FAA Alternative Jet Fuels R&D and ASCENT Project 01

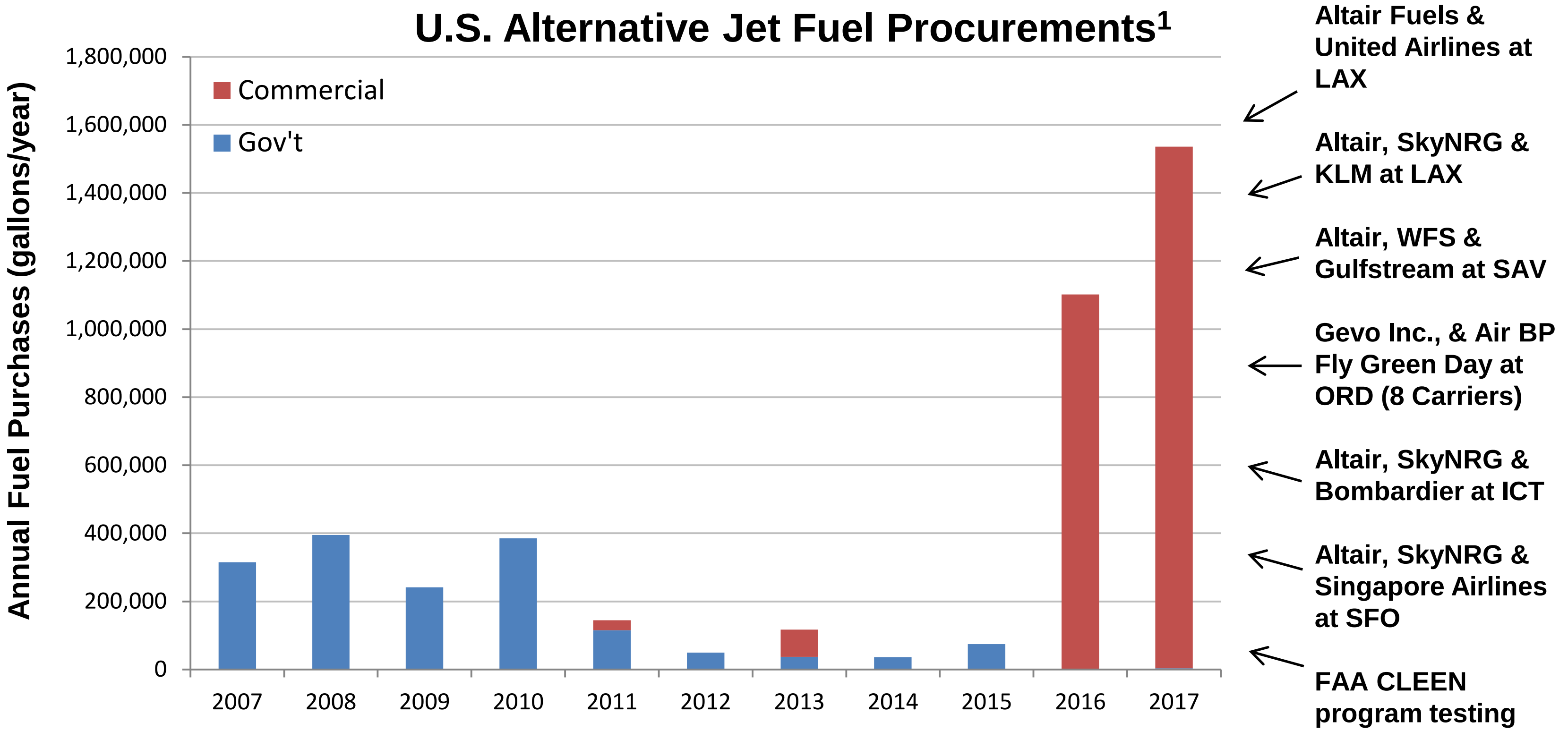
Presented to: SOAP-Jet Webinar

By: Nate Brown

Date: Feb 23, 2018

Where do we stand?

- **Commercial flights on SAJF are expanding**
- **1.5 million gallons in 2017 from two commercial producers, many commercial user, multiple U.S. airports**



Notes:

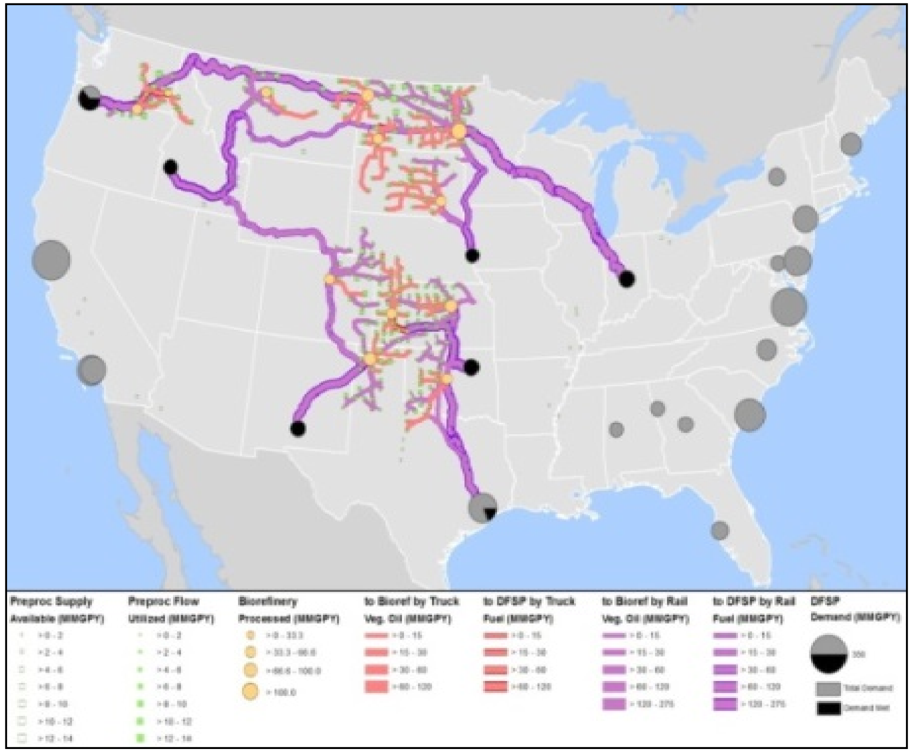
1. Includes procurements of fuel by U.S. government, U.S. airlines, manufacturers, and foreign carriers delivered to U.S. airports

FAA Alternative Jet Fuel R&D Investments

- **Testing**
  - Support certification testing
  - Improve certification process
  - Emissions measurements
- **Coordination**
  - Public-Private
  - Interagency
  - State & Regional
  - International
- **Analysis**
  - Environmental sustainability
  - Techno-economic analysis
  - Future scenarios

Analysis: ASCENT 01 Alternative Jet Fuel Supply Chain Project

- Examine barriers to alternative jet fuel production via the full range of pathways being considered for ASTM approval
- WSU, MIT, Purdue, UT Knoxville (UTK), U. of Hawaii, PSU considering the entire supply chain through multiple lenses:
  - Feedstock production
  - Techno-economics of pathways
  - Existing infrastructure
  - Transportation routes and capacity
  - Community assets



- Quantify economic, environmental, and societal opportunities and challenges & identify opportunities for win-win-wins
- Working with CAAFI and USDA
- Links to U.S. DOT Volpe National Transportation Systems Center, DOE Argonne National Lab & National Renewable Energy Lab (NREL)

Analysis: ASCENT Project 01 Priorities 2017/18

1. International Civil Aviation Organization (ICAO) Alternative Fuels Task Force Support
2. Production Analyses
3. Economic Viability Analyses
4. Lipid-focused (oil based) Analyses
5. **Regional Tactical Deployment Projects**
   - Collaborative projects leverage strengths across A01 team
   - Achieve supply chain development and move toward commercial production
   - Initial projects:
     - **Inland Pacific Northwest** lipid-based alternative jet fuel
     - **Hawaii** C&D waste-based alternative jet fuel
     - **Southeastern U.S.** lipid- and biomass-based alternative jet fuel

ASCENT P1 Regional Approach

Project Groundwork (G)	Regional Deployment Project (D)
G1 - Analysis of feedstock-conversion pathway efficiency, product slate (including co-products), maturation	D1 - Develop detailed supply chain scenarios (feedstock, products/co-products, infrastructure, logistics, conversion method) for analysis/deployment
G2 - Scoping of Techno Economic Analysis (TEA) issues	D2- Stochastic TEA of pathway
G3 -Screening level GHG Life Cycle Analysis (LCA)	D3- Evaluate sustainability and GHG LCA
G4 - Identification of supply chain participants/partners	D4 -Farmer revenue, rural development, economics
G5- Develop appropriate stakeholder engagement plan	D5 - Evaluate social capital/acceptability
G6 - Identify and engage stakeholders	D6 - Evaluate environmental services revenue options
G7 - Acquire transportation network and other regional data for Freight and fuel Transportation Optimization Tool (FTOT) and other modeling	D7 - Evaluate potential economic benefit of project
G8 - Evaluate infrastructure availability	D8- Supply chain risk assessment for business adoption
G9 -Evaluate feedstock availability	D9 - Incorporate regional data into FTOT for geospatial analysis
G10 - Develop specific regional proposal	

Hawaii Regional Project
Island of Oahu

Alternative Jet Fuel Supply Chain
Tropical Region Analysis

Project 001

Project manager: Nathan Brown, FAA
Lead investigator: Scott Turn, Hawaii Natural Energy Institute, University of Hawaii

February 23, 2018
SOAP-JET Webinar

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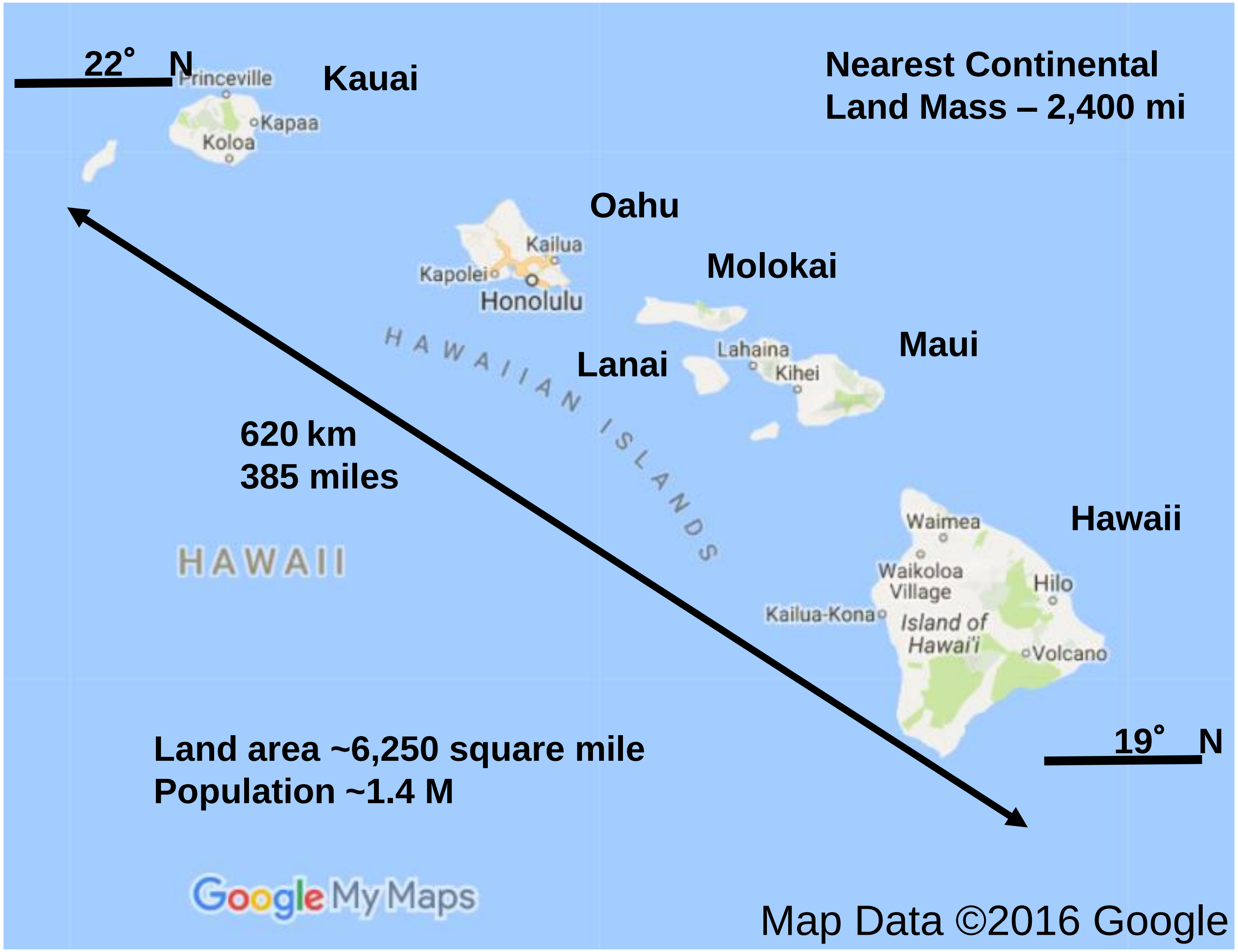
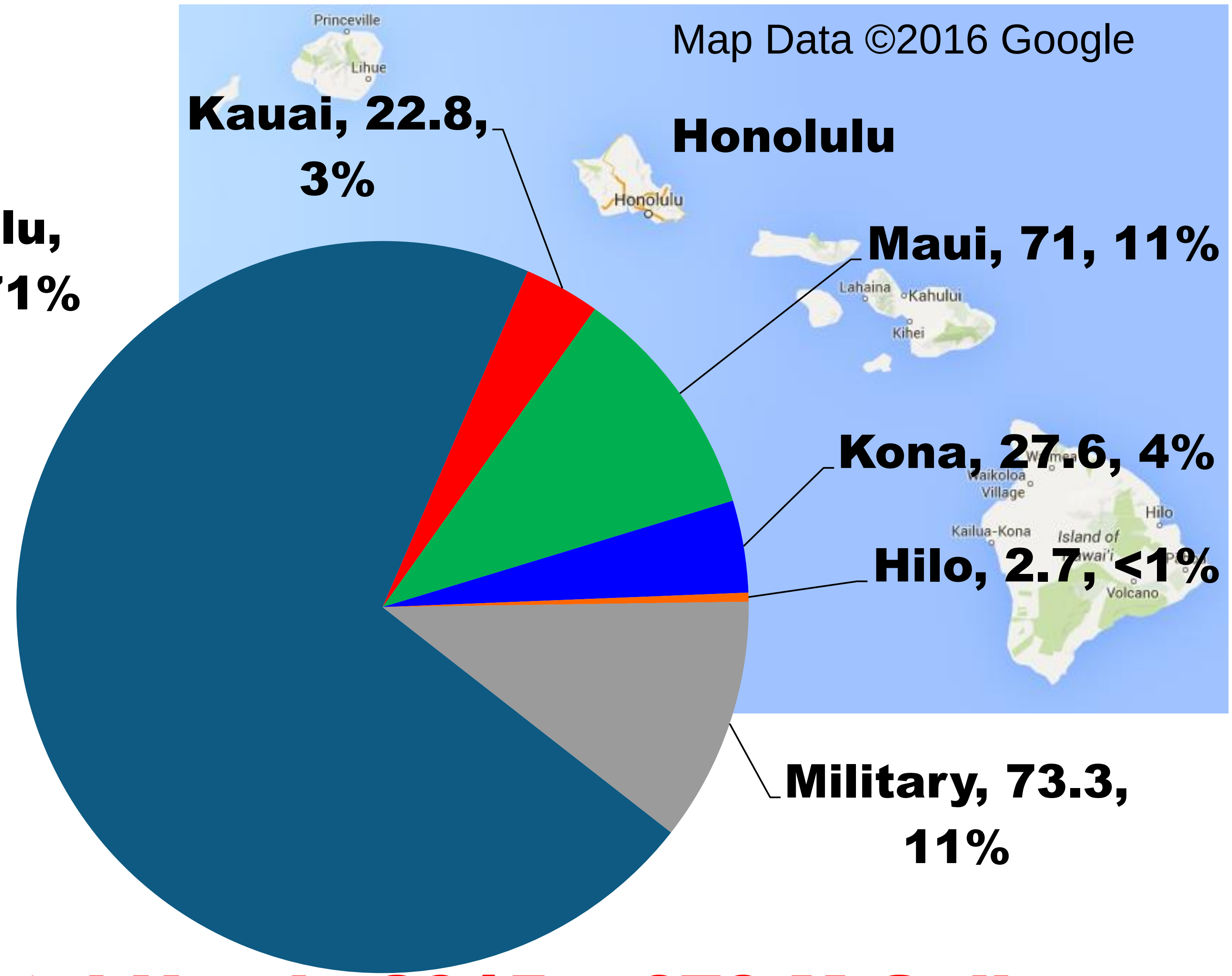


