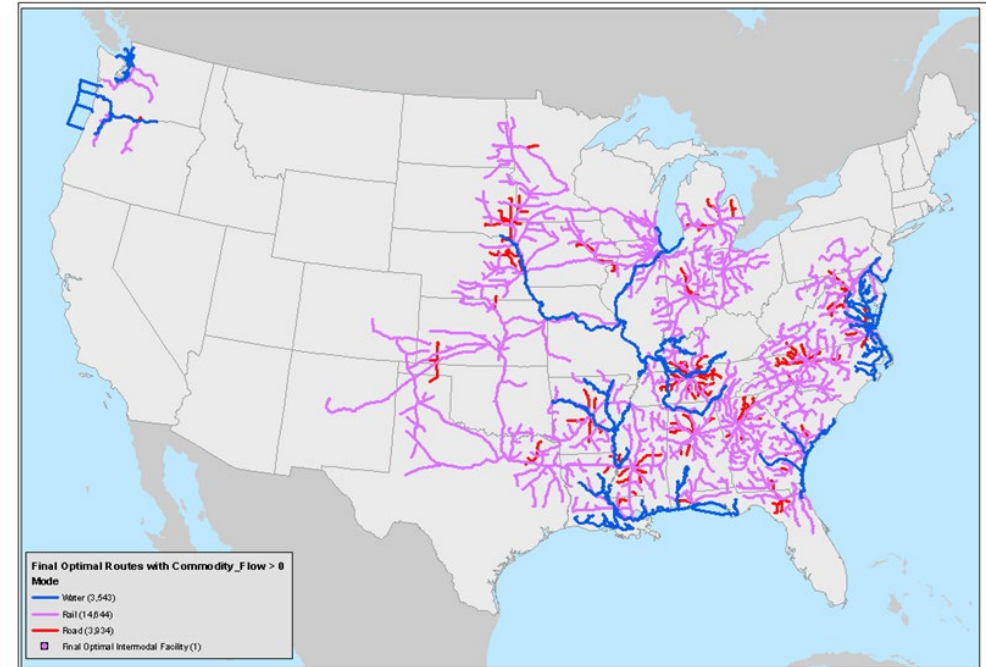


Freight and Fuel Transportation Optimization Tool (FTOT) Training

*Kirby Ledvina, Kristin Lewis, and
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?**

A photograph of a flooded street. Several cars are partially submerged in the water. In the background, there are trees, utility poles, and a building with a sign that says "CHIROPRACTOR". The image is used as a background for the text.

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)

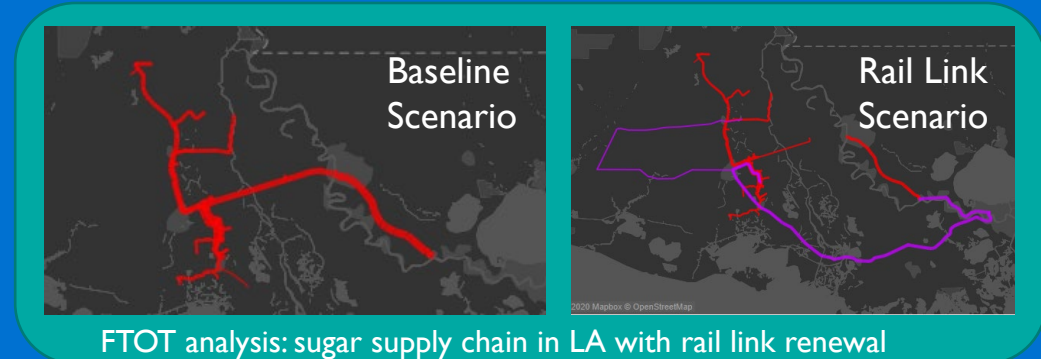
volpeusdot.github.io/FTOT-Public

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:

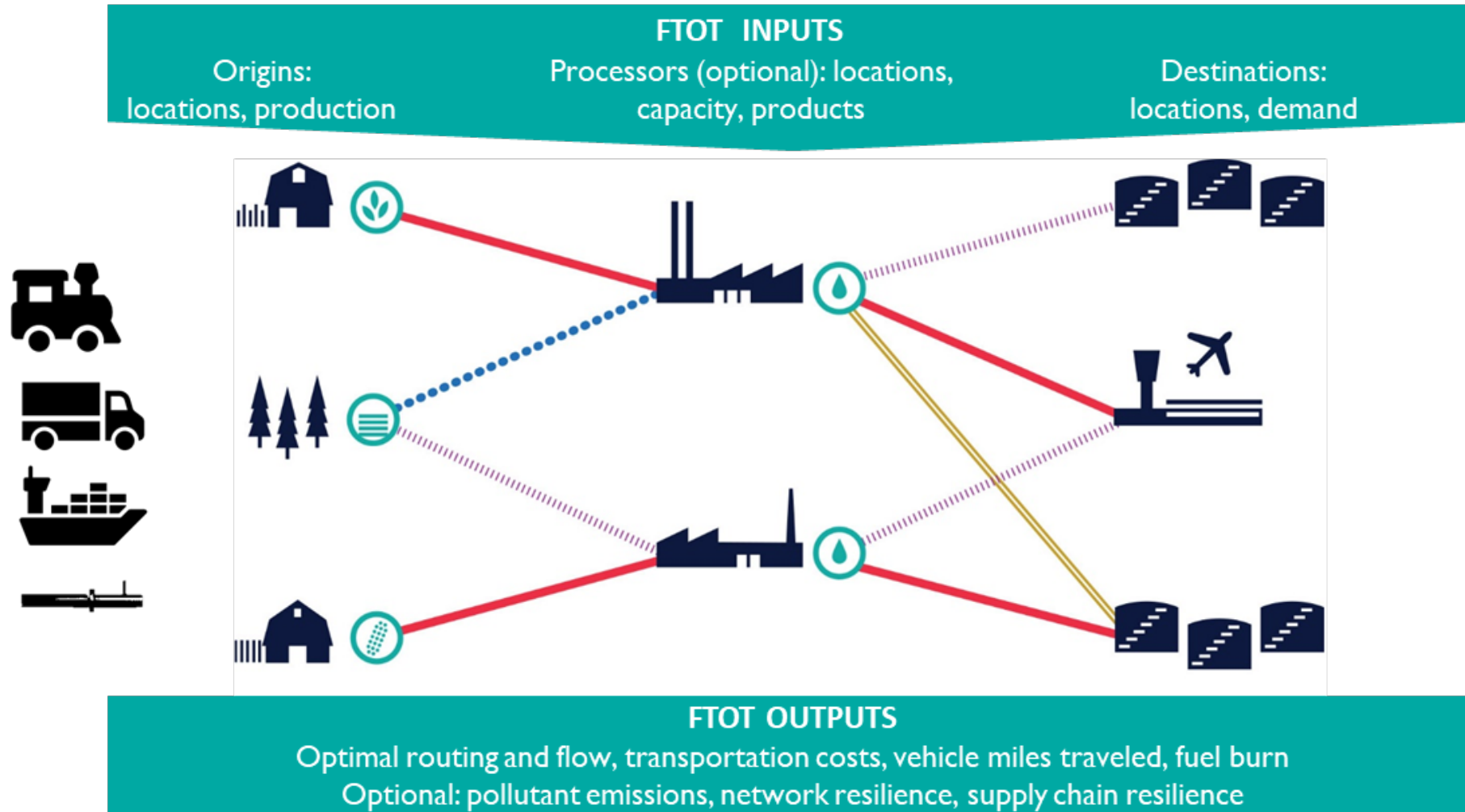
- Supply / demand
- Multimodal infrastructure
- Supply chain / industry patterns
- Disruption and resilience



Enable transportation innovation:

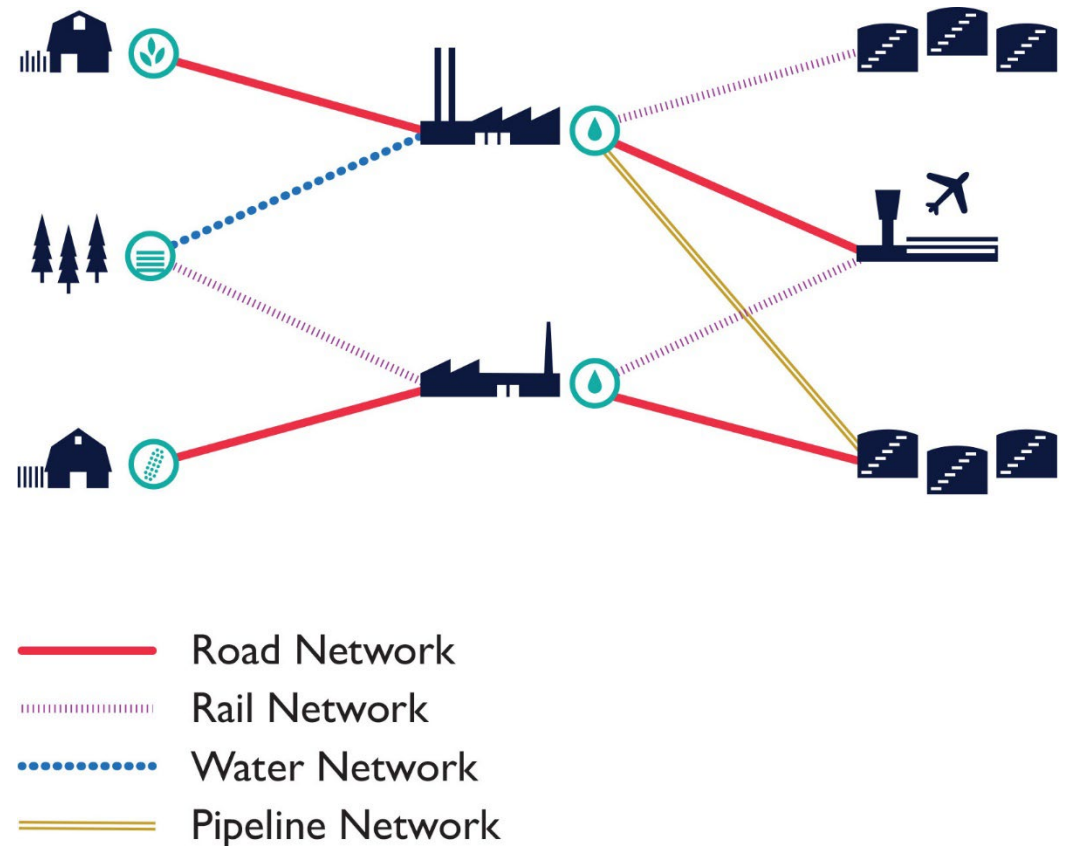
- Transportation infrastructure affects supply chain costs, resilience
- Current and future supply chains impact infrastructure needs

