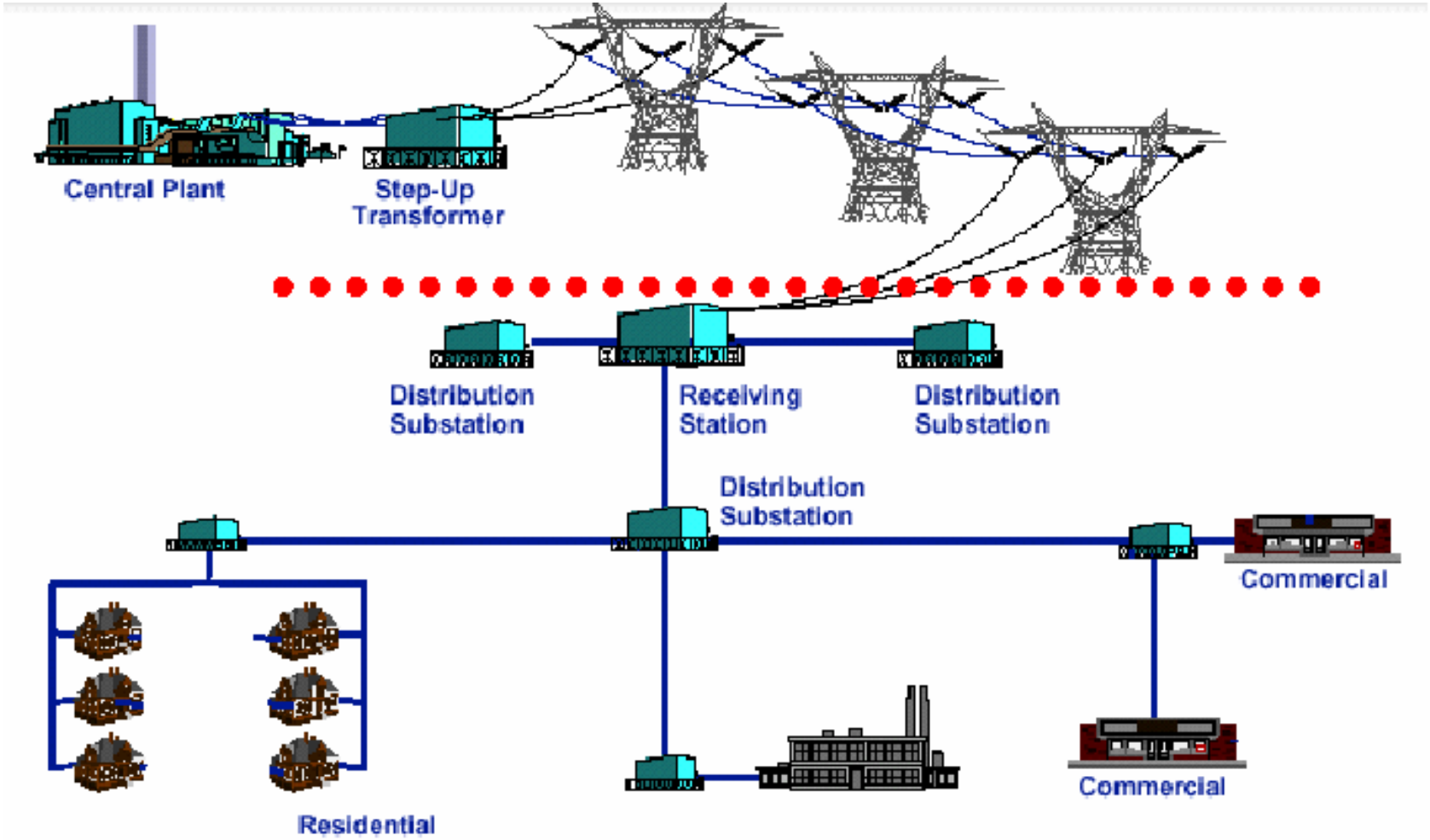
Overview of cogeneration technologies and applications

