

# Waste and Biomass Fired CHP

**Mahmoud Abu-Ebid**

**CHPQA Programme Director**

7<sup>th</sup> December 2010

# Talk Coverage

- **Fuel Types**
- **ECAs for additional equipment (for EfW)**
- **Scheme Boundaries**

# Fuel Inputs

## Conventional Fuels

- Natural gas
- LPG
- Gas Oil
- Other Commercial Fuel Oils
- Coal and Coke

# Fuel Inputs

## Alternative Fuels

- By-Product Gases
- Biogas
- Waste Gas or Heat
- Liquid Biofuels
- Liquid Waste
- Biomass or Solid Waste
- Wood Fuels



# Fuel Inputs

## Alternative Fuels

- **By-Product Gases**

products from industrial processes (blast furnace gas, coke oven gas and refinery fuel gas), which may include constituents such as hydrogen, ethane, propane etc

# Fuel Inputs

## Alternative Fuels

- By-Product Gases
- **Biogas**



gas produced by the anaerobic digestion (AD) of biological materials (such as sewage gas, landfill gas, food processing waste, pharmaceutical waste and municipal waste)

# Fuel Inputs

## Alternative Fuels

- By-Product Gases
- Biogas
- Waste Gas or Heat

- waste gases (such as carbon monoxide or volatile organic compounds), or
- waste heat (such as the exhaust gas from high temperature processes, or as a product of exothermic chemical reactions)

# Fuel Inputs

## Alternative Fuels

- By-Product Gases
- Biogas
- Waste Gas or Heat
- **Liquid Biofuels**

Manufactured liquid biofuels as defined in the EU Biofuels Directive (such as **biodiesel, bioethanol rapeseed oil, etc**)



# Fuel Inputs

## Alternative Fuels

- By-Product Gases
- Biogas
- Waste Gas or Heat
- Liquid Biofuels
- **Liquid Waste**

Material of biological or non-biological origin from domestic and industrial activity (such as Tallow, Fats and biological oils, solvents, recycled used vegetable oil)

# Fuel Inputs

## Alternative Fuels

- By-Product Gases
- Biogas
- Waste Gas or Heat
- Liquid Biofuels
- Liquid Waste
- **Biomass or Solid Waste**

Such as ....

- energy crops,
- waste wood,
- municipal solid waste,
- industrial solid waste,
  - hospital waste,
- agricultural residues,
  - straw,
- and sewage treatment residues



# Fuel Inputs



## Alternative Fuels

- By-Product Gases
- Biogas
- Waste Gas or Heat
- Liquid Biofuels
- Liquid Waste
- Biomass or Solid Waste
- **Wood Fuels**

Commercial-grade wood fuels (such as

- clean woodchips,
- logs and wood pellets,

but **specifically excluding energy crops and waste wood, which are classed as biomass**)

## Alternative Fuels – Energy Inputs

- All CHPQA analysis is based on **Gross Calorific Value GCV**
- This is to be in an **as-fired condition**  
 **$GCV_{(af)}$  or  $GCV_{(ar)}$  (as received)**

$$GCV_{ar} = GCV_{dry} \times (100-m)/100$$

where m = moisture (as received), weight %

Knowing moisture and hydrogen content, it is possible to convert between GCV and NCV

# Biomass – Energy Inputs



Wood Fuel Calorific Values						
Dry Net CV	MJ/kg	18.3				
Hydrogen % (dry)	Wt %	6.00				
Latent heat of vaporisation of water	MJ/kg	2.442				
<hr/>						
Moisture = moisture / (moisture + dry wood)	wt %	0	10	20	30	40
Net CV (as received)	MJ/kg	18.300	16.226	14.152	12.077	10.003
Hydrogen content (as received)	wt %	6.0	5.4	4.8	4.2	3.6
Gross CV (as received)	MJ/kg	19.608	17.648	15.687	13.726	11.765
Dry Gross CV	MJ/kg	19.608	19.608	19.608	19.608	19.608
Gross/Net CV (dry)		1.071	1.071	1.071	1.071	1.071
Gross/Net CV (as received)		1.071	1.088	1.108	1.136	1.176
<hr/>						
Moisture = moisture / (moisture + dry wood)	wt %	50	60	70	80	90
Net CV (as received)	MJ/kg	7.929	5.855	3.781	1.706	-0.368
Hydrogen content (as received)	wt %	3.0	2.4	1.8	1.2	0.6
Gross CV (as received)	MJ/kg	9.804	7.843	5.883	3.922	1.961
Dry Gross CV	MJ/kg	19.608	19.608	19.608	19.608	19.608
Gross/Net CV (dry)		1.071	1.071	1.071	1.071	1.071
Gross/Net CV (as received)		1.237	1.340	1.556	2.298	N/A

# Biomass – Energy Inputs

## Example:

200 tonnes of wet wood with 60% moisture.

