YANMAR ENERGY SYSTEMS

Products Overview

YANMAR America Corporation
Michael Alfano
Regional Sales and Service Manager
michael-alfano@Yanmar.com

Introduction of YANMAR

YANMAR America Division

Industrial Engines

Commercial Marine Engines

Energy Systems

Parts

Agriculture Equipment

Construction Equipment

UTVs

REMAN

YANMAR America
Regional Headquarters: Adairsville, GA, USA
Incorporated: 1981 President: Tim Fernandez
Employees: 240

Production (JPN)

YANMAR Energy System Manufacturing Co., Ltd, Okayama, JPN

Product
CHP (Cogeneration)
GHP (Gas Heat Pump)

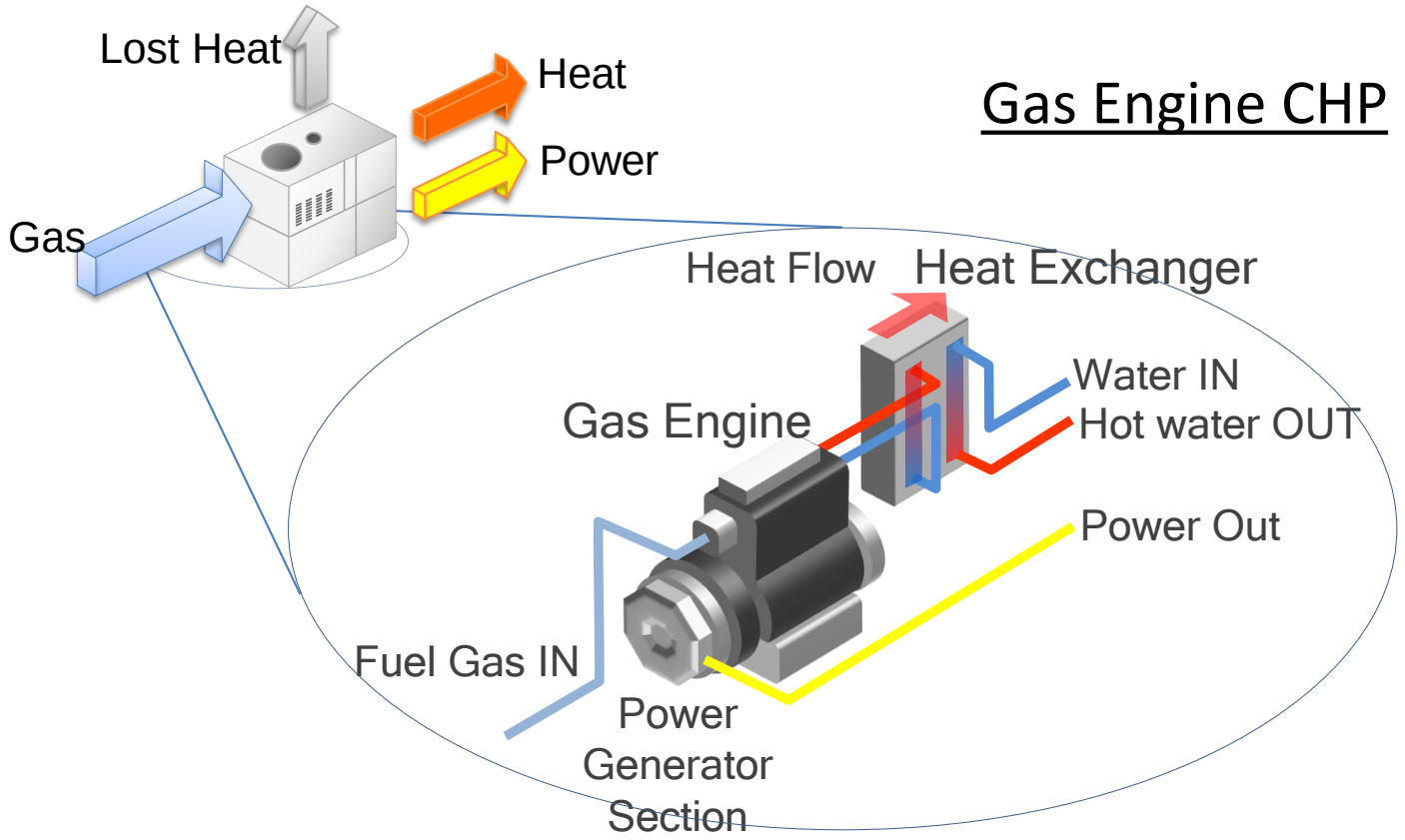
YANMAR America and Training centre (EVO//CENTRE)

YANMAR America, Adairsville, GA, USA
YANMAR Training Centre (EVO//CENTRE), Acworth, GA, USA

YANMAR Micro-CHP

What is CHP?

- CHP is an abbreviation for **C**ombined **H**eat and **P**ower.
- CHP is also known as “Cogeneration,” which is the production of both **heat** and **electricity**.



Main Features of YANMAR micro CHP

- **Gas Engine Reliability**

  YANMAR's gas engine has been used for more than 25 years with more than 300,000 installed units (6,000 mCHP units)

- **Efficient Engine and Electric Generation**

  Electric Generation Efficiency:

  35kW = 32.0%

- **Durability**

  Long Maintenance Interval

  35 kW = 7,500 hours

  Low Operating Sound

  35 kW = 62dB(A) at 3 feet (when the radiator fan stops)

- **Easy Customization**

  Multiple unit operation (up to 16 units), Blackout Start, etc.

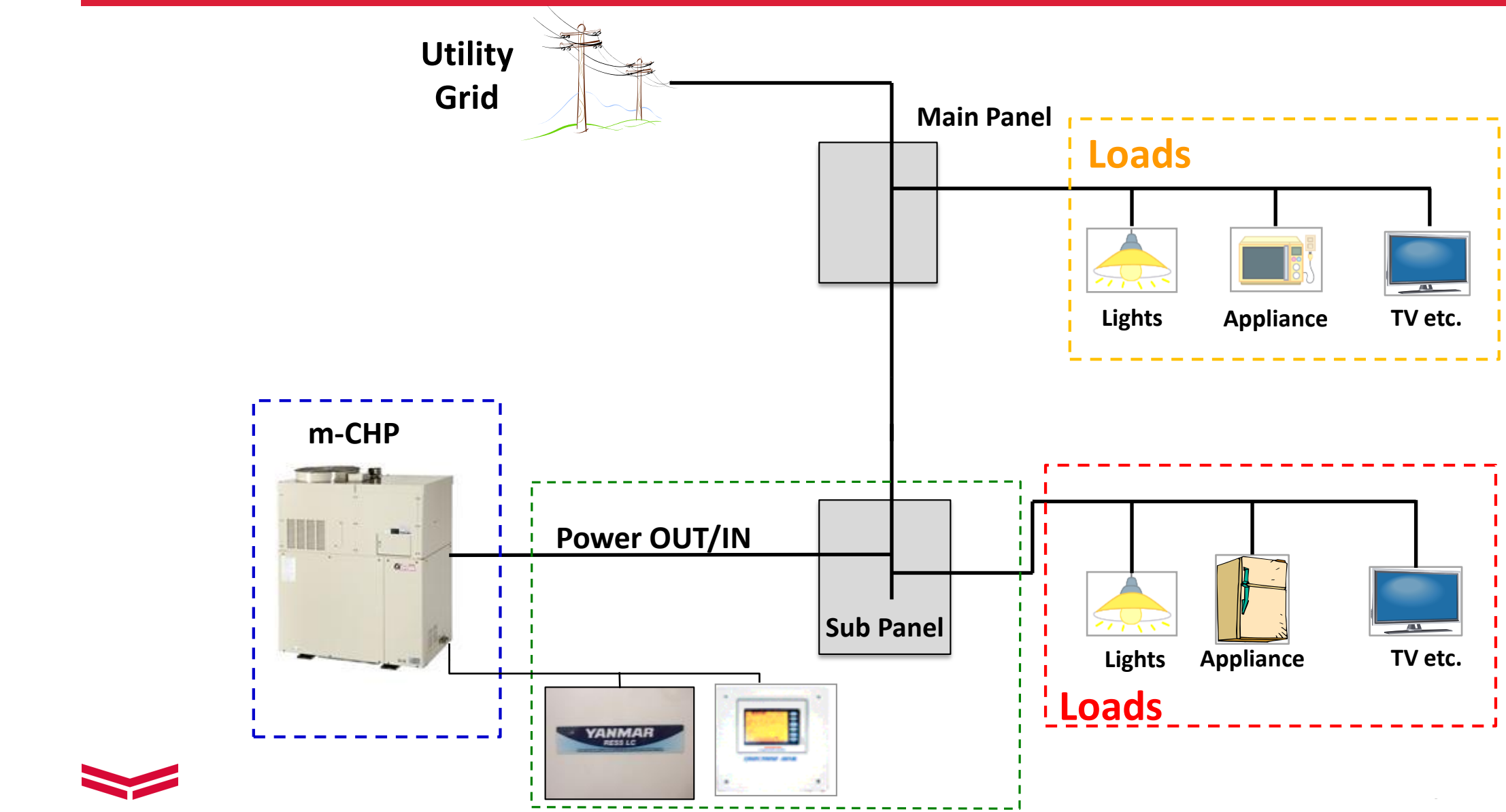
- **Remote Monitoring System (optional)**
- **Built-in Radiator**
- **Built-in Inverter**