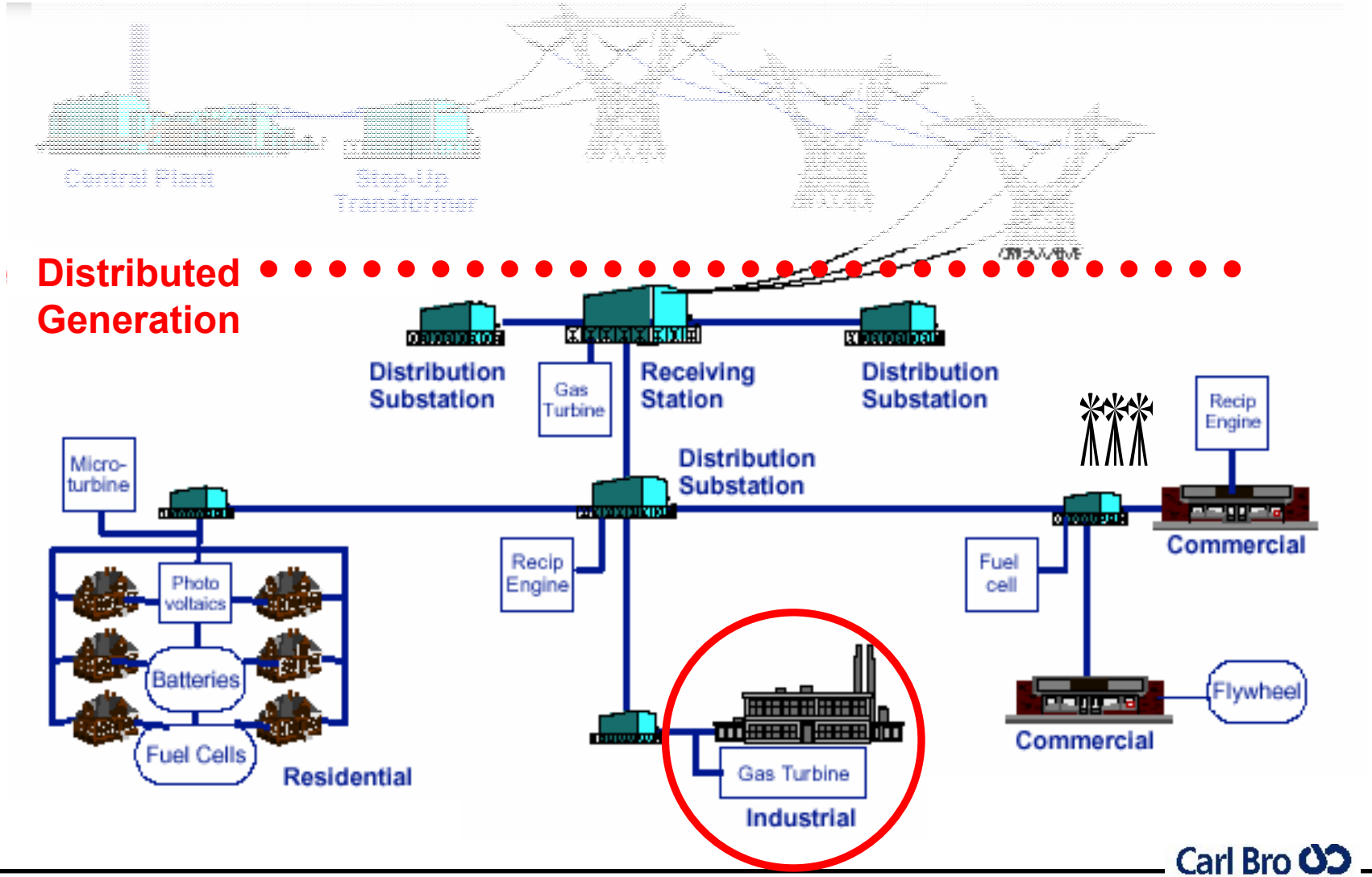
2004 Cogeneration Day in Singapore
23 April 2004
York Hotel, Singapore

Thomas Hernoe
Environmental Expert

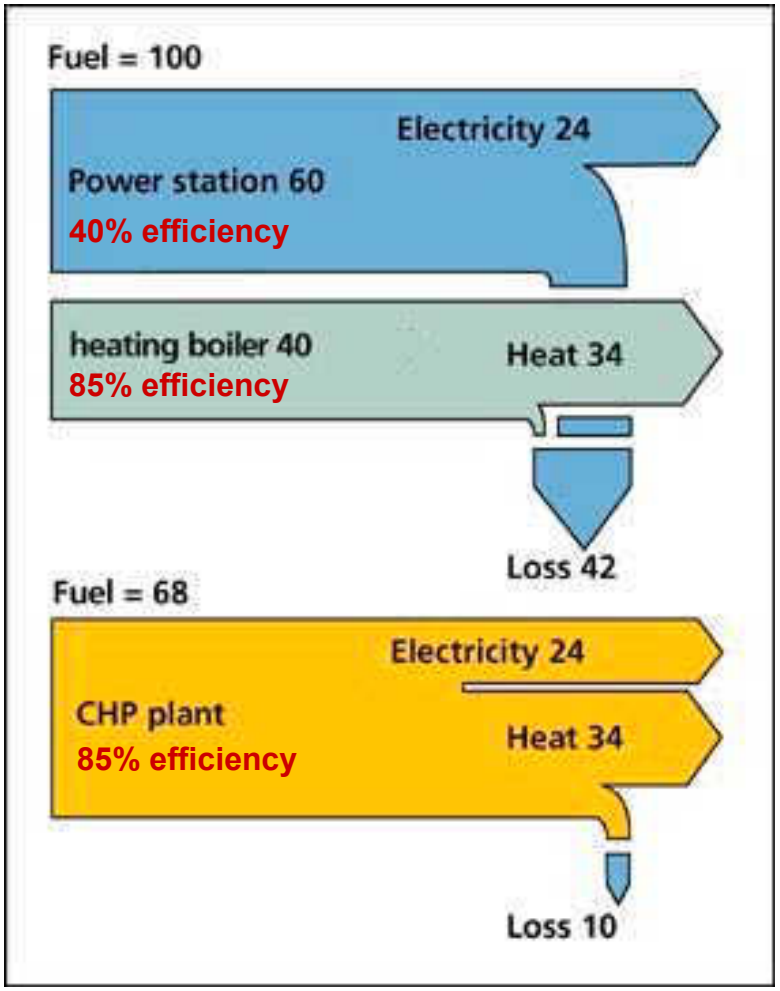
Central generation



Cogeneration and distributed generation



What is cogeneration



Definition

Simultaneous generation of two different forms of useful energy using one single primary energy source.
Most usual:

- electrical
- thermal: heating or cooling

Cogeneration

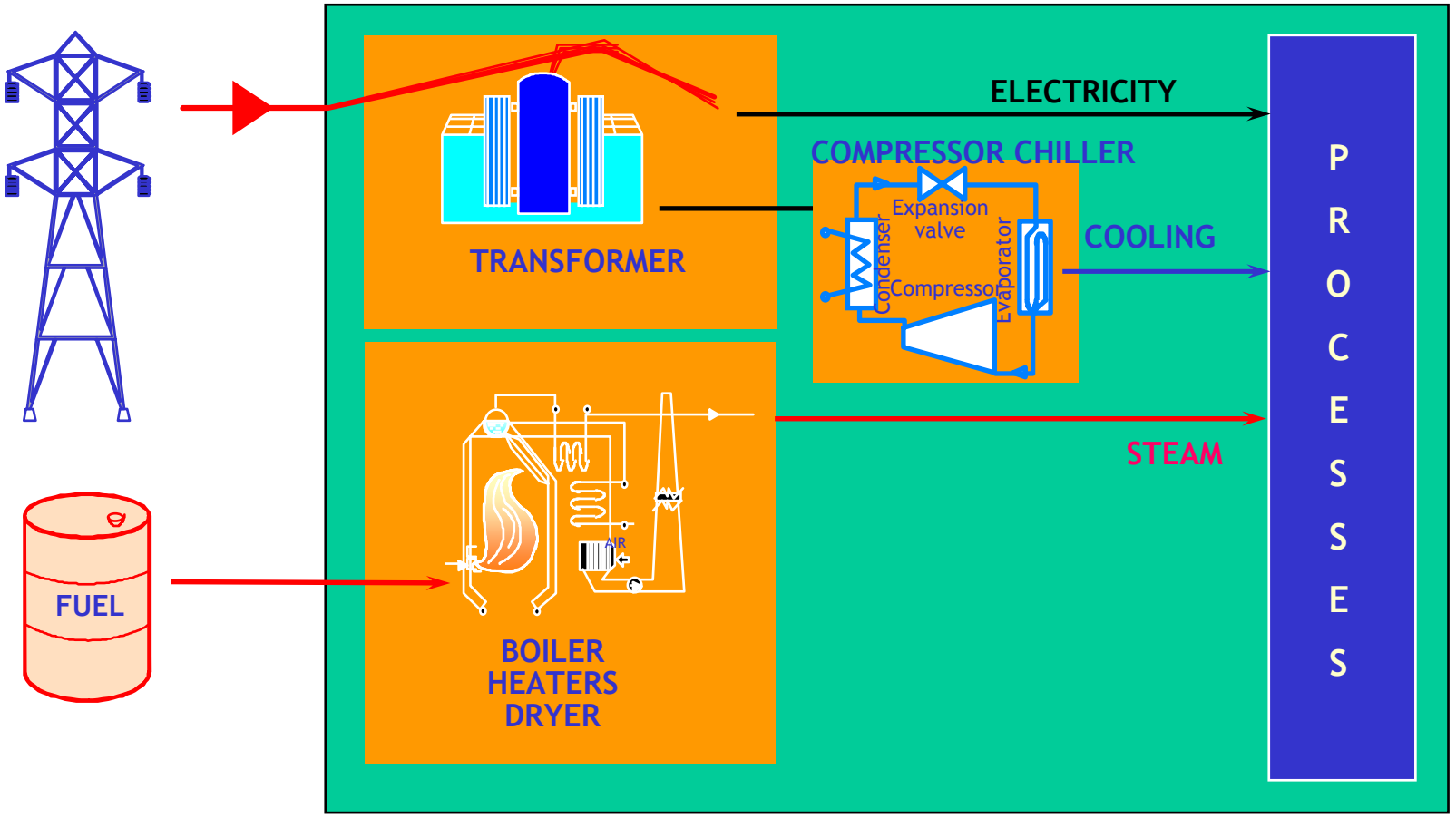
Meets the same demands –

but with ~ 30% energy savings

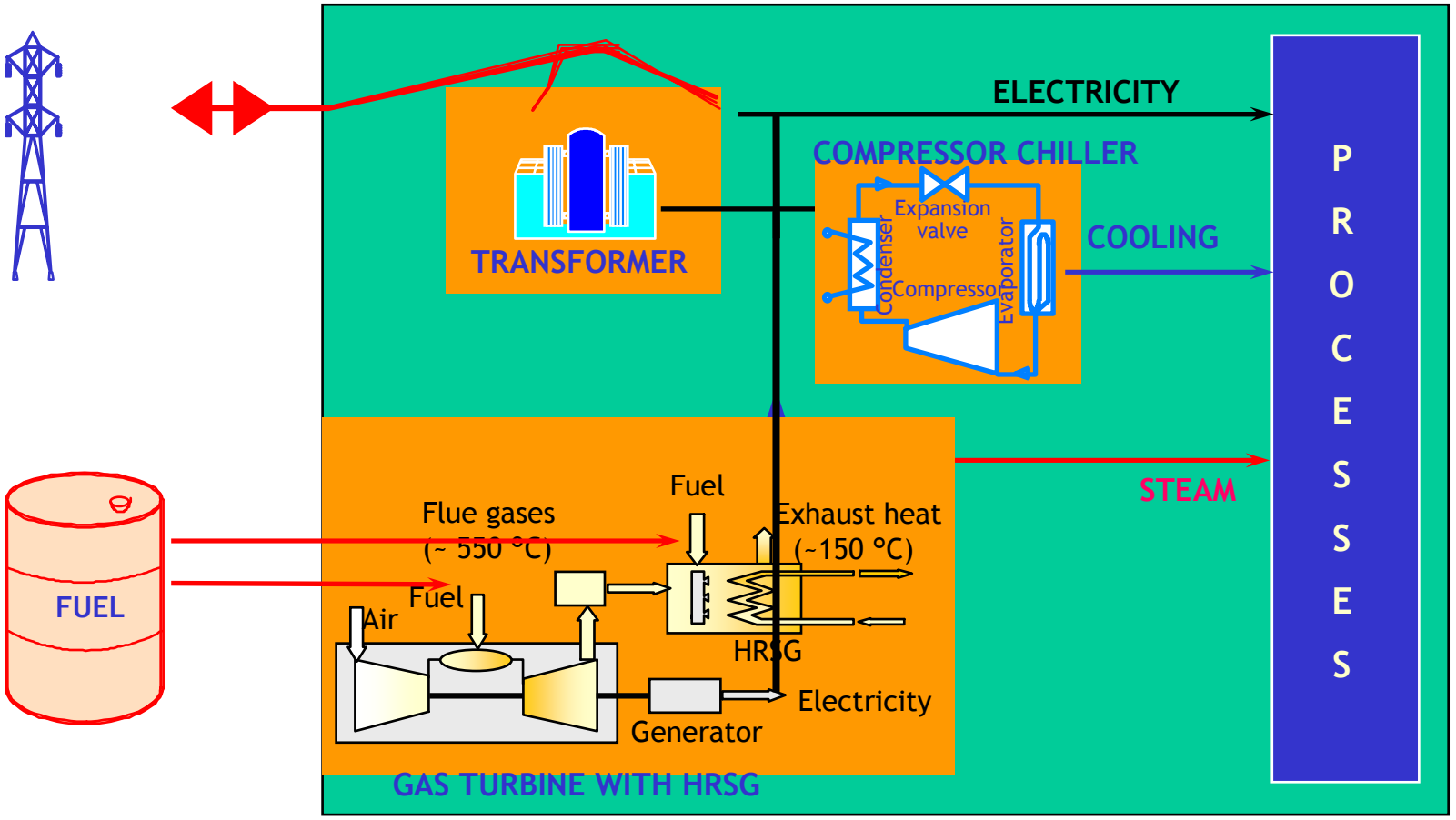
Benefits of cogeneration

- Lower primary energy consumption
- Lower transmission and distribution losses
- Less burden on national government for power generation
- Less environmental pollution

"Traditional" industrial or commercial unit



Cogeneration industrial or commercial unit



Typical cogeneration applications

Industrial

