% of the EU's consumption by 2010. The EU has recognised the high priority role of biomass in achieving this target i.e. over 80% of the increase would come from biomass.

7. Available Biomass Resource in Ireland

Biomass resources can be measured on the basis of being technical, feasible or practicable resources (refer to definitions in Annex A).

The biomass resource potential in Ireland is significant. This can be gauged by looking at an estimate of the feasible resource for the year 2020 which was extracted from the ESBI/ETSU Altener Report 1997 and is presented in table 4 below. All biomass fuels listed in table 4 are included in Article 2 (b) of the EU Directive on Sustainable Electricity from RES[7].

[6] Energy for the Future, Renewable Sources of Energy - White Paper for a Community Strategy and Action Plan Com (97) 599 final (26/11/1997).

[7] EU Directive on the promotion of electricity produced from renewable energy sources in the internal electricity market 2000/0116 (COD), 2001.

Clearly the practicable resource which would derive from this scenario would be considerably less. The short rotation coppice (SRC) contribution of 59,512 GWh/yr that is indicated in Table 4, for example, would imply that some 2 million ha or almost 50% of the land currently under agriculture would be given over to the growing of this crop.

Nevertheless the point is made that the capacity is there to significantly contribute to Ireland's total primary energy supply. Were short rotation coppice planted on 420,000 ha, or about 10% of the land under agriculture (a reasonable assumption given the set aside policy and the changing situation within the agriculture sector) the energy produced would be equivalent to that provided by coal in 2000, or about 14% of the total Primary Energy Supply (TPES) in that year.

Table 4: Estimate of the projected Irish resource for electricity from biomass *(Source: ESBI/ETSU Altener Report, 1997; Employment figures calculated using Ecotec Report, 2000)*

Biomass Fuel Category	**Feasible Capacity**[1]	**Feasible Energy**	**Investment Required**	**Jobs**[8]		**Indigenous Energy Potential**		**GHG Savings**
	(MWe)	(GWh/yr)	MEuro	C+I (FTE)	O+M (FTE)	% of TED	% of TPES	Mtonnes of CO_2 equivalent
Estimates for electricity from biomass in 2020								
Short Rotation Coppice	8,506	59,512	12,503	212,300	30,946	119.28	23.71	44.3
Landfill Gas	305	2,438	282	1,275	195	4.89	0.97	11.6
Industrial Wood Residue	273	1,912	401	2,378	191	3.83	0.76	1.4
Forestry Residue	197	1,397	290	1,714	280	2.80	0.56	1.0
Dry Agricultural Residue *(combustion of poultry waste, straw, mushroom compost)*	86	689	126	747	318	1.38	0.27	0.3
Wet Agricultural Residue *(anaerobic digestion of pig and cattle slurries)*	73*	585*	292	2,427	351	1.17	0.23	3.1
Sewage Gas	3*	23*	12	100	6	0.05	0.01	0.1
Total (excluding wet agri-residues and sewage)	9,443	66,556	13,906	220,941	32,287	133.40	26.58	61.8

FTE – Full Time Equivalents (employment), C+I – Construction and Installation, O+M – Operation and Maintenance, TED – Total Electricity Demand, TPES - Total Primary Energy Supply. Resource based on 15% discount rate and wholesale price cap of 7 Eurocent/kWh, except for * where price would be greater than 7 Eurocent/kWh. Full annual inflation indexation. CHP considered most economic route for power from solid biomass fuels. The current installed electrical capacity in Ireland from all sources is 4,821 MWe.

In the near term, the practicable resource for energy from biomass is based on waste streams, including municipal waste streams, agricultural wastes and forest industry residues. This is reflected in the targets proposed in section 9.

Energy production from landfill gas currently provides 15 MWe of generated power. In addition to being a substitute for fossil fuel consumption, the exploitation of landfill gas also reduces methane emissions from landfill, methane being a serious problem because of its greater global warming potential. As noted earlier, however, the long term potential of landfill gas is limited by current and future changes in waste management practices.

Agricultural residues also have good existing resource potential and the economic feasibility of anaerobic digestion of agri-residues improves when it is considered not only as a source of energy but also as a method of treating agricultural wastes.

[8] Net jobs, taking into account jobs displaced in conventional energy technologies

Industrial wood residues and forest residues have considerable potential for development in the near term, based on the application of developed technologies. In addition, the predicted growth in forestry in Ireland would indicate that this resource will increase over the medium term. As well as being a suitable fuel for direct use in combustion plant, these residues can also be processed into refined fuels e.g., a market could be created for fuels such as wood pellets in Ireland.

In the short and medium term short rotation forestry will continue to be expensive relative to landfill gas, agricultural residues and forest industry residues for the generation of electricity – willow based fuel costs are between Euro 44 – 84 per oven dry tonne (1.1 – 2.1 Eurocent per kWh) excluding transport[9]. However, given the potential of SRC to deliver major benefits, as elaborated here, a significant development and support programme covering all aspects of the fuel supply and energy production chain should be initiated now.

The development of energy from forest industry residues will be an important forerunner to the later exploitation of short rotation coppice. In the earlier phases, experience with conversion technologies as well as many elements of the logistics of implementation will be gained. Hence, we expect that biomass residues/wastes, will be used initially in heat and power applications (to 2010). Energy crops will become competitive from 2010 onwards at which point they will become the dominant source of biomass based energy.

8. Current Irish Situation & Policy

Ireland has the lowest use of biomass in Europe. This is due to many factors, including a lack of consumer awareness and understanding that biomass is a clean renewable resource. There is also a lack of familiarity with the use of biomass for energy and a lack of policy and targets for biomass development. Ireland has, however, considerable experience in solid fuels, especially through the existing peat and forest industries.

The heat and power industries' failure to diversify fuel types has also impeded biomass development in Ireland. In addition, the exclusion of environmental externalities has contributed to Ireland having the lowest use of biomass in Europe. Including externalities markedly improves the competitiveness of energy from biomass as can be seen from European experience shown in Figures 4 and 5 (Annex A).

