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# Performance of Heating Systems in Singapore

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# CONTENT PAGE

- Introduction to Heating Systems / Assessment Methodology / Metrics



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## **Introduction to Heating Systems / Assessment Methodology / Metrics**



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# Heating Systems

- Boilers
  - Fired equipment for the generation of steam
- Furnaces
  - Fired equipment for the heating of process streams
- Hot oil heaters
  - Fired equipment for the heating of hot oil medium
- Cogeneration
  - Simultaneous production of both electricity and heat for process use (ie, gas turbines)
  - Complex steam and power system, multiple steam headers, numerous boilers / furnaces / steam turbines



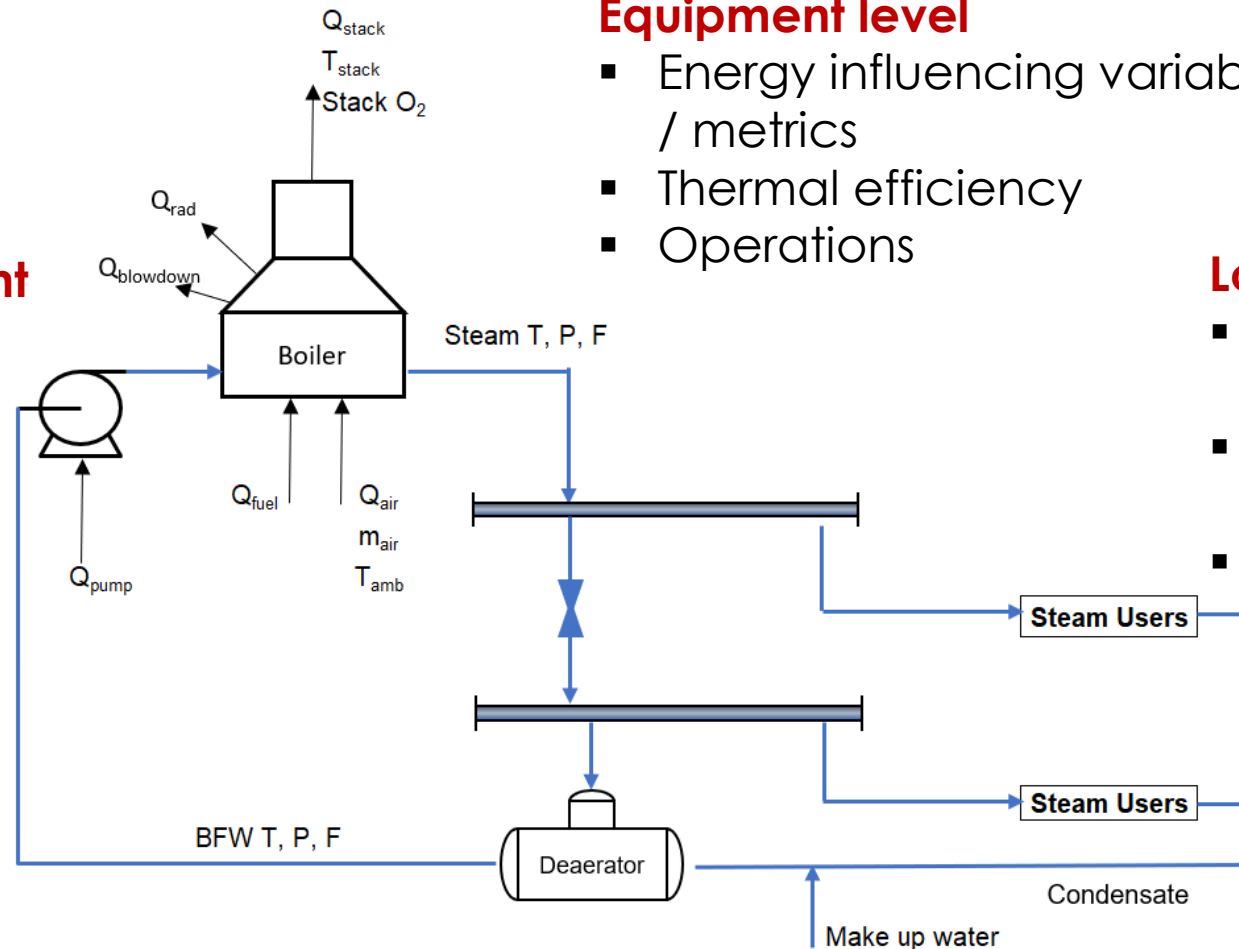
# Boilers – Assessment Methodology

## Ancillary Equipment

- BFW pumps
- Deaerators

## Instrumentation

- Overall heat/mass balance (loss accounting)



