

ORPC and microgrid inverters

*Panel Discussion: Wave Energy Powered Microgrids
EWTEC 2019, Napoli*



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September 3rd, 2019

Background on ORPC

- Founded in 2004, headquartered in Portland, Maine, USA
- 28 employees based in USA (Maine, Alaska, Washington), Canada (Quebec), and Ireland
- Develop and deploy
 - hydrokinetic power systems for use in rivers and tidal settings
 - renewable energy microgrid systems



RivGen® Power System

Remote community river sites



Power

- 50 kW rated (at 2.25 m/s)
- 80 kW rated (at 3.5 m/s)
- Operational up to 3.5 m/s

Logistics

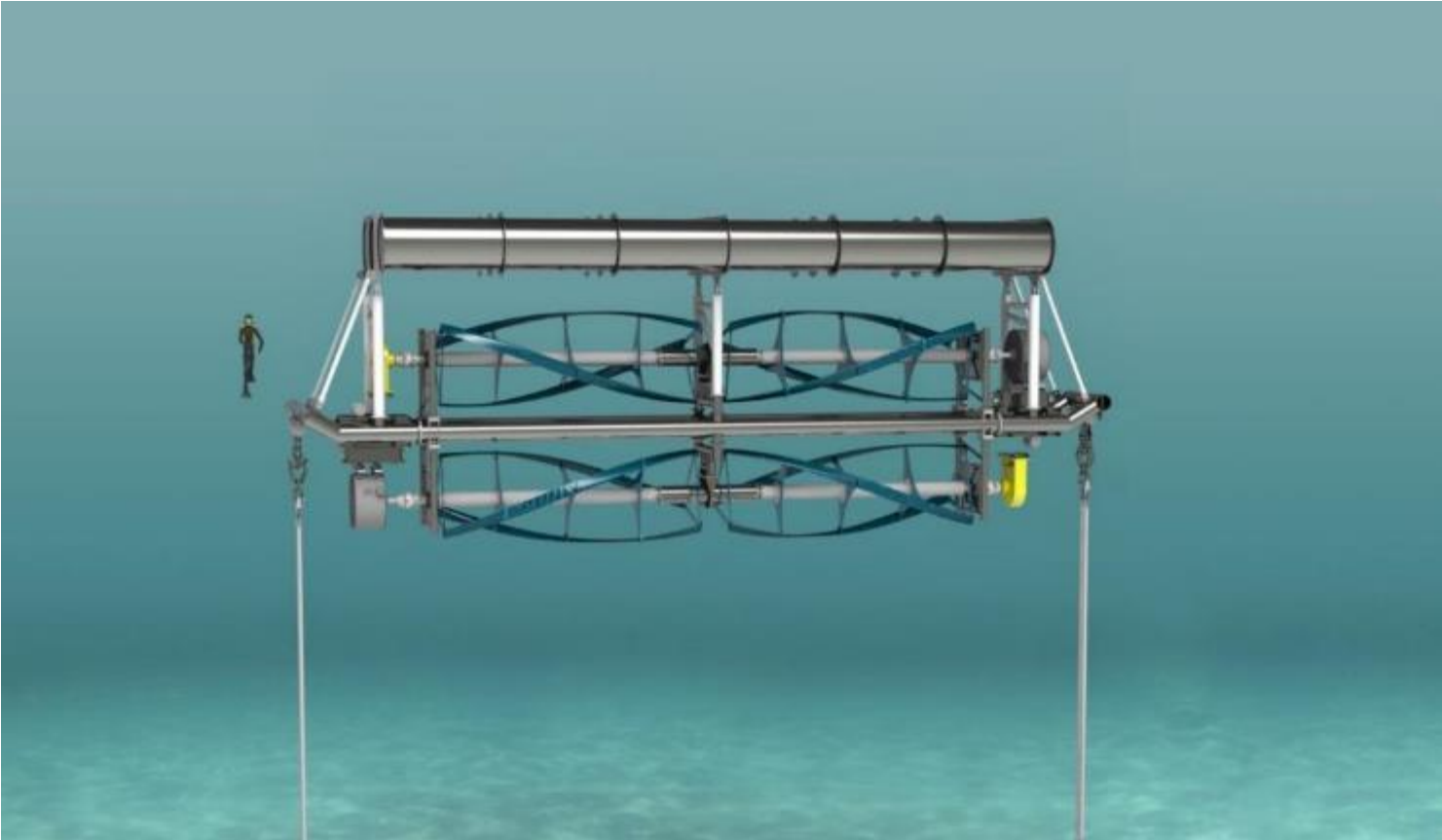
- Transportable in standard Shipping containers
- Modular onsite assembly
- Towable, self-deploying system

