Freight Analysis Framework, Version 5 (FAF5): Overview of Base Year/Forecasted Data and FAF Web-Based Tool Demonstration

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Agenda

• Overview of FAF5 & Base Year Data  
  Birat Pandey, FHWA

• Overview of FAF5 Forecast Data  
  Paul Bingham, IHS Markit

• FAF5 Web-Based Tool Demonstration  
  Hyeonsup Lim, Oak Ridge National Laboratory

• Q&A  
  Facilitated by Alisa Fine, USDOT Volpe Center

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Expected Learning Outcomes

- Improved understanding of FAF5 updates
- Enhanced ability to use FAF5 for freight analysis
- Increased knowledge of FAF5 web-based tools
What is FAF?

FAF5 Webpage: https://ops.fhwa.dot.gov/freight/freight_analysis/faf/

FAF Provides a Comprehensive Picture of Freight Movement in the U.S.

- Includes information on:
  - Weight and value of freight transported
  - Types of commodities and transport mode
  - Freight truck routings
- Offers tools to obtain customized data for analysis
- Updated every 5 years in conjunction with economic census

What Information Does FAF5 Include?

What is Moving?
• Types of commodities

Where is it Moving?
• Between metropolitan areas
• Between States
• Between U.S. and foreign countries
• Within U.S. including States and metropolitan areas

How Much is Moving?
• Tons, ton-miles, and value of goods moved (various modes including truck, rail, air, and water)

How Much is Expected to Move (flow scenarios)?
• Base year estimates
• 30-year forecasts

FAF Data Include:
• 42 commodity categories
• Domestic flows
• Freight exports and imports
• Weight and value by 6 transport modes
• 3 forecast scenarios
How are Geographies Represented in FAF5?

FAF Zones Include:

- Domestic zones (representing 50 States and the District of Columbia)
- International zones (8 regions):
  - Canada
  - Mexico
  - Rest of Americas
  - Europe
  - Africa
  - Southwest & Central Asia
  - Eastern Asia
  - Southeast Asia & Oceania

Additional information on FAF zones is available at: https://www.census.gov/programs-surveys/cfs.html

Domestic FAF zone shapefiles are available on the FAF5 webpage at https://faf.ornl.gov/faf5/

What are FAF5 Base Year Data Sources?

Commodity Flow Survey (CFS) 2017
National survey of shippers in U.S. at FAF zone level

Imports and Exports
Census-provided data collected by U.S. Customs and Border Protection for U.S. gateways

Other Federal Data Sources
Other data such as crude petroleum data from the Energy Information Administration

= FAF5 Base Year 2017
What Does the CFS Include?

Examples of CFS industry categories:

- Broader industry category examples (3-digit NAICS* code level):
  - Mining (except oil and gas)
  - Food manufacturing
  - Machinery manufacturing

- More granular industry category examples (4-digit NAICS code level):
  - Warehousing and storage
  - Newspaper, periodical, book, and directory publishers

Overview of CFS:

- Shipper-based survey that collects information on how U.S. businesses transport materials and goods; types of commodities shipped; value/weight of shipments; and other information

- Joint effort by the Bureau of Transportation Statistics, USDOT, and U.S. Census Bureau; required by law

- Includes data from approximately 100,000 businesses, representative of 5 industries: mining, manufacturing, wholesale trade, retail and services, and some auxiliary establishments (e.g., warehouses)

Additional information on the CFS is available at:
https://www.census.gov/programs-surveys/cfs/about.html

*NAICS = North American Industry Classification System
What Does the CFS Exclude?

Percentage Share of CFS Out of Scope Data: FAF5 Base Year 2017 (Examples)


Additional information on CFS out of scope data for FAF5 is available from the FAF5 Base Year data development report: https://ops.fhwa.dot.gov/freight/freight_analysis/faf/
What are FAF5 Forecasted Data Sources?

Domestic Freight Model
- U.S. macro economic model
- U.S. regional model

International Freight Model
- U.S. international trade and global trade model

FAF5 Forecasted Data
(3 growth scenarios)
What is New in FAF5?

**Origin-Destination Flows**
- New data base year (2017)
- Updated data to horizon 2050 with 5-year increments
- New short-term forecasts for 2020, 2022, and 2023
- Revised annual estimates for 2018 and 2019
- Updated base year data and forecast data development processes

**Highway Network Flows**
- Updated model highway network (dualized Interstates and included ramps)
- Added new truck flows by commodity groups
- Added new truck flows (domestic, imports, and exports)
- Overhauled highway network model and routing algorithms
- Added new customized model software and analysis capability

**Special Products and Data Tools**
- Updated features for web-based data products
- Added new FAF data visualization tools
- Added new national truck flow maps
- Added new State-level truck flow maps
- Added new summary tables by FAF zones
- Added a new special tabulation of CFS 2017 for small areas
What Can FAF Help Me Do?

