STAKEHOLDER MEETING

HAWAII ENERGY STRATEGY 2006

Honolulu
October 24, 2006

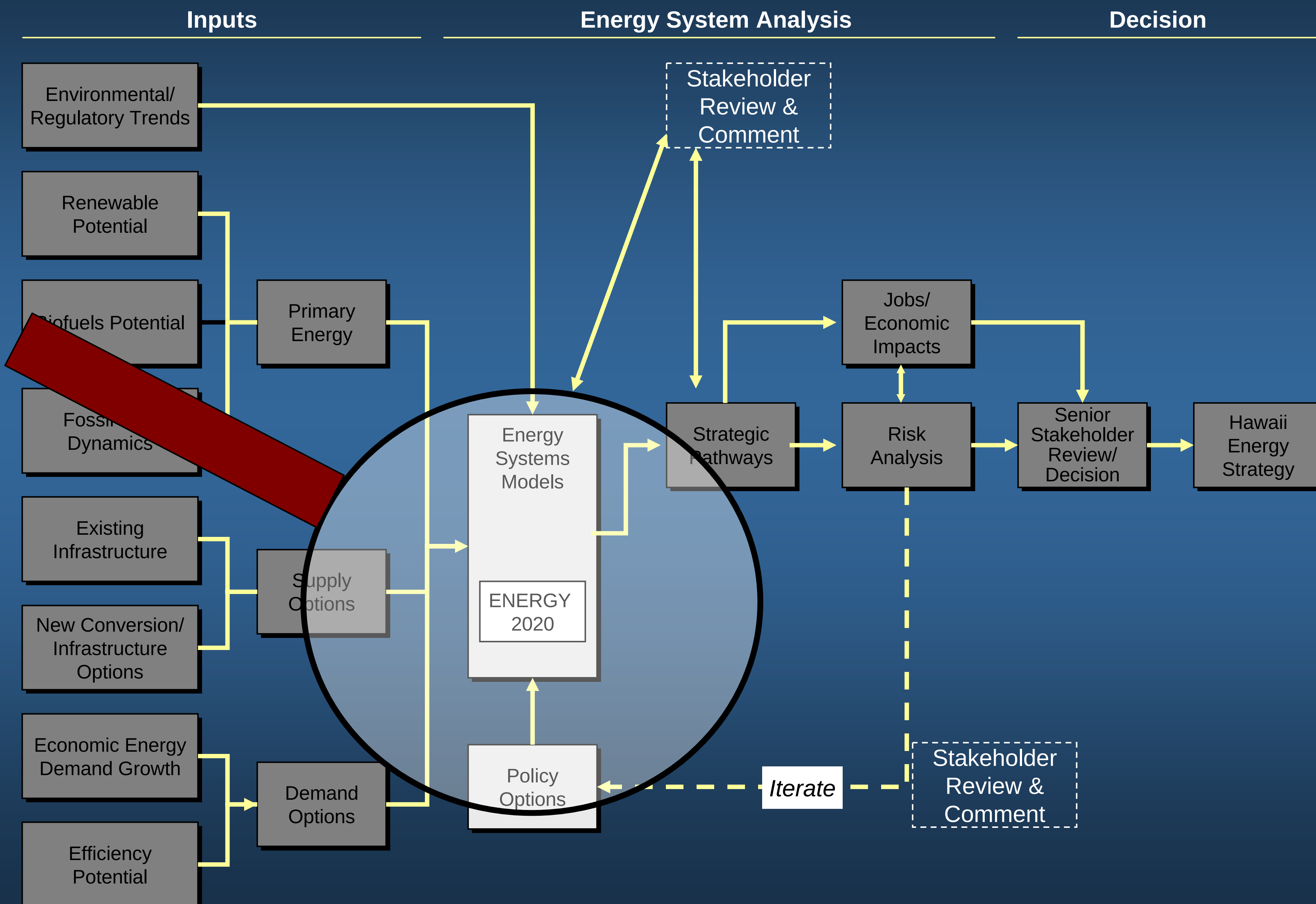
Objectives

- Understand how the Energy 2020 Model process works
- Present initial findings on the how Hawaii’s energy system would respond to scenarios of adequate global oil supplies vs. constrained supplies
- Discuss the implications of these emerging findings to Hawaii
- Listen to the stakeholders regarding insights or concerns from this analysis

Agenda

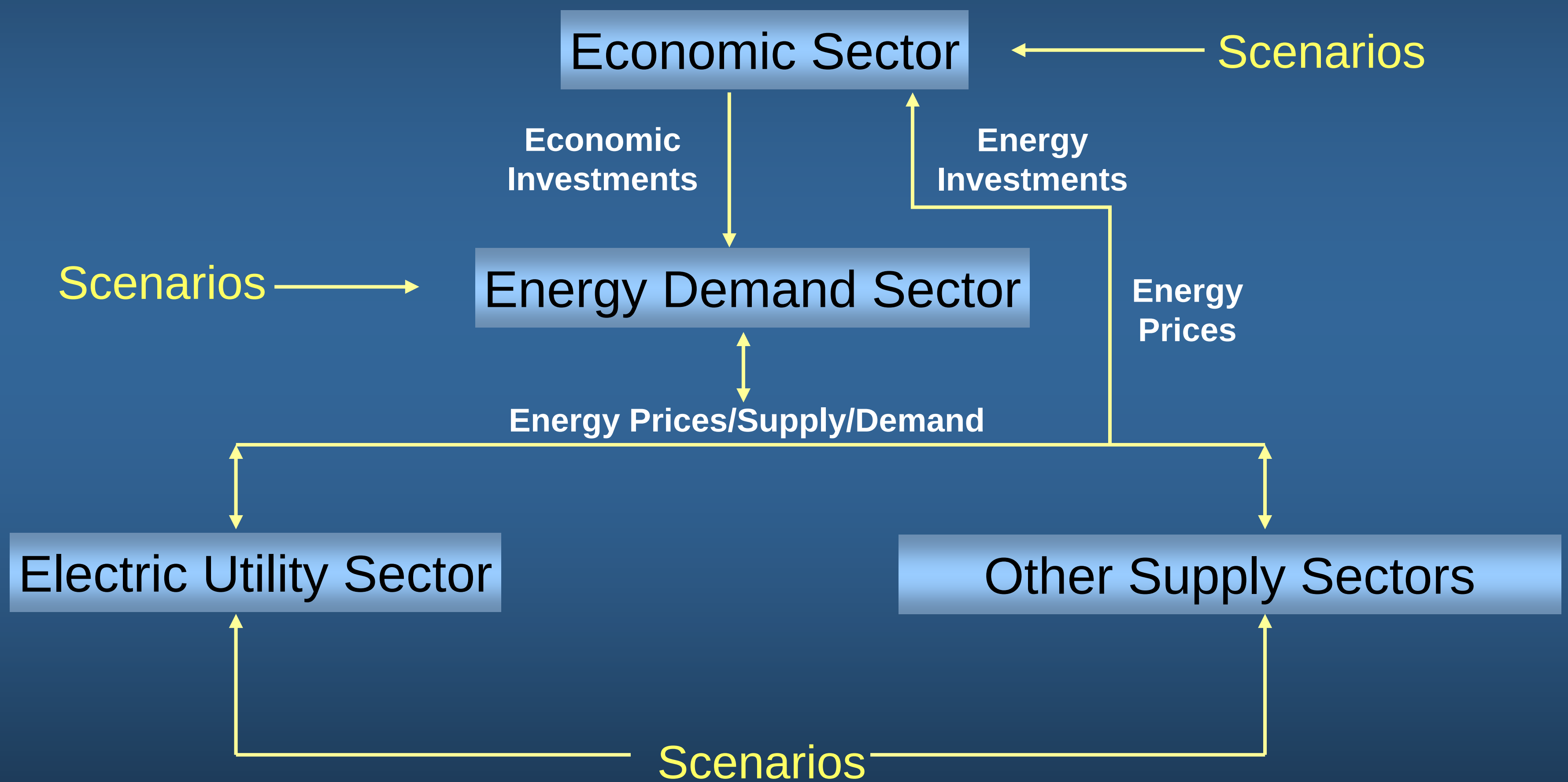
- Project Status
- Energy 2020 Model Inputs
- Initial Model Results and Implications
- Break
- Debriefing August Biofuels Summit
- Stakeholder Discussion
- Next Steps

Where We Are In the Process



Energy 2020 Model Inputs

Energy 2020 Overview



Demand Data Inputs Were Drawn From Publicly Available Information

Demand-Side Inputs	Data Sources
Historical Demand and Consumption (By Economic Sector and By End Use)	Federal Energy Regulatory Commission (FERC) Form No. 1 Utility Annual Reports filed with Public Utilities Commission Utility-sponsored DSM Studies Dept. of Taxation Liquid Fuel Tax Base DBEDT records
Device Efficiency	U.S. Dept. of Energy Studies California State Studies Technology Research Organizations (e.g. ESource)

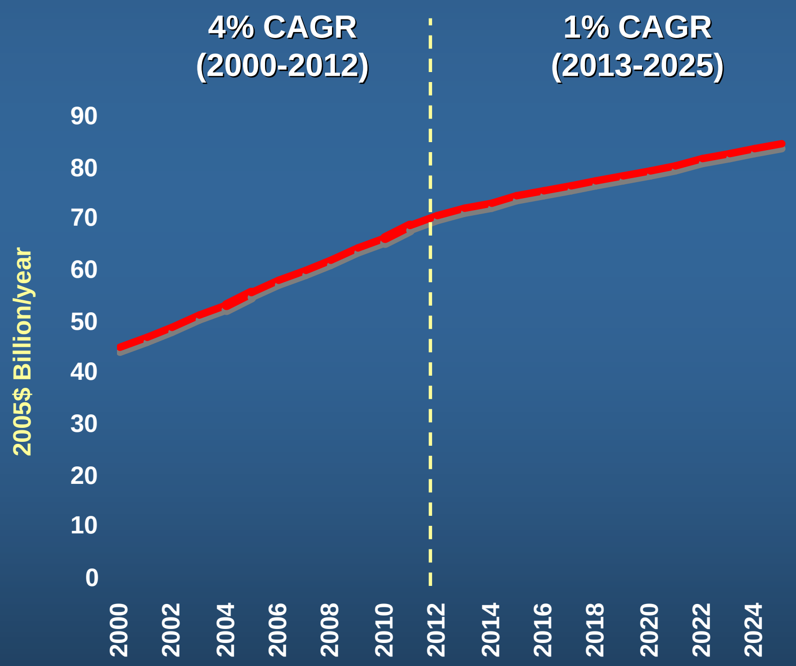
Supply Inputs Were Also Drawn From Publicly Available Information

Supply-Side Inputs	Data Sources
Historical Capacity, Generation and Financial Data	‣ Federal Energy Regulatory Commission (FERC) Form No. 1 ‣ Utility Annual Reports filed with Public Utilities Commission
Utility Capacity Expansion Plans	‣ Utility Integrated Resource Planning (IRP) documents
Historical Fuel Prices	‣ Hawaiian Electric Industries (HEI) fuels division; KIUC ‣ EIA State Energy Consumption Price and Expenditure Estimates (SEDS) ‣ EIA Annual Energy Review

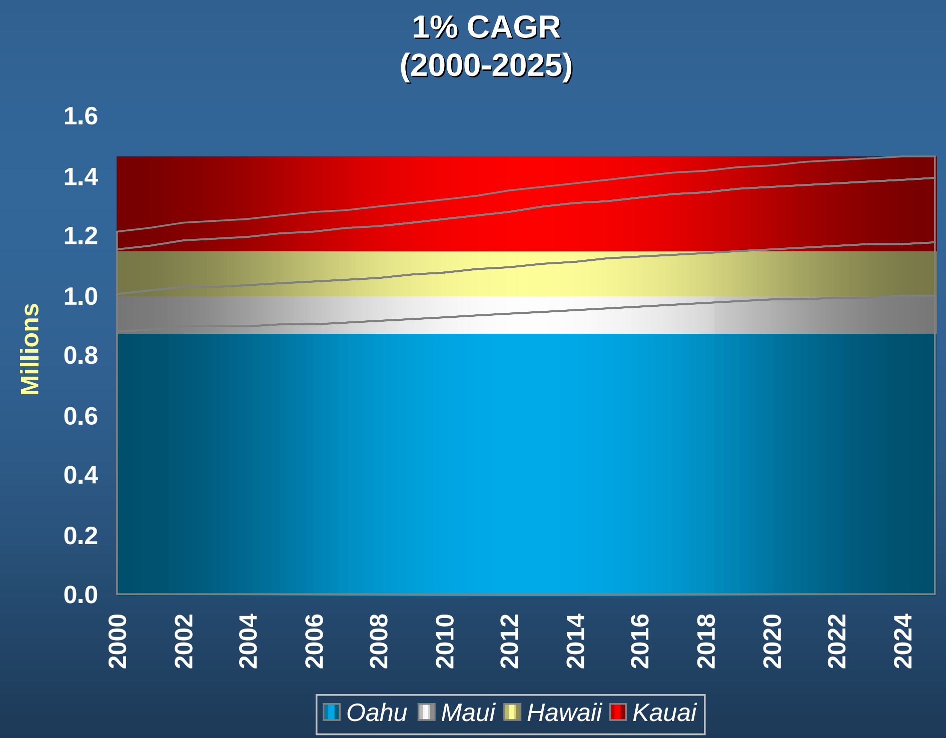
REMI Economic Assumptions Are Based on Stable Modest Growth

REMI Reference Case

Gross State Product



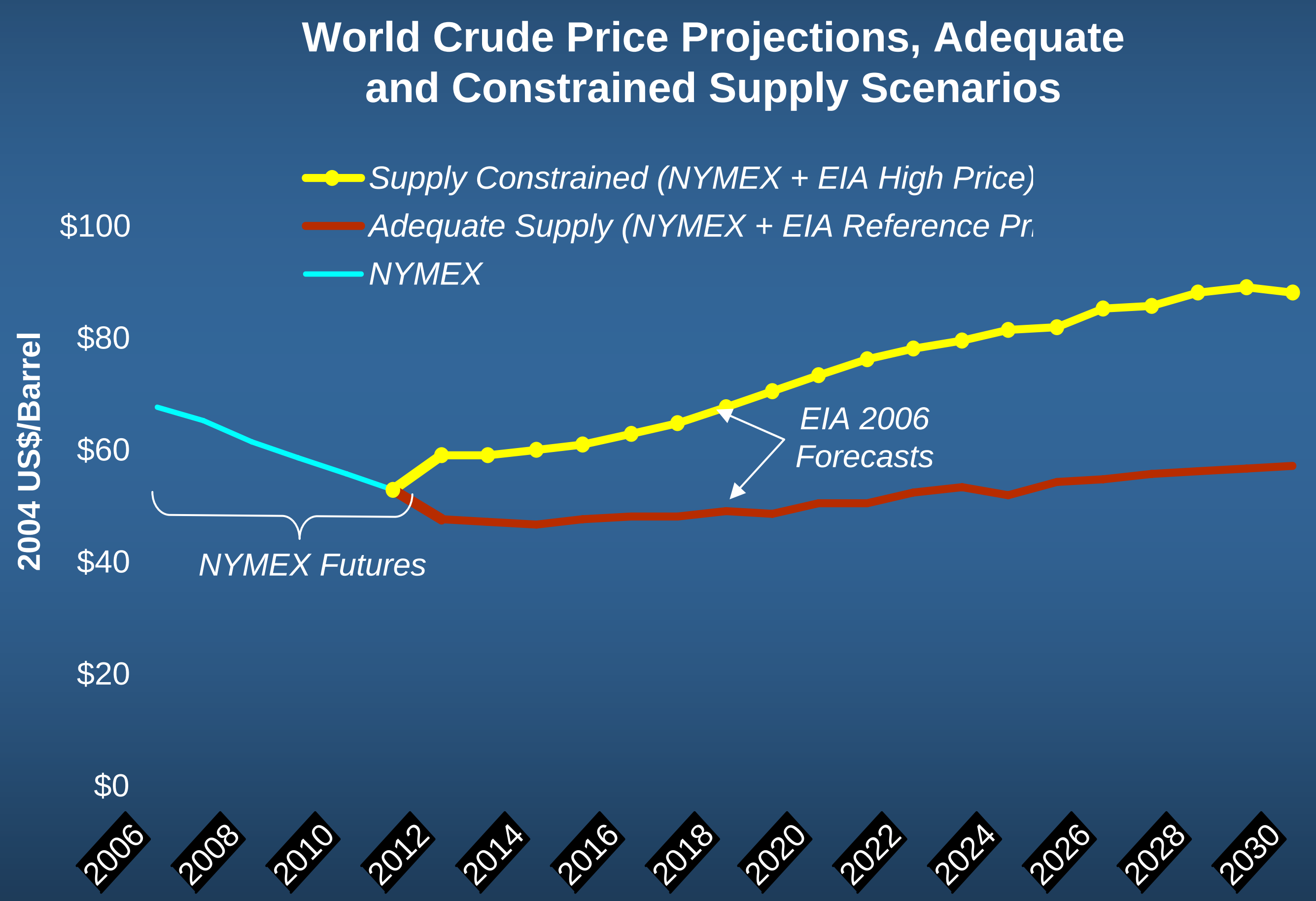
Population



Today, We Will Discuss the Results of the First Two Energy System Scenarios

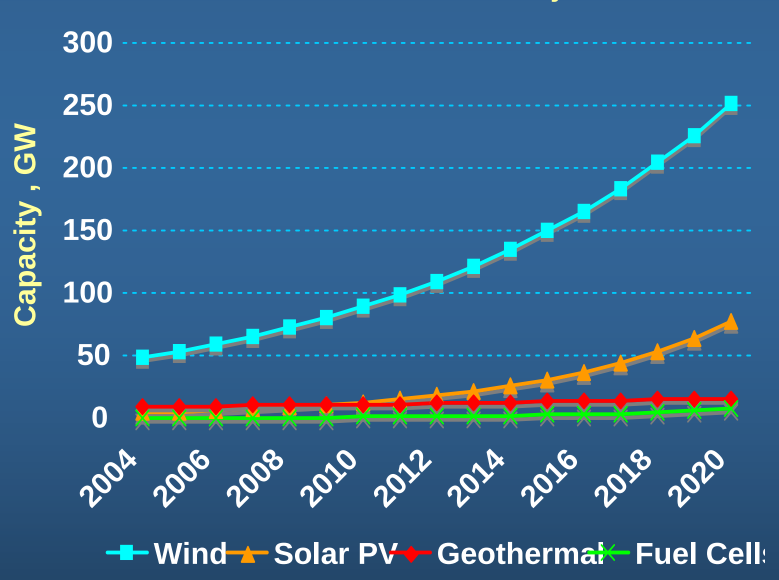
- **"Adequate Supplies" – Moderate Long Run Prices**
  - EIA base primary fuel price forecast (AEO 2006)
  - No disruptive technological change until 2020
- **"Constrained World" – High Fuel Prices and Climate Change Regulation**
  - EIA high case primary fuel price forecast
  - High prices accelerate disruptive technological change
- **"Commodity Cycle" – Cyclic Fuel Price Forecast**
  - Cyclical primary fuel price forecast (high, then low)
  - High prices create demand-side response that lowers demand for oil