Physical

- 5 m to 10 m water depths
- 15.7 m(l) x 3.5 m(h) x 14.4 m(w)
- 29,500 kg (dry weight)

TidGen® Power System

Remote community tidal sites



Power

- 125 kW rated at 2.25 m/s
- 350 kW rated at 3.0 m/s
- Operational up to 3.5 m/s

Logistics

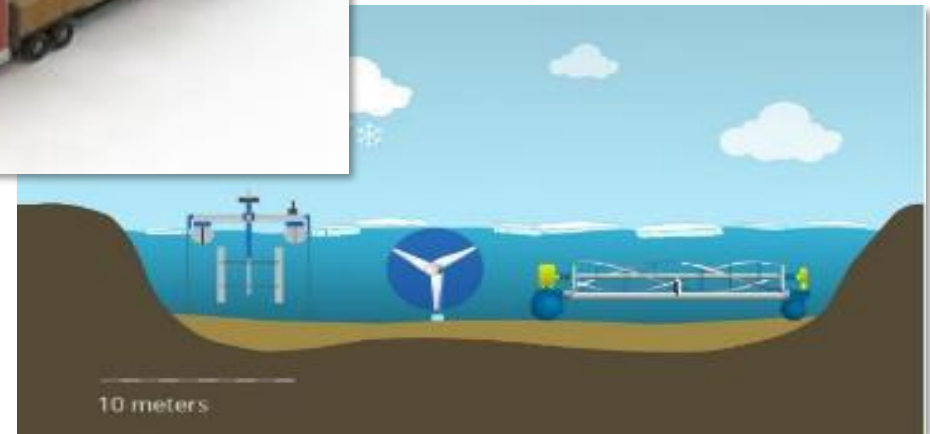
- Transportable in standard shipping containers
- Modular onsite assembly
- Deployment within one tidal cycle

Physical

- >15 m water depths
- 20 m(w) x 7.9 m(h) x 4.6 m(d)
- 57,000 kg (dry weight)