22˚ N
Princeville
Kauai
Kapaa
Koloa
Nearest Continental
Land Mass – 2,400 mi
Oahu
Kailua
Kapolei
Honolulu
Molokai
HAWAIIAN ISLANDS
Lanai
Lahaina
Kihei
Maui
620 km
385 miles
HAWAII
Waimea
Waikoloa Village
Hawaii
Hilo
Kailua-Kona
Island of Hawai'i
Volcano
19˚ N
Land area ~6,250 square mile
Population ~1.4 M
Google My Maps
Map Data ©2016 Google

Jet Fuel Use in Hawaii, 2015 Commercial Airports and Military (million gallons)



Total Use in 2015 -- 679 M Gallons

Value Chain for AJF Production

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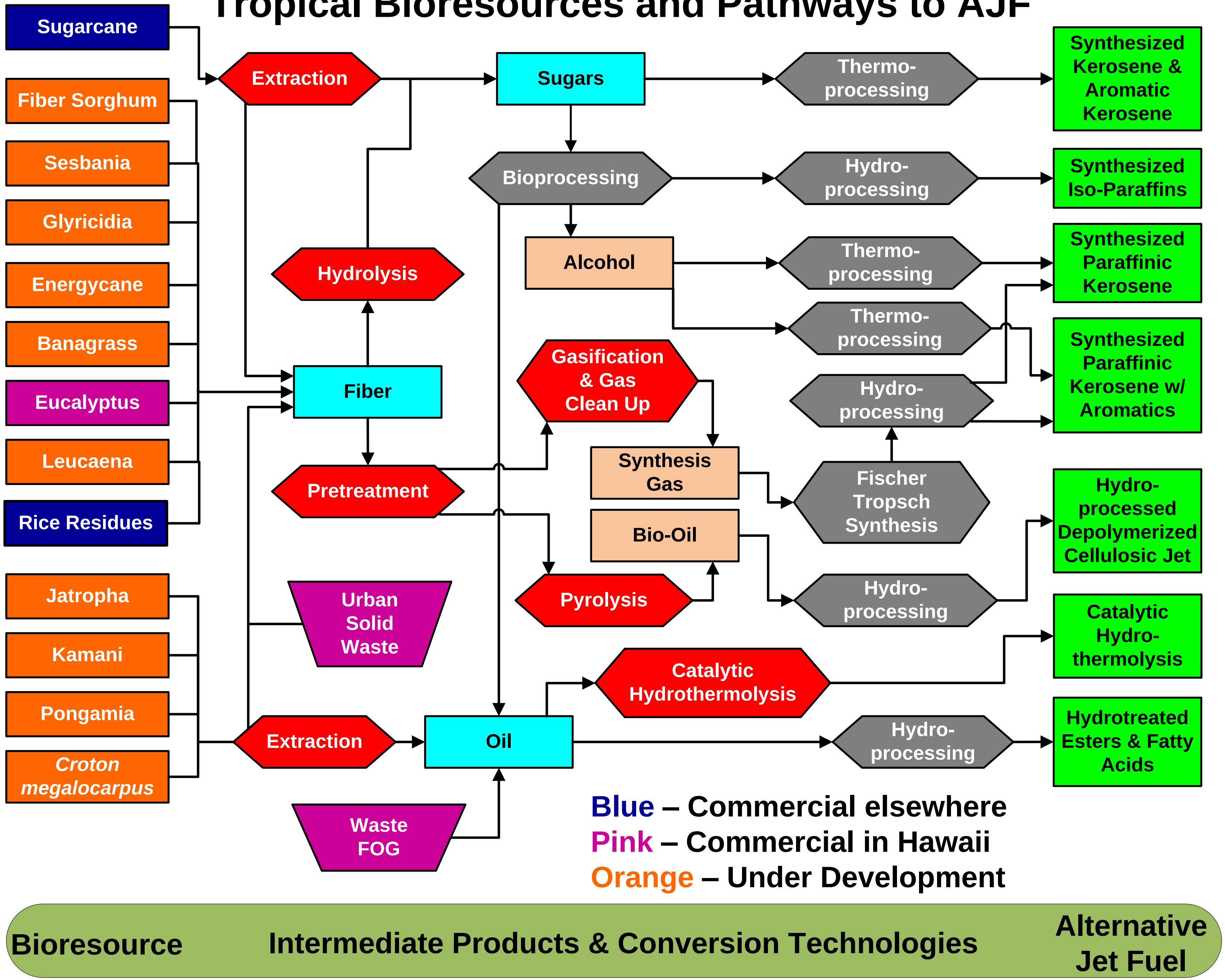
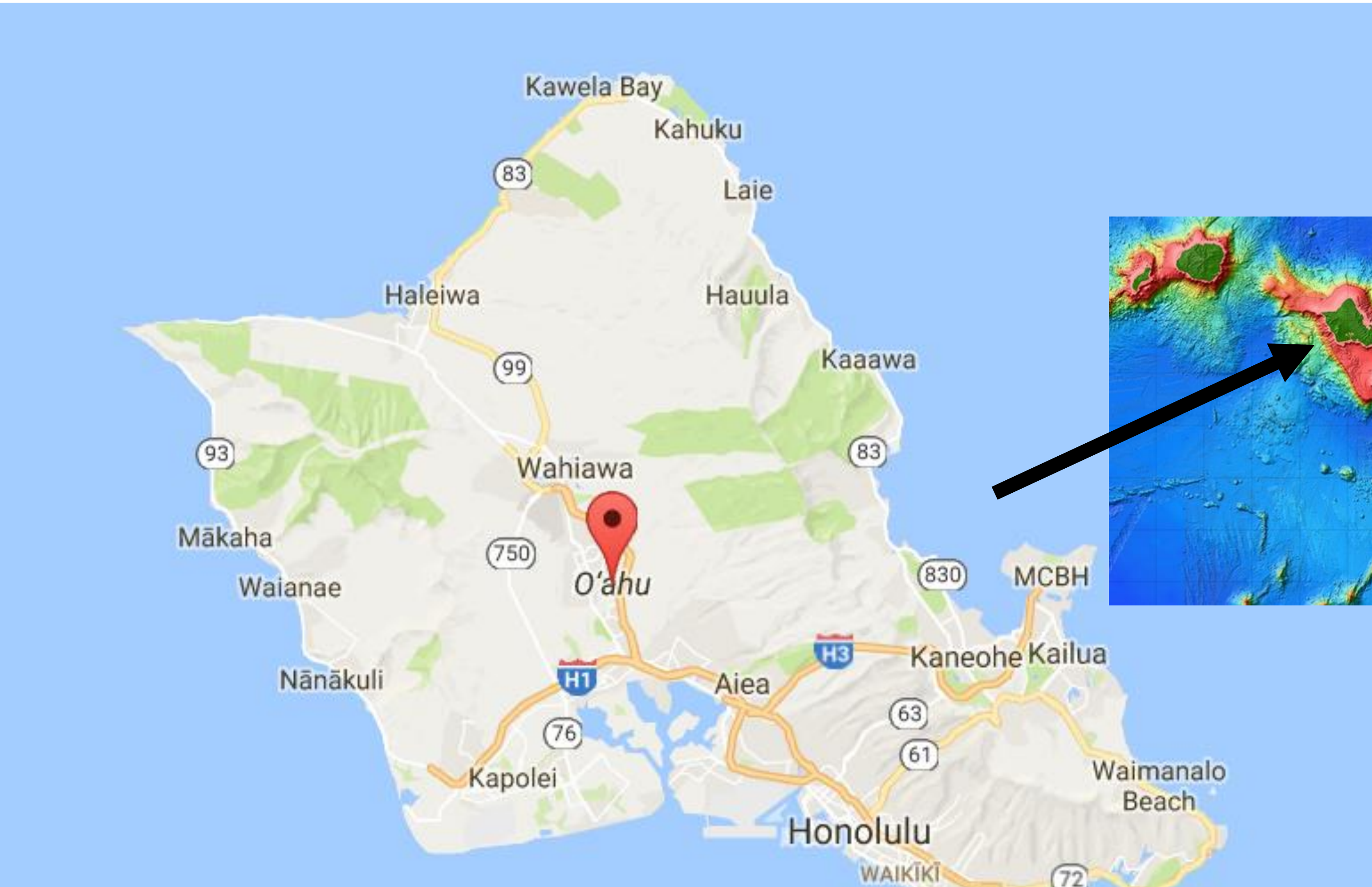
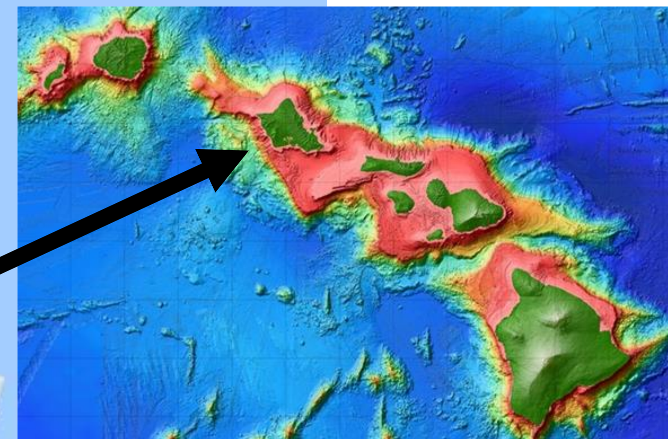
Feedstock Production	Feedstock Logistics	Conversion	Distribution	End Use

Agriculture ---- Industry ---- Investors ---- Government ---- Community

Tropical Bioresources and Pathways to AJF







Island of Oahu
City & County of Honolulu
~600 sq miles (~25 mi x 25 mi)
Population ~1 million

