Co Generation:
Options & Implementation

Presented By

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BERLIN CONSULT GCC

Introduction

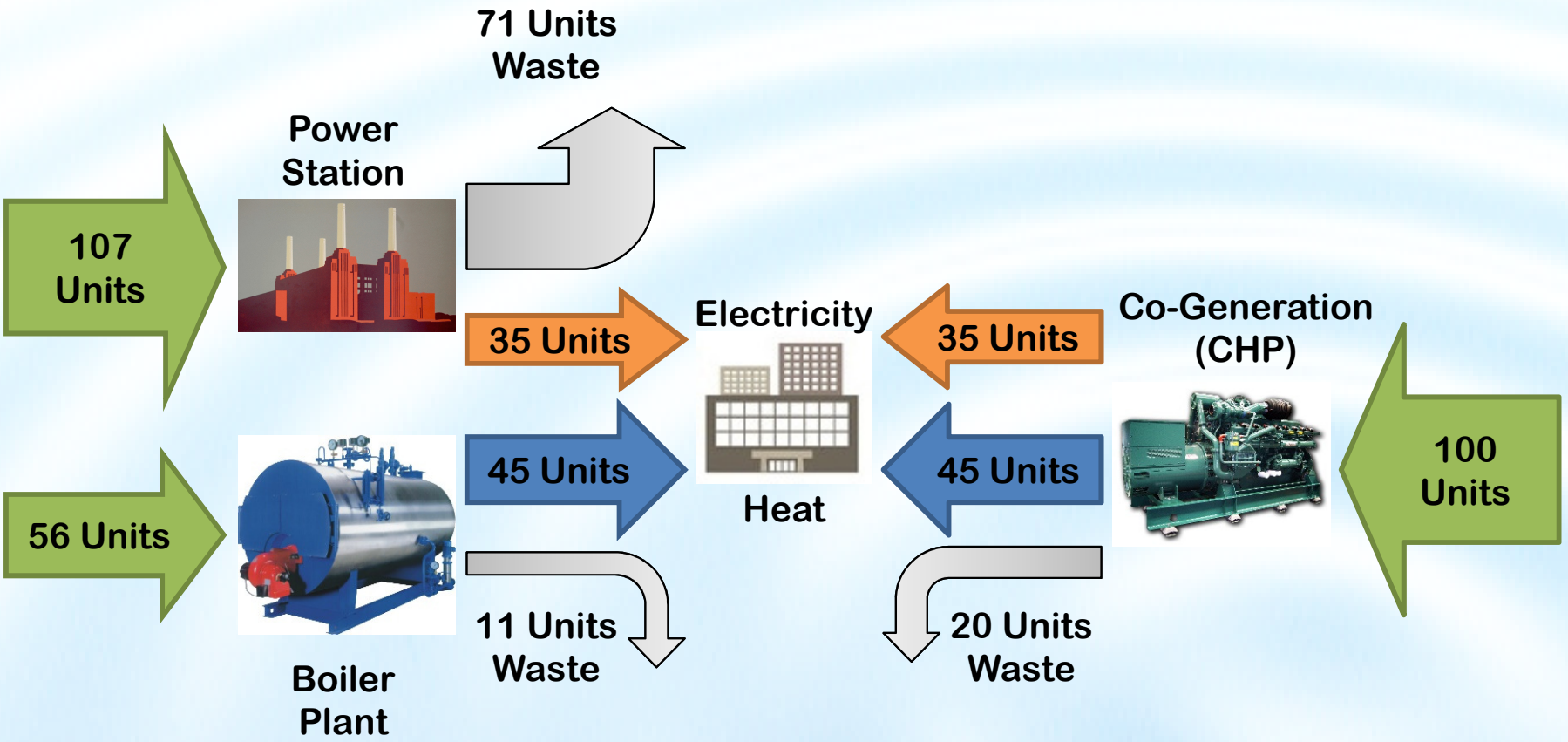
- Co-Generation: What is it ?
- System Options
- Key Considerations
- Viability
- Client Framework
- Questions

Co-Generation: What is it ?