Wood and agro-industries, food processing, pharmaceutical, pulp and paper, oil refinery, textile industry, steel industry, cement industry, glass industry, ceramic industry

Residential, commercial & institutional

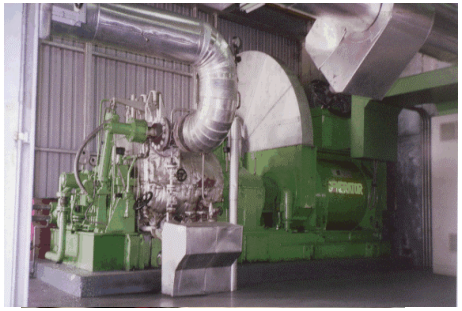
Hospitals, schools & universities, hotels, houses & apartments, stores & supermarkets, office buildings

District cooling

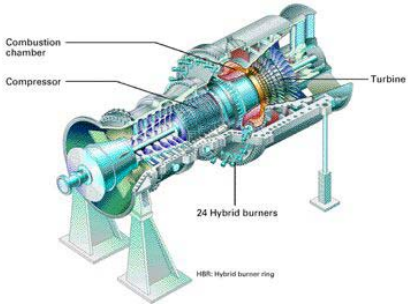
Airports, office & commercial buildings, dwellings and houses

Cogeneration & distributed generation technologies

Steam Turbines



Gas Turbines



Engines

Combined Cycles

Microturbines

Fuel Cells

Stirling eng.

