

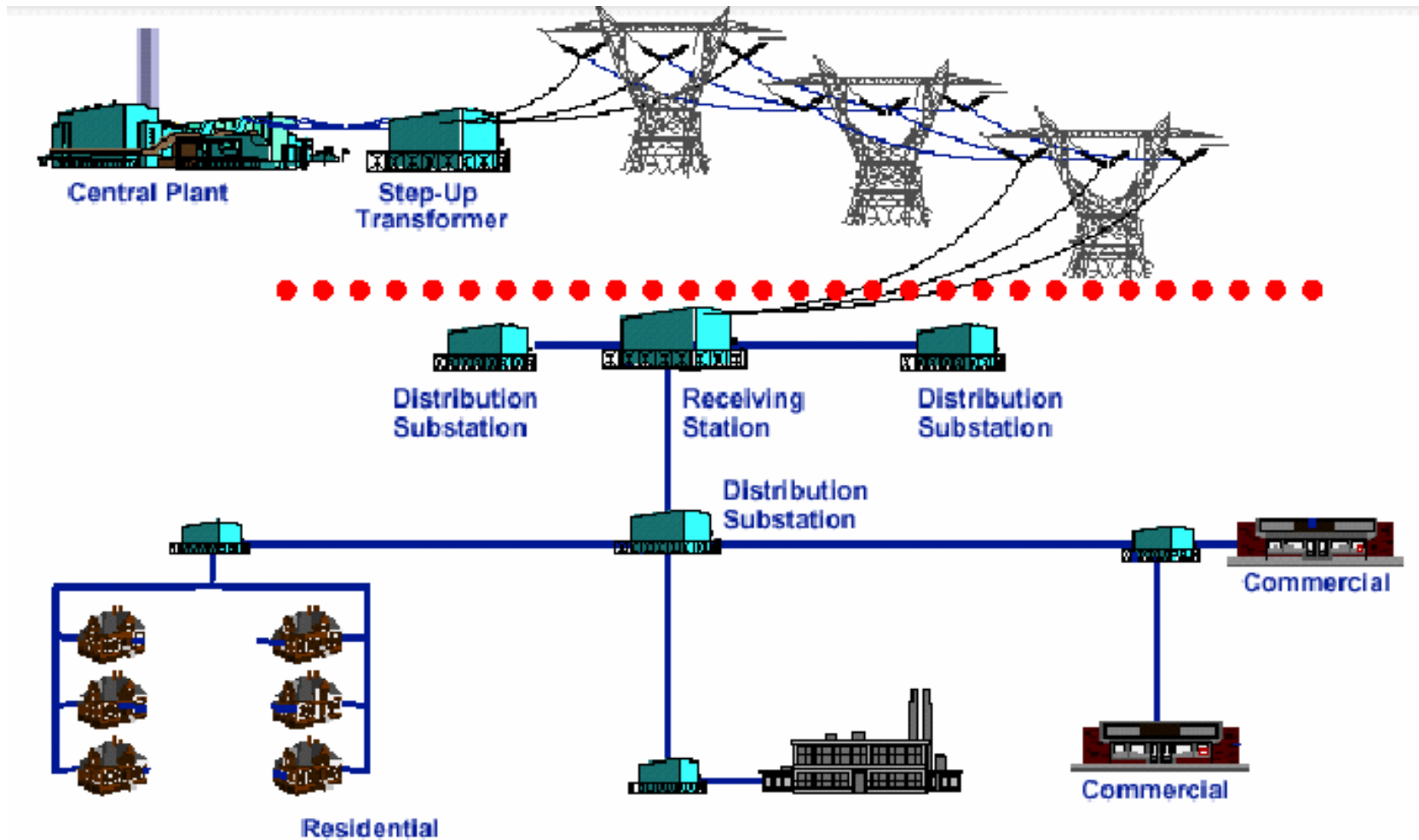


Overview of cogeneration technologies and applications

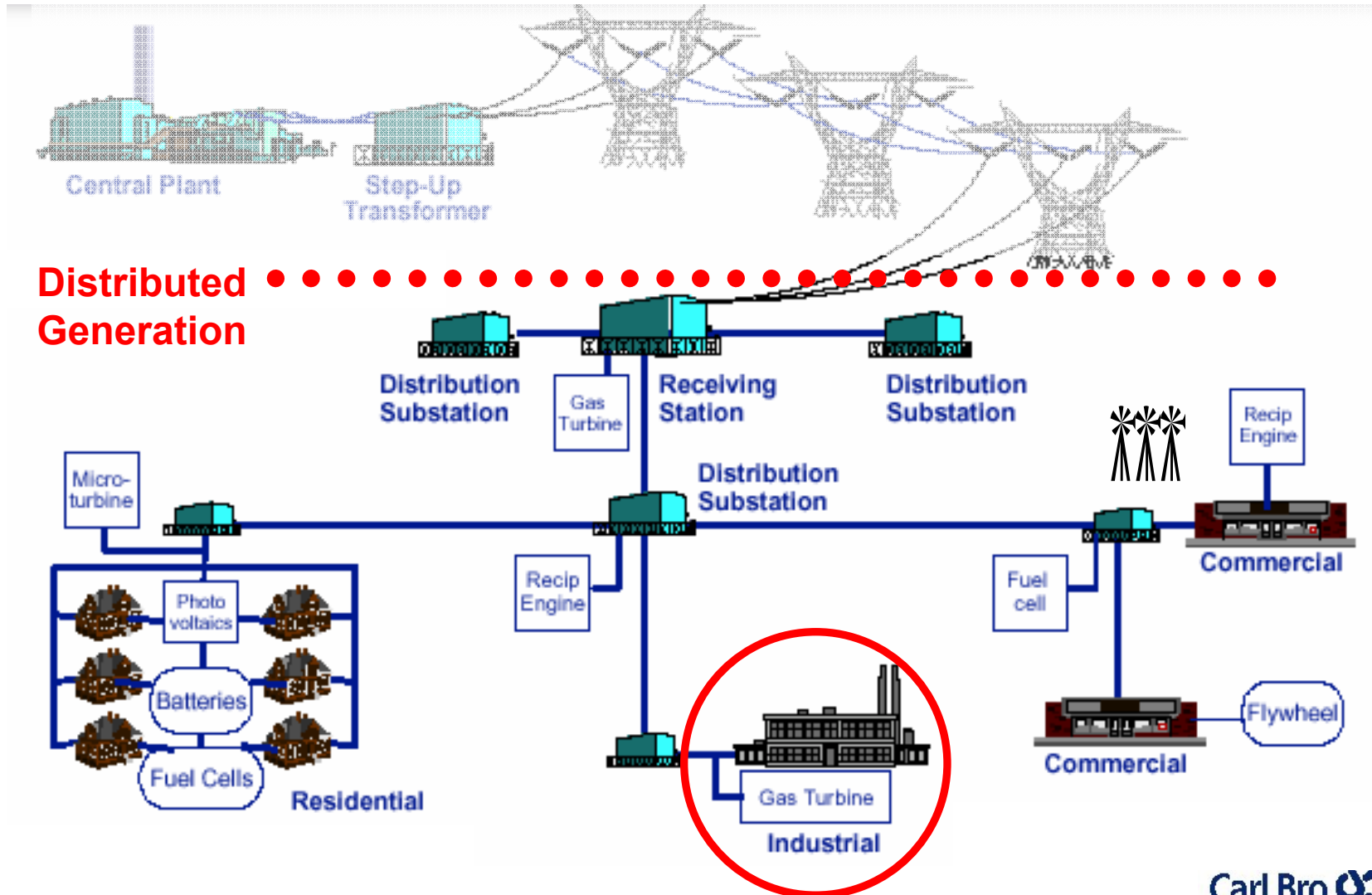
**2004 Cogeneration Week in Indonesia
18 May 2004, Gran Melia Hotel, Jakarta**