- Effective utilisation of ***Normally Wasted Heat Energy*** produced by an industrial process;
  - Typically when generating Electricity;
  - Also using waste heat to generate Electricity.

- Also known as ***Combined Heat & Power*** (CHP).

Co-Generation: Concept



49% ..... OVERALL EFFICIENCY 80%

Common Co-Gen Systems

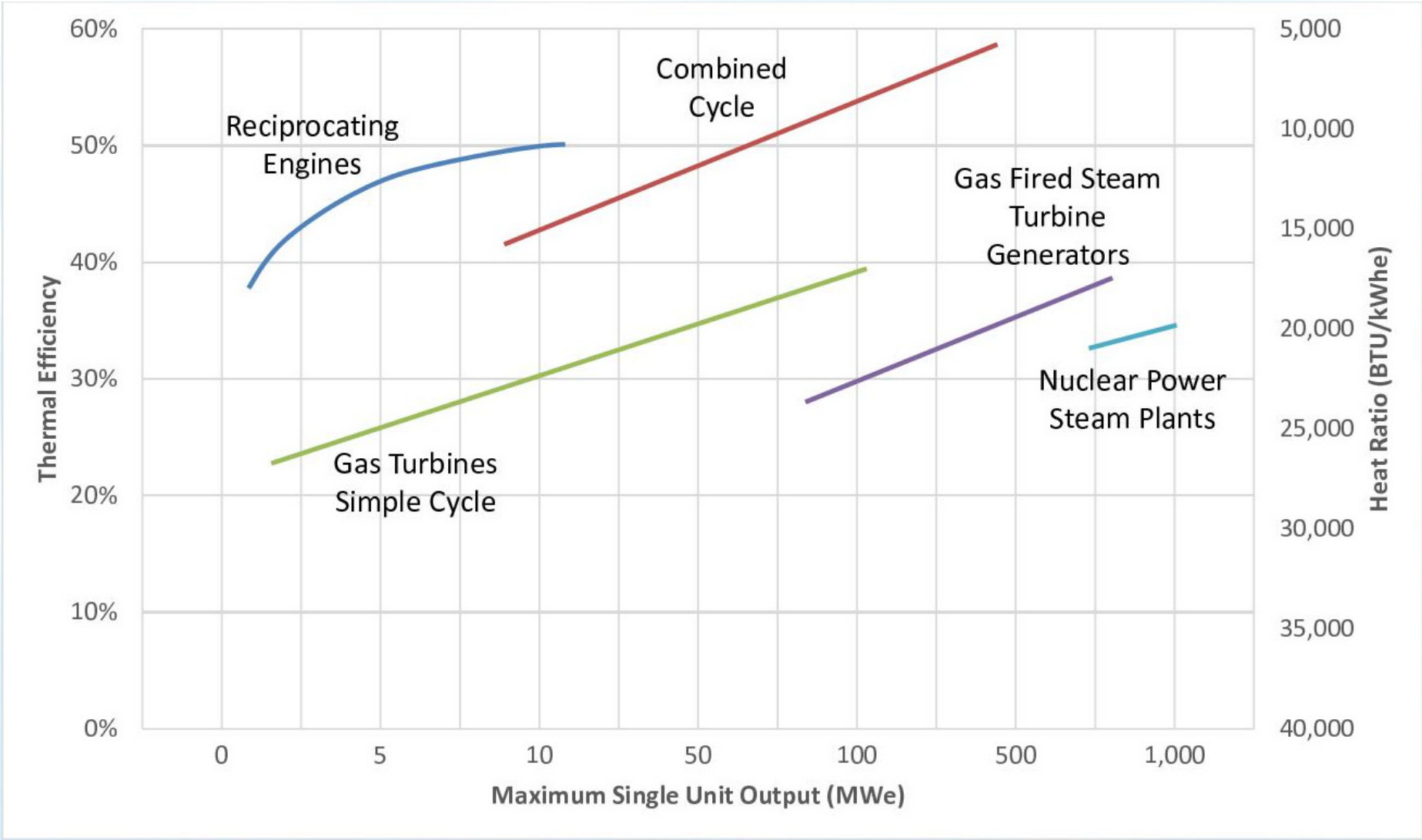
- Reciprocating Engines:
  - Natural Gas;
  - Gas Oil (Diesel);
  - Heavy Fuel Oil (HFO).
- Steam Turbines;
  - Utilising Heat from bespoke boilers or Industrial Process.
- Gas Turbines;
- Combined Cycle (Gas Turbine & Steam Turbine);
- Other Systems;
  - Micro-turbines;
  - Fuel Cells.

