Convert Waste Heat to Useful Power

ORC solution

Organic
Rankine
Cycle
Technology

Yoka Cho
General Manager
yoka@irankine.com

Introduction

iRankine designs, integrate and installs complete Organic Rankine Cycle (ORC) solution for the production of power from heat with smart energy management system.

GPROSYS proposes standard ORC solutions from 100kWe to 2 Mwe for two main applications, with or without a cogeneration system:

Energy Efficiency:

Recovery of industrial waste heat

(cement, glass, chemical, steel plant, compression station etc.)

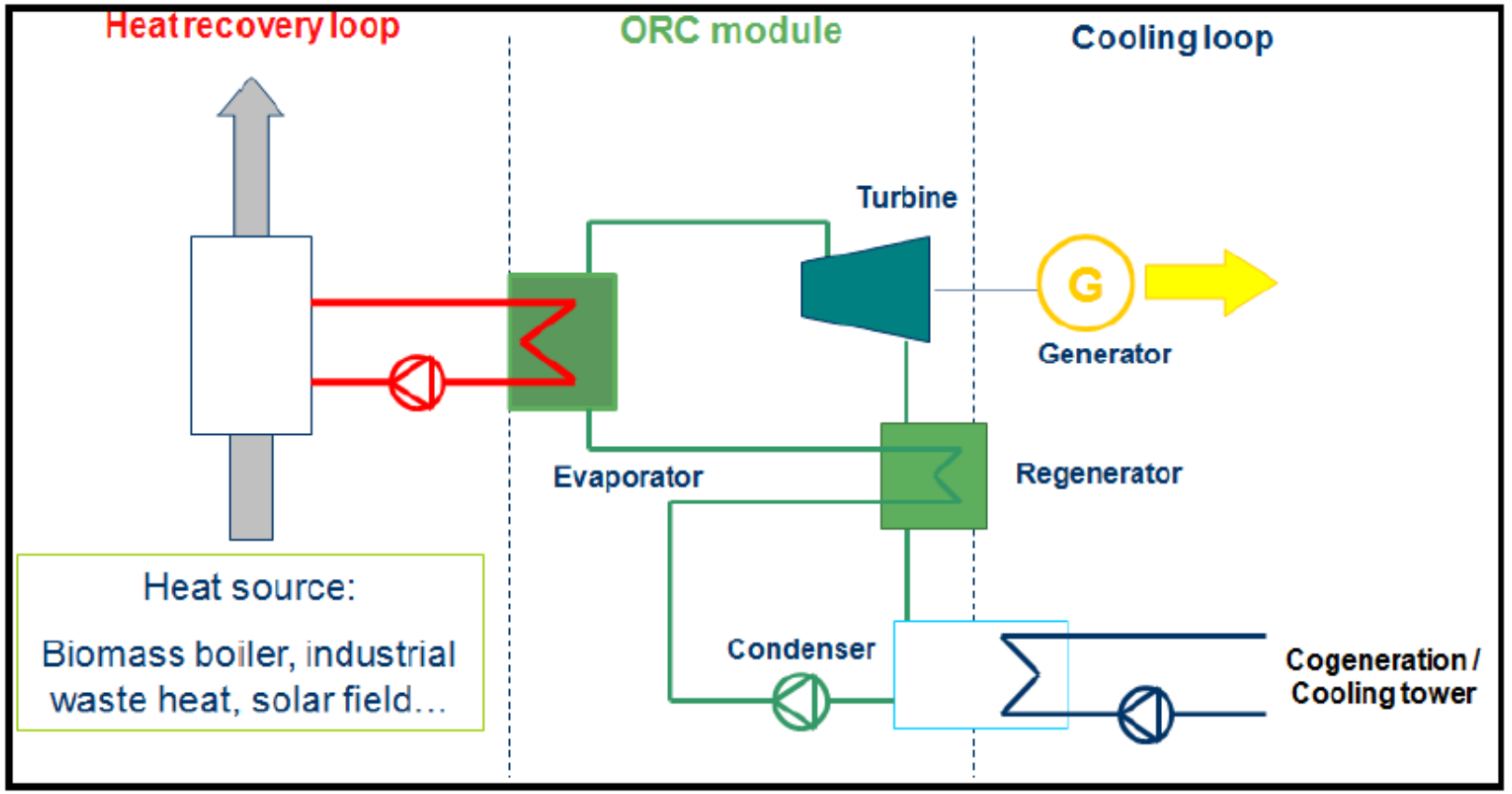
Recovery of engines waste heat

(diesel, natural gas or biogas engines)

