Climaespaço - Lisbon

Trigeneration and DHC, this strictly commercial project, was born to provide the Expo98 intervention zone with a sustainable supply of energy.

4x10 Km of DHC

Condenser cooling with Tagus water

Electrical power 4.7 MW

Cooling power 40 MW

Heating power 44 MW

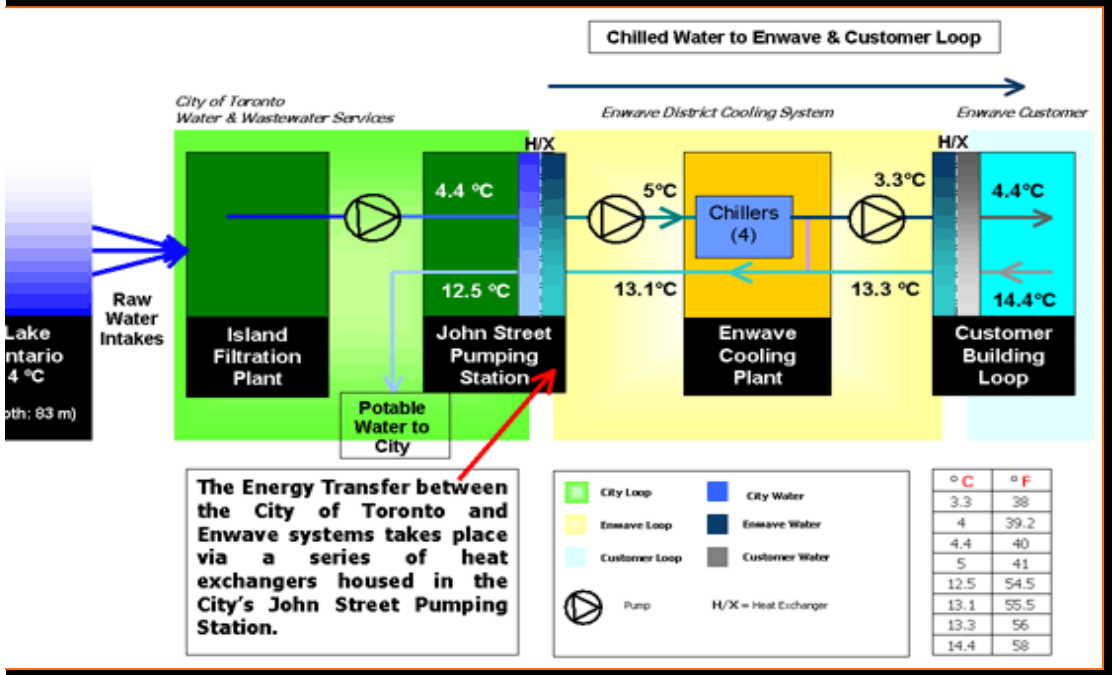
TES 15000 m3 of CHW@4ºC

Annual revenues 6.7M€@2001

Profitable Utility Company

75% over primary energy

Toronto Deep Lake Water Cooling



DPLW will be available in Spring of 2004

heat exchangers between ENWAVE and Toronto's water supply system (4,4ºC to 12,5ºC).
Water piped from a depth of about 85m.
35 MW of capacity is freed from the electrical grid
45,360 kg of refrigerants are eliminated
C02, N0x and S0x emissions are reduced

District Cooling
Energy use is reduced by up to 75% compared with conventional chiller equipment
DLWC cooling saves 30 million kWh/year, enough to meet the power requirements of 4,200 homes

SHETLAND

- Expansion of a heat network
- Waste to Energy plant
- Homes, schools, public buildings.

- Community Energy Grant: £500,000
- Public sector cost saving: £150,000
- Residential fuel bill saving: £22,000

LEICESTER

- LCC with Powergen Energy Solutions Ltd
- Turnkey operation
- Tackling Fuel Poverty
- 3 CHP schemes each with approx:
  - 600 kWe gas reciprocating engine CHP
  - 950 kW heat output
- High and Low rise residential, shops, school, old folks home

- Just received £5M grant for largest CHP network in Europe?
- LCC with IT – ESCo initiated?
- Electricity exported across DNO system to other LCC sites
- Income re-invested in effective energy

SOUTHAMPTON DISTRICT ENERGY ESCo

- Council / Utilcom ESCo
- Originally Geothermal, increasingly Gas CHP (90%), planned Anaerobic Biogas CHP
- > 70,000 MWh Energy
- > 5.7 MWe Electricity to grid
- > 1,200 MWh providing Chilled Water
- > 11km insulated pipes
- > 2km radius of Heat Station
- > 20 major customers
- Includes 3 Hotels, Hospital, HE College, Shopping Centre, Residential, Civic, Leisure
- Plans to incorporate 49MW power station

MANCHESTER

UMIST

- Expansion of campus heat network
- Installation of absorption chilling
- Community Energy Grant: £533,499
- Annual fuel bill saving: £270,621

Manchester District Council

- ESCo partners Powerminster in PFI
- Replace Gas warm air and electric heat
- Installing 2x 150kWe CHP
- 417 homes
- Annual saving £75k

ABERDEEN

Aberdeen University…

- 4th Feb 2004 - **£1,753,000 grant** for CHP
- **3 halls** of residence, **28 academic** buildings

City of Aberdeen …

- **Aberdeen Heat and Power ESCo**
- Upgrades to fabric, insulation and heating
- CHP proposed as solution for **59 multi-storey blocks**
- (4505 homes) currently electrically heated
- £**736,000 grant** for 1st phase CHP (4 blocks, 288 flats)
- Eliminate Fuel Poverty affecting 70% of residents
- Rolling program anticipated…

GLASGOW AND SURROUNDINGS

Recent…

- 4 Feb 04 – Clydebank HA – £775,760
- CHP. 400 homes, school, hall

- 4 Feb 04 – Midlothian – £500k grant
- CHP / Heat-pump (mine-water)
- 500 new build homes, school, offices

- University of Glasgow – £66k grant
- Reverse cycle heat pump ICM bldg
- £16k for CHP feasibility study

- No Glasgow ESCo?

- Glasgow Tackling Fuel Poverty
- Heating, insulation, glazing etc.
- Individual homes

Further back…

- Hutchestown circa 1999 CHP
- Refurbishment (conservatory balconies, over-cladding, double glazing)
- 1000+ homes
- Cost £3200 saves £500 p.a. per home

- Easthall circa 1992
- conservatories, insulation, solar close?

