Island/Tropical Supply Chain Development for Sustainable Aviation Fuel

Lessons learned & Next Steps:

The Aloha Carbon Project

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Hawaii's Energy Picture
At CAAFI Launch in 2008

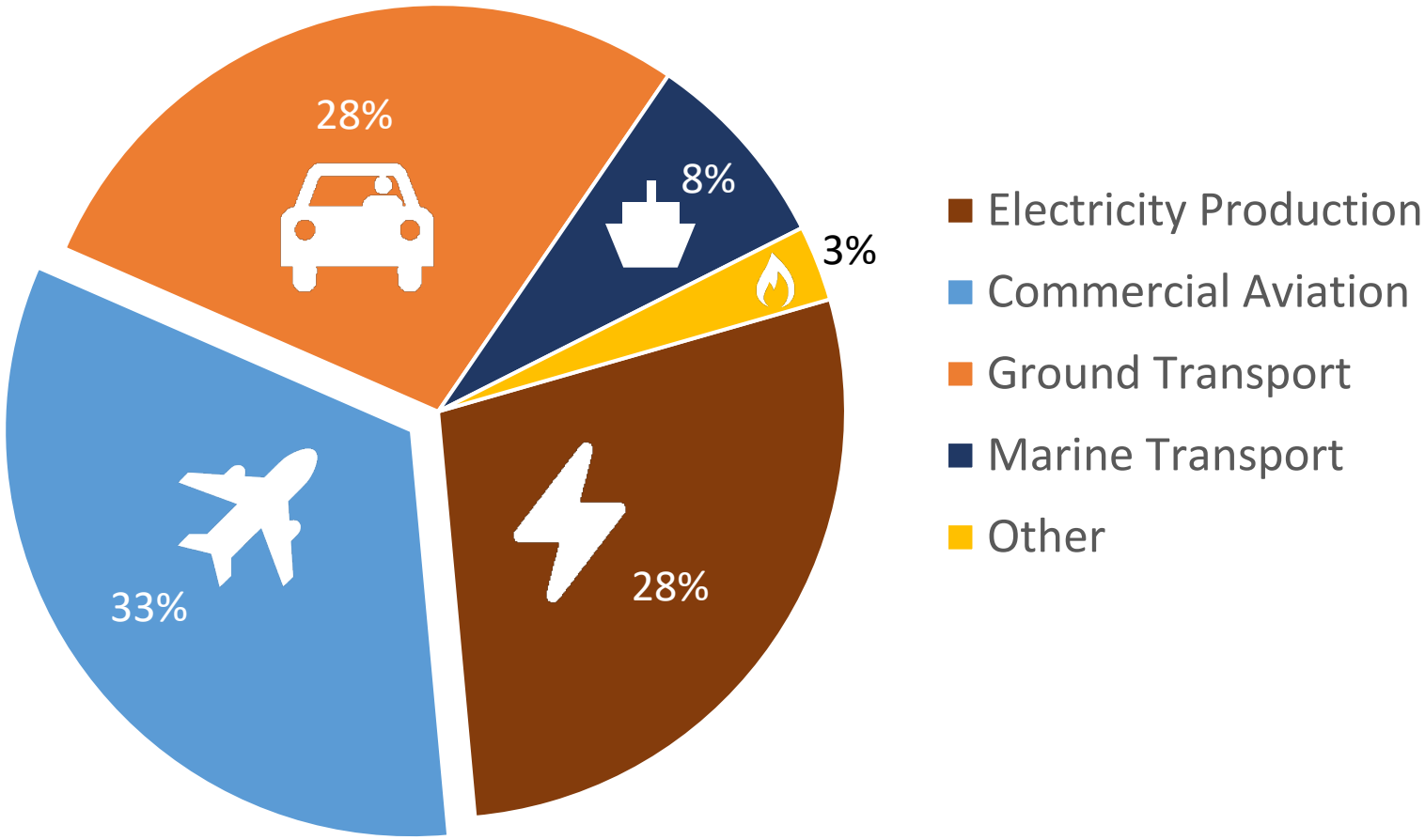

Next Stop
2600 miles

Why SAF is Important:
Annual Visitor Arrivals by Mode

Data sources: Hawaii Tourism Authority Annual Visitor Research Report 2018

Arriving…. Image by: Ian Charleton (2016) via Flickr

Hawaii's Petroleum Use by Sector



Analysis of 2016 data by Joelle Simonpietri, Hawaii Natural Energy Institute from sources: Hawaii Department of Business, Economic Development, and Tourism; Defense Logistics Agency for Energy Pacific

Feedstocks Evaluated for SAF 2008-2022

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2008-2018: Agricultural Crops

- Sugarcane bagasse
- Microalgae
- Tropical Oilseeds
  - Jatropha
  - Pongamia
- Energy Cane
- Tropical timber
- Pineapple waste

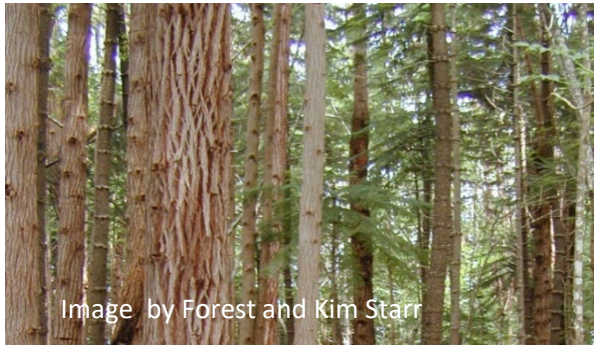
2018 – Today: Wastes

- Municipal Solid Waste
- Construction and demolition debris
- Greenwaste & invasive species
- Wastewater treatment waste

Hawaii Feedstock Readiness Levels as of 2012

High (6-9)

Now: Algae, energy cane, crop residues, tropical oilseeds



FSRL: 7 Timber: 10MGY from eucalyptus plantations

FSRL: 7 Energy Cane: 16MGY from abandoned sugar cane land

FSRL: 7 ??MGY from Produce Waste

Low (1-5)

Future: Algae, energy cane, inedible tropical oilseeds

FSRL: 4

FSRL: 5

FSRL: 3

FSRL: 4

Energy Cane

Jatropha

Pongamia

Sunflower

Kauai Algae Demonstration Facility

Images courtesy of Dr. Dave Hazlebeck, Global Algae Innovations

GLOBAL ALGAE INNOVATIONS

But at the same time
on these islands
(and many others)..

