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ASSESSING THE IMPACTS OF WAVE ENERGY INTEGRATION IN A REMOTE CANADIAN COMMUNITY EQUIPPED WITH A DISTRICT HEATING GRID

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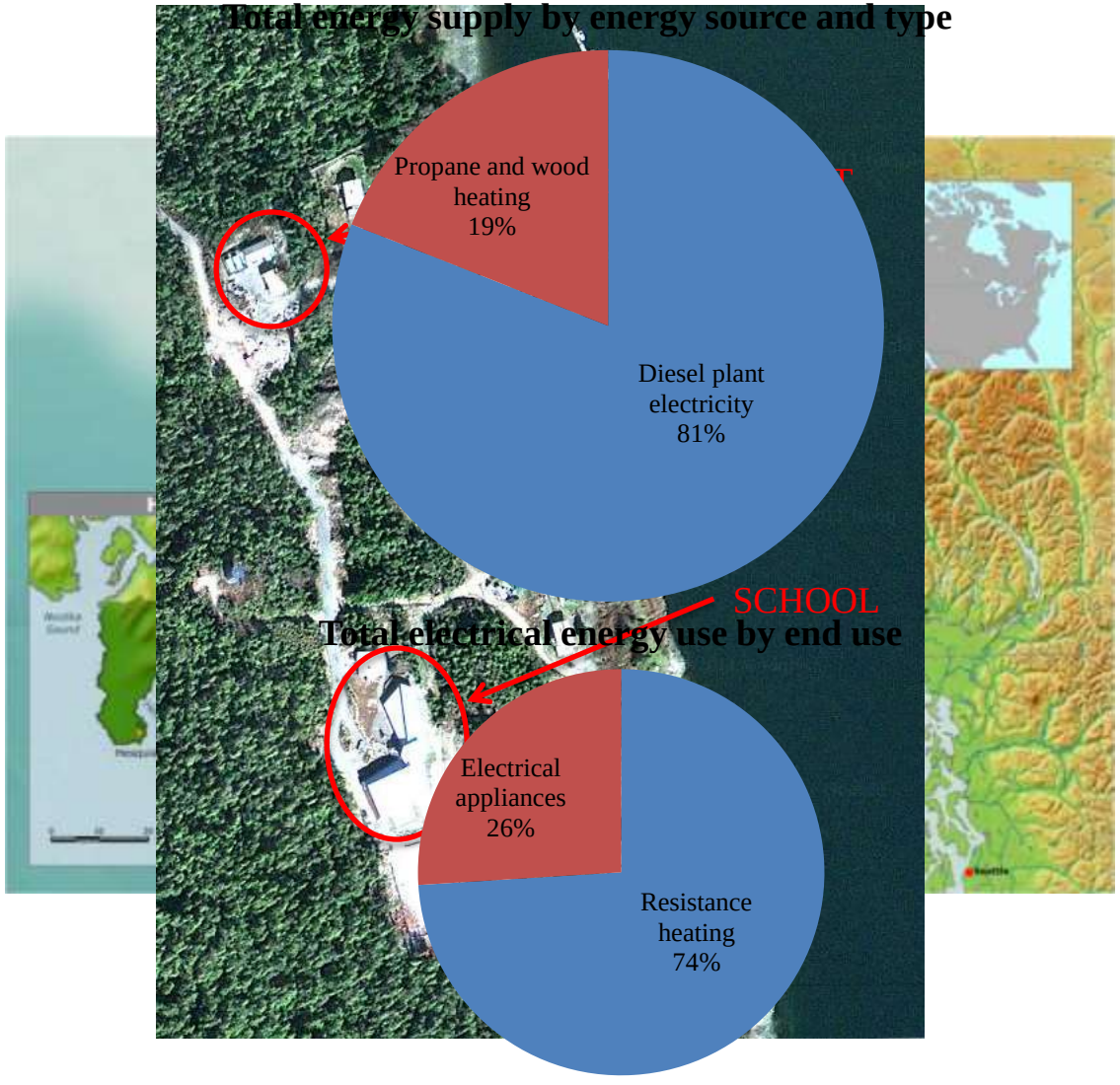
4DH
4th Generation District Heating Technologies and Systems