Google

Map data ©2017 Google

Map data ©2017 Google Terms Send fee

PVT Land Company
Nānākuli, Hawaii
http://www.pvtland.com

Map data ©2017 Google

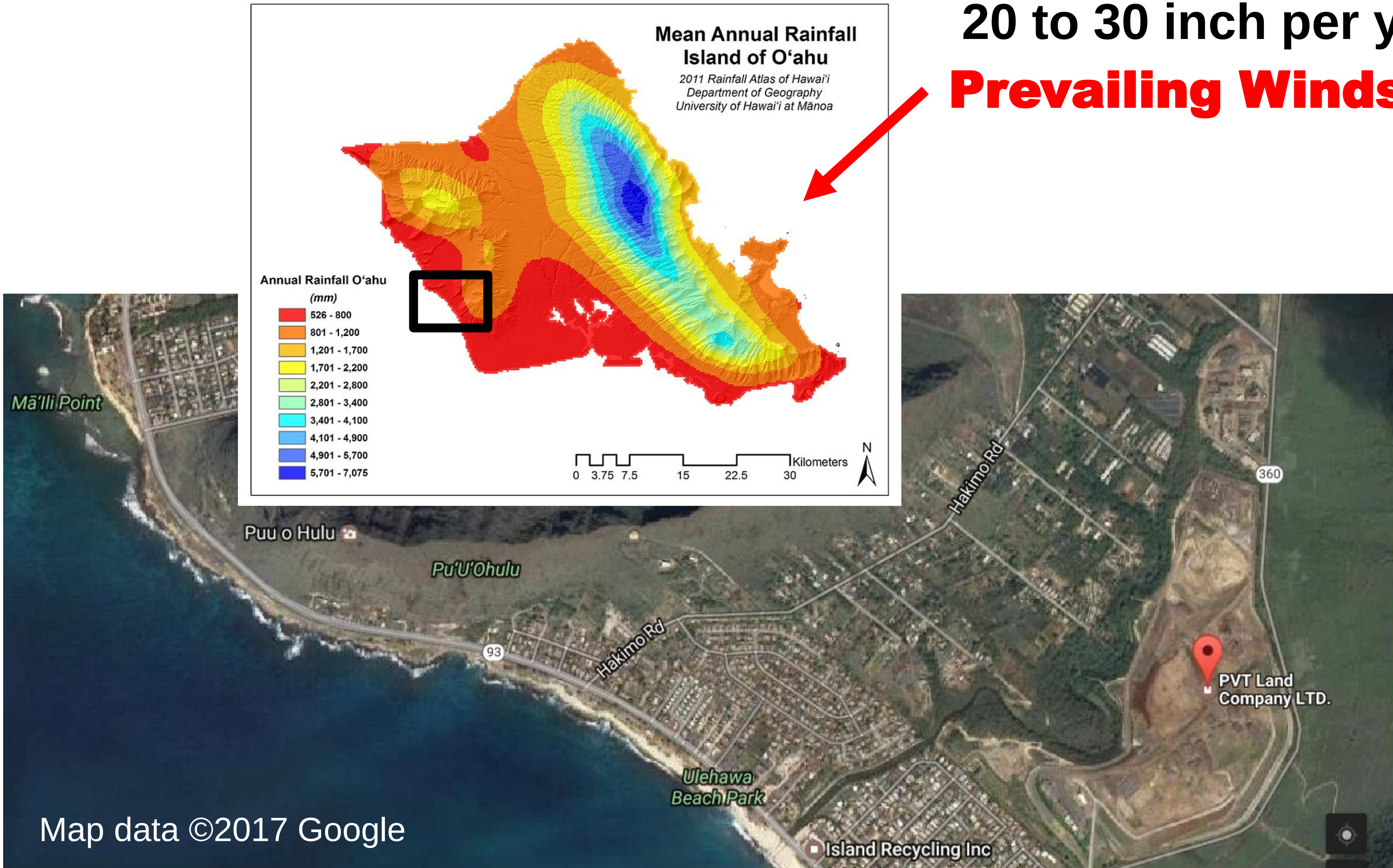
- **PVT is the only construction & demolition landfill on Oahu**
- **Current intake 1,775 tons C&D waste per day**
- **~50% of intake converted to feedstock, up to 900 tpd**
- **Waste-in-place also "mined" for additional "feedstock"**
- **Feedstock: wood, plastic, cloth, paper, and other organics**
- **Recycling system to generate feedstock was dedicated in 2014, currently processing and stockpiling material**
- **Tipping fee $50 per ton, or $54 per ton for LEED certified**

PVT Feedstock Processing Facility

PVT Site Characteristics

Rainfall – 525 to 800 mm per yr
20 to 30 inch per yr

Prevailing Winds

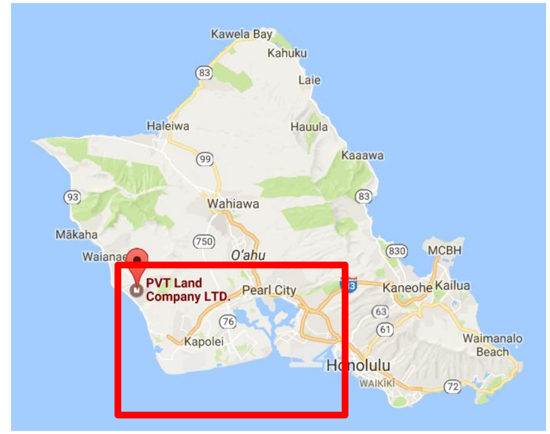


PVT Feedstock Characterization

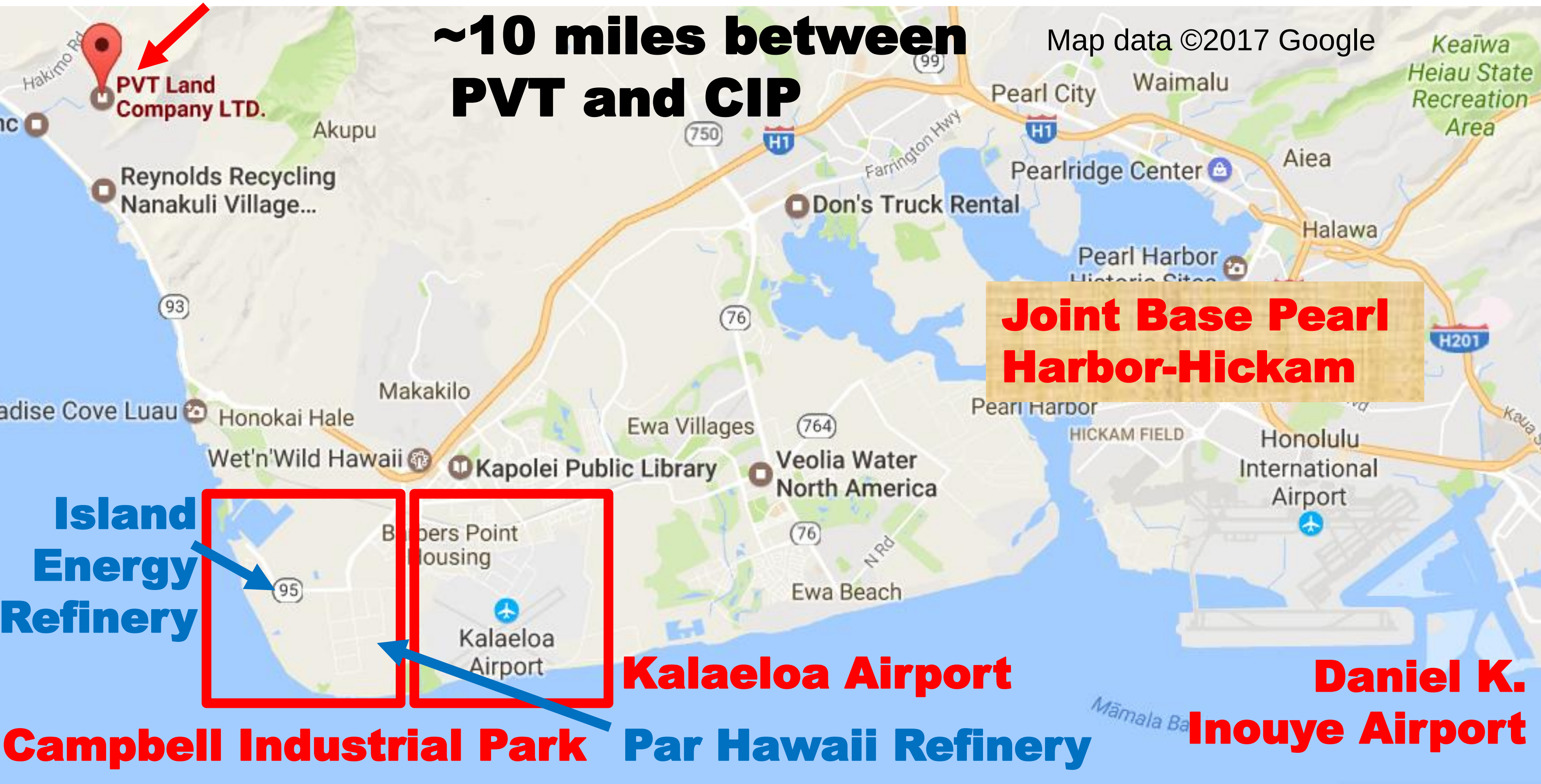
- **Characterization of feedstock properties needed to inform conversion process design**
  - Ultimate analysis for major elements: C, H, O, N, S
  - Proximate analysis: volatile matter, fixed carbon and ash
  - Major ash species: K, Cl, Na, P, Mg, Si, Fe, Ti, Al, and Ca
  - Minor ash species: Mn, Fe, Cu, Zn, Rb, and Sr
  - Moisture content
  - Energy content or heating value
- **Characterization of feedstock properties needed for logistics particle size of materials, bulk densities, etc.**
- **Time series data to assess variability in supply**

Value Chain for AJF Production

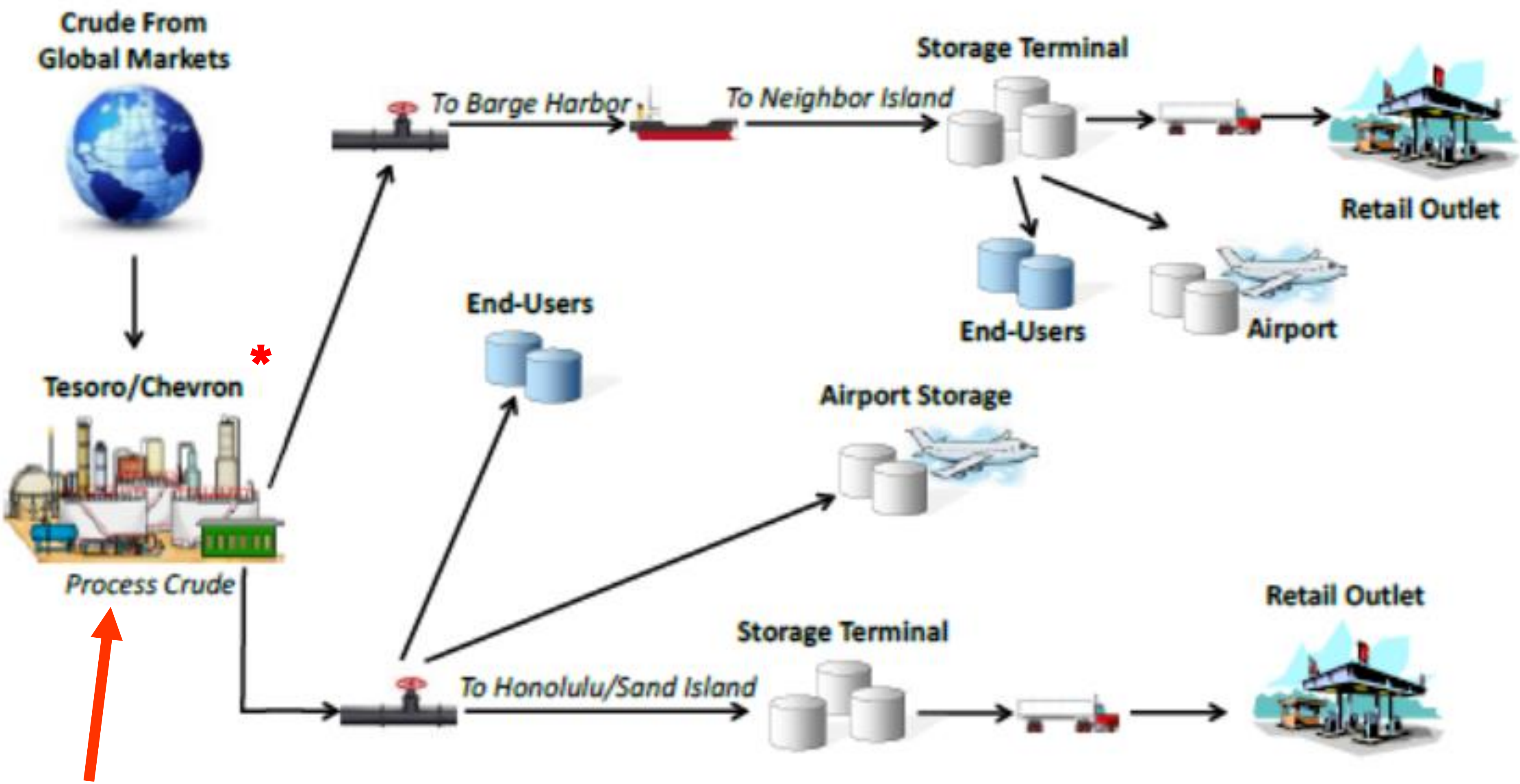
Possible Locations of Value Chain Participants



PVT Land Company



Hawaii Petroleum Supply Schematic



*** Currently Par Hawaii and Island Energy refineries**

Source: Hawaii Refinery Task Force Report, 2013

Questions?

