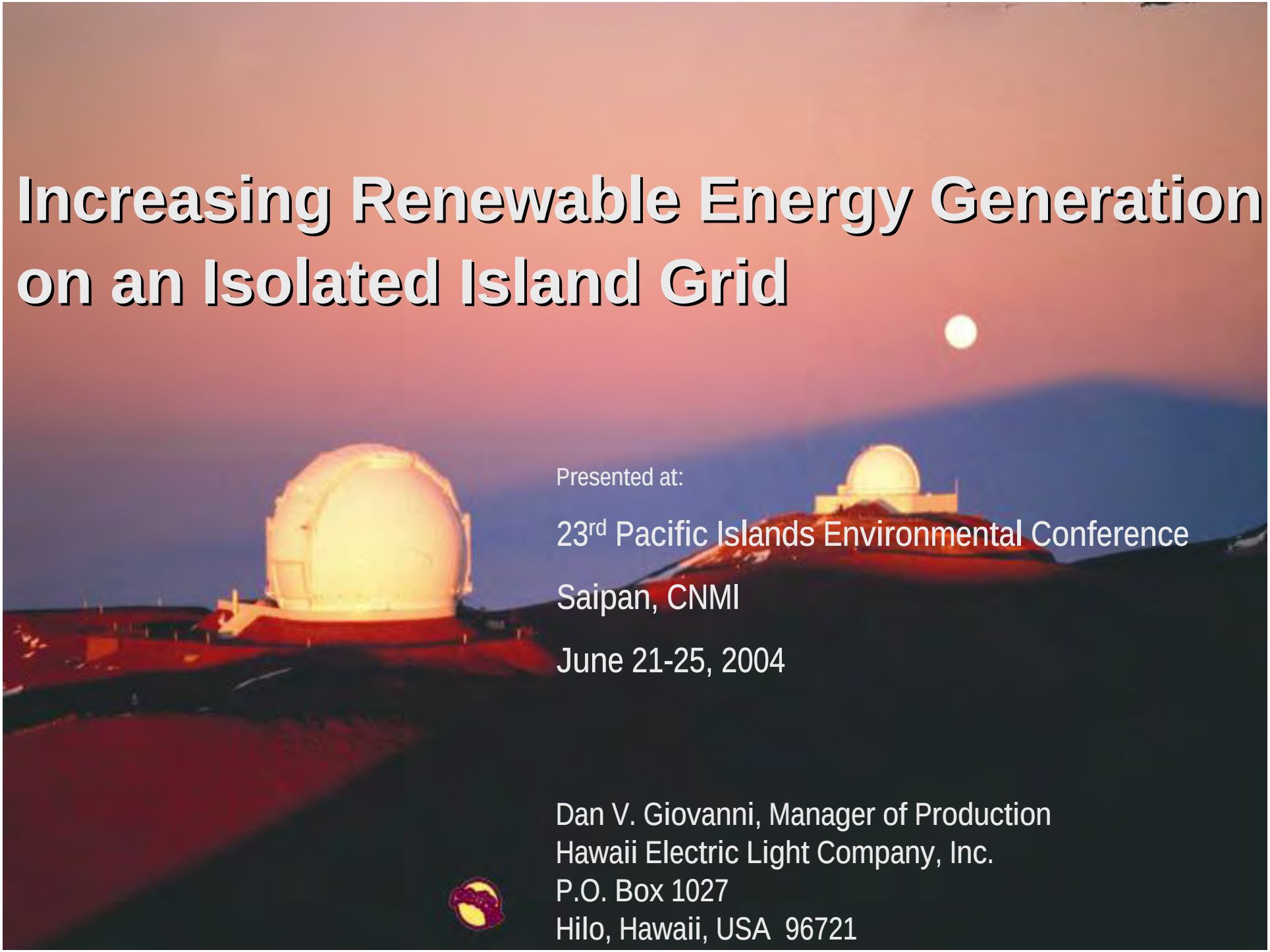

Increasing Renewable Energy Generation on an Isolated Island Grid

Presented at:

23rd Pacific Islands Environmental Conference

Saipan, CNMI

June 21-25, 2004

Dan V. Giovanni, Manager of Production
Hawaii Electric Light Company, Inc.
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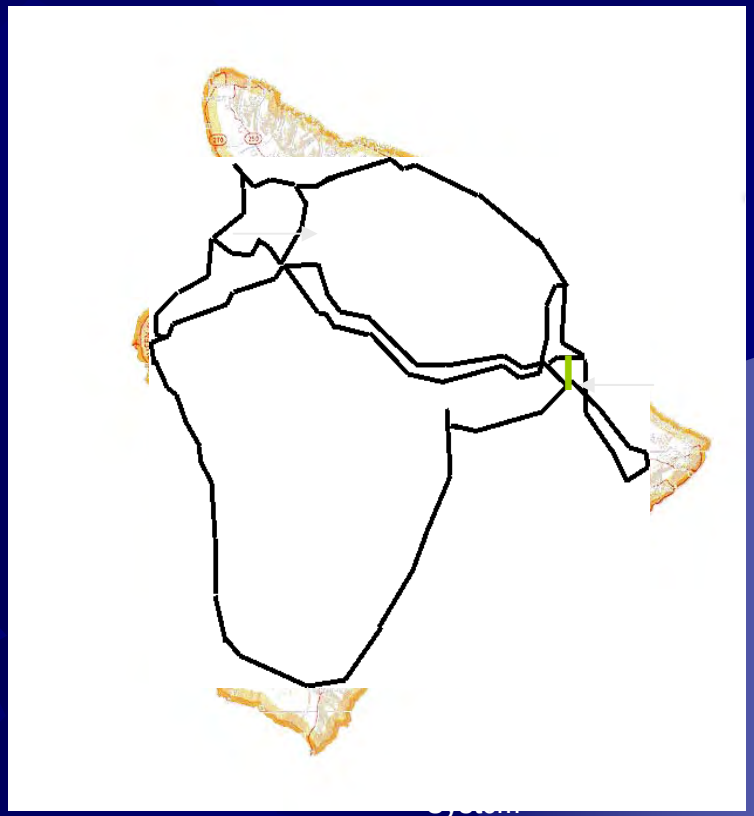
Hilo, Hawaii, USA 96721

