Micro CHP in Europe

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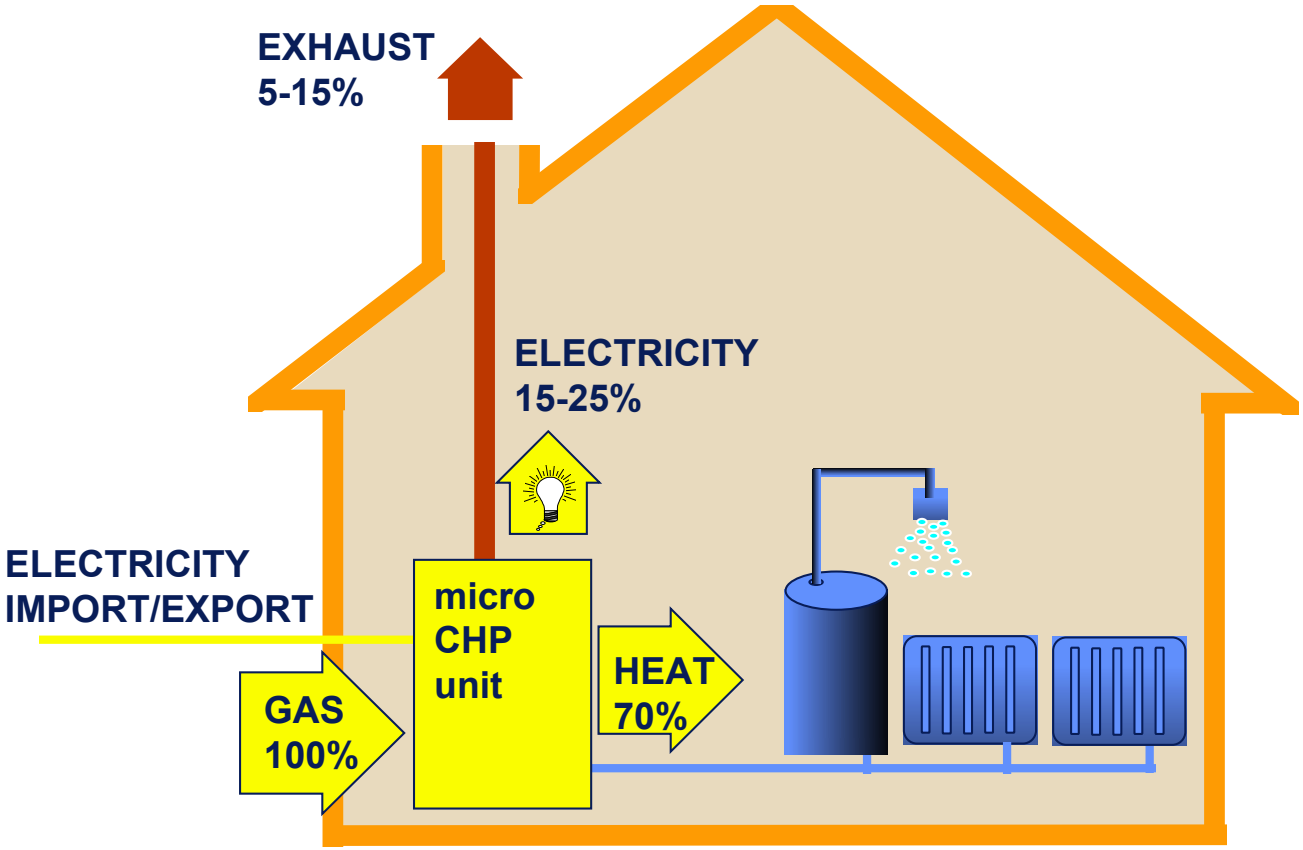
Definition of micro CHP

- *"A direct replacement for a boiler in a hydronic heating system, which simultaneously produces heat & electrical power"*

- G83/CEN technical definition
  - "generator with rated output of ≤16A per phase"
- DCHP functional definition
  - "one unit per home"

