STAKEHOLDER MEETING

HAWAII ENERGY STRATEGY 2007

Honolulu
December 13, 2006

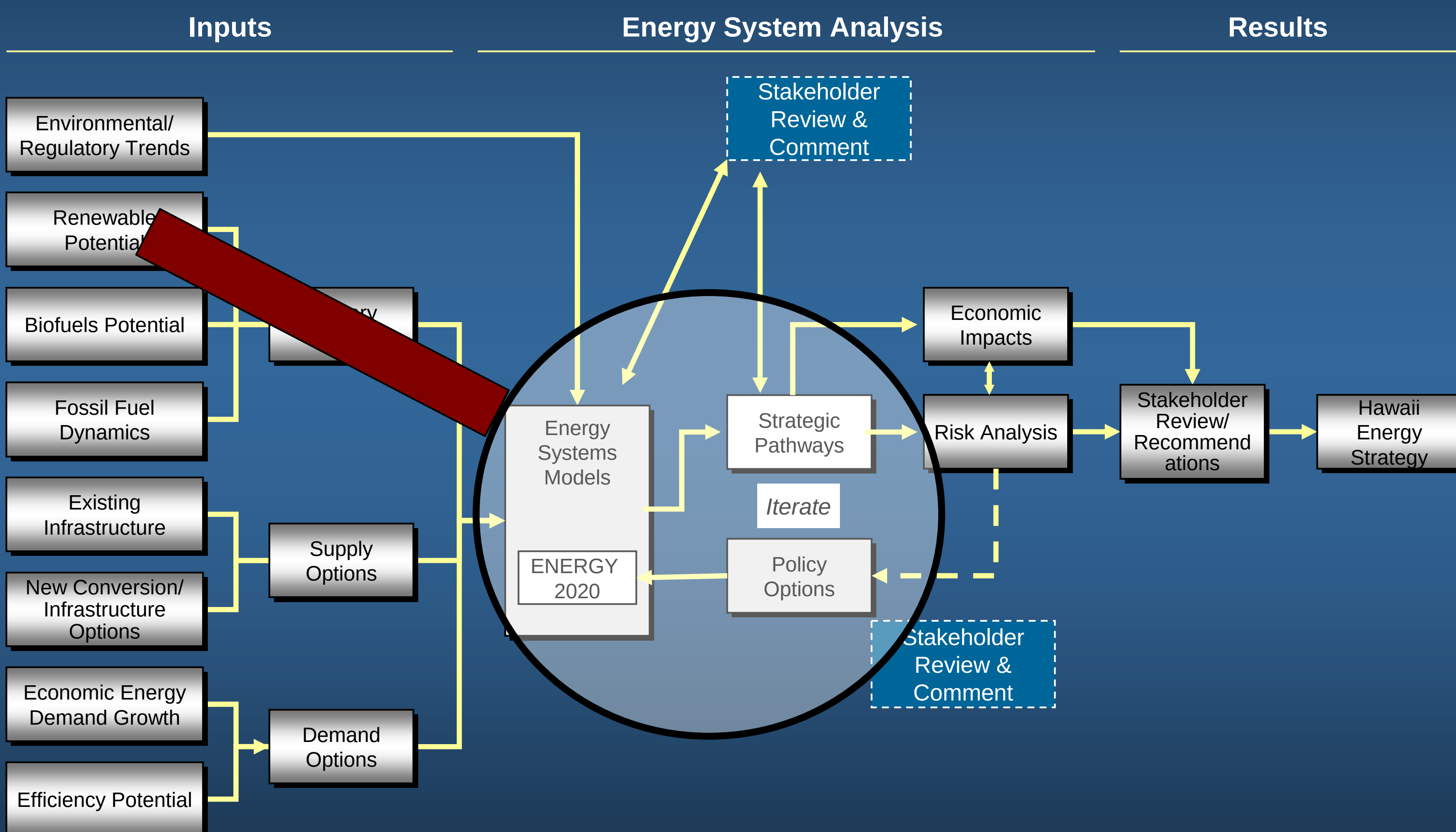
Objectives

- Update findings on how Hawaii's energy system would respond to oil price scenarios based upon adequate global oil supplies vs. constrained supplies
- Present findings on how Hawaii's energy system would respond to an oil price scenario based upon commodity cyclic supplies
- Discuss the implications of these emerging findings to Hawaii
- Present and discuss findings and implications of policy scenarios
- Listen to the stakeholders regarding insights or concerns about this analysis

Agenda

- Project Status and Energy 2020 Model Inputs
- Model Results and Implications
- Policy Modeling Results and Implications
- Break
- Stakeholder Discussion
- Next Steps

Where We Are in the Process



Energy 2020 Model Inputs

Today, We Present the Modeling Results of All Three 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**
  - 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

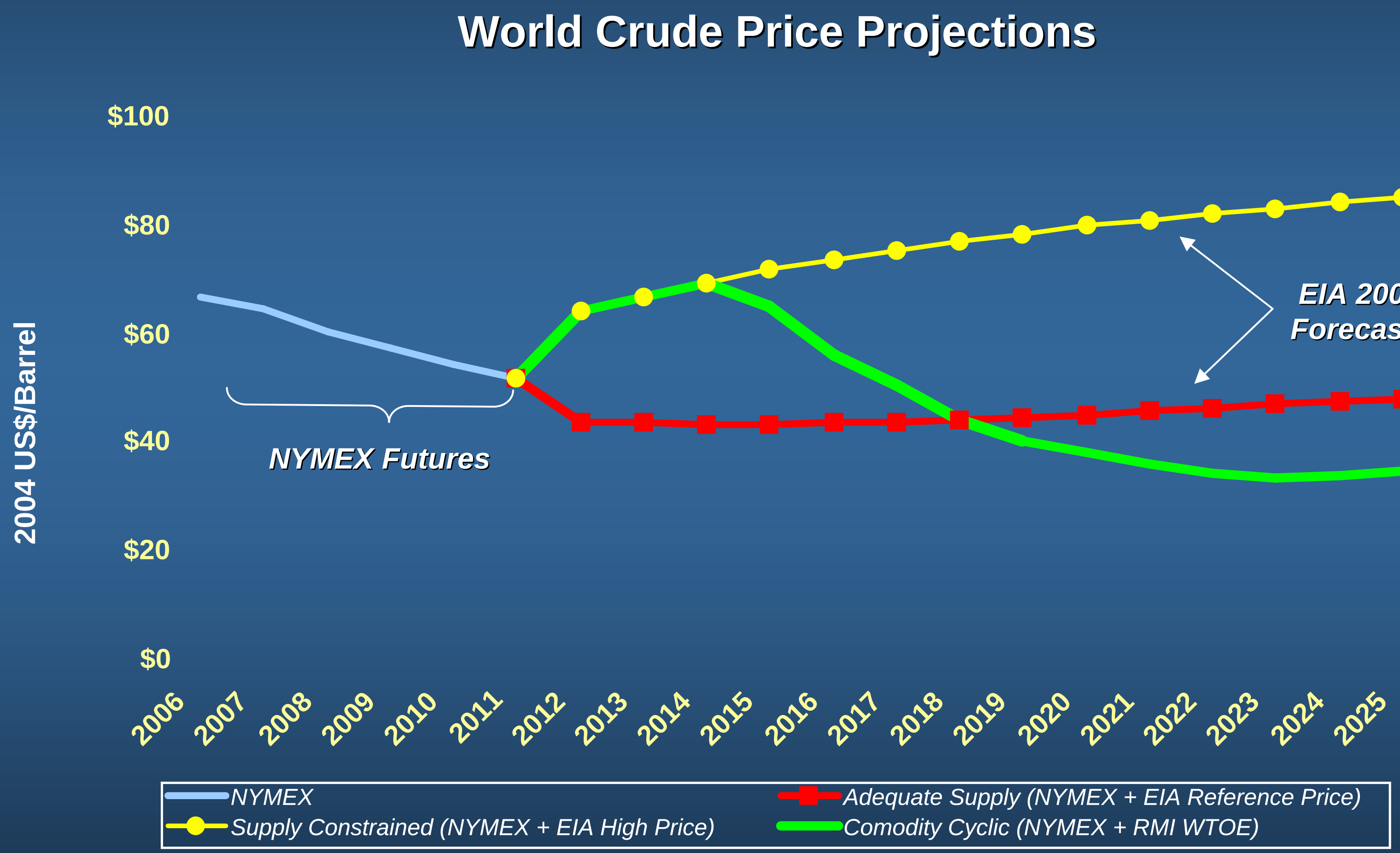
Historical Inputs for E2020 Were Drawn From Publicly Available Information

- **Demand-Side Inputs**
  - Historical demand and consumption (electricity and transportation sectors)
- **Supply-Side Inputs**
  - Historical fuel prices
  - Fuel price projections
  - Historical utility capacity, generation, and financial data
  - Utility capacity expansion plans
  - Transportation efficiency (mpg) & fuel supply (includes biofuels) projections
- **REMI Economic Assumptions**
  - Macroeconomic elements such as GSP, employment, income, population
  - Drives interactions within energy sector

Projected Inputs for E2020 Were Adjusted Based on Scenario Analyzed

- **Fuel Price Projections**
- **Demand-Side Inputs**
  - End use device efficiency and unit cost improvements (residential lighting, residential and commercial space cooling)
  - Transportation
    - Light cars and trucks efficiency (mpg)
    - Penetration of flex-fuel vehicles
    - Vehicle miles traveled (VMT)
- **Supply-Side inputs**
  - Renewable energy capital costs
  - Biofuels
    - Production cost
    - Supply availability, native, and imports

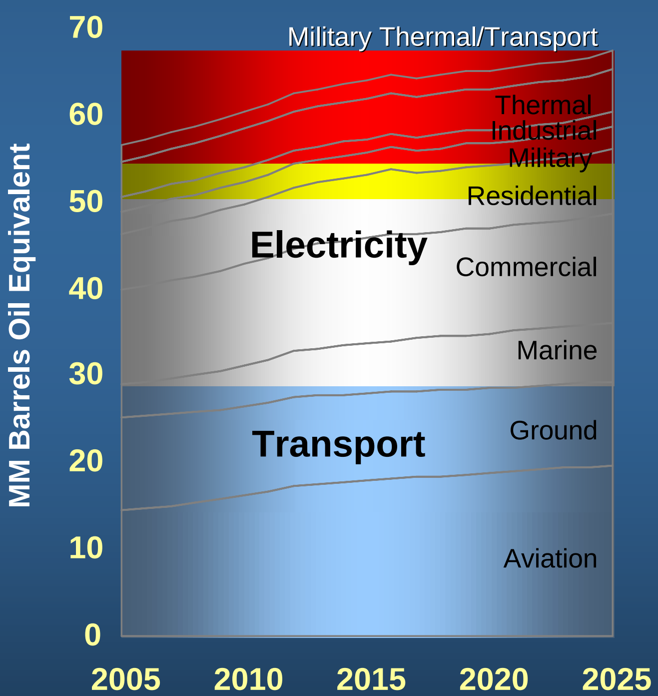
NYMEX Energy Prices Reflect the Market for the Next 5 Years. EIA High and Reference Cases Used for Adequate and Constrained Scenarios



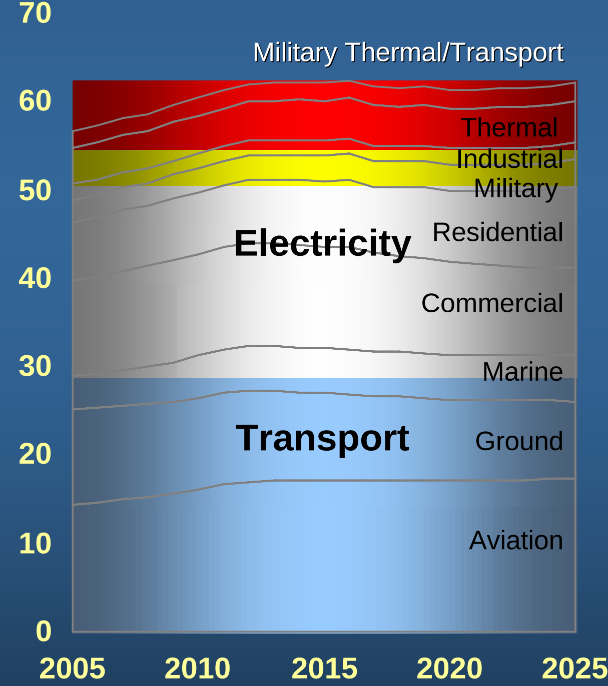
E2020 Model Results

Total Demand Stabilizes at ~60 Mmboe/yr by 2025 in Constrained. Cyclic Demand Catches Up to Adequate Demand By 2025 as Prices Fall, Driven by Transportation

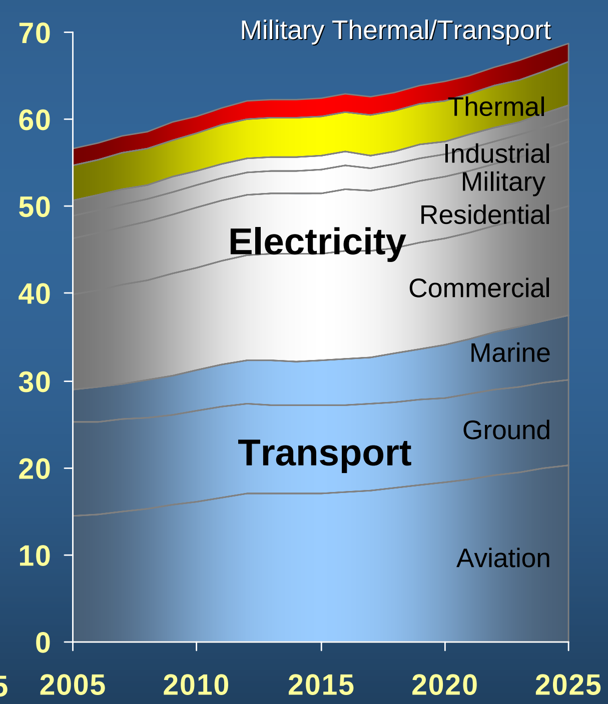
Adequate Supplies
Hawaii Total Energy Demand