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

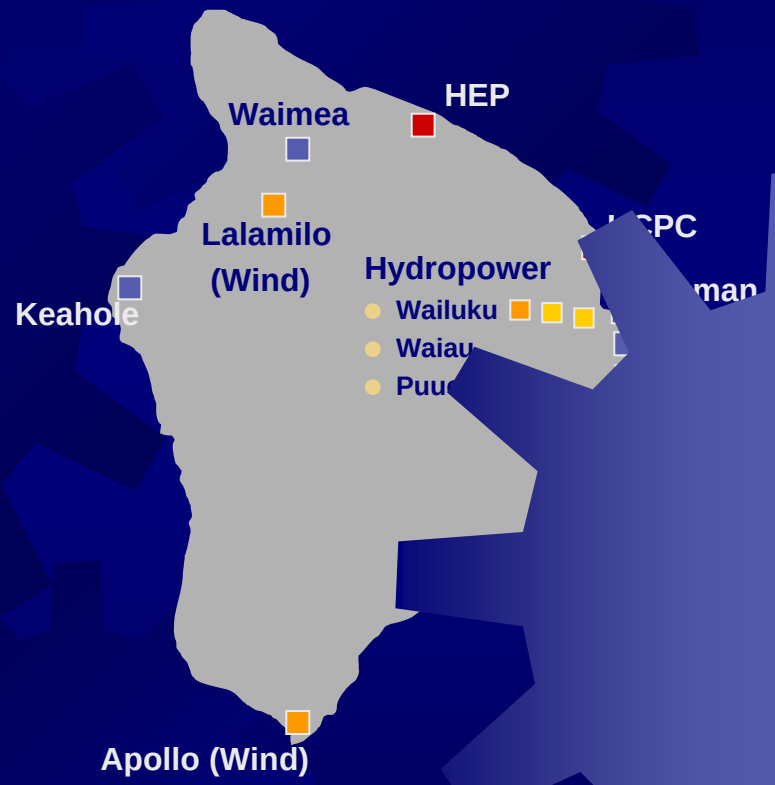
HELCO Transmission System

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

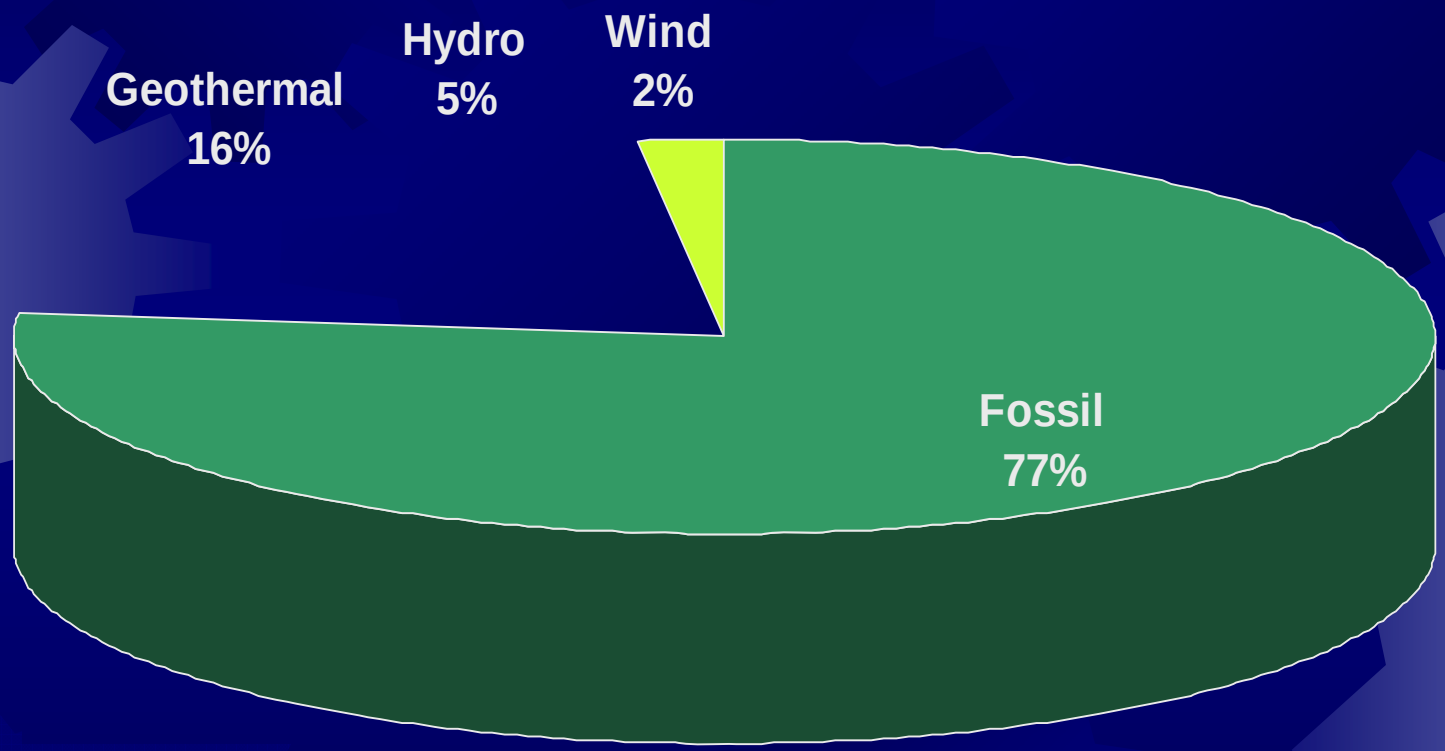


HELCO Power Supply System

- 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

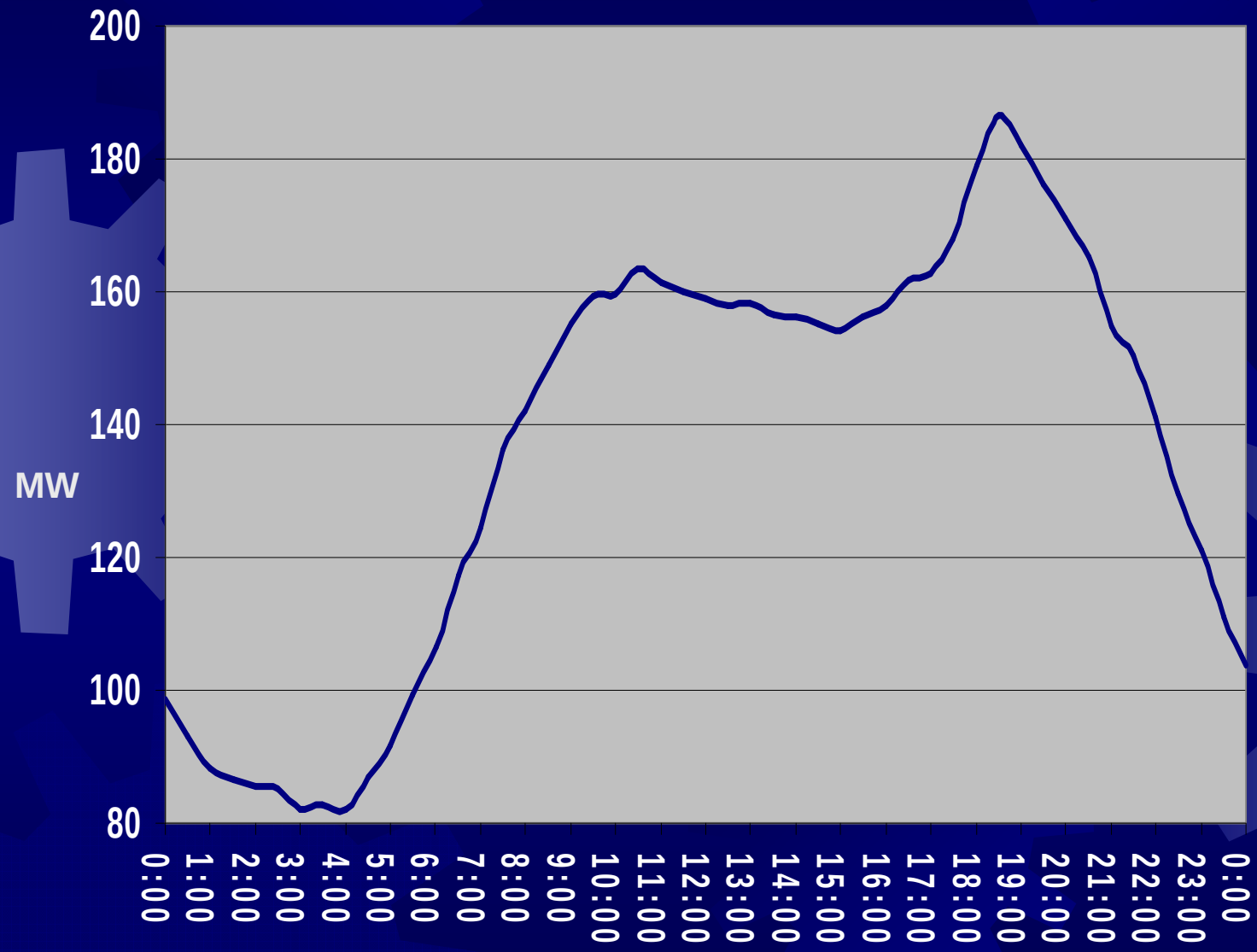
Comparative size of the … and customer density