Renewable Energy:

- Biomass
- Geothermal
- Solar thermal

ORC (Organic Rankine Cycle) Principle



- **Low boiling point (15 ℃) working fluid——R245fa**
- **Utilize low grade waste heat that vapor cycle can not work with**

ORC applications

Emission gas 150 ℃ -300 ℃
Hot water 90 ℃ -250 ℃
Waste steam 100 ℃ - 130 ℃

Manufacturing Sector Waste Heat Inventory by Industry and Temperature Range
(reference temperature at 120 °F)

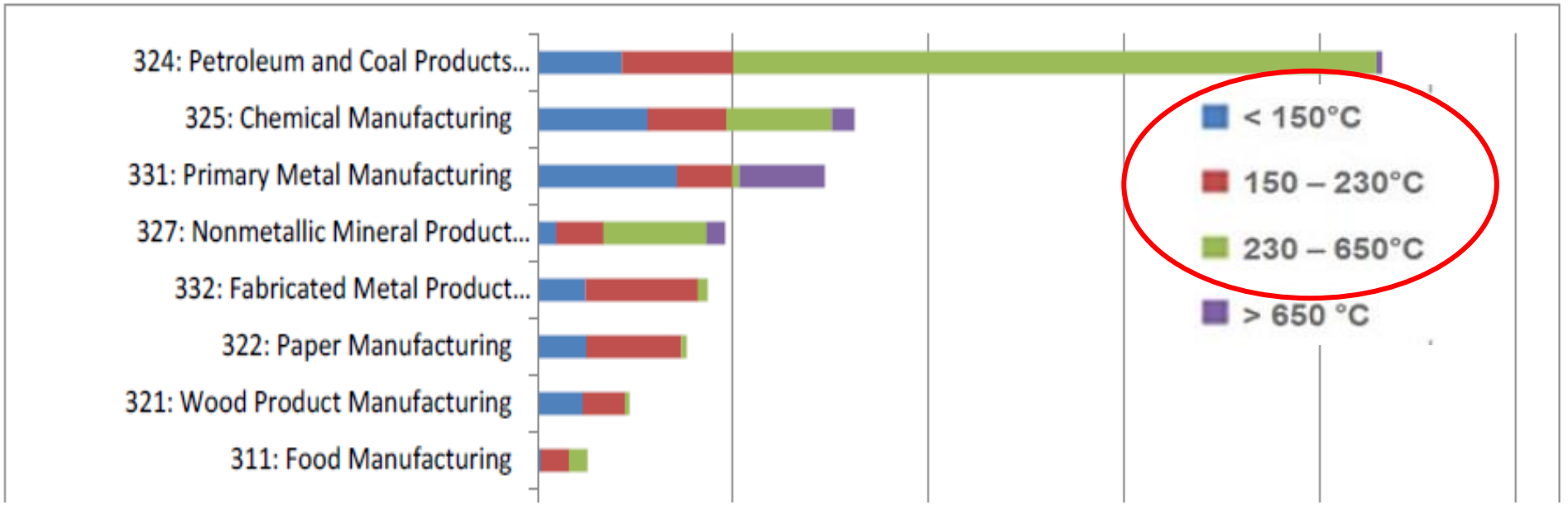
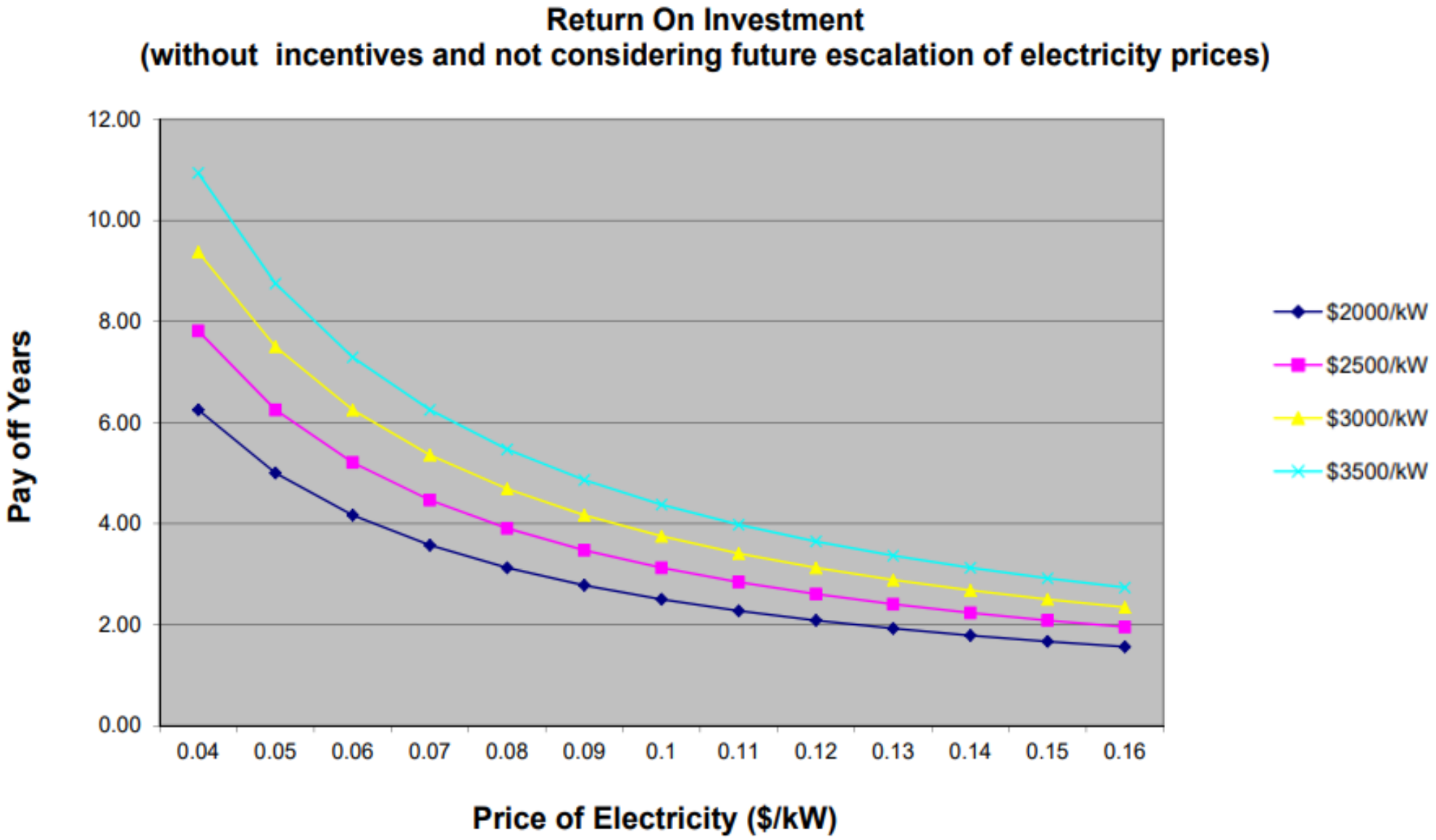


