Bioliquids-CHP
Power generation from Biomass

Bioliquids CHP: Technical and Economic Assessment

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Objectives

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1. State of Art of biomass and bioliquid CHP systems review
2. Performance and cost assessment
3. Environmental assessment
4. Market assessment

Issues

- Very few examples of bioliquids utilisation for CHP
- Data often poorly defined, especially costs

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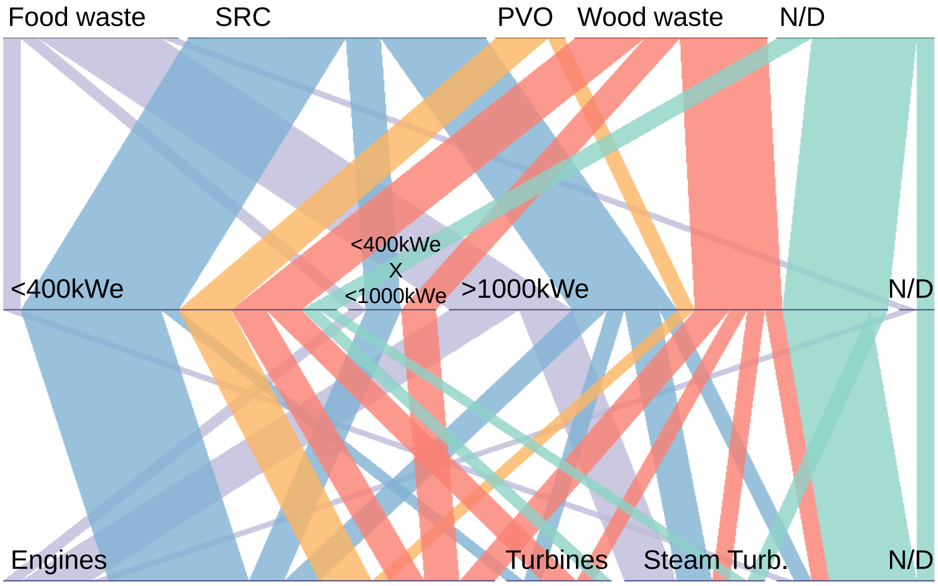
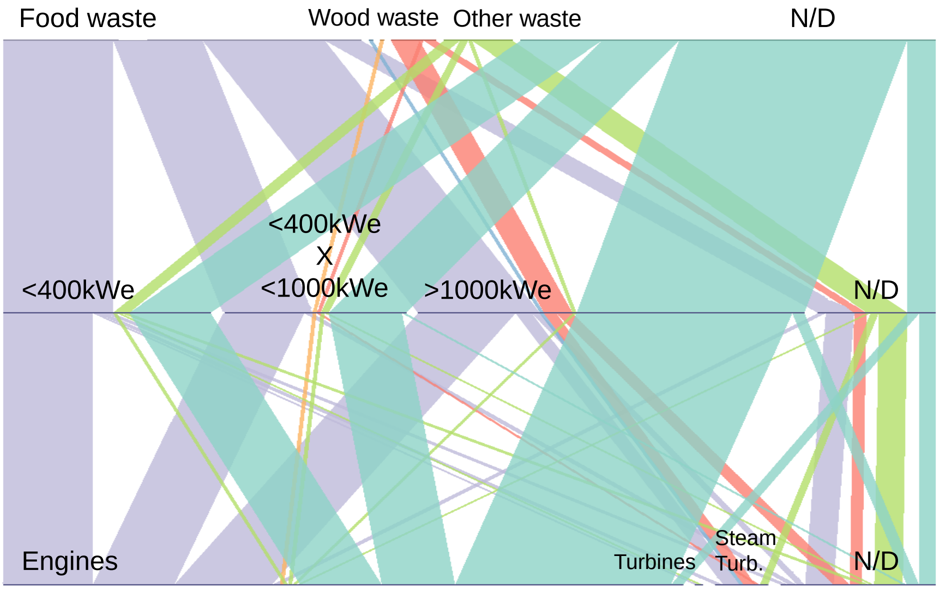
State of the art

UK database



State of the art

Netherlands database. (No data for Italy/Russia)



TEA model

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Scope of Techno-economic Assessment (TEA) model