Oahu 597 sq. mi., 474 p…

Maui 1,128 sq. mi., 53…

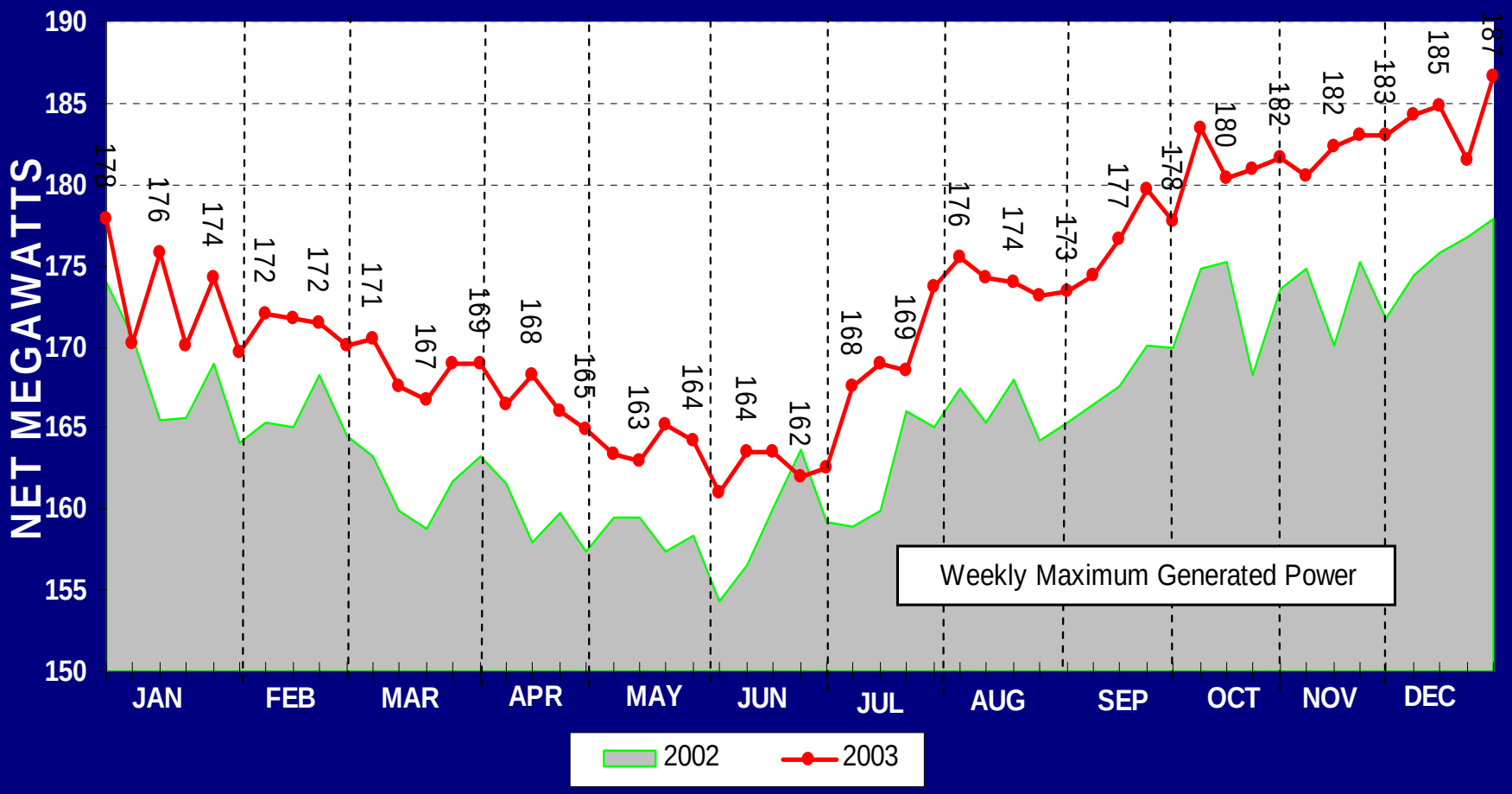
Big Island 4,028 sq. …
17 per sq. mi.

