Hawai'i Powered
Hawai'i Clean Energy Initiative

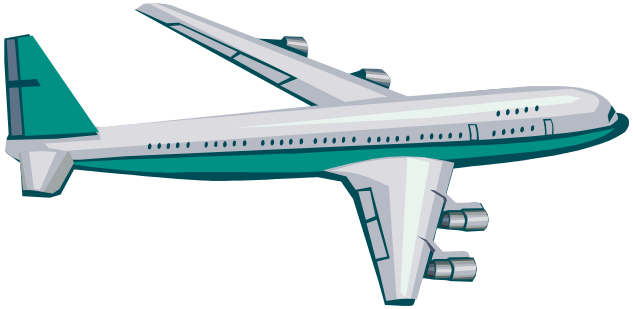
Biofuels 101

Hawaii Agriculture Conference

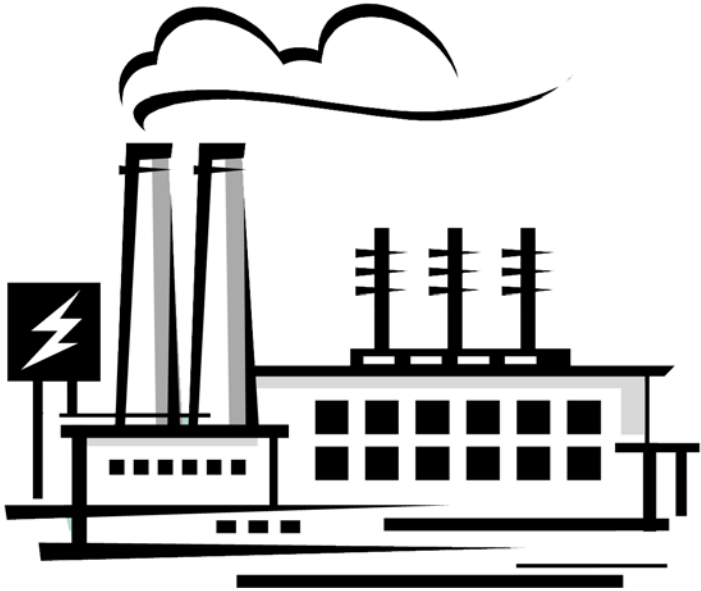
September 24, 2010

Hawai`i State Energy Office

What are Fuels?



- Fuels are **stored energy**
  solid, liquid, or gaseous
- Available when and where we need them
- For transportation, cooking, industry
- For electricity generation - dispatchable



