Gas CHP

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Gas CHP overview

- Technical aspects
- Financial aspects
- Planning considerations
- Case study

Combined Heat and Power (CHP)

- Generates electricity while utilising 'waste' heat from the process
- Effective where electricity cost is much higher than gas cost
- Relies upon assumed high CO_2 burden from grid-supplied electricity
- Benefits from reduced distribution losses
- Scalable from 5kW + but efficiency affected at smaller outputs

CHP system fuel 100 units

Heat

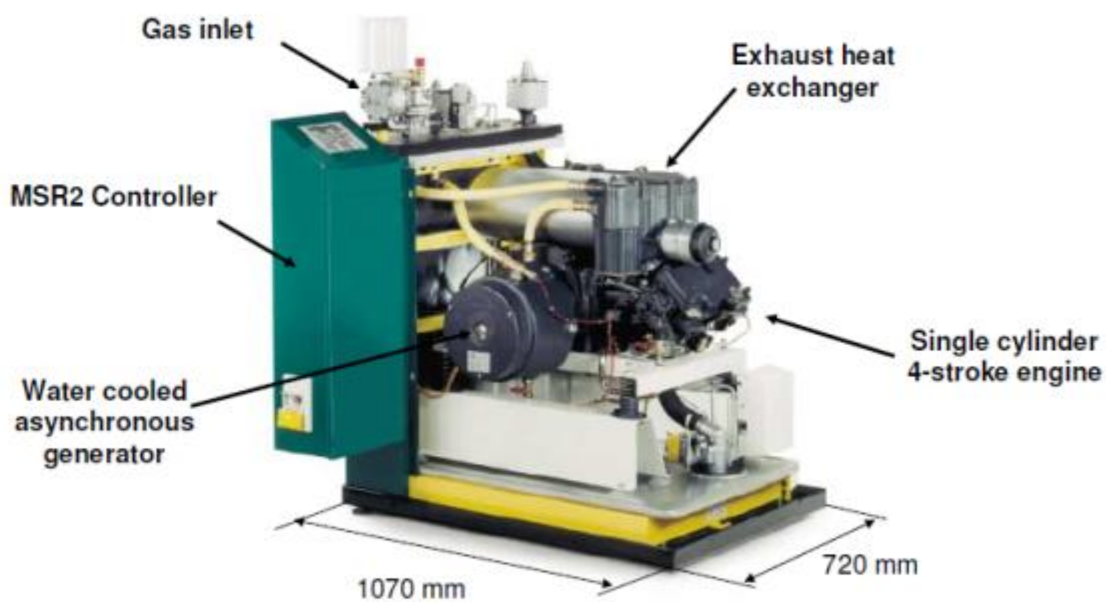
50 units

Electricity

30 units

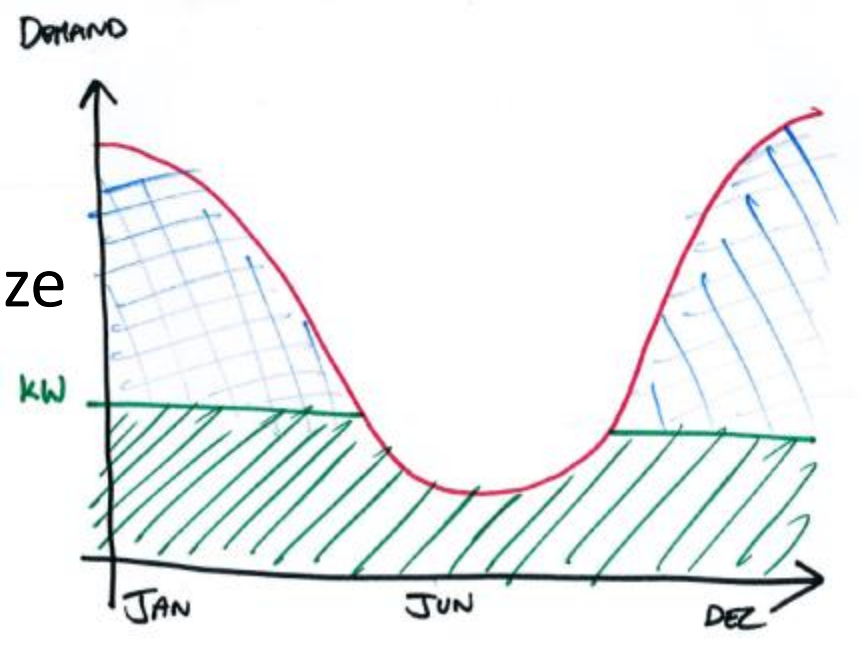
Key Components

- CHP engine
- Heat recovery (water jacket and exhaust recovery)
- Inverter
- Electrical export meter
- Suitable electrical connection
- Top-up boilers

