Hawaii Transportation Energy Analysis: Marine Efficiency Options

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Outline

- About the ICCT
- Project background
- Baseline marine energy consumption
- Unique characteristics of shipping energy use
- Energy-saving tactics evaluated
ICCT mission and activities

The mission of ICCT is to dramatically improve the environmental performance and efficiency of cars, trucks, buses and transportation systems in order to protect and improve public health, the environment, and quality of life.

- Non-profit research institute
- Air pollution and climate impacts
- Focus on regulatory policies and fiscal incentives
- Activity across modes including aviation and marine
- Global outreach, with special focus on largest markets
Disclaimer

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HCEI 2011 roadmap established an aggressive goal

**Goal**: Reduce the use of petroleum in ground transportation by 70% or ~ 385 MGY by 2030

<table>
<thead>
<tr>
<th>Strategy with 2010 baseline</th>
<th>2015 target</th>
<th>2020 target</th>
<th>2030 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce vehicle miles traveled (VMT)</td>
<td>2% VMT reduction</td>
<td>4% VMT reduction</td>
<td>8% VMT reduction</td>
</tr>
<tr>
<td>Incorporate renewable fuels into transportation sector</td>
<td>E10 and biodiesel consumption at 2010 level (~45 million gallons)</td>
<td></td>
<td>150 million gallons</td>
</tr>
<tr>
<td>Improve standard vehicle efficiency of fleet</td>
<td>25 mpg cars 18 mpg LT</td>
<td>30 mpg cars 22 mpg LT</td>
<td>35 mpg cars 28 mpg LT</td>
</tr>
<tr>
<td>Accelerate the deployment of electric vehicles (EVs) and related infrastructure</td>
<td>4K EV sales (10K on road)</td>
<td>10K EV sales (40K on road)</td>
<td>30K EV sales</td>
</tr>
</tbody>
</table>

MGY: million gallons per year
### Comparing 2015/2020 goals with 2013 status

<table>
<thead>
<tr>
<th>Strategy with 2010 baseline</th>
<th>2015 target</th>
<th>2020 target</th>
<th>2013/2014 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce vehicle miles traveled (VMT)</td>
<td>2% VMT reduction</td>
<td>4% VMT reduction</td>
<td>19% increase in VMT</td>
</tr>
<tr>
<td>Incorporate renewable fuels into transportation sector</td>
<td>E10 and biodiesel consumption at 2010 level (~45 gallon)</td>
<td>52 million gallons</td>
<td></td>
</tr>
<tr>
<td>Improve standard vehicle efficiency of fleet</td>
<td>25 mpg cars</td>
<td>30 mpg cars</td>
<td>25 mpg for cars &amp; LT combined</td>
</tr>
<tr>
<td></td>
<td>18 mpg LT</td>
<td>22 mpg LT</td>
<td></td>
</tr>
<tr>
<td>Accelerate the deployment of electric vehicles (EVs) and related infrastructure</td>
<td>4K EV sales (10K on road)</td>
<td>10K EV sales (40K on road)</td>
<td>1K EV sales (~3K on road)</td>
</tr>
</tbody>
</table>

On-road fuel use of 525 MGY in 2013 as compared with 496 MGY in 2010; a 6% increase.
Core strategies under consideration for transportation energy roadmap

- Light- as well as heavy-duty vehicle efficiency improvements
- Transition to electric drive vehicles (EVs and FCVs)
- Alternative fuels including biofuels and natural gas
- Vehicle demand management/promotion of transit and non-motorized transport
- Improving aviation efficiency
- Improving marine efficiency
Timeline for transportation energy analysis

• Stakeholder workshop: November 2014
• Vehicle Efficiency Options, January 8, 2015 (webinar)
• Continued stakeholder engagement
  • Workshop on Electric drive vehicles: January 13-14, 2014
  • Web-meetings on aviation and marine tactics: early February 2015
• Qualitative and quantitative evaluation of tactics (January/February 2015)
• Assess complementarity with existing Hawaii policies/plans and budgets (February/March 2015)
• Seek broad agreement on plan and implementation steps (April/May 2015)
• Final report (June 2015)

• Late 2015: Actual work begins on implementing an integrated transportation energy strategy with shared roles and responsibilities
Baseline marine energy consumption
Fuel sales to ocean-going vessels in Hawaii

- Bunker sales to ocean-going vessels (OGVs) fluctuate widely around 110 million gallons per year, 2.5% of total U.S. bunker sales, 10% of total liquid fuel sales in Hawaii.

