



Waste Heat Recovery Power Generator

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Introduction – Why recover waste heat?

Current Situation

- Increasing energy prices and CO₂ emission controls
- 20-50% of industrial energy consumption released as waste heat
- Proven technology

Industry changes

- Mandate for “Green facility & footprint”
- Convert waste heat into monetary value in the form of electricity
- Can be applied to several industrial applications

**Huge potential in waste heat recovery although not known
As other alternative energy types like solar, wind, biomass**

Waste heat sources in an Oil & Gas complex

DIESEL ENGINES:

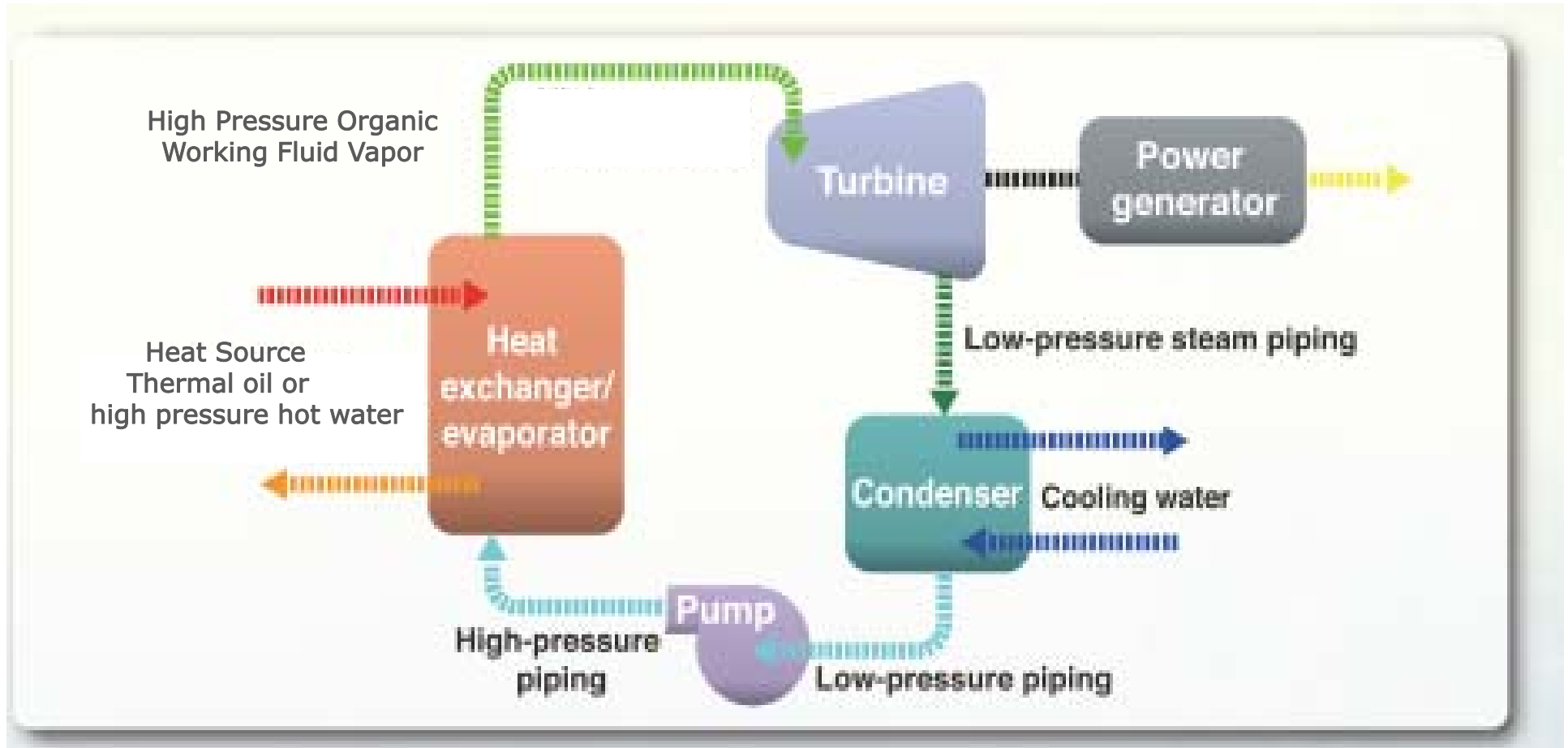
- Typical Diesel Engine Shaft Power Efficiency : ~ 40-45%
- Exhaust Temperature: 850 – 950 ° F
- Exhaust Gas Thermal Loss: ~ 30-35%
- Jacket Cooling Thermal Loss: ~ 15-20%