Alternative Jet Fuel Supply Chain Analysis

ASCENT 1

Regional Supply Chain Approaches

Development of a Supply Chain for the Production Jet Fuel from Oilseeds Grown in the Pacific Northwest

Project Manager: Nathan Brown, FAA
Lead Investigators: M. Wolcott, K. Brandt, N. Martinkus
Graduate Student: Dane Camenzind, WSU

[January 22, 2018]

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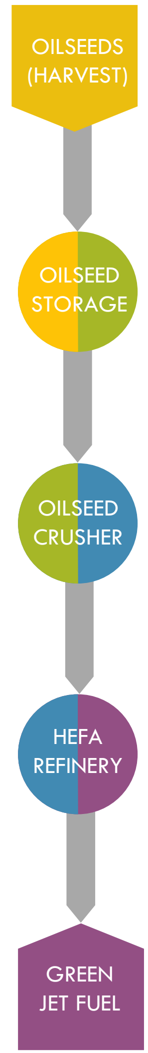
SIMPLE SUPPLY CHAIN MODEL



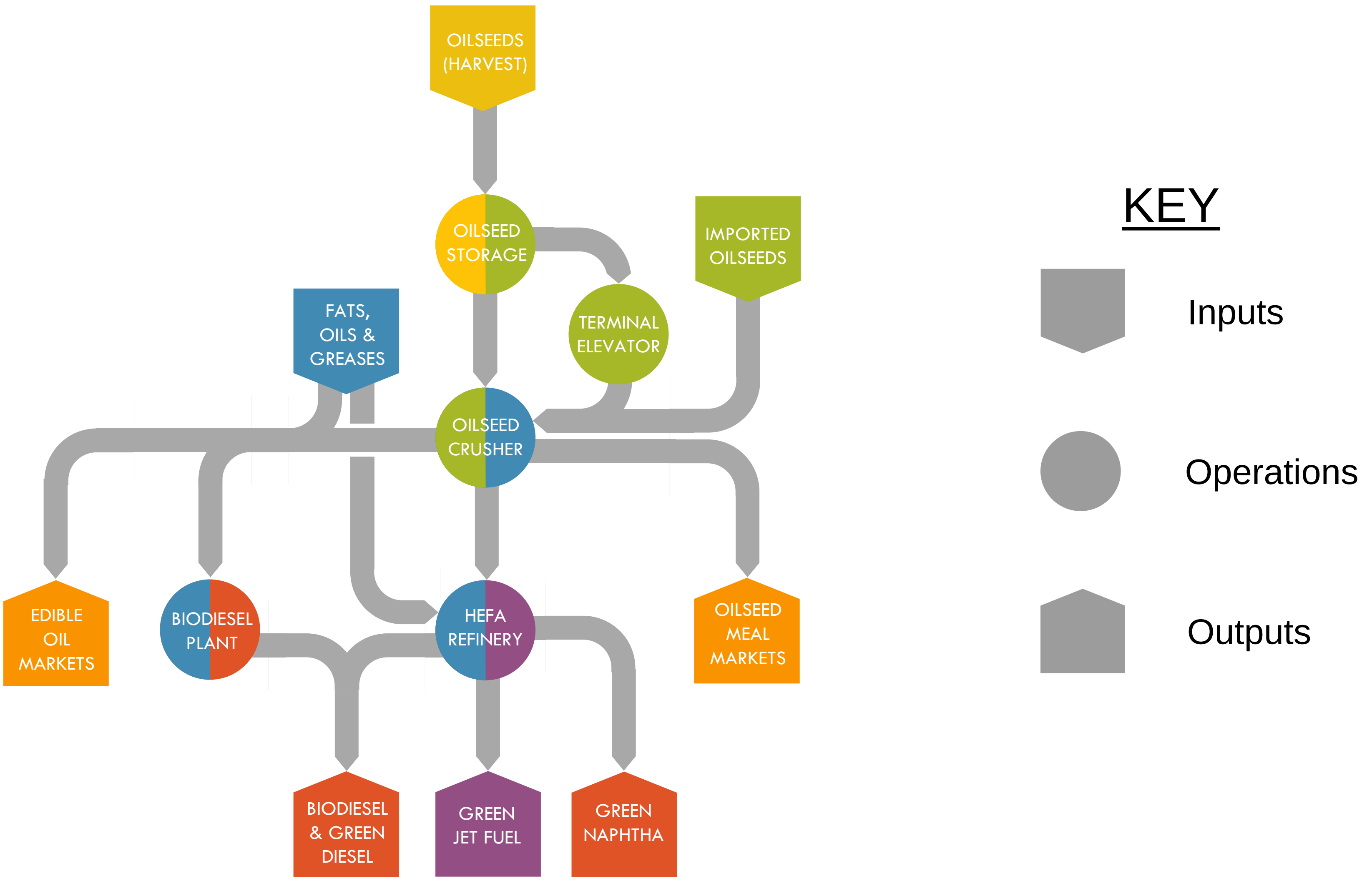
KEY

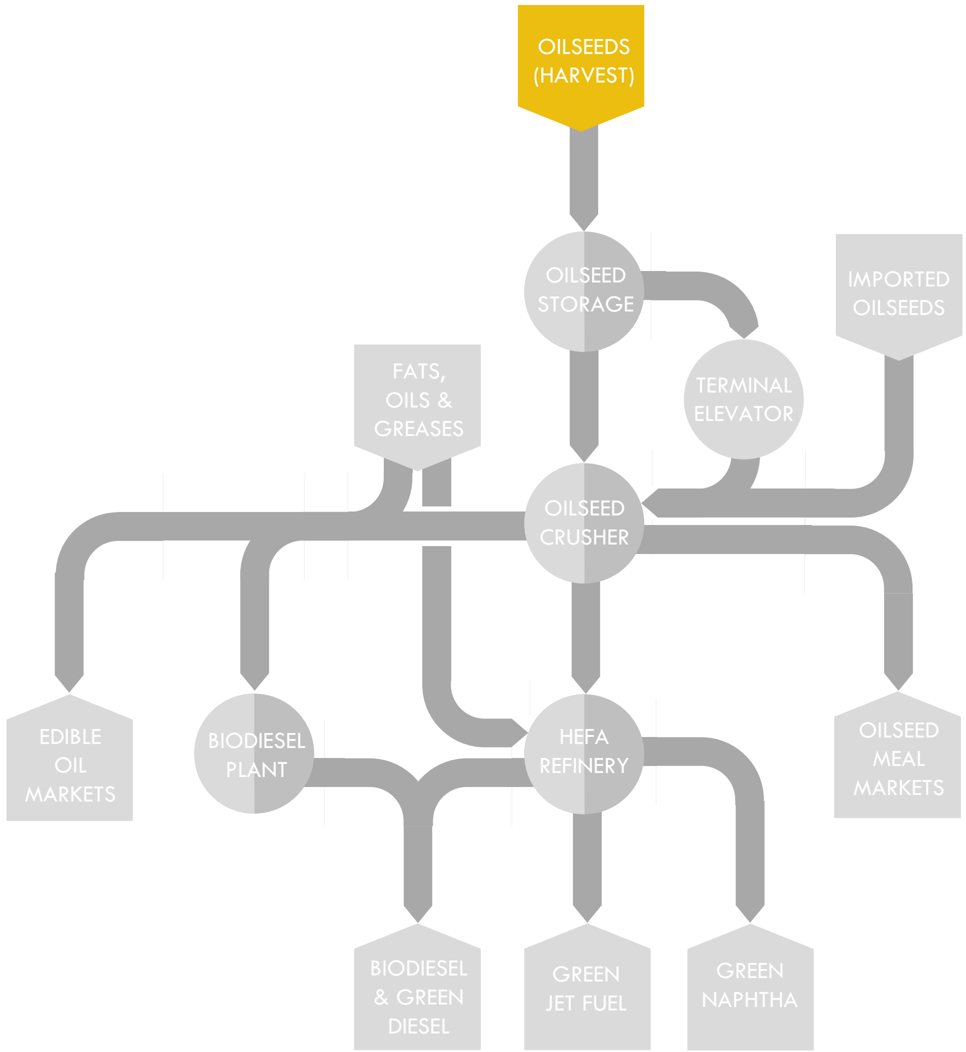
Inputs

Operations

Outputs

COMPLEX SUPPLY CHAIN MODEL




OILSEEDS (HARVEST)
OILSEED STORAGE
IMPORTED OILSEEDS
TERMINAL ELEVATOR
FATS, OILS & GREASES
OILSEED CRUSHER
EDIBLE OIL MARKETS
BIODIESEL PLANT
HEFA REFINERY
OILSEED MEAL MARKETS
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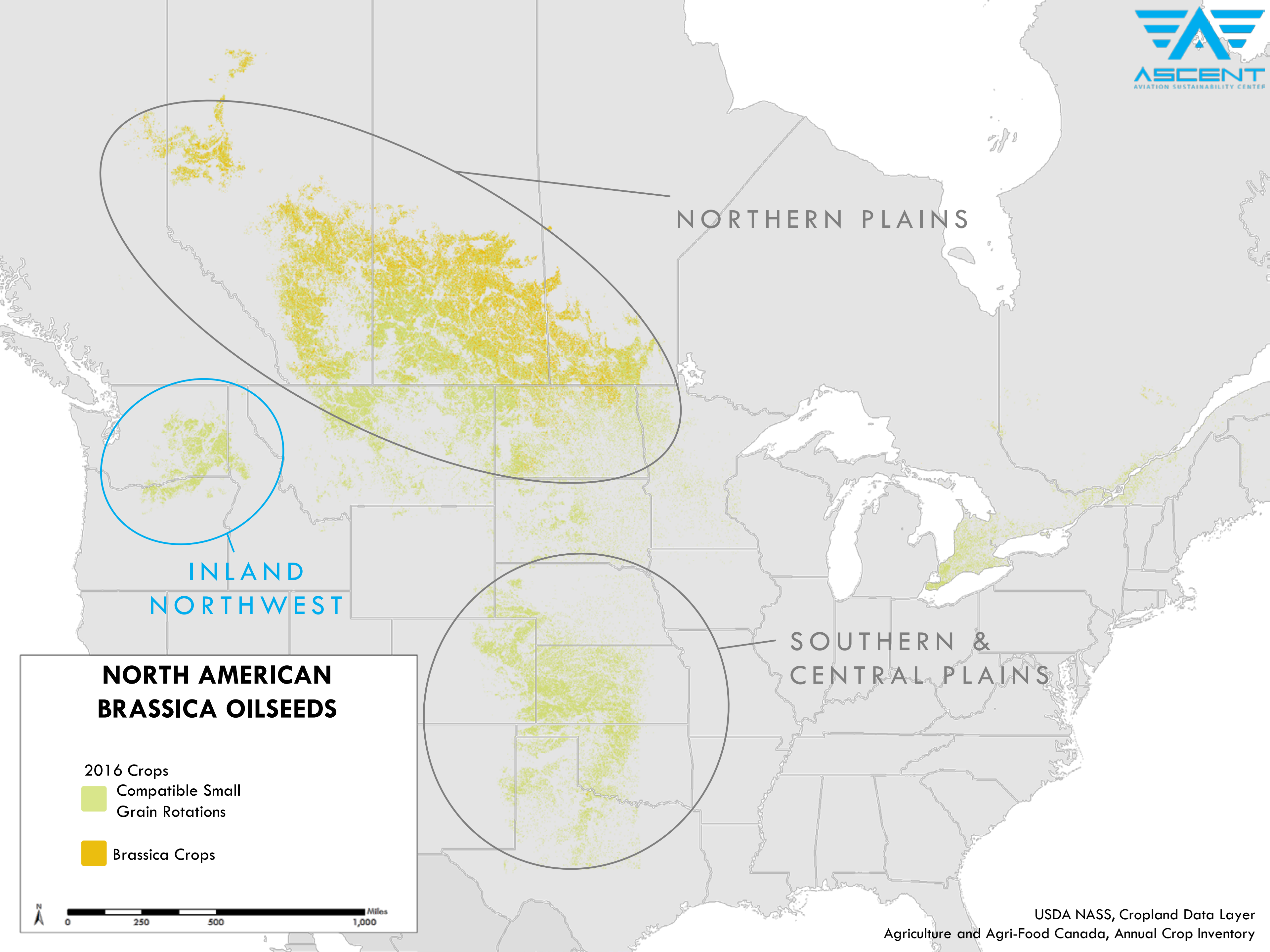
GREEN JET FUEL
GREEN NAPHTHA



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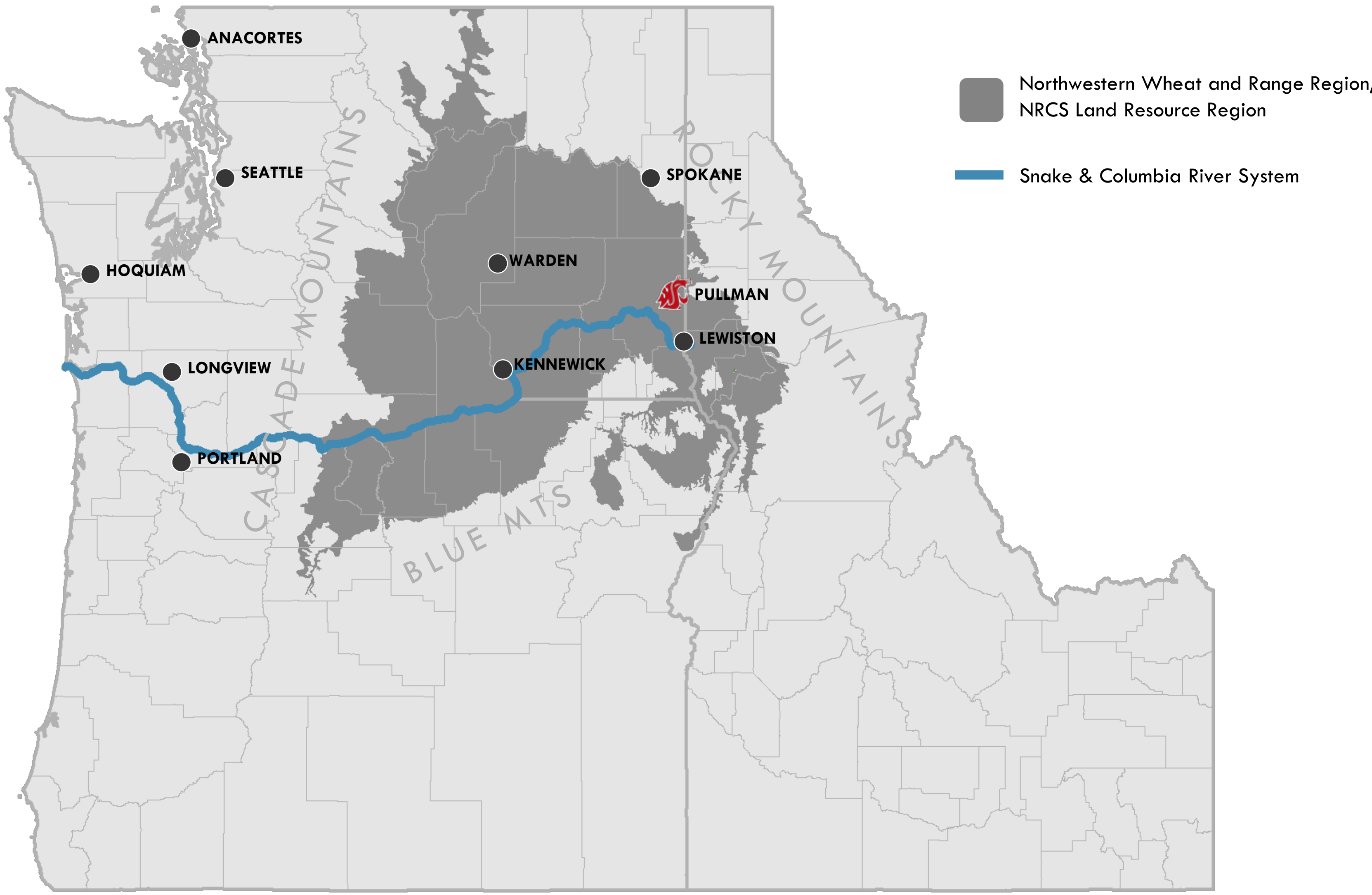
NORTHERN PLAINS
INLAND NORTHWEST
SOUTHERN & CENTRAL PLAINS
NORTH AMERICAN BRASSICA OILSEEDS
2016 Crops
Compatible Small Grain Rotations
Brassica Crops
Miles
0
250
500
1,000
N
USDA NASS, Cropland Data Layer
Agriculture and Agri-Food Canada, Annual Crop Inventory