Main Spec

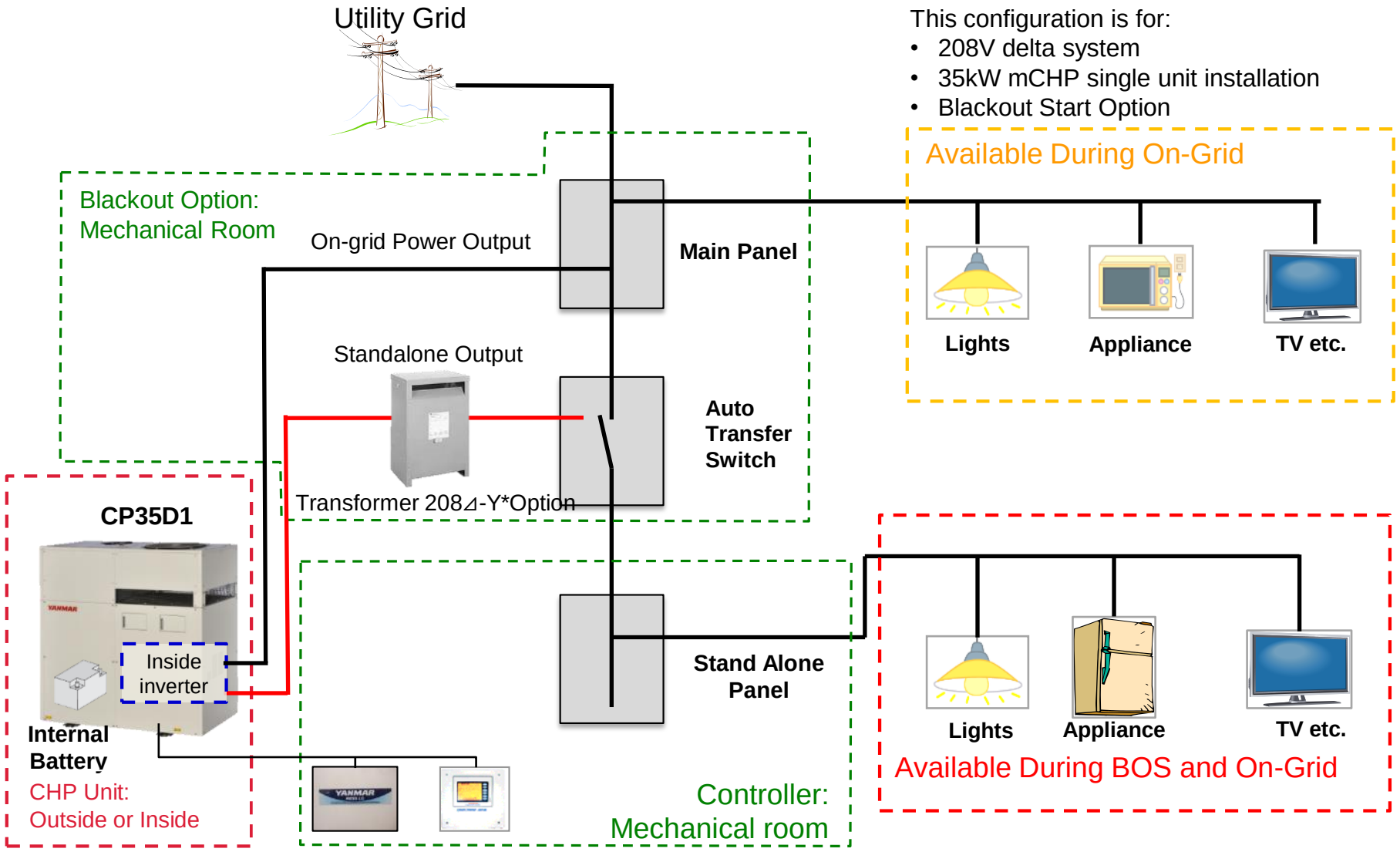
No	Item			Unit	
1	Model				CP35D1(Z)-TNU(W)
2	Power output	Power output *1		kW	35kW, 35kVA
		Voltage		V	208 Delta
		Phase and Wire			3 Phase, 3 wire
3	Heat output	Recovered heat		kBtu/kW	204.1 / 59.8
		Rated temp		F / C	Inlet: 167/75, outlet:176/80
		Rated hot water flow		gal/min (L/min)	43.3 (164.0)
4	Fuel gas	Type			Natural gas
		Pressure	Standard	in.WC (kPa)	8.03 (2.0)
			Working rage	in.WC (kPa)	8.0 to 10.0 (2.0 to 2.5)
		Consumption (LHV base)		kBtu (kW)	367.5 (107.7)
5	Input power supply	Voltage		V	208
		Rated power consumption	Radiator Fan Stop	kW	0.75
			Radiator Fan ON	kW	1.00
5	Gross efficiency	Overall efficiency		%	87.0
		Generating efficiency		%	32.0
		Engine efficiency		%	55.0
6	Package	Size		Inch(mm)	W:78.7(2000), D:31.5(800), H:78.5(1995)
		Weight		Lbs/kg	3106 (1410), 3197(1450):BOS
7	Operation noise	Radiator Fan stop		dB(A)	62
		Radiator Fan operation		dB(A)	64
8	Generator	Number of phase / wire		-	3 phase 4 wire
		Insulation class of armature coil		-	F type
		Bearing type		-	No bearing
10	Maintenance	Interval		hr	7,500

*1 Test Conditions: Temperature 59ºF, Humidity 30%, Altitude 0m fuel gas maximum heat value in EPA regulation.

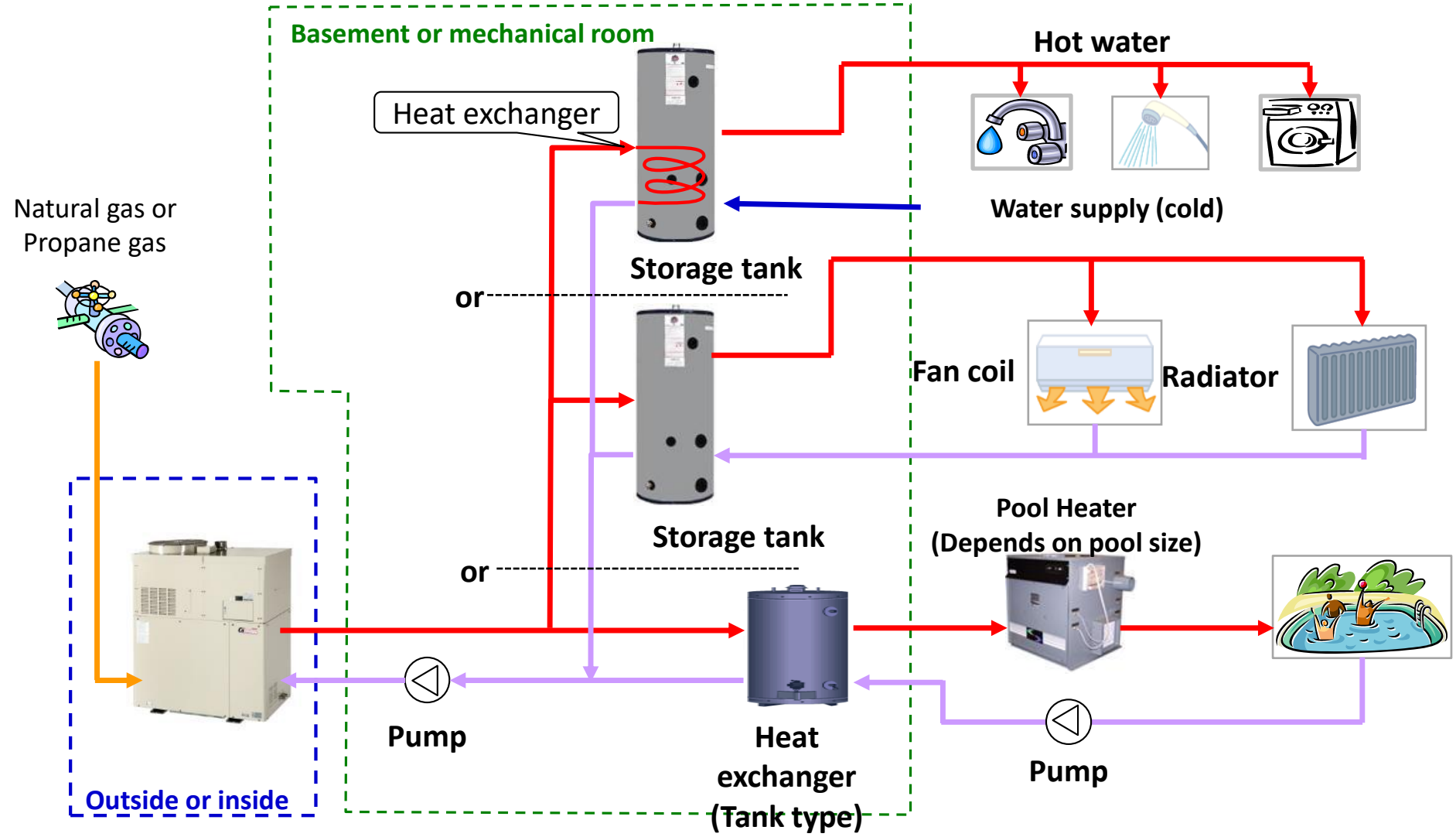
Electrical Configuration (Grid-Tied)



External System Configuration (Electric – BOS Option 35kW)



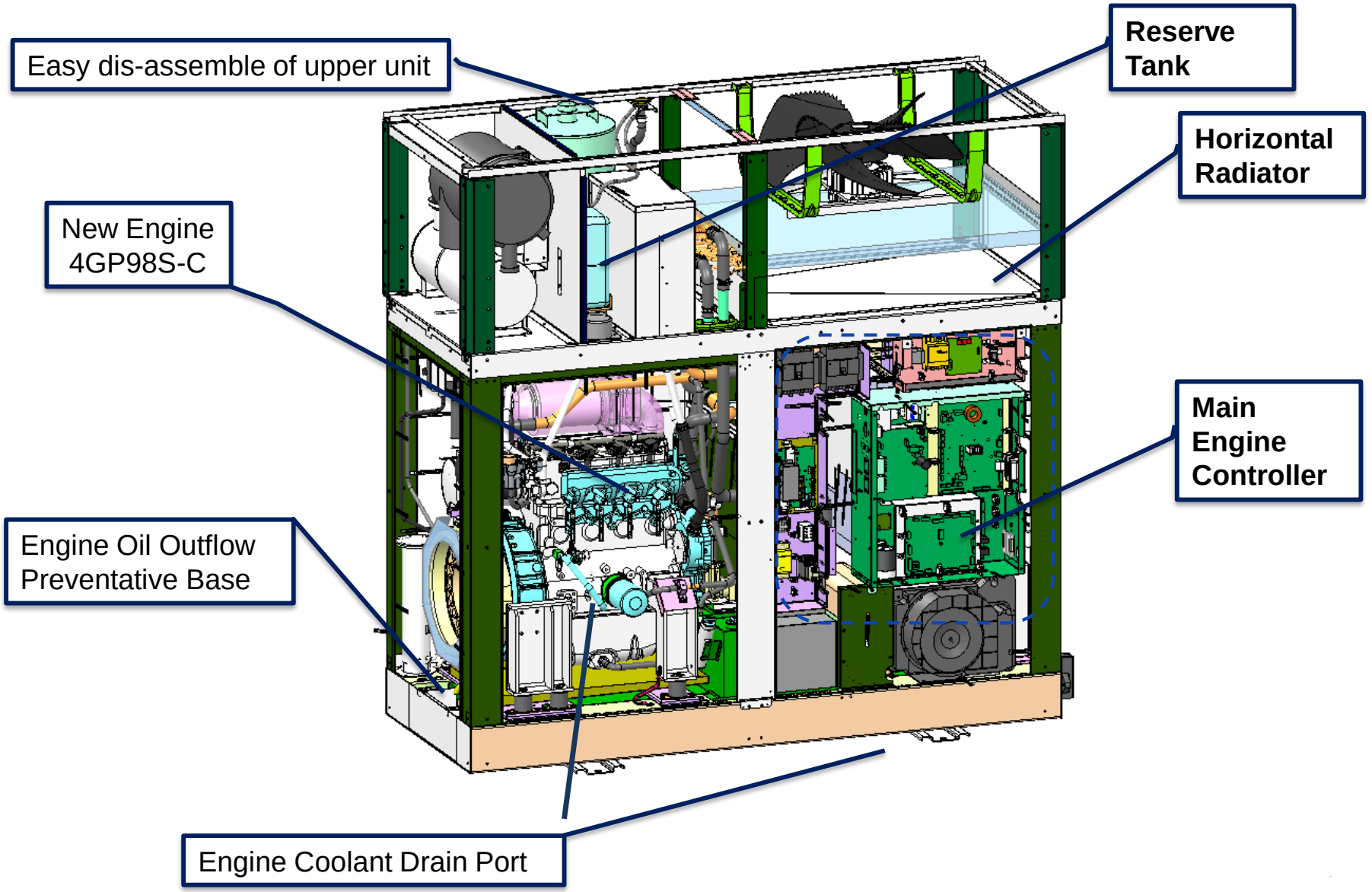
System Configuration (Hot water)