Tourism grows to be largest sector of the economy

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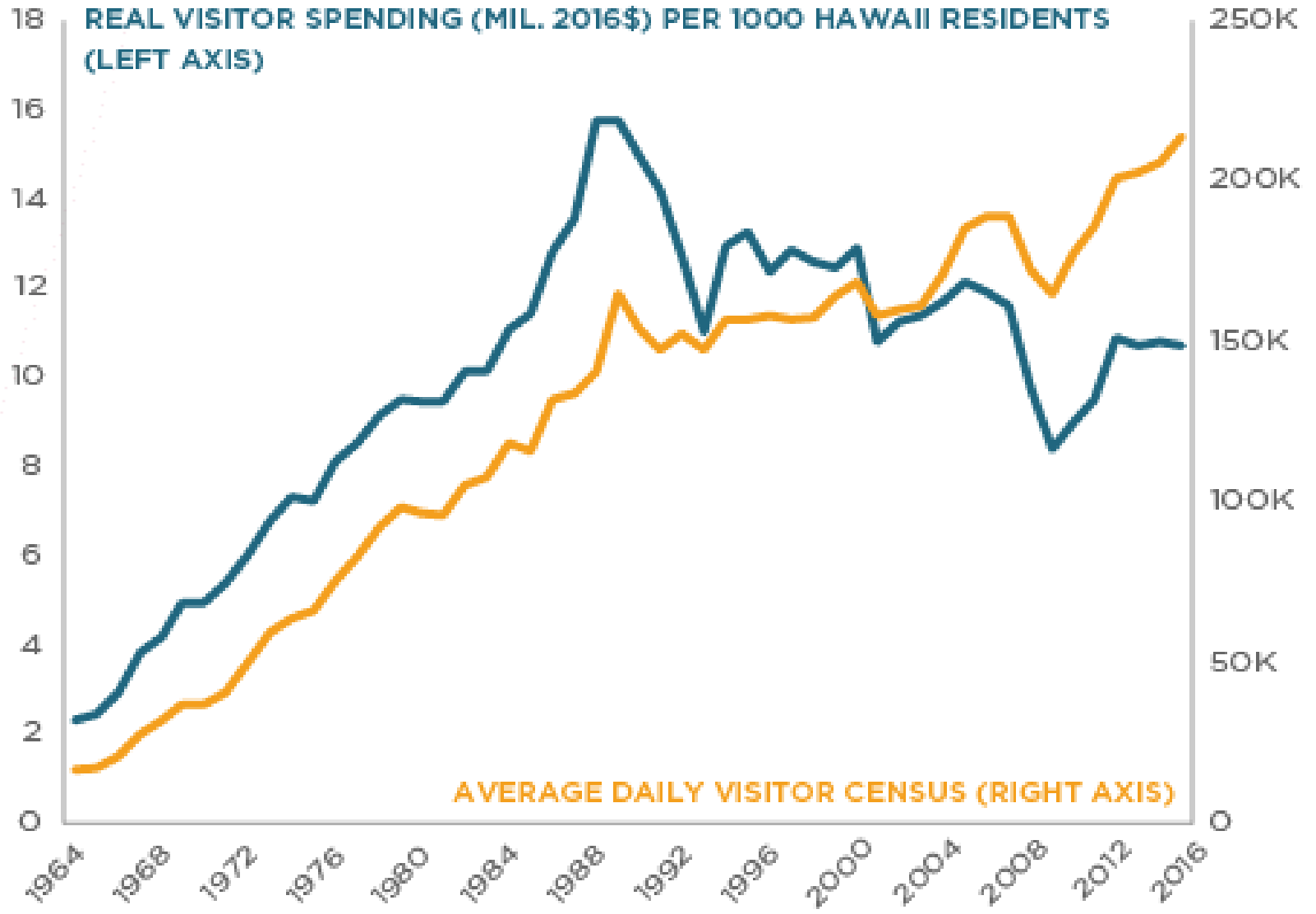

Dr James Mak: Jan 2017 https://uhero.hawaii.edu/how-many-tourists-is-too-many/

While monocrop agriculture of the colonial era dies

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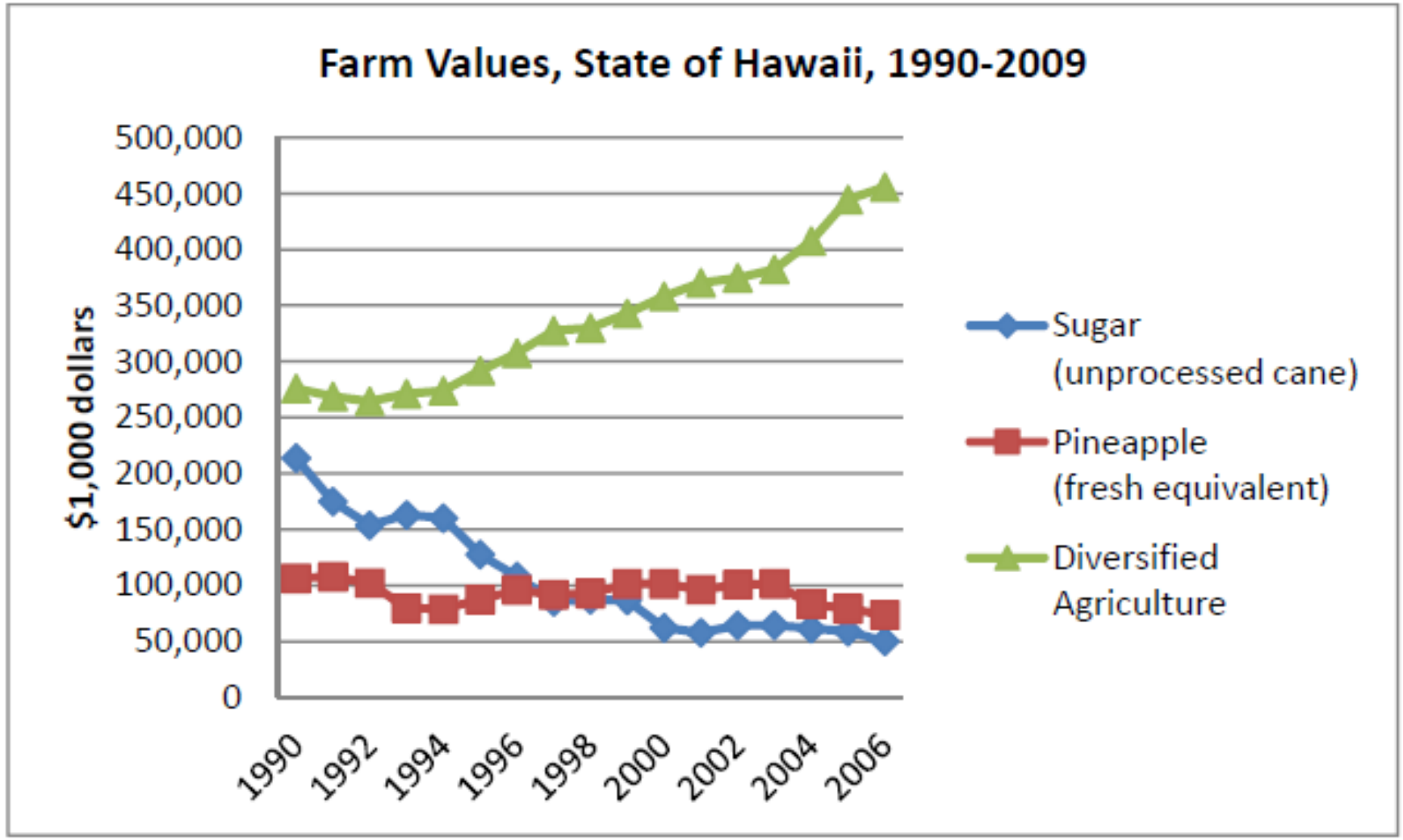
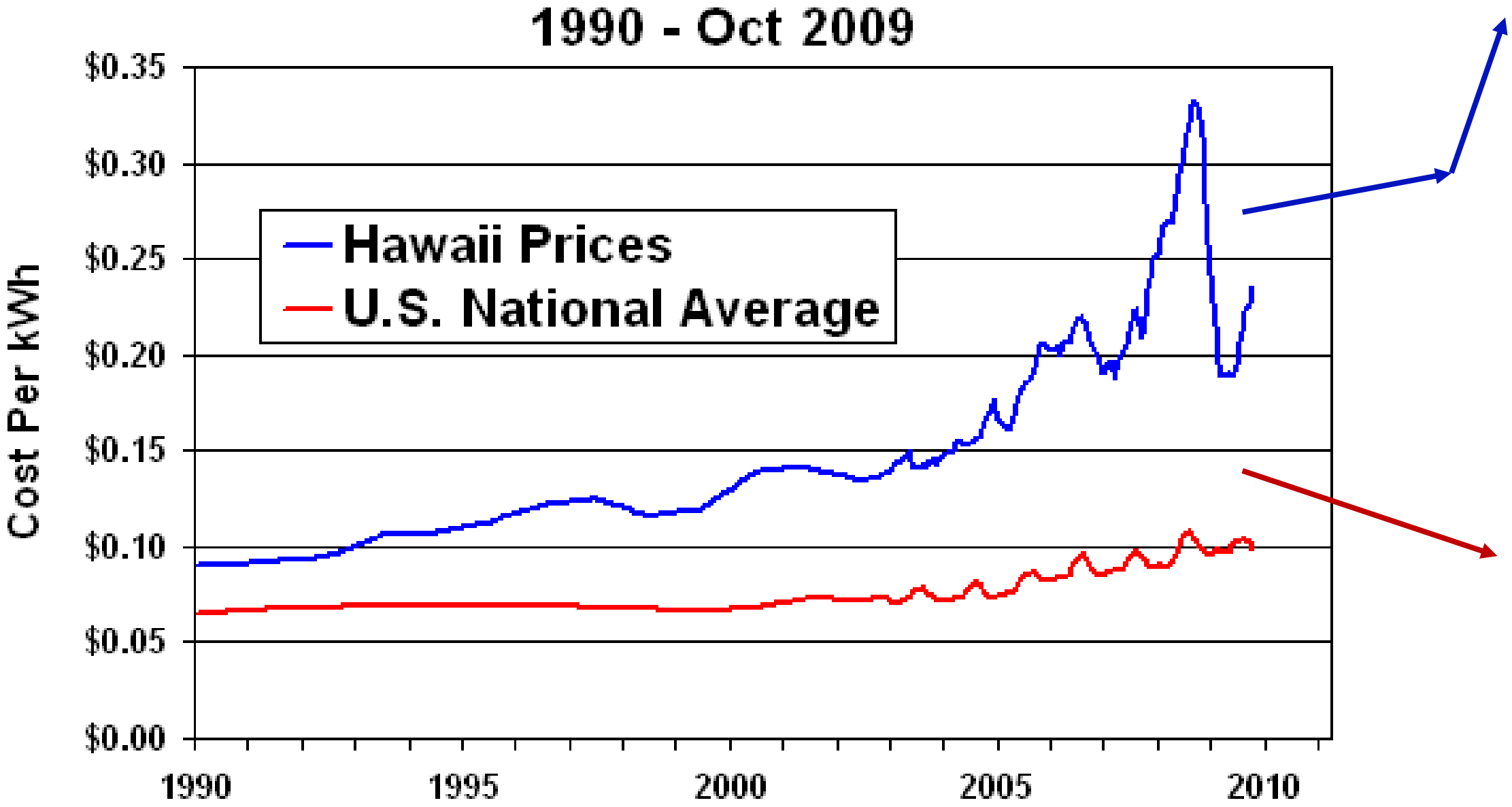