Case Study Community: Hesquiaht First Nation

Community status (2011):

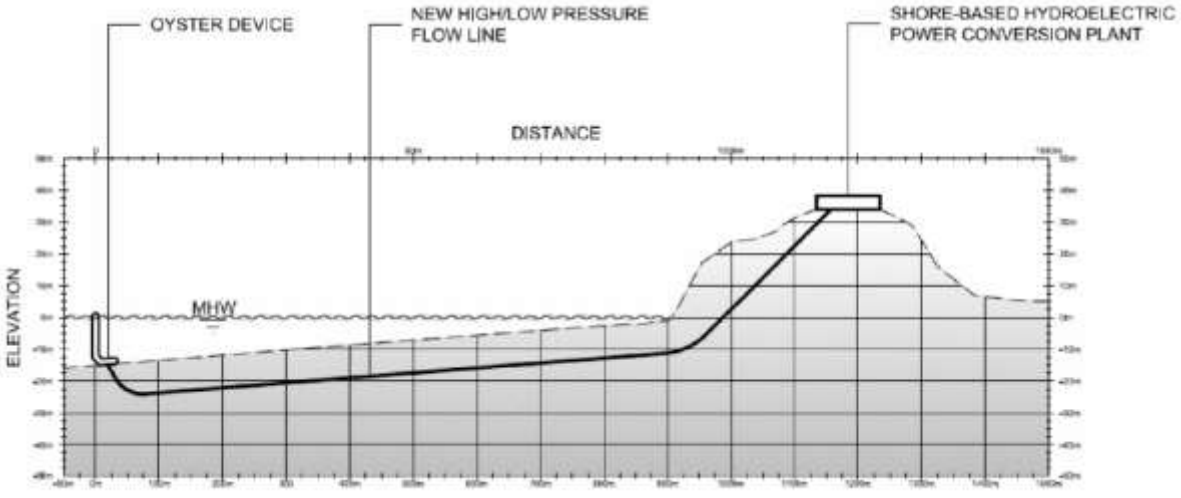
- Located in Refuge Cove (Hot Springs Cove)
- Population: ~ 85 - 135
- Dwellings: ~ 43 residential and 7 non-residential
- Hesquiaht currently does NOT have a district heating grid
- Energy supply: Diesel electricity primarily used for heating and electrical appliances. Residential dwellings burn wood and propane for additional heating

