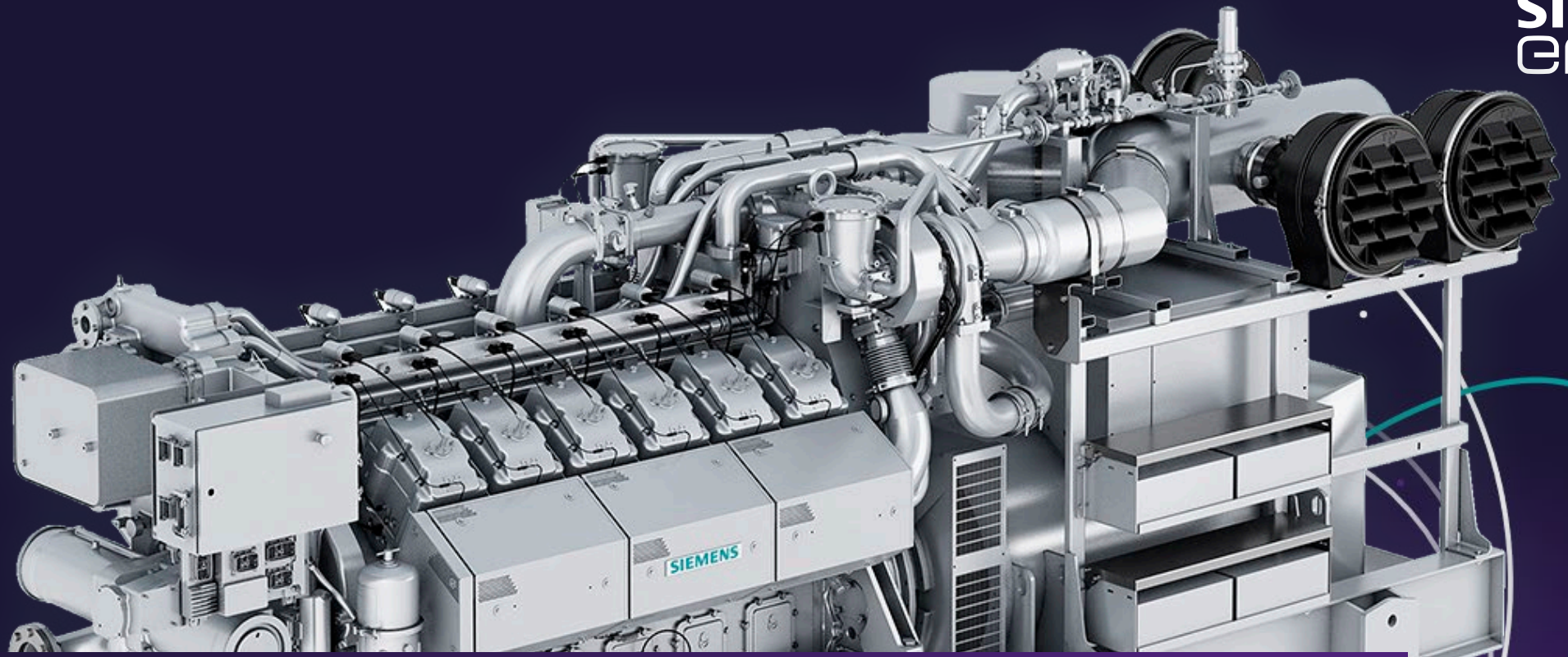
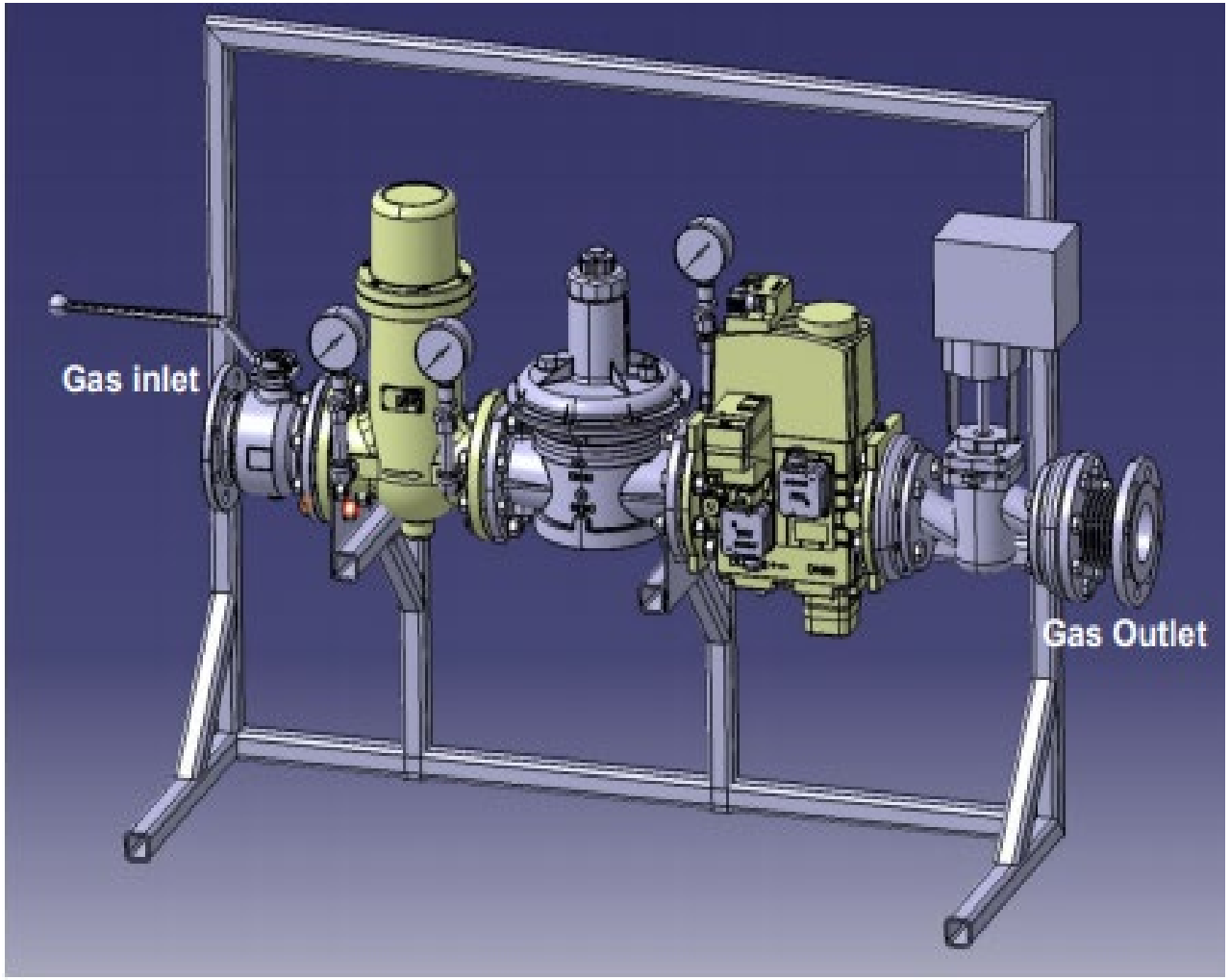