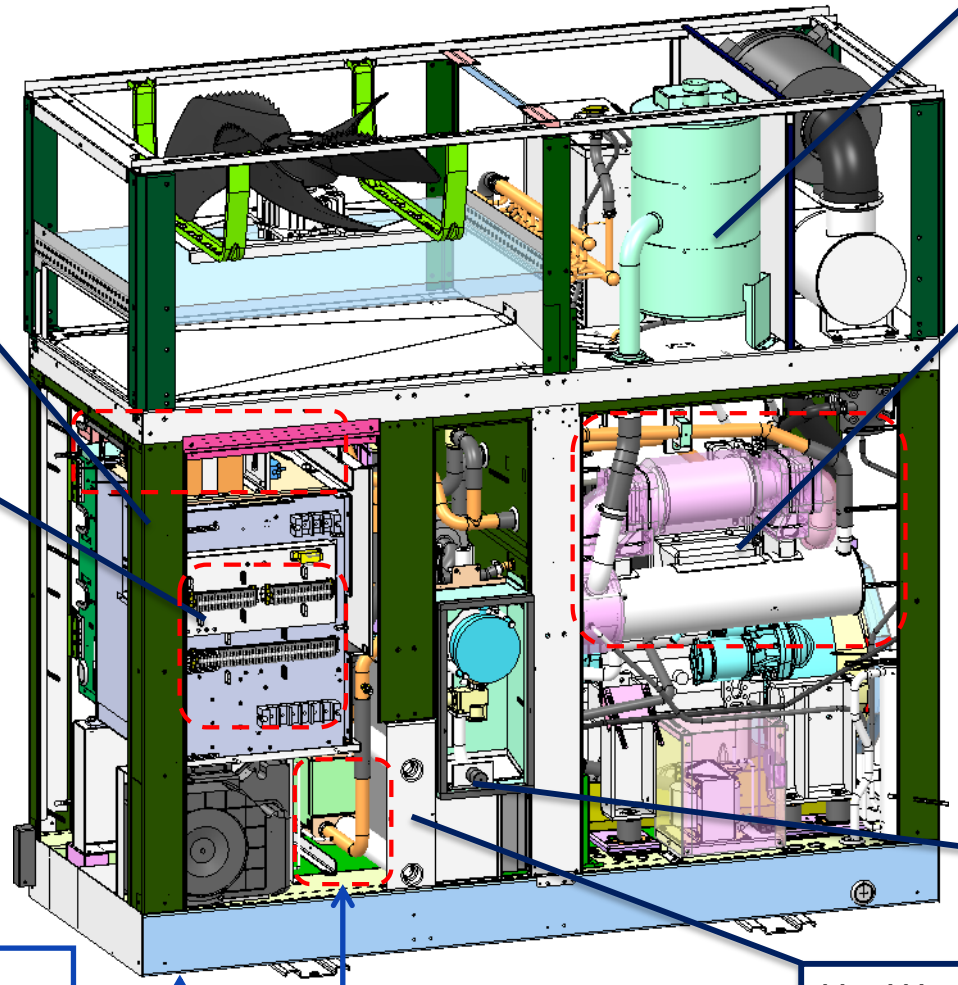
Structure

Notes: YANMAR CP35D1 certified as
CSA C22.2 No.100 Motors and Generators
CSA C22.2 No.14 Industrial Control Equipment

Main Structure (Front)



Main Structure (Rear)



Silencer Integrated Mist Separator

Battery Unit (Only BOS Mode)

Exhaust Gas Parts

Electrical Terminal

Fuel Gas Inlet

Hot Water Inlet/Outlet

2-way Wiring Connection Point (Wall and Base)

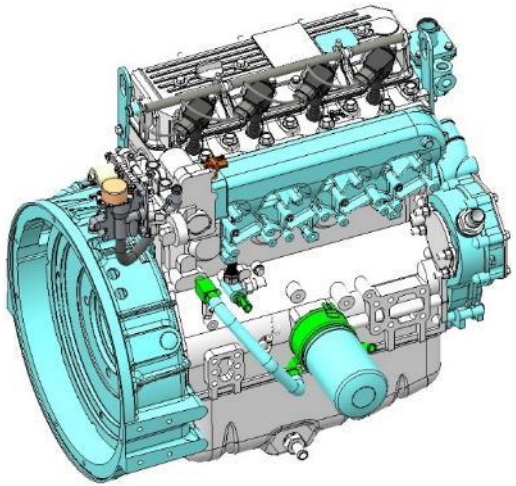
Engine

Stoichiometric Combustion Engine

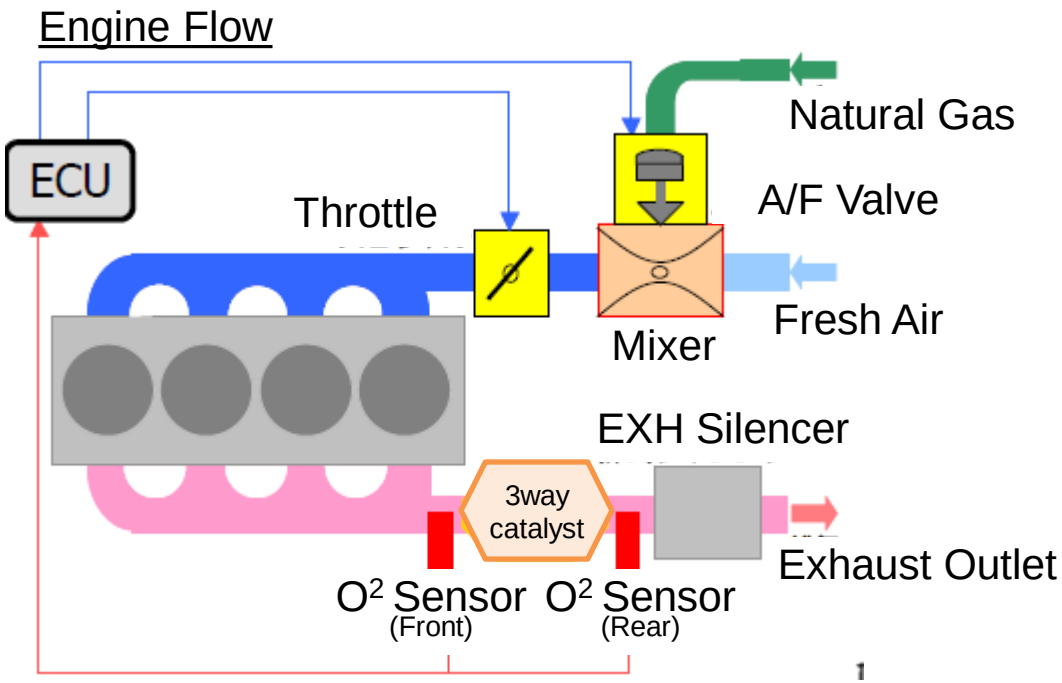
If there is exactly enough fresh air provided to completely burn all of the natural gas, the ratio is known as a stoichiometric mixture.

3-way Catalyst

A 3-way Catalyst is designed to simultaneously convert three pollutants (CO, HC, NOX) into harmless emissions.