Data Source: EIA (2014), Bunker sales to ships in Hawaii
Fuel sales to small boats vary even more over time, with increasing gasoline sales.

Data provided by Hawaii DBEDT
Combined fuel sales to shipping in Hawaii

- Bunker sales to ocean-going vessels (OGVs) dominate total energy use
- Baseline in 2020: 122 MGY (OGVs) and 3 MGY (small boats)
Unique characteristics of shipping energy use
Not all oil is the same
Regulatory changes in the coming years

- Global bunker demand will undergo a sea change in the next few years
- Ship operators have to store multiple fuels in tanks, leading to changes in demand for different marine fuels in Hawaii

Marine fuel is much cheaper

- Cheap fuel may damp the implementation of alternative fuels (i.e. LNG)

ICCT (2013) “Assessment of the fuel cycle impact of LNG as used in international shipping

EIA (2013) Hawaii price differences from U.S. average
http://www.eia.gov/state/?sid=HI#tabs-5
Market situation in shipping market

- Unlike aircraft, OGVs usually purchase fuels in markets where they are cheaper and carry them during other voyages.
- Consequently, raising the energy efficiency of OGVs does necessarily mean reduced demand for marine fuels at a given port.
  - For analysis purpose, we assume energy savings will translate to lower energy demand in shipping in Hawaii.
Energy-saving tactics evaluated
A marginal abatement cost curve was applied to assess tactics to reduce energy consumption from shipping in Hawaii.
Marine fuel efficiency improvement tactics considered

- Slow steaming when ships approach 40 nautical miles of Port of Honolulu
- Fuel surcharge for shipping fuels sold in Hawaii
- Hull cleaning for OGVs and small boats
- Propeller polishing for OGVs and small boats
- Onshore power for OGVs visiting Port of Honolulu
Slow steaming

- Main engine fuel consumption scales with the cube of operational speed
- Encouraging OGVs to reduce speeds outside ports would reduce fuel consumption and air emissions
- Port of Los Angeles and Port of Long Beach (POLB) both applied this method

\[
F_{ij} = \left[ MF_k \right] \left( \frac{s_{ik}}{s_{0k}} \right)^3 \left( \frac{AF_k}{24} \right) \frac{d_{ij}}{s_{ik}}
\]
Effectiveness

- Assumptions
  - Estimated energy consumption at Port of Honolulu using PoLB inventory and relative cargo throughput
  - Cargo growth increases 5% annually between 2011 and 2020
  - Speed reduced to 12 knots into the speed limit zone

- Effectiveness
  - 0.8 MGY
  - $0.5 million incentive in discounted port dues
  - $0.61 per gallon (excluding cost or gains from fuels from shipping companies)

- Policy implication: voluntary slow steaming program with incentives such as discounted port dues
Marine fuel efficiency improvement tactics considered

- Slow steaming when ships approach 40 nautical miles of Port of Honolulu
- **Fuel surcharge for shipping fuels sold in Hawaii**
- Hull cleaning for OGVs and small boats
- Propeller polishing for OGVs and small boats
- Onshore power for OGVs visiting Port of Honolulu
## State and local sales taxes on transportation fuels

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Gasoline</th>
<th>Highway Diesel</th>
<th>Highway LPG</th>
<th>Non-highway Diesel</th>
<th>Non-highway LPG</th>
<th>Aviation</th>
<th>Marine bunkers</th>
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</thead>
<tbody>
<tr>
<td><strong>State</strong></td>
<td>17</td>
<td>17</td>
<td>5.2</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>-----</td>
</tr>
<tr>
<td><strong>County</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honolulu</td>
<td>16.5</td>
<td>16.5</td>
<td>5.4</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Maui</td>
<td>16.0</td>
<td>16.0</td>
<td>4.3</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Hawaii</td>
<td>8.8</td>
<td>8.8</td>
<td>2.9</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Kauai</td>
<td>17.0</td>
<td>17.0</td>
<td>5.6</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
</tbody>
</table>

http://www.tfhawaii.org/taxes/fuel.html
Relative low bunker price in Hawaii drew ships calling Port of Honolulu purely for bunker around 2006, causing a spike in bunker demand (see slide 10)