## Equipment level

- Energy influencing variables / metrics
- Thermal efficiency
- Operations

## Load Management

- Heat (steam) use optimization
- Heat integration (pinch analysis)
- Condensate recovery

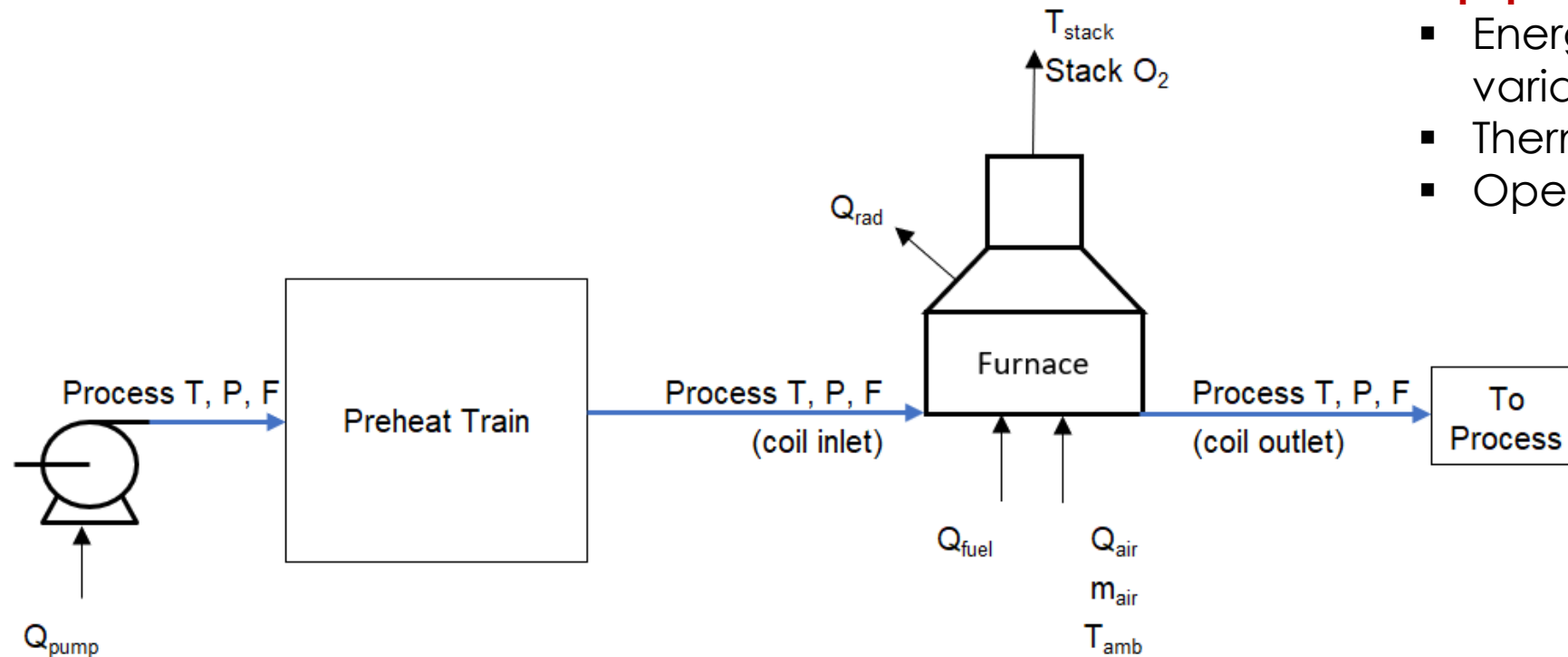


# Boilers – Metrics

Energy System	Metric	Method
Boiler equipment only	Thermal efficiency (%)	Calculated
	Energy performance gap (Gcal/h)	Calculated
	Stack temperature (°C)	Measured
	Stack oxygen (%)	Measured
	Steam flow (t/h)	Measured
General steam and condensate system	Overall mass / energy balance of steam system	Calculated
	BFW pump specific energy consumption (kW/unit throughput)	Calculated
	Condensate recovery (%)	Calculated
	Deaerator pressure	Measured



# Furnaces – Assessment Methodology



## Equipment level

- Energy influencing variables / metrics
- Thermal efficiency
- Operations

## Ancillary Equipment

- Charge pumps

## Load Management

- Heat integration (energy recovery into preheat train)



# Furnaces – Metrics

Energy System	Metric	Method
Furnace equipment only	Thermal efficiency (%)	Calculated
	Energy performance gap (Gcal/h)	Calculated
	Stack temperature (°C)	Measured
	Stack oxygen (%)	Measured
Furnace preheat train	Charge pump specific energy consumption (kW/unit throughput)	Calculated
	Coil inlet temperature (°C)	Measured

