Transport scenarios: the who, what, why, and how

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What will the future of transport look like?
What are transport scenarios? Why do we develop them?

- Solution space for possible futures
- Plausible storylines / narratives
- Used to inform strategic decision making (policy, companies, investing)
- Toward 2030 and later (not forecasts)
- Transport demands = rapidly growing

Political

Behavioral

Macro (tech., econ., ...)

Transport demands = rapidly growing
What do transport scenarios tell us? What are their main outputs?

- # of vehicles sold, in fleet
- vehicle-km / passenger-km / tonne-km
- fuel mix
- GHG and air pollutant emissions
- infrastructure needs
- Interactions and interdependencies between transport modes, and between other sectors of the economy
What types of problems do scenarios address? Who pays attention to them?

- Local (municipalities)
  - Air quality
  - Traffic / congestion
  - [...]

- National (governments)
  - Fuel economy standards
  - Networks (high-speed rail, EV charging)
  - [...]

- International (institutions)
  - Greenhouse gas emissions
  - Sustainable Development Goals
Countries have agreed, by consensus, to reduce their greenhouse gas emissions “as soon as possible” and to do their best to keep global warming “to well below 2 degrees C”.
Transport and the UN’s Sustainable Development Goals (SDGs)

Source: https://sustainabledevelopment.un.org/

- Road traffic accidents
- Air quality
- Energy efficiency
- Reliable/resilient infrastructure
- Public transport
- Fossil fuel subsidies
Ambitious targets for electric vehicles

- Governments across the world have set ambitious targets for EVs. (Collectively, by 2025, sales of ~7 million per year, or ~30 million cumulative stock … compared to >1000 million passenger vehicles globally at present)
- Automakers also have big plans. (e.g., VW Group has pledged that BEVs will comprise 20-25% of its annual sales by 2025; 2-3 million per year.)
- A consortium of companies, governments, and other organizations announced at the 2015 United Nations Climate Change Conference (COP 21) the “Paris Declaration on Electro-Mobility and Climate Change and Call to Action”.

Paris Declaration on Electro-Mobility and Climate Change
& Call to Action

Lima – Paris Action Agenda

Transport contributes almost one-quarter (23 percent) of the current global energy-related greenhouse gas (GHG) emissions and is growing faster than any other energy end-use sector. GHG emissions from transport are anticipated to rise from today’s levels by nearly 20 percent by 2030 and close to 50 percent by year 2050 unless major action is undertaken.

Limiting the global temperature increase to below 2 degrees Celsius requires changing this transport emissions trajectory, which involves the development of an integrated electromobility ecosystem encompassing various transport modes, coupled with the low-carbon production of electricity and hydrogen, implemented in conjunction with broader sustainable transport principles.

Stated targets:
- 100 million electric-drive LDVs by 2030 (~2 million today)
- 400 million electric-drive 2/3-wheelers by 2030 (~250 million today)

Source: http://newsroom.unfccc.int/media/521376/paris-electro-mobility-declaration.pdf
How are transport scenarios produced?

• Short answer:
  – Construct a storyline and then build a computer model.

• Longer answer:
  – Identify what to study and the desired output…
  – …and the critical drivers affecting those outputs.
    • For transport: population, income, prices, urban form, policies, people’s attitudes/preferences
  – Collect enough data to make informed assumptions and write correct equations (input => output)
  – Build model and vary critical drivers to understand their importance for the scenario(s)
Total Passenger Mobility Growth (1950-2005)
Shift Toward Faster Modes (1950-2005)

Public Transport  
Personal Light-Duty-Vehicles  
High-speed travel (air, rail)

Who produces transport scenarios?

Universities, Research institutes (IIASA, PIK, UC-Davis, Chalmers, …)

International govt. institutions (IEA, IRENA, ITF)

National / Sub-national govt. departments (U.S. EIA, cities)

Companies (BP, Shell, ExxonMobil, Statoil)

NGOs, Think-tanks (ICCT)

For a group of scenario developers producing international transport scenarios, see the International Transport-Energy Modeling (iTEM) consortium (https://transportenergy.org/).
What are the major uncertainties with respect to future transport?

• Car ownership trends (e.g., among younger gen.)
• Emerging economies’ transport pathways
• Electric vehicles
• Disruptive technologies
  – Connected and autonomous vehicles (CAVs)
  – Shared mobility
  – 3D printing
• Policy and financing
  – What to invest in? What to subsidize, how much, for how long?
Transport characterized by long time-scales

Gasoline-electric Lohner-Porsche, 1900.
http://www.hybrid-vehicle.org/hybrid-vehicle-porsche.html

Hugo Junkers' 1924 design for a giant flying wing. The wing was to accommodate 26 cabins for 100 passengers, carry a crew of 10, and have enough fuel for 10 hours of flight.
http://www.century-of-flight.net/Aviation%20history/flying%20wings/Early%20Flying%20Wings.htm

Source: Andreas Schaefer (UCL)
Questions?
Comments?