(Adapted from data the Statistics of Hawaii Agriculture prepared by the Hawaii Department of Agriculture, 1990-2006).

Electricity Prices grow to be 10X the U.S Average




Kū Kiai Kahuku
TOO BIG
TOO CLOSE
ADLF MONSTER
TURBINES

Need to address Climate, Waste, AND community issues

This pile is just one day of the C&D waste wood landfilled on Oahu daily.

It needs to be properly handled and recycled/disposed somewhere.
We could divert approximately 40% to make fuel, and reduce the impact of the waste hauling and disposal on the Nanakuli and Waianae coast communities communities.

Restoration of traditional Hawaiian agricultural practices

PACIFIC BUSINESS NEWS

Hawaiian Commercial and Sugar operation to be auctioned off in January

An aerial view of the HC&S plantation.

By Duane Shimogawa – Reporter, Pacific Business News
Dec 29, 2016, 3:00pm HST **Updated** Dec 29, 2016, 10:51pm EST

IN THIS ARTICLE

- Agriculture — Topic
- Chris Benjamin — Person
- Commercial Real Estate — Industry
- John Deere — Person
- Manufacturing — Industry
- Rick Volner — Person

Hawaiian Commercial & Sugar Co.'s 36,000-acre plantation on Maui, which closed last week and effectively ended the era of the sugar industry in Hawaii, is auctioning off its equipment and items, Pacific Business News has learned.

Great American Group, on behalf of the Alexander & Baldwin Inc. subsidiary, is holding a live online and on-site auction from Jan. 18-19, starting at 10 a.m. each day.

The auction includes more than 450 pieces of equipment, machinery, pick-up trucks, trailers, construction equipment and agriculture equipment by manufacturers such as CAT, John Deere, Hitachi, Peterbilt, Ford and Toyota.

Agricultural land is converted to resident and visitor housing

The remaining agriculture and conservation land is overrun by invasive species

Feedstocks Evaluated for SAF 2008-2022

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2008-2018: Agricultural Crops

- ~~Sugarcane bagasse~~
- ~~Microalgae~~
- ~~Tropical Oilseeds~~
  - ~~Jatropha~~
  - ~~Pongamia~~
  - Sunflower
- ~~Energy Cane~~
- ~~Tropical timber~~
- ~~Pineapple waste~~

2018 – Today: Wastes

- ~~Municipal Solid Waste~~ (Electricity)
- Construction and demolition debris
- Greenwaste & invasive species
- ~~Wastewater treatment~~ (RNG) waste
- Diversified crop waste

So bringing all those lessons learned together for a supply chain for SAF…

~2000 tons of C&D waste landfilled each day on Oahu

- ❑ Nearly the same amount as the waste combusted to make electricity at H-Power
- ❑ Landfill is deeply unpopular, located near Hawaiian Homestead areas in Nanakuli
- ❑ Act 74 bans waste landfilling within ½ mile of residences effective 15 Sep 2020
- ❑ Oahu needs a safe alternative for disposal, or illegal dumping goes up 8-10X

Which is not a unique challenge to Hawaii:

>560 million tons of C&D waste landfilled each year in the U.S.A.

- ❑ More than 2X the municipal solid waste generated yearly in tonnage
- ❑ Contaminated with treatment chemicals, paint, and glue
- ❑ Cannot be re-used in power plants, mulch, or compost

U.S. Environmental Protection Agency Sustainable Materials Management Program

What we do:
Recycle waste into low-greenhouse gas jet fuel and hydrogen

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Separate

Gasify

Refine

Use

Competitive Niche: Greenhouse Gas Reduction

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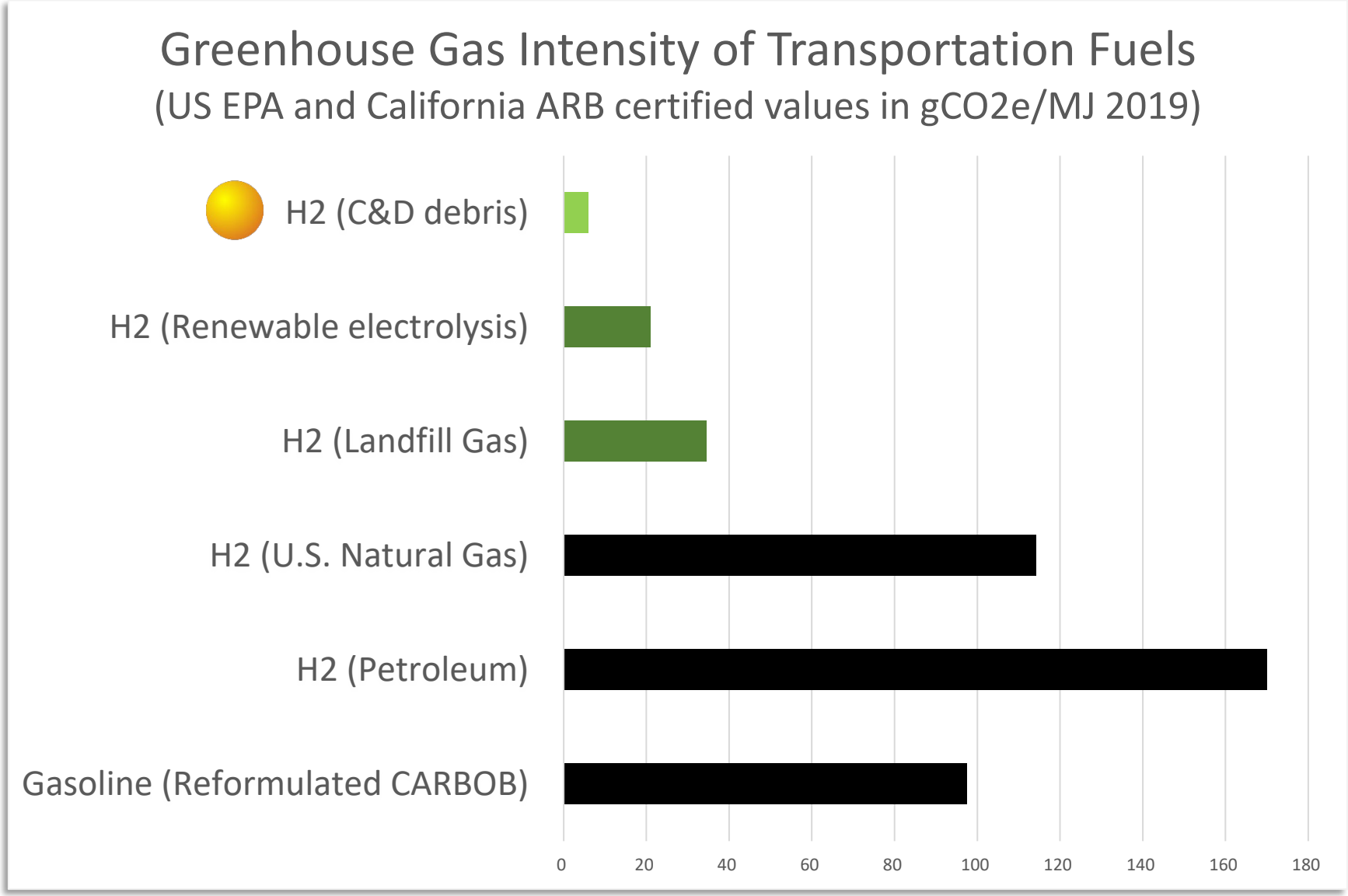
The Hawaii project would displace 100,000 tonnes of CO_2 per year…
"This emission reduction from one C&D wood-to-fuel conversion project is equivalent to the carbon stored by 70,000 – 165,000 acres of U.S. forests per year"

