GE
Energy

One engine.
Three powerful results.

Trigeneration with
Jenbacher gas engines.

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Trigeneration of heat, cooling and power

Refrigeration is required for ...

- air conditioning (e.g., hotels, conference centers, office buildings)
- industrial processes (e.g., food, chemical, computer industry)

Possibilities for refrigeration:

- Absorption chillers
- Compression-type refrigeration machines

Absorption chiller technology offers the most established and economic solution for reduced emission air conditioning systems.

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Key figures for refrigeration

- Approximately 150 to 170 kW of cold output is required per 1,000 m^2 of office space
- **Tons of refrigeration (TR)** is the unit for cold energy:
  - 1 TR(US) = 3.52 kWh
  - 1 TR(metric) = 3.86 kWh
- **Coefficient of performance (COP)** describes the efficiency of an absorption chiller:
  - Hot water chiller: COP between 0.6 and 0.8
  - Double-effect steam chiller: COP between 1.2 and 1.3

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Absorption chillers are an ideal alternative to conventional refrigeration

Working principle

- Two substances (e.g., water and lithium bromide salt) are separated through the addition of heat (desorption)
- They are then reunited through heat removal (absorption)
- Desorption and absorption at varying pressure conditions in a vacuum range:
  - Desorption: 80 mbar
  - Absorption: 10 mbar
- Water and lithium bromide salt generate chilled water in the temperature range from 6 to 12°C, ammonia and water are used for low temperature chilling down to -60°C

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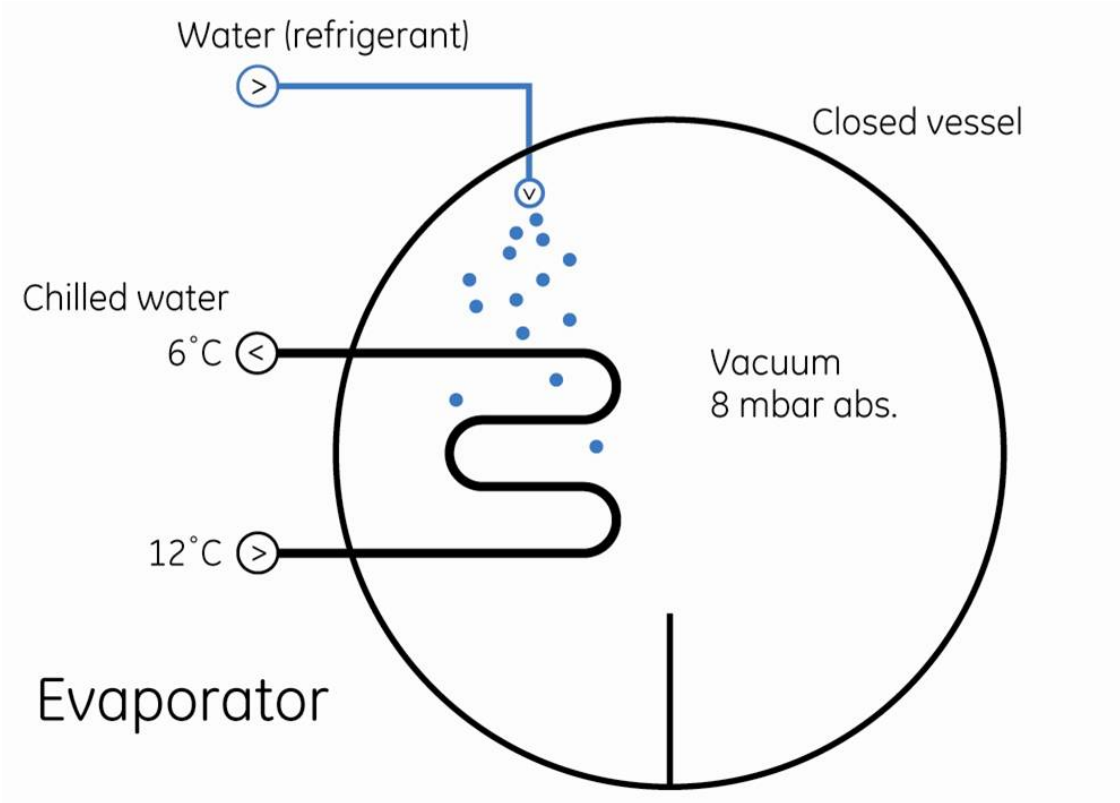
Absorption chiller: Step 1 – Evaporator



Water (refrigerant) evaporates at 4.5°C due to high vacuum (8 mbar abs.) thus cooling chilled water to 6°C.

