Appendix A

Table A1.

§ Energy:

	Biomass Gasification Combined Cycle[1]		
1) Range of unit size and project size [MW]	113 [1] Estimated 10-200		
2) Nominal efficiency			
i) For electricity generation only [%]	37.2 [1] 35.8 [2]		
ii) For combined heat and power [%]	80 – 85 [3]		
3) Efficiency at partial load	¼ nominal: 18% ½ nominal: 27% ¾ nominal: 32% (1 stage axial steam turbine efficiencies [4])		
4) Flexibility towards fuel, fuel resource availability, plant siting and infrastructures (e.g. cooling water needs, high voltage, grid gas pipes, etc.)	Solid biomass (e.g. woodchips, waste wood, straw, etc). Requires cooling water, and proximity to biomass		

[1] 113MW IGCC plant (gas and steam cycles), 30 year lifetime, 80% load factor for 28/30 years. Fuelled by woodchips from a biomass plantation. Further details in 1. M K Mann and P L Spath, 1997, *Life Cycle Assessment of Biomass Gasification Combined Cycle System*. National Renewable Energy Laboratory: Golden, CO, USA. http://www.nrel.gov/docs/legosti/fy98/23076.pdf

	crop/source.		
5) Flexibility towards exploitation:			
i) Cold start [minutes from 0% to 90% of nominal power]	1 hr (100kW system) 3 hrs (10MW system) 12-48 hrs (>50MW system) [5]		
ii) Warm/lukewarm start [minutes from 0% to 90% of nominal power]	Warm: 30 [6]		
iii) Uncontrollable variation in load [% from nominal power]	+/- 3% [6]		
Total energetic score			

§ Ecology and resource use:

1) Exhaust [average in lifetime, including construction & transport]:			
i) CO_2 [kg/kWh$_{electricity}$]	4.59e-2 [1]		
ii) SO_2 [kg/kWh$_{electricity}$]	3.02e-4 [1]		
iii) NO_x [kg/kWh$_{electricity}$]	6.86e-4 [1]		
iv) PM_{10} [kg/kWh$_{electricity}$]	4.16e-5 [1]		
v) NMVOC [kg/kWh$_{electricity}$]	5.95e-4 [1]		
vi) Methane [kg/kWh$_{electricity}$]	5.07e-6 [1]		
vii) N_2O [kg/kWh$_{electricity}$]	9.54e-6 [1]		
viii) C_{14} [kg/kWh$_{electricity}$]	n/a		
ix) Heavy metals [most important ones, g/kWh$_{electricity}$]	2.53e-12 [1]		
2) Thermal exhaust [TJ/GWh$_{electricity}$]			
i) Into air	No data		
ii) Into water source	No data		
3) Liquid waste			
i) Total liquid waste [kg/kWh$_{electricity}$]	No data		

ii) Total nitrogen into water source [kg/kWh$_{electricity}$] *iii) Total phosphor into water source [kg/kWh$_{electricity}$]* *iv) Total chlorides into water source [kg/kWh$_{electricity}$]* *v) Total sulfates into water source [kg/kWh$_{electricity}$]* *vi) Others ($KMnO_4$, iron, organic materials, solid materials)[Separately]*	2.21e-11 [1] No data 4.9e-9 [1] 8.13e-10 [1] Ammonia: 7.45e-6 Iron: 1.56e-12 Organic: 4.41e-11 Suspended: 2.4e-7 [1]		
4) Solid waste [tons/MWh$_{electricity}$]			
i) Flue dust	No data		
ii) Slurry	No data		
iii) Hazardous waste	0.0 [1]		
iv) Radioactive waste	No data (assume none)		
v) Other solid waste	Total Solid Waste: 6.3e-4 [1]	Total:	Total:
5) Safety and health impacts			
i) Population affected by worst perceived accident during operation [nr of persons]	No data		
ii) Number of deaths over the fuel cycle [persons/MWh$_{electricity}$]	No data		
iii) Other effects			
6) Visual impact and noise			
7) Footprint and use of resources			
i) Primary material moved for construction [kg/kW$_p$ of nominal power	Concrete: 4.57e3 [1]		
ii) Secondary material moved for construction [kg/kW$_p$ of nominal power	Steel: 1.71e3 [1]		
iii) Main materials uses for construction (five) [kg/kW$_p$ of nominal power]	1. Concrete: 4.57e3 [1] 2. Steel: 1.71e3 [1]	1. 2. 3.	1 2. 3.

iv) Primarily material moved for usage e.g. fuel [tons/ $MWh_{electricity}$] *v) Secondary material moved for usage e.g. fuel [tons/ $MWh_{electricity}$]* *vi) Critical materials in construction and usage (materials that may become a limiting factor for the technology) [kg/kW_p of nominal power]* **Total ecological score**	3. Iron: 19.9 [1] 4. Aluminum: 13.3 [1] 5. Woodchips: 1.03 [1] Water: 0.89 [1] Woodchips, as above	4. 5.	4. 5.

§ Economy (without subsidies, price level for 2003):

1) Investment cost [euro/MW] 2) Availability [hours per year] 3) Operational time [hours of nominal power/year] 4) Reliability [%]	1187 [1] 113MW at 1990 US dollars 1747 [7], 100MW at 2003 US dollars, interpolated 2151 [2] 100MW, unpressurised. At 1997 US dollars 1922 [2] 100MW, pressurized, at 1997 US dollars 8322 (95%) 7008 [1] 98% power gen 96% syngas		

5) Technical life span [years] 6) Construction time [years] 7) Fuel cost [euro/MJ] 8) Operation and Maintenance (O&M) cost [euro/$MWh_{electricity}$] 9) Waste handling and dismantling [euro/ $MWh_{electricity}$] **Total economic score**	30 years [1] 2 years [1] No consistent data - Highly variable 33 [1] 113MW, 1990 US dollars No data		

1.1 References

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