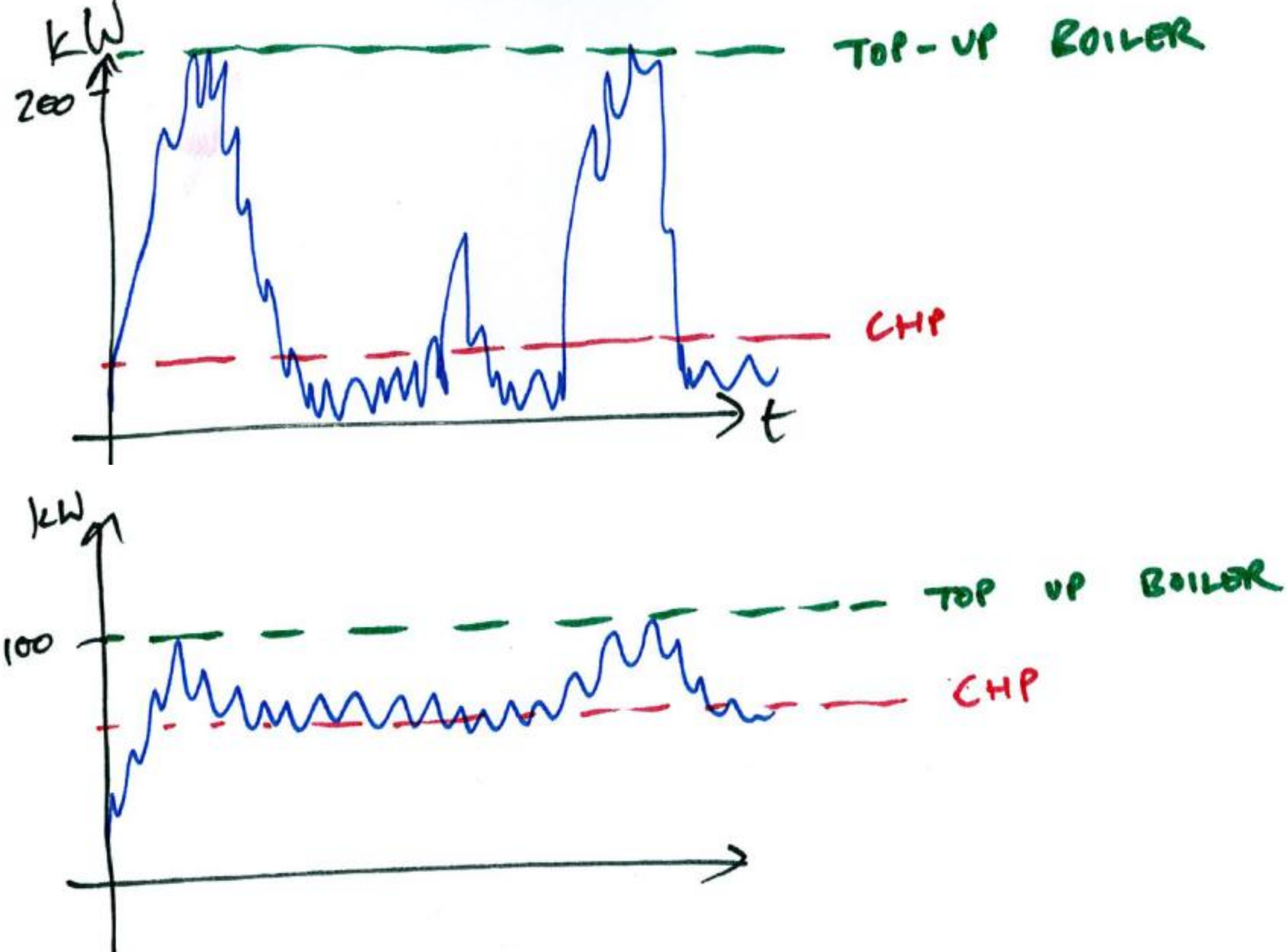


Design issues

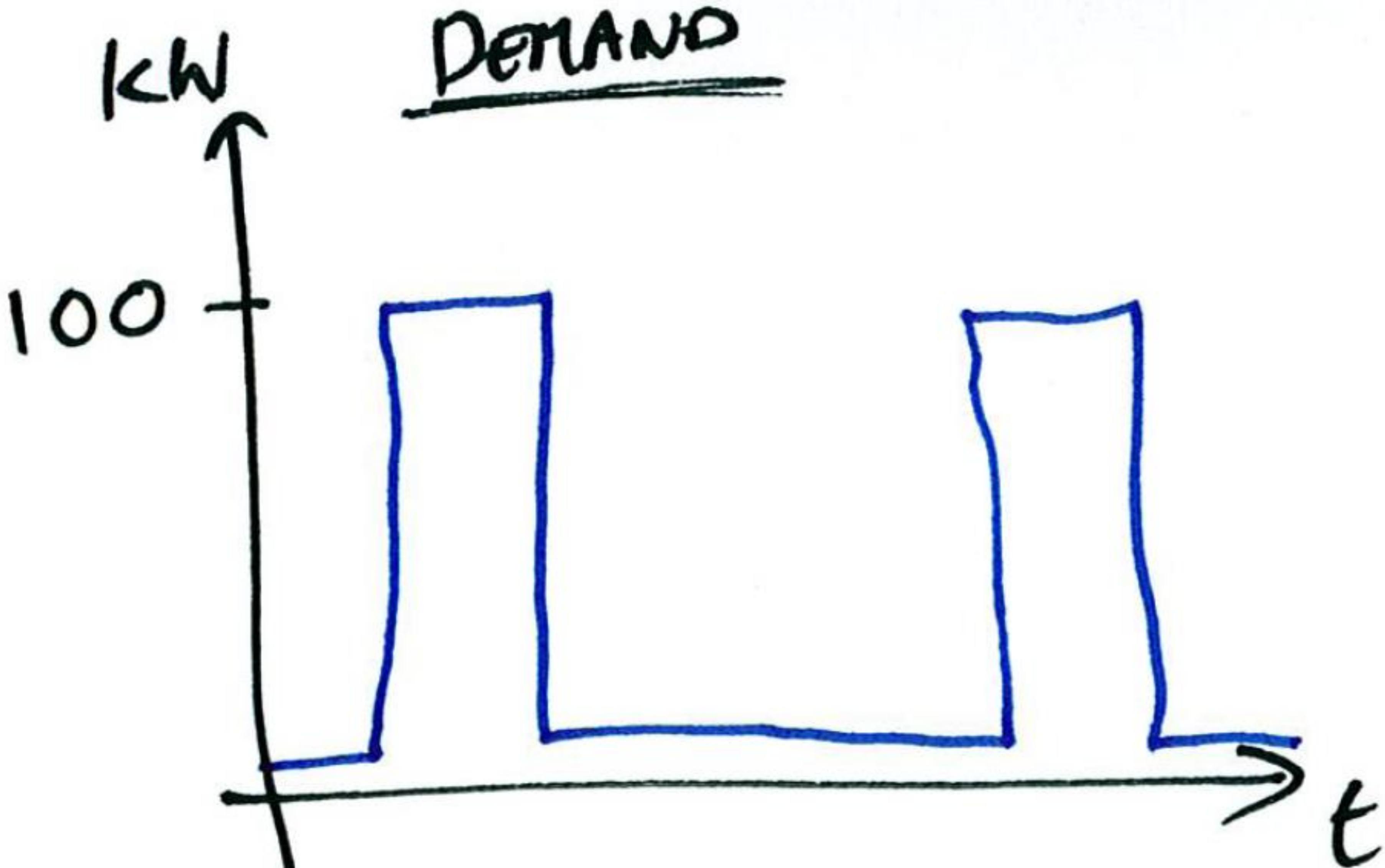
- Base load size and consistency
- Daily and seasonal demand patterns
- Thermal storage
- System size and effect on electrical efficiency
- Noise and vibration damping
- Design for thermal
- Design for electrical
- “Spark gap”
- Efficiency related to system size



