AVFT Tool Help

Introduction

The AVFT Tool can be used to develop the AVFT (Alternate Vehicle Fuel and Technology) table, which allows users to modify the fraction of vehicles capable of using different fuels and technologies. Specifically, for each source type and model year, the AVFT table allows users to define the fraction of vehicles that use:

- gasoline,
- diesel,
- E-85,
- CNG,
- battery electric (BEV), and
- fuel cell electric (FCEV)

The decimal values between 0 and 1 in the AVFT table represent the fraction of each model year and source type that use each of the above fuels and technologies; they sum to 1 for each model year of each source type. When using the AVFT table, MOVES requires fuel type distributions for every model year included in the run. MOVES models vehicles from age 0 to age 40. For example, if you are modeling calendar year 2030, MOVES would require a fuel type distribution for every model year between 1990-2030.

The purpose of this tool is to project future fuel type distributions based on the combination of local historic data and projected national trends. It can also gap-fill local historic fuel type distribution data if necessary. The projections are applied to model years beyond the last complete model year in the input data to the user-specified analysis year. If multiple calendar years are to be modeled, you can select the latest analysis year and use the tool output for all MOVES runs.

The resulting AVFT table can then be imported into MOVES using the County Database Manager, Project Database Manager, or the Input Data Sets command.

Using the Tool

1. Preparing Input Data

The local historic data used as input to the AVFT Tool should be provided in the format of the AVFT table.[1] These local inputs can be derived from vehicle registration data. For example, the following steps describe a high-level overview of how you can transform such data into the AVFT table format:

a. Map vehicle types to MOVES source types (sourceTypeIDs) and map fuel types to combinations of MOVES fuel types (fuelTypeIDs) and engine technologies (engTechIDs). MOVES source types, fuel types, engine technologies, and their allowable combinations are listed in the onroad cheat

[1] A template for the AVFT table can be generated by clicking the "Create Template" button in the "Input/Output Files" section of the AVFT Tool.

sheet (available in the Help menu in MOVES), and are described in detail in Section 2 of the Population and Activity of Onroad Vehicles in MOVES5 (EPA-420-R-24-019) technical report.

b. Sum the vehicle counts by sourceTypeID, modelYearID, fuelTypeID, and engTechID.
c. Sum the total counts by sourceTypeID and modelYearID.
d. Calculate the fuel type distributions by dividing the vehicle counts (step b) by the total counts (step c), and save these fractions in a column called fuelEngFraction.
e. The resulting table should have the following columns in this order:
    i. sourceTypeID
    ii. modelYearID
    iii. fuelTypeID
    iv. engTechID
    v. fuelEngFraction

2. Tool Input Selections

Specify the input parameters for the tool in the Tool Input Selections section. See the MOVES Technical Guidance (EPA-420-B-24-043) for EPA recommendations for these inputs.

a. **Last complete model year in input data.** The model year selected for this parameter becomes the baseline for the future projections made by the tool. Specifically, the last complete model year is needed, as partial model years are common in vehicle registration data. For example, if your vehicle registration data were pulled on July 1, 2023, they would contain a partial view of the model year 2023 cohort since not all model year 2023 vehicles were sold by this date. In addition, the data may contain model year 2024 registrations. In this example, you would select 2022 as the last complete model year in the input data.

b. **Analysis year.** Select the calendar year that you intend to model (i.e., the year selected on the Time Spans panel in the RunSpec). The tool will project fuel type distributions for all model years between the last complete model year and the analysis year (inclusive).

c. **Gap-filling Method.** If gaps exist in the input data, the AVFT Tool will fill them to avoid getting errors when you use the results of this tool. Gaps may exist for several reasons, such as if a fuel type is not present in the original data source and is simply not included in the input data (e.g., there are no CNG refuse trucks in the local area, so the input data are missing rows for CNG [fuelTypeID 3] refuse trucks [sourceTypeID 51]). Another example is where certain model year and source type combinations are not present in the original data source (e.g., no transit buses in the local area were purchased in some specific years). The gap-filling method is selected individually for each source type and specifies how the AVFT Tool should address these issues:
    - Automatic. This method provides missing key combinations with a fuelEngFraction value of 0. However, if any source type and model year combinations are missing entirely, the tool will use the national default fuel type distributions instead.
        - In the missing CNG refuse trucks example above, the AVFT Tool would add rows for fuelTypeID 3, sourceTypeID 51, and all model years with a fuelEngFraction value of 0.
        - In the transit bus missing model years example above, the AVFT Tool would add national default fuel distributions for the missing model years.

