Utility of Waste heat through

1) Power generation

2) Generation of hot water – Cogeneration

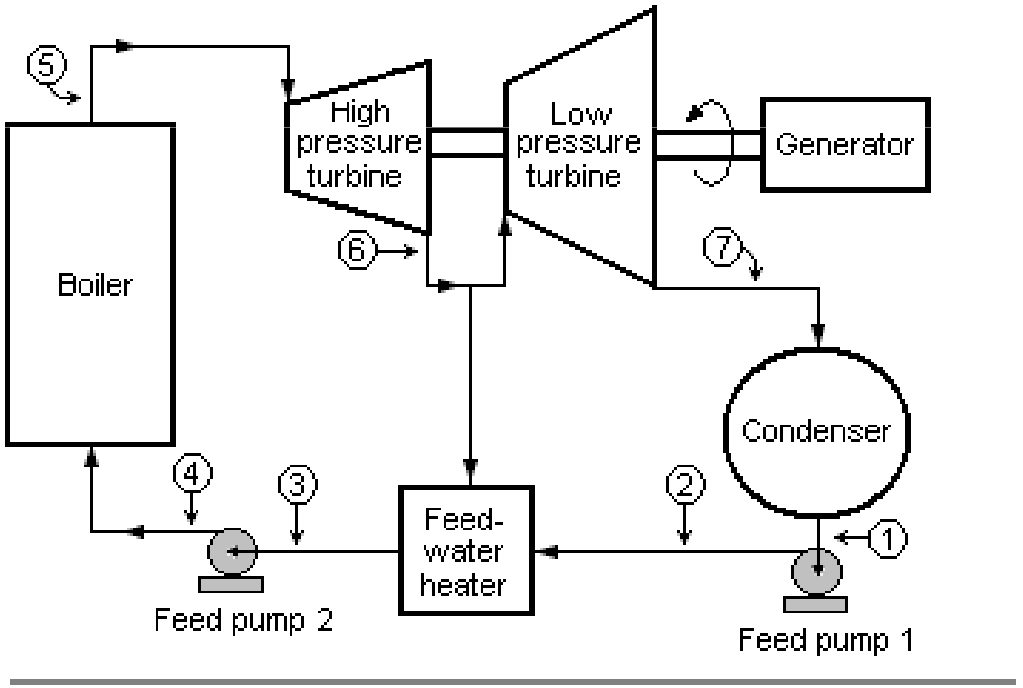
3) Generation of chilled water – Through Absorption chillers