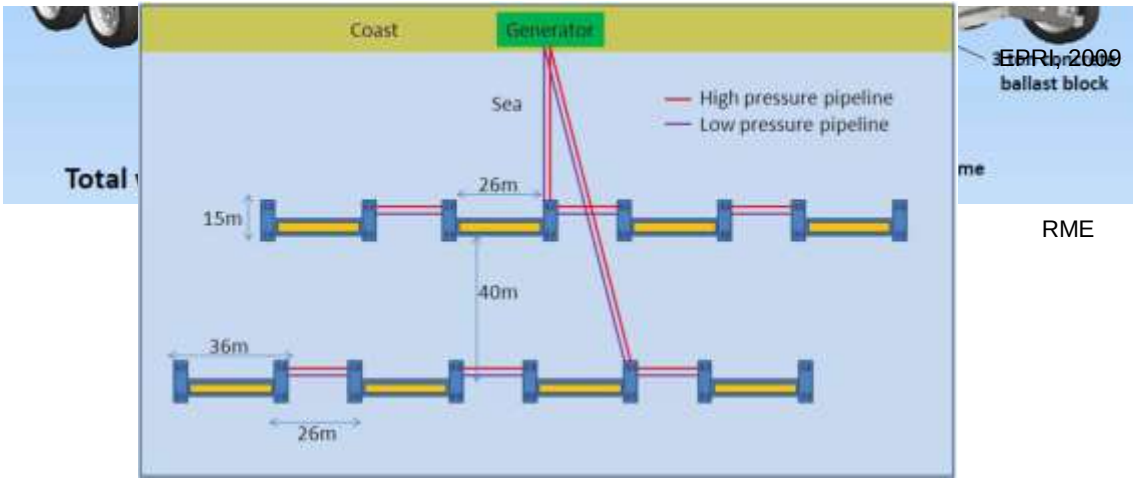


Wave Power: Resource And Generation

Wave Energy Converter (WEC) model

- Moderate to high Energy (RME) device
- Nameplate rating = 35 kW
- Located near shore ~ 100 m
- Device has been ocean tested and achieved conversion efficiencies of ~ 30%
- Multiple devices can be arranged in arrays to produce more power



