IEA ETP Energy Demand Sector Models

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Agenda

- Energy demand sector models – transport, buildings, industry
- H_2 infrastructure model
- TIMES supply side model and H_2 generation
- Simplified dispatch model and storage
- Discussion of capabilities and limitations

Overall ETP modelling framework

- **Supply side:**
  - **TIMES – Energy system least cost optimization model**

- **Demand side**
  - **Split into three sectoral models: Transport (MoMo), Industry and Buildings**
  - **All demand side models are technology rich simulation tools which allow for sectoral projections of energy use, emissions and costs until 2050**

ETP Mobility Model (MoMo)

- It is a spreadsheet model of global transport energy use, emissions, safety, and materials use
  - analysis of a multiple set of scenarios, projections to 2050
  - Based on hypotheses on GDP and population growth, fuel economy, costs, travel demand, vehicle technology shares

- World divided in 29 regions, incl. a good number of specific countries
  - USA, Canada, Mexico, Brazil, France, Germany, Italy, UK, Japan, Korea, China, India
  - The model is suitable for handling regional and global issues

- It contains a large amount of data on technology and fuel pathways
  - full evaluation of the life cycle GHG emissions
  - cost estimates for new light duty vehicles
  - estimates for fuels costs and fuel distribution infrastructure
  - section on material requirements for LDV manufacturing

- It is based on the "ASIF" framework:

  Activity (passenger travel) * **S**tructure (travel by mode, load factors) * Energy **I**ntensity = **F**uel use