The Freight and Fuel Transportation Optimization Tool (FTOT)



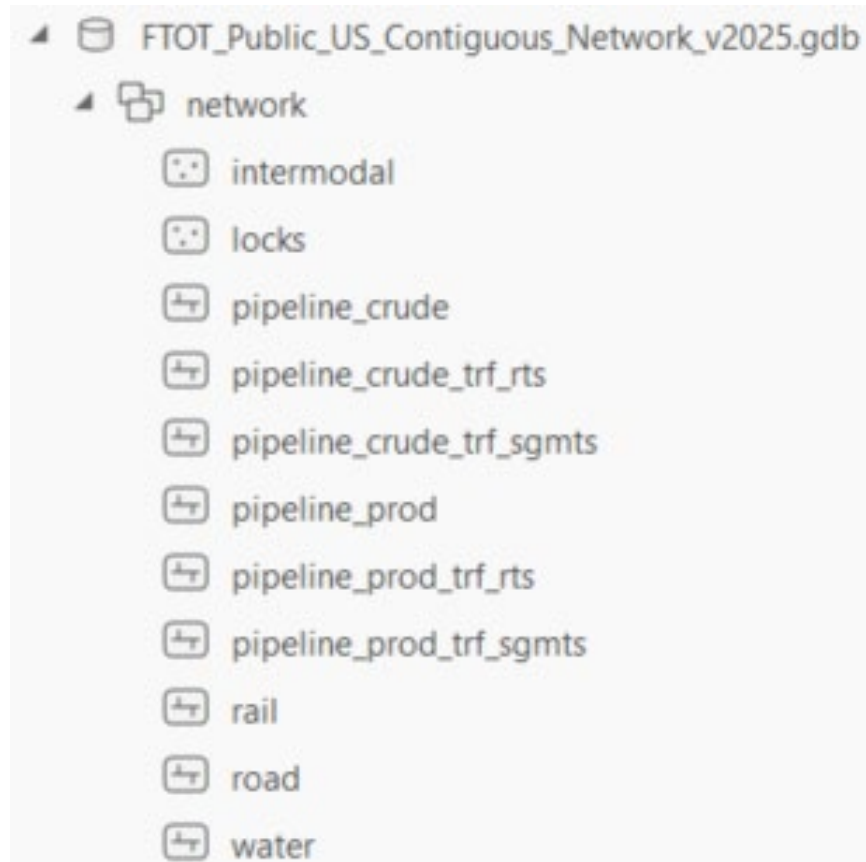
FTOT optimizes routing of supply chain scenarios over a multimodal transportation network

- Transportation costs (per mile, tariff)
- Transloading costs
- Impedances / weightings
- (Optional) CO₂ 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.

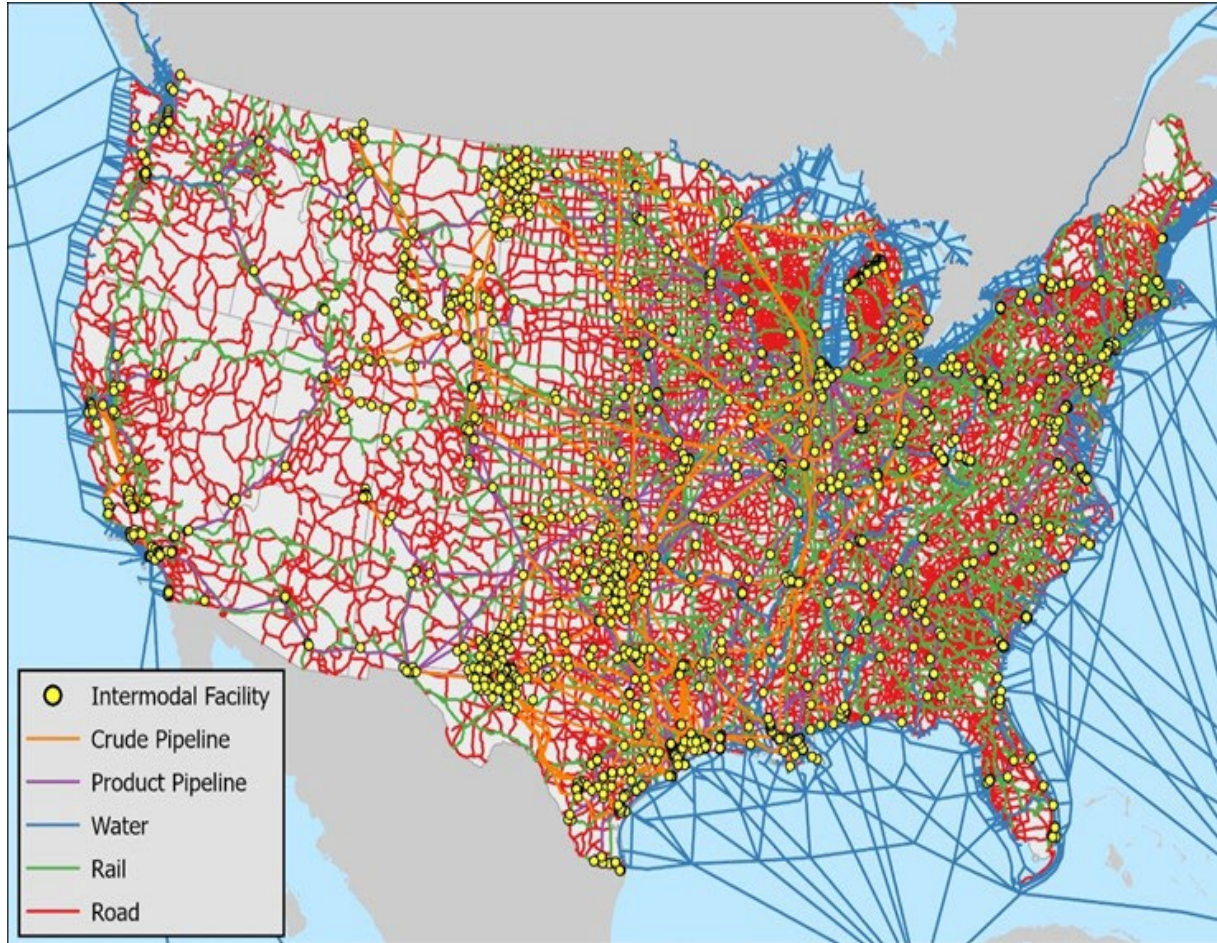
FTOT Network Format



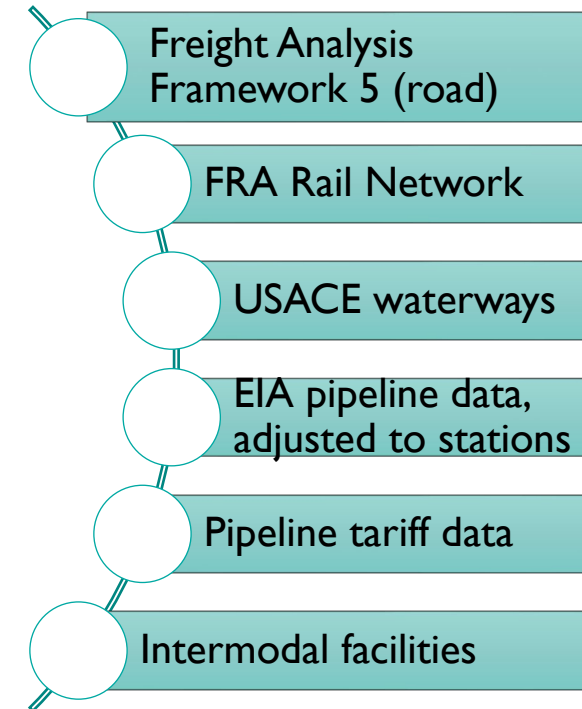
Aligned with **Generalized Modeling Network Specification (GMNS)**

