

Roadmap Data Update and Model Validation Documentation

September 2017

This document provides an overview of the updates that were made to the Roadmap model during the summer of 2017, and indicates the associated data sources. The model update consisted of four phases: 1) data collection and compilation, 2) analysis of data quality and comparison with historical modeled estimates, 3) population of inputs into Roadmap model, and 4) calibration of Roadmap model.

The data collection phase surveyed a series of official data sources for most of the Roadmap regions/countries (Table 1). Official data up to the year 2015 were first compared with the current version of the Roadmap model and with IEA's Mobility Model (MoMo)¹ to check for consistency in definitions (e.g. vehicle classification) and continuity with historical estimates (years 2000–2010). Official data sources with sufficient data quality and detail were used as inputs to the updated Roadmap model. Data gaps were filled using updated estimates from MoMo.

Table 1: Data Sources and Models Surveyed for Model Validation

Region	Data Source
Aggregate Regions	International Energy Agency Mobility Model (MoMo)
Australia	Australian Bureau of Statistics (ABS) Bureau of Infrastructure, Transport and Regional Economics (BITRE)
Brazil	Institute of Energy and Environment (IEMA)
Canada	North American Transportation Statistics Database Statistics Canada Environment Canada (ECCC) Transport Canada
China	Chinese National Bureau of Statistics ICCT China Model (internal)
EU-28	European Commission Statistical Pocketbook ICCT EU Pocketbook
India	Society of Indian Automobile Manufacturers (SIAM) ICCT India Model (internal)
Japan	Ministry of Land, Infrastructure, Transport and Tourism (MLIT) Greenhouse Gas Inventory Office of Japan Japan Automobile Manufacturers Association, Inc. (JAMA) Statistical Handbook of Japan
Mexico	North American Transportation Statistics Database (NATS) Mexican Automotive Industry Association (AMIA) National Institute of Ecology and Climate Change (INECC) National Association of Buses, Trucks and Tractor Trucks (ANPACT)
Russia	MoMo
South Korea	MoMo
U.S.	U.S. Energy Information Administration Annual Energy Outlook (EIA AEO) Bureau of Transportation Statistics (BTS) Transportation Energy Data Book Environmental Protection Agency (EPA)
Other	International Organization of Motor Vehicle Manufacturers (OICA)

¹ OECD/IEA. Mobility Model, March 2017 version.

Inputs were updated for on-road modes and rail, including for passenger and freight transportation (Table 2). The key inputs that were updated for on-road modes included transportation activity (passenger-km and tonne-km), in-use vehicle stock, new vehicle sales, share of sales by engine technology, load factors, energy intensity of new vehicles, and annual VKT per vehicle. These inputs were updated for each mode: light-duty vehicle (LDV), bus, two-wheeler (2W), three-wheeler (3W), light heavy-duty truck (LHDT)², medium heavy-duty truck (MHDT)³, and heavy heavy-duty truck (HHDT)⁴. Additional data were used for the model calibration for on-road modes rather than being directly input to the model. These parameters include VKT, energy consumption and CO₂ emissions. The key inputs that were updated for passenger and freight rail included transportation activity and energy intensity.

Table 2: Summary of Inputs Updated

Metric	On-Road	Railway
Transportation activity	x	x
Load factors / payload	x	x
Stock	x	
Sales	x	
Share of sales by engine technology	x	
VKT per vehicle	x	
Energy intensity	x	x

Transportation Activity

Previous versions of the Roadmap model projected future changes in transportation activity according to projections of population, gross domestic product, and fuel prices. Subsequently, the model was updated to enable the input of any set of activity projections; this enabled the application of the Roadmap model to assess the air pollution and health impacts under activity projections developed by UC Davis/ITDP and the International Transport Forum (ITF, 2015; Replogle & Fulton, 2014). The Baseline scenario of the updated Roadmap model applies projections of transportation activity from a combination of sources, including ICCT models for China and India, IEMA's models for Brazil, and MoMo's "4DS" for other regions.

On-Road

The majority of the on-road activity data were updated based on MoMo's 4DS scenario. The five exceptions to this rule are China, India, Brazil, the EU, and the U.S.