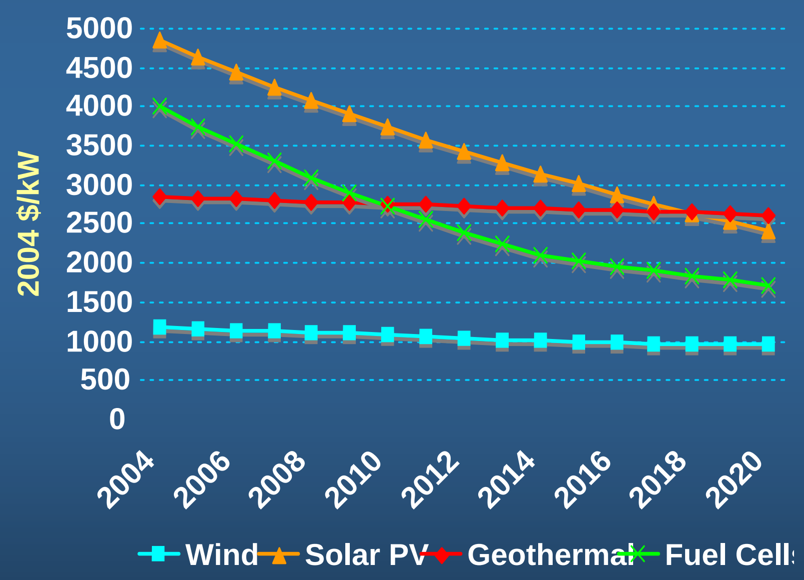
NYMEX Energy Prices Reflect the Market for the Next 5 Years Then Used EIA High And Reference Cases For Adequate And Constrained Scenarios



Even in "Adequate Supplies", Renewable Energy Technologies Worldwide is Assumed to Improve Over Time as Production Scales Up

- Wind power costs drop 18% with experience and scale
- Less mature and faster-growing technologies will enjoy cost reductions that may allow them to overtake geothermal: 50% for solar PV and 57% for fuel cells.

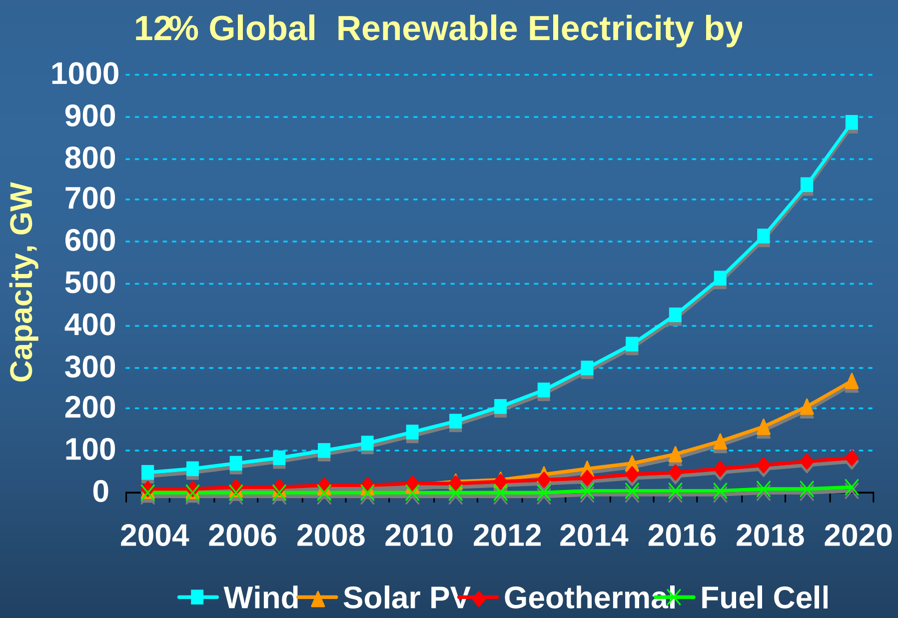


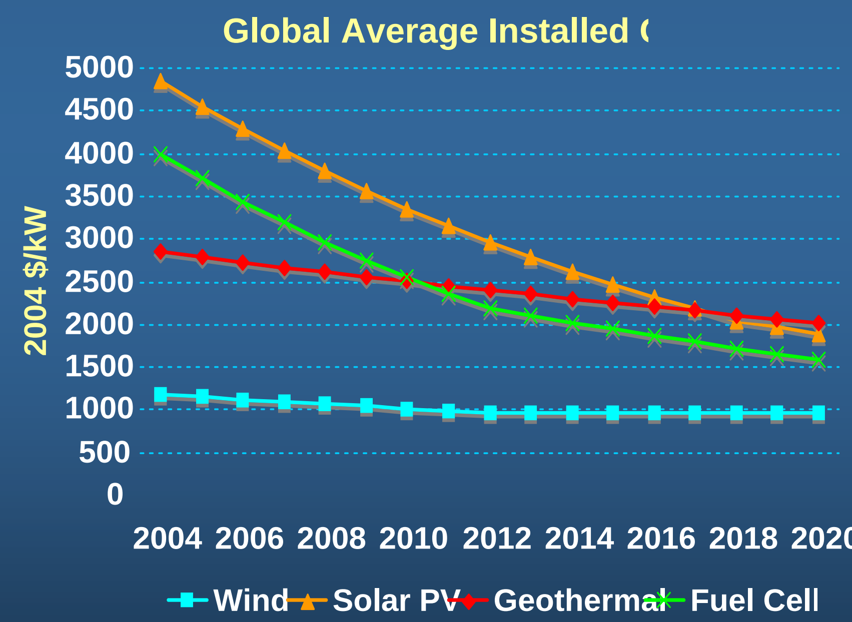


Sources: IEA, 2004, World Energy Outlook, and BCC Research, Fuel Cells and Battery Technologies

Constrained Supplies: Strong, Sustained Demand for Renewable Energy Worldwide Significantly Lower Costs

- Wind unit costs drop 19%, as technology becomes mature.
- Solar, geothermal and fuel cells all make impressive cost reductions: 61% for solar PV, 60% for fuel cells, and 29% for geothermal.
- Rapid growth in renewables to meet climate stabilization targets 12% of worldwide electricity from non-hydro renewables by 2020

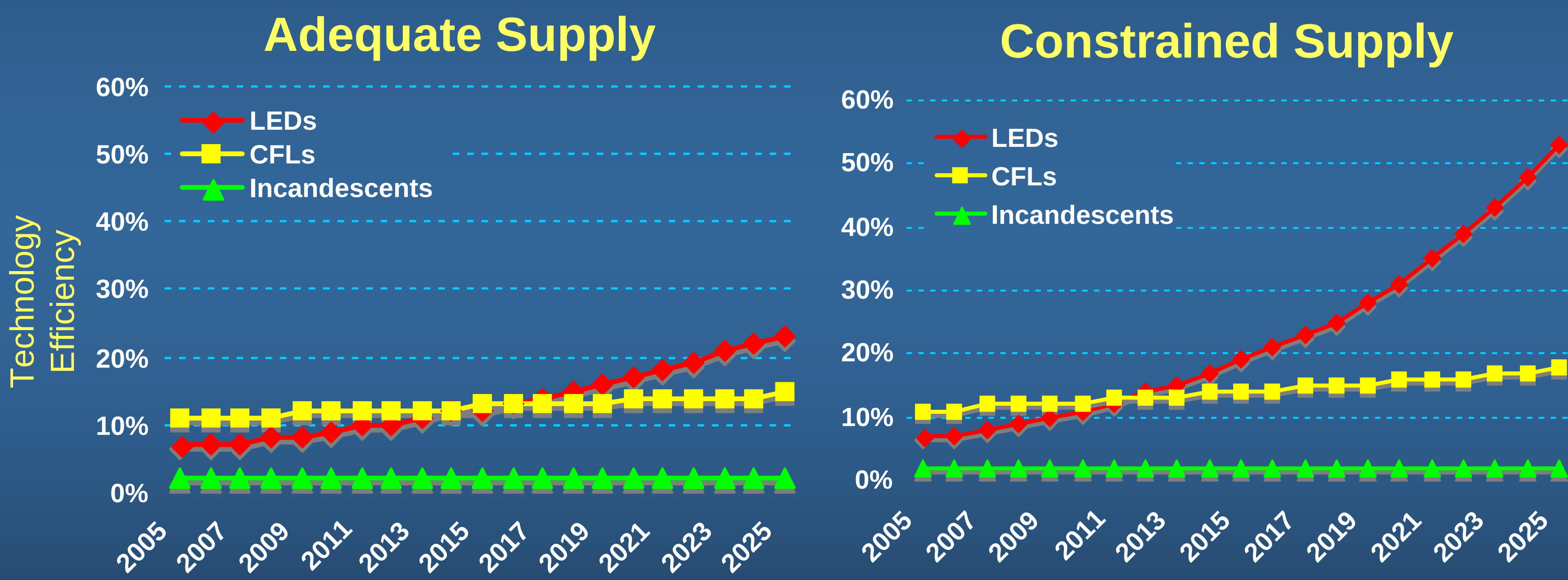




Source: adapted from Global Wind Energy Council, "Wind Force 12: A blueprint to achieve 12% of the world's electricity from wind power by 2020," 2005

End Use Technology Efficiency Accelerates Nationally in the Constrained Scenario

Technology Efficiency Evolution in E2020: Lighting Inputs Example

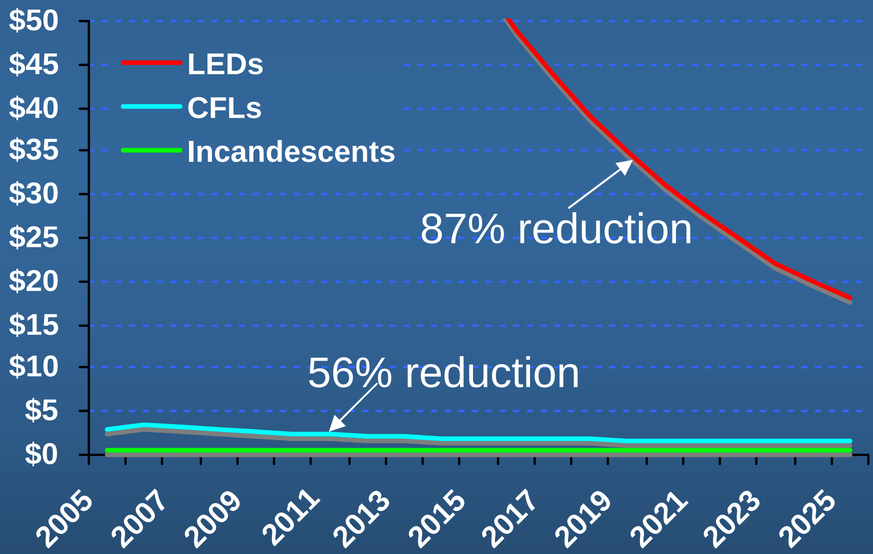


Sources: Broderick, James. 2004. *US DOE Solid State Lighting Status and Future.* SPIE 49th Annual Meeting, August 8.
Drennen, Thomas. 2001. A Market Diffusion and Energy Impact Model for Solid State Lighting, SAND2001-2830J, August
E Source. 2005. *Lighting Technology Atlas*.

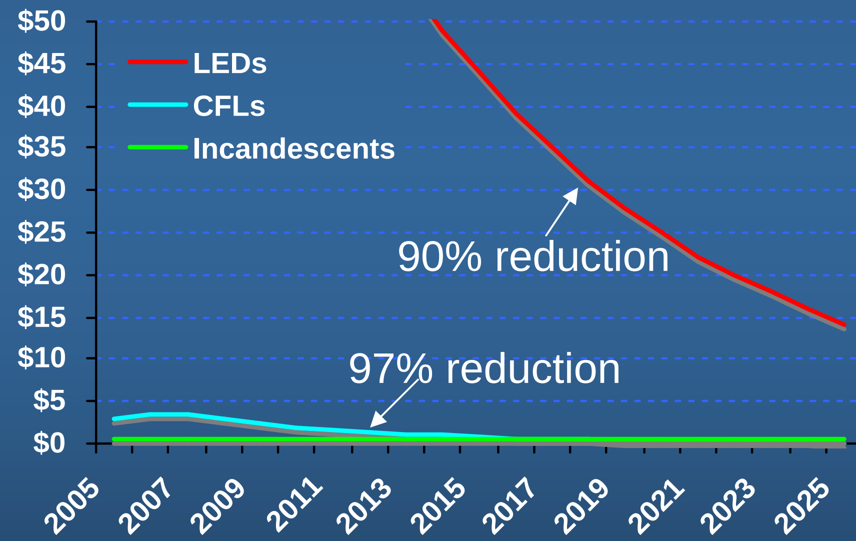
End Use Technology Cost Reductions Accelerates Nationally in the Constrained Scenario

Technology Cost Evolution in E2020: Lighting Inputs Example

Adequate Supply



Constrained Supply



Sources: Broderick, James. 2004. *US DOE Solid State Lighting Status and Future.* SPIE 49th Annual Meeting, August 8.
Drennen, Thomas. 2001. A Market Diffusion and Energy Impact Model for Solid State Lighting, SAND2001-2830J, August
E Source. 2005. *Lighting Technology Atlas*.