Daily Load Profile

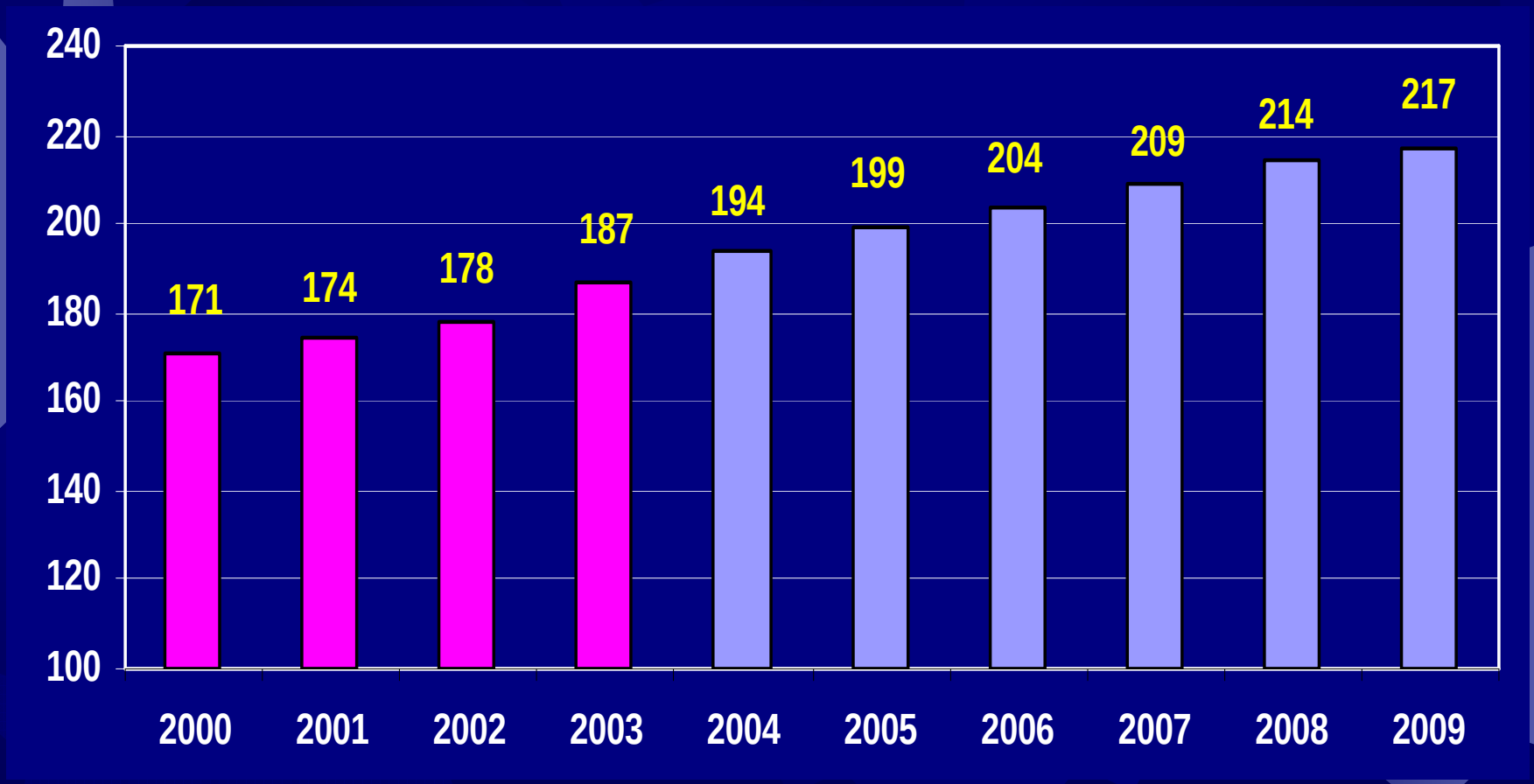


December 30, 2003

Daily Peak Load – Annual Profile

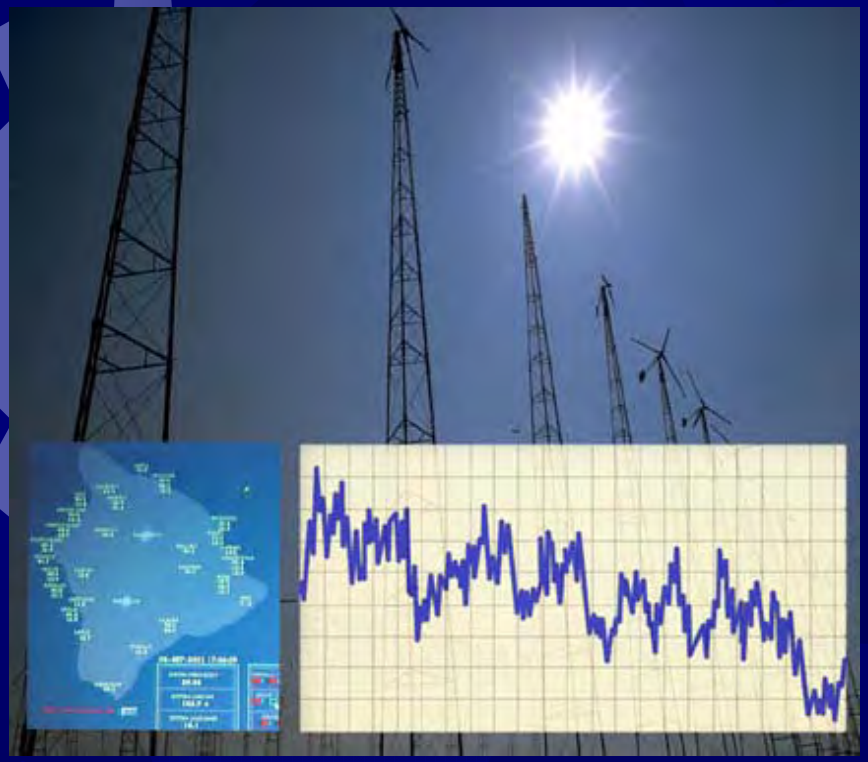


Annual Peak Load



Expanding the Use of Renewable Energy