Engine Flow

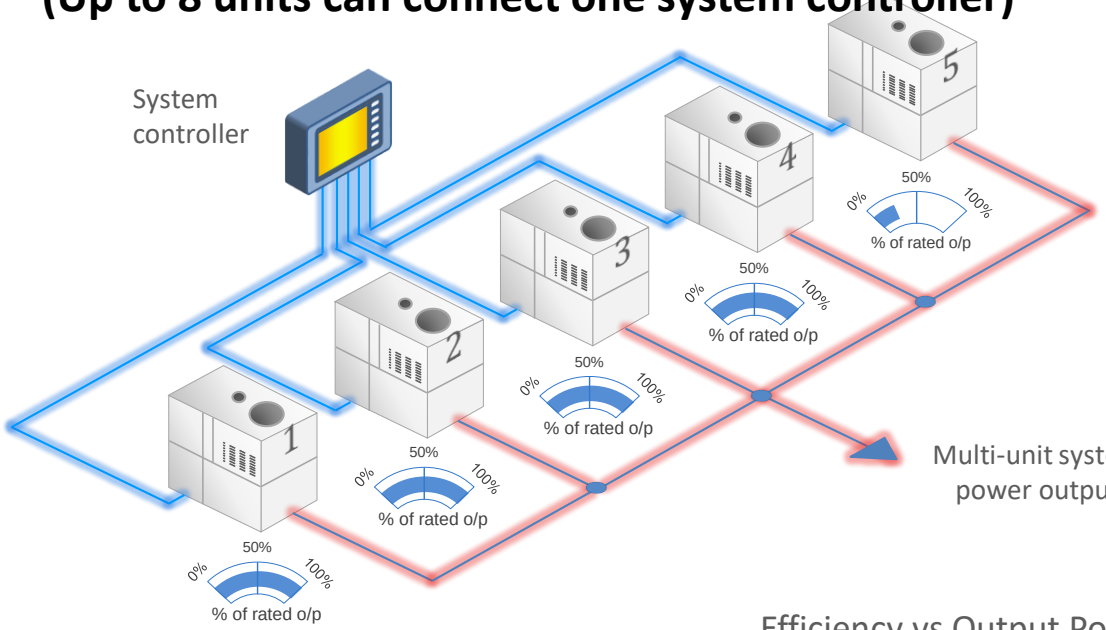


Multiple installation

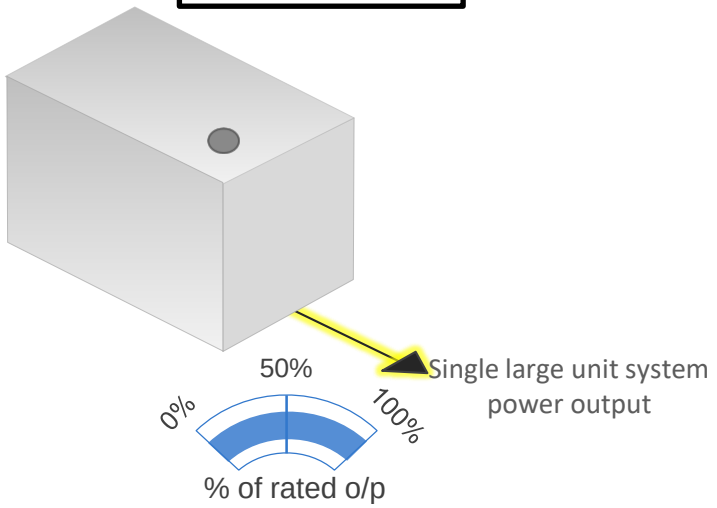
Higher Efficiency at Partial Loads

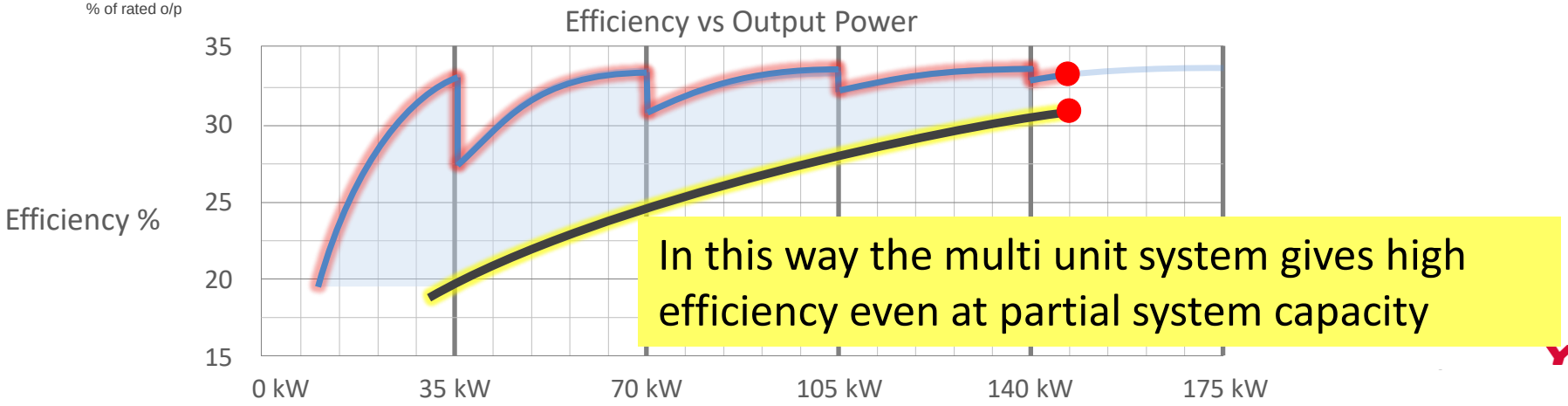
35 kW x 5 = 175 kW

(Up to 8 units can connect one system controller)



175kW x 1

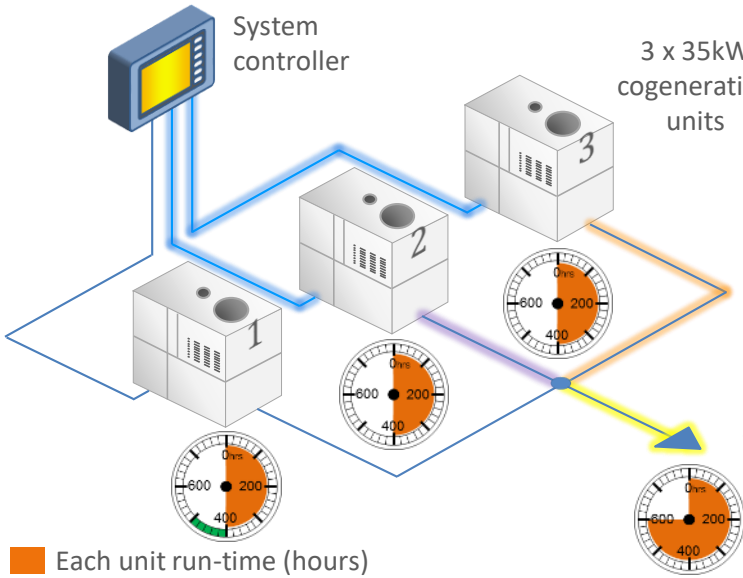




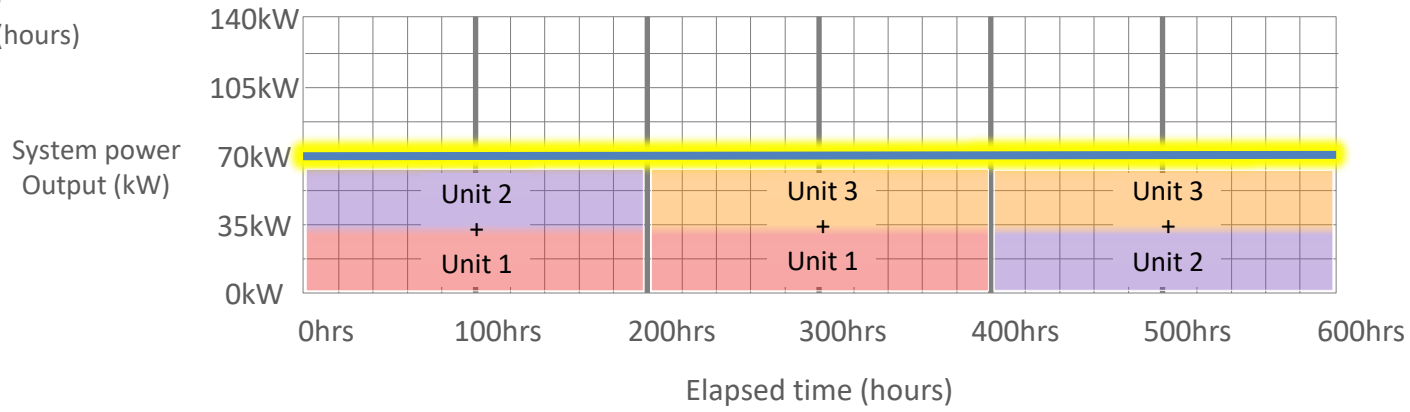
In this way the multi unit system gives high efficiency even at partial system capacity

Rotation Operation

System operating time: at end of 400-600 hour period
Load = 70kW (unit 1 + 3)



In this way the multi unit system acts like a large unit for servicing so the units can be serviced during the same visit to the site – also the system can carry on operating during servicing each unit in turn and using the other units

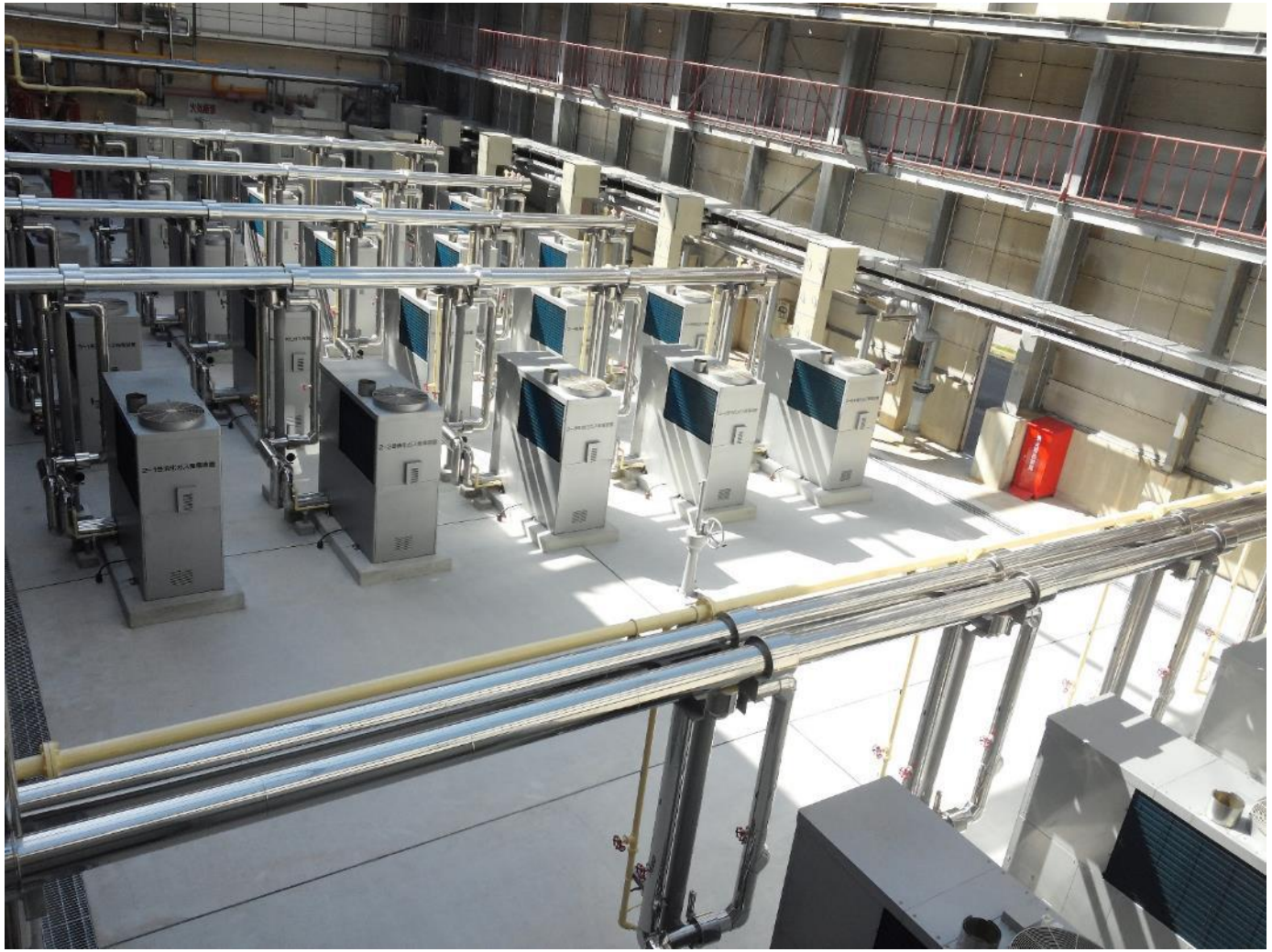


Yanmar's CHP units are designed to target Residential & C&I sector.

