A G E N D A

Inaugural Meeting of the Hawaii Wind Working Group
Honolulu Airport Hotel
3401 North Nimitz Highway
Honolulu, Hawaii
April 8, 2002

8:30 AM **Introductions**
Maurice Kaya, Energy Program Administrator, Hawaii State Energy Office

Welcome; Update on Federal Wind Programs & Incentives
Curtis Framel, Regional Coordinator, Emerging Technologies; U.S. Department of Energy, Seattle Regional Office

9:00 AM **WIND ENERGY UPDATE**

U.S. and International Utility Scale Wind Update
Brian Parsons, Project Manager for Wind Applications, National Renewable Energy Laboratory

Offshore Wind Development
Dr. Bruce Bailey, President, AWS Scientific

Regulatory and Policy Issues and Status
Ron Lehr, National Wind Coordinating Committee

10:00 AM **HAWAII'S WIND RESOURCE**
Karen Conover, President, Global Energy Concepts

10:30 AM **WIND ENERGY FOR HAWAII: PAST, PRESENT, & FUTURE**

17 Years of Wind on the Big Island
Dan Giovanni, Energy Specialist, Hawaii Electric Light Company

Wind on Oahu, Maui, and Molokai
Art Seki, Energy Specialist, Hawaiian Electric Company

Recent Collaborative Efforts
Maria Tome, Alternate Energy Engineer, Hawaii State Energy Office

A Perspective on the Future for Wind in Hawaii
Warren Bollmeier, President, Hawaii Renewable Energy Alliance

11:30 AM **PERSPECTIVES ON DEVELOPMENT**
Keith Avery, Vice President of Development, Urban Power Company

12:15 PM **LUNCH**
Curtis Framel, USDOE: "Highlights from Other States' Wind Working Groups"

1:30 PM **PANEL DISCUSSIONS: WIND ENERGY ISSUES & POLICIES**

1:30 **Technical Issues Panel**
Moderated by Brian Parsons, National Renewable Energy Laboratory
Bob Zavadil, Senior Consultant, Electrotek Concepts, Inc.
Tom Wind, P.E., Wind Utility Consulting
Tom Simmons, Vice President of Power Supply, Hawaiian Electric Company

2:30 **Nontechnical Issues Panel**
Moderated by Eileen Yoshinaka, U.S. Department of Energy
Edwin Lindsey, President, Maui Cultural Lands Inc.; Consultant, Na Kupuna O Maui
Mike Edwards, Director, Sustainable Kauai
Sam Lemmo, Dept. of Land and Natural Resources, Land Division, Planning Branch

3:30 PM **BREAK**

3:45 PM **BREAKOUT GROUPS (Concurrent sessions)**

3:45 **Wind Working Group**
Moderated by Brenner Munger, Manager of Power Supply, HECO

3:45 **Federal Agencies Group**
Moderated by Ed Cannon, National Wind Technology Center

4:45 PM **Close***

***Please complete the survey and turn it in before you leave.**
If you forget, please fax it to 586-2536. Thank you!

Wind Powering America
A Regional Perspective

Curtis Framel
Regional Coordinator, Emerging Technologies
U.S. Department of Energy, Seattle Regional Office
Hawaii Wind Working Group
April 8, 2002

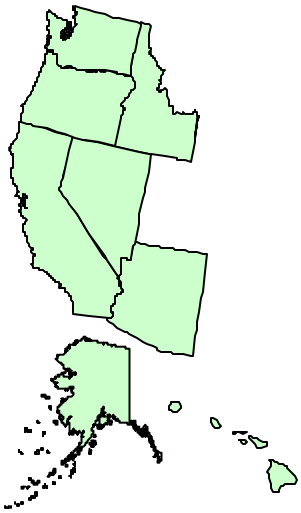
US Department of Energy
Office of Energy Efficiency
and Renewable Energy (EERE)

Mission

To ensure that Federal programs for efficient energy and clean power technologies are implemented at the regional, state and local levels, providing Americans with a stronger economy, healthier environment, and more secure future.

EERE's Regions

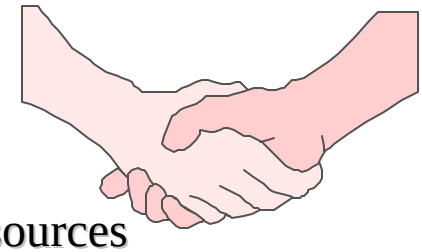
What we offer



Services

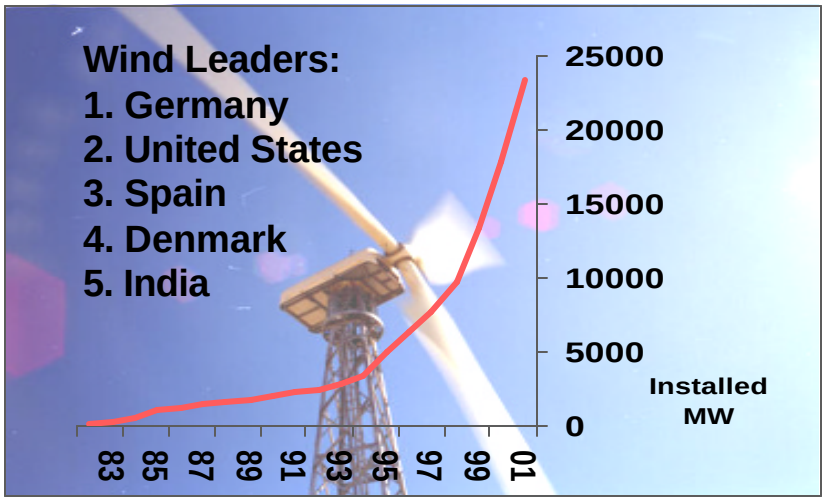
- Financial Assistance
- Technical Assistance
- Leverage Investments
- Identify Opportunities
- Build Partnerships

Opportunities for Partnerships



Rebuild America
Million Solar Roofs
Geopowering the West
Distributed Energy Resources
Clean Cities
Building Standards and Codes
Wind Powering America

Taking Off Worldwide



Wind Energy Getting Cheaper

- 1979: 40 cents/kWh

- 2001: under 4 cents/kWh (unsubsidized)

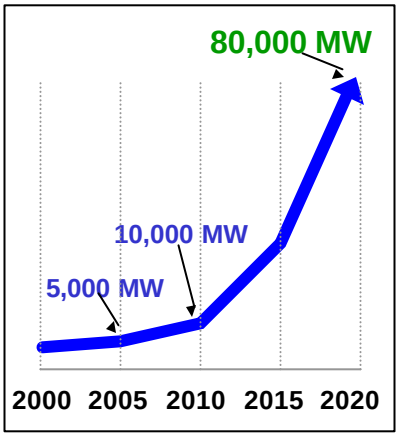
- Increased Turbine Size
- R&D Advances
- Manufacturing Improvements

The Time is Right

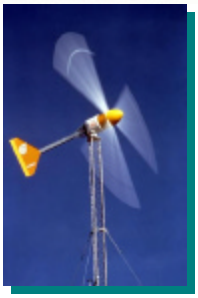
- Wind Technology Readiness
- Rural Economic Development Needs
- Electric Industry Restructuring
- Climate Change
- Energy Security

Wind Powering America Federal Goals

- National
  - 5% nation's electricity by 2020
  - Double the # of states with >20MW to 16 by 2005, Triple to 24 by 2010
  - Federal purchase of 5% wind energy by 2010 (1,000MW)



Sizes and Applications



Small (£10 kW)
Homes
Farms
Remote Applications (e.g. water pumping, telecom sites, icemaking)

Intermediate (10-250 kW)
Village Power
Hybrid Systems
Distributed Power
Military Installations

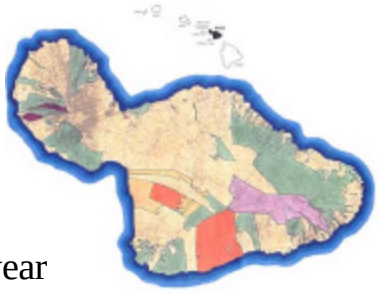
Large (250 kW - 2 MW)
Central Station Wind Farms
Distributed Power

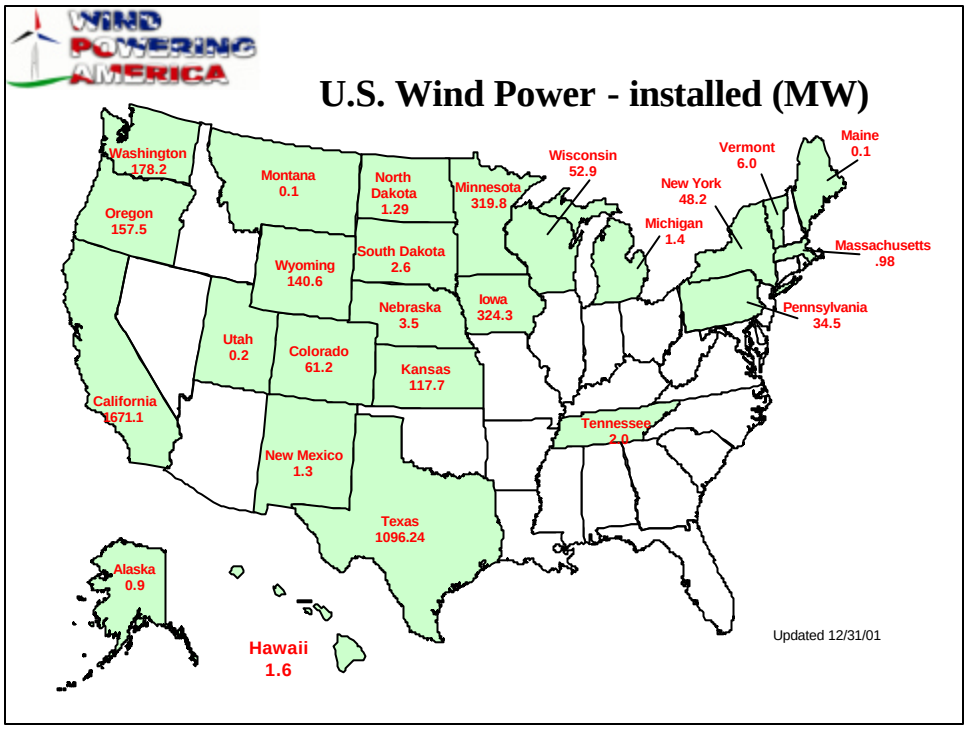
National Benefits

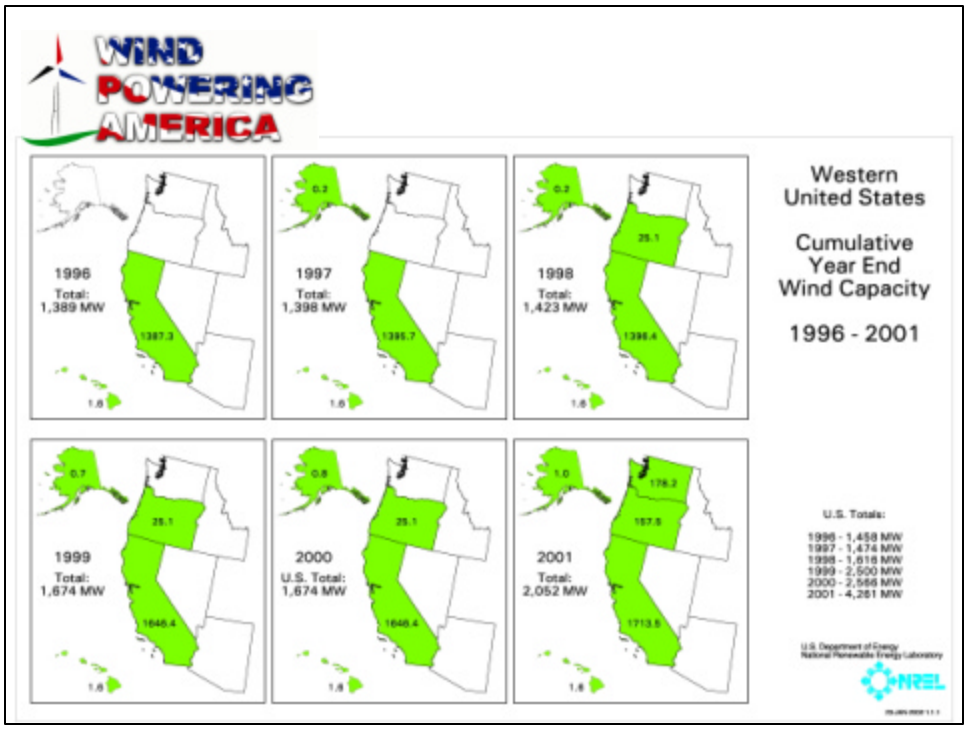
- $60 billion in capital investment in rural America over 20 years
- $1.2 billion in new income for farmers, Native Americans, and rural landowners over 20 years
- 80,000 permanent jobs by 2020
- 35 million tons of carbon displaced in 2020

Land Owners, Communities, Economic Development and Local Government Officials

- Messages
  - Wind as a new “crop” for local income and economic development
  - Hawaiian Homelands (187,000 acres)
  - Create jobs in a new industry
  - Average $2,000 per turbine per year
  - Stable prices in volatile markets
  - All-American resource




WIND POWERING AMERICA
U.S. Wind Power - installed (MW)
Washington 178.2
Oregon 157.5
California 1671.1
Montana 0.1
Wyoming 140.6
Utah 0.2
Colorado 61.2
New Mexico 1.3
North Dakota 1.29
South Dakota 2.6
Nebraska 3.5
Kansas 117.7
Texas 1096.24
Minnesota 319.8
Iowa 324.3
Wisconsin 52.9
Michigan 1.4
Illinois
Tennessee 2.0
New York 48.2
Vermont 6.0
Maine 0.1
Massachusetts .98
Pennsylvania 34.5
Alaska 0.9
Hawaii 1.6
Updated 12/31/01


WIND POWERING AMERICA
1996
Total:
1,389 MW
1997
Total:
1,398 MW
1998
Total:
1,423 MW
1999
Total:
1,674 MW
2000
U.S. Total:
1,674 MW
2001
Total:
2,052 MW
Western United States
Cumulative Year End Wind Capacity
1996 - 2001
U.S. Totals:
1996 - 1,458 MW
1997 - 1,474 MW
1998 - 1,516 MW
1999 - 2,500 MW
2000 - 2,566 MW
2001 - 4,261 MW
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

WPA Goals/Strategy

- **<u>Nurture State Markets</u> - Identify and overcome barriers to large and small scale wind energy development**
  - Leverage partnerships
  - Create/Leverage partnerships
  - Leverage resources
  - Nurture pilot applications
  - Provide broad education
  - Secure broad support
  - Seize market opportunities
  - Provide **much-needed** Federal and State leadership

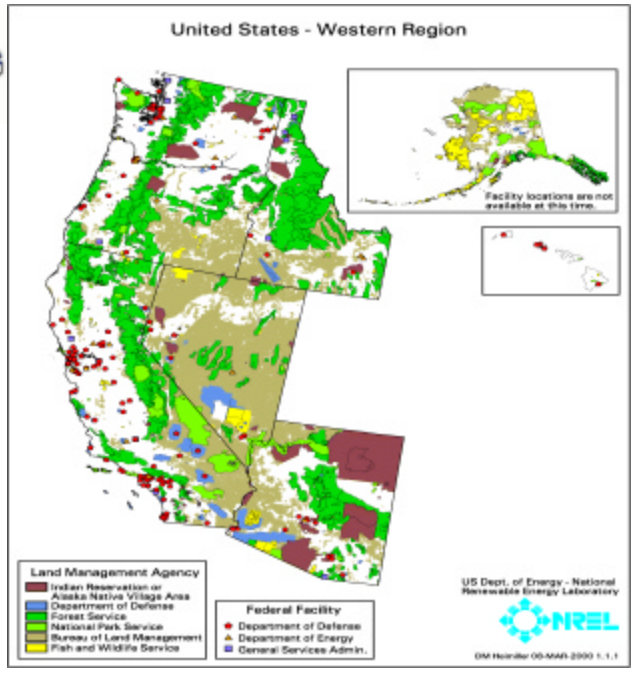
Education and Outreach

Education Materials

- Workshops/events
- Wind coalitions
- Regional/State web sites
- Landowner guides
- Small wind guides
- State wind guides
- Wind calendar
- Technical support
- Earth Day materials
- Presentations
- Regional leveraging
- On-line tools

State Workshops and Working Groups

- **Objectives**
  - Target States in most need
  - Host state-wide forum
  - Secure state-wide coordination
  - Leverage resources
  - Identify key barriers/opportunities
  - Secure high visibility
  - Secure key support
  - Provide strong education



Primary Areas of Focus

- Green Power

Purchasing electricity generated from renewable sources, including solar, wind, geothermal, biomass, landfill gas and small hydropower.

Executive Order 13123

"Greening the Government Through Efficient Energy Management"

- Section 404 Electricity Use
  - Include green power provisions in RFP's "whenever procuring electricity"
  - Can use energy efficiency savings to pay premium
- Renewables Goal: 2.5% by 2005
  - "***Renewable energy***" means energy produced by solar, wind, geothermal, and biomass power
  - Credit towards EE goals

Other Federal Renewable Goals

- Department of Energy Directive
  - 3% of DOE electricity from non-hydro renewable energy by 2005
  - 7.5% by 2010
- Wind Powering America
  - Encourage federal agencies to purchase 5% of electricity from wind by 2010
- Proposed Senate Bill includes Federal Purchase Requirement (S1766, Section 263)

What We're Doing

- **State/Regional Wind Workshops**
- **Supplemental Environmental Projects**
- **Anemometer Loan Programs**
- **Resource Maps**
- **Tribal Power**
- **Public Power Outreach**
- **Federal Aggregations**
- **Share Story of Success**
- **Education/ Outreach/ Training**

Program Results

- 20 State wind events - Over 6,000 attend
  - State Governors, Congressmen, Senators, Utilities, public…
- 1st ever State Wind Coalitions
- 1st ever pilot projects
- 1st ever state repositories/centers of expertise
- Numerous education products/initiatives
- Resource leveraging in/among states
- WPA Regional Office goals on track
- Numerous state wind legislation bills pass
- Numerous wind farms announced nationally

Challenges

- Cost of Electricity
- Restructuring
- Siting/Permit process
- Institutional Biases
- Transmission/ Distribution

A Vision for the Future

-New DOE Office of Wind and Hydropower

-Offshore and onshore wind development

-More diverse energy portfolio, less dependent on fossil fuel

-The new hydrogen economy

Contacts

- DOE Regional Office
  - Curtis Framel (206) 553-7841; curtis.framel@ee.doe.gov
  - Chuck Collins (206) 553-2159; chuck.collins@ee.doe.gov
  - Eileen Yoshinaka (808) 541-2564; eileen.yoshinaka@ee.doe.gov
- DOE Headquarters
  - Phil Dougherty (202) 586-7950
  - www.eren.doe.gov/windpoweringamerica
- National Energy Laboratories
  - Larry Flowers (303) 384-6910 (www.nrel.gov/wind)
  - Brian Parson (303) 384-6958
- American Wind Energy Association
  - (2002 National Meeting, Portland, OR June 2-6)
  - www.awea.org (202) 383-2500

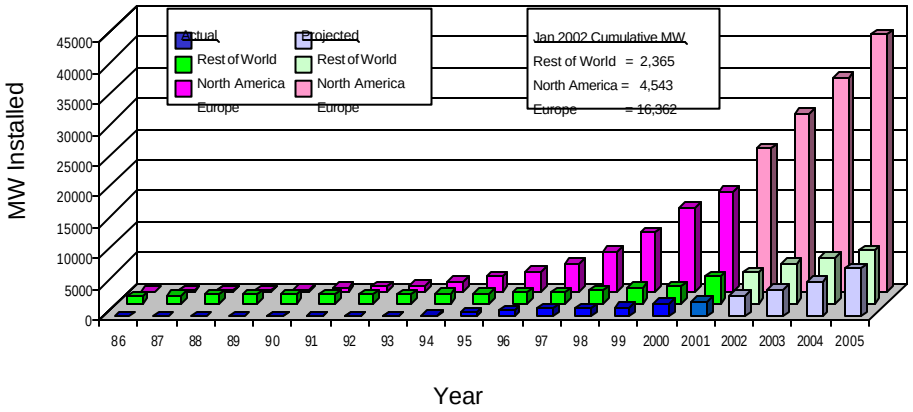
U.S. and International Utility Scale Wind Update

