

Increasing Renewable Energy Generation on an Isolated Island Grid

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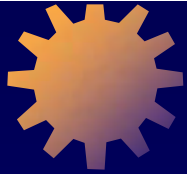
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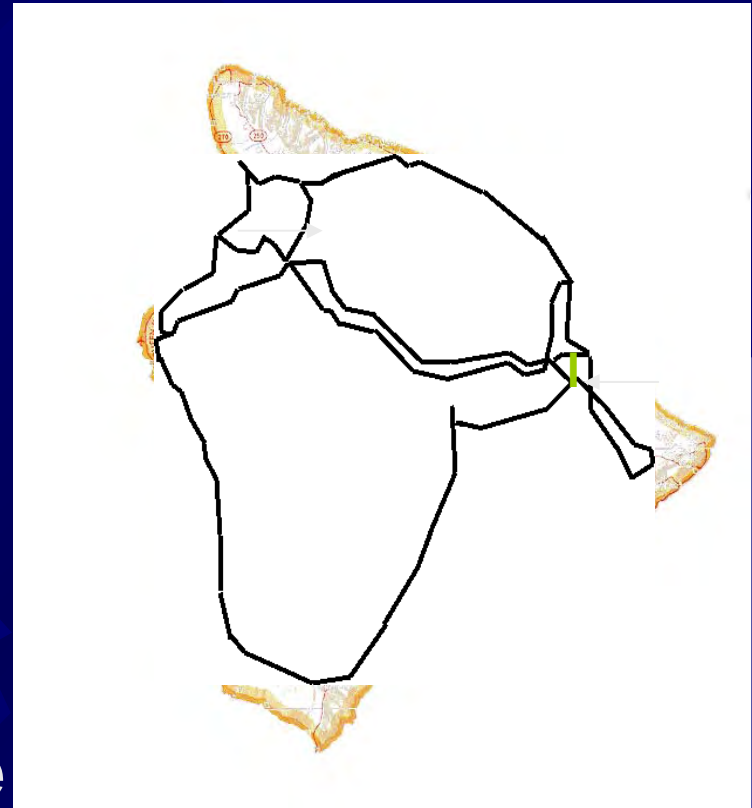
Hawaii Island's Energy Frontier

- ✦ Isolated geography
- ✦ Challenging physical environment
- ✦ High growth rates in energy demand
- ✦ Low population density
- ✦ High potential for diverse, renewable energy development



HELCO Transmission System

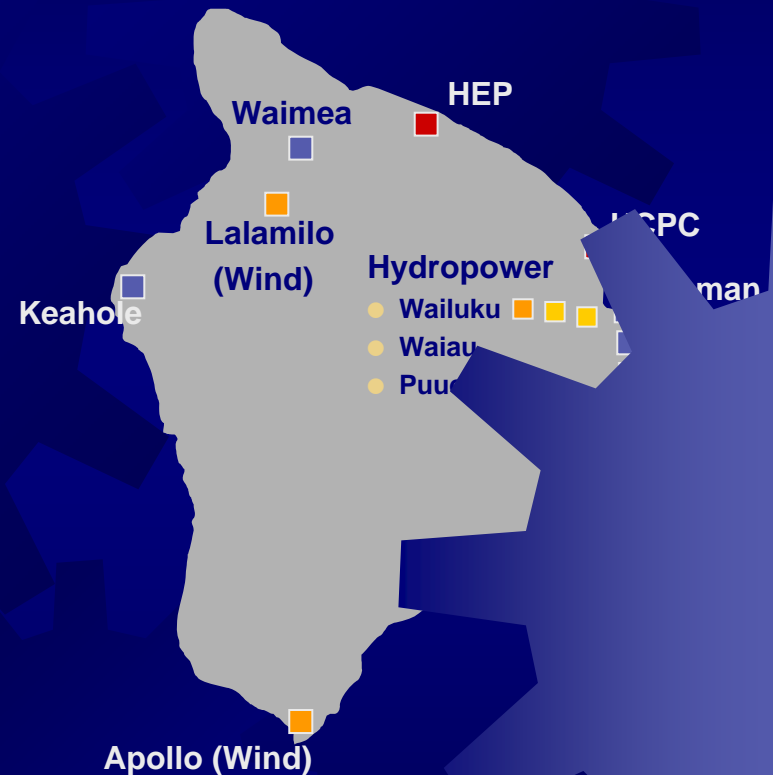
- ✱ Isolated transmission grid
- ✱ 4 major cross-island ties
- ✱ Limited capacity in some areas