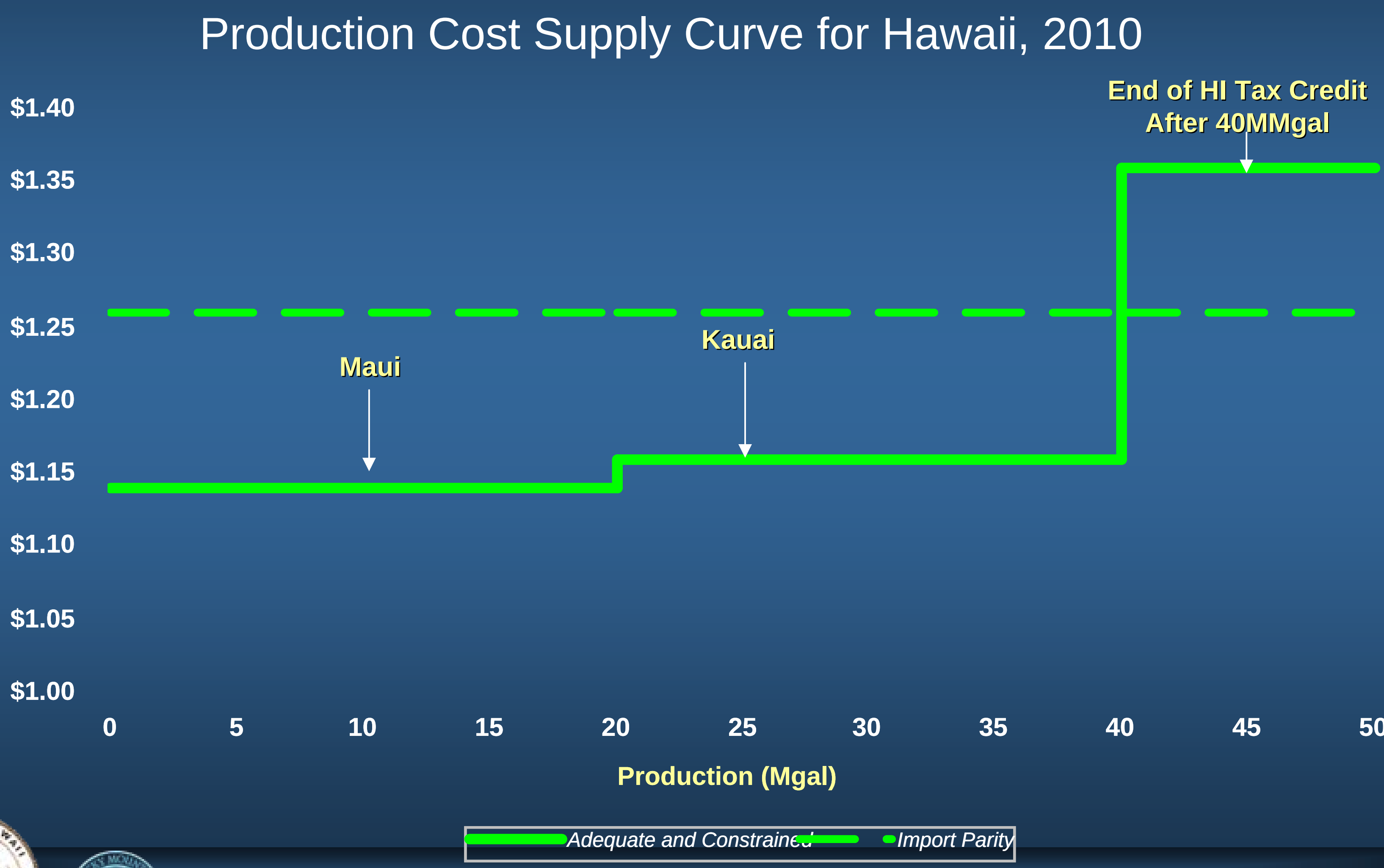
For Efficiency, Life Cycle Costs Matter, Though Adoption Can Be Slowed By High Capital Costs

	Incandescent	CFL	LED
Electricity Cost	15 cents	15 cents	15 cents
Technology Cost	$0.60	$2.50	$35.00
Hours Operation	55,000	55,000	55,000
Technology Life (Hours)	1,000	10,000	75,000
Replacement Frequency	55x	5.5x	0x
Labor Cost	$1.00	$1.00	$1.00
Connected Watts	100	25	15
Energy Consumed	55,000	1,375	825
Electricity Cost	$825	$206	$124
Replacement Capital	$33	$14	$0
Replacement Labor	$55	$6	$0
Total Life Cycle Cost	**$913 per bulb**	**$226 per bulb**	**$124 per bulb**

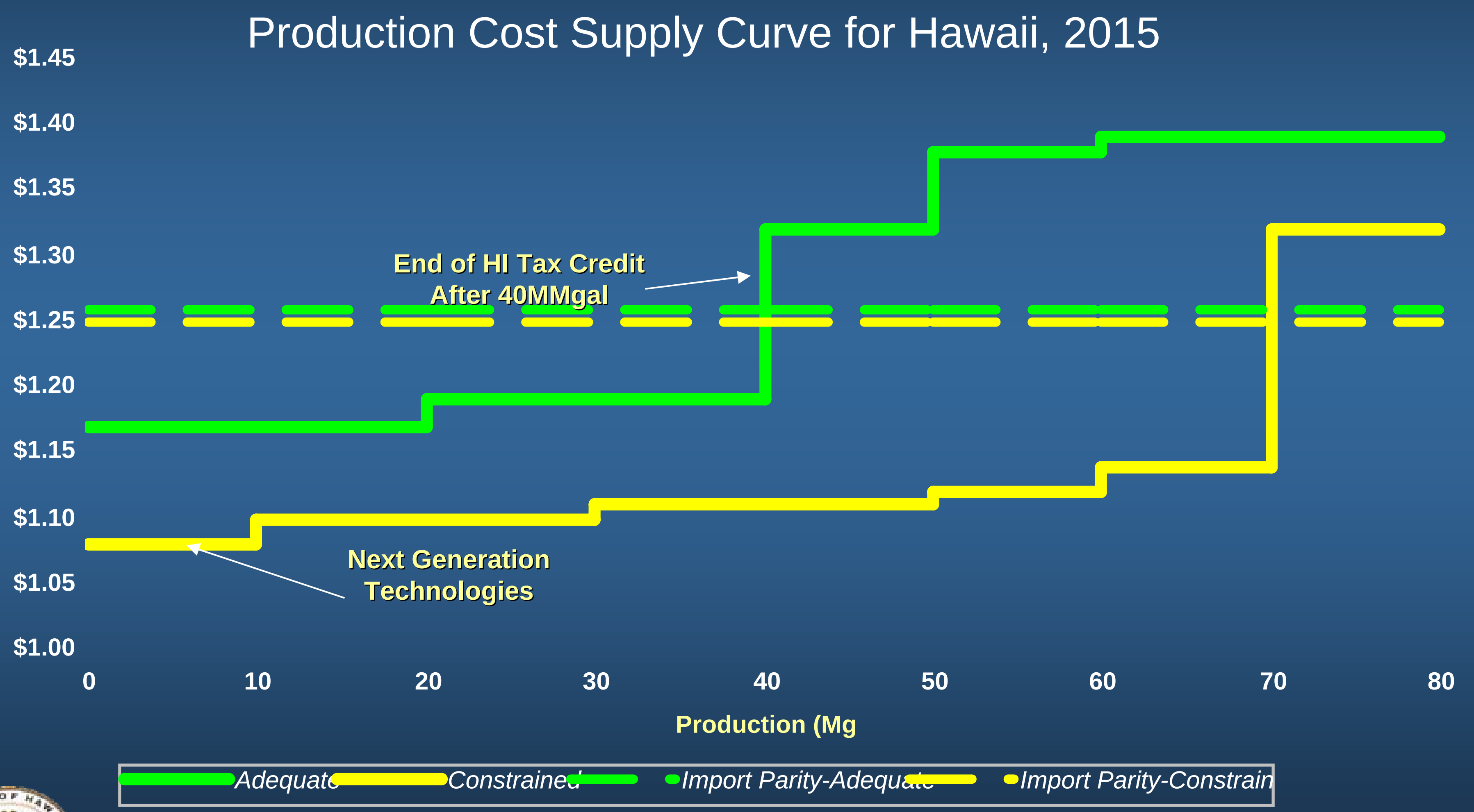
Biofuels Costs and Conversion Efficiency Assumptions Vary by Scenario

		Adequate Supplies	Constrained
Conventional Ethanol	Plant Capital Cost ($/gal)	$0.07 (w/ HI tax credit) to $0.28	Same
	Plant Variable Cost ($/gal)	$1.51 (Mi) to $2.08 (Hi)	$1.47 (Mi) to $1.99 (Hi)
	Conversion Efficiency (gal/ton)	1dry ton sugarcane = 61.16 gal eth.	Same
	Feedstock cost $/ton	$81.87 (Mi) to $118.30 (Hi)	$83.09 (Mi) to $119.60 (Hi)
Cellulosic Ethanol	Plant Capital Cost ($/gal)	$0.57 (w/o HI tax credit)	Same
	Plant Variable Cost ($/gal)	$1.13 (Mi) to $1.25 (Hi)	$1.09 (Mi) to $1.16 (Hi)
	Conversion Efficiency (gal/ton)	1dry ton banagrass = 90.6 gal eth.	Same
	Feedstock cost ($/ton)	$71.55 (Mi) to $86.89 (Hi)	$73.36 (Mi) to $90.51 (Hi)
	Commercial Availability (yr)	2016	2011
Biodiesel	Plant Capital Cost ($/gal)	$0.09 (10MMgal)	Same
	Plant Variable Cost ($/gal)	$0.12 (10MMgal) to $0.13 (1MMgal)	Same
	Conversion Efficiency (gal/lb)	1 gal veg oil = 1 gal biodiesel	Same
	Feedstock cost ($/gal)	$1 (waste oil) to $1.6 (soy oil)	Same

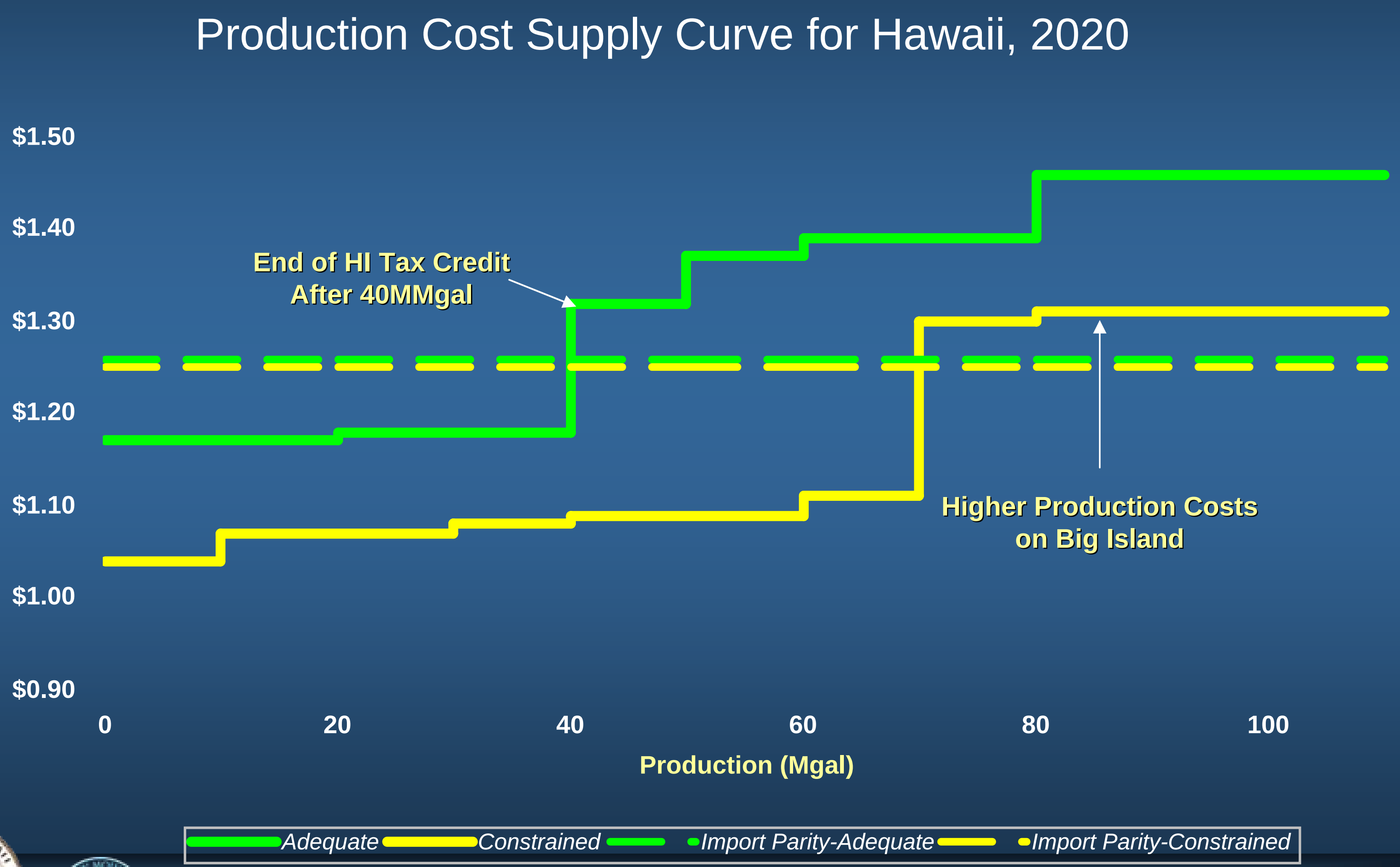
40 MMgal of Ethanol Can be Cost Effectively Produced by 2010 Due to HI Tax Credits



Next Generation Biofuels Technology Becomes Viable in Constrained Scenario

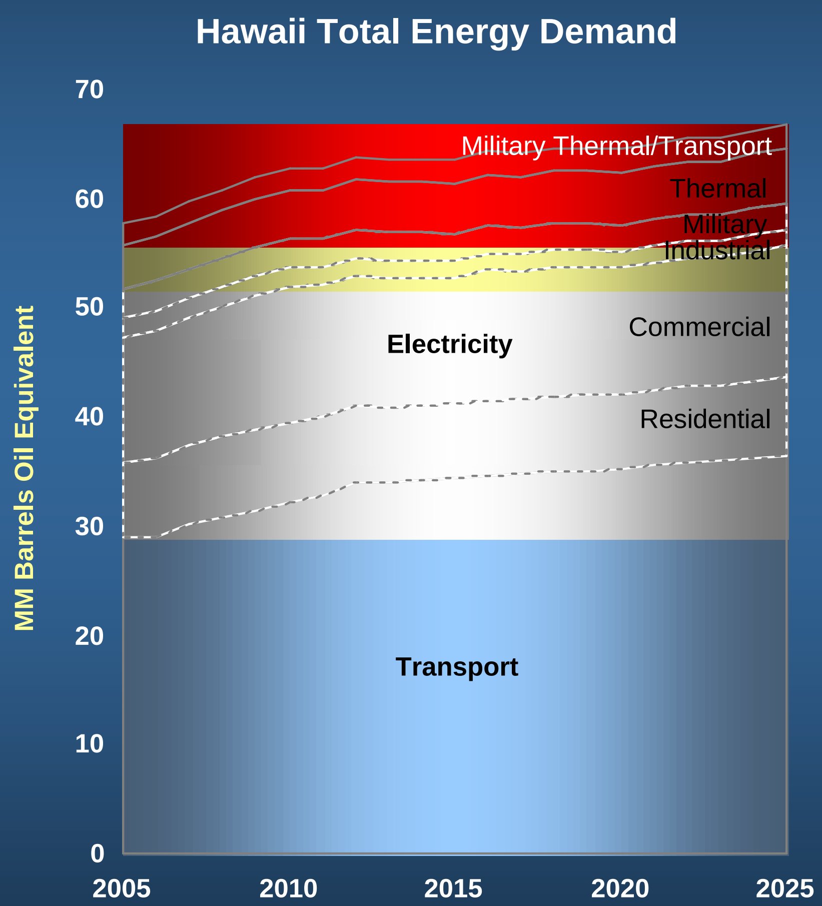


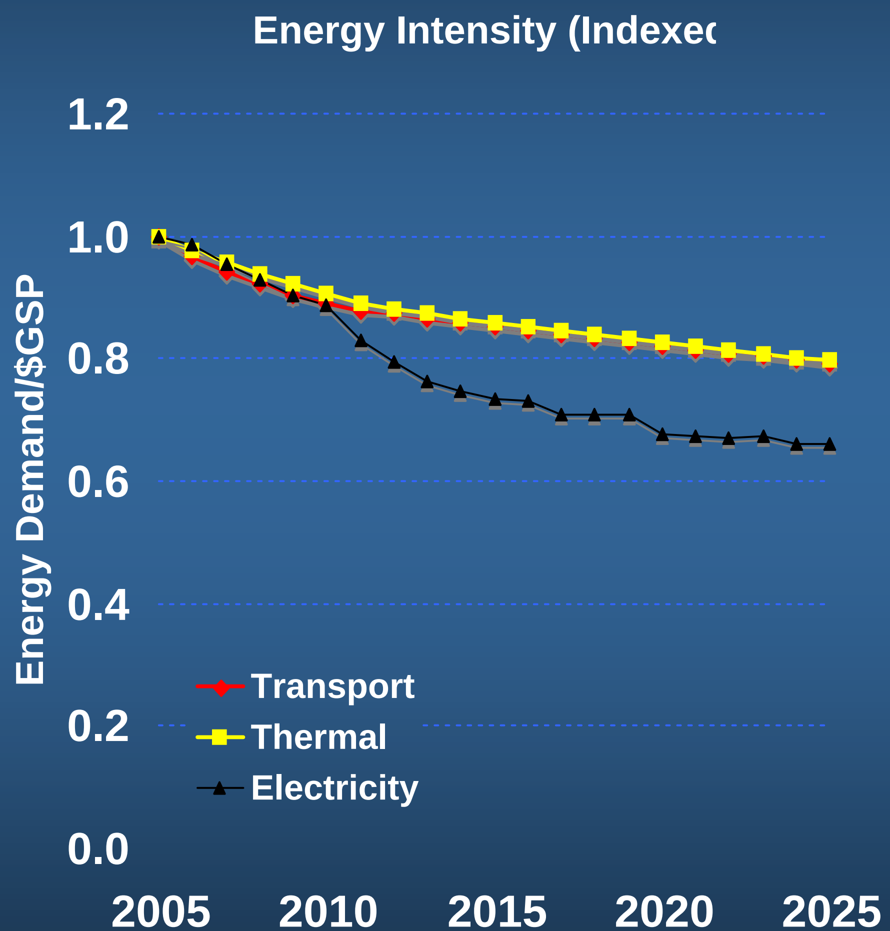
Production Moves to the Big Island in the Long Term, Using Next Generation Technologies