Fig: US industries; manufacturing sector waste heat Inventory (list not exhaustive) (source: ICF International study 2015 4))

Cost and return



Cost and return

WHR cost in the USA

Table 5. Waste Heat to Power Costs

Technology	Cost Characteristic	Electric Capacity for WHP Technology				
		50-500 kW	500-1,000 kW	1-5 MW	5-20 MW	>20 MW
Steam Rankine Cycle	Installed Capital Cost, $/kW	$3,000	$2,500	$1,800	$1,500	$1,200
	O&M Costs, $/kWh	$0.013	$0.009	$0.008	$0.006	$0.005
Organic Rankine Cycle	Installed Capital Cost, $/kW	$4,500	$4,000	$3,000	$2,500	$2,100
	O&M Costs, $/kWh	$0.020	$0.015	$0.013	$0.012	$0.010

Source: ICF analysis based on equipment manufacturer input.

We can supply

ORC	Installed cost	3000	2600	2300	2000	1800

Return e.g.

Running hours 8000 h/year，electricity price 0.12 USD/kWh，even smallest capacity ORC 3000/（8000*0.12）=3.15 years

Product and Service

ICE

Marine
Bio-gas
coalbed gas
oil field gas

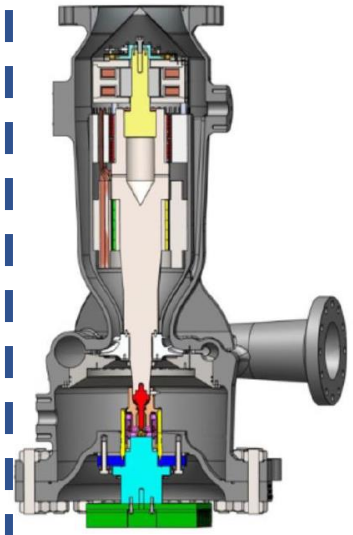
Biomass

Industry waste heat

Geothermal

Solar thermal

Standard Product



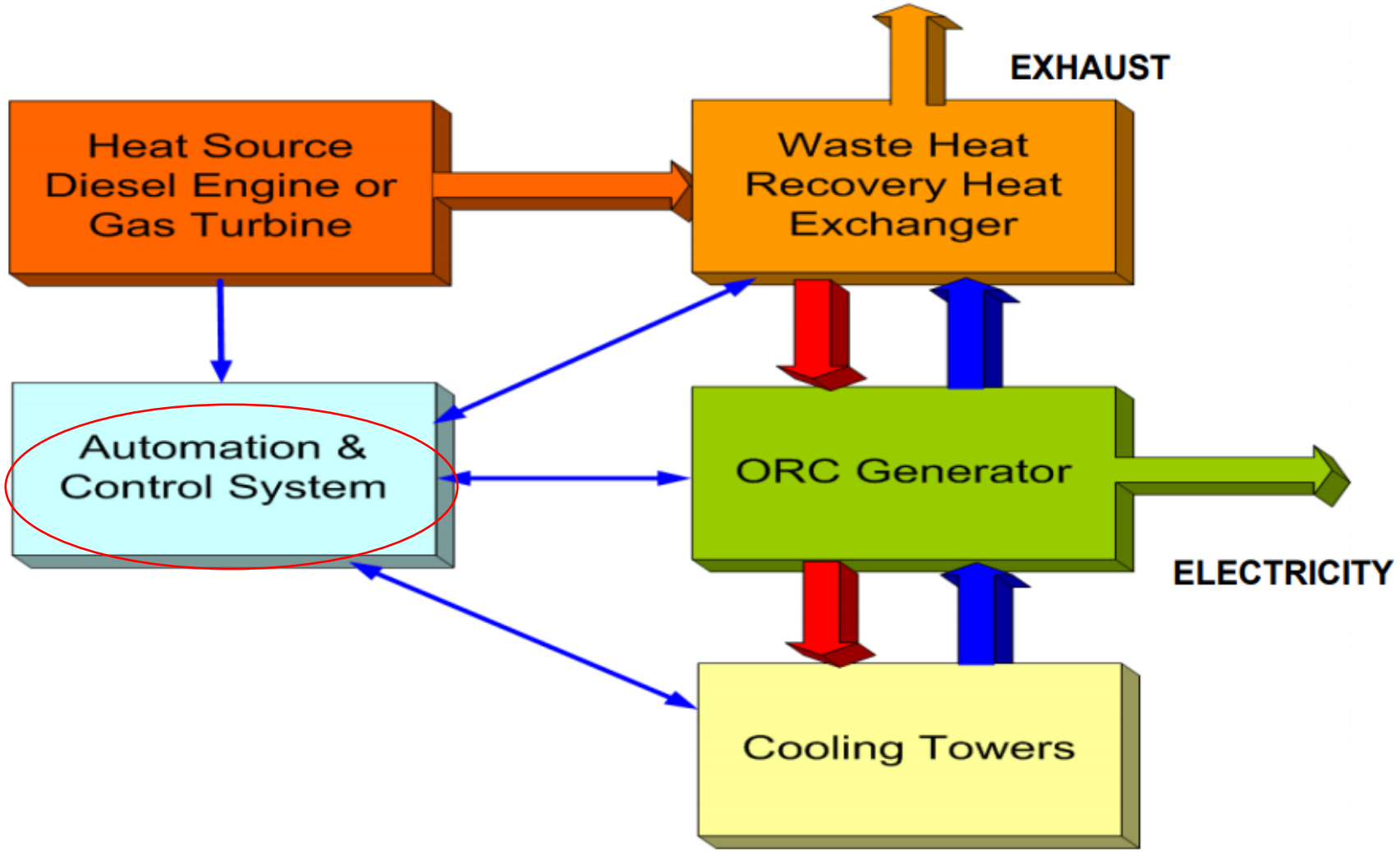
300 kW

- Magnetic Bearing
- Radial Turbine
- Permanent magnet
- No Leaking
- Direct coupling