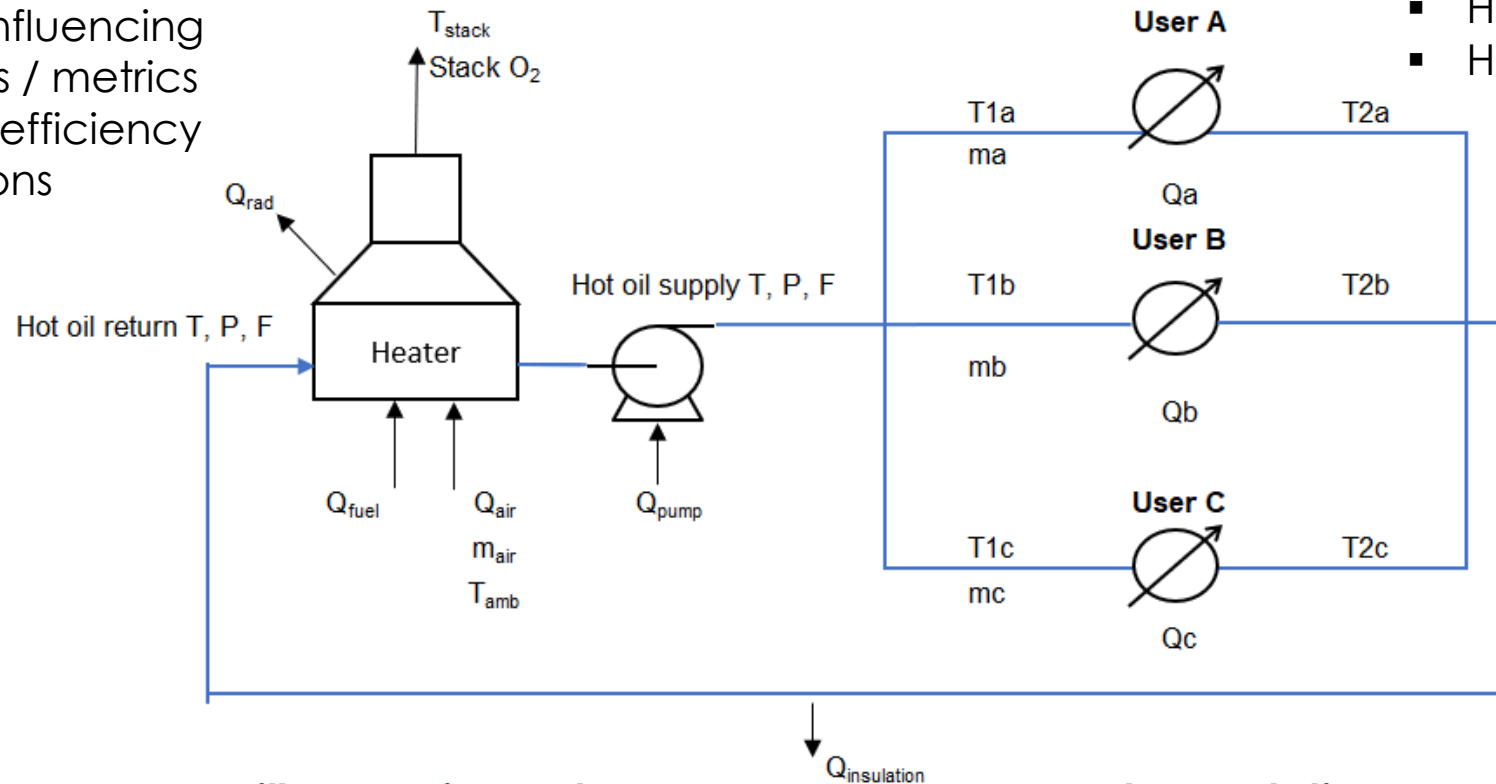




# Hot Oil Heaters – Assessment Methodology

## Equipment level

- Energy influencing variables / metrics
- Thermal efficiency
- Operations



## Load Management

- Heat (hot oil) use optimization
- Heat integration

## Ancillary Equipment

- Hot oil pumps

## Instrumentation

- Overall heat/mass balance (loss accounting)

