This slide deck summarizes a comparison of activity inputs and emissions results between the Roadmap model and other national and international models. This deck is the result of an annual data update and validation process, which is conducted to:

- Ensure use of best data and methods
- Evaluate input parameters and model algorithms
- Update input data
  - Ensure most accurate and consistent data sources for all regions
  - Update historic data by using reliable data
- Validate output data
  - Calibrate historical numbers with statistics
  - Compare projected trends with major global/national models
New to 2013 Validation

- Projections extended to 2050 from 2030
- HDT sub-categories: LHDT, MHDT, HHDT
- Conventional pollutants: BC, NO\textsubscript{x}, PM\textsubscript{2.5}
- Comparison with Roadmap Version 1.0
- Development of Roadmap Version 2.0 (internal)
  - Updated passenger/freight activity, sales and stock data
  - Fuel efficiency
  - Emission factors
    - Because of the update in emission factors, there is significant discrepancy between versions 1.0 and 2.0 in terms of conventional pollutants
  - Sulfur effects
  - Scrappage program
  - Annual estimation of local air pollutants
  - All Roadmap in the following slides refers as Roadmap Version 2.0
# Models/Data Sources for Comparison

<table>
<thead>
<tr>
<th>Region</th>
<th>Model</th>
<th>Agency</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global Aggregate Regions</strong></td>
<td>MoMo</td>
<td>IEA's Mobility Model</td>
<td>2005-2050</td>
</tr>
<tr>
<td></td>
<td>GCAM</td>
<td>Global Change Assessment Model</td>
<td>2005-2050</td>
</tr>
<tr>
<td></td>
<td>MESSAGE</td>
<td>IIASA's MESSAGE Model</td>
<td>2005-2050</td>
</tr>
<tr>
<td></td>
<td>GAINS</td>
<td>IIASA's Greenhouse Gas and Air Pollution Interactions and Synergies</td>
<td>2000-2030</td>
</tr>
<tr>
<td><strong>U.S.</strong></td>
<td>AEO</td>
<td>Annual Energy Outlook</td>
<td>2010-2040</td>
</tr>
<tr>
<td></td>
<td>BTS</td>
<td>Bureau of Transportation Statistics</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>Data Book</td>
<td>Transportation Energy Data Book</td>
<td>2000-2010</td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td>NATS</td>
<td>North American Transportation Statistics Database</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>NRCanada</td>
<td>Natural Resources Canada</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>Environment Canada</td>
<td>Environment Canada</td>
<td>2000-2010</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td>SENER</td>
<td>Mexico Federal Government Ministry Of Energy</td>
<td>2005-2010</td>
</tr>
<tr>
<td><strong>Brazil</strong></td>
<td>IEMA</td>
<td>Brazil's National On-Road Emission Inventory</td>
<td>2000-2020</td>
</tr>
<tr>
<td><strong>EU-28</strong></td>
<td>Pocketbook</td>
<td>EU Transport Statistical Pocketbook</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>EC 2010</td>
<td>European Commission 2010 - EU Transport GHG 2050</td>
<td>2010-2050</td>
</tr>
<tr>
<td></td>
<td>TREMOVE</td>
<td>EU-wide Transport Model</td>
<td>2000-2030</td>
</tr>
<tr>
<td><strong>Russia</strong></td>
<td>NIIAT</td>
<td>Scientific and Research Institute of Motor Transport</td>
<td>2010</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>FEEI</td>
<td>Fuel Economy and Environmental Impacts Model</td>
<td>2005-2050</td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>MLIT</td>
<td>Ministry of Land, Infrastructure, Transport and Tourism</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>GHG Inventory Office</td>
<td>Greenhouse Gas Inventory Office of Japan</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>Statistics Bureau</td>
<td>Statistical Handbook of Japan</td>
<td>2000-2010</td>
</tr>
<tr>
<td><strong>India</strong></td>
<td>TERI</td>
<td>The Energy and Resources Institute</td>
<td>2000-2050</td>
</tr>
<tr>
<td><strong>South Korea</strong></td>
<td>Kostat</td>
<td>Statistics Korea</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>MOTIE</td>
<td>Ministry of Trade, Industry and Energy</td>
<td>2000-2010</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
<td>2000-2010</td>
</tr>
<tr>
<td></td>
<td>BITRE</td>
<td>Bureau of Infrastructure, Transport and Regional Economics</td>
<td>2000-2020</td>
</tr>
<tr>
<td></td>
<td>ABARE</td>
<td>Australian Bureau of Agricultural and Resources Economics and Sciences</td>
<td>2000-2020</td>
</tr>
</tbody>
</table>
Global Passenger Vehicle Activity