Materials Imported to Oahu – Million Tons, Annually

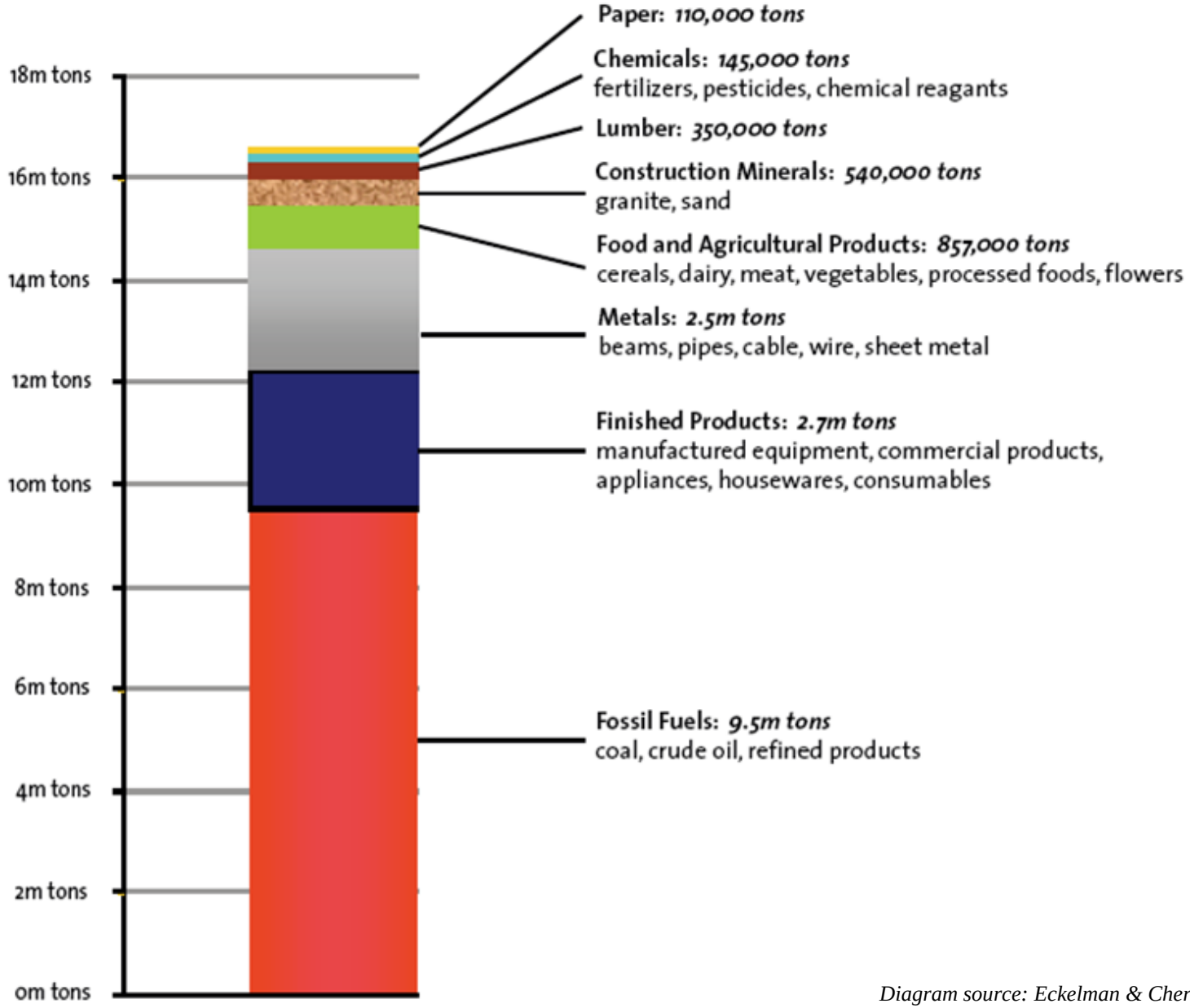
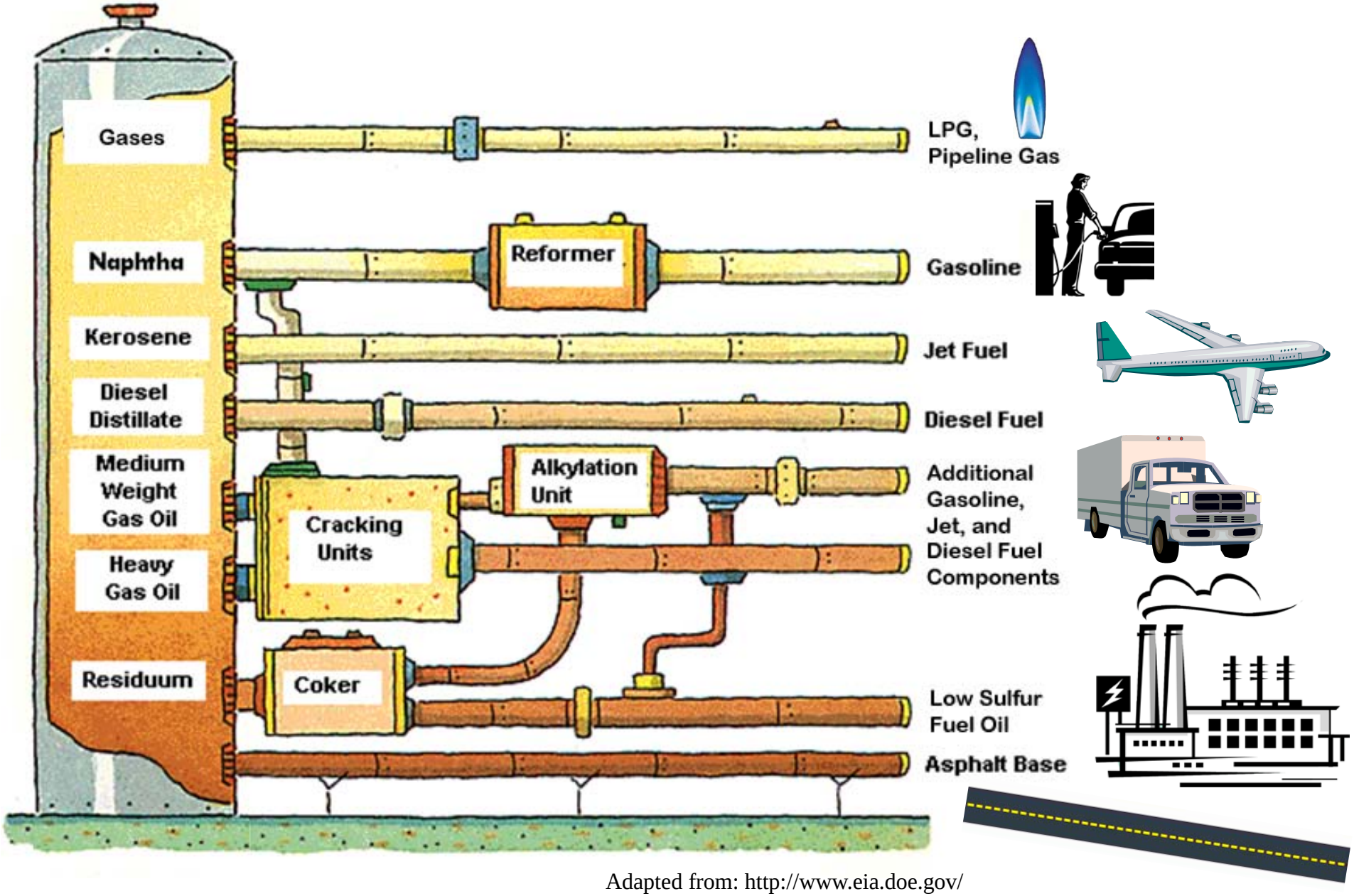