INLAND PACIFC NORTHWEST



CROPPING SYSTEMS

- Focus on dryland systems
- Decisions often based on moisture availability
  - Summer fallow is common in drier areas
- Brassicas are viewed as secondary crops with benefits for soil health and grass weed control

FERDINAND, ID – June 3

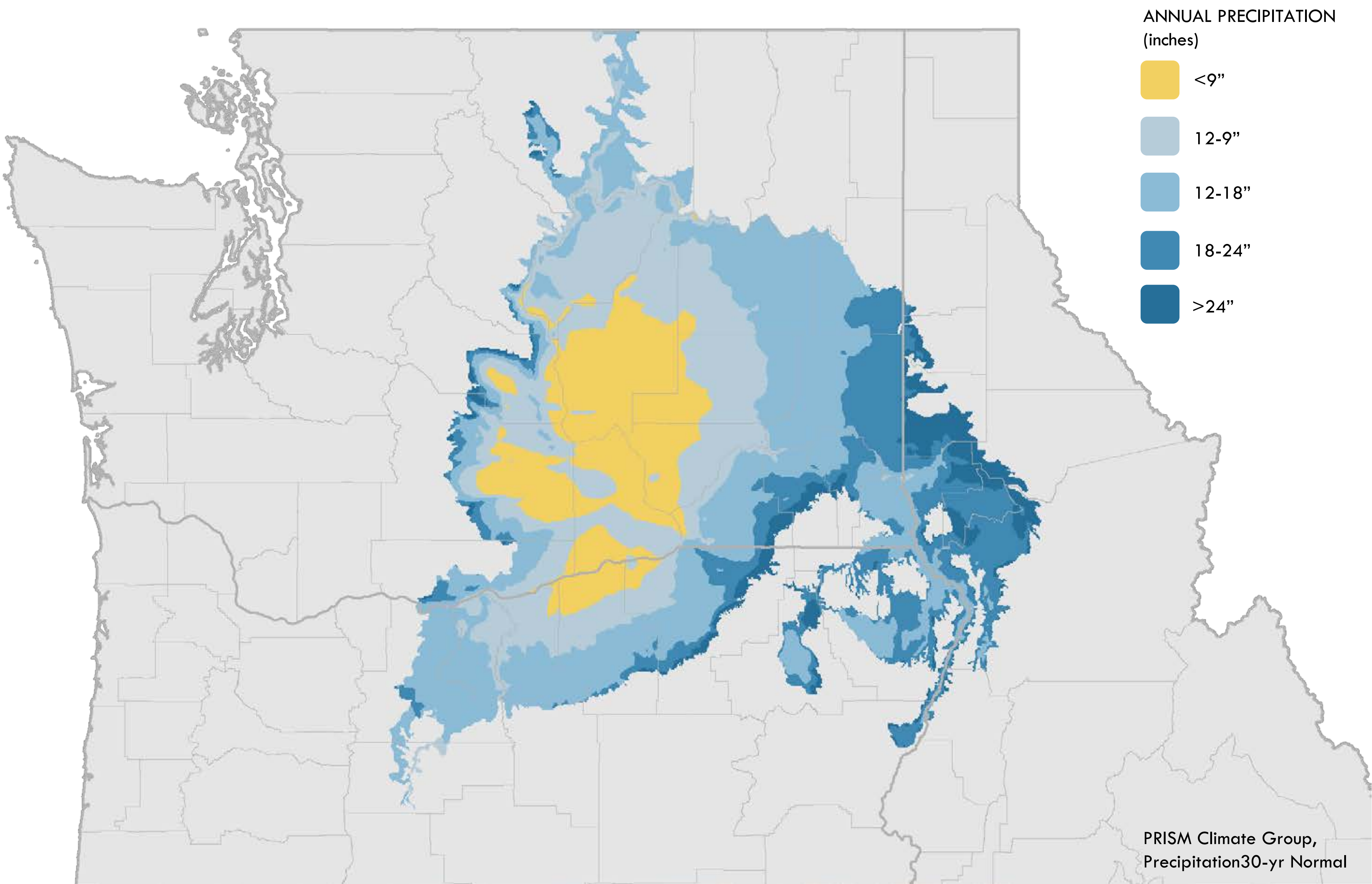
COMMON CROPS

SMALL GRAINS
- Winter Wheat
- Spring Wheat
- Barley

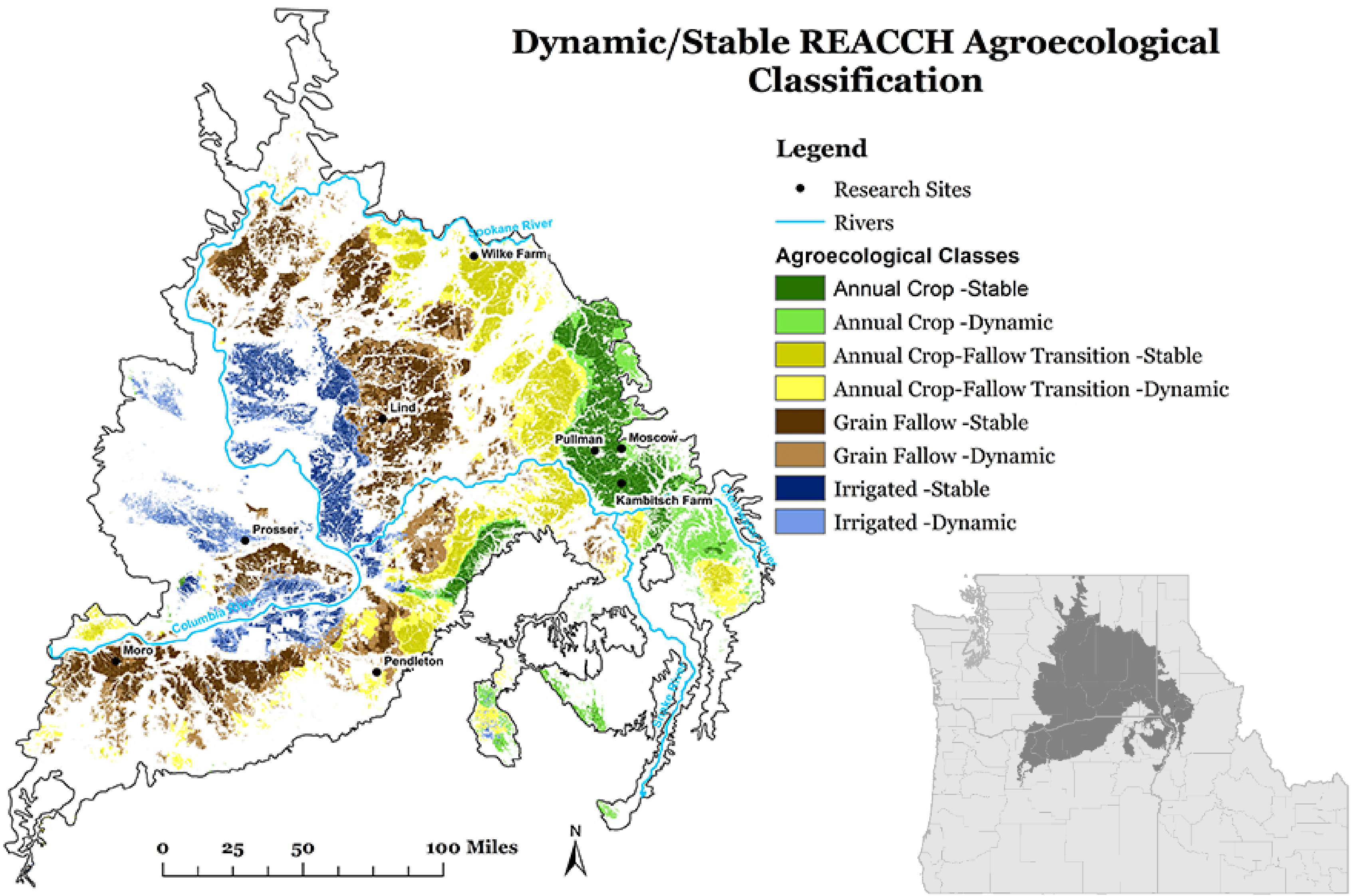
PULSES
- Peas
- Lentils
- Garbanzo Beans

BRASSICA OILSEEDS
- Canola/Rapeseed
- Mustard
- Camelina
- Carinata

PRECIPITATION



AGROECOLOGICAL CLASSES



REACCH
Regional Approaches to Climate Change –
PACIFIC NORTHWEST AGRICULTURE

David Huggins – WSU/ARS
Sustainable Agroecosystems Research

AGROECOLOGICAL CLASSES

GRAIN FALLOW
- >40% fallow

Rotations:
- WW-F
- WW-F-WC-F

TRANSITION
- 10-40% fallow

Rotations:
- WW-SW-F
- WC-SW-F
- WW-SC-F

ANNUAL CROP
- <10% fallow

Rotations
- WW-SW-Pulse
- WW-Pulse
- WW-SW-SC
- WC-SW

USDA NAIP Imagery

CROP YIELDS

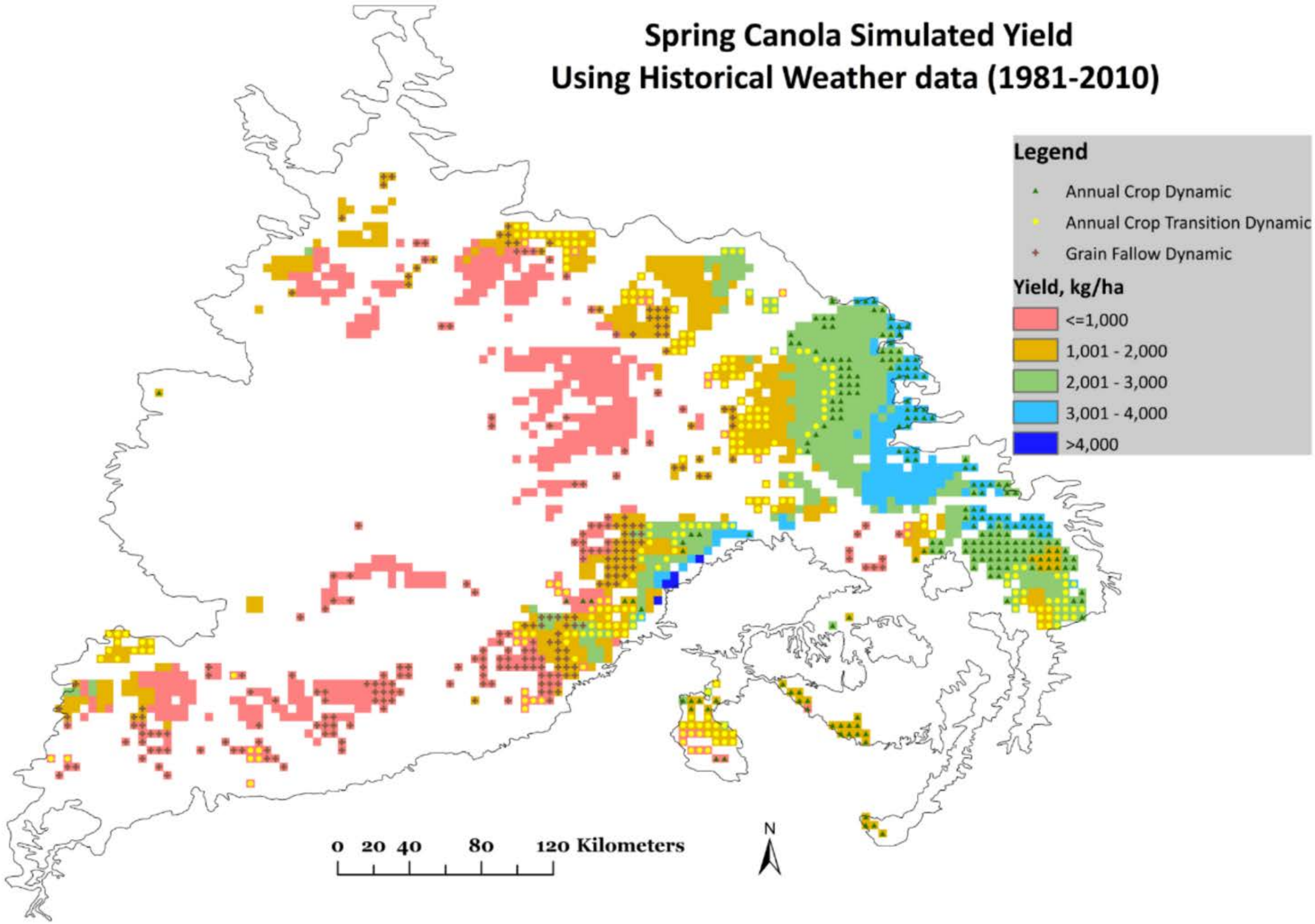


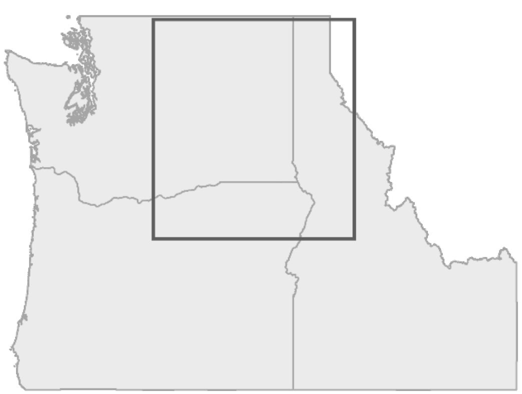
Figure 15. Spring canola yields obtained using historic weather data.