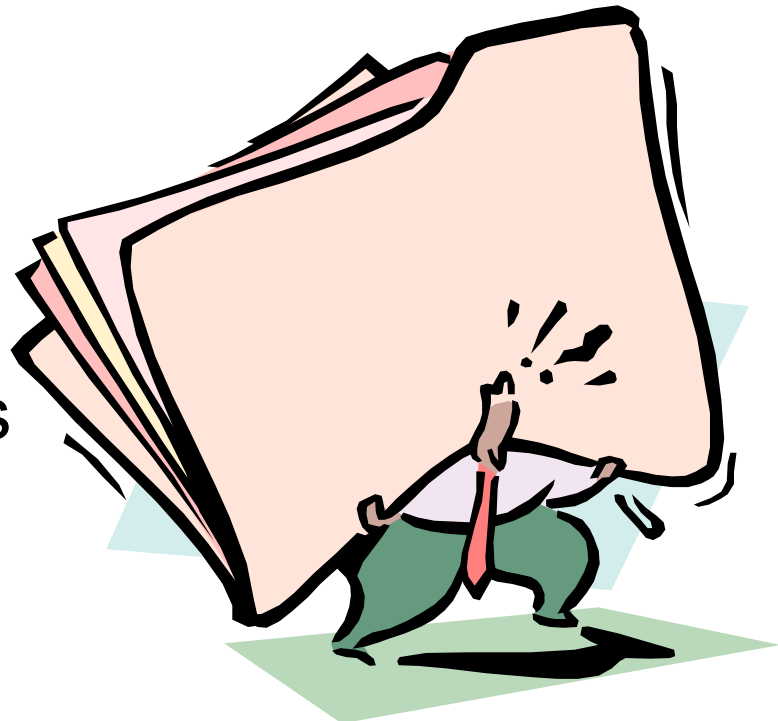
Micro CHP concept



Micro CHP replaces boiler in conventional central heating system

Requirements for micro CHP

- noise, vibration
- size, weight
- capital cost
- service cost/intervals
- heat/power ratio
- running hours



Potential UK impact of DCHP

- 15-22GWe installed capacity
- equivalent to nuclear capacity (not output)
- 12 million suitable homes in UK
- 67 million tonnes CO_2 reduction annually

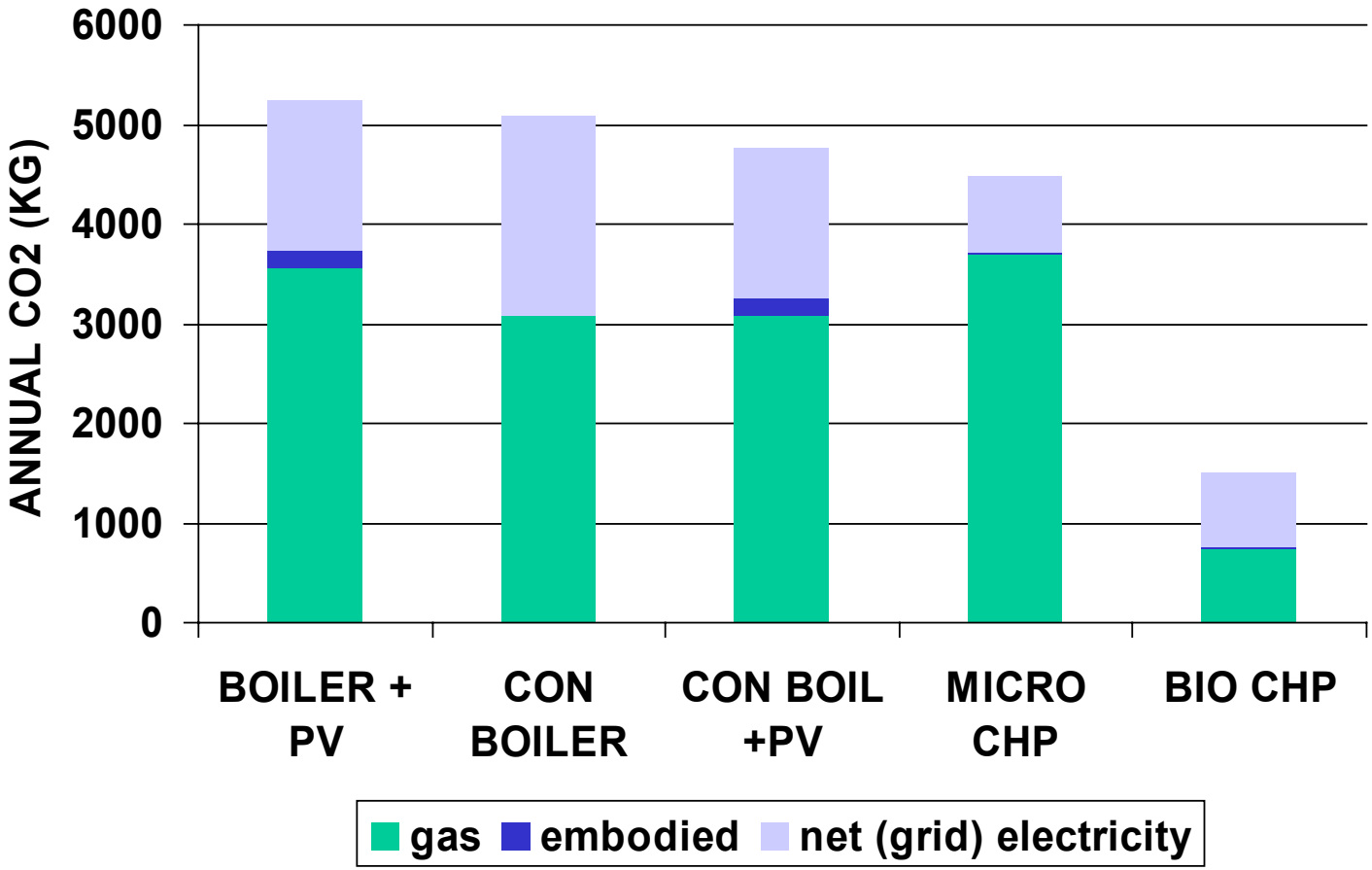
- ~250,000 p.a by 2010
- 1,000,000 installed systems by 2010
- ~2 million tonnes CO_2 p.a. by 2010