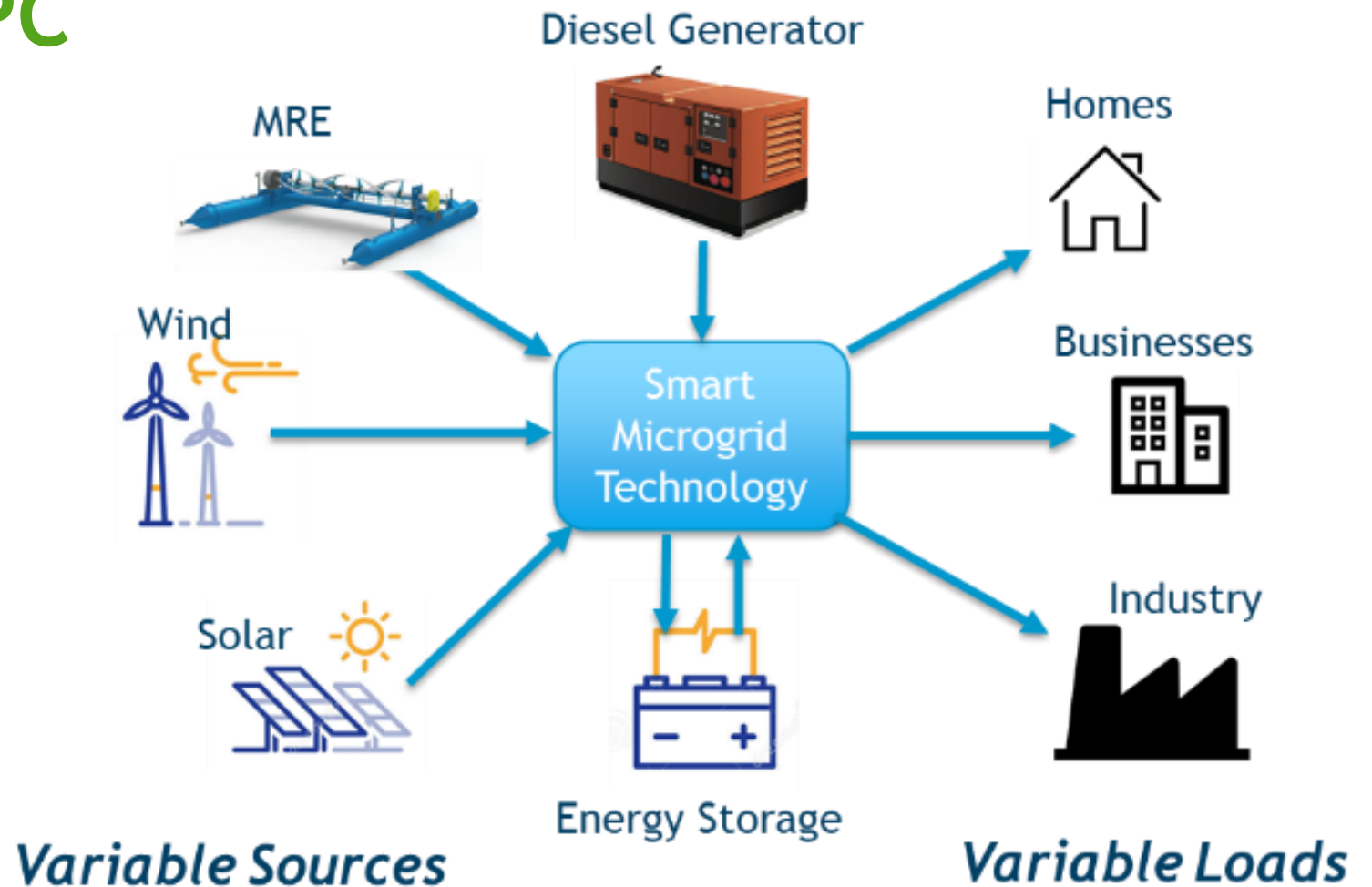
ORPC technology advantages

- Low CAPEX and OPEX costs.
- Reduce and stabilize cost of electricity for remote communities
- 20 year design life
- Lower vertical profile for shallower sites and positioned to catch optimal current and avoid debris
- Self-deploying pontoon support structure system
- Operates while completely submerged, not visible and no interference with navigation
- No known adverse impact on the marine environment