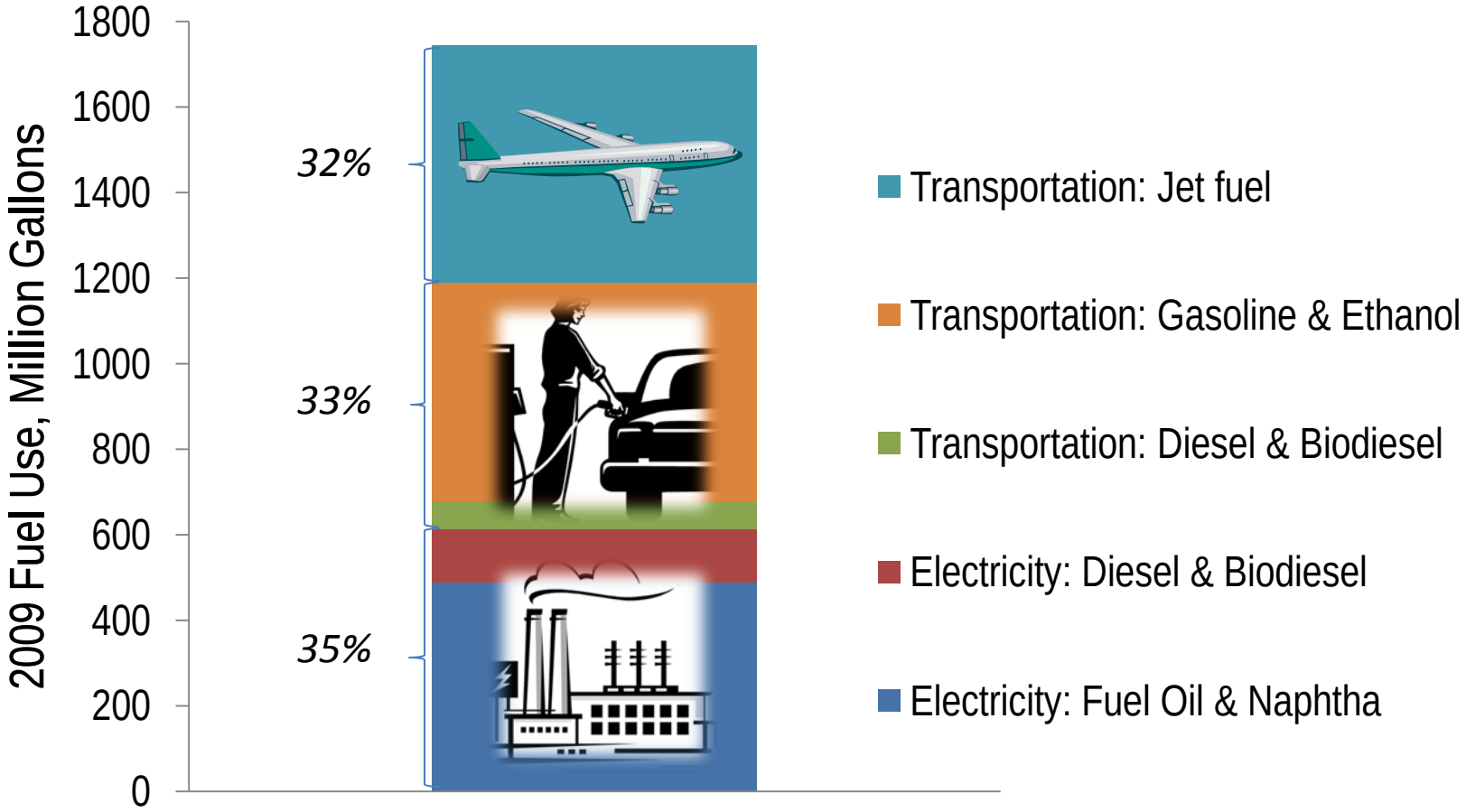
Diagram source: Eckelman & Chertow 2009

Hawaii's 2 Refineries Produce:



Adapted from: http://www.eia.doe.gov/

Liquid Fuel Use in Hawaii



Biofuels for Electricity Generation and Transportation

- Wide range of fuels (e.g. ethanol, diesel, gasoline, jet fuel) may be derived from biomass.

✓ Liquid fuels: transportable from source to the end-user, and from one island to another, using conventional distribution systems.

✓ "Drop-in" biofuels (under development) will be usable in place of fossil-based fuels without modification to existing infrastructure.

✓ The chemical energy stored in biofuels is available on demand; it can stabilize the utility grid to enable greater use of variable sources.

- Production requires a healthy agricultural sector.
- Without the ability to grow the feedstock, a bioenergy industry is not possible.