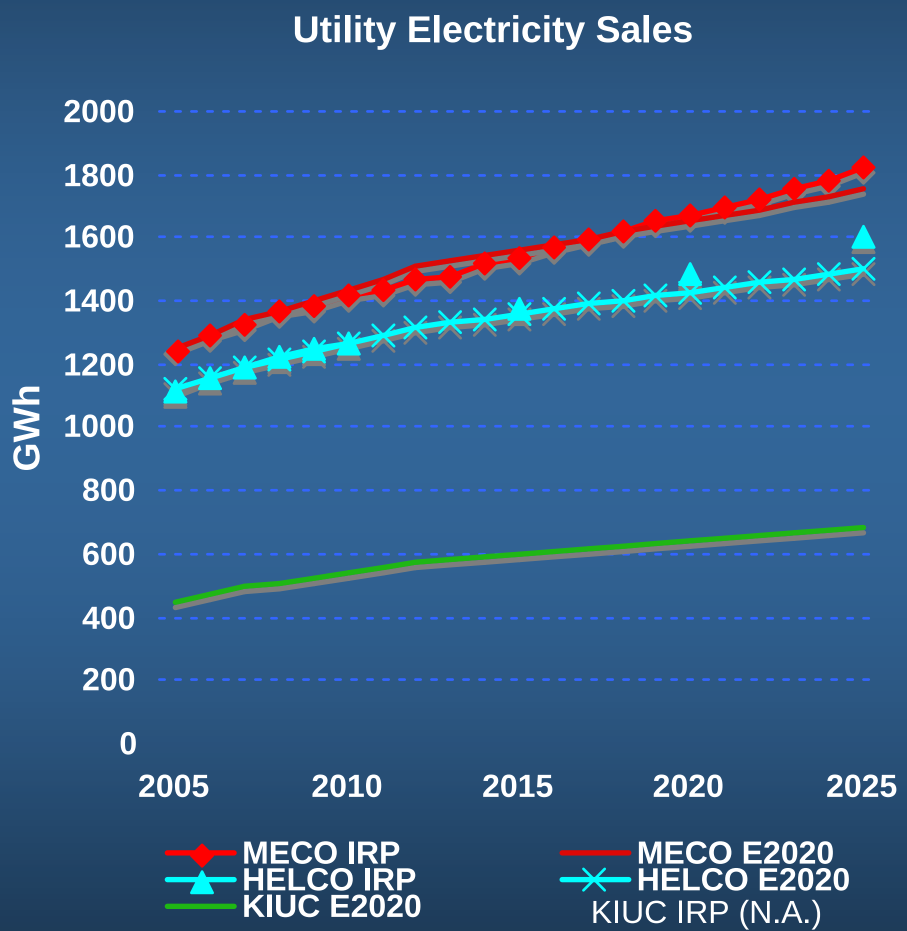
Preliminary Findings: Adequate Supplies and E2020 Calibration

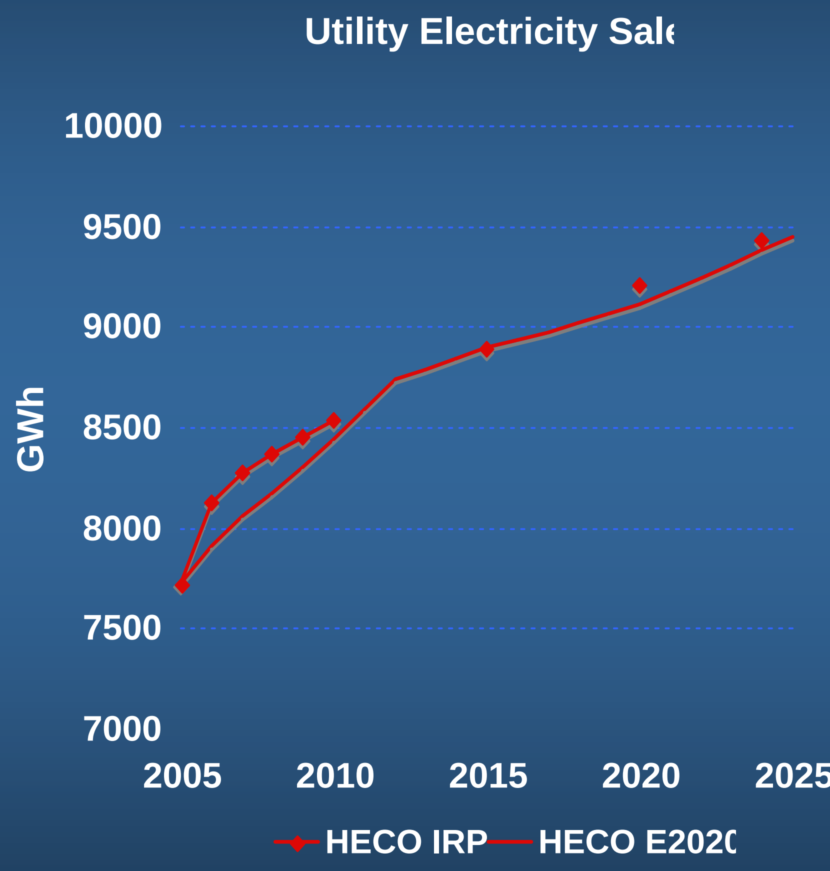
Hawaii's Energy Demand Accelerates at 0.6%/yr to Reach 63 Mmboe By 2020, While Intensity improves By 24% From 2005 To 2020





Calibrating E2020: Electricity Sales are Very Close to Utility IRP Projections





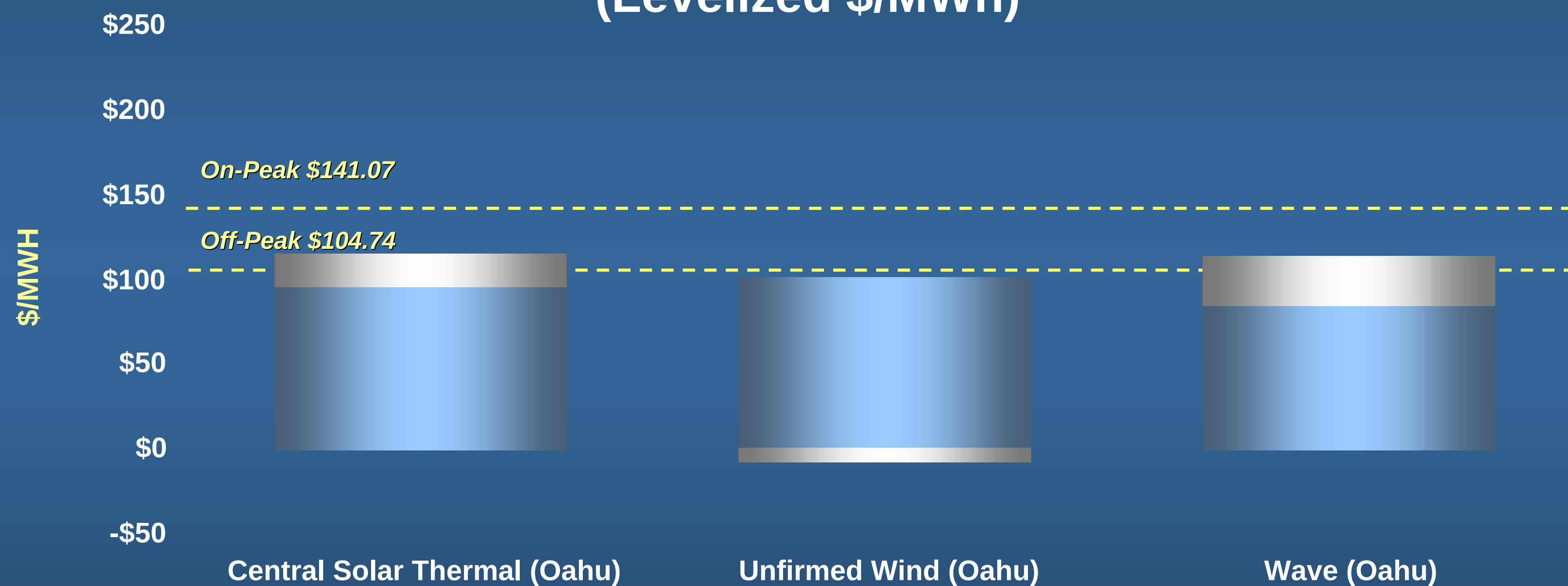
Note: IRP forecasts as of 02/04 (HECO), 07/04 (HELCO), and 01/06 (MECO)

Even Under the Adequate Scenario, Some Renewables Are Cost Competitive When Fuel Costs Are Taken Into Account.

Capacity Factor	83%	60%	60%	39%	83%	65%	95%
Capacity	30	120	20	30	10	180	25

Even Under the Adequate Scenario, Renewables Can be Cost Competitive With HECO's Avoided Costs of Electricity

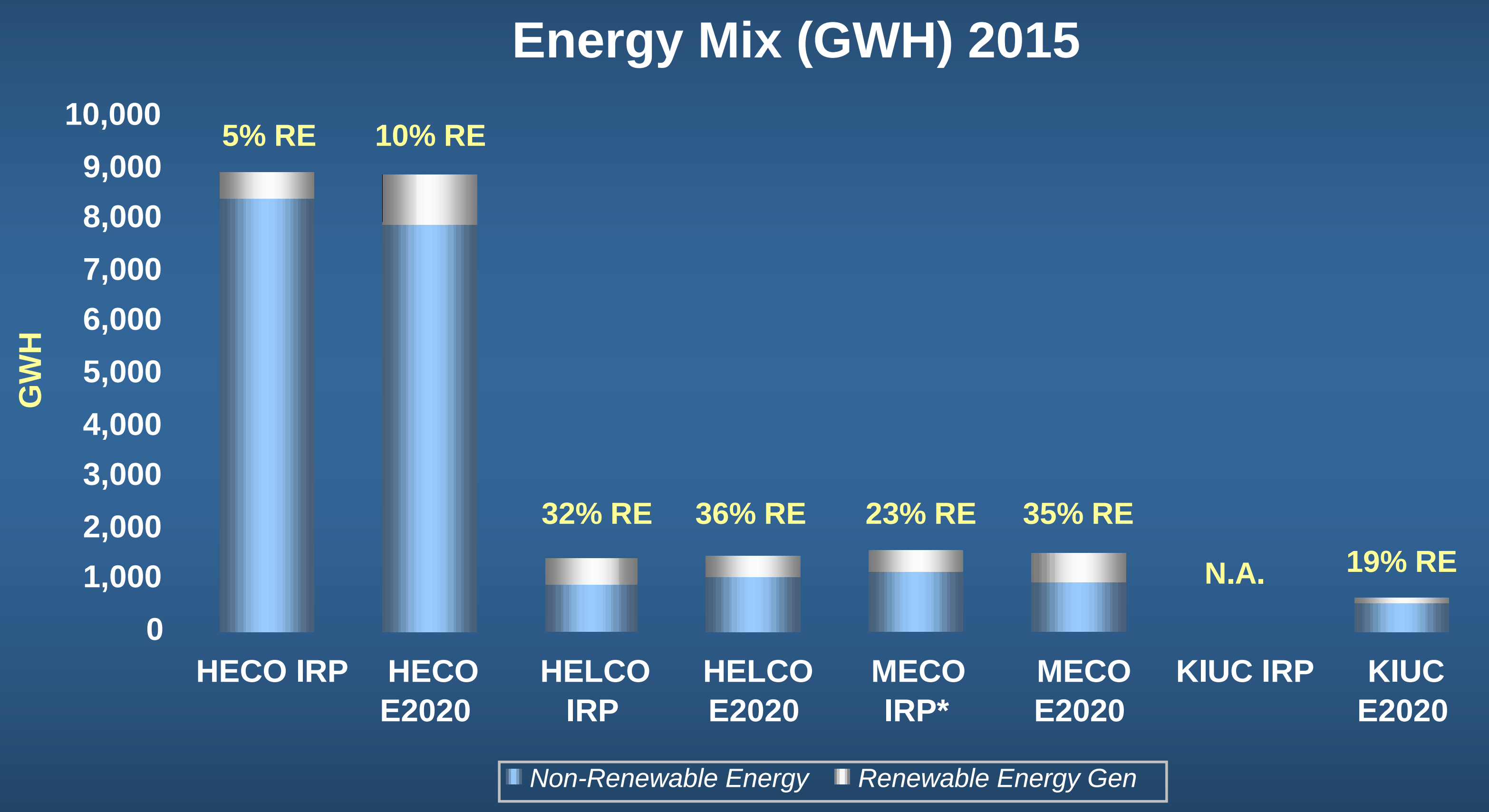
Costs to Run Power Plants Installed in 2012 (Levelized $/MWh)



	Central Solar Thermal (Oahu)	Unfirmed Wind (Oahu)	Wave (Oahu)
Capacity Factor	39%	26%	38%
Capacity	33	10	10

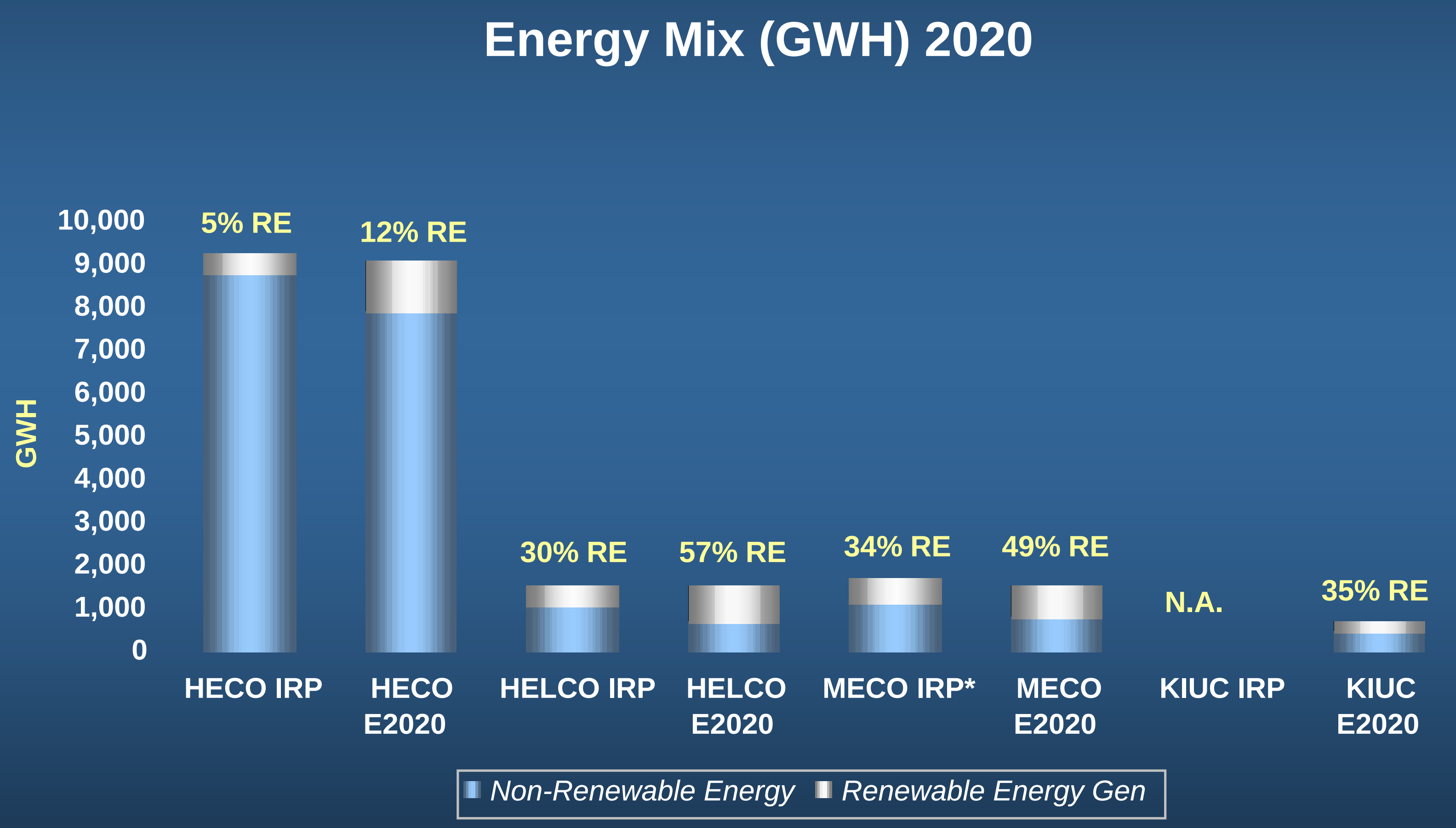
Capital | O&M Total | Fuel

Calibrating E2020: The State's Electricity Supply Mix Shifts Significantly to Renewable Energy by 2015



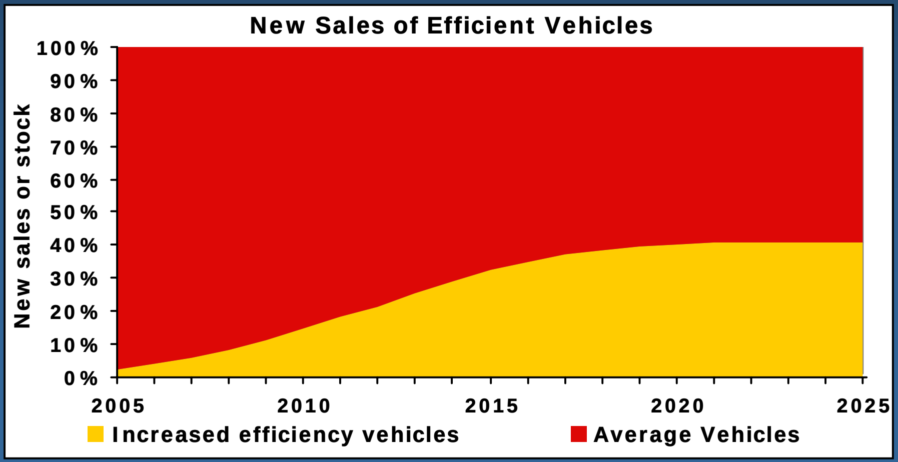
**MECO IRP renewable energy fraction includes energy efficiency. RE only values not available. Source: MECO IRP-3, Strawman Finalist Plans for 032106TechMtg_r1.xls - Summary*

