

UHERO

THE UNIVERSITY HAWAII CENTER FOR ENERGY AND RESOURCES  
OF THE UNIVERSITY OF HAWAII

ENERGY AND GREENHOUSE GAS  
SOLUTIONS PROGRAM

# HAWAII'S ENERGY POLICY AND ROLE OF BIOFUELS

KANAE TOKUNAGA

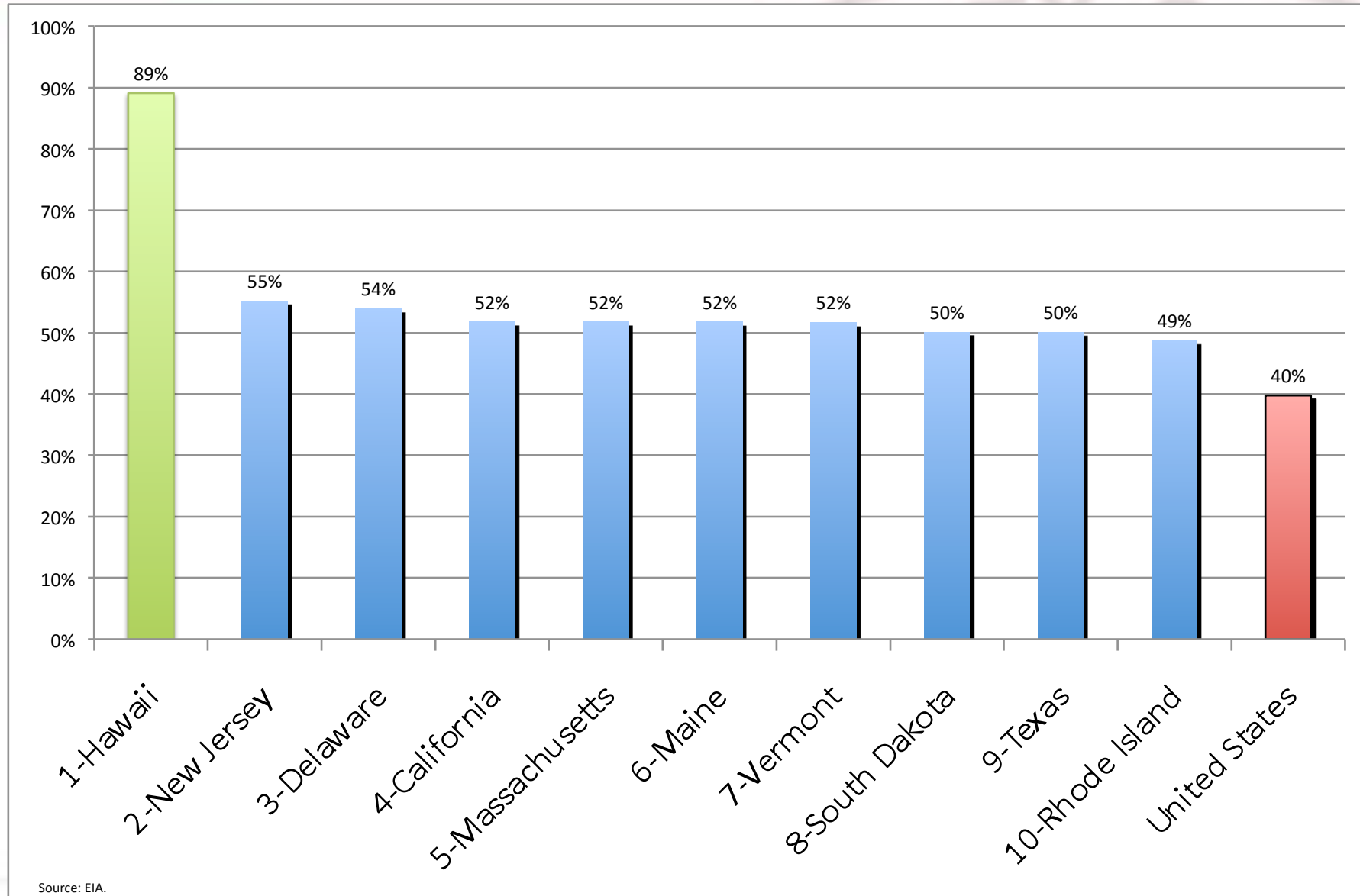
NORTHEAST ASIA ECONOMIC FORUM  
YOUNG LEADERS PROGRAM

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# HAWAI'I IS NO. 1!

