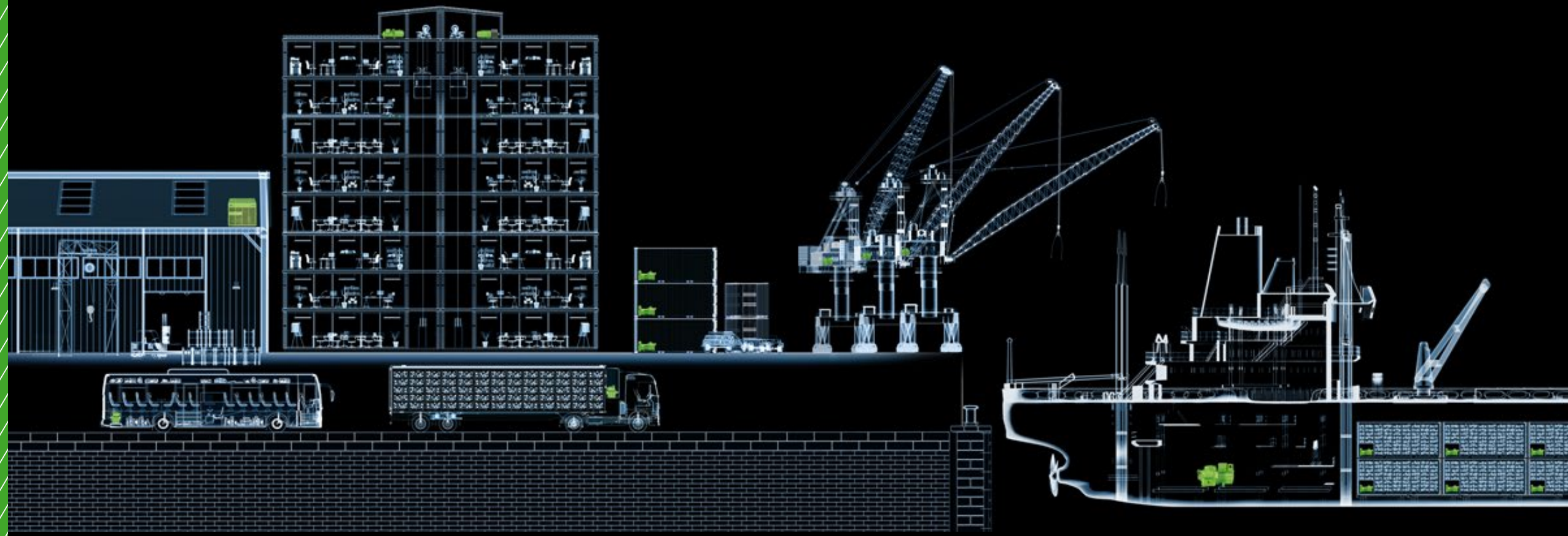


ElectraTherm
Evolution of the Active Cooler

Pacific Power Association Presentation – 29 September 2020

David Knight

Bitzer

DAS HERZ DER FRISCHE

OUR INVOLVEMENT IN THE PACIFIC

Participation Pacific Power Association Conferences

- Tonga - 2016
- Samoa - 2017
- Palau - 2018
- Cook Islands - 2019
- 2020 – sadly no conference
- 2021 – we look forward to reconnecting in person

POHNPEI WASTE HEAT RECOVERY PROJECT

B:Power a.s. in association with **ElectraTherm** have been awarded a contract by Pohnpei Utilities Corporation for the design, supply, installation and commissioning of 200kW ORC Waste Heat Power Generation Unit at the Nanpohnmal Power Plant, Pohnpei Micronesia.

The contract provides for the design and installation of a complete waste heat recovery and power generation system incorporating exhaust gas heat exchanger installed on existing diesel generators, three off **Power+6500B^{+}** containerized ORC's, Efficient Coolers, interconnecting pipework and control system integrated with the Nanpohnmal Power Plant.