- Heatwise – since 1980's
- Draughtproof, Insulate, CH.
- 110,000 homes

- Old DH coal, then oil
- 70's oil crisis - conversion to gas

WOKING ESCo – Thameswey Energy Ltd (TEL)

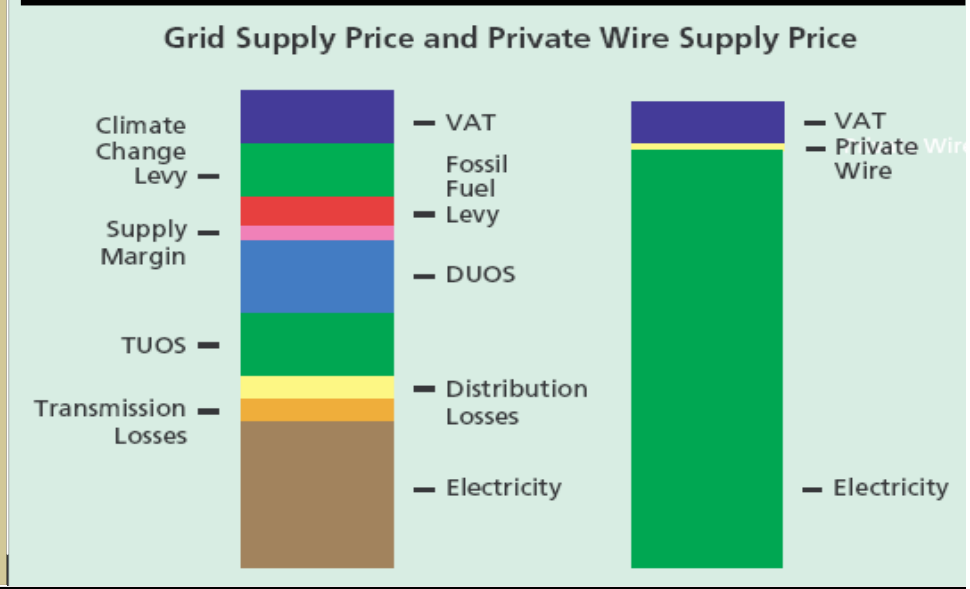
• Thameswey Energy Ltd (TEL) 19% /81%
- PP JV with ESCO International A/S (Dk)
- Green costs <= Brown electricity
(avoid TUOS, DUOS, CCL, FFL, losses)
- Private and public elec wire networks
- Heat and chilled water mains

• Phase1 Town Center:
- 1.46MWe CHP (130% peak e)
- 1.4MW absorbtion cooling
- 160m3 thermal storage
- 2 Hotels, 3 leisure, council offices

• Phase 2 Woking Park
• 200kWe Fuel Cell CHP (ONSI PAFC)
- 836 kWe Recip Gas CHP (135% peak e)
- Leisure, Council residential
- 100m3 thermal storage

• Smaller sites - Integrated PV / CHP
- Sheltered housing by DNO network
- Civic offices (Town Center network)
- Other Council Buildings

TEL funds projects through profits, grants and private finance.



WOKING ESCo – Thameswey Energy Ltd (TEL)

- Mini CHP, Integrated PV / CHP

- 6 council small scale sites, 2 examples..

- Priors Croft sheltered housing (mini CHP)

- 33 1 bed flats
- 22kWe CHP (50kW heat), 6x cond boiler
- import / export thru DNO network
- private wire within residence
- energy efficiency measures

- Brockhill Integrated PV / CHP

- UK's largest domestic PV install
- BP Solar BP 580 mono – xtal pseudo sq
- Initial 36.5kWp PV + 30kWe gas CHP
- Solar meets summer load, CHP winter
- No electricity required from grid
- Is connected to DNO network – net exporter
- Phase 2 – increase PV to 81kWp
- Solar cost £351k (-£75k grant received)
- Reduced cost due to simplified private wire connection vs normal grid connect

Installing the PV arrays on the Brockhill elderly residents home.

WOKING ESCo – Thameswey Energy Ltd (TEL)

• One Grid Connect per private wire network

(Low cost v multiple Dist'n network connects)

• Operate in Island mode if Grid down (130% peak e)

Indirect benefits to private wire customers:

• No capital costs

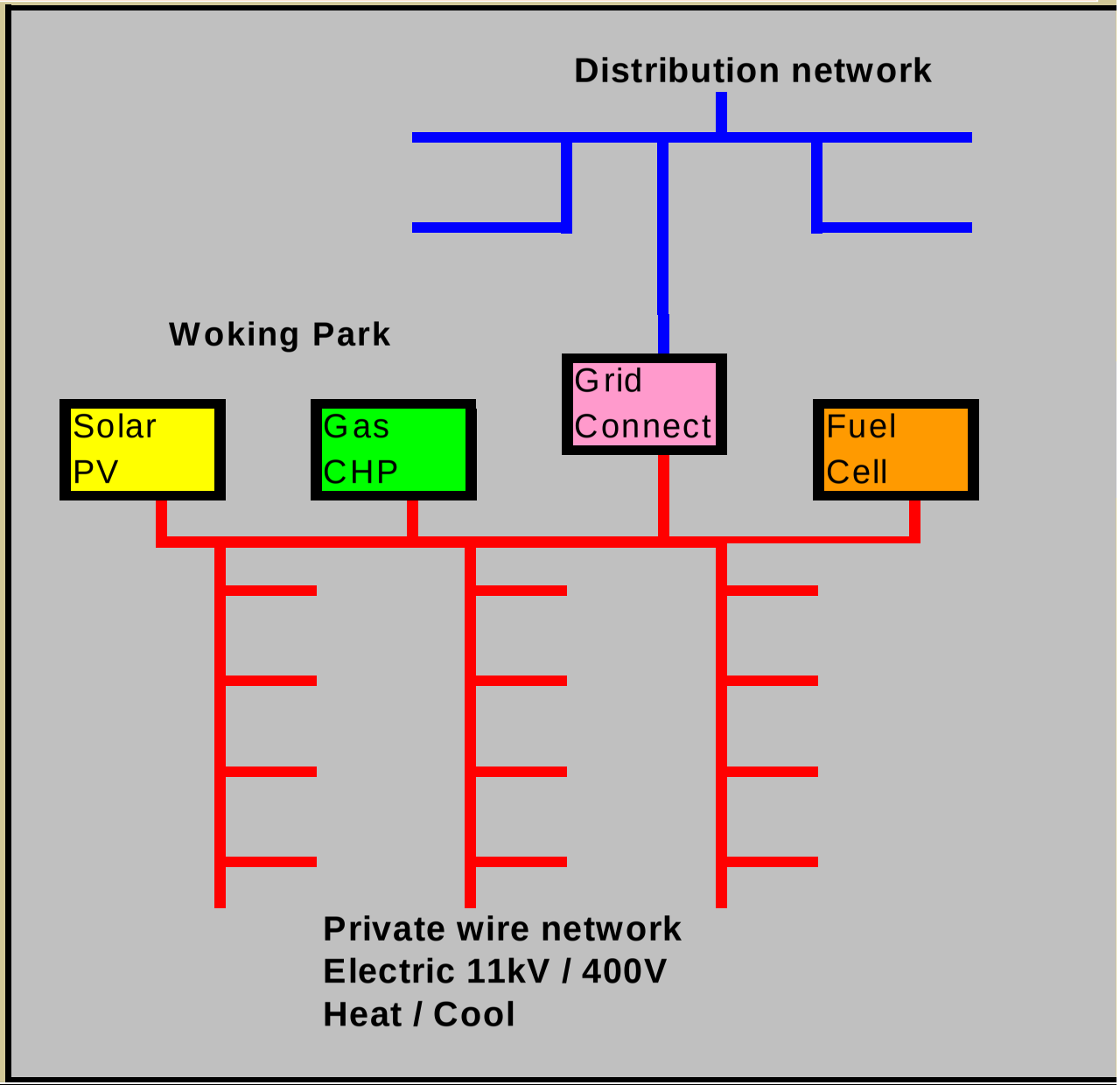
• No plant room costs

• No backup generation costs

• No maintenance costs

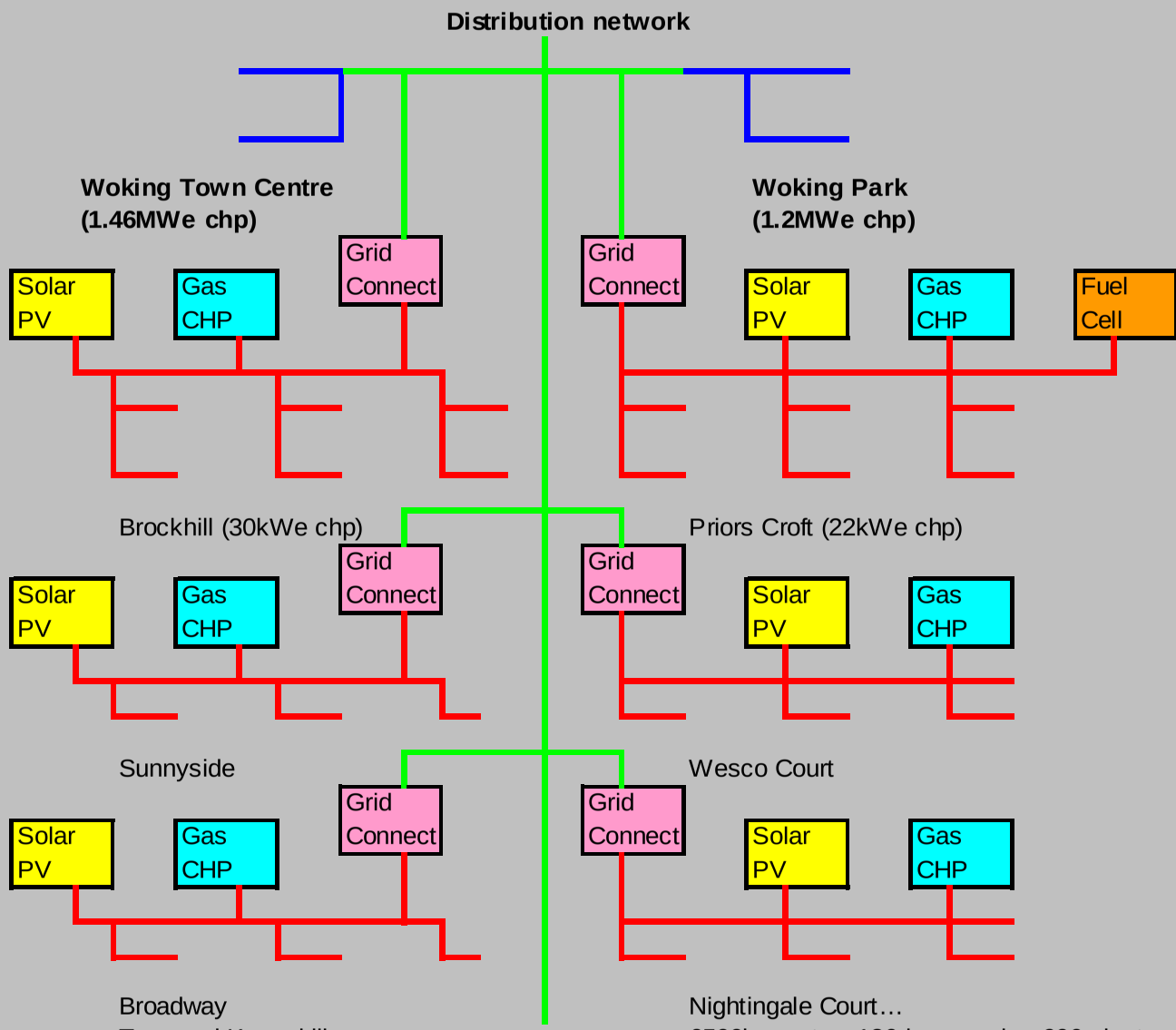
• Non electric refrig / aircon

• Risk moved to supplier



WOKING ESCo – Thameswey Energy Ltd (TEL)

• CHP sites connected through Distribution Network



WOKING ESCo – Thameswey Energy Ltd (TEL)

Utilise Distribution Network:

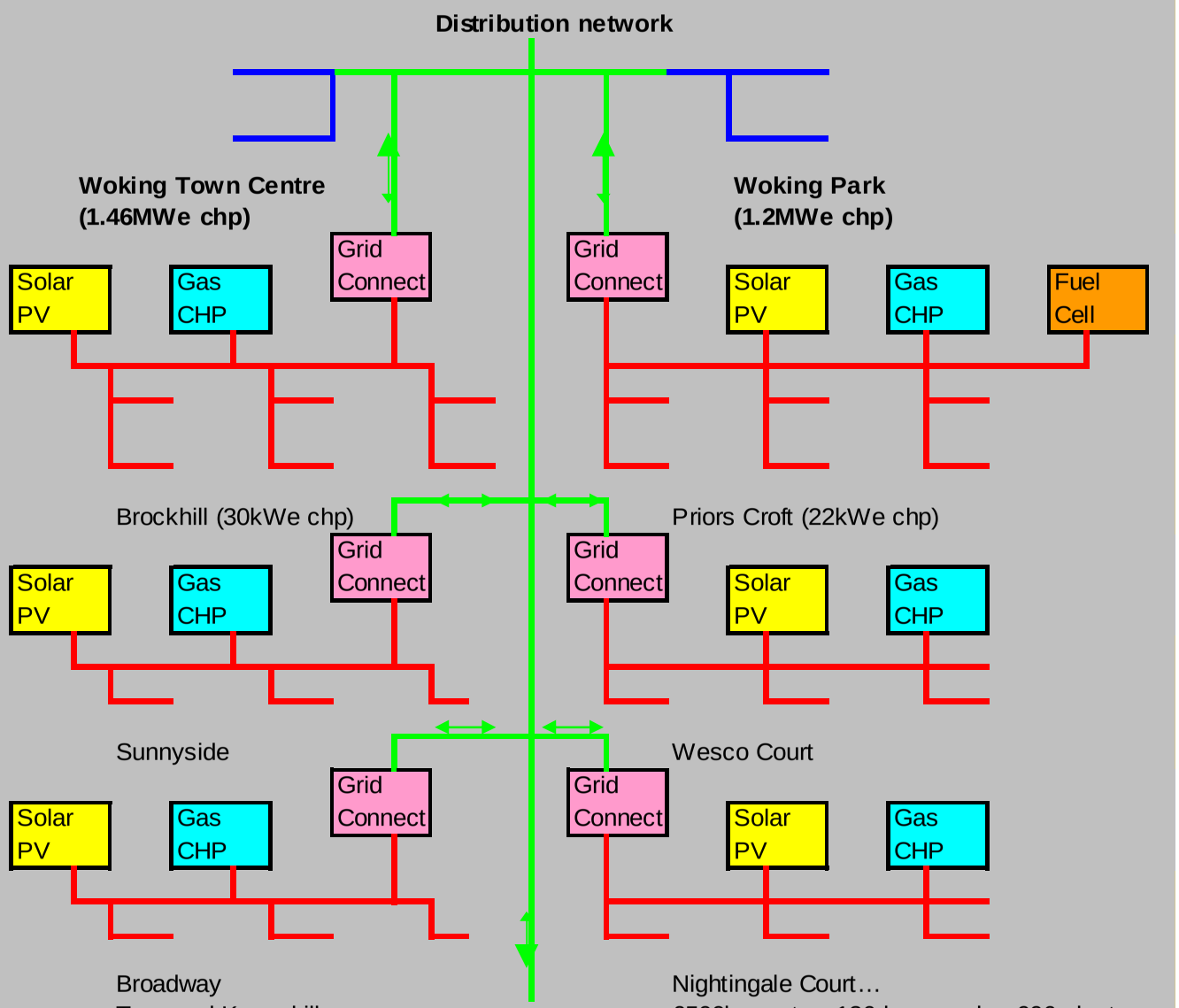
- Exempt Supplier Status

  (Electricity regs. 2001)

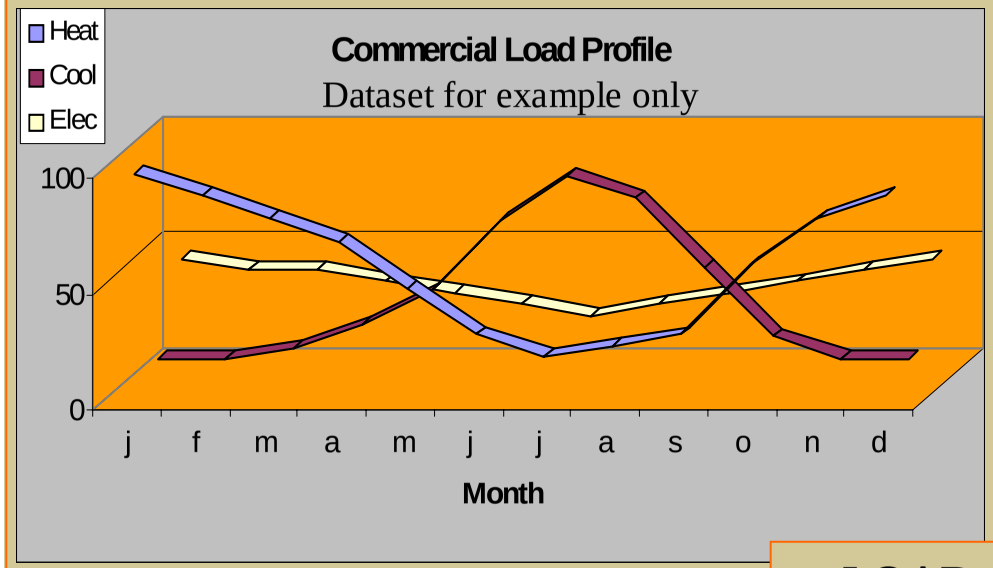
- Up to 100MWe Pwire
- Up to 5MWe over DN
- Aim is all electricity consumed locally

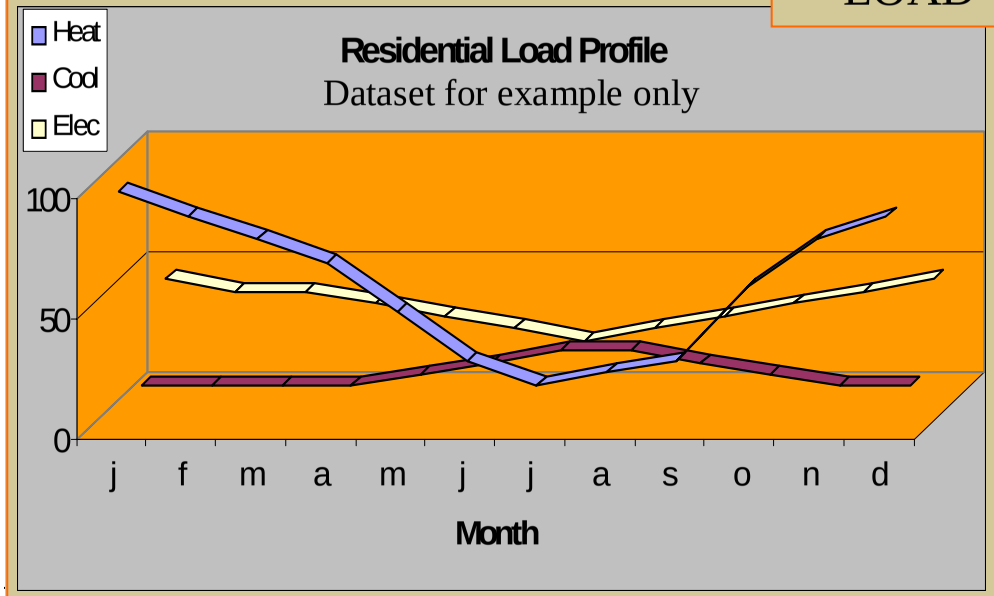
Benefits:

- Maximise Profits
- Easy Growth
- Balance, standby, top-up, backup and export to grid
- Allows maintenance
- Low risk



WOKING ESCo – Thameswey Energy Ltd (TEL)





LOAD v SUPPLY

Commercial Supply (Town Centre, Woking Park):

- Med scale CHP (1-1.5MWe)
- Multiple Boilers, thermal storage
- Absorption chillers
- PV

EXPORT ELECTRICITY

Residential Supply (Brockhill..):

- Small scale CHP (~30kWe)

  (winter use only)
- Multiple Boilers
- PV

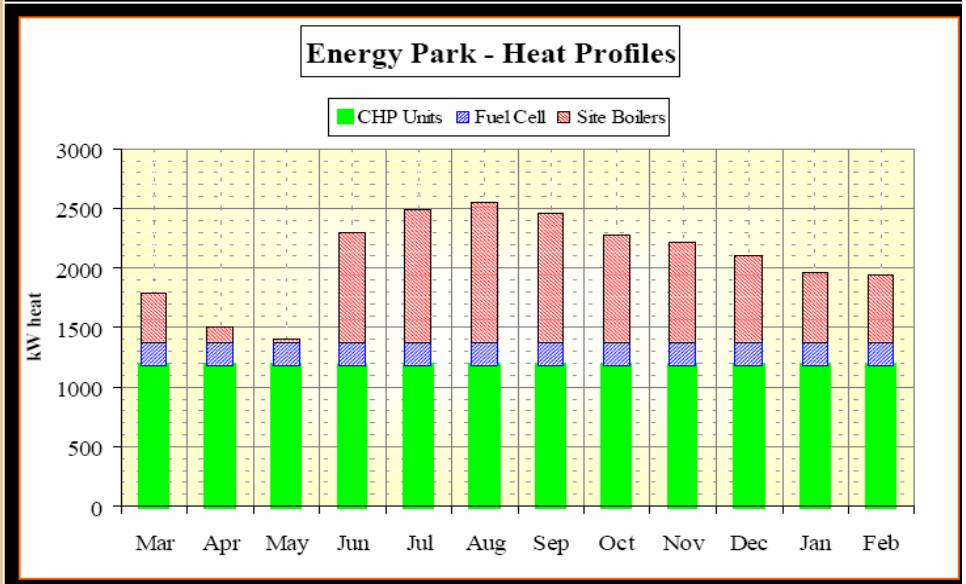
ENERGY INDEPENDENCE

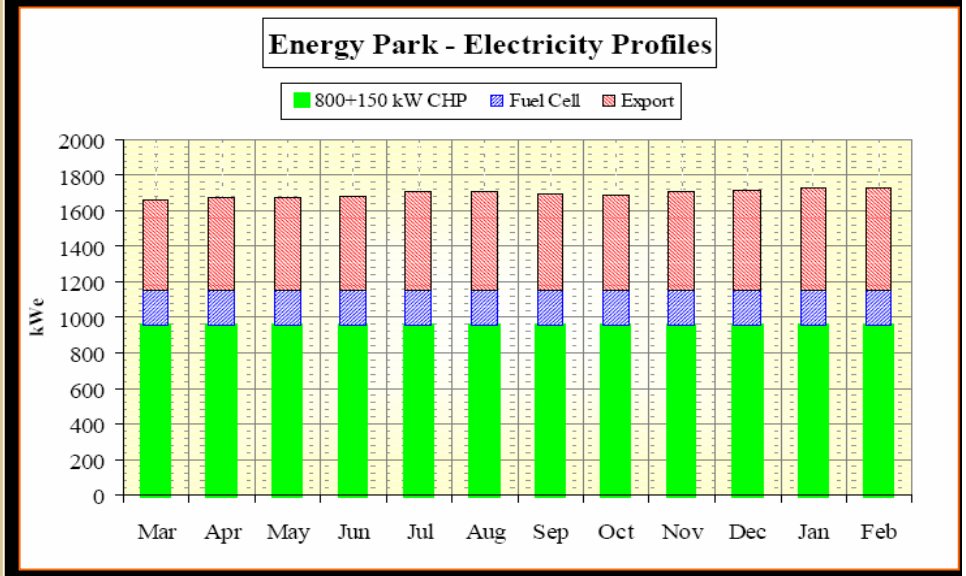
WOKING ESCo – Thameswey Energy Ltd (TEL)