Potential EU impact of DCHP

- 60GWe installed capacity
- equivalent to nuclear capacity (DE, UK)
- 40 million suitable homes
- 200 million tonnes CO_2 reduction annually

- 1 million installations p.a by 2010
- 15 million tonnes CO_2 p.a. by 2010

Life cycle CO_2 emissions*



*based on a typical UK family house

Impacts on Distribution Networks

- Loss of revenue
- Additional effort
  - Incentives
- Design & operation of network
- Standard of supply
  - CI/CML (DCPR)
  - Power quality
  - Security of supply (P2/6)
- Safety

Connection to network

- Previous system (G59) too complex
- Type approved products/interfaces
- Certified installers
- Notification
- Progress so far
  - UK draft engineering recommendation (G83)
  - European (CEN) workshop agreement
  - CENELEC in progress

Connection to network - who pays?

- DNO = all customers
  - natural route for natural monopoly?
  - public service
- Individual micro CHP operators
  - highly complex
- All micro CHP operators
  - equitable
  - incorporate in tariff

Connection to home

- Thermal: “drop-in” replacement
- Electrical
  - Fusing
  - Connection to ring main (UK)
  - Connection to cooker spur (or other high rated spur)
  - Avoiding nuisance trips - network support
- Metering & control
  - Integration with controls (load management)
  - Remote metering

Economic case for micro CHP

- marginal investment cost recovered by value of generation +/- marginal gas consumption
  - marginal cost depends on production cost
  - generation depends on running hours
  - marginal gas consumption depends on technology (heat:power ratio, η_t)
- importance of “spark spread” - future price volatility
- value of location (time & space)

