Programme Area: Distributed Energy

Project: Macro DE

Title: Executive Summary - DE2002 / WP3.3: Technology Development Opportunities

Abstract:

The objective of the Distributed Energy (DE) Programme is to increase the uptake of DE through the development of integrated systems in order to reduce through-life costs, improve ease of installation and increase efficiency in the combined generation of heat and electricity. Within this programme framework the objective of the Macro DE FRP will develop and validate a software methodology to enable the design of optimised DE solutions where clusters of demand sites are linked with appropriate DE supply equipment. The project will quantify the opportunity for Macro level DE (up to 50MW) in the UK and the potential to accelerate the development of appropriate technology by 2020 for the purposes of significant implementation by 2030.

Context:

This project quantified the opportunity for Macro level Distributed Energy (DE) across the UK and accelerate the development of appropriate technology by 2020 for the purposes of significant implementation by 2030. The project studied energy demand such as residential accommodation, local services, hospitals, business parks and equipment, and is developing a software methodology to analyse local combinations of sites and technologies. This enabled the design of optimised distributed energy delivery solutions for these areas. The project identified a number of larger scale technology development and demonstration projects for the ETI to consider developing. The findings from this project is now being distilled into our Smart Systems and Heat programme. The ETI acknowledges that the project was undertaken and reports produced by Caterpillar, EDF, and the University of Manchester.

ETI Executive Summary

Programme: Distributed Energy

Project Name: Macro DE

Deliverable: DE2002 / WP3.3: Technology Development Opportunities

Introduction

The objective of the Distributed Energy (DE) Programme is to increase the up-take of DE through the development of integrated systems in order to reduce through-life costs, improve ease of installation and increase efficiency in the combined generation of heat and electricity. Within this programme framework the objective of the Macro DE FRP will develop and validate a software methodology to enable the design of optimised DE solutions where clusters of demand sites are linked with appropriate DE supply equipment. The project will quantify the opportunity for Macro level DE (up to 50MW) in the UK and the potential to accelerate the development of appropriate technology by 2020 for the purposes of significant implementation by 2030.

As such the key outcomes from the project are:

- Evaluation of the potential benefits of system aggregation and optimisation techniques
- Characterisation of energy demand and supply profiles for typical UK site types (typically 100 kWe – 10 MWe)
- Development of software methodology which analyses and integrates combinations of sites to enable optimised DE solutions
- UK benefits case for the development of such an approach
- Identification of the UK deployment and CO2 reduction opportunity for macro DE systems

Basis of Designs

This report is the final deliverable in a work package focused on characterising the supply equipment which could potentially be used as a power centre in any large scale distributed energy deployment. The characterisation of Macro Distributed Energy equipment, based on

specifically defined criteria, within the DE technology value chain as illustrated in Figure 1, is for inclusion into WP4's pre-prototype tool library. The work package was split into 3 parts:

D3.1) Documentation of DE equipment to be characterised

D3.2) Collate performance characteristics of commercially available DE equipment

D3.3) Model supply improvements to equipment already under development or which could theoretically impact the commercial viability of macro scale DE.