None CHP

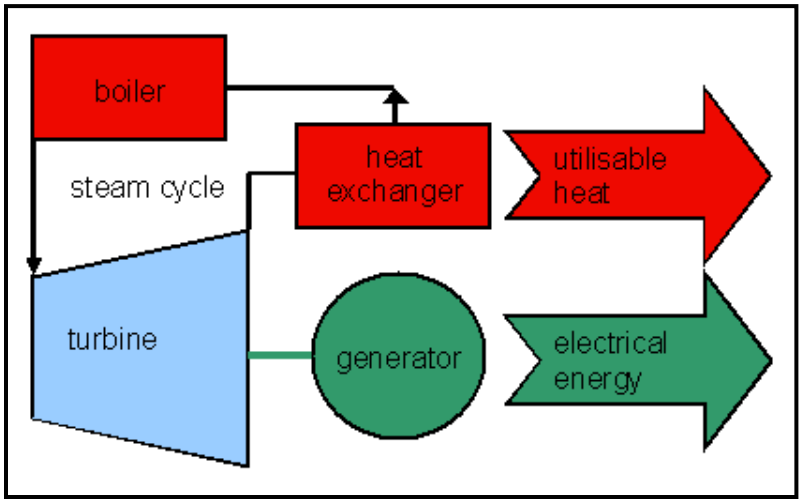
Wind turbines

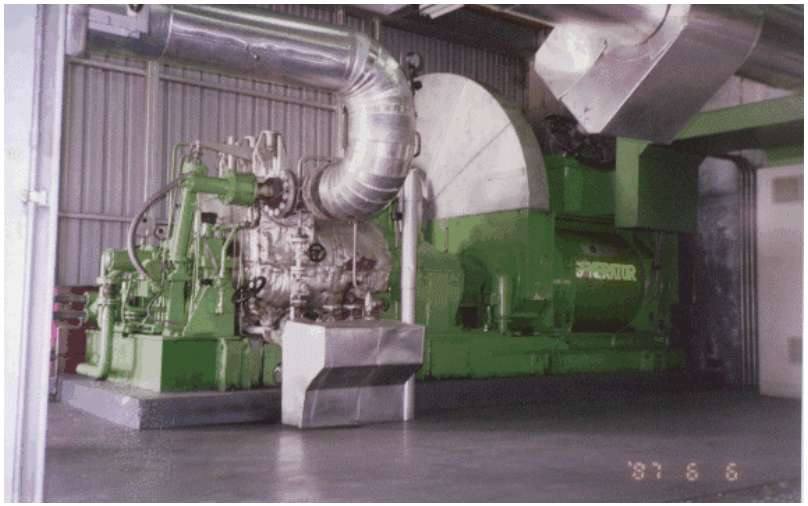
Hydro

Cogeneration technologies parameters

PRIME MOVER	FUEL USED	SIZE RANGE (MWe)	HEAT: POWER RATIO	ELECTRICAL GENERATING EFFICIENCY	TYPICAL OVERALL EFFICIENCY	HEAT QUALITY
PASS OUT STEAM TURBINE	ANY FUEL	1 to 100+	3:1 to 8:1+	10 - 20%	UP TO 80%	STEAM
BACK PRESSURE STEAM TURBINE	ANY FUEL	0.5 to 500	3:1 to 10:1+	7 - 20%	UP TO 80%	STEAM
EXTRACTION STEAM TURBINE	ANY FUEL	0.5 to 500	1:1 to 10:1+	20 - 47%	73 - 90%	HOT WATER
COMBINED CYCLE GAS TURBINE	GAS AND OIL	3 to 300+	1:1 to 3:1*	35 – 55%	73 - 90%	STEAM HOT WATER
OPEN CYCLE GAS TURBINE	GAS AND OIL	0.25 to 50+	1.5:1 to 5:1*	25 – 42%	65 – 87%	STEAM HOT WATER
COMPRESS. IGNITION ENGINE	GAS AND OIL	0.2 to 20	0.5:1 to 3:1*	35 – 45%	65 - 90%	STEAM HOT WATER
SPARK IGNITION ENGINE	GAS AND OIL	0.003 to 6	1:1 to 3:1	25 - 43%	70 - 92%	HOT WATER

Steam turbine cogeneration





Advantages

Versatility of fuel
(solid, gaseous and liquid fuels)