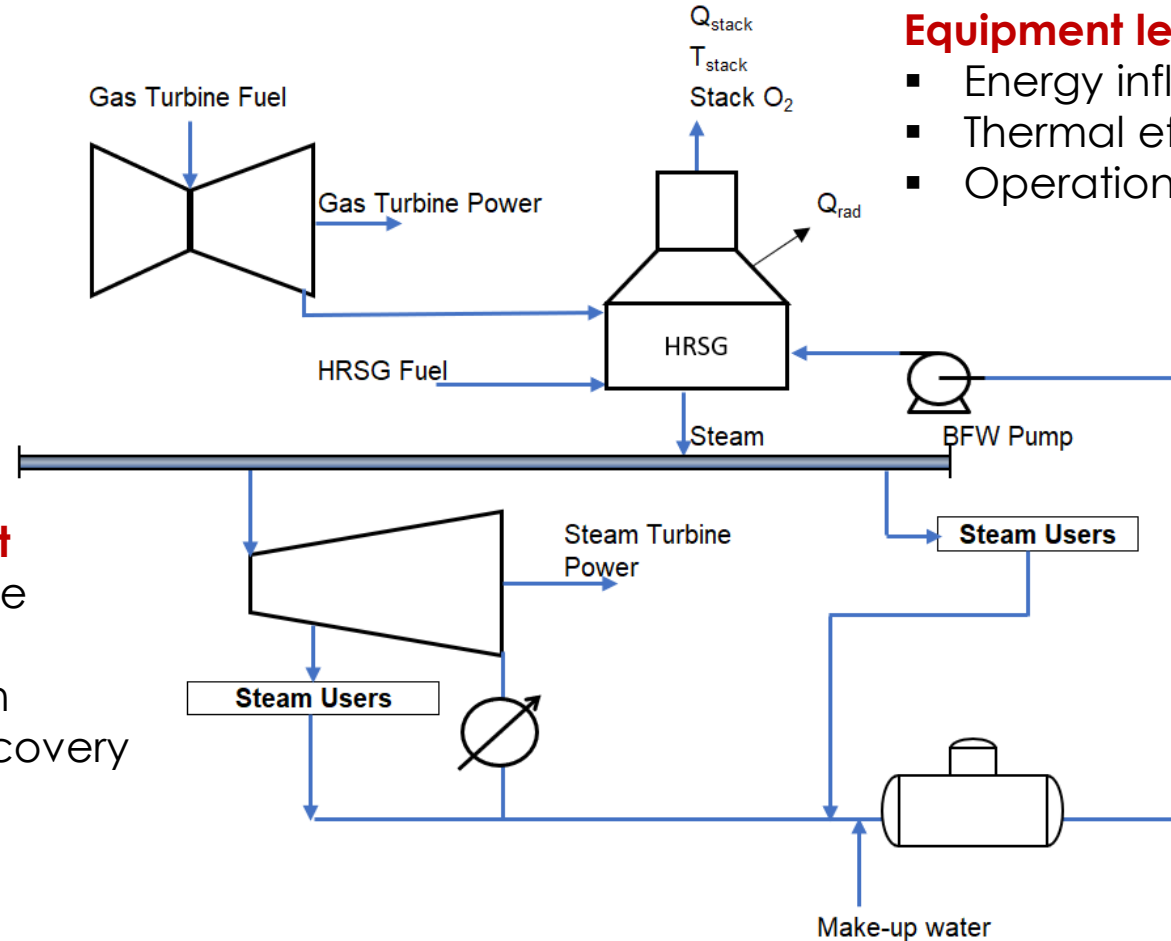


# Hot Oil Heaters – Metrics

Energy System	Metric	Method
Heater equipment only	Thermal efficiency (%)	Calculated
	Energy performance gap (Gcal/h)	Calculated
	Stack temperature (°C)	Measured
	Stack oxygen (%)	Measured
	Hot oil supply temperature (°C)	Measured
	Hot oil return temperature (°C)	Measured
Hot oil system	Overall mass / energy balance of hot oil system	Calculated
	Hot oil pump specific energy consumption (kW/unit throughput)	Calculated



# Cogeneration – Assessment Methodology



## Load Management

- Heat (steam) use optimization
- Heat integration
- Condensate recovery

## Equipment level (GT/HRSG/STG)

- Energy influencing variables / metrics
- Thermal efficiency
- Operations

## Ancillary Equipment

- BFW pumps
- Deaerators
- STG condenser

## Instrumentation

- Overall heat/mass balance (loss accounting)



# Cogeneration – Metrics

Energy System	Metric	Method
Entire cogeneration system	Thermal efficiency (%)	Calculated
	Energy performance gap (%)	Calculated
Gas turbine only	Thermal efficiency (%)	Calculated
HRSG only	Thermal efficiency (%)	Calculated
	HRSG stack temperature (°C)	Measured
Steam turbine only	Thermal efficiency (%)	Calculated
General steam and condensate system	Overall mass / energy balance of steam system	Calculated
	Condensate recovery (%)	Calculated
	BFW pump specific energy consumption (kW/unit throughput)	Calculated
	Deaerator pressure	Measured



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