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World leaders in power asset management solutions



CHAPNET Micro-CHP: The Technology Takes Off

9th November 2004

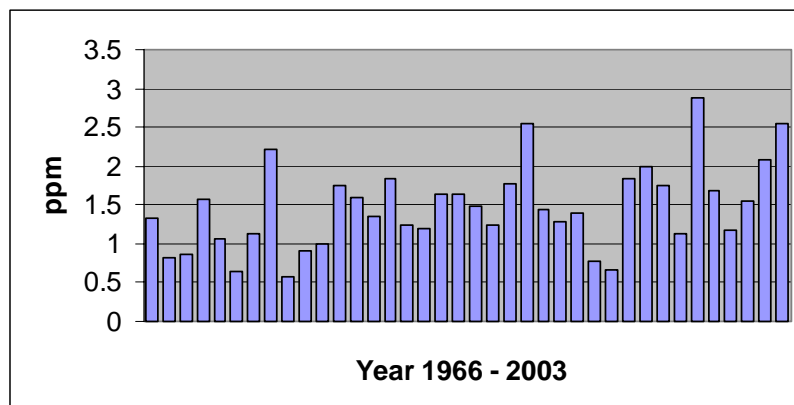
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Why Do We Need Micro-CHP?

- To produce power efficiently
- To reduce CO₂ production

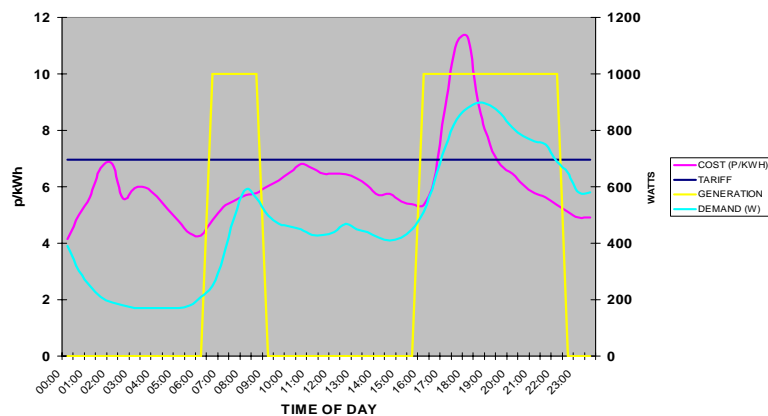
CO₂ in Atmosphere



Why Else Do We Need Micro-CHP?

- To make money
- To help balance the network???

Coincidence of High Cost with Micro-CHP Generation



Getting it Right for the Householder

- Look like a household product
- Sufficient heat at all times
- Quiet, well packaged

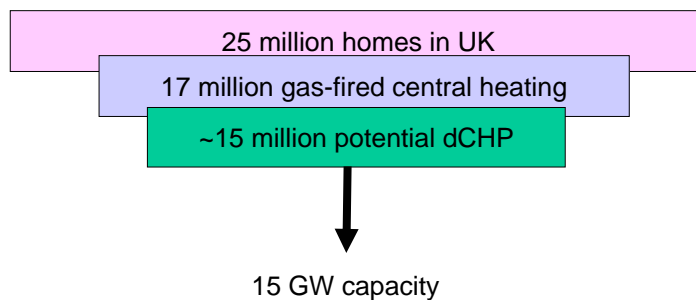
Standard Sale

- Acceptable installed cost
- Low bills (electricity & gas)

ESCo

- Acceptable fuel & rental package

UK Potential Market



UK	Generating capacity ~ 70GW Peak demand ~ 60GW
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EU Potential

- 60GWe installed capacity
- Equivalent to nuclear capacity (DE, UK)
- 40 million suitable homes
- 200 million tonnes CO₂ reduction annually

- 1 million installations / **year** by 2010
- 15 million tonnes CO₂ / year by 2010

Market Characteristics

ANNUAL BOILER SALES ('000s)

- UK >1500
- Germany > 750
- NL > 250
- Italy > 1000

Available Technologies

- 1 Stirling Engines
- 2 Fuel Cells
- 3 ICEs
- 4 Rankine Cycle Engines

1. Stirling Engines

- DISENCO (SIGMA)
 - ($3\text{kW}_e / 9\text{kW}_{th}$)
- Whisper Tech Mk.4
 - ($0.85\text{-}1.2\text{ kW}_e / 6\text{-}8\text{ kW}_{th}$)
- BG Microgen
 - ($1\text{kW}_e / 5\text{-}36\text{kW}_{th}$)
- ENATEC
 - ($1\text{kW}_e / 6\text{-}24\text{+kW}_{th}$)

1. Stirling Engines

DISENCO (SIGMA)

- DIStributed Energy COmpany
- SIGMA disappeared c. 2 years ago
- Disenco bought rights in late 2003 / 2004
- Set up in Sheffield UK
- Latest version redesigned by Ricardo
- 3 kW_e / $9 - 11 \text{ kW}_{th}$
- 25 Field units planned Autumn 2004



1. Stirling Engines

Whisper Tech Mk.4

- $0.85 - 1.2 \text{ kW}_e$ / $6 - 8 \text{ kW}_{th}$
- Commercial Launch Nov. 2003
 - Powergen selling 400 units
- August 2004 E.ON signed agreement with Whisper Tech to buy 80,000 units



1. Stirling Engines

BG Microgen

- FPSE based on SunPower design
- $1\text{kW}_e / 5\text{-}36\text{kW}_{th}$
- Wall hung - can be combi
- Claimed efficiency 93%
- Recently announced delay
 - commercially available spring 2007
 - pulled out of CT trials



