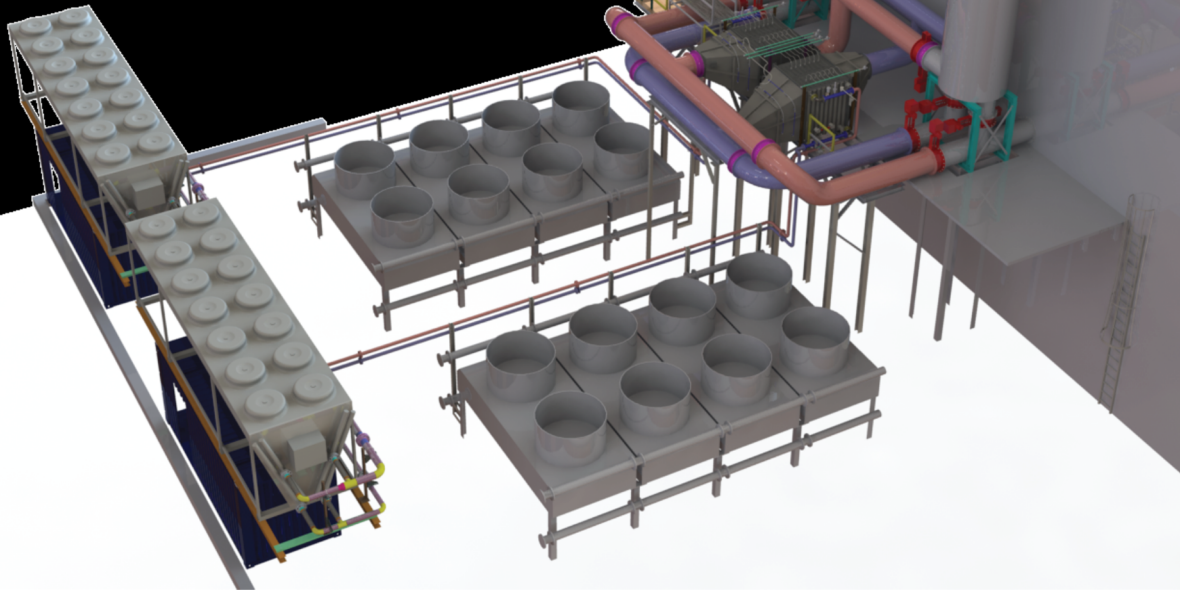




Powering the
Marshall Islands
with cleaner power
from heat



HEAT
RECOVERY SOLUTIONS



Containerized Clean Cycle II

Graphics:
units (left side of the
graphic) connected to
exhaust of the existing
reciprocating engines
(right side of the graphic).

KEY FEATURES

LOCATION

Majuro, Marshall Islands

SYSTEM SIZE

194 kW net electrical

EST. ANNUAL FUEL DISPLACEMENT

350,000 liters

EST. ANNUAL PRODUCTION

1,552,000 kWh

EST. 10YR CO₂ AVOIDANCE

10,000 tons of CO₂

FOOTPRINT

20 ft ISO containers

EST. CAPACITY FACTOR*

>95%

New heat to power site installed to be commissioned in November of 2019

Heat Recovery Solutions (HRS) has installed two Clean Cycle™ heat to power generators for the Marshall Electric Company (MEC) to offset engine fuel use under a 10 year agreement between the two companies.

The units will generate an estimated 194kW of net electrical power from the heat of existing engines that MEC operates on the island of Majuro. Over the 10 year agreement, the Clean Cycle units, which require no added fuel and produce no additional emissions, are expected to displace 3.5 million liters of fuel and 10,000 metric tons of CO₂. The Clean Cycle heat recovery project is an integral part of MEC's overall strategy to reduce dependency on fossil fuel, CO₂ emissions while cutting the overall cost of producing electricity to its customers.

The agreement between the two companies is structured so that MEC pays a portion of the savings they realize each month from the fuel the Clean Cycle units offset. The power produced by the Clean Cycle units allows the engine to run at a lower power output level, while the combined power production (Clean Cycle + engine) remains unchanged. Lower average engine output levels result in overall lower fuel consumption, which saves utilities on fuel bills, while reducing greenhouse gas emissions.





Picture - a view of the existing engine exhaust system in Majuro.

The Clean Cycle units offset fuel consumption while having a minimal impact on the way the existing engines and grid operate

System Design & Integration

The heat source for the Clean Cycle units is the exhaust from 2 x 6.4 MW engines operating on fuel oil.

Only one engine runs at a time, so our team designed a system of engine dampers and valves to ensure that the engine heat is utilized, regardless of which engine is running. Once the heat is captured using exhaust gas heat exchangers, a pressurized water system delivers the thermal energy to the Clean Cycle containers, which generate the electricity.



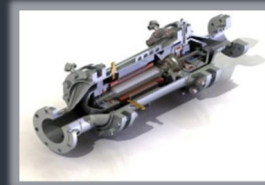
Clean Cycle II Skid

About the Clean Cycle technology

The Clean Cycle units generate electricity in a process called the Organic Rankine Cycle (ORC). In this process, the heat from the engines turns a liquid refrigerant in the Clean Cycle into a vapor, which passes through a turbine generator, causing it to spin and create electricity.

At the core of the Clean Cycle is the Integrated Power Module (IPM), which houses a turbine generator on magnetic bearings in an hermetically sealed unit. This technology requires, no oils, lubricants, overhauls, manned operation, or maintenance over a 15 year life.

The Clean Cycle generators are mounted in standard 20ft ISO shipping containers and have built-in power electronics and inverters to produce electricity at 480 volts, 60Hz and ready for grid interconnection. The power produced by the Clean Cycle units is base-load, further minimizing grid integration costs.



Integrated Power Module (IPM)