Constrained Supplies
Hawaii Total Energy Demand

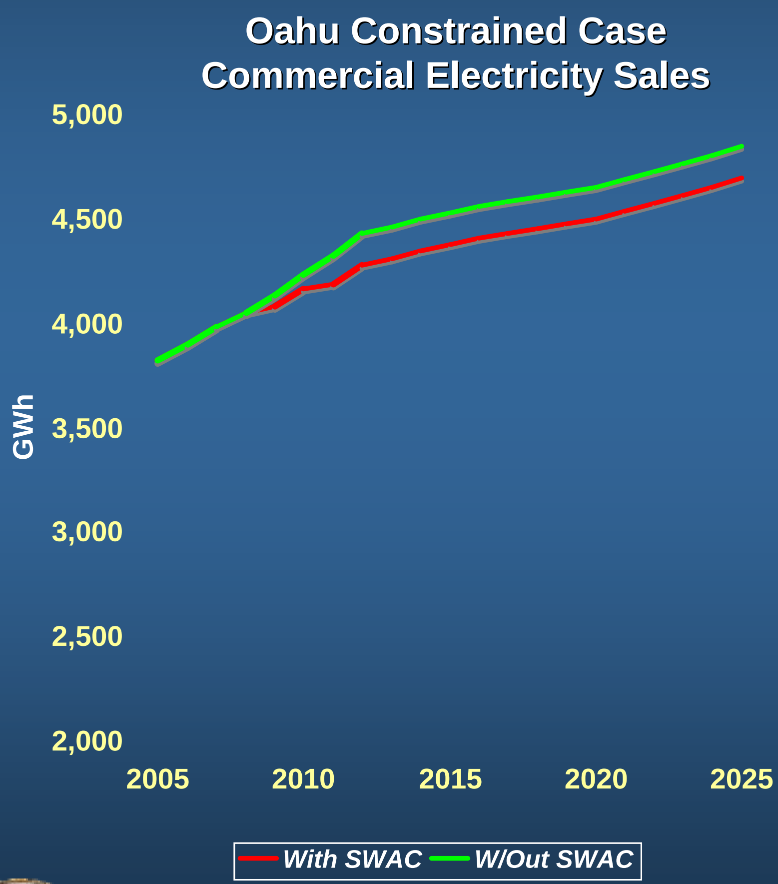


Commodity Cyclic
Hawaii Total Energy Demand

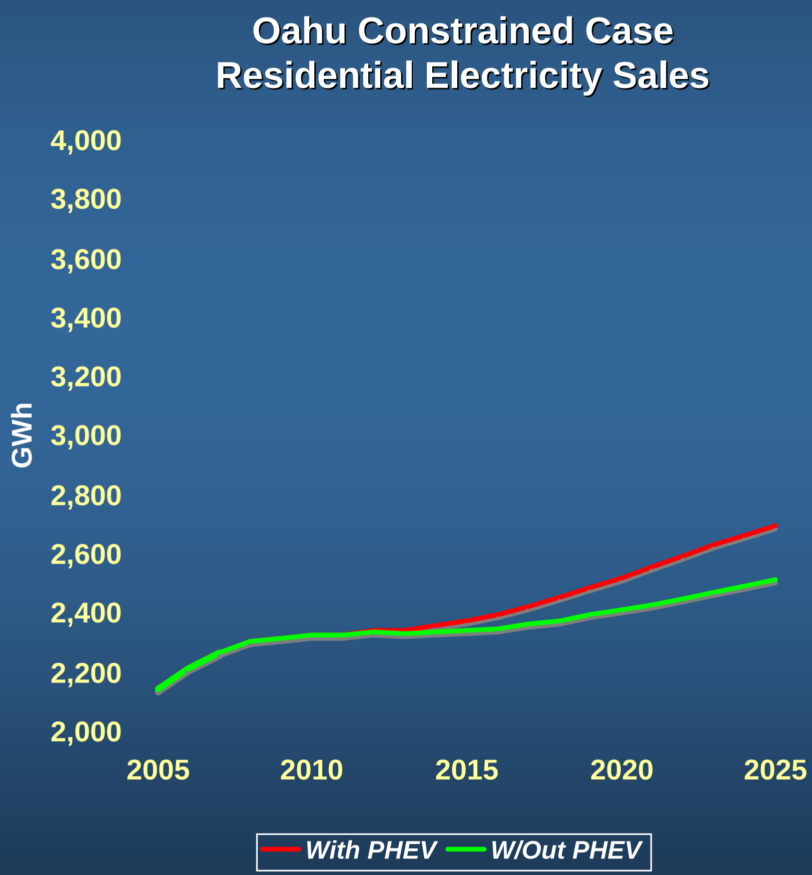


SWAC Installation and PHEV Adoption are Also Modeled in the Constrained Scenario on Oahu

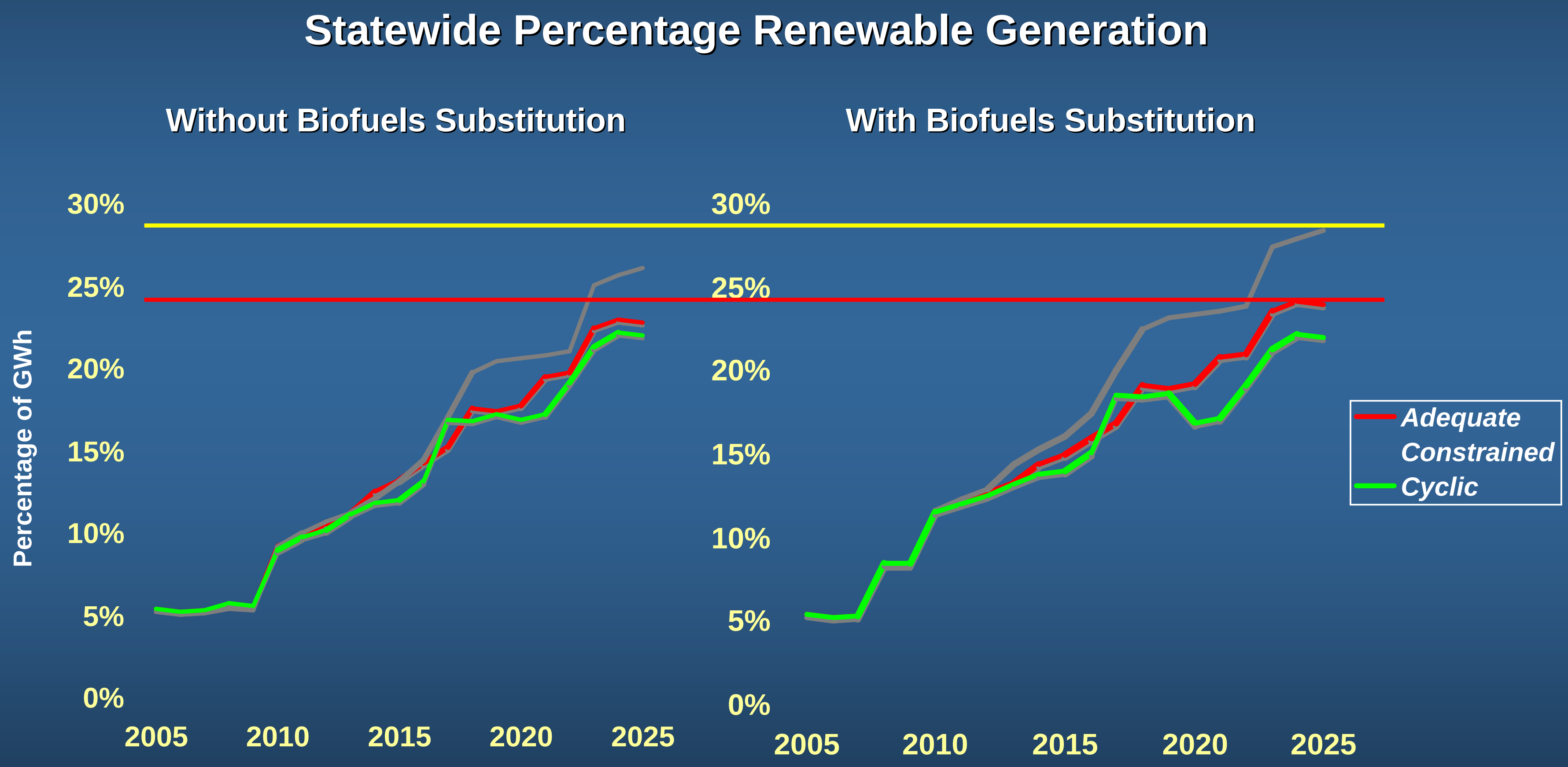
SWAC Impact



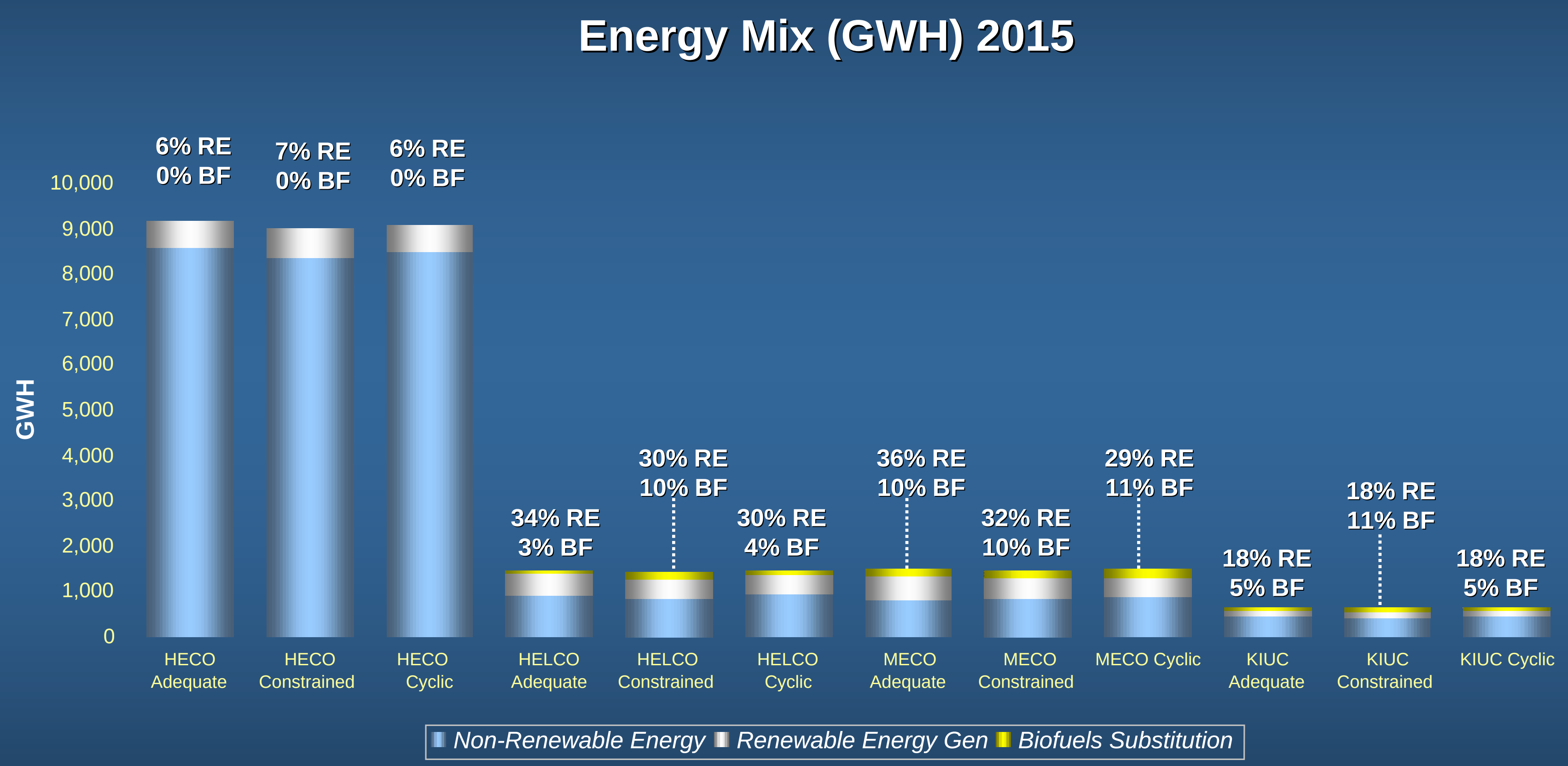
PHEV Impact



Biofuels Substitution for Electricity Generation Increases Renewable Resource Penetration for All Scenarios

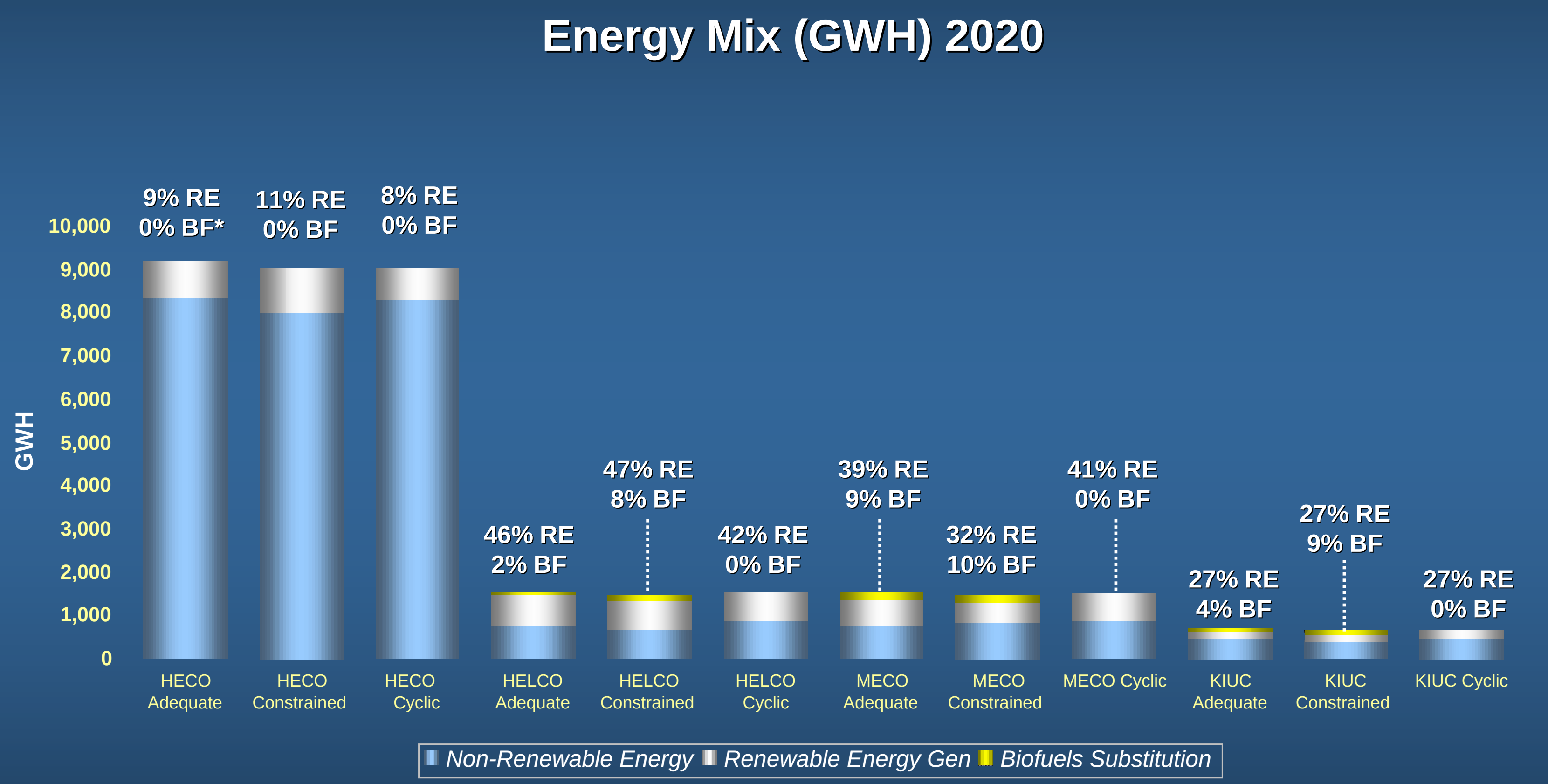


The State's Electricity Supply Mix Shifts Significantly to Renewable Resources by 2015



**Biofuels Substitution (BF) refers to biodiesel and ethanol substituted in diesel and naphtha-fired plants. Other bioenergy such as refuse and biomass are included in Renewable Energy (RE).*

Utilities Exceed Renewable Energy Generation Targets In All Scenarios by 2020



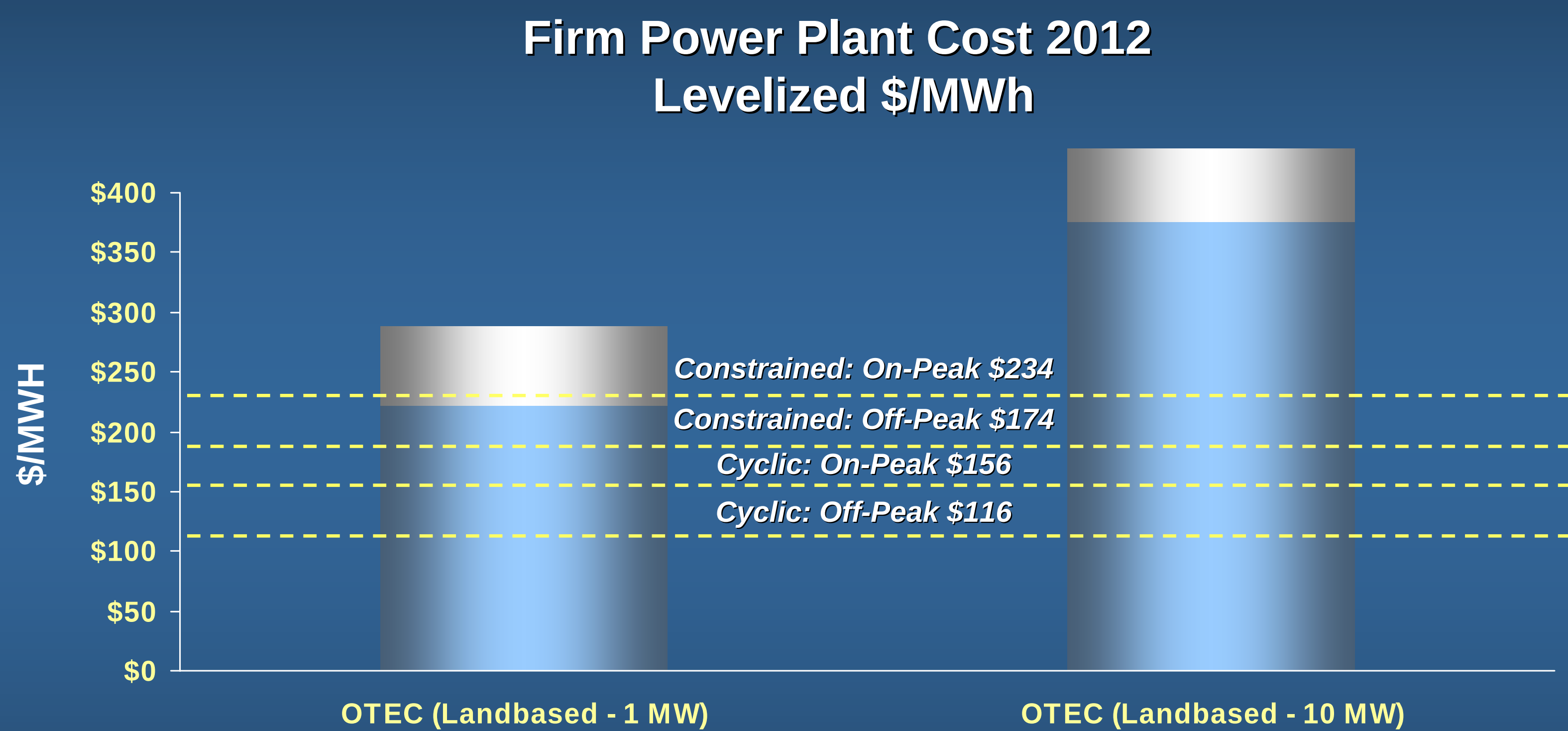
*Biofuels substitution (BF) refers to biodiesel and ethanol substituted in diesel and naphtha-fired plants. Other bioenergy such as refuse and biomass are included in Renewable Energy (RE).

