National and local policies to promote sustainable transport
Published since 2006

Energy & GHG emission futures under three main scenarios:

- **6DS, 4DS and 2DS**
  - 6DS: ‘static baseline’
  - 4DS: current strategies and recent pledges extended to 2050
  - 2DS: CO₂ emission mitigation scenario
Addressing sustainable development: action in all sectors is needed

End-use sectors and supply-side sectors each provide around half of the cumulative reductions between the 6DS and 2DS.
Action in cities will be critical

Final energy demand in the 4DS

- Urban – World
- Non-Urban – World

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Action in cities will be critical, notably in emerging and developing economies.

Two-thirds of the growth in global energy demand to 2050 comes from cities in emerging and developing economies.
Cities are key to carbon abatement

Cities represent 70% of the cost-effective CO₂ abatement potential through 2050
Focus on sustainable urban energy systems

- **Policy objectives**: GHG mitigation targets, environmental sustainability, energy security, and economic development
- How *local and national energy policies* can be effectively aligned

Transport chapter

- Transportation *activity, energy demand* and *GHG emissions*
- Focus on *urban* areas, also with analysis of non-urban parameters
- *Global, regional* and *national* estimates
- Projections under the different ETP model *scenarios*
- Analysis of the sustainable energy *technology options*
- Identification of *policy solutions*
Global passenger transport energy demand in 2015, by mode

- Primarily cars, followed by aviation
- 2-wheelers (primarily in non-OECD)
Freight energy demand
Mode matters

Global freight transport energy demand in 2015, by mode

- Shipping accounts for 81% of all tkm
- But trucks account for the majority of energy use
Passenger transport activity in 2015

Mode matters

National Passenger transport activity (pkm) in 2015, by mode

USA 6.3 trillion pkm

China 9.25 trillion pkm

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Passenger transport energy use in 2015

Mode matters

Transport final energy use per capita (gigajoules per year)

USA 25.9 EJ
China 13.2 EJ
Drivers of modal choices in cities

- Population density & Urban form

Policies:
- Price signals (fiscal policies)
- Travel demand management
- Regulatory policies
- Public transit provision
  - Infrastructure
  - Operation subsidies
- Information & Communication Technologies
  - Mobility as a Service (MaaS)

Source: IEA analysis using data from the *Millennium City Databases* Union internationale des transports publics (UITP) (2015), Millennium City Databases for Sustainable Transport, database, UITP, Brussels.
GHG emissions in 2015

Well-to-wheels GHG emissions in 2015, by mode

- Transport is the least diversified energy demand sector
- Fuel production well-to-tank emissions are primarily due to refining
- GHG emission distribution mirrors closely energy demand
Many technologies can contribute to realizing the 2DS

- Information and communication technologies (ICT)
  - To manage travel demand (i.e. enable “avoid/shift”)
  - To enable more efficient vehicle operations (i.e. enable “improve”)

- “Hardware” technologies to improve the energy efficiency of vehicles
  - Both incremental and transformational
  - *Electrification* of road transport – cars and trucks

- Fuel supply pathways with low carbon intensity
  - Advanced and sustainably sourced biofuels
Transport energy demand projections
Policy and technology have great potential

Global Energy for Transport in 2015 & in 2050 in the ETP Scenarios

Transport energy demand:

2015  107 EJ
2050  100 (2DS) - 184 EJ (6DS)
Need to decouple activity & emissions
Avoid/shift, vehicle efficiency, low carbon fuels

GHG Emissions in the 2DS, 4DS, and 6DS – 2010 to 2050

OECD transport emissions have peaked

Non-OECD transport emissions can be brought back to current levels in 2050
Policy recommendations

Use a coherent portfolio of instruments

National/Supra-national policies
- Removal of fuel subsidies
- Vehicle taxes
- Introduction of well-to-wheel CO$_2$ taxation on fuels
- Fuel economy standards
- RD&D support

Local measures
- Compact cities
- Pricing policies
- Regulatory measures
- Public transport investments
## Policy portfolio