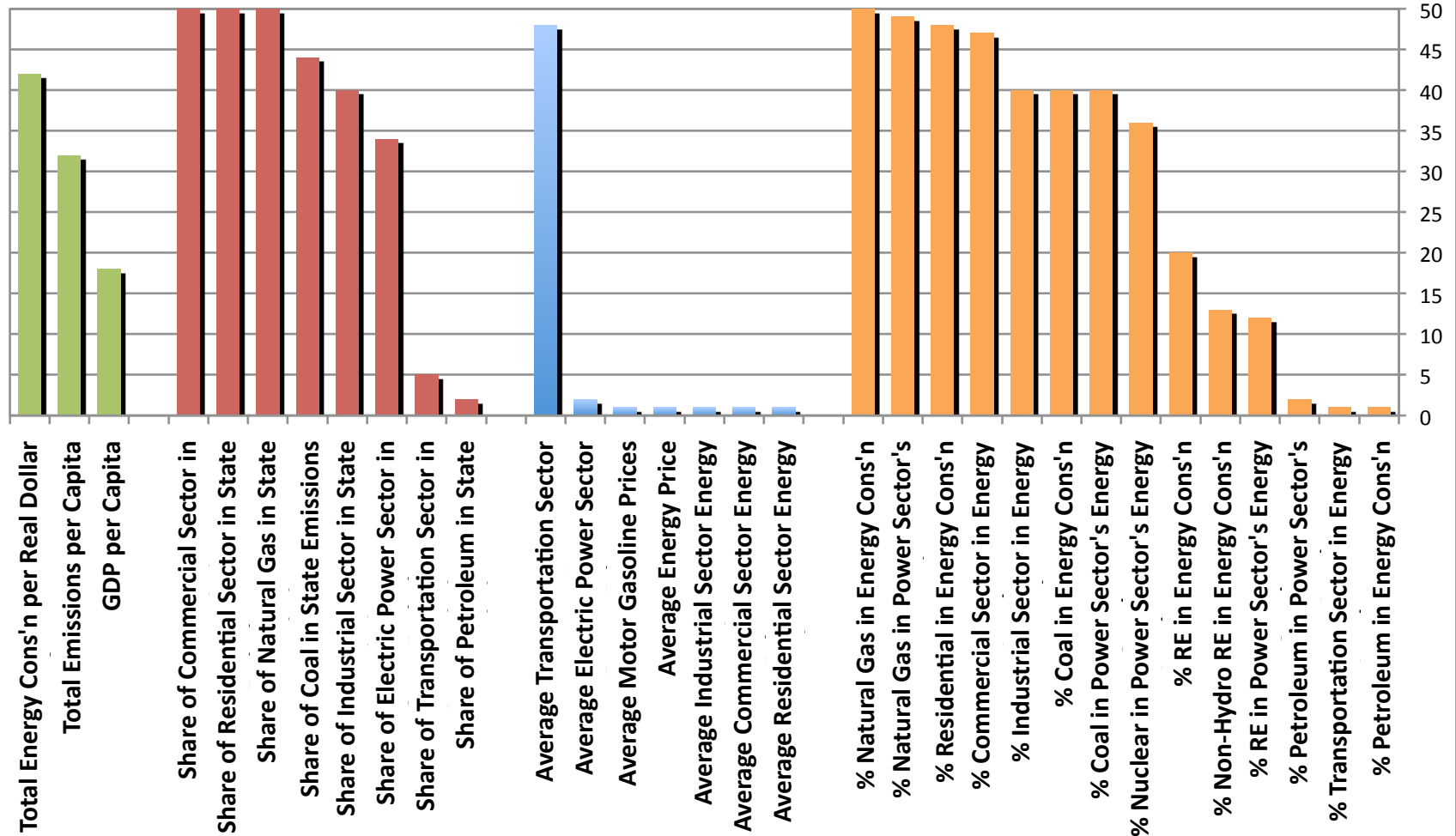


# SHARE OF PETROLEUM SHARE OF PETROLEUM IN