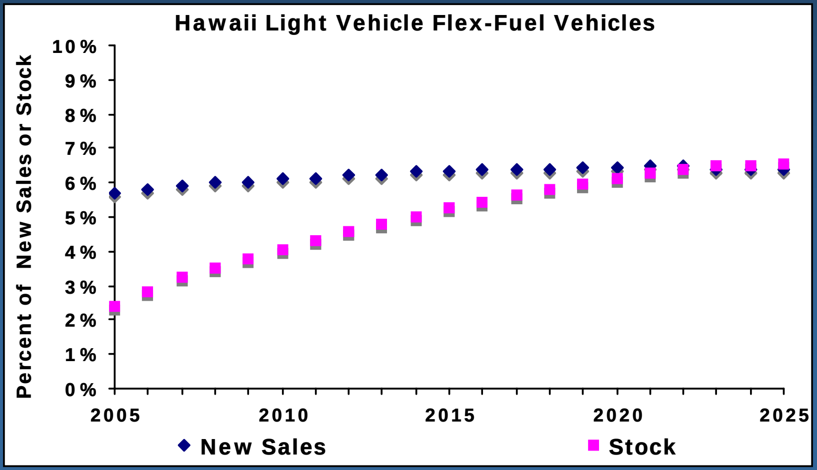
By 2020, Utilities Exceeds 20% RPS Target Even in Adequate Supplies Scenario

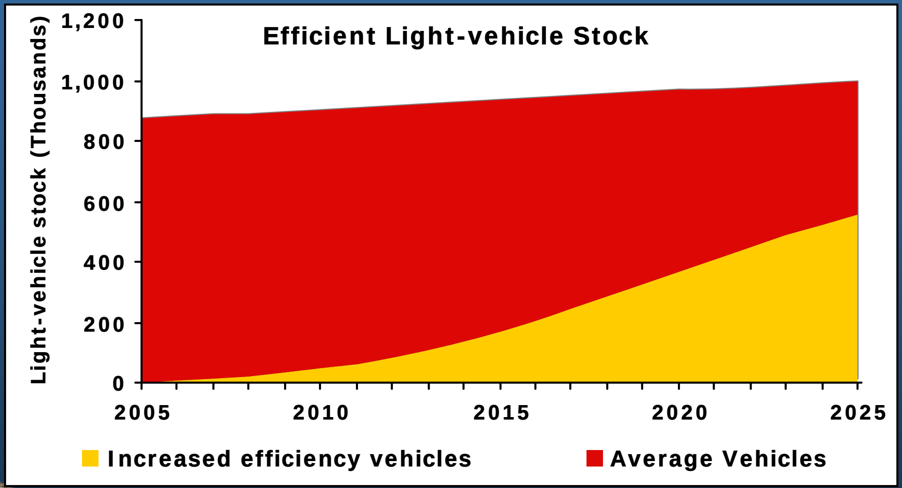


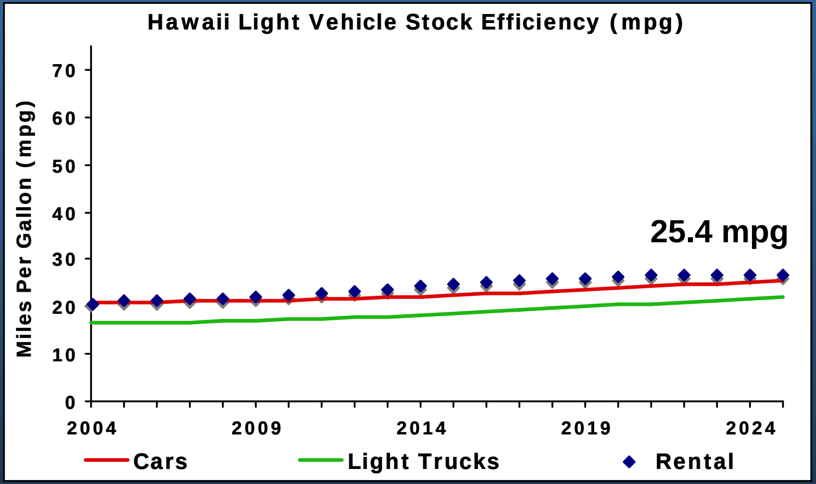
**MECO IRP renewable energy fraction includes energy efficiency. RE only values not available. Source: MECO IRP-3, Strawman Finalist Plans for 032106TechMtg_r1.xls - Summary*

State Transportation Fleet Efficiency Marginally improves From 21 mpg to 25.4 mpg in Adequate Supplies



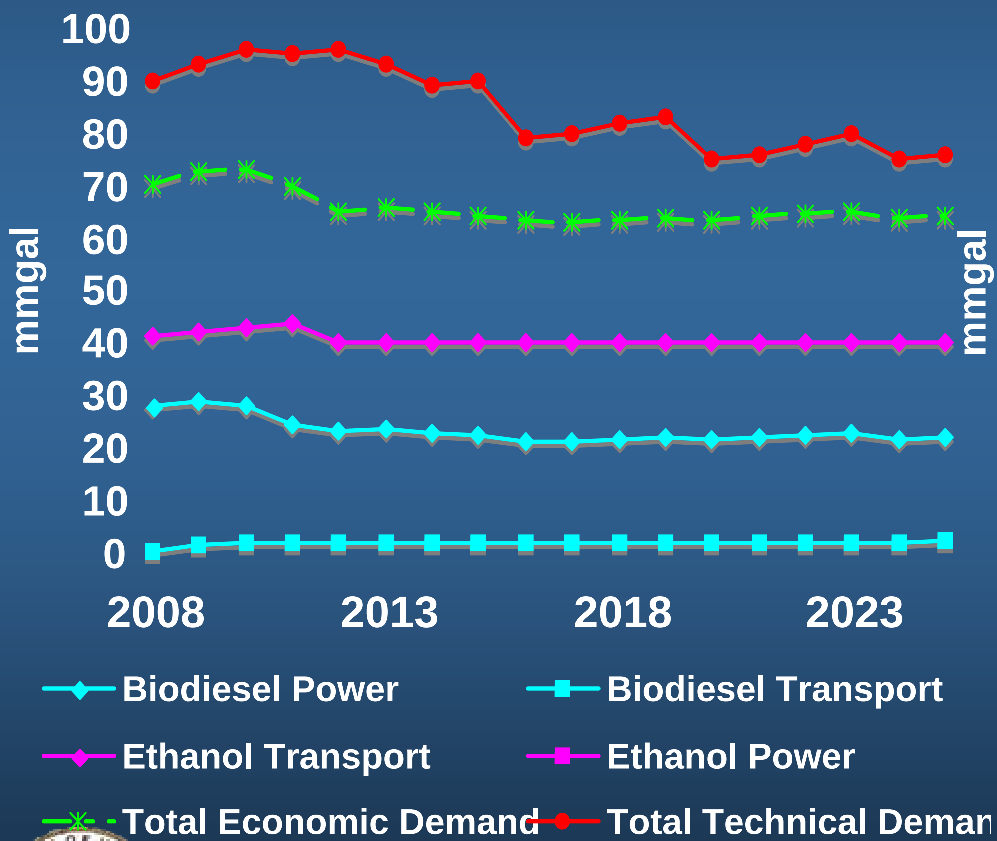




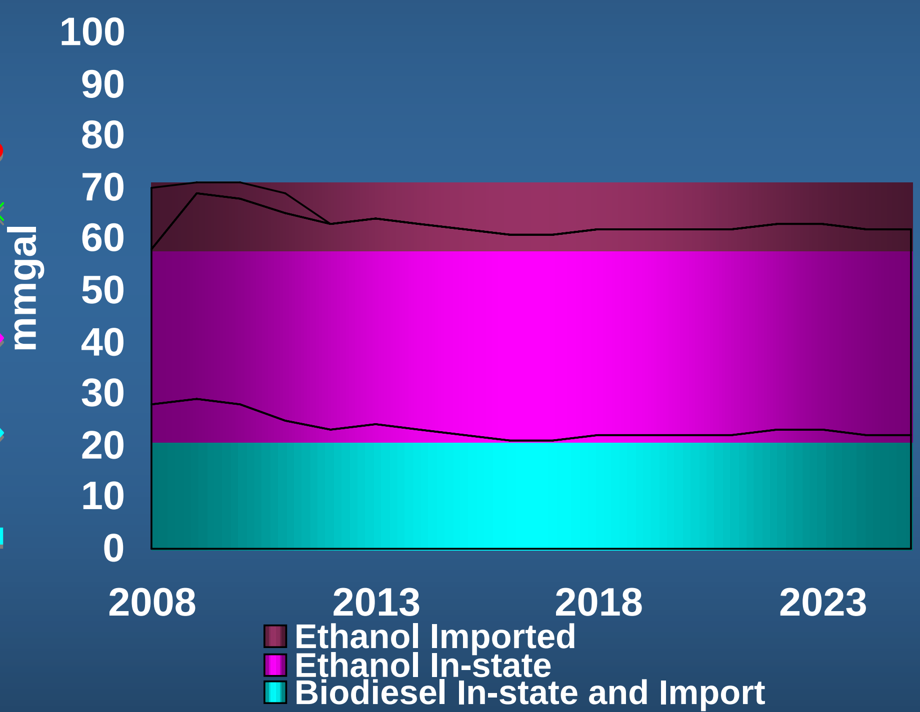


State Biofuels Demand, Particularly for Ethanol, Will Be Steady

E2020 Ethanol and Biodiesel Economic Demand

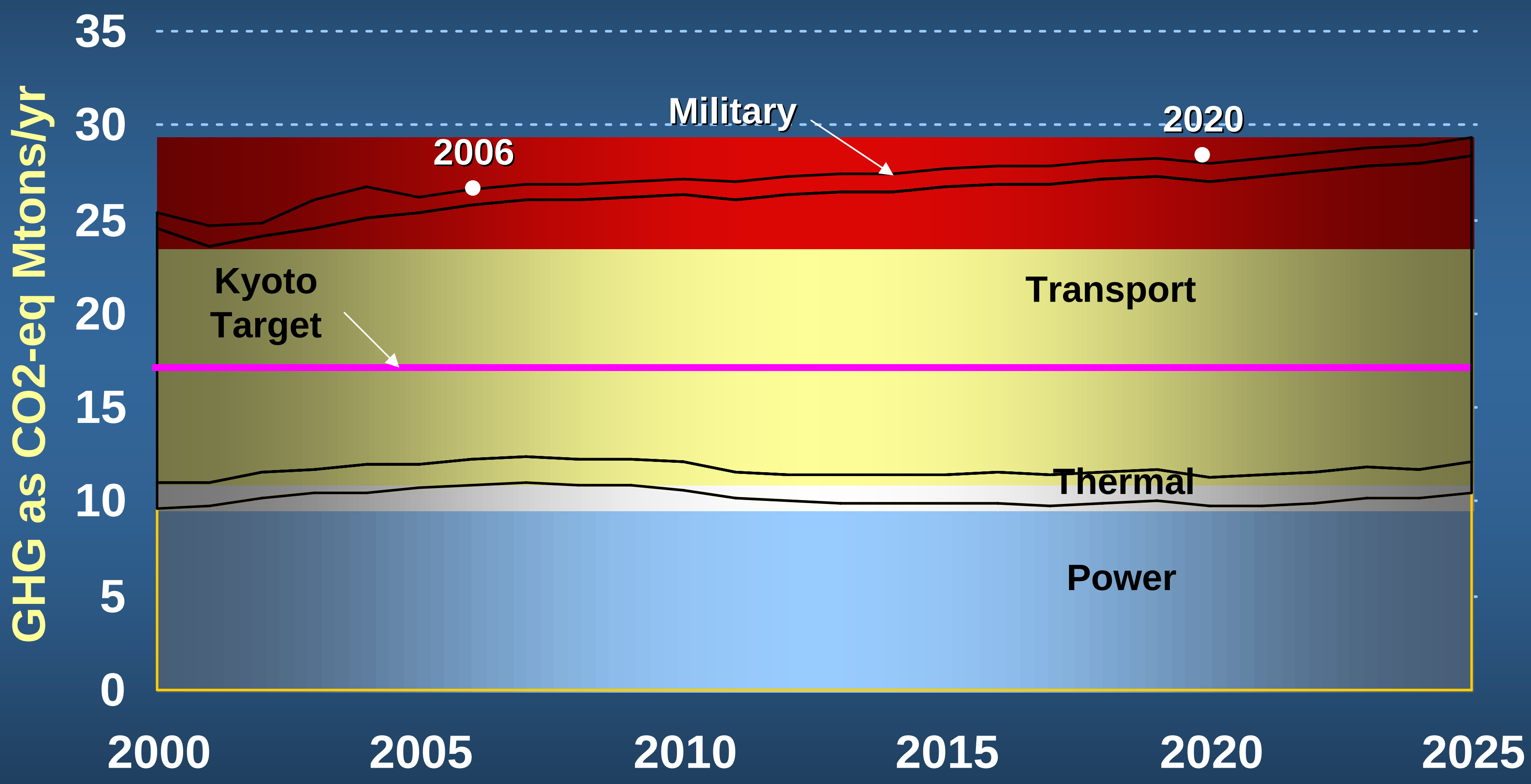


Ethanol and Biodiesel Production Capacity*

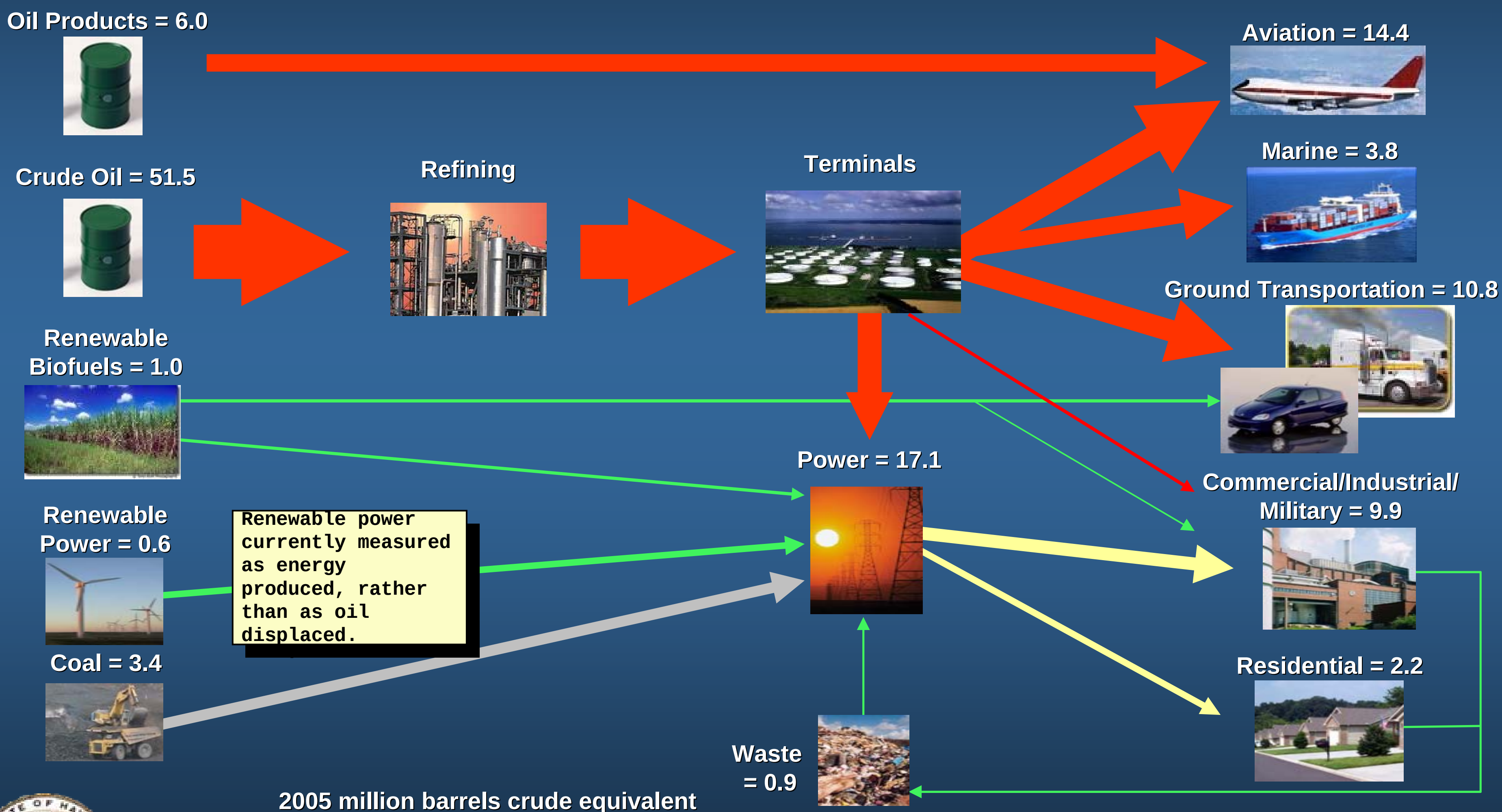


*Only plants at or below import parity were considered.