FAF can help:
- Inform freight analysis and decision-making
- Improve understanding of current and projected future freight needs
- Enhance understanding of current and projected future freight movement
- Illuminate links between freight and economic activity
- Improve freight performance monitoring and management
- Better visualize freight flows and other freight data

Examples of FAF Use Cases:
- Support development of or updates to the State Freight Plan
- Help identify commodity corridors and trade lanes
- Provide control totals for modeling needs to understand State/regional freight connectivity
- Help conduct macro-level analysis for drafting grant applications
What Skills are Needed to Use FAF5?

• Basic understanding of origin-destination flows of vehicles or commodities
• Basic understanding of freight shippers, freight carriers, freight storage and distribution, and freight consumption
• Basic knowledge of industry inputs, outputs, and economic measures
• Basic data manipulation skills such as cross tabulation, data plotting, and understanding of basic statistical measures

FAF is designed to be user friendly.

Users do not need specialized expertise or software to access FAF data or utilize FAF tools for data customization.
### What are Some Considerations in Using FAF5?

#### FAF5 Strengths

- Publicly available and user friendly
- Trusted, long-standing Federal data source
- Considers national and international trade
- Includes multimodal perspectives
- Includes 42 commodity group types
- Forecast assumptions are balanced
- Supports analysis at multiple scales
- Supports network flow analysis on the National Highway System, higher functional class roadways, and on multicounty corridors

#### FAF5 Limitations

- Not tailored to a specific region
- Potential inconsistency with local growth scenarios
- Local roadways not fully captured
- May not have enough granularity for local-scale analysis; local-level analysis likely requires supplemental data
- Commodity details may be insufficient for some types of analyses
What is an Example of a FAF Output?

Example: national commodity flows and volumes
What is an Example of a FAF Output?

Example: State freight through-flows

Estimated FAF Flow for Trucks Passing Through Missouri on National Highway System 2050

Note: Major flows include domestic and international freight moving by truck on highway segments with more than twenty-five (25) tons per day and between places typically more than fifty (50) miles apart.

Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework (FAF), version 5.2. Flows include 42 different commodities represented in FAF.

*State to State Flows represent annual tons of freight transported by trucks that pass through Missouri including imports and exports that use Missouri as the gateway port.*
What is an Example of a FAF Output?

Example: State freight tonnage by mode: current base year (2017) and forecasted horizon year (2050)

Texas freight tonnage by mode: 2017 and 2050*

<table>
<thead>
<tr>
<th>Mode</th>
<th>2017</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Tons</td>
<td>3,308,058,120</td>
<td>4,967,119,536</td>
</tr>
<tr>
<td>Air (includes truck-air)</td>
<td>183</td>
<td>360</td>
</tr>
<tr>
<td>Multiple modes &amp; mail</td>
<td>733</td>
<td>1,111</td>
</tr>
<tr>
<td>Pipeline</td>
<td>263</td>
<td>381</td>
</tr>
<tr>
<td>Rail</td>
<td>1,799</td>
<td>2,626</td>
</tr>
<tr>
<td>Truck</td>
<td>237</td>
<td>443</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note that total displayed in the bar chart above does not include the mode category: “Other.”

### Top Five Freight Destination States for Kentucky: 2017

<table>
<thead>
<tr>
<th>Origin State</th>
<th>Destination States</th>
<th>Tons (Million)</th>
<th>Percentage Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky</td>
<td>Kentucky</td>
<td>160.2</td>
<td>49%</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Tennessee</td>
<td>49.9</td>
<td>15%</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Indiana</td>
<td>15.3</td>
<td>5%</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Ohio</td>
<td>13.8</td>
<td>4%</td>
</tr>
<tr>
<td>Kentucky</td>
<td>South Carolina</td>
<td>11.7</td>
<td>4%</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Remaining States</td>
<td>79.1</td>
<td>24%</td>
</tr>
</tbody>
</table>