<table>
<thead>
<tr>
<th>Scope</th>
<th>Policy category</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Avoid/Shift</td>
</tr>
<tr>
<td>Local</td>
<td>Pricing (congestion charges, tolls parking fees)</td>
<td>Possible</td>
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<tr>
<td></td>
<td>Regulatory (access &amp; parking restrictions, low emission zones)</td>
<td>Possible</td>
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<td></td>
<td>Public transport investments</td>
<td>Possible</td>
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<td>National</td>
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<td></td>
<td>Fuel economy regulations</td>
<td>Possible</td>
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<td></td>
<td>Vehicle taxation, feebates</td>
<td>Possible</td>
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<td></td>
<td>Low carbon fuel standards</td>
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<td></td>
<td>Alternative fuel mandates</td>
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<td></td>
<td>RD&amp;D support</td>
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</tbody>
</table>
Transport energy use declines by 40% across the OECD, and increases by 35% across the non-OECD.

Substantial diversification of energy supply.
Transport energy use declines by 14% across the OECD, and more than doubles across the non-OECD

Some diversification of energy supply
Transport energy use essentially stagnates in the OECD, and increases by more than 250% across the non-OECD.

Marginal diversification of energy supply
In the 2DS, by 2050 one billion cars are electric vehicles and public transport travel activity more than doubles.
Annual expenditures are greater only for infrastructure in the 2DS
The bulk of these costs would be for high-speed rail
Local and national actions can make the low-carbon transition possible

Leveraging all solutions to urban energy sustainability requires strong private and public action both at local and national levels.
This map is without prejudice to the status of sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area. Experts from countries shown above participate in activities of the Technology Collaboration Programmes.
Explore the data behind ETP

www.iea.org/etp
Supplemental Slides and further discussion

- The Mobility Model (MoMo)
- ETP 2016 methods
- More detailed results from ETP 2016
- Highlights of other recent publications
  - Global Electric Vehicle Outlook
  - Energy and Air Quality, WEO Special Report
  - Global Fuel Economy Initiative
- Upcoming projects
  - Trucks
  - WB2DS
The **Mobility Model** (MoMo)

- Estimation of transport activity (pkm, tkm, vkm) and vehicle stock
- Evaluation of new vehicle registrations by powertrain and characterization of the vehicles by age
- Calculation of the energy use
- Estimation of CO₂ and pollutant emissions

The basic ASIF structure:

\[
F = \sum_i F_i = A \sum_i \left(\frac{A_i}{A}\right) \left(\frac{F_i}{A_i}\right) = A \sum_i S_i l_i = F
\]

where, \( F = \) total fuel use [MJ/year]  
\( A = \) vehicle activity [vkm/year]  
\( I = \) energy intensity [MJ/vkm]  
\( S = \) structure (shares of vehicle activity) [%]  
and \( i \) is an index of vehicle modes and classes – MoMo models vehicles belonging to several modes. Vehicle activity can also be expressed as the product of vehicle stock [vehicles] and mileage [km/year].

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**The Mobility Model (MoMo)**

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**Project history**

**2003**
World Business Council for Sustainable Development and the Sustainable Mobility Project transport model
Scenarios exploring transport energy use, CO₂ and pollutant emissions, safety and materials use

**2004**
SMP model developed further as IEA Mobility Model (MoMo)
MoMo data used for the IEA ETP analysis and ETP 2006

**2006-2008**
- Deeper analysis of vehicle technology potential, including plug-in hybrid electric vehicles (PHEVs)
- Elasticities of travel and ownership with respect to GDP and oil prices
- Integration of significant historical data in MoMo
- Development of scenarios for the IEA Energy Technology Perspectives (ETP) project in 2008

**2008-2012**
- Improved user friendliness and detailed modular approach
- Expanded coverage of countries and regions
- Development of modal shift scenarios
- Scenario-specific vehicle, fuel and infrastructure costs