The current government support structure for biomass electricity (Alternative Energy Requirement) is effectively targeted at landfill gas only. There is, as yet, no provision in AER for other biomass technologies and fuels. AER IV was open to all CHP types but only gas fed projects were successful.

In line with the White Paper for a Communiy Strategy and Action Plan (1997)[10], the Irish government produced the Green Paper on Sustainable Energy (1999), which aims to install an additional 500MW_e of electrical capacity from renewable energy by 2005. The published projection for biomass electricity plant is 84 MW_e installed by 2005 *(Source: RESG target based on Green Paper on Sustainable Energy, 1999 in Strategy for Intensifying Wind Energy Deployment, 2000)*.

It is clear that the target of 30 MW_e from biomass in AER II will not now be built. Within existing measures and given a 3 to 5 year 'lead time' for commercial biomass power plants, the 84 MW_e

[9] Biomass Development Plan – a development plan for wood biomass in Ireland with electricity generation as the benchmark end use, ESBI/ESRI EU Altener report, 1995.

[10] Energy for the Future, Renewable Sources of Energy - White Paper for a Community Strategy and Action Plan Com (97) 599 final (26/11/1997).

projection is unlikely to be achieved. Hence, there is a requirement for new realistic targets for biomass in the short and medium-term.

9. Potential of Biomass Development and Proposed Targets

The present day feasible Irish resource for electricity from biomass has been calculated at 311 MW_e at a price range of 3.3 to 7 Eurocent per kilowatt-hour[11]. The feasible electricity from biomass resource projected for the year 2020 is considerably larger, standing at 9,443 MW (66,556 GWh), although the practicable resource is considerably less than this as noted in section 7 above. To date, just 15 MW_e of capacity has been installed (from landfill gas).

With government support, in the short-term (by the year 2005), and based on our analysis of the market, commercial technologies, previous resource studies, including the 1997 ESBI/ETSU EU Altener study and the Biomass objectives of the 1997 EU White Paper on Renewable Energy (COM (97) 599, 1997), we believe that biomass could provide an additional 45MW_e installed electrical capacity in 2005 (33MW_e from wood and agri-residue biomass CHP, 10MW_e from landfill gas and 2MW_e from biogas). In addition, it is possible to achieve a further 35MW_{th} capacity of biomass heating plant. The combined total capacity of 80MW would contribute 0.4% of our Total Primary Energy Supply in 2005, with the fuel coming mainly from the available biomass residues/wastes stream including forest residues, industrial wood residues and agri-residues.

In the medium-term (by the year 2010), we consider it practical to achieve an installed capacity of 195MW_e of biomass power, with a further 145MW_{th} capacity from biomass heating. The combined total capacity of 340MW would contribute 1.4% of our Total Primary Energy Supply in 2010, with the fuel coming, once again, mainly from the available biomass residues/wastes stream including forest residues, industrial wood residues and agri-residues. These targets over the short and medium terms are detailed in table 5 with the impacts being shown in Tables 5 and 6, while the costs are summarised in Table 7 and the benefits are summarised in Table 8.

[11] ESBI/ETSU EU Altener Report 'Total Renewable Energy Resource in Ireland', 1997.

Table 5 Suggested short and medium-term targets, impacts of achieving these targets (Source: Targets from Renewable Energy Information Office Projection based on our comprehensive analysis of the market, commercial technologies, previous resource studies, including the 1997 ESBI/ETSU Altener study and the Biomass objectives of the 1997 EU White Paper on Renewable Energy (COM (97) 599, 1997); Other: EU Ecotec RES & Employment Report, 2000; IEA Energy Policies of IEA Countries – Ireland Review, 1999)

	Biomass Technology Category		**Suggested Additional Target by 2005/2010** (MW)	**Annual Electricity produced - based on 8000 hours/yr** (MHh/yr)	**Indigenous Energy Production Potential**			**GHG Savings** (Mtonnes CO_2 equiv./yr)
					% TED	% THD	%TPES	
Biomass Electricity or CHP	**Landfill Gas**	*2005*	10[1]	80,000	0.28		0.05	0.35
		2010	22	176,000	0.52		0.09	0.77
	Biomass Steam Cycle CHP* *Ind. Wood*	*2005*	25	200,000	0.70		0.12	0.07
		2010	130	1,040,000	3.07		0.54	0.36 - 1.19
	Agri-residue	*2005*	8	64,000	0.22		0.04	0.02
		2010	36	288,000	0.85		0.15	0.1 – .33
	Biogas AD *Multi-fuel*	*2005*	2	16,000	0.06		0.01	0.004 - 0.014
		2010	7	56,000	0.17		0.03	0.1 - 0.314
Biomass Heating	**Biomass Heating** Industrial *(using forest & Ind. wood residue)*	*2005*	20			0.27	0.09	0.06
		2010	70			0.87	0.29	0.20
	Large buildings *(using forest & Ind. wood residue)*	*2005*	15			0.20	0.07	0.04
	Using 50% energy crops for 2010	*2010*	75			0.93	0.31	0.21
	TOTAL	**2005**	**80**		**1.26**	**0.47**	**0.38**	**0..54 - 0.55**
		2010	**340**		**4.61**	**1.80**	**1.41**	**1.74 - 3.01**

[1] Additional target of 10MW for 2005. As 15 MW of LFG is already operational in Ireland the total target. TED – Total Electricity Demand, THD – Total Heat Demand, TPES – Total Primary Energy Supply, GHG – Greenhouse Gas.