**Thomas Hernoe
Environmental Expert**

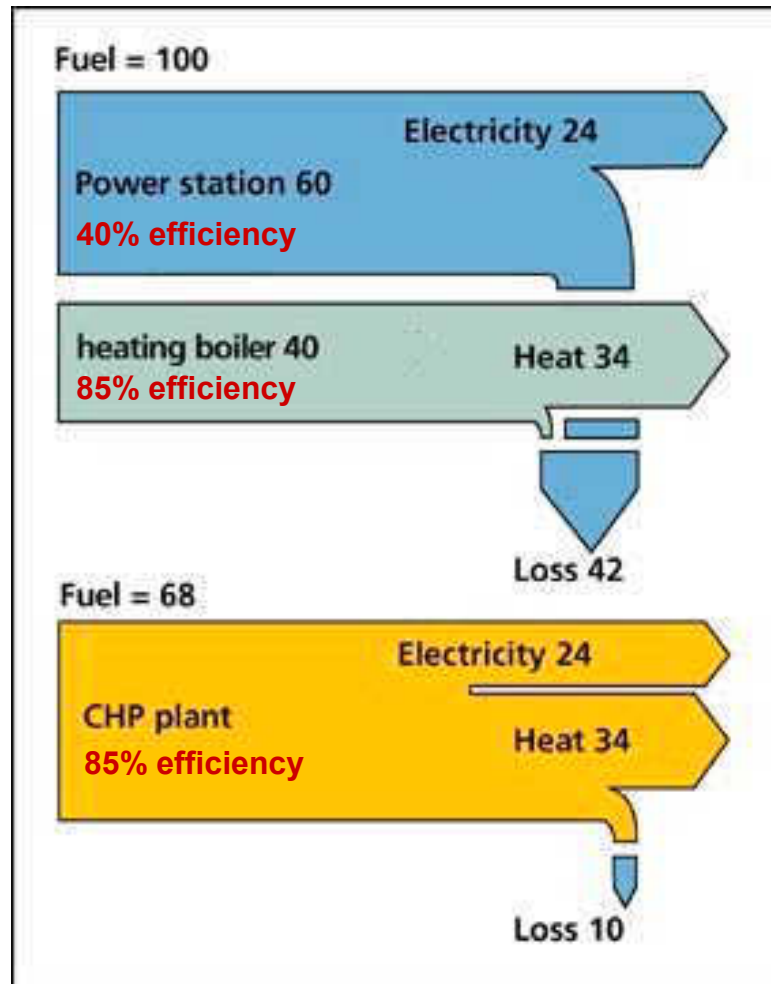
Central generation



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 

- **Less environmental pollution**
- **Lower fuel cost**

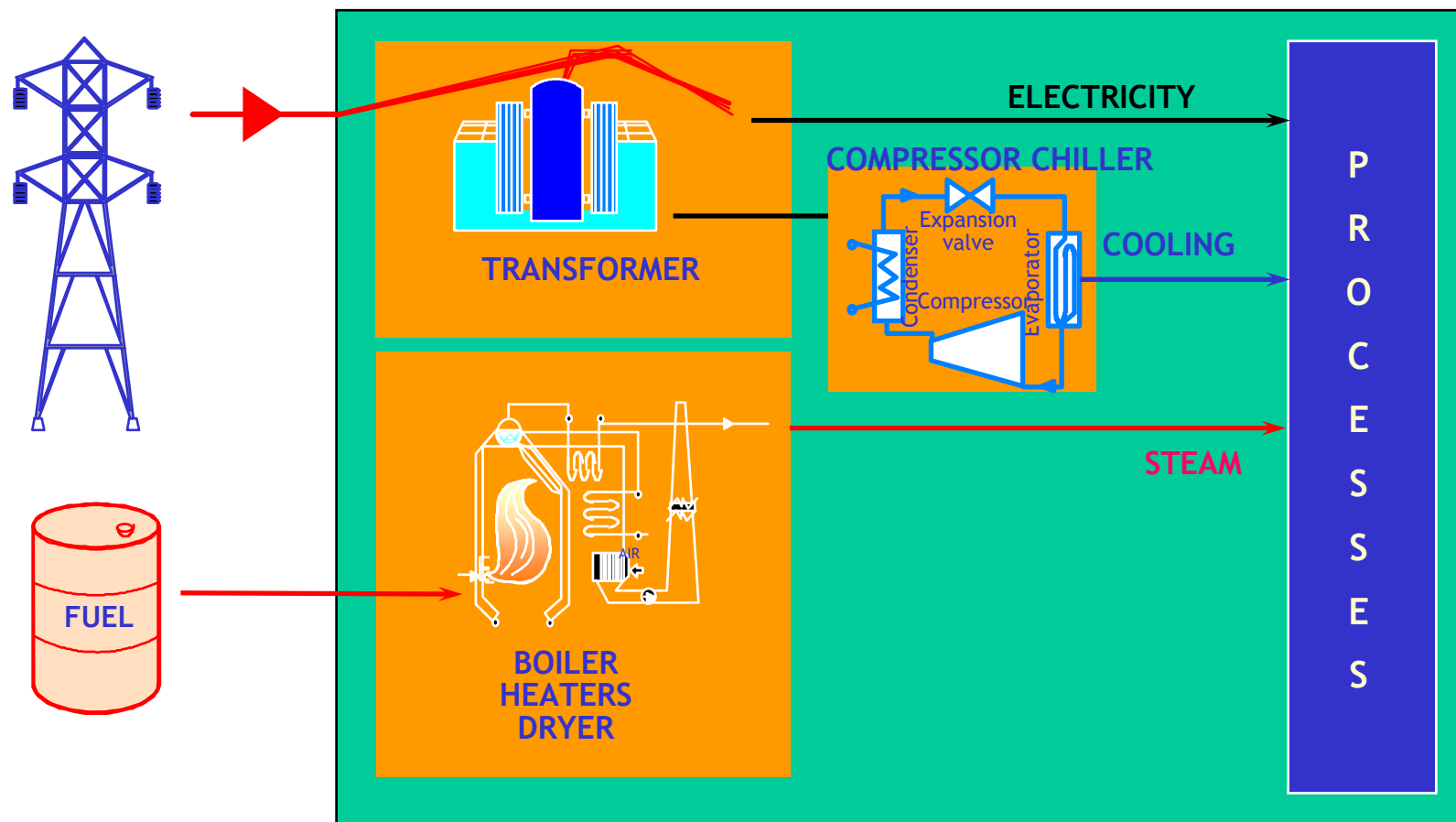
Location close to energy consumption 

- **Lower transmission and distribution losses**

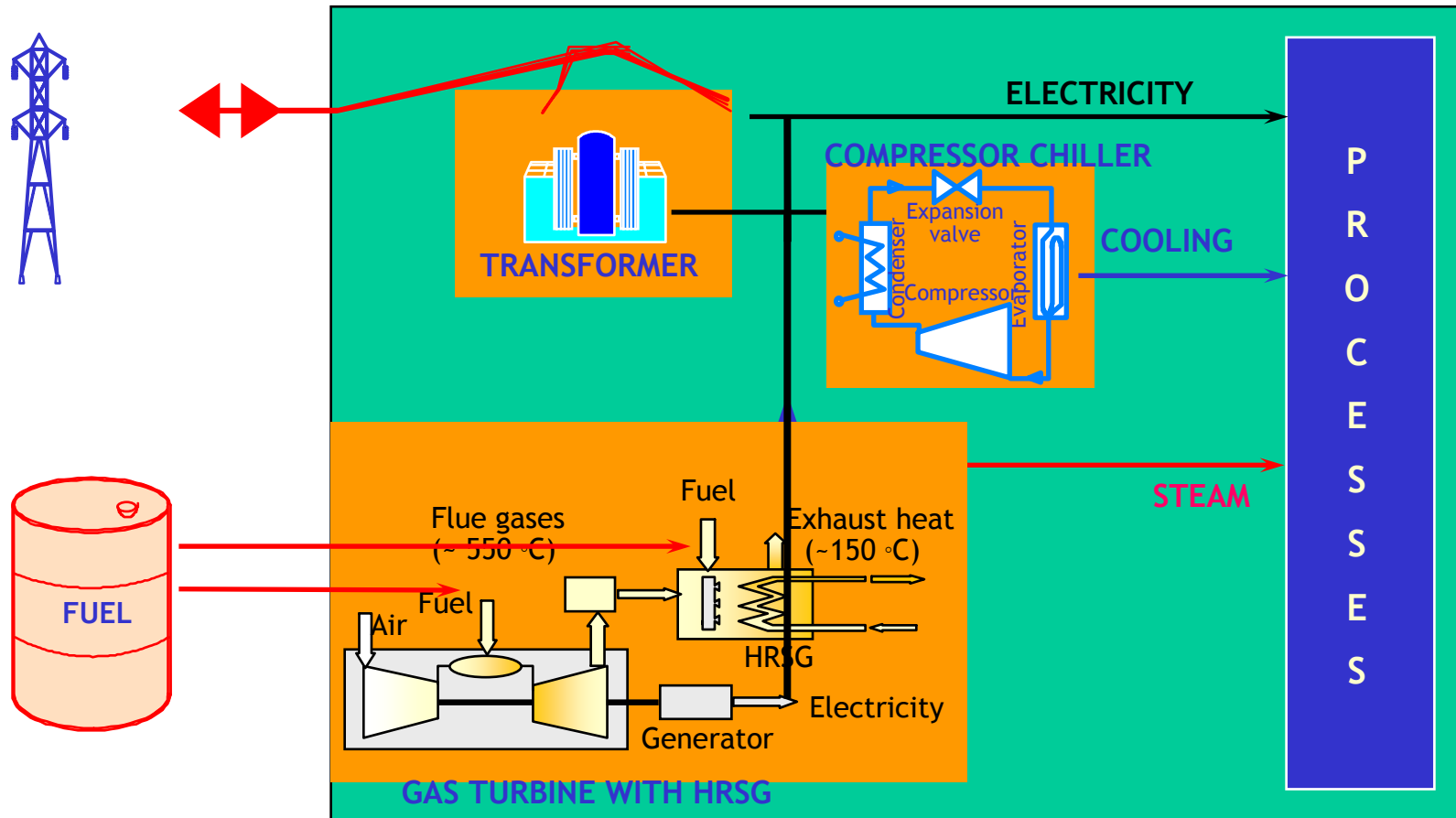