Hawaii Wind Working Group – April 8, Honolulu

Brian Parsons
National Wind Technology Center
brian_parsons@nrel.gov
303 384-6958

National Renewable Energy Laboratory

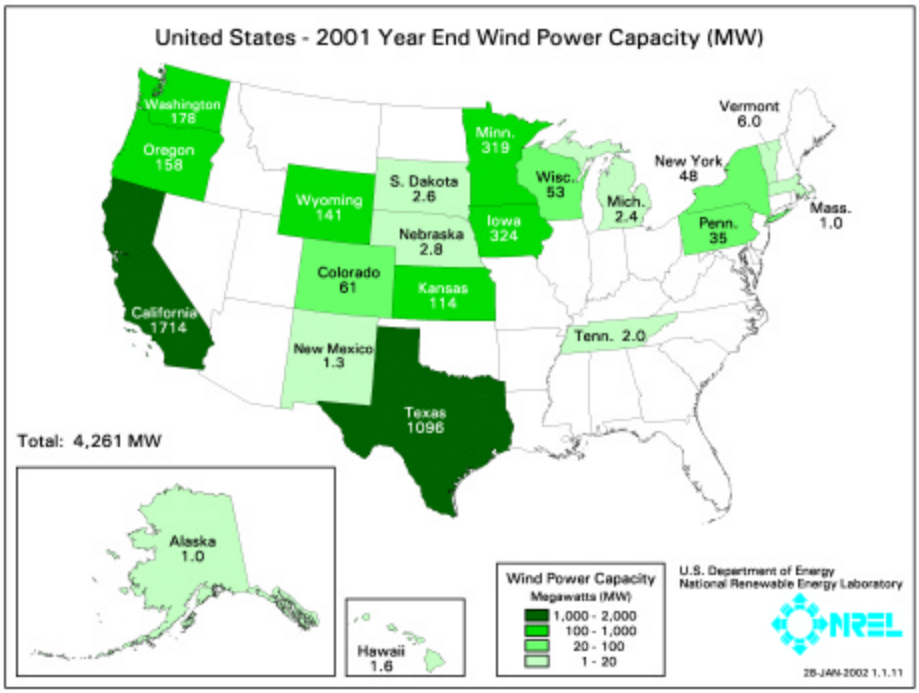
Growth of Wind Energy Capacity Worldwide



Sources: BTM Consult Aps, March 2001
Windpower Monthly, January 2002

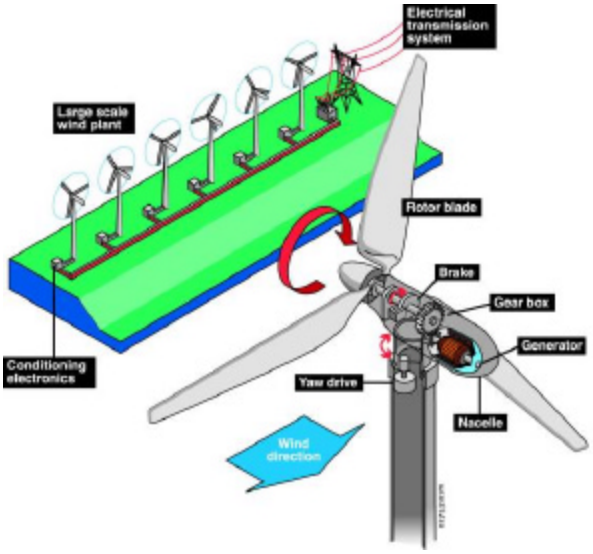
International Market

- Europe
  - high mandated purchase rates (85-90% of retail, 10-12 cents/kWh)
  - strong government and public commitment to the environment, including climate change
  - population density & existing developments driving off shore deployment in Europe
  - Parts of Germany, Denmark, and Spain 20% penetration
- Developing World
  - huge capacity needs
  - lack of existing infrastructure (grid)
  - pressure for sustainable development (IDB's, climate change)
  - tied aid

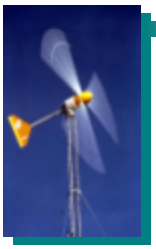


Wind Energy Technology

At it's simplest, the wind turns the turbine's blades, which spin a shaft connected to a generator that makes electricity. Large turbines can be grouped together to form a wind power plant, which feeds power to the electrical transmission system.



Sizes and Applications



Small (≤10 kW)
- Homes
- Farms
- Remote Applications

(e.g. water pumping, telecom sites, icemaking)

Intermediate (10-250 kW)
- Village Power
- Hybrid Systems
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Large (250 kW - 2+MW)
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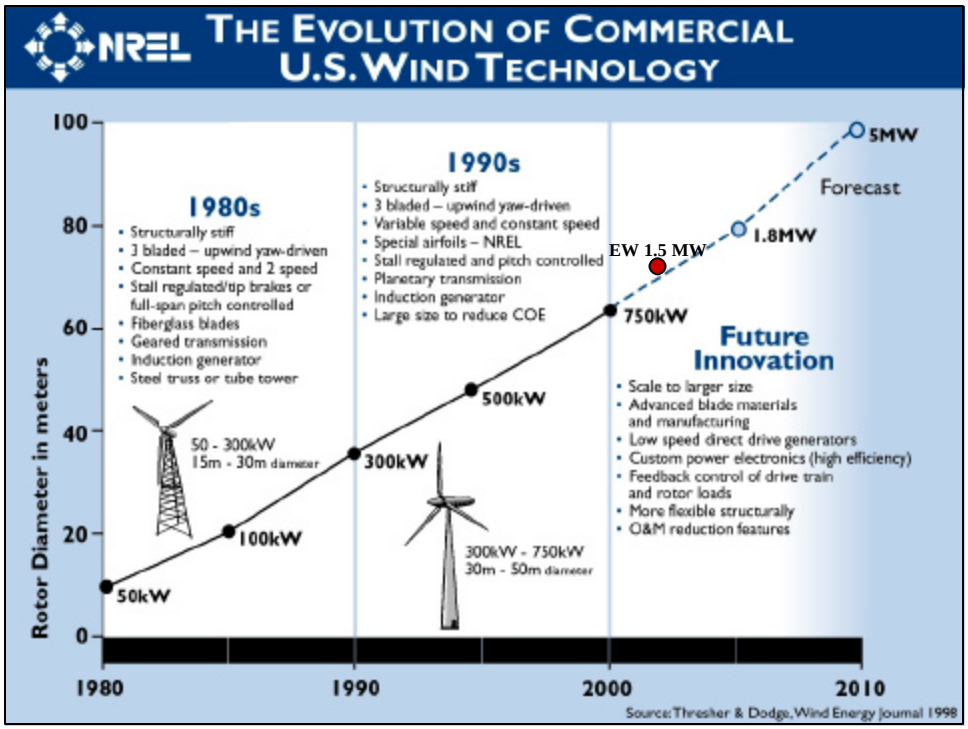
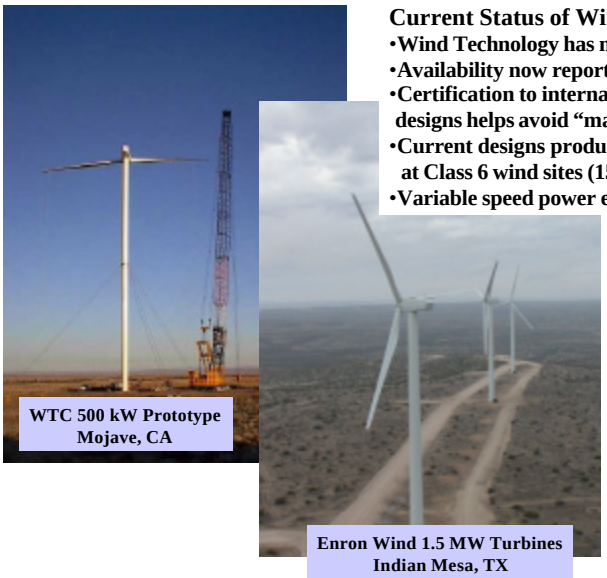


NREL

Low Wind Speed Technology Development



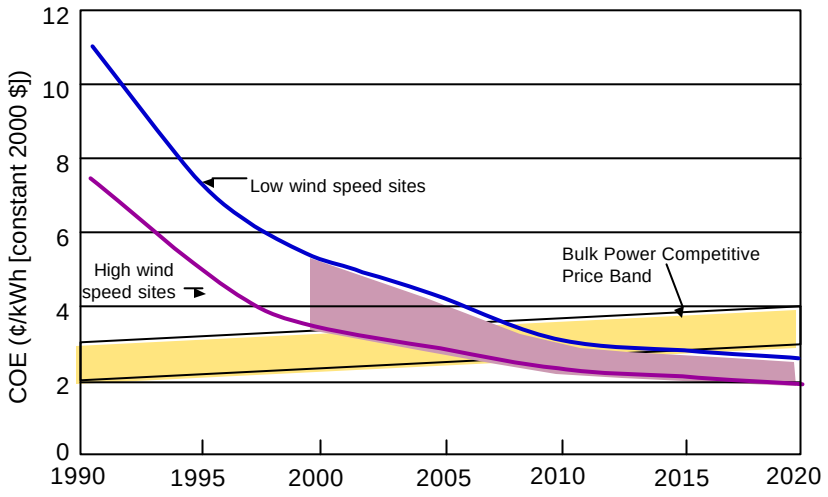
Current Status of Wind Technology:

- **Wind Technology has matured over 25 Years**
- **Availability now reported at 98-99%**
- **Certification to international standards for new turbine designs helps avoid "major failures"**
- **Current designs produce electricity for 4-6 cents/kWh at Class 6 wind sites (15 mph or higher average wind)**
- **Variable speed power electronics mitigate some grid issues**

Low Wind Speed Technology Innovations for the future:

- **Larger-scale 2 to 5 MW, with rotors diameters to 120 meters**
- **Flexible, thin high-speed rotors**
- **Extendable rotor concepts**
- **Hybrid glass-carbon rotors**
- **Load feedback control systems**
- **Custom designed low-speed, permanent-magnet generators**
- **Self-erecting tall tower designs, 85 to 100 meters tall**
- **Offshore wind turbines**

Wind Cost of Energy



Finances and Incentives

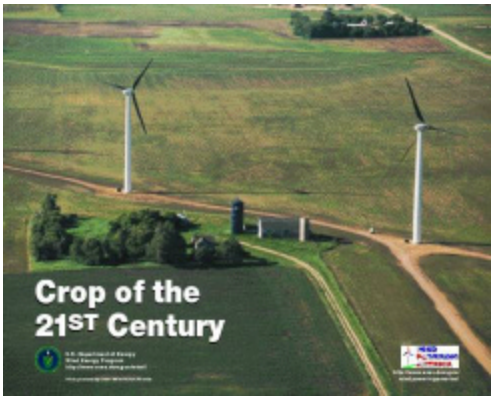
- Production Tax Credit
  - 1.7 cents/kWh (escalating) for 10 years equates to around 1.1 cents/kWh reduction in contract price
  - Currently available for plants installed by 12/03 (deadline pressure *increases* costs)
  - 5 year extension being debated
- State and Local tax, etc. can be significant
  - +/- 0.5 cents/kWh impact
- Public Power (100% debt at tax free rates)
  - 60% of GenCo or IPP cents/kWh
  - Renewable Energy Production Incentive available, but annual appropriation leads to limited value when financing projects

Economic Development Opportunities

- Land Lease Payments: 2-3% of gross revenue $2500-4000/MW/year
- Local property tax revenue: 100 MW brings in on the order of $1 million/yr
- 1-2 jobs/MW during construction
- 2-5 permanent O&M jobs per 50-100 MW,
- Local construction and service industry: concrete, towers usually done locally
- Investment as Equity Owners: production tax credit, accelerated depreciation
- Manufacturing and Assembly plants expanding in U.S. (Micon in IL, LM Glasfiber in ND)

Key Deployment Issues for Wind Power

- Permitting and Siting (visual, noise, avian, land use)
- Transmission: capacity allocation, RTO formation, new line builds/planning
- Power Variability: impact on utility operations
- Evolving competitive markets
- Green power markets
- Policy environment – PTC, RPS, state tax provisions



Resources: On The Web

- AWEA Web site: http://www.awea.org
- NWTC Web site: http://www.nrel.gov/wind
- WPA Web site:
  http://www. Windpoweringamerica.gov
- Homepower Web Site: http://www. homepower.com
- Windustry Project: http://www. windustry.com

Topics

- Why Offshore?
- Highlighted US Projects
  - Southern New England
  - Nantucket Sound
  - Long Island
- HECO Considerations

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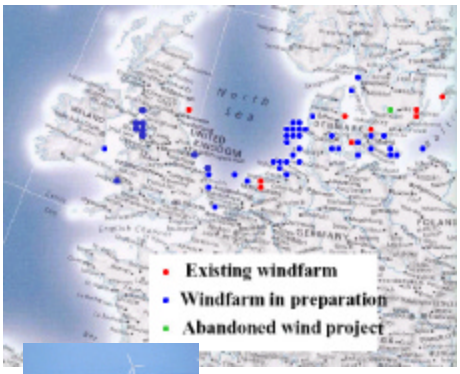
Why Go Offshore?



Projects in Europe

Over 10,000 MW of new offshore planned in next decade

Similar reasons in Europe & Northeast

- Green initiatives
- Shortage of land sites
- Windy offshore waters
- Near major load centers
- High energy costs

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Offshore Challenges

- Immature Application
- Higher Costs
- Economy of Scale
- Lower availability
- Unique Infrastructure
- Corrosive, hostile environment
- Longer permitting & construction schedule
- Cable vs. Hydrogen

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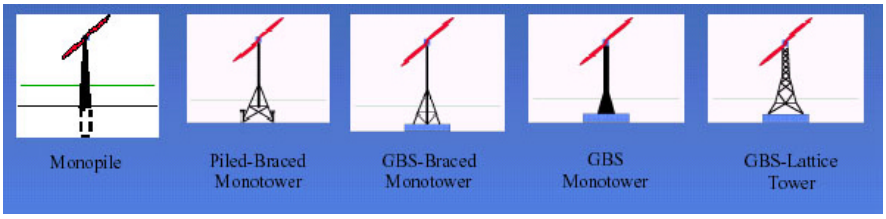
Offshore Foundations

Current Technology



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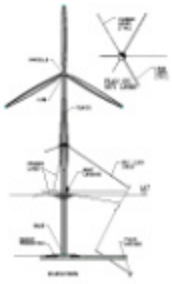
Offshore Foundations

Advanced Technology

Guyed Tower



Self-Installing

Semi-submersible

Floating tethered platform makes offshore potential virtually unlimited, since ocean depth and seabed morphology aren't issues.

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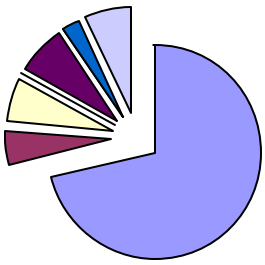
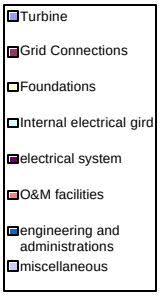
Costs

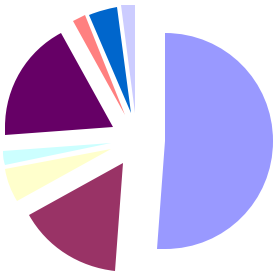
Onshore





$1000 - $1200/kW

Offshore



$1500 - $1,700/kW

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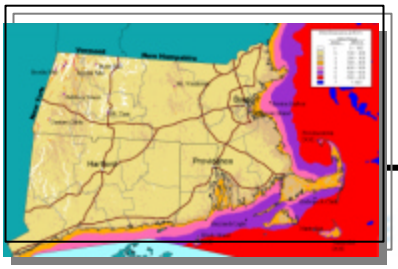
Southern New England's Wind Characteristics for Wind Power Applications

Project Objectives:

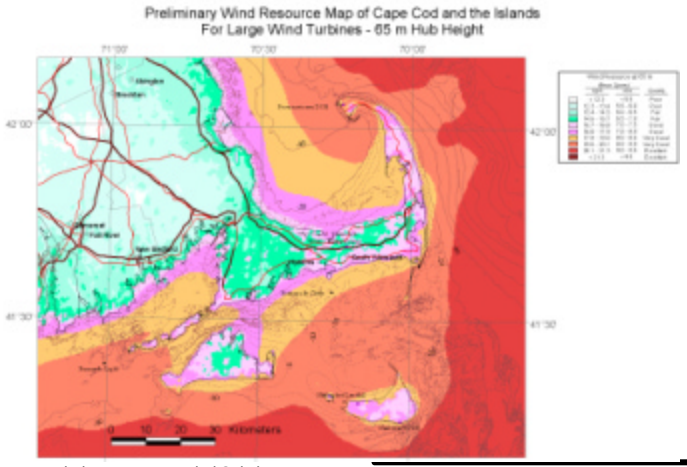
Facilitate planning of offshore and inland wind projects by:

- Taking new wind measurements offshore
- Assessing offshore measurement platforms
- Mapping southern New England's wind resources

Sponsored by Connecticut Clean Energy Fund, Massachusetts Technology Collaborative, and Northeast Utilities Services Co.



Wind Map of Cape Cod Region



Wind Map By TrueWind Solutions

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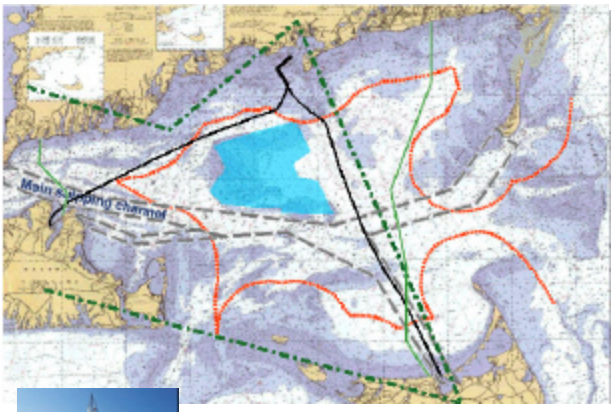
Nantucket Sound

Cape Wind™



Cape Wind Associates

- **420 MW**
- **Protected shallow water in Federal waters outside of other activities**
- **Close to shoreline, interconnect, and load center**
- **1/3 by 1/2 mile turbine spacing**

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Nantucket Sound

Cape Wind™

- **350-400 jobs over 18-24 months**
- **35-50 O&M jobs**
- **9 miles of 115 kV cabling (all under-water/ground)**

Cape Wind Associates

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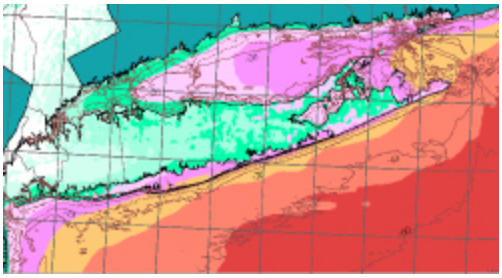
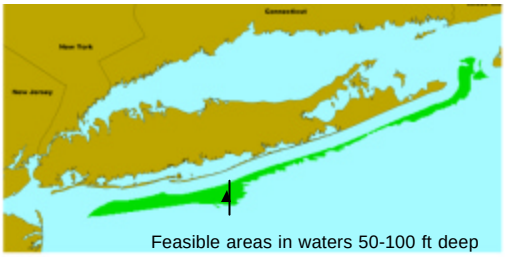
Long Island Offshore Feasibility





Feasible areas in waters 50-100 ft deep

- Sponsored by LIPA & NYSERDA
- Establish siting criteria
- Produce wind map
- Investigate legal & environmental issues
- Estimate transmission interconnection costs and impacts

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Conclusions

- Offshore is the *only* option for large-scale wind in many coastal areas
- Offshore poses interesting opportunities *and* big challenges
- Pioneering European experiences will provide useful lessons
- Hawaii is an obvious offshore candidate

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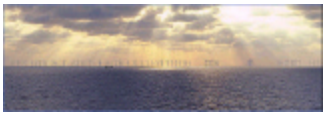
Offshore Feasibility for Oahu's East Shore