Process starts with bioliquid and delivers heat and power products

- Developed in Excel
- Simple to use by developers, decision makers, stakeholders
- Flexible inputs controlled by user: fuel, prime mover and size (capacity)
- Location is variable – IT, NL, RU, UK

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TEA model - capital costs

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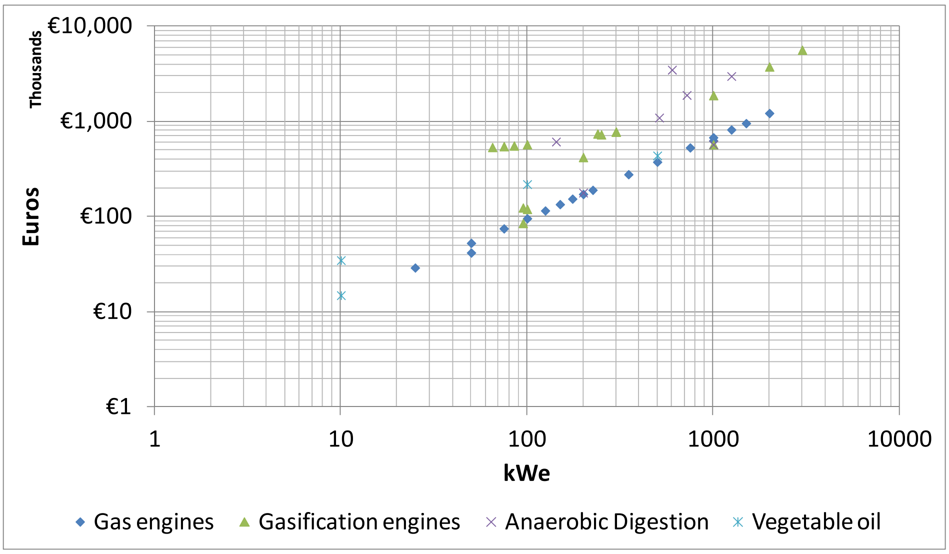
- Piston internal combustion engines database - Capital cost



TEA model - efficiency

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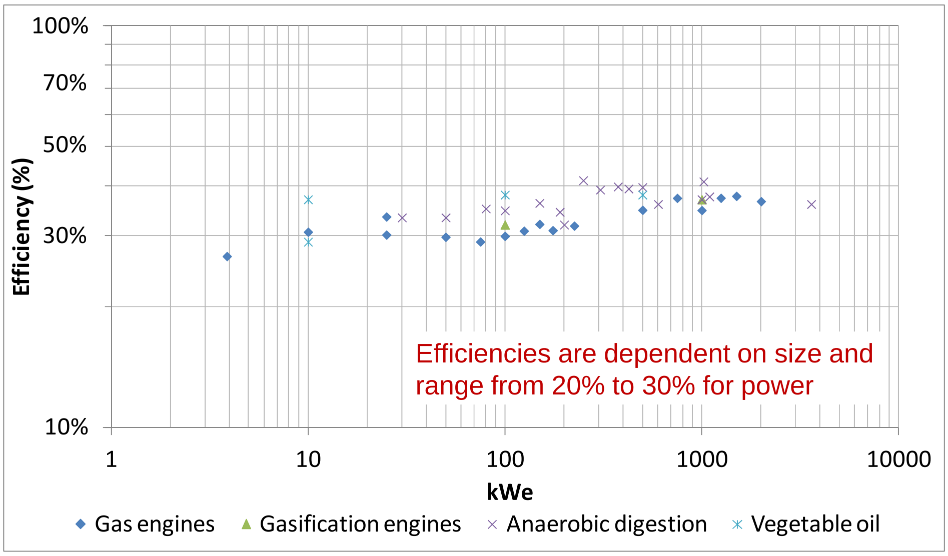
- Piston internal combustion engines database - Efficiency



TEA model input screen

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Location	United Kingdom	
Gross capacity (electric)	1000 kWe	
Prime mover	Engine	
Fuel	Bio-Oil	
CHP hours operation	Year	8000
Power sold to grid	80%	
Heat sold to others	50%	
Proportion by shareholders	30%	
Loan period	10 years	
Interest rate	5%	
Annual inflation	2%	
Project lifetime	15 years	
Grants received	15%	