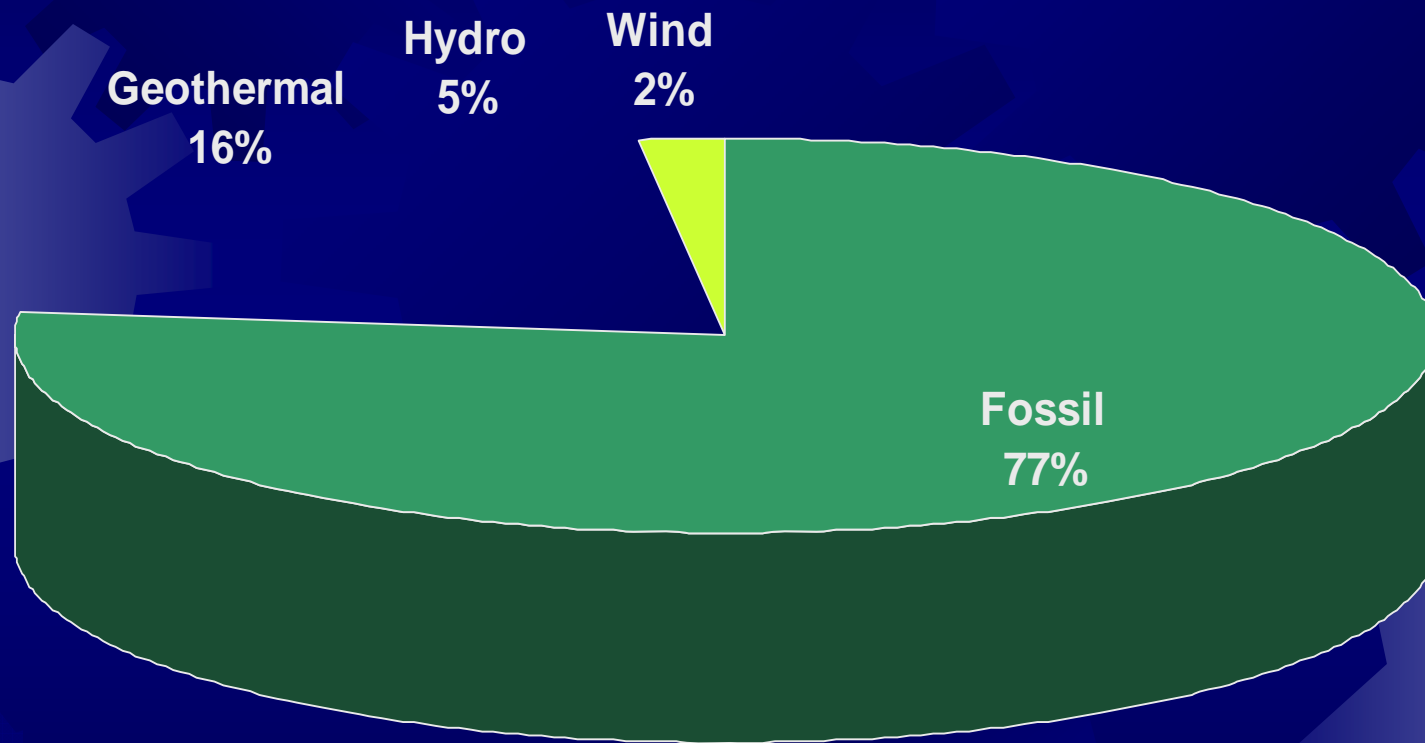
HELCO Power Supply System

- ☀ Diverse generating sources
- ☀ Geographical mismatch of sources and customer loads
- ☀ Mix of HELCO-owned and IPP facilities
- ☀ Aging equipment





HELCO Renewable and Fossil Fuel Generation Mix



Hawaii Renewable Portfolio standard: 10% by 2010
20% by 2020



Customer Density

Lower customer density Higher costs of service

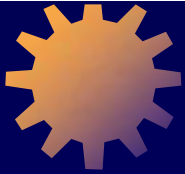
Comparative size of the islands and customer density

Oahu 597 sq. mi., 474 p.