Siemens-Energy Gas Engines:
Important Technical Considerations in the Application of a Biogas CHP Plant

Content overview

Fuel Considerations



Fuel Energy

LHV

- Energy per unit volume of gas
- Typically ranges between 590 – 650 Btu/SFC for biogas
- Extended range requires methane signal

Methane Number

- Indicates the volatility of the fuel

Contaminants

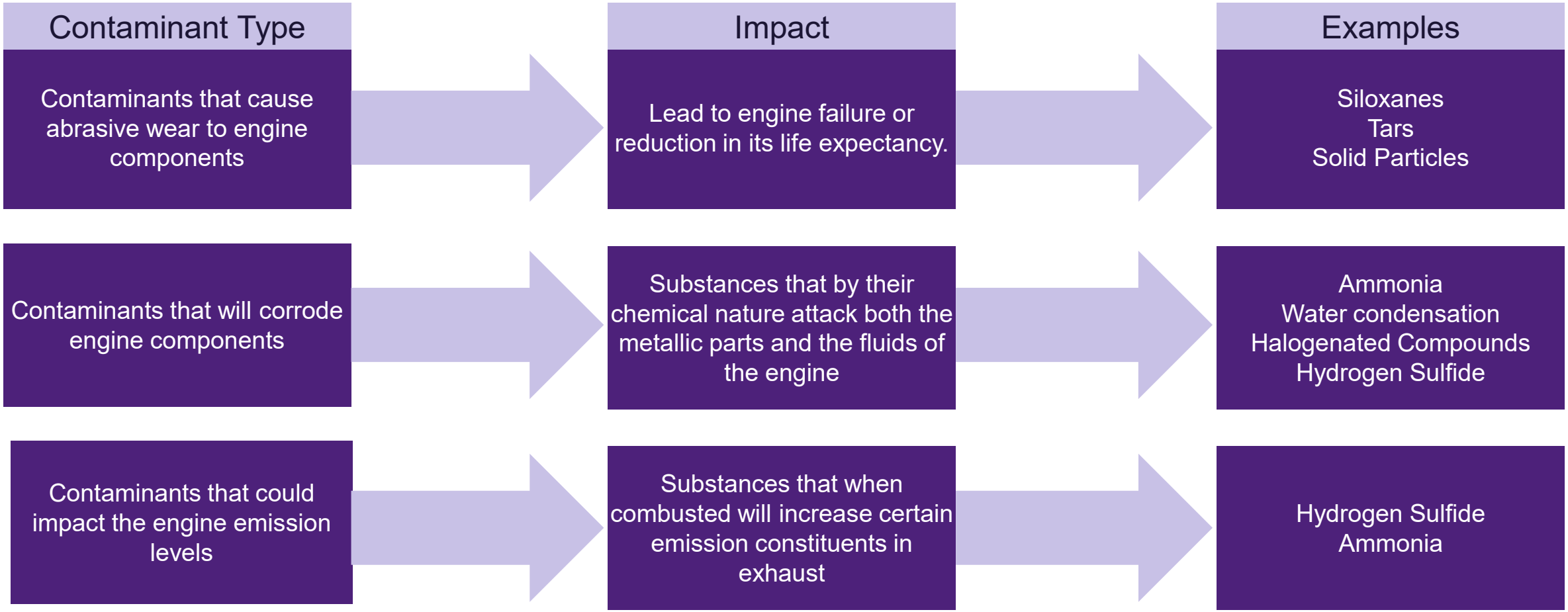
Hydrogen Sulfide

- Attacks metallic parts of the engine
- Premature degradation of lubrication oil
- Generates sulfur oxides in exhaust
  - *Attack exhaust gas piping and can reduce catalyst life*
  - *Emissions of sulfur oxides may be limited by law*

Silicon Compounds

- These crystalline compounds form abrasive particles in engine
- Can jam valves, pistons and other parts essential to operation
- Reduces oil properties which in turn affects engine parts

Contaminants



Fuel Considerations

What is fuel blending?

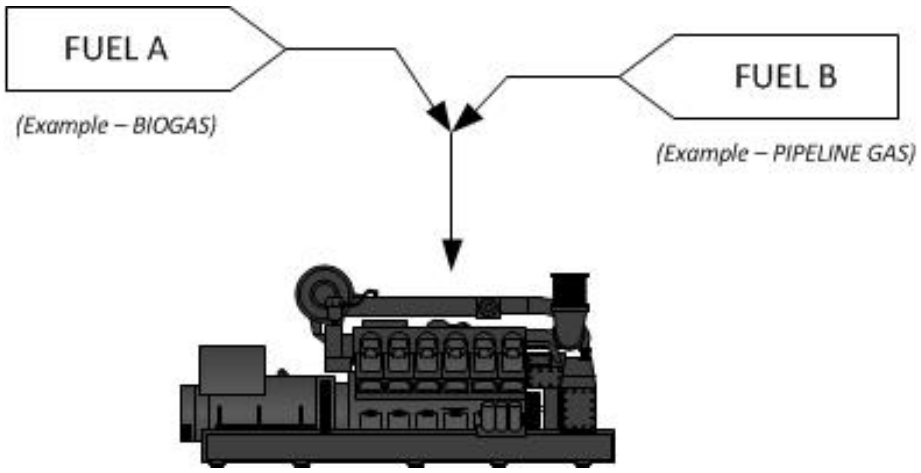
Combining gaseous fuel supplies from two different and separate sources for use in a running engine while maintaining engine performance.

Why?

To compensate for the variability in one fuel source by supplementing from a second known and reliable source.

For Example

Waste Water Treatment Plants
Biogas and Natural Gas



Operating Modes:

- Mode 1: 100% Fuel A (Biogas)
- Mode 2: Fuel Blending. Blending ratio determined by algorithm or customizable through 4-20 mA signal.
- (90 / 10 ratio)
- • Mode 3: 100% Fuel B (Natural gas)