Size and Efficiency

Unit Type	Typical Size	Electrical Efficiency	Total Efficiency
Reciprocating Engines	30kW – 10MW	27 - 41%	77 - 80%
Steam Turbines	500kW – >250MW	5 - 40+%	~ 80%
Gas Turbines	500kW – 300MW	24 - 36%	66 - 71%
Combined Cycle	30kW – 1MW	~ 60%	~ 80%
Micro Turbines	30kW – 1MW	22 - 28%	63 - 70%
Fuel Cells	0.5kW – 2.8MW	35 - 54%	74 - 86%

SOURCE: U.S. EPA: "Catalog of CHP Technologies"

Comparison of Systems



SOURCE: Bartol (1997)

Reciprocating Engines

- Advantages;
  - Variety of Fuels;
    - Natural Gas, Gas Oil (Diesel), Heavy Fuel Oil.
  - 'Load Following' capability;
  - Fast Start-up.
- Disadvantages;
  - High maintenance costs;
  - Generates primarily 'Low Grade' heat;
  - Requires cooling if heat not utilised.

Steam Turbines

- Advantages;
  - Linked to boilers with variety of fuels;
  - Long working Life;
  - High reliability.
- Disadvantages;
  - Slow Start-up;
  - Low 'Power-to-Heat' ratio;
  - Requires Boiler or Steam source.

Gas Turbines

- Advantages;
  - High reliability;
  - Low emissions;
  - High grade heat;
  - No cooling required.
- Disadvantages;
  - Poor efficiency at low load;
  - Output falls as ambient temperature rises;
  - Requires high gas pressure.