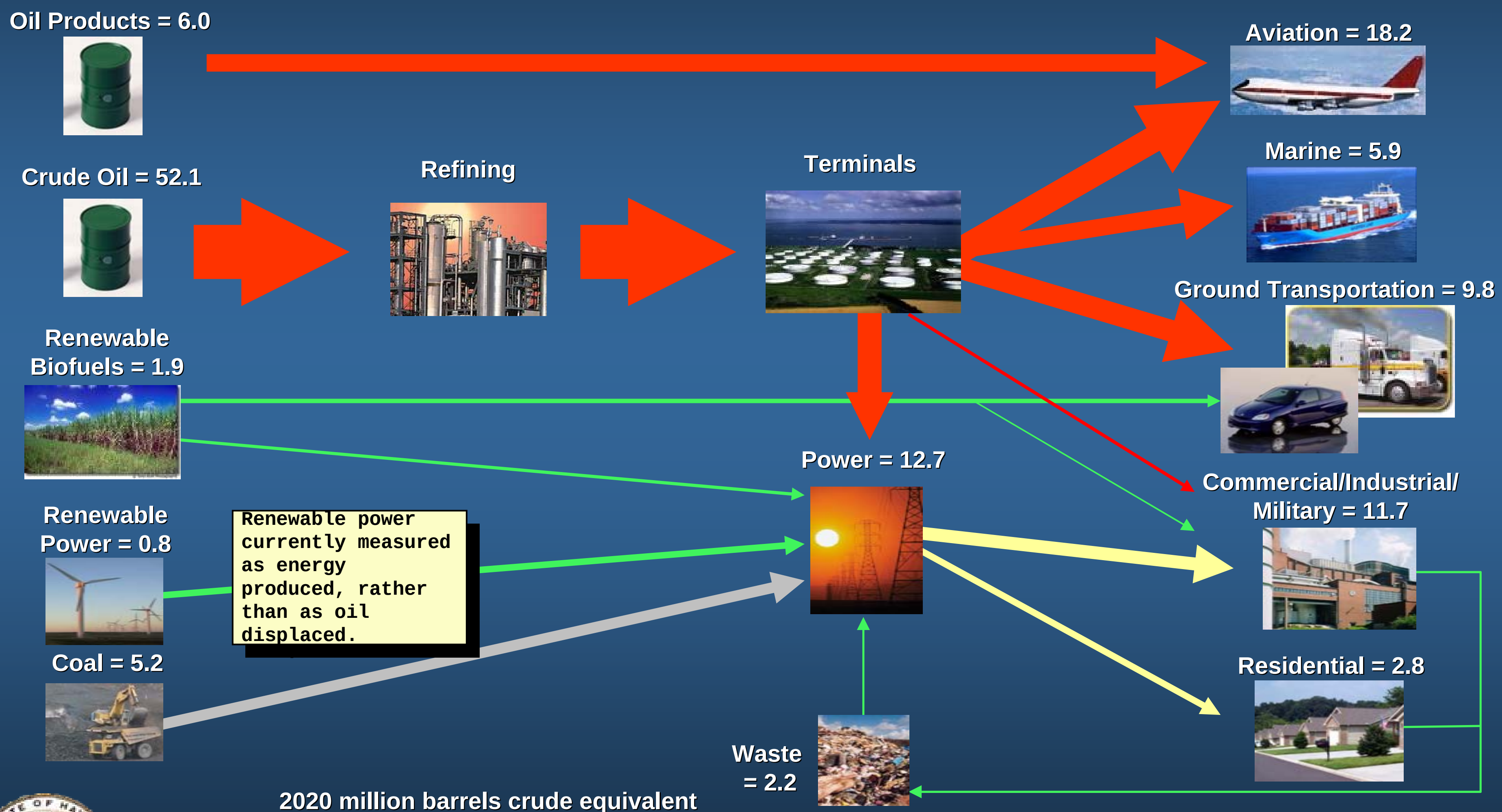
Hawaii's GHG Emissions Will Rise by 5% From the 2006 Baseline by 2020



Hawaii's Current Energy System Is 91% Dependent On Oil

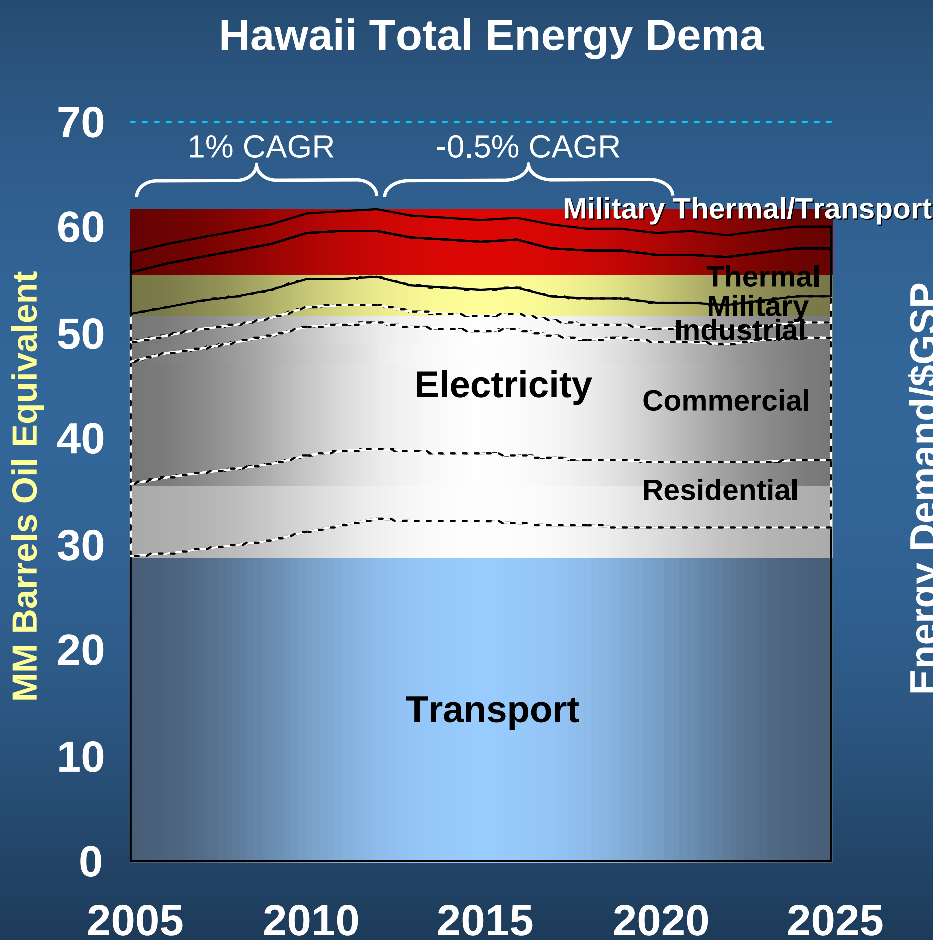


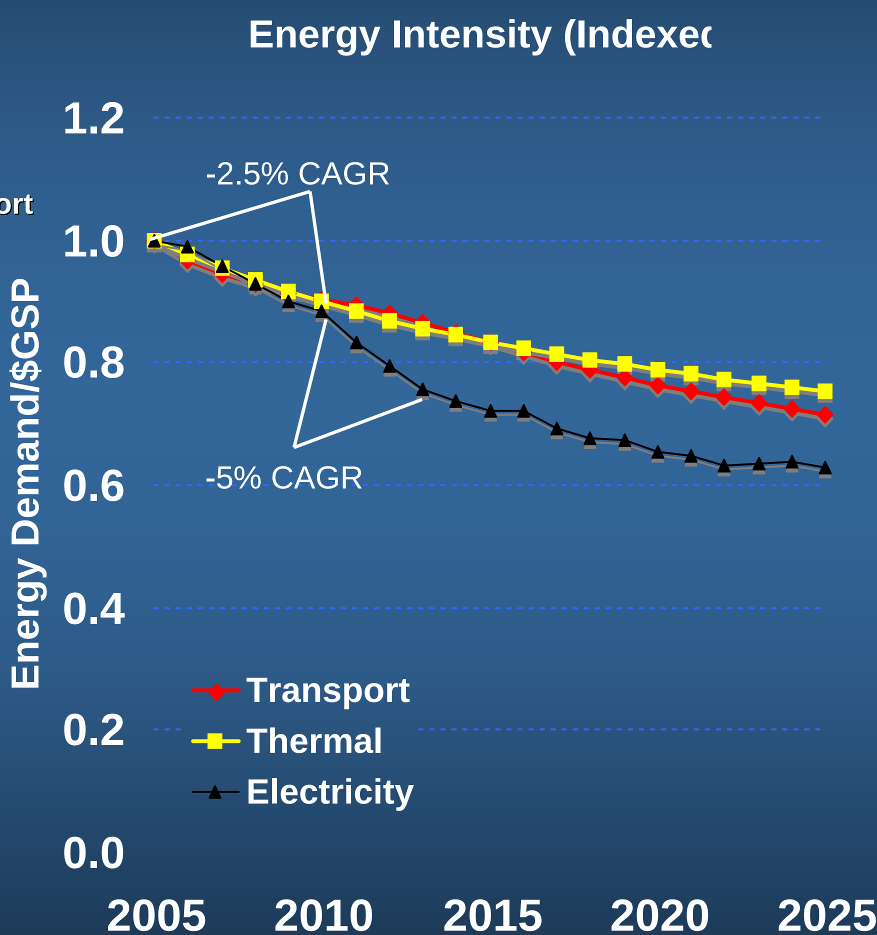
By 2020, We Will Reduce Oil Dependence to 85%, if Supplies Remain Adequate



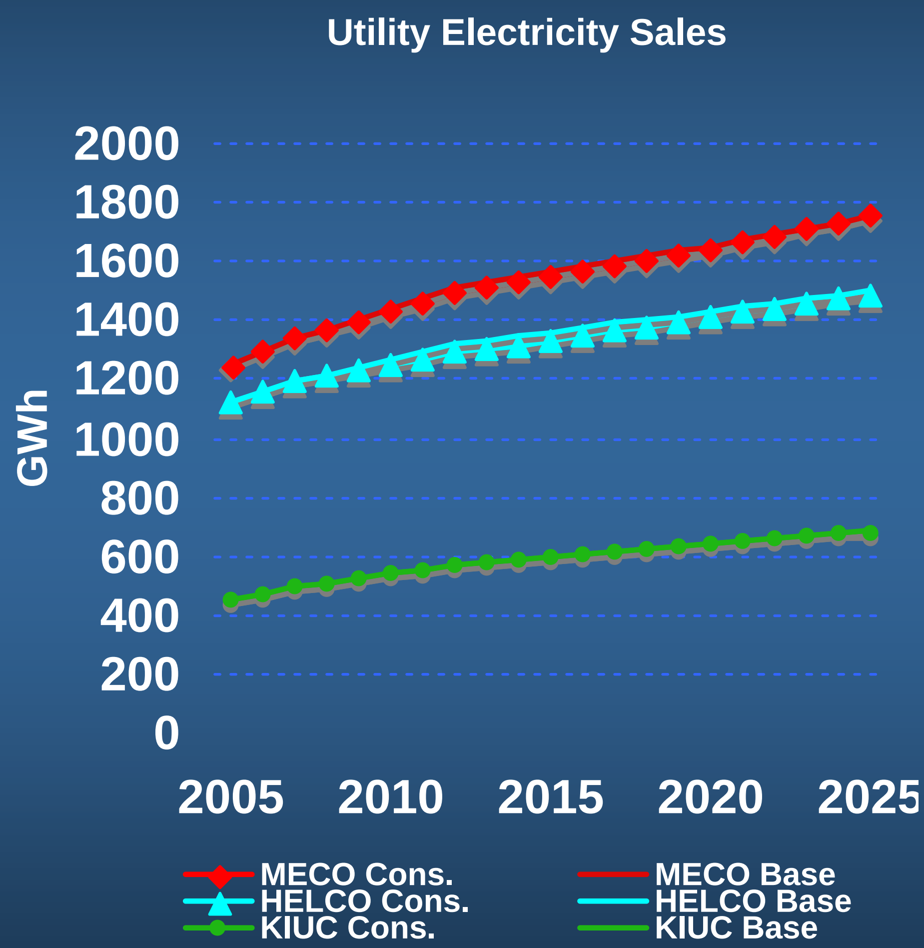
Preliminary Findings: Constrained Oil Supply

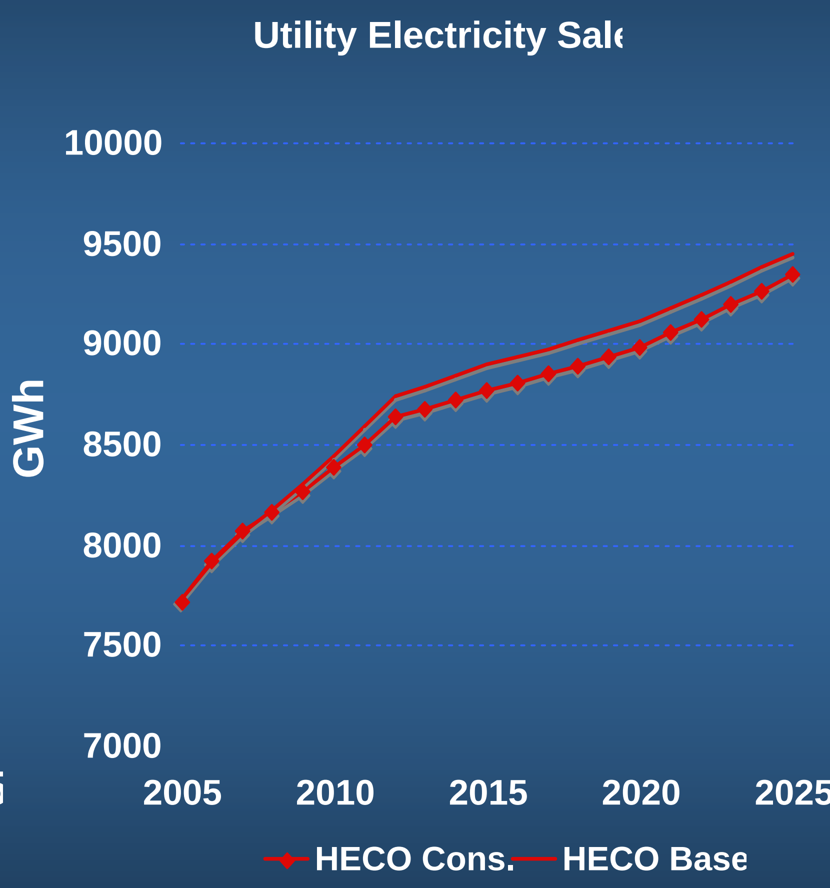
High prices cause energy demand growth to fall after 2012, stabilizing at 60 Mmboe by 2020, while energy intensity improves by 28% due to more efficient technologies