Ocean Energy Potential Remains Largely Untapped

- **Potential for wave energy for electricity is substantial**
  - **180 MW feasible potential and ~570,000 MWh/yr generation[(1)]**
  - **Hawaii is among best locations in the world, with sites available on all islands, the largest potential sites located off Oahu**
  - **Studies predict ~$7,000/kW in capital cost by 2012[(2)]**

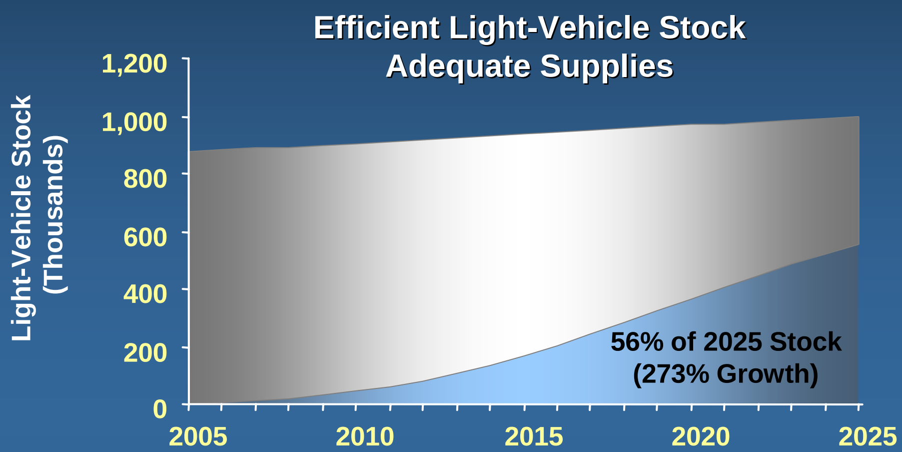
1 *Siting and potential from personal communications Energetech Australia Pty Ltd, Ocean Power Delivery Ltd, Wave Dragon.*
2 *Previsic, Mirko et al., 2005. "System Level Design, Performance and Costs: Hawaii State Offshore Wave Power Plant." Table 6. Electric Power Research Institute, Global Energy Partners, and Electricity Innovation Institute, January.*

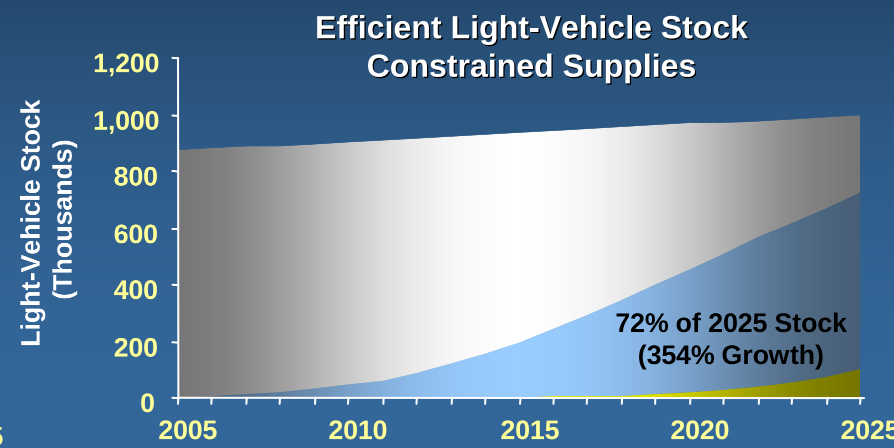
Existing Ocean Thermal Energy Conversion (OTEC) Projects Exceed Projected Avoided Costs; Future Improvements Should be Monitored

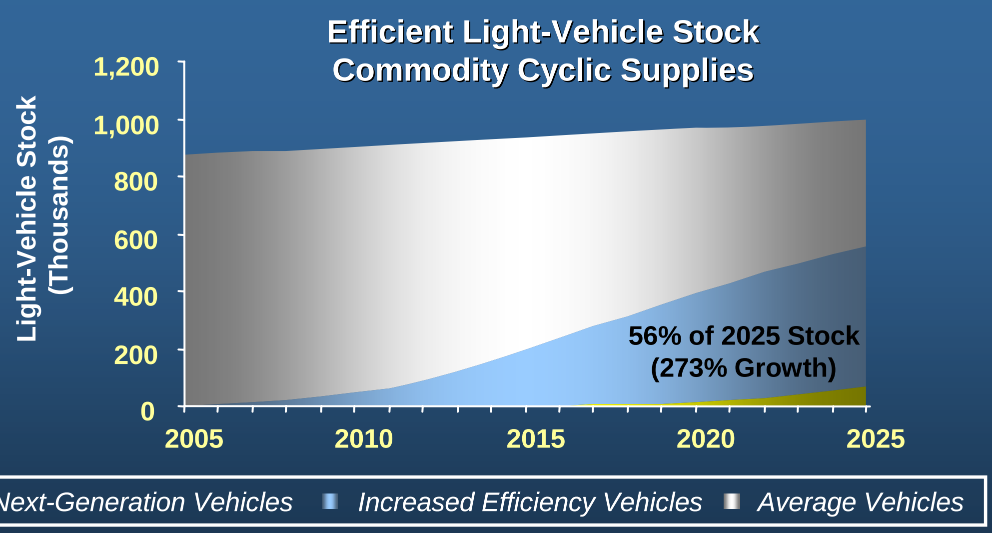


Capacity Factor	90%	90%
Unit Capacity (MW)	1	10

Constrained Supply Prompts Increased Adoption of Efficient Vehicles; Cyclic Similar to Adequate, but Includes Next-Generation Vehicles

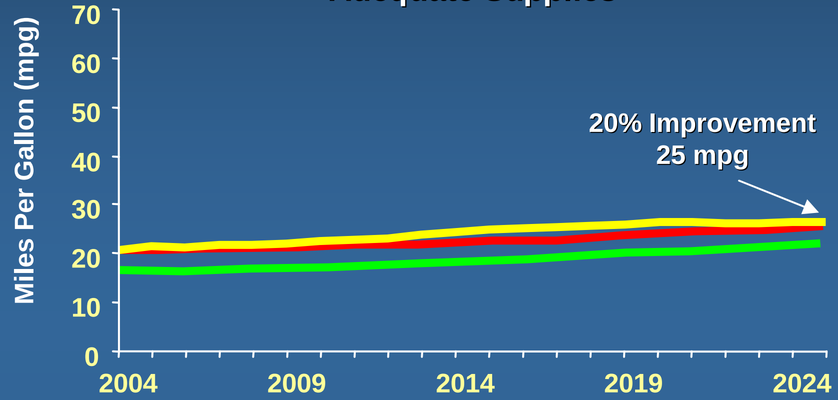






Relative to Adequate Scenario, State Transportation Fleet Efficiency Improves Less Dramatically In Cyclic Compared to Constrained

Hawaii Light Vehicle Stock Efficiency (mpg)
Adequate Supplies



Hawaii Light Vehicle Stock Efficiency (mpg)
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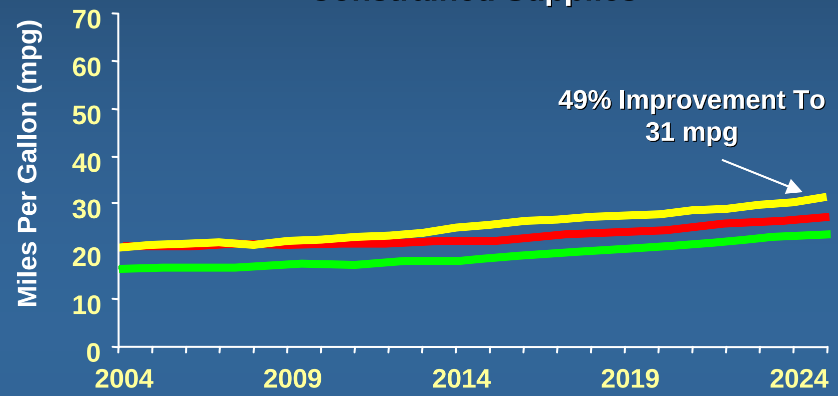
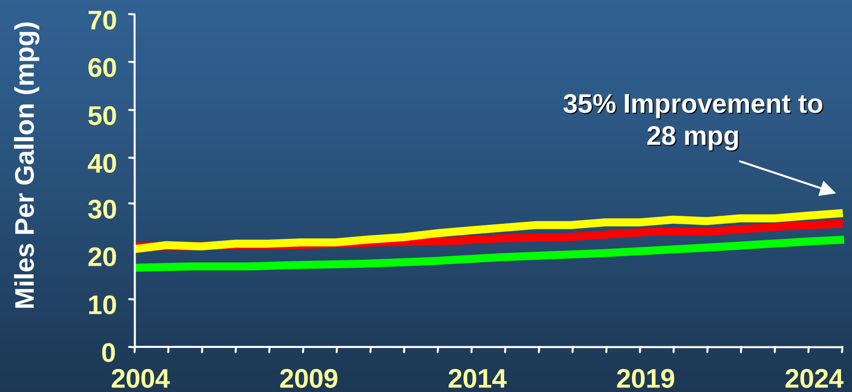
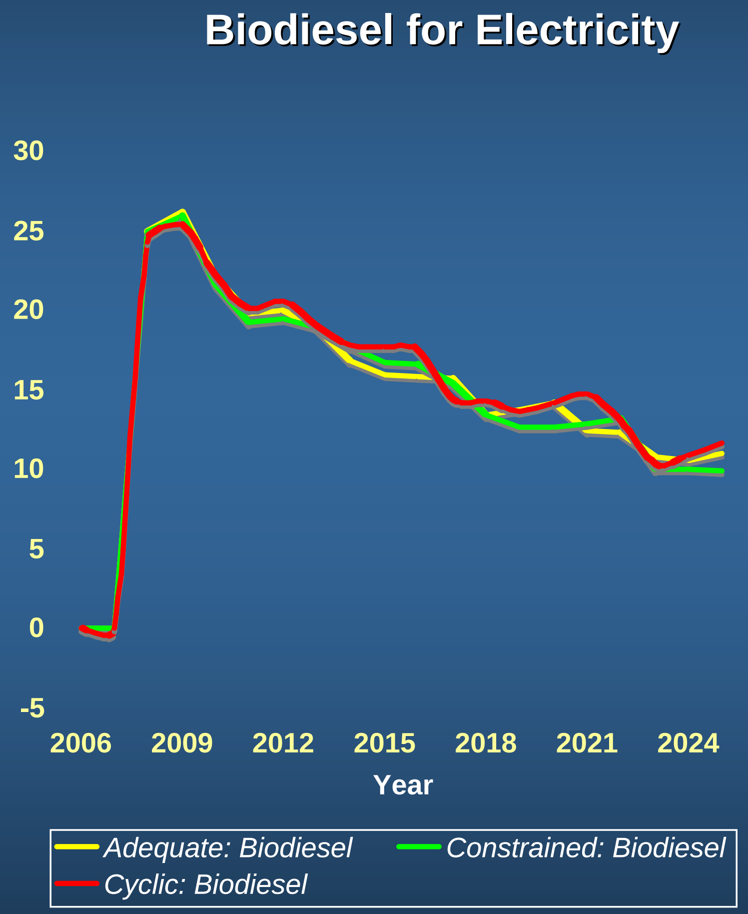


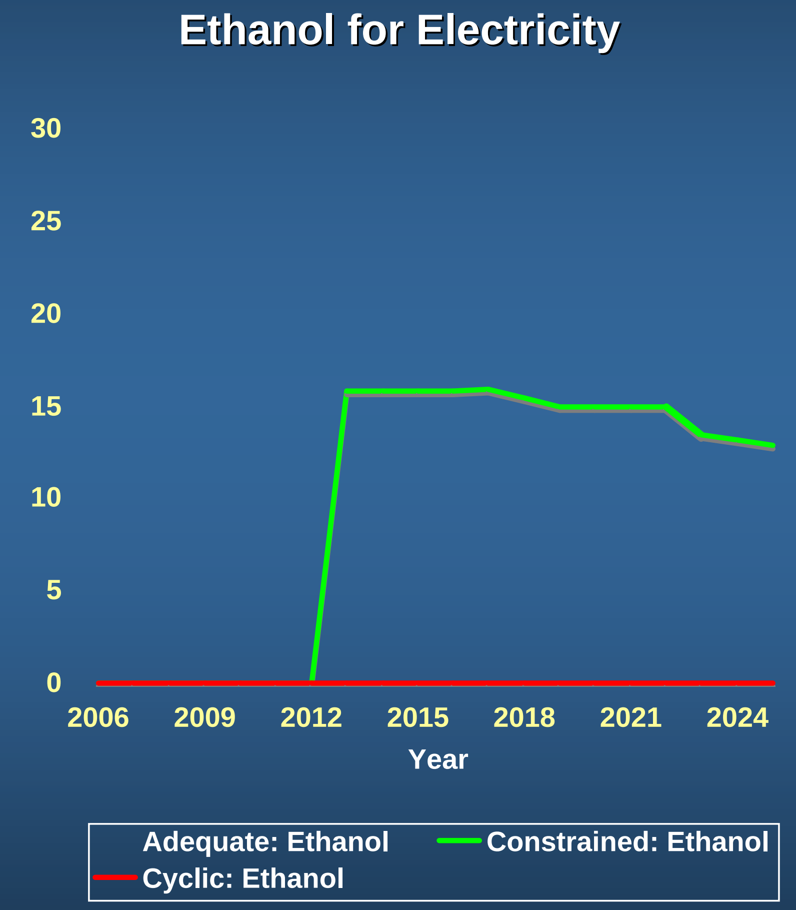
Hawaii Light Vehicle Stock Efficiency (mpg)
Commodity Cyclic Supplies