Oil or Fiber may be Converted to Drop-in Biofuels

Bio-oil from fiber

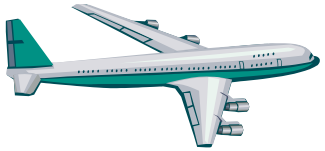
Vegetable oil/animal fat

Algal oil

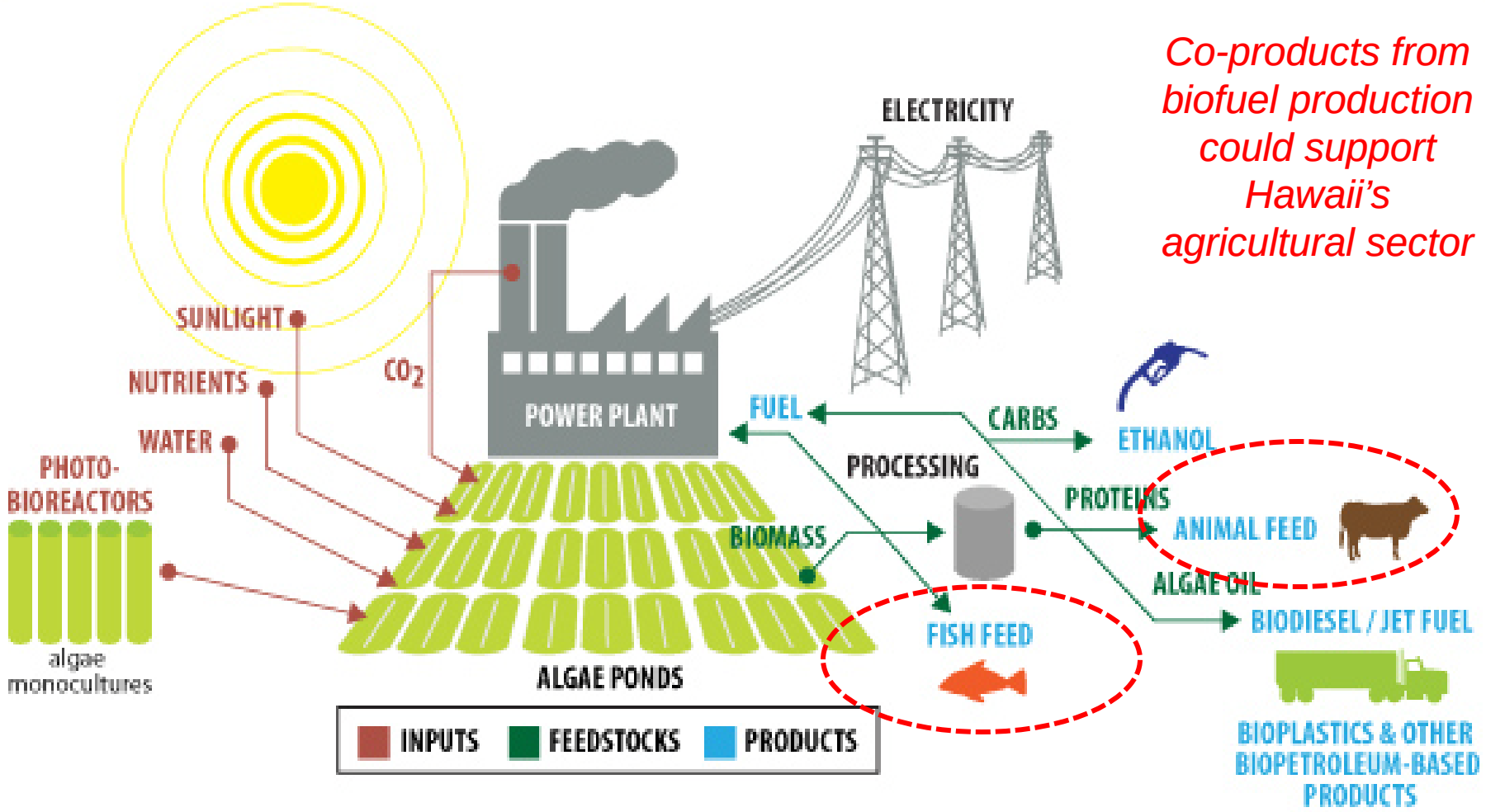
Renewable oil

Hydrotreating & refining

Diesel, gasoline, jet



Co-products from biofuel production could support Hawaii's agricultural sector



*Some processes give multiple products: 40% jet / 30% diesel / 20% gasoline

Graphic: HR Biopetroleum

Participants in Biofuels Development

- Landowners
- Farmers
- Refiners
- End-users
- Conversion technology proprietors
- Fuel distributors
- Investors
- Government, Regulators, Researchers

Public and private partnerships to leverage funds and expertise.

The Road to

Locally Produced Food & Fuel

Processing Facilities

- Small, distributed local facilities convert sugars, oils, and/or fiber to fuels (ethanol, biodiesel); co-products (feeds, fertilizers, electricity, etc.); and/or bio-oil (for refinement at central facility).
- Centralized Hawaii facility converts bio-oil to refined fuels – biomass-based diesel, jet fuel, gasoline.

Fuel Distributors

- Blend biomass-based fuels with petroleum-based fuels.
- Ensure that fuels meet all Federal, State, industry, and manufacturer specifications.
- Communicate that fungible biomass-based fuels have the same properties and handling as their petroleum-based counterparts, and can be blended, transported, stored, and used in the same equipment.

Fuel Users

- Land and Marine: Use biomass based fuels alone or in blends with petroleum based fuels.
- Utility: Use biodiesels, bio-oil, and other biomass-based fuels as dispatchable power in support of other renewable energy sources; capture or provide CO_2 to algae producers.
- Aviation: Complete testing, demonstration, and certification for use in civilian and military aircraft.

Small Farms

- Identify opportunities to increase revenues or reduce costs via electricity, feed, fertilizer, by-products, or bioenergy / bio-oil feedstock production and application.
- Participate in crop trials and co-product testing when appropriate.