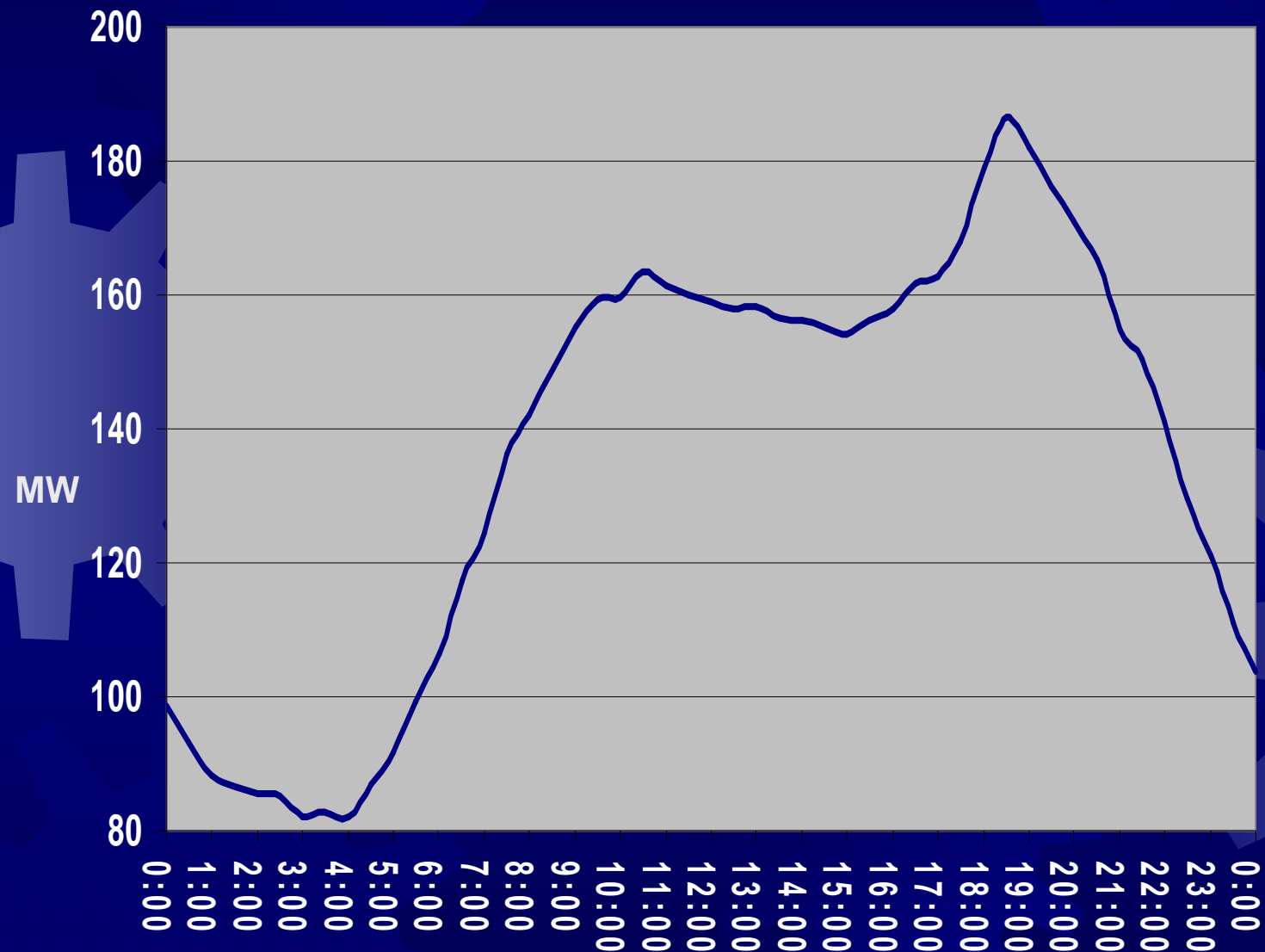
Maui 1,128 sq. mi., 53

Big Island 4,028 sq. mi.,
17 per sq. mi.