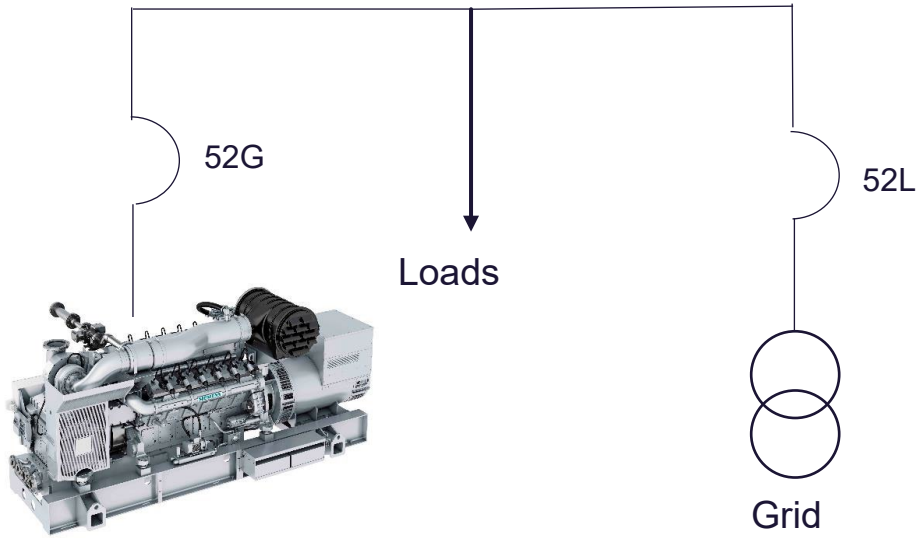
Advantages & Benefits of Fuel Blending

Drivers	Advantage & Benefit
1 **Maximize economic benefit of the plant**	• Better payback • Maximize use of incentives
2 **Optimize sizing and equipment selection**	• Flexibility to adapt to the required load • Maximize the amount of energy provided from biogas
3 **Environmentally Responsible**	• Reduces flaring • Eliminates the need to deliver power from a remote source
4 **Ensures constant energy availability from CHP Plant**	• Decreases likelihood boilers will need to be fired • Helps to avoid sourcing electrical supplies from the grid