CHP Use Cases in North America

Residential	 Luxury Home, NY 10kW, 2013	 Luxury Home, CT 10kW, 2011	 Residential Building, CT 10kW, 2015
Commercial & Industrial	 Green Metals, Canada 35kW, 2016	 Trans-Alaska Office Building, AK 35kW, 2016	 Hyatt Place Hotel, ME 10kW, 2014
	 Chatham University, PN 2 X 10kW, 2016	 Kwaan Health Clinic, AK 10kW, 2014	 Ridge Road Community Center, AK 5kW, 2014

Multiple Unit Installation



Installation Example – Multi-Unit Rooftop for Airline Catering Facility

Installation Example Rooftop Bronx NY Mullti-family

Installation Example Multi-Unit – Home to Suites Hotel, Portland ME

Installation Example Famous Dave's Restaurant ,Scarborough, Maine

Maintenance

Maintenance Intervals

- 35D1's maintenance interval is every 7,500 hours
- YANMAR provides optional 60,000 hour maintenance packages

Items		Regular Service 7,500 hrs or 5 years	Regular Service 12,500 hrs or 5 years	Regular Service 25,000 hrs or 5 years	Overhaul 30,000 hrs or 10 years
Engine	Lube Oil	Replace	Replace	Replace	Replace
	Oil Filter	Replace	Replace	Replace	Replace
	Air Element	Check	Replace	Check	Replace
	Coolant	Replace	Replace	Replace	Replace
	Spark Plug	Check	Replace	Check	Replace
	Valves	Check, Adjustment	Check, Adjustment	Check, Adjustment	Check, Adjustment
	Exhaust Neutralizer	Check, Additional	Check, Additional	Check, Additional	Check, Additional
	Oxygen Sensor	Replace	Replace	Replace	Replace
	Rubber Hoses	Check	Check	Check	Replace
	Body	Check	Check	Check	Check
Generator	Body, etc.	Check	Check	Check	Check
CHP Package	Rubber Hoses	Check	Check	Check	Replace
	Vibration Isolator	Check	Check	Check	Replace
	Pump, Fan Motor	Check	Check	Check	Replace
	Noise, Vibration	Check	Check	Check	Check
	Bolts, Terminal Loose	Check	Check	Check	Check
Inverter		Check	Check	Check	Replace FAN
Battery		Every 4 years or every 20,000 hours			

YANMAR GHP

What is GHP

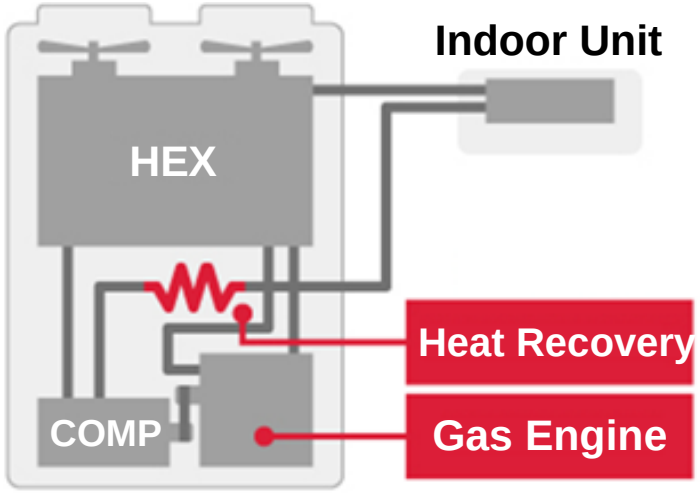
Gas **H**eat **P**ump (Gas engine driven Heat Pump)

YANMAR GHP

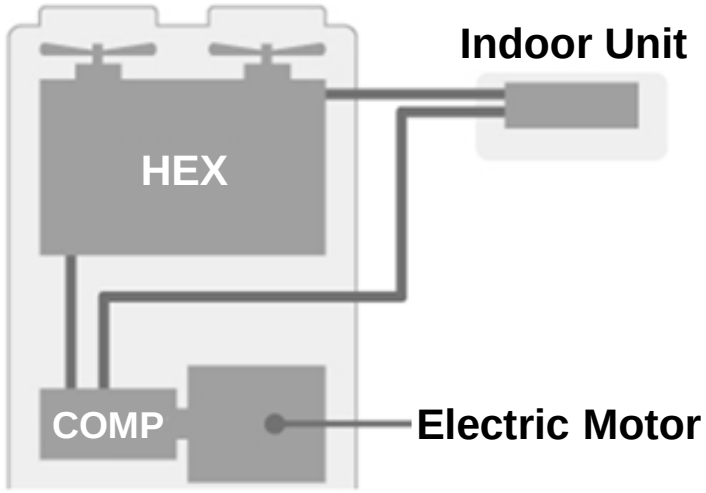
- Driven by a small gas engine
- Multi-split system
- Can connect multiple units

Traditional Electric (EHP)

- Driven by an electric motor
- Can connect multiple units



GHP



EHP

What is GHP

YANMAR GHP Variable Refrigerant Flow (VRF) is a modular, commercially applied air conditioning and heating system that distributes refrigerant from the outdoor unit to multiple indoor units providing efficiency, comfortable individual user control and reliability in one flexible package.

YANMAR's GHP VRF System is built on 4 basic product elements:

Outdoor Unit

+

Indoor Unit

+

Piping

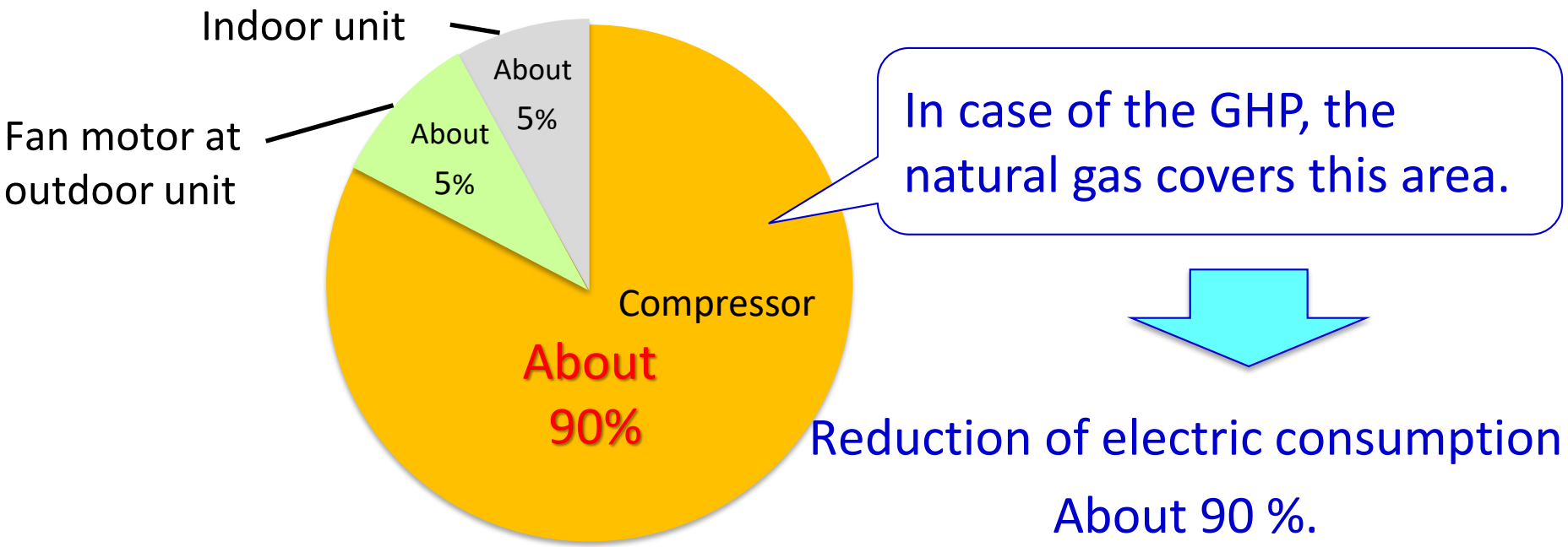
+

Controls

Reduce up to 90% of electricity use

- The GHP system can reduce the electric consumption about 90%

  - The ratio of energy consumption at heat pump system



What is GHP

Main Features VRF Technology:

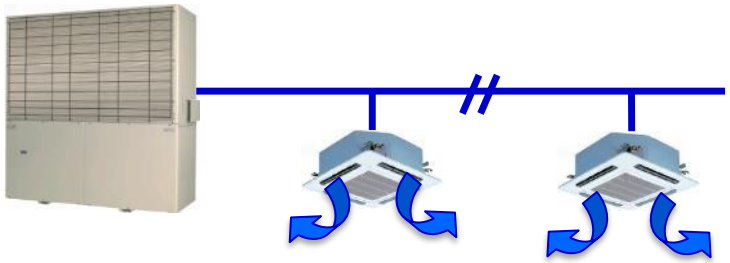
- **YANMAR's Gas Engine Reliability**
  YANMAR's gas engine has been used for more than 24 years with more than 300,000 installed units
  Low Power Consumption
  14 RT = 0.86 kW (Cooling)
- **Durability**
  Long maintenance interval of 10,000 hours
  Compressor Warranty: 7 years or 28,000 hours
- **VRF (Variable Refrigerant Flow) Air Conditioning System**
  Heat pump and heat recovery (3 pipe) offer high energy savings and comfortable heating and/or cooling.
- **Low Operating Sound**
  14 RT = 58dB(A) at 3 feet (when the radiator fan stops)
- **Faster Heating Using Heat Recovery**
- **Remote Monitoring System**
- **Anti-salt Paint is a Standard Option**

2 pipe and 3 pipe (heat recovery system)

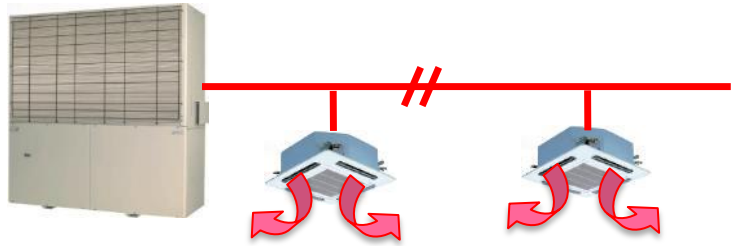
- The GHP has reverse cycle. Cooling or Heating are available with one GHP system.