Total Freight Originated in Kentucky: 330.0 100.0%

### Top Five Freight Destination FAF Area for Louisville Kentucky: 2017

<table>
<thead>
<tr>
<th>Origin FAF Zone</th>
<th>Destination FAF Zone</th>
<th>Tons (Million)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Louisville KY-IN (KY Part)</td>
<td>Louisville KY-IN (KY Part)</td>
<td>35.8</td>
<td>59%</td>
</tr>
<tr>
<td>Louisville KY-IN (KY Part)</td>
<td>Rest of KY</td>
<td>6.2</td>
<td>10%</td>
</tr>
<tr>
<td>Louisville KY-IN (KY Part)</td>
<td>West Virginia</td>
<td>3.0</td>
<td>5%</td>
</tr>
<tr>
<td>Louisville KY-IN (KY Part)</td>
<td>Rest of IN</td>
<td>2.5</td>
<td>4%</td>
</tr>
<tr>
<td>Louisville KY-IN (KY Part)</td>
<td>Nashville TN</td>
<td>1.0</td>
<td>2%</td>
</tr>
<tr>
<td>Louisville KY-IN (KY Part)</td>
<td>Remaining FAF Zones</td>
<td>12.1</td>
<td>20%</td>
</tr>
</tbody>
</table>

Total Freight Originated Louisville KY-IN (KY Part): 60.5 100.0%

FAF5 Forecasted Data
FAF5 Forecast Data Background

• FAF5 forecasts:
  - From FAF5 base year (2017)
  - Updated every 5 years like FAF base year data
  - Include forecasts out 30 years (to 2050)

• Driven by IHS Markit’s commercial forecasting system of economic scenario models

FAF forecasts provide policy-makers and planners with freight demand scenarios to help analyze:

- How future freight movements impact congestion, infrastructure, safety, equity and the environment
- Impacts on freight from shifts across industries and economic geographies
- How and where to make investments to improve freight movements
- How freight will impact economic development
FAF5 Flow Data: What is Included?

FAF5 forecasts include:

- Domestic, import. and export flows
- Estimates for 2020, 2022, and 2023
- Estimated every 5 years from 2025 to 2050
- 42 Standard Classification of Transported Goods (SCTG2) commodity categories by weight and value
- Seven modes (Truck, Rail, Water, Air with Truck-Air, Multiple Modes and Mail, Pipeline, Other and Unknown)
FAF5 Forecasts: How We Do It

- Forecasts use long-term econometric forecasting modeling for economic growth scenarios
- U.S. freight activity is derived from domestic U.S. and foreign supply and demand for goods in the economy
  - U.S. macroeconomic forecasts drive multiregional input/output forecast modeling by industry sector for the U.S.
  - International country macroeconomic and industry forecasts modeling drive U.S. commodity trade forecasts by commodity
FAF5 Forecasts: Key Assumptions

• U.S. economic fundamentals remain solid for next 30 years
• Impacts of existing trade policies are assumed to continue in the future
• Sustained capital investments in technology (including automation) improve industrial productivity
• Shift in retail purchasing behavior towards e-commerce
• Increased environmental regulation of transportation
• Energy transition continues away from carbon fuels
• Less reliance on petroleum fuel tax revenues

FAF5 Forecasts and Economic Impacts

• Forecasts include available economic data as of April 2021
• Forecasts include assumptions regarding the recovery in economic activity
FAF5 Total Tonnage Forecast by Flow Type

Drop in 2020 value due to less freight activity

Drop in 2020 value due to less freight activity

### FAF5 Forecast Results – Baseline Growth for Domestic Modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Thousand Tons 2017</th>
<th>Thousand Tons 2050</th>
<th>Compound Annual Growth Rate (CAGR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air (includes truck-air)</td>
<td>2,136</td>
<td>4,231</td>
<td>2.1%</td>
</tr>
<tr>
<td>Multiple modes &amp; mail</td>
<td>536,088</td>
<td>919,106</td>
<td>1.6%</td>
</tr>
<tr>
<td>Pipeline</td>
<td>3,132,993</td>
<td>4,413,841</td>
<td>1.0%</td>
</tr>
<tr>
<td>Rail</td>
<td>1,202,016</td>
<td>1,146,624</td>
<td>-0.1%</td>
</tr>
<tr>
<td>Truck</td>
<td>11,848,259</td>
<td>17,545,223</td>
<td>1.2%</td>
</tr>
<tr>
<td>Water</td>
<td>662,453</td>
<td>855,079</td>
<td>0.8%</td>
</tr>
<tr>
<td>Other and unknown</td>
<td>93,634</td>
<td>27,116</td>
<td>-3.7%</td>
</tr>
<tr>
<td>Total</td>
<td>17,477,579</td>
<td>24,911,219</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