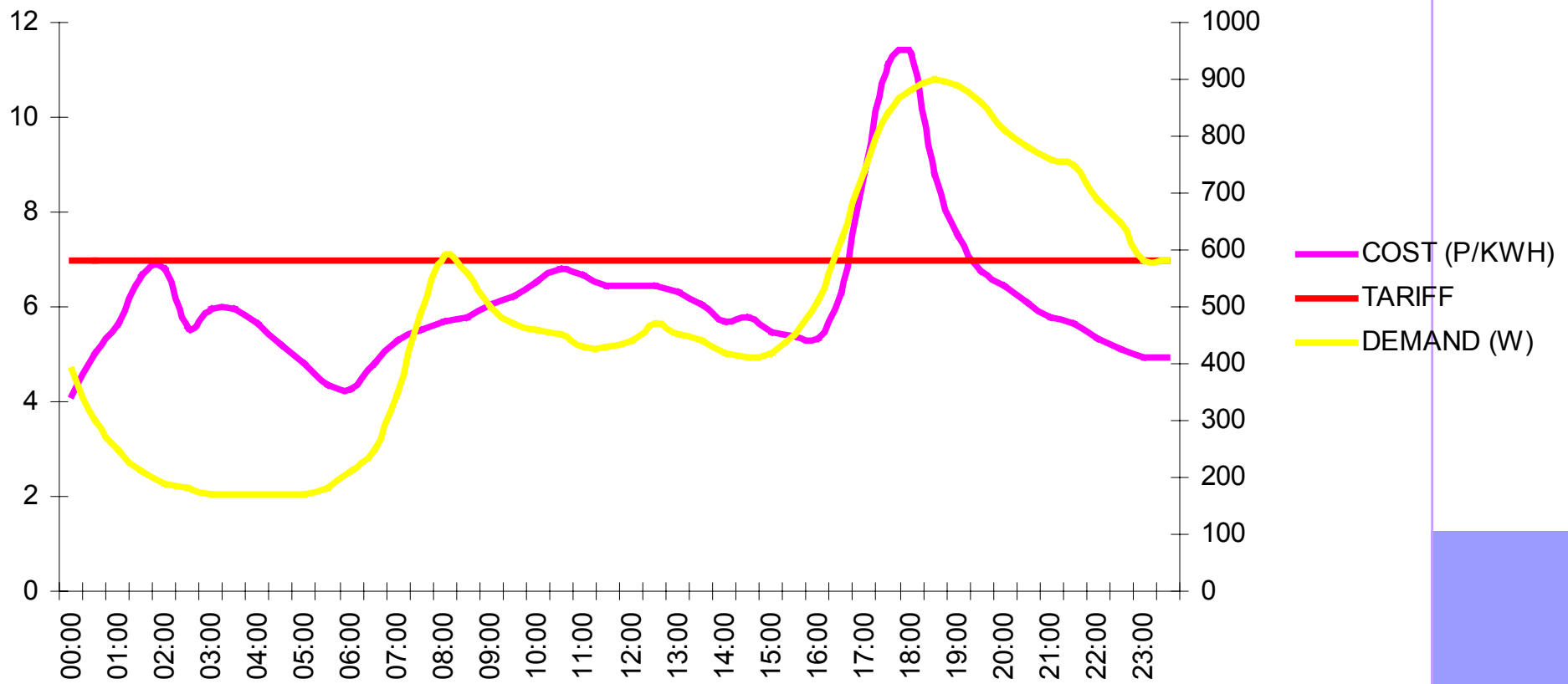
Cost/value recovery

- Metering
- Settlement
- CCL exemption
- ROC accreditation
- Emissions Trading
- Balancing market/volatility
- Aggregation of export