- **Preliminary discussions with HECO for a feasibility study**
- **Considerations:**
  - Siting based on water depth, wind resources, exclusion zones
  - Seabed morphology & waves
  - Grid interconnection
  - Potential environmental, visual and cultural impacts
  - Capital and O&M cost estimates
  - Economic analysis

aws scientific

Wind Regulatory and Policy Issues

Ronald L. Lehr, Attorney
4950 Sanford Circle West
Englewood, CO 80110-5127
303 504-0940
rllehr@msn.com

Wind in Utility Generation Portfolios

- Xcel Energy (PSCo)--Colorado PUC orders "good faith negotiations" for 162 MW wind farm
  - Gas price projections
  - Ancillary service costs
  - Forecasting
- Aquila Energy (Utilicorp United)--2 KS wind farms
- BPA--1000 MW wind RFP
- Pacificorp--Power Marketing RFP
- AEP/CSW--Renewables Subsidiary
- Excelon--Power Marketing Team/Community Energy

Wind in Markets for Customer Choice/Competitive Markets

- www.eren.doe.gov
- California
- New England: CT, MA, ME, NH, RI
- New Jersey
- Pennsylvania
- Texas
- Ohio

Wind in Utility Green Pricing Programs--

- Required in IO, MN, NT, WA
- 89 examples--NREL “Top Ten List” categories:
- Number of Customers : LADWP 89,000
- Percent of Customers : Moorhead, MN 7%
- MW of new renewables : Austin Energy 79.6
- Lowest premium charged : Roseville Electric, SMUD 1 cent/kWh

Wind in Voluntary Markets/Green Certificates

- Green Tags or Renewable Energy Credits
- Internet tags offerings:
  - www.Sterlingplanet.com <http://www.Sterlingplanet.com> (green tickets $30.00/month)
  - BEF: www.greentagsusa.org <http://www.greentagsusa.org>($40-220/yr--CO2 calculator)
  - PGE National Energy: www.purewind.net <http://www.purewind.net>(NY--$40.00)
  - Los Angeles: www.LADWP.com <http://www.LADWP.com> ($3.00/mo. Min.)
  - Vision Quest Windelectric: www.greenenergy.ca http://www.greenenergy.ca> (C$9.50 per 100 kWh)
  - Iowa Energy Tags (tm): www.waverlyia.com/WLP/ <http://www.waverlyia.com/WLP/> ($50 per tag)

Wind in Environmental Compliance

- Supplemental Environmental Projects (“SEPs”)
- Colorado Department of Public Health and Environment enforcement action
- Penalties due for violations
- Portion of penalties to wind purchase

Wind in Tax, Energy, and Utility Policies

- Production Tax Credit/REPI-extended until 12/31/03; five year extension pending
- Renewables Portfolio Standard
  - AZ, CT, HI (goal), IL, IO, ME, MA, MN (soft), NV, NJ, PA, TX, WI
- System Benefits Charges: 15 states
  - $265m/1500 MW to date (LBL)
  - http://cleanenergyfunds.org
  - CA, CT, DE, IL, ME, MA, MT, NJ, NM, NY, OH, OR, PA, RI, WI
- Net metering: 36 states

Wind in Energy Markets

- Wholesale market issues
  - Control area operators, ISO and RTO
  - scheduling requirements, imbalance penalties
- Operations integration
  - forecasting, dead bands, monthly netting at market prices

Hawaii Renewable Energy Resource Assessment

Karen Conover
Global Energy Concepts

Presented to
Hawaii Wind Working Group
Honolulu, Hawaii

April 8, 2002

Background

- ***Renewable Energy Resource Assessment and Development Program*** completed by GEC in 1995 as part of the Hawaii Energy Strategy
  - Identified potential sites for renewable energy projects in Hawaii
  - Collected wind and solar resource data
  - Developed cost and performance estimates for each potential project

Hawaii's Abundant Renewable Energy Resources

- *Wind*
- *Solar*
- *Geothermal*
- *Biomass*
- *Hydro*
- *Ocean technologies*

Approach to Estimating Cost and Performance

- ***Cost and performance based on site-specific resource data and conditions***
- ***Two conceptual plant designs were developed***
  - ***Current technology***
  - ***Future technology***
- ***Optimistic, nominal, and conservative cases were considered to account for uncertainty***
- ***Costs were estimated consistent with EPRI TAG methodology***

Approach to Estimating Cost and Performance (cont.)

- *Costs include permitting, interconnection, land acquisition, equipment, installation, commissioning, and O&M*
- *Transmission upgrade requirements based on best available information or utility IRP estimates*
- *Cost of energy calculated for each project for comparison purposes*

Update of Selected Cost and Performance Estimates

- *Completed for DBEDT in late 2000*
- *Focused on most promising technologies and locations*
- *Projects offer near-term opportunities*
- *Representative sampling – other projects are possible*
- *Most projects described in 1995 report; some variations*

List of Projects Included in 2000 Update

Technology	Island	Location	Capacity MW
Geothermal	Hawaii	Kilauea [1]	8, 22
Hydroelectric	Hawaii	Umauma Stream	13.8
	Kauai	Wailua River	6.6
Photovoltaic	Hawaii	N Kohola	5
	Oahu	Pearl Harbor	5
Wind	Hawaii	Kahua Ranch [2]	10
		Lalamilo Wells	3, 30, 50
		North Kohala	5, 15
	Kauai	N. Hanapepe	10
		Port Allen	5
	Maui	McGregor Point [2]	20
		NW Haleakala	10, 30, 50
		Puunene	10, 30
	Oahu	Kaena Point	3, 15
		Kahuku	30, 50, 80

[1] The 8 MW project is a topping unit that could be added to the existing 30 MW facility. The 22 MW project could be installed in 2005 as a separate power plant at the same location.

[2] Future projects were not evaluated because actual projects are currently under development which will preclude additional projects at these locations.

Cost of Energy – Current Projects (2000)

Technology	Island	Location	Capacity MW	COE $/kWh
Geothermal	Hawaii	Kilauea	8	$0.045
Hydroelectric	Hawaii	Umauma Stream	13.8	$0.076
	Kauai	Wailua River	6.6	$0.093
Photovoltaics	Hawaii	N Kohola	5	$0.298
	Oahu	Pearl Harbor	5	$0.305
Wind	Hawaii	Kahua Ranch	10	$0.055
		Lalamilo Wells	3	$0.044
		Lalamilo Wells	30	$0.046
		Lalamilo Wells	50	$0.044
		North Kohala	5	$0.043
		North Kohala	15	$0.043
	Kauai	N. Hanapepe	10	$0.067
		Port Allen	5	$0.073
	Maui	McGregor Point	20	$0.051
		NW Haleakala	10	$0.055
		NW Haleakala	30	$0.064
		NW Haleakala	50	$0.061
		Puunene	10	$0.077
		Puunene	30	$0.083
	Oahu	Kaena Point	3	$0.068
		Kaena Point	15	$0.070
		Kahuku	30	$0.067
		Kahuku	50	$0.059
		Kahuku	80	$0.069

Cost of Energy – Future Projects (2010)

Technology	Island	Location	Capacity MW	COE $/kWh
Geothermal	Hawaii	Kilauea (in 2005)	22	$0.044
Hydroelectric	Hawaii	Umauma Stream	13.8	$0.075
	Kauai	Wailua River	6.6	$0.092
Photovoltaics	Hawaii	N Kohola	5	$0.205
	Oahu	Pearl Harbor	5	$0.212
Wind	Hawaii	Lalamilo Wells	3	$0.037
		Lalamilo Wells	30	$0.038
		Lalamilo Wells	50	$0.037
		North Kohala	5	$0.036
		North Kohala	15	$0.036
	Kauai	N. Hanapepe	10	$0.057
		Port Allen	5	$0.062
	Maui	NW Haleakala	10	$0.047
		NW Haleakala	30	$0.053
		NW Haleakala	50	$0.051
		Puunene	10	$0.061
		Puunene	30	$0.069
	Oahu	Kaena Point	3	$0.057
		Kaena Point	15	$0.058
		Kahuku	30	$0.055
		Kahuku	50	$0.054
		Kahuku	80	$0.057

Small-Scale Applications Also Exist

- *Grid-connected*
- *Remote, off-grid*
- *Applications on all islands*

- *Only small-scale applications considered on Molokai and Lanai*

Conclusions

- *Significant cost and performance improvements achieved since 1995*
- *Wind and geothermal offer least cost*
- *Significant opportunities exist on all islands*

Wind Energy on the Big Island

Presented by:
Dan Giovanni, Manager, Production Department
Hawaii Electric Light Company, Inc

Presented at:
USDOE/DBEDT Wind Energy Forum
Honolulu Hawaii
April 8, 2002

History

Existing Wind Farms
Kamaoa: 7.0 MW
Lalamilo: 2.3 MW

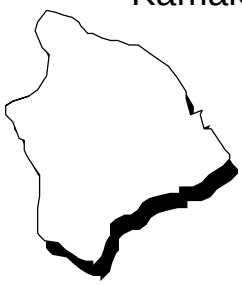
History

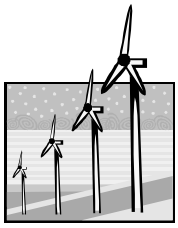
No longer in Operation:

Wind Power Pacific Investors 1: 306 kW

Wind Power Pacific Investors 2: 3060 kW

Kamakani Ikaika: 500 kW

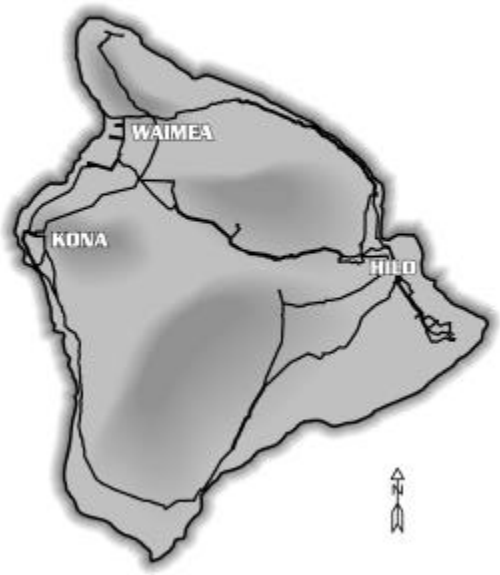




HAWAII ISLAND

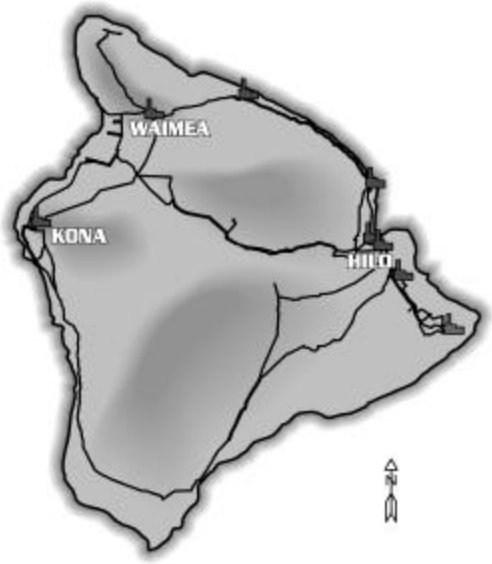
Transmission Lines

HAWAII ISLAND
Major Load Centers

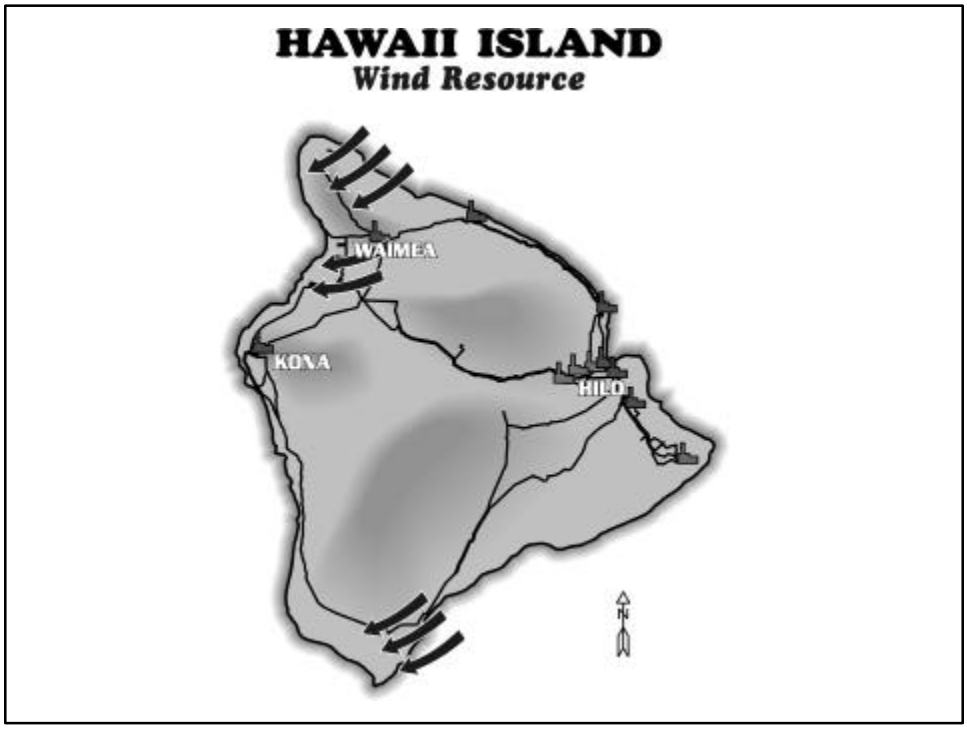


HAWAII ISLAND
Thermal Generation

HAWAII ISLAND
Geothermal

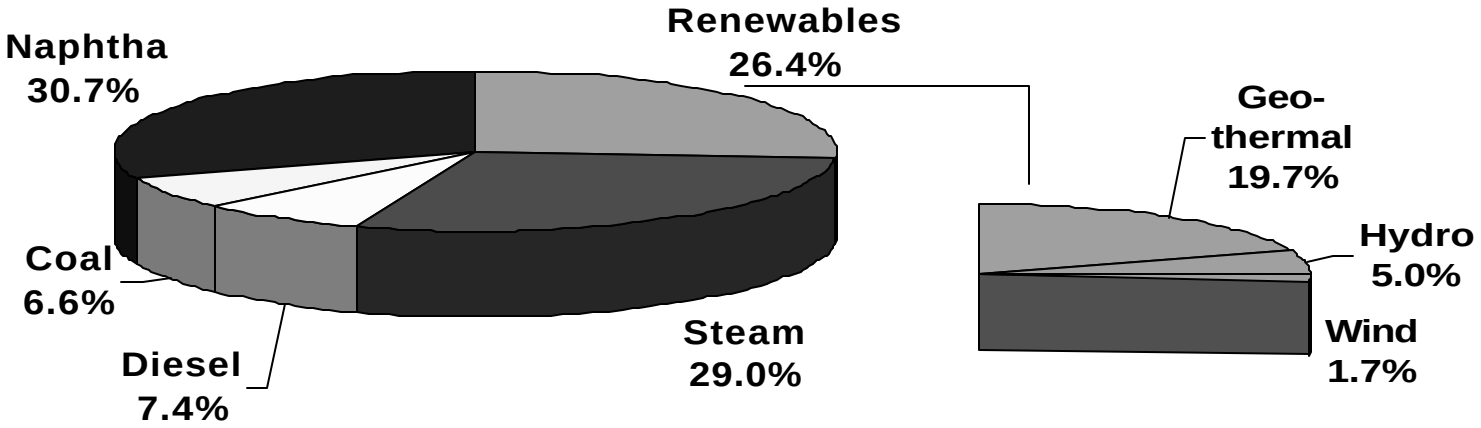


HAWAII ISLAND
Hydroelectric


HAWAII ISLAND
Wind Resource
WAIMEA
KONA
HILO
N

Renewables on the HELCO System in 2001

Renewable energy resources including hydroelectric, wind, and geothermal, supplied approximately 26% of the Big Island's electricity needs in 2001.



GEOTHERMAL provided 19.7% of the island's electricity in 2001. The Puna Geothermal Venture power plant is located in the lower Puna district near Pohoiki.

HYDRO supplied 5.0% of the island's electricity in 2001. Power plants include HELCO's Puueo and Waiau hydroelectric plants and the Wailuku River Company's hydroelectric facility all located on the Wailuku River near Hilo.

WIND supplied 1.7% of the island's electricity needs in 2001. HELCO's Lalamilo wind farm located near Waimea is capable of producing up to 2.0 megawatts of wind power. HELCO also purchases power from Apollo Energy Corporation's wind farm located at South Point. Future wind projects from independent power producers are planned at Kahua Ranch and Upolu Point in North Kohala.

SOLAR benefits thousands of Big Island customers by providing power through small-scale photovoltaic (PV) systems and by reducing electrial loads through solar water heating. Large PV installations by non-utility generators provide over 200 kilowatts of load reducing power. HELCO continues to promote solar technologies through education and demonstration projects including the Sun Power for Schools program.