HELCO's Challenges



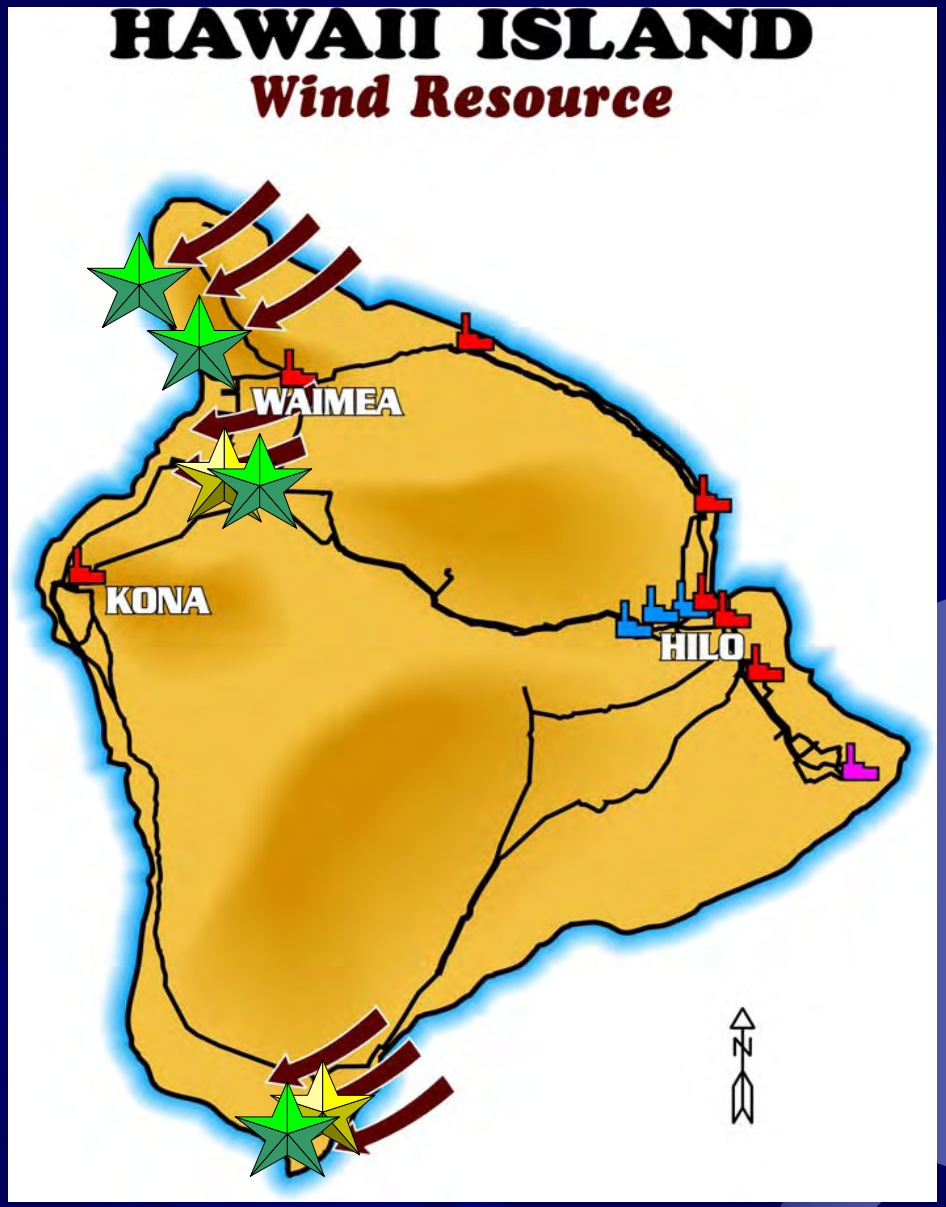
- Wi… …
  sectio…
- Wind, s…ar, …d h…dro require firm back-up
- Volatile power output disrupts power quality
- Geothermal resources difficult to manage