Well - established technology

Flexibility in the size & output of plant

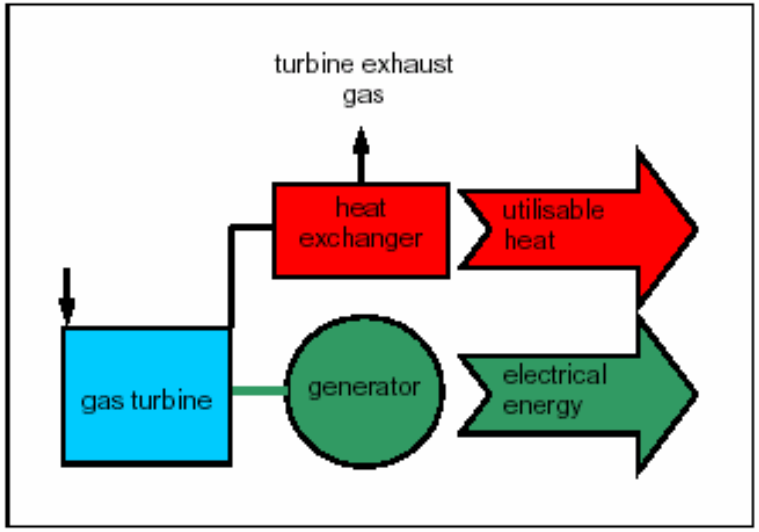
Disadvantages

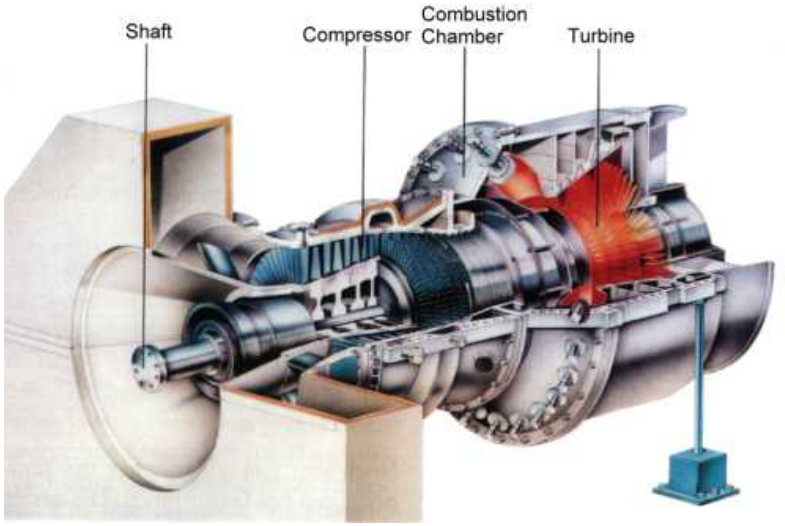
Low electrical efficiency

Low part load performance

High operating cost

Gas turbine cogeneration





Advantages

High reliability

Wide fuel range capability, gas, petroleum, light oil

Relatively low investment cost per kW electrical output

Low emission

Disadvantages

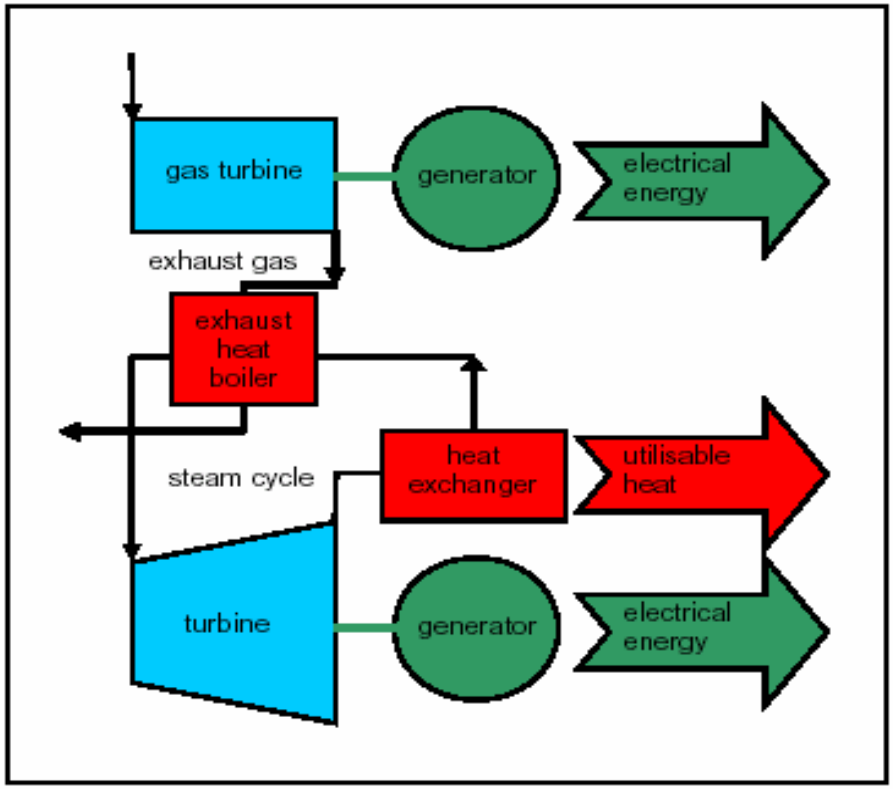
High fuel cost

Poor efficiency at low loading (can operate continuously at low loads)

Long operation hours required

High maintenance cost

Combined steam & gas cycle



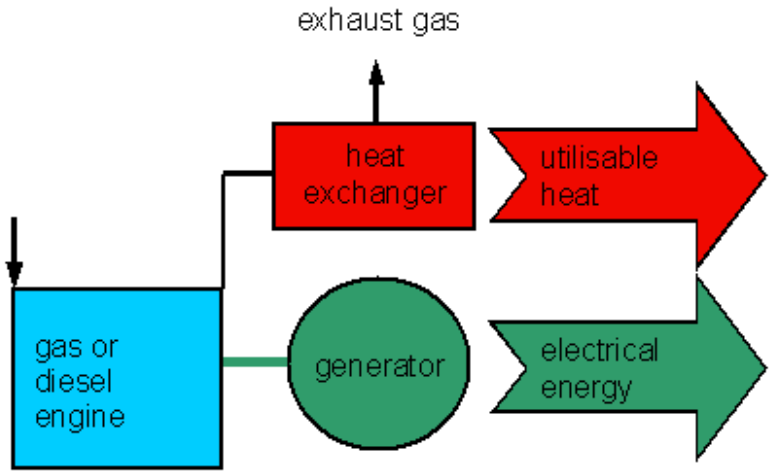
Advantages

High electrical efficiency

Disadvantages

Only for large scale plants

Gas engine cogeneration



Advantages

High power efficiency over a wide load range

Relatively low investment cost per kW electrical output

Power or processes can be non continuous

Disadvantages

Low pressure steam or low temperature hot water

Low heat to power demand ratio

High maintenance cost

Cogeneration & HVAC utilisation (1)

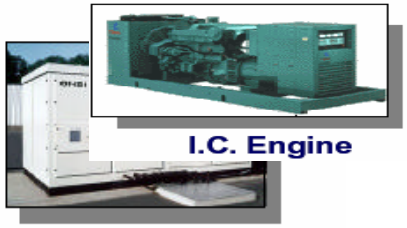
(Heat Ventilation Air Condition)

