Renewable CHP Heat Cost Curves for RHI Setting

Report for DECC

AEA/R/ED57904
CHP MACC
Date

Customer:

Department of Energy and Climate Change (DECC)

Customer reference:

RMP3071

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AEA reference:

Ref: ED57904- CHP MACC

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[Publish Date]

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Introduction

In this study, the marginal costs for 2020 of generating heat (per MWh) using renewable CHP have been estimated relative to those of generating this heat using conventional gas boilers. These costs are net of the value of the associated generated power.

This exercise has been carried out for each of almost 300 different sector/size combinations segments, covering the whole of the UK, and these have then been plotted to produce Marginal Heat Cost Curves for heat from renewable CHP. The individual segments making up the graphs were then ordered from lowest to highest £/MWh with their widths representing the amount of heat in TWh.

Key assumptions

- 3rd party develops and operates the renewable CHP
- Customer supplied with electricity at the full central retail price projected by DECC
- Surplus Electricity sold to Grid at full DECC export price projection for large >25MWe schemes but at a 20% discount for < 25MWe schemes to reflect a PPA.
- Heat supplied at a price 20% less than it would cost to generate themselves at the DECC gas price projection (including carbon and CCL).

Further:

- All costs are as predicted in 2020 but in 2011 real terms.
- Where price forecasts are in a different base year, these have been converted to '2011 real' using DECC GDP deflators (provided by M Roome)
- Capital costs are annualised at a discount rate of 12% post tax which equates to 18.92% pre tax over an investment lifespan of 10 years, assuming a 2020 tax rate of 23% (the main rate set by HMRC for 2013 http://www.hmrc.gov.uk/rates/corp.htm)

2020 Energy Prices

- Bio liquid Engine fuel = £69.76/MWh (as advised by DECC in July 2012). Equates to approximately 72p/litre based on a calorific value of bio-diesel of 10.3kWh/litre.
- Biomass Steam Turbine fuel = Wood chip prices £22.63/MWh (as advised by DECC in July 2012). Equates to approximately £85/Tonne based on a calorific value of 3.75MWh/Tonne
- Natural Gas for Counterfactual gas boilers = £31.64/MWh (as given by DECC for CHP modelling)
- On site Electricity retail value = £113.42/MWh (as given by DECC for CHP modelling for med/large schemes but also applied to small sites)
- Export projections = £68.40/MWh for >=25MWe Schemes (as given by DECC for CHP modelling) and £54.72/MWh for <25MWe Schemes reflecting a 20% discount for a PPA.

2020 Policy Prices and CO2 Factors

- ROCs Value = £45/MWhe (1.5ROCs/MWhe for Biomass generation)
- No RHI or ECA (Mac Curves show cost without RHI to see how much RHI is required)
- CO2 Price = £17.31 (as per 81-iag-toolkit-tables-1-29 forecast table 3)
- Gas CO2 Intensity = 0.1836TCO2/MWh
- Elec CO2 Intensity = 0.414 TCO2/MWe (as per 81-iag-toolkit-tables-1-29 forecast table 1)
- EU-ETS CO2 Allowance on counterfactual/top up gas boilers = 30% in 2020
- Standard CCL on Gas = £1.69/MWh and Elec = £4.85/MWh as current (i.e.assumed to rise in line with inflation)
- All Industrial Sectors assumed to be in a CCA paying 35% of CCL on gas and 10% on elec
- Renewable LECs assumed to continue trading at 80% of standard elec CCL value = £3.88/MWhe

Technical and Cost Data

- Heat Led CHP sizing and operation.
- Top up and counterfactual Gas Boiler capex and opex assumed to be the same with or without CHP so not included in modelling
- Seasonal efficiency of top up and counterfactual Gas Boilers = 85% (GCV) for small service sector boilers and 81% (GCV) for industrial and large service sector boilers.