➢ <u>2 pipe system (Standard)</u>

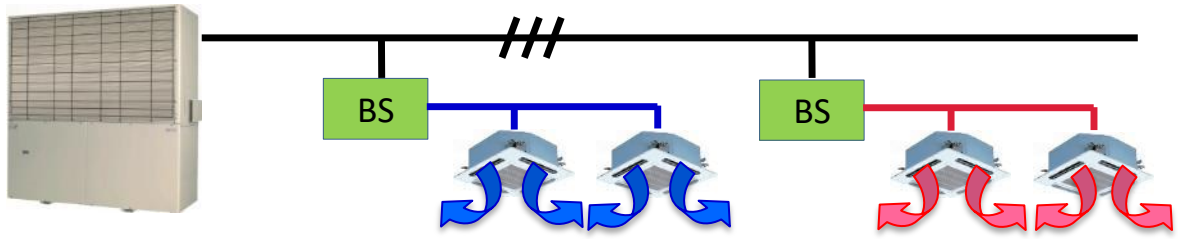
Cooling mode (Summer)



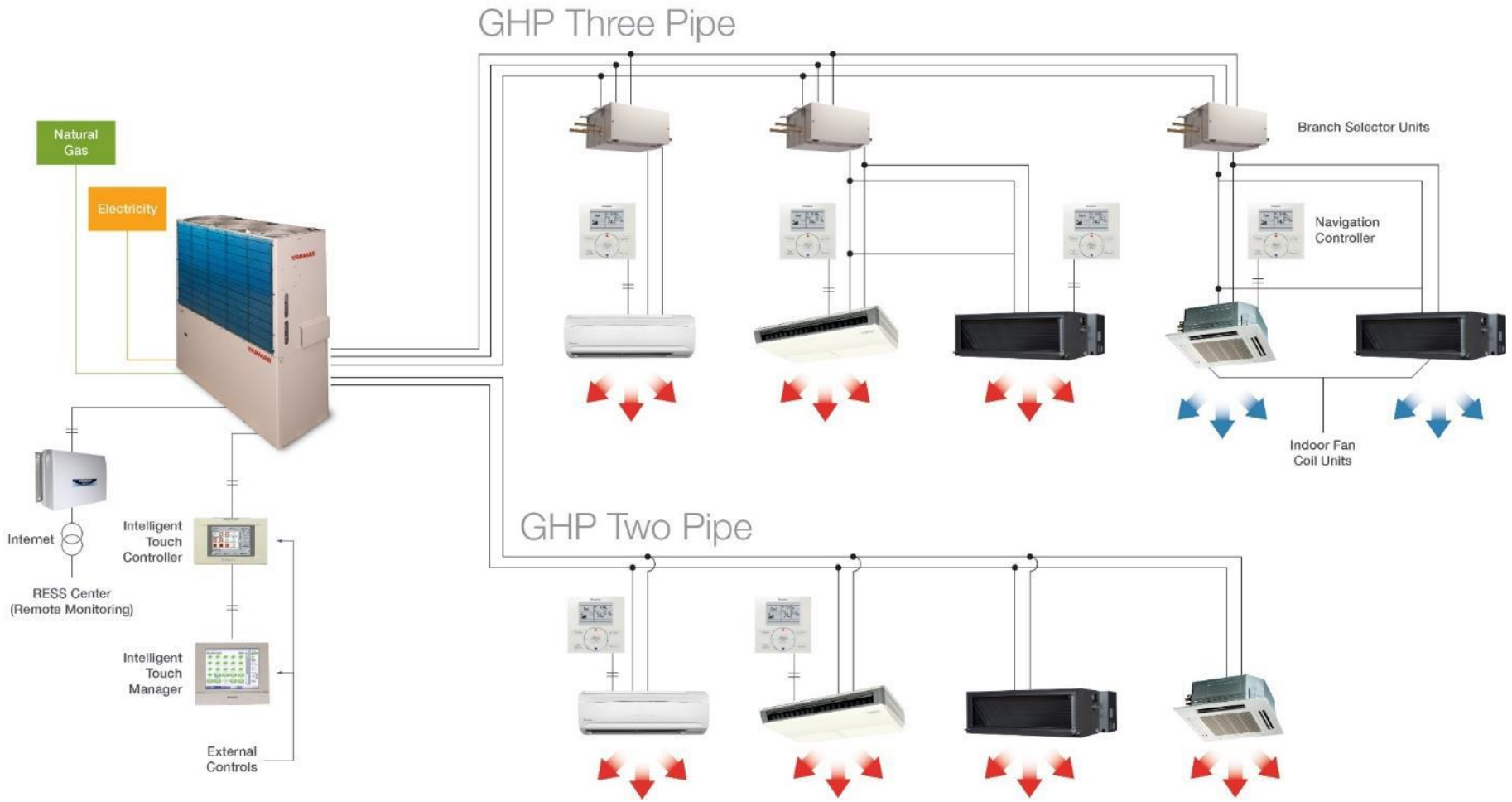
Heating mode (Winter)