In Table 5 greenhouse gas (GHG) savings are calculated on the basis of electricity generation only and in relation to the amount of CO_2 equivalent produced by combined cycle gas turbine (CCGT) plant when generating a similar quantity of electricity for

- Landfill gas in both the 2005 and 2010 cases; avoidance of methane emissions is a major factor in the calculation of the CO_2 equivalent abatement;
- Biomass steam cycle CHP in the 2005 case with a range being given in the 2010 case; the most likely projects for development to 2005 are those where heat is currently being provided by the combustion of biomass so that only the electricity from fossil fuels is being displaced; beyond 2005 it is hoped that CHP developments will take place where both heat and power currently provided by fossil fuels will be displaced.

Biogas AD is taken as fossil fuel displacement for both heat and power supply; the range shown indicates the uncertainty in terms of methane emission abatement and has yet to be properly quantified.

The scenarios for 2005 in Table 5 present the minimum greenhouse gas emissions abatement levels that could be anticipated. It is likely that actual benefits would be significantly more favourable.

Table 6 Estimate of the employment and cost impacts of achieving the proposed targets *(Source: EU Ecotec RES & Employment Report, 2000)*

	Biomass Technology Category	**Suggested Additional Target by 2005/2010** (MW)	**Jobs** (FTE) C+I	**Jobs** (FTE) O+M	**Total Invest-ment Capital Cost** (MEuro)	**Net Annual AER Support Needed**[2] (MEuro)	**Capital Grant Support for Demons-tration** (MEuro)
Biomass Electricity or CHP	**Landfill Gas** *2005* *2010*	10[1] 22	40 90	7 14	9.3 20.4	1.21 2.67	0 0
	Biomass Steam Cycle CHP* *Ind. Wood 2005* *2010*	25 130	161 860	16 83	37.5 195	5.20 27.04	3.75 19.5
	Agri-residue 2005 *2010*	8 36	52 238	17 75	12 54	1.66 7.49	1.2 5.4
	Biogas AD *Multi-fuel 2005* *2010*	2 7	59 224	6 23	8 28	0.39 1.36	0.8 2.8
Biomass Heating	**Biomass Heating** Industrial *(using forest & Ind. wood residue) 2005* *2010*	20 70	52 185	21 73	12 42		1.2 4.2
	Large buildings *(using forest & Ind. wood residue) 2005* *Using 50% 2010 energy crops for 2010*	15 75	32 165	16 189	7.5 37.5		0.75 3.75
	TOTAL 2005 **2010**	**80** **340**	**396** **1,762**	**83** **457**	**86.3** **376.9**	**8.46** **38.56**	**7.70** **35.65**

The projected employment figures shown in Table 6 which would result from the proposed developments are net jobs. The total investment capital costs are based on the capital cost estimates shown in Table 3. In calculating the Net Annual AER support, AER unit price supports are compared to the Best New Entrant price from the Commission of Energy Regulator (€0.044/kWh).

Table 7 Estimated costs of developing short-term (to 2005) targets for proven biomass technologies.

Energy from Biomass	Target for 2006 (MW)	Annual Energy Delivered[1] (GWh)	Net Annual AER Support (MEuro)	Non-recurring Capital Grant Support for Demonstration Needed - 10% grant (MEuro)	Net Cost per Tonne of CO_2 (Euro/ tonne CO_2)[3]
Electricity	45	360	8.5	5.75	19.7
Heat	35	280	-	1.95	1.3
Total	**80**	**640**	**8.5**	**7.70**	**16.4**

Table 8 Potential benefits of developing short-term targets (to 2005) for proven biomass technologies.

Energy from Biomass	Target for 2005 (MW)	Annual Energy Delivered[1] (GWh)	Annual Tax Income from Jobs (MEuro) O+M	Non-recurring Tax Income from jobs (MEuro) C+I	GHG Savings (Mtonnes CO_2 equiv./yr)[2]
Electricity	45	360	0.3	2.3	0.45
Heat	35	280	0.2	0.6	0.1
Total	**80**	**640**	**0.5**	**2.9**	**0.55**

[1]Conversion from MW to GWh based on 8000 operational hours/yr, allowing for plant downtime. [2]15 year plant life is assumed.
AER – Alternative Energy Requirement, C+I – Construction and Installation, O+M – Operation and Maintenance.

10. Issues Affecting Deployment of Biomass

The main factors currently affecting the deployment of energy from biomass are described in the following:

10.1 Intrinsic characteristics

Biomass is the only renewable energy that needs a feedstock, which is both an advantage and disadvantage. The major advantage is that it is not an intermittent source, as the fuel can be stored, and the energy dispatched when required.

Feedstock Consequences

- Fuel cost variability increases risk that is reflected in the costs in Table 3.
- Techniques for harvesting /chipping /drying /storing of fuels must be planned for in addition to conversion technology (also reflected in costs in Table 3 i.e. costs quoted are delivered costs).
- Fuel-supply chains linking agriculture/forestry and energy plants must be reliable.
- Supply needs to be abundant and cost effective.

It is recommended that all biomass plants are multi-fuel feed to allow consumers some choice in the type of fuel.

10.2 Capital Cost

In general, biomass conversion equipment is capital intensive in common with other renewable technologies.

Capital Cost Consequences

- Difficult to compete with fossil fuel technologies on a capital cost basis.
- Heat and power production costs are higher than fossil fuel plants.
- May be difficult to finance projects due to perceived higher investment risks. Investors will favour the lower investment risk of fossil fuel plants.

10.3 New Technology

Gasification and pyrolysis have higher efficiencies but have not yet been commercially proven.

New Technology Consequences

- May be difficult to finance projects due to perceived high risk.
- Delays to projects due to developers having to overcome technical difficulties with new & unproven plant.
- The 'lead time' for the development of a biomass power project is typically 3 – 5 years. However, the 'lead time' for biomass heating plants is faster than this, typically 1 – 2 years. The ready availability of financial support from SEI's current Renewables RD&D programme will encourage development of heating plants on the shorter end of this time-scale. However in order to stimulate and sustain an Irish biomass power industry, long term support under the AER process is a prerequisite.

10.4 Information, Education and Training

Lack of experience and familiarity with biomass technologies amongst key players.