- 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

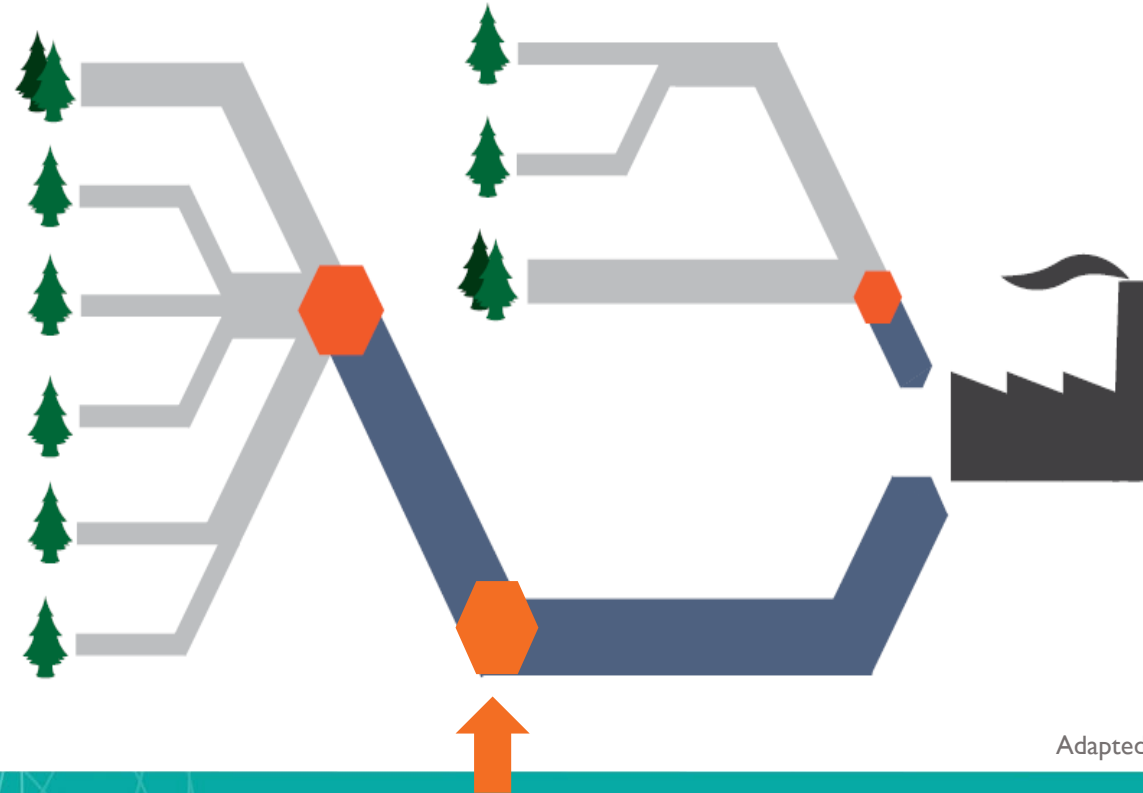
FTOT Default U.S. Multimodal Network



Network components



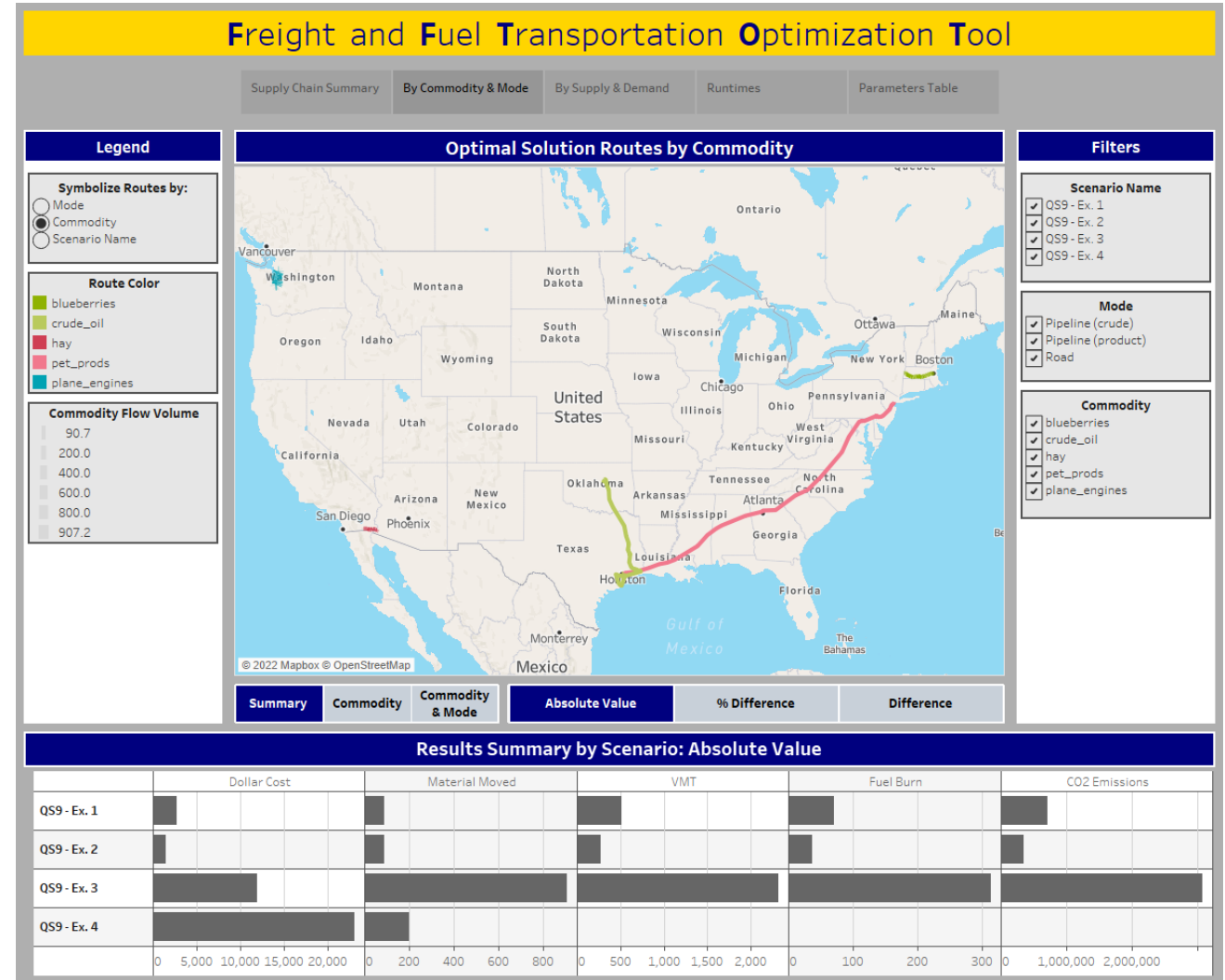
FTOT can help identify candidate facility locations based on optimized transportation patterns.



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

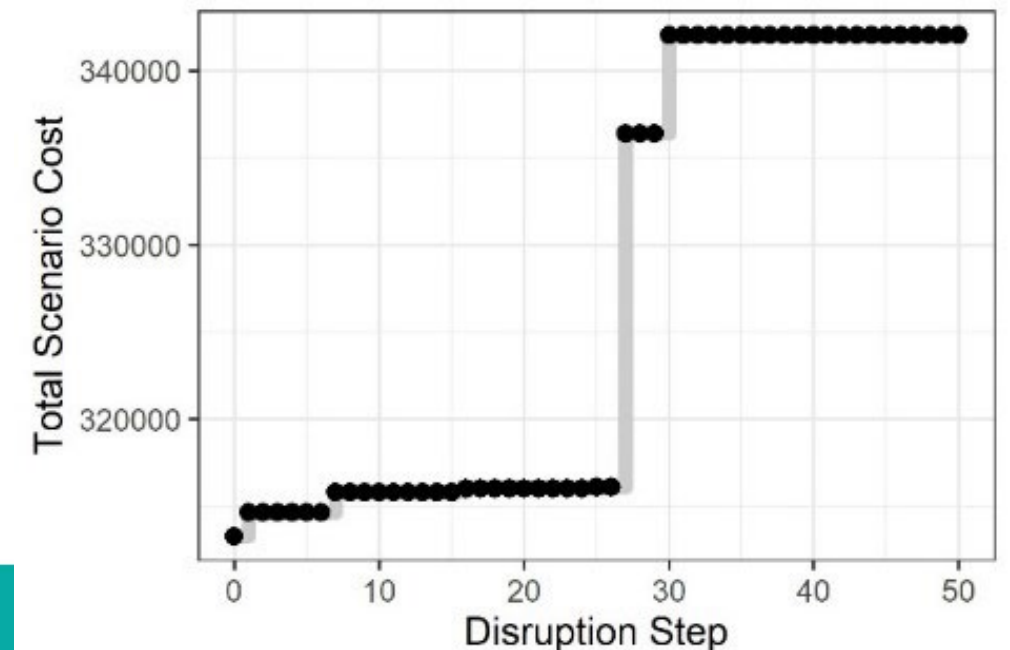
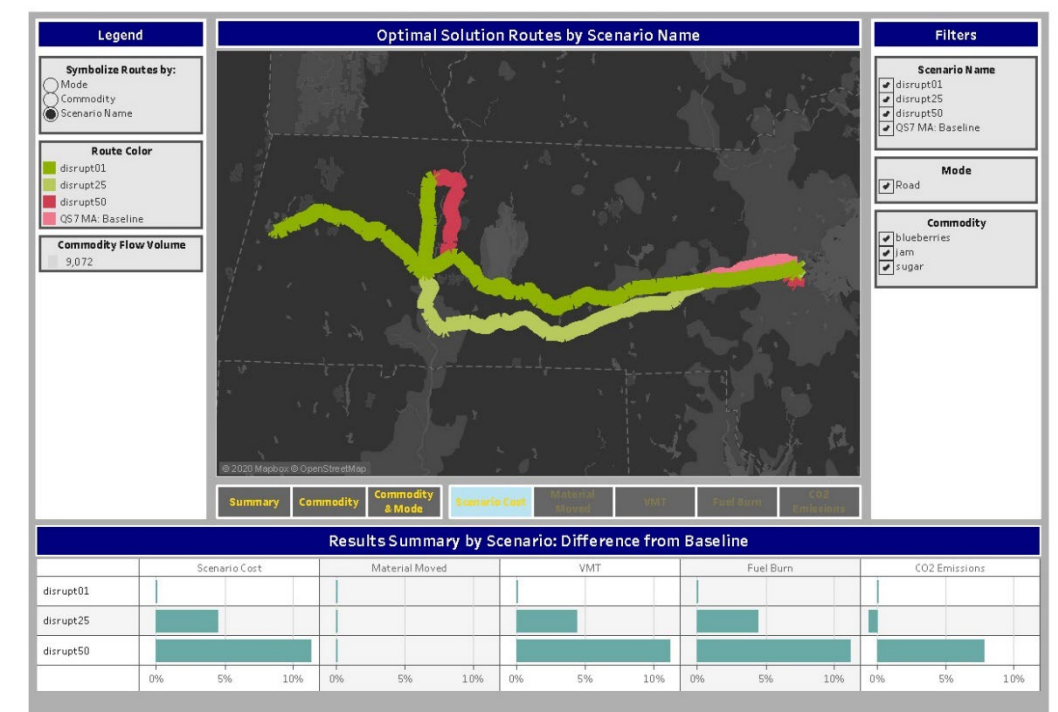
Manual network or supply chain modifications