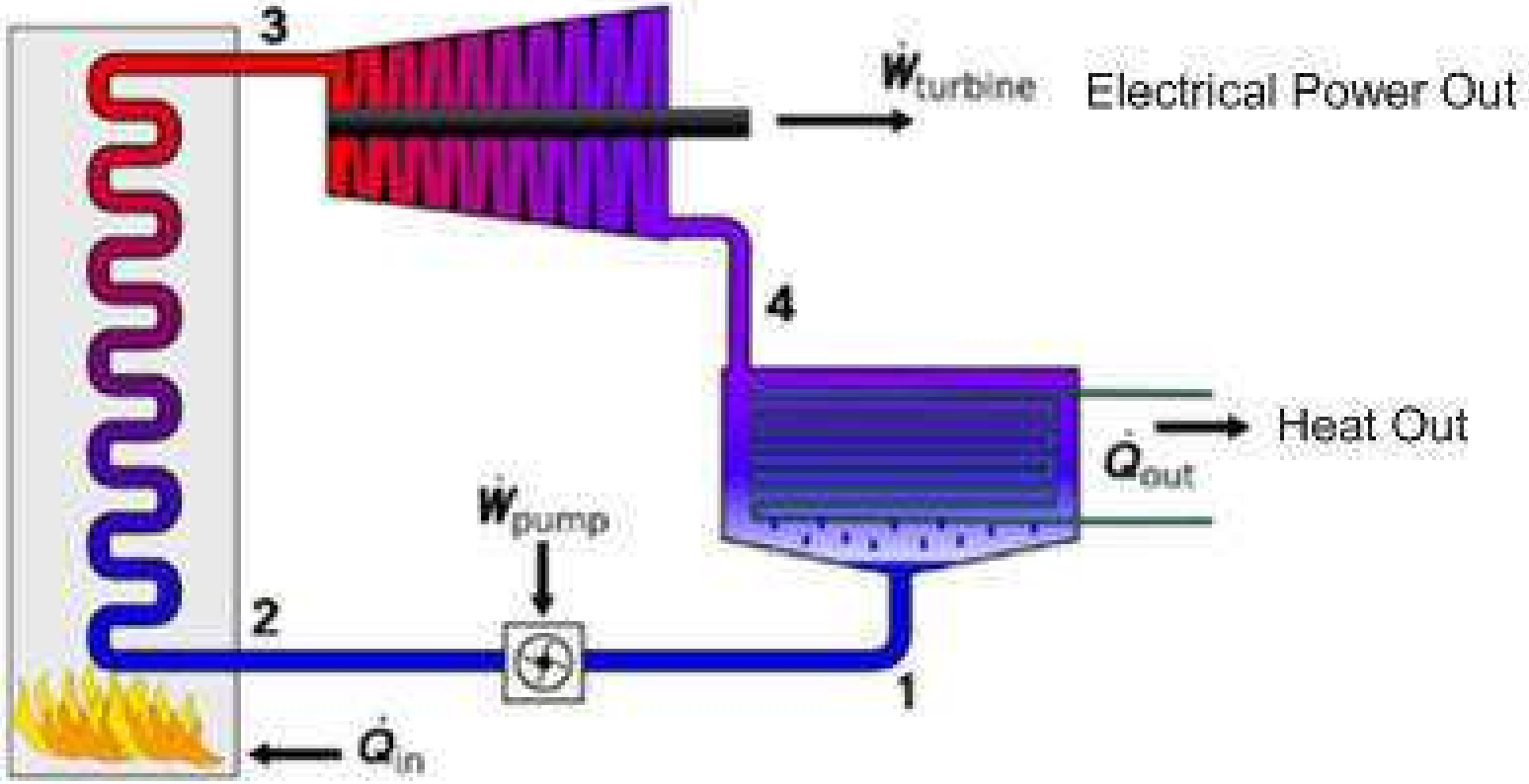
Power generation

- Through organic Rankine Cycle.