- *China & India:* The activity figures were based on internal ICCT models.

² Includes trucks with a GVWR of 8,500 – 14,000 lb

³ Includes trucks with a GVWR of 14,000 – 33,000 lb

⁴ Includes trucks with a GCWR above 33,000 lb

- *Brazil*: IEMA data were used as inputs for years 2000 – 2025; the activity for years 2030 - 2050 was calculated based on MoMo’s projected activity growth rates.
- *EU*: MoMo 4DS data were used as inputs for years 2000 – 2015; activity for years 2020 – 2050 was calculated based on the European Commission’s projected activity growth rates.
- *U.S.*: MoMo 4DS data were used as inputs for years 2000 – 2015; activity for years 2020 – 2050 for LDV, LHDT, MHDT, and HHDT were calculated based on the EIA’s projected VKT growth.

Some activity data also were collected for the U.S. (EIA); however, we chose to use the MoMo 4DS data for the U.S. due to a limited timeframe in the official data that would lead to discontinuity in the activity figures throughout 2000-2050.

Railway

Both passenger and freight rail activity data were updated based on MoMo’s 4DS scenario for all 16 regions. Since the ICCT models for China and India do not independently project rail activity, rail data and projections for China and India were also updated with data from the 4DS (unlike the on-road data for these countries).

Load Factors / Payload

Load factors and payload inputs for 2000 - 2050 were updated according to MoMo 4DS data. These inputs were calculated by dividing transportation activity by VKT. Four exceptions to the rule were China, India, Brazil and EU:

- *China & India*: Load factors were based on internal ICCT models.
- *Brazil*: Load factors were based on IEMA data.
- *EU*: Load factors for LDV, bus, and HHDT were calibrated to yield results that align with the European Commission’s energy consumption data.
- *US*: 2015 load factors were calibrated so that VKT matched that of EIA. Load factors for years 2020 – 2050 were set equal to the 2015 number.

Stock and Sales

The stock and sales data were updated based on official data or MoMo data, depending upon data availability for the region/country. The following section provides an overview of the sources used for each region/country. Note that ‘MoMo historical data’ refers to IEA’s historical database, which differs slightly from their 4DS scenario.

Aggregate regions

- Aggregate regions include Other Latin America, Other Europe, Other Asia-Pacific, Middle East, and Africa.
- MoMo historical data were used for 2015 updates.
- Where historical estimates have been substantially revised, data for 2000–2010 were updated to ensure consistency with 2015 estimates.

United States

- EIA data were used for LDV, LHDT, MHDT, and HHDT 2015 stock and sales updates.
- MoMo historical data were used for 2W and bus 2015 stock and sales updates, since these figures are not reported by EIA.
- LHDT stock data for 2000–2010 were updated with MoMo data since these were well aligned with EIA data through 2015.

Canada

- MoMo historical data were used for 2015 updates.

Mexico

- MoMo historical data were used for 2015 updates.
- Magnitude of MoMo data generally aligned with official data sources (NATS and OICA), which report data at a higher level of aggregation.
- LHDT stock figures are higher than those used in the previous Roadmap model. This is likely due to a reclassification of vehicle types; some of what may have been considered LDV in the past are likely now included in LHDT (refer to Table 3 for current vehicle classifications).

Brazil

- IEMA data were used for 2015 updates.
- Historical estimates (2000-2010) also were updated with IEMA data.

EU-28

- MoMo historical data were used for 2015 update.
- Magnitude of MoMo data generally aligned with official data sources (EU Pocketbook).

Russia

- MoMo historical data were used for 2015 updates.

China

- Data from Chinese National Bureau of Statistics were used for 2015 updates.
- The activity is consistent with the projections from the ICCT China Model.

Japan

- MoMo historical data were used for 2015 updates.
- Magnitude of MoMo data generally aligned with official data sources (MLIT and OICA).
- LHDT stock figures are higher and MHDT stock figures are lower than those used in the previous Roadmap model. This is likely a result of a standardization in vehicle classifications (i.e. based on weight) from MHDT to LHDT. MoMo data align with JAMA data; therefore, MoMo data were used for the update.