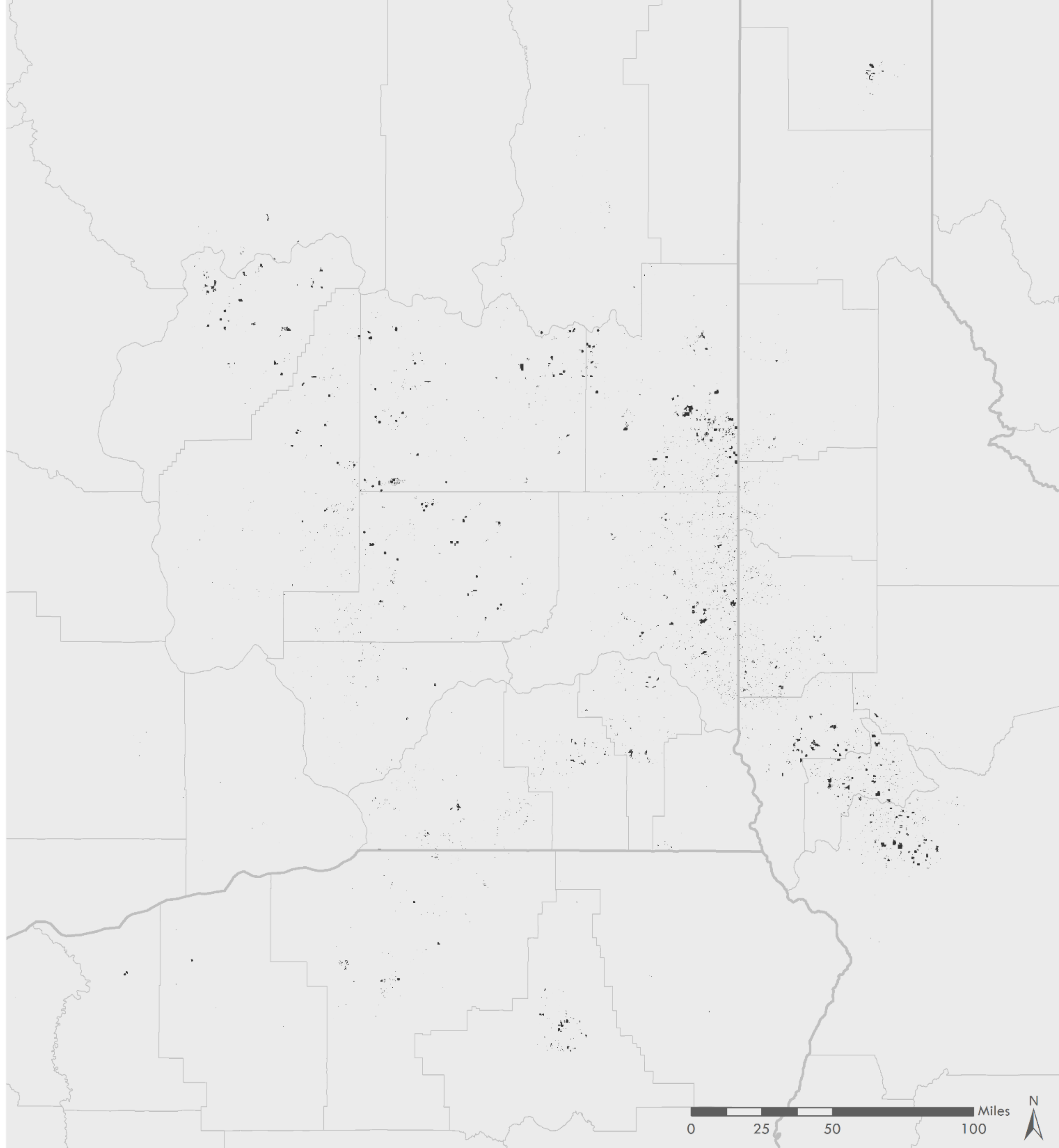
GRID INPUTS

- 2016 USDA Cropland Data Layer (CDL)
- Canola

Production

■ Canola



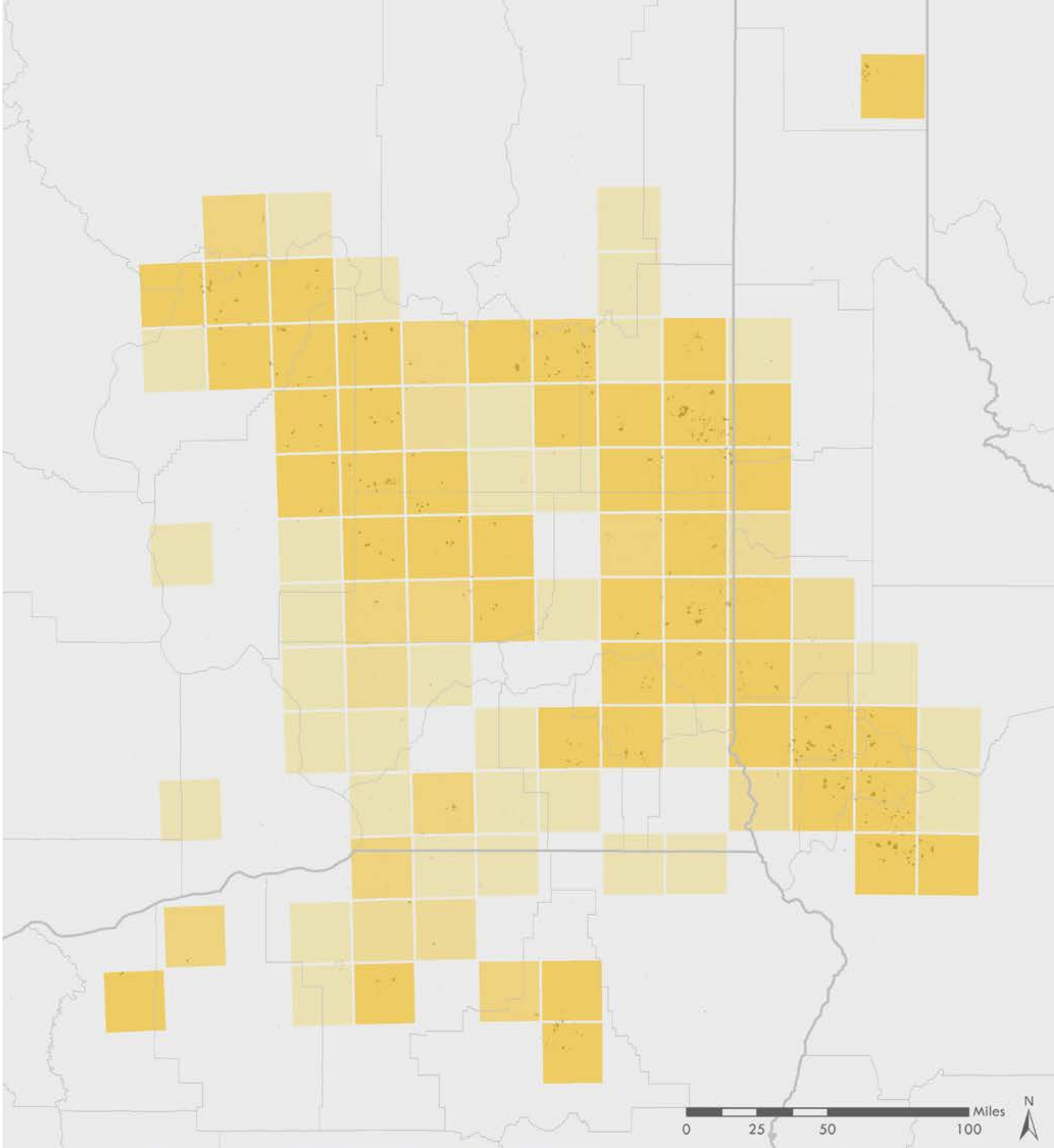


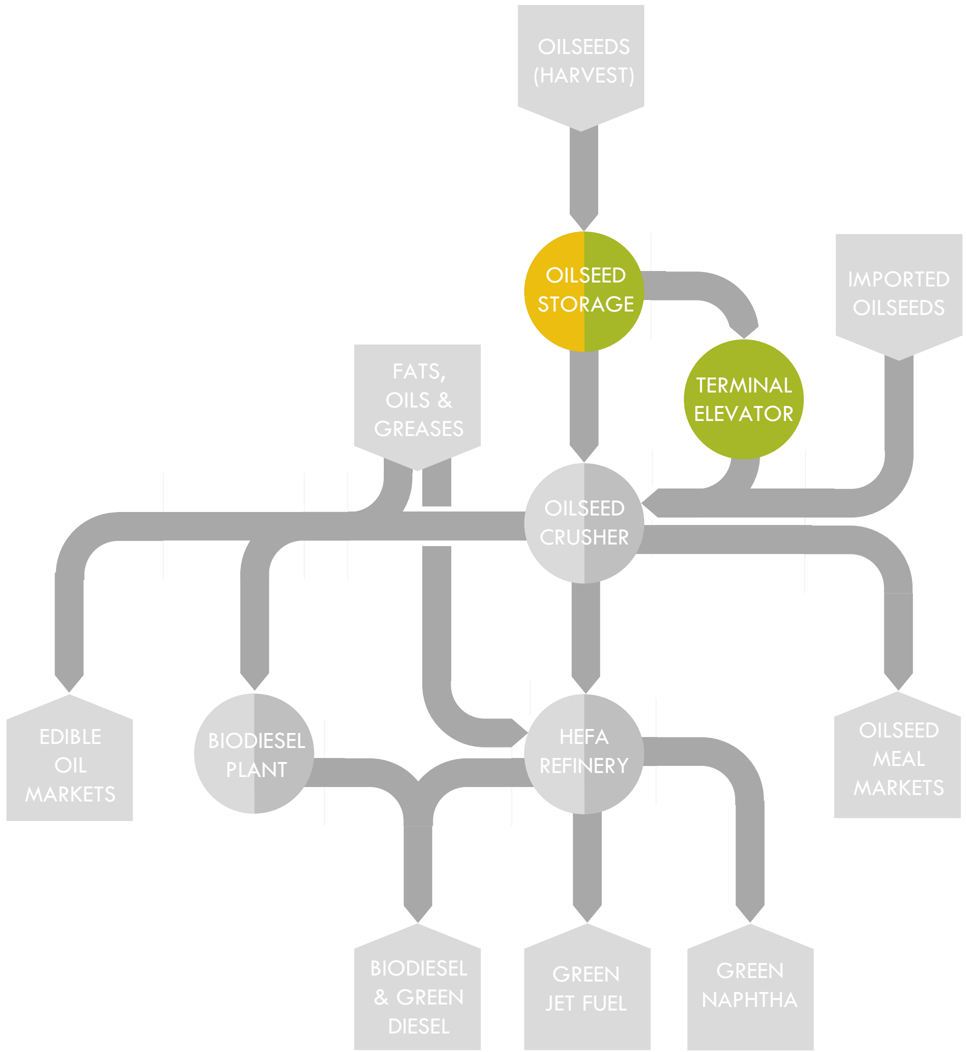
GRID INPUTS

- 2016 USDA Cropland Data Layer (CDL)
- Canola
- 25 km grid (96 cells)

Production Points
Tons at Harvest

- < 25
- 25 - 50
- 50 - 100
- 100 - 250
- > 250

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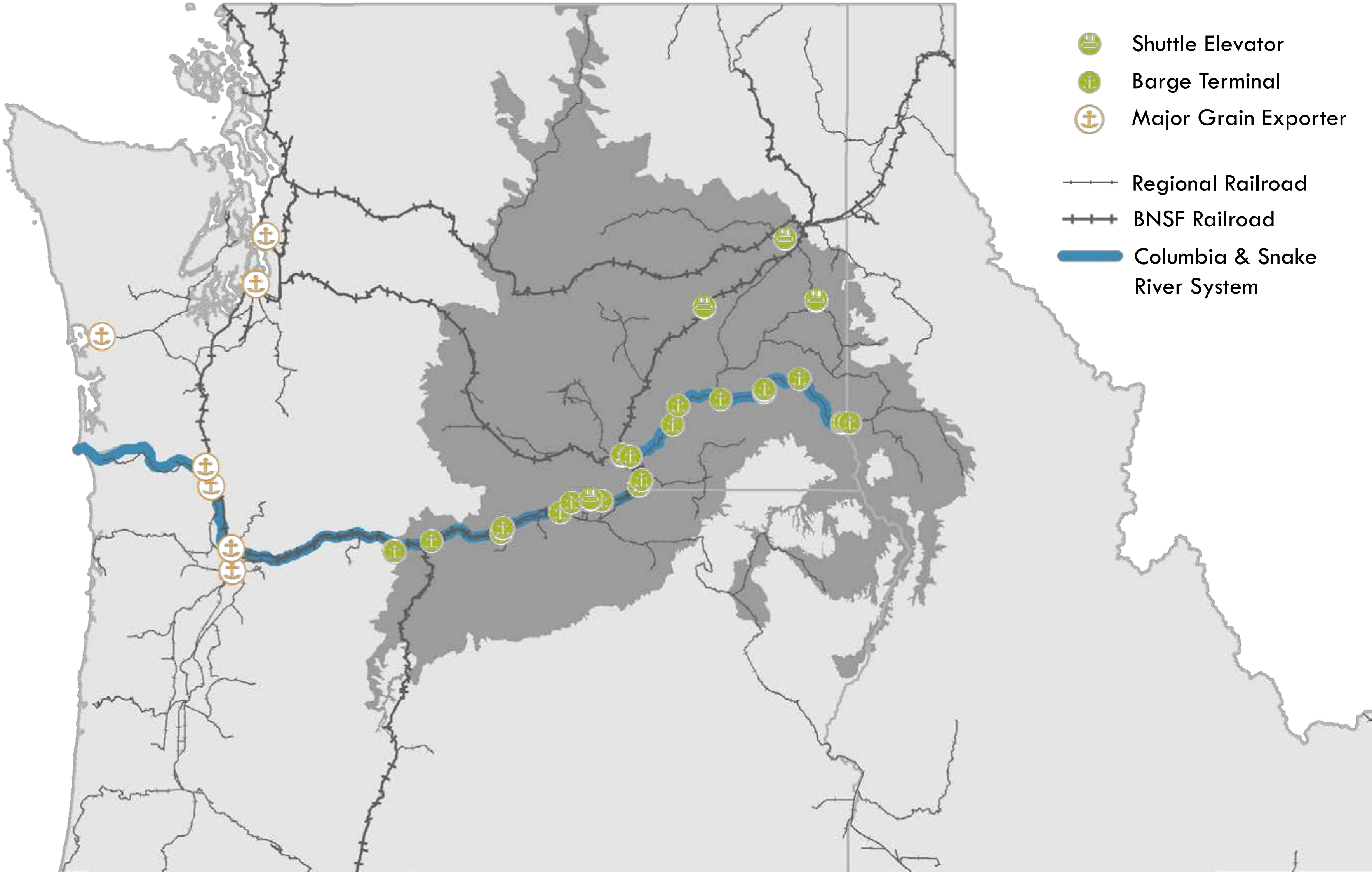
OILSEED STORAGE