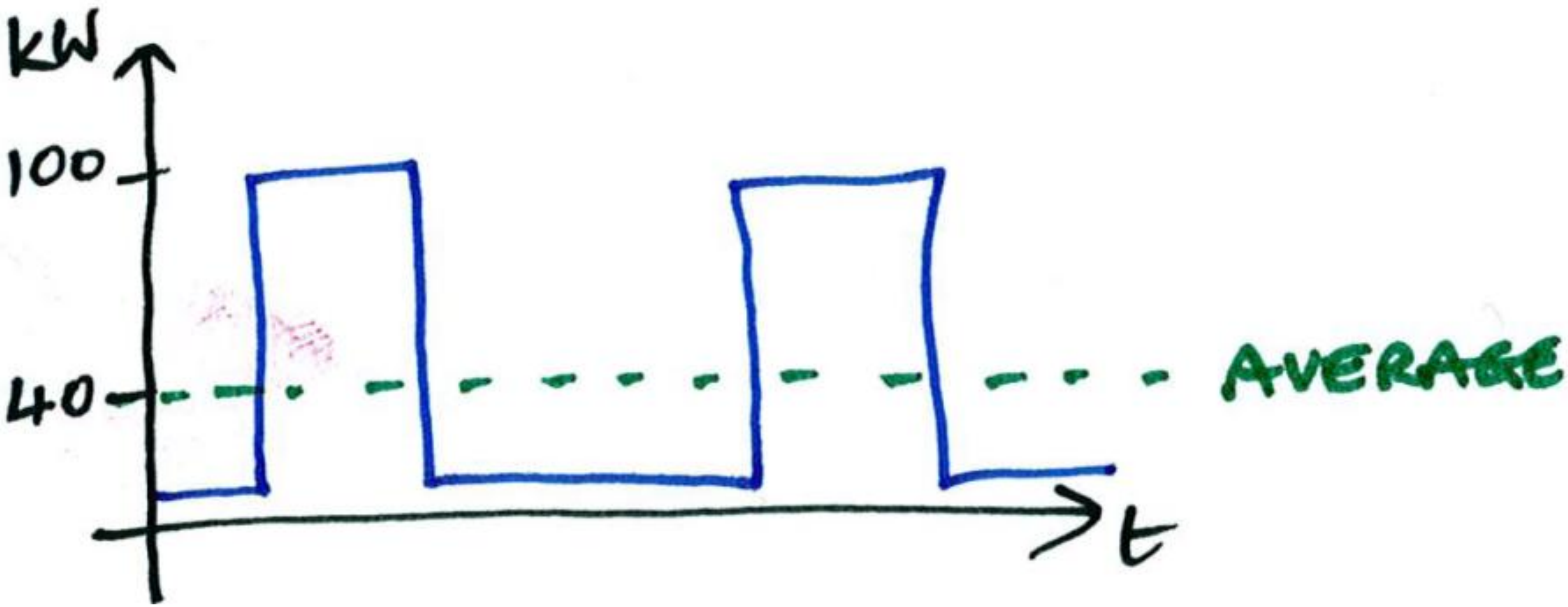
The importance of demand profiles



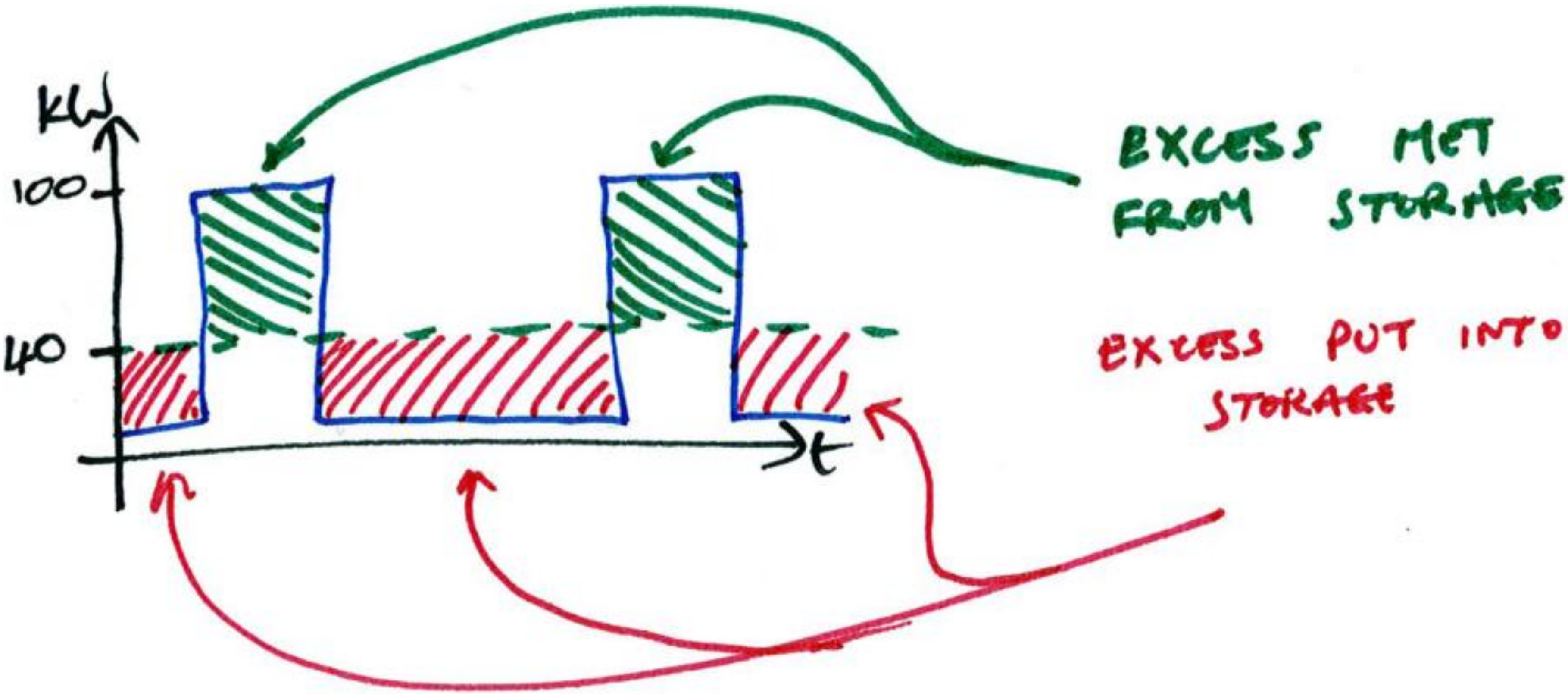
Thermal storage



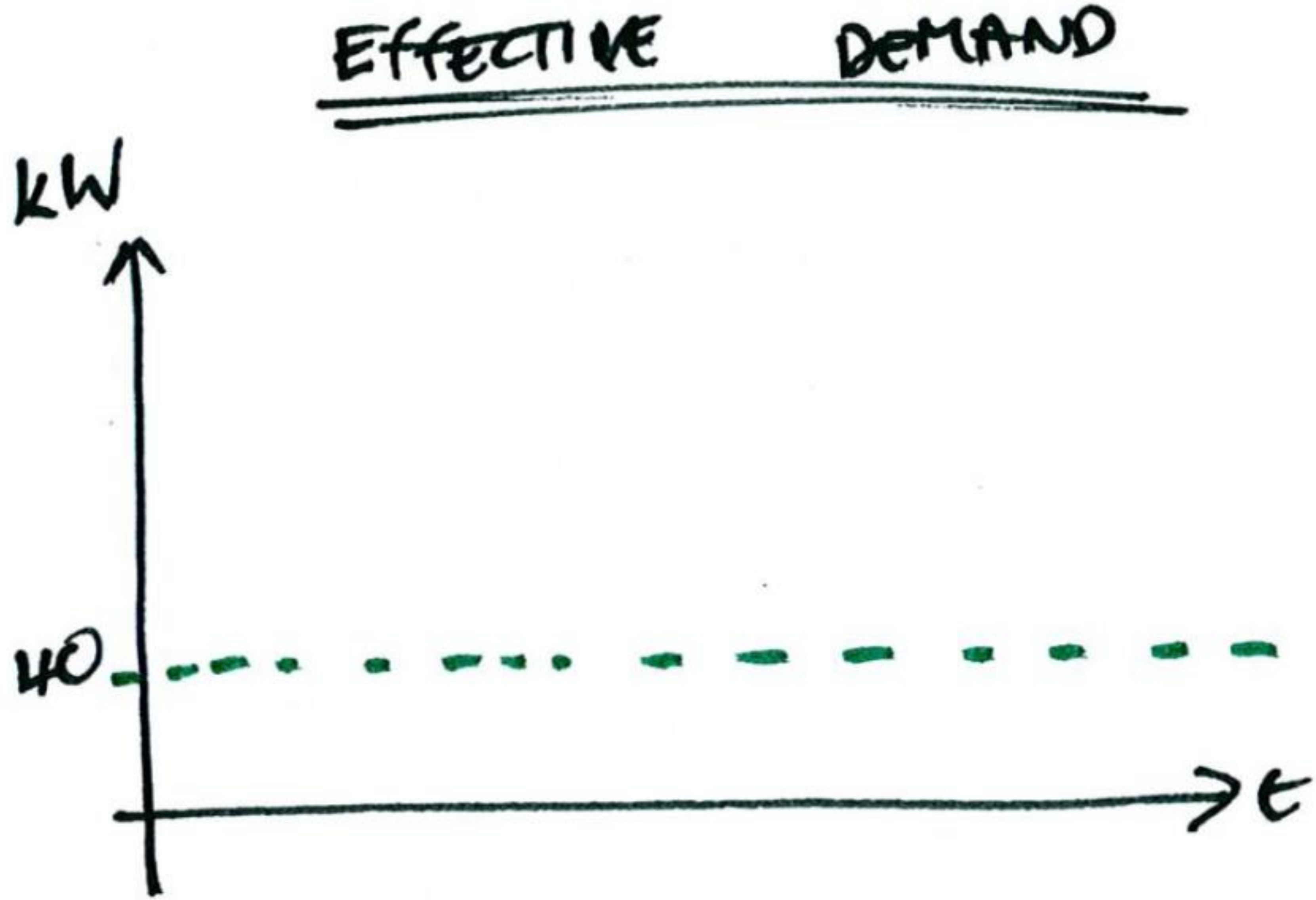
Thermal storage



Thermal storage



Thermal storage



Potential applications

- Most effective with smooth base load demand, e.g.
- Sports centres
- Large public buildings
- NHS sites
- Heat networks
- Anywhere with sufficient demand and effective use of thermal storage to smooth peaks in demand