Source: THERMAX

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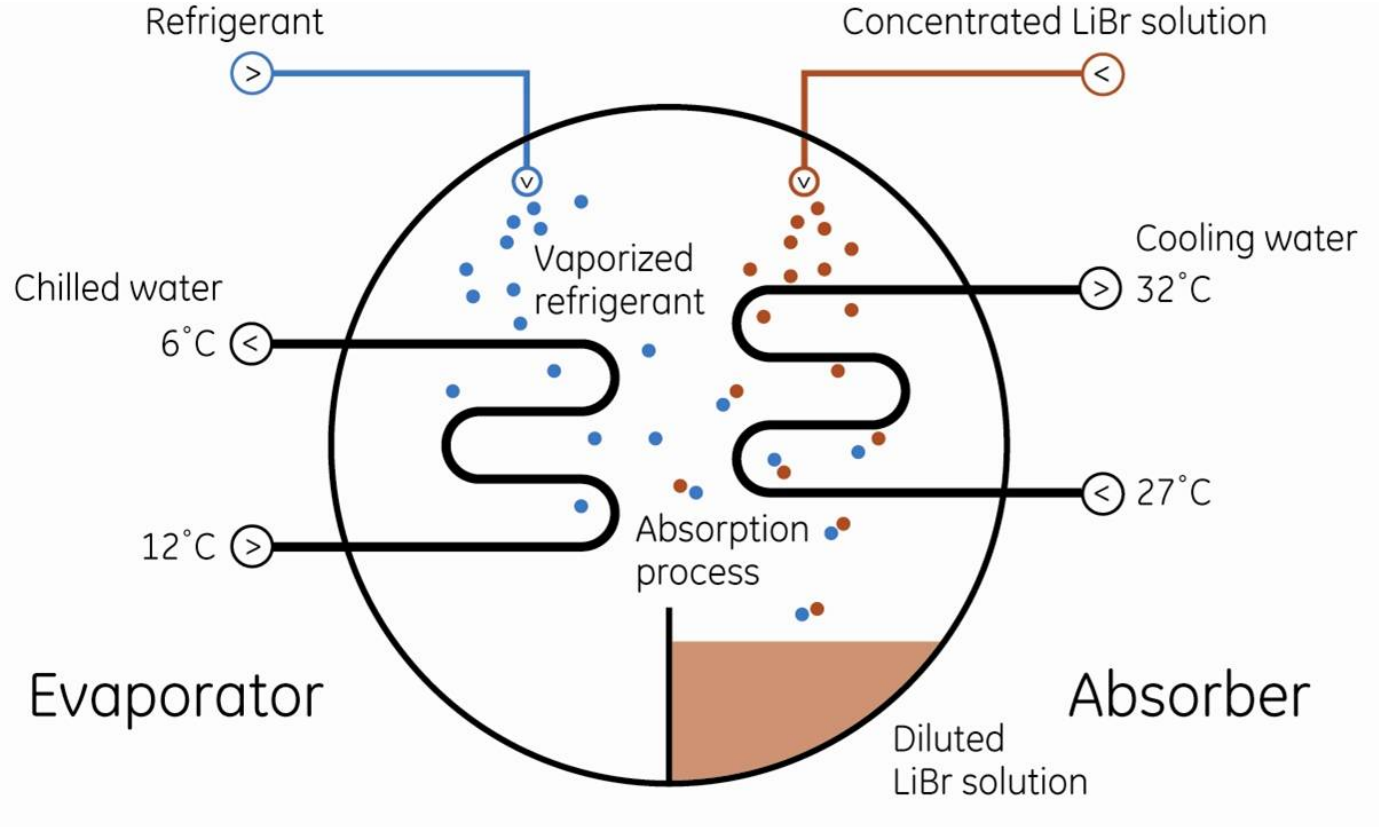
Absorption chiller: Step 2 – Absorber



Highly concentrated LiBr solution absorbs the evaporated water due to high hygroscopic affinity.