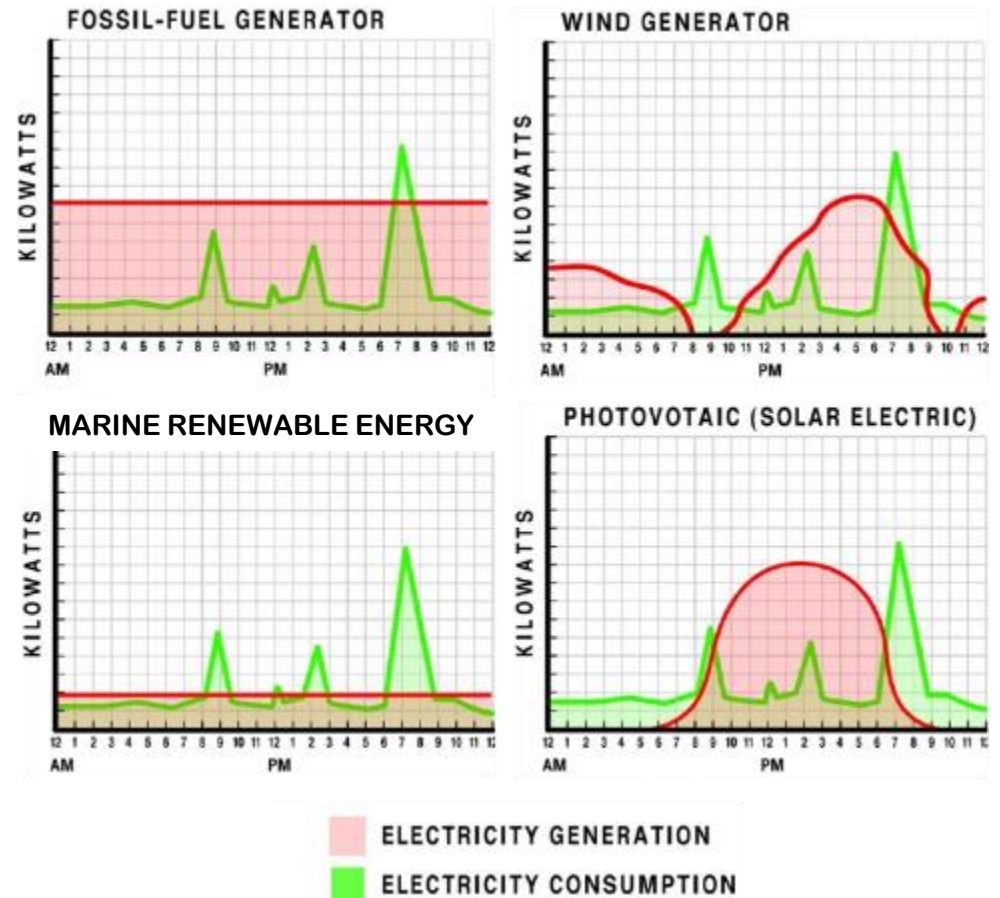
Microgrids and ORPC

- Integration platform for local generation, storage, and demand within local distribution grid
- Able to operate in 2 operation modes (grid-connected and islanded)
- Active operation of the distribution network
- Typically would be reliant on diesel generator to provide base load and grid reference voltage and frequency



Load & output microgrid challenges

- Because power generation from solar and wind is intermittent, diesel generators must often remain as backup to the grid.
- However, rivers can provide nearly constant and predictable sources of power generation, enabling diesel generators to be turned off completely.
- RivGen® is ideal grid-forming technology