Cars *Light Trucks* *Rental*

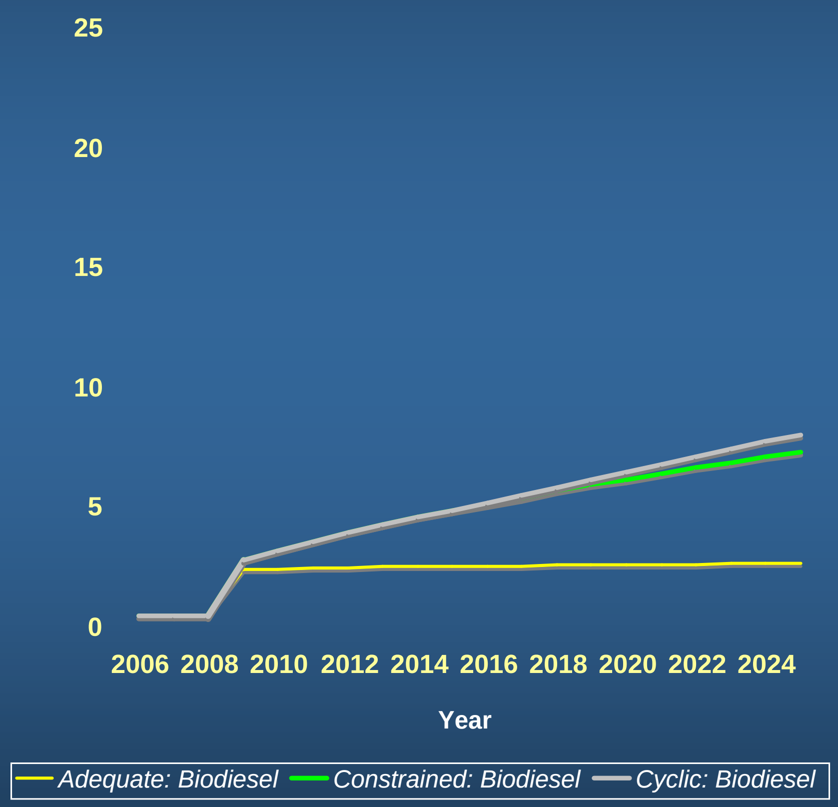
Biodiesel Plays a Bigger Role in Electricity Sector than in Ethanol



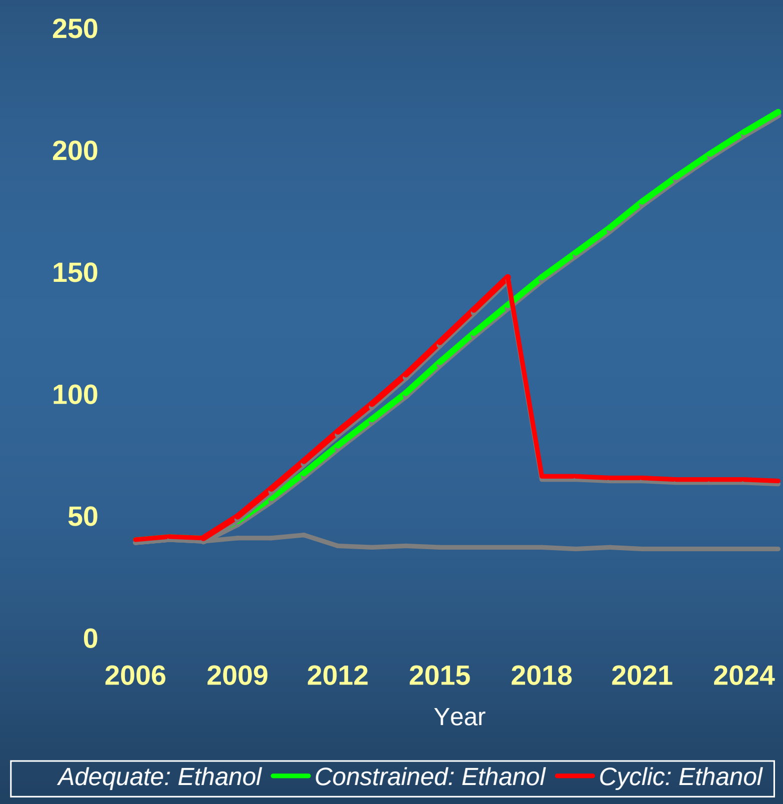


Transportation Sector Provides a Bigger Market for Ethanol, But the Demand is Highly Dependent on Gasoline Price

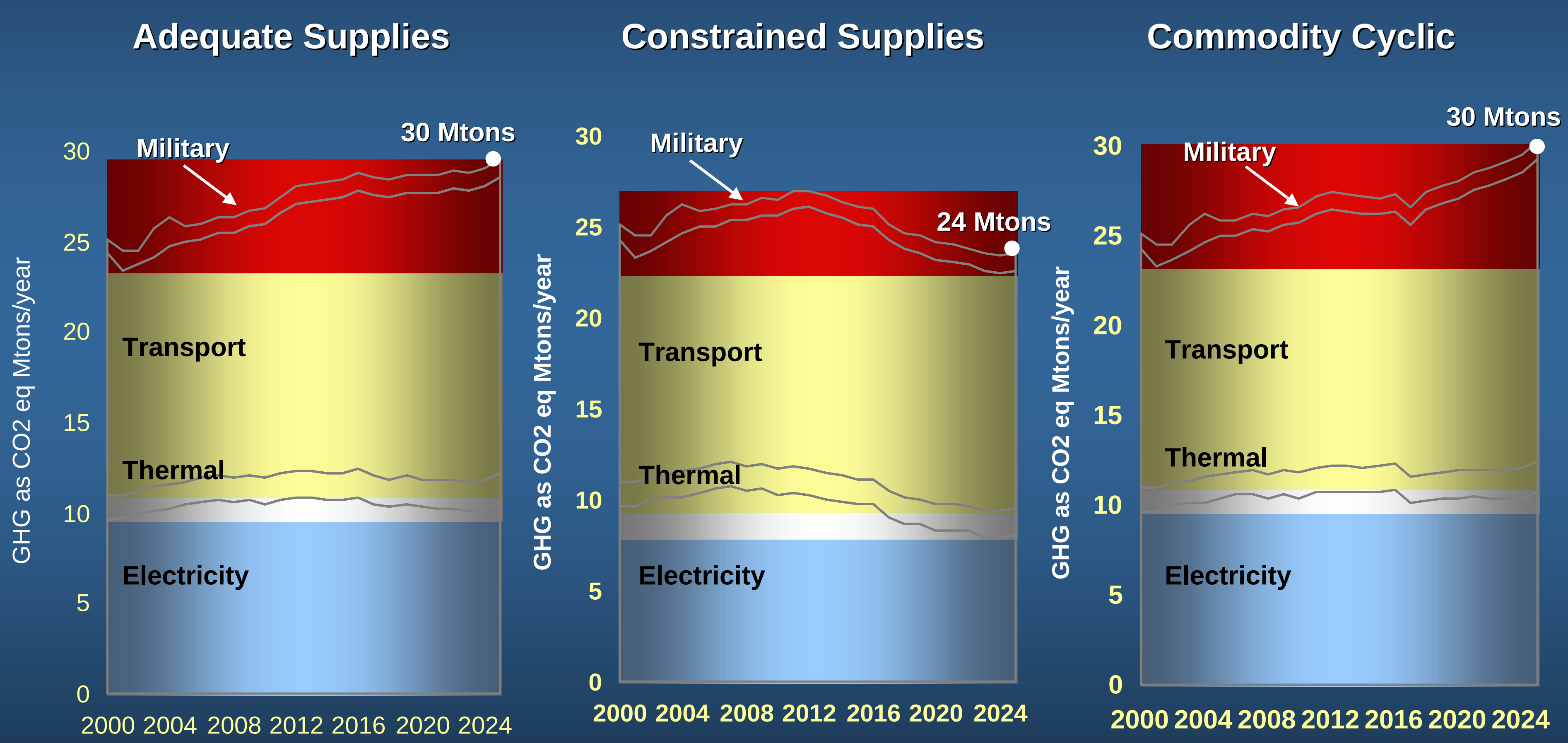
Biodiesel for Transportation



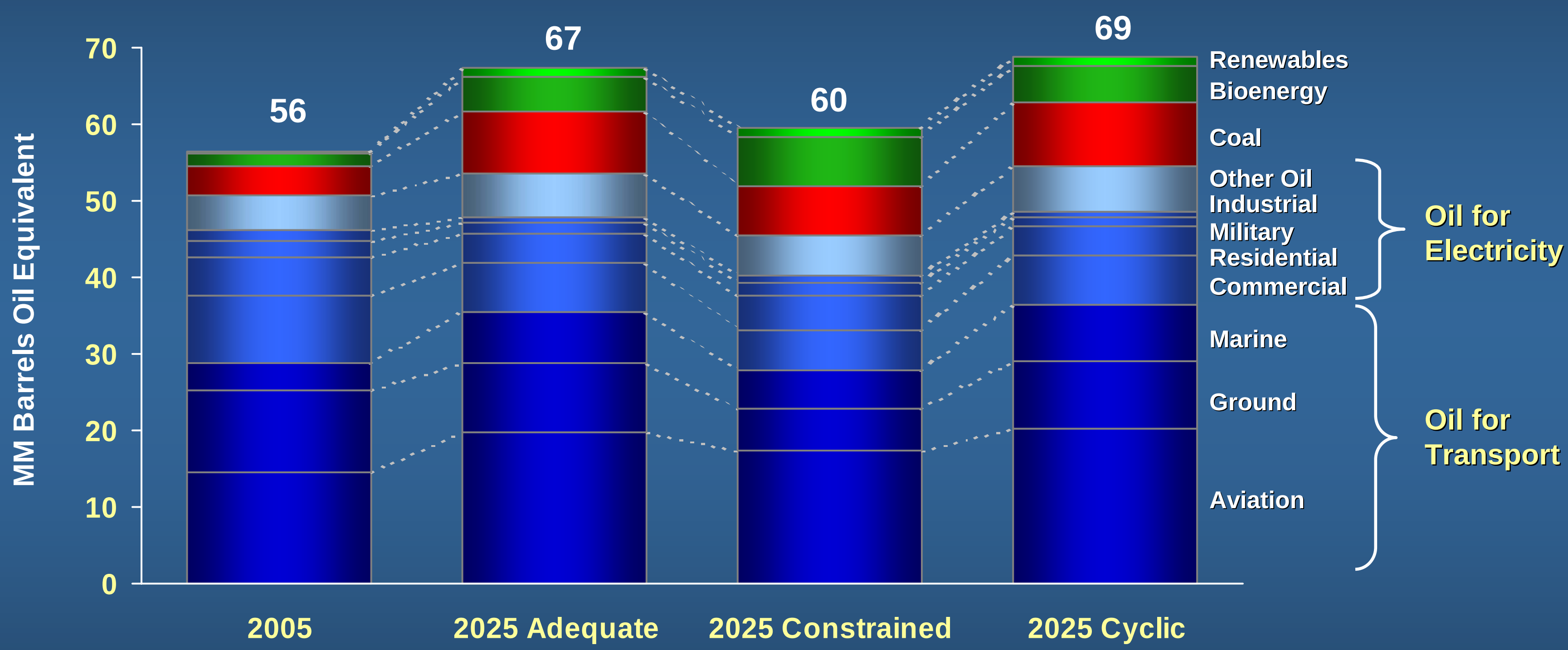
Ethanol for Transportation



State Total CO2 Emissions Decline Along With Demand in Constrained; Emissions Catch Up to That of Adequate By 2025 as Fuel Prices Fall



Oil Dependence Declines in all Cases and Most Significantly in Constrained; Absolute Oil Consumption Up Slightly by 5%-7% in Adequate and Cyclic by 2025



	2005	2025 Adequate	2025 Constrained	2025 Cyclic
Oil Consumed (Mmboe/yr)	51	54	46	54
Oil Dependence	90%	80%	77%	79%

Implications

If Oil Supplies Are Adequate, There is Little Impetus for the Energy System to Change

- In the absence of policies, Hawaii would reach 19% renewable energy 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 target of 20% by 2020 would not be met.
- The total energy system would remain largely dependent on oil, leaving Hawaii's economy vulnerable to oil prices spikes; energy consumption increases 20% by 2025 and our security is *not* improved.

If Oil Prices Continue to Rise, the Energy System will Shift to Renewables, But Remain Largely Dependent on Oil in Absence of Accelerating Policies

- **Higher prices will stabilize total energy demand by 2012 at ~60 Mmboe due to adoption of efficiency technologies**

- **The State plateaus at 22% renewable energy by 2020**
  - **Construction of some plants deferred as demand growth slows**
  - **Construction of 180 MW coal plant eliminated on Oahu in 2025**
  - **Non-firm renewable energy such as wind and solar thermal are added to displace oil-fired generation**

- **The transportation fleet becomes more efficient and fuel flexible by 2015, though changes little until 2015. E85 vehicles are introduced at a large scale.**

- **Hawaii biofuels take off due to market demand from electricity sector, and the AFS of 20% is achieved. 70 MM gallons of biofuels produced in state and the rest is imported**

- **Absolute oil consumption declines 10% and the total energy system would become more diverse. Though almost 15% less dependent on oil, it still supplies 77% of energy consumed in absence of accelerating policies.**

Rising and Falling Oil Prices Results In an Energy System That Resembles Adequate Supplies In Long Term

- Rising prices in short term initially stimulates energy system to reduce oil dependence. However, consumption grows again, to 69 mmboe/yr by 2025 as prices fall to record lows.
- Renewable energy generation in 2025 falls to 17% as prices fall. Demand catches up to adequate demand
- Transportation fleet efficiency improves stimulated by short period of high prices; E85 vehicles are introduced but run on gasoline when prices fall
- Biofuels would be developed on the most productive agricultural sites available, and the E10 standard could be meet by indigenous fuels. However state misses AFS targets in absence of policies.
- State arrives at point similar to adequate supplies by 2025

Emerging Policy Implications

- Policies needed regardless of scenario to move state away from majority dependence on oil
- Acceleration of electrical efficiency is needed to further reduce oil dependence
- Renewable biomass, solar (PV and thermal), and wave viability depend on fossil fuel prices, but wind, geothermal, and MSW are robust
- Vehicle efficiency and flex fuel incentives needed NOW to accelerate fleet turnover
  - These policies need time to take effect in the market place
- In state production incentives needed to grow Hawaiian biofuels feedstock production to scale and R&D investment necessary to remain competitive with overseas imports

Policies Analysis

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 2

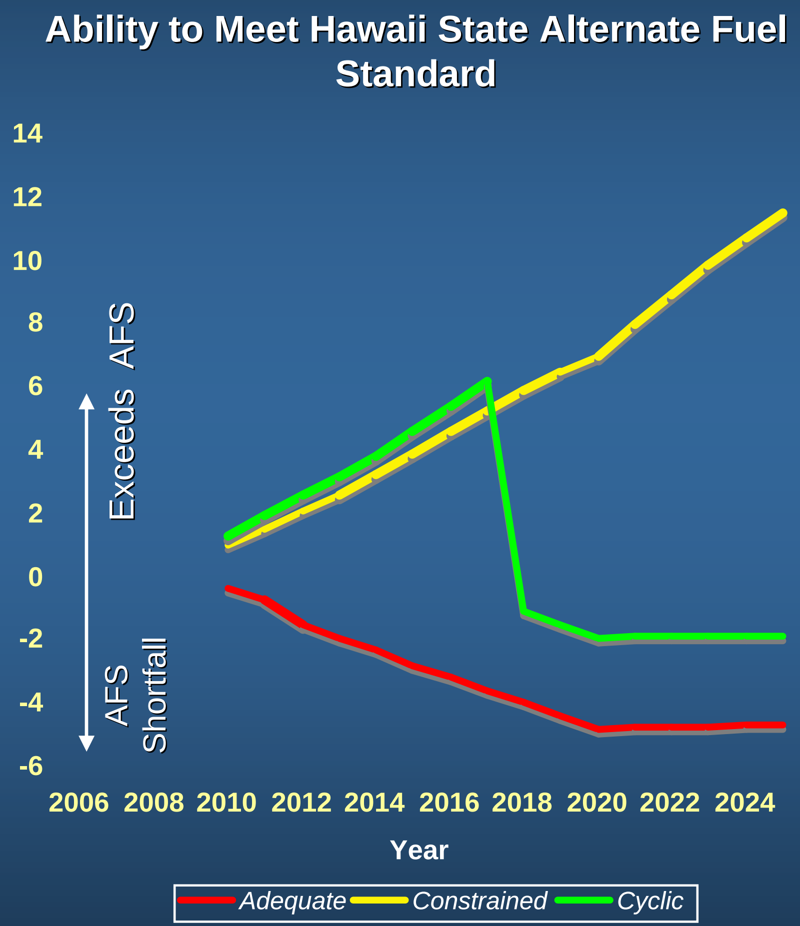
- Following this review, we narrowed down the most practical policies for quantitative analysis:
  – RPS that requires 20% renewable resources by 2020
  – Existing AFS goal of 10% on highway fuel in 2010, 15% in 2015, and 20% in 2020 to come from non-traditional fuels such as ethanol and biodiesel
  – Sliding scale subsidy for biofuels relative to oil price for alternative fuels
  – Feebates for consumer vehicles
  – Carbon cost adder on fuels (low and high levels)
  – Stand-alone energy efficiency standard of 20% by 2020