**2013+**
- Assessment of urban transport activity, passenger demand generation, and policy responses
- Refined assessment of aviation, maritime shipping, and rail modes
- Partial integration with TIMES systems optimization model (in cooperation with China’s Energy Resource Institute (research division of the NDRC)
- Refined generation of activity projections, demand generation of road and rail freight (underway)
- Assessment of public costs and revenues (underway)
The Mobility Model (MoMo)

An essential tool for transport-related research and policy activities on:

- **Fuel efficiency**: Global Fuel Economy Initiative (GFEI)
- **Vehicle technology**: Electric Vehicle Initiative (EVI)
- **Cooperative efforts**: Railway Handbook on Energy Consumption and CO2 emissions with *International Union of Railways (UIC)*

MoMo is shared with:

- other directorates in the IEA (e.g. Global Energy Economics – WEO; the Energy Efficiency Directorate – EEfD)
- the EIA and the International Transport Forum, who uses it for the formulation of its Transport Outlook
- “MoMo partners”, i.e. sponsors and collaborators – mainly from the private sector – providing Voluntary Contributions and/or in-kind help

- Currently 20 MoMo partners
- leaders across industry, government, independent research institutes, and academia
What is urban?

**UN:** “The traditional distinction...based on the assumption that urban areas... provide a different way of life and usually a higher standard of living than...rural areas.”

“this distinction has ‘blurred’ in many industrialized countries, and *population density* has replaced socio-economic status as the main feature distinguishing urban from non-urban regions.”
ETP 2016 Methods

Text size scales with GDP per capita

Urban ≠ Population Density

Matching minimum population density threshold (people per square kilometre)

Percent Urban in 2015 according to the United Nations

ETP
ETP 2016 – GIS analysis, urban vs. non-urban
Example using Germany’s Urban regions

People per km²
Cars, followed by aviation, are the main energy consumers in passenger transport in all global regions.

In cities, cars account for 76% of the total (90% in the OECD).

In the non-OECD, the energy used by two wheelers exceeds that of urban LCVs and medium trucks.
Freight transport activity in 2015
Cities account for 1% of the total activity...

- Activity

- Energy demand
Focus on low carbon fuels

- In 2DS, 2050 demand for alternative energy carriers attains nearly 15 EJ in cities and exceeds 20 EJ for non-urban transport.
- This is more than twice the urban demand of 4DS, and three times larger for non-urban.
- 2DS-4DS differences in 2030 are smaller: the uptake of alternative fuel vehicles and low-carbon fuels is stronger in the long term.
## Local policies
### Examples of measures already in use

<table>
<thead>
<tr>
<th>Pricing</th>
<th>Regulatory instruments</th>
<th>Public transport and walking and cycling support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion charging, cordon pricing, tolls (e.g. London, Milan,</td>
<td>Access restrictions (e.g. “yellow label” restrictions in Chinese cities).</td>
<td>Shared bicycle systems and bicycle parking (e.g. Vélib’ in Paris, Citi Bike in New York).</td>
</tr>
<tr>
<td>Singapore, Stockholm). Parking pricing (widespread in North American,</td>
<td>Low-emission zones (e.g. time-of-day restricted access for freight trucks, as in many</td>
<td>Investments in cycling and walking paths, and sidewalks.</td>
</tr>
<tr>
<td>European and Japanese cities, most prevalent in the central business</td>
<td>European cities).</td>
<td>Transit infrastructure projects/ extensions (e.g. the Paris Métro; Bogotá’s Transmilenio).</td>
</tr>
<tr>
<td>districts of densely populated cities).</td>
<td>Registration caps (e.g. in Singapore, Shanghai and other Chinese cities).</td>
<td>Transit fare subsidies (e.g. local, regional and federal subsidies pay for roughly half of faires on systems in many European and Chinese cities).</td>
</tr>
<tr>
<td>Parking restrictions/reductions in parking supply (e.g. progressive</td>
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<tr>
<td>elimination of off-street parking in Copenhagen, Paris and other</td>
<td>street parking in Copenhagen, Paris and other European cities).</td>
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<tr>
<td>European cities).</td>
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</tbody>
</table>