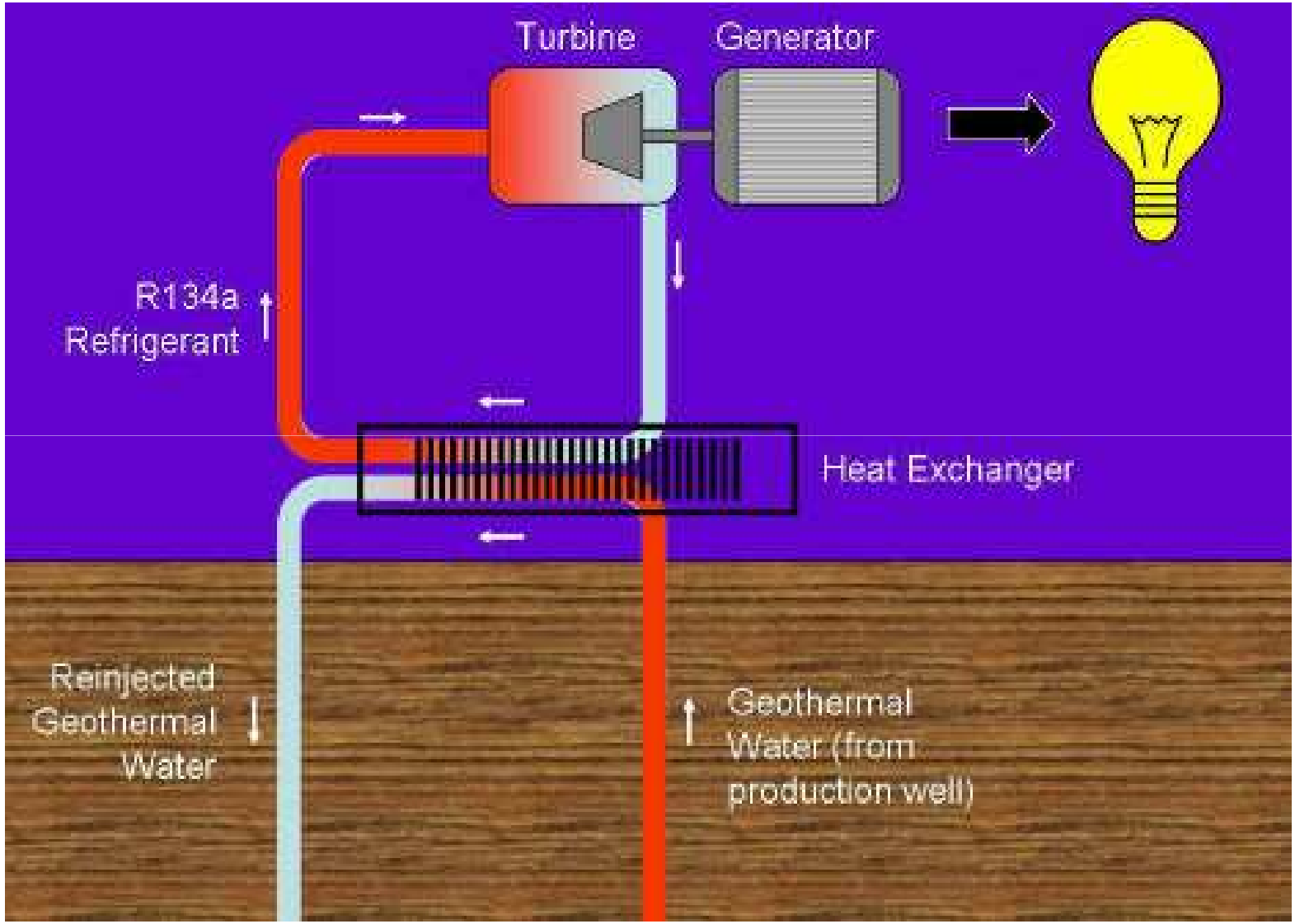
The working principle of the organic Rankine cycle is the same as that of the Rankine cycle: the working fluid is pumped to a boiler where it is evaporated, passes through a turbine and is finally re-condensed.

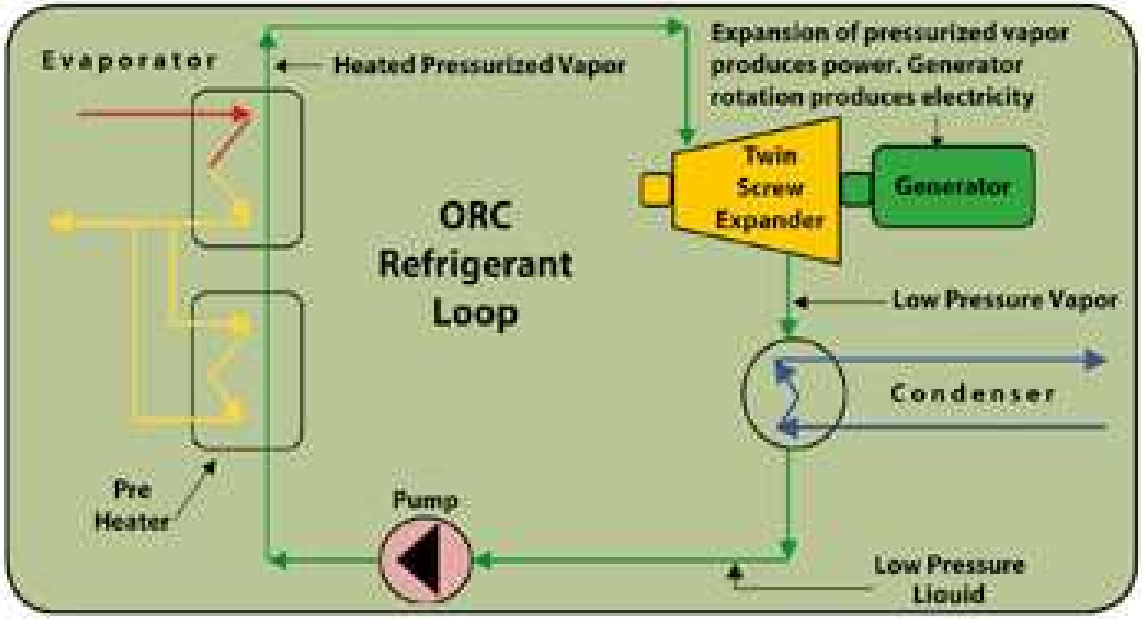
The **Organic Rankine cycle** (ORC) is named for its use of an organic, high molecular mass fluid with a liquid-vapor phase change, or boiling point, occurring at a lower temperature than the water-steam phase change.