Private investment 

- **Less burden on national government for power generation**

“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



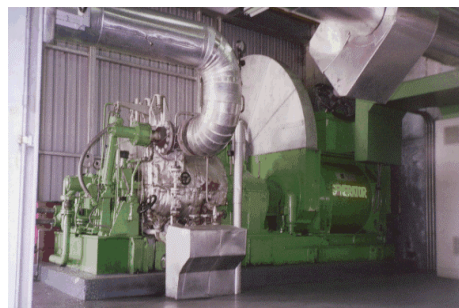
District cooling

Airports, office & commercial buildings, dwellings and houses

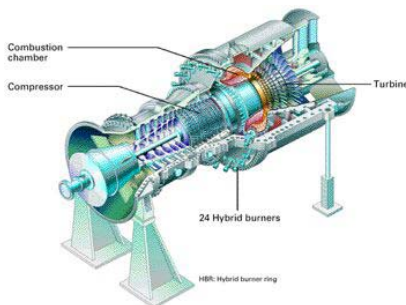


Cogeneration & distributed generation technologies

Steam Turbines



Gas Turbines



Engines



Combined Cycles

Microturbines



Fuel Cells



Stirling eng.



None CHP

Wind turbines



Hydro

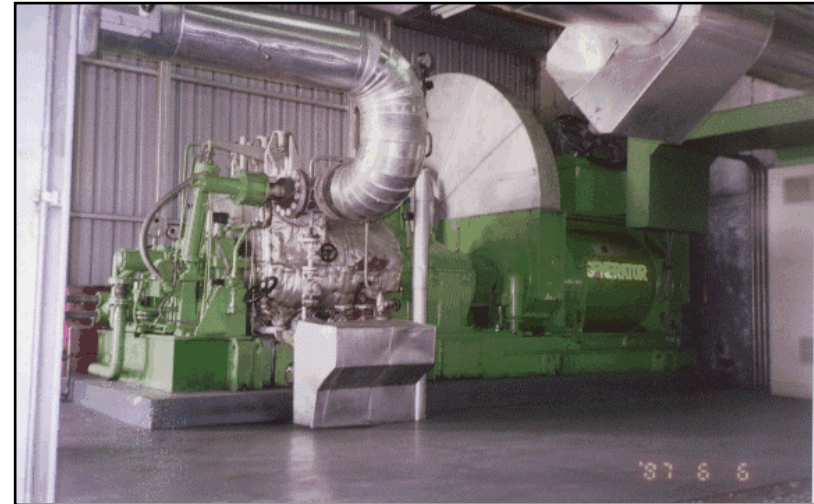
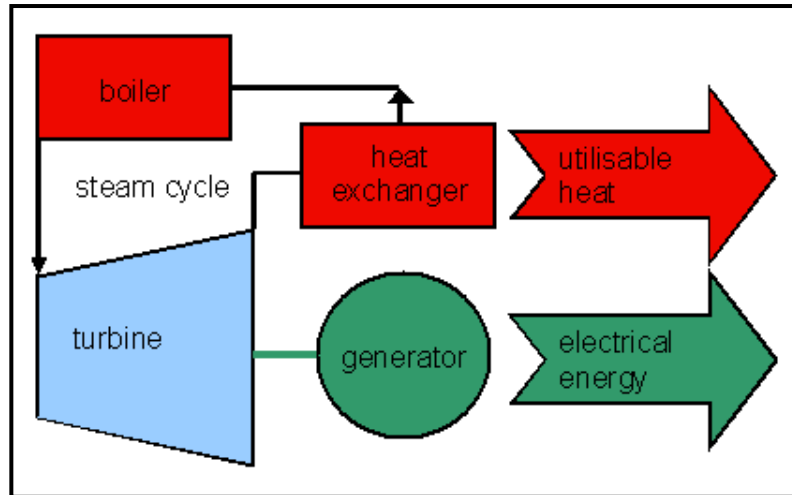




Cogeneration technologies parameters

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



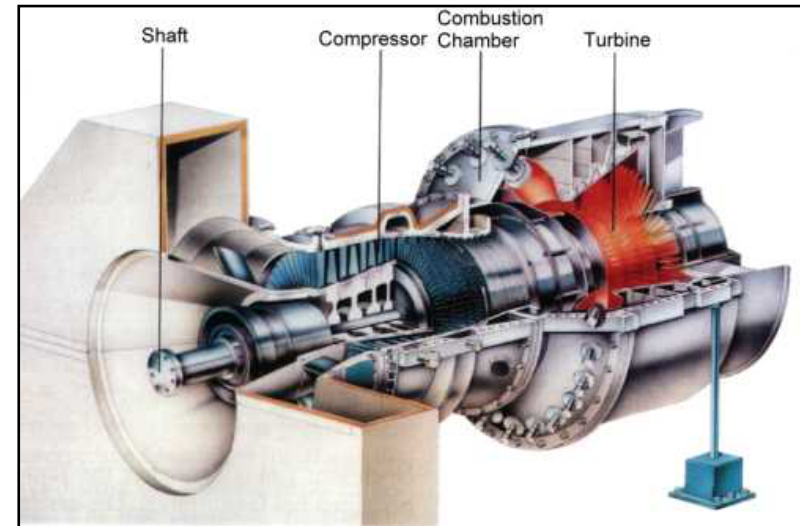
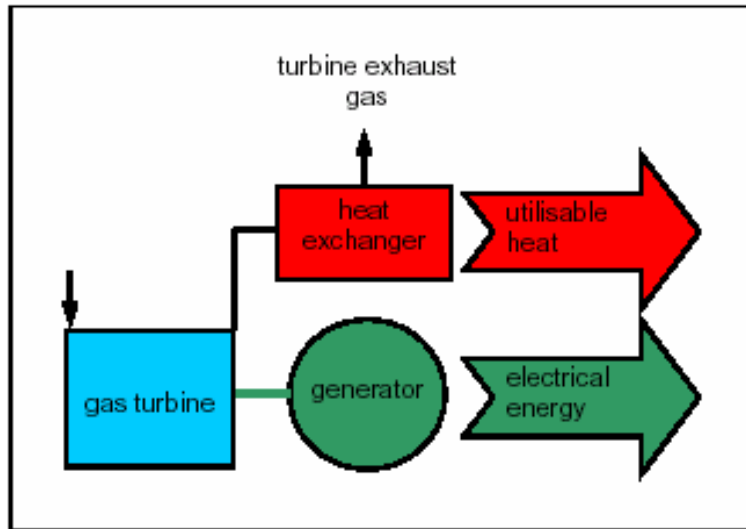
Advantages