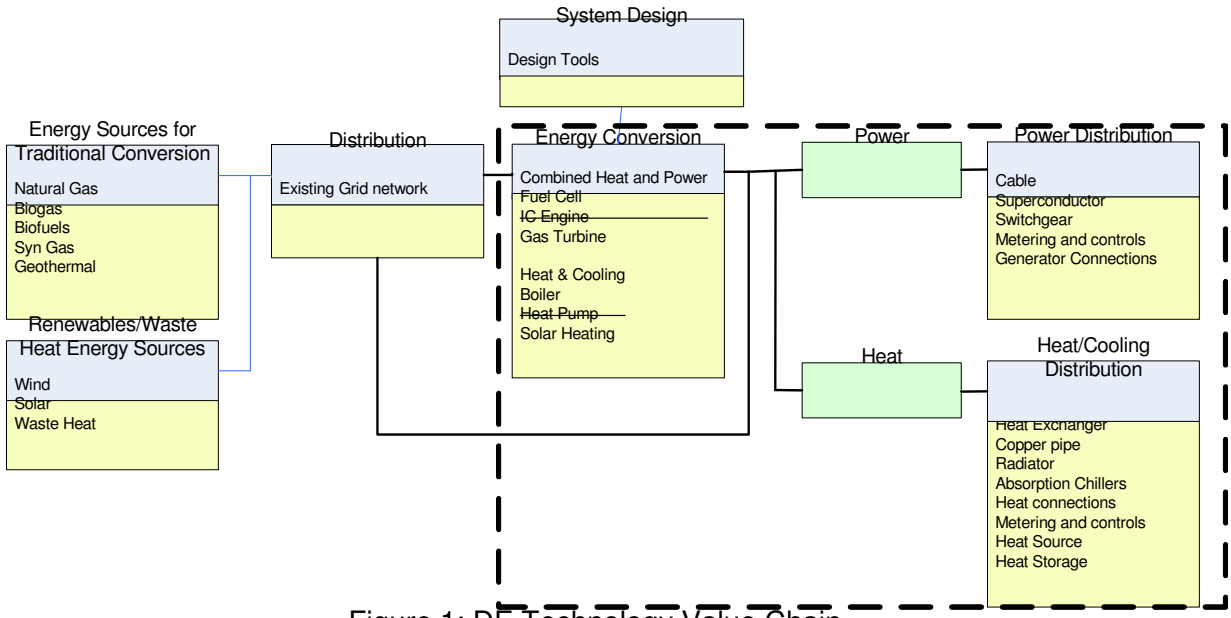

Figure 1: DE Technology Value Chain

The technologies previously agreed for inclusion in the pre-prototype tool library are:

1) Gas boiler
2) Fuel cell
3) Large scale solar heating
4) Large scale heat pump
5) Gas engine
6) Gas turbine
7) Heat storage

In addition the following technologies were included for consideration in the tool library:

8) Ground source heat pumps

9) Dual-fuel type compression ignition engine

10) Large scale CHP using combined cycle gas turbine

11) Energy from waste

    a. Incineration

    b. Anaerobic digestion

12) Biomass Power System

    a. Gasification

    b. Biomass combustion CHP plant

13) Biomass boiler

14) Condition monitoring system

For each of the technologies the following characteristics were captured, these were then entered into the pre-prototype model developed in work package 4:

	Model			
General	Total kWe			
	Fuel Type			
	Fuel heat value, MJ/Nm3			
	Cost of energy input, £/Nm3			
	Fuel CO2 generation, kg/Nm3			
Capital Costs	Capex (Installed Cost), £/kWe			
	Expected lifespan, h (average)			
	Footprint (Package), m x m			
Operating Costs	Availability of the Technology , %			
	Fixed Maintenance Cost, £/yr			
	Variable Maintenance Cost, £/kWhe			
	CO2 manufacture, g/kWe			
Performance				
	Load, %	Fuel consumption, Nm3/h	Electrical output, kWe	Thermal output at 99 deg C, kWth
	100			
	75			
	50			

Table 1: Macro DE Technology data characteristics captured

The definitions of each of the parameters are as follows:

Model Data	**Definitions and Assumptions Used**
Capital expenditure	The capital expenditure (Capex) represents the cost to supply and install the required equipment at a typical site. To ensure a fully operational system, the cost includes the supply of the balance of plant

(Capex)	(BOP), such as heat exchangers and pipes, required to connect to the existing site infrastructure. The housing of the equipment, or the bricks and mortar, are considered in WP4.
CO_2 of manufacture	The CO_2 of manufacture defines the mass of CO_2 used to manufacture the equipment. The ISO 14040 and ISO 14044 have been followed.
CO_2 of generation	The CO_2 of generation defines the mass of CO_2 that is released when a fuel undergoes complete combustion.
Availability	The availability metric represents the ratio of time when the equipment is fully operational, versus the time when the equipment is non-operational as a result of planned/unplanned maintenance.
Fixed maintenance cost	The fixed maintenance cost defines the cost associated with maintaining the equipment independent of its usage. The cost has been defined over the period of a year, assuming that installation and operation of the equipment is in line with the manufacturer's recommendation and guidelines.
Variable maintenance cost	The variable maintenance cost defines the cost associated with maintaining the equipment dependant on its usage. The cost has been defined assuming that installation and operation of the equipment is in line with the manufacturer's recommendation and guidelines.

Table 2: Model data definitions and assumptions

Key findings and Results summary

The objective of this task was to characterise the required 100kW$_e$ – 50MW$_e$ distributed energy equipment to form a library of DE supply equipment models and to project, by consultation, the technical improvement of these technologies in 2020 and 2030. This has been accomplished and the technology characteristics documented in an extensive spreadsheet.

The projected technical improvements (2020 – 2030) were obtained from consultations with manufacturers and experts in the industry. For the mature technology like gas engine, the projected technical advancement is the future technical standard which is set by the main players in the field. For less developed technologies like fuel cells, the projected technical advancement is the technical judgment from the manufacturers who were contacted.

Further work

The models described in this deliverable will be incorporated into the pre-prototype model developed within WP4. This model will be used to quantify the opportunity for Macro DE in GB and to identify key areas for technology development.

References

Extensive references are included within the deliverable.