1. Low Pressure Cool Liquid
2. High Pressure Liquid/Vapor
3. High Pressure Hot Gas
4. Low Pressure Hot Gas


Turbine
Generator
R134a
Refrigerant
Heat Exchanger
Reinjected
Geothermal
Water
Geothermal
Water (from
production well)



How the cycle works –

1) Heat captured by the evaporator is used to boil the working fluid into vapour.

2) Under pressure the vapour is forced through the screw expander, turning it to spin an electric generator.

3) The vapour is cooled and condensed back into a liquid in the condenser.

4) The working fluid is pumped to higher pressure and returned to the evaporator to repeat the process.

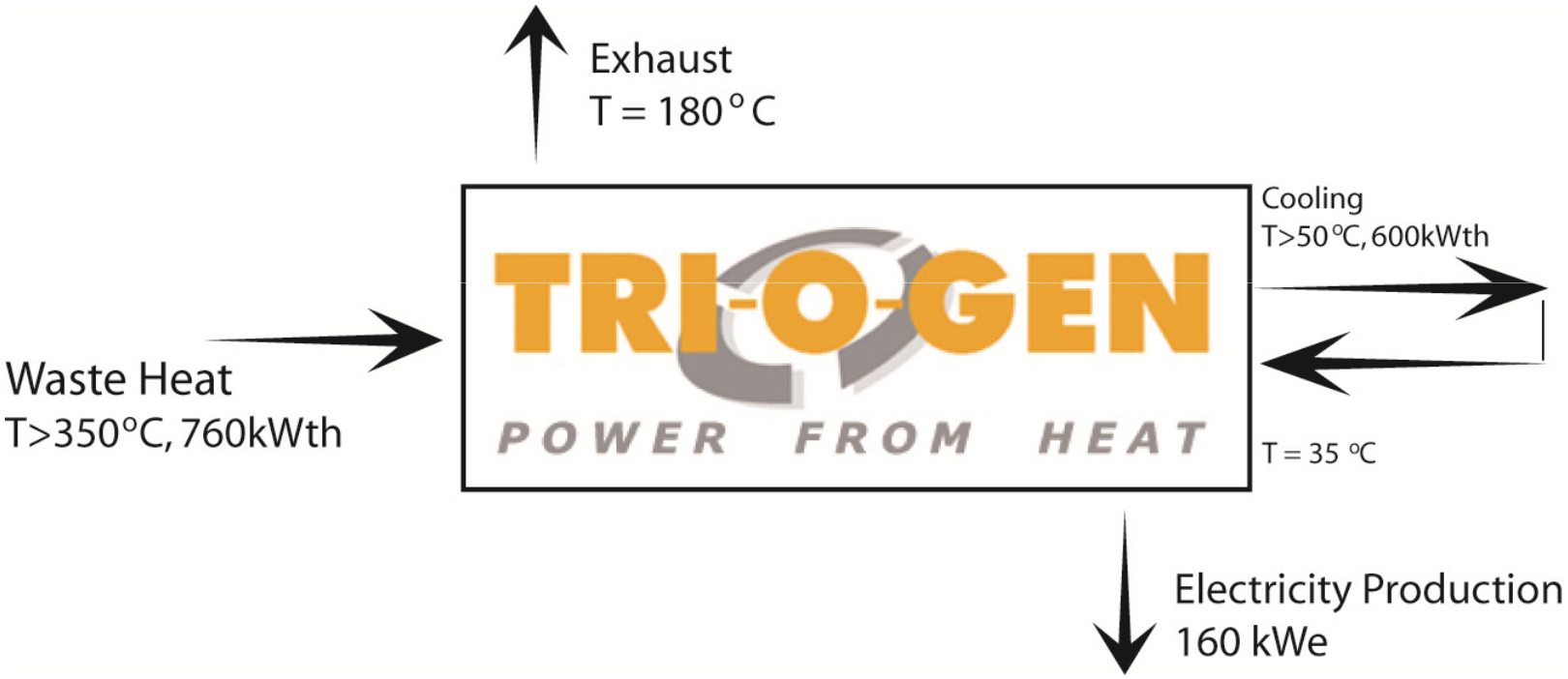
Working fluid – Refrigerants like R-134a.