- 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

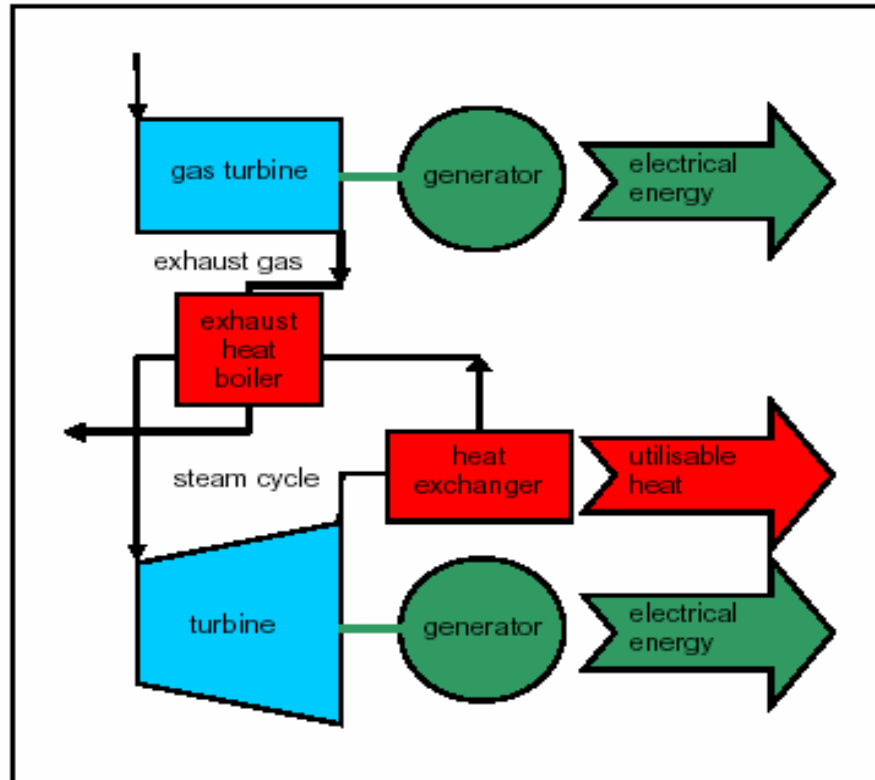
High fuel cost

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

Long operation hours required

High maintenance cost

Combined steam & gas cycle



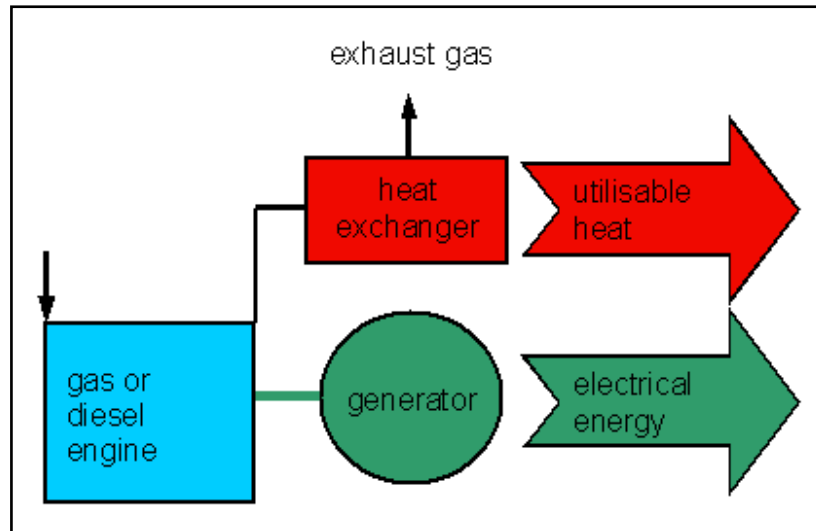
Advantages

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



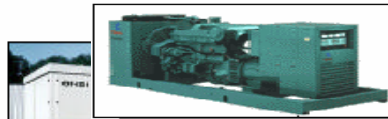
Gas-turbine



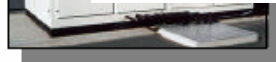
Solid Oxide Fuel Cell



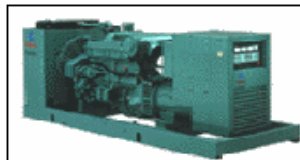
Micro-turbine



I.C. Engine



Commercial Phosphoric Acid Fuel Cell



I.C. Engine



Residential PEM Fuel Cell

°C

500

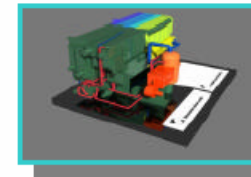
400

300

200

100

Thermally-Activated HVAC Technologies



Triple-Effect Absorption Chiller



Double-Effect Absorption Water-Cooled Chiller



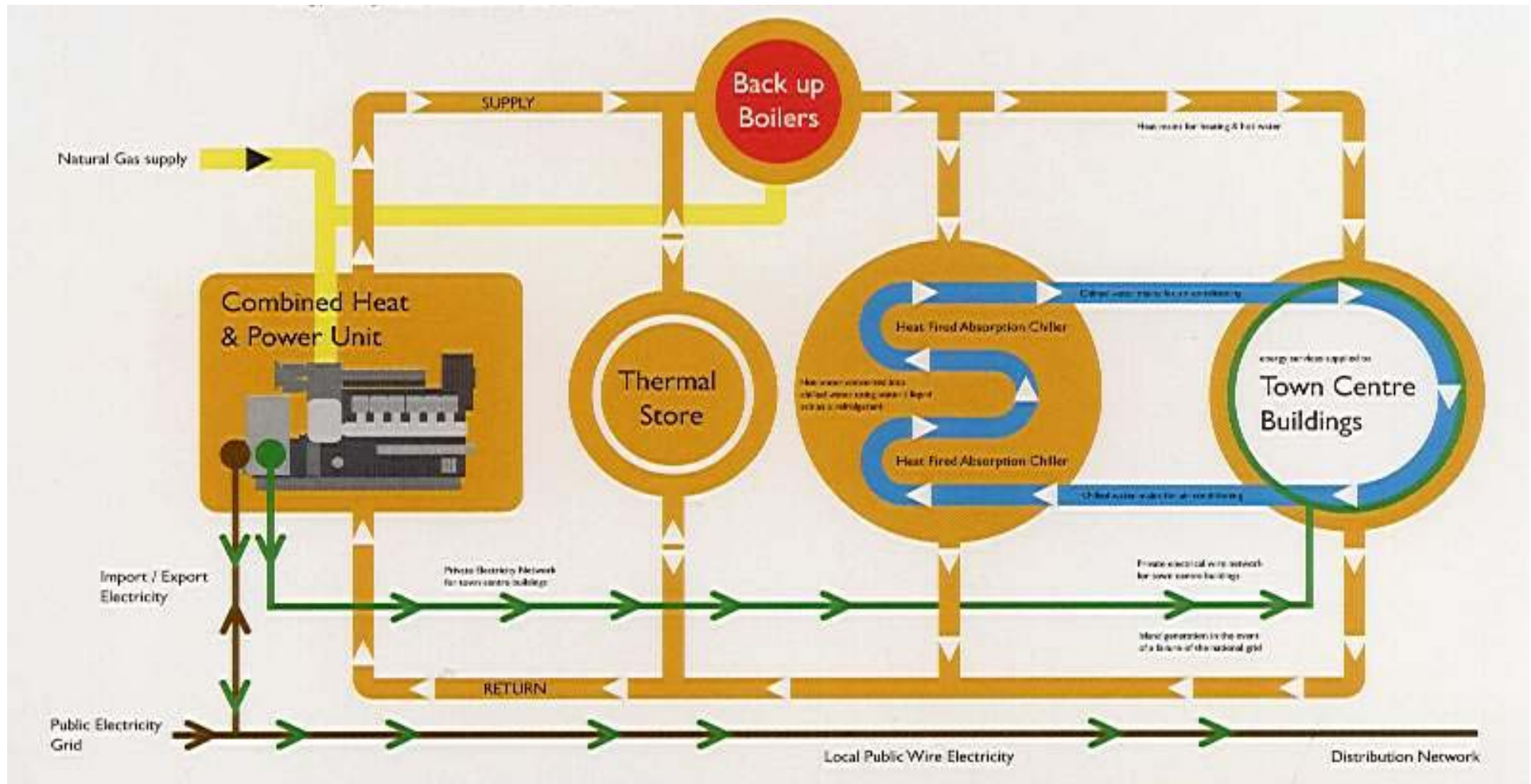
Single-Effect Absorption Chiller



Desiccant Technology

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

Case 1: Gas cogeneration in Kuala Lumpur International Airport



**40 MW natural gas cogeneration
(or Jet A1 fuel)**

- Gas Turbine Generator 2 x 20 MW
- Heat Recovery Steam Generator 2 x 40 tph
- Auxiliary Gas Boiler 2 x 25 tph & 1 x 40 tph

Chilled water 30,000 RT