Information & Education Consequences

- Low knowledge of and low confidence in biomass conversion technologies from existing electricity and heat supply industries;
- Reluctance to invest in biomass developments.

CHP generation and heat only production from biomass waste streams can be developed immediately and should be incorporated into spatial planning. While district heating is not currently developed in Ireland, it is expanding rapidly on an international scale and could be integrated into forward spatial planning in Ireland. In any case local-heating schemes could be adopted where feasible.

11. Overview of options to increase deployment of biomass[12]

There is a need to focus on least cost options and those projects that would have the highest possibility of being successful when deciding which sector of the market to target initially. The primary market players for biomass in Ireland are shown in Table 9.

[12] Renewable Energies: Success Stories, European Environment Agency environmental issue report no. 27, 2001.

Table 9: Primary Market for Development of Energy from Biomass

Priority Rating	Electricity Use	Heat Use	Fuel Availability
1. Industrial e.g. boardmills, sawmills	Yes	Yes	Yes
2. Agri-businesses e. g. creameries, co-operatives	Yes	Yes	Yes
3. Commercial buildings	Yes	Yes	No
4. Large buildings e.g. schools, hospitals, apartment blocks	Yes	Yes	No
5. Domestic buildings	Yes	Yes	No

The recommended methods of achieving the type of biomass development applicable to Ireland include:

1. building confidence in the biomass market through establishment of successful demonstration projects and encouraging best practice examples;
2. reducing costs of biomass energy through R&D in biomass technologies, biomass fuel production techniques and economies of scale which would result in market growth;
3. linking R&D to market feedback by monitoring R&D and demonstration projects and linking these with promotion and marketing activities;
4. promoting standards, codes of practice and guidelines for planners and decision-makers to increase familiarity with biomass projects and hence avoid delays in approving the establishment of biomass projects;
5. providing detailed studies of the potential, environmental impact and market integration of biomass in order to produce an important source of information for developers, planners and decision-makers.

11.1 Political & legislative Support

- Long-term policies favouring renewable energy including biomass will ensure rapid expansion of biomass;
- Regional energy policies could bring forward energy from biomass plans that are even more supportive than those at National level;

11.2 Demonstration Support

- Primary support measures to develop the different sectors:

  Power/CHP sector: Provide a guaranteed/stable, direct market support mechanism for biomass CHP plants and biogas AD plants for developers and consumers; The AER competitive tendering process offers a 15 year market support mechanism for biomass-to-electricity technologies and would provide the primary impetus to biomass power/CHP developments;
  Heat Sector: Provide investment subsidy support for demonstration of modern industrial and commercial heating systems with the exception of those based on landfill gas. Provide R&D support for the application of best practice techniques.

  - Demonstration programme in the industrial/agri-business sector:
    - Demonstrate biomass CHP for space and process heating as well as electricity supply;
    - Demonstrate marketing and financial instruments for industrial projects (third party financing, etc.).

- Demonstration programme in commercial and large buildings:
  - Demonstrate, on a broad basis, biomass in mainstream building projects, in particular in public buildings;
  - Demonstrate marketing and financial instruments (guaranteed energy results, grouped purchasing etc.);
  - Demonstrate new forms of energy services (ESCO's, leasing, energy metering and billing etc.);
  - Facilitate technical support for feasibility analysis, design and engineering of biomass projects.

11.3 Fiscal Support

Fiscal support mechanisms are increasingly used in other European countries as primary methods of rewarding the environmental benefits of biomass compared with energy generated from fossil fuels;

- Taxes on CO_2, SO_2, NOx emissions would make biomass fuels more competitive compared to fossil fuels;
- Tax exemptions or reductions for individuals or companies investing in biomass projects or services (e.g. accelerated depreciation);

11.4 Market Identification Support

- Identify the potential of various biomass resources;
- Identify the needs (both technical and economic);
- Identify the market characteristics.

Identify the best route/development methods i.e. focus on 'biggest first' and application of best practice examples.

11.5 Information, Education and Training to Raise Awareness

- Develop a strategy for end-users;
- Identify target groups, sector leaders;
- Awareness raising with potential fuel suppliers (agricultural/forestry), distributors and installers;
- Basic education on planning and use of energy from biomass at all levels of education;
- Training courses for installers in parallel with an R&D programme to assist realisation of projects;
- Public acceptability
  - highlight non-energy benefits e.g. socio-economic gains to help public acceptability;
  - highlight environmental benefits;
  - encourage developers to work with local communities to inform them about new development opportunities;
  - establish the role of local energy agencies.

11.6 Market Development

- Extension of above mentioned information and support measures to other players in the sector;
- Equipment performance labelling in terms of (i) environmental energy performance and (ii) cost performance;
- Fuel quality labelling;
- Price labelling;
- Encouragement of professional energy service company participation.

12. Key Players

The biomass sector involves a number of parties, covering both fuel supply and energy production. The schematic in Figure 7 (Annex A) summarises the key players involved.

Any biomass strategy will need to be comprehensive, covering various government departments including:

- Department of Communications, Marine and Natural Resources;
- Department of Agriculture, Food and Rural Development;
- Department of the Environment and Local Government;
- Department of Finance

12.1 Existing Activities

COFORD, the National Council for Forest Research and Development, are supporting a number of supply-chain projects in the area of biomass energy (projects ongoing). At a high level, their strategy is set by the National Development Plan. At a more practical level they are concerned that there is no clear market for forest residues and they are looking to biomass energy as a potential market. COFORD are of the view that there are few technical barriers to increasing deployment of energy from biomass, and that government market support will be required to kick-start the industry. They have set up a 'Wood for Energy' Strategy Group to consider strategic issues around the use of wood for energy (sawmill residues, harvesting residues & pulp from thinnings). The group consists of COFORD, Coillte, the Irish Timber Growers' Association, The Irish Farmers' Association and the Irish Timber Council, and will steer the consultants in preparing a report outlining the policy barriers to development of wood-biomass based energy production (see Section 13.5).