Distributed Generation Technologies

Gas-turbine

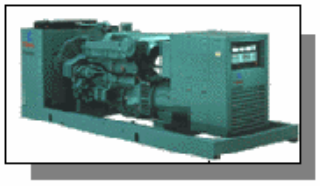
Solid Oxide Fuel Cell

Micro-turbine



I.C. Engine

Commercial Phosphoric Acid Fuel Cell



I.C. Engine

Residential PEM Fuel Cell

°C

500

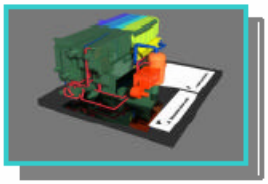
400

300

200

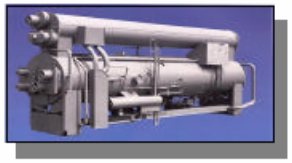
100

Thermally-Activated HVAC Technologies



Triple-Effect Absorption Chiller

Double-Effect Absorption Water-Cooled Chiller



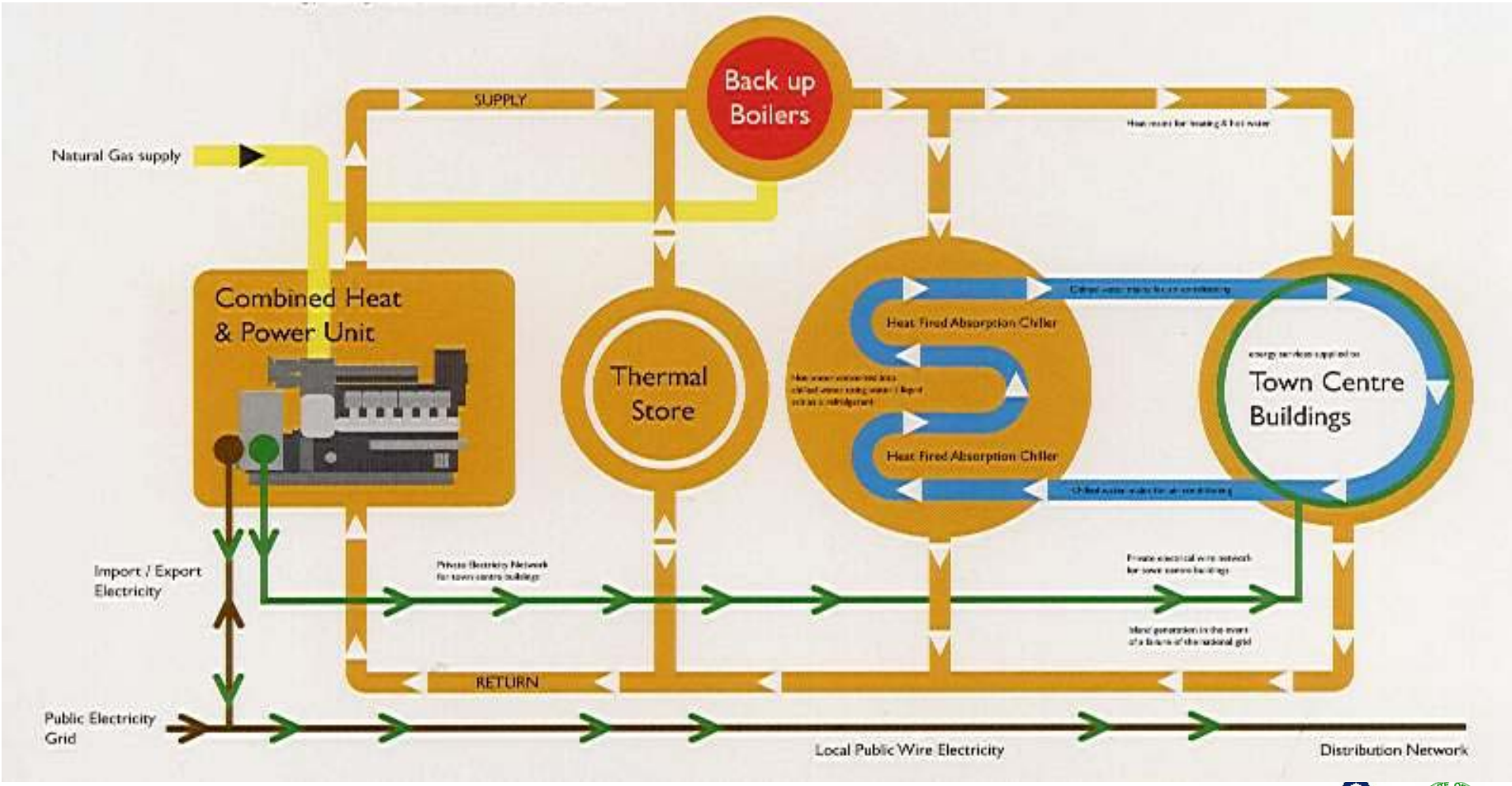
Single-Effect Absorption Chiller

Desiccant Technology

Carl Bro Intelligent Solutions

Cogeneration & HVAC utilisation (2)

(Heat Ventilation Air Condition)