Update all

- Drop-down options
- Conditionals for limits
- Error messages
- Macros: To update scenarios charts
- Variables are on a separate tab

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TEA model outputs

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Output highlights

- Internal Rate of Return (IRR)
- Power production cost
- Heat production cost
- All costs are normalized to Euros$_{2010}$
- Year by year results can be accessed
- Other variables have a default value
- Averages are used for Russia

Variables

- Fuel price
- Labour cost
- Maintenance cost
- Capital cost and depreciation
- Power and heat prices
- Grants availability
- Interest rate changes

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TEA model base cases

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Base Case for each country

	Italy	Netherlands	Russia	United Kingdom
Size (kWe)	1,000	1,000	1,000	1,000
Prime mover	Engine	Engine	Engine	Engine
Fuel	Bio-oil	Bio-oil	Bio-oil	Bio-oil
Fuel price (€/tonne)	134.6	138.4	119.7	130.0
Power production cost (€/kWe)	0.0937	0.1005	0.0798	0.0873
IRR (%)	10.4	0.0	6.3	0.9

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TEA model outputs

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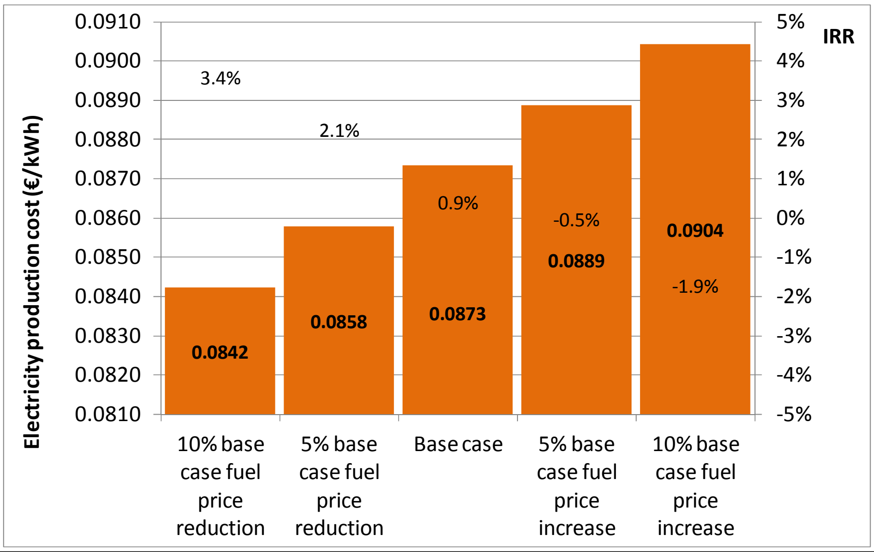
Fuel price variations for UK using bio-oil in a 1000kWe engine



TEA model outputs

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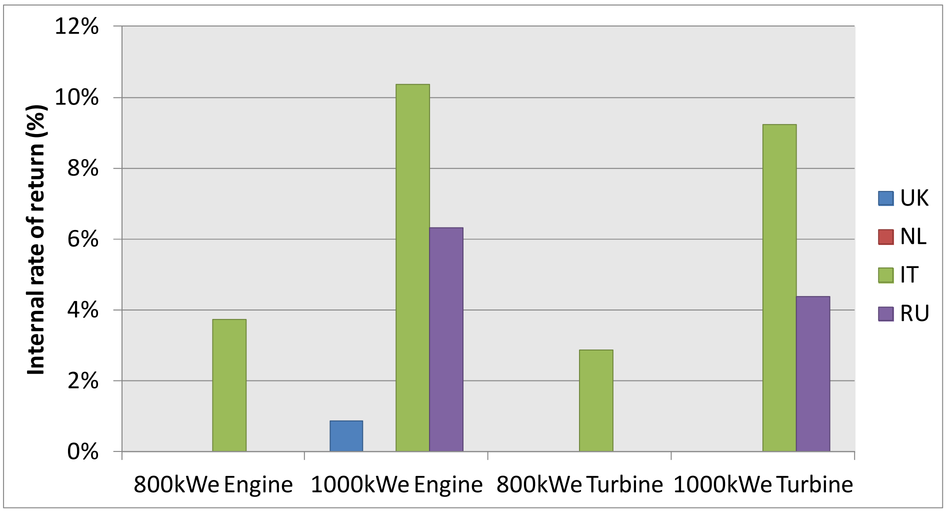
IRR comparison between countries using bio-oil, no fuel subsidies