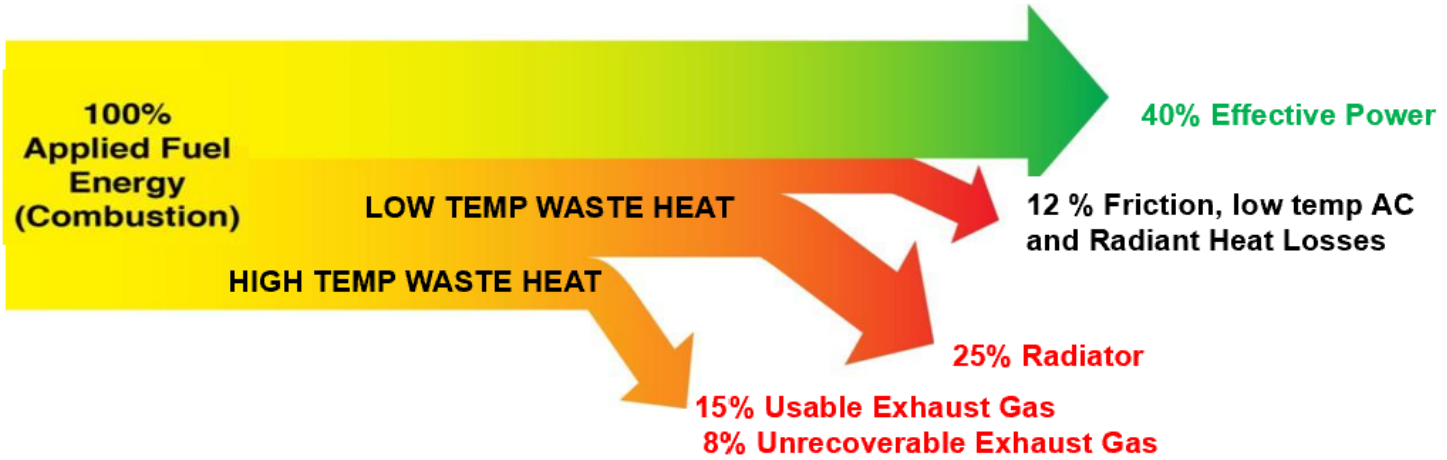
The **Power+6500B^{+} ORC's** to be installed are the latest generation units incorporating the successful **BITZER HSE85 125 kWe Twin-Screw Expander** and upgraded control system.

POHNPEI WASTE HEAT RECOVERY PROJECT

The Issue

All engines create heat during operation, converting energy contained within a liquid/gas fuel into mechanical energy that can the be used to rotate a power generator.

Typically engines convert 40 – 45% of the fuel into electrical power with the remainder lost in high and low temperature waste heat



For the safe operation of the engine it is necessary to remove the low temperature heat through the engine cooling (jacket water) system and the issue to be solved was how to do this in an energy efficient and cost effective way.

TRADITIONAL ENGINE COOLING

Traditional Engine Cooling Systems have required either direct mechanical or electrical energy to provide the necessary rejection of heat

The engine operator has both a **direct cost** to create the heat (fuel cost) and a **cost** to reject this heat!

These direct costs are ongoing and **never stop** whilst the engine is operating and has a direct impact on the profitability of the generating asset

TRADITIONAL ENGINE COOLING – RADIATOR SIZING

The design and sizing of Engine Cooling Systems are based on several factors including;

- Heat load to be rejected
- Ambient temperature range
- Engine manufacturer's recommendations
- Cost

The capital cost is based on the number of cooling coils and fans required to provide cooling of the engine jacket water. The more coil size and quantity of fans the more efficient cooling but with a higher capital cost and higher ongoing operating costs through fan and pump power consumption.

The need for peak cooling capacity at the highest ambient temperature typically only occurs for a short period with the radiator being under utilized during the remainder of the time and therefore the radiator selection is a compromise between efficient cooling and capital/operating costs.