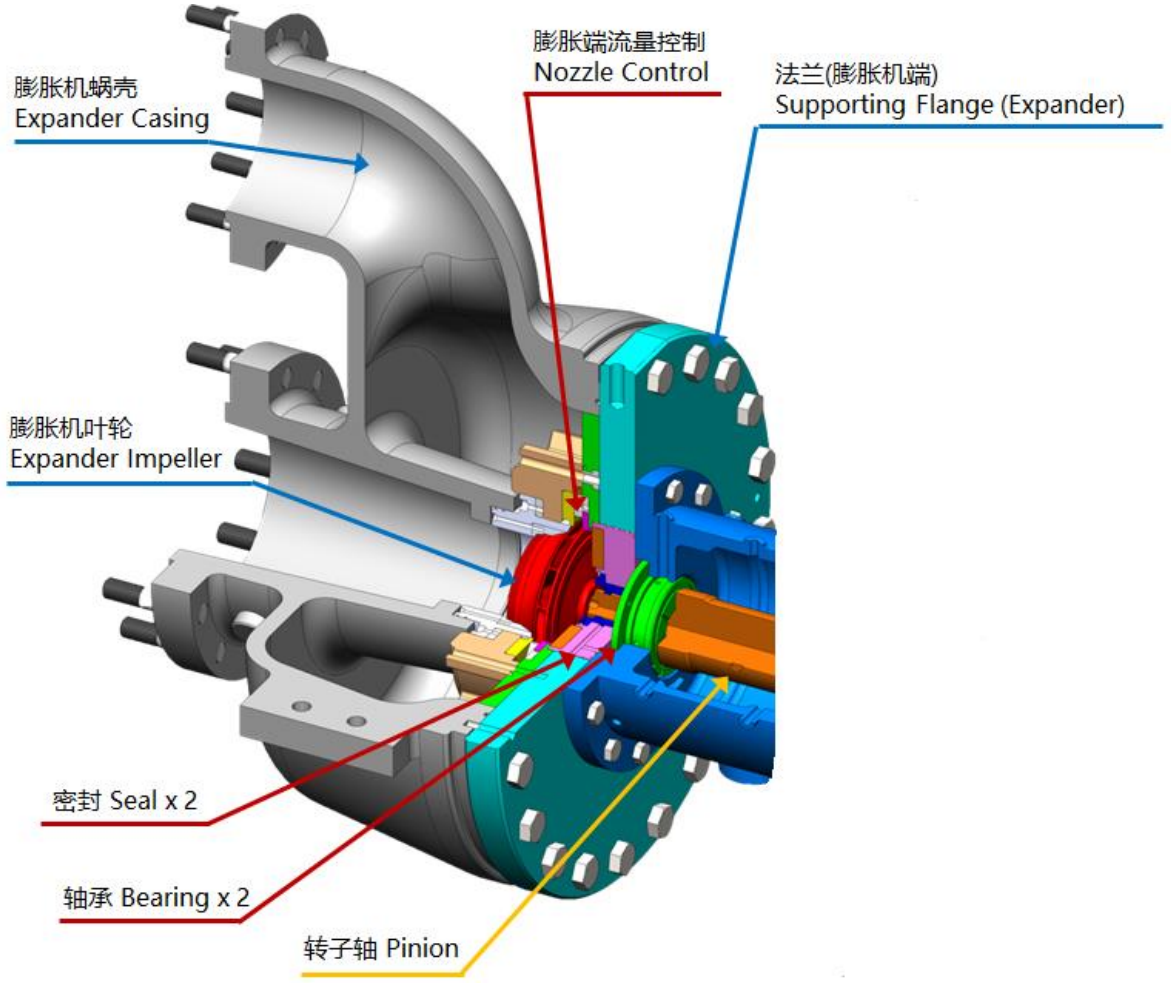
Customization

- Oil film bearing
- Axial/Radial Turbine
- asynchronous / synchronous
- Gearbox

Core Technology of ORC : Control



Core Components of ORC: Turbine Expander



Expender Efficiency **83%~ 86%**

Power output adjustment range **30%~ 110%**

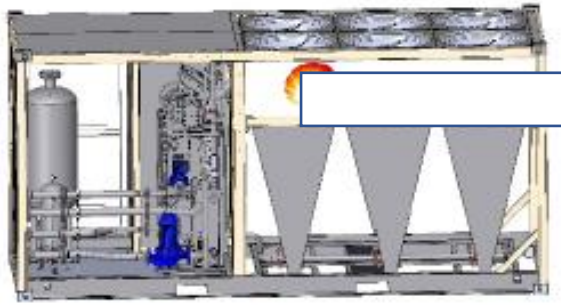
ORC system with Turbo Expander & Generator

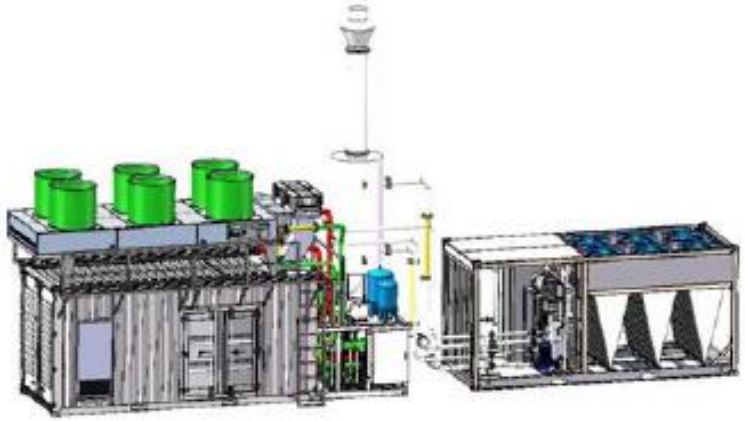
- System Configuration with **Turbo Expander**

+ Generator + Evaporator + Condenser + Pumps + Piping & Valves + Controls

- Recovering and Generating Electricity from Waste Heat, LNG Cold Energy and other Energy Transferring Process through Organic Rankine Cycle.
- Waste Heat Sources including hot liquids (90℃ and above), low pressure steam and hot gases (250℃ and above).
- Water cooled or Air cooled.
- ORC fluid can be R245fa, R134a, propane, butane or Mixed Refrigerants typical for LNG process.
- Expander Efficiency: up to 87%
- Power Generation: 50~8,000 kW