TEA model outputs

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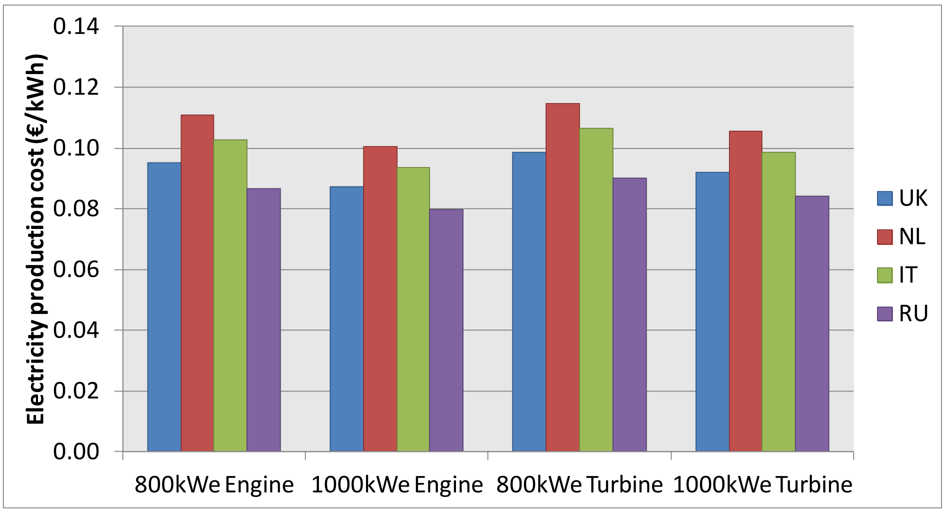
Electricity production cost comparison between countries using bio-oil



Environmental assessment

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Results

- Literature review showed previous LCA emissions savings
- GEMIS and BEAT V2 are suitable alternatives to a full LCA
- BEAT V2 was selected for environmental impact assessment
- Savings of between 70 to 92% are possible for bio-oil, compared to 536g CO_2 equivalent/kWh for light fuel oil in a 1MWe unit

Bio-oil feedstock	**Bio-oil specific greenhouse gas emissions (g CO_2 equivalent/kWh)**
Forest residues	47.2
Industrial residues	45.8
Short rotation forest	88.3
Cereals	149.0
Stalks	49.7
Thistle	98.5
Light fuel oil for comparison	536.0

Market assessment

Scope

- To review and compile previous work on bio-liquids as fuel in terms of fuel quality and potential market in CHP applications

Results. Bioliquids as fuel

- Some PVO have quality standards allowing them to be used as fuels (e.g. rapeseed oil)
- Biodiesel has EU and ASTM quality standards
- Bio-oil has developing quality standards at CEN and ASTM, but there is very little commercial production

Market assessment results

Market size

- Italy - Significant interest in PVO. Projected 600% growth by 2020 in number of units compared to 2007 figures. No data on current usage.
- Netherlands - Use of food waste with engines of 1000kWe capacity is the current trend. Future development is in district heating and greenhouse applications.
- UK - Use of SRC in engines of less than 400kWe capacity is the current situation. Potential growth is sewage and wood industries.
- Europe - biomass for cogeneration could account for between 10 to 20GWe capacity in 2020 from virtually zero in 1999. About 20% could be up to 1000kWe units. The market value is around **2000m€**

Project outputs

Promotion pack contains:
- Technologies, case studies and environmental performance

Documents to be provided:
- Draft report and Excel based performance and cost model

Publications:
- Small and micro combined heat and power (CHP) systems. Advanced design, performance, materials and applications" Woodhead Publishing Series in Energy No.18
- TCBiomass conference, Chicago, September 2011 "Upgrading fast pyrolysis liquids: blending bio-oil, biodiesel and (bio)alcohols"
- Biomass fuelled combined heat and power - Situation in the UK and the Netherlands Bioten Conference Proceedings, Birmingham September 2010.
- Bio-oil-biodiesel blend concept in process of patenting
- Paper on blends submitted for publication

Thank you

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