TOTAL ENERGY CONSUMPTION, 2007



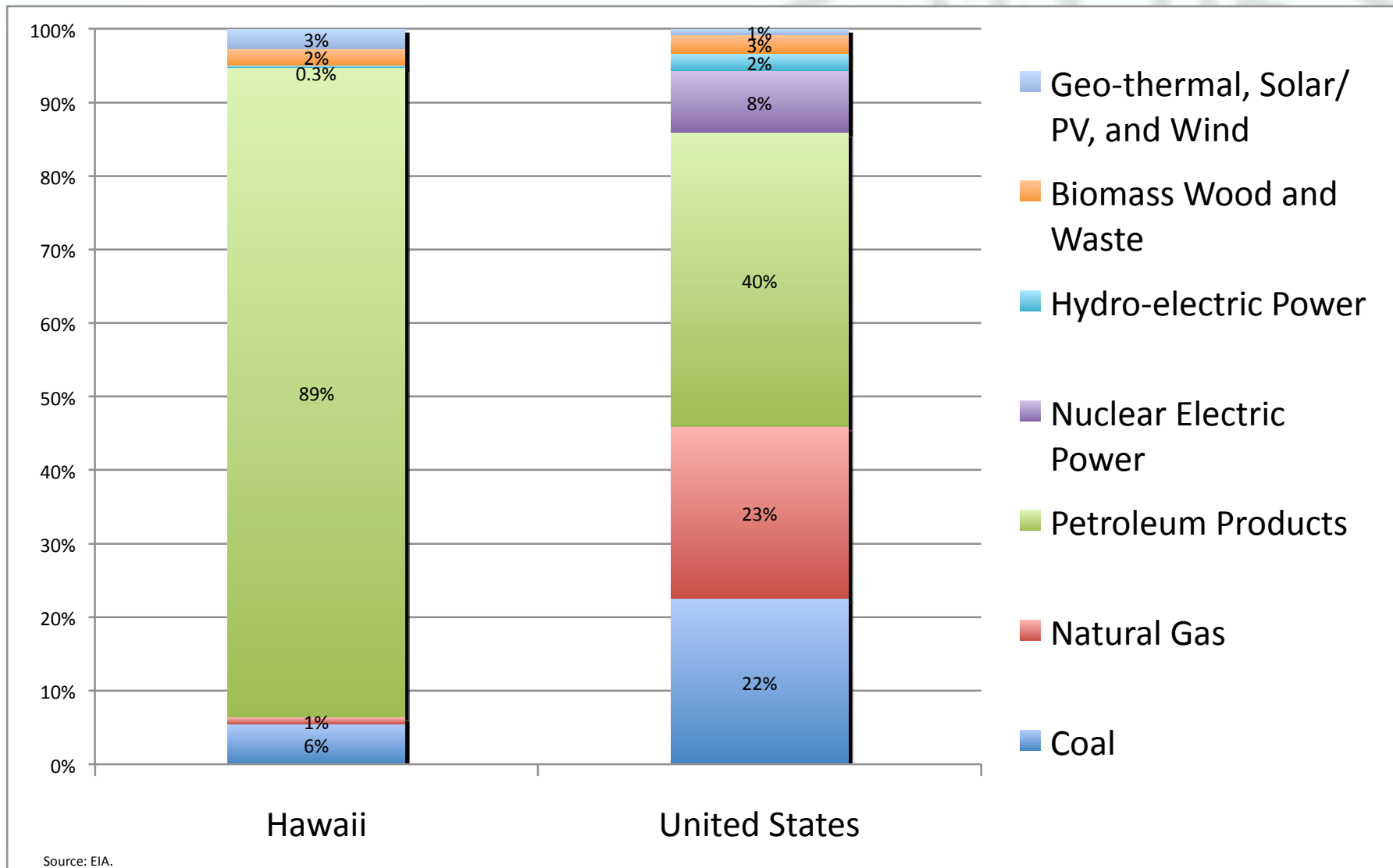
Source: EIA.