GAS TURBINES:

- Typical Gas Turbine Shaft Power Efficiency : ~ 40-45%
- Exhaust Temperature: 800 -900 ° F
- Exhaust Gas Thermal Loss: ~ 50-55%

Organic Rankine Cycle (ORC) Generator

BASIC COMPONENTS OF ORC UNIT



ORC Power Generator Unit

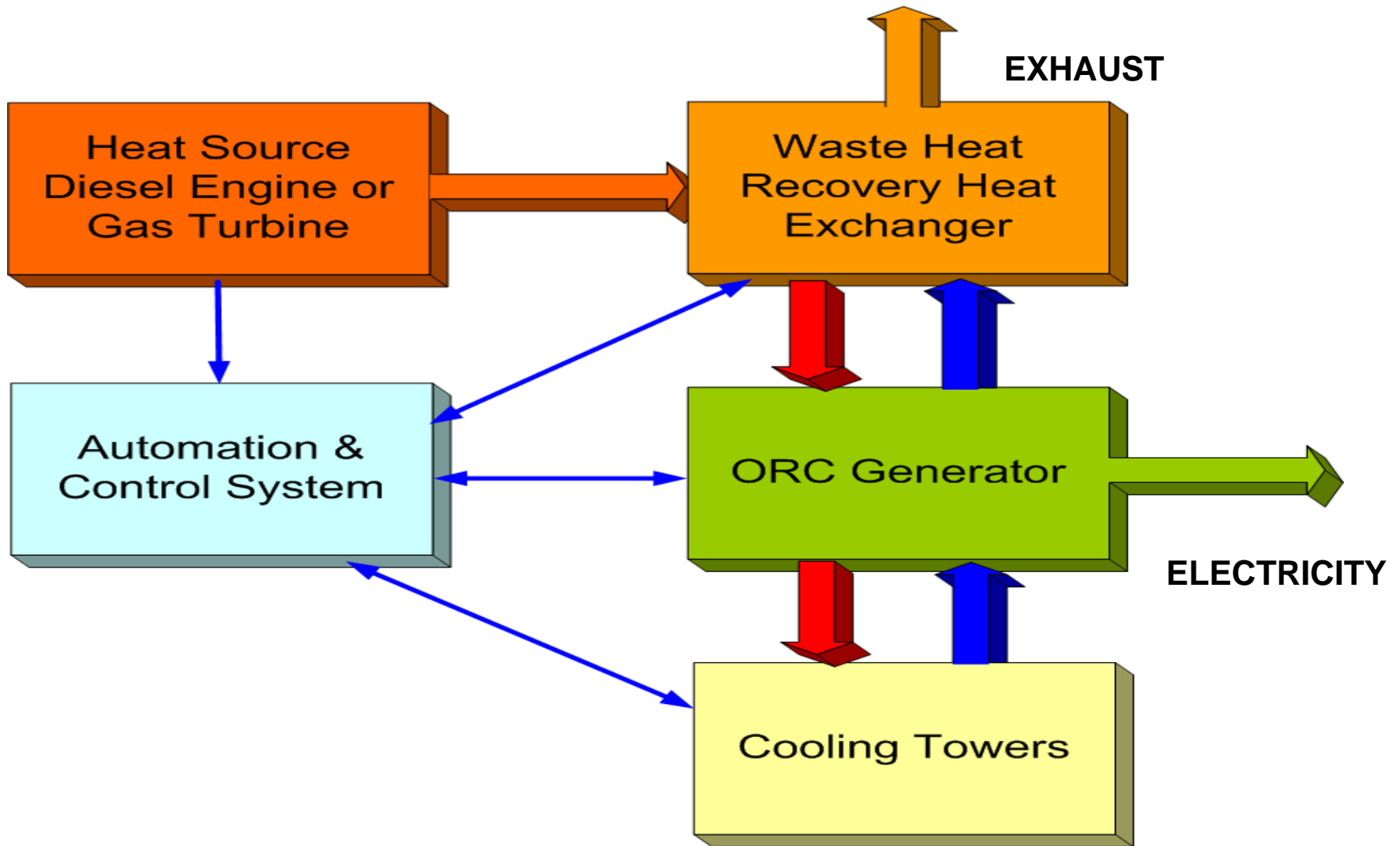


Units are available from 250 kW up to 10 MW

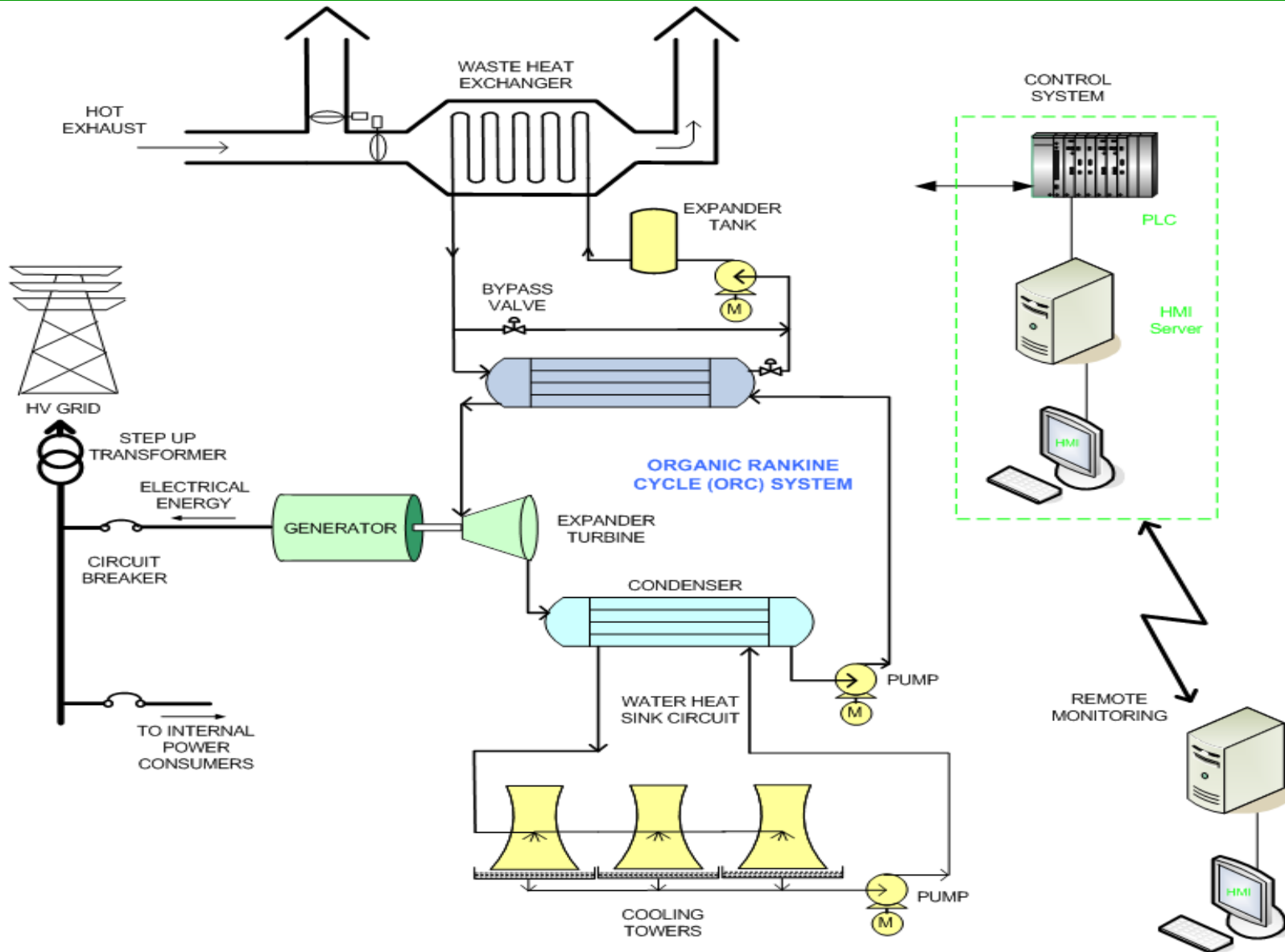
ORC System Properties

- Working fluid R245fa or Silicon based depending on the resource temperature
- Heat source: Hot water or Thermal Oil 195–580F (91° - 305° C)
- Cooling requirement: Water 39F–109F (4° - 43° C)
- Controls: PLC with Remote monitoring Web-based gateway Operation
- Designed for unattended operation
- Enclosure Not required

