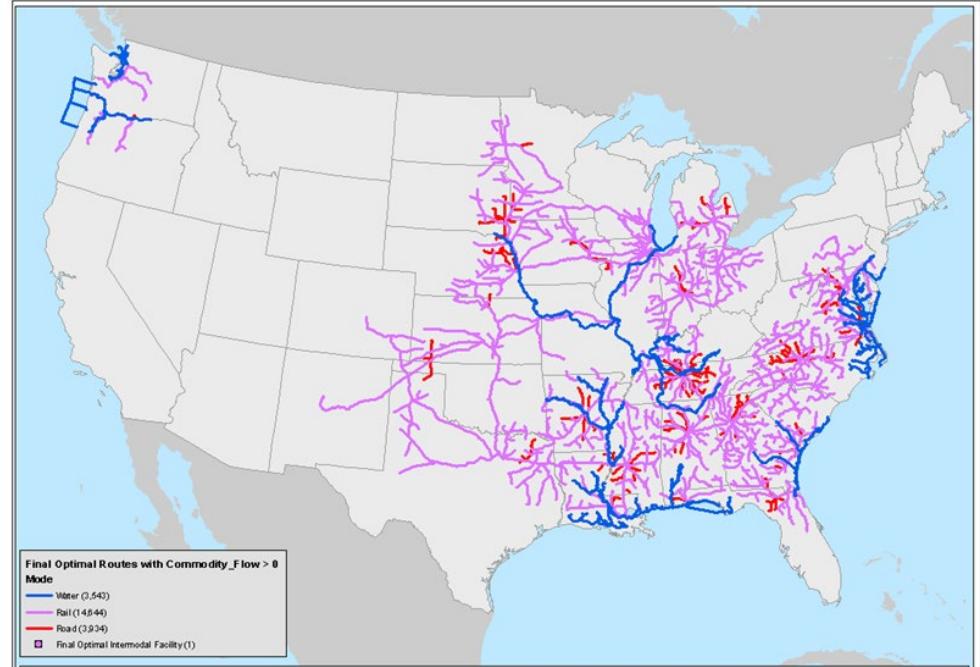


# Freight and Fuel Transportation Optimization Tool (FTOT) Training

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*Kevin Zhang*

*July 29, 2025*



# Today's Agenda

- |           |                                 |
|-----------|---------------------------------|
| 1:00-1:15 | FTOT Overview                   |
| 1:15-2:00 | Walkthrough: Technical Demo     |
| 2:00-2:35 | Breakout Session: SAF Scenarios |
| 2:35-3:00 | Reconvene and Conclusion        |



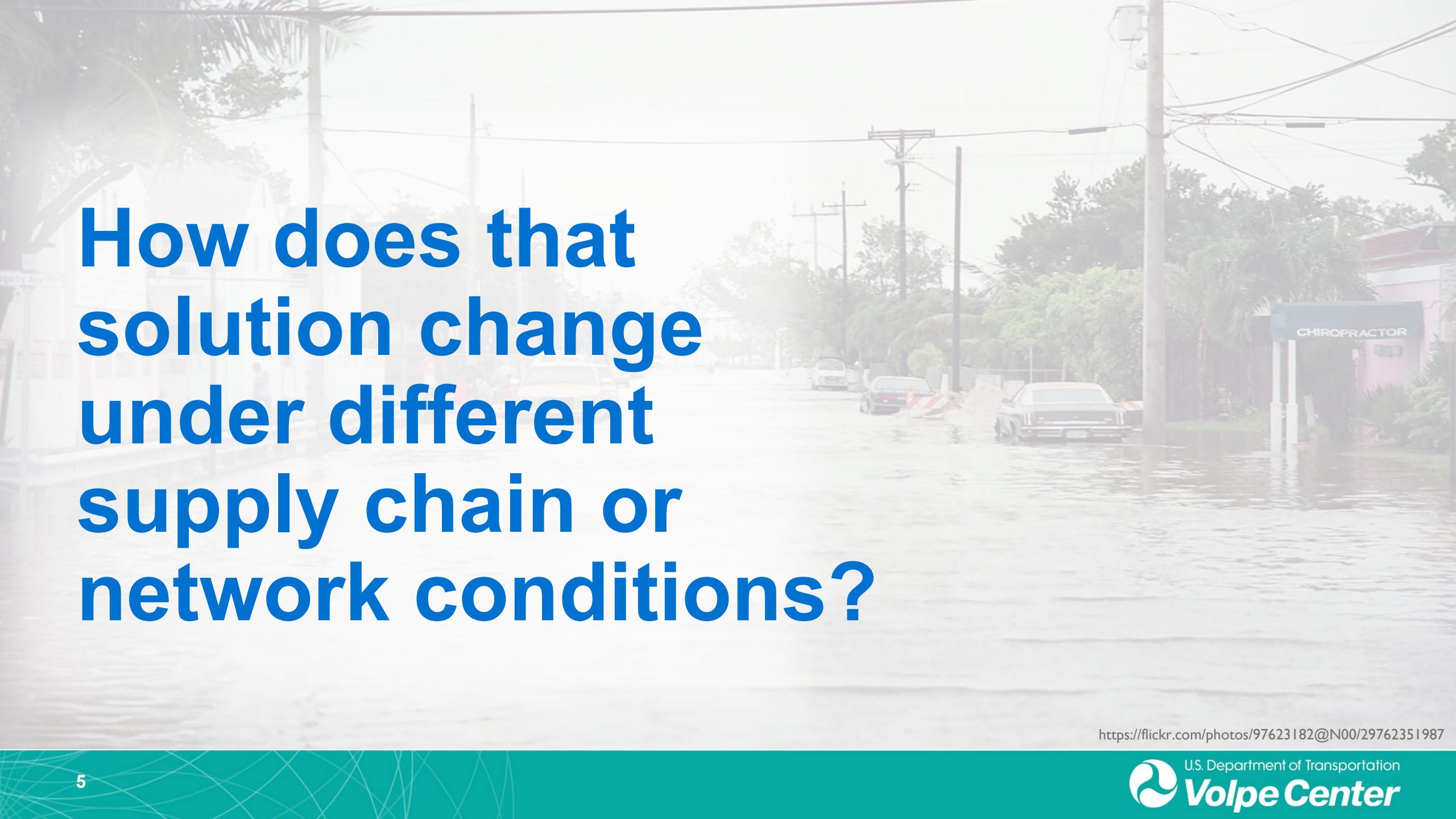
**Transportation  
is a critical element  
of freight and fuel  
supply chains.**

- Intermodal Facility
- Crude Pipeline
- Product Pipeline
- Water



**What is the best transportation solution to maximize supply chain delivery and minimize costs and/or emissions?**

papa1266 / 123rf

A photograph of a street completely submerged in floodwater. Several cars are visible, either partially or fully submerged. Utility poles and power lines stand in the water. A sign for a "CHIROPRACTOR" office is visible on the right side of the frame. The overall atmosphere is one of a severe flooding event.

**How does that  
solution change  
under different  
supply chain or  
network conditions?**

<https://flickr.com/photos/97623182@N00/29762351987>

**FTOT can help  
explore scenarios to  
answer these questions.**

# The Freight and Fuel Transportation Optimization Tool (FTOT)

[volpeusdot.github.io/FTOT-Public](https://volpeusdot.github.io/FTOT-Public)

## Key features:

- Public/open-source scenario testing tool.
- Optimizes supply chain routing and flows to maximize delivery and minimize cost.
- Commodity/supply chain agnostic.
- Multimodal: road, rail, waterway, pipeline.
- Optional: Identify candidate processor sites based on optimal transportation patterns.
- Results by commodity, mode, facility, scenario.
- Users: governments, academia, private sector