Source: THERMAX

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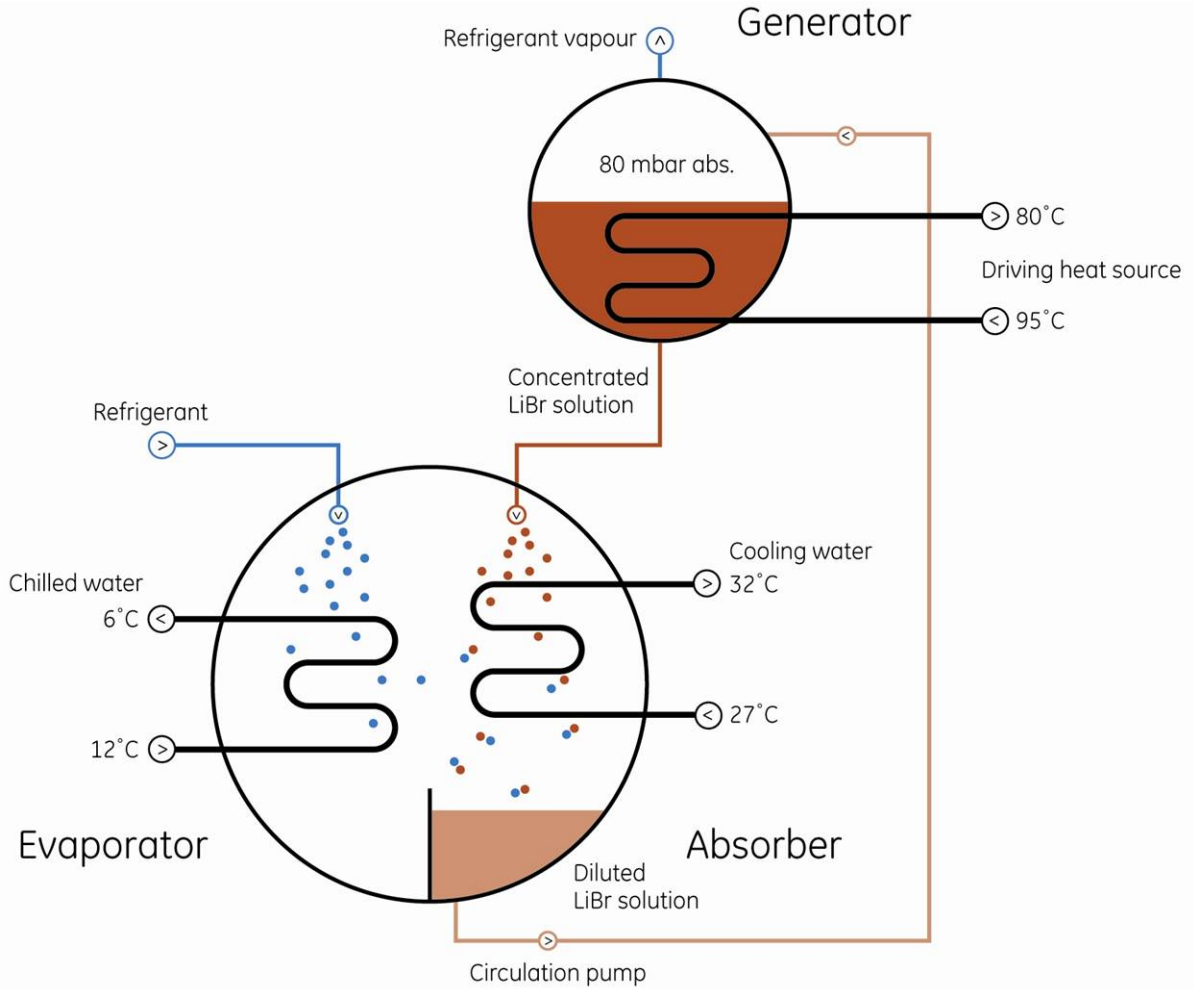
Absorption chiller: Step 3 – Generator

As the LiBr solution becomes diluted by absorption, it must be re-concentrated by means of an outside heat source.