Large Farms

- Evaluate long-term business plans that include production of food, feed, energy, fuels, and co-products.
- Determine cost-effective scale(s) of production.
- Monitor changes in petroleum supplies and prices, fuel production technologies, crop yields, production and harvesting costs; and market(s) for product(s).
- When feasible, obtain financing; develop project(s); modify as necessary to capture new opportunities.

Seed Farmers / Ranchers / Other Producers

- Work with potential feed producers to evaluate and test suitability of co-products for local livestock and aquatic use.
- Identify opportunities to increase land utilization through co-production or intercropping.

Conduct Research & Demonstrations; Provide Information & Support

- Crops: Conduct crop trials to determine Hawaii yields; hybrids suited to various Hawaii conditions, i.e. grasses (cane, sorghum); oilseeds; tree nuts; algae; trees (eucalyptus; seedless leucaena; timber); other crops, especially those with food or feed potential
- Water: Research & demonstrate use of non-potable sources; demonstrate low-loss irrigation techniques; provide information to farmers.
- Land: Provide soil type, slope, rainfall, solar insolation, temperature, and other relevant information in GIS format and downloadable maps; research potential use of lava lands.
- Harvesting: Develop and demonstrate technologies appropriate for Hawaii.
- Processing and Fuel Production: Reduce technical risk through private- and government-funded research; develop co-product utilization technologies and markets.
- Information: Establish Hawaii bioenergy website; provide information on projects, funding, incentives.
- Coordination: Facilitate introductions and discussions between investors, project developers, landowners, funding agencies, researchers, consultants, technical experts, and public and private organizations; provide capability for public input and community outreach.
- Sustainability: Provide scientific data on crop, processing, and resource utilization and best practices.
- Analysis: Develop agricultural/bioenergy decision model, with current agricultural entities and various processing facility, biorefinery, and by-product scenarios included.
- Policy: support existing Hawaii biofuel and agricultural operations.

Support Agricultural Sector

- Land: Protect good agricultural land and provide long term leases and reasonable lease rents for farmers.
- Water: Maintain aging irrigation systems and plan and develop new systems. Ensure access to reliable, consistent and affordable water for agriculture.
- Energy: Address rising transportation, fertilizer, fuel, electricity, feed and other input costs through use of local resources.
- Labor: Develop programs to ensure agricultural labor availability and agricultural worker housing.
- Revenue and financing: Increase revenue (electricity sales; value from co-products); develop long term contracts to offset market volatility concerns.