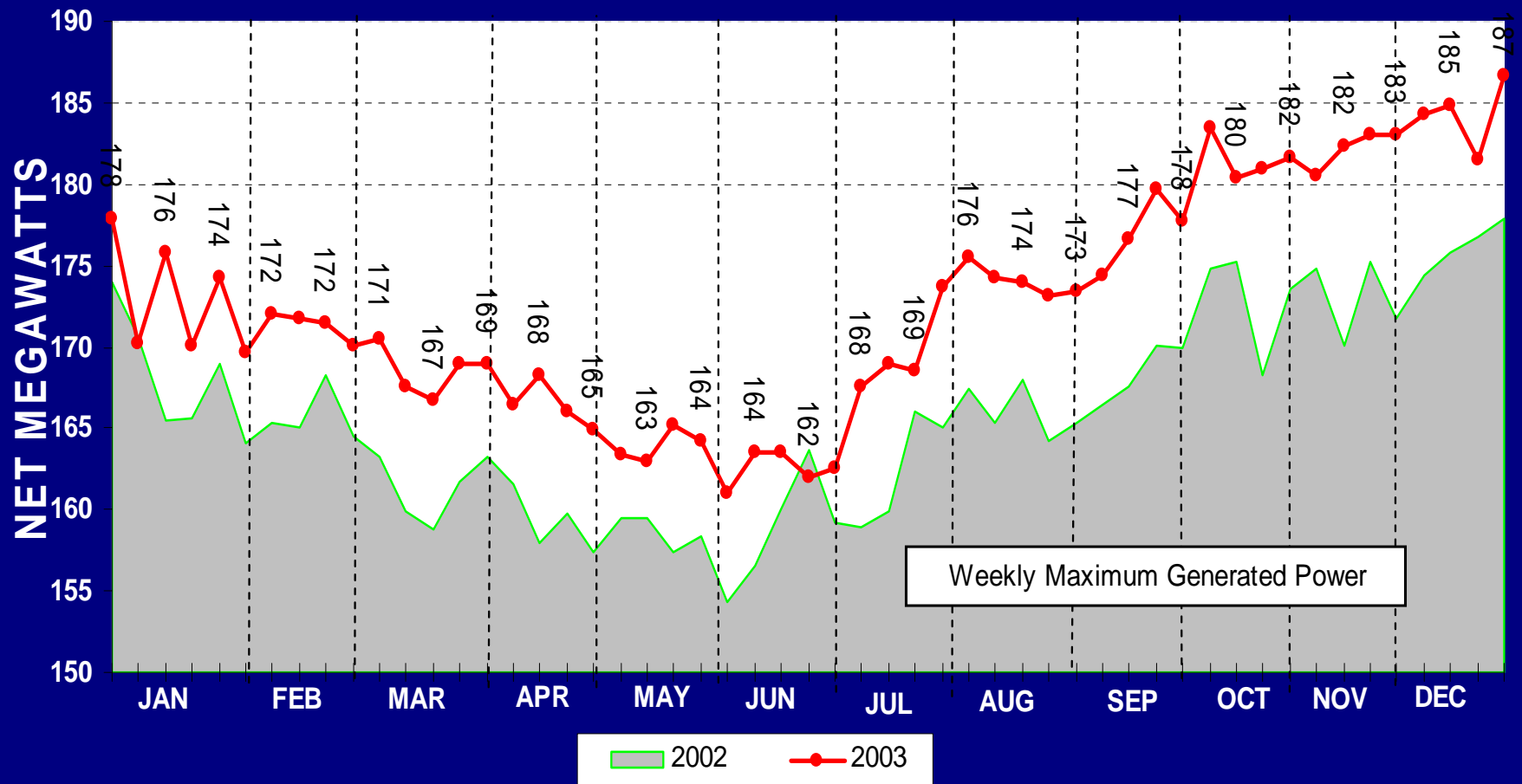
Daily Load Profile



December 30, 2003

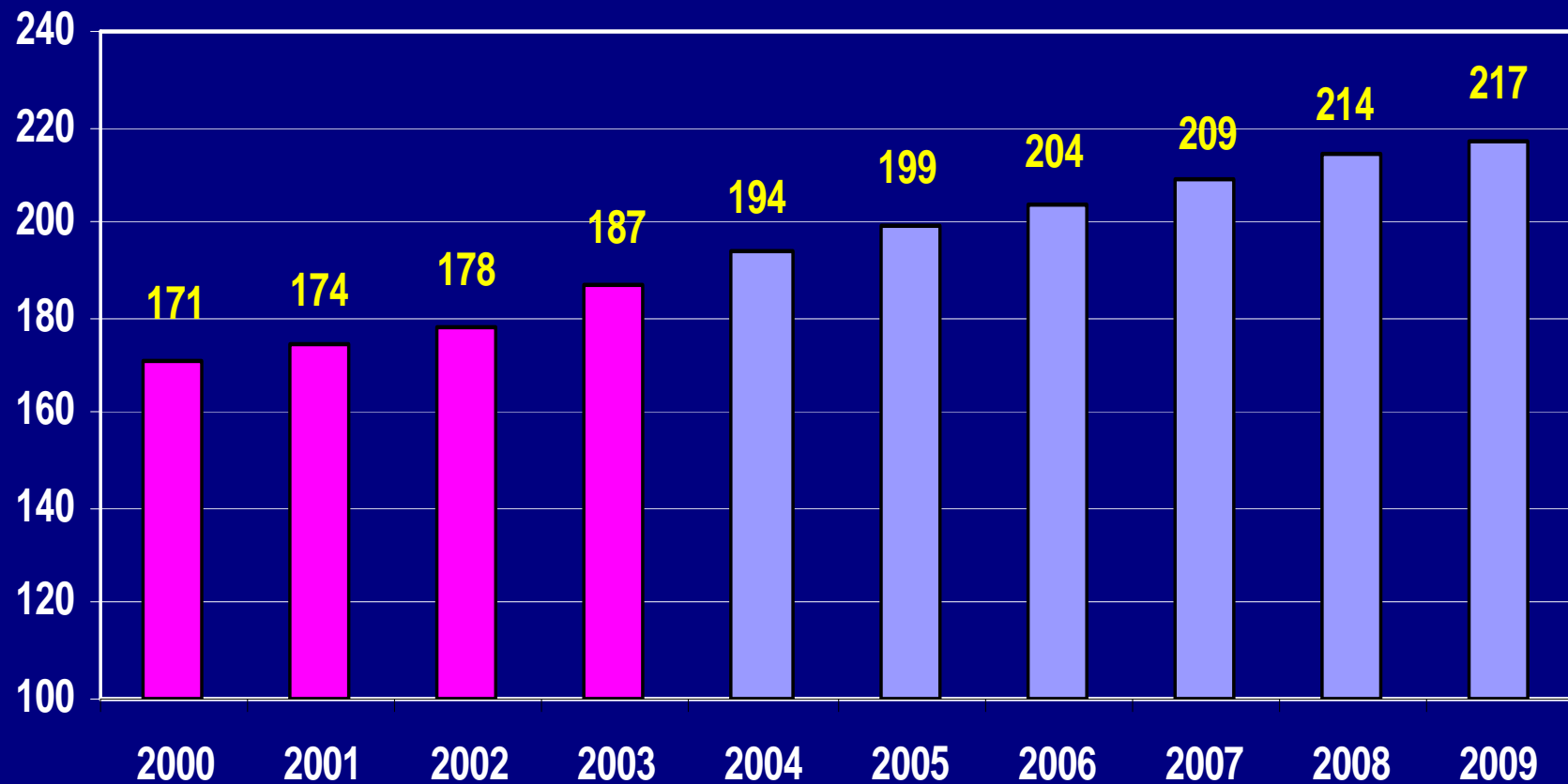


Daily Peak Load – Annual Profile





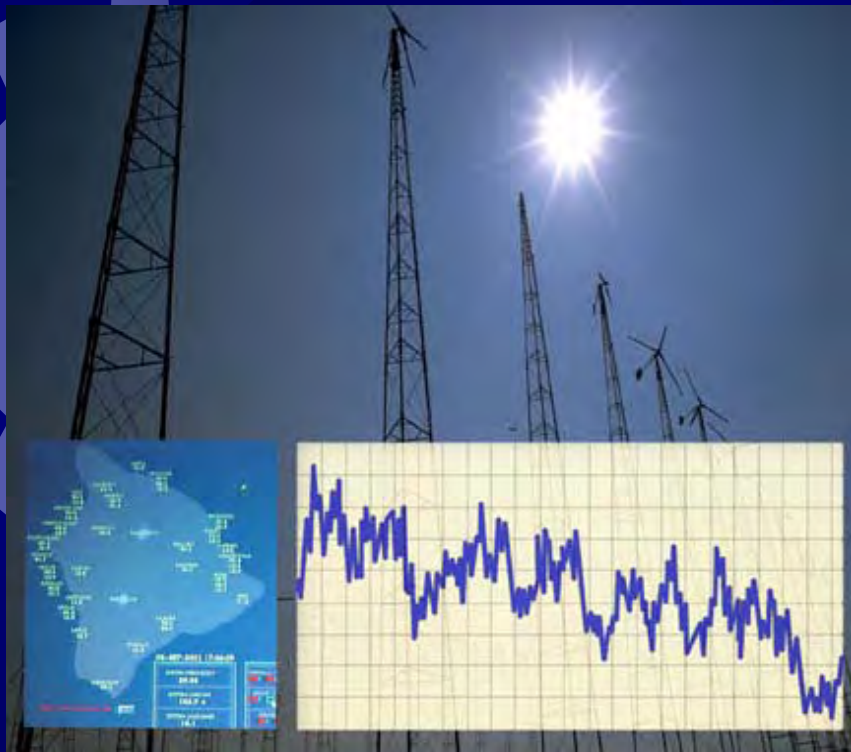
Annual Peak Load





Expanding the Use of Renewable Energy

HELCO's Challenges



- ✱ Wind section
- ✱ Wind, solar, and hydro require firm back-up
- ✱ Volatile power output disrupts power quality
- ✱ Geothermal resources difficult to manage



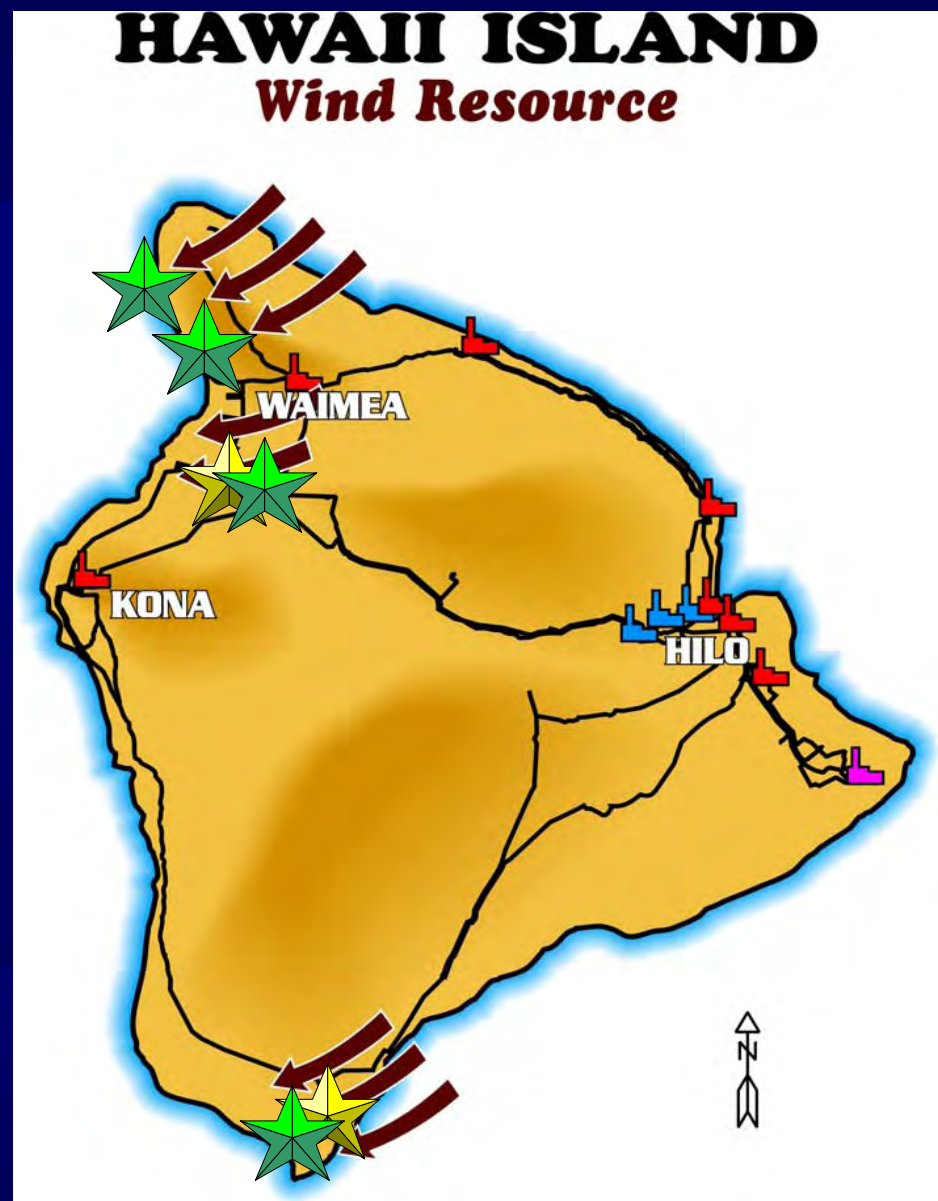
Today's Wind

- Lalamilo 2.3 MW
- Kamaoa 7.0 MW



Future Wind

- Hawi 10 MW
- Lalamilo 3 - 30 MW
- Kamaoa 20 MW





HELCO Lalamilo Windfarm





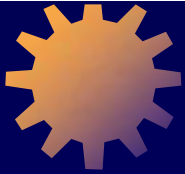
Kamaoa Windfarm





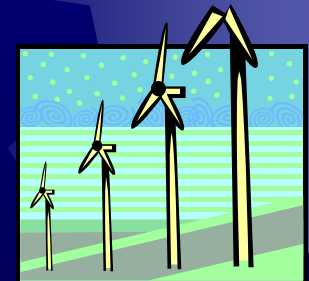
Wind Energy Issues

- ✱ As-available resource; needs back up
- ✱ Regulating unit to maintain system stability
- ✱ Ride through for frequency excursions
- ✱ Excess wind energy leads to curtailments
- ✱ Energy storage could firm resource but is costly
- ✱ WTG's are tallest structure on the view plane