➢ <u>3 pipe system (Heat Recovery)</u>



Basic Layout

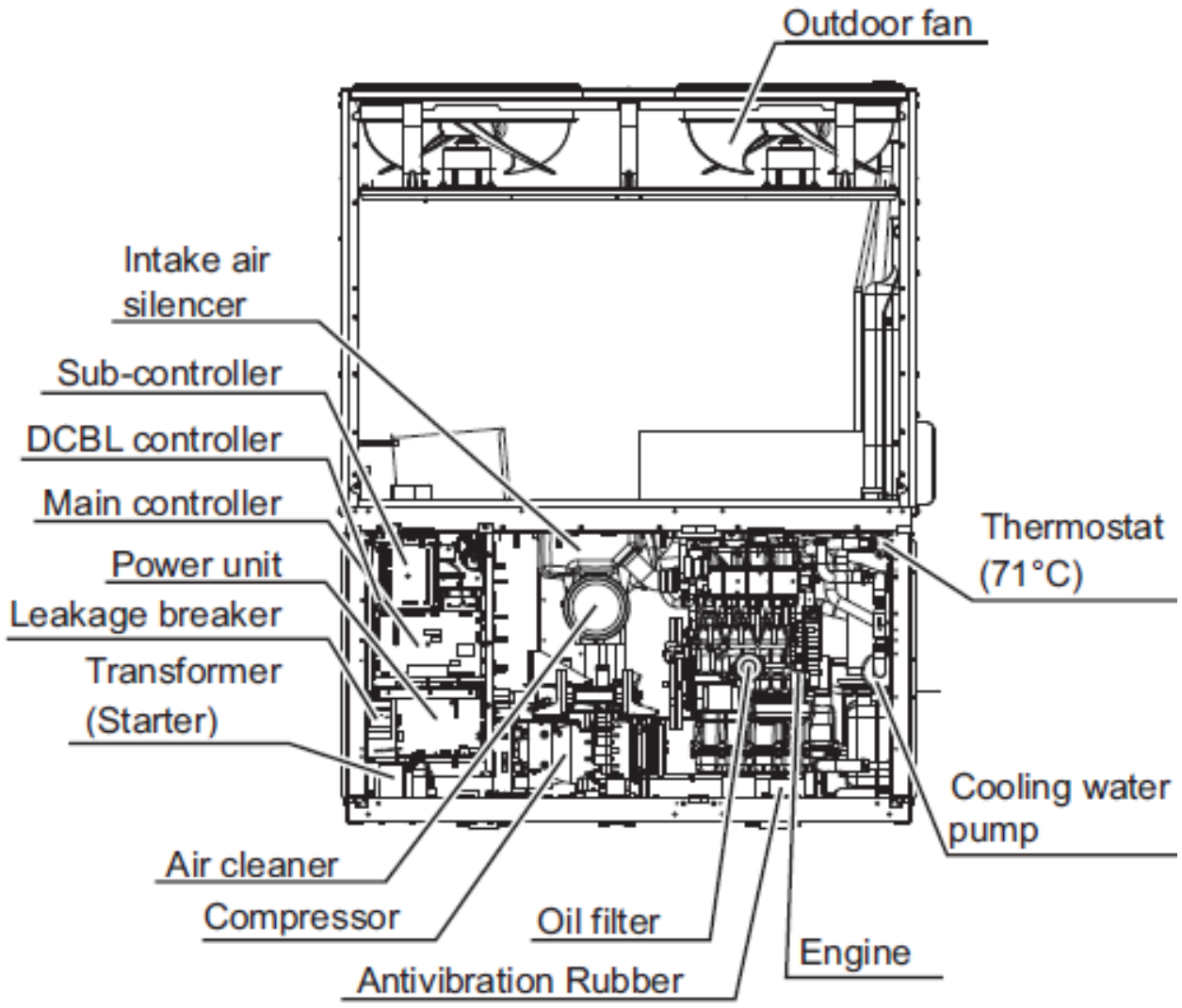


Main Spec

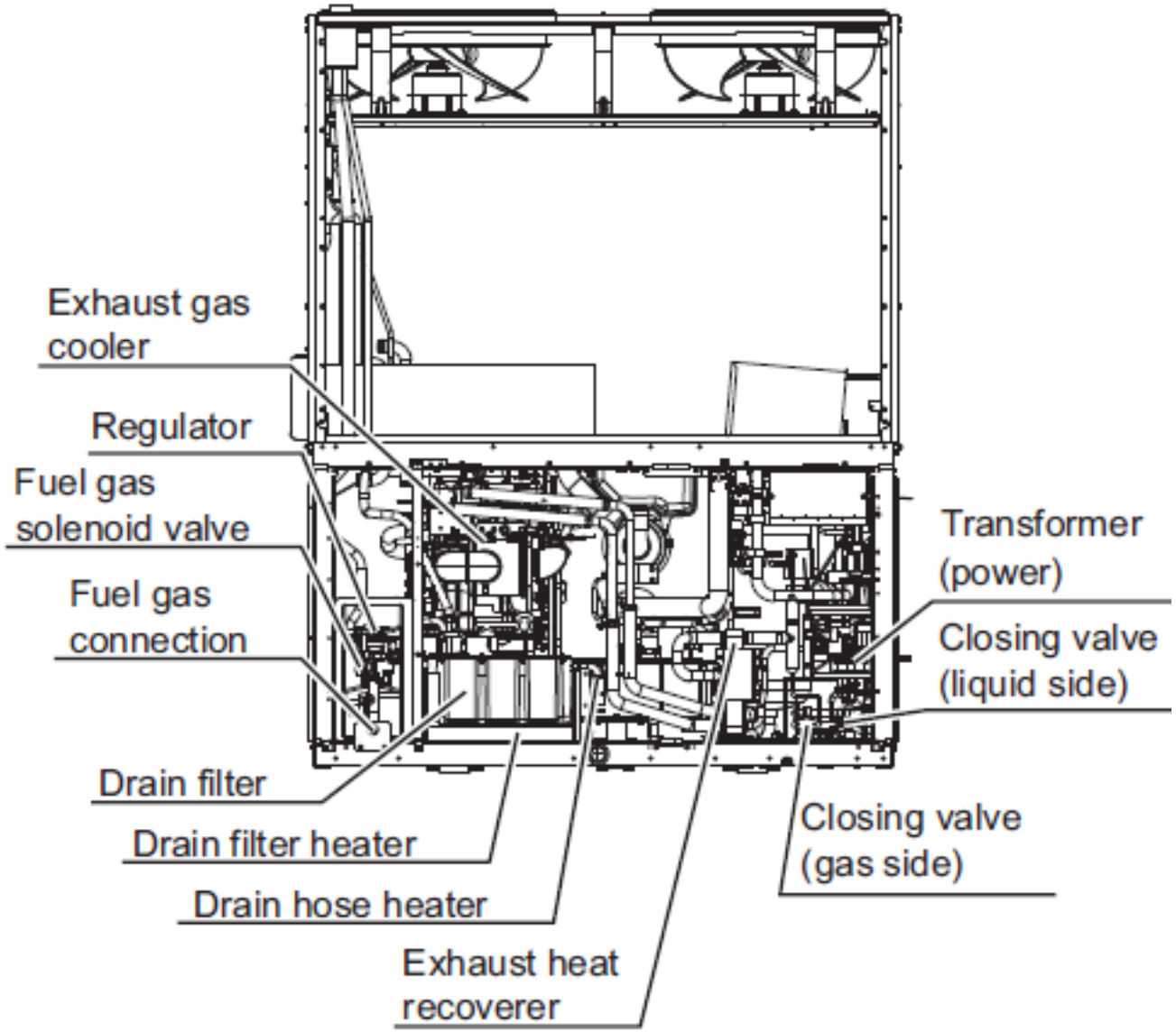
Model Number	NNCP096	NNCP120	NNCP144	NNCP168	NFZP168
Cooling capacity RT (kW)	8 (28.1)	10 (35.2)	12 (42.2)	14 (49.2)	
Heating capacity Btu (kW)	106,000 (31.6)	134,000 (39.6)	156,000 (46.9)	189,000 (58.0)	
Number of Pipes	2				3
Height inch (mm)	85 7/16 (2170)				
Width inch (mm)	66 9/16 (1690)				
Depth inch (mm)	31 1/2 (800)				
Weight lbs (kg)	1896 (960)			1940 (880)	1962 (890)
Refrigerant Pipe Size (Liquid, Gas)	3/8, 7/8	1/2,1	1/2, 1-1/8	5/8, 1-1/8	5/8, 1-1/8, 7/8 (Discharge)
Number of Connectable IDU	2 to 16	2 to 20	3 to 24	3 to 29	3 to 29
Total capacity of CIU * [%]	80 to 130	70 to 130	60 to 130		
Refrigerant type	R410A				

Structure

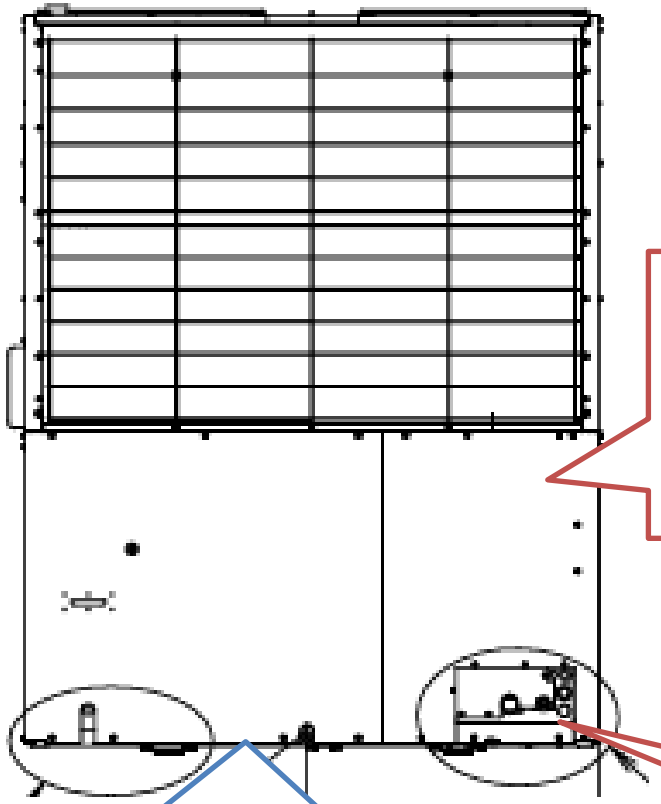
Main Structure (Front)



Main Structure (Rear)



Connection

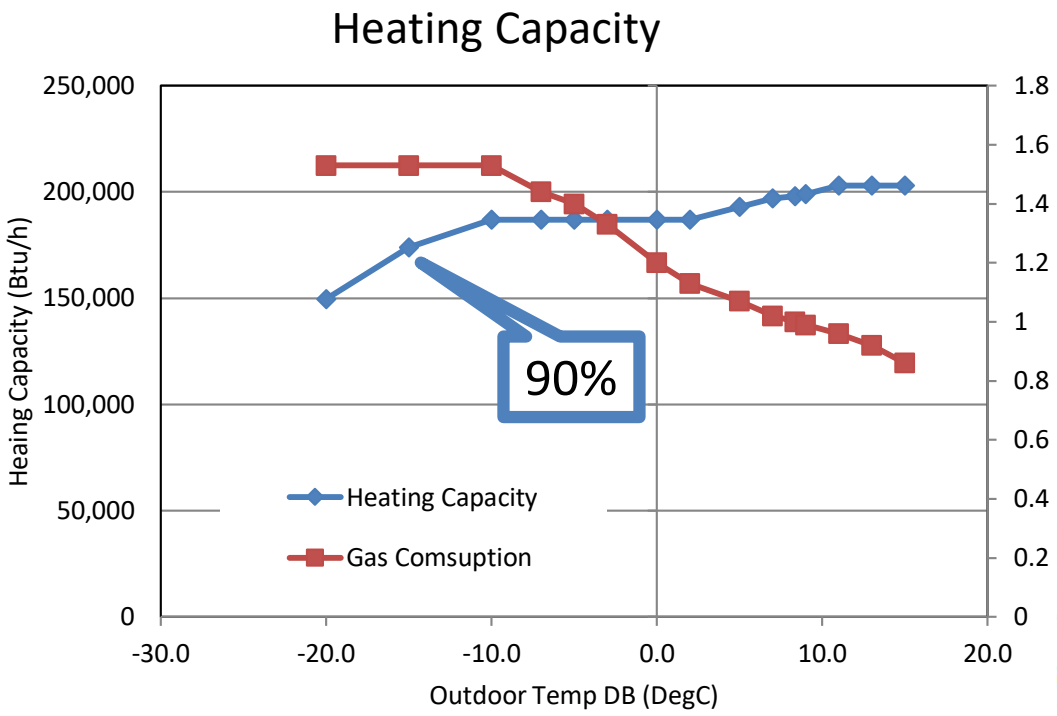


Electricity
- 208V /230V /240V
- Single phase

Natural Gas Connection
- 3/4 ”
- Pressure 4 to 10 inches of Water

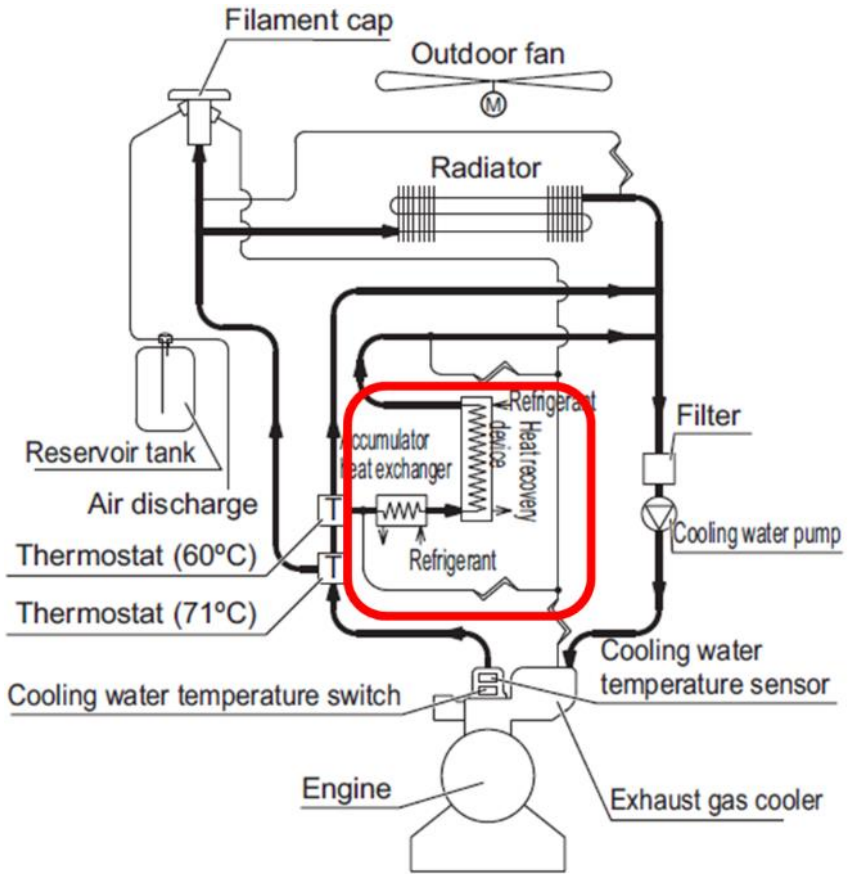
Refrigerant
- Gas 1-1/8”, Liquid 5/8”
- R410A
- Design Pressure 430 psi
- Air tightness test 550 psi