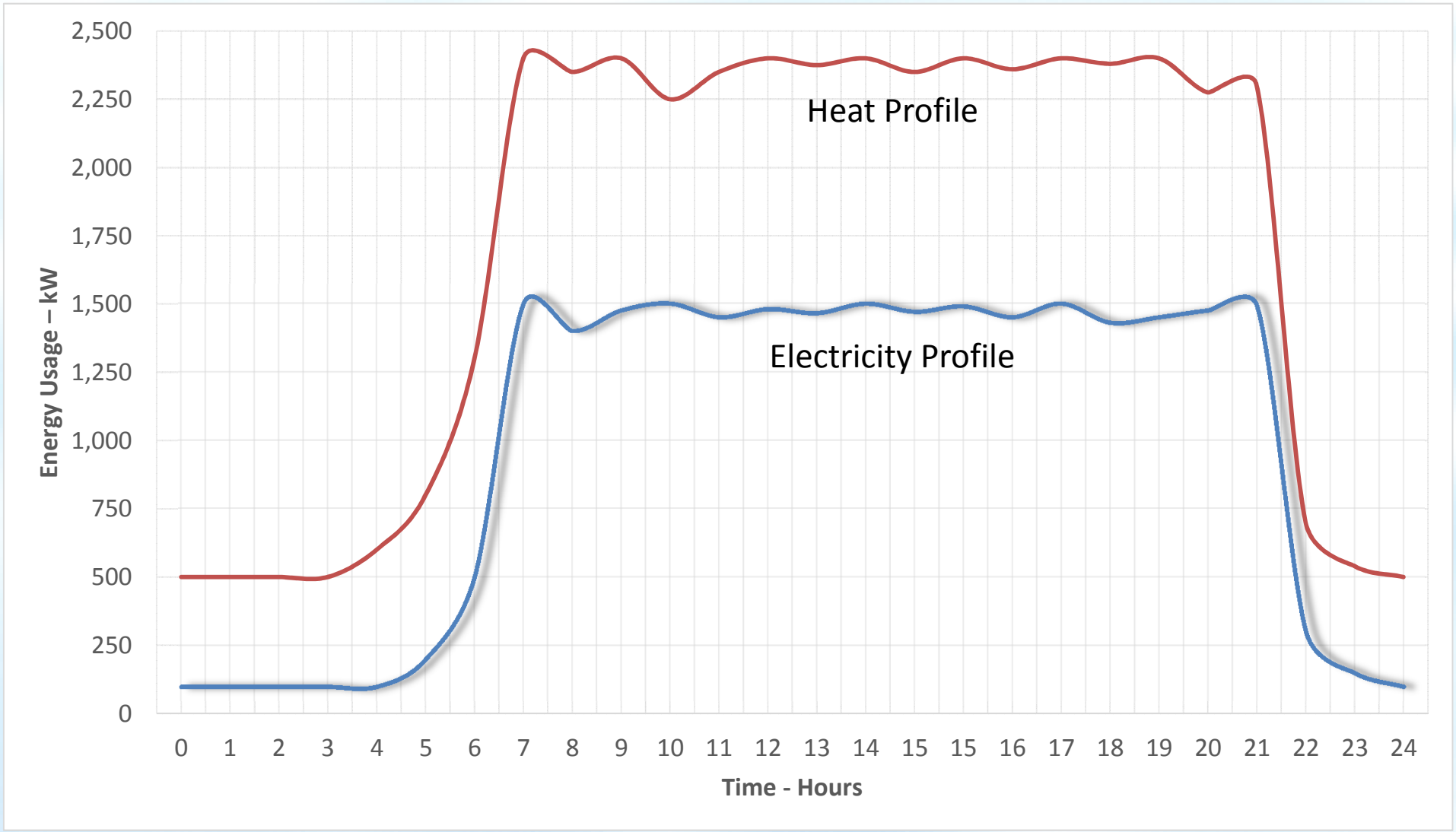
Combined Cycle

- Advantages;
  - High power efficiency;
  - High reliability;
  - Low emissions.
- Disadvantages;
  - Cost effective only for larger installations;
  - Output falls as ambient temperature rises;
  - Requires high gas pressure.