- Steam Absorption Chiller (12 x 2,500 RT)

Operation since 1997

Petronas Tower (452 m)



Case 2: Gas cogeneration in Petronas Tower, Kuala Lumpur

25.8 MW natural gas cogeneration

- Gas turbine generator
2 x 4.2 MW & 2 x 8.7 MW
- Heat Recovery Steam Generator
2 x 10.7 tph & 2 x 18.7 tph
- Auxiliary gas boiler
2 x 47 tph

Chilled water 30,000 RT

- Electrical Centrifugal Chiller
3 x 5,000 RT
- Steam Turbine Centrifugal Chiller
3 x 5,000 RT
- 4 km chilled water network of pipes

Operation since 1996



Case 3: Hybrid cogeneration - industrial estate (1)

Map Ta Phut Industrial estate in Thailand

- Located 200 km southeast of Bangkok in Rayong Province
- Area 9.6 km², location close to sea
- Natural gas pipeline
- 80 MVA substation–115 & 22 kV transmission line from Map Ta Phut

Cogeneration plant

- Hybrid cogeneration using coal and natural gas
- One of the largest IPP investments in Southeast Asia
- Base-load electricity sale to state utility Electricity Generating Authority of Thailand (EGAT). 25-year Power Purchase Agreement (PPA)



Case 3: Hybrid cogeneration-industrial estate (2)

514 MW cogeneration

- Gas turbines 6 x 35 MW
- Steam turbines 2 x 152 MW
- Circulating Fluidised Bed Boilers 2 x
- Heat Recovery Units 4 x