The AC800 removes the need for compromise between performance and cost with the radiator cooling capacity being fully utilized all year round either for just engine cooling at peak ambient temperatures or engine cooling/ power production

THE SOLUTION

The solution is to stop **wasting** the rejected heat and use this heat to create the energy necessary for the operation of the engine cooling system and to efficiently use the full cooling capacity of the radiator all year.

The **ElectraTherm Active Cooler** uses the heat rejected in the engine jacket water system to provide the necessary power to achieve energy efficient cooling of the jacket water and under optimum conditions generates excess power that is added to the generators overall output.

The Active Cooler **SAVES** costs in the operation of the engine cooling system, **HELPS** in engine operating efficiency through more efficient cooling and **CREATES** additional Income by selling the excess power generated.

SOME HISTORY

Early in the development of the **Power+Generator, Electratherm** recognised the opportunity to use the technology for the efficient cooling of diesel engines. In conjunction with the Southern Research Institute and the US Navy, ElectraTherm participated in a successful field testing program to demonstrate the efficiency gains achievable through the use of waste heat for power generation.

This trial replaced the PTO driven engine radiator of a Cummins 1.2MW diesel generator with a combination of the Power+Generator, a pump/ heat exchanger skid and an efficient dry cooler.

Whilst this trial was a success, demonstrating impressive energy gains, the combination of three items of equipment to replace a single cooler was not deemed practical

THE TASK

Having recognised the issue and the solution the task of the **ElectraTherm Engineering Team** was to combine our successful **Power+Generator ORC technology** with the latest dry cooler technology for a complete energy efficient engine cooling package

The design brief was to re-engineer the **Power+Generator** into a compact ORC with a simplified control system, integrated with a dry cooler for the primary purpose of engine cooling with the ability to generate excess power as a secondary consideration.

DESIGN PROCESS

Task One was to define the difference between the **Power+Generator** and the **Active Cooler**.

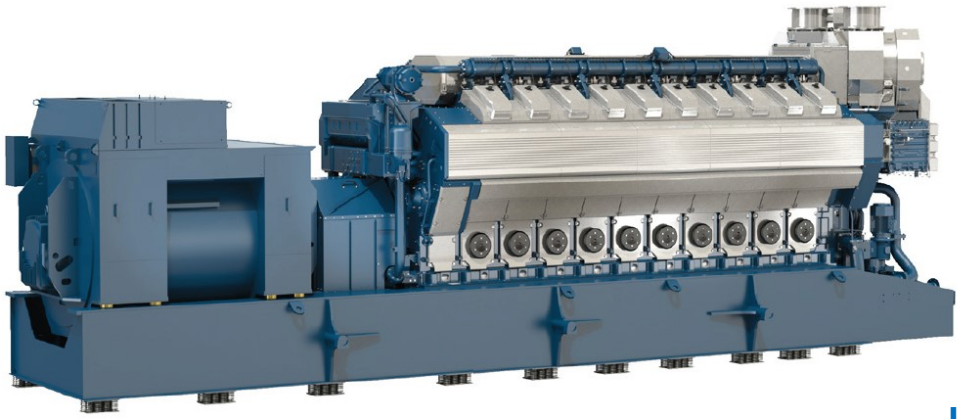
The **Power+Generator** primary role is to generate power efficiently from a low temperature heat source using a combination of heat exchangers, twin screw expander and a sophisticated PLC based control system.

The **Active Cooler** role is to be an efficient, typically self powering, engine cooling system with power generation as a secondary consideration.

Task Two was to determine the best combination of equipment and control system which maintains the integrity of our ORC technology whilst achieving efficient cooling of the engine jacket water at both high and low ambient temperatures.

Task Three, based on our previous experience, was to develop an integrated solution in a single package - replace a radiator with a radiator.