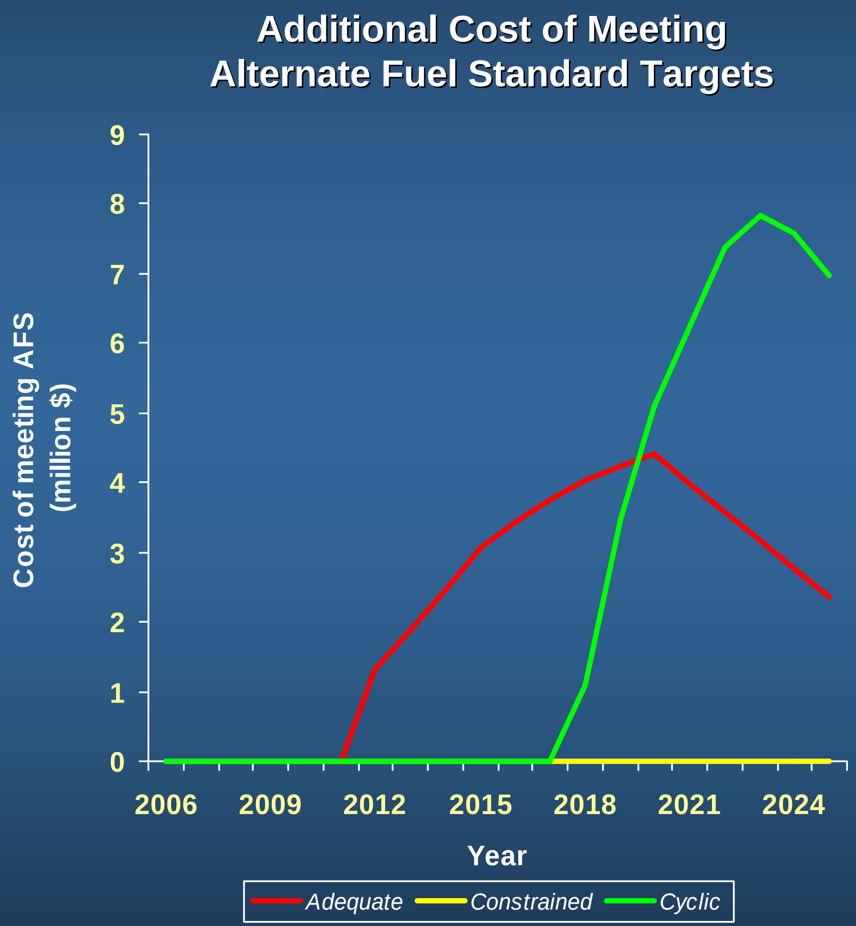
Including Biofuels Substitution and Renewable Electrical Energy Ensures That Hawaii Meets the RPS

- Renewable energy exceeds minimum required (7.5% RE by 2015, 10% RE by 2020) in all scenarios even in absence of RPS

- Overall targets are met in all scenarios only when utility efficiency and biofuels substitution are included
  - RPS target would not be met in cyclic scenario without renewable electrical energy (i.e. electrical efficiency)
  - In 2015, Biofuels substitution alone helps utilities achieve RPS targets (15% generated from “renewable resources”) in adequate and constrained scenarios
  - In 2020, Biofuels substitution alone helps utilities achieve RPS targets (20% generated from “renewable resources”) in constrained scenarios only, but is insufficient in adequate scenario

Depending on Oil Price, Hawaii Might Not Meet AFS Targets Without Additional Policies

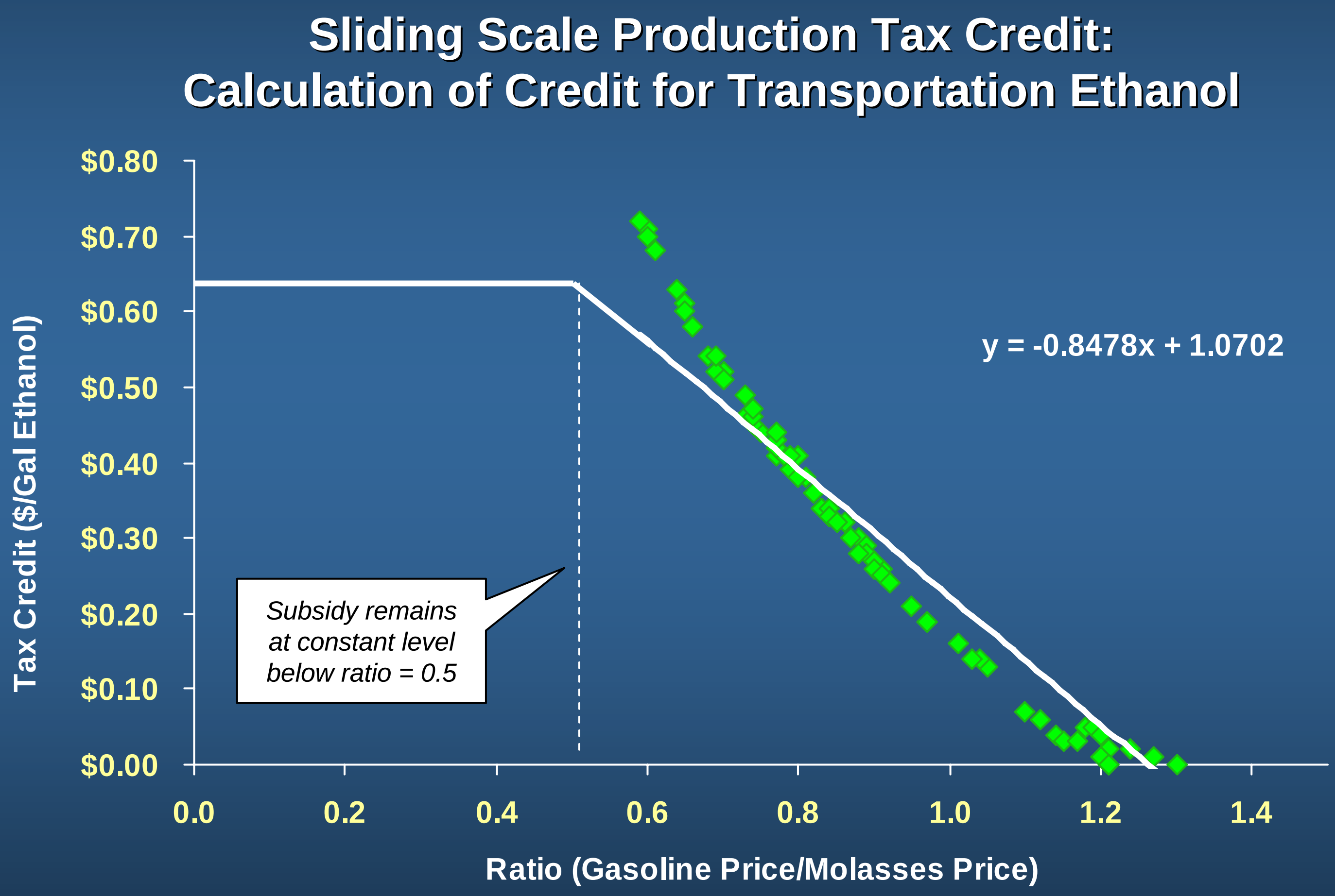




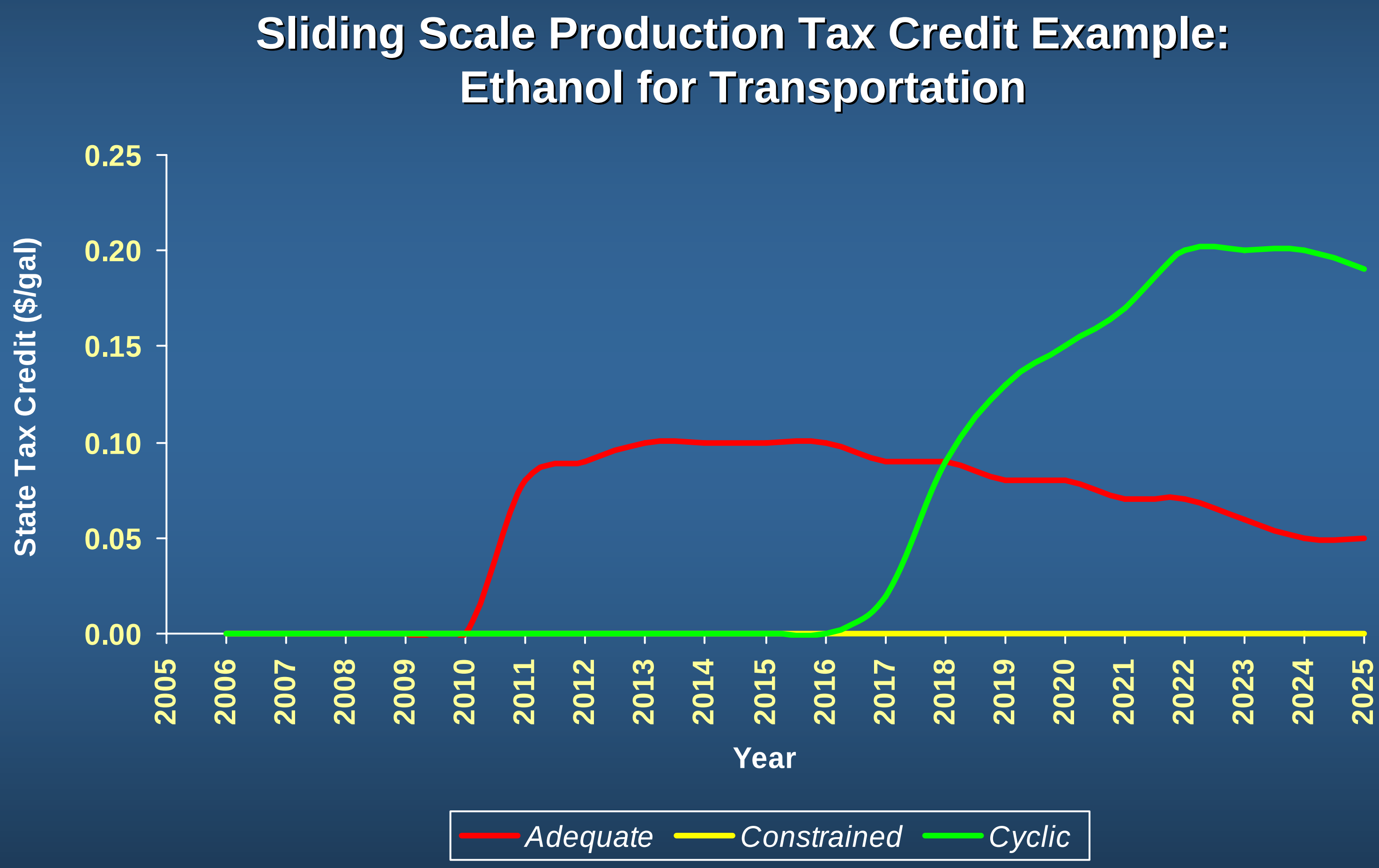
Alternate Fuels Standard

- Hawaii easily meets the AFS targets in the Constrained scenario
- Based on cost-effective supply, Hawaii does not meet the AFS targets in the Adequate scenario, and stops meeting it in 2017 in the Cyclic scenario
- The cost of meeting the AFS (based on $/gallon subsidy needed to make more E85 cost effective) ranges from $1-$4 million/year in Adequate to between $1-$8 million/year in Cyclic scenario
- However, in the Adequate scenario, we do not forecast a sufficient number of FFVs to meet the AFS, even if the fuel were cost-effective
- Therefore, based on these assumptions it is impossible to meet the AFS in the Adequate scenario

Sliding Scale Subsidy for Biofuels



Sliding Scale Subsidy for Biofuels



Sliding Scale Subsidy for Biofuels

- Modeling shows that transportation biodiesel does not require an additional subsidy in any of the three scenarios
- Biofuels for electricity are priced differently than biofuels for transportation, because utility fuel is not taxed
- Therefore, the sliding scale model cannot be applied directly to utility fuel purchases
- However, price volatility is a key issue for utilities
- The State of Hawaii, the Hawaii Public Utilities Commission, and HEI/KIUC should work together to develop an appropriate mechanism to support utility use of biofuels

Feebates Reduce Gallons Used, Without Mandating that Consumers Switch Vehicle Classes

- Tax rebates have historically focused on high-mpg vehicles
  - Fuel economy is the wrong metric (mpg)
  - Non-linear in term of cost of fuel, gallons used, CO2 emitted
  - 1 mpg improvement on a 15mpg vehicle (i.e., Ford *Expedition*) saves 10x as much fuel as a 1mpg improvement on a 58mpg vehicle (i.e., Toyota *Prius*)
- Gallons Per Mile (GPM) is better metric
  - GPM = 1/mpg
  - Policies based on GPM equally value a saved gallon of gasoline
- Size of fee or rebate: $1,000 for each 0.01 difference between efficient vehicle and target fuel economy in gallons per mile (GPM)
  - Rebate* = $1,000 x (GPM(target) - GPM (efficient))/0.01
  - Example 1: Toyota *Prius* (55 mpg); target (30 mpg)
    - Expected rebate: $1,515
  - Example 2: Ford *Crown Victoria* (20 mpg); target (27.5 mpg)
    - Expected fee: $1,364

*David Greene, Oak Ridge National Laboratory

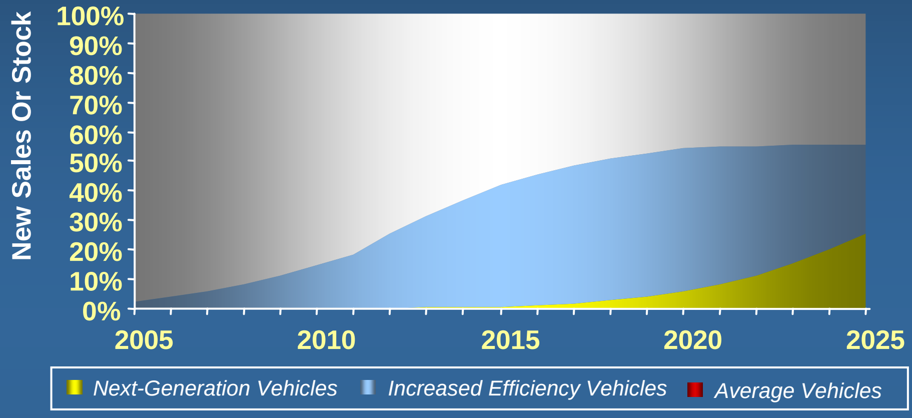
Feebates are a Revenue Neutral Way to Incent Efficient Vehicle Adoption

- Advantages
  - Prompt buyers to purchase more fuel efficient vehicles (gallons/yr) while maintaining vehicle utility
  - Works through the market to drive efficient vehicle purchase
  - Revenue neutral to state treasury; technology neutral; size neutral
  - Transparent to consumer at point of purchase
  - Internalizes entire 14-year vehicle fuel savings (consumers normally only consider 3 years)
  - Ideal policy works to reduce gallons used, without mandating that consumers switch vehicle classes
  - Unlike standards, by increasing the target fuel economy each year, feebates reward and propel continuous improvement