Source: THERMAX

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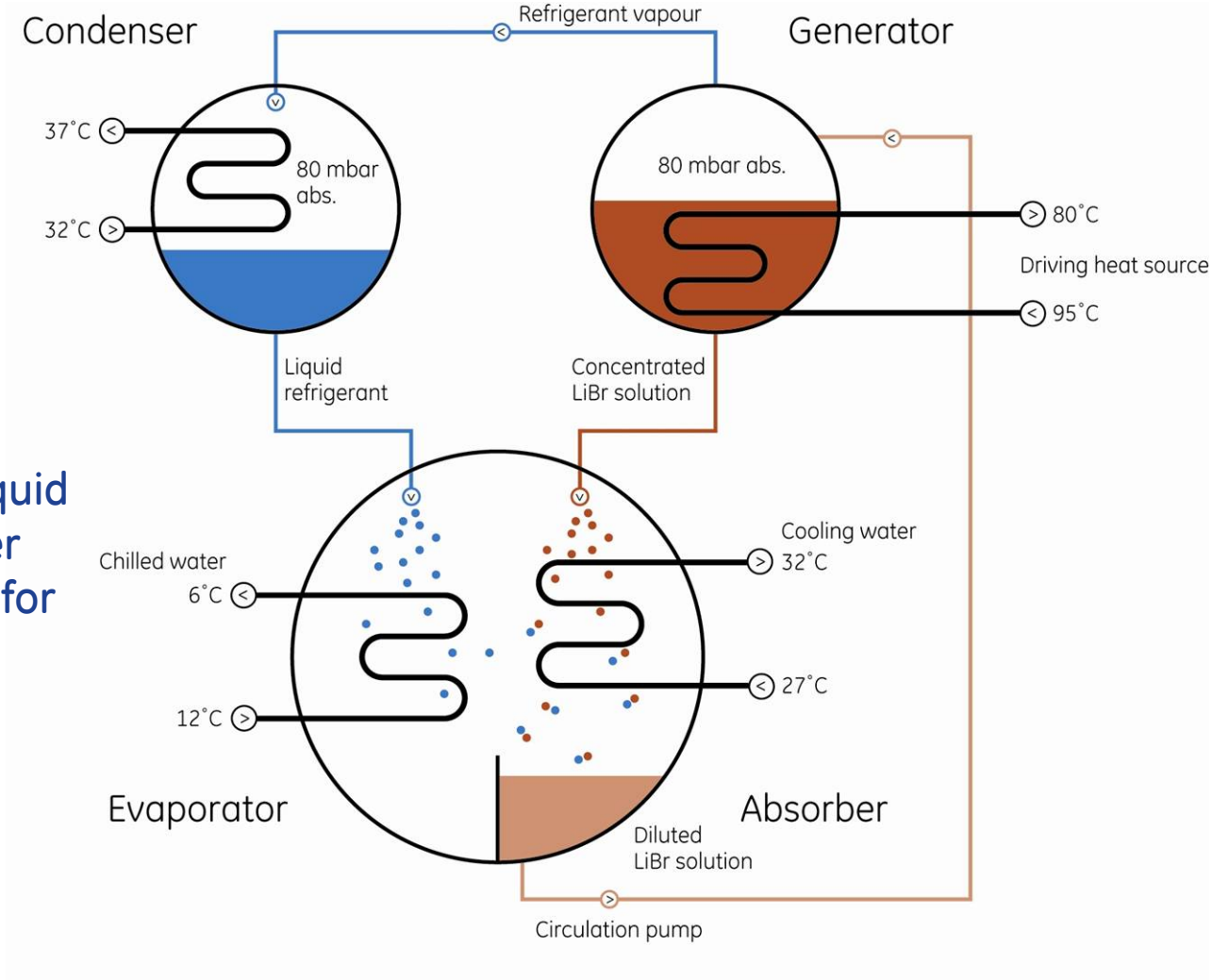
Absorption chiller: Step 4 – Condenser

The water vapor is brought back to the liquid phase in the condenser and is again available for the circuit.