System Load Demand

Throughout the day, the system load demand varies on the HELCO power grid

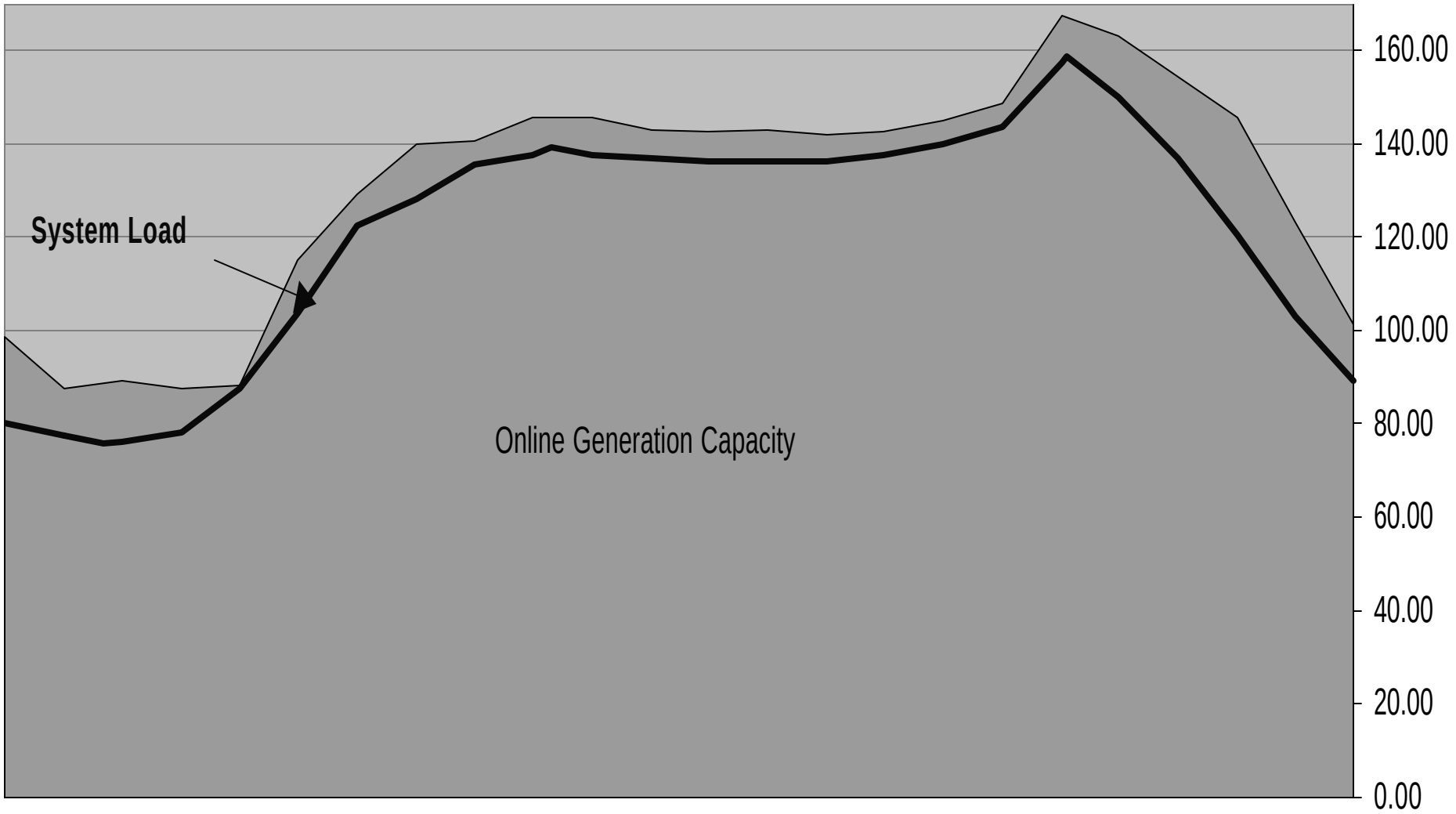
The minimum load is in early morning

The peak load is at dusk

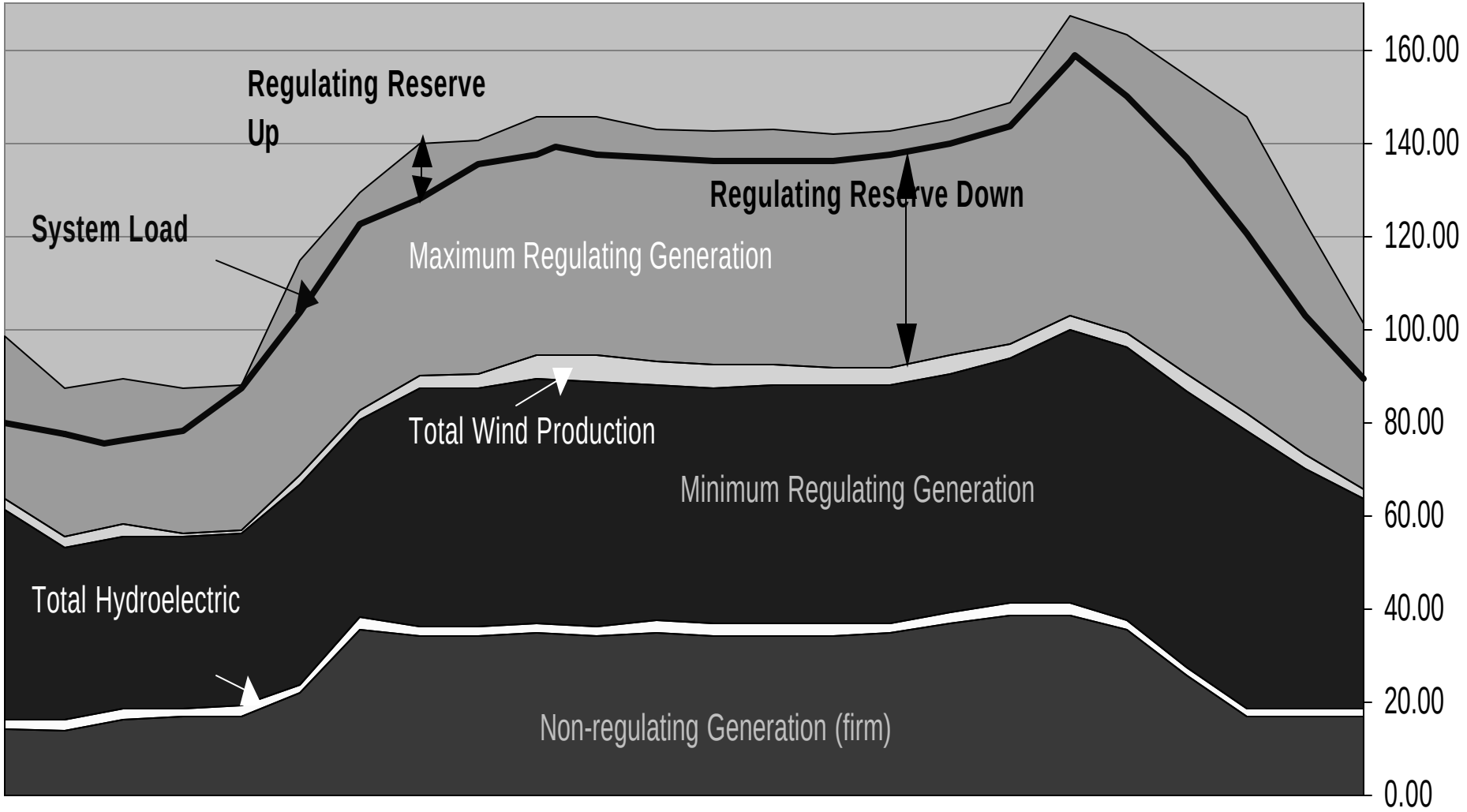
System Operations

HELCO System Operations matches the generation production to the system demand throughout the day

HELCO Load Curve for 3/21/02
Generation Capcacity from Actual Measured Data



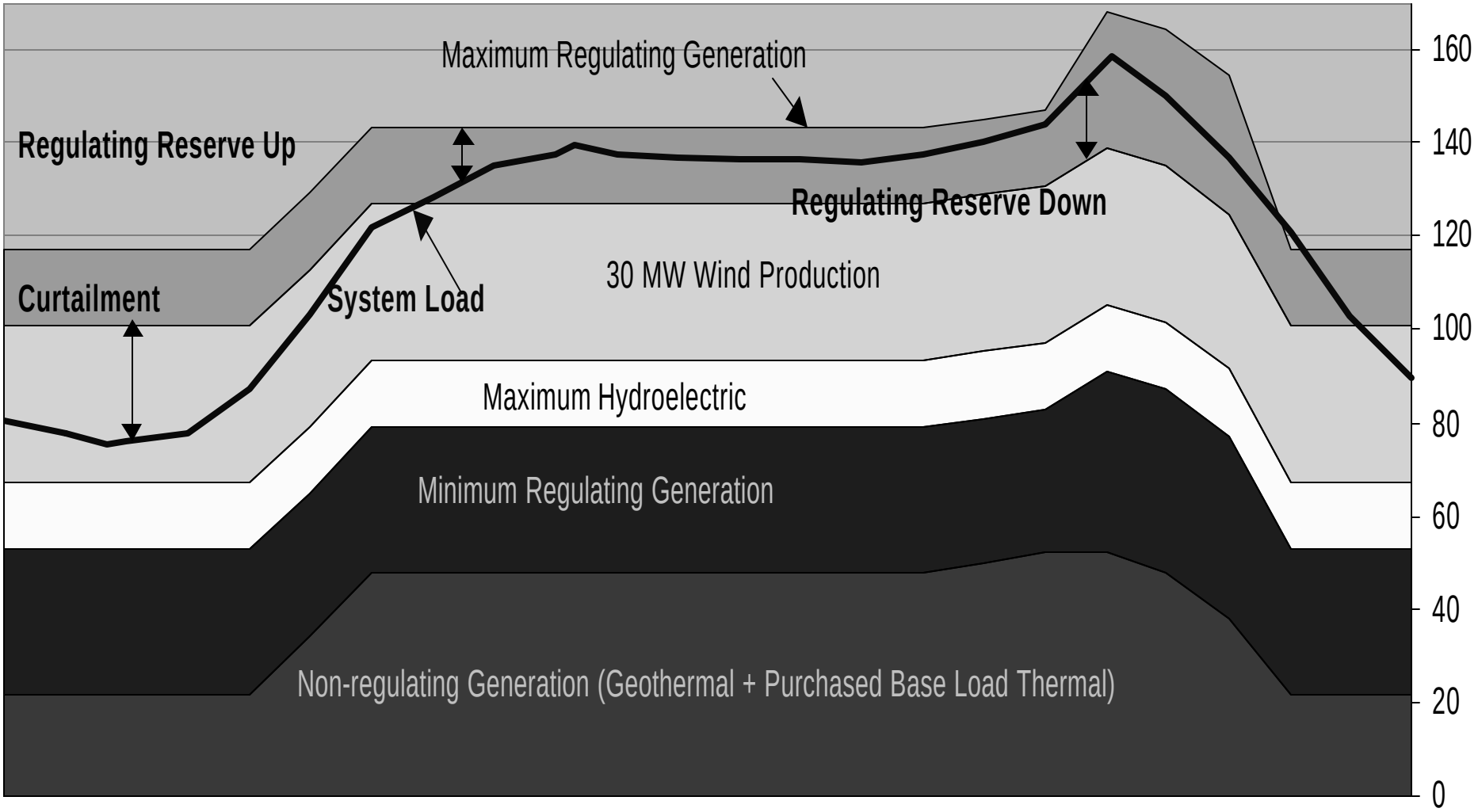
HELCO Load Curve for 3/21/02
Generation Characteristics from Actual Measured Data



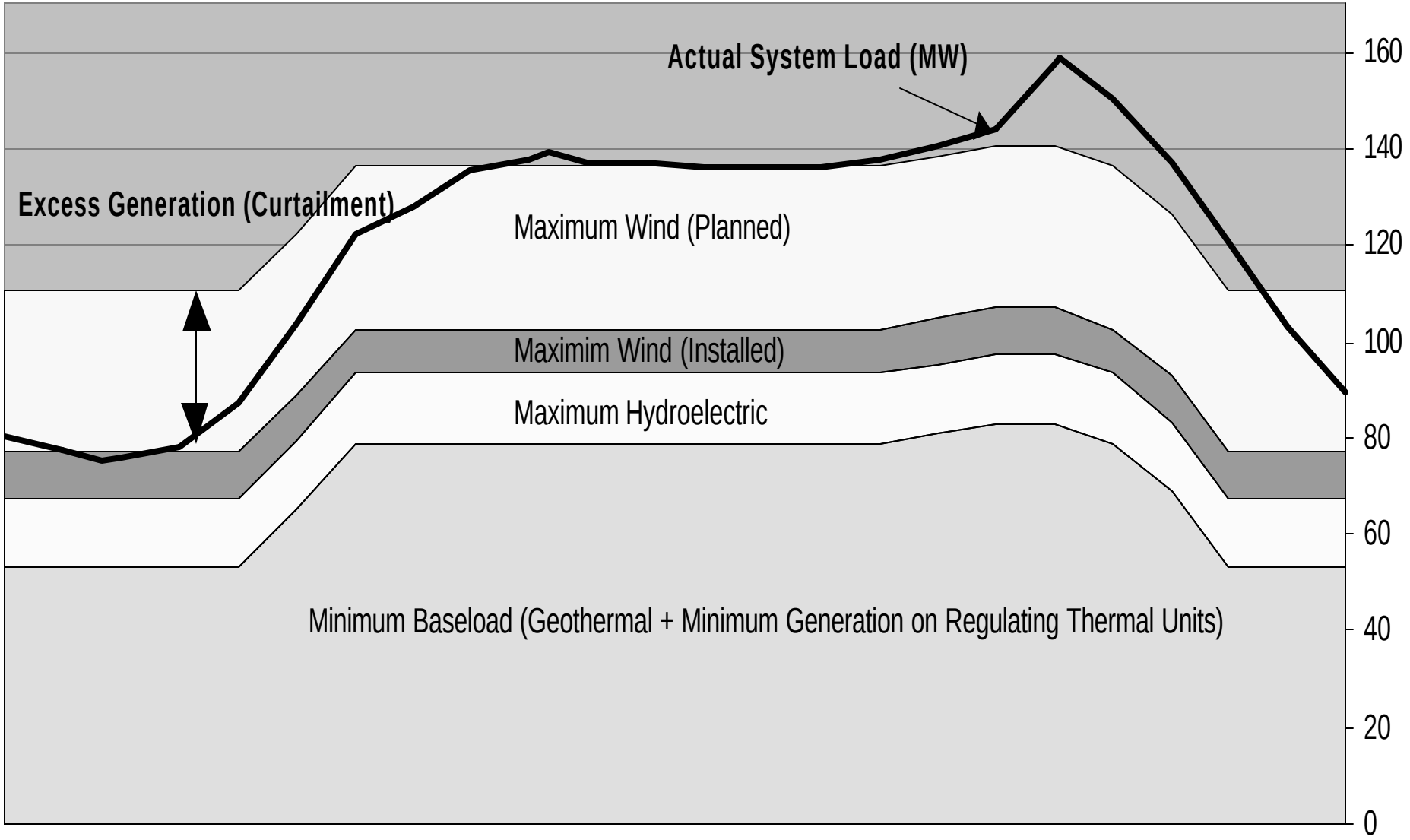
HELCO Load Curve for 3/21/02

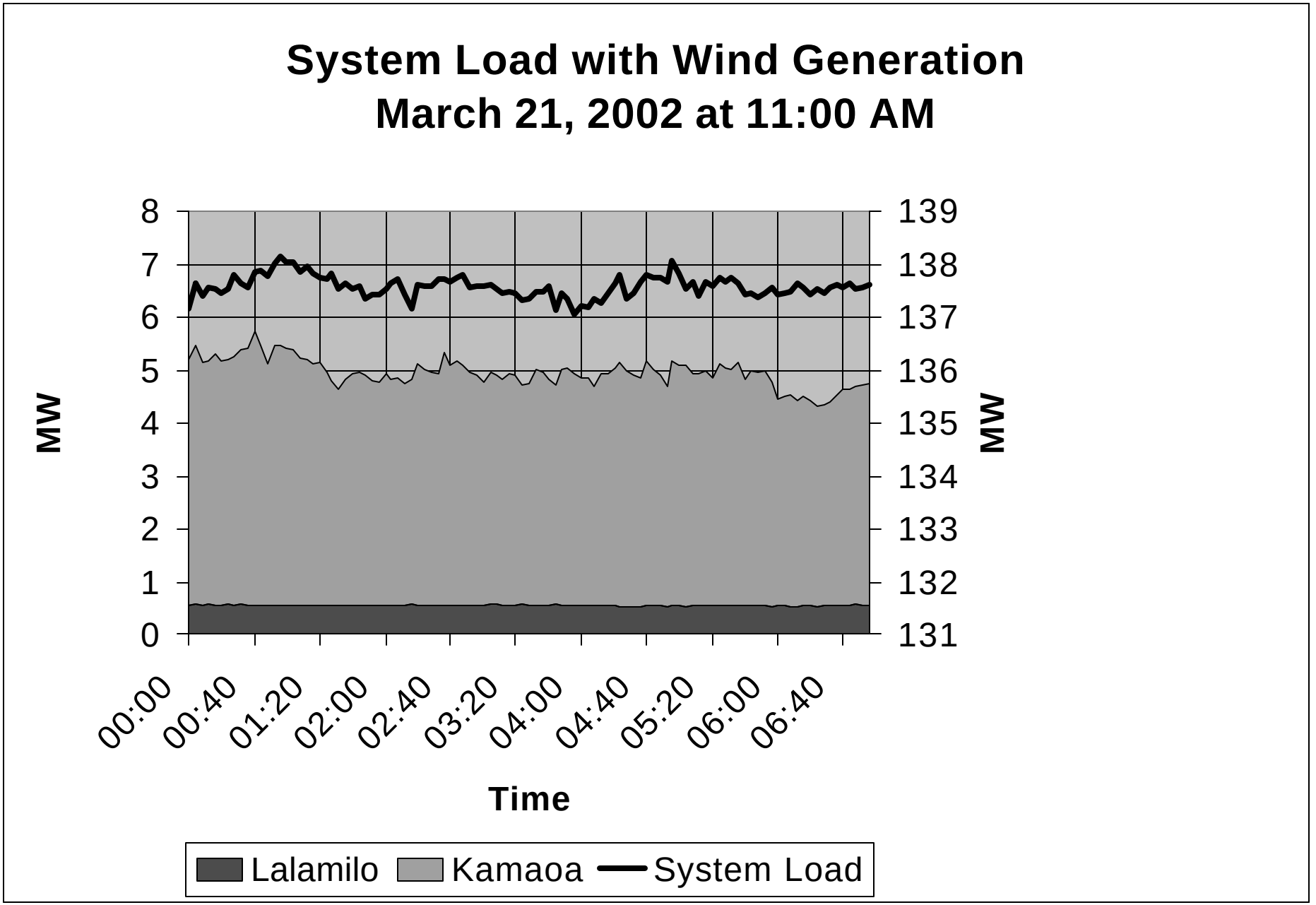
Generation Characteristics for Future Wind Production

(Assumes Three Steam Units can Maintain Frequency)



HELCO Load Curve (Typical)
With Minimum Base-load + Maximum As-avaialable Generation




System Load with Wind Generation
March 21, 2002 at 11:00 AM
MW
MW
8
7
6
5
4
3
2
1
0
139
138
137
136
135
134
133
132
131
00:00
00:40
01:20
02:00
02:40
03:20
04:00
04:40
05:20
06:00
06:40
Time
Lalamilo
Kamaoa
System Load

Conclusions

- Electricity generation on the Big Island is very diversified with 26% from Renewables in 2001
- Experience with 1st-generation wind turbine technology dates back to 1985; comprised <5% of total generation at apex.
- Load centers and load growth in concentrated in West Hawaii and generation is concentrated in East Hawaii, hence transmission issues are critical in terms of technical infrastructure and cost.
- Wind resources are very good on the Big Island but located at weak spots in the transmission system and where electricity demand (i.e., load) is minimal.
- New wind farms totaling 43 MW in progress (>25% of peak demand)

Conclusions (cont'd)

- Load varies by factor of 3X on a daily basis; balancing of load and generation achieved primarily through automatic generation control (AGC) of thermal units.
- Wind energy is volatile on sub-second basis, which can adversely affect power quality. Need 3rd-generation wind turbine technology to help alleviate power quality problems (e.g, frequency deviation) on the grid.
- Renewable generation (wind, hydro, geothermal) can not be scheduled when needed.
  - Wind accommodated today due to amount of wind generation relative to that of regulating units.
  - Future--- To accommodate significantly more wind generation, wind farms must meet power quality standards and face curtailments at times.

Thank You

Wind Energy Development on Oahu, Maui and Molokai

U.S. Department of Energy
Wind Working Group Meeting

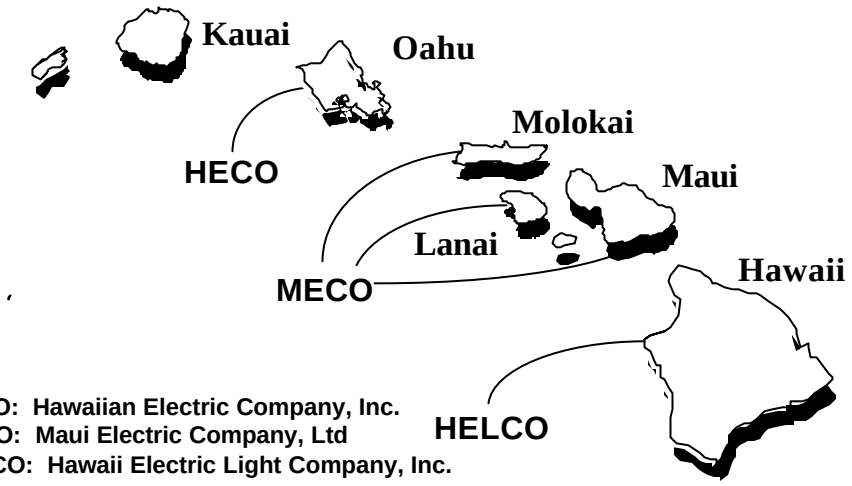
Arthur Seki
Hawaiian Electric Company, Inc.

Honolulu, Hawaii
April 8, 2002

Presentation Topics

- **Electric utility background**
- **Wind development activities on various islands**
  - **Oahu**
  - **Maui**
  - **Molokai**

Hawaiian Electric Company Utilities



HECO: Hawaiian Electric Company, Inc.
MECO: Maui Electric Company, Ltd
HELCO: Hawaii Electric Light Company, Inc.

Characteristics of Hawaii Utilities

- Relatively small utility systems.
- No grid interconnections.
- Generation reliability is critical.