Actual Woking Park Data…

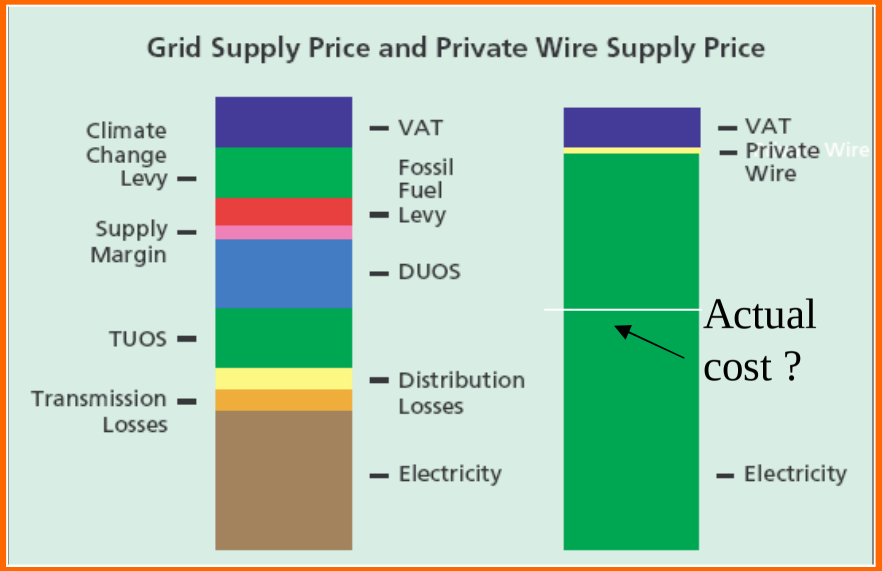
Leisure complex

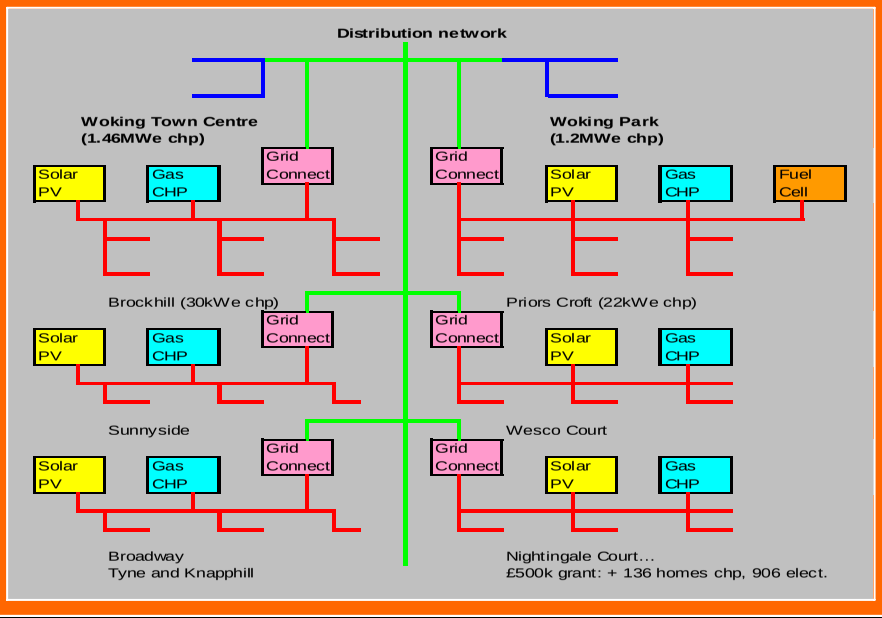
DTI Fuel Cell Monitoring Project
(Prof M Fry)





WOKING ESCo – Thameswey Energy Ltd (TEL)





Key Learning

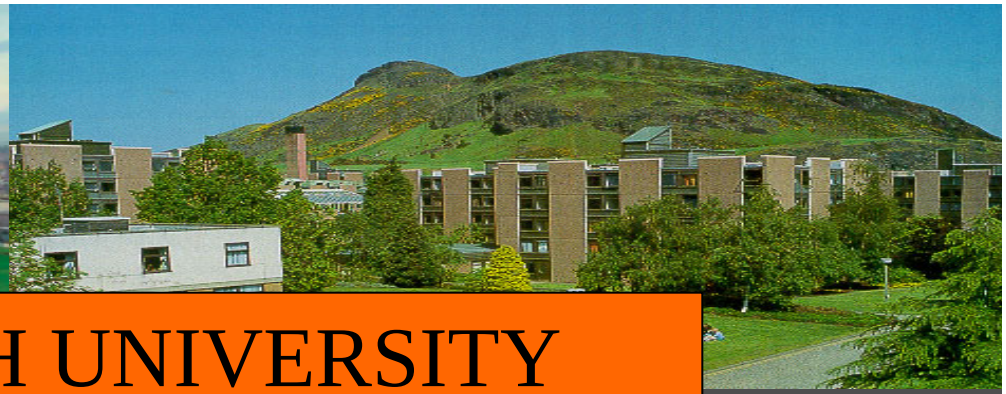
- EESCO – Energy Efficiency
- ESCO – Energy Supply
- Danish experience
- Exempt supplier
- Profitable electricity
  - Private wire
  - Distribution network
- Sizing strategy
- Load v Supply balancing
- Islanding benefits
- Plant, Maintenance, Risk benefits
- Investment RES / CHP combinations

(FC 16 yr pb, PV 25yr+ pb)

EDINBURGH

City of Edinburgh…
- LEEP – Apr 2003, pilot study, tenement flats (ESRU)
- Western General Hospital, 1MWe gas engine CHP operated by SSE

Edinburgh University…
- **Estate Management Company (SPV)**
- 4 Feb 2004 – **£2.7M grant** for CHP to replace steam
- 19 teaching and research buildings
- 6 Feb 2003 – **£1.6M grant** for 2.7MWe CHP to replace steam
- > 30 buildings
- 7 Aug 2002 – **£250k grant** for 526kWe CHP to replace steam
- 2069 study bedrooms



EDINBURGH UNIVERSITY

ings Buildings

Chancellor Square

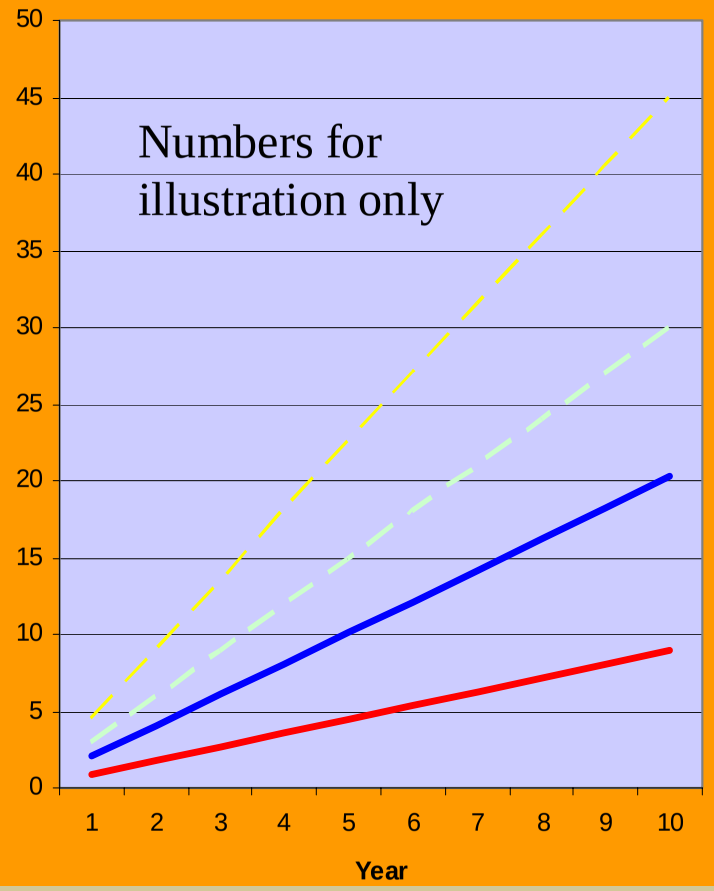
Pollock Halls

- CHP to replace steam – 49 buildings inc 2069 residences
- 2004 £2.7m grant for 19 teaching and research buildings at Chanceller Square
- 2003 £1.6m grant for >30 buildings at Kings Buildings (2.7MWe/2.8MWth)
- 2002 £250k grant for 2069 residences at Pollock Halls (526kWe/667kWth, Private wire)