### FAF5 Forecast Results – Baseline, Top 2017 Tonnage Export Commodities

<table>
<thead>
<tr>
<th>SCTG2</th>
<th>SCTG2 Commodity</th>
<th>2017 Tons (Millions)</th>
<th>Rank 2017</th>
<th>2050 Tons (Millions)</th>
<th>Rank 2050</th>
<th>CAGR 2017-2050</th>
<th>Growth 2017-2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Coal</td>
<td>119</td>
<td>1</td>
<td>74</td>
<td>12</td>
<td>-1.5%</td>
<td>-38%</td>
</tr>
<tr>
<td>18</td>
<td>Fuel Oils</td>
<td>117</td>
<td>2</td>
<td>203</td>
<td>1</td>
<td>1.7%</td>
<td>74%</td>
</tr>
<tr>
<td>2</td>
<td>Cereal Grains</td>
<td>103</td>
<td>3</td>
<td>152</td>
<td>4</td>
<td>1.2%</td>
<td>48%</td>
</tr>
<tr>
<td>3</td>
<td>Other Agricultural Products</td>
<td>75</td>
<td>4</td>
<td>132</td>
<td>6</td>
<td>1.7%</td>
<td>76%</td>
</tr>
<tr>
<td>19</td>
<td>Coal and Petroleum Products, not elsewhere classified (n.e.c.)</td>
<td>72</td>
<td>5</td>
<td>159</td>
<td>3</td>
<td>2.4%</td>
<td>121%</td>
</tr>
<tr>
<td>17</td>
<td>Gasoline and Aviation Turbine Fuel</td>
<td>68</td>
<td>6</td>
<td>136</td>
<td>5</td>
<td>2.1%</td>
<td>100%</td>
</tr>
<tr>
<td>16</td>
<td>Crude Petroleum Oil</td>
<td>64</td>
<td>7</td>
<td>163</td>
<td>2</td>
<td>2.9%</td>
<td>155%</td>
</tr>
<tr>
<td>20</td>
<td>Basic Chemicals</td>
<td>56</td>
<td>8</td>
<td>113</td>
<td>8</td>
<td>2.2%</td>
<td>102%</td>
</tr>
<tr>
<td>41</td>
<td>Waste/scrap</td>
<td>48</td>
<td>9</td>
<td>124</td>
<td>7</td>
<td>2.9%</td>
<td>158%</td>
</tr>
<tr>
<td>4</td>
<td>Animal feed</td>
<td>42</td>
<td>10</td>
<td>95</td>
<td>9</td>
<td>2.5%</td>
<td>126%</td>
</tr>
</tbody>
</table>

## FAF5 Forecast Results – Baseline, Top 2017 Tonnage Import Commodities

<table>
<thead>
<tr>
<th>SCTG2</th>
<th>SCTG2 Commodity</th>
<th>2017 Tons (Millions)</th>
<th>Rank 2017</th>
<th>2050 Tons (Millions)</th>
<th>Rank 2050</th>
<th>CAGR 2017-2050</th>
<th>Growth 2017-2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Crude Petroleum</td>
<td>438</td>
<td>1</td>
<td>484</td>
<td>1</td>
<td>0.3%</td>
<td>11%</td>
</tr>
<tr>
<td>19</td>
<td>Coal and Petroleum Products, n.e.c.</td>
<td>69</td>
<td>2</td>
<td>48</td>
<td>10</td>
<td>-1.1%</td>
<td>-30%</td>
</tr>
<tr>
<td>18</td>
<td>Fuel Oils</td>
<td>61</td>
<td>3</td>
<td>47</td>
<td>11</td>
<td>-0.8%</td>
<td>-23%</td>
</tr>
<tr>
<td>32</td>
<td>Base Metal</td>
<td>45</td>
<td>4</td>
<td>69</td>
<td>7</td>
<td>1.3%</td>
<td>53%</td>
</tr>
<tr>
<td>17</td>
<td>Gasoline</td>
<td>42</td>
<td>5</td>
<td>36</td>
<td>20</td>
<td>-0.5%</td>
<td>-14%</td>
</tr>
<tr>
<td>13</td>
<td>Non-Metallic Minerals</td>
<td>36</td>
<td>6</td>
<td>105</td>
<td>2</td>
<td>3.3%</td>
<td>192%</td>
</tr>
<tr>
<td>31</td>
<td>Non-Metallic Mineral Products</td>
<td>34</td>
<td>7</td>
<td>39</td>
<td>17</td>
<td>0.4%</td>
<td>15%</td>
</tr>
<tr>
<td>36</td>
<td>Motorized vehicles</td>
<td>33</td>
<td>8</td>
<td>73</td>
<td>5</td>
<td>2.4%</td>
<td>121%</td>
</tr>
<tr>
<td>22</td>
<td>Fertilizers</td>
<td>31</td>
<td>9</td>
<td>103</td>
<td>3</td>
<td>3.7%</td>
<td>232%</td>
</tr>
<tr>
<td>20</td>
<td>Basic chemicals</td>
<td>30</td>
<td>10</td>
<td>37</td>
<td>18</td>
<td>0.6%</td>
<td>23%</td>
</tr>
</tbody>
</table>