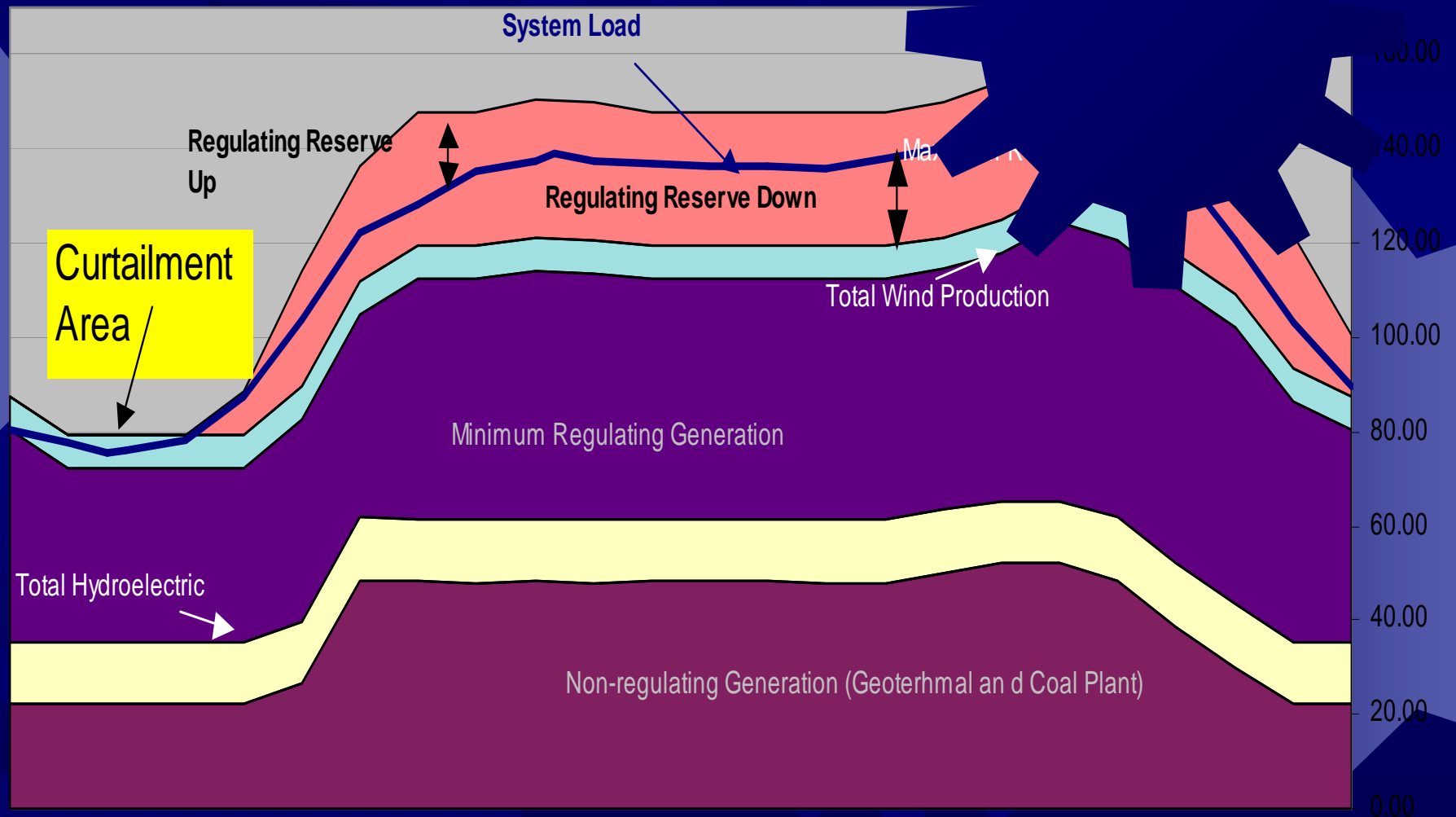
Increased Wind Energy on HELCO System

- ★ HELCO Goal → Add wind energy to the HELCO power grid, and preserve Power Quality and Reliability
- ★ Potential system impacts
 - Increased capacity of as-available power
 - Increased duty on regulating units
 - Need additional operating reserve
 - Further curtailment of wind generation