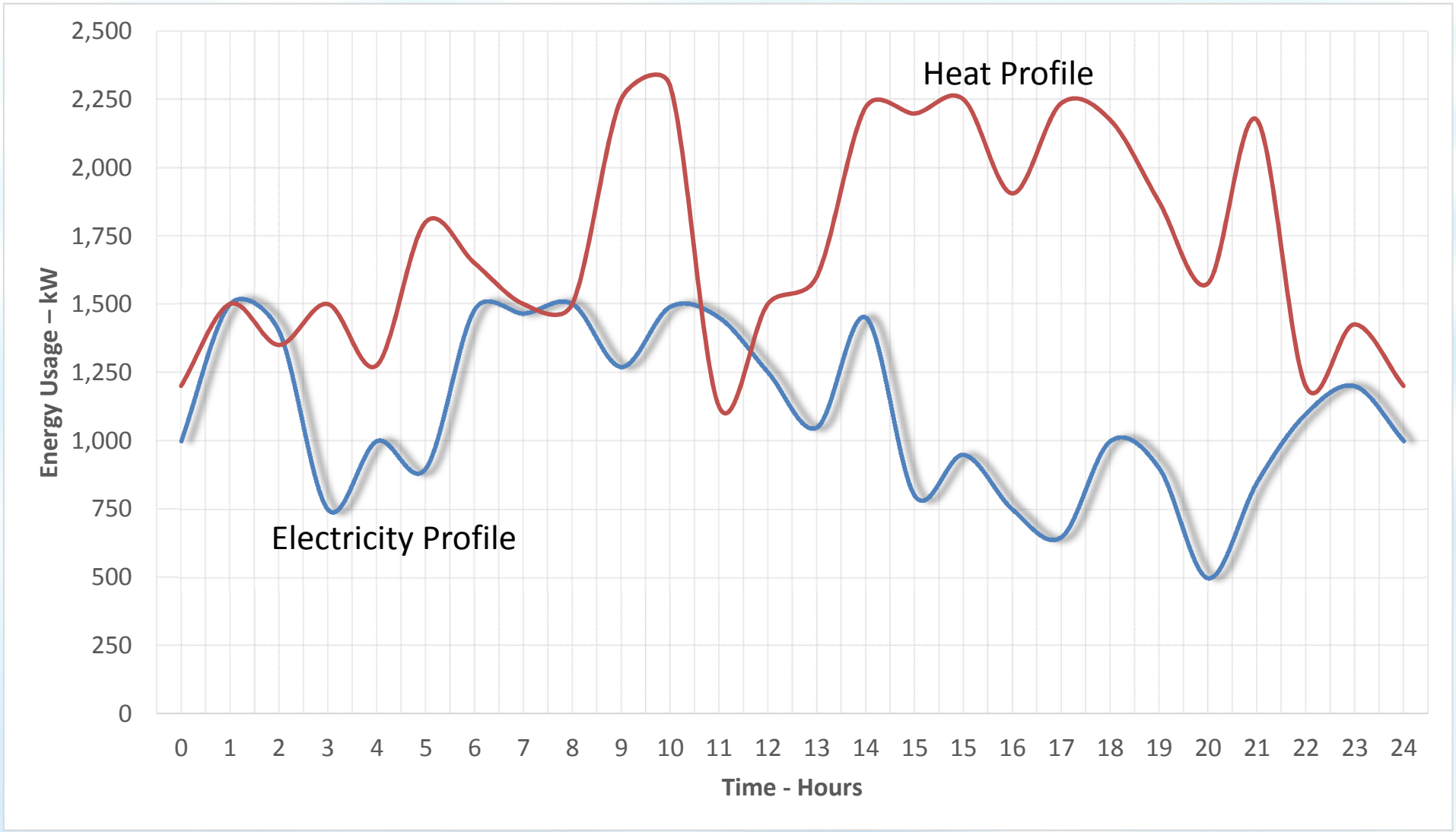
Key Considerations

- Base Loads
  - Heat (… and grade of heat required);
  - Electricity.
- Utilities Costs
  - Fuel price high => Lower Savings;
  - Electricity Price high => Higher Savings.
- Business Limitations.
  - Location for installation;
  - Cost of Borrowing.