Agricultural Land is Limited

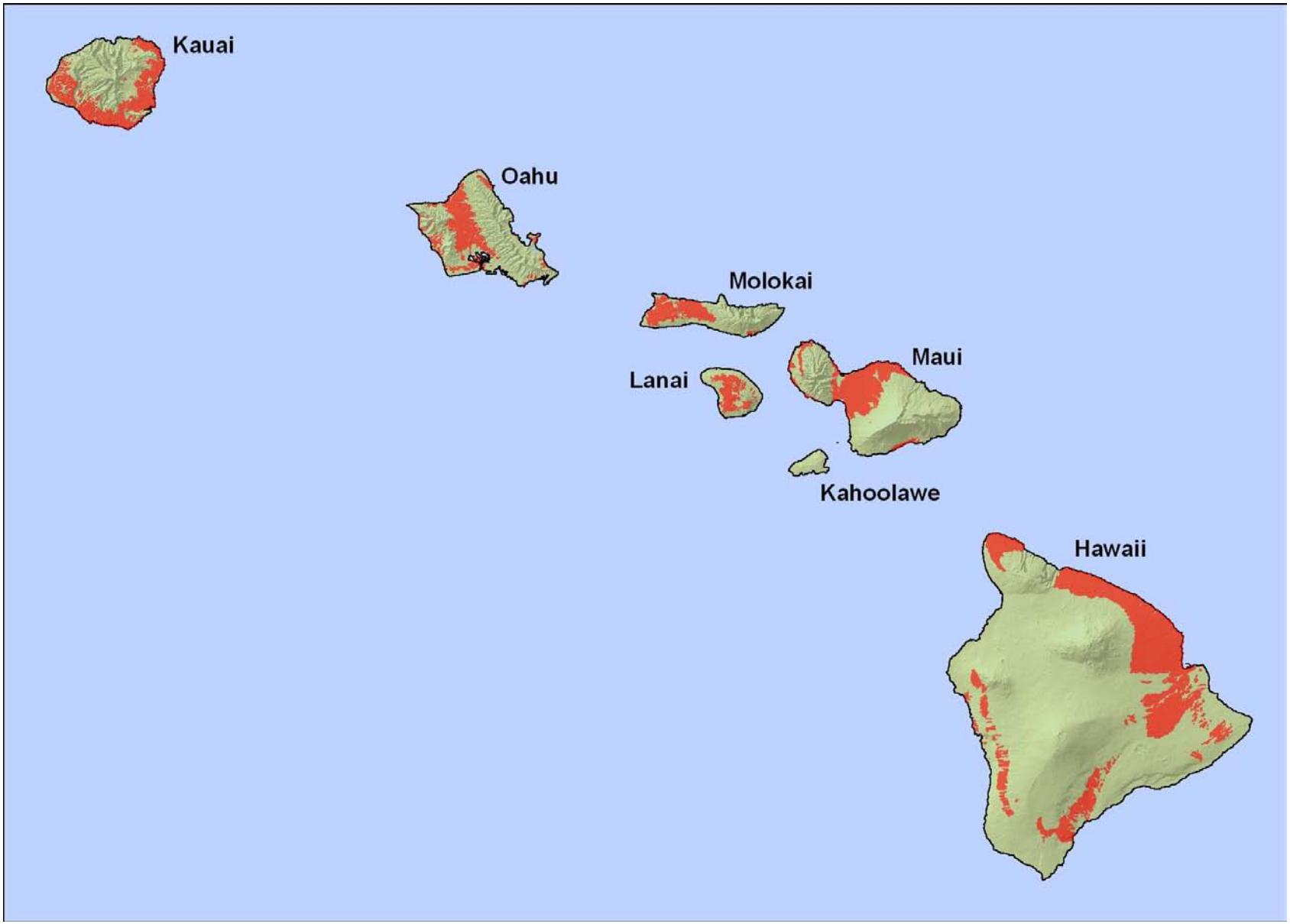


Table 9-3. Hawai'i Agricultural Lands by Island (acres)							
	Hawaii	Maui	Molokai	Kauai	Oahu	Lanai	Total
Nonprime Rainfed Lands	652,836	90,386	38,492	20,468	12,319	6,575	814,501
Prime Irrigated Lands	97,679	65,893	11,126	53,020	55,919	16,741	300,378
Total	750,515	156,279	49,618	73,488	68,238	23,316	1,114,879

Table 1-6. Maximum Theoretical Hawai'i Biofuel Production Potential					
Fuel	Bio-oil	Ethanol	Green Gasoline	Green Diesel	Green Jet Fuel
Theoretical Potential = about 800 million gallons / yr. Does not include potentially higher yields from algae or marginal land acreage.					
Total	763	1,297	848	779	810

Former Plantation Lands Potentially Usable for Bioenergy Production (Acres)*

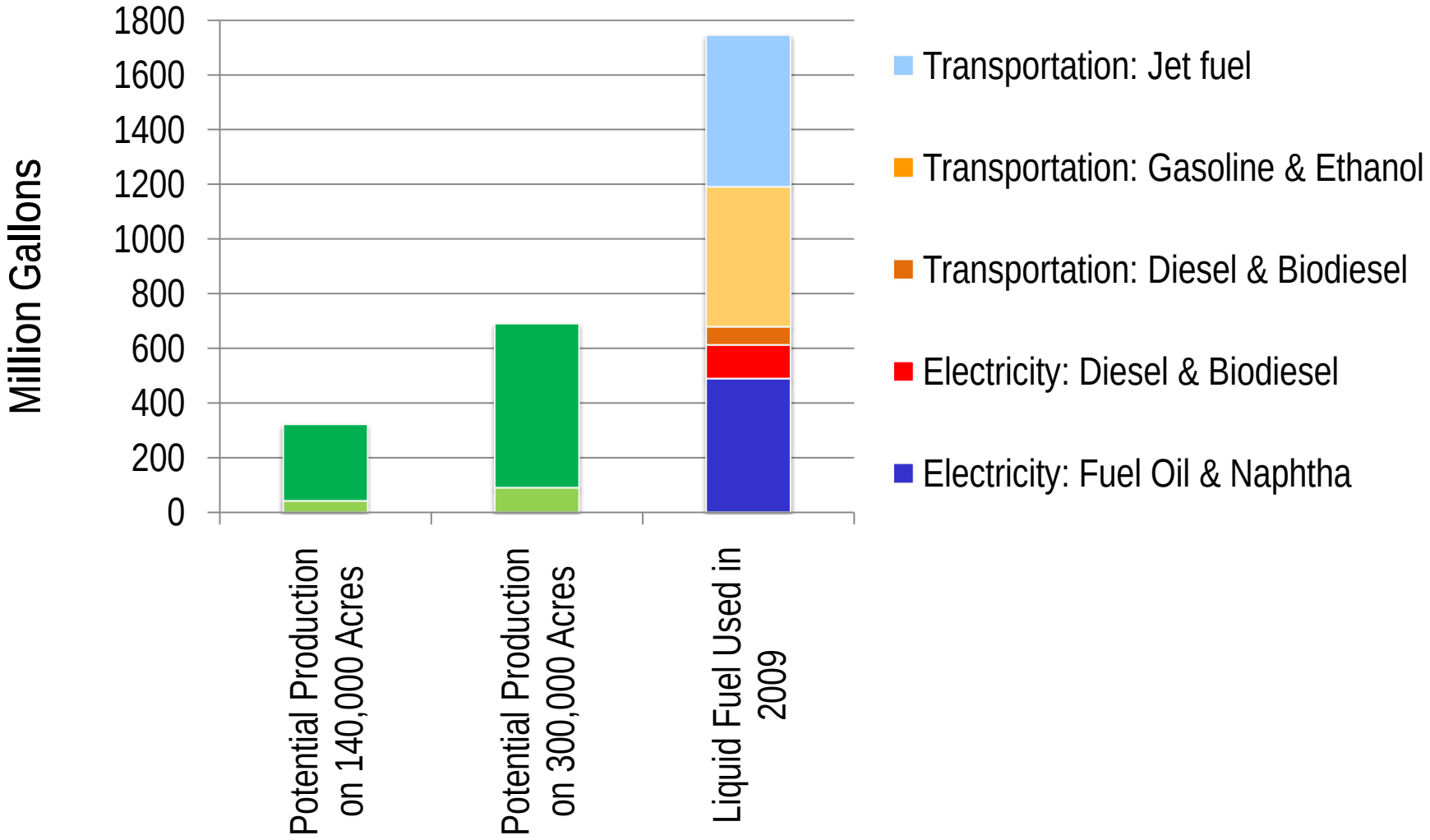
	Public	Private	**Total**
Big Island	8,618	27,299	35,917
Kauai	10,766	22,149	32,915
Maui	1,109	42,371	43,480
Molokai	-	2,102	2,102
Oahu	-	22,259	22,259
Statewide	20,493	116,180	**136,673**