## Analyze impacts of changes in:

Supply / demand

Multimodal infrastructure

Supply chain / industry patterns

Disruption and resilience

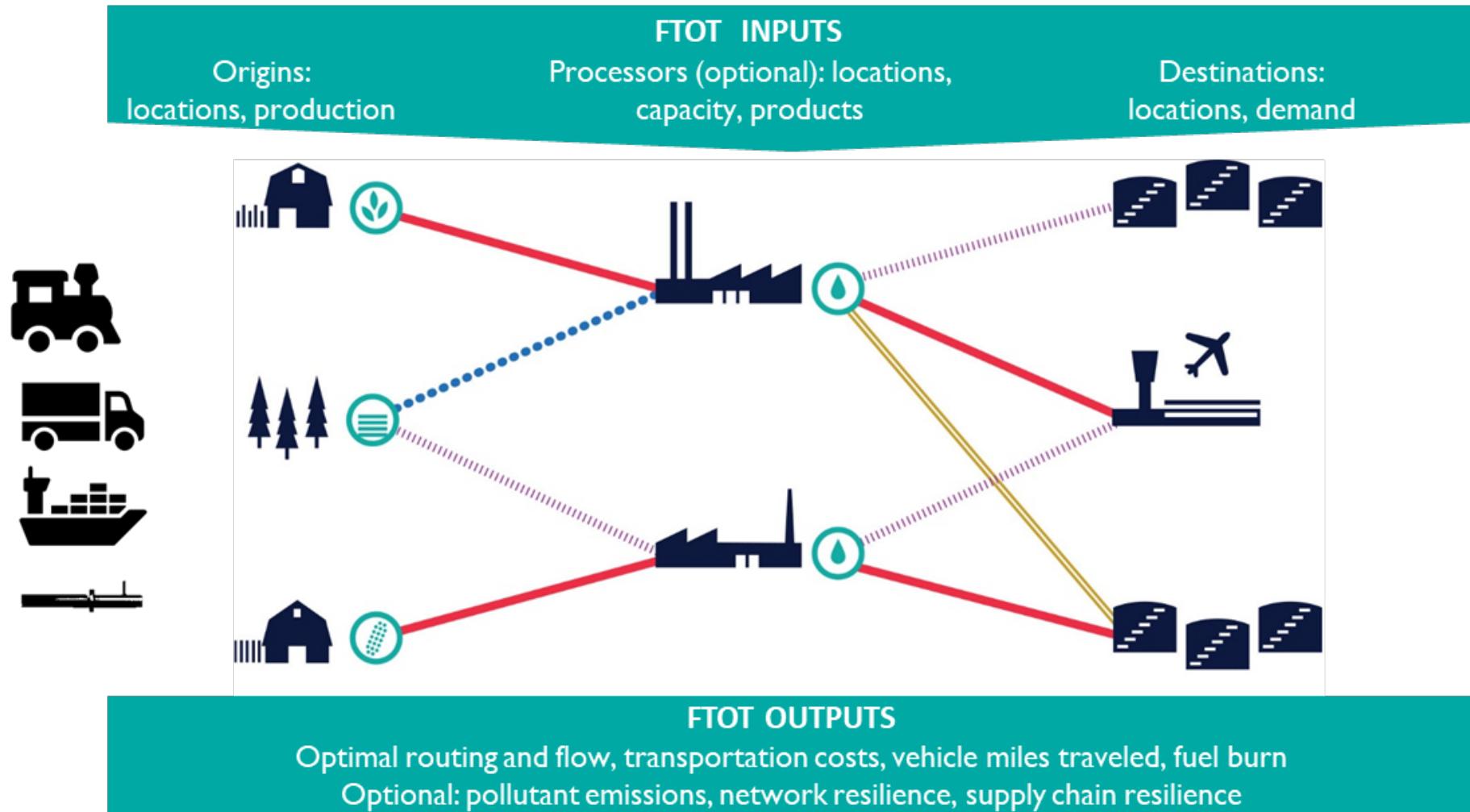


## Enable transportation innovation:

Transportation infrastructure affects supply chain costs, resilience

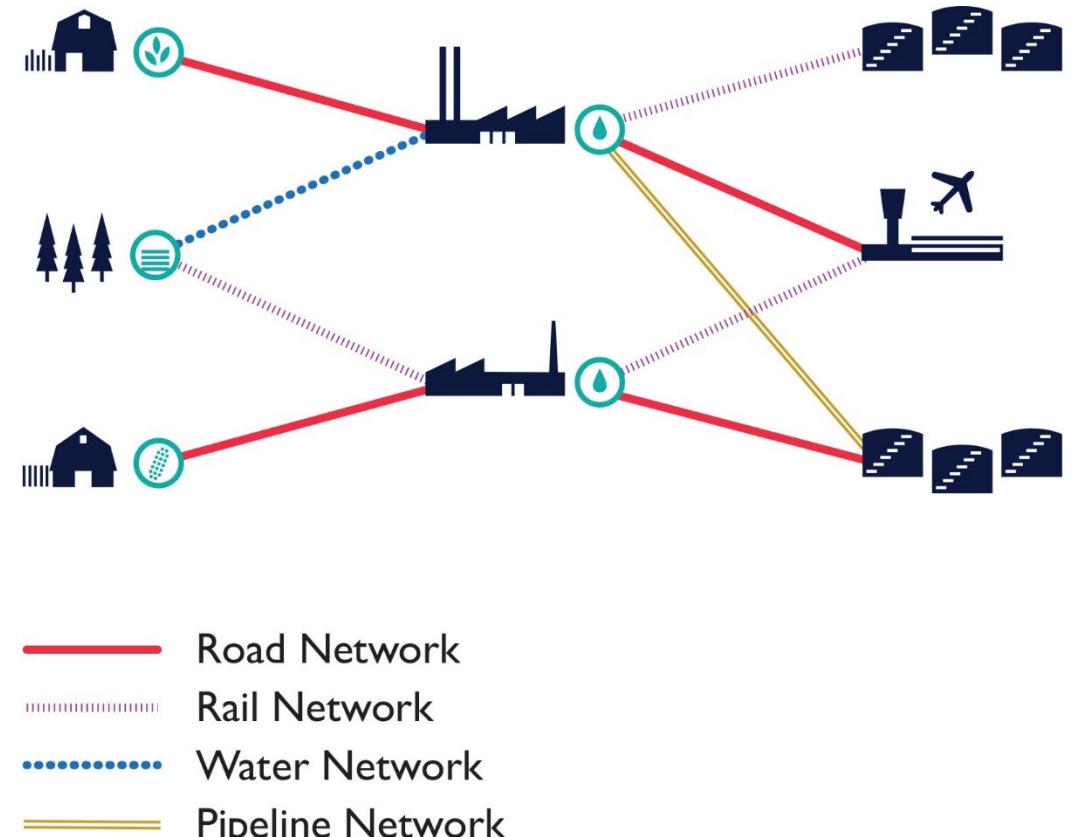
Current and future supply chains impact infrastructure needs

# The Freight and Fuel Transportation Optimization Tool (FTOT)



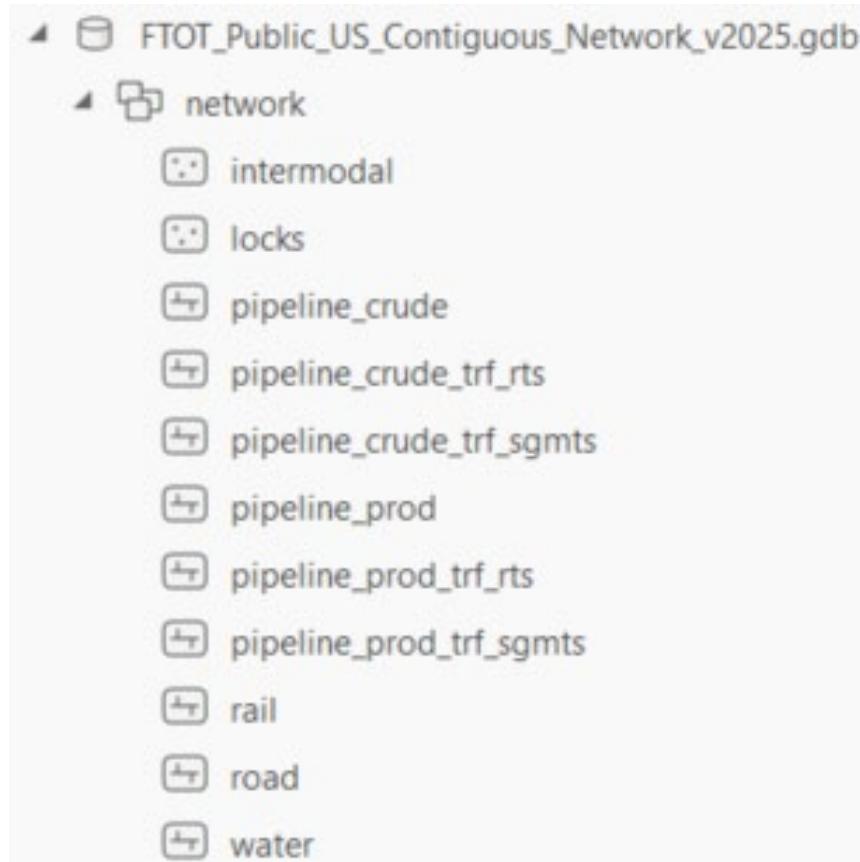
# FTOT optimizes routing of supply chain scenarios over a multimodal transportation network

- Transportation costs (per mile, tariff)
- Transloading costs
- Impedances / weightings
- (Optional) CO<sub>2</sub> emissions costs
- Facility characteristics and output (efficiency, product slate, min / max size, build cost)
- Demand at destinations (adjusted by blend level restrictions if needed)
- Modal flow capacity



Optimizing flow and routing of raw materials (e.g., wood, agricultural feedstocks) to processing locations to produce fuel, which is sent to destinations to fulfill demand.

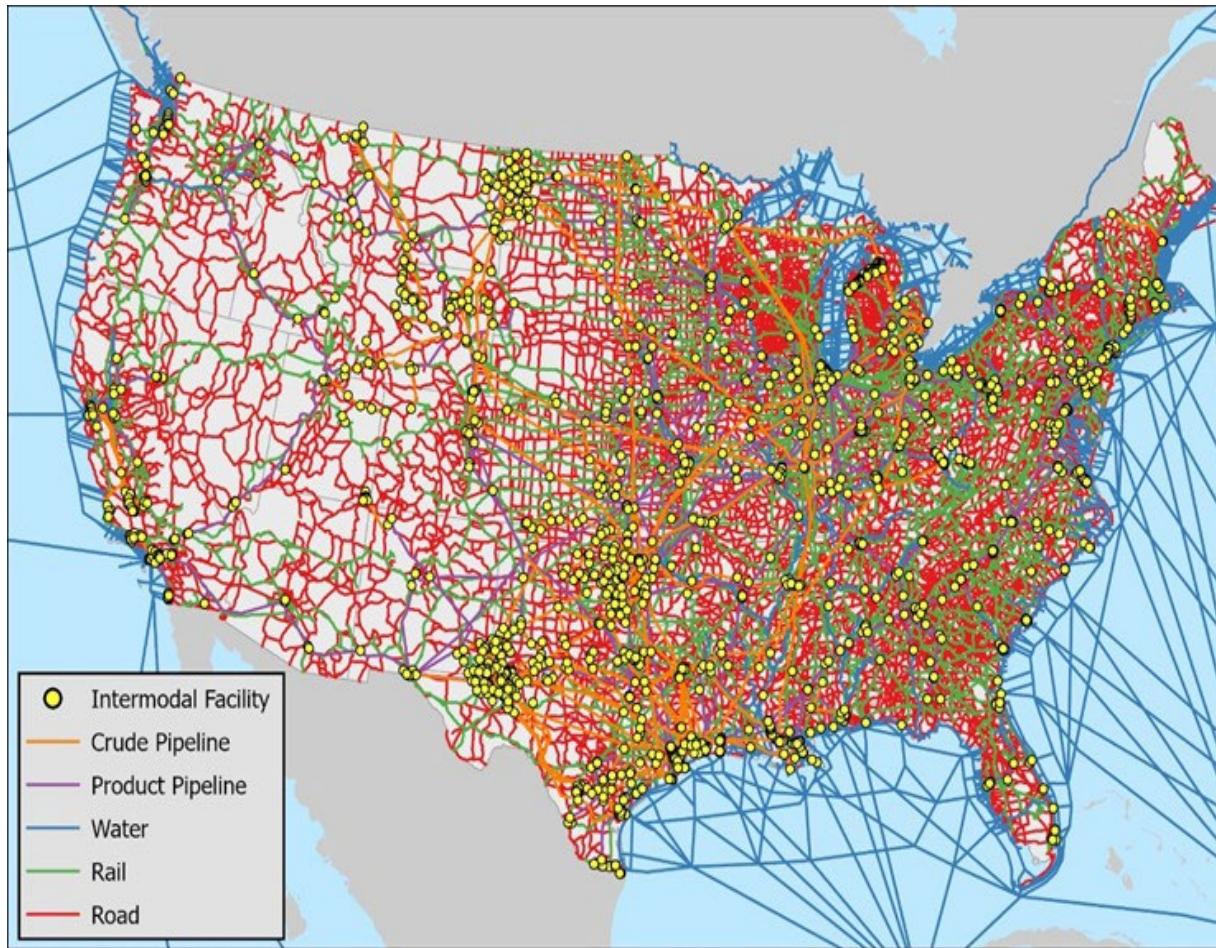
# FTOT Network Format



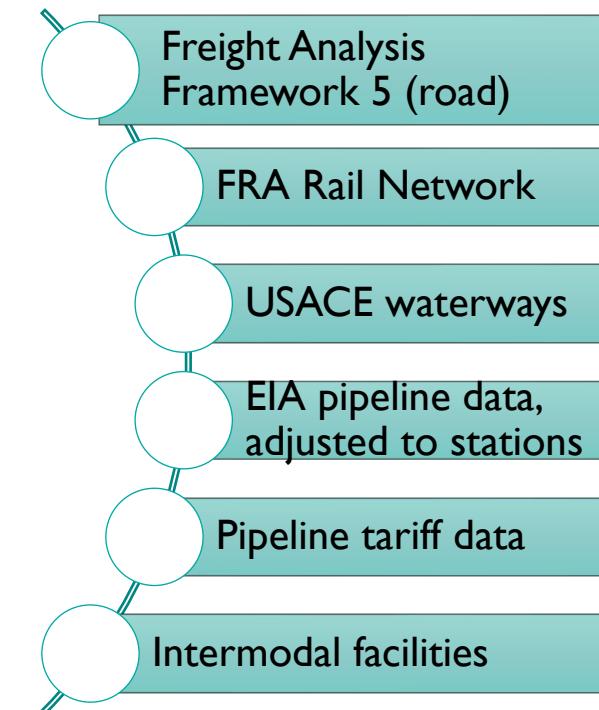
## Aligned with Generalized Modeling Network Specification (GMNS)

- Generalized field names
- Flexible distance units and coordinate system
- Many fields are optional to enhance flexibility for alternative networks (determines which optimization constraints are used)
- Enables local / international networks

