Sustainable Transportation Summit

H2@Scale Stakeholder Panel Session

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HNEI

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Strategic Focus for Hawaii (H2)

- ✓ **Demonstrate cost effective infrastructure to produce, distribute, and dispense hydrogen;**
- ✓ **Focus on fleet vehicles starting with public transportation & county trucks;**
  - ➢ **Central fueling - 30 kg per day per bus;**
  - ➢ **Public benefit - tax dollars support public transportation needs;**
- ✓ **Industry will take care of the vehicles;**
- ✓ **Support early heavy users of hydrogen to develop a hydrogen market;**
- ✓ **Private industry will take over when it sees it can make money.**

Building Blocks for Infrastructure Development

1. **Political Will**
2. **Policies & Plans**
3. **Resources**
4. **Strategic Market Transformation Projects**
5. **Community Support**
6. **Strategic Partners**

We are addressing all 6 of these in Hawaii!

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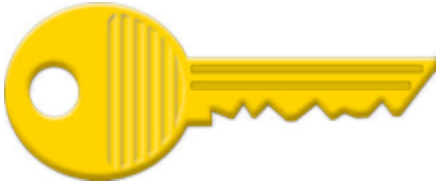
Political Will



Consistent Long-Term Political, Policy, and Financial Support

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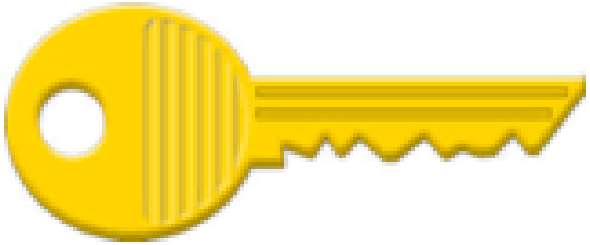
Hawaii Policies in Statute

- ✓100% RPS for electrical sector utilities
- ✓Barrel Tax
- ✓Hawaii Hydrogen Fund
- ✓Hydrogen Implementation Coordinator

PROJECTS



Projects Need to be Strategic

- **Need to demonstrate the economic viability and benefits of the technology.**
- **Will not get private investment until the numbers work out relative to other options.**

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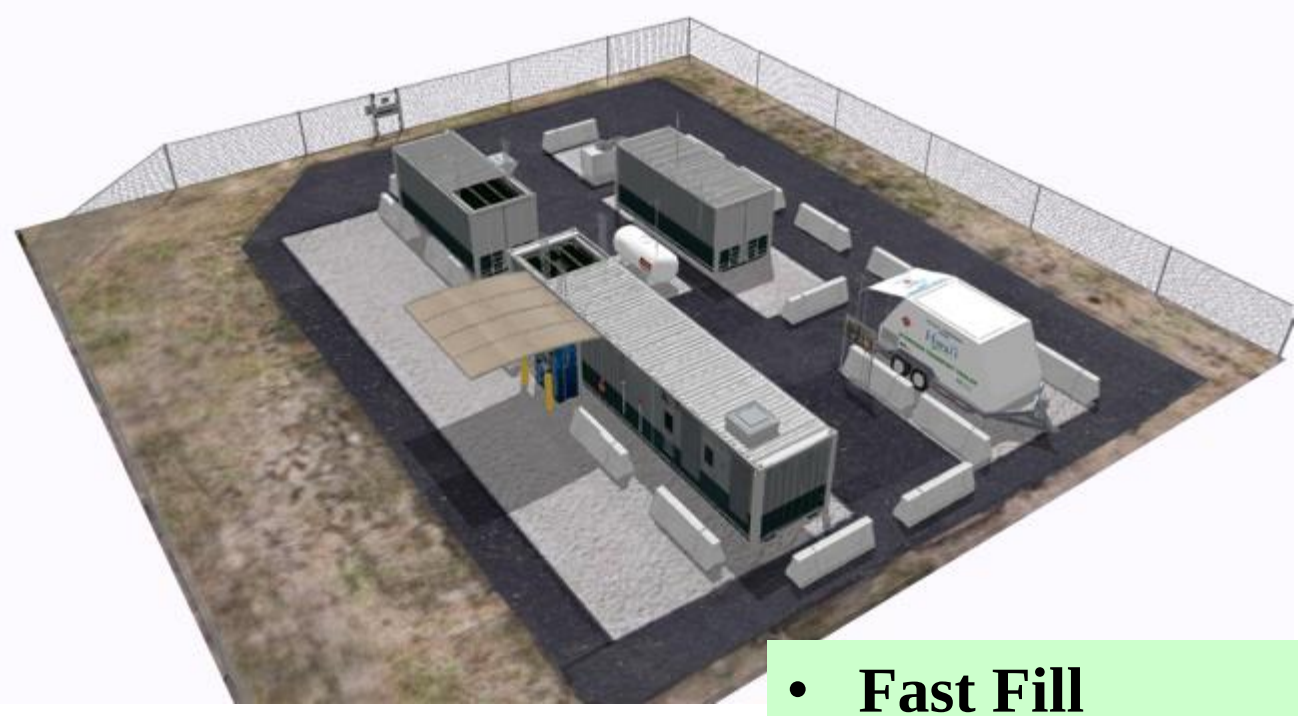
MCBH Hydrogen 350/700 Bar Station