Content overview

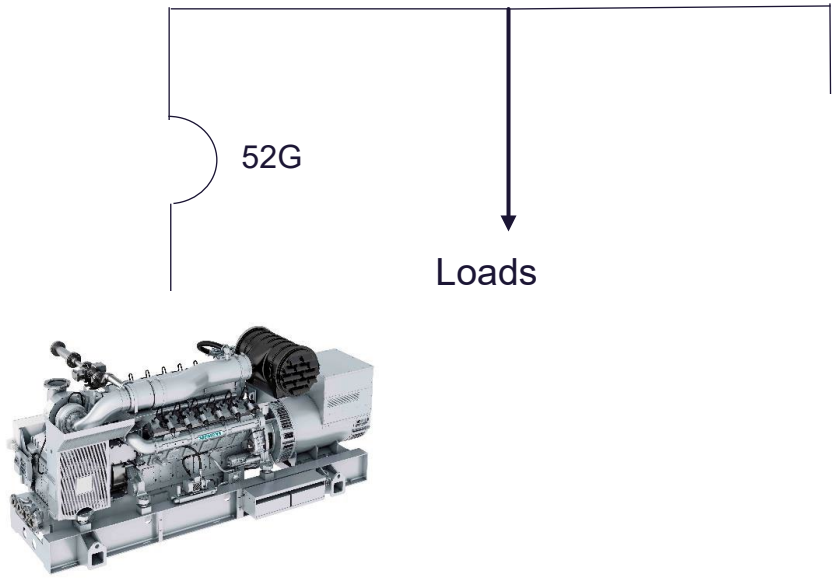
Mode of Operation

Parallel to Grid



- Baseload
- Import Control
- Export

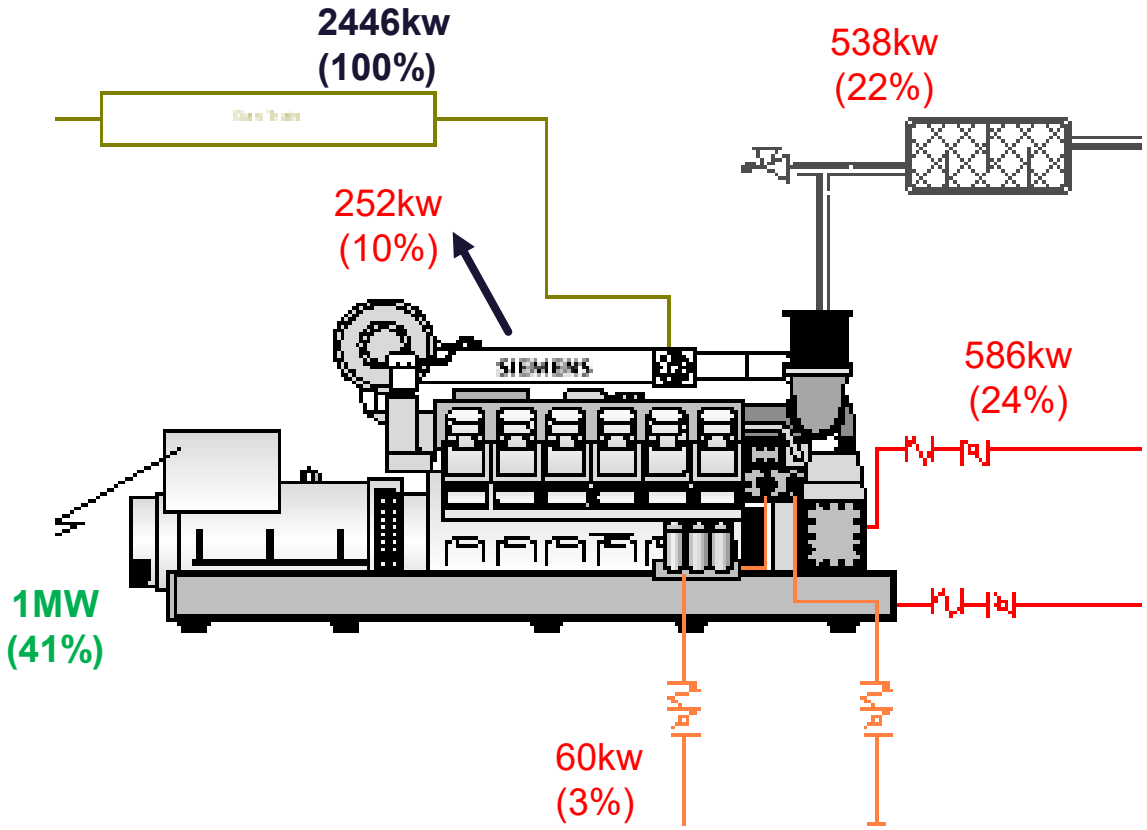
Island Mode