* not including landholdings under 1000 acres where sugarcane, seed crops, or coffee are currently being cultivated

Annual Biofuel Potential from 140,000 acres

Million gallons used in 2009	1746
Value at $70 per barrel	$ 2,909,455,025
Fuel Gallons (petroleum equivalent) per acre	300 - 2000
Liquid fuel potential from 140000 acres	42 - 280 million gallons per year
% of 2009 fuel	2% - 16%
Value at $70 per barrel	$ 70 - $ 467 million
Value at $100 per barrel	$ 100 - $ 667 million
Value at $150 per barrel	$ 150 - $ 1000 million

Liquid Fuel Use and Potential Production in Hawaii



kWh per Acre

One acre of Bio-oil * (Via Pyrolysis)	
Dry tons/acre/year	20
Gal bio oil per ton	150
Gal bio oil / acre	2,000
Btu/gal bio oil	75,000
Btu/kWh	10,190
kWh/acre/year	22,100

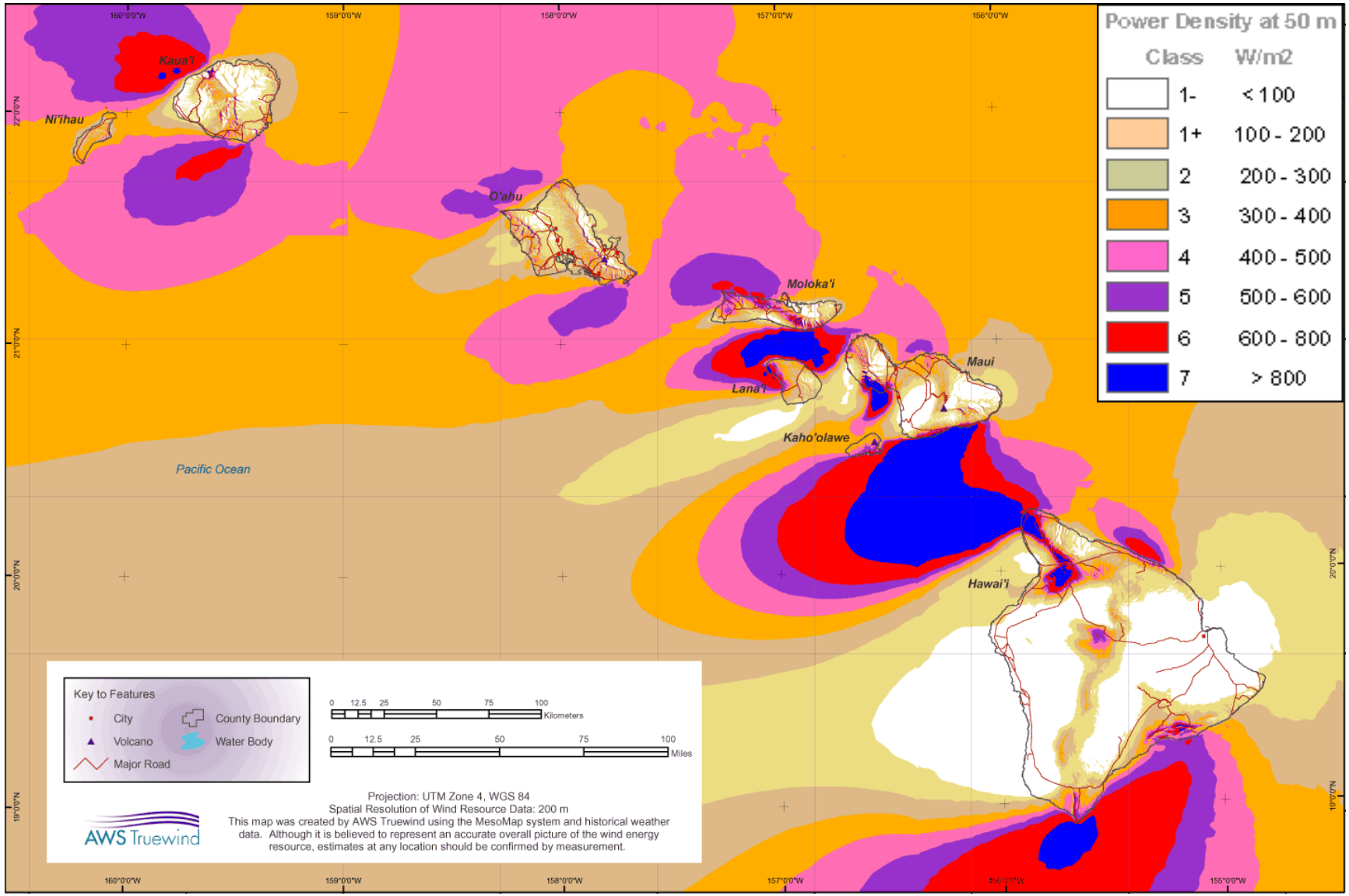
One acre of Wind **	
kW per acre	150
Capacity factor	35%
Hours per year	8,760
kWh/acre/year	459,900