Twin screw expanders

Sources of waste heat to drive ORC systems.

- Exhaust gases from

1. Natural gas engines
2. Biogas engines
3. Gas turbines
4. Flare gas
5. Process heat
6. Exhaust from furnace
7. Solar hot water
8. Jacket water from engines
9. Geothermal water


Exhaust
T = 180 °C
TRI-O-GEN
POWER FROM HEAT
Cooling
T>50 °C, 600kWth
Waste Heat
T>350°C, 760kWth
T = 35 °C
Electricity Production
160 kWe

TRI-O-GEN
POWER FROM HEAT

SIMONS GREEN ENERGY SOLUTIONS

- Closed loop ORC
- Net Electrical Power 60kW – 160kW
- Minimum Heat Input 350°C
- Exhaust Temperature 180°C
- Thermal intake: 760 kWth
- Cooling water : 600 kWth
- Waste Heat from
  - Cogeneration
  - Process Heat
  - Furnace
  - Boiler

SIMONS GREEN ENERGY SOLUTIONS

ELECTRA THERM®

Green Machine

- Closed loop ORC
- Low temperature waste heat input – 85 to 116^{0}C
- Net Electrical Power 30 - 50kW
- Waste Heat from
  - Cogeneration
  - Process Heat
  - Furnace
  - Boiler

Advantages:

- **No additional fuel consumption**
- **Near zero emissions**
- **No creation or disposal of waste**
- **Displaces fossil fuel based energy**
- **No new transmission required**