Average Variation

This represents the average absolute variation between model trajectories and the average trajectory.
Global Freight Vehicle Activity

Average Variation

This represents the average absolute variation between model trajectories and the average trajectory.

Unit: billion vehicle-km

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0

2000-2010: 18%
2015-2030: 15%
2035-2050: 16%

Average Variation!
Global Total Energy Consumption (excl. Waterborne)

Average Variation

This represents the average absolute variation between model trajectories and the average trajectory.
Global TTW CO2 Emission (excl. Waterborne)

This represents the average absolute variation between model trajectories and the average trajectory.
U.S. Comparison

**Passenger Vehicle Activity**
- Roadmap
- MoMo
- GCAM
- BTS
- GAINS
- MESSAGE
- Roadmap 1.0
- AEO

**Freight Vehicle Activity**
- Roadmap
- MoMo
- GCAM
- BTS
- Data Book
- GAINS
- MESSAGE
- Roadmap 1.0
- AEO

**Total Energy Consumption**
(excluding Waterborne)
- Roadmap
- MoMo
- GCAM
- BTS
- Data Book
- GAINS
- MESSAGE
- Roadmap 1.0
- AEO

**Total TTW CO₂ Emission**
(excluding Waterborne)
- Roadmap
- MoMo
- GCAM
- BTS
- US EPA
- BTS
- MESSAGE
- Roadmap 1.0
- AEO
U.S. Comparison

Total TTW NOx Emission

Unit: thousand metric tons

Roadmap
GAINS
Roadmap 1.0

Total TTW PM2.5 Emission

Unit: thousand metric tons

Roadmap
GAINS
Roadmap 1.0
U.S. 2010 Model Outputs Comparisons (excluding Waterborne)

**Total Energy Consumption**

![Graph showing total energy consumption for different modes of transportation using various models.]

- Roadmap
- MoMo
- GCAM
- BTS
- Data Book
- MESSAGE
- AEO
- Roadmap 1.0

**TTW CO2 Emission**

![Graph showing total CO2 emissions for different modes of transportation using various models.]

- Roadmap
- MoMo
- GCAM
- Data Book
- US EPA
- MESSAGE
- AEO
- Roadmap 1.0
Canada Comparison

**Passenger Vehicle Activity**

- **Unit:** billion vehicle-km
- **Roadmap**
- **MoMo**
- **GCAM**
- **NRCAN**
- **GAINS**
- **MESSAGE**
- **Roadmap 1.0**

**Freight Vehicle Activity**

- **Unit:** billion vehicle-km
- **Roadmap**
- **MoMo**
- **GCAM**
- **NATS**
- **NRCAN**
- **GAINS**
- **MESSAGE**
- **Roadmap 1.0**

**Total Energy Consumption**

- **(excluding Waterborne)**
- **Unit:** PJ

**Total TTW CO₂ Emission**

- **(excluding Waterborne)**
- **Unit:** million metric tons
Canada Comparison

**Total TTW NOx Emission**

- Roadmap
- GAINS
- Roadmap 1.0
- Environment Canada

**Total TTW PM2.5 Emission**

- Roadmap
- GAINS
- Roadmap 1.0
- Environment Canada

Unit: thousand metric tons
Canada 2010 Model Output Comparisons
(excluding Waterborne)

**Total Energy Consumption**

- Units: PJ
- Graph shows comparisons across different models:
  - Roadmap
  - MoMo
  - GCAM
  - NRCana
  - MESSAGE
  - Roadmap 1.0