India

- SIAM historic sales data were used for 2015 updates.
- The estimation of stock and activity in the ICCT India Model were adopted in the Roadmap for consistency.

South Korea

- MoMo historical data were used for 2015 updates.

Australia

- MoMo historical data were used for 2015 updates.

Share of Sales by Engine Technology

The shares of sales by engine technology were updated using official data or MoMo data, depending upon data availability for the region/country. MoMo data were used for all regions except for the U.S., Brazil, China, and India. Data for these regions were sourced from the U.S. Energy Information Administration, IEMA, ICCT's China model, and ICCT's India model, respectively. Note that historical data (2000-2010) were updated if the 2015 data source was inconsistent with previous years.

Energy Intensity

Energy intensity inputs by region and mode are regularly validated. Adjustments were made to both on-road and rail energy inputs.

On-Road

For the EU, energy consumption was calibrated to match European Commission figures using the following adjustments:

- Set new diesel MHDT efficiency to 24.9 L/100km (based on [ICCT report](#))
- Set new diesel HHDT efficiency to 43.1 L/100km (based on [ICCT report](#))
- Set new diesel bus efficiency to 14 MJ/km (based on [VTT data](#))
- Set LHDT in-use fuel consumption adjustment to 25%
- Load factors were adjusted for years 2000 – 2015 to match energy outputs

For the U.S., energy consumption was calibrated to match EIA figures for LDV, LHDT, MHDT, and HHDT using the following adjustments:

- Set LDV in-use fuel consumption adjustment to 35%
- Set LHDT in-use fuel consumption adjustment to 30%
- Set MHDT in-use fuel consumption adjustment to 30%
- Set HHDT in-use fuel consumption adjustment to 3%

Rail

Energy intensity (MJ/ton-km) were calculated based on MoMo 4DS data for 2000 – 2015. Projected energy intensity for years 2020 – 2050 was set equal to that of 2015.

Emission Factors

By default, the model applies emission factors for local air pollutants derived from COPERT4 V10.0. Considering their application to regions throughout the world, these emission factors include adjustments based on driving speed and cycle that reflect a set of global-average emission rates for the vehicle modes defined in the Roadmap model. However, an inherent limitation of the global emission factors is that they cannot account for the shares of vehicle types within each Roadmap mode, which vary across

regions. In future iterations of the Roadmap model, we intend to specify emission factors at a more granular level, especially for the LHDT and Bus modes.

Vehicle Classification

Vehicle classifications differ by data source and region, and can shift over time. Table 3 outlines which vehicle types are included in each Roadmap-defined mode by region.

Table 3: Mode Classifications by Region

Mode	Global Aggregate Regions, Canada, Mexico, EU-28, Russia, Japan, South Korea, Australia	U.S.	Brazil	China	India
LDV	- Passenger cars - Light-duty trucks	- Light-duty vehicles (< 8,501 lbs, automobiles and light trucks)	- Passenger cars - Light commercial vehicles	- Mini passenger vehicles - Small passenger vehicles	- Passenger cars - Utility and multi-purpose vehicles
Bus	- Buses - Minibuses	- Buses - Minibuses	- Urban buses - Coach buses - Micro buses	- Medium passenger vehicles - Large passenger vehicles	- Light duty buses - Medium duty buses - Heavy duty buses
2W & 3W	- Two-wheelers - Three-wheelers	- Two-wheelers	- Motorcycles	- Two-wheelers	- Two-wheelers - Three-wheelers
LHDT	- Light commercial vehicles	- Commercial trucks (8,501 - 10,000 lbs) - Light medium trucks	- Semi-light heavy-duty trucks - Light heavy-duty trucks	- Mini trucks - Small trucks	- Light-duty trucks
MHDT & HHDT	- Medium freight trucks - Heavy freight trucks	- Medium trucks - Heavy trucks (> 26,000 lbs)	- Medium heavy-duty trucks - Semi-heavy heavy-duty trucks - Heavy heavy-duty trucks	- Medium trucks - Heavy trucks	- Heavy duty single unit truck - Heavy-duty combination tractor