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The MoMo model: status and developments

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Project development

2003

WBCSD project and **SMP model**

- First Generation Model available on the SMP website
- SMP model used for the Mobility 2030 report
  - scenarios exploring energy use, CO_2 and pollutant emissions, safety and materials use

2004-2005

SMP model developed further into the **MoMo model**

- The IEA ETP model uses the MoMo assumptions for travel demand growth, vehicle fuel economies, mileage
- MoMo data used for the IEA ETP analysis

2006-2007

We're here to plan the **next step** of this analysis...

- Deeper understanding of vehicle technology potential
- Enlarged focus on non-LDVs
- Elasticities
- Stronger link to ETP work
- Improved use of the MIT work (link to fuel economies)
- Modules on resource availabilities

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What is MoMo?

- It is a spreadsheet model of global transport, energy use, emissions, safety, and materials use
  - analysis of a multiple set of scenarios
  - Based on hypotheses on GDP and population growth, fuel economies, costs, travel demand, vehicle and fuel market shares
- It contains a large amount of information (data) on technologies and fuel pathways
  - full evaluation of the life cycle GHG emissions
  - reference case projection to 2050, calibrated to IEA WEO 2004 through 2030
    - fuel economy projections
  - cost estimates for new light duty vehicles
  - estimates for fuels costs and taxes
  - section on material requirements for LDV manufacturing
- It is based on the "ASIF" framework:

  Activity (passenger travel) * Structure (travel by mode, load factors) * Energy Intensity = Fuel use

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Analytical capabilities

- Tracking of
  - Activity
  - Intensity
  - Energy use
  - GHG emissions (on a WTW, a TTW basis)
  - Pollutant emissions (CO, VOCs, PM, lead and NO_x)
  - Costs (only for LDVs)
- 11 world regions covered

  The model is suitable for handling regional and global issues
- Focus on light-duty vehicles

  A stock model has been developed only for LDVs
- Material requirements have been integrated in the model
  - Analysis of changes in expected vehicle sales (e.g. fuel cells) and how they impact on materials requirements (e.g. precious metals)
  - Full life-cycle analysis for emissions from LDVs

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Coverage of transport modes

- **2-3 wheelers**
- **Light duty vehicles**
  - Spark ignition ICEs
  - Compression ignition ICEs
  - Spark ignition ICE hybrids
  - Compression ignition ICE hybrids
  - Hydrogen ICE hybrids
  - Fuel cells
- **Heavy and duty vehicles**
  - Passenger
    - Minibuses
    - Buses
  - Freight
    - Medium freight trucks
    - Heavy freight trucks
- **Rail**
  - Passenger
  - Freight
- **Air**
- **Water transport**
  - National
  - International

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Coverage of fuel pathways

- **Liquid petroleum fuels**
  - Gasoline
  - Diesel (high- and low-sulphur)
- **Biofuels**
  - Ethanol
    - Grain, sugar cane, advanced technologies (lignocellulose)
  - Biodiesel
    - Conventional (fatty acid methyl esters, FAME), advanced
- **Synthetic fuels**
    - GTL and CTL
- **CNG/LPG**
    - CNG, LPG, biogas
- **Hydrogen**
    - from natural gas, with and without CO_2 sequestration
    - from electricity, point of use electrolysis, with and without CO_2 sequestration
    - from biomass gasification
    - advanced low GHG hydrogen production

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Model strengths/weaknesses

- **Substantial data availability** for developed and developing regions
  - Activity growth (based on GDP and population projections)
  - Fuel economy
  - Cost estimates
  - A thorough data update (to 2005) is required
  - Many data gaps still exist
  - some assumptions are weak and need to be improved
- "What-if" analysis
  - The effects of policies on fuel demand, CO_2 emissions and pollutant emissions can be analysed quickly
  - Full "back-casting" is possible
  - "off-line" analysis and assumptions that must be developed to get robust results
- Interesting perspective: **combined use of MoMo and ETP**
  - MoMo seems best suited for hypotheses of the FE side
  - ETP offers feedback on fuels, including competing options, and can result in MoMo fuel scenarios
  - The two approaches can be combined

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Next step
File improvements

- The file **size is large** and needs to be reorganized
  - All **spark ignition vehicles** (including H_2 and CNG), can be treated **together**, with no loss of information
  - **Input** sources for the existing "off-line" analysis should be excluded from the core file and added to satellite files
  - The **output** sheets should be reorganized prioritizing the results that need to be pointed out
  - **Some calculations** (e.g. pollutant emissions) should be **aggregated**
  - Some tables can be grouped
  - Some links can be rationalised
- The **user-friendliness** should be further **improved**
  - The approach used for LDVs should be extended to other modes
  - A menu-based approach could also be used for outputs