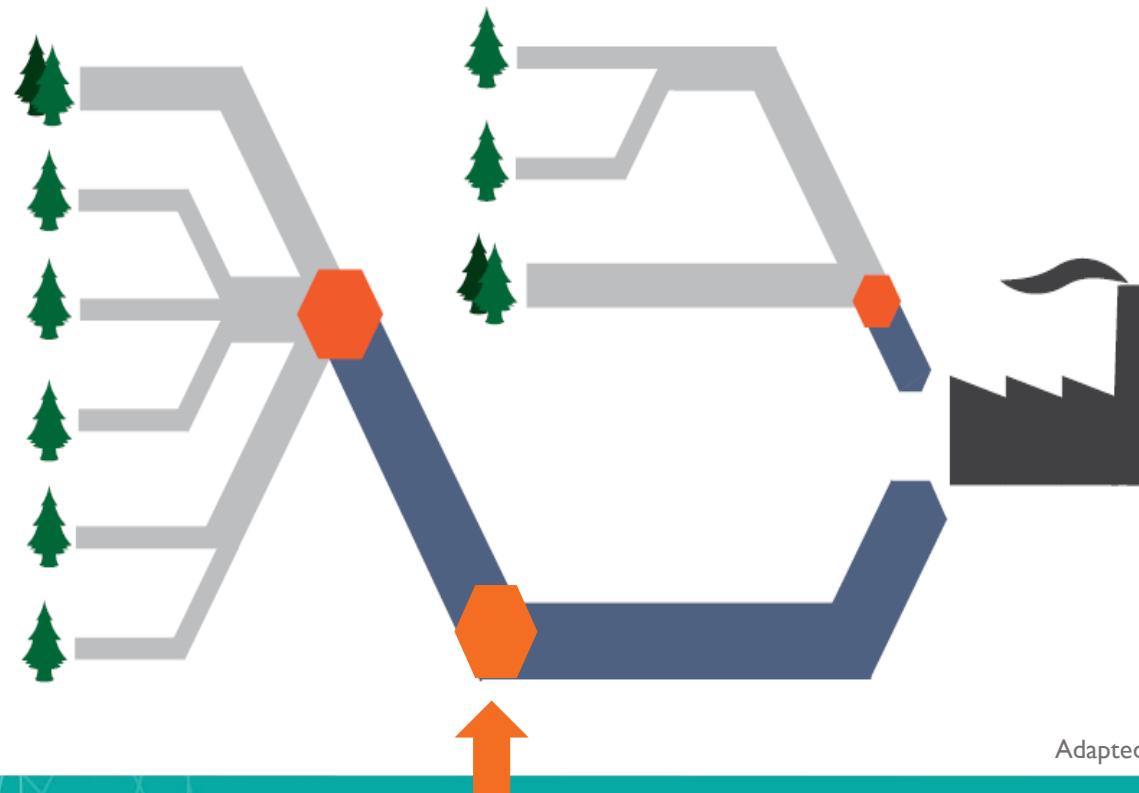
# FTOT Default U.S. Multimodal Network



## Network components



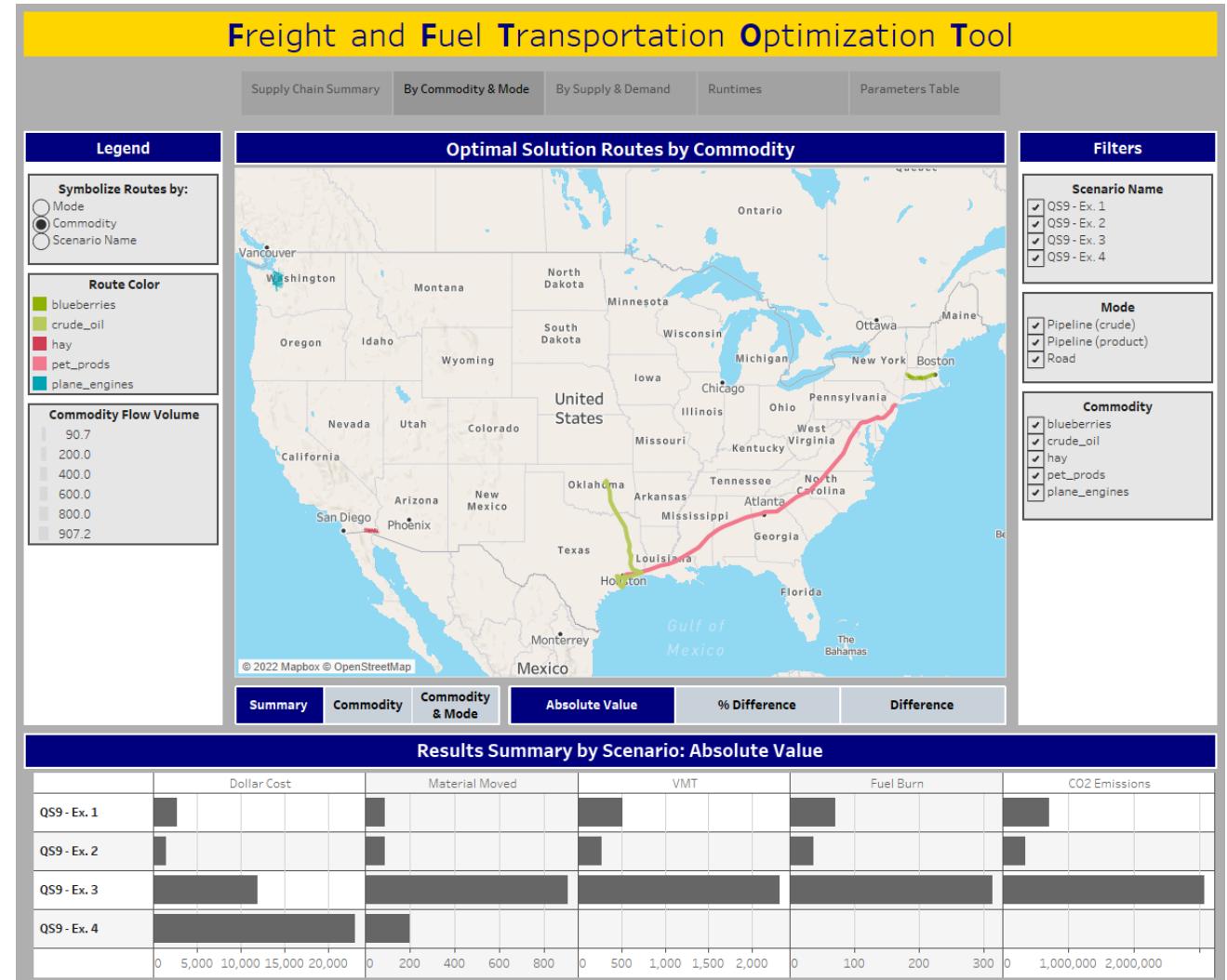
# FTOT can help identify candidate facility locations based on optimized transportation patterns.



Adapted from graphic by Dane Camenzind, WSU, used with permission.

# Visualizing Results

- Maps
  - Candidates and facilities used
  - Optimal routing and mode choice
- Tableau dashboards
  - Single scenario
    - Cost, distance, VMT, fuel burn, emissions
    - Filter by mode or commodity
  - Comparison of scenario variations



# FTOT also enables resilience analyses

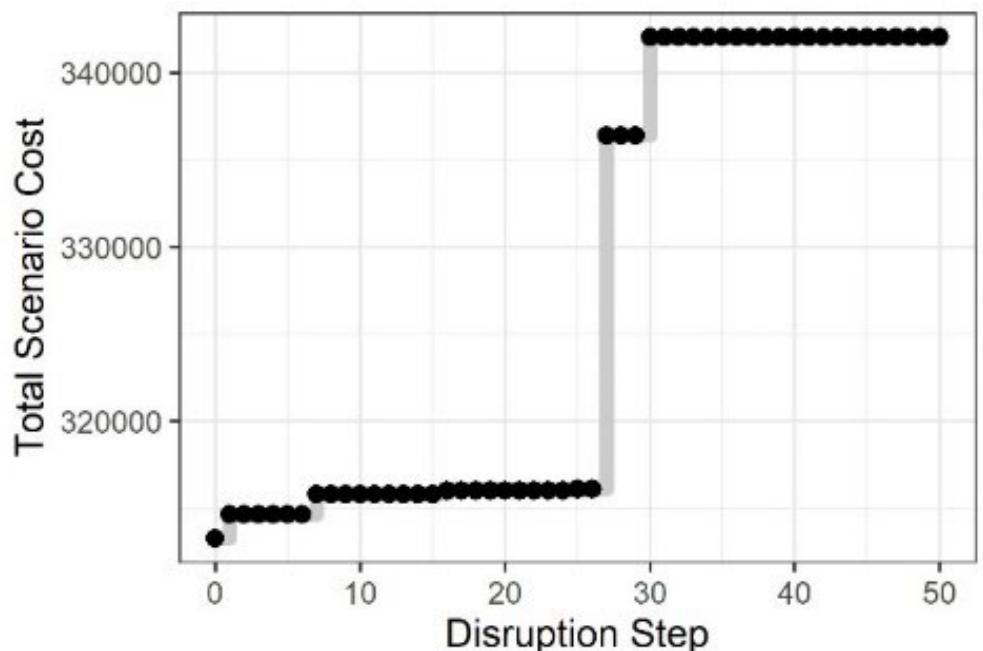
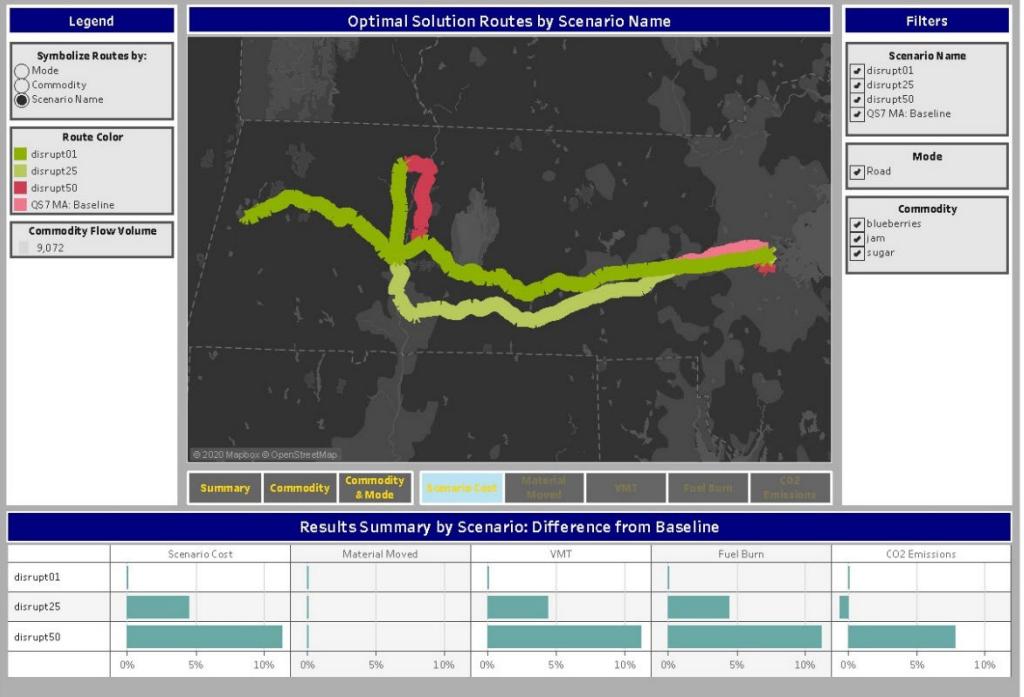
Manual network or supply chain modifications

Link rank and removal process

- Rank optimal solution roadway links by 'importance.'
- Sequentially remove links and reanalyze.
- Change in cost indicates effect on scenario performance.
- Highlights stability of solution.
- Can help home in on key links.

Supply chain resilience testing module

- Developed with Lee et al. at WSU.
- Leverage hazard scenarios and infrastructure fragility curves.
- Estimate supply chain resilience based on delivery.



# FTOT can be used to explore effects of changes in...

## Demand and Supply

Change demand for freight (e.g., City X wants more of a commodity than City Y)?

## Multimodal Transportation Infrastructure

Add or remove infrastructure (e.g., inland port)?

## Supply Chain / Industry Infrastructure

Have FTOT generate candidate facilities along the supply chain (e.g., processors)?

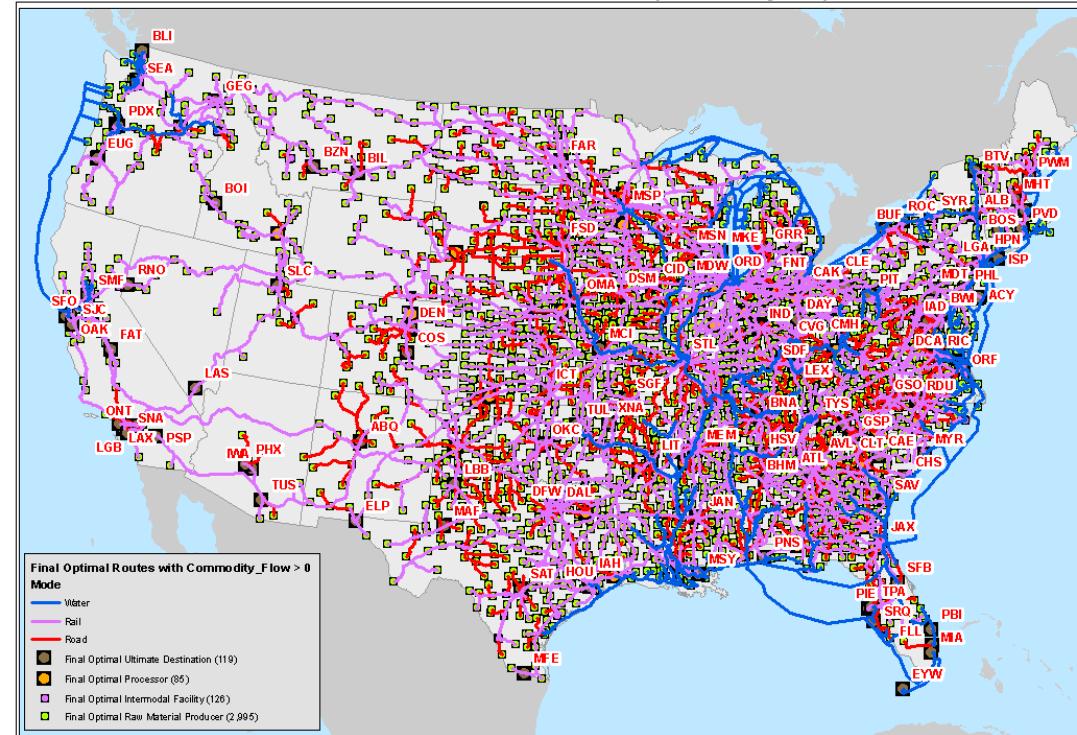
## Disruption and Resilience

Model key link(s) getting knocked out due to a disruption/hazard (e.g., a flood)?