FAF5 Total Flows by Scenario

FAF5 Forecasts – Flow Difference Compared to Baseline Estimates

FAF5 Trade Forecasts – Difference from Baseline Scenario

## FAF5 Forecast Results – Baseline Top Domestic Commodity Categories

<table>
<thead>
<tr>
<th>SCTG2</th>
<th>SCTG2 Commodity</th>
<th>2017 Tons (Millions)</th>
<th>Rank 2017</th>
<th>2050 Tons (Millions)</th>
<th>Rank 2050</th>
<th>CAGR 2017-2050</th>
<th>Growth 2017-2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Coal-and Petroleum Products n.e.c.</td>
<td>2,538</td>
<td>1</td>
<td>4,126</td>
<td>1</td>
<td>1.5%</td>
<td>63%</td>
</tr>
<tr>
<td>12</td>
<td>Gravel</td>
<td>1,882</td>
<td>2</td>
<td>2,961</td>
<td>2</td>
<td>1.4%</td>
<td>57%</td>
</tr>
<tr>
<td>17</td>
<td>Gasoline</td>
<td>1,367</td>
<td>3</td>
<td>1,023</td>
<td>6</td>
<td>-0.9%</td>
<td>-25%</td>
</tr>
<tr>
<td>31</td>
<td>Nonmetal min. prods.</td>
<td>1,227</td>
<td>4</td>
<td>1,845</td>
<td>3</td>
<td>1.2%</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>Cereal grains</td>
<td>1,211</td>
<td>5</td>
<td>1,230</td>
<td>5</td>
<td>0.05%</td>
<td>2%</td>
</tr>
<tr>
<td>18</td>
<td>Fuel oils</td>
<td>875</td>
<td>6</td>
<td>778</td>
<td>10</td>
<td>-0.4%</td>
<td>-11%</td>
</tr>
<tr>
<td>15</td>
<td>Coal</td>
<td>790</td>
<td>7</td>
<td>96</td>
<td>33</td>
<td>-6.2%</td>
<td>-88%</td>
</tr>
<tr>
<td>3</td>
<td>Other ag prods.</td>
<td>648</td>
<td>8</td>
<td>709</td>
<td>13</td>
<td>0.3%</td>
<td>9%</td>
</tr>
<tr>
<td>41</td>
<td>Waste/scrap</td>
<td>642</td>
<td>9</td>
<td>703</td>
<td>14</td>
<td>0.3%</td>
<td>10%</td>
</tr>
<tr>
<td>7</td>
<td>Other foodstuffs</td>
<td>628</td>
<td>10</td>
<td>967</td>
<td>7</td>
<td>1.3%</td>
<td>54%</td>
</tr>
</tbody>
</table>

FAF5 Forecast Results – Growth Rates for all Commodities

CAGR (2017-2050) by Domestic Commodity and Tonnage

FAF5 Forecast Regional Growth Rates, Tonnage

FAF5 Web-Based Tool Demonstration
Overview

Data Tabulation Tool available at:
https://ops.fhwa.dot.gov/freight/freight_analysis/faf/
https://faf.ornl.gov/faf5/dtt_total.aspx

Extraction
• Provides subset of data based on user selection

Tabulation
• Provides ability to further customize tabulation of the selected subset data.

Visualization
• Provides ability to create bar/pie charts, Sankey diagrams, origin-destination flow maps, etc.

### Overview

**Designed For:**
- Querying and extracting a subset of FAF data
- Generating customized tabulation
- Visualizing simple data summaries

**Not Intended For:**
- Downloading the entire FAF5 dataset
  - [https://ops.fhwa.dot.gov/freight/freight_analysis/faf/](https://ops.fhwa.dot.gov/freight/freight_analysis/faf/)
- Complex data analytics
- Creating a story board
Demonstration Example

What are the major freight shipments from Texas? (by tonnage)

• Top destination State by tonnage
• Top commodities
• Mode share of each commodity
• FAF zone level origin-destination distribution
To ask a question, you may:

- Type into the chat pod
- Choose the “raise hand” feature if you wish to ask a question by computer audio; facilitator will identify you and then unmute your line
- After the webinar:
  - Email FAF@dot.gov

FAF5 and detailed data documentation is available at: https://ops.fhwa.dot.gov/freight/freight_analysis/faf/
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