1. Stirling Engines

ENATEC

- FPSE developed for CHP with ECN
- Linear generator from Stirling Technology Co.
- $1\text{kW}_e / 6\text{-}24+\text{kW}_{th}$
- 110 litre boiler
- Large field trials planned 2005-6
- Development ongoing
 - to reduce costs
 - for manufacture



2. Fuel Cells



- Higher first cost
- Longer running hours

VAILLANT (5kW_e)

BAXI / EFC (1.5kW_e)

SULZER HEXIS (1kW_e)

CFCL (1kW_e)

OSAKA GAS (1kW_e)

2. Fuel Cells

VAILLANT

- Sell over 2M boilers p.a. in Europe
- Use Plug Power stack
- Commercial launch scheduled 2010
- EU sales 250,000 by 2010
- 4.6 kW_e / 1.7 - 7 kW_{th}
- Extra burner 25 - 280 kW_{th}
- Main market Germany
- Smaller units rumoured



2. Fuel Cells

BAXI / EUROPEAN FUEL CELLS

- Baxi acquired EFC in October 2002
- Currently developing Beta unit
- 1.5kW_e plus additional burner
- Field trials in UK planned shortly
- Not commercially available until 2009-12



2. Fuel Cells

SULZER HEXIS

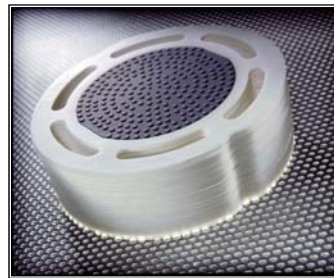
- 1 kWe SOFC
- Supplementary burner
- Hot water tank
- >100 field trial units mostly in Germany
- Next devt. due late 2004 / 2005
- Some stack problems experienced
- Truly commercial product - Galileo
 - due 2005/6
 - quantities of 1000 - 10,000 / year



2. Fuel Cells

CFCL

- 1 kW_e SOFC plus additional burner
- Aug 2004 CFC (Europe) Ltd. formed
- CERAM designing manufacturing plant
 - Capacity of 50-100MW of stacks p.a.
- Thermally cycles
- First CHP demonstrators
 - in Australia in December
 - in Europe in April 2005
- Ramp up production in 2007



2. Fuel Cells

OSAKA GAS

- Currently focussing on Honda Ecowill
- Claimed launch of 1 kW_e unit in 2005
- Unit will be a fuel cell

3. Internal Combustion Engines

- | | |
|-------------------------|-------------------------------|
| 1 . Honda | 1 kW _e |
| 2 . Baxi / SenerTec | 5 kW _e |
| 3 . Vaillant / Ecopower | 4.7 kW _e |
| 4 . EC Power | 9, 12, 15, 17 kW _e |

3. Internal Combustion Engines

HONDA ECOWILL

- 1 kW_e / 3.25 kW_{th}
- 20% electrical efficiency
- Maintenance every 6000 hours
- Market introduction March 2003
 - met target sales of 2000 units in year 1

3. Internal Combustion Engines

BAXI / SENERTEC

- Baxi bought SenerTec 2002
- 5 - 5.5 kW_e / 12.5 kW_{th}
- Claimed c. 10,000 installations in Europe
- Cost around €13,000



3. Internal Combustion Engines

VAILLANT / ECOPOWER

- On sale in EU for several years
- Sold by Power Plus Technologies
- 4.7 kW_e / 12 kW_{th}
- Were seeking demonstration units for 2004



3. Internal Combustion Engines

EC POWER

Feb 2004 Prices

- 9 kW_e diesel - £9000
- 12 kW_e gas - £11,600
- 15 kW_e gas - £13,000
- 17 kW_e diesel - £13,000
- Service every 5,000 hours

4. Rankine Cycle Engines

- Some way off but developing fast
- Developments include:
 - Baxi / Energetix
 - Enginion
 - Cogen Micro

4. Rankine Cycle Engines

Baxi / Energetix

- Baxi purchased Energetix Micro Power in 2004
- 1 kWe unit
- Low electrical efficiency
- Uses refrigerant & scroll expander

4. Rankine Cycle Engines

Enginion

- German based
- 4.6 kWe
- Claimed up to 92% efficient
- E.ON purchased a share in 2002
- Uses steam and reciprocating engine

4. Rankine Cycle Engines

Cogen Micro

- Australian based
- 2.5 kW_e
- 12 kW_{th}
- Uses steam and reciprocating engine
- Little heard recently

Market Leaders

- At 5 kWe - Baxi SenerTec
- At 1 kWe - Whisper Tech

BUT

Watch out for

- low cost Rankine cycle
- low cost fuel cells (eg CFCL)

CONCLUSIONS

- Success is Essential
- Will be a commercial impact on networks
- Field trials - customer confidence
- Co-ordinated promotion
 - (CHAPNET / MicroCHEAP)

MORE OF THE SAME !

Domestic Sector Desired Actions

- Reduced sales tax
 - UK has planned 5% for all installations
- Energy labelling of products (A, B, C, D...)
- Cenelec interconnection standard EN50438
- Reasonable return for export

To be Addressed....

- Installation / service infrastructure
- Training - chronic problem
- Technical standards - in progress
- Billing, metering, settlement
- Financial support (It all helps !!!)
 - Grants
 - Tax reductions
 - Green tariffs
 - Support for biofuels