# Ongoing Work

- Future Agricultural and Energy Supply Chains – in support of FAA Office of Environment and Energy (with ASCENT (<https://ascent.aero/>))
  - Southeast – Tennessee region case study of wood-based biofuel supply with University of TN, Knoxville.
  - Hawai'i – Exploration of oilseed supply chains and interisland transport for co-processing with University of HI.
  - Colombia – Baseline lipid-to-biodiesel and future SAF supply chains with Washington State University (WSU) and Colombian partners.
  - Dominican Republic – SAF scenario development with WSU
  - Canada / U.S. cross-border SAF supply chains with WSU
- Other Fuels / Energy Supply Chain Analyses
  - Maritime fuels supply chain analysis – Ports of Seattle and Corpus Christi case studies of waste-based biofuel supply with NREL in support of DOE Bioenergy Technologies Office.
- Future Agricultural Supply Chain Analysis
  - Hemp supply chain analysis – Western regional case study in support of Oregon State University Global Hemp Innovation Center.
- Hazmat Incident Risk (Social, Environmental Impacts)
  - Developing risk-based optimization approach in support of PHMSA.

FTOT Results (Example)

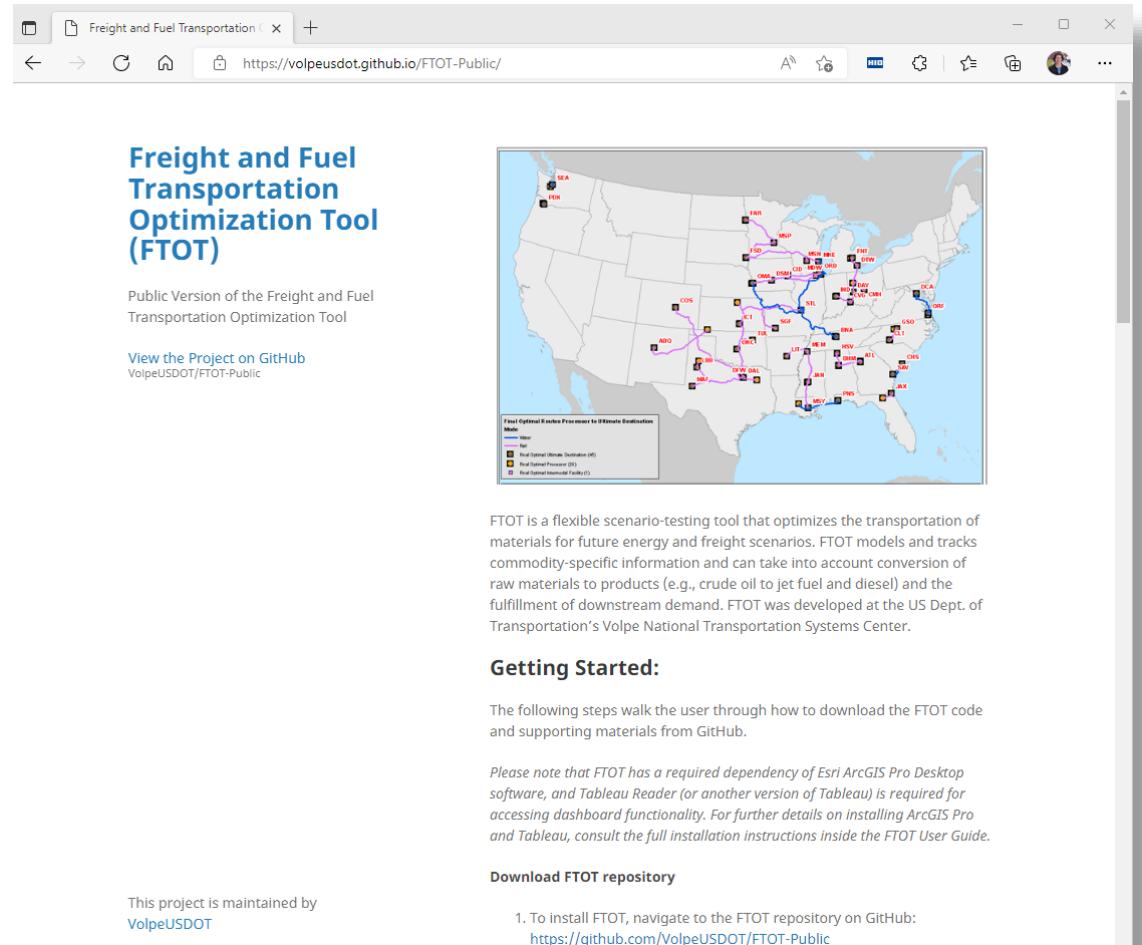


Source: USDOT Volpe Center – See also: <https://doi.org/10.1002/bbb.1951>

# FTOT is free and publicly available

[volpeusdot.github.io/FTOT-Public](https://volpeusdot.github.io/FTOT-Public)

- Includes full documentation and “Quick Start” scenarios, default datasets, default networks.
- Updated versions released quarterly.
- Current development sponsored by FAA.
- Issues / bugs / requests can be raised on GitHub site or through [FTOT-Team@dot.gov](mailto:FTOT-Team@dot.gov).
- Training / informational video library is always expanding.
- We welcome feedback and suggestions, additional projects, collaborations.



The screenshot shows a web browser window displaying the FTOT-Public website at <https://volpeusdot.github.io/FTOT-Public/>. The page title is "Freight and Fuel Transportation Optimization Tool (FTOT)". Below the title, it says "Public Version of the Freight and Fuel Transportation Optimization Tool". There is a link to "View the Project on GitHub" and "VolpeUSDOT/FTOT-Public". A map of the United States is shown with several cities marked and connected by lines, representing a network. A legend titled "Fuel Optimal Routes Preference by Strategic Optimization Model" includes categories: Major (blue), Major General Motorway (red), Major General Motorway Auxiliary (green), Final Refinery Processor (orange), and Final Refinery Intermediate Facility (purple). At the bottom left, it says "This project is maintained by VolpeUSDOT". On the right, there is a section titled "Getting Started:" with instructions and a note about required software dependencies.

**Freight and Fuel Transportation Optimization Tool (FTOT)**

Public Version of the Freight and Fuel Transportation Optimization Tool

[View the Project on GitHub](#)  
VolpeUSDOT/FTOT-Public

Fuel Optimal Routes Preference by Strategic Optimization Model

- Major
- Major General Motorway (Red)
- Major General Motorway Auxiliary (Green)
- Final Refinery Processor (Orange)
- Final Refinery Intermediate Facility (Purple)

This project is maintained by VolpeUSDOT

**Getting Started:**

The following steps walk the user through how to download the FTOT code and supporting materials from GitHub.

*Please note that FTOT has a required dependency of Esri ArcGIS Pro Desktop software, and Tableau Reader (or another version of Tableau) is required for accessing dashboard functionality. For further details on installing ArcGIS Pro and Tableau, consult the full installation instructions inside the FTOT User Guide.*

[Download FTOT repository](#)

1. To install FTOT, navigate to the FTOT repository on GitHub:  
<https://github.com/VolpeUSDOT/FTOT-Public>

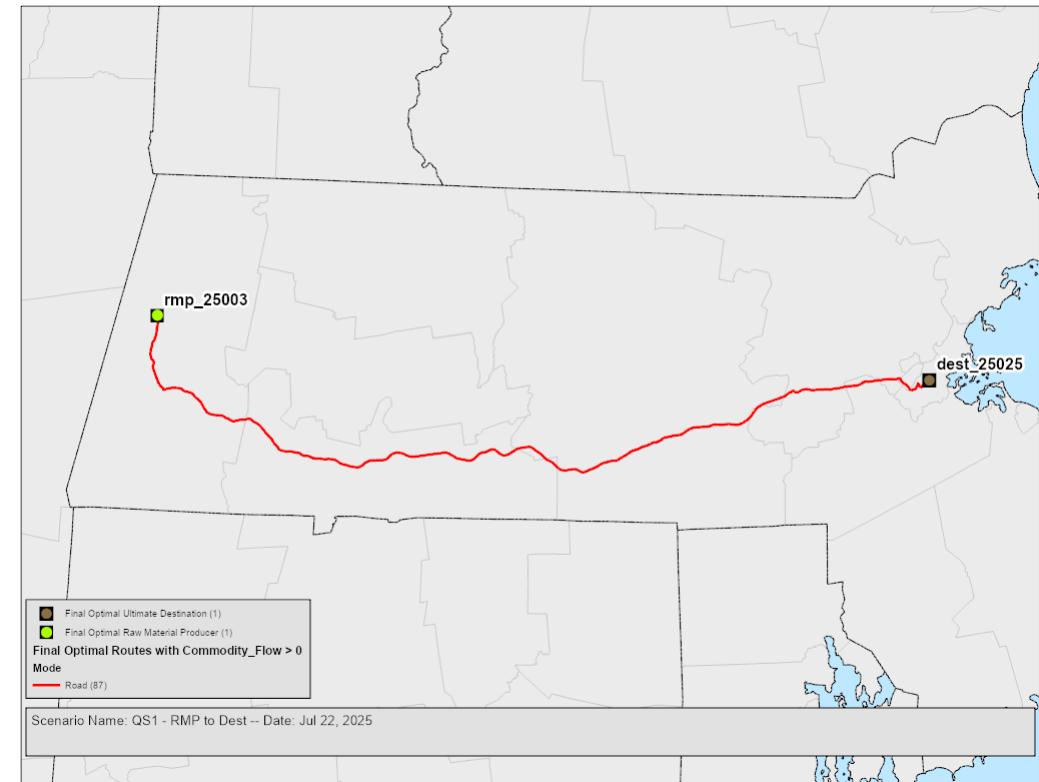
# Questions?

# Walkthrough: Technical Demo

# Quick Start #1

- A hypothetical New England scenario transporting blueberries between a single origin and destination
- Facilities and commodities
  - One **raw material producer (RMP)** in western MA supplying up to 100 tons of blueberries
  - One **destination** in eastern MA with demand of 100 tons of blueberries
- Optimal solution flows 100 tons of blueberries via road, fulfilling all demand.