    - If a source type is completely missing from the input data, selecting this method will use the national default fractions for that source type.
- Use defaults, renormalize inputs. This method inserts the national default fuelEngFractions for missing key combinations, and then proportionally reduces the user-provided fuelEngFractions so that the distributions sum to 1 for all model years.
    - This method is useful when a fuel type is used locally, but it was not captured in the local data.
    - For example, if your local data do not include any CNG single unit trucks, but you know they exist in the local area, the AVFT Tool would add the default CNG fractions and then proportionally reduce all the other single unit truck fuels so that the single unit truck distributions sum to 1.
    - This method renormalizes user-provided fuelEngFractions when a non-zero fraction is added from the defaults or when the provided fuelEngFractions did not originally sum to 1. A warning message will be reported in the latter case.
- Use defaults, preserve inputs. This method inserts proportionally reduced national default fuelEngFractions for missing key combinations.
    - This method is useful only when you only have data about a limited number of fuel types.
    - For example, if you know the local sales fractions for electric light-duty vehicles and want to use the default distributions for internal combustion vehicles, the AVFT Tool would add the default gasoline, diesel, and E-85 fractions, then renormalize them so that when combined with your user-supplied EV fractions, the fuelEngFractions sum to 1.
- Note that regardless of which gap-filling method is selected, the AVFT Tool will gap-fill back to model year 1950, the earliest model year that MOVES can model.

d. **Projection Method.** The projection method is selected individually for each source type and specifies how the AVFT Tool should estimate fuel type distributions for model years between the last complete model year and the analysis year. Detailed descriptions of each method are provided in an appendix of the MOVES Vehicle Population and Activity technical report, but they are briefly described as follows:
    - Proportional. This method projects future fuel type distributions based on proportional differences between the local and the national distributions in the last complete model year in the input data. This preserves differences between local conditions and the national average, while still accounting for expected changes in national fuel type distribution trends. Note that this method includes boundary limits so that extreme differences between the national averages and local conditions will not be fully reflected in the projected data.
    - National Average. This method applies the national default fuel type distributions for all model years beyond the last complete model year in the input data.
    - Known Fractions. The known fractions method allows you to provide known fuel fractions for specific fuel types. The proportional method is then used to project any fuel types not provided. The input format for the known fractions is the same as the other input data for this tool. Known fractions can be provided for one or more fuel types and should be provided for all projected model years (that is, all model years between the last complete

model year and the analysis year). If this method is used for multiple source types, a single known fractions input file should be used, containing the known fractions for each source type projected with this method.

- Constant. This method applies the last complete model year in the input data distributions as-is to all projected model years.

Note: Source types can be excluded from the output of the AVFT Tool by unchecking the box next to the source type name.

3. Input/Output Files

In the Input/Output Files section, specify the file path to your input data (as prepared in step 1). The input data may be provided in MS Excel format (.xlsx or .xls) or comma-separated values format (.csv). If you use Excel, the tool will ask you to specify which tab contains your data. If you need a template to ensure your data are formatted correctly, you can create one by clicking the "Create Template" button.

If you have selected the "Known Fractions" method for one or more source types, the "Known Fractions" controls will be enabled. These controls function the same as the "Input AVFT File" controls described above. Note that if you click "Create Template" for the known fractions input, you will be prompted to select the source type and fuel type combinations to be included in the template. The generated template will include all combinations that you select, along with all model years between the last complete model year and the analysis year.

Finally, specify the file name and location where the results of the AVFT Tool should be saved. Note that the tool's output must have the .xlsx extension.

4. Run the Tool

Once all the controls are filled out, run the tool by clicking "Run AVFT Tool". If there are any warning or error messages, they will be displayed in the Messages box. These messages can be saved for further investigation using the "Save Messages" button. Any error messages will need to be addressed before output will be generated.

5. Quality Assurance Steps

The output of the tool is an Excel file which contains the resulting AVFT table and graphs of each source type's fuel type distributions. The graphs are not needed by MOVES but are provided so that modelers can ensure that the results of this tool appear reasonable. Note that the graphs require Excel 2021 or later (or a continuously updated Excel product, such as Microsoft 365) to work automatically. If this product is not available to you, you may need to use an alternative method to visually inspect the resulting AVFT table.

The resulting output table also includes a "Messages" tab, which records any runtime messages the tool produced when generating this file, and an "InputXML" tab, which records the tool selections in XML format.