	Oahu	Big Island	Maui	Molokai	Lanai
System Capability (net), MW	1,615	253	245	12.0	10.4
Recorded System Peak (net), MW	1,191	174	191	6.5	5.2
Recorded System Minimum (net), MW	519	69	77	2.3	1.9

Kahuku Wind Energy Research MOD-0A Wind Turbine (1980)

- U.S. Department of Energy/NASA wind demonstration project
- HECO operated MOD-0A for 2 years
- Westinghouse 200 kW design
- Most productive of all 4 MOD-0A installations
- Capacity factor ~36 percent

Kahuku Wind Farm Development Wind Farm, Ltd. (1981)

- 80 MW private wind farm development at Kahuku
- EIS prepared
- 20-4 MW wind turbines
- 138 kV line from Wahiawa to Kahuku
- Project never developed

Kahuku Wind Farm
Westinghouse Wind Turbines (1985)

- **HERS owned and operated from 1985-1993**
- **15 - 600 kW Westinghouse turbines**
- **Production lower than projected**
- **Operation and maintenance was higher than projected**
- **Westinghouse design**

Kahuku Wind Energy Research
Boeing Mod-5B Wind Turbine (1987)

- **HERS owned and operated from 1987-1993**
- **3,200 kW Boeing turbine**
- **World's largest wind turbine**
- **Last of federal-sponsored turbines**
- **Production was lower than projected**

Kahuku Wind Farm (1985)

- HERS owned and operated 12 MW wind farm from 1985 to 1993
- U.S. Windpower proposed a 15 MW wind farm (1991)
  - PUC approved power purchase agreement; however at lower price
  - U.S. Windpower decided not to pursue
- New World Power owned and operated from 1993 to 1996 (bankrupt)
- Reverted to landowner, Campbell Estates
- U.S. Army acquiring parcels at Kahuku for training

Kaena Point Wind Energy Development (1994)

- Air Force examined (1-2 MW) wind farm development
- DOD funds available for renewable energy development
- Wind turbine solicitation
- Draft EA developed for review. Issues raised related to
  - Aesthetics
  - Bird kills
  - Cultural
  - Archeological
- Air Force withdrew solicitation--recommended project not be funded

Maui Wind Energy Development
Windane Wind Turbine (1984)

- Danish Pacific Windpower owned and operated
- MECO hosted 340 kW wind turbine demonstration
- MECO later purchased the unit (1989)
- Dismantled due to structural problems (1991)

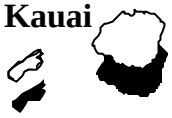
Maui Wind Energy Development
(1984, 2002)

- 10 MW private wind farm development in Kapalua (1984)
  - Power purchase agreement (PUC approved)
  - Problems in obtaining financing and land lease
  - Power purchase agreement terminated (1989)
- Future 20 MW private wind farm development in Kaheawa (2001)
  - EIS accepted
  - CDUP received
  - Negotiating for land lease

Molokai Wind Energy Development
Vestas Wind Turbines (1991)

- 1 MW private wind farm development on Molokai
  - Power purchase agreement (PUC approved)
- Wind-Diesel wind farm demonstration
  - 3-100 kW Vestas wind turbines
  - 1-100 kW diesel generator
- Electronic problems due to possible lighting strike (1994)
- Power purchase agreement terminated (1997)

Where Will Future Wind Energy Come From?



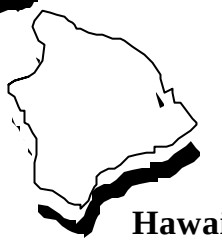
Kauai

Max. potential* – 95 MW
~~DOE 5% goal – 350 MW~~

Oahu

Max. potential* – 100 MW
~~DOE 5% goal – 42 MW~~

Maui



Hawaii

* Max. wind generation potential identified for Hawaii; "Renewable Energy Resource Assessment & Development Program", Year 2000 update (DBEDT)

Maui may have excess wind resources; Oahu may be limited

Interconnect Islands & Export Wind Energy

- Interconnecting island grid systems would allow exporting of wind energy to Oahu
- Interconnection studies have been performed:
  - Tri-Island Study (1985)
  - Tri-Island Cable Project (1989)
  - Hawaii Deep Water Cable Program (1990)
  - HECO Generation Siting Study (1992)
- Technically feasible, but economics are not attractive

Off-shore Wind Energy on Oahu

- Oahu is Hawaii's primary load center; however, suitable wind sites on Oahu are limited
- Land-intensive renewable energy projects must compete with other uses
- Off-shore wind energy may be an option to expand wind development for Oahu

Conclusions

- **Goal**
  - **U.S. Department of Energy "Wind Powering America"—5% wind by 2020**
- **Wind incentives**
  - **Federal wind production tax credit extended to the end of 2003**
  - **State wind tax credit available to mid-2003**
- **Future development**
  - **20 MW wind farm at Kaheawa, Maui**
  - **Possible offshore wind development for Oahu**

Wind-related Collaborative Efforts in Hawaii Over the Past 10 Years

Maria Tome

State of Hawaii
Department of Business,
Economic Development & Tourism
(www.state.hi.us/dbedt/ert)

Presentation Overview

1993-1994:	Energy and Environmental Summit
1994:	Hawaii Wind Workshop
1994-1996:	Renewable Energy Collaborative (PUC Docket 94-0226)
1995, 2000:	Hawaii Energy Strategy

1993-1994:
Energy and Environmental Summit

- Collaborative process convened by the Legislature to solicit input on energy and environmental legislation
- Kick-off meeting held in June, 1993. Committees formed:
  - Education
  - Compliance and Enforcement
  - Energy
  - Recycling
- Between June and October, committees met to discuss issues and draft legislation
- Summit held on October 23, 1993.
- Several legislative measures were introduced in the 1994 session. Some measures succeeded; others failed
- Some bills that did not pass in 1994 have since been enacted.

1994:
Hawaii Wind Workshop

Technology and Industry - Presenter: Sue Hock (NREL); Panel Members: Eric Miller (Kenetech), Bob Gates (Zond), Jeff Maurer (NWP), Robert Lynette (RLA), Edan Harel (TRM)

Resource Availability - Presenter: Karen Conover (R. Lynette & Associates); Panel Members: Monty Richards (KRL), Dick Cameron (HC&S), Mason Young (DLNR)

Utility Integration Issues - Presenter: Charlie Smith (Electrotek); Panel Members: Alva Nakamura (HECO), Ed DeMeo (EPRI), Jonathan Lynch (NPS)

Project Development - Presenter: Dr. Jan Hamrin (Hansen, McQuat, Hamrin & Rohde, Inc.); Panel Members: Dan Ching (HECO), Curt Maloy (NWP), Keith Avery (Zond)

Government Support to Industry - Presenters: Ron Loose (DOE), Maurice Kaya (DBEDT); Panel: Lawrence Mott (NPS), Mike Boughton (MEDB), Dr. David Rezachek (DBEDT)

Benefits of Windpower to Hawaii - Presenter: Tom Gray (AWEA); Panel members: Dr. Richard Joun (DBEDT), John Mapes (CA), Paul Brewbaker (BOH)

Integrated Resource Planning - Presenter: David Moskovitz (Consultant); Panel: Roy Uemura (HECO), Blair Swezey (NREL), Colette Gomoto (PUC)

Stakeholder Perspectives - Chairman: Andrew Trenka (PICHTR); Presenters: Ron Lehr (Consultant), Tom Jezierny (MECO), Warren Lee (HELCO)

Public Perspectives - Presenter: Clyde Murley (NRDC); Panel Members: Dr. Ira Rohter (GP), Scott Derrickson (HEC), Dr. Michael Jones (UCS)

Regulatory Perspectives - Presenter: David Moskovitz (Consultant); Panel: Yukio Naito (PUC), Gerry Sumida (Carlsmith Ball), Ron Lehr (Consultant)

Legislative Perspectives - Presenter: Eric Sikkema (National Conference of State Legislatures); Panel: Matt Matsunaga (Hawaii), Dr. Duke Bainum (Hawaii), Robert Herkes (Hawaii)

1994 Hawaii Wind Workshop:
Proceedings Available

Proceedings of the 1994 Hawaii Wind Workshop are available:

www.hawaii.gov/dbedt/ert/hww94

1994-1996:
Renewable Energy Collaborative

Public Utilities Commission (PUC) Docket 94-0226 was initiated, at the request of the 1994 Legislature, to:

- Study the policies, statutes, and programs of other jurisdictions, as well as the strategies employed by these jurisdictions to implement the deployment of renewable energy resources;
- Examine policies presently employed by the State of Hawaii with respect to facilitating the utilization of renewable energy resources;
- Identify barriers to the development of renewables in Hawaii, and
- Formulate strategies to remove the barriers and implement the use and development of renewables in Hawaii.

Renewable Energy Collaborative:
Parties to the Docket

21 Parties:

- **Counties** of Hawaii, Kauai, and Maui
- **State agencies**: DBEDT, DCCA
- **Utilities**: HECO, MECO, HELCO, KE
- **Land Owners**: Hawaiian Commercial and Sugar Company; Kahua Ranch, Ltd.
- **Non-utility energy companies**: Inter-Island Solar Supply; Makani Uwila Power Corporation; Energy Resource Systems; TRM/Wind Energy International, Inc.; Waimana Enterprises, Inc.; Zond Pacific, Inc.
- **Consultants**: the Pacific International Center for High Technology Research; RLA Consulting Inc.
- **Individuals**: the Honorable Senator Matt Matsunaga; David Rezachek

Renewable Energy Collaborative:
NREL Report

Recommendations:

- A clear pronouncement by the State that renewable energy development remains an important objective, and the establishment of a concrete goal for renewable development and supporting policies.
- Establishment by the State of an official preference that all new generating capacity employ renewable energy resources unless it is demonstrated, on a case-by-case basis, that the employment of renewables is not in the public interest.
- Development of financial incentives to utilities, renewable energy providers, and customers that could be funded from general revenues or by a "systems benefit charge" assessed on all electricity customers.

Renewable Energy Collaborative:

NREL Report

Recommendations (continued):

- Establishment of a portfolio standard to create a market for the development of renewables by imposing a minimum renewable energy requirement for the State's electricity mix.
- Development by the utilities of a competitive green power product that allows customers to exercise voluntarily a preference for electricity from renewable energy sources.
- Authorization for alternative renewable energy providers to supply renewable energy service options directly to a utility's wholesale and retail customers.
- Establishment of a net energy metering policy that allows customers to offset high retail rates with small-scale renewable electric systems.

Renewable Energy Collaborative:

Barrier Groupings

Barriers grouped into 10 categories:

1: Avoided cost
2: Penetration level
3: Permitting & Land Availability
4: RE Revenue Stream & financing
5: RE not in Utility 20-year plans
6: Lengthy power purchase negotiations
7: Regulatory Structure
8: Environmental & Social Impacts
9: Status of technologies
10: Governmental Commitment

Barrier Grouping #1: Insufficient avoided cost prices for developer financing

1.a - Uncertainties regarding the applicability and availability of state income tax credits to renewable energy ("RE") projects

1.b - Cost effectiveness of RE resources

1.c - Unresolved avoided cost issues

1.d - Current fuel adjustment clause passes risk of oil price variability to customers

1.e - Evaluation and consideration of the beneficial impacts of renewable energy use relative to conventional fossil fuel resources

1.f - Inability of utility system operation models and economic models to accurately and adequately model and evaluate renewable energy systems

Strategies Proposed to Address Issues in Barrier Grouping #1

1.a.1 - Seek clarification from DoTax regarding applicability of existing tax credits to large RE facilities

1.a.2 - Support and maintain existing RE tax credits to the extent appropriate

1.a.3 - Examine the efficacy of additional State incentives to encourage RE

1.b.1 - Deploy renewables that appear to be currently cost-effective… monitor costs of other renewables

1.b.2 - Improve the cost-effectiveness of renewable resources through research, development, and demonstration

1.b.3 - Increase/refocus the government tax incentives currently available

1.b.4 - Provide government support in addition to government tax incentives (to expedite permitting, to make government sites available, etc.)

1.b.5 - Develop and implement a green pricing tariff

1.b.6 - Energy wheeling for counties

1.b.7 - Net billing payment rates for small RE systems

1.c.1 - Reduce the uncertainty regarding avoided costs

1.c 2 - If any avoided capacity costs can be reasonably demonstrated for an as-available resource, the amount … should be included in determining the value and pricing of the resource

1.c.3 - Analyze combined effects of a variety of distributed renewable energy projects in a given service area

1.d.1 - PUC eliminate the ECAC on a forward-going basis

1.d.2 - Conduct analysis (on how to) flatten the risk and impacts on ratepayers of oil price variability

1.e.1 - Require utilities to pay an externalities adder above avoided cost

1.e.2 - Develop and implement a "green pricing" tariff

1.e.3 - Consider a production incentive for RE developers funded by a utility customer surcharge

1.f.1 - The PUC should approve the stipulated agreement ... and resolve … Docket No. 7310

1.f.2 - Consider modeling conventions and generation capacity expansion criteria that are sensitive to the contribution of as-available resources towards system reliability

Renewable Energy Collaborative:
Report Available

The 1996 Public Utilities Commission Report to the Hawaii State Legislature, "*STRATEGIES TO FACILITATE THE DEVELOPMENT AND USE OF RENEWABLE ENERGY RESOURCES IN THE STATE OF HAWAII*," is available:

www.hawaii.gov/dbedt/ert/puc940226

1995, 2000:
Hawaii Energy Strategy

TECHNICAL ADVISORY GROUPS

Technical Advisory Groups were comprised of members of Hawaii's "energy community", including energy companies, utilities, environmental groups, and state and county government organizations. Sub-committees were formed for periodic review of the progress and results of each project.

PUBLIC PARTICIPATION WORKSHOPS

October 23, 1992.	130 participated in the workshop; 82 participated by mail.
January 11, 1994.	180 registered to attend and another 110 who could not attend requested a copy of the *Status Report* and the questionnaire.
September 20, 1995.	Workshop presented final report and provided the public with a final opportunity for input into the 1995 HES.
December 9, 1999.	Workshop presented updated HES (HES2000) and received public comments. About 80 participants.

Hawaii Energy Strategy:
Report Available

The Hawaii Energy Strategy 2000 report is available:

www.hawaii.gov/dbedt/ert/hes2000

Summary

- Information is available from previous workshops and "working group" efforts
- Some of those efforts were quite broad; consensus was difficult
- Since those previous efforts, some important advancements have been made in wind energy
- Other previously-identified issues remain
- Using existing work will avoid the need to start from scratch

A PERPECTIVE ON THE FUTURE OF WIND IN HAWAII

HREA COMMENTS

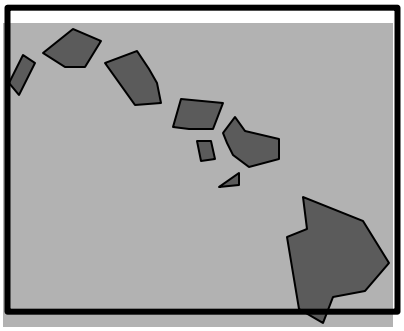
HAWAII WIND WORKING GROUP

HONOLULU, HAWAII

APRIL 8, 2002

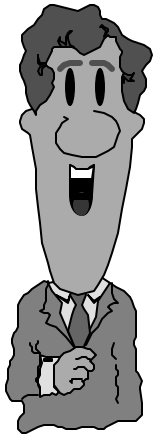
AGENDA

- HREA'S MISSION AND OBJECTIVES
- HISTORY – WHAT HAVE WE LEARNED?
- FUTURE – HOW DO WE INVENT IT?



HREA MISSION

HREA WILL PR0MOTE, THROUGH EDUCATION AND ADVOCACY, THE UTILIZATION OF RENEWABLES FOR A SUSTAINABLE, ENERGY-EFFICIENT, ENVIRONMENTALLY-FRIENDLY, ECONOMICALLY-SOUND FUTURE FOR HAWAII



HREA OBJECTIVES

- EDUCATE STAKEHOLDERS IN HAWAII REGARDING THE ENERGY, ENVIRONMENTAL AND ECONOMIC BENEFITS OF RENEWABLES, AND
- SUPPORT THE INCREASED USE OF RENEWABLES IN HAWAII FOR ALTERNATIVE PATHS TO HEATING SOURCES, ELECTRICITY AND FUELS

HREA MEMBERS

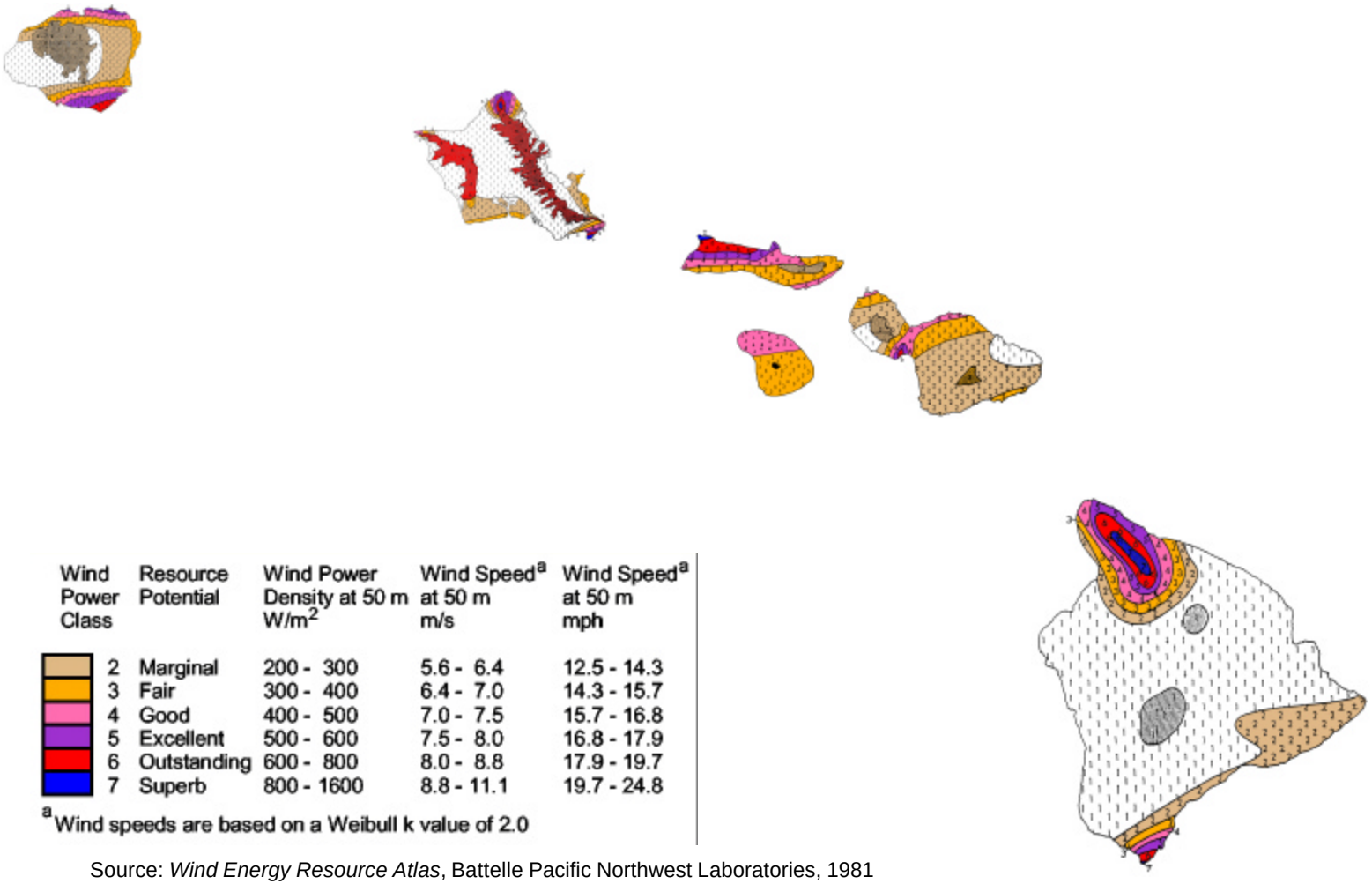
INDIVIDUALS PLUS:

- **APOLLO ENERGY CORPORATION**
- **ENRON WIND CORPORATION**
- INTER ISLAND SOLAR SUPPLY
- POWERLIGHT CORPORATION
- WAILUKU RIVER HYDRO

HISTORY – WHAT HAVE WE LEARNED?