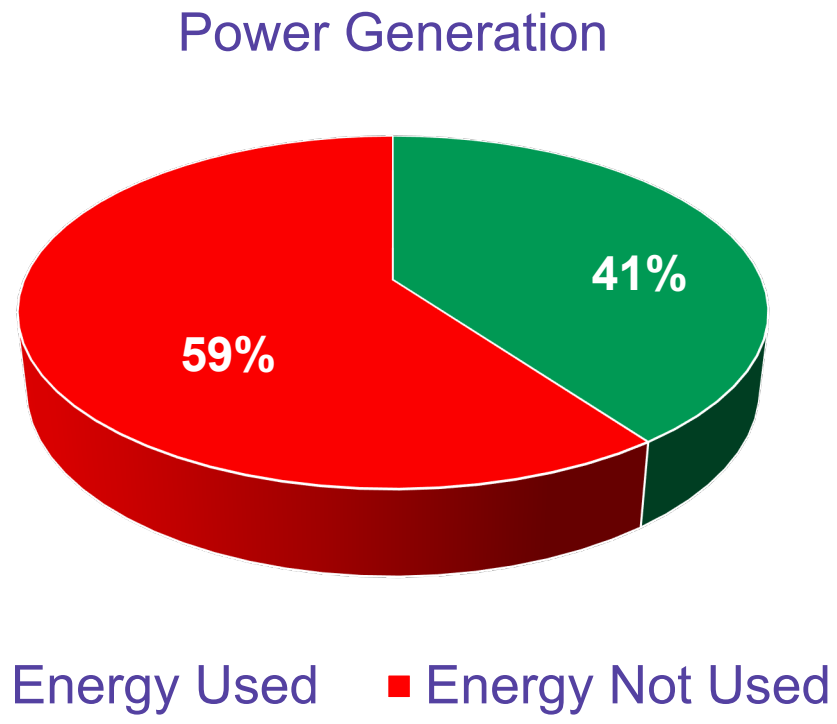


- Starting requirements
- Load acceptance capabilities

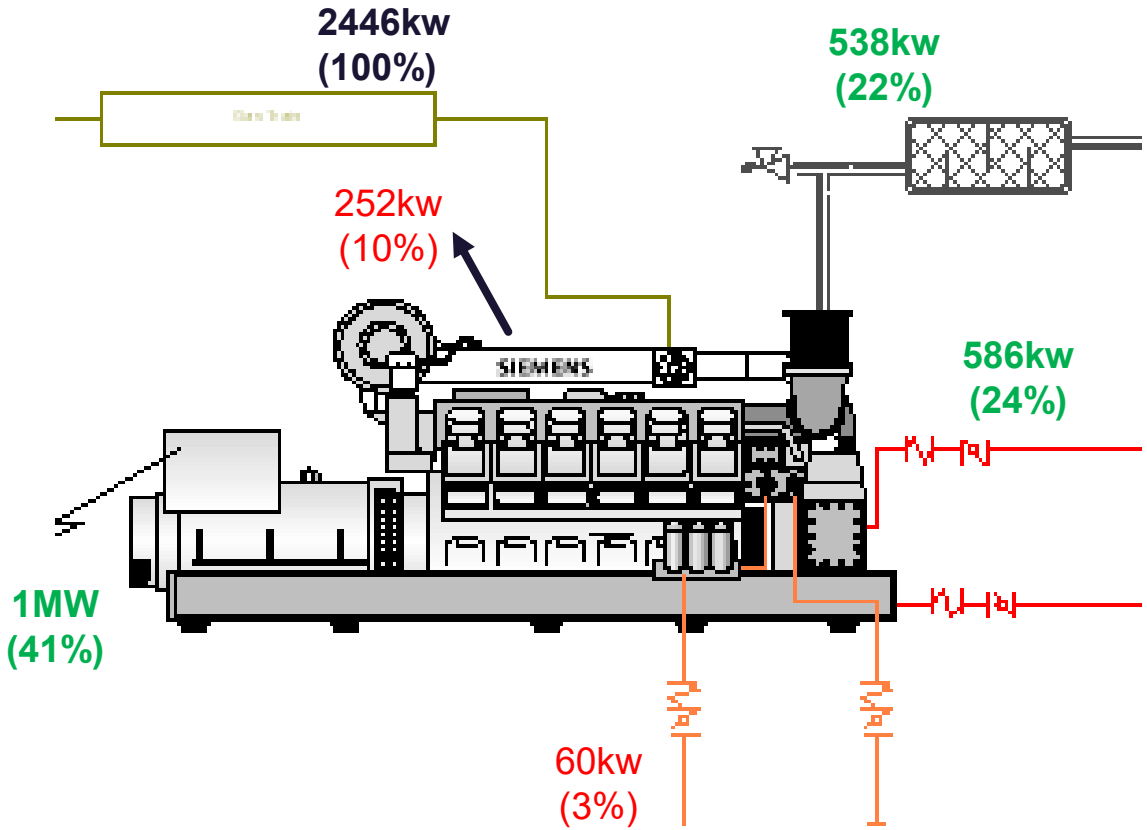
Content overview

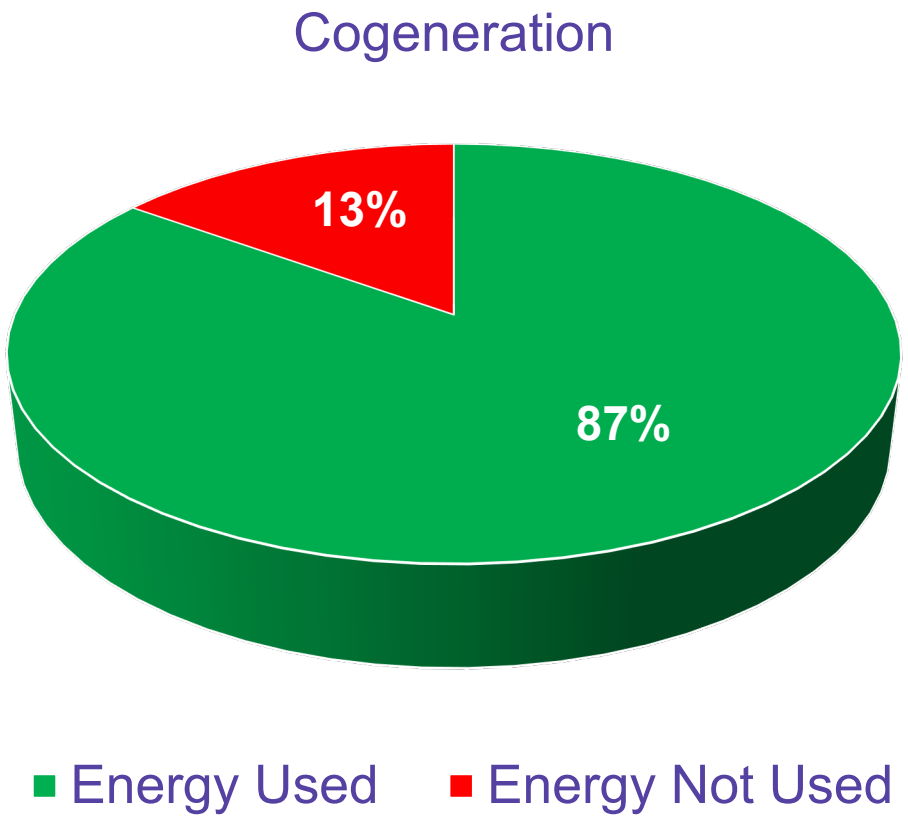
Application of Heat