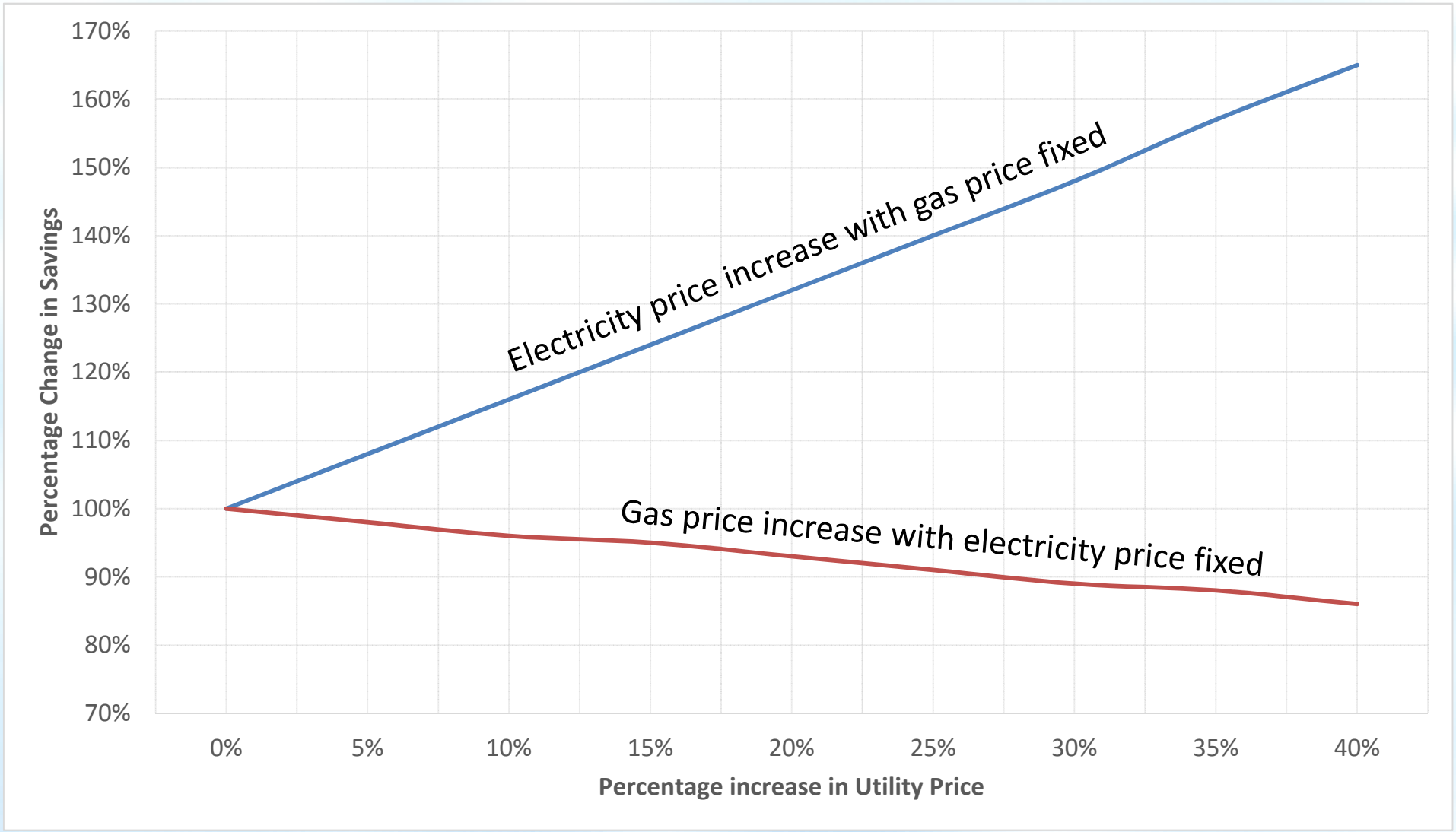
Load Profile - 1



Load Profile - 2



Impact of Utilities Price



Viability Example

Medium Cost Project

Cost = $900,000

Saving = $300,000

Payback = 3 years

High Cost Project

Cost = $4,000,000

Saving = $1,000,000

Payback = 4 years

Commercial Viability

Payback & Internal Rates of Return		DO the Project if your cost of borrowing is lower than this IRR					
Simple Payback (Years)	8						0%
	5					0%	12%
	4				0%	8%	13%
	3			0%	13%	20%	29%
	2		0%	23%	35%	41%	48%
	1	0%	62%	85%	93%	97%	100%
Equipment Life, or Project Timescales (Years)		1	2	3	4	5	8

SOURCE: U.S. EPA: "Putting Energy into Profits"

Assuming 8 year Period

Medium Cost Project	**High Cost Project**
Cost = $900,000	Cost = $4,000,000
Saving = $300,000	Saving = $1,000,000
Payback = 3 years	Payback = 4 years
Return = 29%	Return = 13%
Total Saving = $2.4m	Total Saving = $8m

Client Framework

- What Energies do we use & how?
- What are our Energy Costs?
- How secure is our Electricity Supply?
- What is our Future at this location?
- What are the limitations of the facility?
- Are there any legal/technical restrictions?
  - Specific Business Objectives / Issues
  - Are we allowed to generate our own electricity?
  - Is there an open Electricity Market ? … etc.
- What are our investment & borrowing criterion?

Developing the Solution

SOLUTION = TECHNICAL + COMMERCIAL

- Technical:
  - Energy Usage & Cost
  - Systems & Efficiencies
  - Base load Calculations
  - Modelling Solutions & Savings
- Commercial:
  - Client Requirements/Limitations
  - Investment & Borrowing
  - Future Projection/Business Plans

Questions ?

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