SCSglobal SERVICES
Setting the standard for sustainability™



Progress toward First-of-a-Kind Plant

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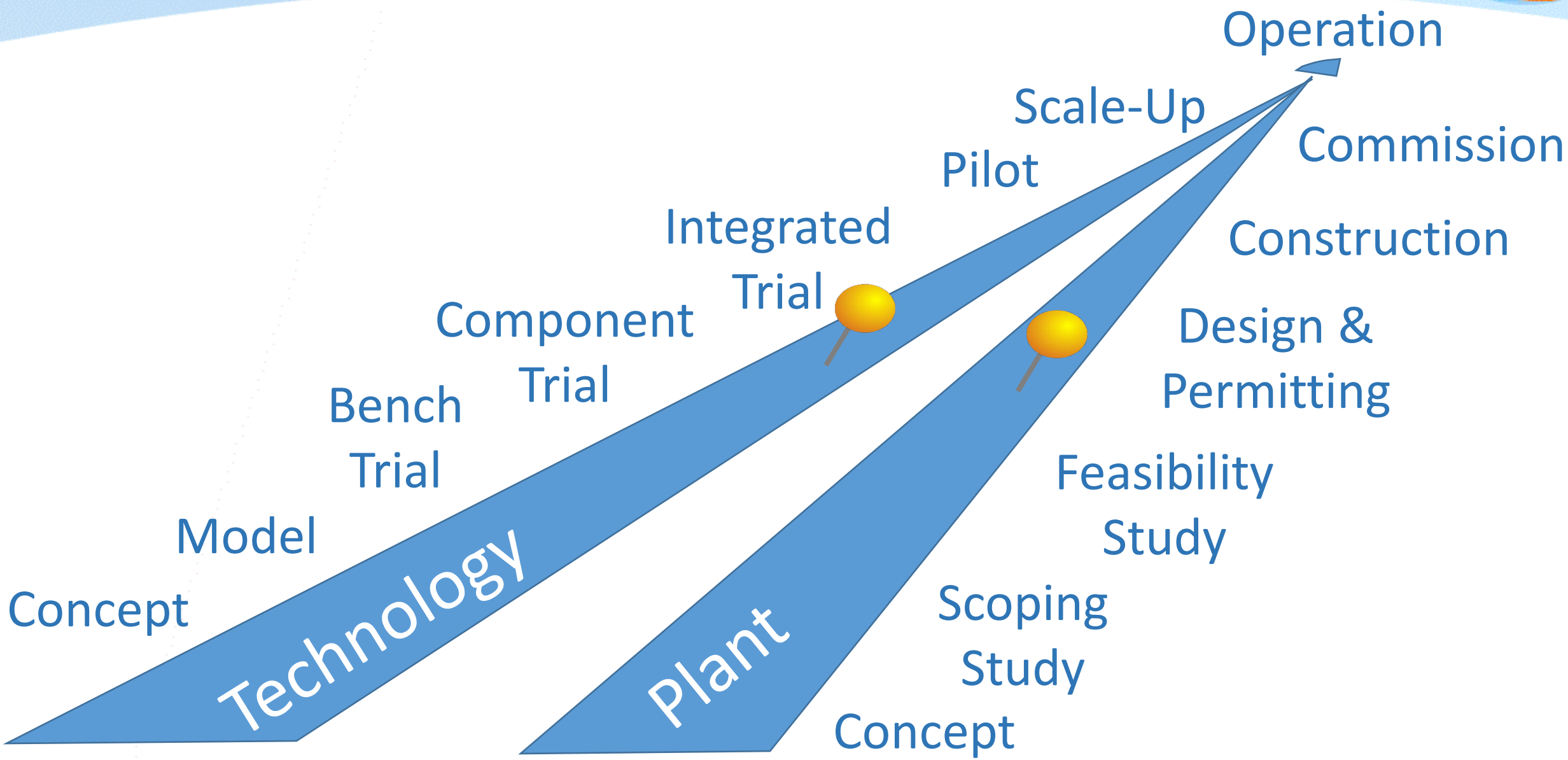

Introducing the Aloha Carbon HNL Project

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- ✓ Construction & Demolition Debris
- ✓ Gasification & reformation technology
- ✓ Approx 12 MGY (500 tons per day feed)
- ✓ Equity LOI/SAFE agreements for Honolulu

WOOD GROUP

amec foster wheeler

WOA WEST OAHU AGGREGATE

PINERIDGE farms inc.

ULU A'E LEARNING CENTER

island RECYCLING

Huí Kū Maolí Ola
Transforming Land Back To 'Āina

Papahana Kuaola

UNIVERSITY of HAWAI'I WEST O'AHU

EERC

In Closing:

- Address local needs
- Use local feedstock
- Innovate
- Leverage network
- Launch Aloha Carbon!

Questions?

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End of slide show

Aloha Carbon:
Community-informed waste diversion and recycling into transportation fuel

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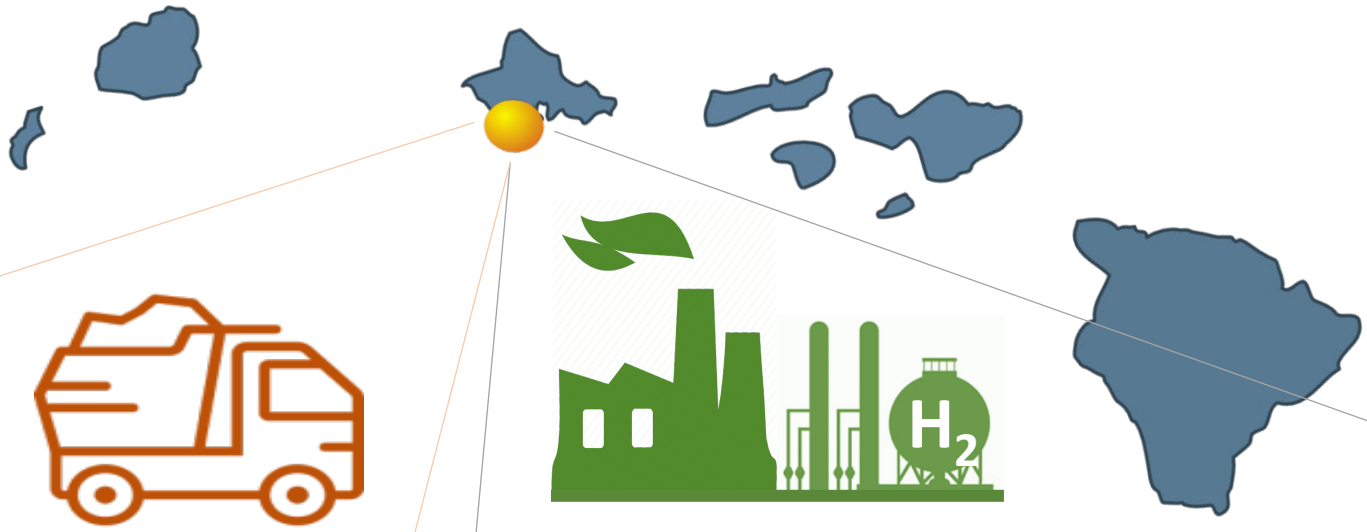
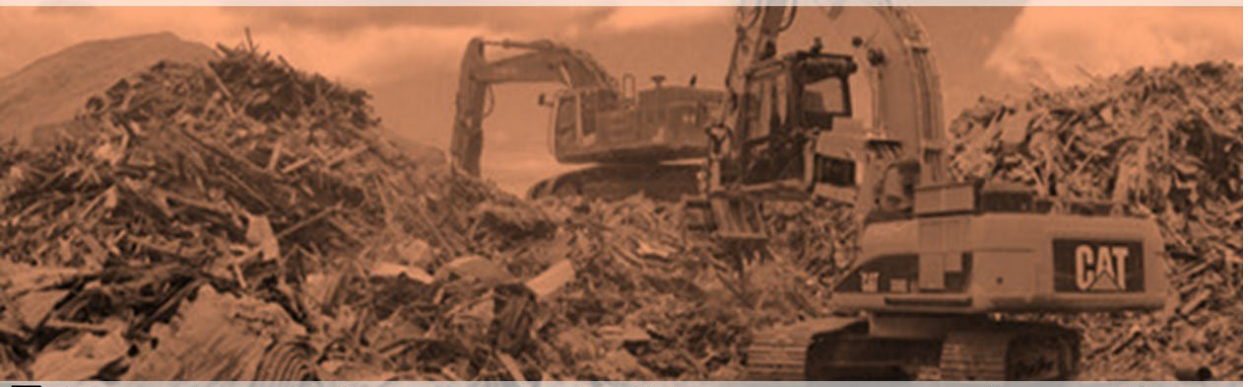