Metric	Value	Units
Transport Cost	\$2,568	USD
Total Flow	100	U.S. Tons
Network Used	134.8	Miles
Vehicle Distance Traveled	518.4	Miles
CO <sub>2</sub> Emissions	717,558	Grams



**Exercise: Create a disruption scenario based on QS #1**

# FTOT Inputs

## Batch file (.bat)

Runs the scenario

```
1 @ECHO OFF
2
3 cls
4 set PYTHONDONTWRITEBYTECODE=1
5 REM -- default is #ECHO OFF, cls (clear screen), and disable .pyc files
6 REM -- for debugging REM @ECHO OFF line above to see commands
7 REM -----
8
9 REM run_v7.bat generated by FTOT run.bat upgrade tool
10 REM -----
11
12 REM -----
13 REM ----- ENVIRONMENT VARIABLES -----
14 REM -----
15 set PYTHON="C:\FTOT\python3_env\python.exe"
16 set FTOT="C:\FTOT\program\ftot.py"
17 set XMLSCENARIO="C:\FTOT\scenarios\quick_start\qsl_rmp_dest\scenario.xml"
18
19
20
21 REM -----
22 REM ----- RUN THE FTOT SCRIPT -----
23 REM -----
24
25 REM -- SETUP: SETUP FTOT FOR THE SCENARIO
26 %PYTHON% %FTOT% %XMLSCENARIO% s || exit /b
27
28 REM -- FACILITIES: ADD FACILITIES LOCATIONS AND
29 REM -- COMMODITY DATA FILES TO THE SCENARIO
30 %PYTHON% %FTOT% %XMLSCENARIO% f || exit /b
31
32 REM -- CONNECTIVITY: CONNECT THE FACILITIES TO THE NETWORK AND
33 REM -- EXPORT FROM GIS TO NETWORKX MODULE
34 %PYTHON% %FTOT% %XMLSCENARIO% c || exit /b
35
36 REM -- GRAPH: CREATE THE NETWORKX GRAPHS FROM THE
37 REM -- NETWORK AND FACILITIES
38 %PYTHON% %FTOT% %XMLSCENARIO% g || exit /b
39
40 REM -- OPTIMIZATION: SET UP THE OPTIMIZATION PROBLEM
41 %PYTHON% %FTOT% %XMLSCENARIO% ol || exit /b
42
```

**Scenario XML file**  
Has scenario settings, defaults, and input file paths

```
1 <Scenario xmlns="Schema_v8.0.0">
2   <Scenario_Schema_Version>8.0.0</Scenario_Schema_Version>
3   <Scenario_Name>qsl - RMP to Dest</Scenario_Name>
4   <Scenario_Description>This scenario demonstrates simple movements from a RMP to a destination.</Scenario_Description>
5   <Scenario_Inputs>
6     <Common_Data_Folder>C:\FTOT\scenarios\common_data</Common_Data_Folder>
7       <!-- MULTIMODAL NETWORK LOCATION -->
8       <!-- The original copy of the base network. FTOT will not alter this copy. -->
9       <!-- The default multimodal network used in FTOT is provided with the tool and includes the following locations: waterway lock and intermodal facility locations. -->
10      <!-- Units for link length in the network must match the default distance units specified further down -->
11      <Base_Network_Gdb>C:\FTOT\scenarios\common_data\networks\FTOT_Public_US_Contiguous_Network_v202</Base_Network_Gdb>
12      <Disruption_Data>None</Disruption_Data>
13      <!-- GEOSPATIAL FACILITY INFORMATION -->
14      <!-- The original copy of the facility geospatial information. -->
15      <!-- FTOT will not alter this copy. -->
16      <Base_RMP_Layer>C:\FTOT\scenarios\common_data\facilities\counties.gdb\rmp</Base_RMP_Layer>
17      <Base_Destination_Layer>C:\FTOT\scenarios\common_data\facilities\counties.gdb\dest</Base_Destination_Layer>
18      <Base_Processors_Layer>None</Base_Processors_Layer>
19      <!-- FACILITY COMMODITY INFORMATION -->
20      <RMP_Commodity_Data>C:\FTOT\scenarios\quick_start\qsl_rmp_dest\input_data\rmp.csv</RMP_Commodity_Data>
21      <Destinations_Commodity_Data>C:\FTOT\scenarios\quick_start\qsl_rmp_dest\input_data\dest.csv</Destinations_Commodity_Data>
22      <Processors_Commodity_Data>None</Processors_Commodity_Data>
23      <Processors_Candidate_Commodity_Data>None</Processors_Candidate_Commodity_Data>
24      <Schedule_Data>None</Schedule_Data>
25      <Commodity_Mode_Data>None</Commodity_Mode_Data>
26      <Commodity_Density_Data>None</Commodity_Density_Data>
27      <!-- DEFAULT UNITS -->
28      <!-- Set default units for commodities, distance, and currency. -->
29      <!-- Default distance units must match the units used for link length in the network. -->
30      <!-- Default currency units must match the currency used for all cost elements. -->
31      <!-- Default currency units must match the currency used for all cost elements. -->
32      <!-- Default currency units must match the currency used for all cost elements. -->
```

## Input CSV files

A	B	C	D	E	F	G
1	facility_name	facility_type	commodity	value	units	phase_of_matter
2	rmp_25003	raw_material_producer	blueberries	100	tons	solid
3						

A	B	C	D	E	F	G
1	facility_name	facility_type	commodity	value	units	phase_of_matter
2	dest_25025	ultimate_destination	blueberries	100	tons	solid
3						

### Not shown:

- Network and facility GIS data
- Additional CSV files depending on scenario

# FTOT Outputs

- Text and CSV reports
- Maps
  - Static maps
  - ArcGIS project file
- Tableau dashboards
- SQLite database
- Log files for debugging

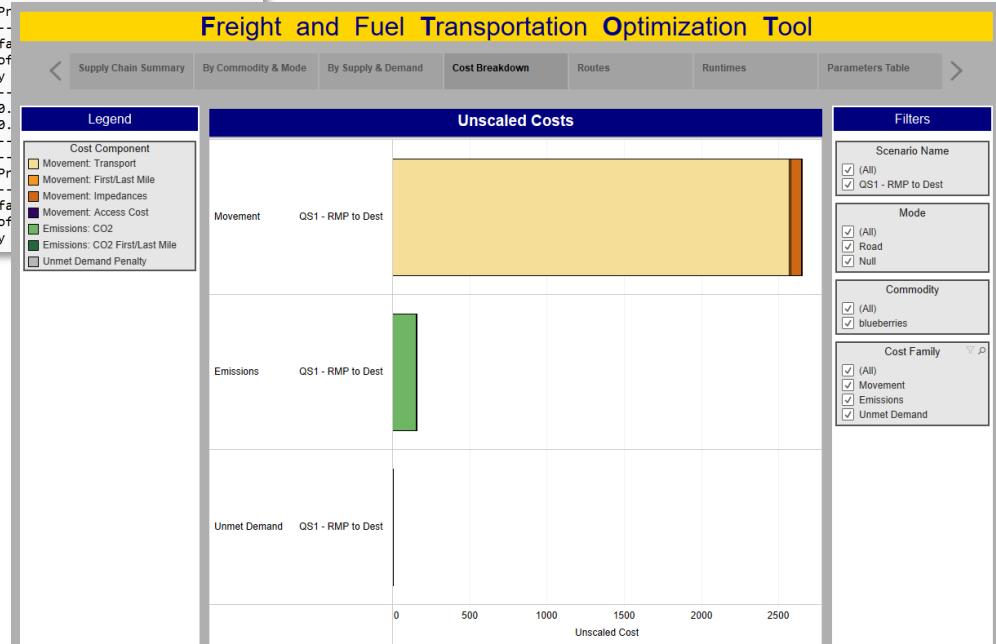
## Text report

With commodity flow, costs, vehicle-distance traveled, facility utilization, and other metrics

```
SCENARIO
-----
Scenario Name : QS1 - RMP to Dest
Timestamp    : 2025-07-22 12:14:19
FTOT Version : 2025.2

RUNTIME
-----
S   : s Step - Total Runtime (HMS): 00:00:34
F   : f Step - Total Runtime (HMS): 00:01:13
C   : c Step - Total Runtime (HMS): 00:09:41
G   : g Step - Total Runtime (HMS): 00:05:50
O1  : o1 Step - Total Runtime (HMS): 00:00:22
O2  : o2 Step - Total Runtime (HMS): 00:00:14
P   : p Step - Total Runtime (HMS): 00:02:49
```

```
RESULTS
-----
F   :
F   : Scenario Total Supply and Demand, and Available Pr
F   :
F   : note: processor inputs and outputs are based on fa
F   : reflect a processing capacity, not a conversion of
F   : commodity_name | facility_type | io | quantity
F   :
F   : blueberries   ultimate_destin i 100.
F   : blueberries   raw_material_pr o 100.
F   :
C   :
C   : Scenario Total Supply and Demand, and Available Pr
C   :
C   : note: processor inputs and outputs are based on fa
C   : reflect a processing capacity, not a conversion of
C   : commodity_name | facility_type | io | quantity
```



## Tableau workbook

With a variety of dashboards

# FTOT Spatial Data

County points

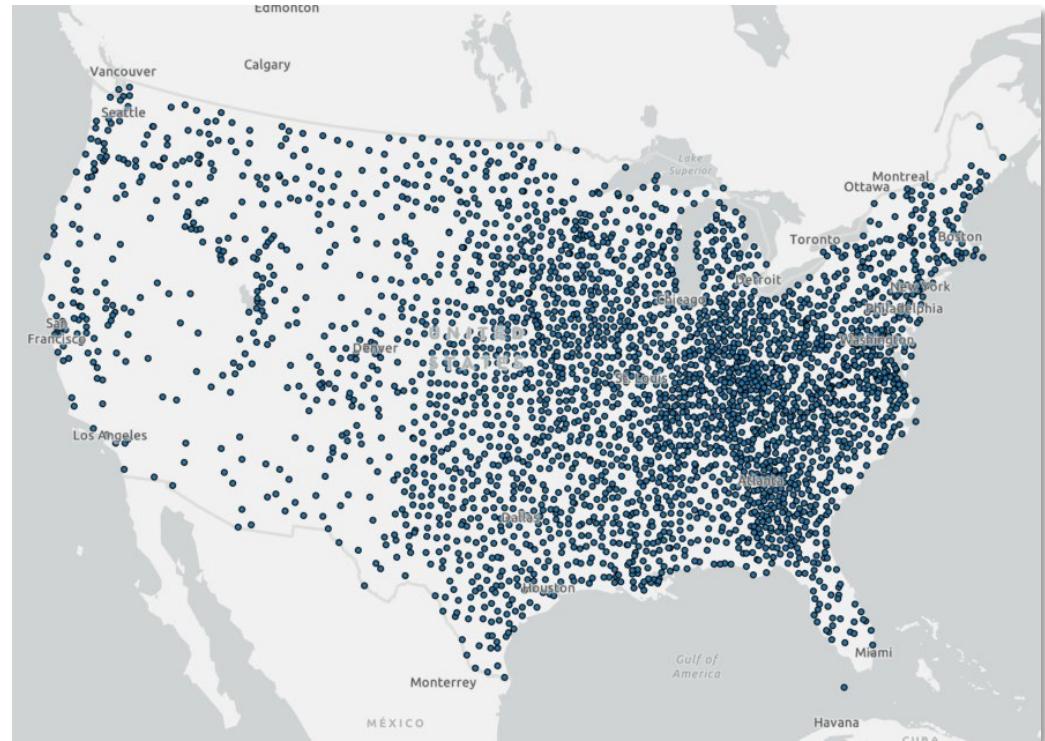
as FTOT's out-of-the-box facility locations

## Default GIS Data (see common\_data folder):

- Multimodal U.S. network
- County-level facilities

## Customization (see FTOT User Guide):

- Add custom facility locations
- Disrupt links within a scenario
- Edit the network directly
  - Add or remove links
  - Add intermodal facilities
- Create a custom multimodal network



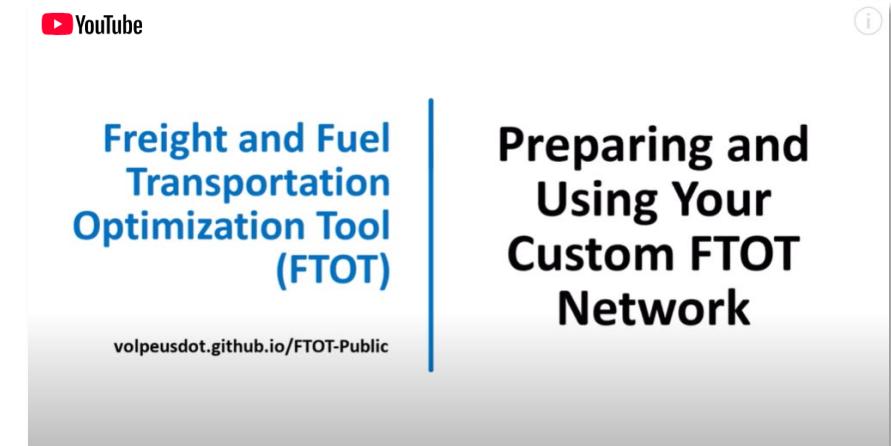
# Building a custom FTOT network

## Why use a custom network?

- More granularity, e.g., with local roads
- Non-U.S. geographies

## Resources

- ✓ [Checklist](#) for FTOT scenario data requirements
- ✓ Network schema in User Guide appendix
- ✓ Network Validation Helper Tool (part of FTOT Tools suite) to verify a custom network is constructed according to the FTOT network schema
- ✓ [Tutorial video](#) for walkthrough with example