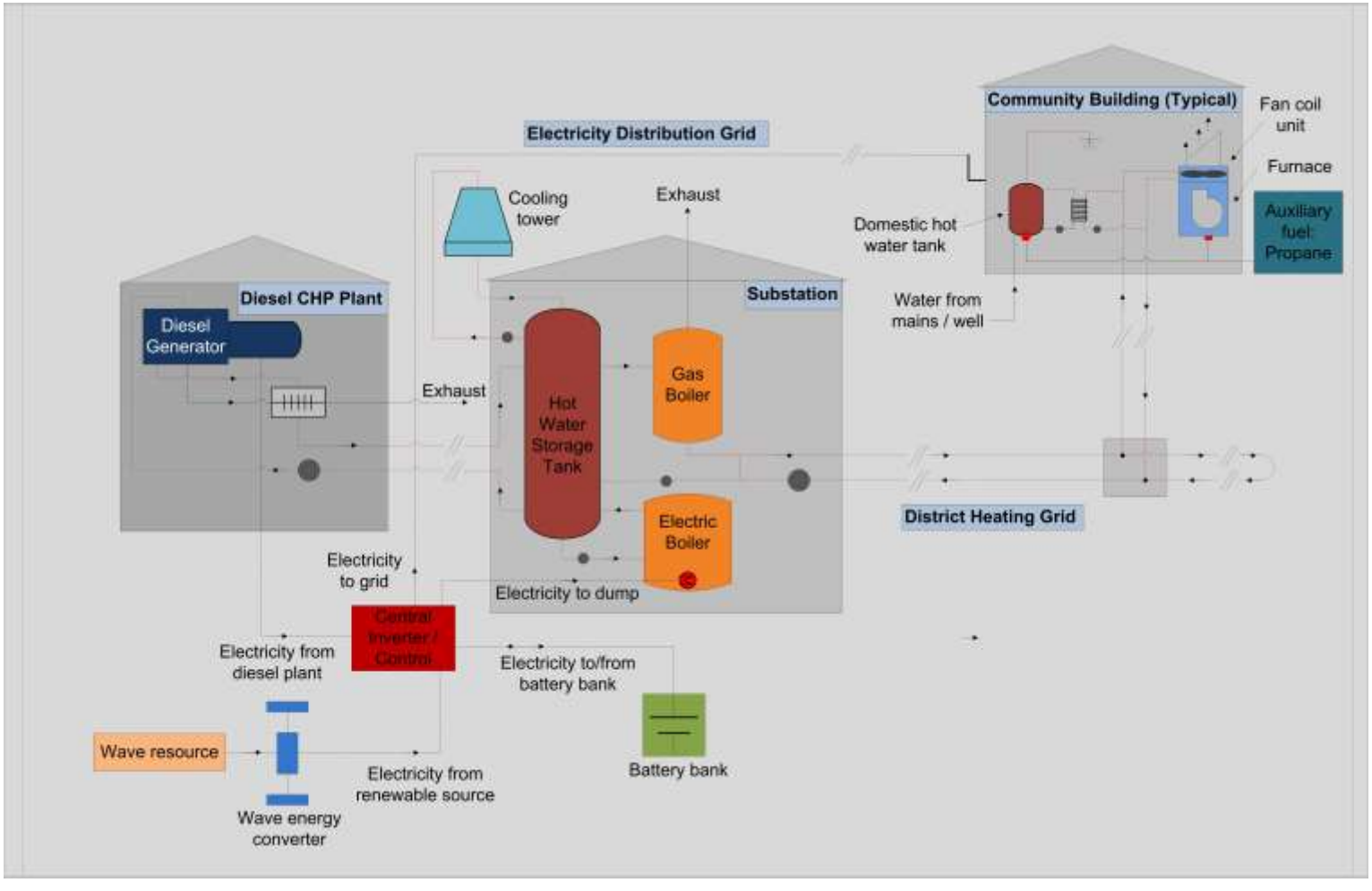


RME

Hesquiaht Community Energy Model

3 Scenarios Simulated

Scenario 3 – Alternative energy system & wave energy & district heating grid