Waste Heat Recovery & Power Generator



Waste heat recovery diagram for Gas turbines & Diesel Engines

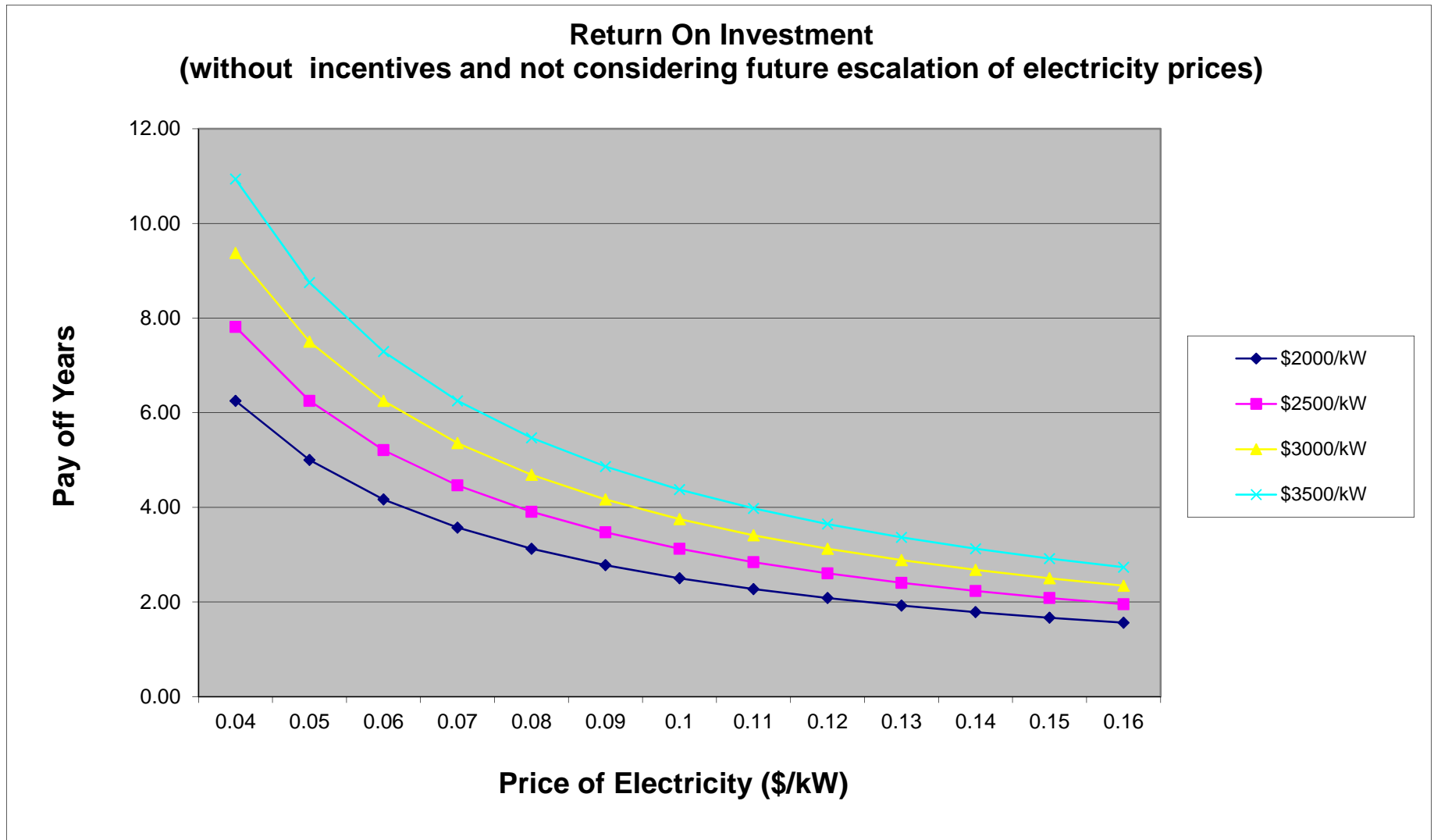


Sample data for Gas Turbines

- Turbine Shaft Power: 10,000 HP (7457 kW)
- Exhaust Waste Heat Recovery : 9,750kW
- Net ORC power : ~ 2243 kW (at 23% efficiency)
- Thermal Oil: ORC inlet 570F / ORC outlet 410F (300C / 210C)
- Thermal Oil Flow: ~ 102 lbs/sec (46 kg/sec)
- Cooling Water : inlet 81F / Outlet 108F or (27 C / 42C)
- Cooling Water Flow: ~ 1900 GPM (430 m3/h)
- Heat Exchanger Size : 33.2 MMBTU