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Next step
LDV technologies

- **Better detail of fuel economy and costs for LDVs** (component approach)
  - Analysis of the **market share of existing technologies**
    - Analysis of current and historical results
    - Need to gather detailed figures, the help of manufacturers is important
  - Analysis of **full potential** for improved LDV fuel economies
  - Hypotheses on **future market penetration** of current and new technologies
    - Engine technologies, engine downsizing (link to MIT)
    - After-treatment
    - batteries, electrical motors, transmission technologies
    - tyres, appliances, lightweighting (MIT), aerodynamics
  - **Plug-in hybrids** could be added in the hybrid worksheets, and this would need to include electricity amongst the fuels
  - Other technologies?

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Next steps

MIT work, data availability, regions

- Better consideration of the **MIT work**
  - Link to MIT work with hypotheses on fuel efficiency (engine downsizing, vehicle lightweighting, plus a "no-changes" case, currently not considered)
  - Module on materials should be extended to HDV and buses (drawing on existing data from MIT)
  - Possible extensions to 2-3 wheelers, rail and air (!), based on additional work from the MIT group, or other consultancy
- **Data availability**
  - Need to include historical figures (not only base year)
  - Opportunities from the work on energy efficiency indicators
  - New calibration needed for RS (World Energy Outlook 2006)
- **Regional enlargement**
  - Possible but needs a thorough data update
  - Important to improve analysis of developing regions
  - Opportunity for outsourcing? E.g. for some of the "+5"

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Next step

Elasticities

- **Elasticities** for travel demand, modal switching and technology penetration **for LDVs**
  - This should be based on fuel prices, but transport demand is also linked to incomes. Effect of prices and income could be added, where appropriate
  - Extensive analysis of the historical trends is required, but it can build on the work done for the World Energy Outlook
  - Difficulties: separation of modal switch, travel demand and technology penetration for improved fuel economy
  - Future patterns: scenario approach?

    E.g. : all energy gain from modal shift, all travel reduction, all new techs: differences, combination of the various effects, policy needs

- **Elasticities for non-LDV** modes
  - Same problems and complexity found for LDVs
  - Need to check against other key historical data
  - Possibility to draw on the experience of WEO analysts
  - Link to non-LDV modeling improvements (see next slide)

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Next step
Non-LDVs, resource availability

- **Improvements for the non-LDV modes**
  - Fuel pathways for some vehicles (CNG for buses, biofuels for aviation)
  - Stock models (following an analysis on data availability), a requirement for the evaluation of costs
  - Better characterization of air transport technologies
  - Separation of urban and intercity passenger rail (lower priority)
  - Role of load factors
  - Need to draw on EEI, OECD work and other studies
  - Costs (very ambitious)
- Modules for the **evaluation of the cumulative fuel use** and its impact on the total **resource availability potentials**
  - This can draw on IEA work for availability potentials carried out for ETP, and UNEP research on biofuels
  - Problem: transport is only a part of the picture

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Next step
MoMo-ETP link, other

- Developing **MoMo and ETP model linkages**
  - Link transport energy demand (especially LDV) to an optimised analysis of global energy supply and demand
  - Better understanding of the fuel supply markets, including competing options
  - Need to work extensively on the implementation of the linkage. Regional enlargement of MoMo to ETP would be beneficial
- Need to create a proper **user manual**
  - Possibility to offer training for company officials
- **Report on the activities**
  - Studies, hypotheses, reasons behind our choices, "off-line" analyses
- **Final report**, including scenario-analysis
  - IEA publications, contribution to next Energy Technology Perspectives

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Items for discussion

Priorities?

1. File improvements
   - Size issues
   - User friendliness
2. LDV technologies (including data requirements)
   - Contribution and potential for fuel economy
   - Costs
3. Integration of MIT work and fuel economies
   - Lightweighting, engine downsizing
4. Regional enlargement
5. Data updates
   - 2005
   - Historical
6. Elasticities (LDVs)
7. Improvements for non-LDV modes
   - Stock models
   - Costs
   - Focus on air transport (the fastest growing mode)
8. Elasticities (non-LDVs)
9. MoMo-ETP linkage
10. Modules on resource availability and actual fuel use
11. Publications