- **Fast Fill**
- **Unattended Operation**
- **Remote Monitoring**
- **Automatic shut down**

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Honolulu Airport Rental Car Bus Fleet

- ✓ **2018 - State DoT operate fleet of 8 transit & 8 shuttle fuel cell buses at HNL airport.**
- ✓ **State provides land at airport**
- ✓ **HCATT/Air Force provide 65 kg/day electrolyzer station**
- ✓ **Private Partner to provide renewable energy source to make H2 and build station & storage**
- ✓ **2016 - $1.2 million in state funds approved for design**

Hawaii Air National Guard F-22 Campus

- ✓ **Energy Storage**
  - ➢ **40% hydrogen**
  - ➢ **30% battery**
  - ➢ **30% TBD**
- ✓ **Goal**
  - ➢ **100% hydrogen flight line**

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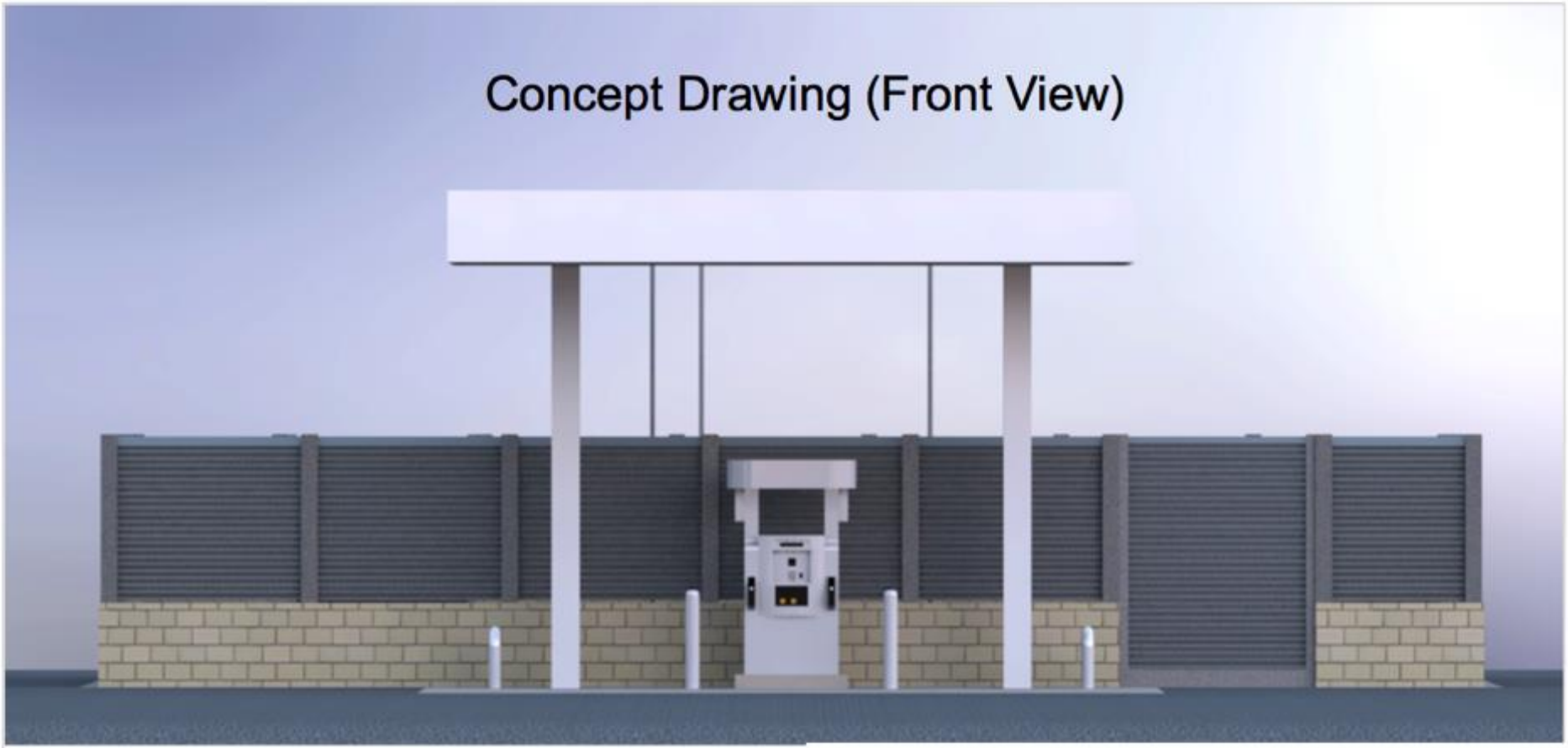
hcatt