# FTOT Network Format

The screenshot shows the ArcGIS Catalog interface with the following structure:

- FTOT\_Public\_US\_Contiguous\_Network\_v2025.gdb**
  - network**
    - intermodal**
    - locks**
    - pipeline\_crude**
    - pipeline\_crude\_trf\_rts**
    - pipeline\_crude\_trf\_sgmts**
    - pipeline\_prod**
    - pipeline\_prod\_trf\_rts**
    - pipeline\_prod\_trf\_sgmts**
    - rail**
    - road**
    - water**

Three attribute tables are displayed in separate windows:

- intermodal** (Top Window):

OBJECTID *	SHAPE *	Facility_ID	Name	Address	City	State	Source	Operator
1	Point	81	USX CORP., CLAIRTON...		Claifton	PA	Army Corps of Engineer...	
2	Point	82	FULLEN DOCK AND W...	382 Klinke Road.	Memphis	TN	Army Corps of Engineer...	
3	Point	83	SUN MARINE TERMINA...	2300 North 347	Nederland	TX	Army Corps of Engineer...	Sunoco
4	Point	84	TECO, BULK TERMINAL	14537 Hwy. 15	Davant	LA	Army Corps of Engineer...	
5	Point	85	CHEVRON PRODUCTS...		RICHMOND	CA	Army Corps of Engineer...	

- pipeline\_crude\_trf\_rts** (Middle Window):

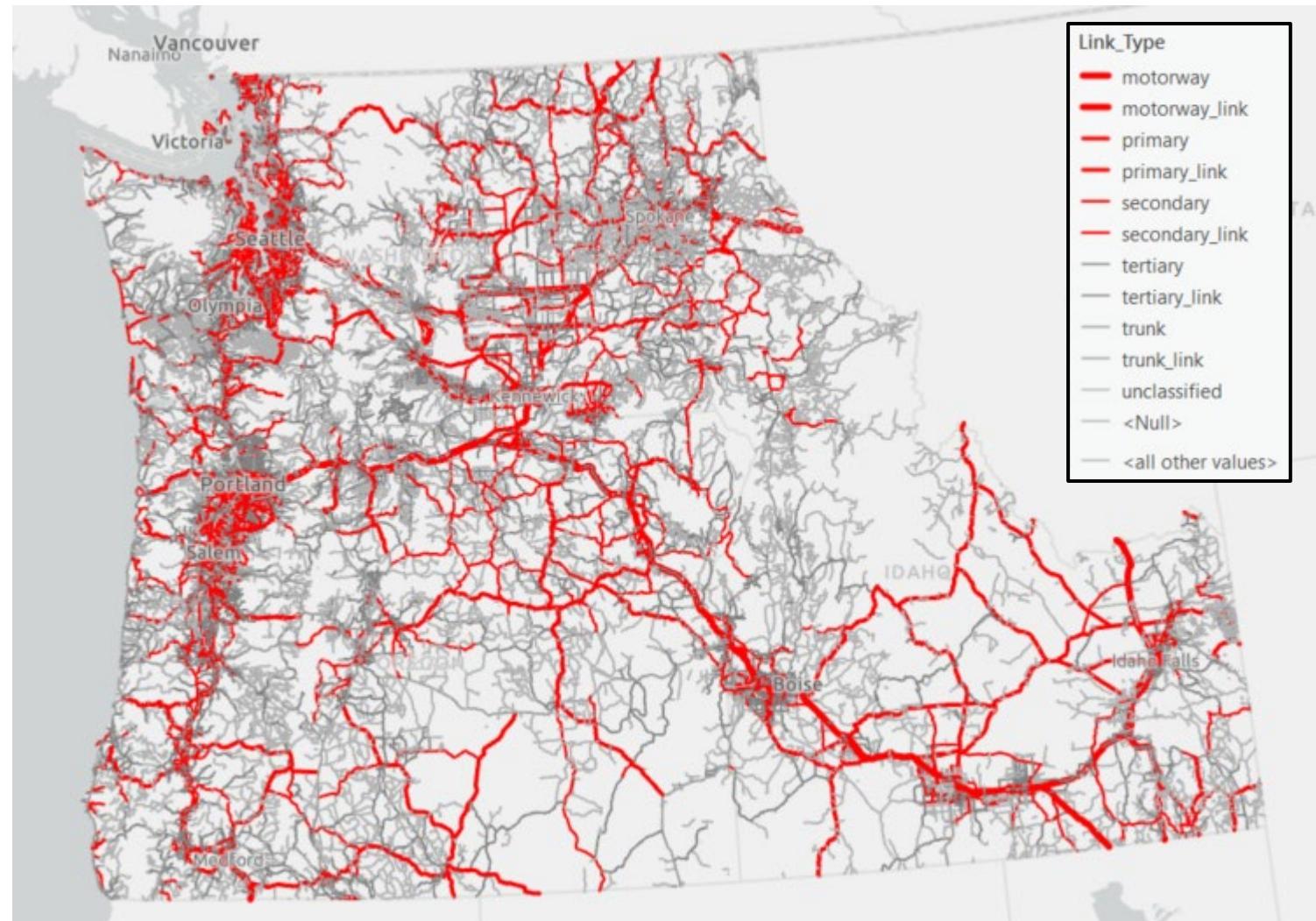
OBJECTID *	Shape *	base_rate	pipeline_name	fr_station	to_station	commodity	Shape_Length	Tariff_ID	Artificial	Dir_Flag
1	Polyline	5.9	Magellan Crude Oil Pip...	Barnhart:Barnhart Station	Baytown:ExxonMobil Re...	Crude Oil	675314.427299	2148	0	1
2	Polyline	0.5	Magellan Crude Oil Pip...	Barnhart:Barnhart Station	Crane:Crane Station (M...	Crude Oil	142156.94939	2149	0	1
3	Polyline	5.5	Magellan Crude Oil Pip...	Barnhart:Barnhart Station	Deer Park:Shell Deer Pa...	Crude Oil	660034.372852	2150	0	1
4	Polyline	5.9	Magellan Crude Oil Pip...	Barnhart:Barnhart Station	Genoa Junction:Conver...	Crude Oil	660698.748969	2151	0	1
5	Polyline	5.9	Magellan Crude Oil Pip...	Barnhart:Barnhart Station	Genoa Junction:ExxonM...	Crude Oil	660698.748969	2152	0	1

- rail** (Bottom Window):

OBJECTID *	Shape *	State	Name	Link_Type	Dir_Flag	Volume	Capacity	VCR	Artificial	Shape_Length
1	Polyline	CA	ACEX	4: Class 1 Rights non-S...	0	0	0	0	0	610.913717
2	Polyline	IL	ALS	4: Class 1 Rights non-S...	0	0	600	0	0	116.21445
3	Polyline	IL	ALS	4: Class 1 Rights non-S...	0	0	600	0	0	228.146527
4	Polyline	IL	ALS	4: Class 1 Rights non-S...	0	0	600	0	0	323.38439
5	Polyline	MO	AM	4: Class 1 Rights non-S...	0	0	600	0	0	518.21793

# Example: Pacific Northwest Road Network

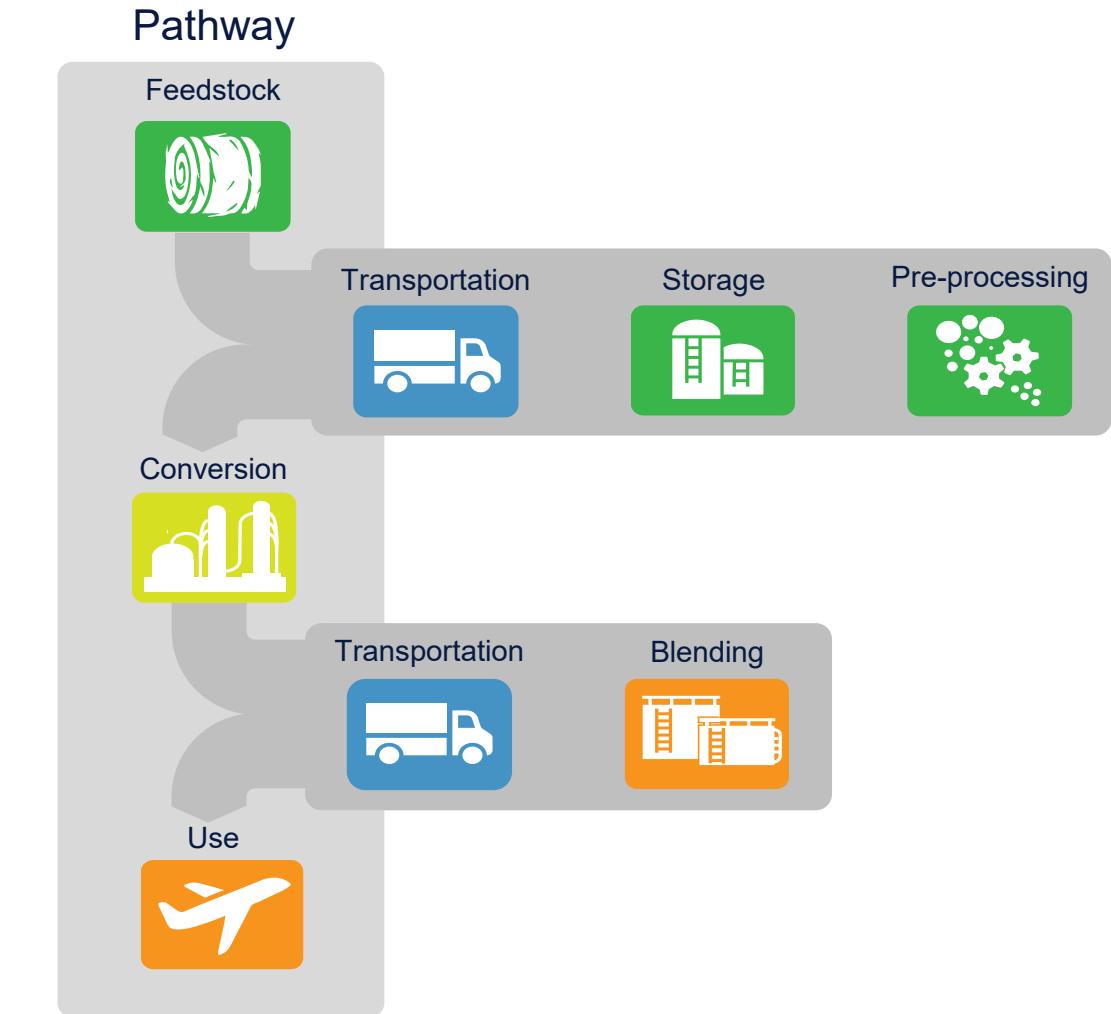
- Default U.S. FTOT network did not have enough granularity for rural areas in PNW.
- Leveraged [OpenStreetMap](#) (OSM) and created scripts to use OSM API (via [OSMNx](#) Python module) to pull data into FTOT format.
- OSM network contains approximately 189,000 network segments representing motorways, trunks, primary, secondary, tertiary, and unclassified roads.
- Used FTOT tools/scripts to ensure connectivity and add other modes.