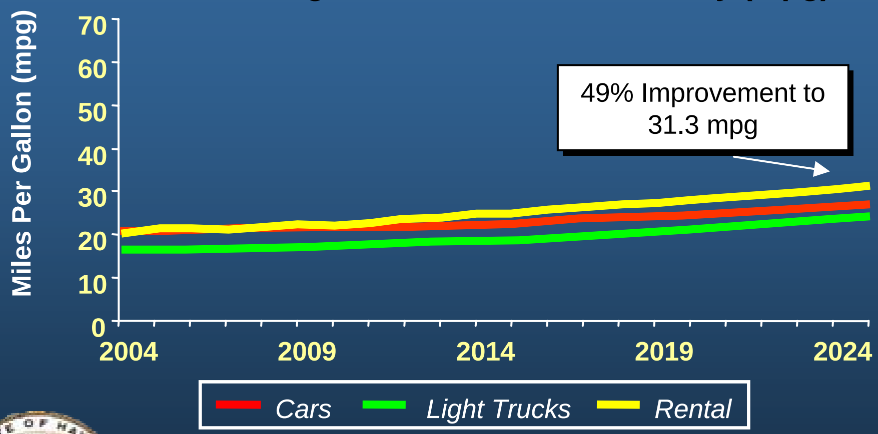
Feebates Shift Vehicle Mix to More Efficient Vehicles After 2015

Without Feebates

New Sales of Efficient Vehicles

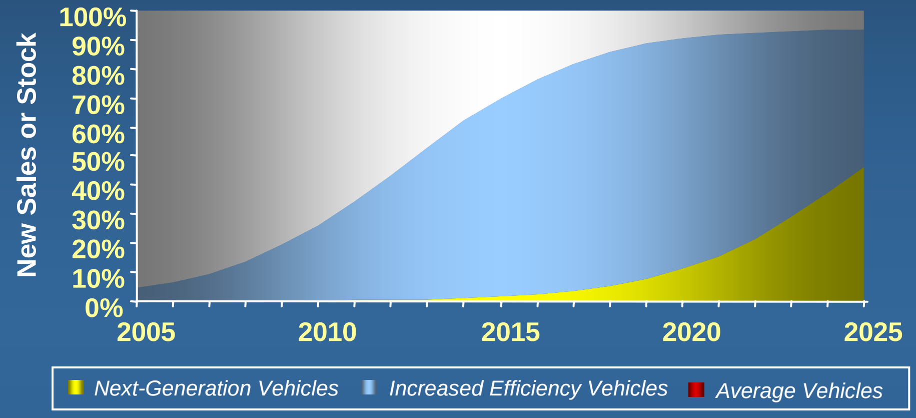


Hawaii Light Vehicle Stock Efficiency (mpg)



With Feebates

New Sales of Efficient Vehicles



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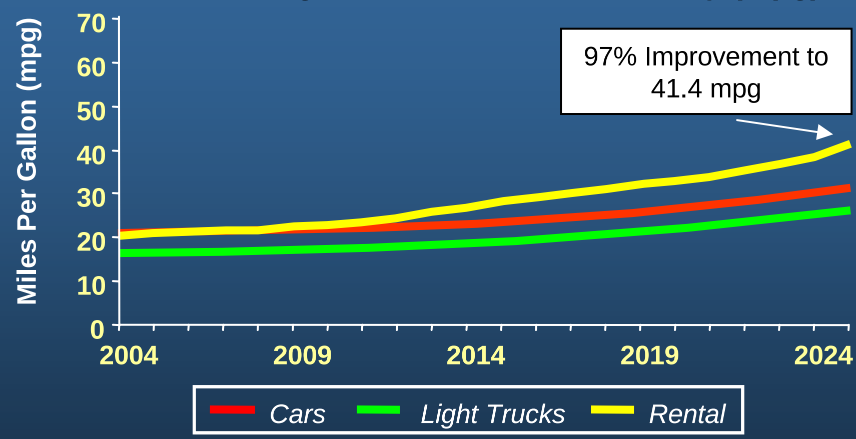
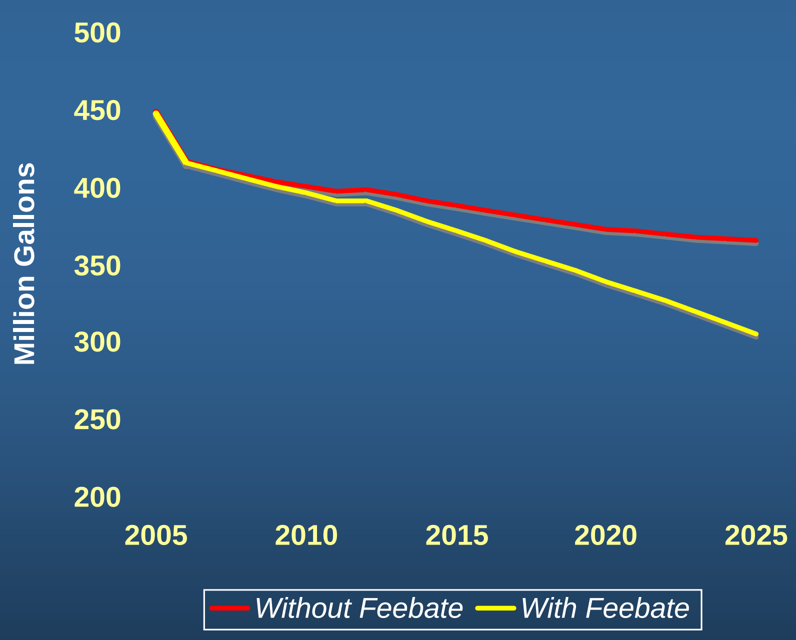


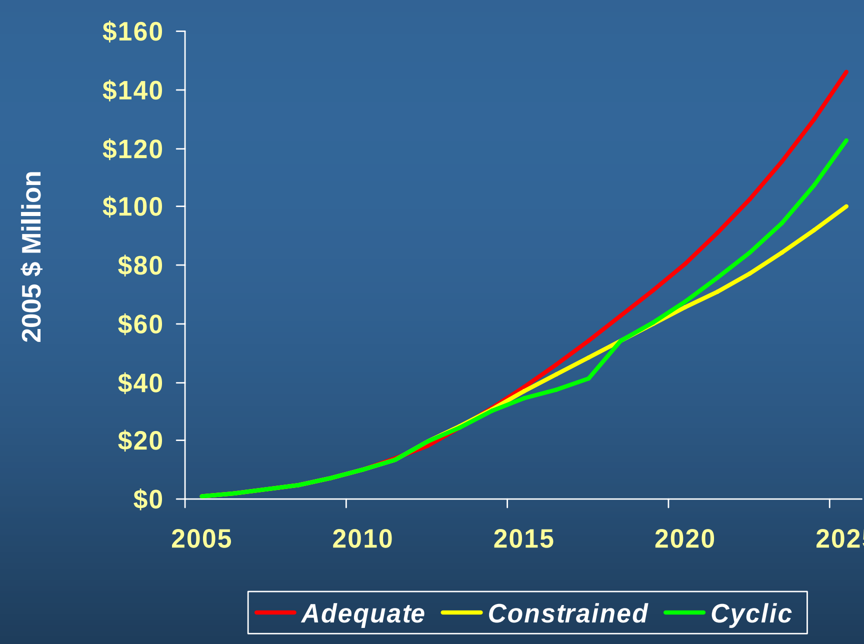
Feebates Further Reduce Fuel Consumption by 7%-9% and Save Hawaii Consumers $65-$80 Million/yr by 2020

- Impact of Feebates is muted in Constrained Scenario due to already high gasoline prices

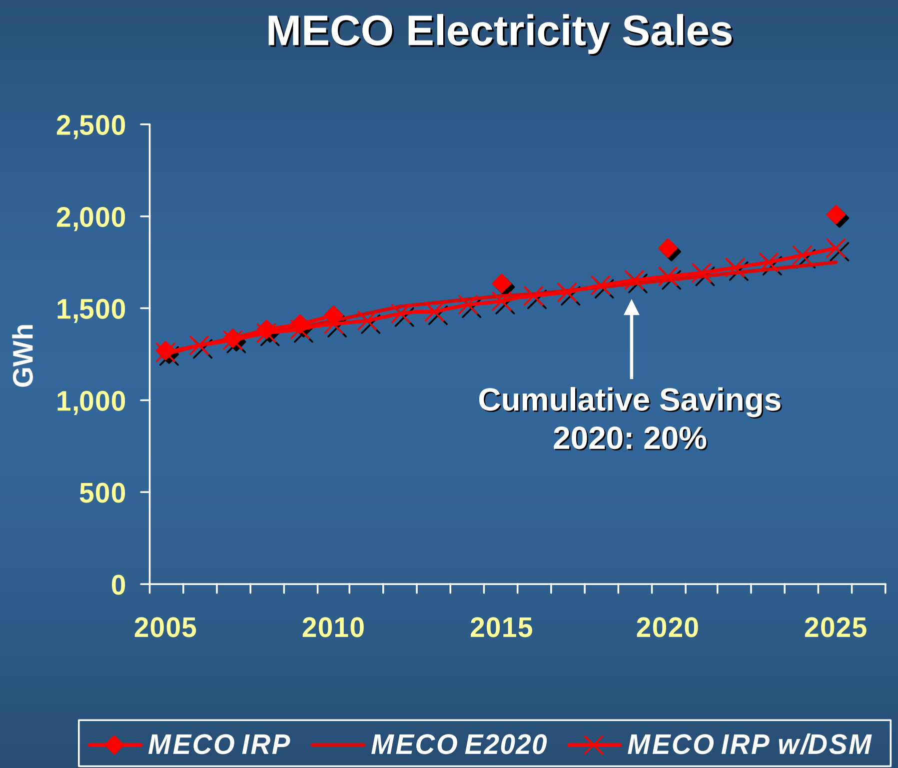
Statewide Gasoline Consumption (Adequate Scenario)

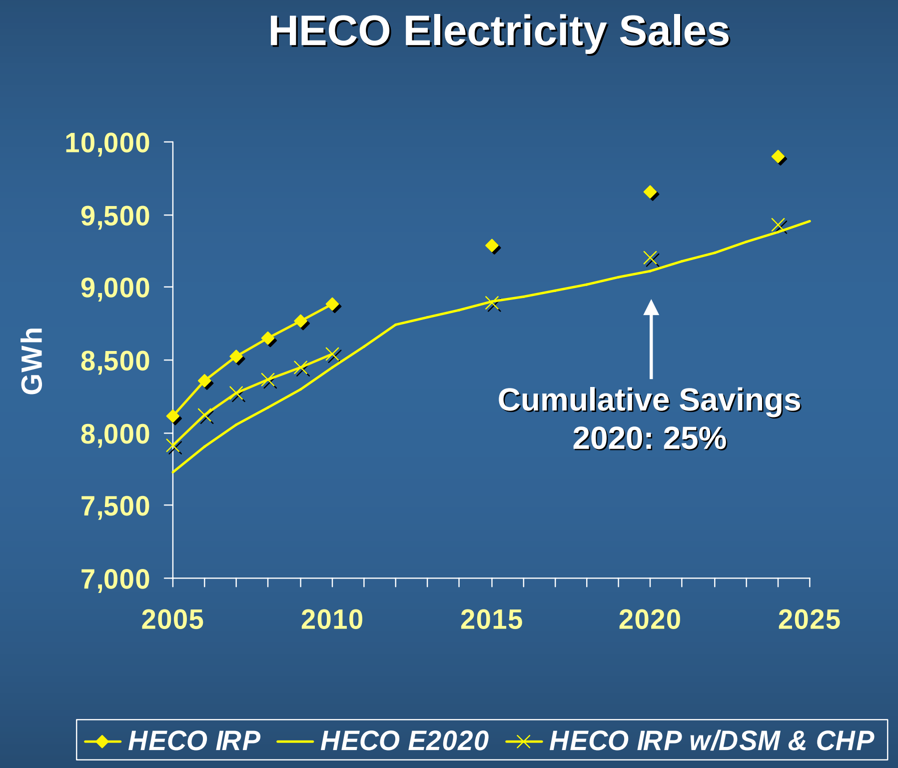


Annual Displaced Gasoline Savings



Efficiency Standard: Utilities Appear On Track to Meet and Exceed 20% by 2020





Notes: KIUC IRP data not available; HELCO sales w/DSM not available
IRP forecasts as of 02/04(HECO), and 01/06 (MECO); DSM projections as of 02/04 (HECO), and 10/05 (MECO).

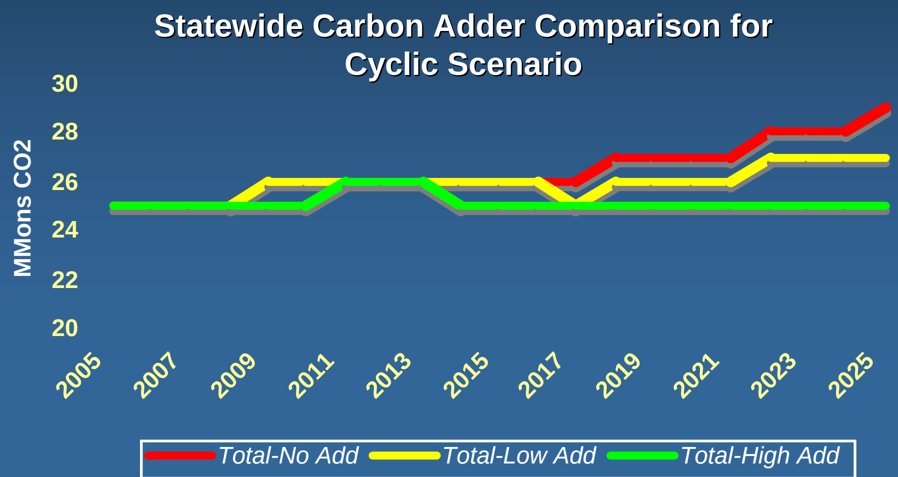
Efficiency Standard : However, Not All Policies Are Yet In Place to Fully Incent Efficiency

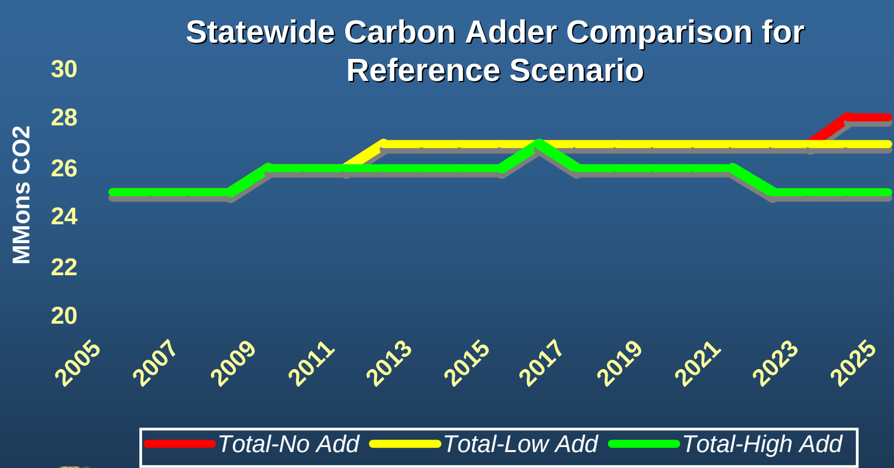
- There are a number of open issues regarding energy efficiency
  - Decoupling: Proposal before the PUC to decouple utility rates from electricity sales, to remove disincentive to fully implement efficiency
  - Third Party Administration: Proposal before the PUC for the partial or entire administration of energy efficiency programs be transferred to another party besides the utility
  - Lost Margin Recovery: A proposal for recovery of lost margins that would allow demand side resources to be treated commensurately with supply side resources investments is before the PUC
  - Shareholder incentives: Proposal before the PUC performance-based incentives for DSM programs