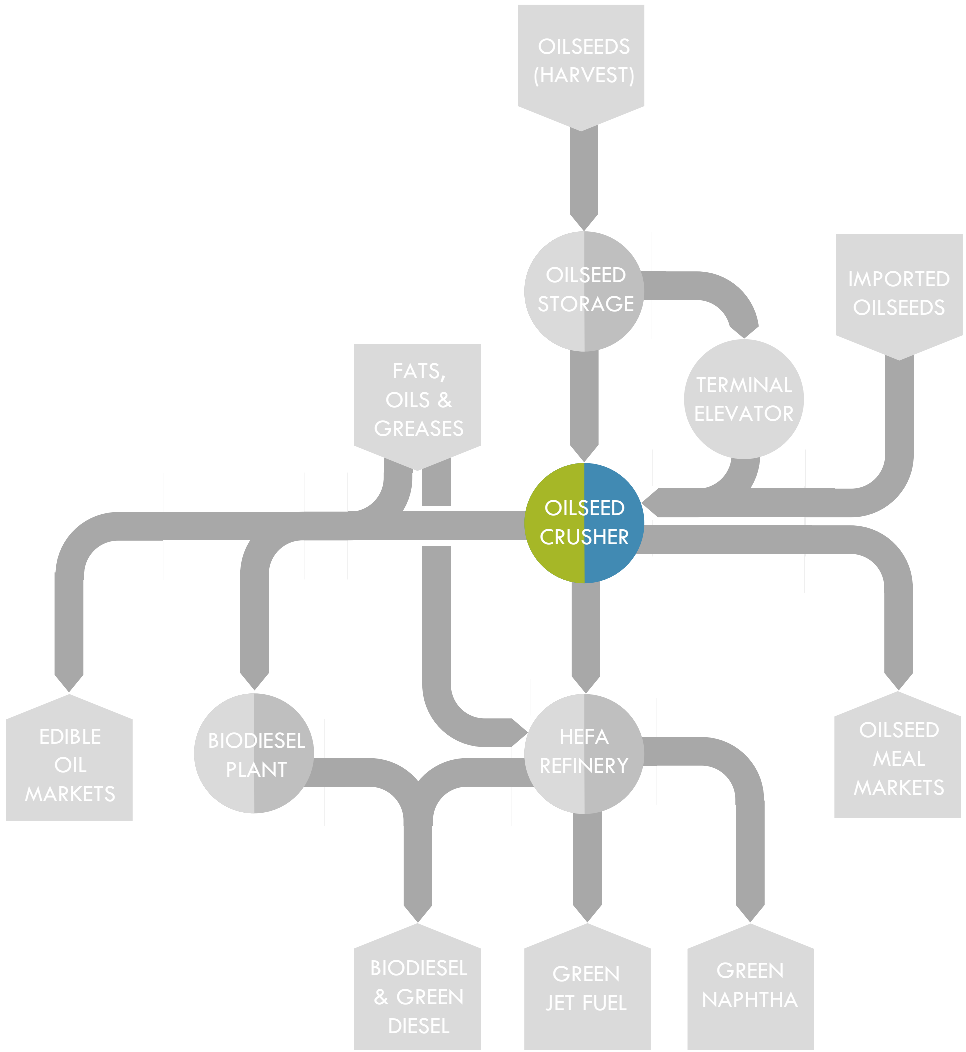
- Long-term storage
- Country elevators are typically built along rail
- Country elevators have an average “catchment radius” of 10-30 miles

ON-FARM BINS


COUNTRY ELEVATOR

EXISTING TERMINALS

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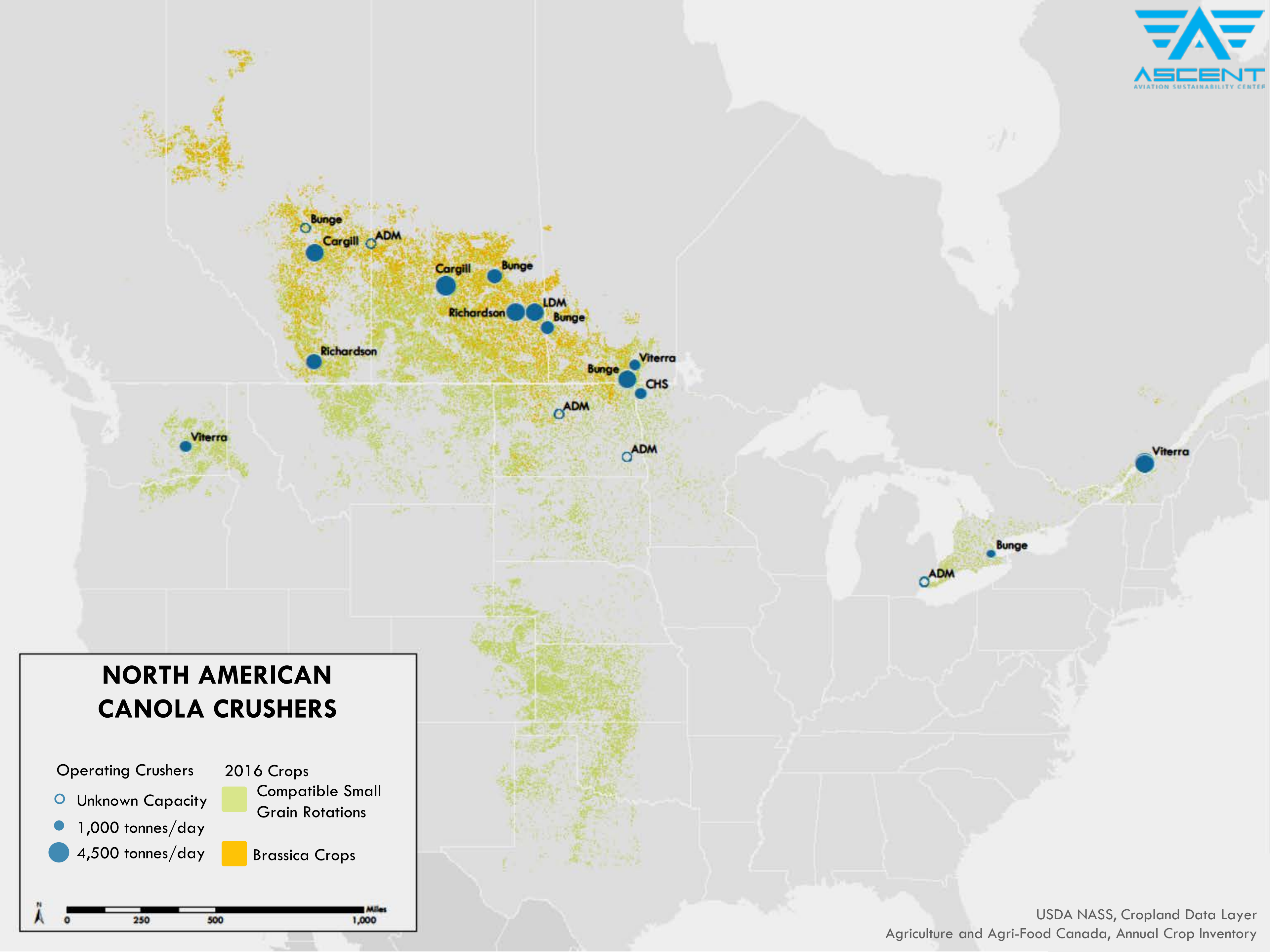

NORTH AMERICAN CANOLA CRUSHERS
Operating Crushers
Unknown Capacity
1,000 tonnes/day
4,500 tonnes/day
2016 Crops
Compatible Small Grain Rotations
Brassica Crops
0
250
500
1,000
Miles
Bunge
Cargill
ADM
Cargill
Bunge
Richardson
LDM
Bunge
Richardson
Viterra
Bunge
CHS
ADM
Viterra
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AVIATION SUSTAINABILITY CENTER
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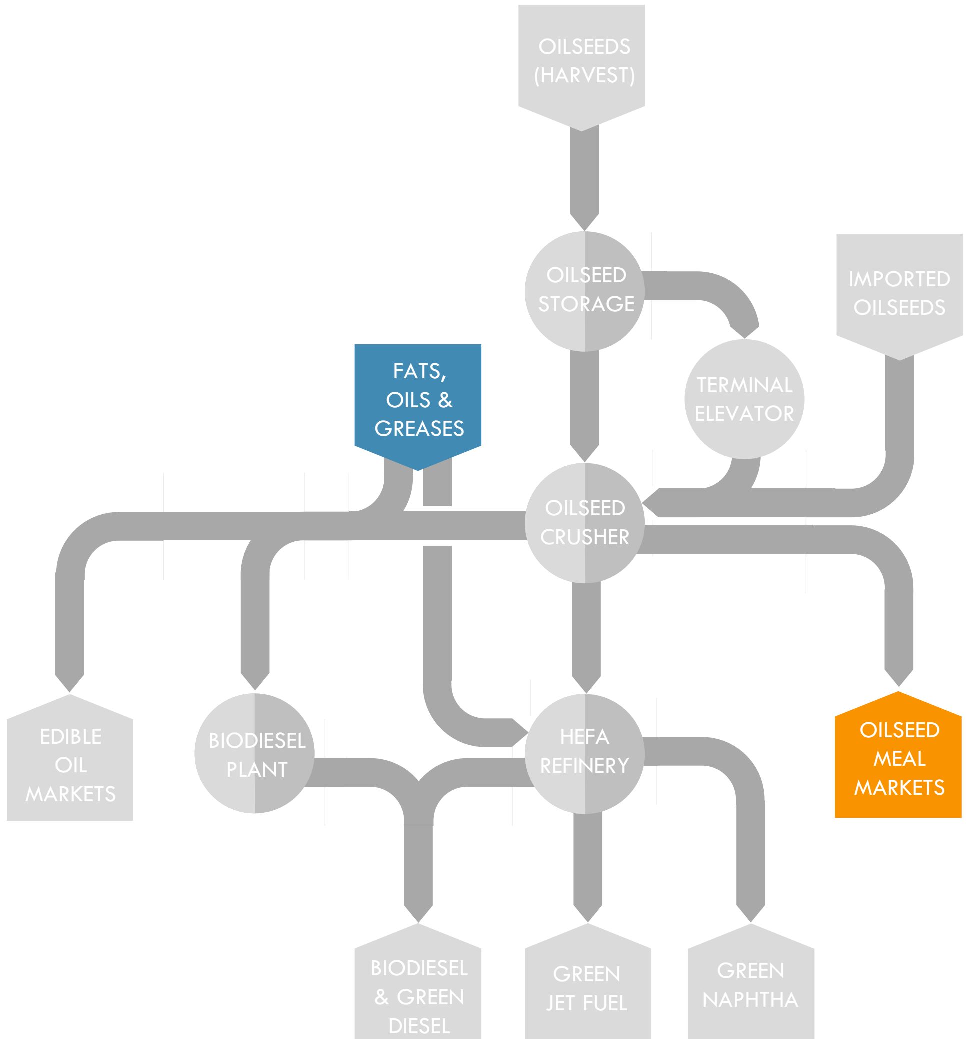