Additional information

Technical Report
Available Cogeneration Technologies in Europe

Part I
Definitions and Systems

December 2003

Technical Report
Available Cogeneration Technologies in Europe

Part II
Technologies and Products

December 2003

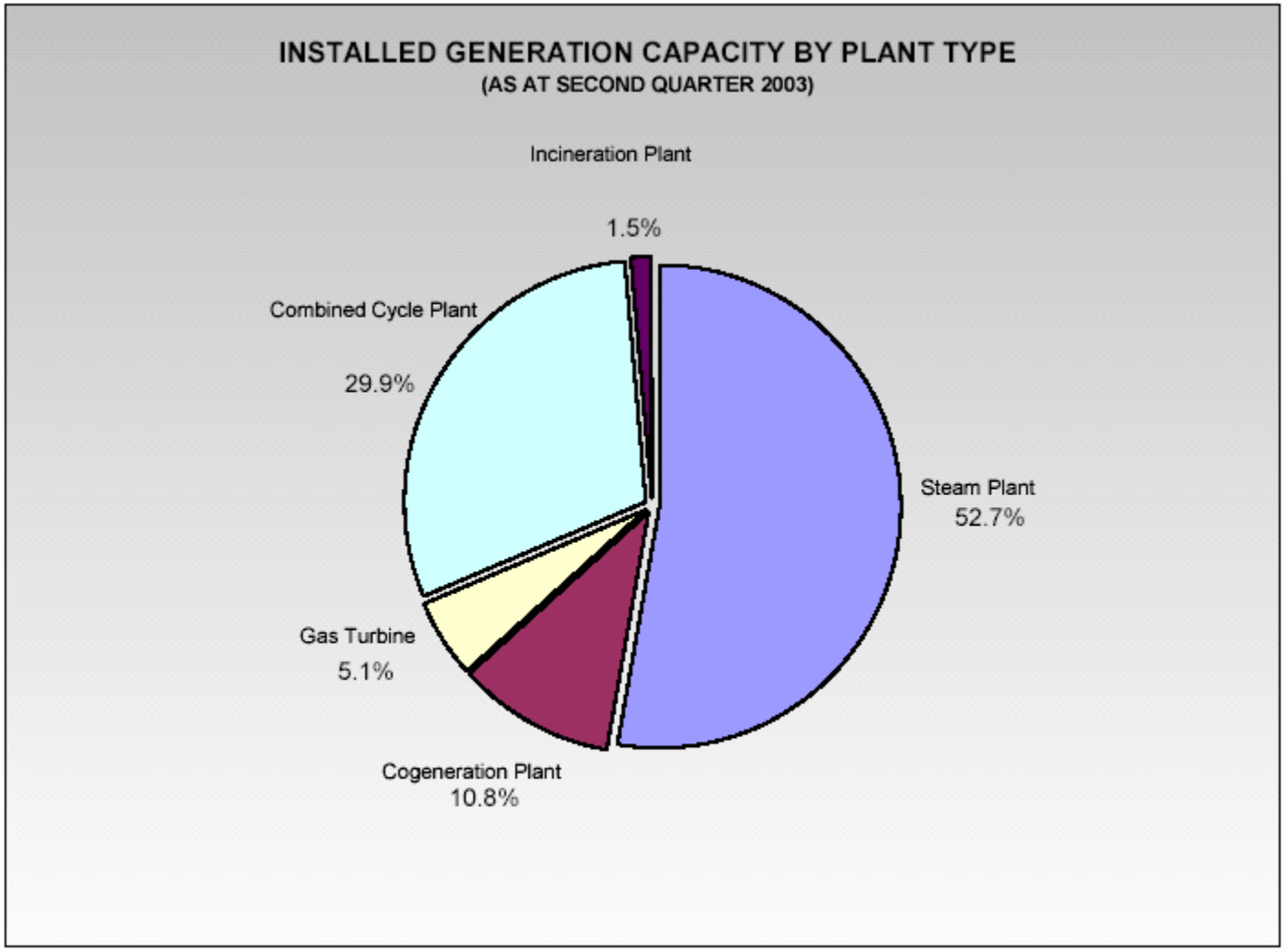
Singapore: Applications of cogeneration

- SembCorp Cogen 900MW to serve petrochemical cluster on Jurong Island – today 600 MW in operation
- ExxonMobil 180MW for own use
- Singapore Syngas 20MW for own use
- Island Power 800MW – today 0 MW
- Keppel Merlimau Cogen 470MW
- 2 COGEN 3 supported FSDPs (total 1.5 MW) using wood waste

Future "Cogen share" of capacity in Singapore

Company	Capacity (MW)	Cogen (%)
Power Seraya	3,100	
Senoko Power	3,300	
Tuas Power	2,670	
SembCorp Cogen	600	**5.6%**
Island Power Company	0	**0.0%**
Singapore Syngas Pte. Ltd.*	20	**0.2%**
Exxon Mobil Asia Pacific Pte. Ltd.*	180	**1.5%**
Keppel Merlimau Cogen	470	**4.0%**
Elba Eastern (Pte) Ltd.*	50	
National Environment Agency	250	
TOTAL	11,740	**11.9%**

* exempt from New Energy Market rules



Note: Incineration plant refers to generation of electricity from refuse incineration by the National Environment Agency (NEA).

Cases

For more information,
please visit COGEN 3 Website at:

http://www.cogen3.net

Thank You !