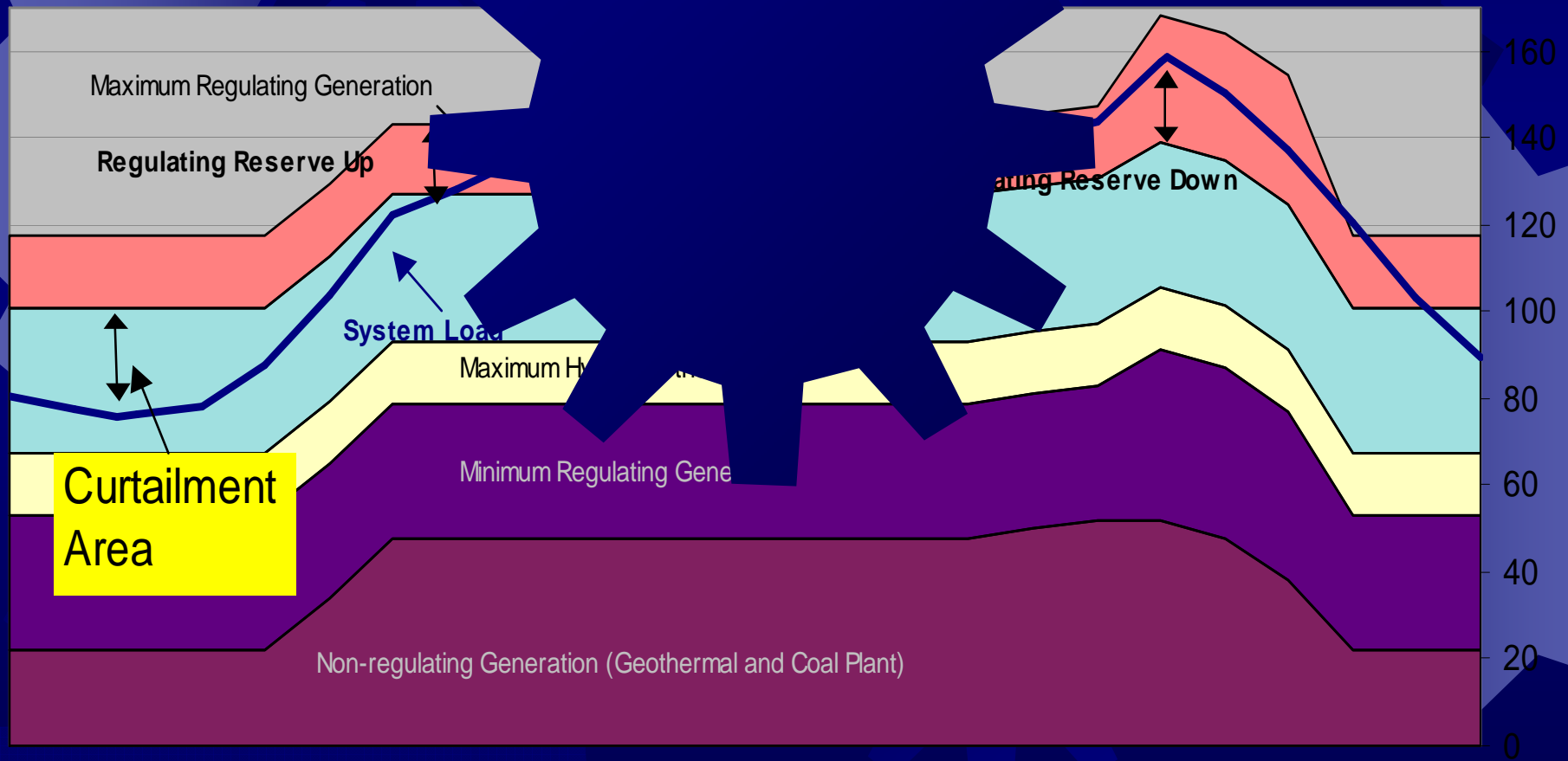


Current Daily Load Profile and Wind Energy Curtailment





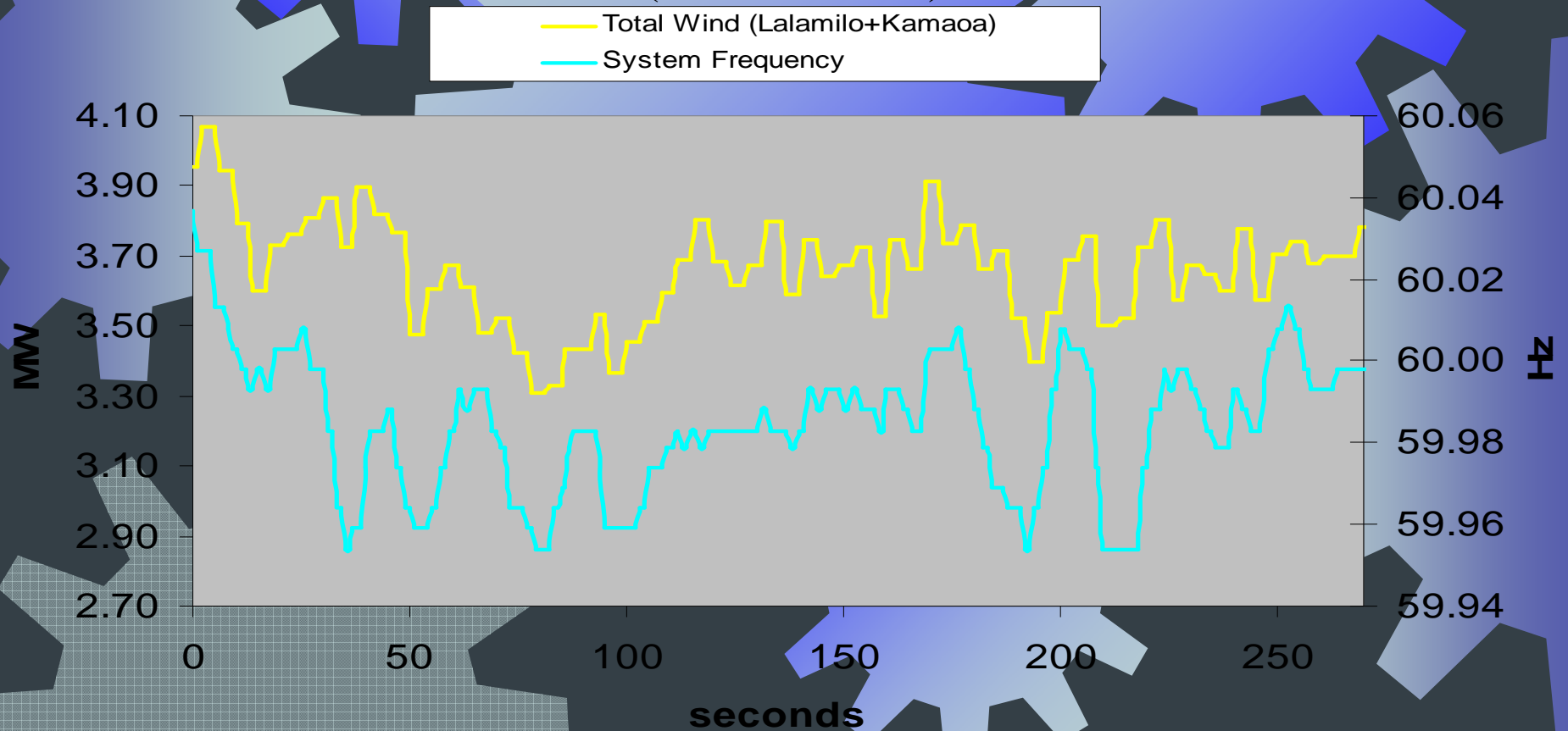
Future Daily Load Profile and Wind Energy Curtailment





HELCO System Frequency Deviation

Wind Farm Production (MW) and System Frequency
(Five Minutes)



Electronic Shock Absorber

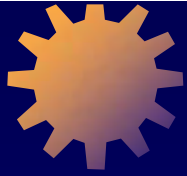
- ☀️ ESA to integrate fluctuating wind power into the electric grid
 - 🔴 Device and controls would mitigate shock, frequency and voltage deviations
- ☀️ HECO received U.S. Dept. of Energy award
- ☀️ Three phase demonstration planned; with private company
- ☀️ Communicated with WTG manufacturers for ESA applications





View Plane





Photovoltaic (PV) Applications Grow



- ☀ Net metered PV education center
- ☀ Kona Gym 15-kw PV system
- ☀ NELHA Gateway Center
- ☀ Large Customer Projects (Mauna Lani, Parker Ranch)



Demand-Side Management



Residential Water Heating Program with Solar Energy

- Provides rebates for solar water heating systems, heat pumps, and also high efficiency water heaters



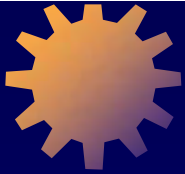
Energy Efficiency Program for Businesses

- Incentives for energy audits and energy efficient electric equipment
- Covers lighting, energy audits, air conditioning, refrigeration, HEV, and custom measures



Load Curtailment – Rider IV

- Discounted rates for businesses who curtail loads during HELCO's daily peak, 5:00-9:00 pm



DSM Good for Businesses

Hilton Waikoloa Village

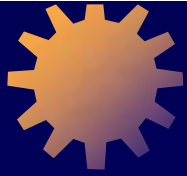