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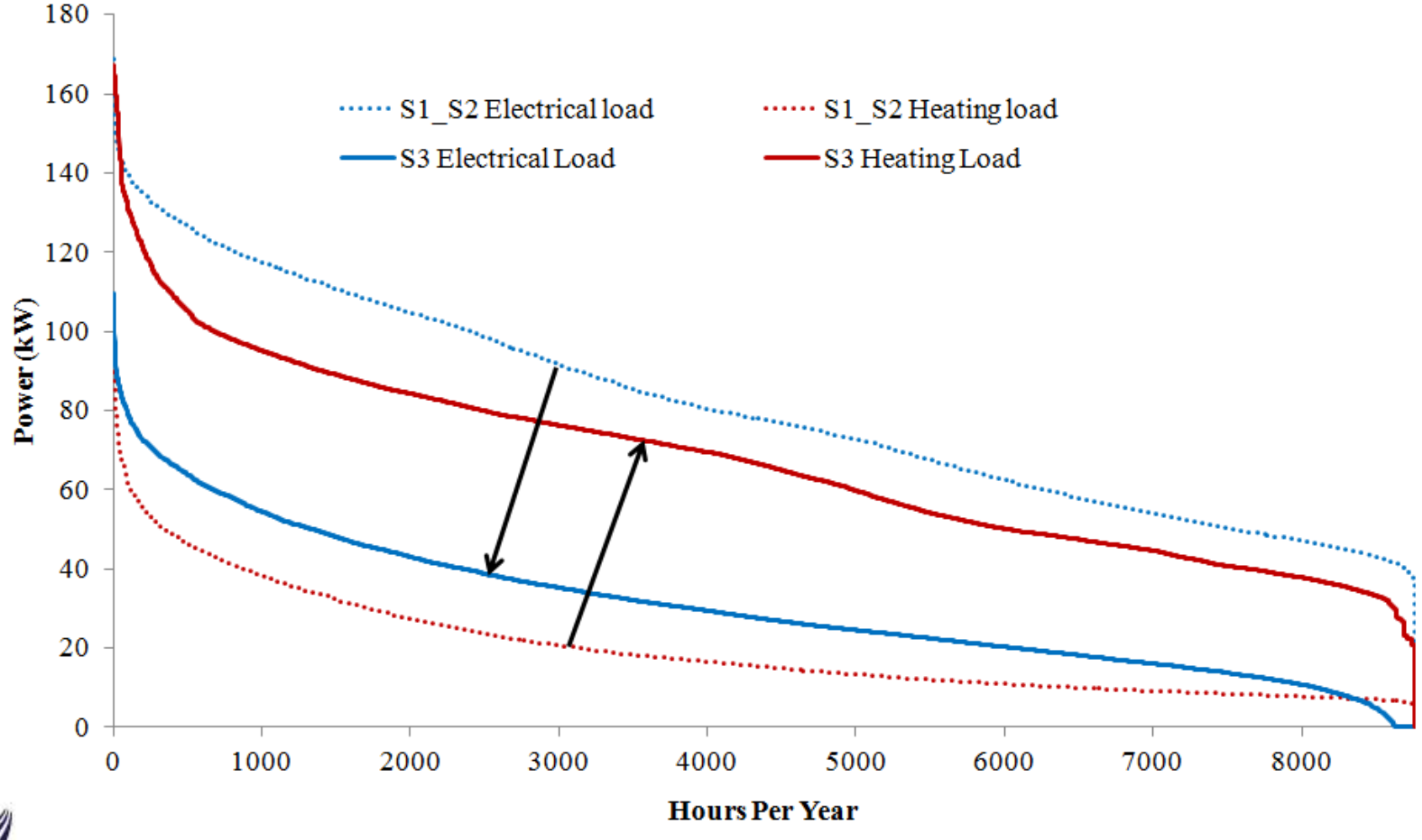
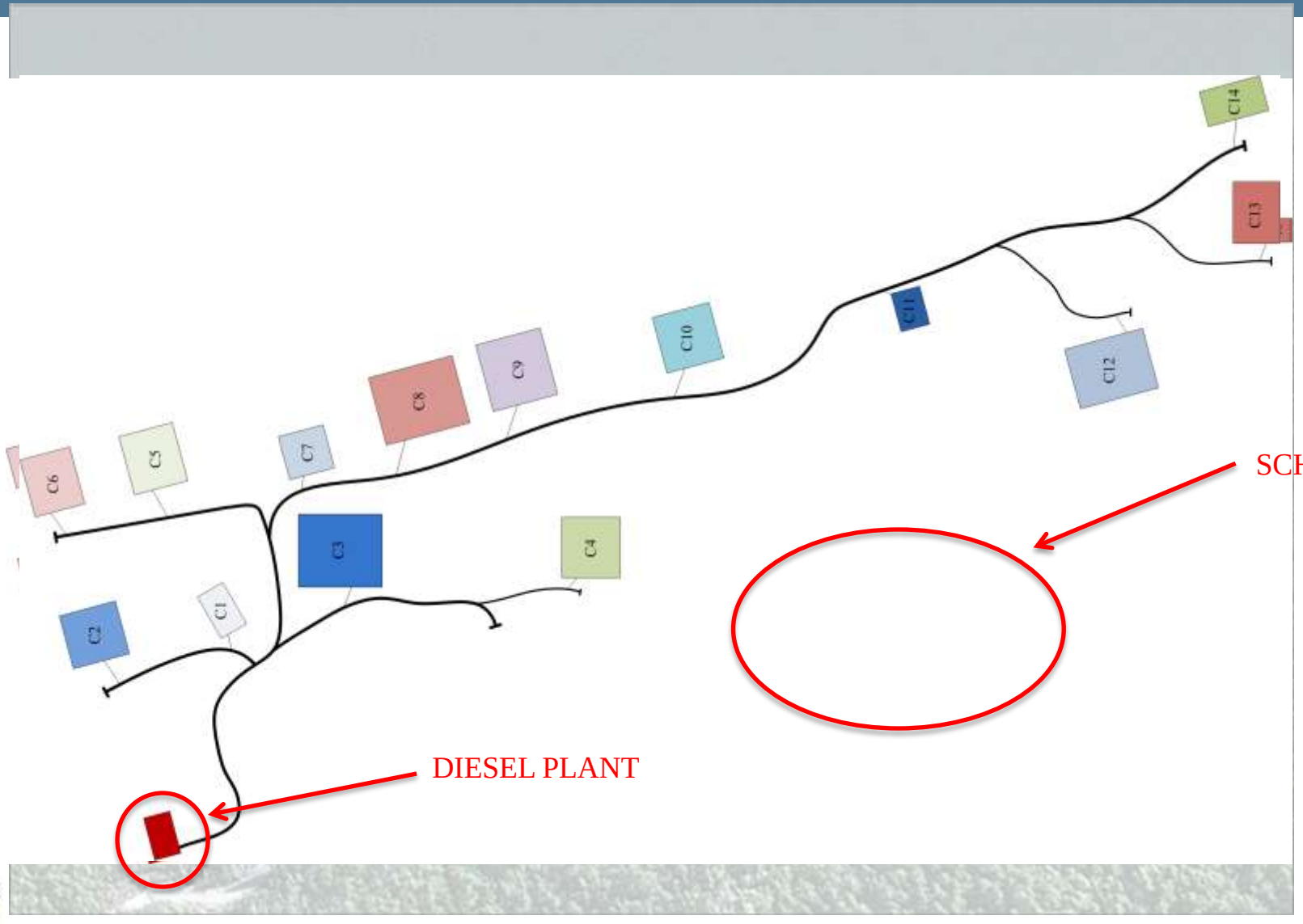
Hesquiaht Community Energy Model