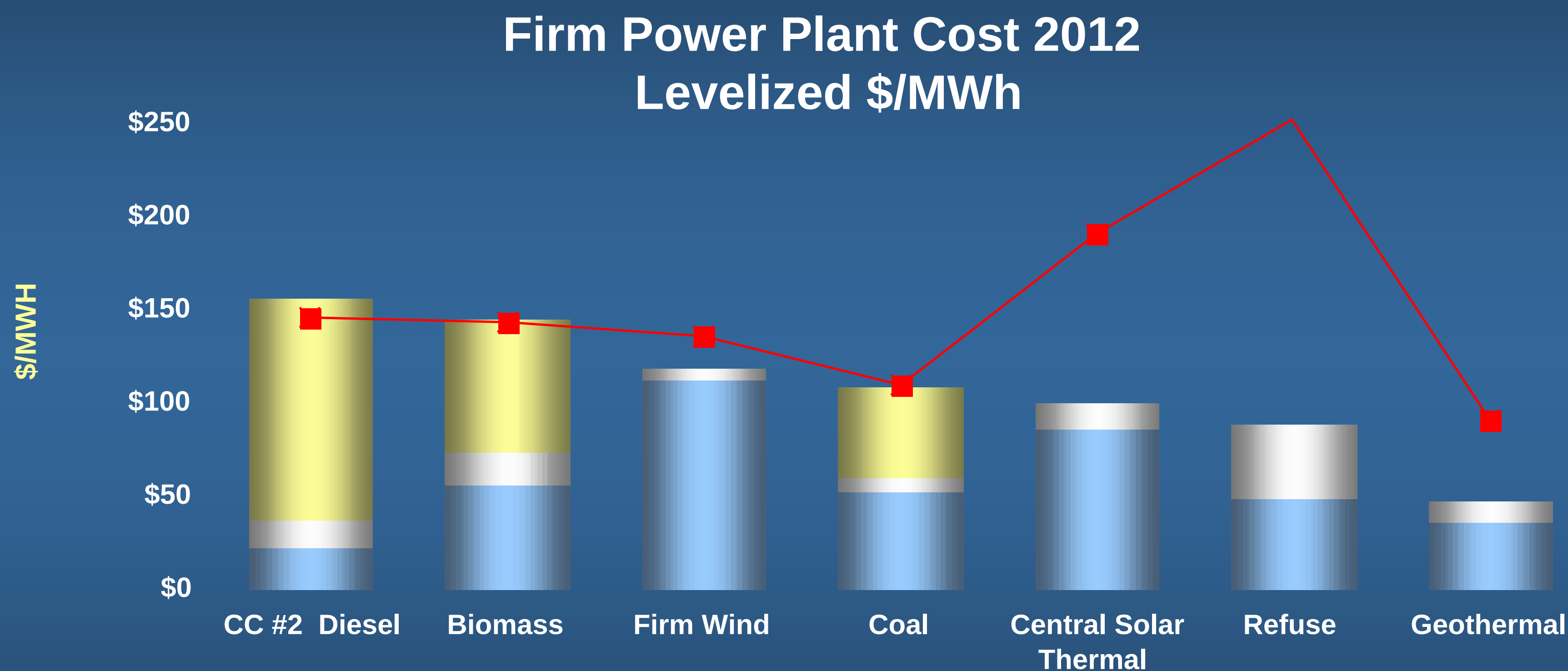


Electricity Sales are 1.2% Lower than Adequate Supplies Scenario by 2020





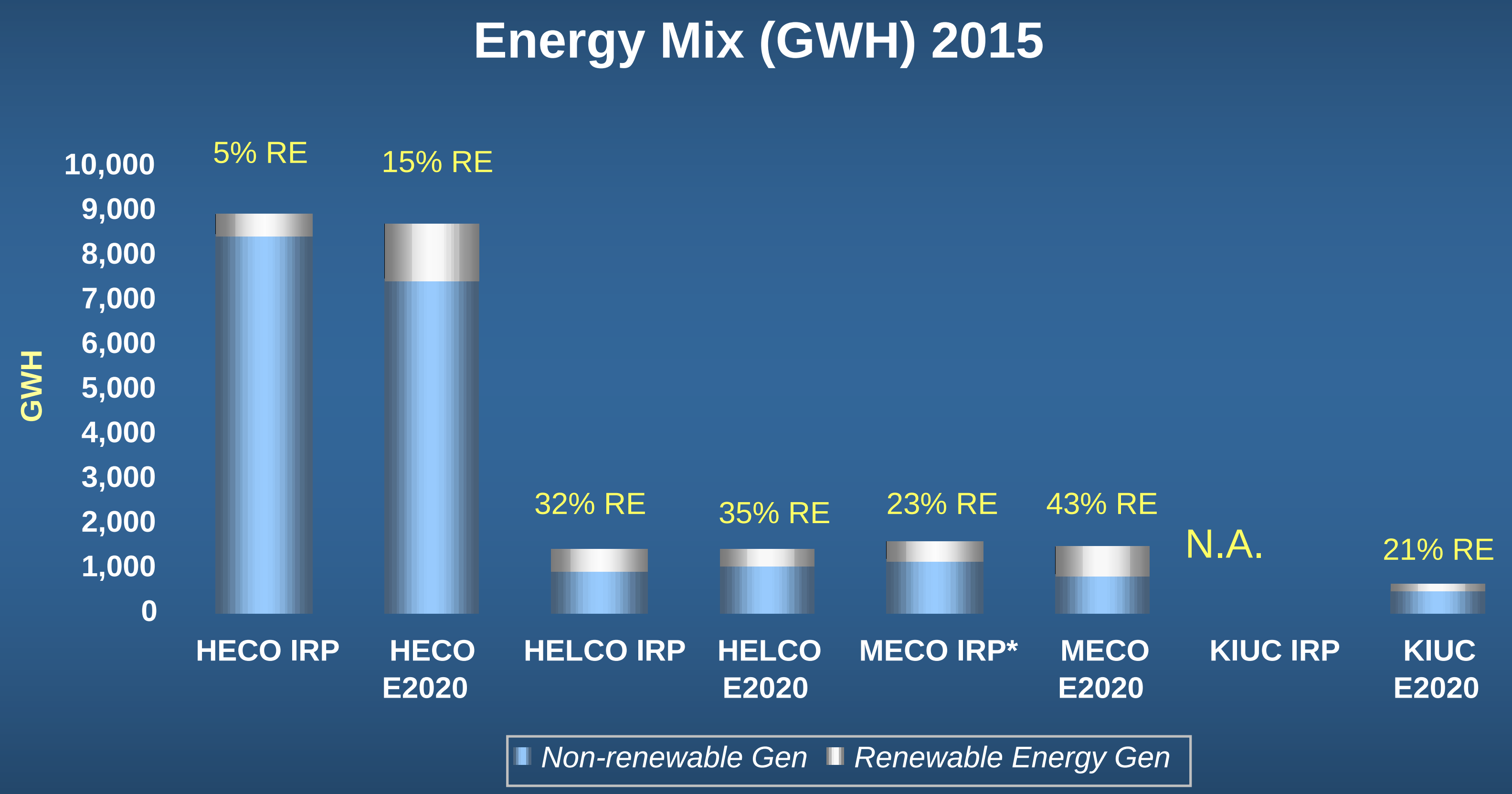
Renewable Energy Technologies Become More Cost Competitive With Oil-Fired Power Generation



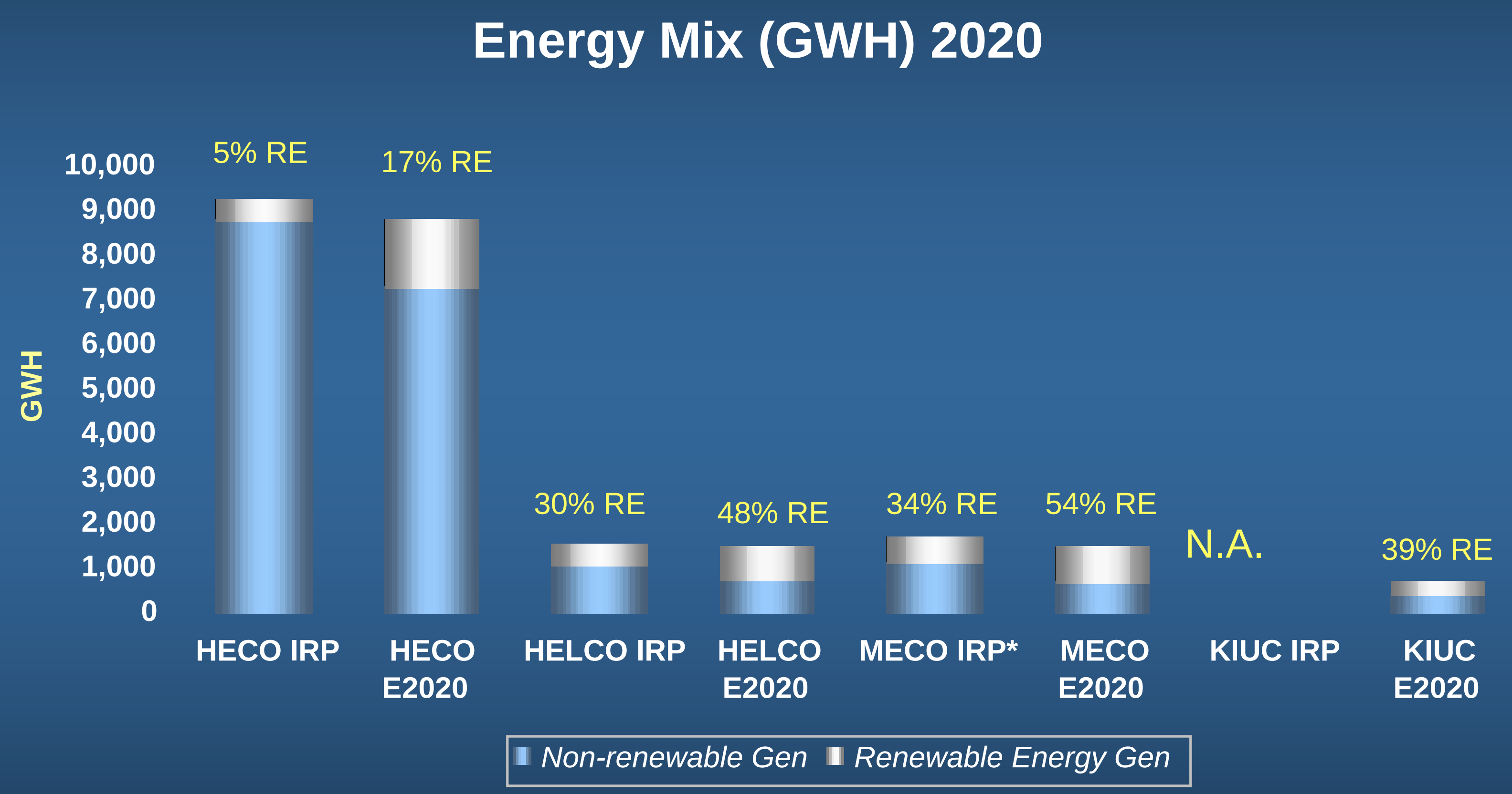
	CC #2 Diesel	Biomass	Firm Wind	Coal	Central Solar Thermal	Refuse	Geothermal
Capacity Factor	60%	83%	60%	65%	39%	83%	95%
Capacity	120	30	20	180	30	10	25

Capital *O&M Total* *Fuel* *Total B&V*

Renewable Energy by 2015 in Constrained Supplies Scenario



More Renewable Energy is Built to Displace Oil in 2020 Even with Lower Demand



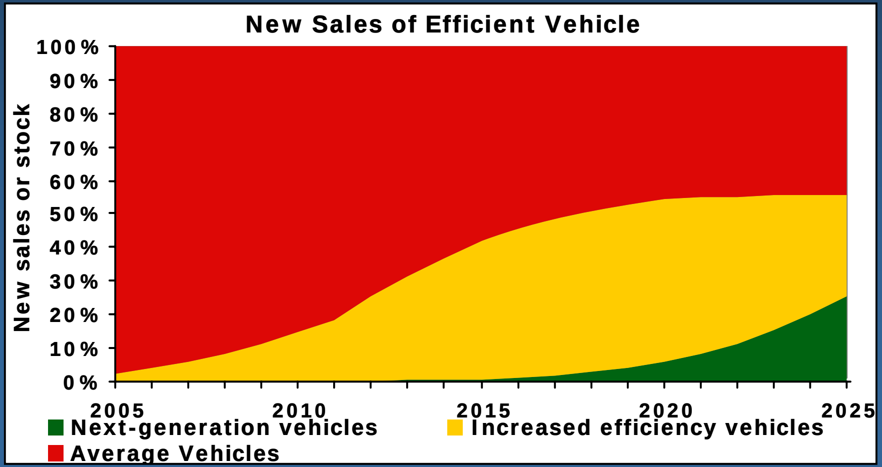
**MECO IRP renewable energy fraction includes energy efficiency. RE only values not available. Source: MECO IRP-3, Strawman Finalist Plans for 032106TechMtg_r1.xls - Summary*

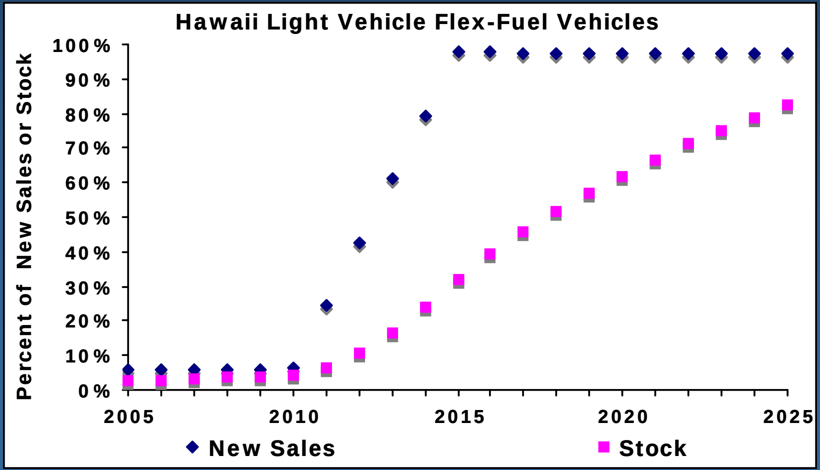
Technology Wild Cards:

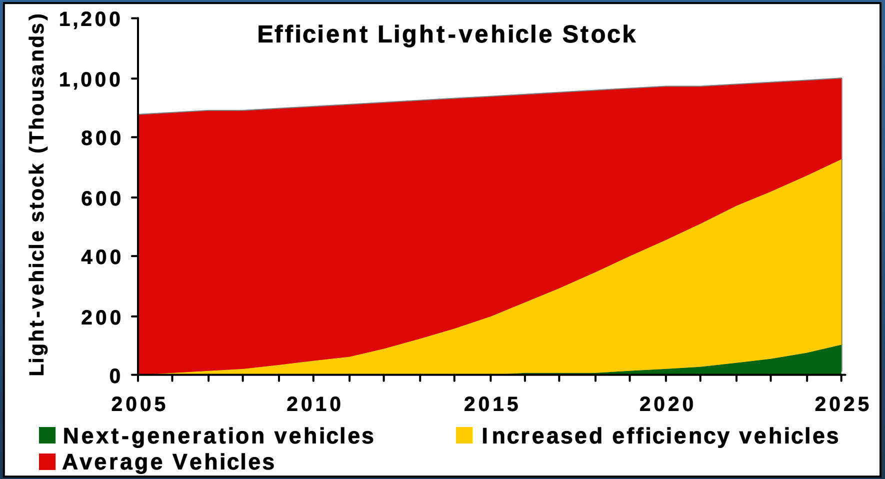
- Large scale SWAC adoption for Honolulu and new coastal resort developments
  - Energy and demand reductions for four projects under study total ~300,000 MWh/yr and 60 MW in 2020, respectively[1]
  - Estimated 20-yr levelized value of ~$1100-1,600/ton-yr including operational benefits (reduced water consumption and wastewater generation)[2]
- Large scale adoption of wave power
  - 180 MW feasible potential and ~570,000 MWh/yr generation[3]
  - Hawaii is among best locations in the world, with sites available on all islands, the largest potential sites located off Oahu
  - Studies predict ~$2000/kW in capital cost by 2012[4]

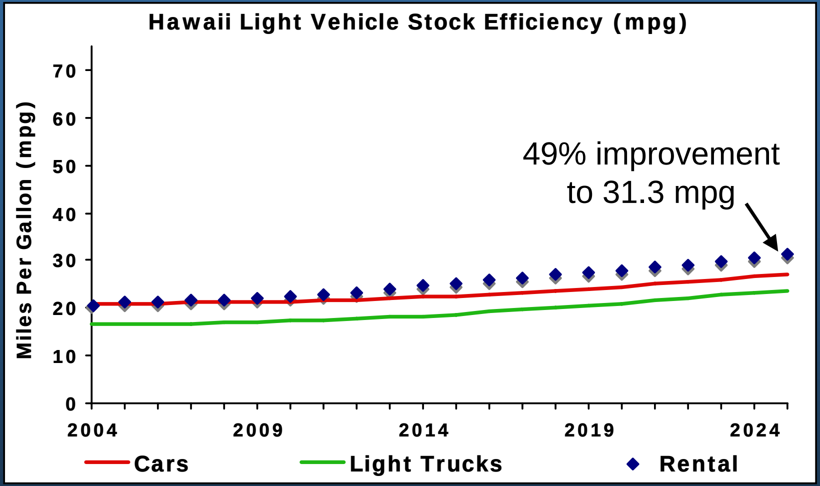
[1]Personal communication. Rezacheck, D. August 2006
[2]DBEDT. 2002. Seawater District Cooling Feasibilitiy Analysis for the State of Hawaii. October. Energy Resources and Technology Division.
[3]Siting and potential from personal communications Energetech Australia Pty Ltd, Ocean Power Delivery Ltd, Wave Dragon.
[4]Previsic, Mirko et al. 2005. "System Level Design, Performance and Costs: Hawaii State Offshore Wave Power Plant." Electric Power Research Institute, Global Energy Partners, and Electricity Innovation Institute, January.