SERVCO PACIFIC: TOYOTA MIRAI

- Toyota begins FCV development in 1992
- Sevco begins Mirai distribution discussion with Toyota in 2012
- Mirai goes on sale in Japan in December 2014
- Mirai authorized by Toyota in only 2 US States: CA and HI
- Servco has been using the Mirai to promote hydrogen vehicles and hydrogen infrastructure in Hawaii

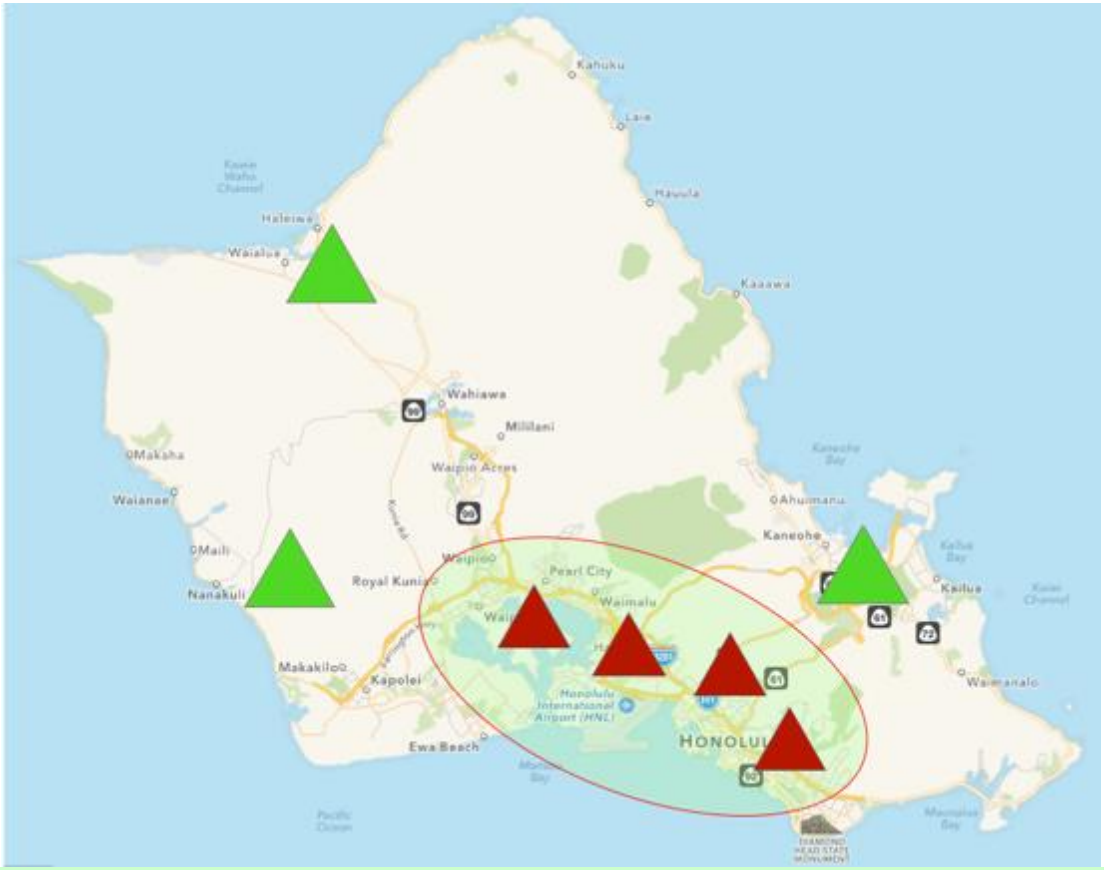
Servco CEO Mark Fukunaga and Hawaii Governor David Ige