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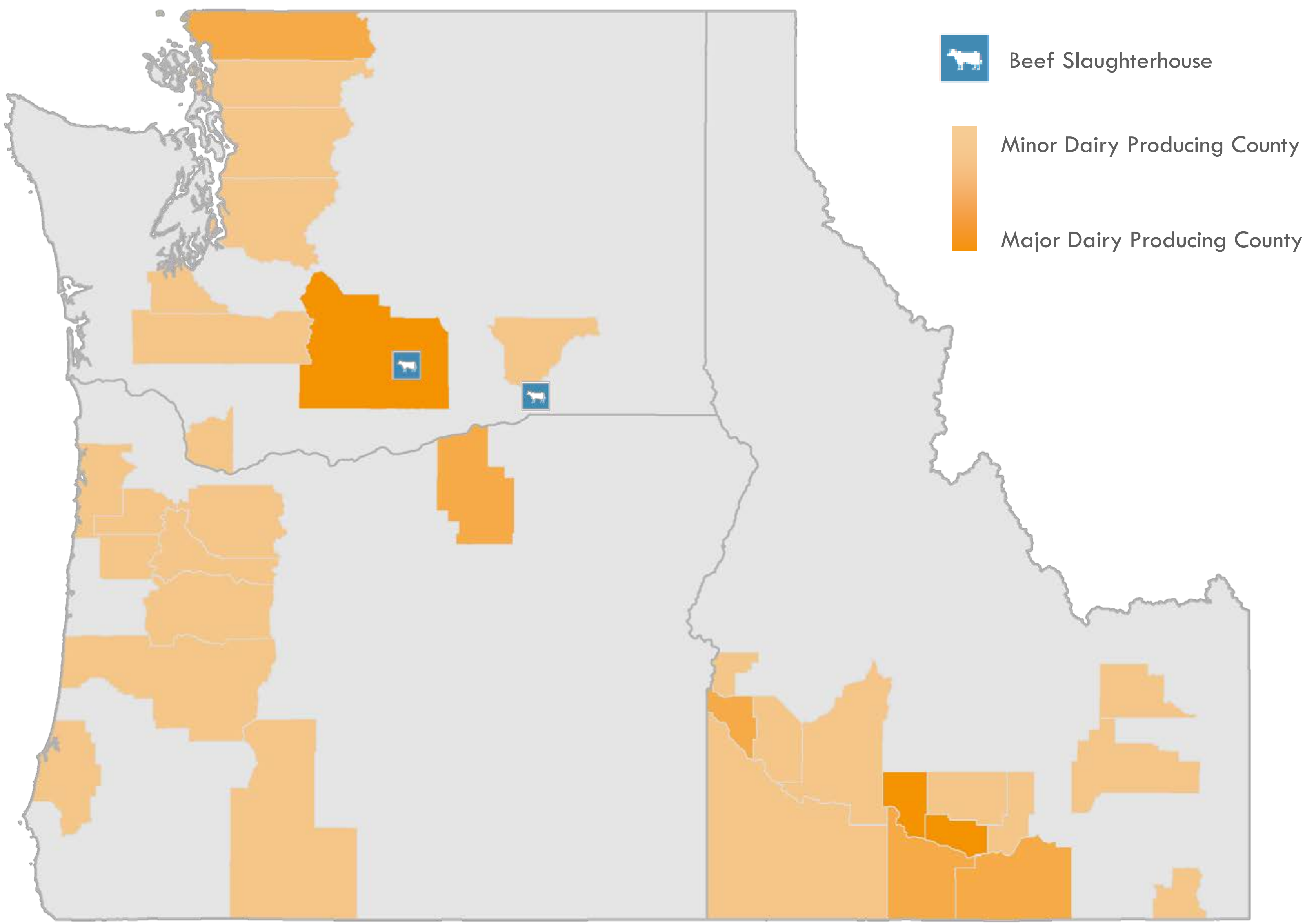
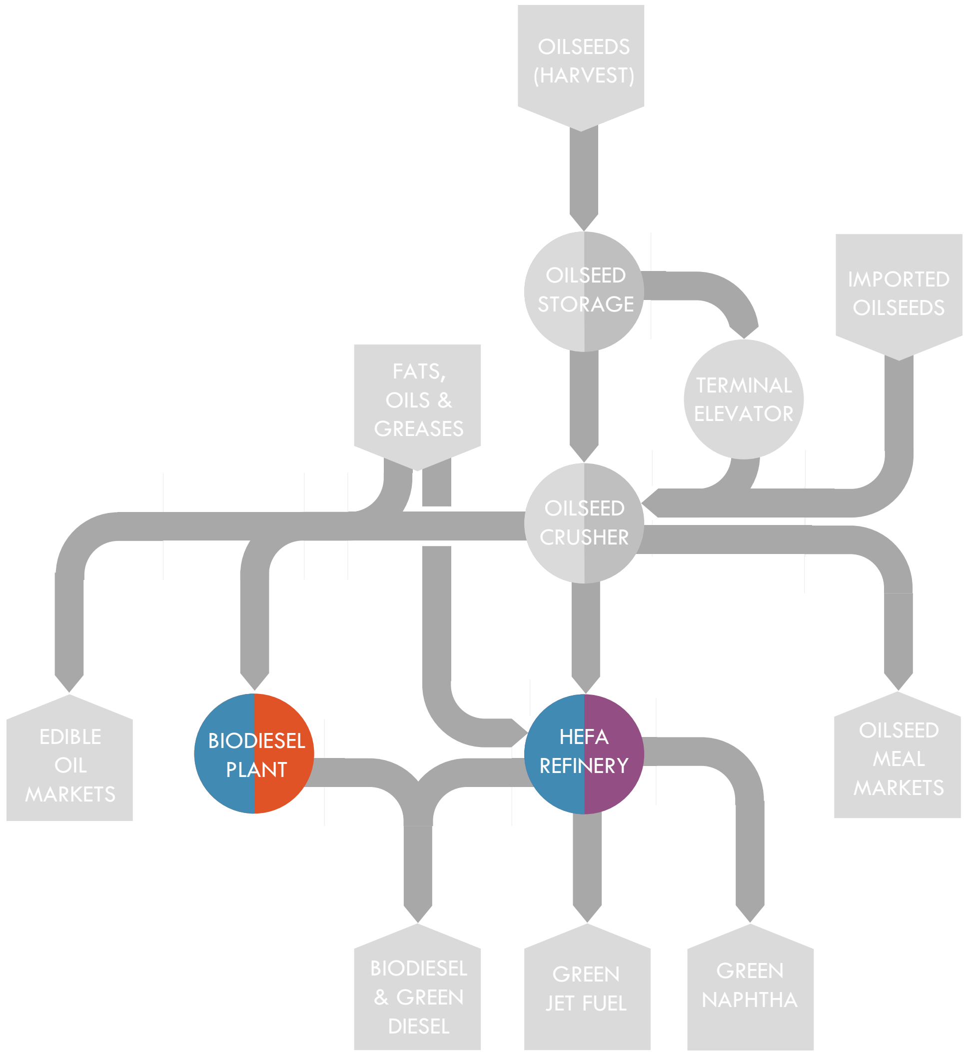
DAIRY & CATTLE

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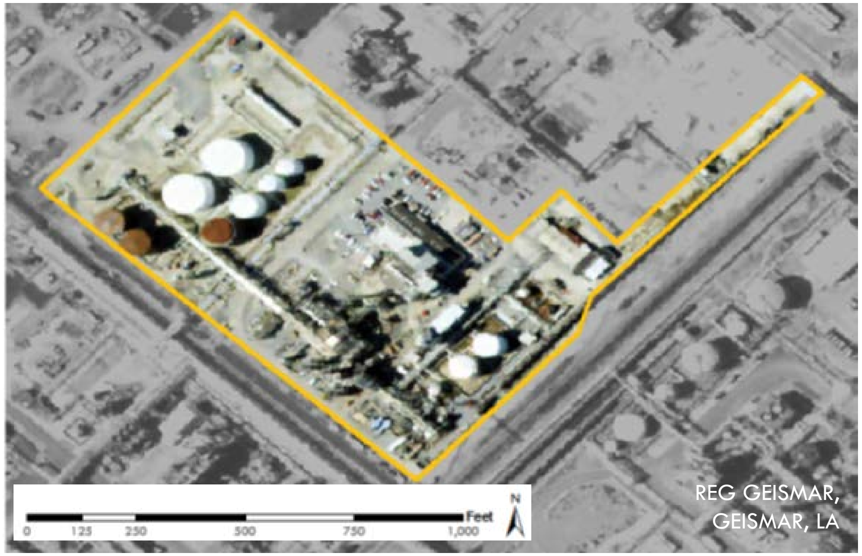
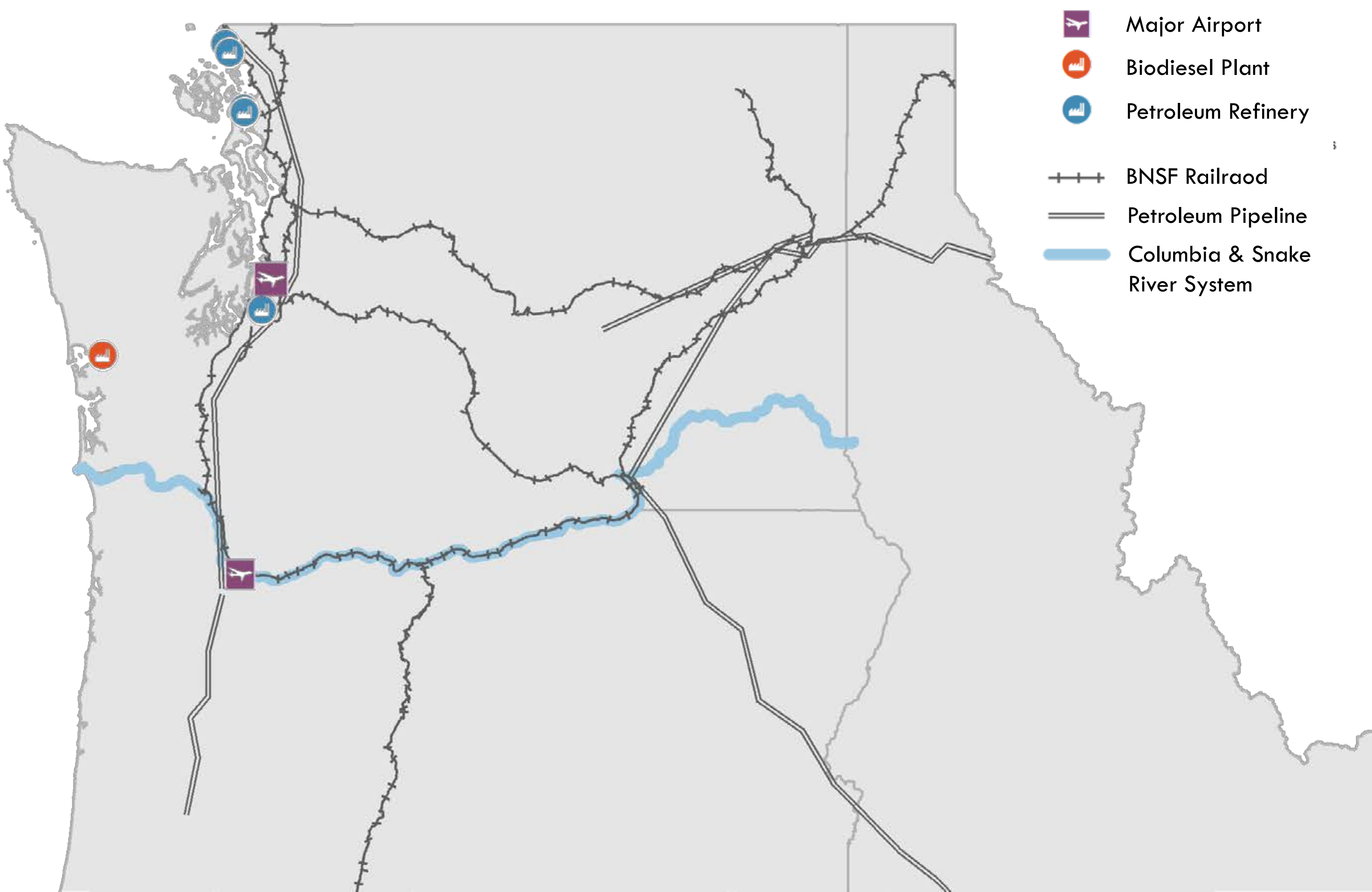
HEFA REFINERIES

- Often converted from or co-located next to existing petroleum refineries
- Conversion process requires hydrogen
  - Often produced from natural gas
- Produces green diesel and naphtha in addition to green jet fuel

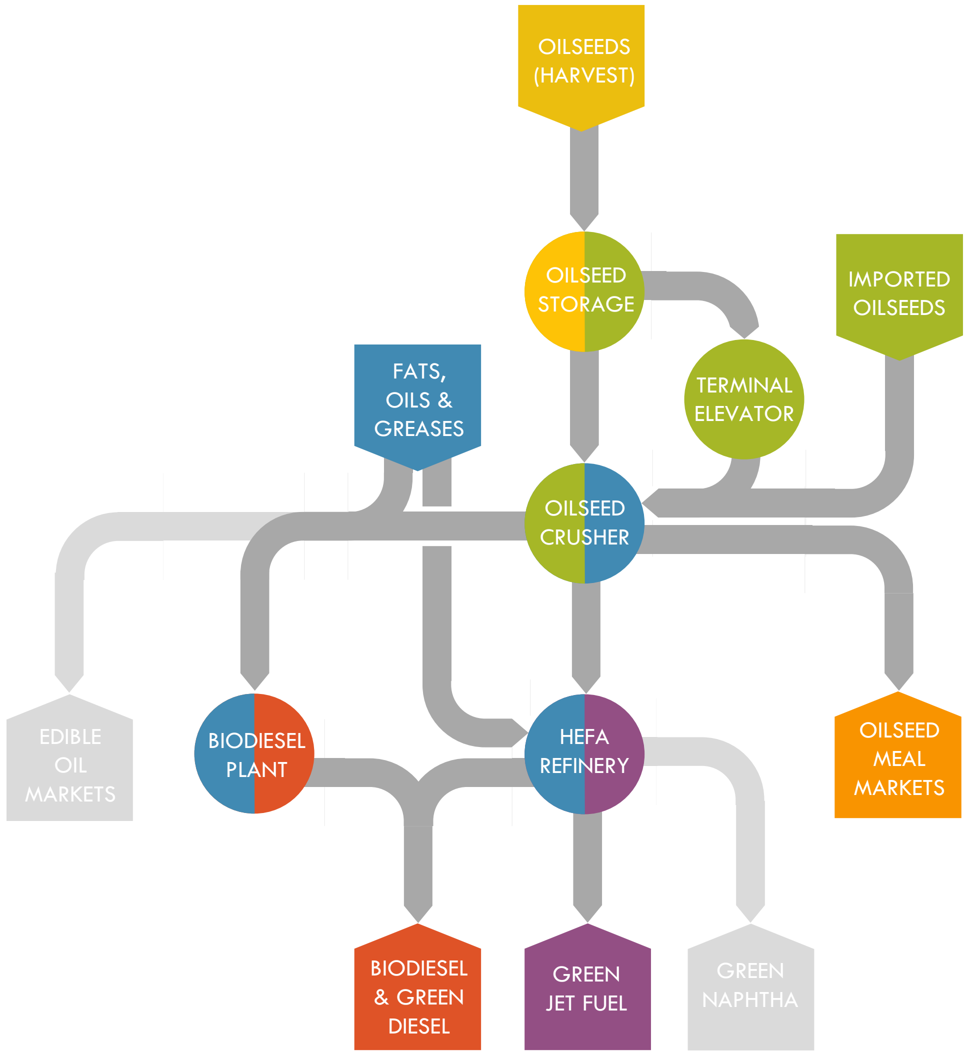


REG GEISMAR, GEISMAR, LA

PETROLEUM INFRASTRUCTURE



PRELIMINARY MODEL RUN



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