3 Scenarios Simulated: S1 - Current , S2 – Current + Wave, S3 – Altered + Wave + District Heating



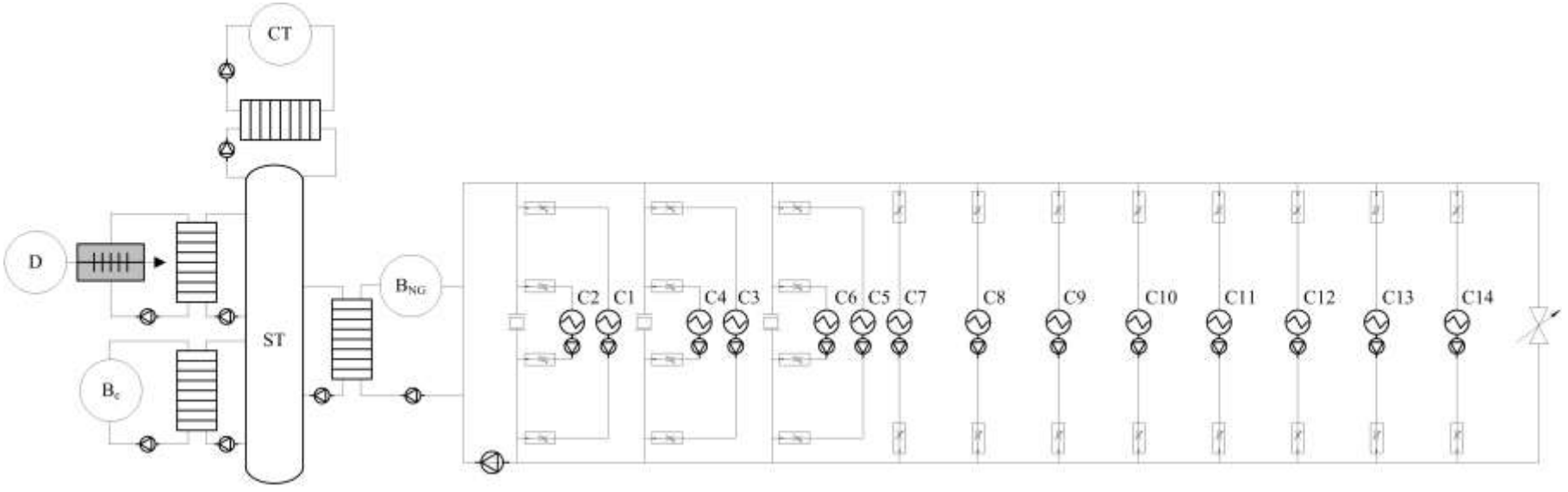
Hesquiaht District Heating Grid

Sizing and Design



Hesquiaht District Heating Grid

Hydraulic Schematic



Legend

D	Diesel generator		Heat exchanger
B_e	Electric boiler		Heat exchanger
B_{NG}	Natural gas boiler		Variable speed pump
			Ball valve
CT	Cooling tower		Differential pressure control valve
			Modulating control valve
ST	Hot water storage tank		Consumer heat exchanger