SERVCO'S HYDROGEN PRODUCTION AND DISPENSING MINI-STATION



- H35 & H70 Dispensing
- On-site Electrolysis hydrogen production
- 22kg design daily usage
- Target commissioning: January 2017

Oahu Hydrogen Stations



7 hydrogen stations could provide enough hydrogen island-wide for the first 5 - 10 years of passenger vehicle market growth

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Central Site Production/Distributed Dispensing

Economically viable electrolytic hydrogen will require low cost electricity + high capital utilization.

- ✓ **Central site production for highest capital utilization;**
- ✓ **Distributed dispensing sites with minimum complexity to reduce fuel distribution costs;**
- ✓ **Optimize additional revenue streams from:**
  - ➢ **Monetizing ancillary services;**
  - ➢ **Sale of hydrogen for transportation**

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Big Island Buses & Hydrogen Transport Trailers

County of Hawaii Bus (1)

HAVO Buses (2)

Hydrogen Transport Trailers (3)

- **Fuel Cell Electric Hybrid Shuttle Buses demonstrate to the general public the advantages of fuel cell buses and electric drive.**
  - **Quiet ride**
  - **No diesel fumes.**
  - **Potential for lower O&M costs (need low cost hydrogen);**
- **Hydrogen Transport Trailer carries 105 kg @ 450 bar. They will demonstrate distributed dispensing using cascade fill to 350 bar using a "Smart" dispenser.**

NELHA Hydrogen Plant

Governor David Ige Reviewing NELHA H2 Station Plans

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HAVO 350 Bar Dispensing Station

- **Drag & Drop "Computer Controlled" Tube Trailers.**
- **Cascade Fill**
- **Boost compressor captures 95% of H2**
- **Unattended Operation**
- **Remote Monitoring**
- **Automatic shut down**

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Must Keep Community Informed

- ✓ Need to justify investment of taxpayer dollars to the taxpayer;
- ✓ Public needs to see an immediate benefit to them:
  - ➢ Public transportation vs. perception of supporting "rich man's toys";
  - ➢ Leverage public infrastructure for private transportation for early adopters.
- ✓ Workforce development for the new jobs created;
- ✓ First Responder training. Helps address safety concerns;
- ✓ Legal and insurance industries need to be educated;
- ✓ Active public outreach campaign

BACKUP SLIDES

2010 to 2020 Renewable Hydrogen Plan

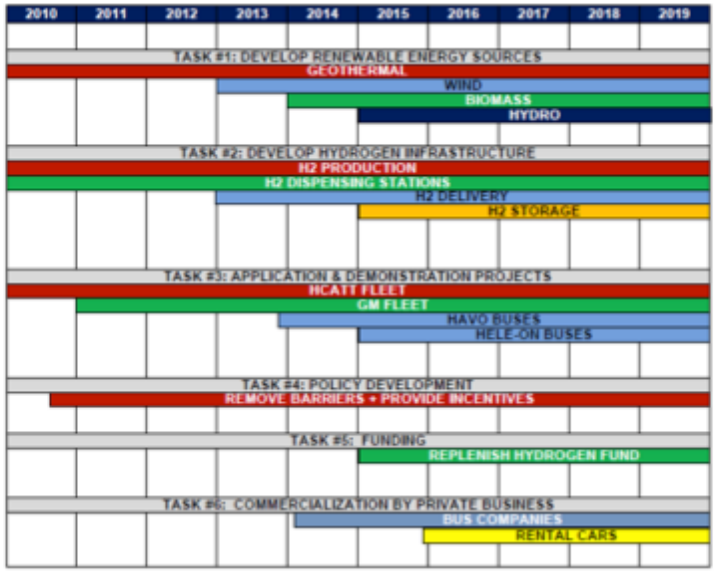
Critical Success Factors

- Rising oil prices stimulate the search for alternatives
- Public support for protecting the environment
- Availability of primary renewable energy sources
- General Motors roll-out in Hawaii
- Toyota Roll-out in Hawaii
- Private industry recognizing business opportunities
- Political will and leadership
- Dedicated funding