Problems we are tackling:

>560 million tons of C&D waste landfilled each year in the U.S.A.



- ❑ More than 2X the municipal solid waste generated annually
- ❑ Contaminated with treatment chemicals, paint, and glue
- ❑ Difficult to re-use in power plants, mulch, or compost

Solutions we are developing:

Green hydrogen & jet fuel from C&D waste

- ✓ 3 project design spirals with community input
- ✓ Local and Hawaiian voices are central to the conversation
- ✓ 97% lower greenhouse gas lifecycle emissions than petroleum

The Aloha Carbon HNL Project

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- ✓ Integrated system technology trial
- ✓ Feasibility study
- ✓ Seed round
- ✓ Competitive grant funding from U.S. EPA, DOE, USDA
- ✓ Equity investor LOI/SAFE agreements for Honolulu project

Another problem we are addressing:

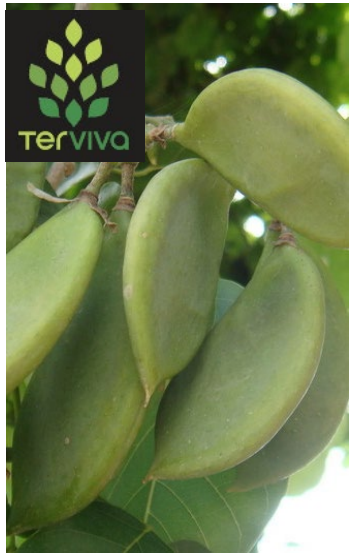
The United Nations' International Civil Aviation Organization Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) requires

carbon-neutral growth in international civil aviation

beginning in 2021

Including for flights to/from Hawai`i

Oahu Island Examples



Tropical Cellulosic Feedstocks

Forest Biomass
(Eucalyptus & Invasive Species)

Energy Cane
(& Invasive Species)

Community acceptability of recycling green waste

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Source: https://www.opala.org/solid_waste/curbside_inspect_and_process.htm

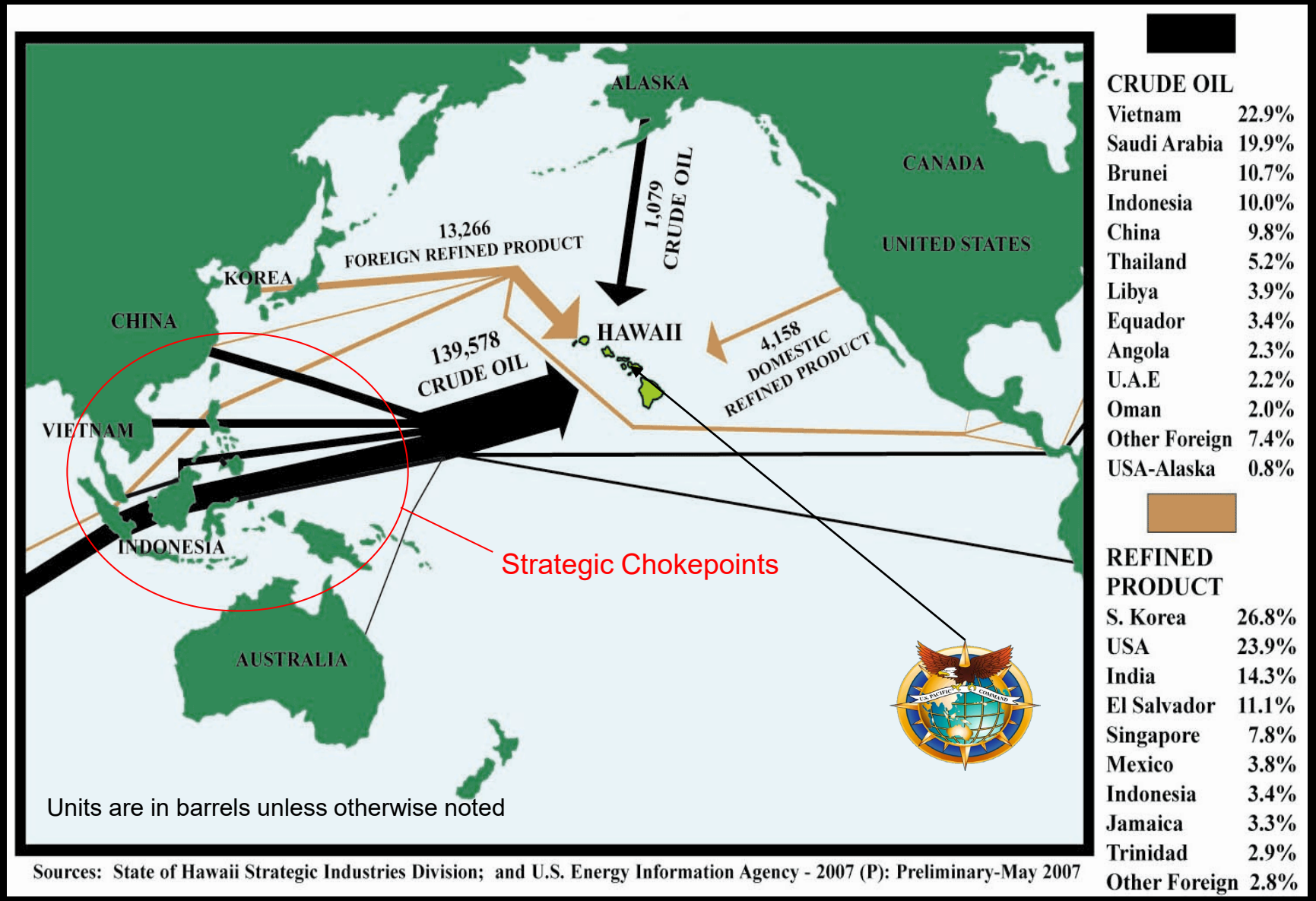
Tropical Oilseeds Feedstocks

Jatropha

Pongamia

Sunflower

The View 10 Years Ago: Hawaii's Petroleum Supply Lines



2008 PER CAPITA OIL CONSUMPTION (barrel per person per year)

Facts to keep in mind …

~11	~25	~2.1	~1.4	~45
EUROPE (average)	US	CHINA	INDIA	HAWAII

Per capital (number of barrels per person per year) oil consumption is an indicator to what extent a nation (or region) is dependent on oil for its energy needs. Per capita consumption data compiled by Manfred Zapka

Green Initiative for Fuels Transition Pacific (GIFTPAC)

Launched Dec 2009

Pacific Command Area of Responsibility

GIFTPAC Objectives

1) Displace 25% of DoD fuel used in Hawaii by 2018, i.e. 32 million gallons per year. The fuel must be domestically produced, non-fossil, meet military specifications, be cost-competitive, and reduce price volatility.
2) Enterprise model inclusive of the local energy market that incorporates the agricultural, energy, environmental, government, industrial, and commercial sustainability objectives.
3) End state with sustainable ongoing competition among multiple commercial entities at many levels.