# SAF Scenario Setup Template

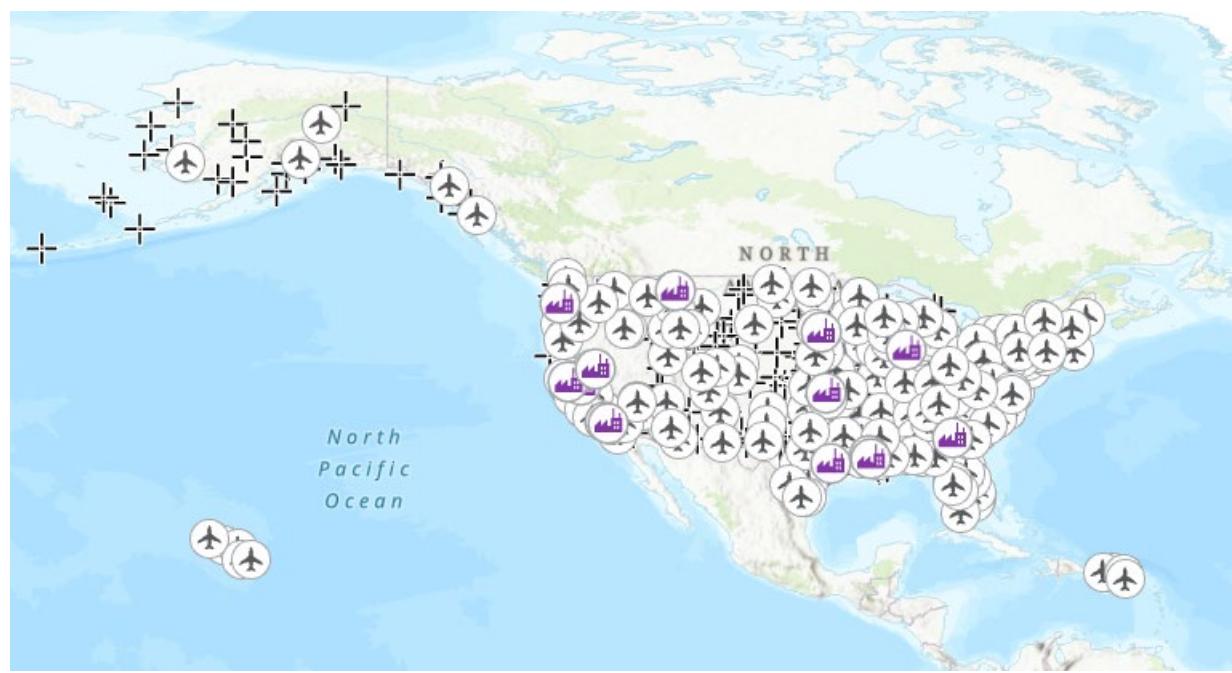
## What is it?

- User-friendly Excel-based template for creating regional sustainable aviation fuel (SAF) supply chain scenarios
- Based on the FTOT Scenario Setup Template
- Follows a generalized supply chain structure for creating SAF
- Queries publicly available or for public use data sources
- **Goal:** Enable users to quickly build a high-level analysis of feedstock availability, conversion needs, and fuel demand for specific SAF pathways



# SAF Template Data Sources

- **Feedstock Data:** [JBEI BioSiting Tool](#) / [DOE Billion-Ton Report](#) / [Renewable Fuels Association](#) – quantities and locations
  - For non-ethanol feedstock classes, county-level quantities queried from JBEI API
  - Geocoded ethanol biorefineries from RFA
- **SAF TEAs:** [ICAO SAF Rules of Thumb](#)
- **Existing SAF Facilities:** [JBEI BioSiting Tool](#) / [BBI International](#) – RD / SAF plant locations
- **Blending Facilities:** [EIA](#) – petroleum product terminal locations
- **Airport Fuel Demand:** Airlines for America (A4A)



SAF facilities geodatabase

## References

- JBEI BioSiting Tool: [biositing.jbei.org/national](https://biositing.jbei.org/national)
- DOE Billion-Ton Report: [https://www.energy.gov/sites/default/files/2024-03/beto-2023-billion-ton-report\\_2.pdf](https://www.energy.gov/sites/default/files/2024-03/beto-2023-billion-ton-report_2.pdf)
- Renewable Fuels Association: <https://ethanolrfa.org/resources/us-ethanol-and-alcohol-to-jet-biorefineries>
- SAF Rules of Thumb: [https://www.icao.int/environmental-protection/Pages/SAF\\_RULESOFTHUMB.aspx](https://www.icao.int/environmental-protection/Pages/SAF_RULESOFTHUMB.aspx)
- BBI International: <https://issuu.com/bbiinternational/docs/biodieselmap-2023>
- EIA: <https://atlas.eia.gov/datasets/eia::petroleum-product-terminals-1/about>

# Currently Available Options in SAF Template

Filter	Values
Market Scenario*	Near-term, Mature-market low, Mature-market medium, Mature-market high, Emerging
Feedstock Categories	Ag processing waste, Agricultural residues, Ethanol, Fire reduction thinnings, FOG, Forest processing waste, Intermediate oilseeds, Logging residues, Other forest waste, Other solid waste, Paper, Plastic, Small-diameter trees
SAF Pathways	Alcohol-to-Jet, Fischer-Tropsch, HEFA, Pyrolysis
Plant Type	Nth, Pioneer
Blending	1,384 facilities filtered by state and city
Airports	112 airports filtered by state, city, FAA hub size

\* Does not apply to ethanol

# User Workflow

1. Fill out the Excel-based SAF Scenario Setup Template
  - Specify supply chain data and scenario settings
  - Combination of filters, drop-down menus, text boxes
2. Run Scenario Conversion Tool in FTOT Tools menu
3. Run FTOT scenario from user-specified directory
4. [Optional] Explore scenario variations through standard FTOT scenario setup process

## Freight and Fuel Transportation Optimization Tool (FTOT) Sustainable Aviation Fuel (SAF) Scenario Setup Template [BETA Version]

The Freight and Fuel Transportation Optimization Tool (FTOT) is a flexible scenario-testing tool that optimizes the transportation of materials for future energy and freight scenarios. FTOT was developed at the U.S. Department of Transportation's Volpe National Transportation Systems Center.

The **FTOT Sustainable Aviation Fuel (SAF) Scenario Setup Template** is a user-friendly helper tool to assist FTOT users in setting up new SAF supply chain scenarios. The specific supply chain modeled includes the movement of user-selected feedstock from county-level raw material producers to refineries, which produce SAF. SAF then flows to blending facilities, which create a fuel blend that flows to airports as the ultimate destination.



Each copy of this template should be updated to reflect input data for a single scenario. When complete, the template can be used as input to the "Scenario Setup Conversion" tool in the FTOT Tools suite, which in turn will output a new scenario directory with (1) the facility-commodity CSV files representing the scenario's supply chain, (2) the scenario XML file with all scenario settings, and (3) the batch file

### SAF Filters tab

**STEP 1. Use filters and text boxes to provide FEEDSTOCK information.**  
Note: Filters (c) and (d) are impacted by filters in Step 2. Clear filters in both Step 1 and Step 2 to reset.

a) Select market scenario*	b) Select states	c) Select commodity	d) Select specific resources	e) Enter usable share of feedstock
Single select	Multiselect	Single select	Multiselect	Share of available feedstock to be used for SAF. Enter a decimal value between 0 and 1, inclusive. 0.50
Billion Ton Scenario Emerging Mature-market high Mature-market low Mature-market medium Near-term	State Alabama Arizona Arkansas California Colorado Connecticut Delaware District of Columbia Florida Georgia Idaho Illinois	Commodity Agricultural residues Fire reduction thinnings FOG Forest processing waste Intermediate oilseeds Logging residues Other forest waste Other solid waste Paper Plastic Small-diameter trees	Resource Barley straw Camerina Carinata Corn stover Cotton field residues Cotton gin trash FOG, animal fats FOG, brown grease FOG, yellow grease Forest waste human generated Hardwood lowland logging resid... Hardwood upland small diameter	Max transport distance for feedstock in default distance units. Please specify default distance units on the Configuration tab. 50

**FUNCTIONS**  
Item Selected  
Item Unselected  
Multiselect Enabled  
Filters Applied  
(Click to Clear Filters)

Note: If an item is unexpectedly unavailable, clear filters from other steps.

**Next: Move to Step 2.**

**STEP 2. Use filters and text boxes to provide REFINERY information**  
Note: Filters (a) and (b) are impacted by feedstock selections above. Clear filters in both Step 1 and Step 2 to reset.

a) Select processing technology	b) Select plant type	c) Include existing SAF refineries?	d) If Y, select states to query for existing refineries
Single select	Single select	If Y, a list of current and planned refineries will be queried.	Multiselect. Selections will be ignored if step (c) is "N"

# Activity: Breakout Groups to Build SAF Supply Chains

- We will break out into small groups to practice building FTOT scenarios for SAF supply chains using the SAF Scenario Setup Template.
- In your groups, refer to the handout and Excel template shared in the chat pod.
- If your group has questions, please let the FTOT team member in your breakout room know.
- At the end of the activity, you'll be automatically be brought back to the main meeting.

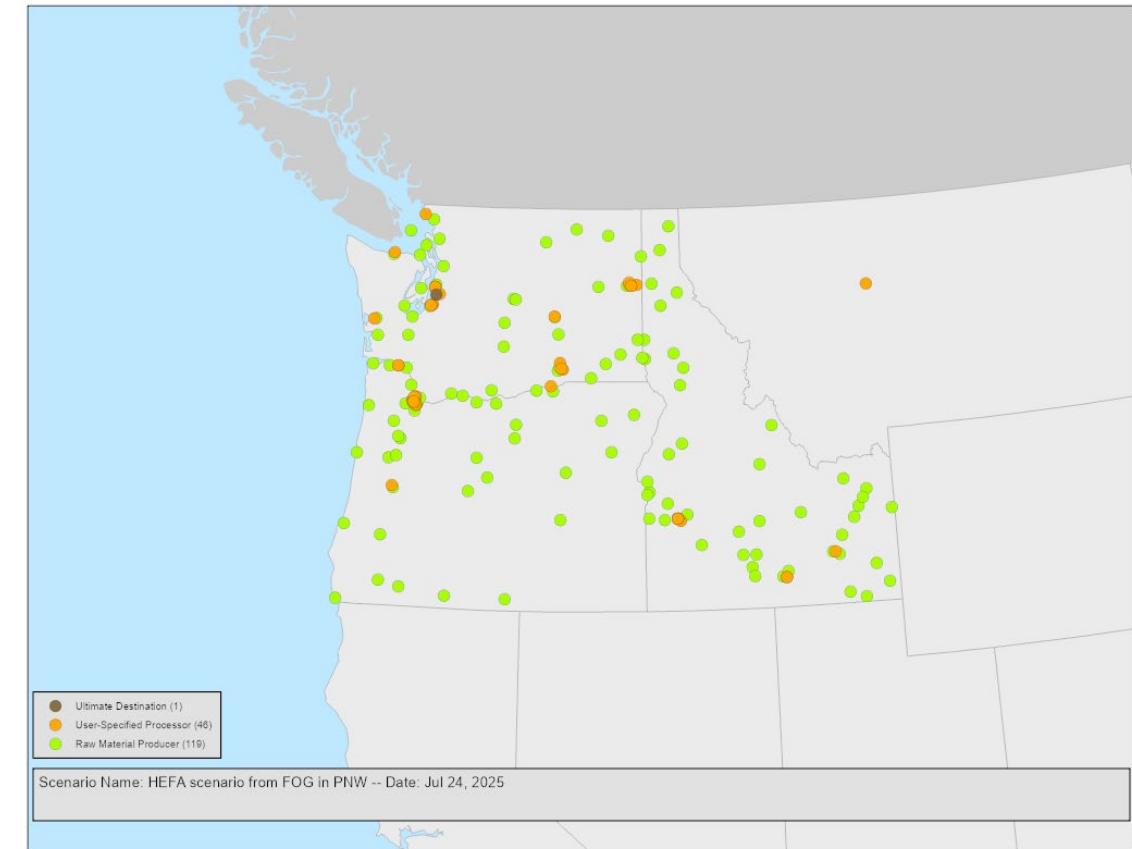
# **Questions on the SAF Scenario Setup Template?**