- University led ESCO
- Finance through fully owned University Estate Management Company covenanting profits to university.
- Funding – estates imp fund (20%), grants, university restructuring fund (private finance)
- CarlBro (DK) Design Consultants
- Crown House (Carillion) 10 year O+M contract

ESTATE IMPROVEMENT VAPOURWARE.....

Estate Energy Improvement Rate



Cum refurbished at 4.5%pa

Cum refurbished at 3%pa

Cum energy saved if 4.5% refurbished each year and 45% improvement when refurbished

Cum energy saved if 3% refurbished each year and 30% improvement when refurbished

ESCO Benefits?

- ESCO gives freedom from public sector borrowing constraints?
- Specialist Energy Co. provides more effective improvements?
- Compare Danish Green Energy Co v Standard PFI?

Dundee University CHP

University created an operating company: DUUSCo to undertake the procurement and operation of the installation. The University became self sufficient in electrical generation (deregulation in UK) with CHP using surplus heat with the existing campus DH (since 1962).

The CHP unit is comprised of 3 gas fired engines, 4 stroke 20 cylinder spark ignition, running at 1500 rpm (3MWe total). Heat recovery from exhaust gas, first stage turbo intercooler and jacket water is passed by plate heat exchangers into the returning district heating system water before it enters the existing boiler plant (pumping?). If water conditions permit, all the available heat is utilised in the pre-heating function. Otherwise some of the heat is used to heat nearby buildings (LT?) and any surplus being dissipated to atmosphere by backup coolers.

A 4 MVA transformer interfaces between the alternators and the University's 11 kV distribution network.

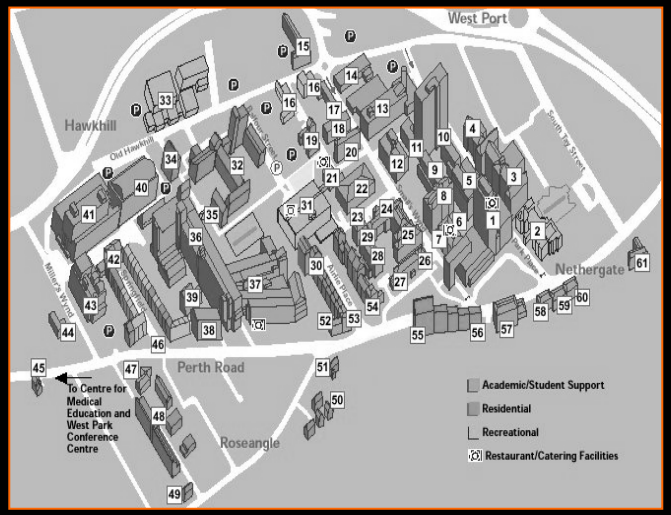
operation of the generators which operate in load following mode with output level set to minimise the electricity importation rate.

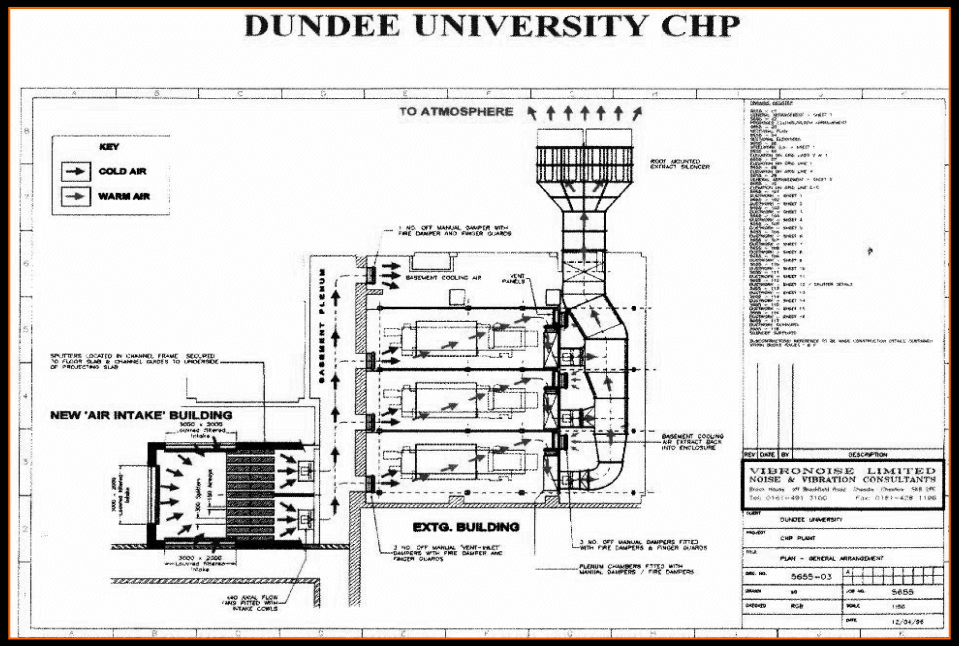
The loads vary from 1.2MW to 3MW. The generators operate to minimise the electricity importation, working 24h/d – 7d/w.