☀ Energy efficient technologies:

- Lighting
- Motors/drives
- Window film

☀ Total rebates:
\$92,000

☀ Energy saved:
1.8 million
kWh/year





Energy Efficiency Partnerships

- ★ **Waikoloa Marriott**
(Outrigger) - high temperature solar thermal system
- ★ **Hapuna Beach Resort Laundry** – ozone laundering system demo
- ★ **North Hawaii Community Hospital** – feasibility of heat pipes for humidity control





HELCO's Puueo Hydroelectric Plant





Hydroelectric Power

- ✱ Run-of-stream schemes are in East Hawaii
- ✱ Public resistance to damming streams
- ✱ Limited potential for large units
- ✱ Small “In-Line” hydro units in water supply pipelines look promising
- ✱ Pumped-storage hydro to be considered



In-Line Hydroelectric Power HELCO & Dept. of Water Supply



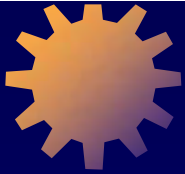


Geothermal

- ✱ Firm, base-loaded generation
- ✱ Resources in Puna, far from major load centers
- ✱ Community acceptance increasing
- ✱ Significant technical and commercial risks



Puna Geothermal Ventures Hawaii Island



Summary

- ✱ >20% of Hawaii Island energy from renewable resources today
- ✱ Wind energy levels expected to increase from 2% to >25% within next few years
- ✱ Many technical issues to overcome in order to preserve power quality
- ✱ Geothermal will continue to play major role
- ✱ Utility – Business partnerships critical to advancing new technologies



**Powering the Big Island
Hawaii's Energy Frontier**

Thank you

**Hawaii Electric Light Company
1894 - 2004**

HELCO 110th Anniversary