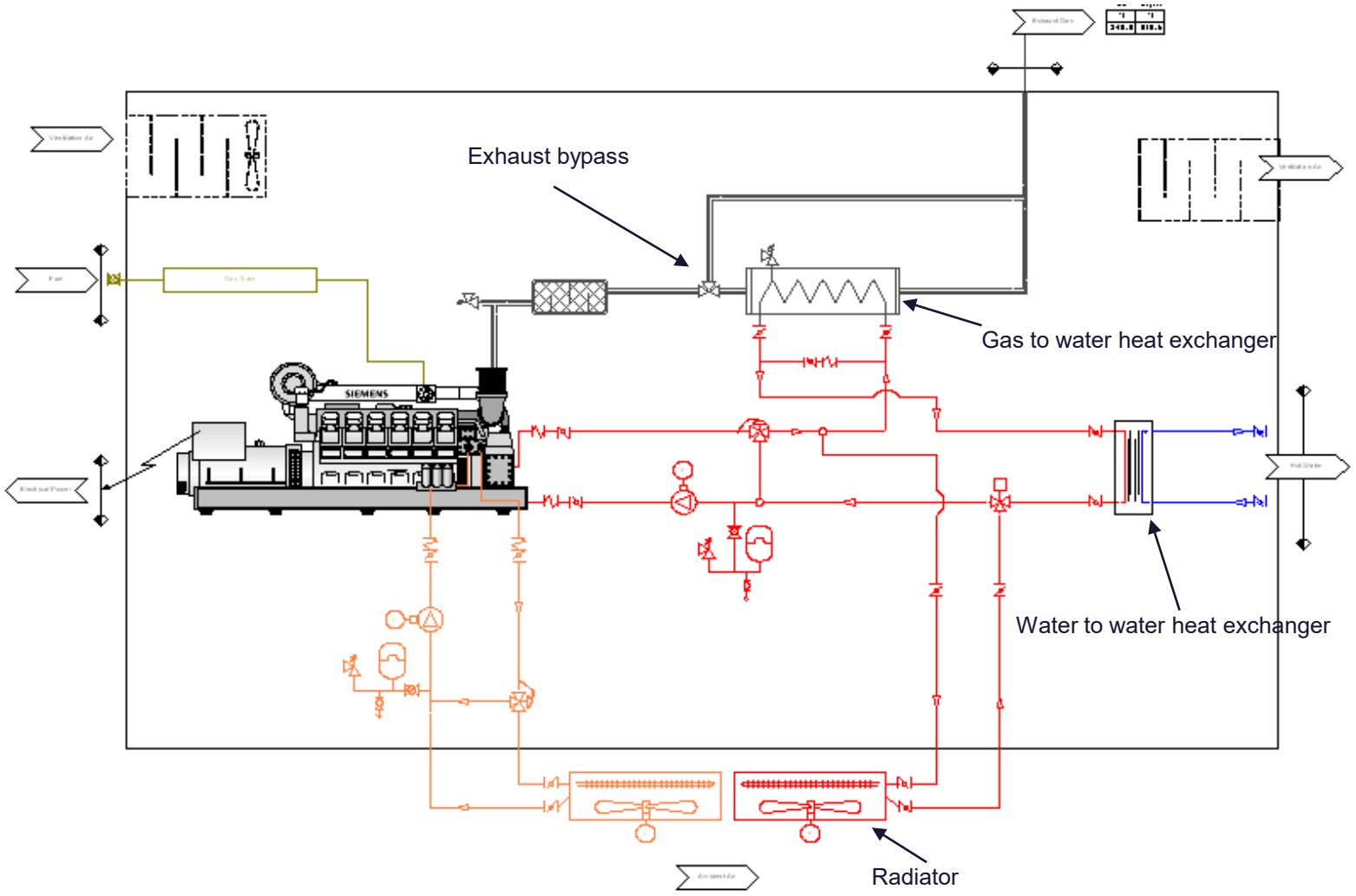


Application of Heat





Application of Heat



Equipment Required

Recovery:

Gas to water heat exchanger

- The heat in the exhaust gases is recovered by passing through a gas-to-water heat exchanger

Water to water heat exchanger

- The high-grade heat of engine jacket water circuit is recovered through water-to-water heat exchanger

Rejection:

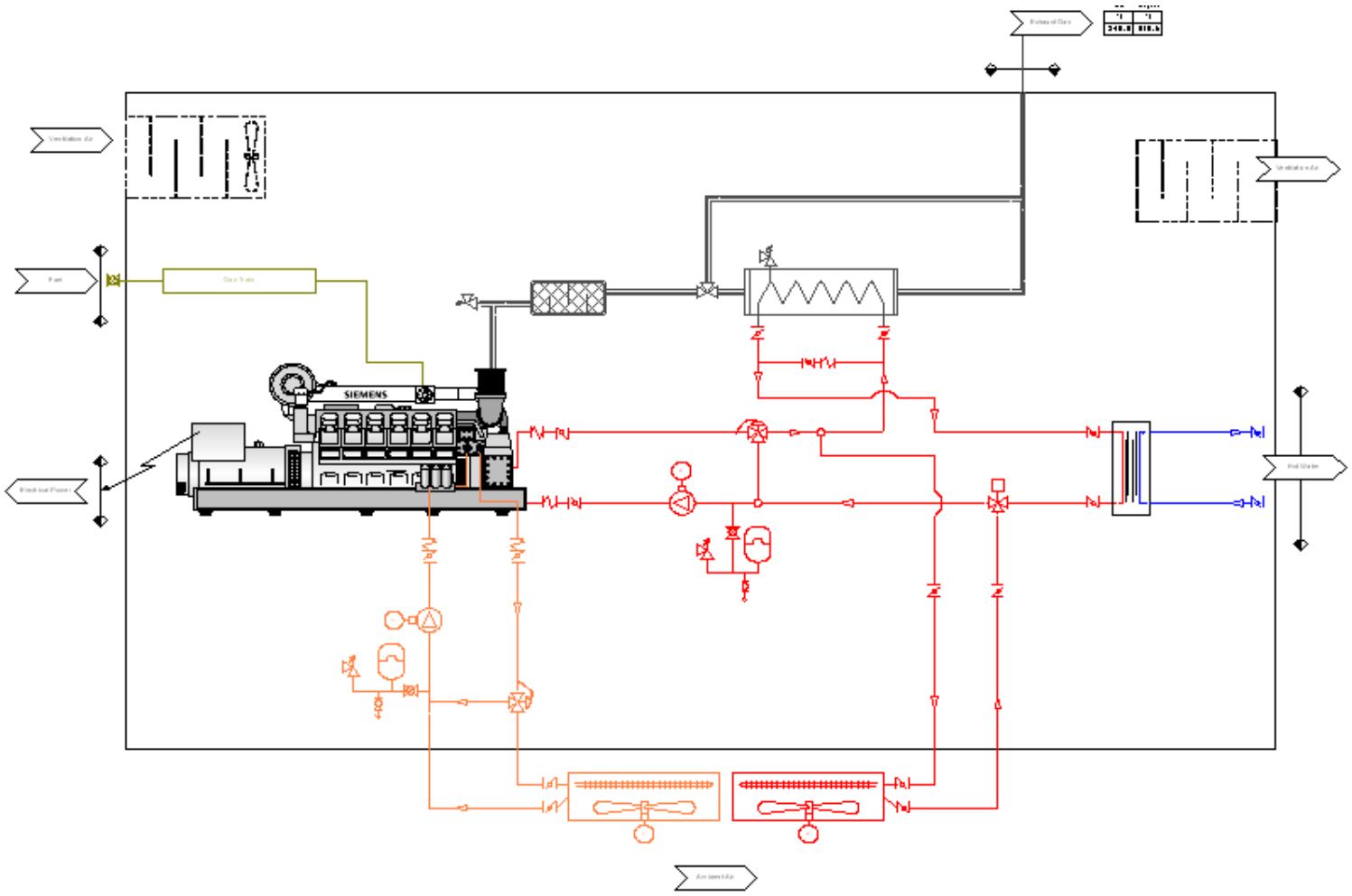
Exhaust bypass

- Manages the amount of exhaust heat recovered based on site demand

Radiator

- Dissipates jacket water heat when not recovered by the site

Application of Heat



Application of Heat

Thermal energy usage

- Steam and/or Hot Water

Steam Applications

- Steam production possible by recovering only the exhaust heat

Hot Water Applications

- Majority of applications using RICE are hot water (~90%)
- Typical configuration will add exhaust heat to jacket water circuit
- The temperature of the process is governed by required jacket water temperatures
- Approximate process water temperatures 185°F-190°F with this arrangement
- Some higher temp options available

In Summary

To realize the economic value of your cogeneration system, it is important to consider the following factor:

- **Review you fuel**
- **Understand your mode of operation**
- **Be specific on how you are going to apply the heat**

Take all of these into consideration and you are on the right path to a successful cogeneration application.

Thank you!

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