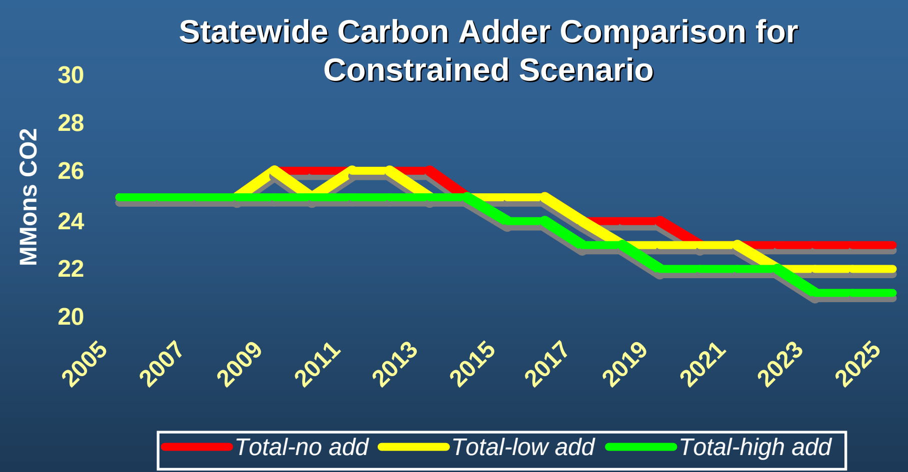
Carbon Cost Adder Policy

- Objective is to promote adoption of climate neutral technologies
- Place a surcharges on price of fuels as a function of its carbon intensity
  - Coal would have the highest premium and gas the lowest
  - No carbon premium added to renewable energy
  - Captures future cost of GHG emissions regulation
- Not necessarily a carbon tax: valuation of carbon would also be required in a cap and trade regime
  - Similar price signal to end consumer
  - Potentially different net cash flow to state
- We looked at impacts to HI energy system using two carbon cost adders
  - Low Adder: modeled after CPUC planning and procurement guidelines - $9/sht ton CO2e in 2006 and escalating 5% per year
  - High Adder: $26/sht ton CO2e in 2006 and escalating 5% per year

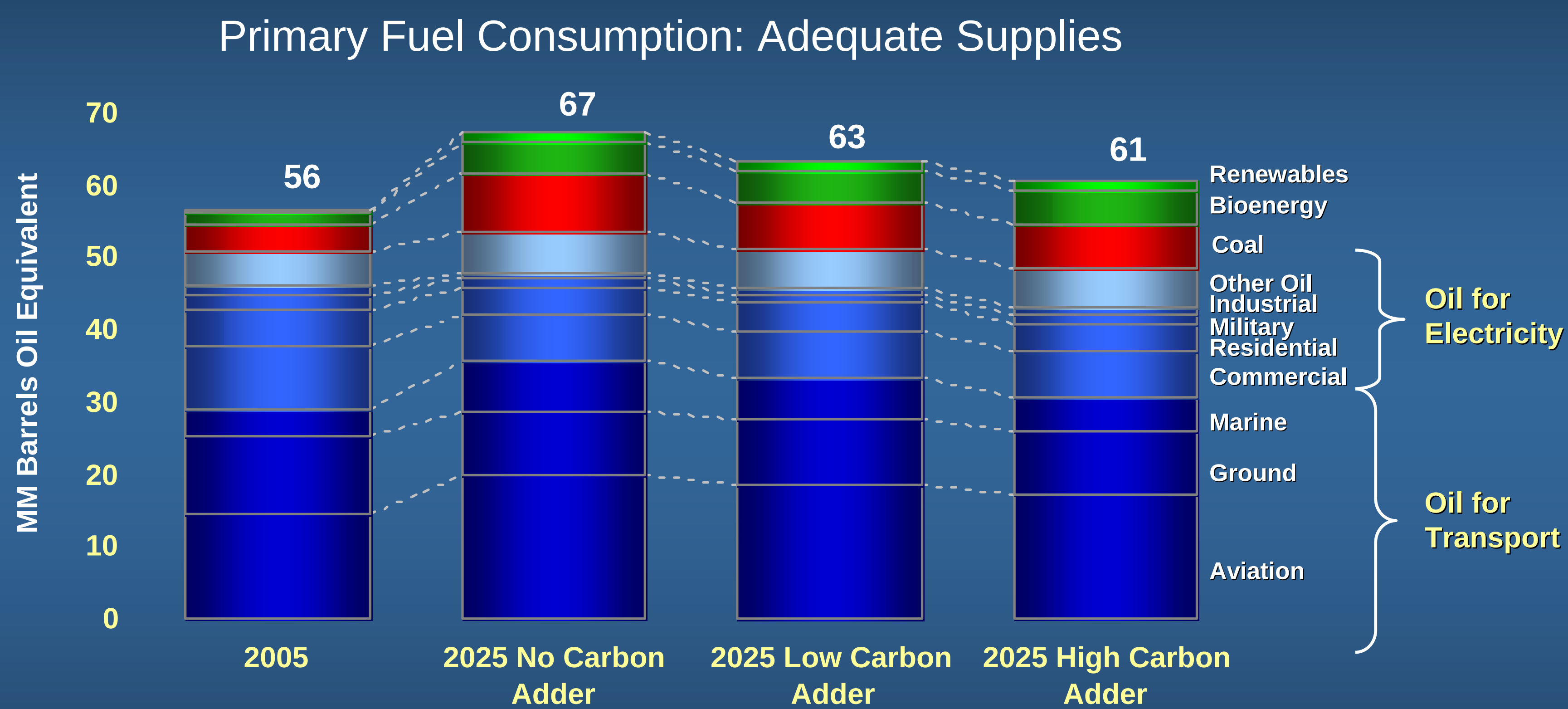
In Absence of High Fuel Prices, High Carbon Adder is Effective in Stabilizing CO2 Emissions







Adequate Supplies: Absolute Oil Consumption Grows by 5% Without Policies; Falls by 5% with High Carbon Adder



Oil Consumed (Mmboe/yr)	**51**	**54**	**51**	**48**
Oil Dependence	90%	80%	81%	80%

Additional Policy Recommendations

- Electric Power Policies
  - Consumer Choice: Green electricity purchasing program
  - Extend Pay-As-You-Save© to retail solar PV installations
  - Conduct more detailed and comprehensive DG potential study
  - Update model energy code (MEC)
- Bioenergy Policies
  - Targeting incentives across value chain:
    - Infrastructure incentives for irrigation and distribution
    - Funding for research and development
  - Provide clarity on water access issue
  - Streamline permitting process

Additional Policy Recommendations

- Transportation Policies
  - Tax Credit on FFV: $2000 maximum tax credit dependent on presence of sufficient infrastructure. FFV receives a 50% credit when 10% of stations sell E85, and a 100% credit when 20% of stations sell E85.
  - Increase State Fleet Vehicle Efficiency: Implement Act 96 passed in 2006
- Climate Change Policies
  - CO_2 emissions performance standard for new energy facilities
  - Update 1998 Climate Change Action Plan
  - Improve emergency preparedness

BREAK

Stakeholder Process

Today’s Discussion Objectives

- Obtain comments and answer questions on
  - Inputs to model
  - Findings from model
- Gather feedback on policies evaluated
- Obtain ideas about additional policy recommendations

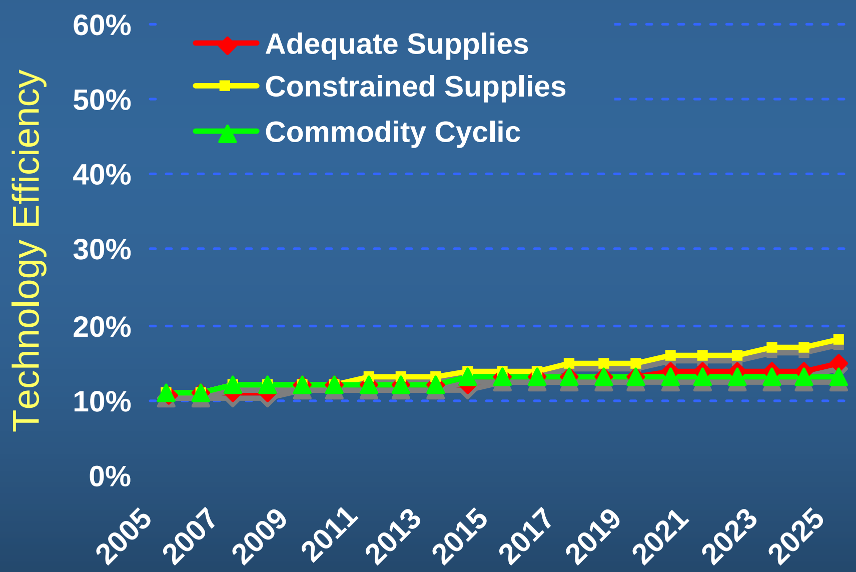
Adjourn

Backup Slides

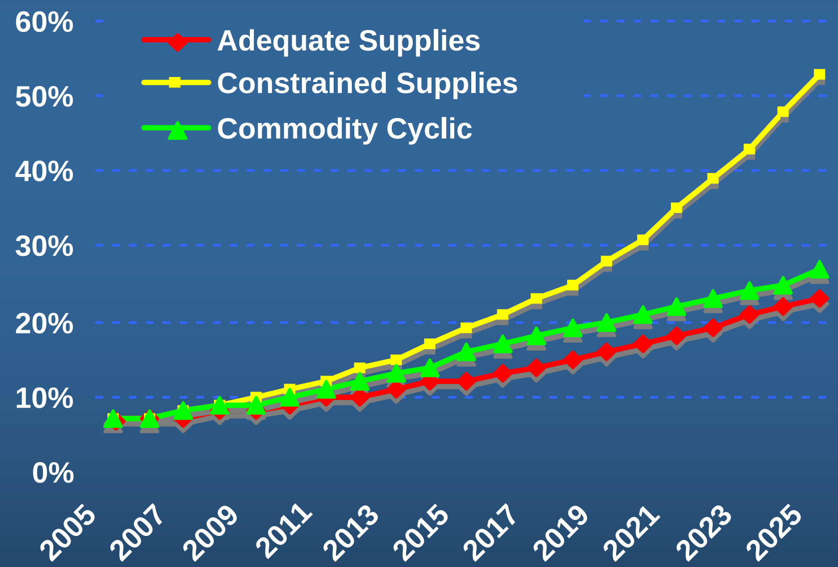
Energy Labs and ESource Studies Project Higher Technical Potential for LED Lighting

Technology Efficiency Evolution in E2020: Lighting Inputs Example

CFLs



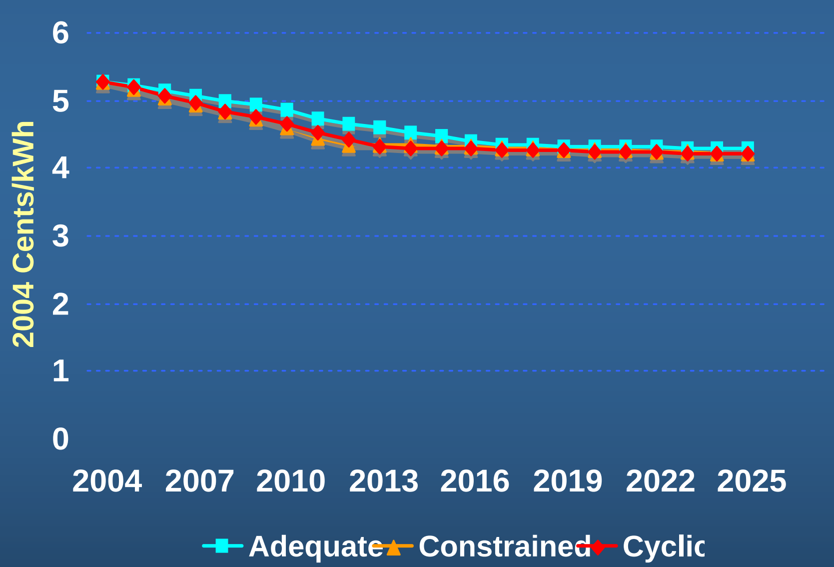
LEDs



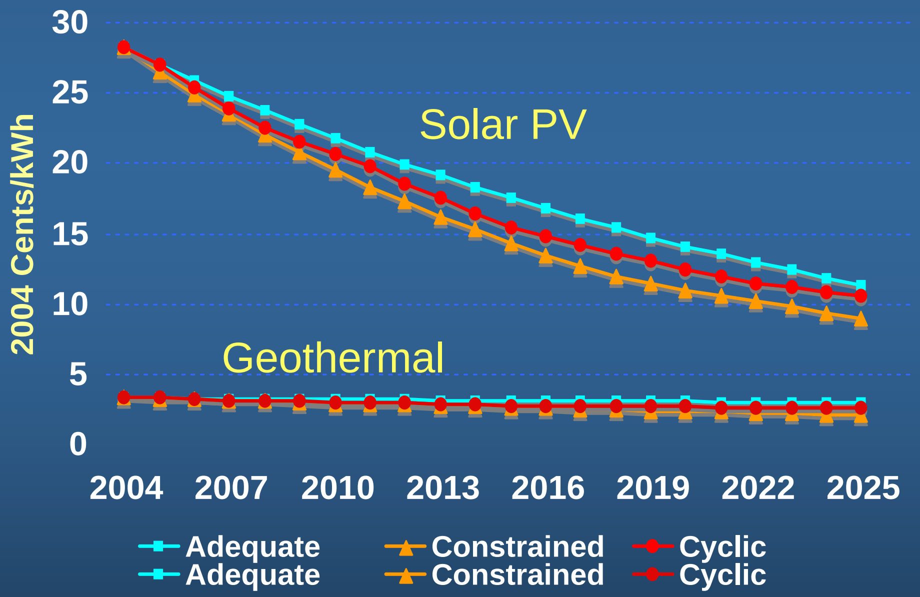
Sources: Broderick, James. 2004. *U.S. DOE Solid State Lighting Status and Future.* SPIE 49th Annual Meeting, August 8.
Drennen, Thomas. 2001. A Market Diffusion and Energy Impact Model for Solid State Lighting, SAND2001-2830J, August
E Source. 2005. *Lighting Technology Atlas*.

Wind Unit Costs Decline and Level Off as Technology Matures. Solar and Geothermal Costs Drop Steeply: 60-68% for Solar PV and 10-36% for Geothermal

Amortized Installed Cost
for Wind



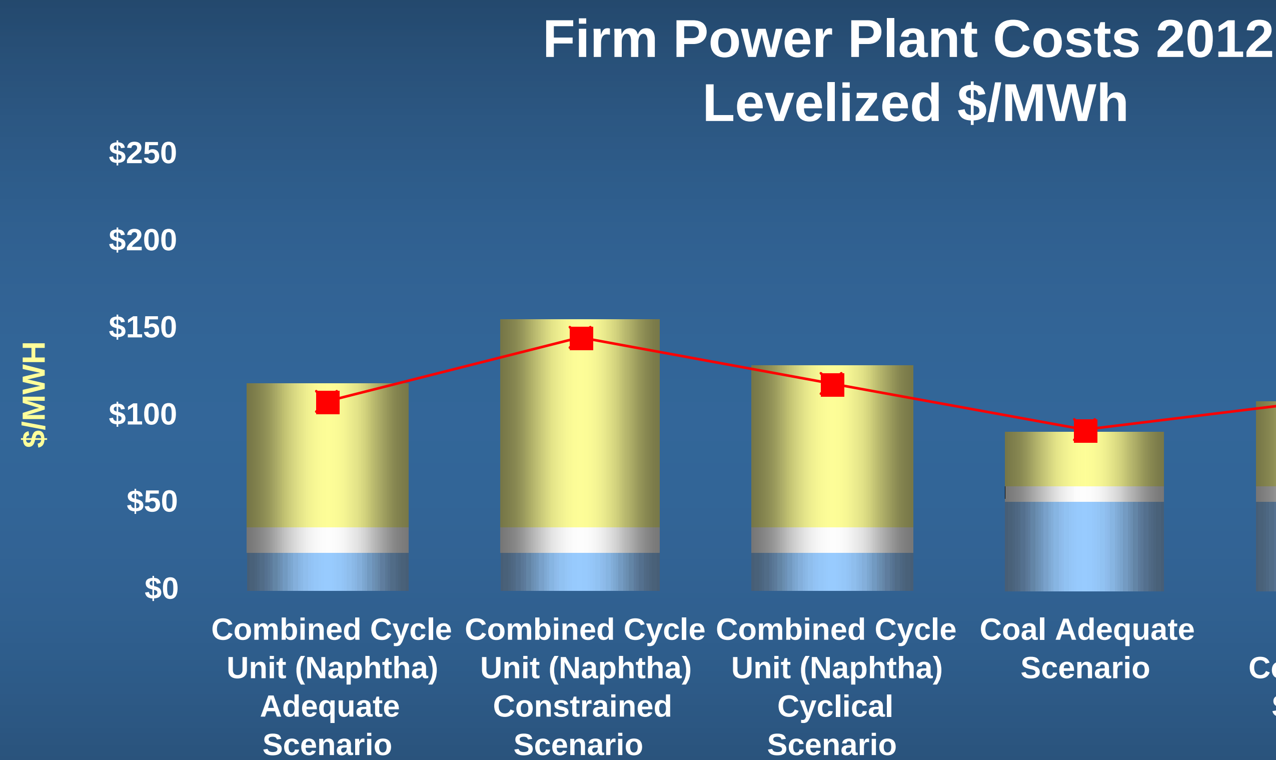
Amortized Installed Cost
for Solar PV and Geothermal



Sources: IEA, 2004, World Energy Outlook, and BCC Research

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

The Cost Effectiveness of Hawaii's Fossil Fuel Burning Plants, Which Supply 93% of the State's Electricity, Is Heavily Dependent on Fuel Prices



Virginia Lacy:

Kitty, I think we need to compare renewables with fossil in the same slide. I'm not convinced these two slides are very effective. (FYI, titles on both slides are my creation.)