6. Input into MOVES

To use the results of this tool with MOVES, use the AVFT importer in the MOVES input database manager's Fuel Tab to select the output file and import it into your run's input database.

Additional Information

The AVFT Tool's selections can be saved to file in XML format by using the "Save Selections" button. A previously saved set of selections can be loaded using the "Load Selections" button.

Additionally, the AVFT Tool can be run on the command line using the `ant avftTool` command, passing the path to an XML specification file as the `-dSpec=` argument. To set up a batch of AVFT Tool runs, you can do the following:

1. Make a template XML specification file by configuring selections in the AVFT Tool's GUI and using the "Save Selections" button.
2. Duplicate the resulting file and modify it in a text editor to point to different input and output files (and changing other parameters as necessary).
3. Write a batch script to call `ant avftTool` for each specification file.

Example Batch File

In this example, the goal is to run the AVFT Tool for three different counties. We have different input data for each county (that is, different input AVFT tables), but the last complete model year and the analysis year is the same for all counties. In addition, we want to use the same gap-filling and projection methods for all counties.

The first step is to use the AVFT Tool's GUI to select the last complete model year, the analysis year, and all the gap-filling and projection methods, as well as specifying the first county's input AVFT file and desired output AVFT file. Save these selections to an XML file using the "Save Selections" button. Our example XML specification file is called "County1.xml" and contains the following:

```
<AVFTTool version="MOVES5">
    <LastCompleteModelYear key="2023"/>
    <AnalysisYear key="2028"/>
    <MethodEntries>
        <MethodEntry sourceTypeID="11" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="21" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="31" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="32" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="41" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="42" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="43" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="51" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="52" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="53" enabled="true" gapfilling="Automatic" projection="National Average"/>
        <MethodEntry sourceTypeID="54" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="61" enabled="true" gapfilling="Automatic" projection="Proportional"/>
        <MethodEntry sourceTypeID="62" enabled="true" gapfilling="Automatic" projection="National Average"/>
    </MethodEntries>
    <InputAVFTFile path="C:\County1_input_avft.xlsx" tab="avft"/>
    <KnownFractionsInput path="" tab=""/>
    <OutputAVFTFile path="C:\County1_output_avft.xlsx"/>
</AVFTTool>
```

The next step is to duplicate County1.xml twice and rename the new files as County2.xml and County3.xml. Then, open and modify the new files so that the `<InputAVFTFile>` entry points to the county's corresponding input AVFT file and the `<OutputAVFTTile>` entry points to a unique output file.

Finally, write a batch script to run the AVFT Tool for each specification file. Our example batch script looks like this:

```
cd c:\Users\Public\EPA\MOVES\MOVES5.0
call setenv
call ant avftTool -Dspec=C:\county1.xml
call ant avftTool -Dspec=C:\county2.xml
call ant avftTool -Dspec=C:\county3.xml
```

After running the batch script, inspect the output files and follow the "Quality Assurance Steps" outlined above in this help document. If everything was successful, the AVFT Tool output files can now be used as input files for MOVES input databases as described in the "Input into MOVES" section above.

Advanced Use Cases

In advanced use cases, modelers may wish to bypass the need for using Excel files and instead directly use MariaDB databases to read and write data. This is an option only when running the tool on the command line. In this use case:

1. Supply the input AVFT database name using the `-DinputAVFTdb=` argument.
    a. This input database must contain a properly formatted AVFT table.
    b. When using this argument, your XML specification file can have a blank `<InputAVFTFile/>` tag, as it will be ignored.
2. Optionally, supply a database name for the output AVFT table using the `-DoutputAVFTdb=` argument.
    a. If this database doesn't exist, it will be created.
    b. If the database exists, but doesn't have an AVFT table in it, it will be created.
    c. If the database exists and has an existing AVFT table in it, the existing table will be truncated before the tool output is saved to it.
    d. Regardless if this option is used, your XML specification file must specify an `<OutputAVFTFile/>` tag containing the path to an output Excel file. This is so that the tool's output can be visually inspected, and any messages are saved. Following the "Quality Assurance Steps" outlined above is important regardless of how the tool is run.
    e. If this option is not used, the output will only be saved to the specified Excel file.

Note that there is no way to supply Known Fractions input data using a database; this information must always be loaded from an Excel or .csv file. Additionally, specifying the same database as the input and output database is not supported; if an output database is specified, it must be different than the input database.