Energy input = GCV (ar) \* Mass (ar)

= 7.843 \* 200 / 3.6

= 435.7 MWh

OR

Energy input =  $GCV_{dry} * Mass_{dry}$

= 19.608 \*  $\{(100-60)/100\} * 200 / 3.6$

= 435.7 MWh

Wood Fuel Calorific Values						
Dry Net CV	MJ/kg	18.3				
Hydrogen % (dry)	Wt %	6.00				
Latent heat of vaporisation of water	MJ/kg	2.442				
<hr/>						
Moisture = moisture / (moisture + dry wood)	wt %	0	10	20	30	40
Net CV (as received)	MJ/kg	18.300	16.226	14.152	12.077	10.003
Hydrogen content (as received)	wt %	6.0	5.4	4.8	4.2	3.6
Gross CV (as received)	MJ/kg	19.608	17.648	15.687	13.726	11.765
Dry Gross CV	MJ/kg	19.608	19.608	19.608	19.608	19.608
Gross/Net CV (dry)		1.071	1.071	1.071	1.071	1.071
Gross/Net CV (as received)		1.071	1.088	1.108	1.136	1.176
<hr/>						
Moisture = moisture / (moisture + dry wood)	wt %	50	60	70	80	90
Net CV (as received)	MJ/kg	7.929	5.855	3.781	1.706	-0.368
Hydrogen content (as received)	wt %	3.0	2.4	1.8	1.2	0.6
Gross CV (as received)	MJ/kg	9.804	7.843	5.883	3.922	1.961
Dry Gross CV	MJ/kg	19.608	19.608	19.608	19.608	19.608
Gross/Net CV (dry)		1.071	1.071	1.071	1.071	1.071
Gross/Net CV (as received)		1.237	1.340	1.556	2.298	N/A

## Use of CHPQA to obtain ECA's

- ECA for CHP is based on the **whole package not individual item**
- Must be **certified by CHPQA**
- Must Achieve the **Power Efficiency Threshold**
- ECA Claim is based on Qualifying Power Capacity **(QPC/TPC)**
- Scheme specific **no type approval/product**
- Certification route- **must identify heat load**
- **EE Cert may be withdrawn** and ECA repaid if Scheme is not built to the design certificated

## Threshold Criteria for ECA's

	QI Threshold	Power Efficiency Threshold
All new or upgraded Schemes <b>Except</b> for the special cases below	$\geq 105$ under MaxHeat Conditions	$\geq 20\%$ under long term annual operation
New or upgraded Schemes that use <b>only</b> biomass or solid or liquid waste fuels	$\geq 105$ under MaxHeat Conditions	$\geq 10\%$ under long term annual operation
New or upgraded Schemes that use part biomass or solid or liquid waste fuels (See note below)	$\geq 105$ under MaxHeat Conditions	$\geq (20 - 10 \times Fw) \%$ under long term annual operation

**Note:** Fw = fraction of total energy inputs as biomass plus solid waste plus liquid waste fuels

# CHP Plant & Machinery that qualify for ECAs

- Installed as part of a CHP Scheme Certified by CHPQA
- List available in CHPQA GN 42 and now also includes equipment eligible only if waste to energy scheme firing Solid Recovered Fuel (SRF).