**TTW CO2 Emission**

- Units: million metric tons
- Graph shows comparisons across different models:
  - Roadmap
  - MoMo
  - GCAM
  - NRCana
  - MESSAGE
  - Roadmap 1.0
Mexico Comparison

Passenger Vehicle Activity

Freight Vehicle Activity

Total Energy Consumption
(excluding Waterborne)

Total TTW CO2 Emission
(excluding Waterborne)
Mexico Comparison

**Total TTW NOx Emission**

**Total TTW PM2.5 Emission**

Unit: thousand metric tons

Roadmap

Roadmap 1.0
Mexico 2010 Model Output Comparisons (excluding Waterborne)

**Total Energy Consumption**
- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap v1.0

**TTW CO2 Emission**
- Roadmap
- MoMo
- GCAM
- SENER
- Roadmap v1.0

**Units:**
- PJ for Total Energy Consumption
- million metric tons for TTW CO2 Emission
Brazil Comparison

Passenger Vehicle Activity

Freight Vehicle Activity

Total Energy Consumption (excluding Waterborne)

Total TTW CO₂ Emission (excluding Waterborne)
Brazil Comparison

**Total TTW NOx Emission**

- Roadmap
- GAINS
- Roadmap 1.0
- IEMA

**Total TTW PM2.5 Emission**

- Roadmap
- GAINS
- Roadmap 1.0
- IEMA

Unit: thousand metric tons

Brazil 2010 Model Output Comparisons (excluding Waterborne)

**Total Energy Consumption**

<table>
<thead>
<tr>
<th></th>
<th>Roadmap</th>
<th>MoMo</th>
<th>GCAM</th>
<th>MESSAGE</th>
<th>IEMA</th>
<th>Roadmap 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&amp;3 Wheelers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TTW CO₂ Emission**

<table>
<thead>
<tr>
<th></th>
<th>Roadmap</th>
<th>MoMo</th>
<th>GCAM</th>
<th>MESSAGE</th>
<th>IEMA</th>
<th>Roadmap 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&amp;3 Wheelers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Latin America-31

### Passenger Vehicle Activity
- **Unit**: million vehicle-km
- **Years**: 2000 to 2050

### Freight Vehicle Activity
- **Unit**: billion vehicle-km
- **Years**: 2000 to 2050

### Total Energy Consumption (excluding Waterborne)
- **Unit**: PJ
- **Years**: 2000 to 2050

### Total TTW CO2 Emission (excluding Waterborne)
- **Unit**: million metric tons
- **Years**: 2000 to 2050
Latin America-41 Comparison

**Total TTW NOx Emission**

- **Unit:** thousand metric tons
- **Roadmap**
- **Roadmap 1.0**

**Total TTW PM2.5 emission**

- **Unit:** thousand metric tons
- **Roadmap**
- **Roadmap 1.0**

---

icct THE INTERNATIONAL COUNCIL ON Clean Transportation
Latin America-31 2010 Model Output Comparisons (excluding Waterborne)

**Total Energy Consumption**

- **Roadmap**
- **MoMo**
- **Roadmap 1.0**

**Total TTW CO2 Emission**

- **Roadmap**
- **MoMo**
- **Roadmap 1.0**

**Unit:** PJ

**Aviation**

**Freight Rail**

**Passenger Rail**

**Truck**

**2&3 Wheelers**

**Bus**

**LDV**

**Unit:** million metric tons
EU-28 Comparison

Passenger Vehicle Activity

Freight Vehicle Activity

Total Energy Consumption
(excluding Waterborne)

Total TTW CO₂ Emission
(excluding Waterborne)
EU-28 Comparison

**Total TTW NOx Emission**

- Roadmap
- GAINS
- Roadmap 1.0
- EC GHG

**Total TTW PM2.5 Emission**

- Roadmap
- GAINS
- Roadmap 1.0

Unit: thousand metric tons

2000 2010 2020 2030 2040 2050

2000 2010 2020 2030 2040 2050

icct  THE INTERNATIONAL COUNCIL ON
Clean Transportation
EU-28 2010 Model Output Comparisons (excluding Waterborne)