# STATE OF HAWAII'S RANKING AMONG 50 STATES



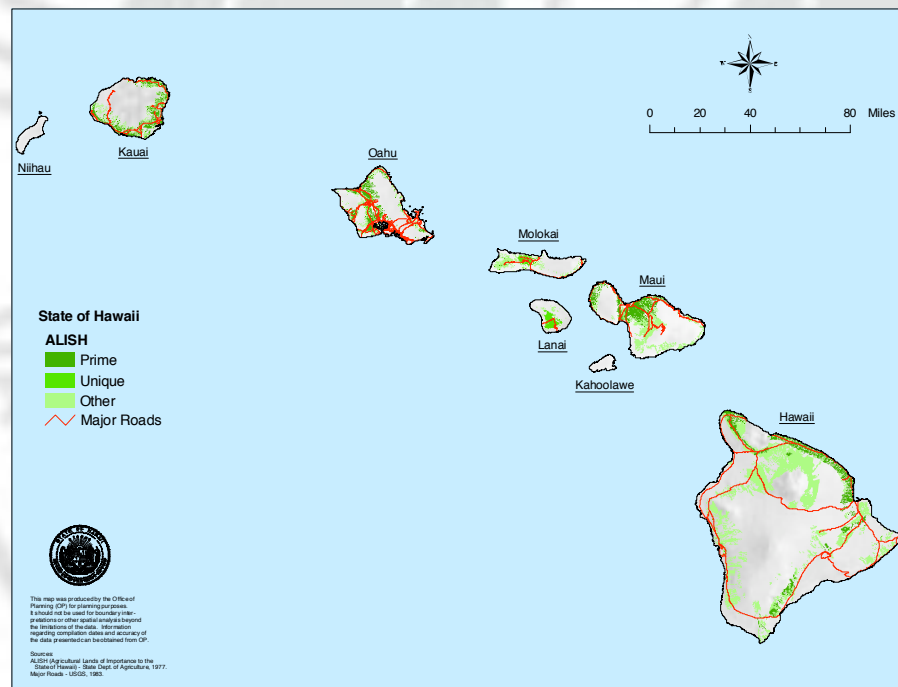
Source: EIA, 2007.

# SHARE OF DIFFERENT TYPES OF ENERGY IN TOTAL ENERGY CONSUMPTION, 2007



# SOME CHARACTERISTICS

- Heavy reliance on oil
- Oil as primary source for electricity production
- Isolated grid