- Generation of hot water – Cogeneration

Separate production of electricity and heat

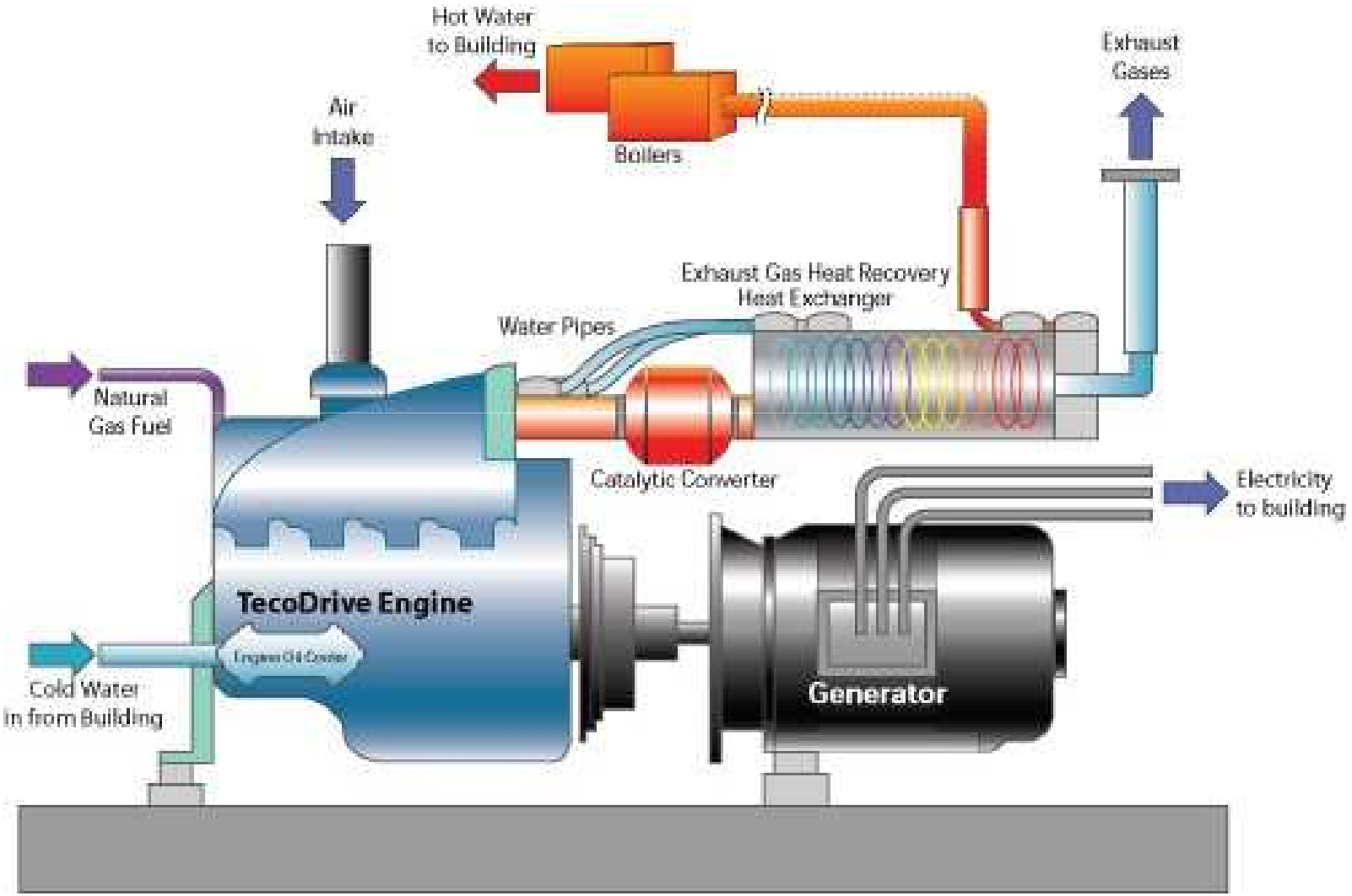
Efficiency: (36+80)/200=0,58 or **58%**

Cogeneration

Efficiency: (30+55)/100=0,85 or **85%**

- Cogeneration is a means of supplying a site's power and thermal energy needs from the combustion of a single fuel and as such is significantly more fuel efficient than conventional technologies.

- There are a range of commercially available and established cogeneration technologies including: reciprocating gas or diesel engines, gas turbines, and steam turbines.


Hot Water
to Building
Boilers
Exhaust
Gases
Air
Intake
Exhaust Gas Heat Recovery
Heat Exchanger
Water Pipes
Natural
Gas Fuel
Catalytic Converter
Electricity
to building
TecoDrive Engine
Engine Oil Cooler
Cold Water
In from Building
Generator

- fuels used for cogeneration include natural gas, hydrogen, LPG, bio-gas, coal, diesel, oil, biomass etc.

- The key benefit of cogeneration is that it can provide a substantial increase in fuel efficiency and therefore achieve significant cost and greenhouse gas benefits.

- Cogeneration meets both the power and thermal requirements of a site from the combustion of the same fuel within a single facility.

- Typical system efficiencies – 90%.

- Typical applications include: hospitals, manufacturing facilities, and leisure centres.

- The primary fuel used in these facilities is natural gas, however there are also applications which use biogas or landfill gas.

Requirements for implementation of Cogeneration:

- A fairly constant thermal and electrical load though out the day
- a relatively consistent thermal to power load ratio
- reliable access to fuel supply at a fixed cost
- suitable site access and space availability
- Concerns regarding emissions in the area

- Waste heat recovery by using absorption chillers for generating chilled water.

Advantages of absorption chillers over conventional electrical chillers:

1) Works on waste heat / low grade energy/ fuels. Electrical consumption is minimal. (10kWs for a 1000kW chiller)

2) No CFCs or HCFCs used in the chiller. Water itself is used as refrigerant. So no Ozone deletion potential.

3) Just 2 moving parts in the chiller – 2 canned motor pumps. So minimum maintenance requirement.