- **1980's – HAWAII'S WINDFARMS**
  - **LIKE IN CA, DEVEOPERS HAD PROBLEMS WITH PROTOTYPE TURBINES AND SITING ARRAYS**
  - **HOWEVER, PROJECTS WERE NOT RE-POWERED: ONLY TWO REMAIN ON-LINE (LALAMILO AND S. POINT)**
- **1994 – WIND WORKSHOP**
  - **BETTER TURBINES, LOWER COSTS**
  - **DO INTERCONNECTION STUDIES**
  - **CONSIDER NEW IPP PROPOSALS**

1981 MAP OF HAWAII'S WIND RESOURCE



Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

[a] Wind speeds are based on a Weibull k value of 2.0

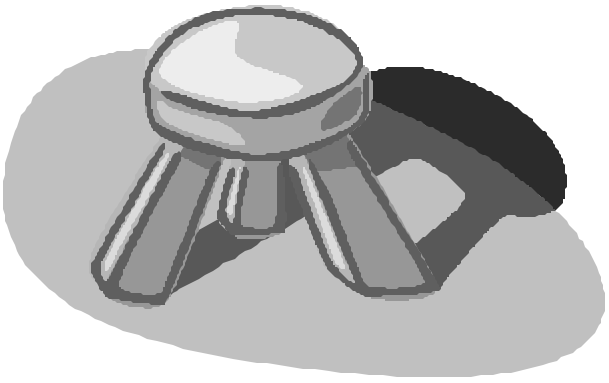
Source: *Wind Energy Resource Atlas*, Battelle Pacific Northwest Laboratories, 1981

Additional wind data available on the Web: www.hawaii.gov/dbedt/ert/winddata

HISTORY – CONTINUED

- **LATE 1990's to TODAY – WHERE ARE WE?**
  - **KAHUA RANCH (ON-LINE – 2002?)**
  - **HAWI (PPA), SOUTH POINT (PPA)**
  - **MAUI (PPA/LEASE), KAUAI (SITE)**
  - **OAHU (IN SEARCH OF A SITE)**
  - **WHAT MAKES A PROJECT VIABLE?**

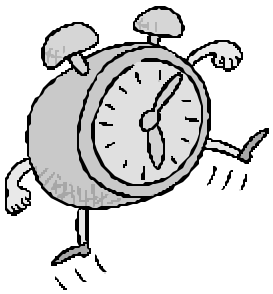
What makes a project viable?



Seat = Project Design/Ownership; Three Legs = Site, Market and Financing

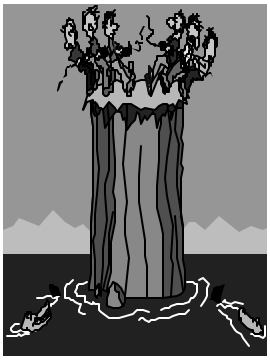
FUTURE – HOW DO WE INVENT IT?

- **CHANGE THE PARADIGM!**
- **SOLVE THE TECHNICAL PROBLEMS!**
- **CREATE A SUSTAINABLE ENERGY FUTURE -- CONSERVE, BE ENERGY EFFICIENT AND WEAN HAWAII OFF OF FOSSIL ENERGY!**



CHANGE THE PARADIGM!

- **TODAY**
  - **RENEWABLES ARE USED WHEN CONVENIENT**
  - **WE LAG THE MAINLAND IN NEW RENEWABLE FACILITIES**
  - **WE HAVE LIMITED COMPETITION IN A REGULATED MARKET**
  - **WE LIVE IN A PURPA WORLD WHERE UTILITY HAS UPPER HAND IN NEGOTIATIONS**

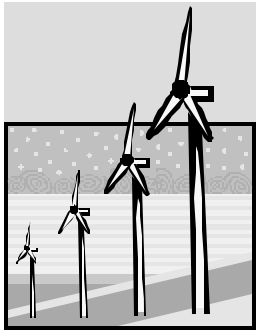


CHANGE THE PARADIGM - CONTINUED!

- **TOMORROW**
  - **RENEWABLES ARE #1, FOSSILS PROVIDE BACK-UP UNTIL THEY ARE NOT NEEDED**
  - **INCREASED COMPETITION AND INNOVATION WITH RPS IN A RESTRUCTURED MARKET**
  - **UTILITY AND IPPs WORK IN PARTNERSHIP**

SOLVE THE TECHNICAL PROBLEMS!

- **STRENGTHEN THE GRID TO ACCEPT MORE DG - GRID MUST BE ROBUST TO ALLOW OMNI-FLOW OF ELECTRONS**
- **ADD STORAGE TO ACCEPT MORE WIND AND OTHER INTERMITTENTS - PUMPED-STORAGE AND BATTERIES NOW, HYDROGEN LATER**
- **ADD SOPHISTICATED CONTROLS TO MAINTAIN GRID STABILITY - ALREADY PROVEN IN REMOTE, SMALL GRIDS, E.G., ALASKA**



CREATE A SUSTAINABLE ENERGY FUTURE!

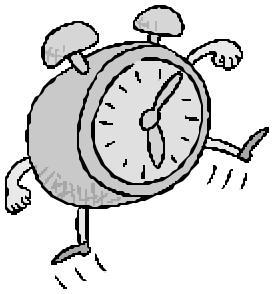
- **POTENTIAL FOR WIND IN HAWAII – FIRST CUT**
  - **ARE THERE LIMITS TO THE PENETRATION OF WIND?**
  - **WHAT PERCENTAGE OF OUR ELECTRICTY CAN WE GENERATE FROM WIND?**
  - **HOW WOULD IT VARY BY ISLAND?**
  - **HOW COULD WE BE INNOVATIVE?**

CREATE A SUSTAINABLE ENERGY FUTURE!

- **ANSWERS**
  - **YES**
  - **100% -- WELL, MAYBE 150% WITH HYDROGEN PRODUCTION**
  - **WE COULD EASILY EXCEED 100% ON HAWAII, MOLOKAI, LANAI, AND MAYBE MAUI; OAHU (TBD)**
  - **LOOK AT HARBOR AND OFF-SHORE INSTALLATIONS, INTER-ISLAND CONNECTIONS, AND WIND-HYDROGEN SUPER TANKERS**

TIME'S AWASTIN (C. P. PETERSEN)!

- **A MODEST PROPOSAL – LET'S**
  - **MAKE THE BIG ISLAND THE MODEL FOR HOW TO ACHIEVE 100% RENEWABLES BY DATE CERTAIN!**
  - **FORM A PARTNERSHIP (UWIG, EPRI, NREL, HELCO, SOH, COH, INDUSTRY, COMMUNITY, ETC.) TO PREPARE AND IMPLEMENT A PLAN TO MAXIMIZE THE USE OF WIND AND OTHER INTERMITTENT SOURCES!**
  - **START TODAY!**



Wind Working Group, Hawaii

Inaugural Meeting

Honolulu, Hawaii

April 8, 2002

Keith Avery, UPC

Hawaii's Wind Resource, Potential, and Barriers

Developers Perspective

Hawaii's Wind Energy Potential

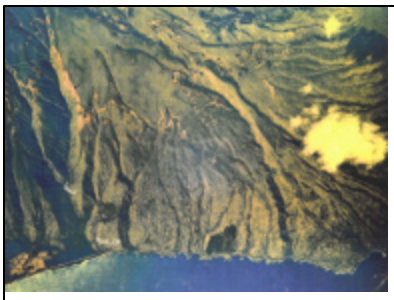
Resource is world class, indigenous, reliable, somewhat predictable, renewable, free.

Various diverse uses:

1. **utility sales**
2. **transportation fuels**
3. **water pumping**
4. **desalinization**
5. **fossil fuel displacement**
6. **balance of trade**

- Location: North Kohala, Big Island, Hawaii
- Description: 9.9MW
- Turbine: (11) GE-900Kw, 55m rotor, 53m tower
- Land: 30 year easement, percentage of gross revenue
- Resource: 20.3mph long term mean, 41.64% net capacity
- Power Purchase Agreement: 20 year term, 5 yr. option
  $.0539Kwhr on peak, $.0398Kwhr 0ff-peak
  escalating at 1.5% annually
  Hawaii PUC approval, June 2001

Kahua Ranch, Hawai'i



Kaheawa Pastures, Maui

Location: south West Maui Mountains, Maui

Description: 19.8MW

Turbine: (22) GE-900Kw, 55m rotor, 53m tower

Resource: 21.5mph, 44.9% net capacity

PPA: Replica of the approved Kahua PPA. 20 yr term starting at $.0513Kwhr on-peak, $.0382Kwhr off-peak. Final editing in process.

Key Issues From A Developers Perspective

- **Limited markets, customers, lack of competition**
- **Availability of permittable lands**
- **Some permit processes**
- **How to maximize wind, integrate into system**
- **Unenforced Energy Plan, lack of commitment to energy self sufficiency**
- **Needs to be financeable, need tax incentives**

Issues Unique To Hawaii

- Island Autonomy
- Unbalanced load, day vs. night
- Almost complete dependency on fossil fuels
- Under utilized natural resources
- Distance from resources

Today's Turbine

- Advanced technology
- Variable rotor speed and pitch
- Aerodynamic efficiency
- Dynamic reactive power control
- Maximum transmission efficiency
- Reduced fatigue- longer life
- Superior power electronics

- Certified, and warranted
- Maximum reliability and availability
- Very low cost of energy

keithavery@hotmail.com

Wind Powering America
State Working Group

Curtis Framel
Regional Coordinator, Emerging Technologies
U.S. Department of Energy, Seattle Regional Office
Hawaii Wind Working Group
April 8, 2002

State Needs

Two Years Ago:

- Weak education at all levels
- Weak & fragmented support base
- Fragmented partnerships
- Weak legislative support
- Few State wind incentives
- Weak state focal point
- Only 8 states with over 20MW
- Few marketing/educational tools
- Few quality wind maps
- Few quality state wind web sites
- Weak national leadership

State Working Group's Role

- Develop its wind resources for electricity generation
- Represents the wind interests within the state
- Works to minimize barriers to wind deployment
- Identify, develop, and implement incentives to wind deployment within the state
- Identify a leader amongst the working group
- Reflect the needs of each particular state

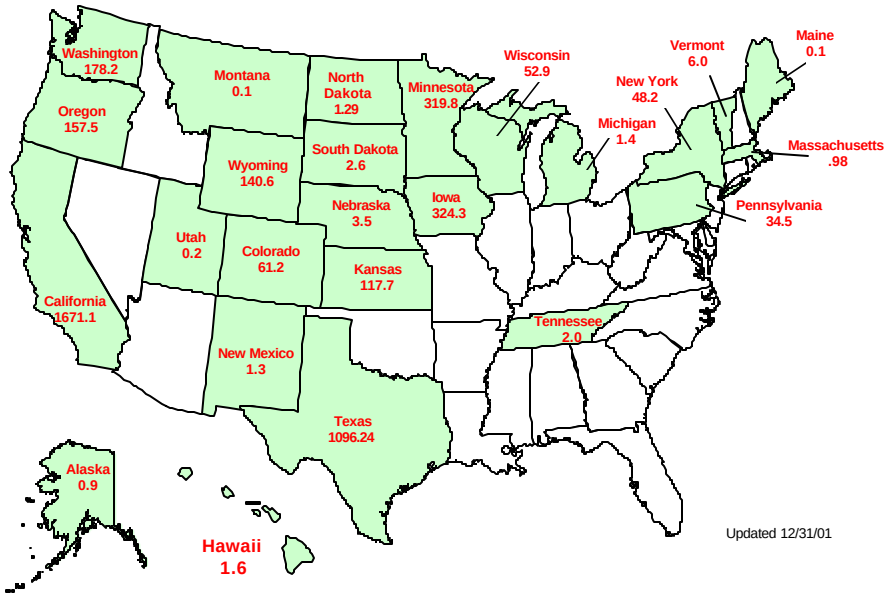
State Workshops and Working Groups

- **Objectives**
  - Target States in most need
  - Host state-wide forum
  - Secure state-wide coordination
  - Leverage resources
  - Identify key barriers/opportunities
  - Secure high visibility
  - Secure key support
  - Provide strong education

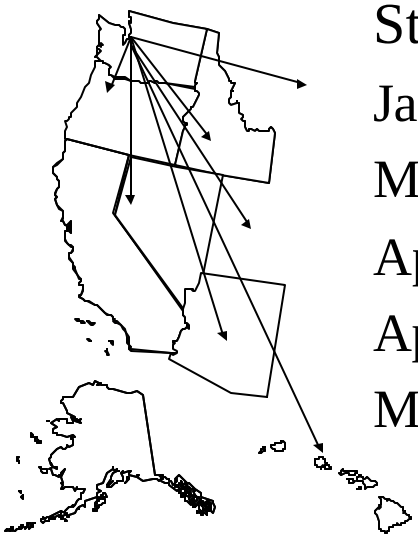
Other states

- Utah – Formed in Fall 2001, over 20 members, developing strategic plan
- New Mexico – Formed Spring 2001, over 15 members, continuing progress
- Oklahoma – Formed Summer 2001, over 20 members, developing strategic plan
- Nebraska – Formed Spring 2001, over 20 members, strategic plan finished
- North Dakota – Formed Summer 2000, over 20 members, implementing strategic plan

U.S. Wind Power - installed (MW)



Education/Information/Training



State Working Groups

January 11th, Reno

March 1st, Olympia

April 8th, Honolulu

April 12th, Phoenix

May 10-13th, Boise

State Working Group Idaho

- **Results**
  - Sparked state interest/support
  - Regular press releases
  - Strategic Plan
  - Town Hall, Community meetings
  - Net Metering passed
  - Proposed 30MW plant - Enxco
- **Event**
  - 1st ever state-wide workshop
  - 150 attend
  - Senator Crapo, key state govt. sponsors
  - Over 20 sponsors
  - Zero current wind development

State Working Group Nevada

- **Results**
  - Formation of wind working group
  - Sparked state coordination
  - Tribal interest in renewables
  - Strategic Plan developed
  - Market primers
    - Most aggressive RPS in Country
    - 280MW Wind farm announced on DOE land
- **Event**
  - Land Use Summit with BLM
  - Governor, PUC, Attorney General, Sierra Club, Energy Task Force
  - Current zero wind development
  - 87% Federal and Tribal Land ownership

Nevada

- Inadequate wind resource data
- Need a policy to ensure win-win solutions for producers and utilities
- Rule making for the RPS needs to be flexible
- Activities of the Task Force for renewable energy and energy conservation
- Data are needed on power system transmission capacity
- Lack of information on small wind resource development applicable to Nevada
- Need to educate policy makers on wind energy
- Need to engage Nevada's electric cooperatives in the development of the wind energy resource
- Need for increased public awareness of all aspects of wind energy

State Working Group Washington

- **Results**
  - Strong public education
  - Formation of wind working group
  - Last Mile Rural Electric Wind Cooperative
  - White Paper developed – Strategic Plan
  - Market Priming
    - 1000 MW RFP by BPA
- **Event**
  - Harvesting Clean Energy I and II
  - 400 attend
  - Governor keynotes, State Senator, Rural Coops, BPA
  - Over 30 sponsors
  - Strategic Plan

State Working Group Arizona

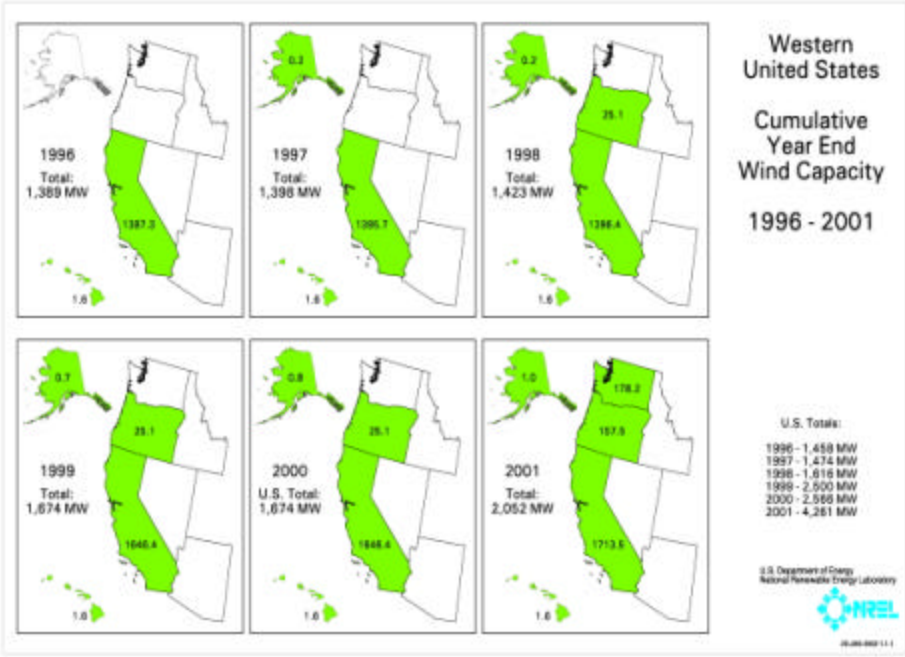
- **Results**
  - Utility involvement
  - August – 8st Wind Conference in Flagstaff
  - Assessment of resource
  - University led group
- **Future??**

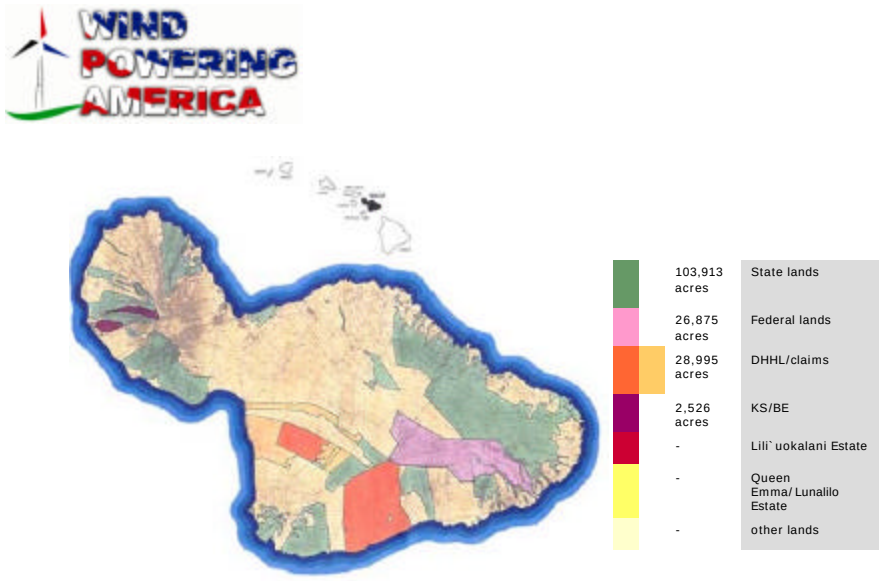
State Working Groups

- WA – Harvesting Clean Energy
- ID – State leadership
- NV – Land use – Bureau of Land Management
- AZ – General awareness
- HI - ??
- Still… AK, OR, CA
- Windpower 2002 State Wind Summit

Our Role...

Assess customer priorities and needs
Identify EERE resources
Offer products and services from DOE
Leverage Federal/ non-Federal resources
Monitor and report performance


Western
United States
Cumulative
Year End
Wind Capacity
1996 - 2001
1996
Total:
1,389 MW
1997
Total:
1,398 MW
1998
Total:
1,423 MW
1999
Total:
1,674 MW
2000
U.S. Total:
1,674 MW
2001
Total:
2,052 MW
U.S. Totals:
1996 - 1,458 MW
1997 - 1,474 MW
1998 - 1,616 MW
1999 - 2,500 MW
2000 - 2,568 MW
2001 - 4,261 MW
NREL


WIND
POWERING
AMERICA
103,913 acres
State lands
26,875 acres
Federal lands
28,995 acres
DHHL/claims
2,526 acres
KS/BE
-
Lili`uokalani Estate
-
Queen Emma/ Lunalilo Estate
-
other lands

Contacts

- DOE Regional Office
  - Curtis Framel (206) 553-7841; curtis.framel@ee.doe.gov
  - Chuck Collins (206) 553-2159; chuck.collins@ee.doe.gov
- DOE Headquarters
  - Phil Dougherty (202) 586-7950
  - www.eren.doe.gov/windpoweringamerica
- National Energy Laboratories
  - Larry Flowers (303) 384-6910 (www.nrel.gov/wind)
  - Bob Neilson (208) 526-8274
- American Wind Energy Association
  - www.awea.org (202) 383-2500

ELECTROTEK CONCEPTS

Hawaii Wind Working Group
Inaugural Meeting

April 8, 2002
Honolulu Airport Hotel
Honolulu, Hawaii

Bob Zavadil
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Maintaining and Operating "The Grid"

- Traditional Utility Functional Areas
  - Design
  - Operations
  - Planning
- Effect of Industry Transformation
  - Technical issues remain unchanged
  - Relocation of traditional responsibilities and authority

ELECTROTEK CONCEPTS

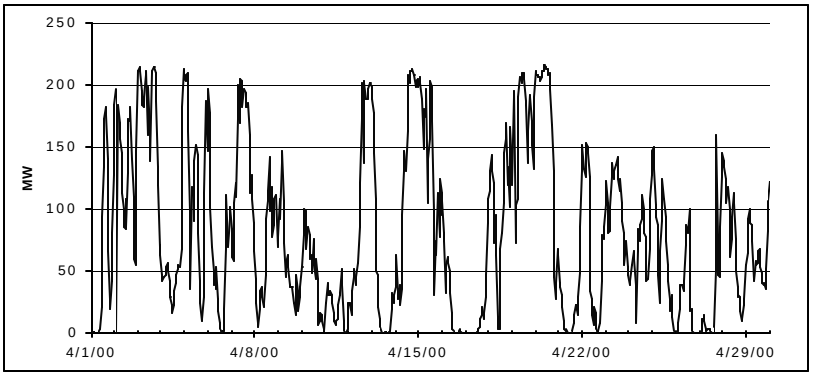
What do windplants “look like”?