THE RESULT – ELECTRATHERM ACTIVE COOLER



JACKET WATER IN

JACKET WATER RETURN

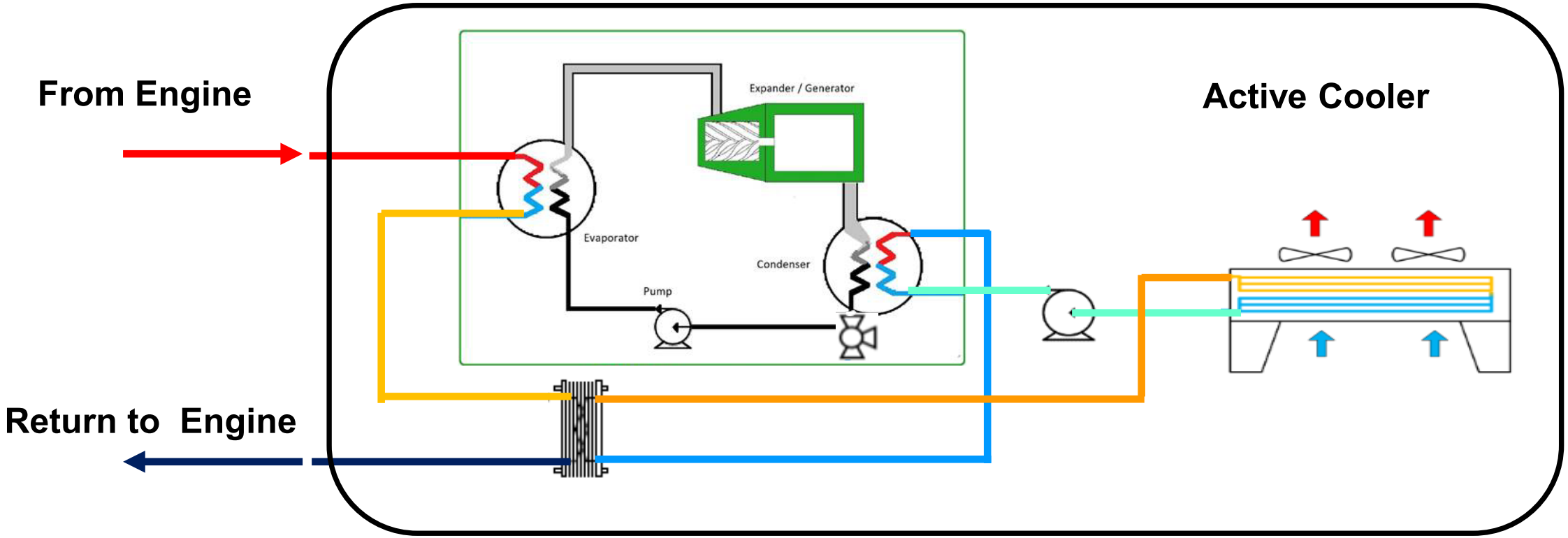
Electricity out

HOW IT WORKS

Renewable

Sustainable

Viable



The **Active Cooler** incorporates a compact ORC (single evaporator, BITZER Twin Screw Expander, single condenser and simplified control system), a secondary HX to control return temperature to the engine and an integrated Dry Cooler as a single package.

WHAT THE ACTIVE COOLER MEANS FOR THE PACIFIC

1. It provides an energy efficient system for engine cooling
2. Adds to power station efficiency through the conversion of energy into more saleable output for the same fuel input
3. Eliminates the need to compromise on Radiator sizing as excess cooling capacity not fully utilised during cooler times of day/year now being used to bolster power output
4. Stops wasting energy and constant ongoing operating costs
5. Adds to utility income – utility profitability
6. And also helps to meet energy efficiency targets through the use of waste heat to generate renewable energy.