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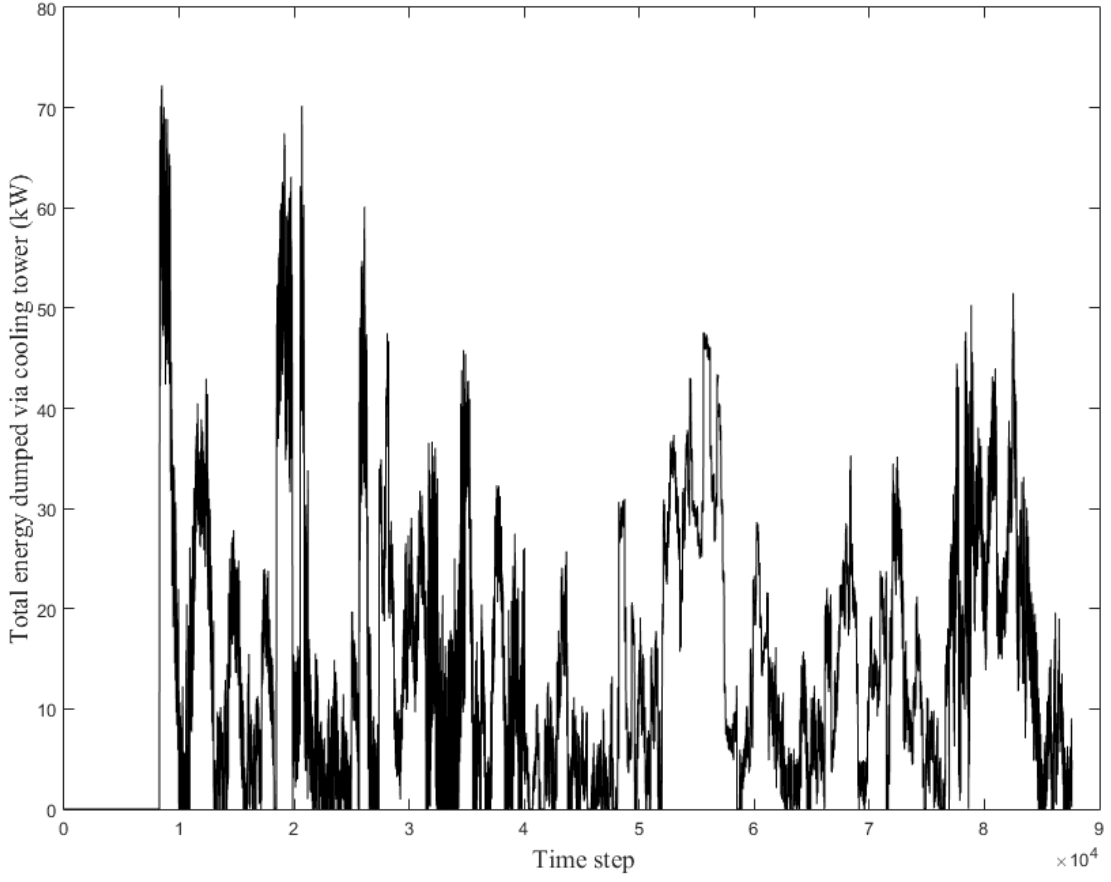
Hesquiaht Community Energy Model

Simulation inputs, operational constraints, and methods

Diesel Combined Heat and Power Plant	
Diesel generator efficiency	40 %
Heat recovered	30 % primary energy
Fuel conversion factor (diesel)	0.25 $kgCO_2$/kWh
Wave Energy Converter Plant	
Rated capacity	50 kW
Efficiency	25 %
Hot Water Storage Tank	
Size	100 m^3
Maximum temperature	95°C
Average heat loss	0.4 % /hour
Initial state of charge	50 %
Central Boiler	
Thermal efficiency	90 %
Fuel conversion factor (natural gas)	0.19 $kgCO_2$/kWh
Independent Building Heating System	
Thermal efficiency	80 %
Fuel conversion factor (propane)	0.214 $kgCO_2$/kWh
District Heating Grid	
Supply temperature	90°C (winter), 65°C (summer)
ΔT at consumer load points	30°C
Pumping efficiency	85 %
Hydraulic pipe model	Steady State - Darcy Weisbach
Thermal pipe model	Steady State – Variable Transport Delay
Simulation Tool	
Simulink®	ODE1 – Euler method
Time step	30 s