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)?

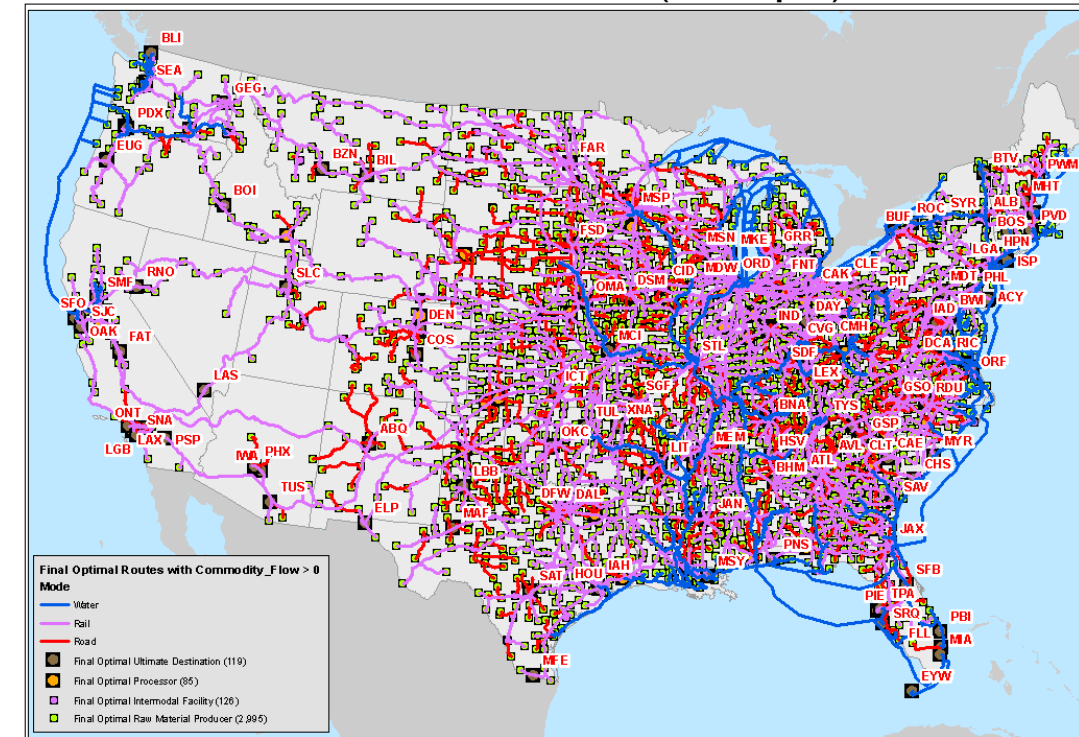
Disruption and Resilience

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)

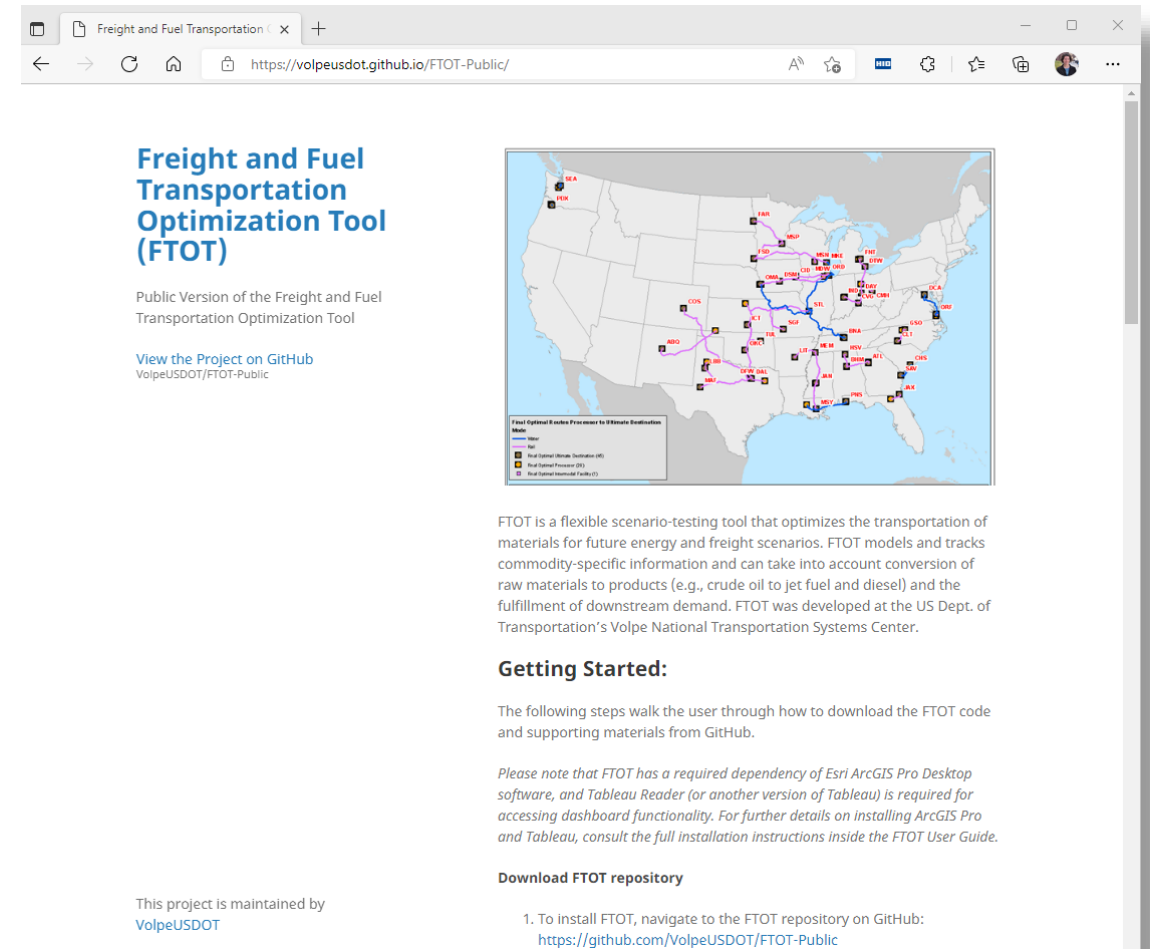


Source: USDOT Volpe Center – See also: <https://doi.org/10.1002/bbb.1951>

FTOT is free and publicly available

volpeusdot.github.io/FTOT-Public

- 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.
- Training / informational video library is always expanding.
- We welcome feedback and suggestions, additional projects, collaborations.



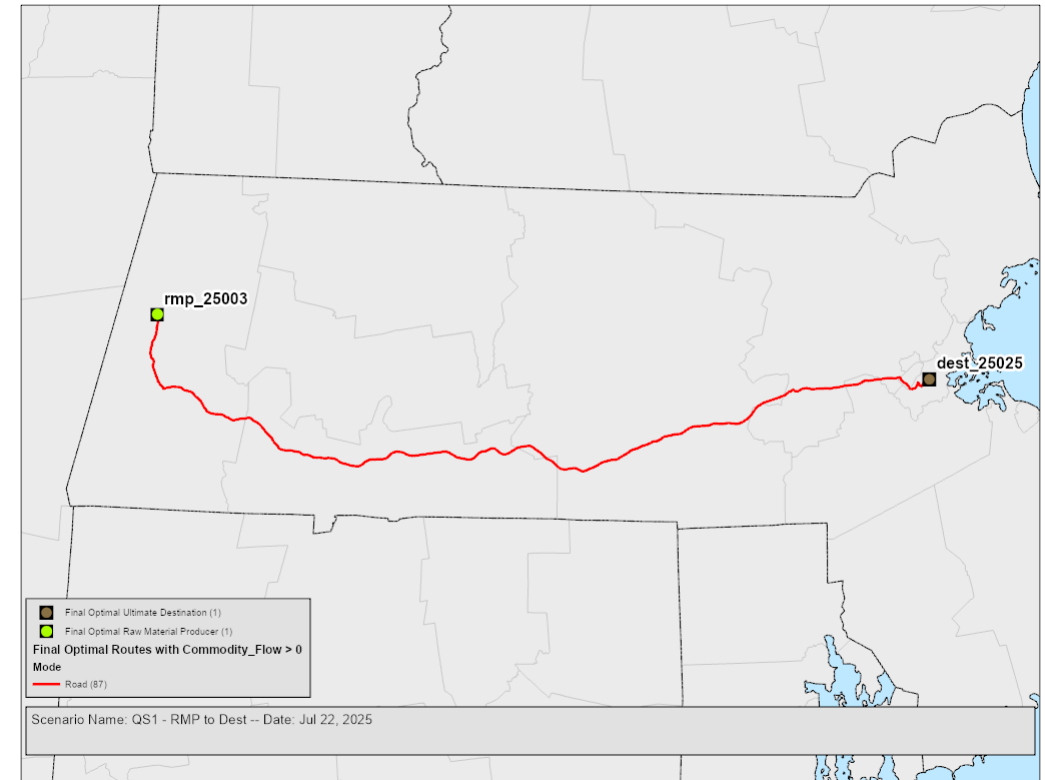
Questions?