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

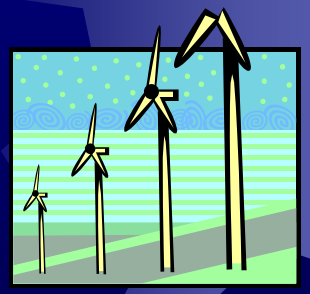
Wind Energy Issues

- As-available resource; needs back up
- Regulating units are needed in order 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

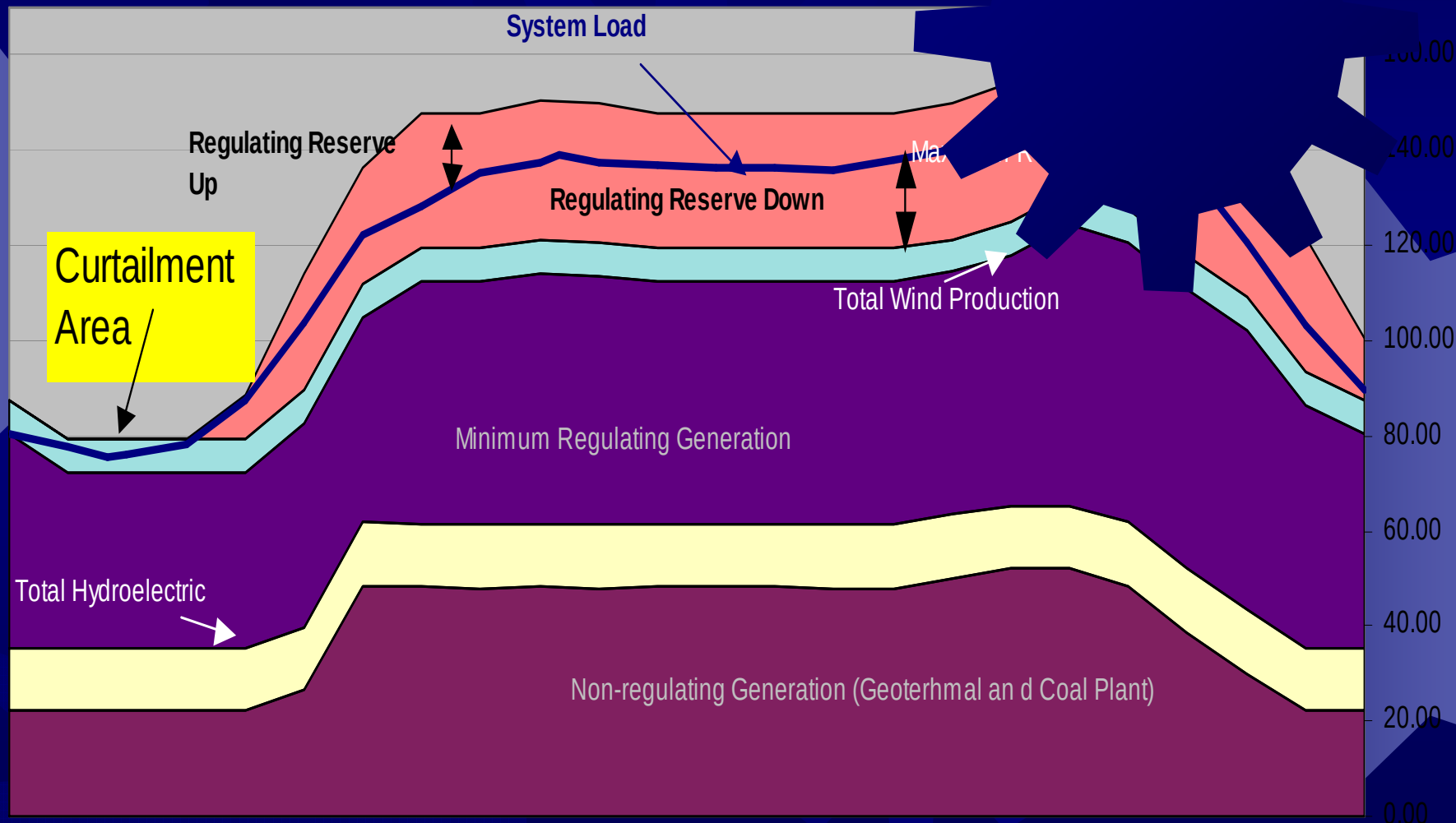
Increased Wind Energy on HELCO System

- HELCO Goal → Add wind energy to the HELCO power grid, and preserve Power Quality and Reliability