Hawaii's Transportation Fleet Shifts to More Efficient and Flex Fuel Vehicles After 2015. Next Generation Vehicles Appear on the Market



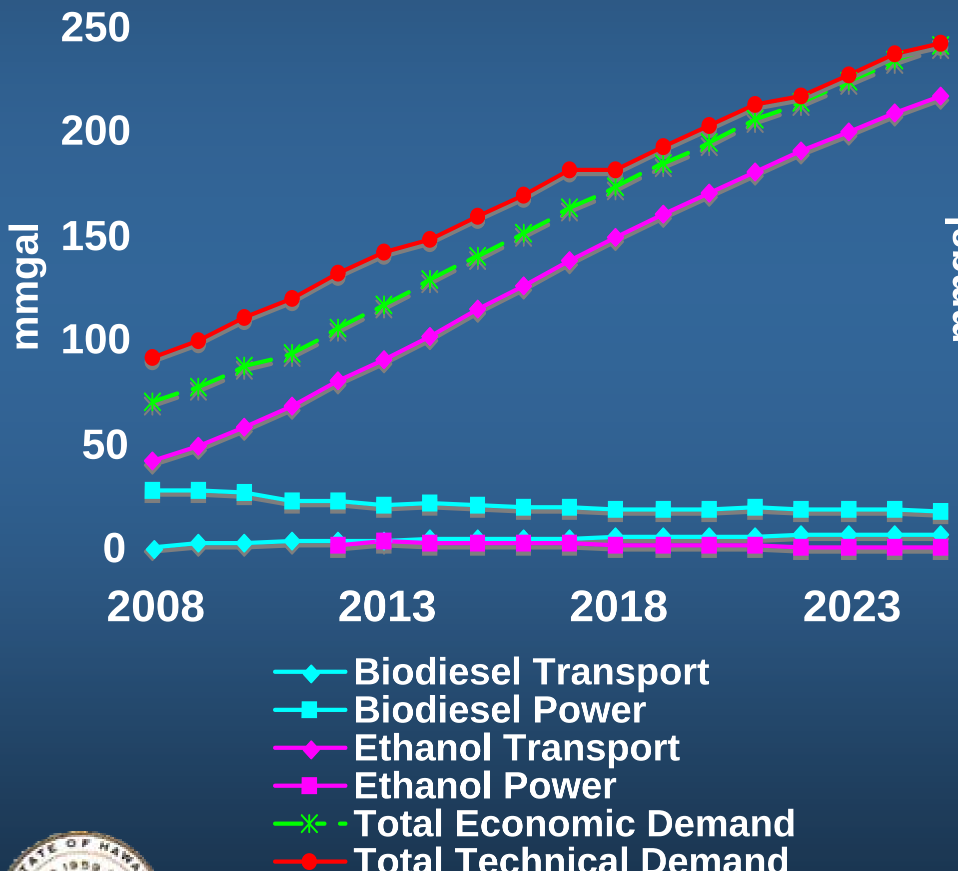




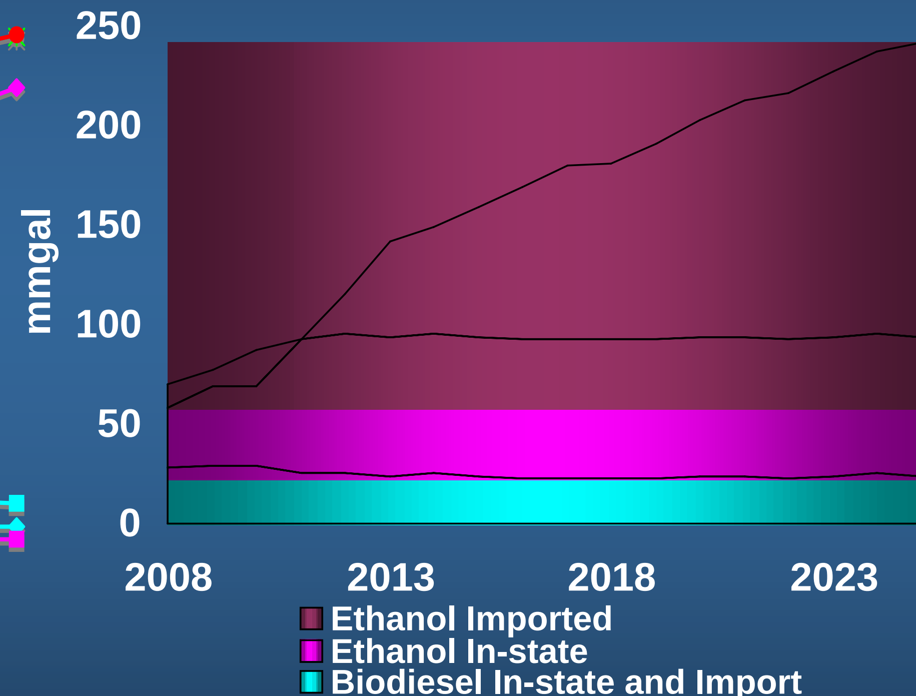


State Biofuels Demand, Particularly for Cellulosic Ethanol, Would Grow Rapidly

E2020 Ethanol and Biodiesel Economic Demand

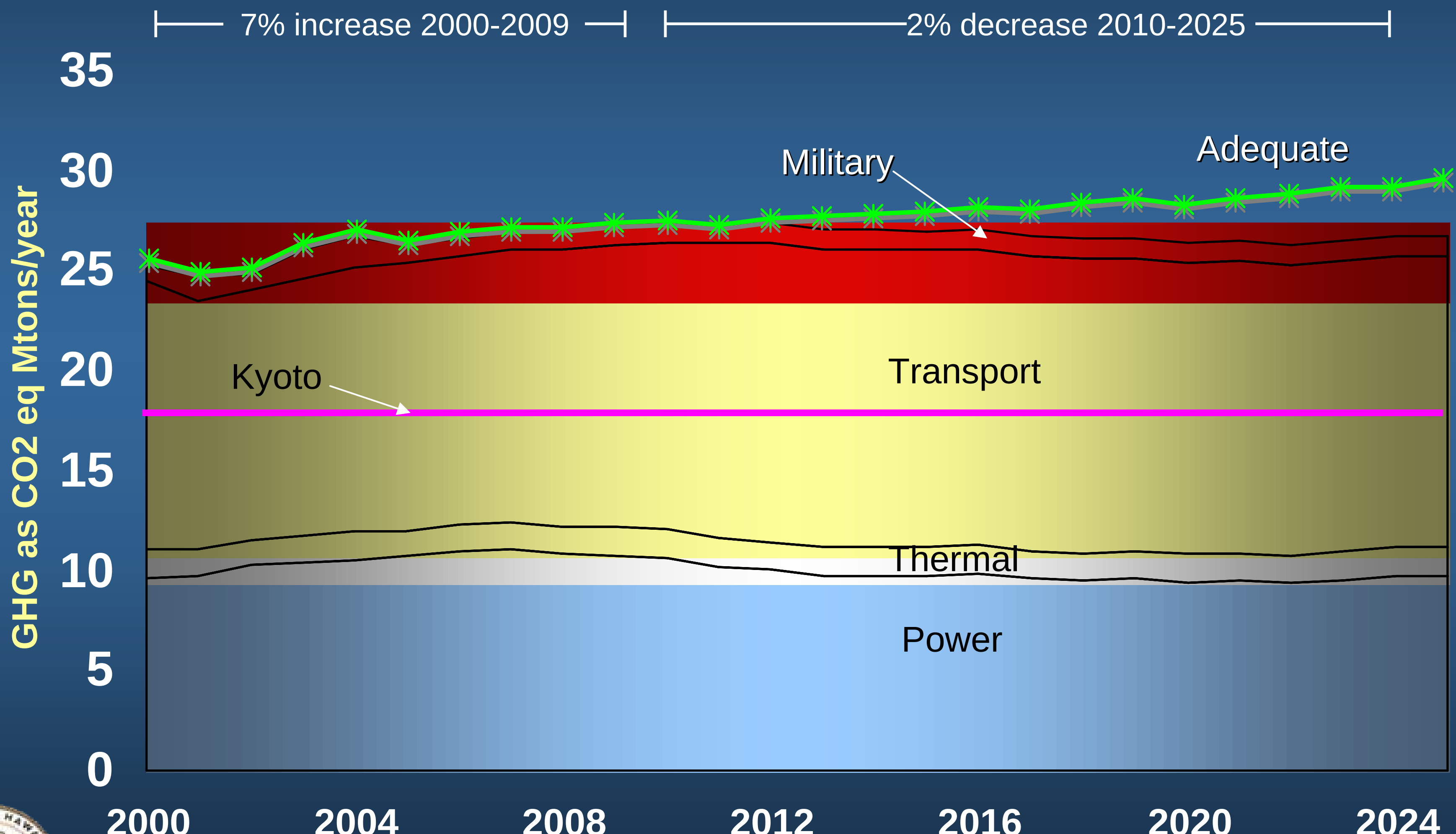


Ethanol and Biodiesel Production Capacity*

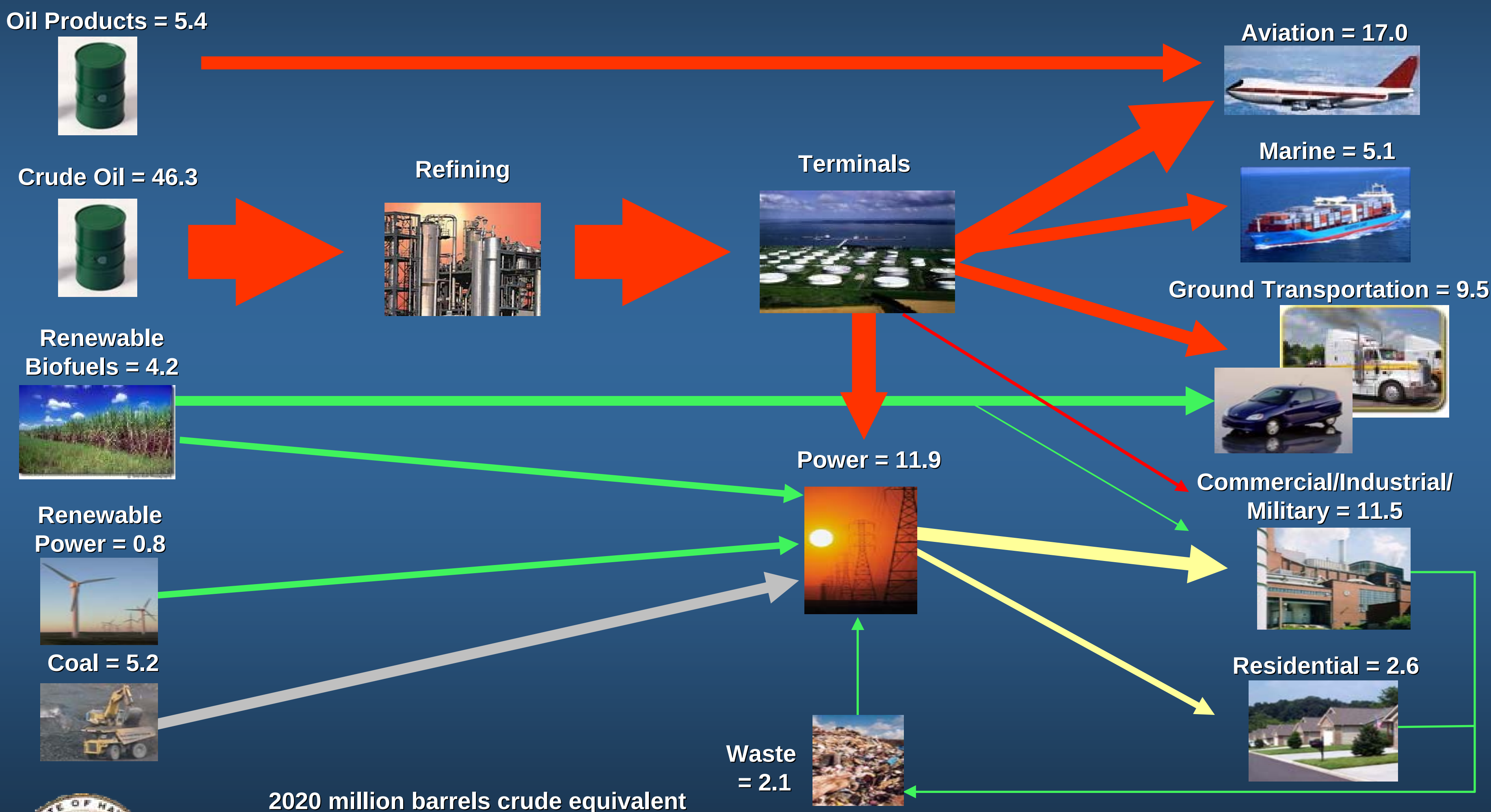


*Only plants at or below import parity were considered.

Hawaii's GHG Emissions Will Decrease by 1% From the 2006 Baseline by 2020



By 2020, 81% of Hawaii's Energy Consumption Comes From Oil-Absolute Oil Demand Drops 10% Below 2005



2020 million barrels crude equivalent

Implications

If Oil Supplies Are Adequate, There is Little Impetus For the Energy System to Change Until 2020

- In the absence of policies, Hawaii would reach 23% renewable power by 2020 due to the advent of new technologies. The system would shift modestly until then.
- However, the transportation fleet would mirror the rest of the U.S., and become only modestly more efficient
- Similarly, some biofuels would be developed on the most productive agricultural sites, and the E10 standard could be meet by indigenous fuels, though the AFS of 20% would not be achieved.
- The total energy system would remain largely dependent on oil, and slow to change should oil prices spike, worsening our dependence and insecurity

If oil prices continue to rise, the energy system will shift to renewables, but it will take a decade in the absence of accelerating policies

- Higher prices will stabilize energy demand modestly by 2012 at 60 Mmboe due to adoption of efficiency technologies
- Hawaii would reach 27% renewable power by 2020
  - Cost effective firm renewable energy sites such as firmed wind and wave are exhausted Utilities expand wave technology and non-firm renewables such as wind and solar thermal to further displace oil-fired generation
- The transportation fleet would become more efficient and fuel flexible by 2015, but would change little until 2015
- Hawaii biofuels would take off due to market demand from power, and the AFS of 20% would be achieved. Over 130 MM gallons of biofuels produced in state
- The total energy system would become more diverse and less dependent on oil, though it takes over a decade due to system inertia in the absence of policies

Emerging Policy Implications

- Vehicle efficiency and flex fuel incentives needed to accelerate fleet turnover
- In state production incentives needed to grow Hawaiian biofuels feedstock production to scale and R&D investment necessary to remain competitive with overseas imports
- Acceleration of electrical efficiency is desired under either scenario for oil prices
- Renewable wind, biomass, solar thermal and wave viability depends on fossil fuel prices, but geothermal and MSW are robust

Policies and Regulations: Phase 1

RMI reviewed existing reports relating to energy policy recommendations for Hawaii (list below not exhaustive):

- Discussions with DBEDT staff
- Recommendations from HES 2000 and 1995
- Recent and past HEPF policy recommendations
- Hawaii Biofuels Summit 2006
- Utility IRPs
- Governor's Energy for Tomorrow Plan
- RMI's own research (e.g. Winning the Oil End Game and Small is Profitable)

Policies and Regulations: Phase 1

- Following this review, we narrowed down most practical policies for testing in E2020:
  - Newly amended RPS (as of 2006) that requires 20% RE by 2020
  - Energy Efficiency standard
  - Feebates for consumer vehicles
  - Existing AFS goal of 10% on-highway fuel in 2010, 15% in 2015, and 20% in 2020 to come from non-traditional fuels such as ethanol and biodiesel.
  - Sliding scale subsidy for biofuels relative to oil price for alternative fuels
  - Carbon cost adder on fuels

BREAK

Hawaii Biofuels Summit

Biofuels Summit was Public-Private Sector Dialog

- ~40+ Private sector senior participants included
  – Major agricultural companies
  – Power and oil companies
  – Biofuels companies (ethanol and biodiesel)
- ~15 Public Sector participants
  – Governor and cabinet members
  – Legislative chairs for energy/agriculture
  – County and federal coordinators
- RMI, as neutral sustainability oriented NGO lead the session
- Session open to press and public

The Biofuels Opportunity is Compelling

- **Energy security increases with fuel diversification and in state production**
- **Fundamental economics vs. oil, even without subsidies, are viable**
- **Market prices for biofuels are at or above after tax credit parity**
- **With existing federal and state subsidies, financial returns are highly attractive to producers and manufacturers**
- **Import substitution is worth $230 MM/yr at 20% AFS target**
  - **Which doubles with biofuels adoption in power and marine sectors**
- **Next generation biofuels technology will improve both economic returns and environmental sustainability**
- **Energy crops create opportunity to preserve important agricultural lands and biodiesel could enhance diversified agriculture**

Universal Barriers Across the Biofuels Value Chain

Agricultural Production → Conversion → Distribution & Storage → End Use

Physical Constraints

- Markets / Production Geographic Mismatch
- Logistical Infrastructure Bottlenecks

Legal and Environmental

- Permit Time and Complexity

Financial Risks

- Oil-Biofuels Spreads vs. Investment Cost Recovery
- R&D Knowledge Gaps
- Stability and Duration of Government Policies & Incentives

Specific Value Chain Barriers




	Agricultural Production	Conversion	Distribution & Storage	End Use
Physical Constraints	• Contiguous land at minimum efficiency scale	• Impact to refinery balances • Moving product to market	• Limited port, terminal, storage capacity • Need for new infrastructure if E85	• Availability, cost and consumer demand for flex fuel vehicles
Legal and Environmental	• Water availability and cost • Environmental emissions/effluents	• Facility zoning on ag lands		• OEM warranties • Air emissions impacts • Reliability of biofuels supply vs. obligation to serve • Prudence of long-term fixed price fuel contracts
Financial Risks	• Lead time to market • Import Parity • Long-term offtake/ minimum price floor • Labor cost/availability • High investment for infrastructure • Crop R&D	• Security of feedstock supply & cost • Duration of off-take agreements	• Recovery of infrastructure investment	• Impact on rates when biofuels > oil

Potential Key Solutions Identified by Summit Participants

- Streamline permitting and secure county cooperation
- Bolster research & development
- Coordinate across the value chain
- Provide incentives for in-state production
- Clarify the water access issue
- Support infrastructure development

Carrying These Potential Solutions Forward

- Summit solutions only the first step
- To actually influence the market, solutions must be developed and made more specific
- First steps:
  - Governor's Office leading effort to streamline permitting process
  - HDOA Important Agricultural Lands process
  - DBEDT coordinating with end-users
  - DBEDT/HEPF are leading HCR 195 process to define incentives for the legislature
  - Path forward less certain for water

Stakeholder Process

Today's Dialog Objectives

- Obtain comments and answer questions on
  - Inputs to model
  - Findings from model
- Gather feedback on critical policies to evaluate

Future Stakeholder Meetings

Present and discuss final ENERGY2020 Results	Early December
Present and discuss strategic options and strategic paths under consideration for recommendation	Early December
Review and comment on policy options and recommendations for implementation plan	TBD