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Back-up slides
Invariants (?) in Travel Behavior: Average Travel Time
Energy Supply

Agriculture, economy, geo-politics,…

Energy Demand

Transport

Industry

Buildings
Breakdown of global transport GHG emissions

Source: IPCC AR5 WG3, Figure 8.1

- Road transport (mostly passenger, but freight growing quickly)
- Rail transport
- Air transport
- Water transport
The ‘legs of the stool’ represent the different ‘levers’ available for reducing transport GHGs.

Source: https://www.fhwa.dot.gov/environment/sustainability/energy/workshops_and_peer_exchanges/seattle_10_2008/gccseattle.cfm
Greenhouse Gas Emissions Identity

\[ GGE = \frac{GGE}{E} \cdot \frac{E}{PKT} \cdot PKT \]

- Greenhouse Gas Emissions
- Fuel Composition
- Energy Intensity
- Travel Demand
Which ‘levers’ hold the biggest potential, or could/should be pulled hardest? …not entirely clear…

Results from the iTEM global transport-energy model comparison (Yeh et al., 2016)

- ‘Economics-based’ IAMs (GCAM and MESSAGE) favor low-carbon fuels. [endogenous]
- ‘Expert-based’ transport-only models (MoMo and Roadmap) favor vehicle efficiency improvements. [exogenous]
- Changes in activity / behavior (mode-shifting, demand avoidance) are more pronounced in MoMo and Roadmap.
- MoMo and Roadmap see the transport sector bearing a greater mitigation burden than GCAM and MESSAGE.
“The automobile has been perfected. No further improvements are necessary.”
-- Allgemeine Automobil Zeitung of Berlin, 1921

Flying cars courtesy of a Dutch manufacturer
(reserve yours now)

Flying (drone) taxis in Dubai
(coming July 2017)
Mitigation burden of transport sector impacts, and is impacted by, mitigation elsewhere in the system.

~2 °C || including CCS

450 ppm CO₂ eq with Carbon Dioxide Capture & Storage

Source: IPCC AR5 WG3, Figure SPM.7
Transport mitigation burden could either be light or heavy before 2050.

\[ \sim 2 \, ^\circ C \ | \ | \ no \ CCS \]

450 ppm CO$_2$eq without Carbon Dioxide Capture & Storage

Source: IPCC AR5 WG3, Figure SPM.7
Transport mitigation measures in NDCs

- 75% of NDCs explicitly identify transport as a mitigation source (among 160 NDCs, 2016-Aug-01)
- 63% propose transport mitigation measures
- 9% include transport emission reduction targets
- 12% include assessments of country-level transport mitigation potential
- Strong bias toward passenger transport: included in 91% of NDCs identifying specific transport modes, while freight is only in 29%.
- High-speed rail (2%), aviation (5%), and walking and cycling (14%) receive less attention.
- High-income countries => vehicle eff. standards and biofuels/elec/H2
- Low/middle-income countries => [eff./fuels] + public transport, vehicle import restrictions, ‘green’ freight

Based on analyses by SLoCaT, Ricardo, GIZ, and German BMUB

Source: http://www.ppmc-transport.org/overview_indcs/
Policies for promoting alternative fuel vehicles

- Targets for cumulative vehicle sales, sales quotas, vehicle mandates
- Vehicle efficiency or emission standards
- Vehicle sales incentives (purchase subsidies, tax credits, fee-bates, reduced registration fees)
- Vehicle manufacturer support (RD&D, production subsidies)
- High transport fuel taxes (also carbon taxes or pricing)
- Government and company vehicle procurement policies, other demonstration & test fleets
- Trialling in car clubs or car-sharing networks
- Recharging and refuelling public infrastructure investments
- Workplace or home charging incentives
- Preferential parking or roadway access; reduced congestion charges or tolls
- Promotions, social marketing, outreach, information campaigns

Two things we’ve learned from recent policy experience in the US and elsewhere…

1. Multi-pronged efforts to promote advanced vehicle adoption are more effective than a single sectoral or economy-wide policy (such as a carbon tax).
2. Whatever the mix of policies, strong coordination across different levels of government (national, state/provincial, and local) is very important.