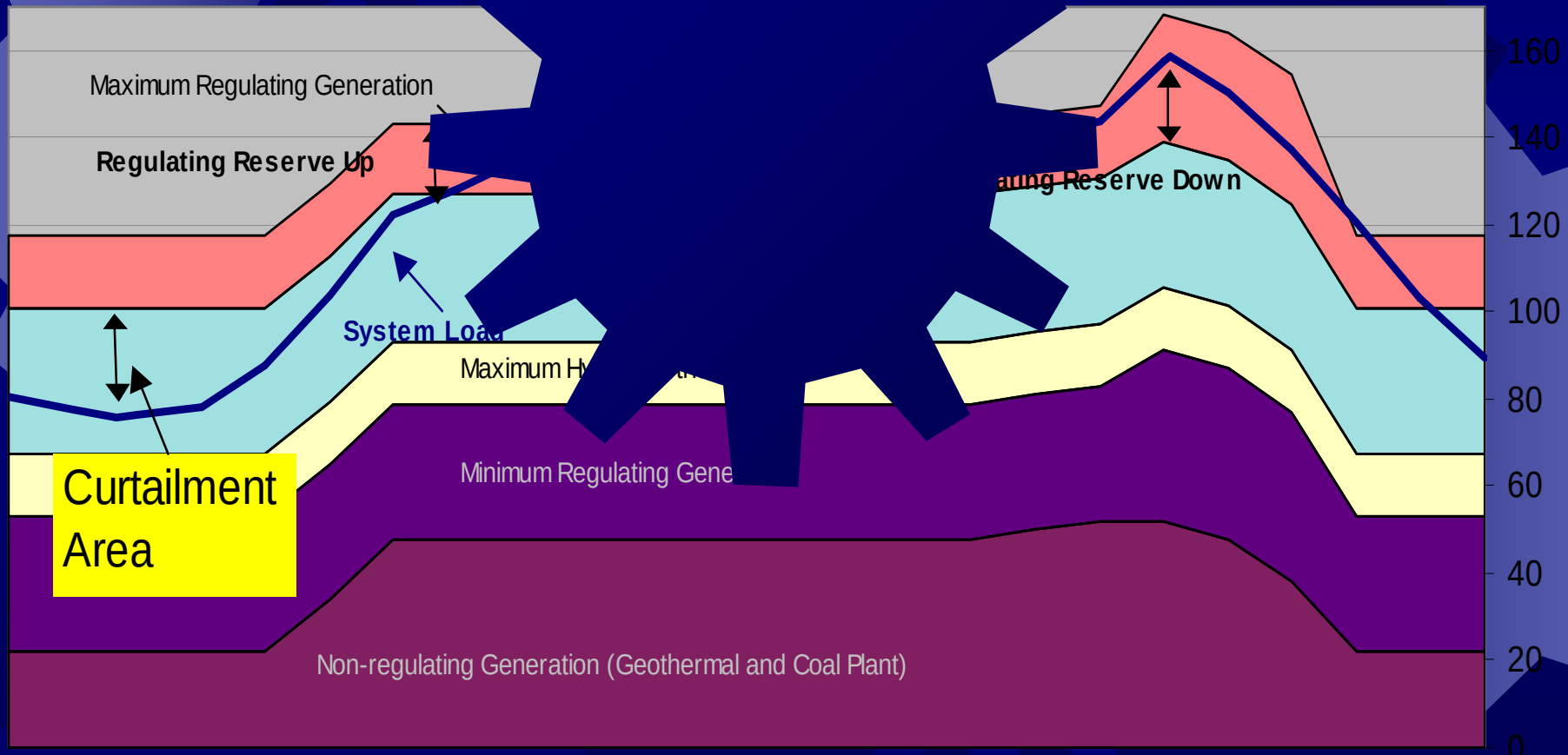
- Potential system impacts
  - Increased capacity of as-available power
  - Increased duty on regulating units
  - Need additional operating reserve
  - Further curtailment of wind generation



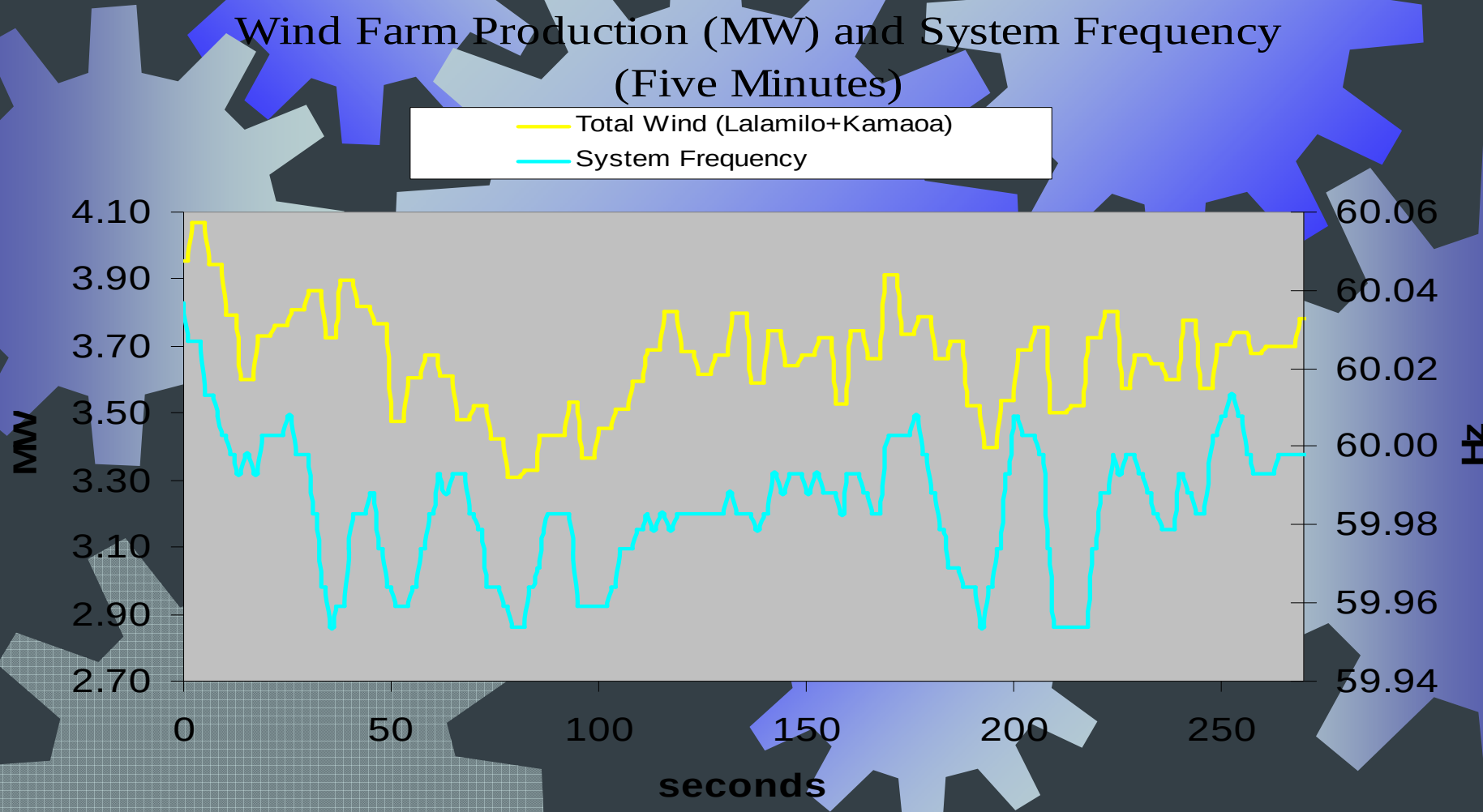
Current Daily Load Profile and Wind Energy Curtai