- Must know to determine how windplants affect the grid
- “Describing” windplants
  - Real power output vs. time
  - Reactive power demand or output vs. time
  - Changes in real power vs. time
  - Changes in reactive power vs. time
- So what do they “look like”?

ELECTROTEK CONCEPTS

Not so good, maybe…

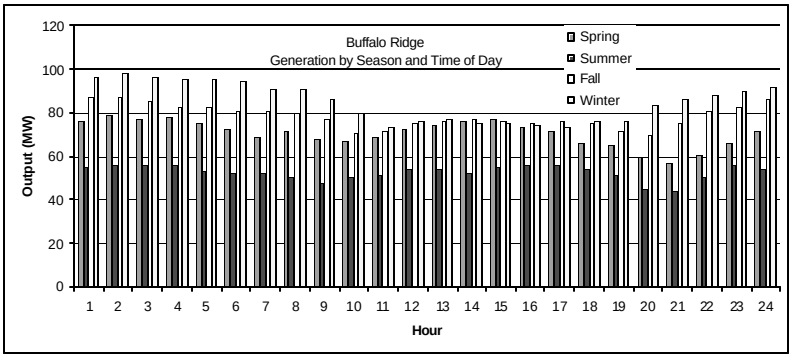
210 MW Windplant in Midwestern U.S.*



ELECTROTEK CONCEPTS

*courtesy National Renewable Energy Laboratory

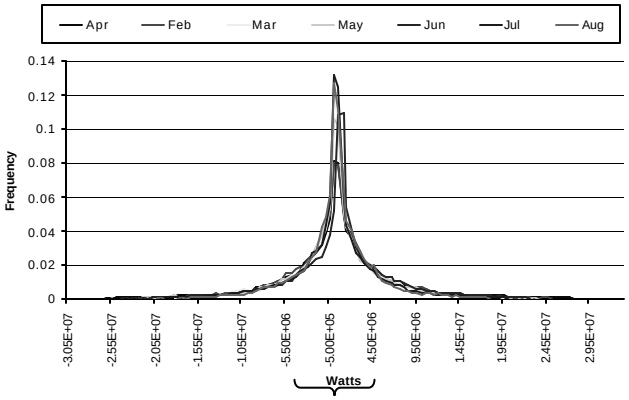
Energy looks a little better…



ELECTROTEK CONCEPTS

But maybe Power isn't so bad either…

Output Variations of 250 MW Windplant
Load-Following (minute-by-minute) time frame



ELECTROTEK CONCEPTS

10 MW

Technical Issues

- Voltage and service quality impacts
- Impacts on real-time operations and scheduling
- Ancillary service issues and questions
- Transmission issues - allocating capacity
- Reliability and security

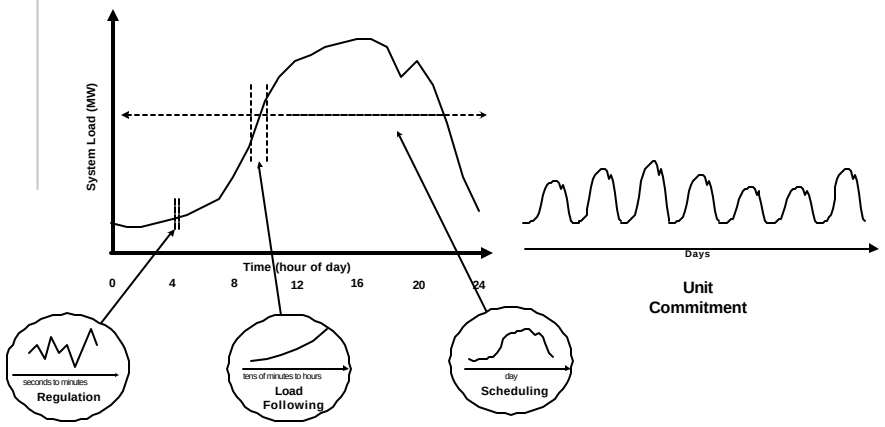
ELECTROTEK CONCEPTS

Voltage and Quality Issues

- Voltage regulation
  - Maintaining voltage at all points and at all times in the network within acceptable window
  - Windplant reactive power and power factor
- Service Quality
  - Flicker – does changing P lead to changing V?
  - Do turbine starts cause voltage to “dip”?
  - Do the turbines create harmonic distortion?

ELECTROTEK CONCEPTS

Generation Scheduling and Operations



ELECTROTEK CONCEPTS

Operator's Dilemma

- Frequency control: *Do windplants make it more difficult to regulate "frequency"?*
- Regulation: *Can windplants affect or increase the area control error (ACE)?*
- Load following: *What happens if windplant output decreases in the morning when load is increasing?*
- Scheduling: *How can committed units be scheduled for the day if windplant output cannot be predicted? What happens if the wind forecast is inaccurate?*
- Committing generating units: *Looking out over the next few to several days, how should or could windplant production be factored into planning what generation units need to be available? Is the effective amount of reserves influenced?*

ELECTROTEK CONCEPTS

Economic Questions

- Cost is the primary metric
- Committing generation that is not needed increases cost
- Scheduling generation that is not needed can increase cost
- Allocating extra load-following capability increases cost
- Violation of system performance criteria can increase cost
- How can these costs be minimized? And, who pays for what is left?
  - Forecasting?
  - Tariffs?
  - Technology?

ELECTROTEK CONCEPTS

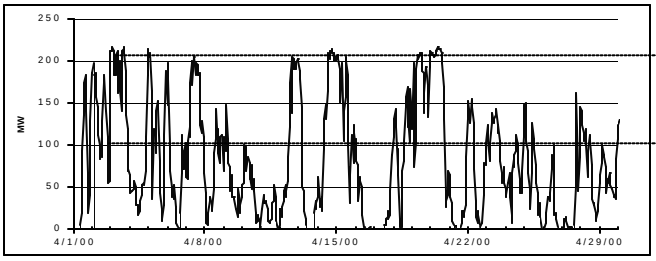
Ancillary Services

- Definitions
  - Voltage regulation and VAR dispatch
  - Regulation
  - Load following
  - Frequency-responding spinning reserve
  - Supplemental Reserve
- By-products of conventional power system operations
- To be bought and sold on the market in the new industry paradigm

ELECTROTEK CONCEPTS

Transmission Capacity Issues

- How do I plan/design/reserve/procure transmission (delivery) capacity for this:



- Present competitive market mechanisms not favorable for wind
- Same issue exists in conventional utility perspective

ELECTROTEK CONCEPTS

Reliability and Security

- Definitions
  - Reliability – probability that available generation will be sufficient to meet demand (very high number, e.g. 99.9%)
  - Security – operate the system in a manner such that it keeps going if something "breaks"
- Vertical utilities and Markets must consider both
- Relevance to wind
  - Capacity (vs. energy) questions (longer-term)
  - Operating restrictions and forced curtailment

ELECTROTEK CONCEPTS

Status

- Still many questions
- Starting to find a few answers
- Transitory nature of power industry is current complication
- Experience and Technology will provide additional answers

Technical Issues

Hawaii Wind Working Group
April 8, 2002 - Honolulu Hawaii

Presentation by
Thomas A. Wind, PE

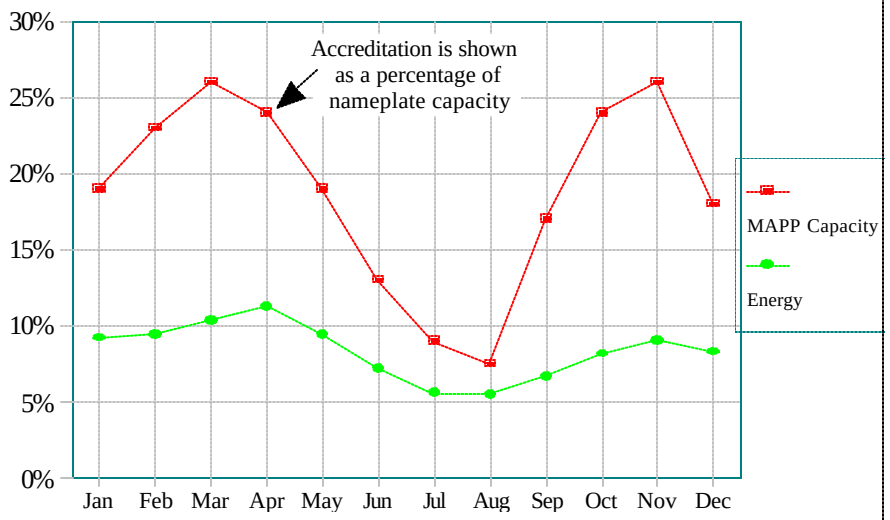
Wind Utility Consulting
Jefferson, Iowa

Topics I Will Discuss

- Generation Capacity Credits
- Interconnecting Wind Turbines Generators (WTG's) to the Distribution System
- WTG Penetration Levels
- What Can Be Done to Increase Wind Generation

Generation Capacity Credits

- A lot of analysis has been done by academics
  - Utilities and Power Pools will probably not rely on the results of this analysis
  - They will need to make their own assessment, hopefully based on concepts presented by academics
- Determining capacity credits will primarily be driven by the needs of utilities and marketers

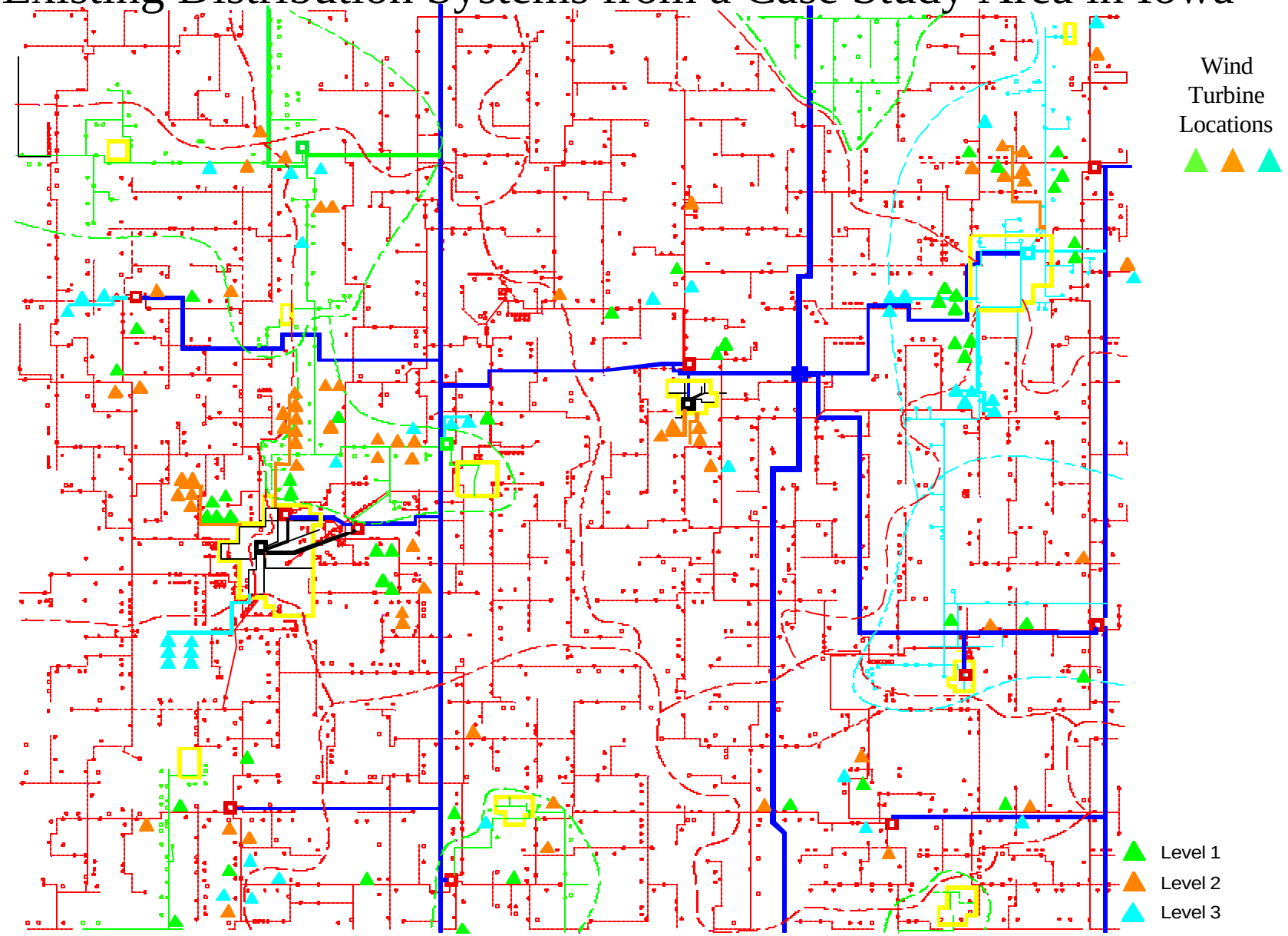


MAPP Power Pool Capacity Credit is based on 50/50 probability of the generation being at that value or higher during the daily peak

Interconnecting WTG's to the Distribution Grid

- Very viable option for single units or small clusters
- Feasibility depends upon:
  - Voltage level of distribution line
  - Distance from the distribution substation
  - Size of the distribution transformer
  - Size of wind turbine
  - Electrical design of wind turbine generator

Possible Locations of Wind Turbines on the Existing Distribution Systems from a Case Study Area in Iowa



Distribution Interconnection Costs in the Midwest Case Study

Cost of Distribution System Reinforcements for Added Wind Generation						
Penetration Level	750 kW Turbines Added		Range of Reinforcement Costs in $/kW			Cumulative Average Cost
	Number	MW	Minimum	Maximum	Average	
Level I	48	36.00	$2	$20	$5	$5
Level II	62	46.50	$27	$105	$61	$36
Level III	41	30.75	$38	$178	$115	$58
Totals	151	113.25				

Wind Generation Penetration Levels

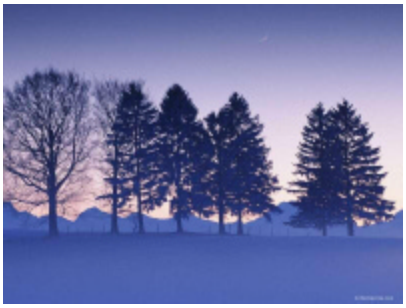
- The maximum level is a question of economics, not physics. Costs tend to go up with higher penetration levels. Depends on:
  - Size of control area
  - Characteristics of utility generation
  - Wind generation patterns
  - Predictability of wind generation

Wind Generation Penetration Levels
(continued)

- A very small municipal utility connected to a large control area could get 25% of its energy from a single large wind turbine – any "penalty" depends on terms in the power supply contract
- Several schools in Iowa will have 100+% penetration (excess sold back to utility)

Wind Generation Penetration Levels
(continued)

- As penetration goes up in a control area, costs will tend to increase due to accommodating intermittency
  - Added spinning non/spinning reserves
  - Potentially more fluctuations in output of load following units
  - Costs at low penetration levels (2-3% of energy) are very minimal
  - Impact probably increases exponentially with penetration

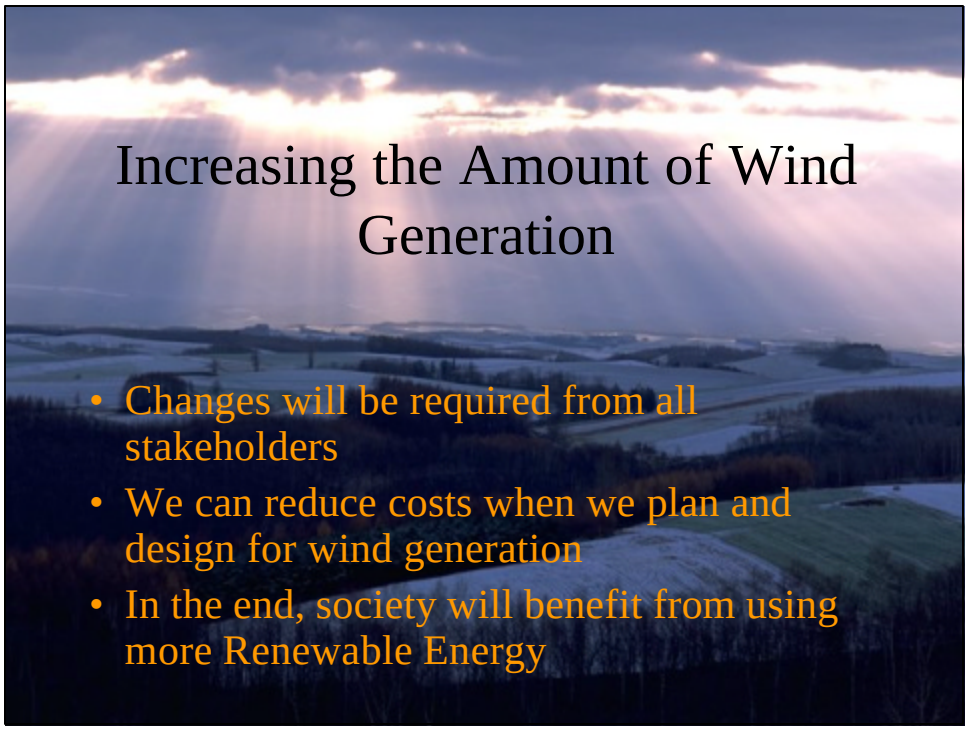


Things the Wind Industry Can Do to Enable More Wind Generation

- Plan for and operate wind generation to be less of a burden and more supportive of the transmission system's needs
- Plan for and accept a certain level of interruptions to accommodate problems with weak transmission grids, thus reducing the required amount of system improvements

Things the Utility Industry Can Do to Enable More Wind Generation

- Work with wind farm owners to reduce the uncertainty in wind farm output forecasts
- Find and plan cost-effective ways to accommodate variability and intermittency problems with wind generation


Increasing the Amount of Wind Generation
• Changes will be required from all stakeholders
• We can reduce costs when we plan and design for wind generation
• In the end, society will benefit from using more Renewable Energy

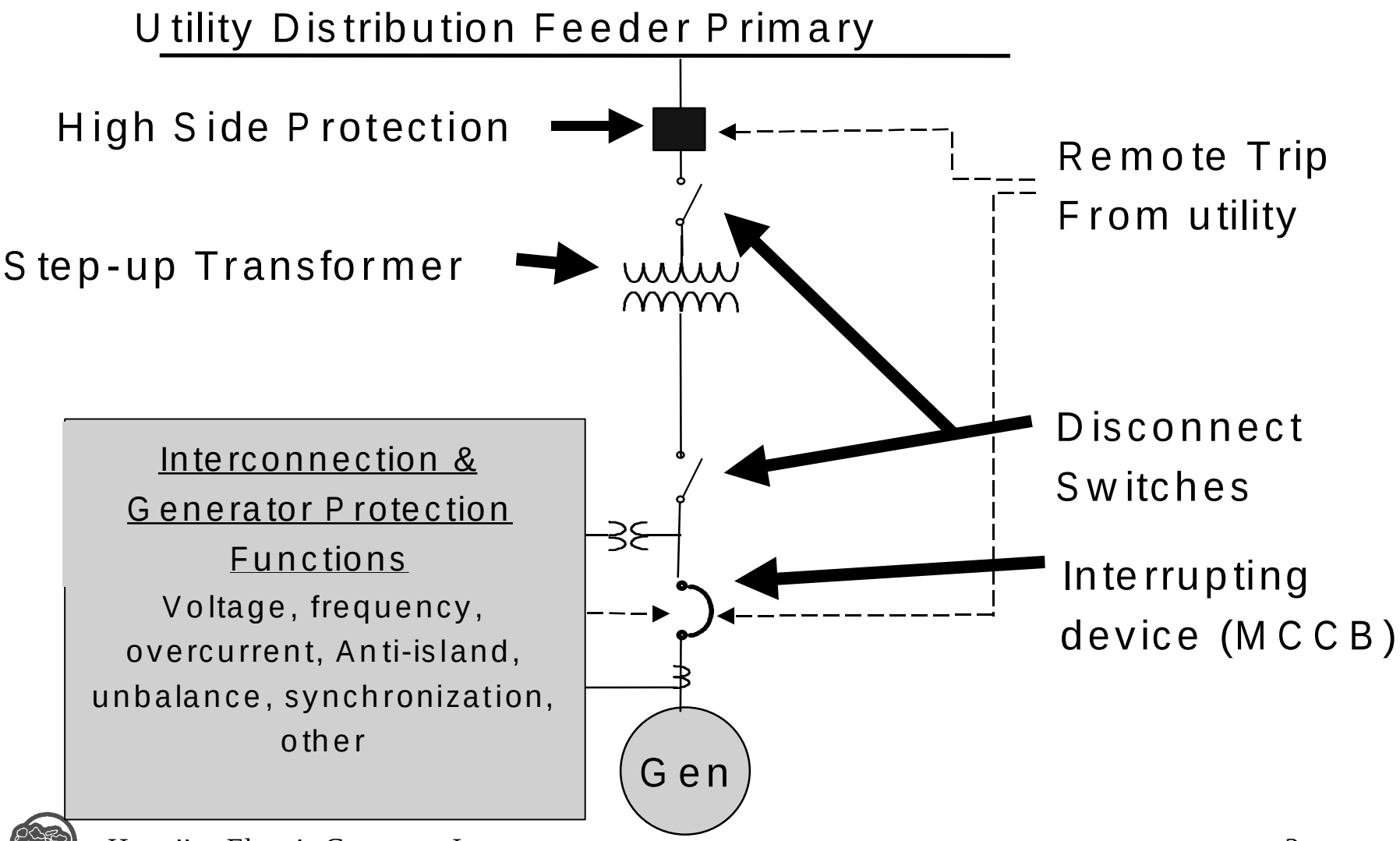
Interconnection

Wind Working Group
April 8, 2002

WHAT ARE INTERCONNECTION STANDARDS?