# ECA – CHP Criteria List

Equipment on list qualifies as Plant and Machinery

- Fuel storage, processing and management
- Prime movers (whether used for electrical generation or direct mechanical drive)
- Electrical generation equipment
- Heat recovery and utilisation equipment
- Supplementary (back-up and top-up) heat
- Management of combustion products and waste heat from prime movers and supplementary heat equipment
- Steam or heat network
- Water treatment (for water entering or being released from the system)
- Ancillary equipment necessary to the operation of a Scheme
- Noise and vibration control
- Access to allow maintenance or inspection

## ECA – Additional Items

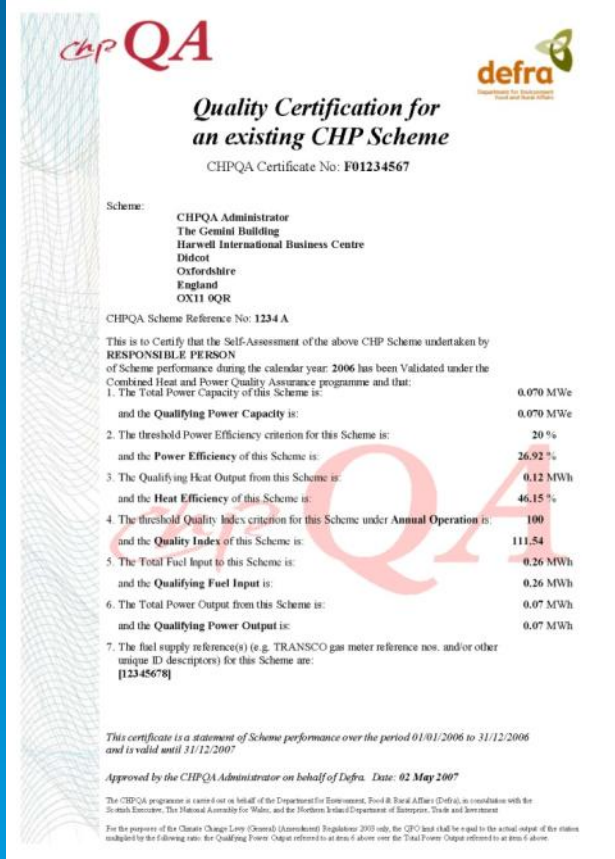
- Crainage inside SRF storage bunker
- Plasma Convertor
- SynGas cleanup equipment
- SynGas compressor
- Furnace/Boiler (fired or heat recovery)
- Sand storage (if CFB boilers being used)
- Continuous Emission Monitoring (CEM) equipment
- Ash and FGT residue collection equipment
- Ash and FGT residue disposal transfer equipment

## ECA for SRF equipment

- For **SRF firing**, need to demonstrate throughput  $\geq 50\%$  of rated capacity in any one tax year
- Have to do this for **five consecutive** years or **forfeit monetary** value of ECA

# Use of CHPQA to obtain LEC's

- LECs are available on qualifying power outputs certified by CHPQA
- Schemes must be Certified by CHPQA and have valid SoS certificate



The image shows a sample CHPQA certificate. It features the CHPQA logo at the top left and the Defra logo at the top right. The title is 'Quality Certification for an existing CHP Scheme' with Certificate No: F01234567. The scheme administrator is listed as 'CHPQA Administrator, The Gemini Building, Harwell International Business Centre, Didcot, Oxfordshire, England, OX11 0QR'. The certificate reference is 1234 A. The main body of the certificate certifies the performance of a CHP scheme for the year 2006, listing various metrics such as power capacity, efficiency, heat output, quality index, and fuel input/output. A large, semi-transparent 'CHPQA' watermark is visible across the center of the certificate. At the bottom, there is a date of approval (02 May 2007) and a note about the certificate's validity period (01/01/2006 to 31/12/2006).

**CHPQA**

**defra**  
Department for Environment  
Food and Rural Affairs

*Quality Certification for  
an existing CHP Scheme*

CHPQA Certificate No: **F01234567**

Scheme:

CHPQA Administrator  
The Gemini Building  
Harwell International Business Centre  
Didcot  
Oxfordshire  
England  
OX11 0QR

CHPQA Scheme Reference No: **1234 A**

This is to Certify that the Self-Assessment of the above CHP Scheme undertaken by **RESPONSIBLE PERSON** of Scheme performance during the calendar year **2006** has been Validated under the Combined Heat and Power Quality Assurance programme and that:

1. The Total Power Capacity of this Scheme is:	0.070 MWe
and the Qualifying Power Capacity is:	0.070 MWe
2. The threshold Power Efficiency criterion for this Scheme is:	20 %
and the Power Efficiency of this Scheme is:	26.92 %
3. The Qualifying Heat Output from this Scheme is:	0.12 MWh
and the Heat Efficiency of this Scheme is:	46.15 %
4. The threshold Quality Index criterion for this Scheme under Annual Operation is:	100
and the Quality Index of this Scheme is:	111.54
5. The Total Fuel Input to this Scheme is:	0.26 MWh
and the Qualifying Fuel Input is:	0.26 MWh
6. The Total Power Output from this Scheme is:	0.07 MWh
and the Qualifying Power Output is:	0.07 MWh
7. The fuel supply reference(s) (e.g. TRANSCO gas meter reference nos. and/or other unique ID descriptors) for this Scheme are:	[12345678]

*This certificate is a statement of Scheme performance over the period 01/01/2006 to 31/12/2006 and is valid until 31/12/2007*

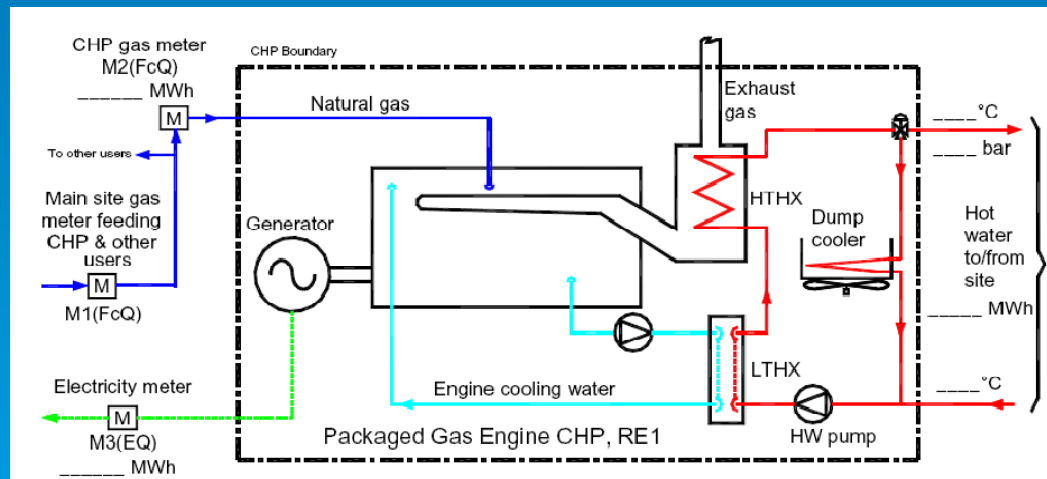
Approved by the CHPQA Administrator on behalf of Defra. Date: **02 May 2007**

The CHPQA programme is run on behalf of the Department for Environment, Food & Rural Affairs (Defra), in consultation with the Scottish Executive, The National Assembly for Wales, and the Northern Ireland Department of Enterprise, Trade and Investment

For the purposes of the Climate Change Levy (CCL) (Amendment) Regulations 2007 only, the CPO (and shall be equal to the actual output of the station multiplied by the following ratio: Qualifying Power Output referred to in item 6 above over the Total Power Output referred to in item 6 above