# HISTORICAL CONTEXT



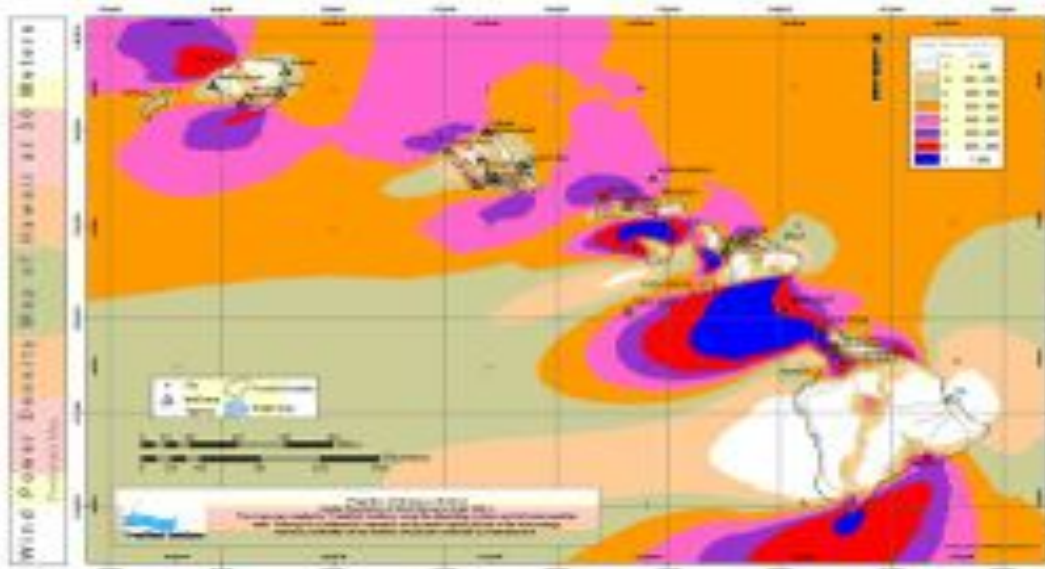
## KEY LEGISLATIONS

- **Hawai'i Global Warming Solutions Act (2007)** – GHG levels to the level of 1990 by 2020
- **Hawai'i Clean Energy Initiative (HCEI) (2008)** – 70% clean energy by 2030, 40% RPS and 30% Energy Efficiency
- **Barrel Tax (2010)** – Barrel tax on petroleum products





# WIND



# SOLAR



# BIOFUELS

## Hawaiian Electric Company Corporate Sustainability Report (2010)

### Moving FORWARD

The Hawaiian Electric companies are continuing to progress toward a clean energy future through valuable partnerships and new initiatives.

#### Biofuels

Liquid biofuels provide a source of renewable energy that can be readily used in existing generation facilities. Rather than abandoning decades of assets of existing facilities and building from scratch, resources can be re-used by switching from "black" oil to "green" biofuels made from biomass, agricultural animal fat, waste oil, and other energy crops.



# BIOFUELS



Source: Hawaii Bioenergy Master Plan – Bioenergy Technology, p3

# HAWAII BIOENERGY MASTER PLAN

- Outcome I: Evaluation of Hawai'i's potential to rely on biofuels as a significant renewable energy resource
- Outcome II: A plan or roadmap to implement commercially viable biofuels development
- OUTCOME III – Strategic partnerships for the research, development, testing, and deployment of renewable biofuel technologies and production of biomass crops
- OUTCOME IV - Biofuels Demonstration Projects
- OUTCOME V – Promotion of Hawai'i's Renewable Biofuels Resources to Potential Partners and Investors for Development in Hawai'i as Well as for Export Purposes



“Act 253: “The primary objective of the bioenergy master plan shall (be to) develop a Hawaii renewable biofuels program to manage the State’s transition to energy self-sufficiency based in part on biofuels for power generation and transportation.”

The background features a large, faded watermark of the University of Hawaii seal. The seal is circular and contains a central torch with a flame, set against a grid. The text "UNIVERSITY OF HAWAII" is visible at the top, and "UA MAU KE EA O KA AINA I KA PONO" is at the bottom. The year "1907" is also present.

# Life Cycle Analysis of Biofuels: Implementation in the State of Hawai'i

# WHAT IS LIFE CYCLE ANALYSIS?



*Source: U.S. Dept. of Energy National Biofuels Action Plan, October 2008*

## FUEL REPLACEMENT SCENARIOS

- ***Scenario 1 - 20% renewable fuel and diesel oil replacement. Displaces 1.88 MM Bbl of residual fuel oil with 2 MM Bbl of renewable fuel oil and displaces 0.55 MM Bbl of diesel with 0.58 MM Bbl of biodiesel***
- ***Scenario 2 - 100% residual fuel and diesel oil replacement. Displaces 9.36 MM Bbl residual fuel oil with 10 MM Bbl of renewable fuel oil and 2.69 MM Bbl of diesel with 2.9 MM Bbl of biodiesel.***