Interconnection standards are specific technical requirements for paralleling distributed generation (DG) with the utility system.

Components of DG Interconnection



WHY DO WE NEED INTERCONNECTION STANDARDS?

- Interconnection standards are necessary to ensure safety, reliability, and power quality.
- Afford consistent application of requirements.
- Help streamline review and approval processes.
- Allow higher levels of DG penetration.

Power System Impacts of DG

- Voltage Regulation
- Power Quality
- Reliability
- Operational Safety
- System Loading
- System Efficiency

Diesel Generators

DG can help in all of the above areas – or it can worsen performance in all the above areas!

HECO's Standards

- **Based on national standards and guidelines**
- **Incorporates features to account for our unique island systems**
- **Filed with the PUC in January 2002**

What Are Addressed By The Interconnection Standards?

- **General Interconnection Guidelines**
- **Design Requirements**
- **Operating Requirements**
- **Protection, Synchronizing, and Control Requirements**

Sample of Interconnection Standards

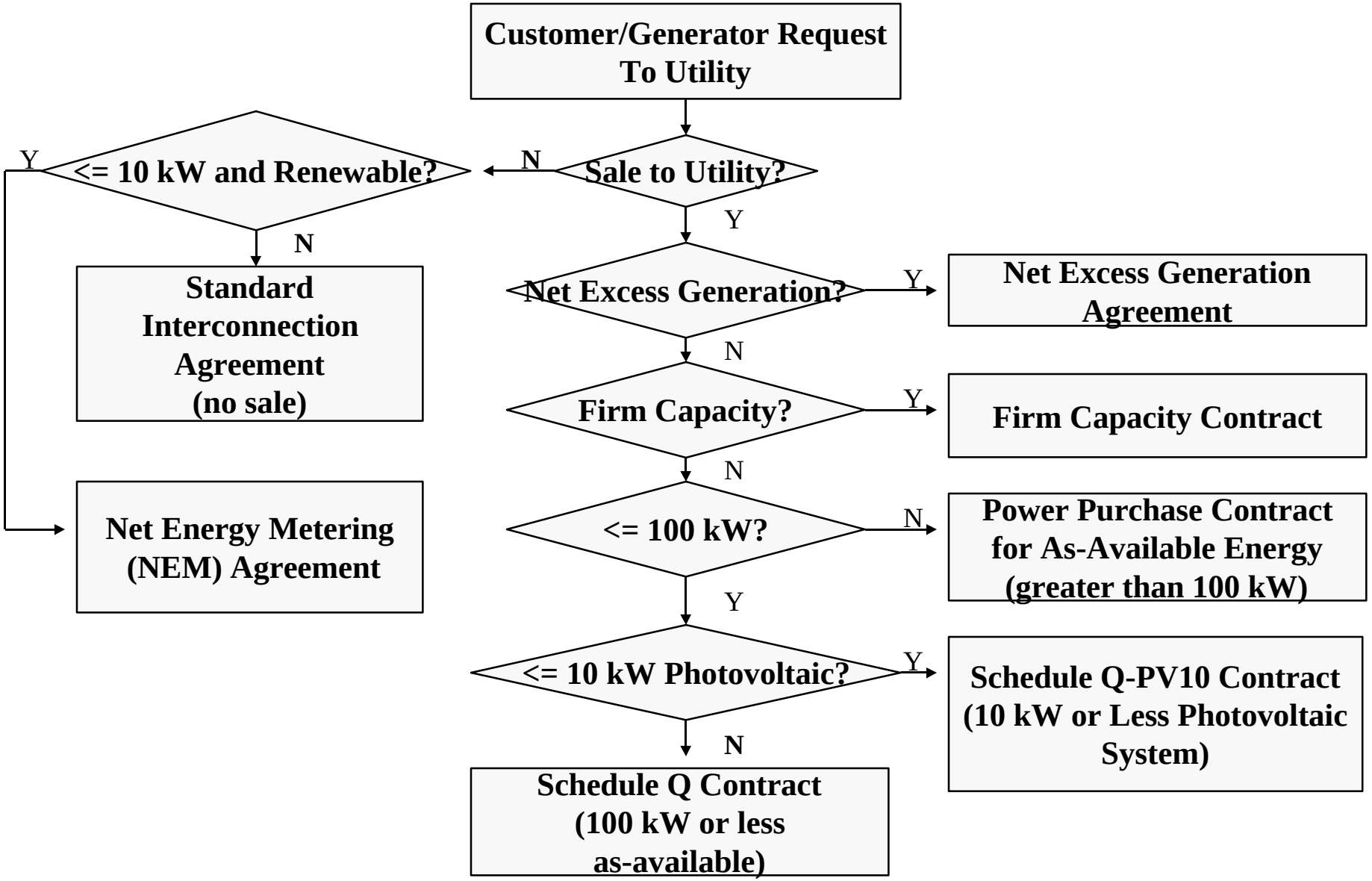
- **Isolation Device - A disconnecting device with a visible break that is accessible and lockable in the open position by authorized utility personnel**
- **Anti-Islanding Provisions**
- **Interrupting Device – A circuit breaker or interrupting device capable of interrupting the maximum available fault current at the site**
- **Protective relaying and coordination of settings**

Disconnect Device

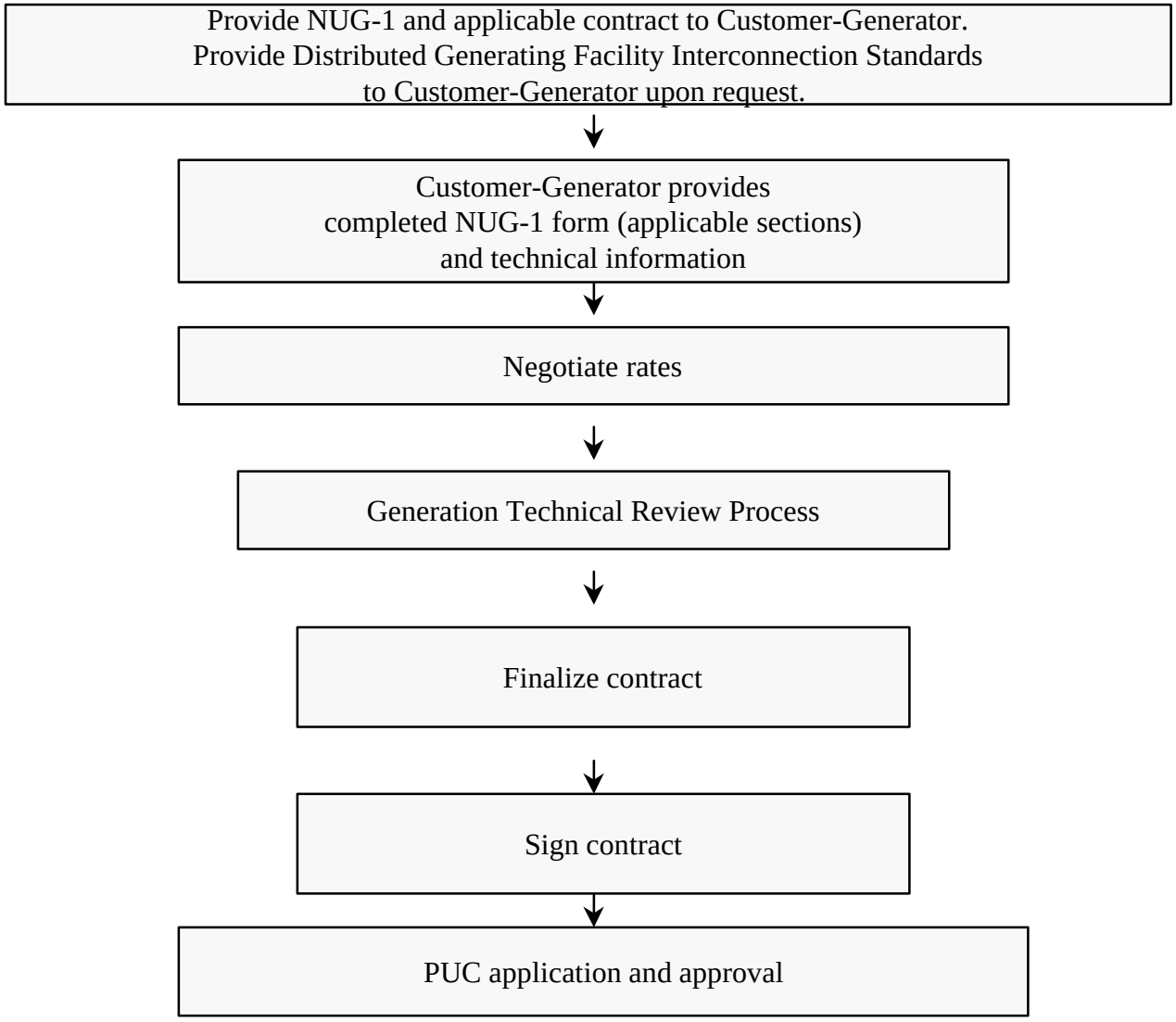
Performance Standards for Wind Farms

- **Ramp rate**
- **Power fluctuation rate**
- **Voltage flicker**
- **Harmonics**

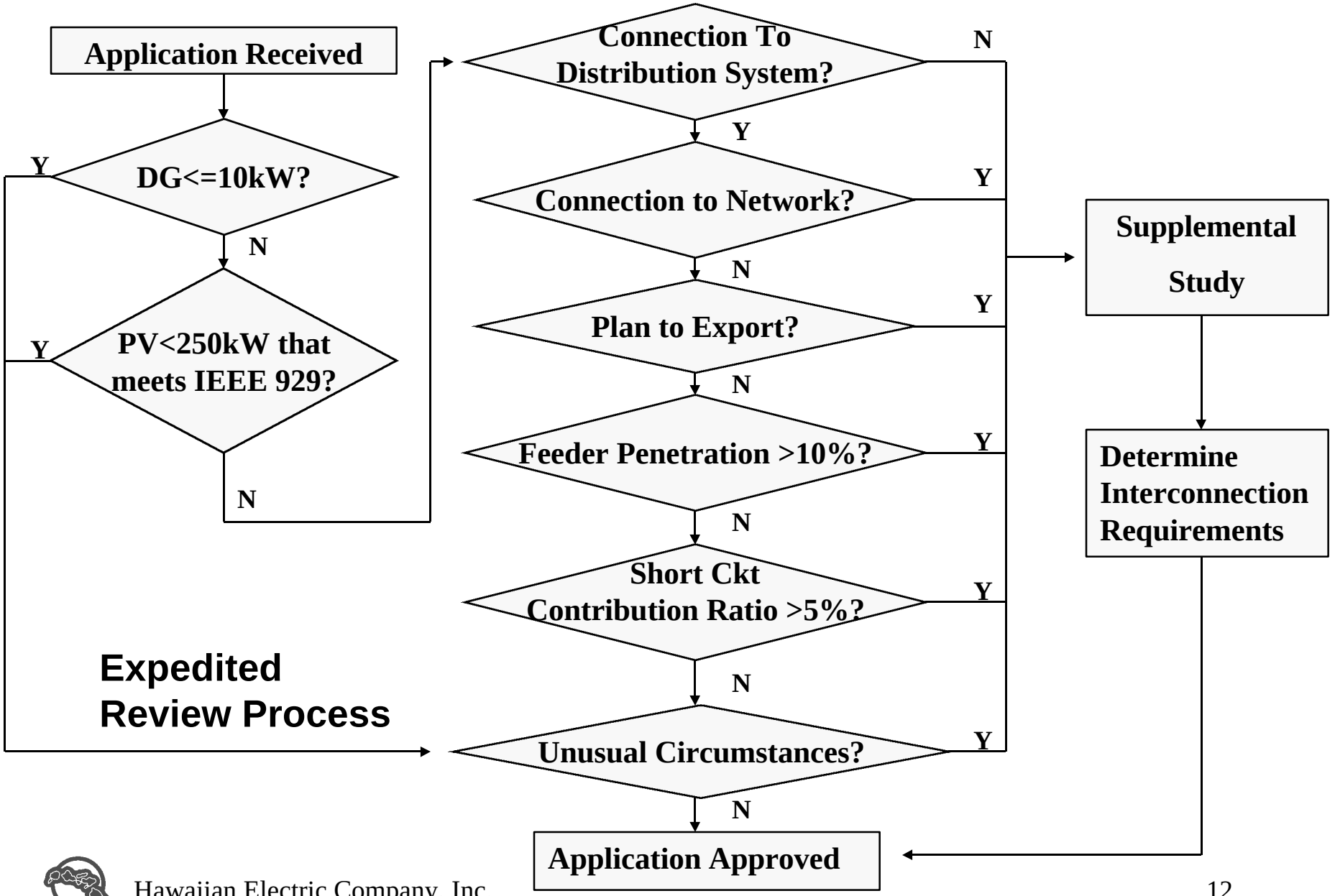
Process for Interconnecting Generators



Typical Contract Process



Generation Technical Review Process



Supplemental Study Considerations

- Location, size, and type of DG
- Distribution circuit voltage and load
- Protection devices on circuit
- Voltage regulation equipment on circuit
- Transformer connection type
- Fault current contribution of DG
- Aggregate DG penetration on circuit
- Export of power

Typical Contract Provisions

- Customer-generator and facility information
- Interconnection equipment requirements
- System protection and operating requirements
- Personnel and system safety
- Permits, approvals, and licenses
- Pricing
- Term of agreement
- Other terms and conditions

SUMMARY

- **Interconnection standards detail the specific technical requirements for interconnecting DG with the utility system**
- **Inappropriate interconnection can harm people and equipment, and reduce reliability and power quality**
- **HECO's interconnection standards follow national guidelines and codes**

Damaged Equipment

SUMMARY

- **Following Standards may help increase allowable penetration levels for DG on utility systems.**
- **Talk to your utility before purchasing or installing equipment.**
- **They will help you through the interconnection process, which includes a technical review and execution of an appropriate contract.**

Wind Power
a Hawaiian View

Edwin Lindsey
Maui Cultural Lands Inc.
1087-A Pookela Rd
Makawao, HI 96768

La`amaomao the Wind God

- **Care takers of the Gourd of Wind God**
- **Names of winds from various parts of Maui**
- **Relationship between native plants and winds**
- **Kane and Fresh water and winds**
- **Winds and Fishing**

Environmental Concerns

- **Advantages of oil turbines**
- **Past monopolistic policies**
- **Power for the future**
- **New power plants**

Consequences of Missed Opportunities

- **Oil spills, ocean, and insurances**
- **Federal funding**
- **Land delivery systems**
- **Public pays for new turbines and power plants**
- **Air pollution**
- **Self sufficiency**
- **Mitigation out fall, plants, alien plants, sanctuaries, hatcheries, improved roads**

Economic Development

- **Power Plantations**
- **Manufacturing**
- **Construction**
- **Improved higher education for employees**
- **Pacific Rim Consultant**
- **Water desalinization becomes cheaper**
- **Pumps**
- **Cost of Power becomes more stabilized**
- **Cost of Business expense reduced**
- **Wind energy requires investors therefore customers free from price increases ----- Oil turbines require customer pay back**

Barriers

- **Reliability**
- **Noise**
- **Site selection**
- **View planes**

Education and Public Awareness

- **Construction of a model town using sustainability and self sufficiency**
- **Media**
- **Tax incentives and mandates**

Summary

Non-technical Issues Panel

Michael Edwards, Director,
Sustainable Kaua'i Mission

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Economic Development

- Renewable energy is a growth industry
- Legislators need to understand that renewable energy is a "high-tech" industry
- Hawaii is to the U.S., as Iceland is to Europe: the "beta test" location for the hydrogen economy.
  - Like Iceland, the Big Island has geothermal
  - Thanks to maturing wind technologies, the other islands will also have opportunities in the hydrogen economy
- Hawaii can't afford to continue importing petroleum
- Wind will play a big part in Hawaii's self-sufficiency and economic security

Legislative/Regulatory Issues

- Change in the regulatory and legislative area is slow. Some of the issues we discuss today are the same as in 1994 – and in 1984.
- Community values are not necessarily reflected in stockholder values.
- If communities own the power supply, it's easier to do the right thing.
- The Legislature and the PUC have the responsibility to make sure the laws and regulations reflect community values.

Legislative/Regulatory Issues

- Focusing on lowest short-term energy cost is missing the real cost – to ourselves, our society, and the future.
- Petroleum pass through
  - Utilities have no incentive to move away from oil; they pass through to others the risk (and cost) of petroleum
  - How can you cay a thirty-year oil-fired plant is economical when cheap oil may not be available in 10 years? (or 1, if there's a war in the Middle East)
- We as citizens and industry professionals must work through the legislature to reform the PUC policies and get to the real solutions

Education, Outreach, and Public Awareness

- Government resists public input
- The public is sometimes apathetic
- Need forums for policy making that directly involve local citizens and affected communities
- Citizens need real authority in the planning process
- Need involvement of diverse views

Education, Outreach, and Public Awareness

- Don’t produce more studies and recommendations.
- Do come up with specific actions and implement them.
- Need to keep decision-makers informed of advances in renewable energy and conservation.
- All stakeholders must be involved – it’s a joint venture.

Education, Outreach, and Public Awareness

- Education is needed so that people will understand
  - the bigger picture
  - how much of our energy supply is in jeopardy
  - all technologies come at a cost
  - that there are always cost/benefits tradeoffs
- Look at what educational materials and examples are available from other locations. Many other areas are struggling with the same issues and tradeoffs.

If you want cold beer and the lights to come on in the future, get ready for wind

S U R V E Y

Inaugural Meeting of the Hawaii Wind Working Group
April 8, 2002

1. Did the meeting cover the topics you thought it would? YES NO
   If "no," please explain: _____

2. Were the other participants the people/organizations you expected? YES NO
   If "no," please explain: _____

3. Please list other people/organizations who should be invited/encouraged to participate, with contact information if you have it (please note that not all who were invited were able to attend):
   _____

4. Do you think forming a Hawaii Wind Working Group is a good idea? YES NO
   Why or why not? _____

5. Are you interested in participating in the Hawaii Wind Working Group? YES NO
   Why or why not? _____

6. Any other comments or suggestions?
   _____

7. (Optional): Name: _____
   Phone number / e-mail : _____

Please turn in this survey before you leave. Or, fax it to (808) 586-2536; send it to DBEDT-ERTD, PO Box 2359, Honolulu, HI, 96804; or call 587-3809. Thank you!