Capacity Factor	60%	65%
Unit Capacity (MW)	120	180

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

Firm Renewable Energy Options Can Be Cost Effective And Also Less Susceptible to Fuel Price Volatility in All Scenarios

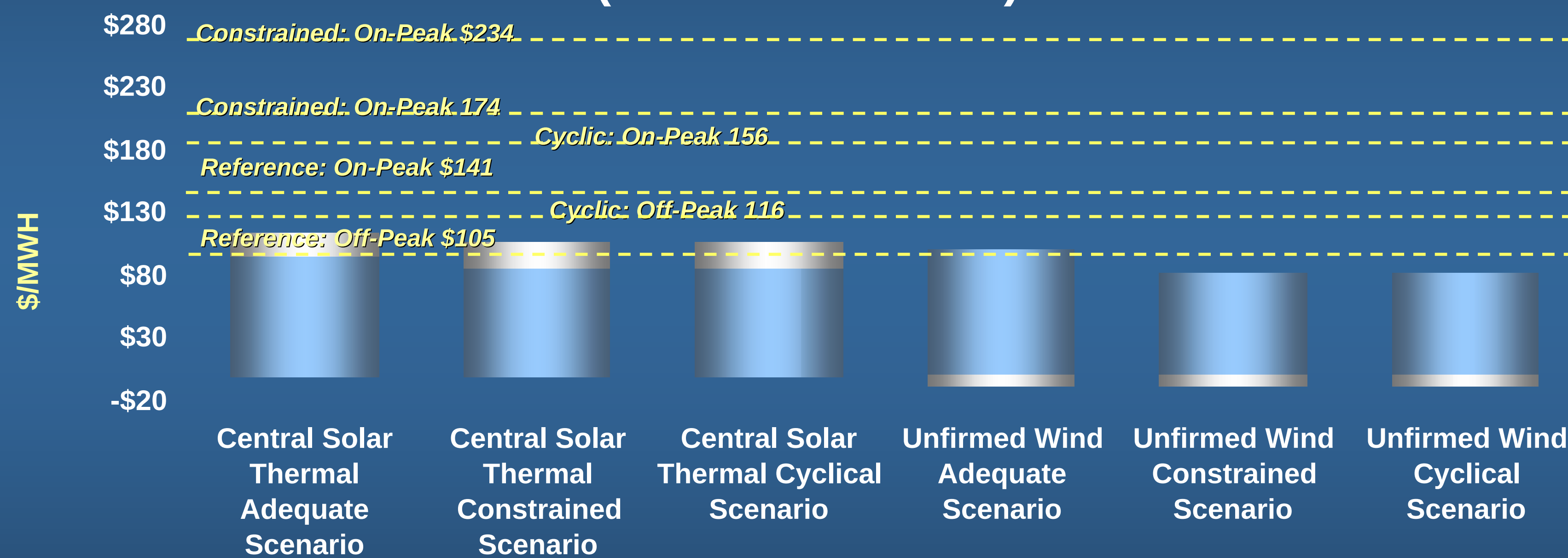
Capacity Factor	83%	83%
Unit Capacity (MW)	30	10

Virginia Lacy:

Lisa: Can you animate this slide. Avoided cost (horizontal) lines for each scenario (Adequate, Constrained, Cyclic) should appear at the same time as levelized cost bars for Solar thermal and Unfirmed Wind of the same scenario.

an be Cost Competitive With led Costs of Electricity

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



Capacity Factor	39%	26%
Unit Capacity (MW)	33	10

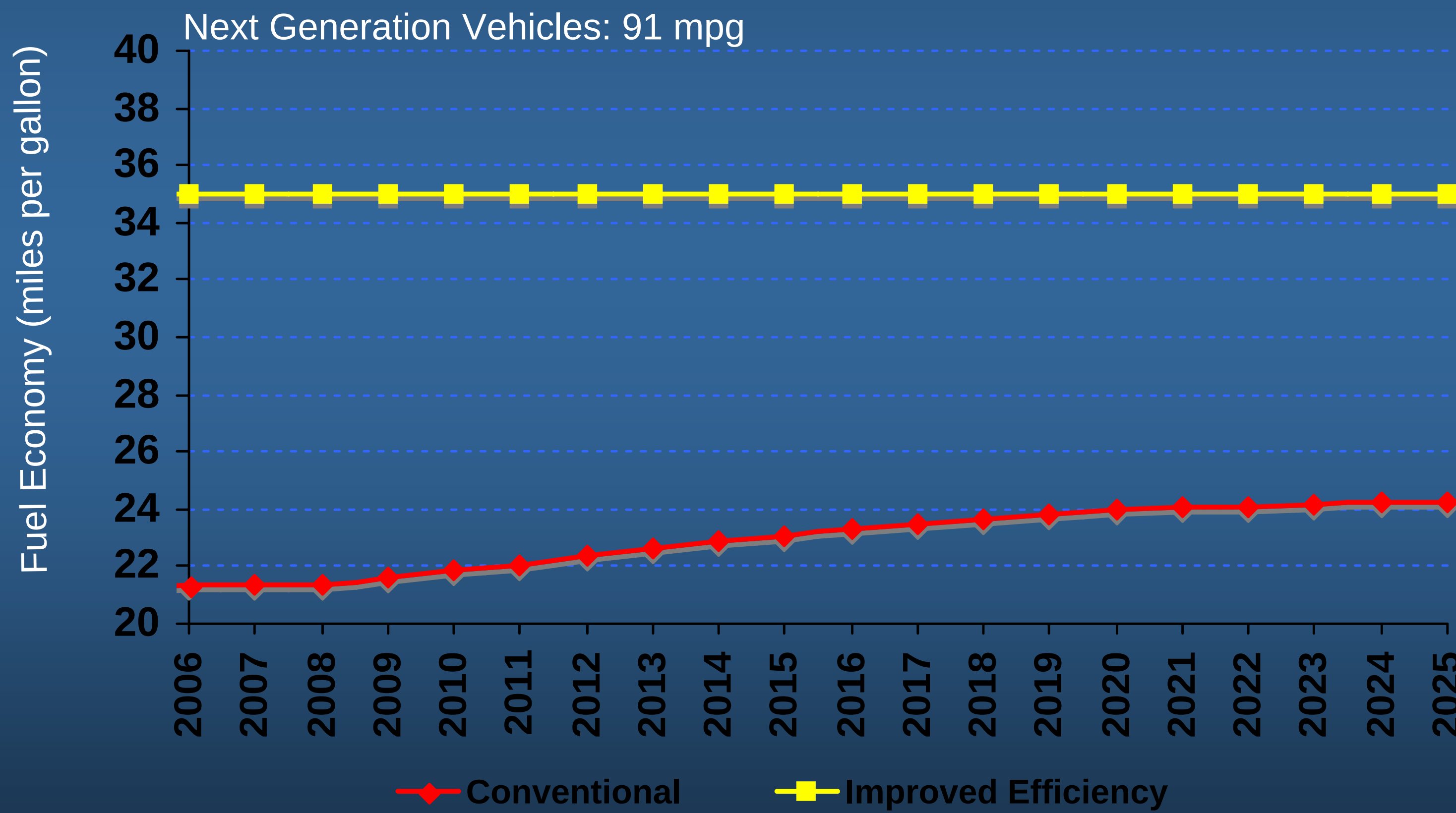
Capital *O&M Total* *Fuel*

Transportation Assumptions for Scenarios Include Fuel Economy, Stock, and VMT for Cars and Light Trucks

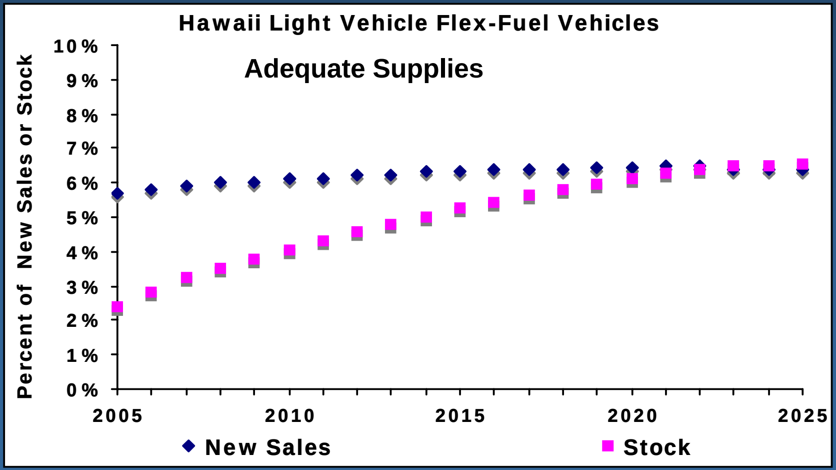
Kitty Wang:

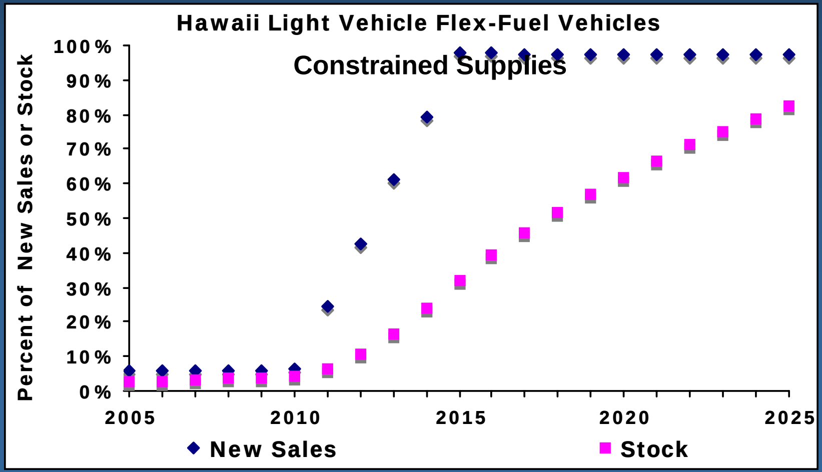
Lisa: Can you "break" the y-axis to plot the Next Generation vehicles @ 91 mpg?

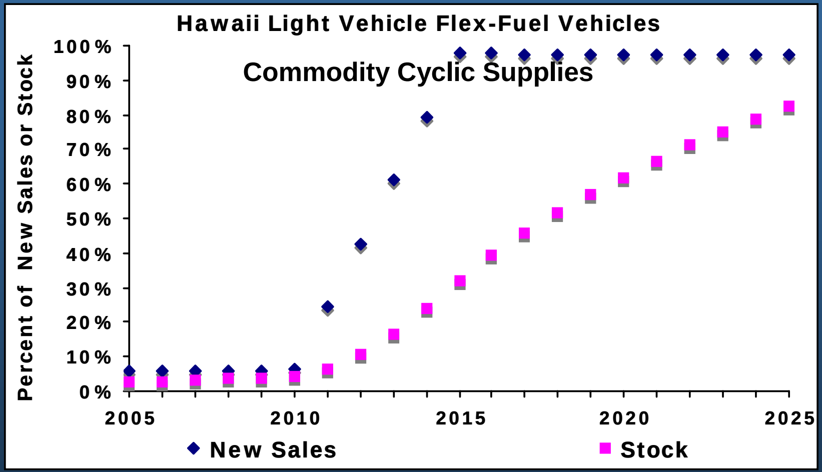
Statewide Fuel Economy of New Cars:
Conventional, Improved Efficiency, and Next Gener



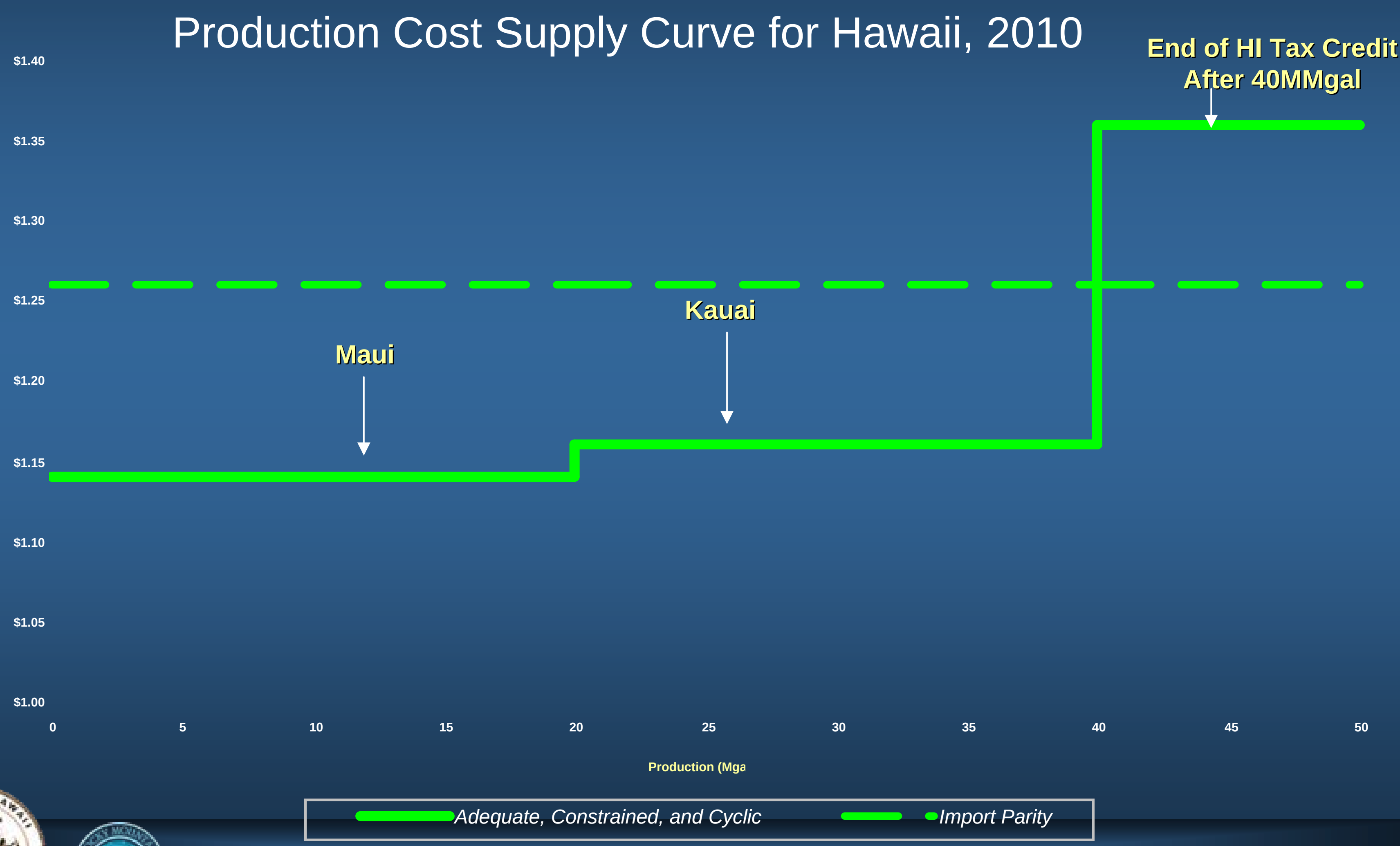
Furthermore, We Assume FFVs Are Introduced in Constrained and Cyclic Scenarios







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