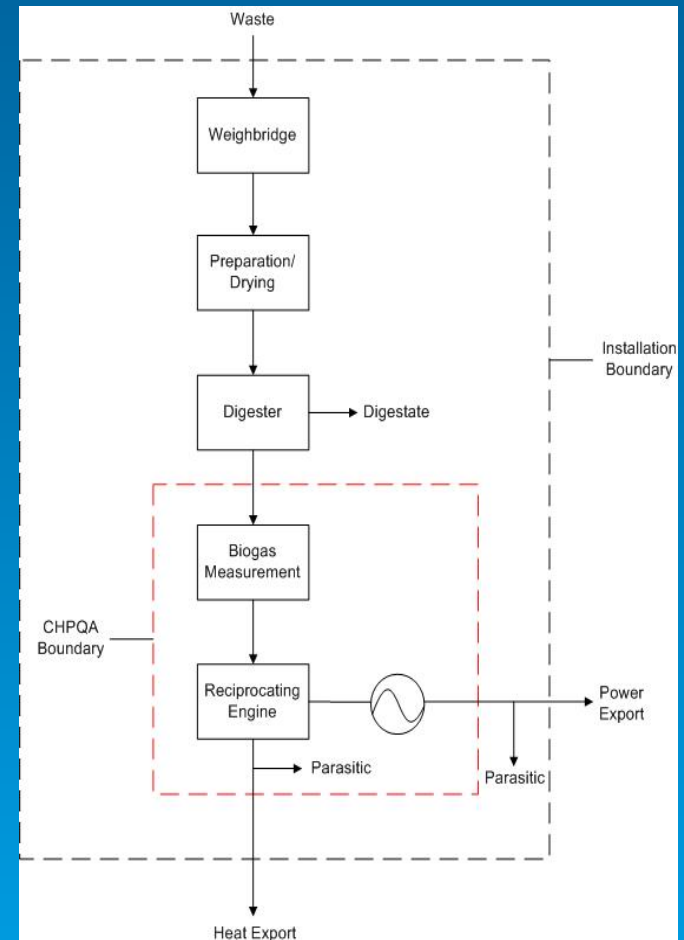
# Scheme Boundaries

- CHPQA allows applicants to propose their own scheme boundaries to suit prime movers, auxiliary equipment, performance etc
- Back-up and top-up boilers are allowed to be included.

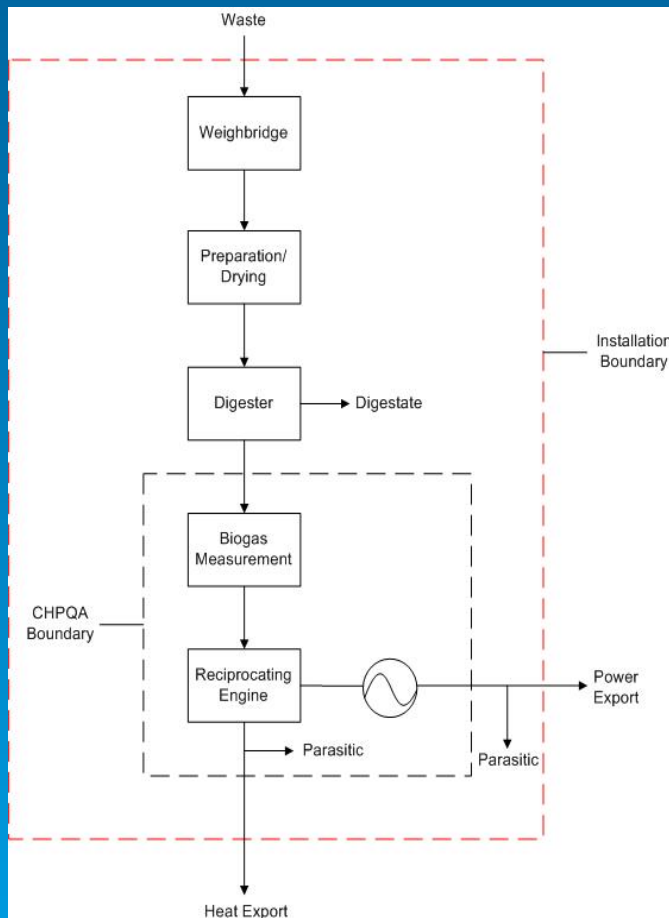


# Scheme Boundaries – Fuel Input

- For biogas fired schemes, the fuel input boundary should normally be drawn at the gas inlet to RE
- Should use the Biogas QI formula



# Scheme Boundaries – Fuel Input



- However, for some gasification processes, the analysis of syngas is extremely difficult and it may be better to measure solid waste at gasifier input
- In these cases can use the solid waste QI formula

# Scheme Boundaries – Useful Heat

## Definition of useful heat

...The heat from a CHP Scheme delivered to satisfy an *economically justifiable demand* for heat or cooling

...For biomass and solid waste schemes the *heat used for drying may be classified as Useful Heat*,.....

...only if it can be demonstrated that such a use is *an economically justifiable option*

# CHPQA Contact details

*Contact the Administrator:*

*Mail: CHPQA Programme  
The Gemini Building  
Fermi Avenue  
Harwell  
Didcot  
OX11 0QR*

*E-mail: [chpqainfo@chpqa.com](mailto:chpqainfo@chpqa.com)*

*tel: 0870 190 6196*

*fax: 0870 190 6334*

*Website feedback: [www.chpqa.com](http://www.chpqa.com)*