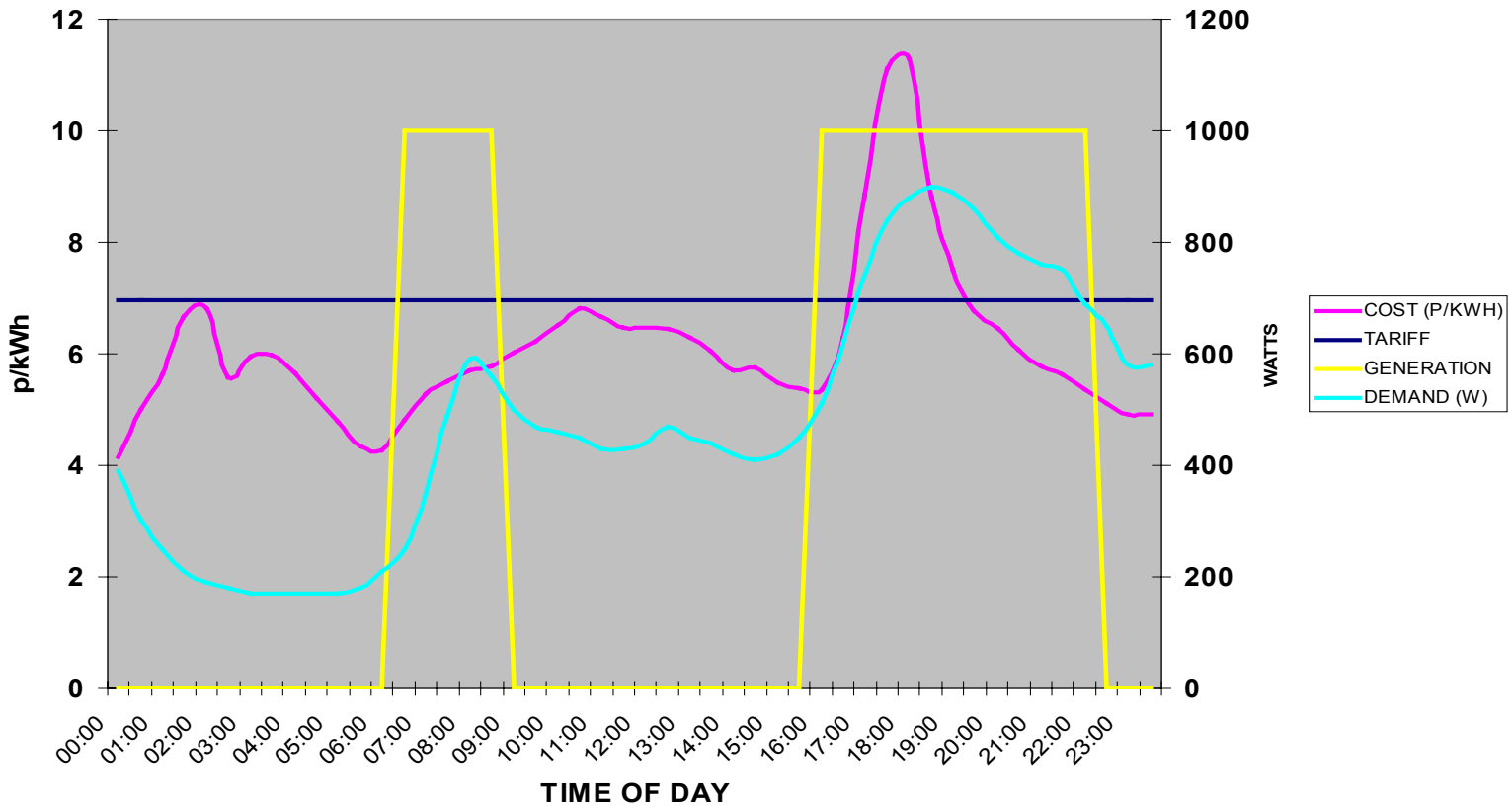
Energy trading options

- Metering
  - Existing + assumption
  - 2-way (import/export)
  - Half-hour
  - Smart-settlement
  - Net
- Settlement
  - Profile (diversified)
  - Aggregation

Profile settlement: supply



Coincidence of high cost with micro CHP generation (domestic)



Characteristics of micro-generation

POWER: HEAT & EFFICIENCY

	kWe:kWt	η el.	η total
Stirling	1:3-1:8	12-30%	90-95%
Fuel cell	1:1-1:3	20-35%	~80%
ICE	1:2-1:3	25-35%	85-90%

Technology status: ICE

- Senertec (5.5kWe)
- Ecopower (5kWe)
- Cogenics (3-5kWe)
- Honda (1kWe)