~30% of Turbine Shaft Power

ORC Payback calculations



ORC Advantages

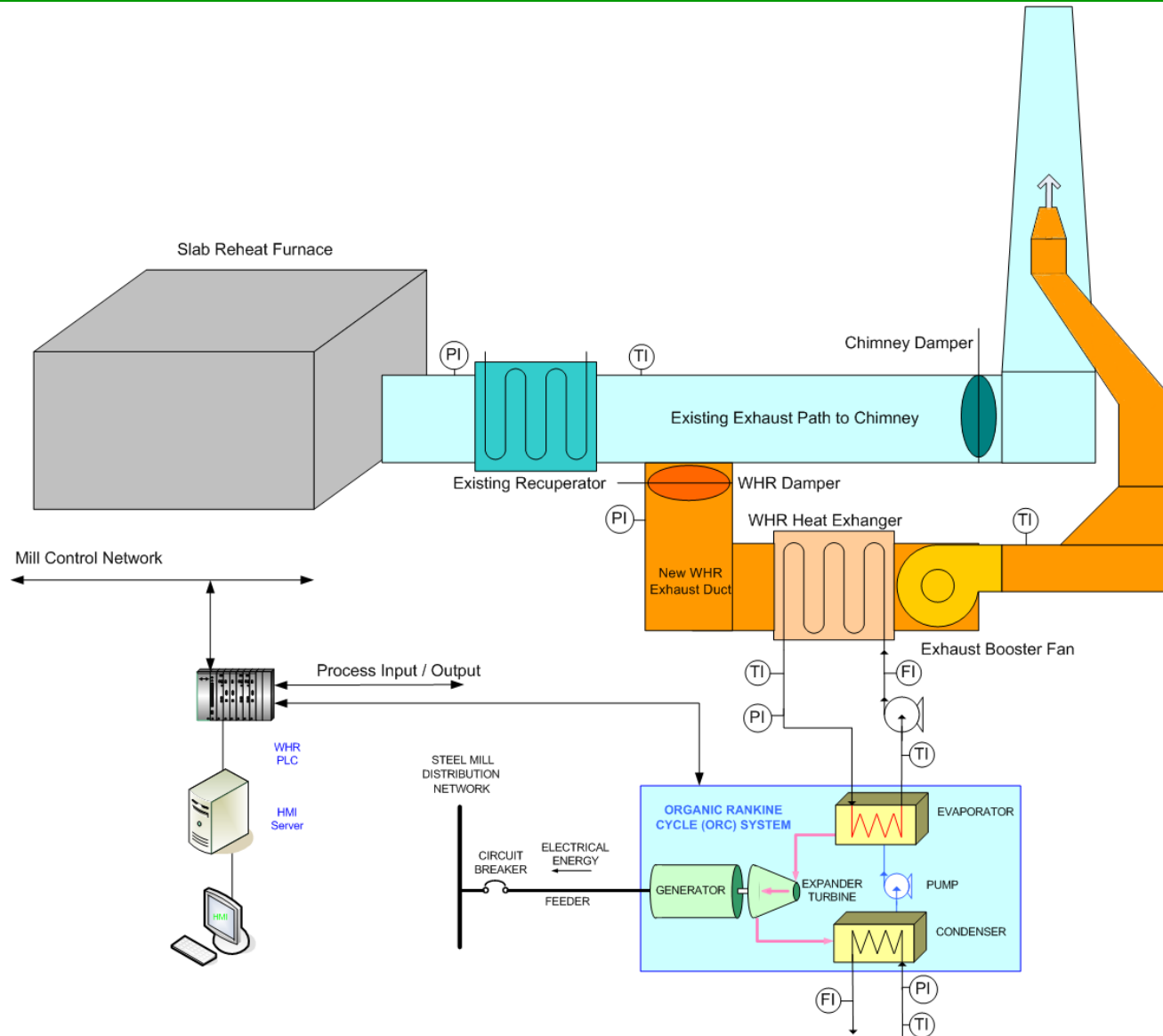
- Auto Start/Stop
- Ability to work with low temperature heat source
- Partial load capability down to 10% power with high efficiency
- Low maintenance, no operator required for operation
- Design life ~ 20 years
- Quiet Operation
- High availability > 98%