Noise control measures were taken to minimise environmental impact (37dBA).

gas reciprocating engine

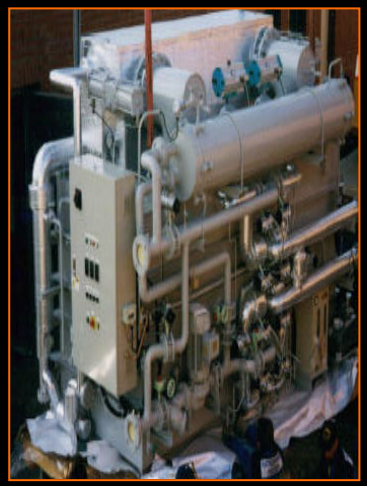
Dundee University Factsheet

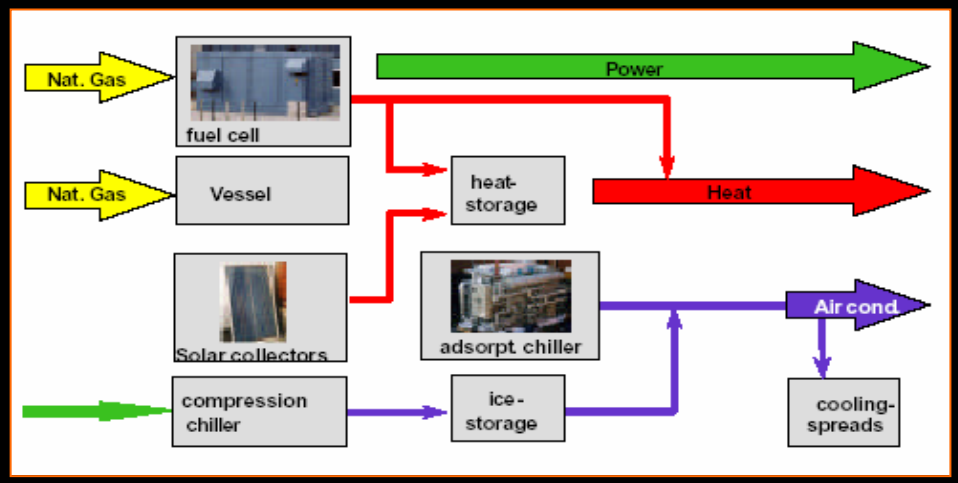




cost	2.000.000£
electrical load	3000kW
heating load (average)	1800kW
cooling load	n.a.
CO2 savings (vs conventional system)	7000t/y
£/kWe	670
£/kWt	1100
£/kWc	n.a.
savings	360.000£/y
pay back	5years

Malteser Hospital Kamenz





- energy efficient building
- EC Thermie's demonstrational project
- fuel cell
- adsorption chiller
- backup boilers and compression chiller
- ice and hot water thermal storage
- solar PV and HW
- 1,8 MW heat
- 220 kW cool
- 440 kW electrical power

Malteser's Hospital in Kamenz

This 210 bed hospital near Dresden was taken as a demonstrational project, under the 5th framework program for RTD – part ENERGY. Hence there was a broad dissemination of results until the plant started to be run by the hospital's technical services.

Due to the innovativeness of some applied technologies, the commissioning was held for over a year, facing several technical problems. These were monitored and are well documented.

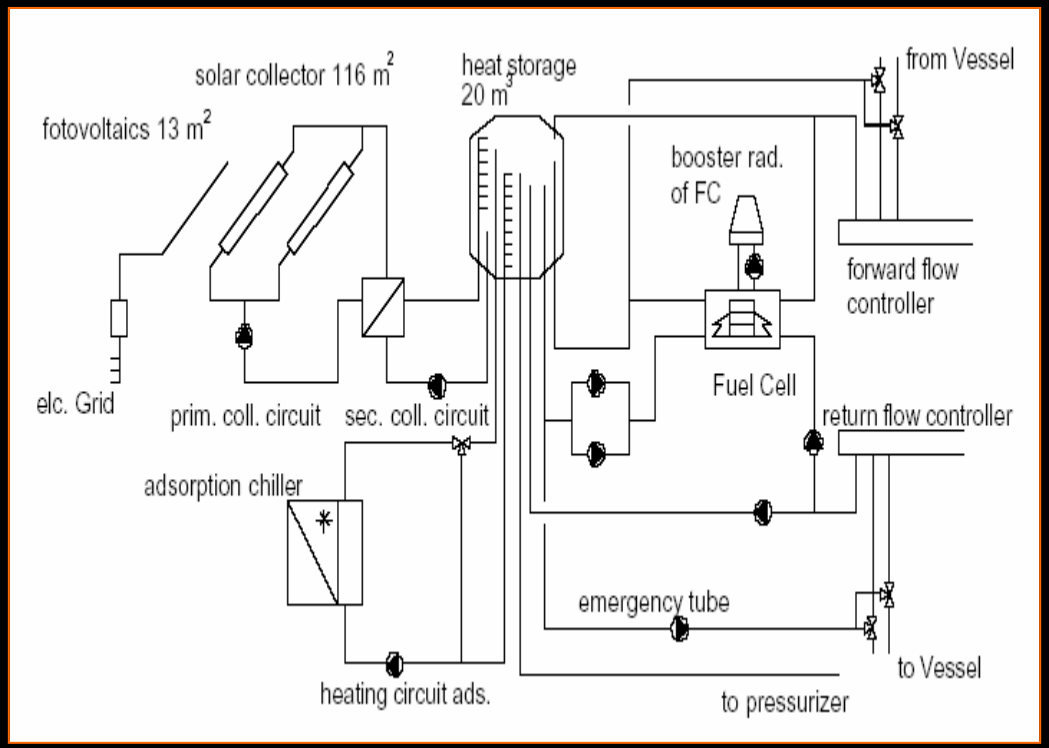
It consists basically in trigeneration, meeting the electrical base load (fuel cell), ambient heating (backup boilers), air conditioning (adsorption chiller – backup compression chiller for peak loads). There is integration of REs (solar hot water and PV's). Gaps in supply demand are minimised with heat storage, ice banks and cold water storing.

overall costs > 3.000.000€
pay back around 10 years! (with 60% of cost funded)

It is a very interesting project for the integration of diverse technologies and all the monitoring taken during comissioning.

schematics

Phosphoric Acid Fuel Cell - natural gas - 200kW electrical base load; 110kW@90ºC; 110kW@60ºC
115 m2 of vacuum solar collectors (40kW@70ºC_August)
2 backup boilers 900kW
heat storage (20m3), ice storage (8m3), CHS (1,5m3)
adsorption chiller 110kW - requires 175kW@80ºC
backup compression chiller (peak loads) 80-120kW
13m2 of PV's (1,5 kWp designed for AC pumps - but connected to the grid)



cost	2.000.000€
electrical load	200kW
heating load	1800kW
cooling load	220kW
CO2 savings (vs conventional system)	n.a.
£/kWe	10.000
£/kWt	1.100
£/kWc	9.000
savings	n.a.
payback (40% overall costs)	10years