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 ₂ 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 cls
3 set PYTHONWRITEBYTECODE=1
4 REM -- default is #ECHO OFF, cls (clear screen), and disable .pyc files
5 REM -- for debugging REM @ECHO OFF line above to see commands
6 REM -----
7 REM run_v7.bat generated by FTOT run.bat upgrade tool
8 REM =====
9 REM ----- ENVIRONMENT VARIABLES -----
10 REM =====
11 set PYTHON="C:\FTOT\python3_env\python.exe"
12 set FTOT="C:\FTOT\program\ftot.py"
13 set XMLSCENARIO="C:\FTOT\scenarios\quick_start\qsl_rmp_dest\scenario.xml"
14 REM -----
15 REM ----- RUN THE FTOT SCRIPT -----
16 REM =====
17 REM -- SETUP: SETUP FTOT FOR THE SCENARIO
18 %PYTHON% %FTOT% %XMLSCENARIO% s || exit /b
19 REM -- FACILITIES: ADD FACILITIES LOCATIONS AND
20 REM -- COMMODITY DATA FILES TO THE SCENARIO
21 %PYTHON% %FTOT% %XMLSCENARIO% f || exit /b
22 REM -- CONNECTIVITY: CONNECT THE FACILITIES TO THE NETWORK AND
23 REM -- EXPORT FROM GIS TO NETWORKX MODULE
24 %PYTHON% %FTOT% %XMLSCENARIO% c || exit /b
25 REM -- GRAPH: CREATE THE NETWORKX GRAPHS FROM THE
26 REM -- NETWORK AND FACILITIES
27 %PYTHON% %FTOT% %XMLSCENARIO% g || exit /b
28 REM -- OPTIMIZATION: SET UP THE OPTIMIZATION PROBLEM
29 %PYTHON% %FTOT% %XMLSCENARIO% o1 || exit /b
30

```

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>Qs1 - 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 fol
10    <!-- The multimodal network also contains waterway lock and intermodal facility locations. -->
11    <!-- Units for link length in the network must match the default distance units specified furth
12    <Base_Network_Gdb>C:\FTOT\scenarios\common_data\networks\FTOT_Public_US_Contiguous_Network_v202
13    <Disruption_Data>None</Disruption_Data>
14    <!-- GEOSPATIAL FACILITY INFORMATION -->
15    <!-- The original copy of the facility geospatial information. -->
16    <!-- FTOT will not alter this copy. -->
17    <Base_RMP_Layer>C:\FTOT\scenarios\common_data\facilities\counties.gdb\rmp</Base_RMP_Layer>
18    <Base_Destination_Layer>C:\FTOT\scenarios\common_data\facilities\counties.gdb\dest</Base_Destin
19    <Base_Processors_Layer>None</Base_Processors_Layer>
20    <!-- FACILITY COMMODITY INFORMATION -->
21    <!-- CSV Files that map facility name to the commodity quantities, units, and inputs/outputs. (i
22    <RMP_Commodity_Data>C:\FTOT\scenarios\quick_start\qsl_rmp_dest\input_data\rmp.csv</RMP_Commodit
23    <Destinations_Commodity_Data>C:\FTOT\scenarios\quick_start\qsl_rmp_dest\input_data\dest.csv</De
24    <Processors_Commodity_Data>None</Processors_Commodity_Data>
25    <Processors_Candidate_Commodity_Data>None</Processors_Candidate_Commodity_Data>
26    <Schedule_Data>None</Schedule_Data>
27    <Commodity_Mode_Data>None</Commodity_Mode_Data>
28    <Commodity_Density_Data>None</Commodity_Density_Data>
29    <!-- DEFAULT UNITS -->
30    <!-- Set default units for commodities, distance, and currency. -->
31    <!-- Default distance units must match the units used for link length in the network. -->
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 | io |
| 2 | rmp_25003 | raw_material_producer | blueberries | 100 | tons | solid | o |
| 3 | | | | | | | |

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

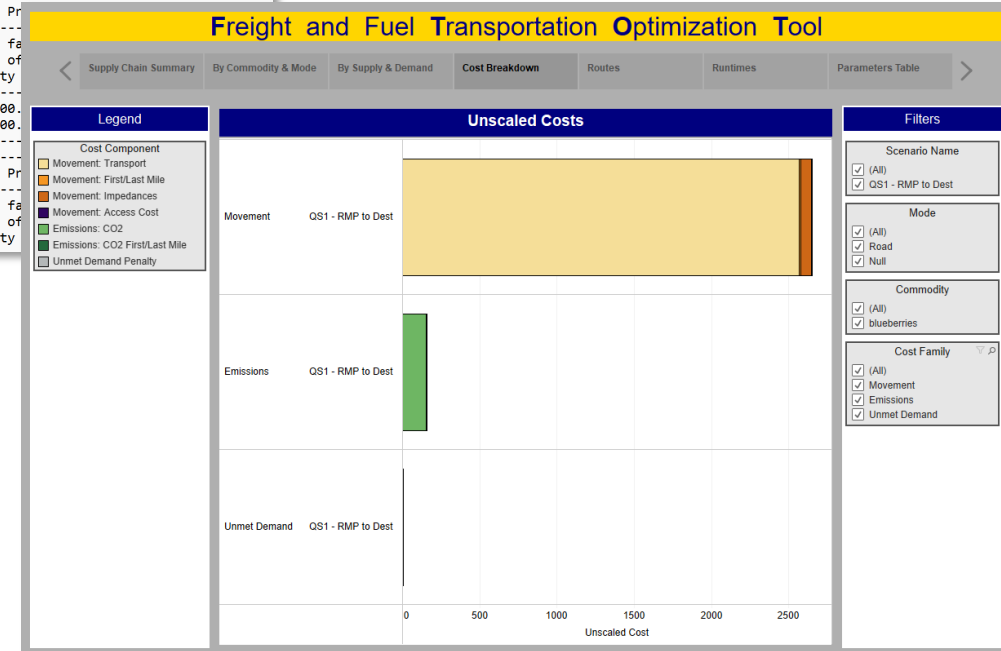
```
SCENARIO
-----
Scenario Name : QS1 - RMP to Dest
Timestamp : 2025-07-22 12:14:19
FTOT Version : 2025.2