Technology status: Fuel Cells

VAILLANT (5kWe) *PEM*

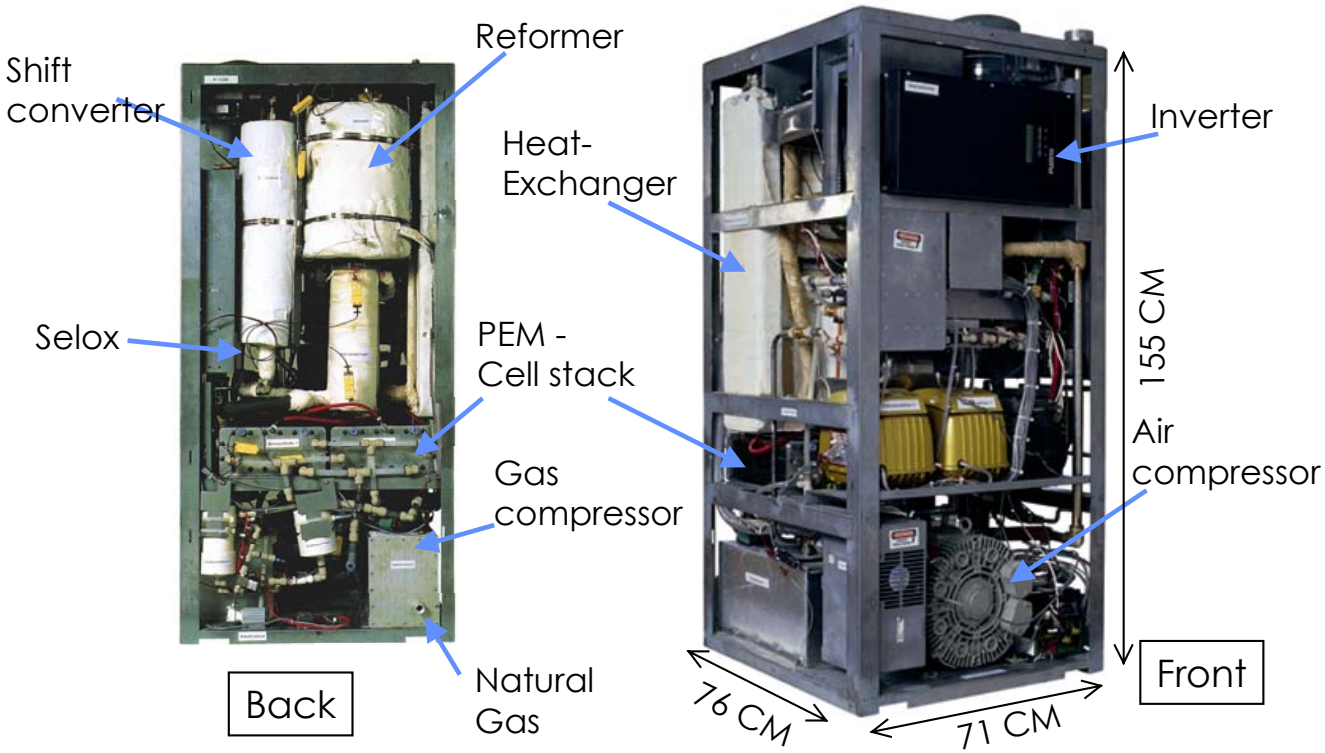
EUROPEAN FUEL CELLS (1.5kWe) *PEM*

Johnson Matthey *PEM*

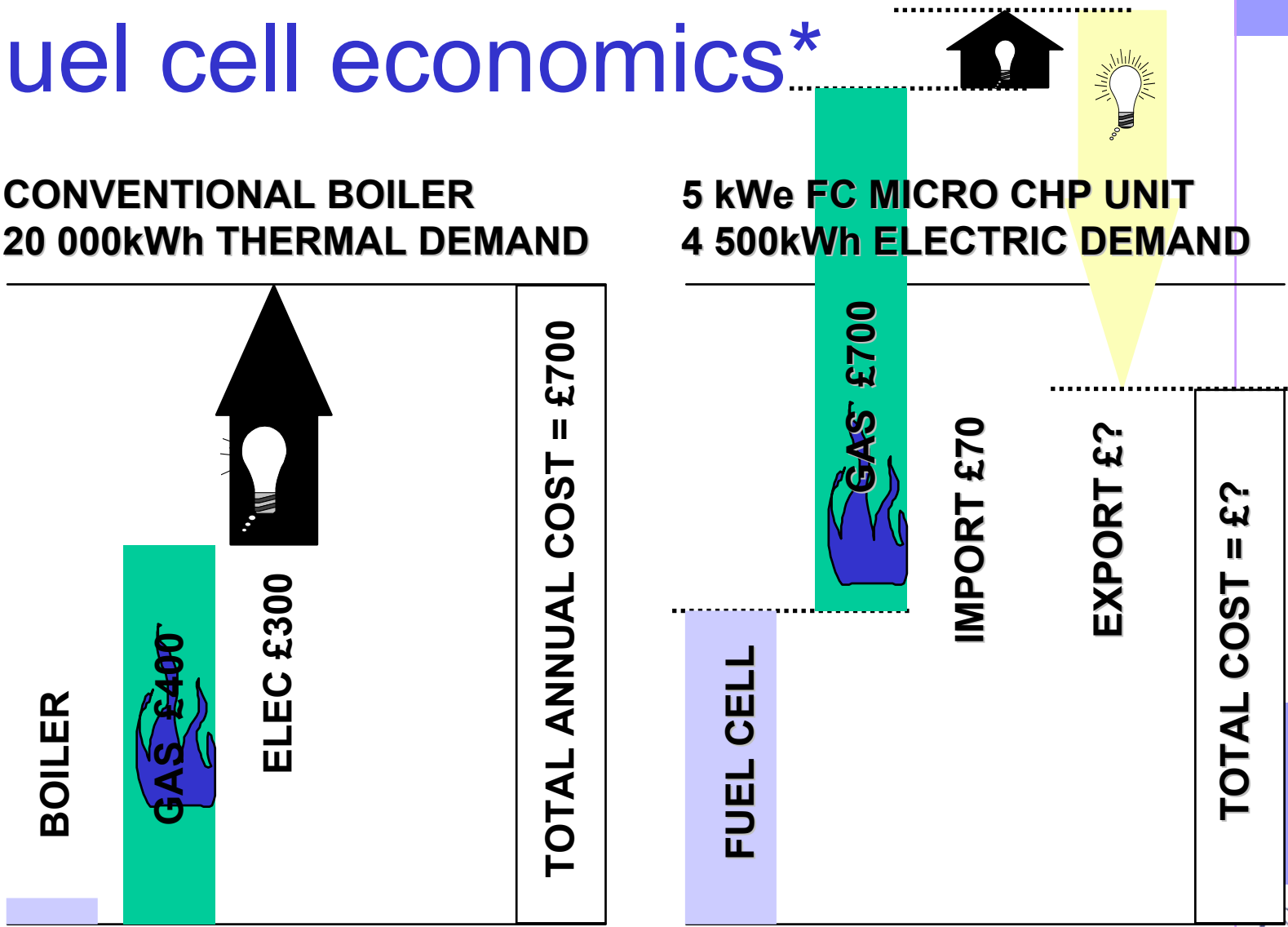
Sulzer HEXIS (1kWe) *SOFC*

Baxi technologies fuel cell

Alpha Unit of the HGC Home Energy Center
3 $kW_{el;}$8 kW_{th}



Fuel cell economics*



* marginal cost basis-end user economics