Strategic Imperatives

- Dependence of air and marine transportation upon fossil fuel.
- Desire for new areas of technological innovation and economic growth
- Regional allies and key nations similarly poor in fossil energy – potential for resource conflict.
- Remote and petroleum-dependent operating bases.
- Desire for complementary food and fuel activity

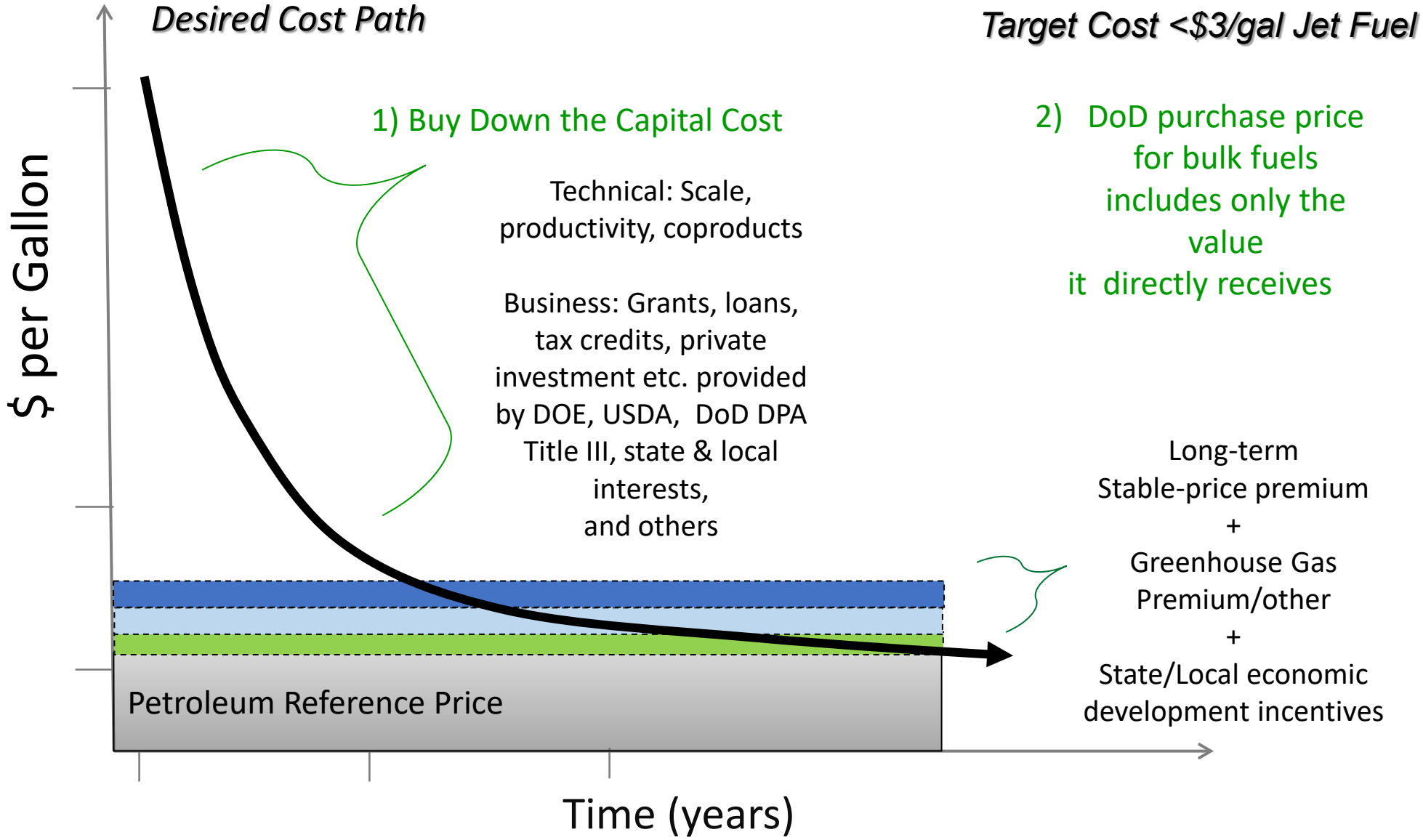
Membership

Co-Sponsors: PACOM and Navy

DoD Members: ASD (OE), DLA-Energy, DARPA, Defense Production Act Title III, AFCO, IMCOM PAC.

Other members: USDOE, USDA, EPA, State of Hawaii, A4A, Hawaiian Electric Co.

Strategy to Reach Competitive Price



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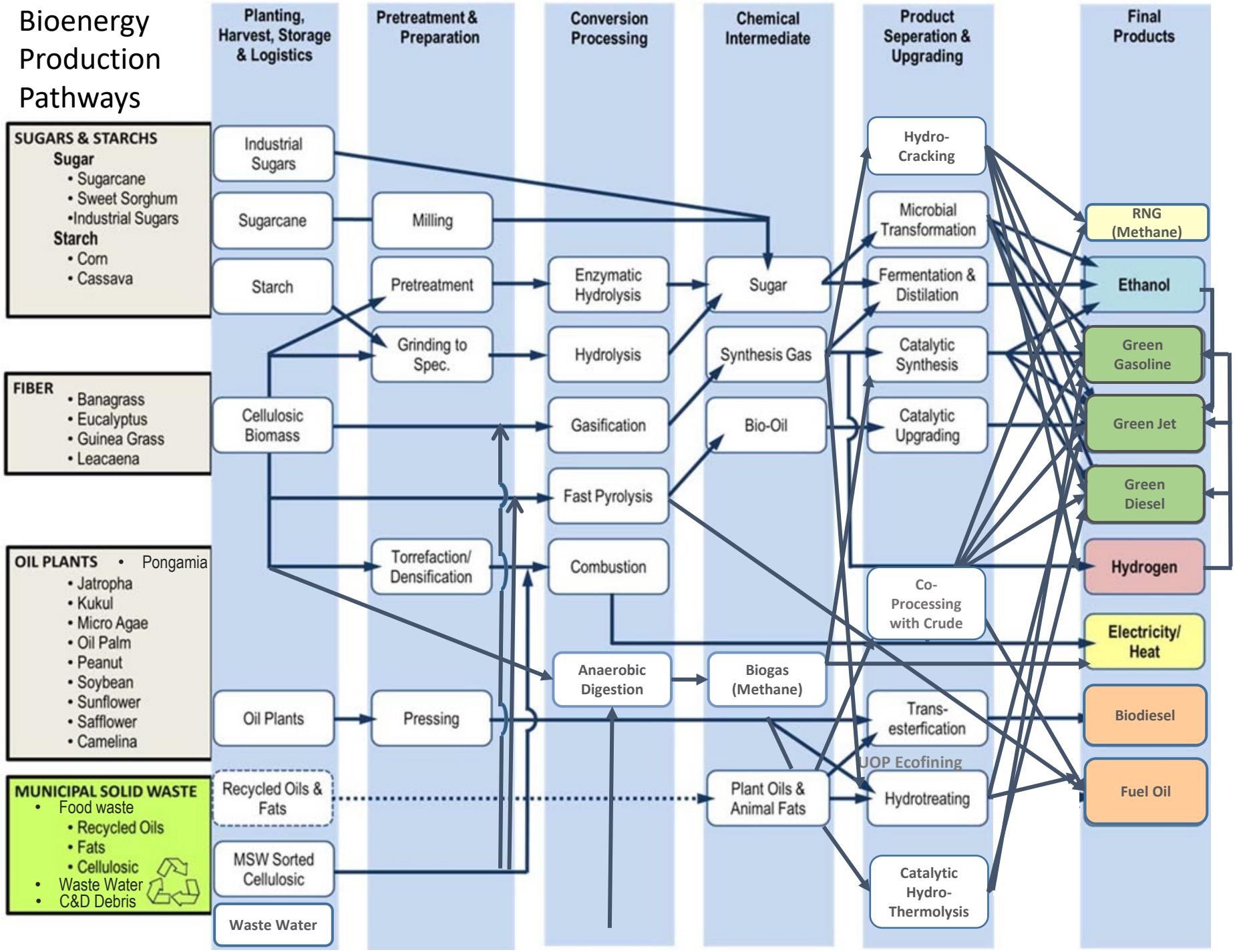
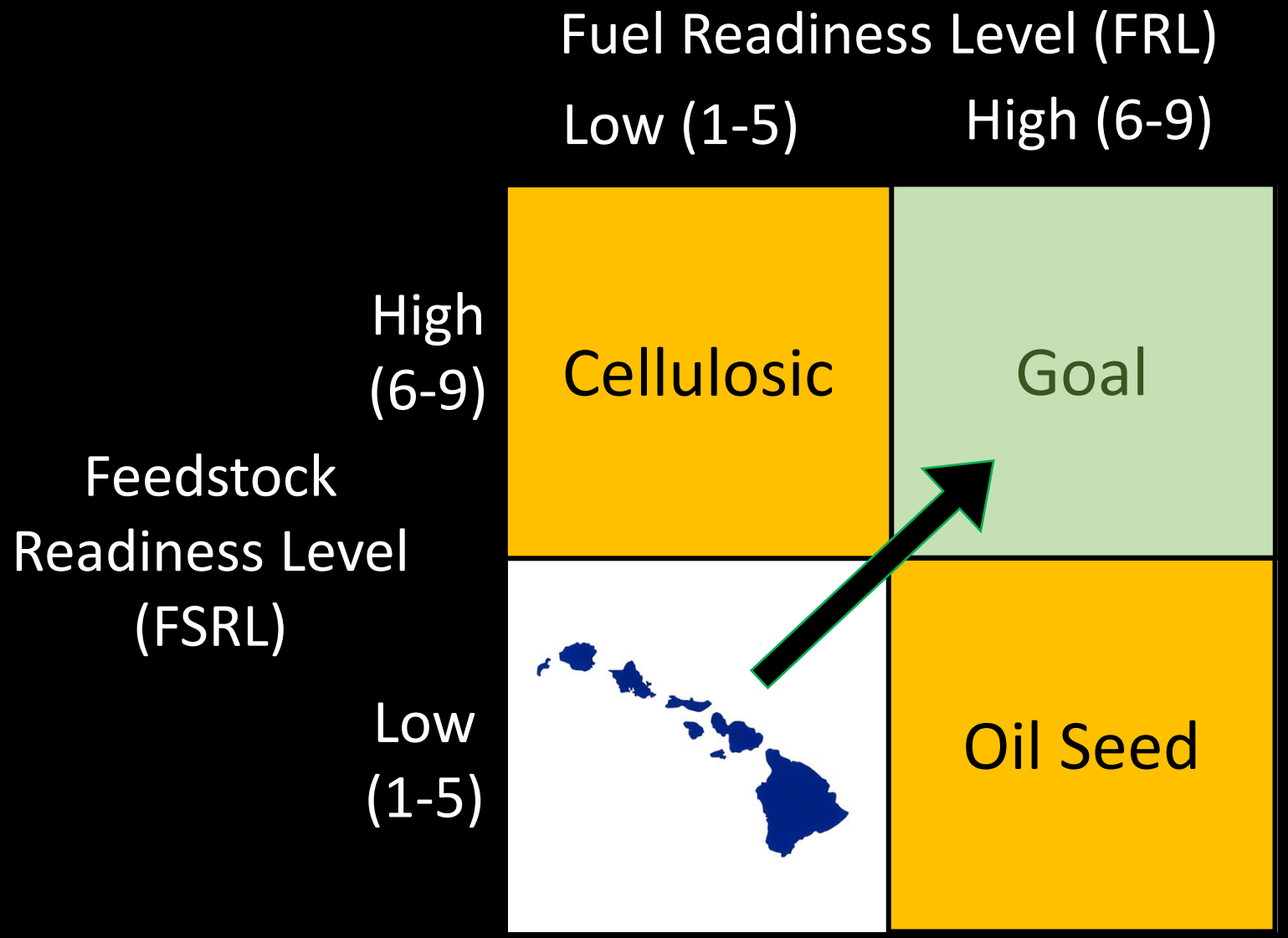
In Hawai'i:

Bioenergy Production Pathways




Fuel Readiness Level (FRL)
Low (1-5)
High (6-9)
High (6-9)
Feedstock Readiness Level (FSRL)
Low (1-5)
Cellulosic
Goal
Oil Seed

Feedstock and Feedstock Systems For "Island Scale" in Hawaii (10-20mgy)

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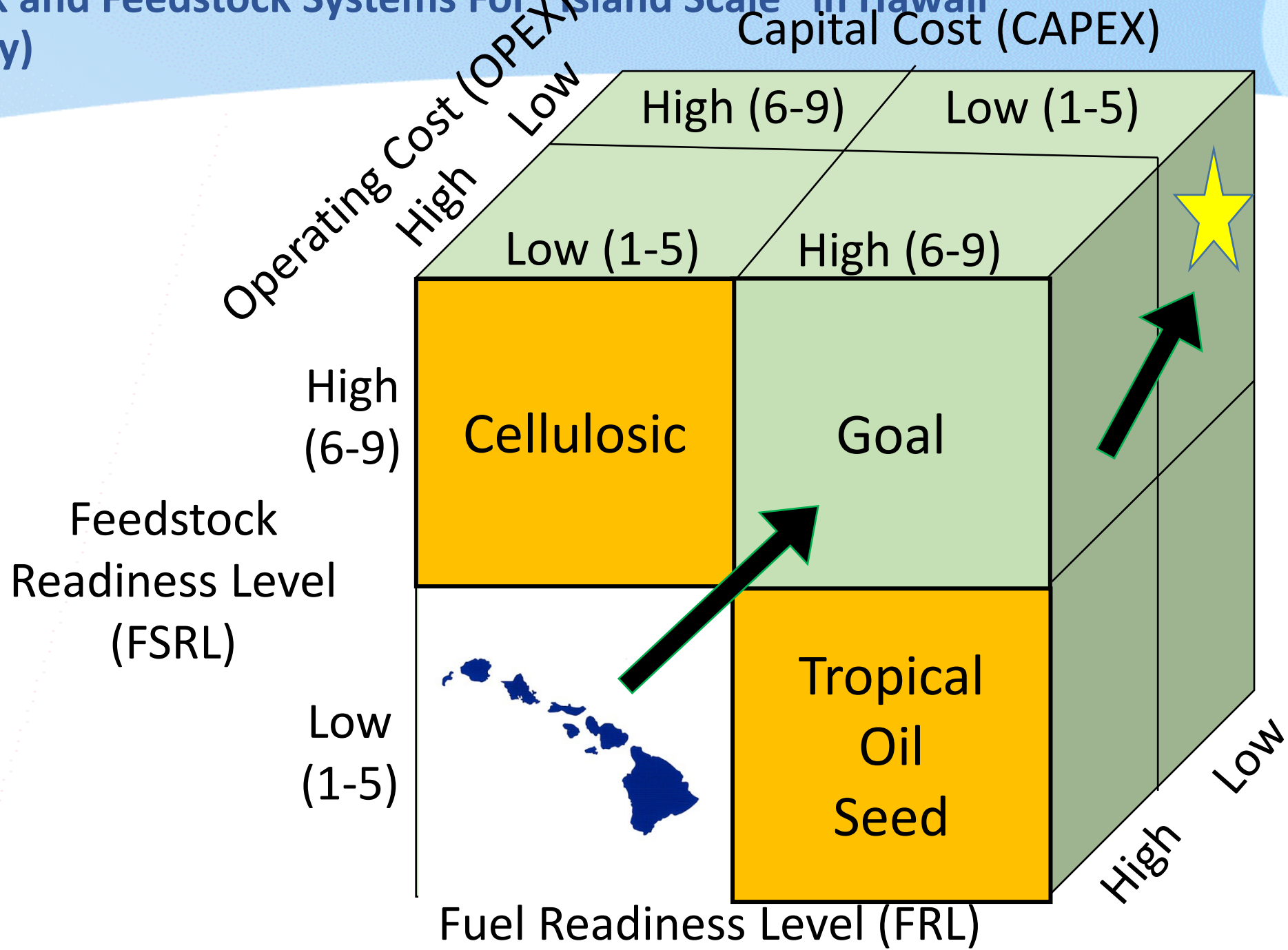
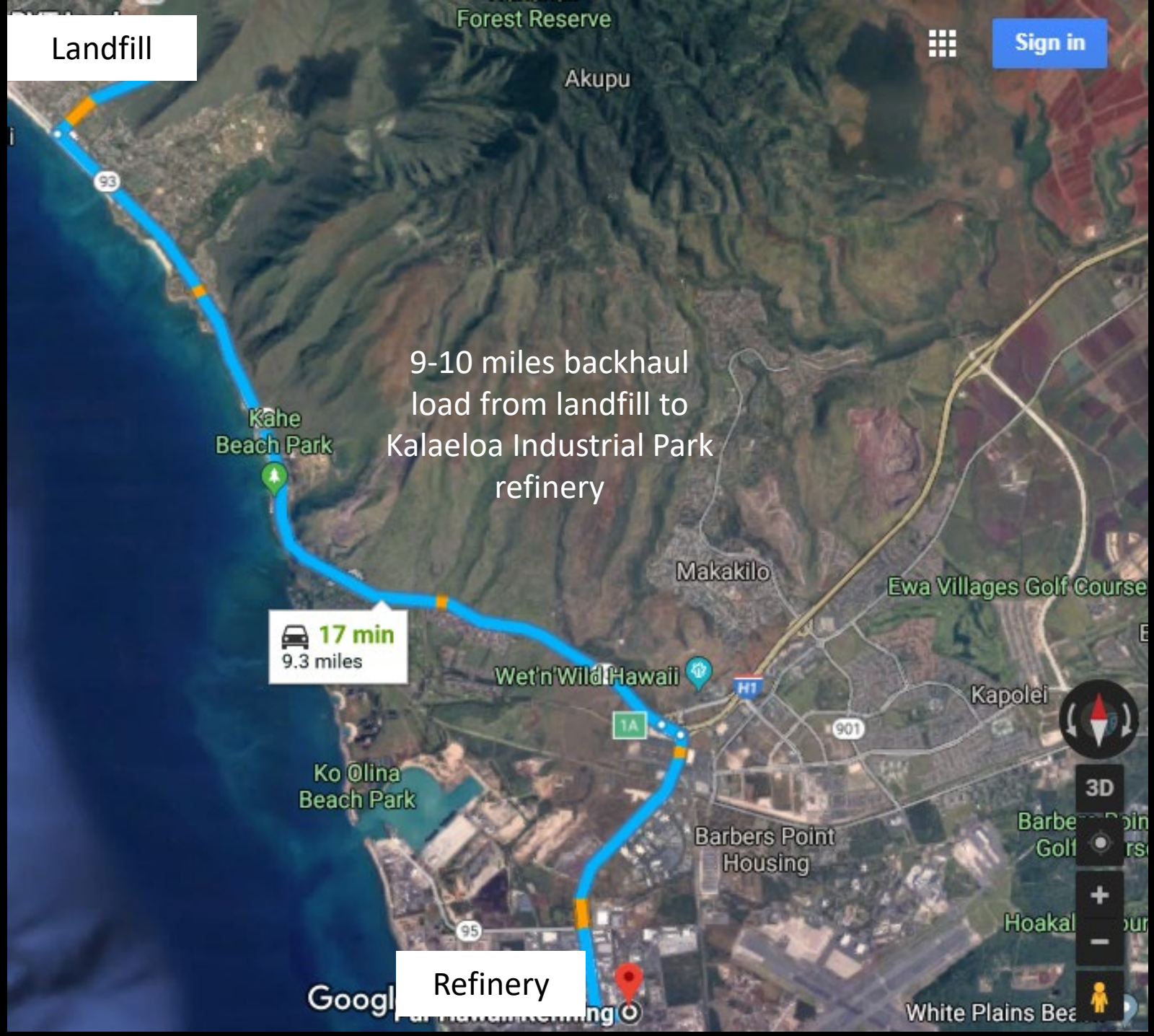