Teagasc have carried out research into biomass (up to 1996), but no work is currently ongoing. They are looking to the DoCMNR to create a market for biomass - they believe that once the market exists, developments in energy from biomass will naturally follow.

A preliminary meeting of the Biomass Strategy Group took place on 2 July 2001 at the request of the then Department of Public Enterprise (DPE). The meeting was attended by representatives from:

- Department of Agriculture, Food & Rural Development
- Department of Public Enterprise
- Irish Energy Centre (now SEI)
- Renewable Energy Information Office (REIO)
- COFORD
- Bord na Mona

The meeting involved discussion of the real potential of biomass systems including anaerobic digestion and wood heating systems in Ireland. The possibility of fuelling large-scale power plants such as the existing plant at Edenderry with wood/biomass was also discussed. It was felt that support methods needed to be identified for the various biomass technologies prior to their successful introduction in Ireland. Minutes for the meeting were prepared by REIO.
[Note: While not present at this preliminary meeting it is recognised that the Department of Finance plays a key role in fiscal relief measures and should be present at future meetings of the Biomass Strategy Group.]

A formal process needs to be established to continue the coming together of the Biomass Strategy Group. Consideration should also be given to the inclusion of the Irish Bioenergy Association (IrBEA) in future discussions.

13. Role for Sustainable Energy Ireland

Sustainable Energy Ireland has a central role to play including involvement in the following:

13.1 Promotion, information, training and advice

- Aid market identification, increase awareness, promote best practice demonstration projects and further market development;

Inputs:

- Production of information brochures, facts sheets, conferences, training seminars;
- Specific biomass campaign for Information/workshops/PR/Education material and events;
- Establish group of key personnel from biomass energy plants put into operation in the coming years to exchange information and experiences as well as to bring new knowledge to the market.

13.2 Biomass Strategy

- Identify & evaluate primary support mechanism options for biomass and advise DoCMNR accordingly;
- Develop strategy for biomass in Ireland and monitor progress.

Inputs:

- Review of support mechanisms in other countries with a view to formulating advice to DoCMNR;
- Liaise with COFORD who are conducting a review of policy barriers to the development of wood-based energy production, in particular outlining possible fiscal instruments to promote biomass energy production & to conduct a cost/benefit analysis of each of them. This report should provide useful input into possible support mechanisms;
- Review economic barriers to biomass development on an on-going basis.

13.3 Renewables RD&D programme

Support for research, development and demonstration of biomass-to-energy projects to increase market and consumer confidence. Co-ordinate with relevant bodies such as COFORD and Teagasc to avoid replication of R&D.

Development programme should focus on:

- solving challenges which are specific to Ireland in the biomass sector. Biomass technology is considerably further along the development curve in other countries - replicating generic work should be avoided. Demonstration of proven technology in the Irish market should be the key short to medium-term focus;
- targeted demonstration of diverse biomass projects to increase familiarisation amongst key target sectors (agriculture, forestry, local authorities etc), biomass fuel suppliers and end-users that will ultimately drive development in Ireland.

Potential projects for development:

- Resource mapping & quantification of fuel supply sources for agricultural/forestry residues & waste - complementary with COFORD project on waste wood;
- Demonstration of best practice examples of biomass energy facilities;
- Assessment of feasible landfill gas resource by county;

- Desk-top study of scale of plant (electricity/thermal) to suit Irish resources & infrastructure;
- Development of fuel supply strategies, covering complete supply chain;
- Survey of potential heat markets in Ireland;
- Evaluation of economic considerations for given bioenergy business sectors to determine the necessary level of public support needed to enable particular sectors to develop;
- Follow-up programme to collect, analyse and disseminate data from biomass projects in order to further increase deployment of biomass in Ireland.

Applications for the programme to be evaluated by SEI using criteria known to applicants.

13.4 Market interaction/feedback

When supporting new energy plants it is essential to collect experiences from these plants and make them available for future plant developers. An evaluation system is essential for the RD&D programme (once at mid-term and once near the end of the programme period) to determine the energy, socio-economic, environmental, financial, technological, regional/local development and employment impacts of bioenergy developments. This can be done by obtaining information, technical and administrative processing of this, analysis and study of the context and outlook, preparation of periodic progress reports and dissemination of same.

13.5 Relevant Current Research/Demonstration work

- Quantification of wood waste resources currently disposed to landfill & suitability as energy source; *(awarded under COFORD budget);*
- Review of policy barriers to development of wood-biomass based energy production; *(will be awarded under COFORD budget - contract negotiations underway. Steering group created - see Section 12.1);*
- Demonstration of whole-tree harvesting - one possible cost effective method of thinning plantations which would ensure that potential supply of pulpwood from early thinnings is realised. *(Planned for 2002 jointly under SEI/COFORD budget);*
- SRC crop trials in Northern Ireland (W. M. Dawson), including bioremediation of landfill leachate and wastewater from municipal water treatment works;
- Demonstration of use of liquid biofuels for heat *(Teagasc).*

14. Beyond 2010

This Briefing Note deals with the development of biomass in the short and medium terms when it is anticipated that this renewable form of indigenous energy could begin to make a noticeable impact on National energy supply. The policy supports that are implemented and the biomass energy schemes that are established in the period to 2010 could provide an important foundation for expansion in the following years.

As the impact of the policy became manifest over the next 4-6 years it would be necessary to carry out a detailed review so that

- course corrections could be implemented for the medium term, if necessary, and
- the policy requirements beyond 2010 could be identified and put in place.

The review could be carried out in the second half of 2006 with these goals in mind.