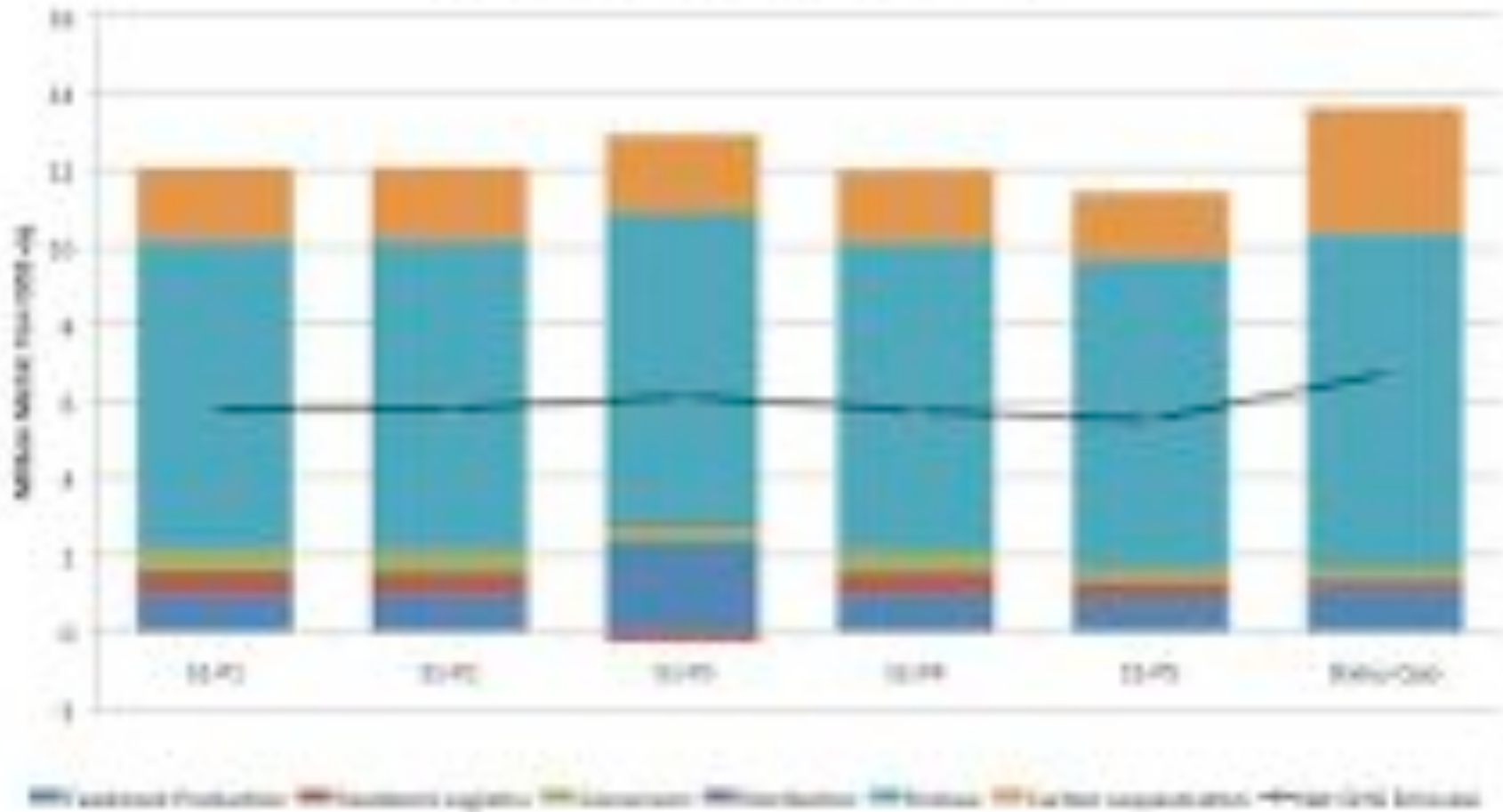


# PATHWAY SCENARIOS

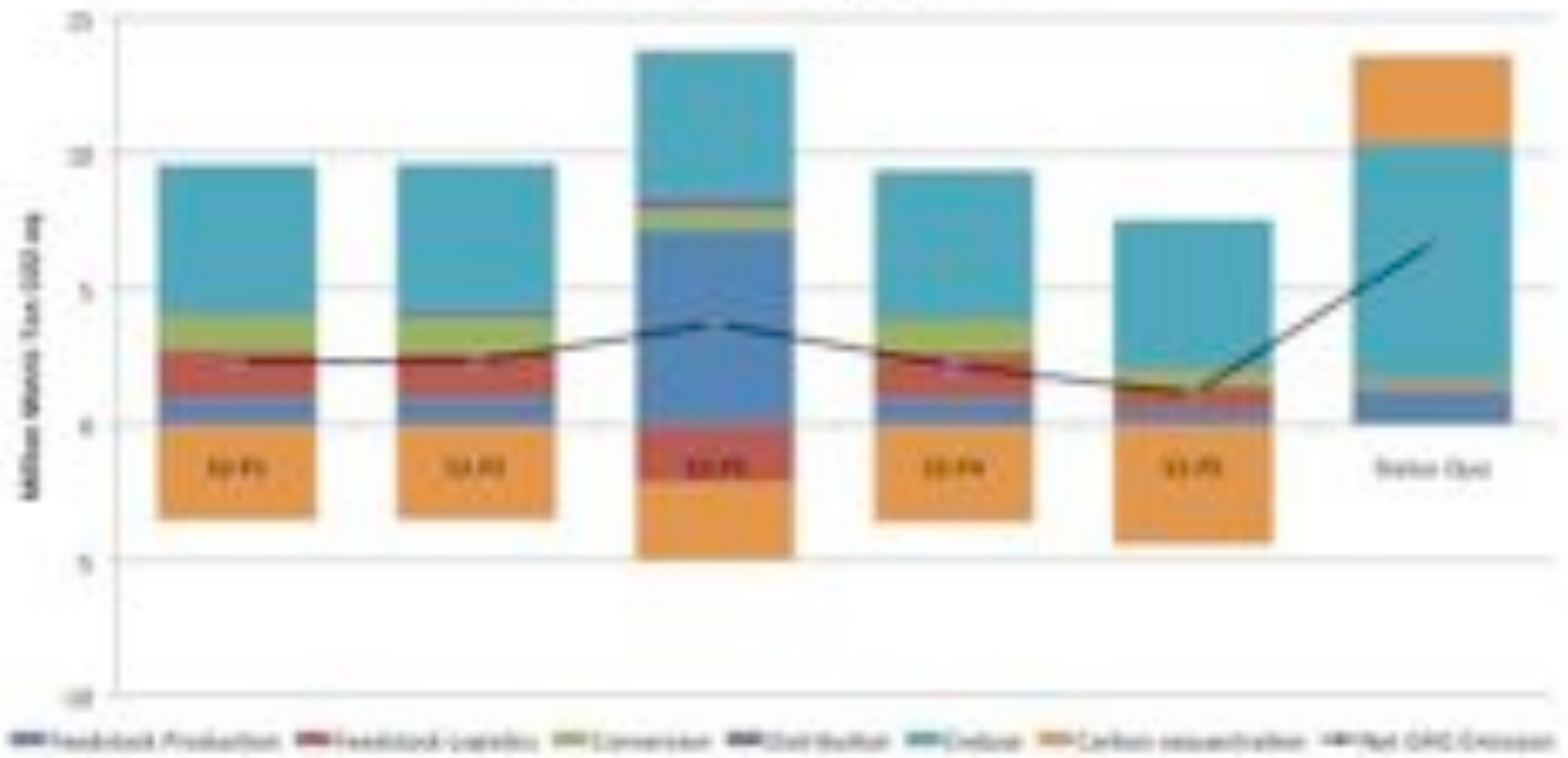
	Crop	Value Chain Activity Locale				
		Production	Logistics	Conversion	Distribution	End-use
Pathway 1	Oil Palm	Malaysia	Malaysia	Hawai'i	Hawai'i	Hawai'i
Pathway 2	Oil Palm	Malaysia	Malaysia	Malaysia	Hawai'i	Hawai'i
Pathway 3	Soybean	US Mainland	US Mainland	US Mainland	Hawai'i	Hawai'i
Pathway 4	Oil Palm	Hawai'i	Hawai'i	Hawai'i	Hawai'i	Hawai'i
Pathway 5	Jatropha	Hawai'i	Hawai'i	Hawai'i	Hawai'i	Hawai'i