OUTPUT EXAMPLE

ElectraTherm
BY BITZER GROUP

FIJI

AC800 ACTIVE COOLER - SUMMARY

Version 4.1
Date 14/09/2020

Location **Nadi** Country **Fiji** Grid 50 Hz

Climate Statistics
Temperature Range
High
Low
Humidity Rating 2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Highest													
Max	30.1	30.4	29.8	29.0	27.8	26.8	26.1	26.2	26.9	28.0	28.9	29.7	28.3
Avg	26.8	26.9	26.6	25.9	24.8	24.0	23.3	23.3	23.9	24.7	25.6	26.3	25.2
Min	23.4	23.4	23.4	22.8	21.8	21.1	20.5	20.3	20.8	21.3	22.2	22.9	22.0
Lowest													
Humidity	81%	82%	84%	83%	80%	80%	78%	76%	76%	78%	79%	80%	80%

Manufacturer	Model	Rated Output	Fuel	Jacket Water Conditions				Est Average Outputs			Offsets		Totals	
				Temp		Flow Rate	Reject Heat	Low	Median	High	Avg Derate	Existing Parasitic	Avg per Hr	Annual Output
				Out	Return									
				^{0}C	^{0}C	l/sec	kWth	kWe	kWe	kWe	kWe	kWe	kWe	kW
CATERPILLAR	KTA50-G3	1000	Diesel	93	82	15	680	19.9	23.4	26.5		10.0	33.5	284,732
CATERPILLAR	3516B	1600	Diesel	90	79	13.5	661	15.7	19.0	21.6		10.0	29.1	247,195
CUMMINS	QST30-G4	880	Diesel	95	82	14	465	12.1	17.2	21.0		10.0	27.2	231,193
CUMMINS	QSK50 G4	1300	Diesel	95	82	17.5	930	18.7	22.5	26.0		10.0	32.6	277,067
MAN	9L 27/38 S	2500	Diesel	85	70	21.5	1306	10.0	13.1	16.0		20.0	33.2	282,112

OUTPUT EXAMPLE

ElectraTherm
BY BITZER GROUP

FIJI

OUTPUT DATA SHEET - CATERPILLAR KTA50-G3 - AC800 ACTIVE COOLER

Version 4.1
Date ########

Engine KTA50-G3 Rated Output 1000 kW Grid 50 Hz Fuel Diesel Oversize Radiator Size kW
J/Water H/Temp 93 C R/Temp 82 C Flow 15 l/s Heat 680 kWth Std Radiator Pow 10 Kwe

Climate Statistics
Location Nadi
Country Fiji
Temperature Range
High 33.9
Low 0.0
Humidity Ratir 2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Highest	33.5	33.9	33.0	32.1	30.8	29.7	28.9	29.2	30.0	31.4	32.3	33.1	31.5
Max	30.1	30.4	29.8	29.0	27.8	26.8	26.1	26.2	26.9	28.0	28.9	29.7	28.3
Avg	26.8	26.9	26.6	25.9	24.8	24.0	23.3	23.3	23.9	24.7	25.6	26.3	25.2
Min	23.4	23.4	23.4	22.8	21.8	21.1	20.5	20.3	20.8	21.3	22.2	22.9	22.0
Lowest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Humidit	81%	82%	84%	83%	80%	80%	78%	76%	76%	78%	79%	80%	80%