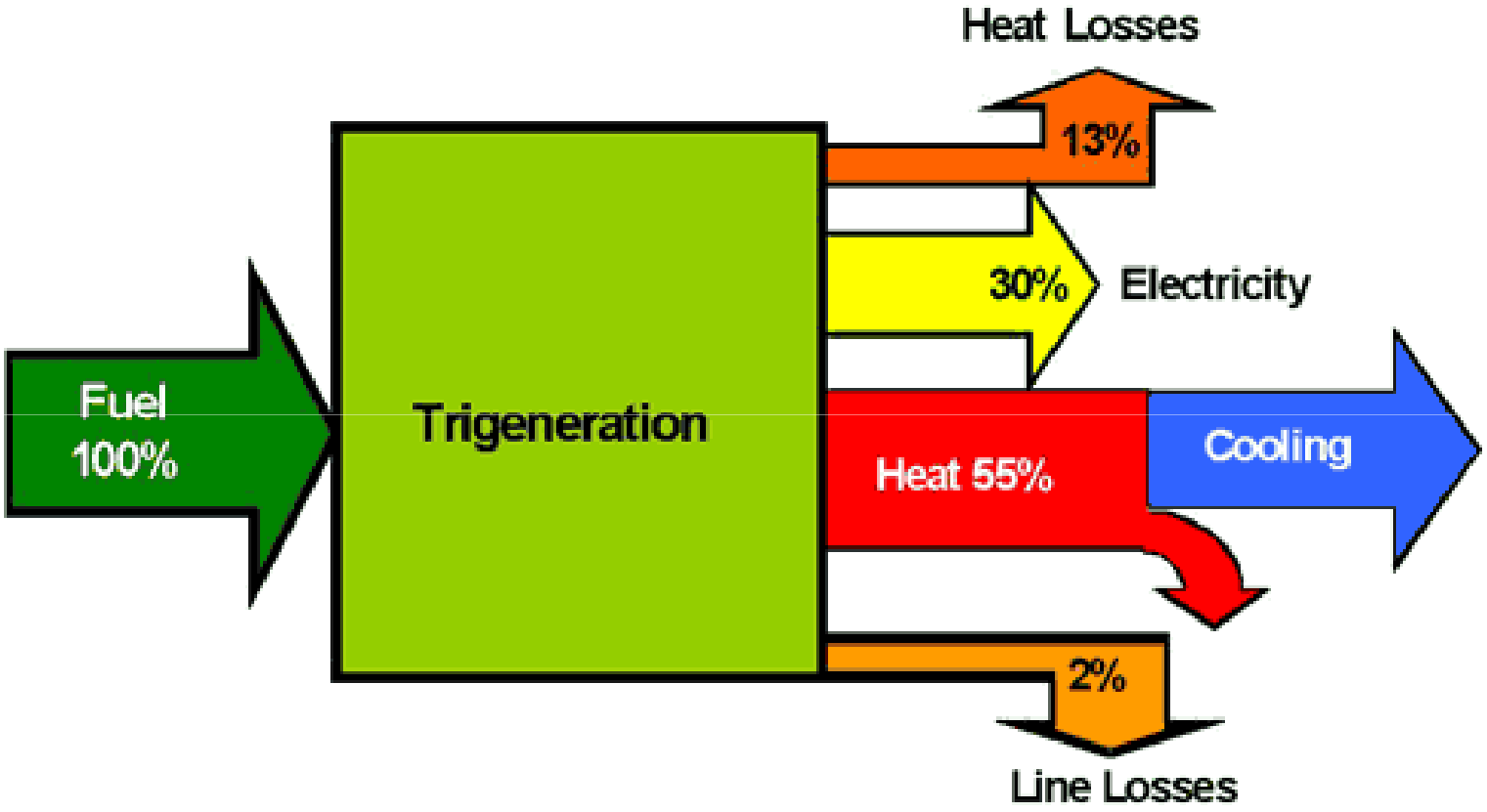
4) Very quite operation.