Annex A

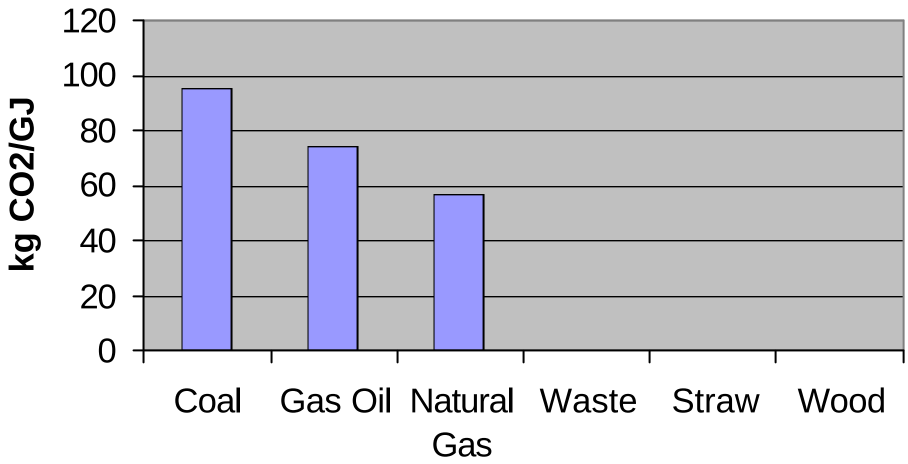


Figure 1 Average CO_2 emissions for fossil fuels and biomass. Source: The Centre for Biomass Technology, 1998.

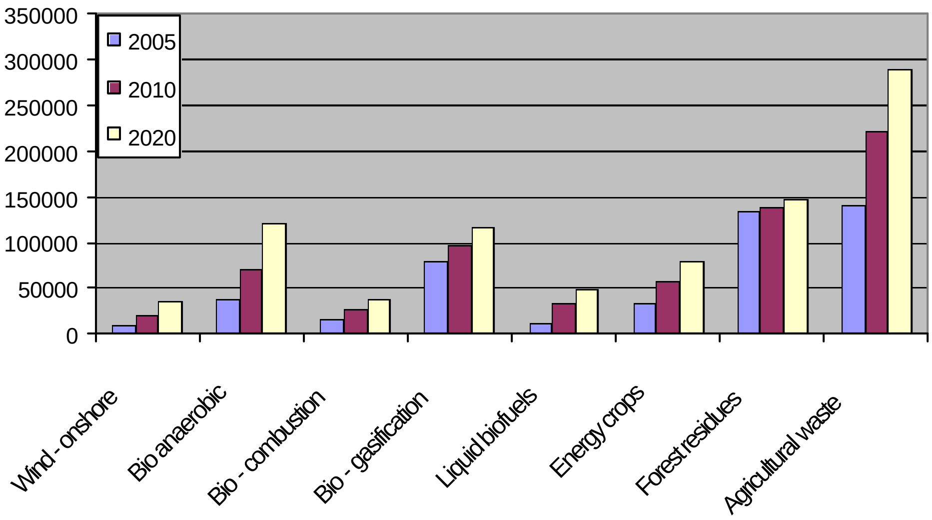


Figure 2 Projected employment in the EU for biomass technologies. Wind is included for comparison. Source: EU Altener Report: Impact of RES on Employment, 2000.

Technical/Feasible/practicable Resources

The technical resource is that part of the total amount of energy existing in a given resource which can be extracted based on existing technology. The feasible resource is that part of the technical resource that can be extracted based on practical considerations; energy is recovered from a landfill, for example, by collecting the gas following the degradation of the material rather than through excavating the landfill to recover the energy from the as yet undegraded material. Finally the practicable resource is that part of the feasible resource that can be extracted having taken economic, environmental, planning and other considerations into account.

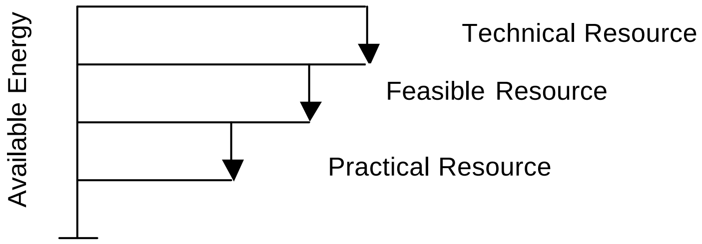


Figure 3 Measurement of resource potentials for biomass

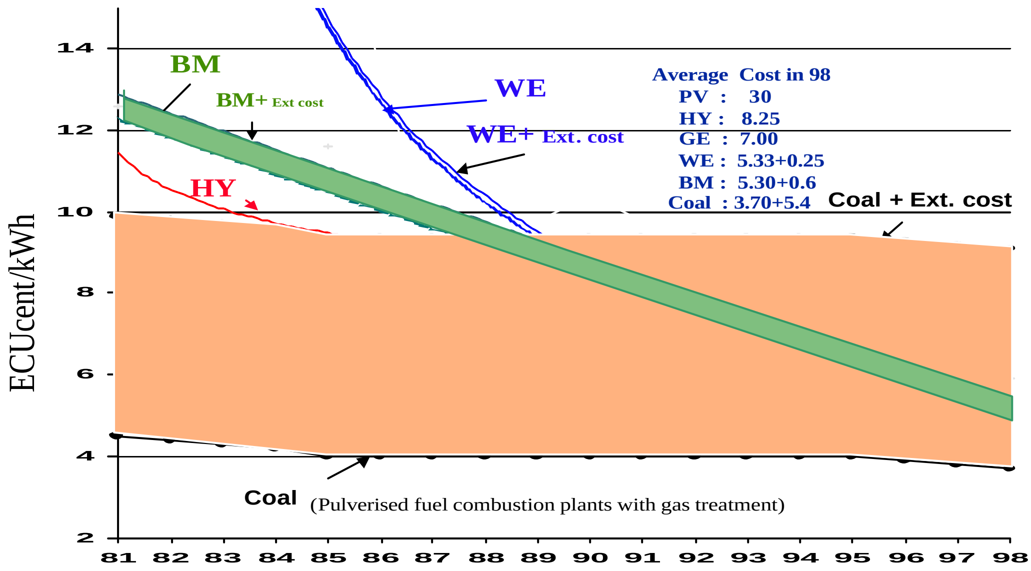


Figure 4 Coal V's RES power plant production cost including external cost. PV – Photovoltaics, HY – Hydro, GE – Geothermal Energy, WE – Wind energy, BM – Biomass. *(Source: Directorate General for Energy and Transport, 2002)*