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 : Scenario Total Supply and Demand, and Available Pr
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 : Scenario Total Supply and Demand, and Available Pr
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
C : -----
```

Tableau workbook

With a variety of dashboards



FTOT Spatial Data

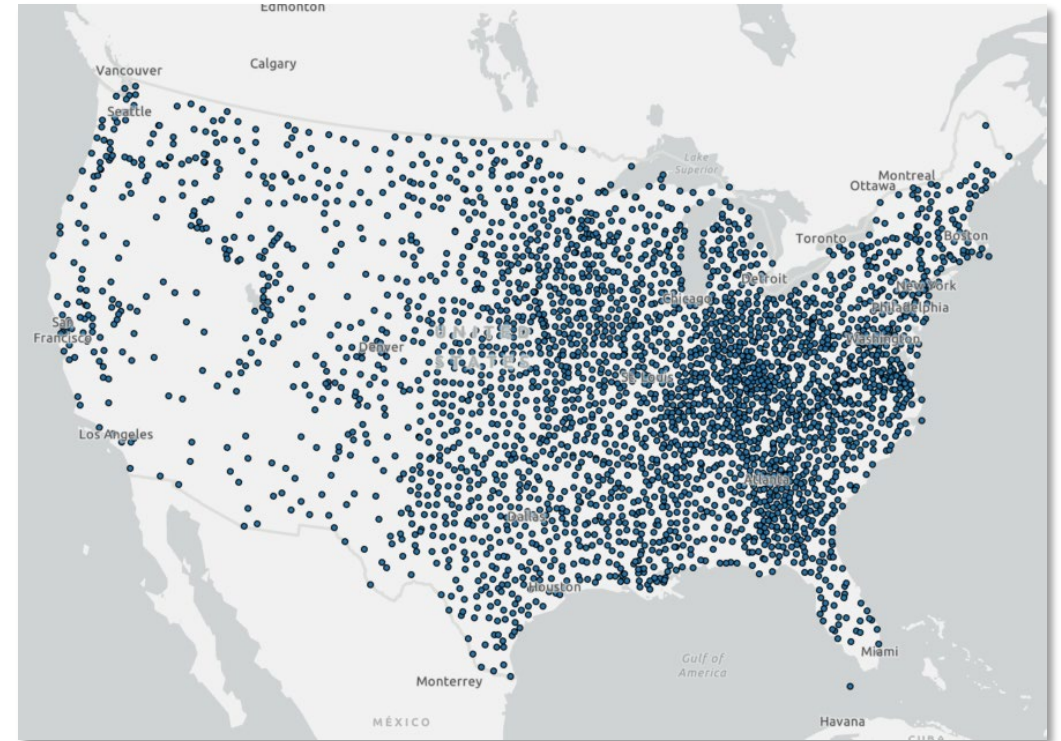
County points
as FTOT's out-of-the-box facility locations

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



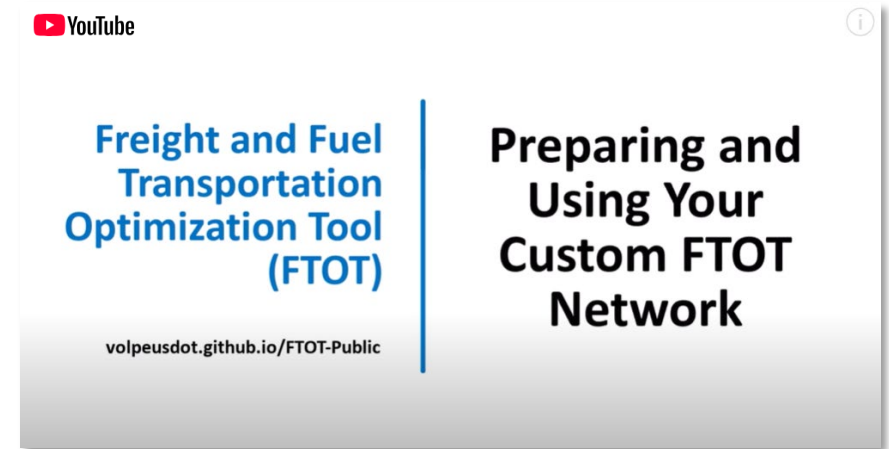
Building a custom FTOT network

Why use a custom network?

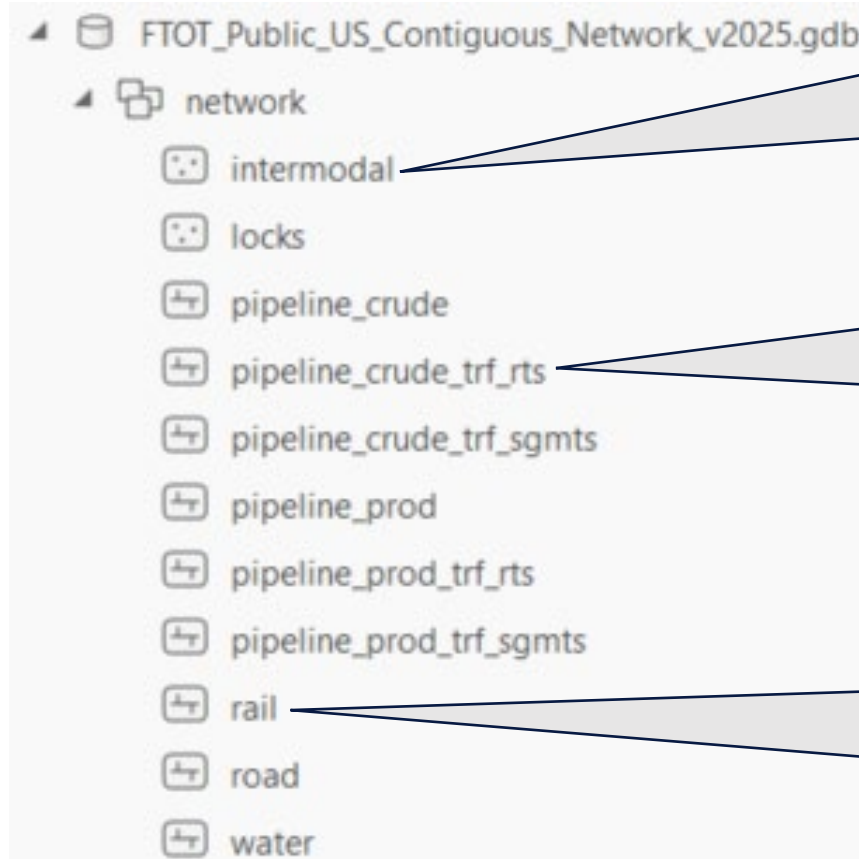
- More granularity, e.g., with local roads
- Non-U.S. geographies

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



| Field: | Add | Calculate | Selection: | Select By Attributes | Zoom To | Switch | Clear | Delete | Copy |
|------------|---------|-------------|---------------------------|----------------------|-----------|--------|---------------------------|----------|------|
| OBJECTID * | SHAPE * | Facility_ID | Name | Address | City | State | Source | Operator | |
| 1 | 1 | Point | 81 USX CORP., CLAIRTON... | | Clairton | PA | Army Corps of Engineer... | | |
| 2 | 2 | Point | 82 FULLEN DOCK AND W... | 382 Klinke Road. | Memphis | TN | Army Corps of Engineer... | | |
| 3 | 3 | Point | 83 SUN MARINE TERMINA... | 2300 North 347 | Nederland | TX | Army Corps of Engineer... | Sunoco | |
| 4 | 4 | Point | 84 TECO, BULK TERMINAL | 14537Hwy. 15 | Davant | LA | Army Corps of Engineer... | | |
| 5 | 5 | Point | 85 CHEVRON PRODUCTS... | | RICHMOND | CA | Army Corps of Engineer... | | |

pipeline_crude_trf_rts

Field:

Add

Calculate

Selection:

Select By Attributes

Zoom To

Switch

Clear

Delete

Copy

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

rail

Field:

Add

Calculate

Selection:

Select By Attributes

Zoom To

Switch

Clear

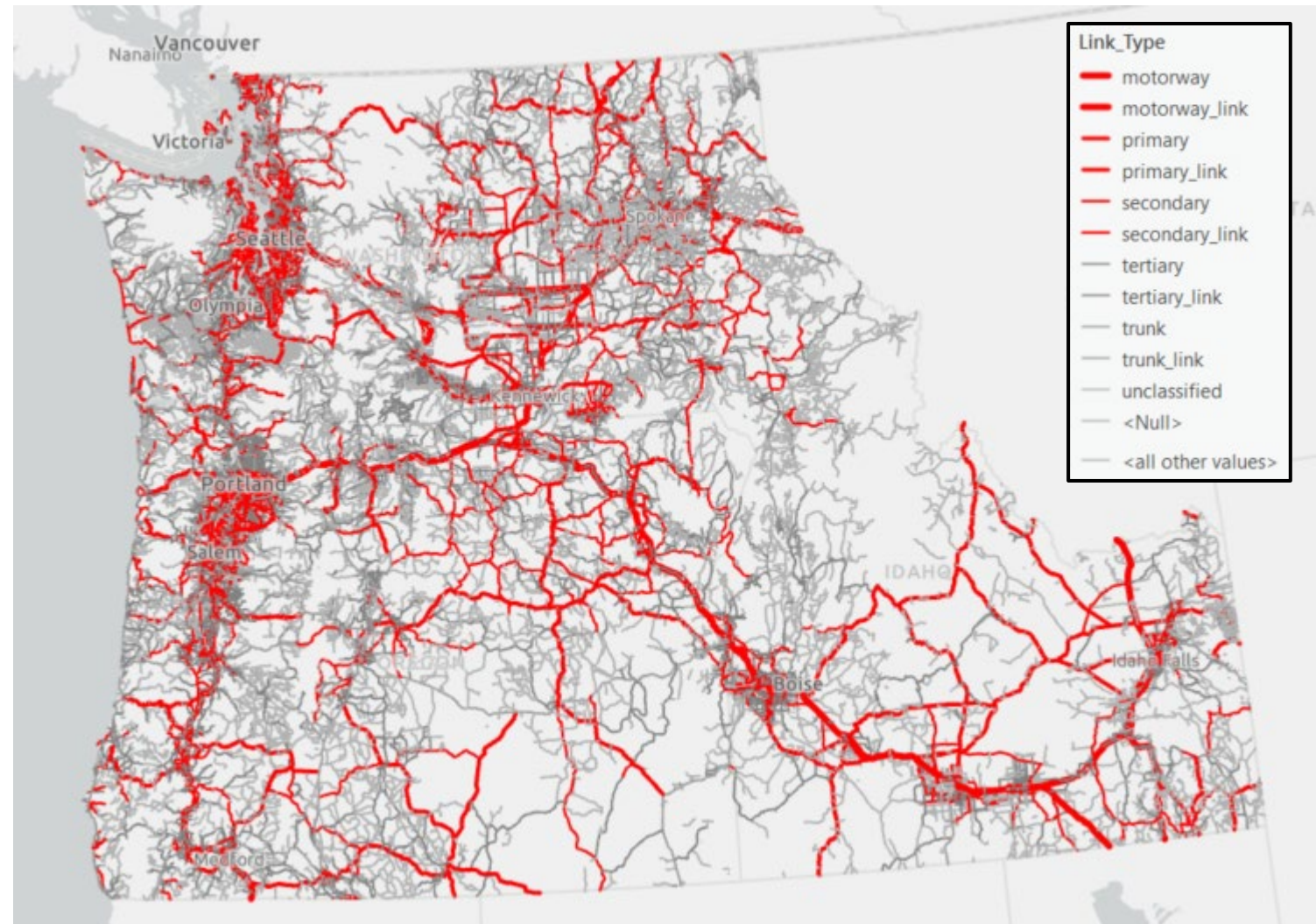
