Integrating OTEC into Isolated Grids: Issues and Opportunities

Laurence J. Shapiro, PE
Burns and Roe Enterprises, Inc.
Power Block Manager – OTEC International, LLC
APCES – September 2013
Small Grid Issues

• Forced outages and/or system faults cause greater frequency & voltage fluctuations.
• Island-specific generation mix (baseload, cycling, peaking, wind, PV, etc.)
• Impact of loss of largest generators relative to system load
• Penetration of as-available renewable generation relative to system load
• Limited disturbance response capability: Quick Load Pickup (QLPU)/Quick Load Rejection (QLR); Under Frequency Load Shedding (UFLS), Ride-through capability.
• Limited fuel diversity and dependence on imports
Large Disturbance Comparison
HECO’s Island System vs. Interconnected Grid

Examples of large frequency deviations caused by loss of generation on a relatively "stiff grid." Not only are the system frequency deviations minimal, but the duration of the transient is less than one second.
California “Duck Curve”
**OTEC Characteristics**

- Base Load Solar Energy (constant vs intermittent wind or solar pv)
- Eliminates need for backup generation when solar pv/wind are unavailable
- Dispatchable (controllable)
- Strong Ramp Rate - Quick Load Rejection and Pickup (inertia and droop)
- High Capacity Factor
- Black Start Capability
OTECE Offers Small Grid Opportunities

• High avoided cost → lower cost generating plants.

• Susceptibility to large frequency and voltage swings → ancillary services

• Large daily load swings → Energy storage/spinning reserve

• Limitless indigenous energy → breaking foreign fossil fuel dependence
Load Smoothing Peak Shaving
SCE—Catalina Island
Storage as System Stabilizer

448 MW Case

- **Generation Output**
- **Battery Output**
- **D Generators Output**

Output (MW)

- 0
- 50
- 100
- 150
- 200
- 250

Time (min)

- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 3
- 3.5
- 4
- 4.5
- 5
- 5.5
- 6
- 6.5
- 7
- 7.5
- 8
- 8.5
- 9
- 9.5
- 10

Burns and Roe
Success Through Solutions