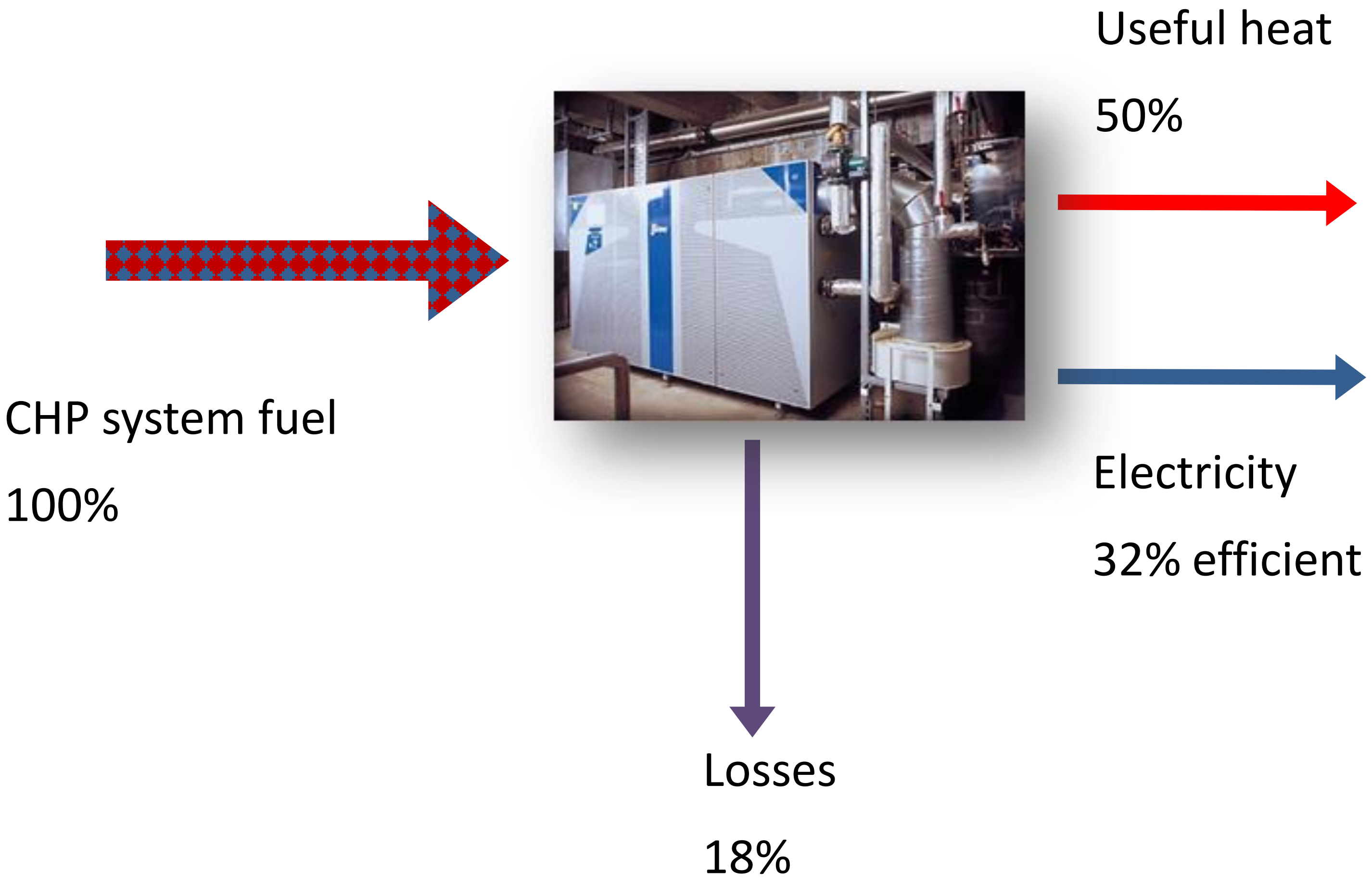
Performance characteristics

- Typical capital costs:
  - £500-£1,500/kW_{th}
- Typical system efficiencies:
  - Electric efficiency: 24% - 45%
  - Thermal efficiency: 35% - 55%
- Typical system size: 5kW_{elec} - 500kW_{elec} +
- Key financial sensitivities:
  - Utilisation – 5,000 run hours per year is rule of thumb
  - "Spark gap"
  - Elec offset cost
  - FiT: Micro CHP pilot (<2kW) – 10p/kWh elec
  - Quantity of elec offset against purchased
  - Local electrical infrastructure capacity
  - Typical payback: 5-50 years!

Planning considerations

- Located within plant room or part of decentralised system?
- Flue height and location
- Location of CHP unit in relation to other buildings
- Noise – hum of engine
- Electrical infrastructure capacity
  - Is the CHP unit intended to feed electricity directly into the building or will surplus be exported?
  - Can local infrastructure support the installation without reinforcement?
  - Will the DNO grant permission for connection to the grid?

Carbon calculation



Carbon calculation

Question:

What is the carbon burden of 1 unit of heat produced from this system?

Carbon calculation

2 units of fuel input

CHP system fuel

100%

Useful heat

50%

1 unit of heat output

Electricity

32% efficient

0.64 units of electricity output

Losses

18%

Gas carbon burden = 0.198kgCO2/kWh

Displaced electricity carbon burden = 0.529 kgCO2/kWh

Carbon calculation

Carbon burden = 0.396 $kgCO_2$

2 units of fuel input

CHP system fuel

100%

Losses

18%

Useful heat

50%

Carbon burden = x $kgCO_2$

1 unit of heat output

Electricity

32% efficient

0.64 units of electricity output

Carbon offset = 0.339 $kgCO_2$

Gas carbon burden = 0.198kgCO2/kWh

Displaced electricity carbon burden = 0.529 kgCO2/kWh

Carbon calculation

Carbon burden = $0.396\ kgCO_2$

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Carbon burden = $0.057\ kgCO_2$