Delete

Copy

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

Example: Pacific Northwest Road Network

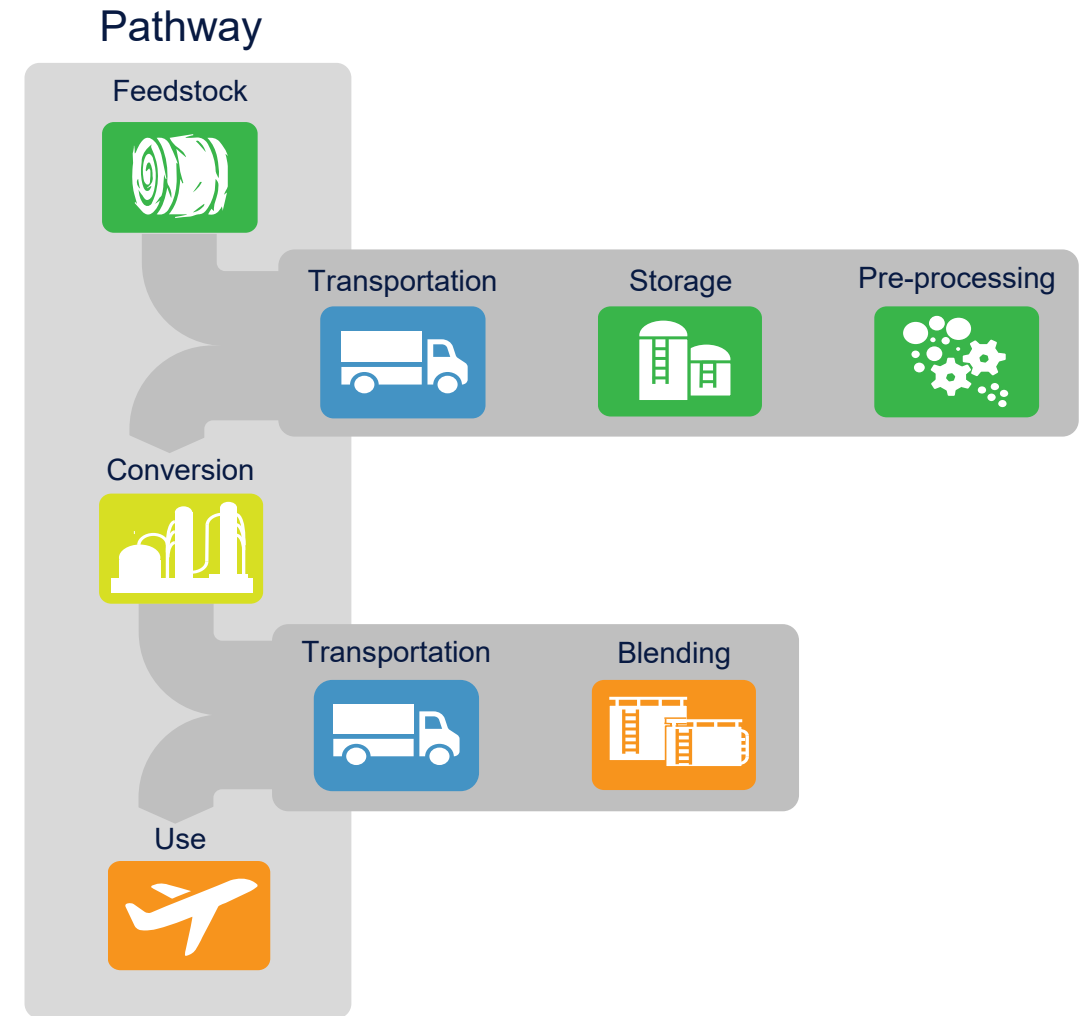
- Default U.S. FTOT network did not have enough granularity for rural areas in PNW.
- Leveraged [OpenStreetMap](#) (OSM) and created scripts to use OSM API (via [OSMNx](#) Python module) to pull data into FTOT format.
- OSM network contains approximately 189,000 network segments representing motorways,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



SAF Scenario Setup Template

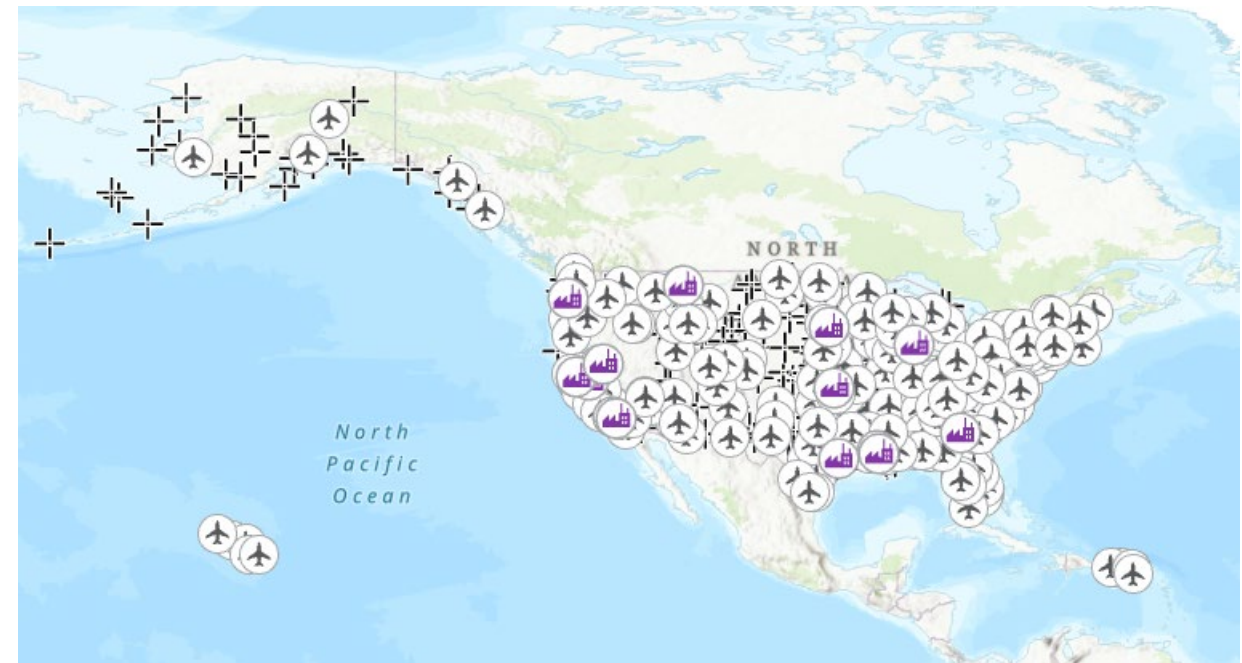
What is it?

- 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

DOE Billion-Ton Report: 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

BBI International: <https://issuu.com/bbiinternational/docs/biodiesemap-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*
Single select
Billion Ton Scenario
Emerging
Mature-market high
Mature-market low
Mature-market medium
Near-term
*See Table ES-1 in the 2023 Billion-Ton Report for scenario definitions:
DOE-BETO 2023 Billion-Ton Report
Error: Select 1 item only

b) Select states
Multiselect
State
Alabama
Arizona
Arkansas
California
Colorado
Connecticut
Delaware
District of Columbia
Florida
Georgia
Idaho
Illinois

c) Select commodity
Single select
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
Error: Select 1 item only

d) Select specific resources
Multiselect
Resource
Barley straw
Camelina
Carinata
Corn stover
Cotton gin trash
Cotton field residues
FOG, animal fats
FOG, brown grease
FOG, yellow grease
Forest waste human generated
Hardwood lowland logging resid...
Hardwood lowland logging resid...

e) Enter usable share of feedstock
Share of available feedstock to be used for SAF.
Enter a decimal value between 0 and 1, inclusive.
0.50

f) Enter maximum transport distance
Max transport distance for feedstock in default distance units.
Please specify default distance units on the Configuration tab.