Source: THERMAX

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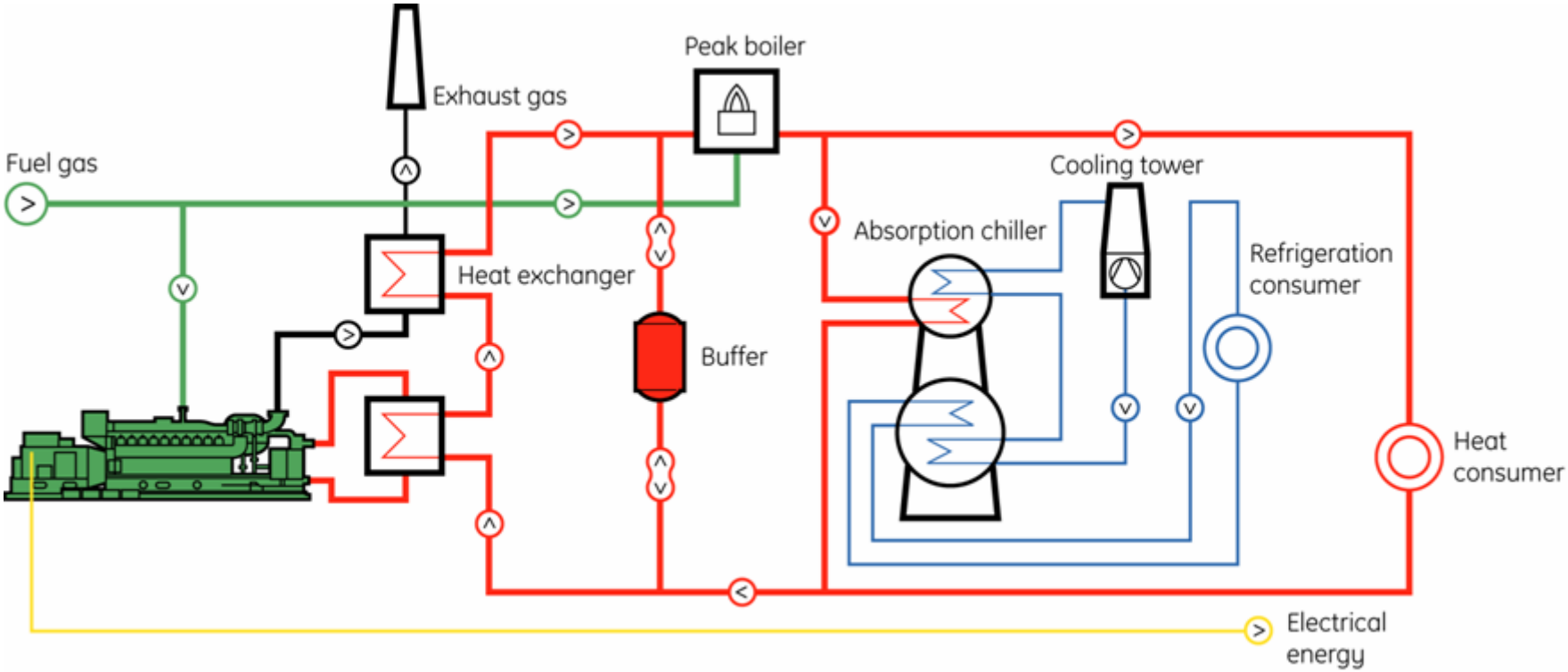
Trigeneration concept: Jenbacher gas engines in combination with absorption chillers



- **Maximum total fuel efficiency**
- **Elimination of HCFC/CFC refrigerants**
- **Reduced overall air emissions**