Fuels

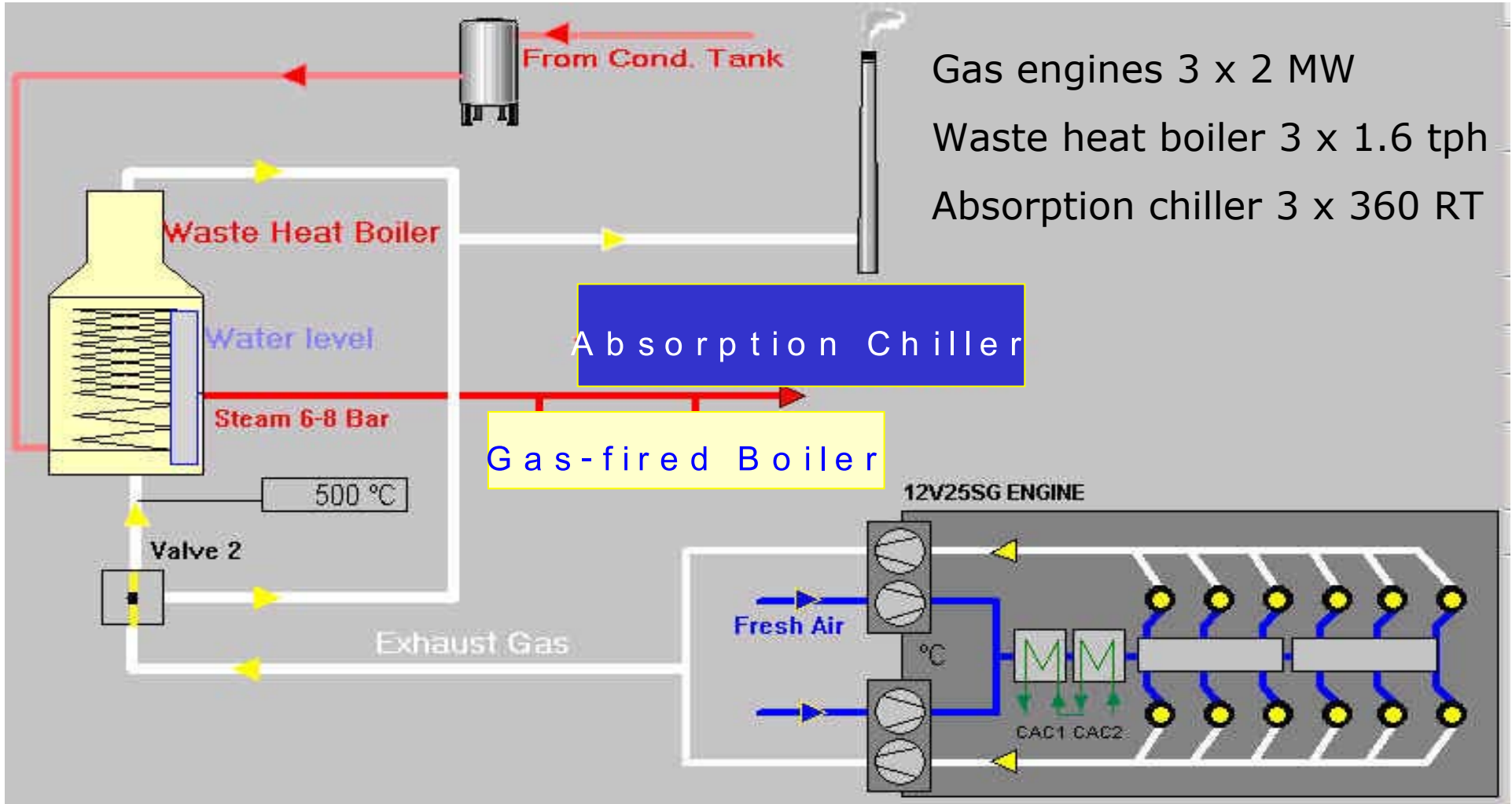
- Natural gas
- Indonesian bituminous coal
- Diesel oil (back up)

Operation since 2000

Supplies

- Electricity, steam (200 tph) and demineralised water (150 m³/h) to industrial estate and the plant
- Electricity to grid

Case 4: Gas industrial cogeneration-cooling (1)



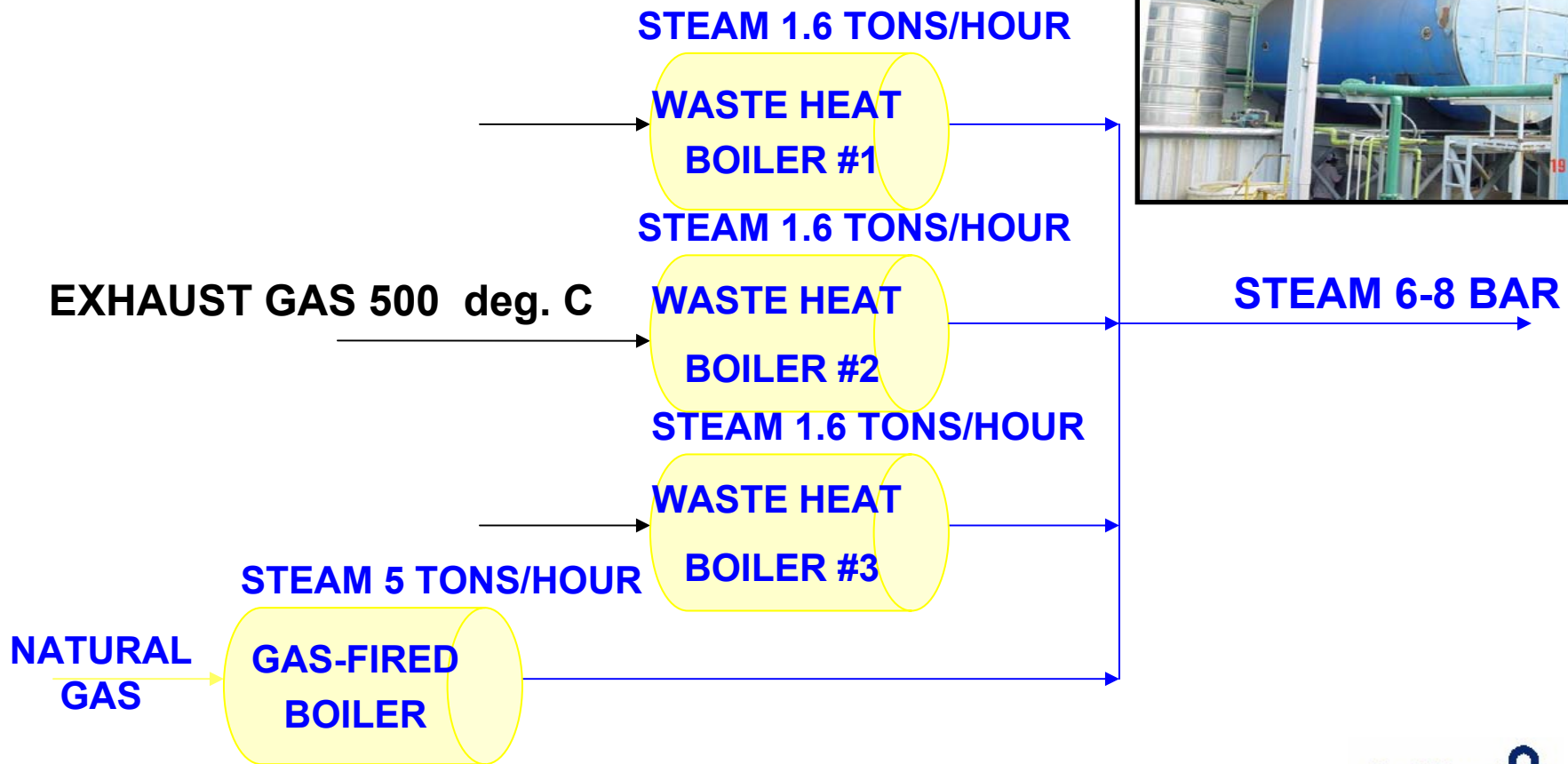
Case 4: Gas Industrial Cogeneration-cooling (2)