Technology status: Rankine cycle

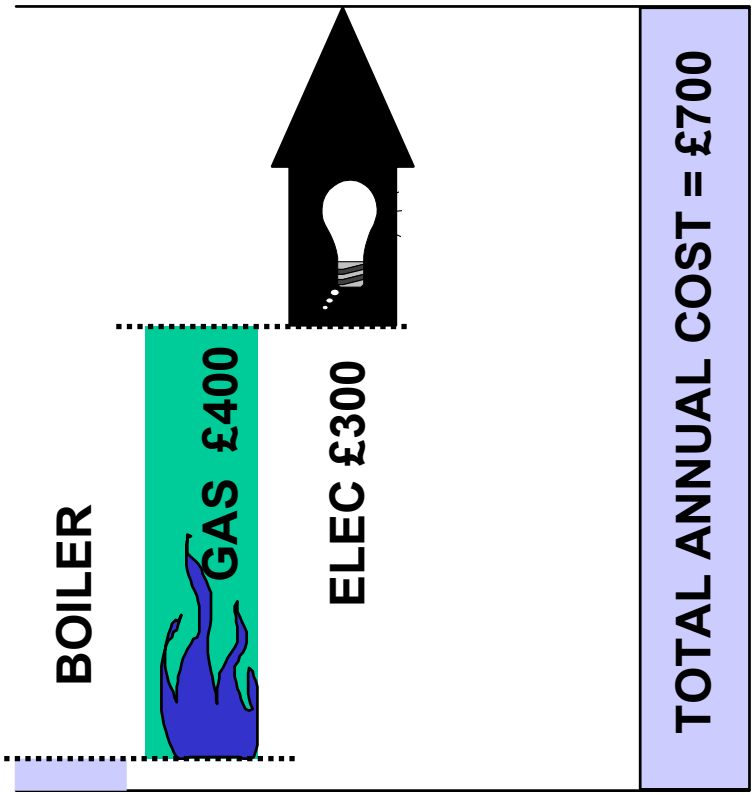
- Cogen Micro (2.5kWe/12kWt)
- Inergen (1kWe/10kWe)
- Climate Energy
- Enginion

Technology status: Stirling engine

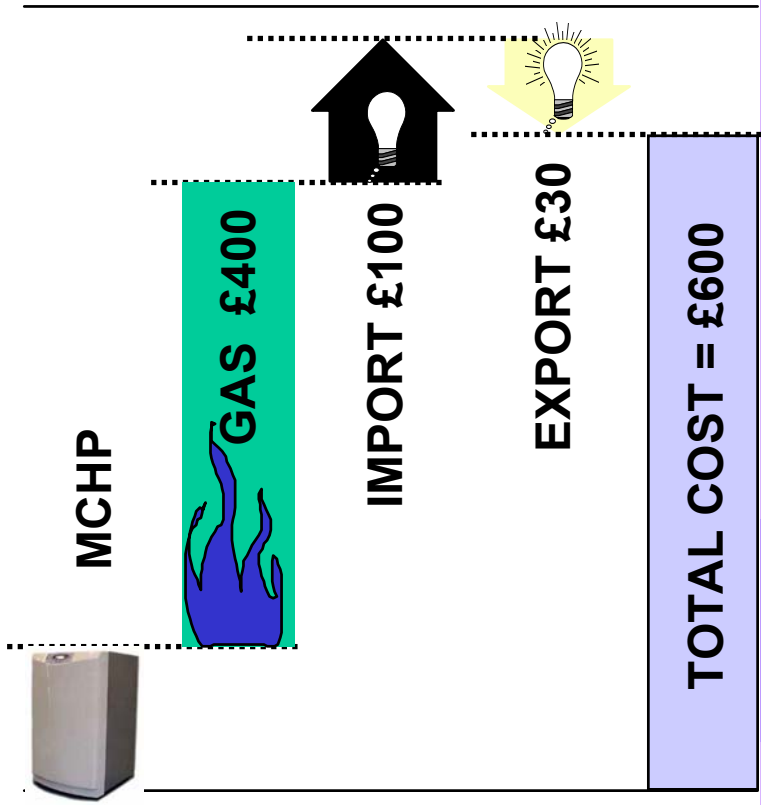
- Whispertech (1kWe/8kWt)
- BG Microgen (1kWe/45kWt)
- Sigma (3kWe/9kWt)
- ENATEC (1kWe/45kWt)
- SIG (1kWe/?)