Hesquiaht Community Energy Model

Scenario 3 simulation outputs for January – Array of 7 WECs



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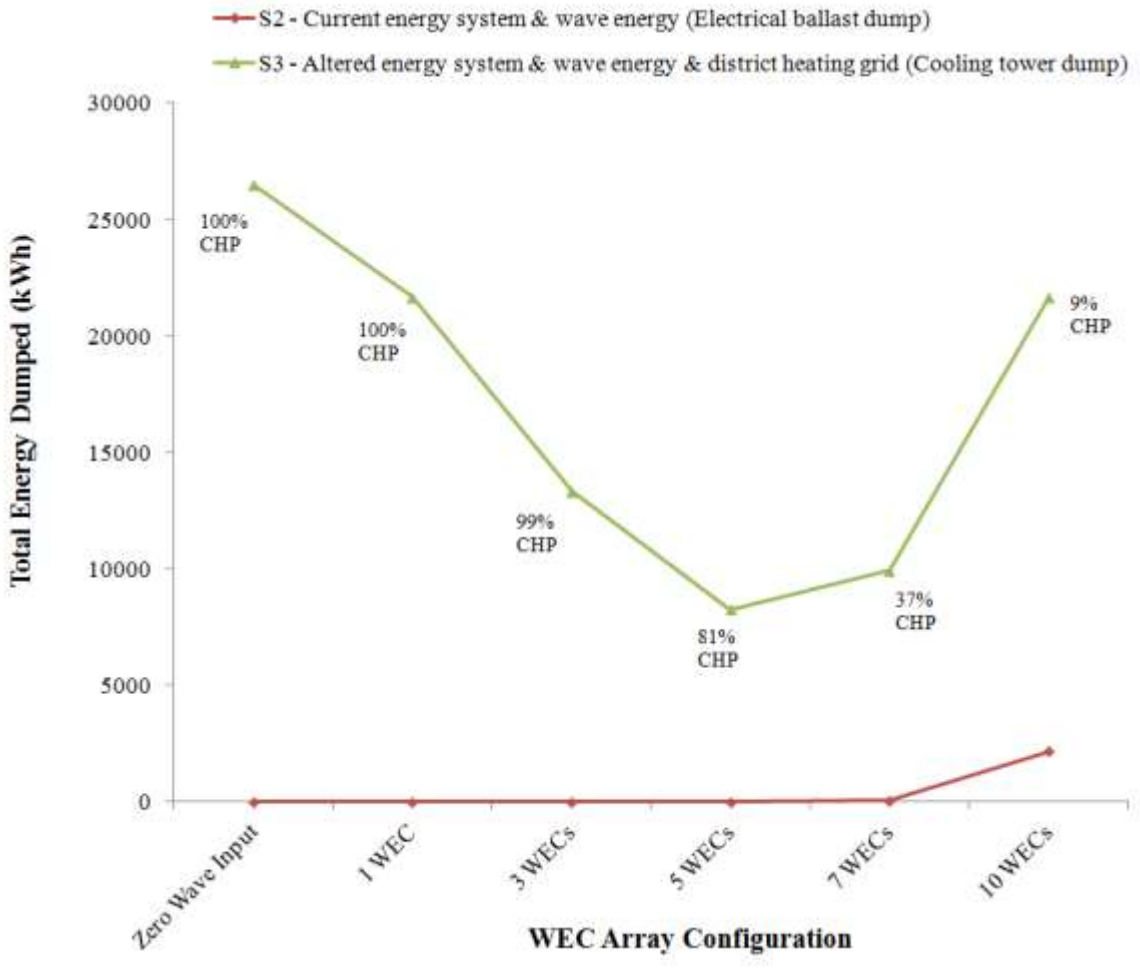
Preliminary Results – January



THANK YOU!

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