30% Diesel and Residual Fuel Oil Substitution



### 100% Diesel and Residual Fuel-Oil Substitution



## REDUCTION IN EMISSIONS AND OIL IMPORTS IN THE ELECTRICITY SECTOR UNDER DIFFERENT PATHWAYS AND SCENARIOS

Scenario	Pathway	Emission Reduction (MM MT CO <sub>2</sub> -eq)	Oil Imports Reduction (MM Bbl)	Emission Reduction compared to Petroleum (%)
Scenario 1: 20% Residual Fuel and Diesel Oil Replacement	<b>Oil Palm</b> , imports crude (Malaysia)	1.24	3.79	13.70
	<b>Oil Palm</b> , imports final product (Malaysia)	1.23	3.79	13.67
	<b>Soybean</b> (US Mainland)	0.78	3.79	8.87
	<b>Soybean</b> , excludes soy meal credit (US Mainland)	0.21	3.79	3.32
	<b>Oil Palm</b> (Local)	1.28	1.97	14.19
	<b>Jatropha</b> (Local)	1.7	2.81	17.91
	Scenario 2: 100% Residual Fuel and Diesel Oil Replacement	<b>Oil Palm</b> , imports crude (Malaysia)	5.99	18.9
<b>Oil Palm</b> , imports final product (Malaysia)		5.98	18.9	65.64
<b>Soybean</b> (US Mainland)		3.92	18.9	44.47
<b>Soybean</b> , excludes soy meal credit (US Mainland)		1.05	18.9	16.72
<b>Oil Palm</b> (Local)		6.21	9.83	67.81
<b>Jatropha</b> (Local)		8.04	14.0	83.07

# EMISSION FACTORS FOR DIFFERENT STAGES OF FUEL PROCESSING

g CO<sub>2</sub>-eq/MJ

Pathway	Feedstock Production	Feedstock Logistics	Conversion	Distribution	End-use (Net)	Net GHG Emissions	Ratio to Oil
Oil Palm, import crude (Malaysia)	8.1	15.6	10.4	1	0.2	35.3	0.40
Oil Palm, import final product (Malaysia)	8.1	14.7	10.4	2.1	0.2	35.4	0.40
Soybean (US Mainland)	61.8	-18.4	5.9	3.7	0.2	53.2	0.60
Soybean, exclude soy meal credit (US Mainland)	61.8	7	5.9	3.7	0.2	78.6	0.89
Oil Palm (Local)	8.1	14.7	10.4	0.1	0.2	33.4	0.38
Jatropha (Local)	4.4	7.6	5.9	0.1	0.2	18.1	0.20
Petroleum Products	8.5	2.3	2.4	0.1	74.9	88.2	1

## CONCLUSION

- **Production phase of the life cycle is the key**
- **Transportation of the fuel contributes to only small amount of emissions**
- **Waxman-Markey legislation estimated carbon prices to range from \$20/mt of CO<sub>2</sub>e to \$85 in 2005USDs from 2020 to 2050 (US-EPA, 2009).**
- **Using the high end of the range means that the additional 2% reduction in emissions from producing biofuels in Hawai'i equates to about a \$0.18/MMBtu cost savings.**

# AGRICULTURAL LAND SCARCE

## Hawaiian grown biocrop energy yield and potential

Biocrop/Water Source	Yield (MMBtu/ha)	Energy Potential BioEnergy Master Plan Optimistic (MM Bbl)	Energy Potential Using All Plantation Lands (MM Bbl)
Oil Palm/rain fed	66	0.24	0.62
Oil Palm/irrigated	88	0.32	0.82
Jatropha/rain fed	33	0.12	0.31
Jatropha/irrigated	85	0.31	0.79

Even if all plantation lands were irrigated and used for growing feedstock crops, the land would produce **less than one million barrels** of biofuels

## NEXT STEP

- **A cost-benefit analysis**
- **An impact assessment of monetizing GHG emission reductions from substituting biofuels - i.e. attaching a price on carbon.**
- **An evaluation of land-use change elements that would not only include resulting GHG emissions, but also added value from preserving or increasing open lands.**



# WHY DO WE CARE?

**Hawai'i's economy  
stands on beautiful  
nature**



**liwi honeycreeper**

**Mahalo!**