The price advantage disappear (see figure below), but the transport supply remain unaffected.
Effectiveness

- No fuel tax exists for ships; a fee surcharge could be viable

Assumptions
- 1% increase of fuel price will reduce fuel sales by 0.15% (average figure from ISL, 2013; Swedish shipping association, 2011; CE Delft, 2010)
- Baseline fuel cost by 2020: $700 per tonne
- $20 surcharge (4%)

Effectiveness
- 0.9 MGY
- -$0.10 per gallon

Policy implication: Consider a fuel surcharge for shipping fuels to encourage hull and propeller polishing business
Marine fuel efficiency improvement tactics considered

- Slow steaming when ships approach 40 nautical miles of Port of Honolulu
- Fuel surcharge for shipping fuels sold in Hawaii
- Hull cleaning for OGVs and small boats
- Propeller polishing for OGVs and small boats
- Onshore power for OGVs visiting Port of Honolulu
Hull cleaning and propeller polishing

- Hull and propellers should be regularly cleaned and polished to reduce resistance in operation.
- Literature shows some shipowners do not follow the maintenance schedule.
- Real savings depend on the penetration rates of both tactics in Hawaii.
Assumptions

- Hull cleaning: 1%-10% energy reduction; $75K – 112K cost for OGVs
- Propeller polishing: 3%-8% energy reduction; $80K - $90K cost for OGVs
- Market penetration rate: 60% (we examined the effect between 60% to 90% penetration rates)
- Both hull cleaning and propeller polishing can be applied to OGVs and small boats
Effectiveness

- Hull cleaning: 3.1 MGY; -$0.47 per gallon
- Propeller polishing: 2.9 MGY; -$0.67 per gallon
- Policy implications: fiscal policies such as tax credit and state subsidies to encourage hull cleaning and propeller polishing business
Marine fuel efficiency improvement tactics considered

- Slow steaming when ships approach 40 nautical miles of Port of Honolulu
- Fuel surcharge for shipping fuels sold in Hawaii
- Hull cleaning for OGVs and small boats
- Propeller polishing for OGVs and small boats
- Onshore power for OGVs visiting Port of Honolulu
Onshore power

- Substitute fuel oil consumption from auxiliary engines for electricity onshore

Assumption:
- Capacity factor of utilities in Hawaii: 60%
- Renewables in the generation mix by 2020: 25%
- Onshore power share: 80%
- Fuel consumption in Port of Honolulu is proportional to the cargo throughput between it and Port of Long Beach

Effectiveness
- 0.1 MGY
- $1,300 per gallon
Effectiveness

- Onshore power is a less feasible option
  - Exchanging oil use at port for oil use in power generation
  - Baseline electricity price is relatively high
  - Overall reduction potential is small
Fuel savings by fully implementing the four tactics

- The four tactics could reduce energy consumption from shipping by 5.1%, or 10.4 MGY, by 2020 and 14.0 MGY by 2030
Summary on fuel savings and cost effectiveness

<table>
<thead>
<tr>
<th>Tactics</th>
<th>Fuel savings</th>
<th>Cost effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow steaming</td>
<td>0.8 MGY</td>
<td>$0.61 per gallon</td>
</tr>
<tr>
<td>Fuel surcharge</td>
<td>0.9 MGY</td>
<td>- $0.10 per gallon</td>
</tr>
<tr>
<td>Hull cleaning</td>
<td>3.1 MGY</td>
<td>- $0.47 per gallon</td>
</tr>
<tr>
<td>Propeller polishing</td>
<td>2.9 MGY</td>
<td>- $0.67 per gallon</td>
</tr>
<tr>
<td>Shore power</td>
<td>0.1 MGY</td>
<td>$1300 per gallon</td>
</tr>
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</table>
For more information…

- Hawaii Clean Energy Initiative Website: http://www.hawaiicleanenergyinitiative.org/
- Two question HCEI survey: http://tinyurl.com/HCEI-trans
- ICCT website: http://www.theicct.org/
- Contact Information:  
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  - Dan Rutherford: dan@theicct.org