Winter Performance – cold ambient temperature -



If outdoor temp going down, use more gas but heating capacity doesn't drop so much

Cooling water diagram

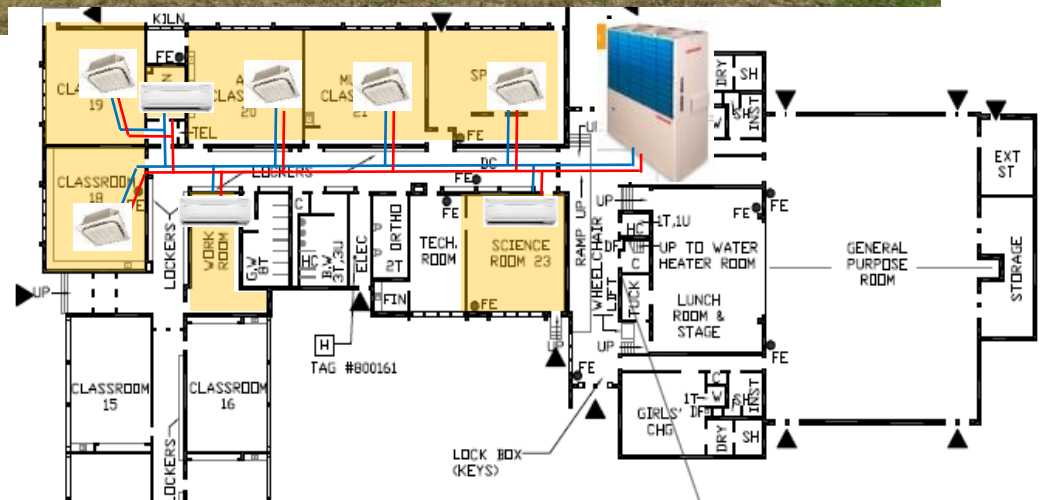


During heating mode,
Recover engine heat to refrigerant
=
Powerful heating & high efficiency

Case Studies

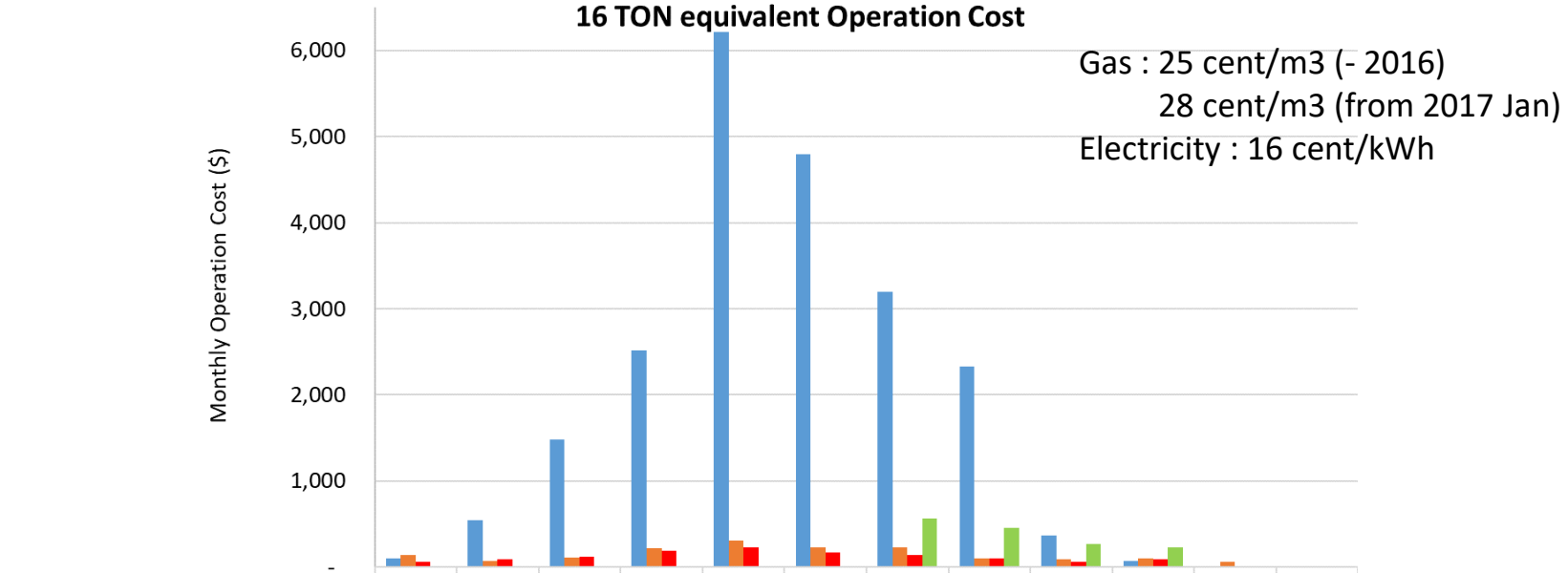
Stewart Avenue public School, Cambridge Ontario

16 TON outdoor unit



Heating and
air conditioning for
classroom

Operation cost comparison



	Sep	Oct	Nov	Dec	JAN	Feb	Mar	Apr	May	Jun	Jul	Aug
Electrical Base Board (2015-2016)	104	542	1,481	2,519	6,211	4,794	3,201	2,334	363	69	-	-
STEWART GHP (2016-2017) GHP	138	74	114	217	303	228	232	97	91	97	64	-
STEWART GHP (2017-2018) GHP	64	89	123	192	229	165	137	103	62	90		
CENTENNIAL (2017-2018) RTU							566	460	265	226		

[Gas Consumption for GHP]

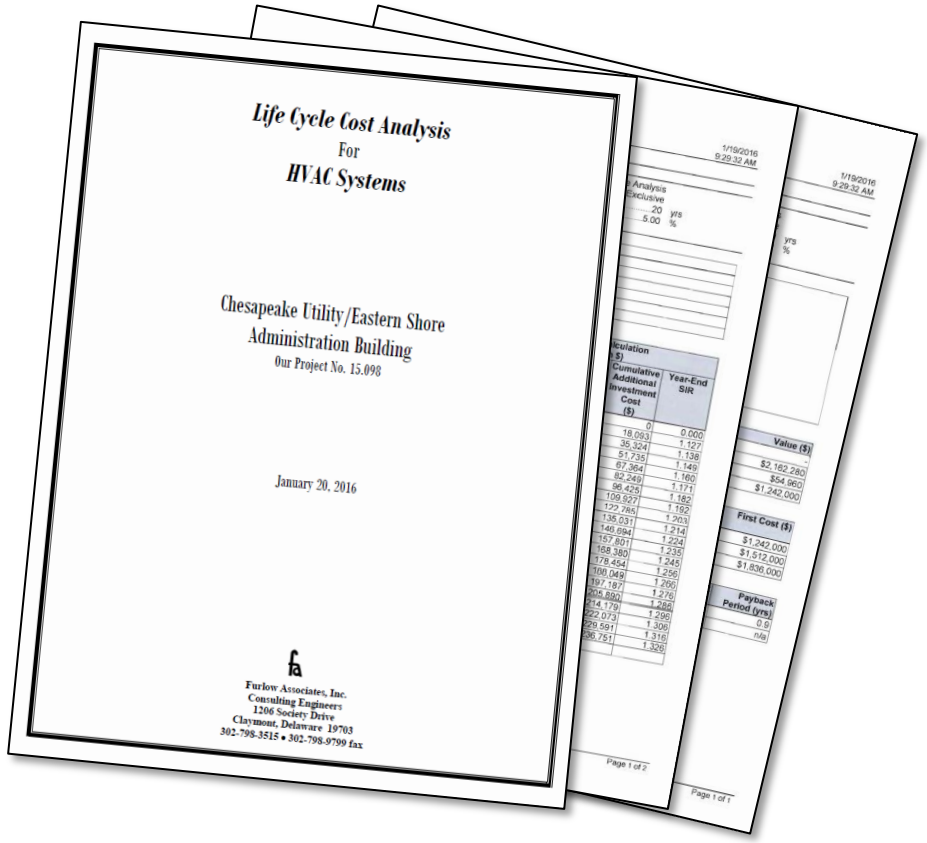
	Sep	Oct	Nov	Dec	JAN	Feb	Mar	Apr	May	Jun	Jul	Aug
2016-2017	423	228	386	799	1033	733	739	258	234	259	138	0
2017-2018	142	229	351	594	727	509	399	281	135	232		

Chesapeake Utilities New HDQ Building – Dover Delaware

HVAC Life-Cycle Cost Analysis (20 years)

Three Systems compared:

1. **Packaged gas-fired heating/DX cooling RTUs**
2. **Condensing boilers and air-cooled chillers, 4-pipe; chilled beams; ERVs.**
3. **Yanmar VRF gas-fired heat pumps, 3-pipe; ERVs.**



And the Winner is….

Yanmar VRF Gas-Fired Heat Pumps

WHY?

- **First Costs – 2nd place. 21% more than RTUs, BUT 18% lower than boiler / chiller / chilled beams option.**
- **Energy Costs – Lowest. Over $21,000/year savings over the other options.***
- **Maintenance Costs – Lowest. (tied with RTUs).**

***Energy savings driven by a significant reduction in electric demand charges.**

Chesapeake Utilities HDQ Building

14 TON outdoor unit

Indoor Equipment

Electric Savings from Choice of Rate Schedule and Demand Charges

Large Commercial (Secondary)			
Cust charge (3-phase):	$	22.50	mo
Demand:	$	13.90	kW
Energy Charge:	$	0.0677	kWh
PPA:	$	-	kWh
GEF Rider:	$	0.000178	kWh

Minimum Demand = 60% of the Peak Month Demand

- **With Gas Heat Pumps, the modeled Demand charge was 46% of the total electric bill.**
- **By contrast, with conventional RTUs, our building's Demand charges would have been 66% of the total electric bill.**
- **With RTUs, the total electric bill was estimated to be 2.3 times higher!**
- **Electricity costs 3X more than natural gas on an equivalent BTU basis**

Thank You