CAT
PVT LAND
COMPANY
LIMITED


CAT
PVT LAND
COMPANY
LIMITED


Landfill
Forest Reserve
Akupu
Sign in
93
9-10 miles backhaul load from landfill to Kalaeloa Industrial Park refinery
Kahe Beach Park
Makakilo
Ewa Villages Golf Course
17 min
9.3 miles
Wet'n'Wild Hawaii
H1
Kapolei
1A
901
Ko Olina Beach Park
3D
Barbers Point Housing
95
Refinery
White Plains Bea

Feedstock
Processing & Storage

Gasify

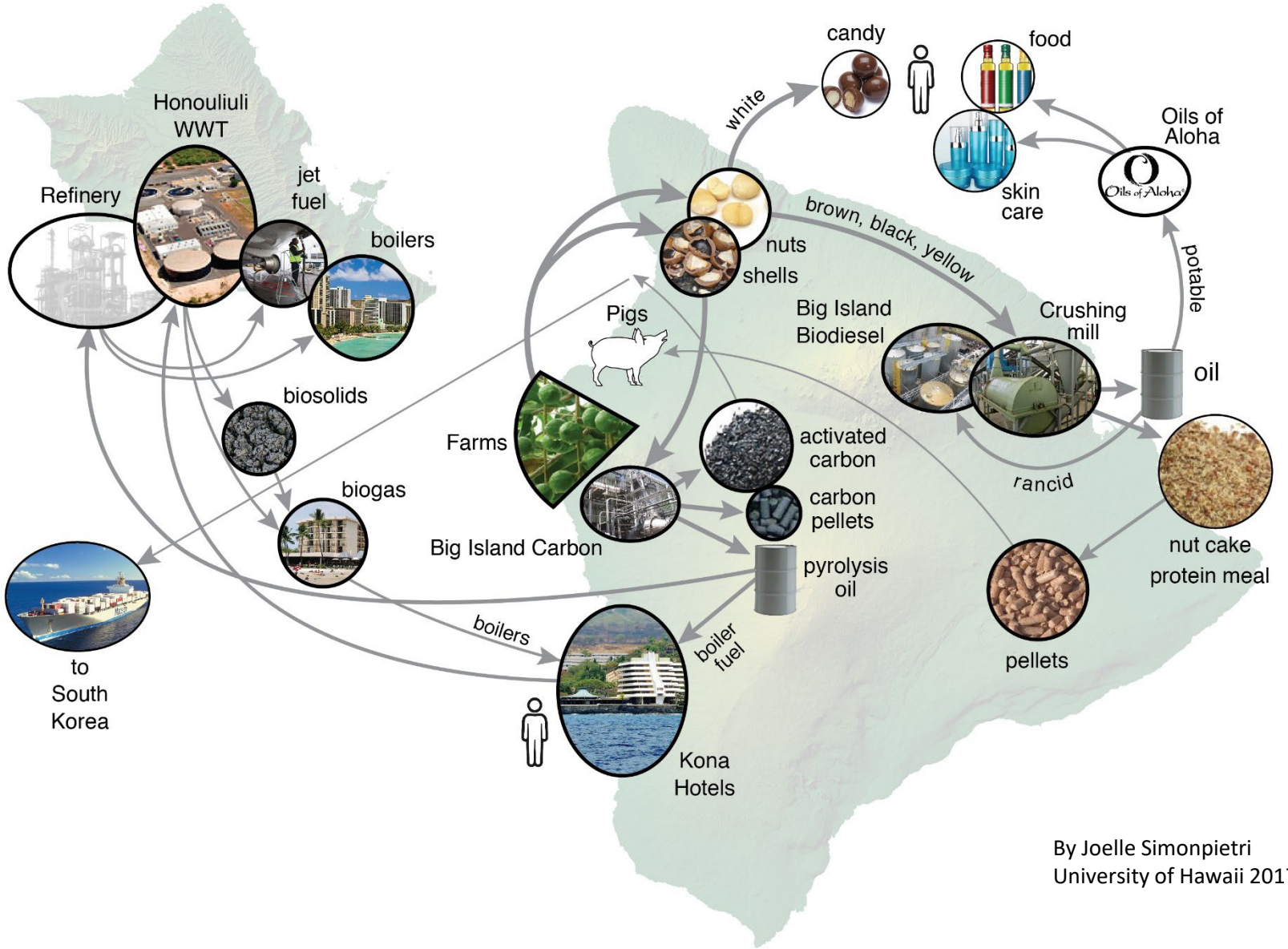
Refine

Use

Lessons Learned

- Feedstock is the primary constraint
- Non-food plants lack coproduct benefits
- Start in your own backyard
- Tackle long-term community problems
- Partner smartly
- Innovate with commercial technology
- Maintain pragmatic optimism

Big Picture: Integrated Food and Energy System



By Joelle Simonpietri
University of Hawaii 2017