Future Daily Load Profile and Wind Energy Curtailment



HELCO System Frequency Deviation



Electronic Shock Absorber

- ESA to integrate fluctu[illegible]n wind power into the elec[illegible]
  - Device and contr[illegible] would mitigate sho[illegible] frequency and volt[illegible] deviations
- HECO received U[illegible]
- 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 Wate[illegible]eati[illegible] Prog[illegible]n with Solar Energy**
  - Provides rebates f[illegible]ating systems, heat pumps and also hig[illegible] water heaters
- **Energy Ef[illegible]ses**
  - Incentives for [illegible]t electric equipment
  - Covers ligh[illegible]ce air conditioning, refrigeration, HE[illegible]n, and custom measures
- **Load Curtailment – Rider M**
  - 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

- **Waiko Marriot (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 [illegible] in East Hawaii
- Public resist[illegible] damming streams
- Limited pot[illegible] 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

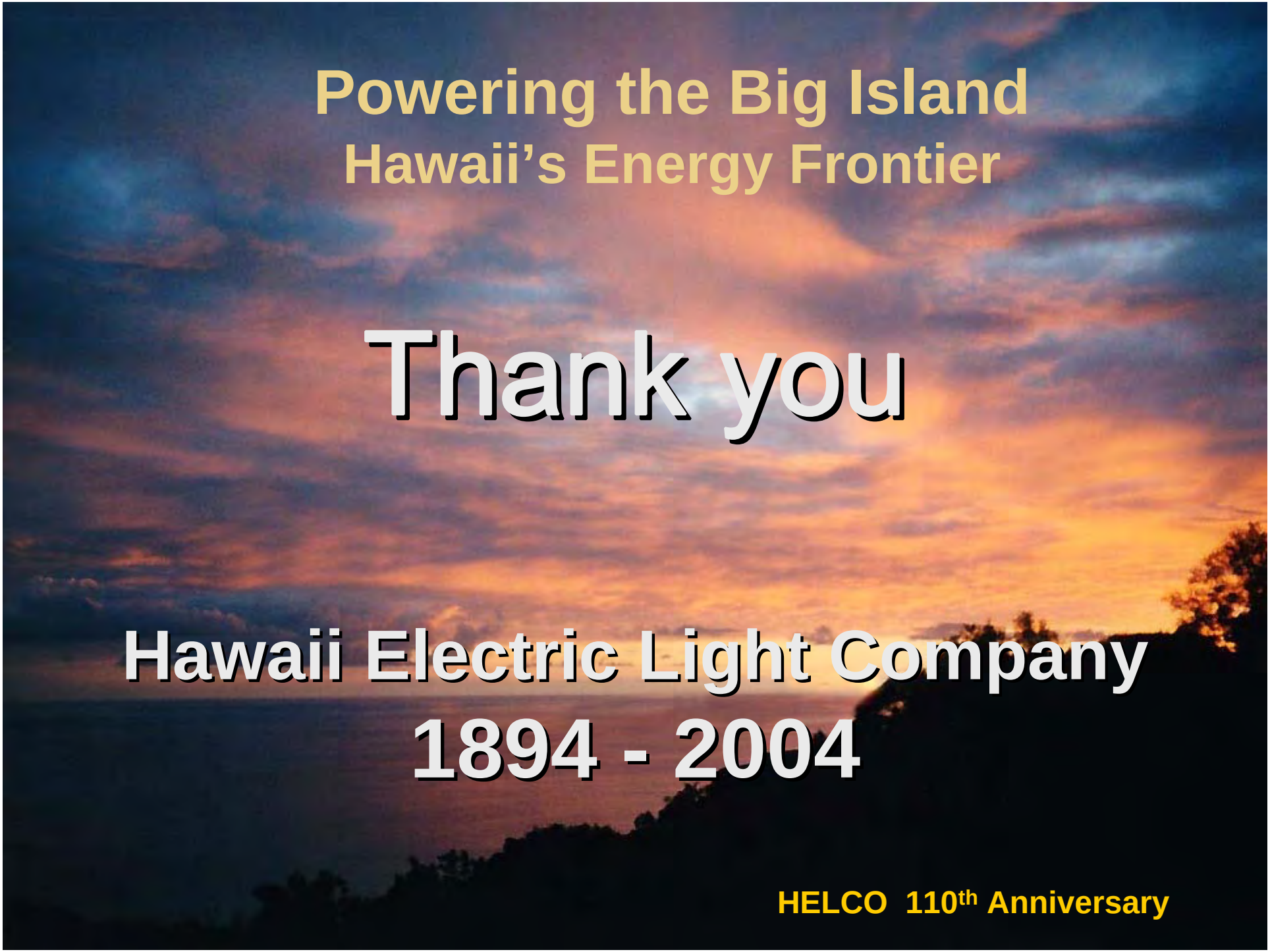
- Firm, base-loaded generation
- Resources in Puna, far from major load centers
- Community acceptance increasing
- Significant technical and commercial risks

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