START

2010

- HCEI
- 1 Oahu Gas Station
- Several supportive policies
- 4 Large-scale demo projects
  - HCATT
  - H2 Power Park
  - Renewable H2
  - GM FCV Rollout



TARGETS

2020

- Fleet of 5,000 FCVs
- 3 major car companies
- 10 Oahu gas stations
- 10 Hawaii gas stations
- 1 Geothermal hydrogen plant
- 2 Wind Hydrogen Plants
- 1 FCV Rental car company
- 50 H2 buses Oahu & BI
- Near-commercial H2 distribution

Challenges

- Economic viability
- Large investment required to build H2 infrastructure
- Renewable energy sources need to be developed on a large scale
- Transportation applications need to be economically viable
- Legislative funding needs to be consistent
- Sense of urgency
- Barriers and inertia hard to overcome

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HI H2 Plan: Major Tasks

Task #1: Develop Large-Scale Renewable Energy Sources:

- **Geothermal, solar, wind, hydro and biomass.**

Task #2: Develop Hydrogen Infrastructure

- **Hydrogen Production, storage, delivery, dispensing stations**

Task #3: Support Application & Demonstration Projects

Task #4: Policy Development

Task #5: Funding

Task #6: Commercialization by Private Business

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Hydrogen Investment Capital Special Fund (HRS 211F-5.7)

- ✓**Objectives:**
  - **Provide seed capital and venture capital for private and federal projects for research, development, & testing;**
  - **Implement the Hawaii Renewable Hydrogen Program;**
  - **Any other purpose deemed necessary to carry out the purposes of the Hawaii Renewable Hydrogen Program.**
- ✓**Sources of Funds**
  - **Appropriations made by the legislature;**
  - **Contributions from public or private partners;**
  - **All interest earned on or accrued to moneys deposited in the special fund.**

Barrel Tax (HRS 243-3.5)

- ✓ **Enacted in 2010**
- ✓ **$1.05 per barrel of oil excluding air transportation;**
- ✓ **Generates ~$27 million per year;**
- ✓ **60% goes to General Fund;**
- ✓ **40% goes to:**
  - ➢ **Oil Spill emergency clean-up fund**
  - ➢ **State energy office**
  - ➢ **State Department of Agriculture**
  - ➢ **Energy Systems Development Special Fund (HNEI)**
- ✓ **Hydrogen projects have received funding from HNEI allocation;**
- ✓ **Potential source for Hydrogen Fund replenishment.**

Need to make a compelling case

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Hydrogen Program Needs to be Cost Effective

- **Program needs to be seen as providing cost effective solutions/benefits:**
  - **What problems can hydrogen fix?**
  - **Is it affordable?**
- **Competing for scarce resources:**
  - **Long term vs. short term;**
  - **Do we fund hydrogen or air conditioners for schools? The kids are suffering today!**
- **Need success stories;**
  - **Technology validated;**
  - **Affordable.**
- **Need champions.**

Scale Introduces Many Challenges

- ✓ **Resources - land use issues - competing use of resources e.g. electricity vs fuel, food vs fuel, etc.**
- ✓ **Political will - supportive policy (HCEI)**
- ✓ **Community support - permitting (DBEDT)**
- ✓ **Financing – strategic partners**
- ✓ **Technologies constantly changing/improving**
  - ➢ **Strategic projects to validate viability**
  - ➢ **Energy infrastructure is very capital intensive**
  - ➢ **"Almost There" is not sufficient to attract private investment, complicates planning process**

Primary Resource Needs (H2-FC)

- **Biomass to Hydrogen**
  - **Sustainable growth at 20 dry tons per acre**
  - **Hydrogen yield, 70 kg/dry ton(NREL)**
- **Electricity to Hydrogen**
  - **36kw-hr/kg thermodynamic limit**
  - **60% efficient to compressed H2**
- **Assume H2-FC vehicles 2x efficiency of current vehicle fleet.**
- **Displacement of 20% of ground transportation fuel**
  - **100 million gal liquid fuel ~ 50 million kg H2)**
  - **35,000 acres "good" agricultural land (dedicated HC&S), or**
  - **3000 GW-hrs/yr of electricity (~30% of current state electrical generation)**

Scale of need requires portfolio of solutions

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