Source: Arctic Energy Alliance and ORPC

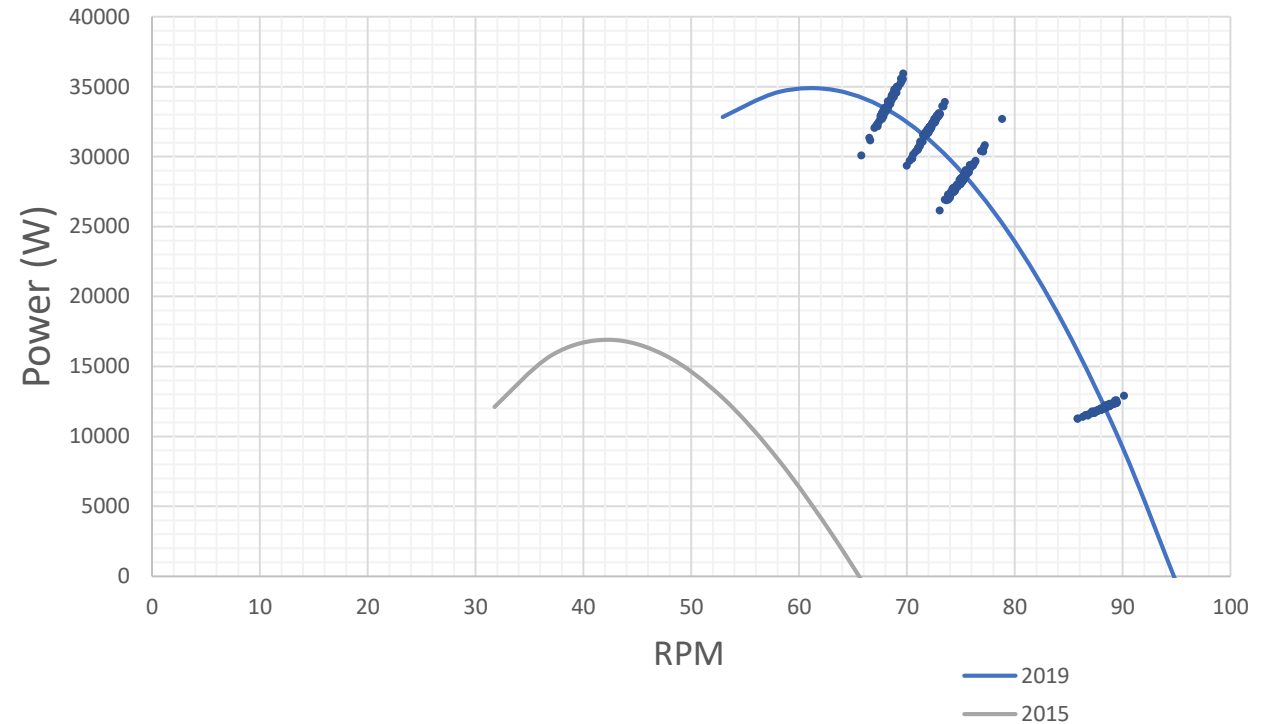
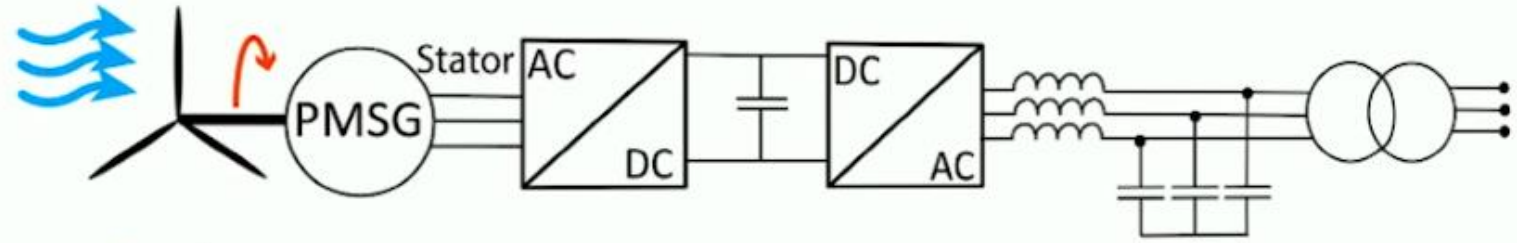
Igiugig Pilot Project - Stage 1

- First Commercial RivGen® project installed in Igiugig in 2019
- Grid tying solution to provide up to two thirds of village load
- Must reduce turbine power output to maintain diesel generator efficiency and minimize diesel consumption
- Highlights need to implement grid forming inverter