# SAF Scenario Setup Template: Demo

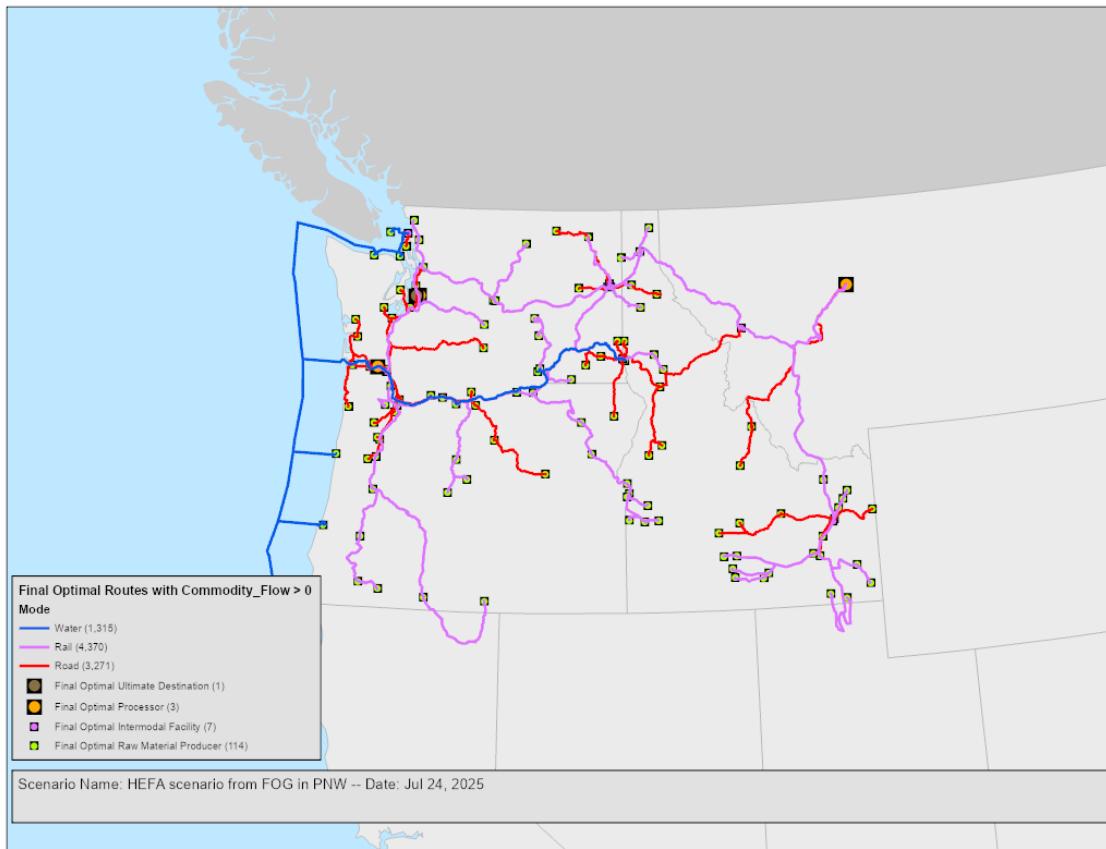
1. Run Scenario Conversion Tool in FTOT Tools menu
2. Run FTOT scenario from user-specified directory
3. [Optional] Explore scenario variations through standard FTOT scenario setup process

# Sample Inputs: HEFA scenario in Pacific Northwest

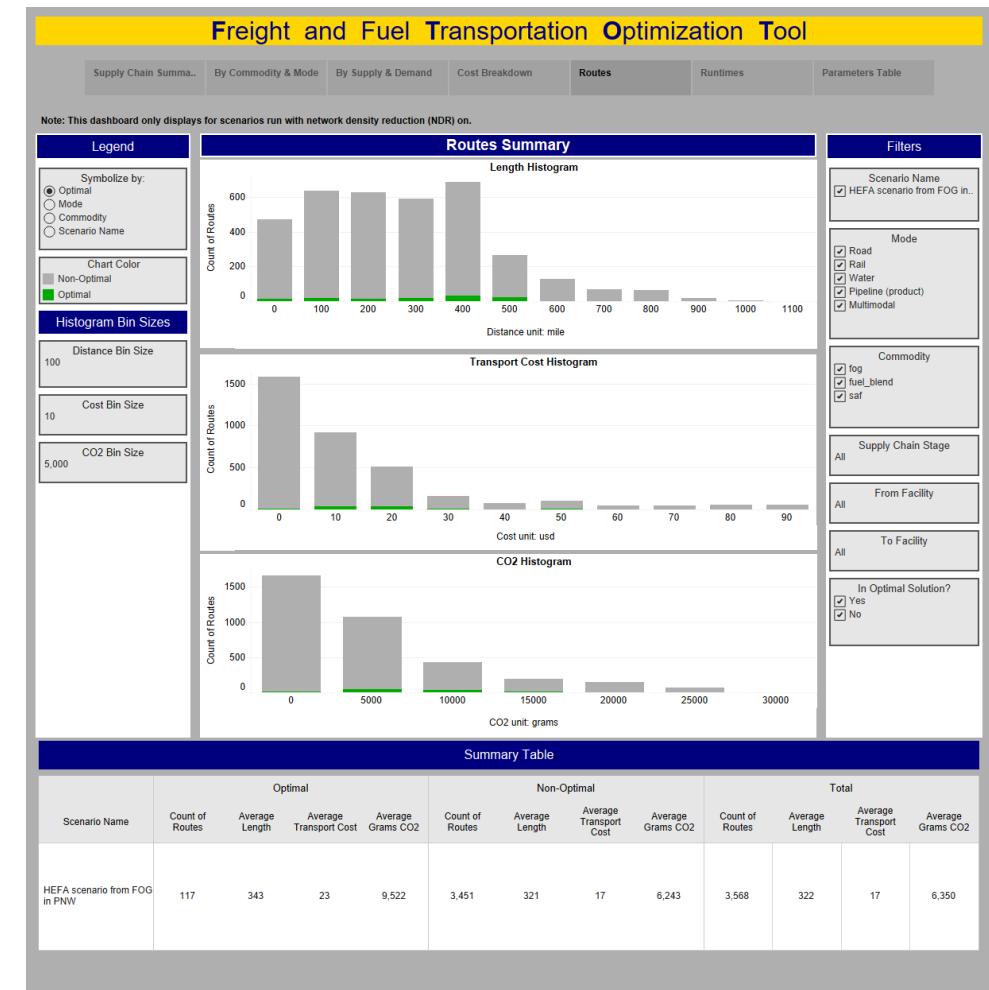
Feedstock Selections	Value(s)
Market Scenario	Mature-market high
States	WA, OR, ID
Commodity	FOG (all resources)
Usable Share	100%
Maximum Transport Distance	500 miles
Refinery Selections	Value(s)
Processing Technology	HEFA
Plant Type	Nth
Include Existing?	Y (from MT, OR)
Blender Selections	Value(s)
States	WA, OR, ID (44 total)
Blend Ratio	50%
Airport Selections	Value(s)
Airports	SEA



# Sample Outputs: HEFA scenario in Pacific Northwest



Feedstock utilization: 100%  
 Demand fulfillment: 11%  
 SAF production at 2 existing facilities



# Potential Adjustments to Initial SAF Scenario

## Scenario settings:

- Permitted modes or vehicle types
- Modal artificial link distances
  - Look closely at facility connections to rail and water in particular
- FTOT-generated locations for candidate processors
  - E.g., are there more that you would want to include?
- Unmet demand penalty
  - What is the total transport cost per gallon/liter of delivered fuel?

## Examine impacts of:

- Changes to feedstock supply or airport SAF uptake
- Changes in techno-economics (e.g., facility capacity, capex)
- New transportation infrastructure
- Supply chain disruption and resilience

# After the Training: Potential Next Steps

- Run the Quick Starts and Reference Scenarios
- Explore the FTOT default U.S. network in ArcGIS Pro
- Watch the Creating a Custom Scenario video
- Try out the Excel-based scenario setup templates
- Create a scenario comparison dashboard

# Useful References and Links

- FTOT Public landing page: <https://volpeusdot.github.io/FTOT-Public/>
  - Installation instructions
  - Video series
    - FTOT Overview: <https://volpeusdot.github.io/FTOT-Public/#ftot-overview>
    - Installing FTOT: <https://volpeusdot.github.io/FTOT-Public/#installing-ftot>
    - Running Your First Scenario: <https://volpeusdot.github.io/FTOT-Public/#running-your-first-ftot-scenario>
    - Customizing Your Own Scenario: <https://volpeusdot.github.io/FTOT-Public/#customizing-your-own-ftot-scenario>
  - Documentation, network, and example scenario data: [https://volpeusdot.github.io/FTOT-Public/data\\_download.html](https://volpeusdot.github.io/FTOT-Public/data_download.html)
- GitHub code repository: <https://github.com/VolpeUSDOT/FTOT-Public>
  - Python code
  - Report bugs and feature requests in “Issues” tab
- Public documentation
  - Technical documentation – description of how FTOT works, underlying data and assumptions, FTOT structures and functions
  - User guide – installation instructions and details on how to customize and develop scenarios, how to create input files, and how to interpret results
  - Quick start tutorial – how-to guide for running pre-built quick start scenarios
  - Reference scenarios documentation – how-to guide for running reference scenarios to demonstrate FTOT functionalities
- Marketing materials
  - [FTOT 2-pager](#)
  - [Minimum data requirements](#)
- FTOT users' group – email [FTOT-Team@dot.gov](mailto:FTOT-Team@dot.gov) to be added
- Resilience tools
  - FTOT Link Rank and Removal tool: [https://github.com/VolpeUSDOT/FTOT-Resilience-Link\\_Removal](https://github.com/VolpeUSDOT/FTOT-Resilience-Link_Removal)
  - FTOT Supply Chain Resilience tool: [https://github.com/VolpeUSDOT/FTOT-Resilience-Supply\\_Chain](https://github.com/VolpeUSDOT/FTOT-Resilience-Supply_Chain)

# Published FTOT studies and documentation

## Peer reviewed papers

Atnoorkar et al., 2025. Future marine biofuels in the Port of Seattle region. *Frontiers in Energy Research*.  
<https://www.frontiersin.org/articles/10.3389/fenrg.2025.1550093>.

Zhao et al.. 2023. Multi-Component Resilience Assessment Framework for a Supply Chain System. *Sustainability* 15(7): 6197. Special issue: Towards Resilient Infrastructure.  
<https://doi.org/10.3390/su15076197>.

Ma et al., 2022. Probabilistic Wildfire risk assessment methodology and evaluation of a supply chain network. *International Journal of Disaster Risk Reduction*. <https://doi.org/10.1016/j.ijdrr.2022.103340>.

Zhao et al., 2022. Effect of Connected and Autonomous Vehicles on Supply Chain Performance. *Transportation Research Record*. <https://doi.org/10.1177/0361198122111542>

Shi et al.. 2019. Analysis of Renewable Jet from Oilseed Feedstocks Replacing Fallow in the U.S. *Northern Great Plains Sustainable Chemistry and Engineering*: 7(23): 18753-18764.  
[doi/10.1021/acssuschemeng.9b02150](https://doi.org/10.1021/acssuschemeng.9b02150).

Lewis et al. 2018 U.S. Alternative Jet Fuel Deployment Scenario Analyses Identifying Key Drivers and Geospatial Patterns for the First Billion Gallons. *BioFPR*:  
[doi.org/10.1002/bbb.1951](https://doi.org/10.1002/bbb.1951).

Shi et al. 2017. Life cycle water footprint analysis for rapeseed derived jet fuel in North Dakota. *Sustainable Chemistry and Engineering*: Web, April 6, 2017:  
<http://pubs.acs.org/doi/abs/10.1021/acssuschemeng.6b02956>.

Ukaew et al. 2016. Full chain life cycle assessment of greenhouse gases and energy demand for canola-derived jet fuel in North Dakota, United States. *ACS Sustainable Chemistry and Engineering*. DOI: [10.1021/ACSSUSCHEMENG.6B00276](https://doi.org/10.1021/ACSSUSCHEMENG.6B00276).

## Downloadable technical documents [available on GitHub](#)

- FTOT Technical Documentation
- FTOT User Guide
- FTOT Quick Start
- FTOT Reference Scenarios

# Thank you!

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and

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## Current Sponsors

**FAA Office of Environment and Energy (PM Prem Lobo)**

Primary public tool development and SAF scenarios

**Pipeline Hazardous Materials Safety Administration**

**U.S. Dept. of Energy Bioenergy Technologies Office**

**U.S. Dept. of Agriculture**

**Oregon State University**

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