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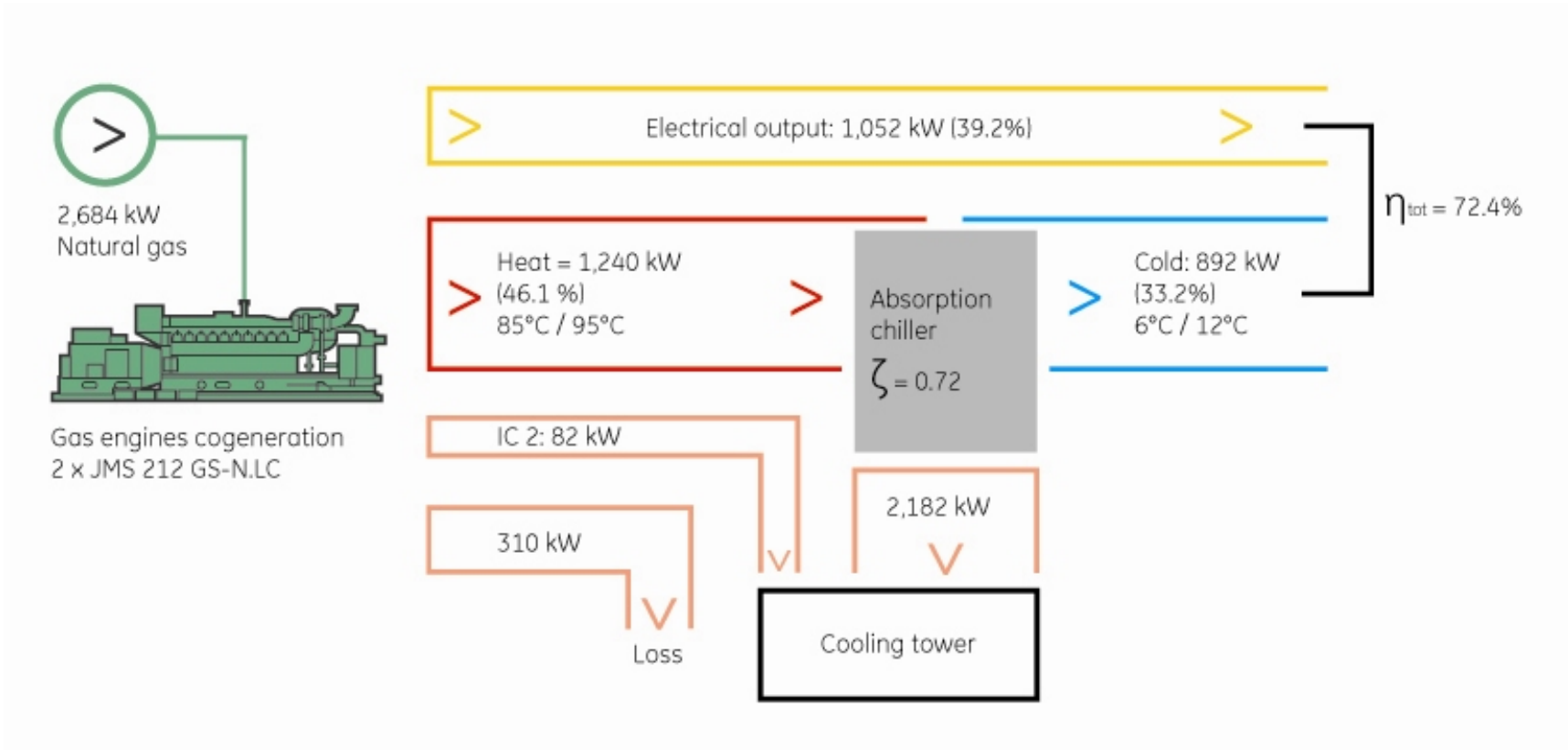
Energy flow of the CHCP (combined heat, cooling and power) plant TUS Celje, Slovenia



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CHCP systems supply heat, chilled water, and electricity

- Hot water from the cooling circuit of the cogeneration plant serves as drive energy for the absorption chiller
- Hot exhaust gas from the gas engine can be used as energy source for steam generation ⟶ steam for highly efficient, double-effect steam chiller
- During cold seasons the heat can be utilized to cover on-site heat requirements
- Electricity can be fed into the public grid or used to cover electricity requirements of the plant

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Advantages of trigeneration systems over conventional refrigeration technology

- Operated with heat, utilizing inexpensive “excess energy”
- No moving parts in absorption chillers, no wear and therefore low maintenance expenses
- Noiseless operation of the absorption system
- Low operating costs and life-cycle costs
- Water as refrigerant, no use of harmful substances for the atmosphere

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The Jenbacher product team is constantly working on customized solutions

Absorption chiller technology represents an optimal solution for a year-round efficient source of cooling and heat, especially when used in combination with a gas engine cogeneration system.

More than 300 trigeneration systems with Jenbacher gas engines are already in operation throughout the world.

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Trigeneration plant Airport Cologne/Bonn

No. of units and engine type:	4 x JMS 616 GS-N.LC
Fuel:	Natural gas
Electrical output:	7,744 kW
Thermal output:	8,800 kW (RW/FW 70/95°C)
Refrigeration output:	3,900 kW (by 2 absorption chillers) 3,300 kW (by 2 compression-type machines for peak cooling)
Commissioning:	November 1998

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Trigeneration plant TUS Celje, Slovenia

No. of units and engine type:	2 x JMS 212 GS-N.LC
Fuel:	Natural gas
Electrical output:	1,052 kW
Thermal output:	1,240 kW
Refrigeration output:	892 kW (RW/FW 6/12°C)
Commissioning:	February 2003

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