Application Examples

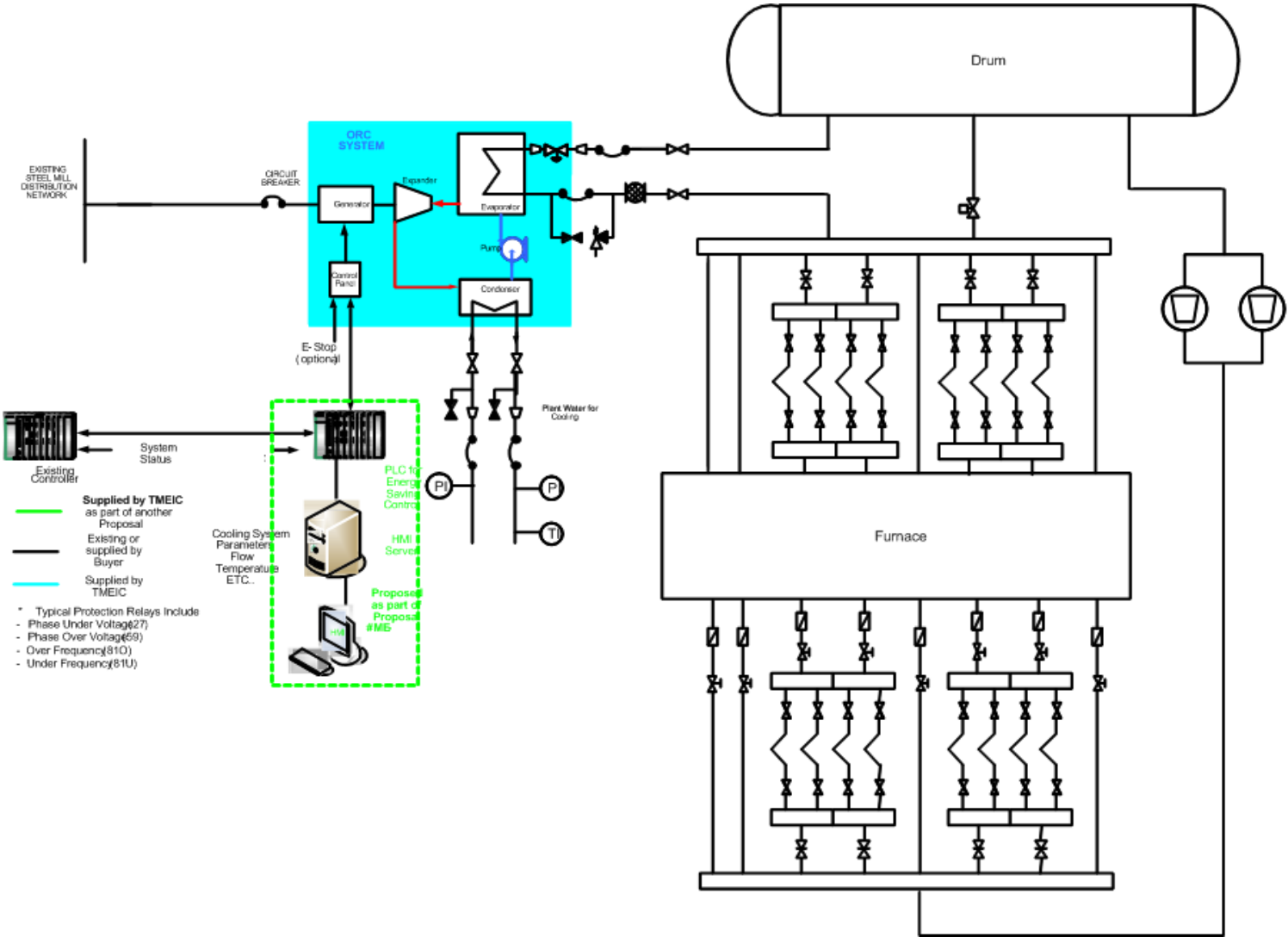
Other ORC applications

Steel Mills



Patent Pending Configuration

ORC generator slab furnace evaporative cooling application

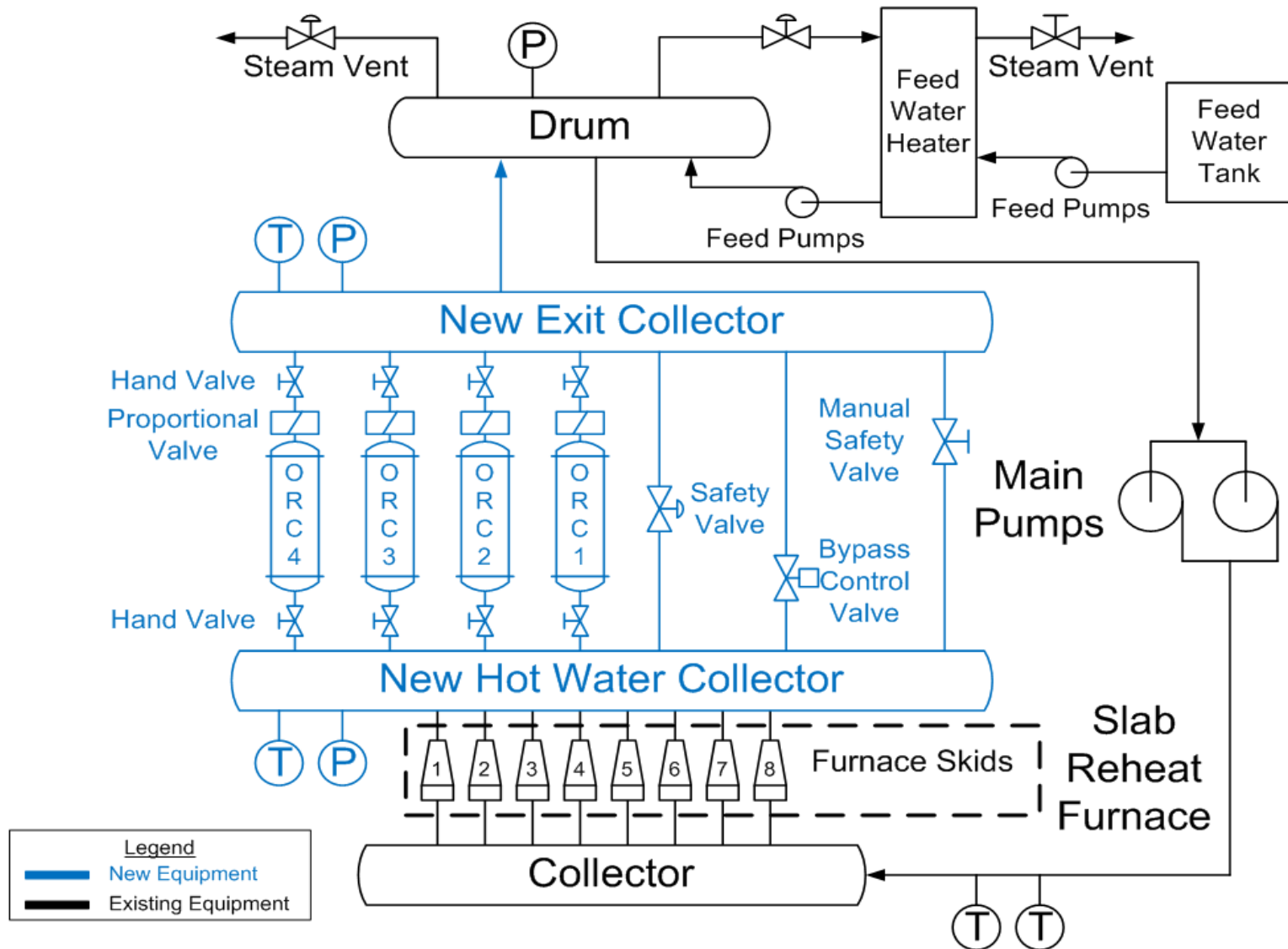


Recent Heat Recovery Project in Turkey

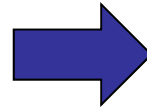
Recovery from slab furnace evaporative cooling system:

- Installed power capacity 1 MW
- Resource Temperature : 140C
- In operation since September 2011
- Typical waste steam was about 16 tons/hour

Recent Heat Recovery Project in Turkey



Recent Heat Recovery Project in Turkey



BEFORE

AFTER

NO MORE WASTE OF STEAM

Recent Heat Recovery Project Pictures



Recent Heat Recovery Project Pictures



Recent Heat Recovery Project Pictures