**Total Energy Consumption**

- Units: PJ
- Comparison models: Roadmap, MoMo, GCAM, TREMOVE, EU Energy, MESSAGE, EC 2010, Roadmap 1.0

**TTW CO₂ Emission**

- Units: million metric tons
- Comparison models: Roadmap, MoMo, GCAM, TREMOVE, MESSAGE, EC 2010, Roadmap 1.0

Legend:
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV
Russia Comparison

Passenger Vehicle Activity

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: billion vehicle-km</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Freight Vehicle Activity

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: billion vehicle-km</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Energy Consumption (excluding Waterborne)

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: PJ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total TTW CO₂ Emission (excluding Waterborne)

<table>
<thead>
<tr>
<th>Year</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit: million metric tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Russia Comparison

Total TTW NOx Emission

Total TTW PM2.5 Emission

Unit: thousand metric tons

Roadmap
Roadmap 1.0
GAINS
Russia 2010 Model Output Comparisons
(excluding Waterborne)

### Total Energy Consumption

- **Unit**: PJ
- **Roadmap**
- **MoMo**
- **GCAM**
- **WEC**
- **NIIAT**
- **MESSAGE**
- **Roadmap 1.0**

### TTW CO₂ Emission

- **Unit**: million metric tons
- **Roadmap**
- **MoMo**
- **GCAM**
- **MESSAGE**
- **Roadmap 1.0**
Non-EU Europe

**Passenger Vehicle Activity**

- Roadmap
- MoMo
- Roadmap 1.0

**Freight Vehicle Activity**

- Roadmap
- MoMo
- Roadmap 1.0

**Total Energy Consumption** (excluding Waterborne)

- Roadmap
- MoMo
- Roadmap 1.0

**Total TTW CO₂ Emission** (excluding Waterborne)

- Roadmap
- MoMo
- GCAM
- Roadmap 1.0
Non-EU Europe Comparison

**Total TTW NOx Emission**

- Unit: thousand metric tons
- Roadmap
- Roadmap 1.0

**Total TTW PM2.5 Emission**

- Unit: thousand metric tons
- Roadmap
- Roadmap 1.0
Non-EU Europe 2010 Model Output Comparisons (excluding Waterborne)

**Total Energy Consumption**

- **Roadmap**
- **MoMo**
- **Roadmap 1.0**

**Unit: PJ**

- **Aviation**
- **Freight Rail**
- **Passenger Rail**
- **Truck**
- **2&3 Wheelers**
- **Bus**
- **LDV**

**TTW CO₂ Emission**

- **Roadmap**
- **MoMo**
- **GCAM**
- **Roadmap 1.0**

**Unit: million metric tons**

- **Aviation**
- **Freight Rail**
- **Passenger Rail**
- **Truck**
- **2&3 Wheelers**
- **Bus**
- **LDV**
China Comparison

**Passenger Vehicle Activity**

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0
- FEEI

**Freight Vehicle Activity**

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0
- FEEI

**Total Energy Consumption** (excluding Waterborne)

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0
- FEEI

**Total TTW CO2 Emission** (excluding Waterborne)

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0
- FEEI
China Comparison

Total TTW NOx Emission

- **Roadmap**
- **GAINS**
- **Roadmap 1.0**

Unit: thousand metric tons

Total TTW PM2.5 Emission

- **Roadmap**
- **GAINS**
- **Roadmap 1.0**

Unit: thousand metric tons

icct
THE INTERNATIONAL COUNCIL ON
Clean Transportation
China 2010 Model Output Comparisons
(excluding Waterborne)

**Total Energy Consumption**

- **Unit:** PJ

**Roadmap**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**MoMo**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**GCAM**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**MESSAGE**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**FEEI**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**Roadmap 1.0**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**TTW CO2 Emission**

- **Unit:** million metric tons

**Roadmap**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**MoMo**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**GCAM**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**MESSAGE**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**FEEI**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV

**Roadmap 1.0**
- Aviation
- Freight Rail
- Passenger Rail
- Truck
- 2&3 Wheelers
- Bus
- LDV
Japan Comparison

Passenger Vehicle Activity

Freight Vehicle Activity

Total Energy Consumption (excluding Waterborne)

Total TTW CO₂ Emission (excluding Waterborne)
Japan Comparison

**Total TTW NOx Emission**
- Roadmap
- GAINS
- Roadmap 1.0

**Total TTW PM2.5 Emission**
- Roadmap
- GAINS
- Roadmap 1.0

Unit: thousand metric tons
Japan 2010 Model Output Comparisons (excluding Waterborne)

Total Energy Consumption

Unit: PJ

Roadmap | MoMo | GCAM | MESSAGE | MLIT | Roadmap 1.0
Aviation | Freight Rail | Passenger Rail | Truck | 2&3 Wheelers | Bus | 2&3 Wheelers | LDV

TTW CO₂ Emission

Unit: million metric tons

Roadmap | MoMo | GCAM | MESSAGE | Roadmap 1.0
Aviation | Freight Rail | Passenger Rail | Truck | 2&3 Wheelers | Bus | 2&3 Wheelers | LDV
India Comparison

Total TTW NOx Emission

Total TTW PM2.5 Emission

Unit: thousand metric tons
India 2010 Model Output Comparisons
(excluding Waterborne)

**Total Energy Consumption**

<table>
<thead>
<tr>
<th></th>
<th>Roadmap</th>
<th>MoMo</th>
<th>GCAM</th>
<th>MESSAGE</th>
<th>Roadmap 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&amp;3 Wheelers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total TTW CO2 Emission**

<table>
<thead>
<tr>
<th></th>
<th>Roadmap</th>
<th>MoMo</th>
<th>GCAM</th>
<th>MESSAGE</th>
<th>Roadmap 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger Rail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&amp;3 Wheelers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
South Korea Comparison

Korea Passenger Vehicle Activity

Korea Freight Vehicle Activity

Total Energy Consumption
(excluding Waterborne)

Total TTW CO₂ Emission
(excluding Waterborne)
South Korea Comparison

**Total TTW NOx Emission**
- Roadmap
- GAINS
- Roadmap 1.0

**Total TTW PM2.5 Emission**
- Roadmap
- GAINS
- Roadmap 1.0

Unit: thousand metric tons
South Korea 2010 Model Output Comparisons (excluding Waterborne)

Total Energy Consumption

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Kostat
- Roadmap 1.0
- Kostat

TTW CO₂ Emission

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0
Australia Comparison

Passenger Vehicle Activity

Freight Vehicle Activity

Total Energy Consumption (excluding Waterborne)

Total TTW CO₂ Emission (excluding Waterborne)

Unit: PJ

Unit: billion vehicle-km

Roadmap
MoMo
GCAM
ABS
BITRE
GAINS
MESSAGE
Roadmap 1.0

BITRE
GCAM
MoMo
Roadmap
Roadmap 1.0
MESSAGE
ABS
GAINS

2000 2010 2020 2030 2040 2050

2000 2010 2020 2030 2040 2050

2000 2010 2020 2030 2040 2050

2000 2010 2020 2030 2040 2050

Unit: million metric tons

100 200 300 400 500 600

100 200 300 400 500 600

100 200 300 400 500 600

100 200 300 400 500 600
Australia Comparison

Total TTW NOx Emission

Unit: thousand metric tons

Total TTW PM2.5 Emission

Unit: thousand metric tons

Roadmap
GAINS
Roadmap 1.0
BITRE
Australia 2010 Model Output Comparisons (excluding Waterborne)

### Total Energy Consumption

- **Roadmap**: Total energy consumption across various modes.
- **MoMo**, **GCAM**, **BITRE**, **MESSAGE**, **Roadmap 1.0**: Comparison of energy consumption for different models.