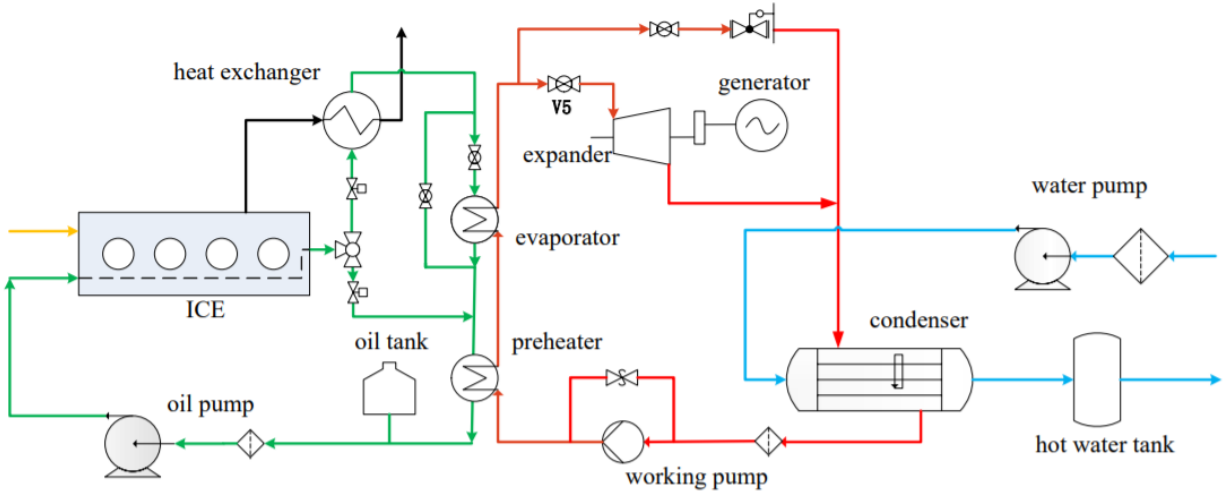
Success case 1 :Gas Engine Application





Engine 42% **ORC 8 ~ 10%** **Combine Module 50 ~52%**

Engine Power: 2,000 HP (1491 kW)
Exhaust Waste Heat Recovery : 1950 kW
Net ORC power : ~ 150kW
Location: Tongxiang, Zhejiang, China
Installation year : 2018
Industry: Power generation of Methane gas from swage treatment in a PET plant



Fuel efficiency 10% UP

Success case 2 :Hot Water Application

Waste heat source : Hot water from fertilizer process
Inlet Temperature: 140 ℃
Outlet Temperature： 120 ℃
Flow rate: 650 t/h
ORC Capacity: 1200kW X 2
Net power output： 1660 kW
Installation year： 2016
Location： Xinxiang， Henan， China

ORC system parameters at Henan fertilizer plant

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Operation Data Sheet					
Parameters	Unit	Case 1	Case 2	Case 3	Case 4
Hot water Flow rate	ton/H	300	300	300	300
Inlet temp.	℃	143	143	143	143
Outlet temp.	℃	120.0	120.0	120.0	119.5
Working fluid		R245fa			
Cooling water inlet temp.	℃	25	25	32	15
Cooling water outlet temp.	℃	35	33	40	23
Flow rate of cooling water	ton/H	633	782	759	802
Rated electric power Capacity	kW	1200			
Net output power	kW	1062	1077	979	1141
System self-consumption power (pump)	kW	93	93	93	93
Voltage	V	10500			
Generator	kW	1200*1.08			
Working load range	%	50-105			
Heat to power Efficiency	%	12.1	12.1	10.7	13.0
Isentropic efficiency of turbine	%	84	84	84	82
Dimension of system	m*m*m	9.3*5.4*3.7（L*W*H）			
Estimated life time	year	20			

Actual running efficiency of ORC at Henan fertilizer plant

Parameter				A			B		C	
Time	Turbine inlet temp. ℃	Turbine outlet Pressure MpaA	Enthalpy at inlet kJ/kg	Entropy at inlet kj/kgK	Turbine outlet temp. ℃	Turbine outlet Pressure MPaA	Enthalpy at outlet kJ/kg	Entropy at outlet kj/kgK	Enthalpy of outlet for isentropic expandation kJ/kg	Isentropic efficiency
20170324	129.7	2.08	495.5	1.8237	67.1	0.22	461.54	1.8502	452.65	79.3%
20170409	136.3	2.01	506.9	1.8534	79.1	0.25	472.93	1.9	465.21	81.5%
20170511	131.6	1.95	501.47	1.8414	79.0	0.31	471.67	1.9	465.39	82.6%
20170827	128.8	1.97	496.9	1.8297	75.0	0.30	467.79	1.8502	460.11	79.1%
20180423	128.2	2.09	492.8	1.817	66.8	0.24	460.81	1.8429	452.11	78.6%
20180524	137.0	2.04	507.27	1.8537	79.8	0.25	473.64	1.8776	465.31	80.1%
20180814	133.2	1.91	504.61	1.8501	85.1	0.35	477.18	1.8679	470.87	81.3%
20190621	130.2	1.92	500.13	1.8388	81.7	0.37	473.27	1.8537	468.03	83.7%

Isentropic efficiency = (A-B)/(A-C)

Stable high efficiency.
No degradation