Month	Climate				Jacket Water Input			Estimated Outputs			Est DeRate	Average Derate	Combined Output/ Saving				Est Output
	Max	Median	Min	Humidity	Temp	Flow	Heat	Low	Median	High	Time	Kwe	Max Temp	Median Temp	Min Temp	Average	97%
	C	C	C	%	C	l/s	kWth	kWe	kWe	kWe							
Jan	30.1	26.8	23.4	81%	93	15	680	17.6	21.9	25.1	0.00%	0.0	27.6	31.9	35.1	31.9	22,989
Feb	30.4	26.9	23.4	82%				17.6	21.9	25.1	0.00%	0.0	27.6	31.9	35.1	31.9	20,765
Mar	29.8	26.6	23.4	84%				18.6	21.9	25.1	0.00%	0.0	28.6	31.9	35.1	31.9	22,989
Apr	29.0	25.9	22.8	83%				18.6	22.9	26.1	0.00%	0.0	28.6	32.9	36.1	32.9	22,989
May	27.8	24.8	21.8	80%				20.7	23.9	27.3	0.00%	0.0	30.7	33.9	37.3	34.0	24,535
Jun	26.8	24.0	21.1	80%				21.9	25.1	27.3	0.00%	0.0	31.9	35.1	37.3	35.1	24,498
Jul	26.1	23.3	20.5	78%				21.9	25.1	27.4	0.00%	0.0	31.9	35.1	37.4	35.1	25,315
Aug	26.2	23.3	20.3	76%				21.9	25.1	27.4	0.00%	0.0	31.9	35.1	37.4	35.1	25,315
Sept	26.9	23.9	20.8	76%				21.9	25.1	27.4	0.00%	0.0	31.9	35.1	37.4	35.1	24,498
Oct	28.0	24.7	21.3	78%				19.6	23.9	27.3	0.00%	0.0	29.6	33.9	37.3	33.9	24,477
Nov	28.9	25.6	22.2	79%				19.6	22.9	26.1	0.00%	0.0	29.6	32.9	36.1	32.9	22,989
Dec	29.7	26.3	22.9	80%				18.6	21.9	26.1	0.00%	0.0	28.6	31.9	36.1	32.4	23,372
Annual	**28.3**	**25.2**	**22.0**	**80%**				**19.9**	**23.4**	**26.5**	**0.00%**	**0.0**	**29.9**	**33.4**	**36.5**	**33.5**	**284,732**

PAYBACK EXAMPLE

Cost

- Ex Works AC800 Active Cooler - $US120,000
- Installation Cost – Similar to a Traditional Remote Radiator System
- Only Additional Costs – Working Fluid and Connection of Power Out Cable

Calculation of Payback/IRR – Factors Taken Into Account

- Capital Cost for S & I of AC800 – LESS Capital Cost for S & I of Traditional Radiator
- Power Cost Savings – Traditional Radiator Power Requirement
- Power Cost Income – Excess Power Generated by AC800

Typical Payback 3 – 5 years depending on Location and Value of Power Generated

ELECTRATHERM AND THE FUTURE – PRODUCT DEVELOPMENT

Continued focus on Power Generation De-Carbonisation through Heat to Power Technology providing Renewable Energy Generation and Energy Efficiency Products to Power utilities and Industry

Our development pipeline includes;

- Larger capacity 250 kWe ORC
- Testing and introduction of next generation working fluids
- Lower temperature heat capability
- Development of Micro Grid Islanding Capability
- Maritime application registration
- System Packaging

MARKETS
HEAT SOURCES

Biomass

Engines

Industrial

Biogas &

WWTP

Geothermal

Oil & Gas

/ Flare

AFTERMARKET SUPPORT

// Technical Training Available

// Service Contracts Available

- // Remote monitoring option
- // 24 / 7 Support line

// service@electratherm.com

ATTRACTIVE TERMS

Financing terms available:

// Targeted payment schedule

Volume purchases:

// Multiple unit discounts

SUMMARY

ElectraTherm continues to support the **Pacific Island Power Authorities** with products to achieve savings in operating costs and improved power generation efficiency.

The **AC800 Active Cooler**, as an energy efficient engine cooling system, reduces power wastage through reduction/elimination of parasitic power loads and provides an opportunity from additional income through excess power generation – all from using the waste heat in the engine jacket water

The **Power+Generator** continues as the premier heat to power generation ORC for the utilization of low temperature heat from a wide variety of sources providing opportunities to generate base load renewable energy on a 24 hrs basis.

We are Here,
We have Solutions for Energy Efficiency,
We work with you to bring your Projects to success

Thank you!

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