SE micro CHP economics*

CONVENTIONAL BOILER
20 000kWh THERMAL DEMAND



1 kWe SE MICRO CHP UNIT
4 500kWh ELECTRIC DEMAND



*** marginal cost basis-end user economics**

EA Technology field trials

- 1990 feasibility study
- 1999 laboratory trials & evaluation
- 2000 sheltered trials (5 units)
- 2001 alpha trials (20 units)
- 2002 beta trials (30 units)
- 2003 “commercial” trials?

SKIP

2002-2003 TRIALS

- 30 installations
- 15 Ipswich area (E)
- 15 Chester area (NW)
  - 10 existing
  - 5 new
- Mix of sizes, ages, constructions and occupancy









technology

Example trial house

- 138m^2 total floor area
- three storey - living on mid floor
- built 1998
- insulation to Building Regulations
- usage pattern
  - continuous occupancy
  - copious showers

Original heating system

- Wall-hung boiler in kitchen (mid-floor)
- Y-plan (3-port valve)
- Single zone
- 7-day programmer
- room/cylinder thermostat

Micro CHP system

- MK III WhisperGen
- Directly below boiler in kitchen
- Integral G83 LOM protection
- Controlled from existing programmer (run signal)
- Remote data logging and on-line diagnostics

Economics (nominal)

• Annual gas bill	£	550
• Annual electricity bill	£	450
• Annual gas consumption	kWh	35 000
• Annual space heat	kWht	18 000
• Annual DHW	kWht	6 000
• Annual electric consumption	kWh	6 000
• Generation	kWhe	3 400
• Projected savings	£	150-200

Environmental comments

- will target CO_2 savings be achieved?
  - higher mean internal temperature (MIT)
  - more likely to mitigate increase in energy demand than actually reduce it?
- target market (not fuel poor)
  - % savings
  - comfort factor

Field trial conclusions

- Raises awareness of pre-existing shortcomings
- Anticipated energy savings may lead to higher comfort demands and consequently lower savings
- Need to target customers carefully and give clear message about what micro CHP will or will not do for them
- Excellent service support essential

What happens next?

- Live market test
  - partnership with housebuilder
- 400 systems to be sold in 2003
- New-build with thermal store
  - improves performance
  - simplifies installation
- Need for ongoing monitoring
  - profile settlement (economic)
  - SEDBUK, EEC etc (environmental)

Compliance & incentives

- Mandatory standards
  - Product (CE marking, applicable directives)
  - Network connection (G83, CWA)
  - Domestic connection (IEE, SEDBUK)
- Desirable “passport to benefits”
  - CHP QA
    - CCL exemption
    - Enhanced capital allowances
  - SEDBUK/EEC
    - EEC eligibility
    - *Renewables* obligation eligibility?

Obstacles

- Technical standards and procedures
  - G83 is great simplification
  - environmental accreditation
- Metering, settlement and trading
  - OFGEM currently seeking appropriate solutions
  - no problem if 100% auto-consumption
- Skills shortage
  - across industry
  - SBGI working group
- Implications for DNO, suppliers etc.

Things to avoid

- Complexity - CHPQA
- Discriminatory charging
- Net metering
  - Unsustainable
  - Encourages lazy thinking & inefficiency
  - Lame duck support
  - Raises (understandably) incumbent hostility
  - Does not reflect true micro CHP value
- Inaction

Conclusion

- Micro CHP is economically viable now
- Emerging technologies and new products will make micro CHP even more cost-effective
- Government incentives will further enhance CHP economics
- Simplified connection and trading will remove technical and economic barriers