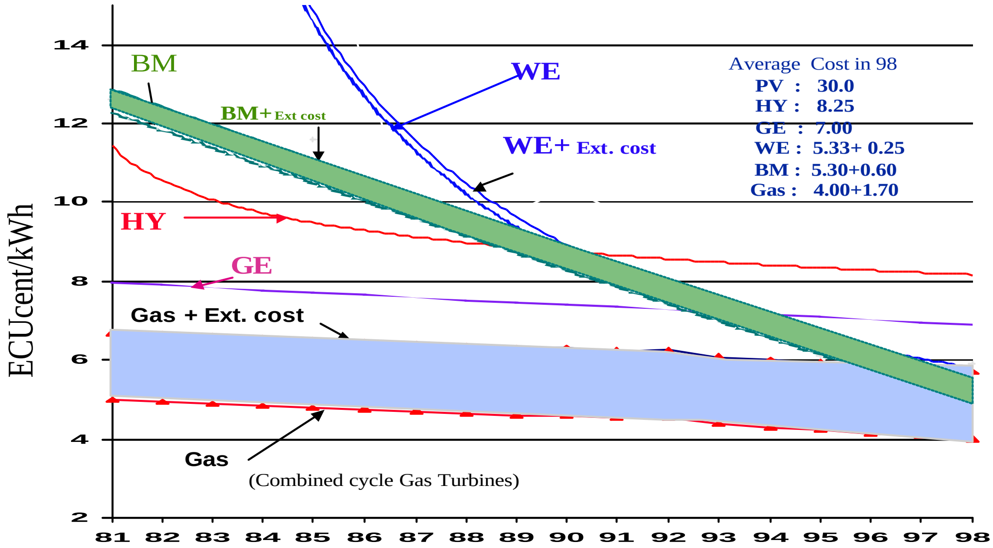


Figure 5 Gas V's RES power plant production cost including external cost. PV – Photovoltaics, HY – Hydro, GE – Geothermal Energy, WE – Wind energy, BM – Biomass. *(Source: Directorate General for Energy and Transport, 2002)*

Biomass Conversion Technologies

Direct Combustion

Dry combustible biomass is burned directly in a combustion system. The heat may be used to generate steam, with electricity generated via a steam turbine. This type of technology is called conventional steam cycle.

Gasification

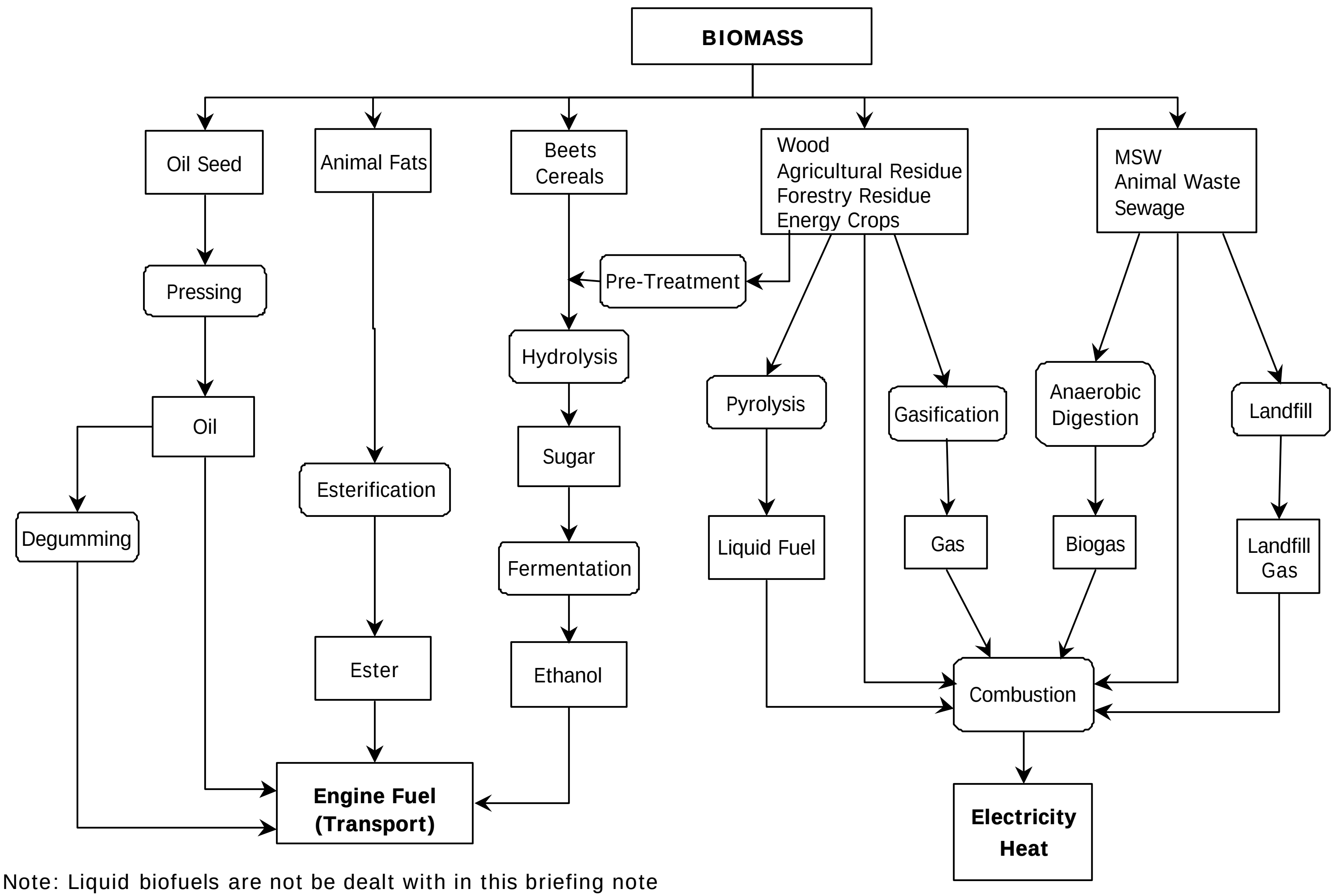
Dry biomass is heated in an oxygen lean atmosphere to generate a combustible gas with a heating value approximately one tenth of that of natural gas. This gas is subsequently burnt in a gas engine (small-scale plants) or gas turbine (large-scale plants) to generate electricity. The waste heat from the turbine exhaust may be used to generate steam, and additional electricity generated via a steam turbine. Waste heat can be used for low grade heating applications. This type of cycle has a higher cycle efficiency than conventional steam cycle.