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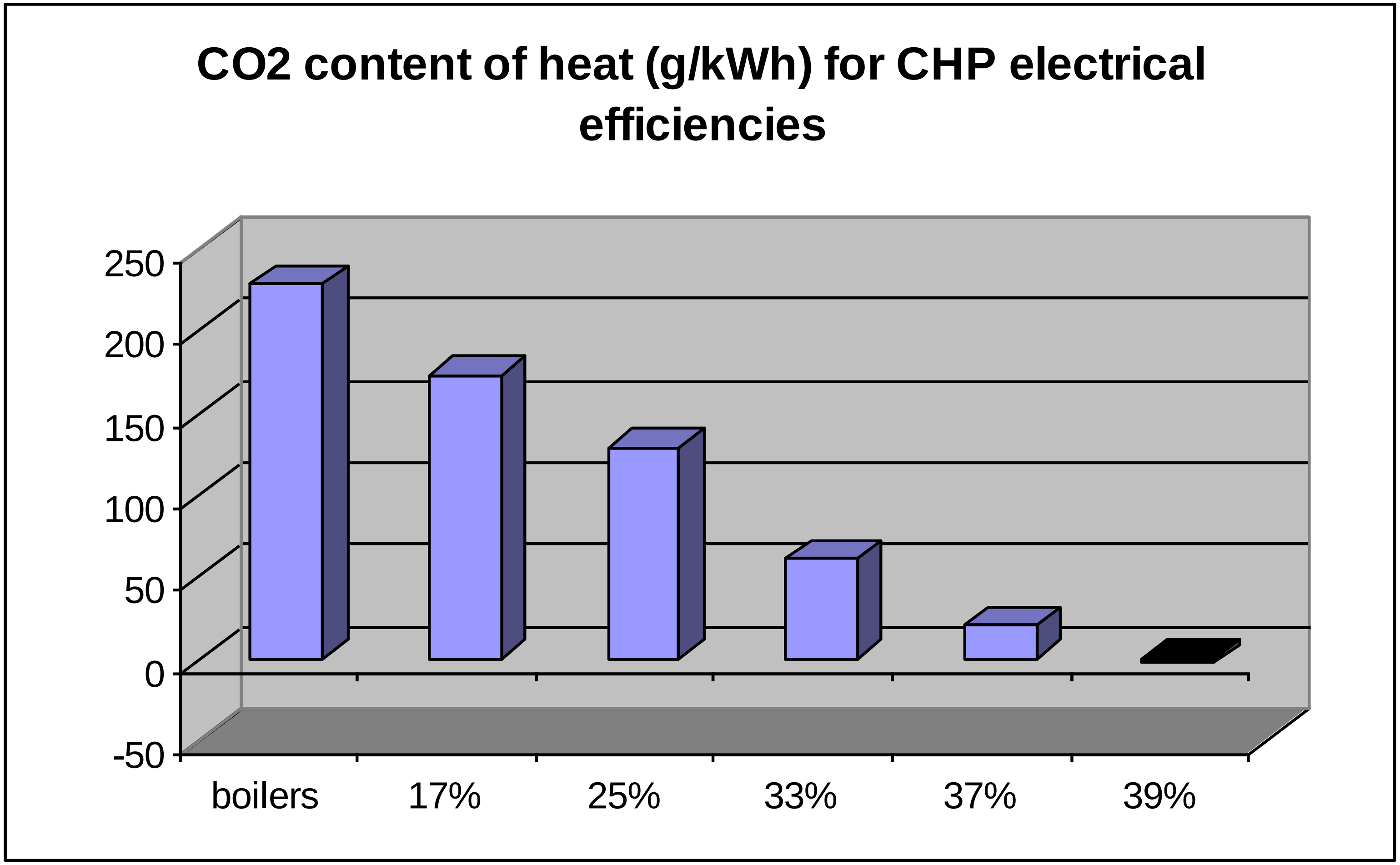
Carbon calculation



Example – gas CHP installation

Value of energy generated by Dachs	kW	hrs	£/kWh	£
Electricity	5.5	5,400	0.10	2,910
Heat	12.5	5,400	0.04	3,960
Total				6,870
Costs	**kW**	**hrs**	**£/kWh**	**£**
Gas costs	22.8	5,400	0.03	4,309
Service	5.5	5,400	0.01	445
Total				4,754
Savings				**2,116**

- Potentially 7 year payback
- Relies upon offsetting purchased electricity
- Must be sized to maximise run time

Questions?

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Gas CHP Exercise: CO_2 calculation

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Exercise

- What is the carbon burden of a unit of heat for a CHP unit with the following parameters?
  - Fuel input: 200kW
  - Electrical output: 54kW
  - Thermal output: 108kW
- How much carbon would be associated with this system delivering 540,000kWh of heat over a year?
- How much carbon could this system save in comparison to a 90% efficient gas-fired boiler in delivering this heat

Carbon burden of gas = 0.198 $kgCO_2/kWh$

Carbon burden of grid displaced electricity = 0.529 $kgCO_2/kWh$