Types of construction

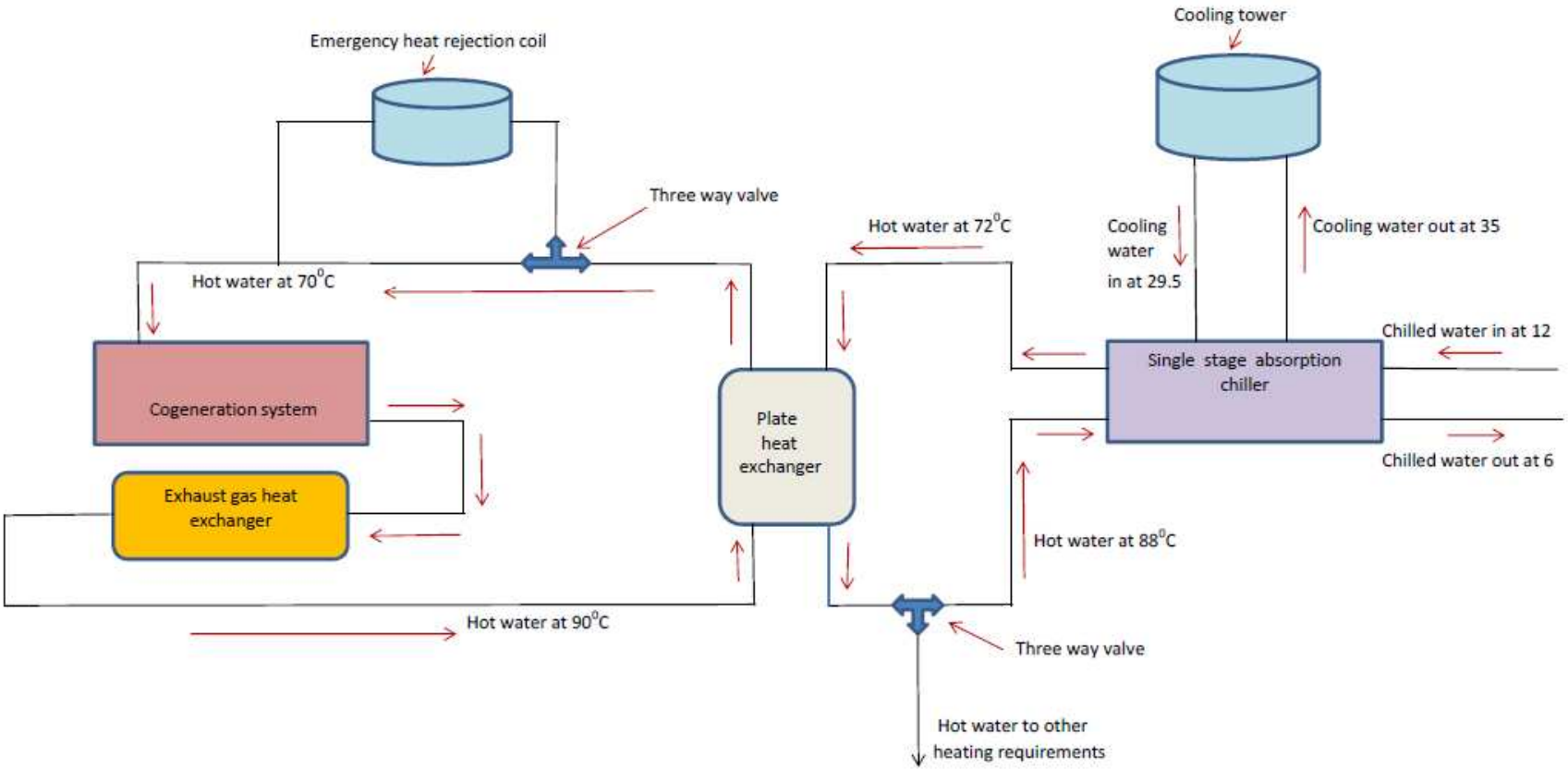
- Single effect chillers with COP of 0.75
- Double effect chillers with COP of 1.35

Types of energy streams:

1. Exhaust gas
2. Hot water – Low temperature and High temp
3. Steam – High pressure and low pressure
4. Natural gas
5. Combination of above.


Heat Losses
13%
30%
Electricity
Fuel
100%
Trigeneration
Heat 55%
Cooling
2%
Line Losses

Typical Tri-generation arrangement



- Thank You.