20:1

* Includes storage (liquid fuels are stored energy)

** Does not include storage (kWh as available)

Excellent Wind Energy Resources



http://hawaii.gov/dbedt/info/energy/renewable/wind

Hawai'i Powered

Hawai'i Clean Energy Initiative

Ted Peck, Energy Program Administrator

Maria Tome, Renewable and Transportation Energy Program Manager

Katherine McKenzie, Renewable Energy Analyst

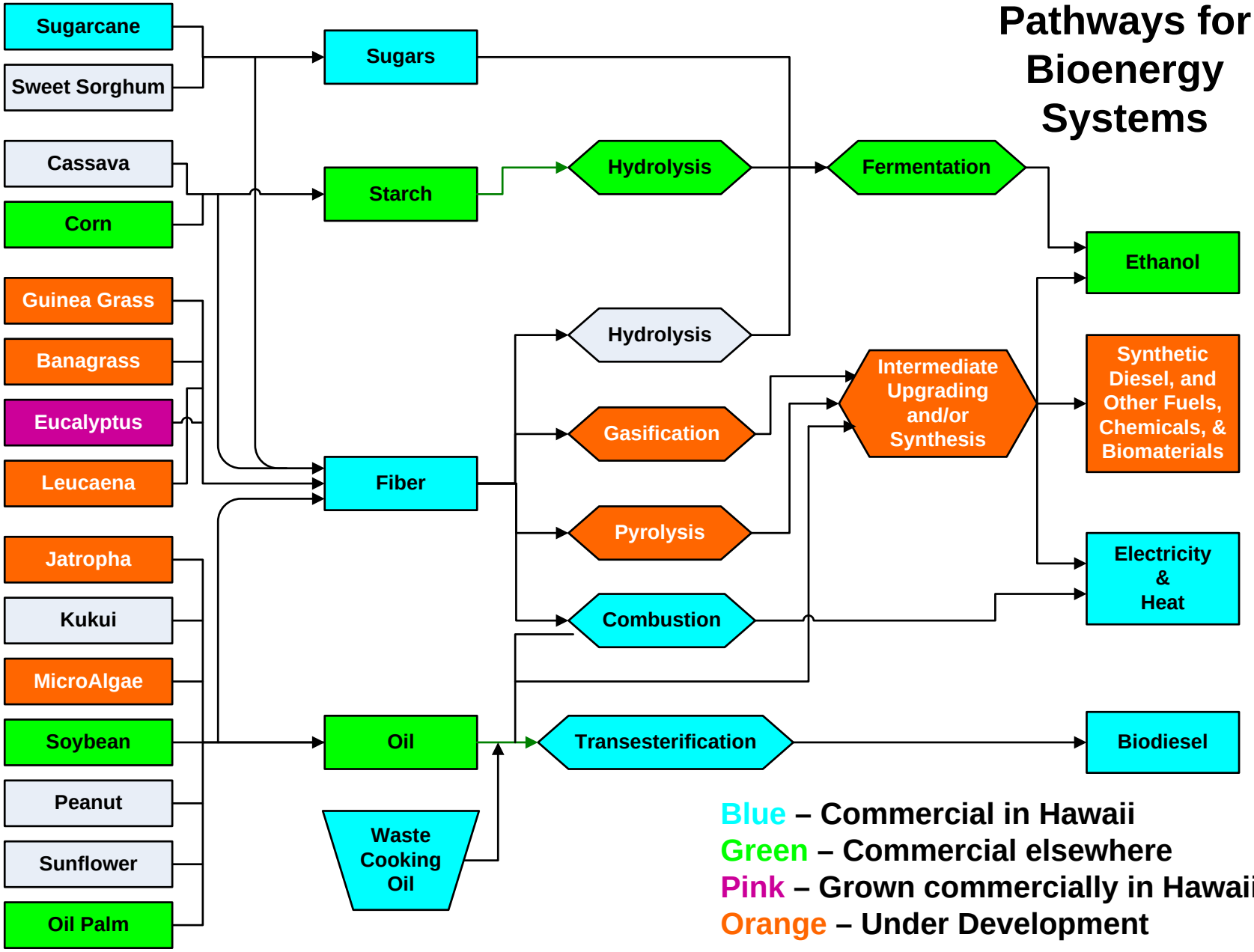
Meredith Kuba, Ph.D., Fuels Specialist

Cameron Black, Permitting Specialist

Timothy Ming, Energy Planning Analyst

hawaii.gov/dbedt/energy

Pathways for Bioenergy Systems



Blue – Commercial in Hawaii
Green – Commercial elsewhere
Pink – Grown commercially in Hawaii
Orange – Under Development

Crops | Intermediate Products | Conversion Technologies | Bioenergy Products