Bio liquid Engines

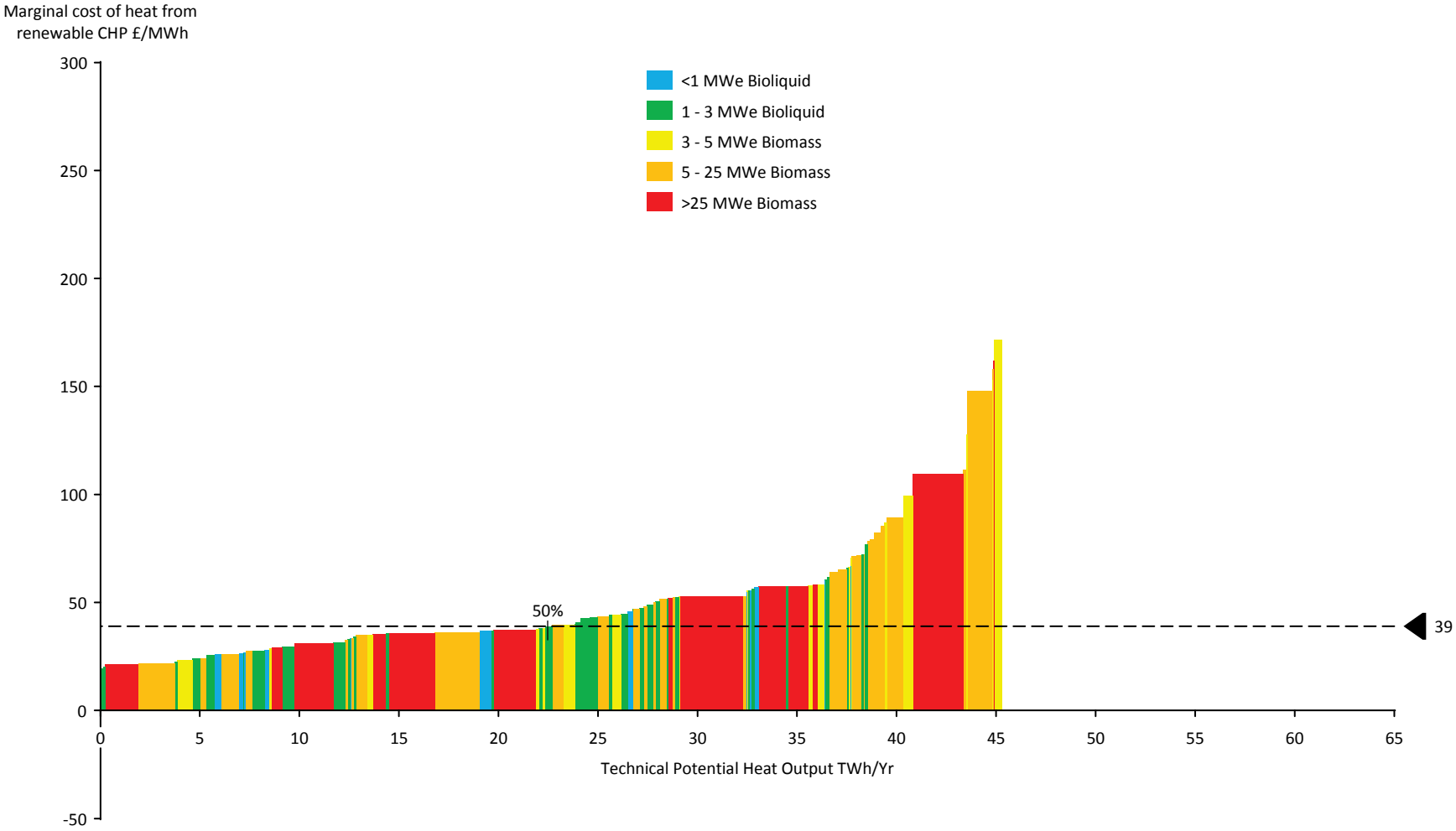
- Capex £/kWe = £1,080 x Cap(MWe) ^-0.15
- Small Engine (50kWe-1MWe) Opex = £13.20/MWhe
- Large Engine (1-3MWe) Opex = £11/MWhe
- Elec Efficiency = 35% (GCV)
- Heat to Power Ratio = 1.0

Biomass Steam Turbines

- Capex =£3,500/kWe (in fully condensing mode) based on recent industrial examples
- Opex = £20/MWhe in fully condensing mode based on advice from industry
- Fully Condensing Gross Power Eff (GCV):- 3-5MWe = 23%, 5-25MWe = 25%, >25MWe = 30%
- Parasitic Load = 10% (i.e. net condensing efficiency = 90% of above values)
- Z ratio (heat extracted/power reduction):- 3-5MWe = 5.7, 5-25MWe = 5.3, >25MWe = 4.4
- Heat to Power Ratio = Site demand H:P or 3.0 whichever is lower

Based on these assumptions the results are shown below.

2020 Heat Cost Curve for new unplanned renewable CHP potential



Conclusions

Around 3.5TWh/Yr of renewable CHP heat is already either in existence or scheduled to be by 2014. In addition to this, here is an estimated further technical potential for around 45TWh/Yr as shown above. This excludes theoretical potential in the refinery sector which is unlikely to be built by 2020 due to the lead times involved and segments where the heat cost would exceed £200/MWht. Based on the base case assumptions and analysis made here, an RHI of around £39/MWht (subject to discount rate) would be required to make 50% (or around 22TWh/Yr) of this further potential cost effective.