Engine and generator



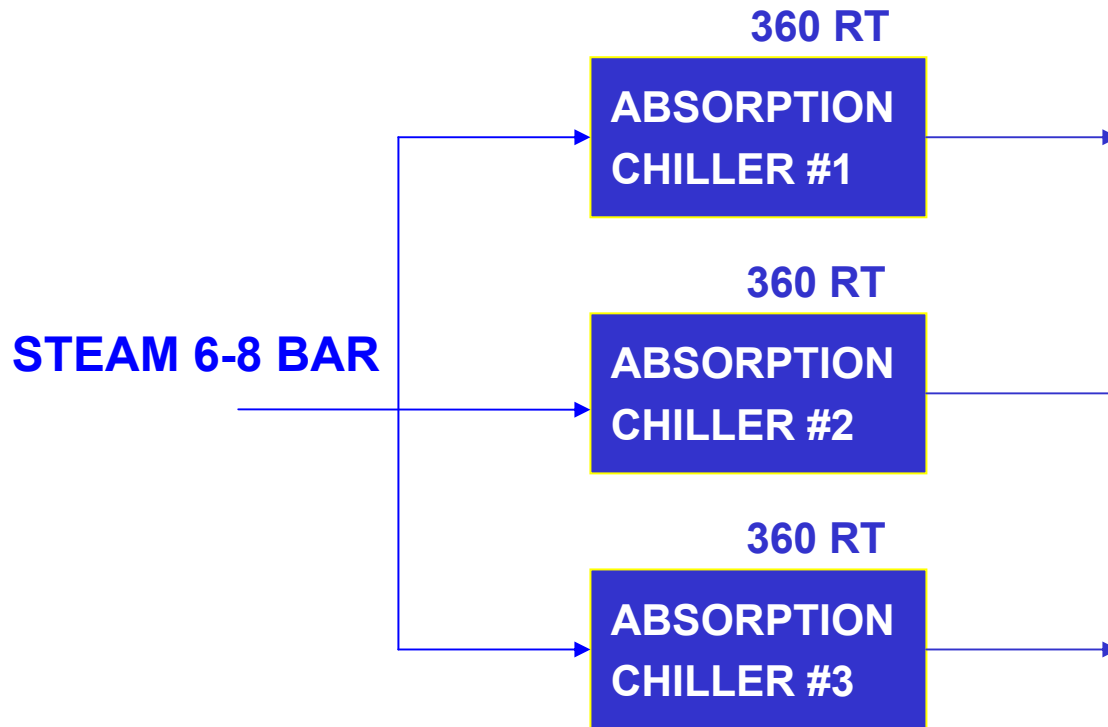
Case 4: Gas industrial cogeneration-cooling (3)

Waste Heat Boiler

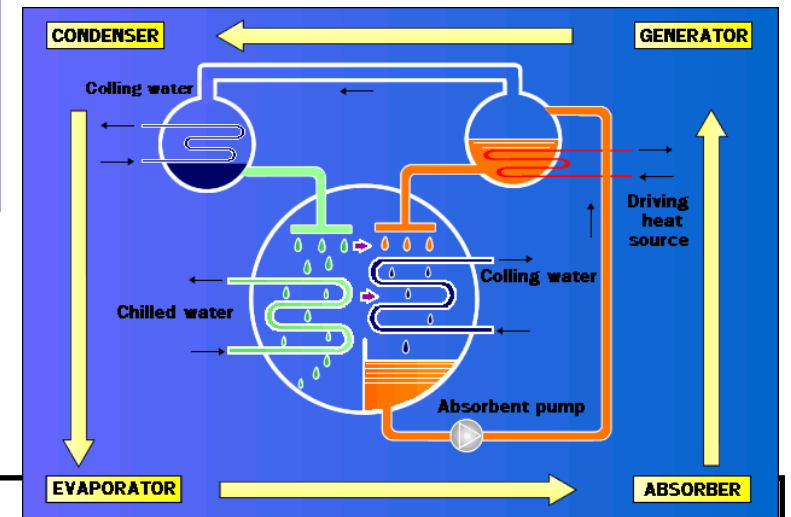


Case 4: Gas industrial cogeneration-cooling (4)

Absorption chillers



CHILLED WATER 7 deg. C



Case 5: Micro-turbine in rubber glove industry

- Bowman micro-turbine 80 kW electricity
- Natural gas
- Hot water up to 80 °C for leaching process
- Implemented by Novalogics Integrated Sdn. Bhd.
- Implemented in 2002





For more information,
please visit COGEN 3 Website at:

<http://www.cogen3.net>

Thank You !