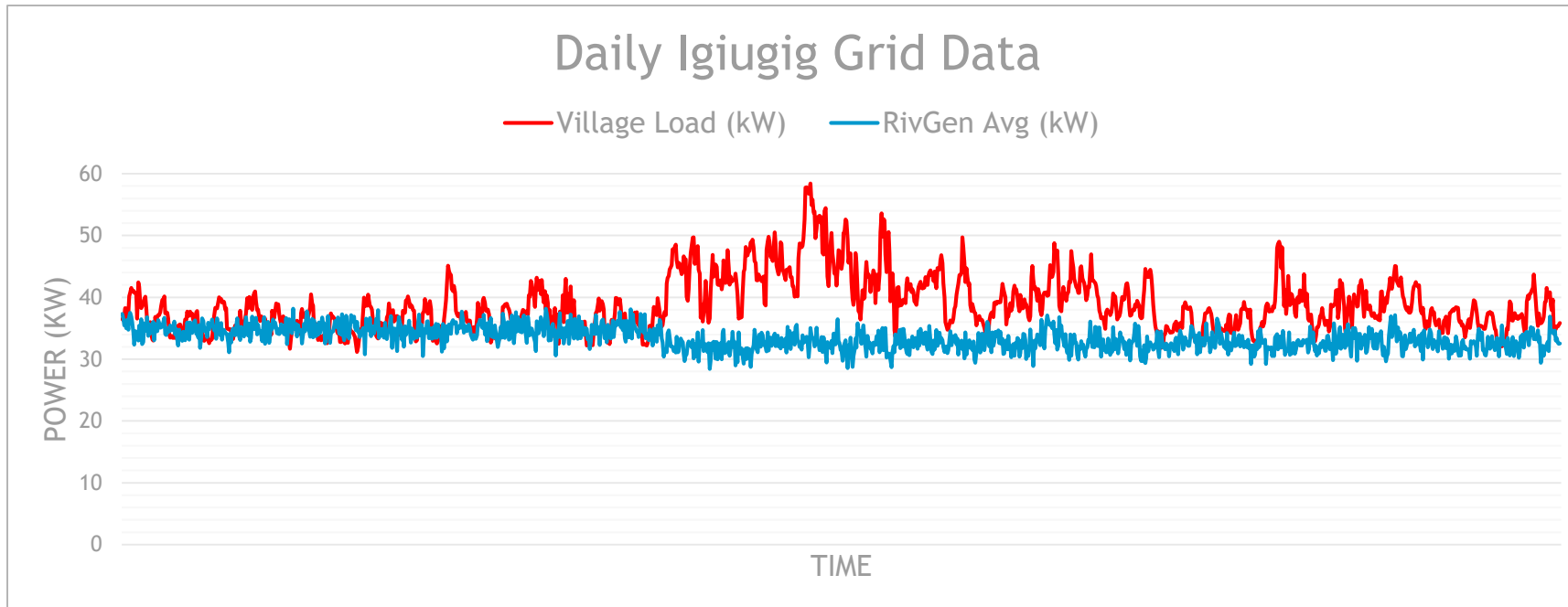


Implementing ORPC in Microgrid network

- ORPC currently uses back to back AC converters to connect to AC grid
- Using COTS VFD and solar inverters
- Variable voltage output from generator based on speed leads to large voltage range requirements of electronics
- Voltage requirements narrow operating range



ORPC RivGen® = predictable and stable



- One RivGen® system operating at 35kW, working with 81% availability will displace **25,000 gallons** of diesel per year
- Single RivGen® device capable of providing full Igiugig vilage load at times, but cannot without grid forming inverter

ORPC ongoing Inverter Development and Testing

- ORPC working with UCC in testing multiple inverter technologies and architectures as part of TAOIDE Horizon 2020 project
- Full scale generator will be dynamometer tested into lab based microgrid with both grid forming and grid tying
 - Switched capacitance inverters, possibly higher efficiencies and more robust
 - IGBT based regenerative COTS VFDs, industrialized system modified to handle larger input voltage range

Igiugig Pilot Project - Stage 2

- Second RivGen to be installed in 2020
- Implementation of grid-forming inverter
- Implementation of Energy Storage
- MHK base load for village of Igiugig