50
Next: Move to Step 2.

FILTER LEGEND
Item Selected
Item Unselected
Note: If an item is unexpectedly unavailable, clear filters from other steps.
FUNCTIONS
Multiselect Enabled
Filters Applied (Click to Clear Filters)

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
Single select

b) Select plant type
Single select

c) Include existing SAF refineries?
If Y, a list of current and planned refineries will be queried.

d) If Y, select states to query for existing refineries
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.

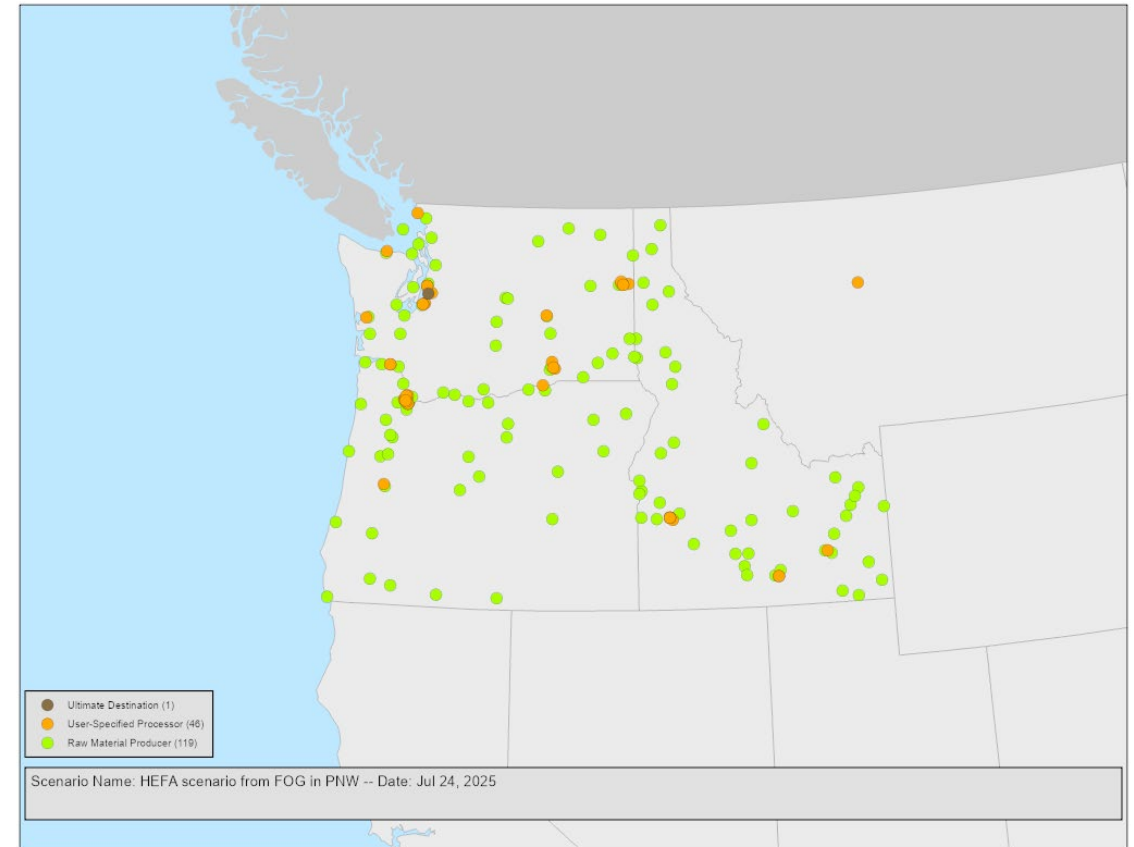
Questions on the SAF Scenario Setup Template?

SAF Scenario Setup Template: Demo

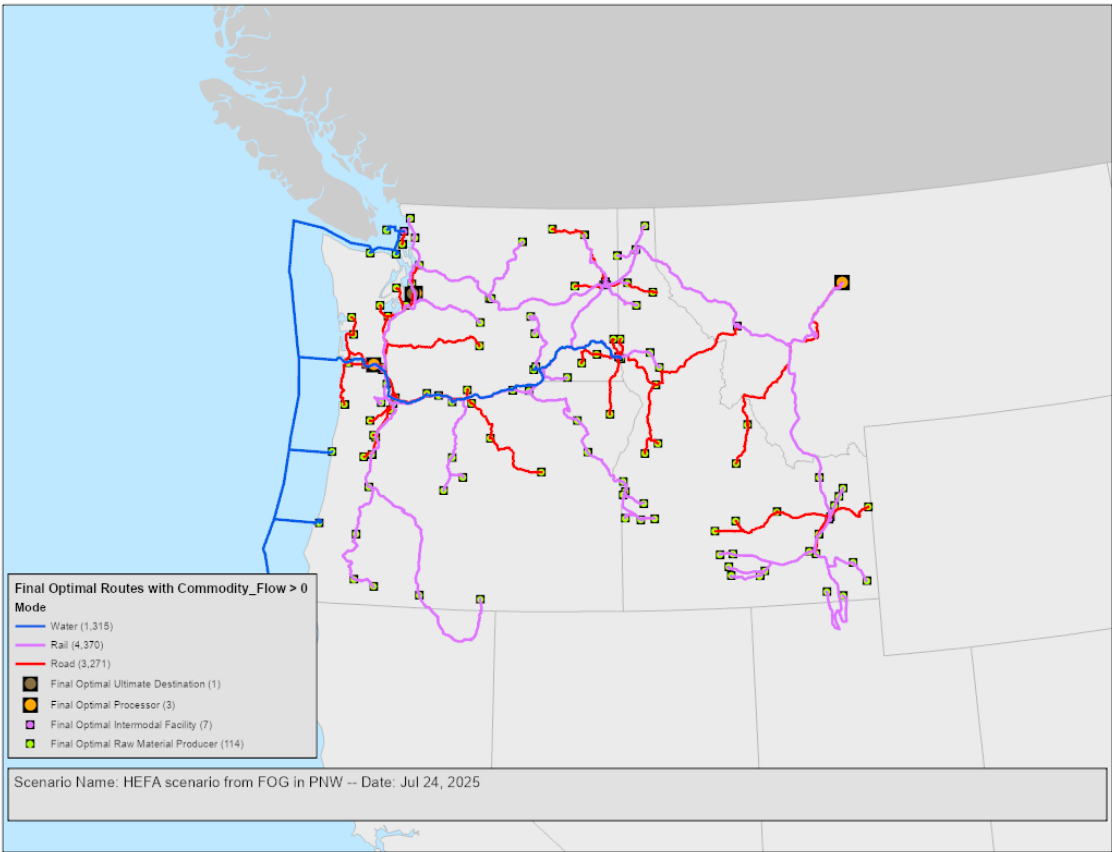
1. Run Scenario Conversion Tool in FTOT Tools menu
2. Run FTOT scenario from user-specified directory
3. [Optional] Explore scenario variations through standard FTOT scenario setup process

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 |



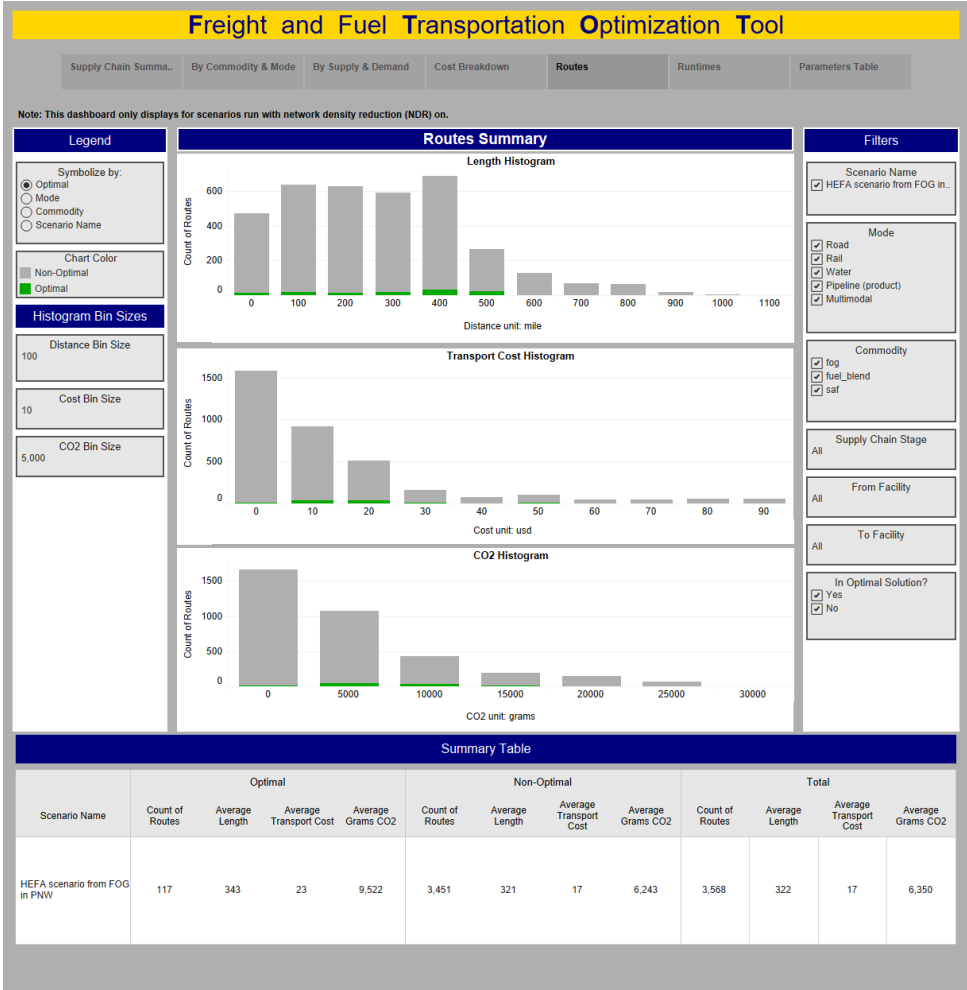
Sample Outputs: HEFA scenario in Pacific Northwest



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
- 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 to be added
- Resilience tools
 - FTOT Link Rank and Removal tool: https://github.com/VolpeUSDOT/FTOT-Resilience-Link_Removal
 - FTOT Supply Chain Resilience tool: 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.

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!

Kirby Ledvina,
Kristin Lewis, Ph.D.,

and

Kevin Zhang, Ph.D.

Energy Analysis and Sustainability Division
Volpe National Transportation Systems Ctr.
US Dept. of Transportation
FTOT-Team@dot.gov

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

Current Development Team (alphabetical):

Olivia Gillham

Michelle Gilmore

Kirby Ledvina

Kristin Lewis, Ph.D. (PM)

Mark Mockett

Matthew Pearlson

Tess Perrone

Gretchen Reese

Peter Wilke

Jae Yun

Kevin Zhang, Ph.D. (Tool Lead)