- Front runners exist amongst cities
- Effects observed in these cities were instrumental to assess the impact of these policies and generalize it in our projections
1.3 million EVs (BEVs + PHEVs) on the roads in 2015

550,000 EVs sold in 2015 (+ 70%)

China became the first EV market in 2015

7 countries >1% market share (Norway, Netherlands, Sweden, Denmark, France, China, UK)

GEVO 2016 also contains: EVSE assessment, policy review, EV purchase subsidies review, aspirational goals to 2020 and 2030
May-June publications
Global EV Outlook 2016 (2/2)

Global EV Outlook 2016

Electric vehicles

The year 2015 saw the global threshold of 1 million electric cars on the road exceeded, coming at 1.26 million. In 2014, only about half of today’s electric car stock existed. In 2005, electric cars were still measured in hundreds. 2015 also saw more than 200 million electric two-wheeler sales on the road, and 170,000 buses, primarily in China.

Charging infrastructure

There are an estimated total of 1.45 million electric car charging points worldwide. In 2015, publically accessible charging facilities have been following the growth trend of the electric car stock in the past year.

Battery technology improvements

Since 2008, battery costs have fallen by a factor four and battery energy density has more than doubled. Technological developments hold the promise to continue to deliver improvements in the forthcoming years.

Policy support

Purchase incentives are among the most influential and the most effective measures promoting electric car sales. Estimates of purchase incentives and market shares for electric cars (BEVs and PHEVs) 2015

Deployment scenarios for the stock of electric cars to 2030

Individual country commitments would bring 13 million electric cars on the road by 2030. The ECV aim is to achieve a deployment of 10 million electric cars by 2030. In both cases, meeting 2030 deployment targets for EVs and PHEVs requires a substantial growth of the electric car stock. Meeting 2030 decarbonisation and sustainability goals requires a major deployment of electric cars by 2030.
Energy producing and consuming sectors are responsible for more than 99% of anthropogenic emissions of sulfur dioxide and nitrogen oxides to the atmosphere, and almost 85% of the emissions of particulate matter.

Power generation and industry are the leading sources of sulfur dioxide (mainly from coal use).

Oil-fuelled vehicles & power generation are leading sources of nitrogen oxides, and the residential sector (bioenergy, kerosene & coal) & industry are the leading emitters of particulate matter.

As the largest source of air pollution, the energy sector must be lead actions to improve air quality around the world.

There is a range of proven policies and technologies with which to do so. In the United States, European Union and Japan, regulations have helped achieve a major drop in emissions in some sectors, but no jurisdiction can claim that the task is complete.

Policies having an impact on air quality include regulations that specify emissions limits for power plants or specific industrial facilities, as well as fuel quality or vehicle emissions standards.

Market-based instruments include levies on polluting fuels, subsidies to encourage fuel-switching & emissions trading schemes.
Project scope

- Long term projection of demand for
  - Medium Freight Trucks (MFTs) – 3.5 tonne to 15.5 tonne Gross Vehicle Weight
  - Heavy Freight Trucks (HFT) – greater than 15.5 tonne Gross Vehicle Weight

- Projecting:
  - Tonne Kilometres
  - Vehicle Kilometres
  - Stock
## ETP 2017 model developments

### Update of freight transport drivers

#### (3/5)

**Explanatory Variable** | **Source**
---|---
Gross Domestic Product – Purchasing Power Parity | IEA
Industry Value Added | IEA
Services Value Added | IEA
Agriculture Value Added | IEA
Population | OECD Stats
Population Density | OECD Stats
Fuel Price | IEA
**Normalised Fuel Price** | -
**Country Area** | -
Vkm - Medium, Large, and Total | OECD Stats
Tkm - Medium, Large, and Total | Eurostat, NATS
No. of Vehicles - Medium, Large, and Total | National Statistics Offices
Rail Tkm | UIC
Road Infrastructure | IEA
Rail Infrastructure | IEA
Road – Rail tkm Ratio | -
Road – Rail Infrastructure Ratio | -
Data availability

- **Tkm**

- **Vkm**