### TTW CO₂ Emission


**Unit**: PJ for Total Energy Consumption, million metric tons for TTW CO₂ Emission.
Asia-Pacific-40

**Passenger Vehicle Activity**

- Roadmap
- MoMo
- Roadmap 1.0

**Freight Vehicle Activity**

- Roadmap
- MoMo
- Roadmap 1.0

**Total Energy Consumption (excluding Waterborne)**

- Roadmap
- MoMo
- Roadmap 1.0

**Total TTW CO2 Emission (excluding Waterborne)**

- Roadmap
- MoMo
- Roadmap 1.0
Asia-Pacific-40 Comparison

**Total TTW NOx Emission**

- Roadmap
- Roadmap 1.0

**Total TTW PM2.5 Emission**

- Roadmap
- Roadmap 1.0

Unit: thousand metric tons
Asia-Pacific-40 2010 Model Output Comparisons (excluding Waterborne)

**Total Energy Consumption**

- Roadmap
- MoMo
- Roadmap 1.0

**TTW CO2 Emission**

- Roadmap
- MoMo
- Roadmap 1.0

Unit: PJ

Unit: million metric tons
Middle East Comparison

Passenger Vehicle Activity

Freight Vehicle Activity

Total Energy Consumption (excluding Waterborne)

Total TTW CO₂ Emission (excluding Waterborne)
Middle East Comparison

Total TTW NOx Emission

Total PM2.5 Emission

Unit: thousand metric tons
Middle East 2010 Model Output Comparisons (excluding Waterborne)

Total Energy Consumption

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0

Unit: PJ

TTW CO₂ Emission

- Roadmap
- MoMo
- GCAM
- MESSAGE
- Roadmap 1.0

Unit: million metric tons
Africa Comparison

**Passenger Vehicle Activity**

- **Unit**: billion vehicle-km

**Freight Vehicle Activity**

- **Unit**: billion vehicle-km

**Total Energy Consumption**

- **Unit**: PJ (excluding Waterborne)

**Total TTW CO₂ Emission**

- **Unit**: million metric tons (excluding Waterborne)
Africa Comparison

**Total TTW NOx Emission**

- **Roadmap**
- **Roadmap 1.0**

**Total TTW PM2.5 Emission**

- **Roadmap**
- **Roadmap 1.0**
Africa 2010 Model Output Comparisons (excluding Waterborne)

### Total Energy Consumption

<table>
<thead>
<tr>
<th></th>
<th>Roadmap</th>
<th>MoMo</th>
<th>GCAM</th>
<th>MESSAGE</th>
<th>Roadmap 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>100</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Freight Rail</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Passenger Rail</td>
<td>100</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Truck</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>2&amp;3 Wheelers</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bus</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>LDV</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

### TTW CO₂ Emission

<table>
<thead>
<tr>
<th></th>
<th>Roadmap</th>
<th>MoMo</th>
<th>GCAM</th>
<th>MESSAGE</th>
<th>Roadmap 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation</td>
<td>100</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Freight Rail</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Passenger Rail</td>
<td>100</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Truck</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>2&amp;3 Wheelers</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bus</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>LDV</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
Passenger Vehicle Activity Average Variation

This represents the average absolute variation between model trajectories and the average trajectory.
This represents the average absolute variation between model trajectories and the average trajectory.
Total Energy Consumption Average Variation (excluding Waterborne)

2000-2010
- U.S.
- Canada
- Mexico
- Brazil
- Latin America-31
- EU-28
- Russia
- Non-EU Europe
- China
- Japan
- India
- South Korea
- Australia
- Asia-Pacific-4
- Middle East
- Africa

2015-2030
- U.S.
- Canada
- Mexico
- Brazil
- Latin America-31
- EU-28
- Russia
- Non-EU Europe
- China
- Japan
- India
- South Korea
- Australia
- Asia-Pacific-4
- Middle East
- Africa

2035-2050
- U.S.
- Canada
- Mexico
- Brazil
- Latin America-31
- EU-28
- Russia
- Non-EU Europe
- China
- Japan
- India
- South Korea
- Australia
- Asia-Pacific-4
- Middle East
- Africa

This represents the average absolute variation between model trajectories and the average trajectory.