Pyrolysis

Dry biomass is rapidly heated in the total absence of oxygen. As a result it decomposes to generate mostly vapours and aerosols and some charcoal. After cooling, a dark brown liquid known as bio-oil is formed which has a heating value approximately half that of conventional fuel oil. The bio-oil can substitute for fuel oil or diesel in many static applications including boilers, furnaces, engines and turbines for electricity and/or heat generation.

Anaerobic Digestion

Microbes decompose the organic matter in wet biomass in the absence of air to produce a biogas consisting mostly of methane, carbon dioxide and water. Anaerobic digestion occurs naturally at landfill sites releasing biogas referred to as 'landfill gas' in this instance. The gas may subsequently be burned for heating applications or used to generate electricity via a gas engine or equivalent.



Note: Liquid biofuels are not be dealt with in this briefing note

FIGURE 6: BIOMASS PRODUCTION PROCESSES

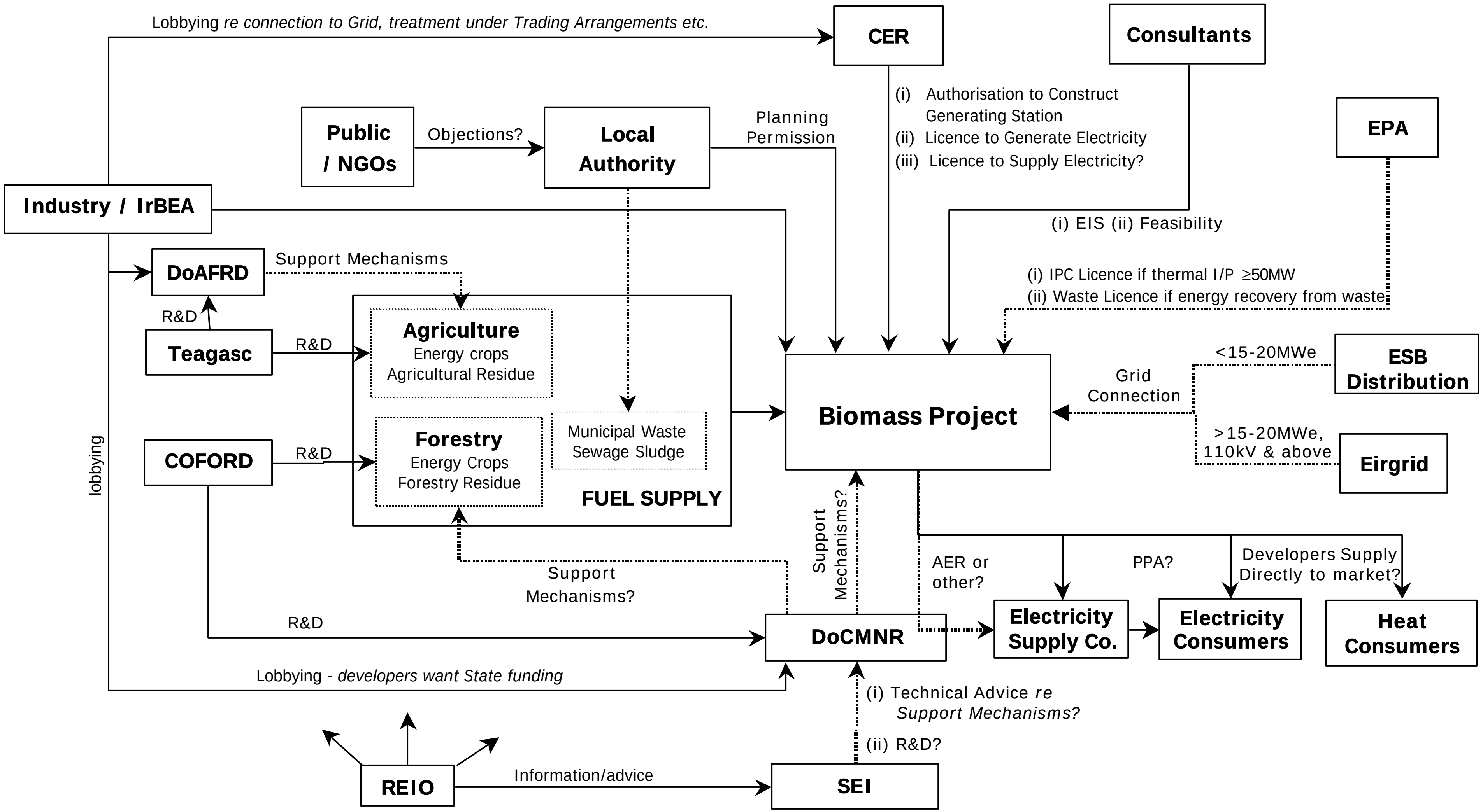


FIGURE 7: BIOMASS PLAYERS AND THEIR ROLES