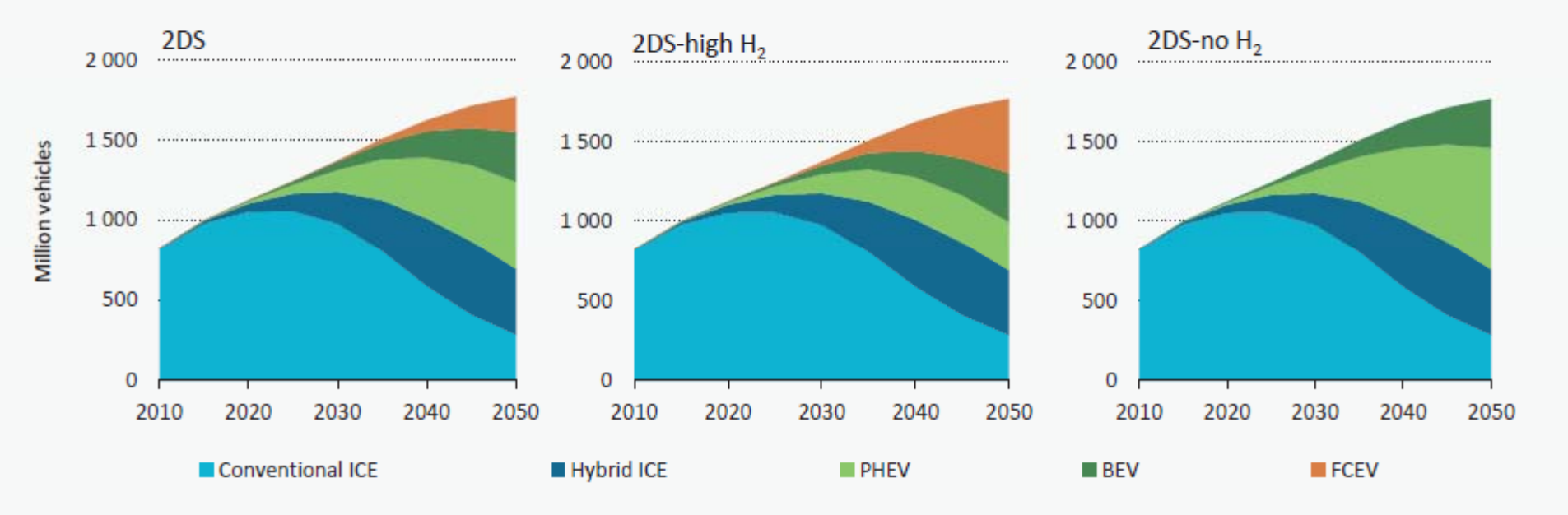
MoMo – Analytical capabilites

- For LDVs and trucks:
  - Technology uptake based on a stock model
  - Tracking of activity, intensity, energy use
  - GHG emissions (on a WTW, a TTW basis)
  - Pollutant emissions (CO, VOCs, PM, lead and NO_x)
  - Fuel and vehicle costs (only for LDVs)
- For buses, 2/3 wheelers, stock, tkm, stock efficiency, energy use and emissions are tracked
- For rail and air total travel activity (in pkm or tkm), stock efficiency, energy use and emissions are tracked
- For shipping, so far just energy use and emissions are tracked
- Material requirements and emissions have been integrated in the model
  - Analysis of future vehicle sales (e.g. fuel cells) and how they impact materials requirements (e.g. precious metals, Li) is possible
  - Full life-cycle analysis for GHG emissions from LDVs (including manufacturing);
  - Tailpipe emissions of various pollutants for road modes

Coverage of transport modes

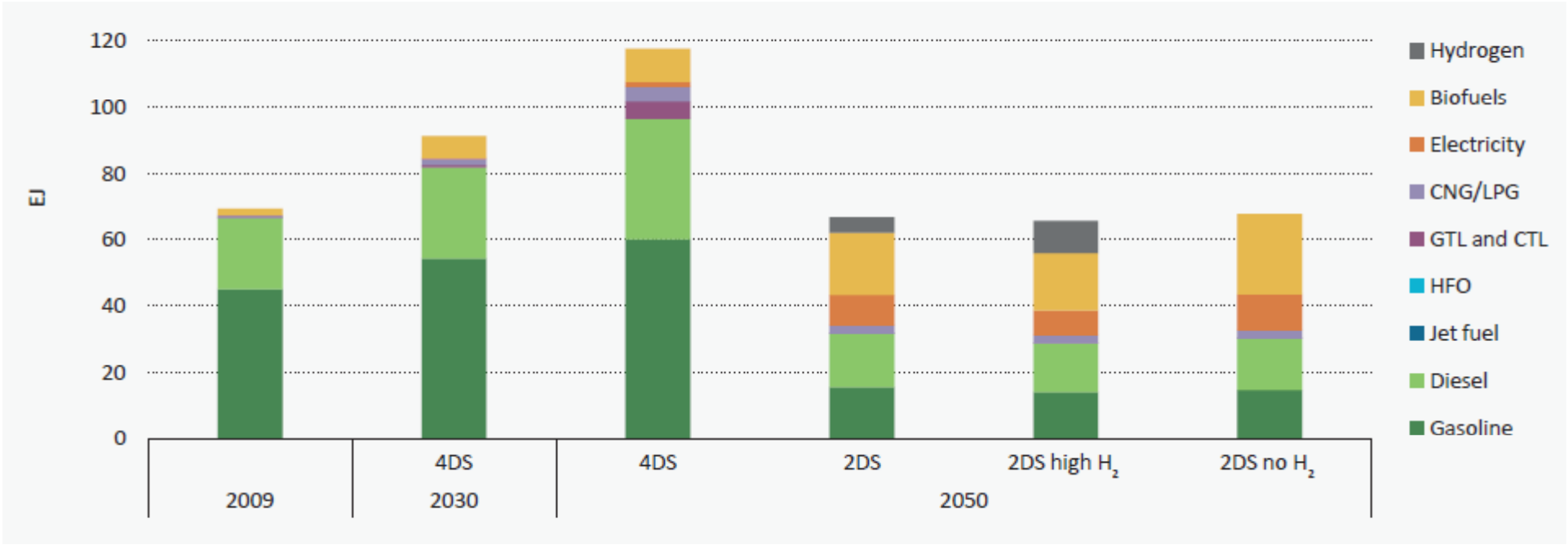
- 2-3 wheelers
- Light duty vehicles
  - Internal combustion (gasoline/diesel/CNG/LPG)
  - Hybrids (gasoline/diesel)
  - Plug-in hybrids (gasoline/diesel)
  - Fuel cell vehicles
  - Electric vehicles
- Heavy duty vehicles
  - Passenger
    - Minibuses
    - Buses
    - BRT systems
  - Freight
    - Medium freight trucks
    - Heavy freight trucks
- Rail (passenger, freight)
  - High-speed rail (to be added in 2013)
- Air (only passenger, new module under dev.)
- Water transport (only freight, new module under dev.)

Vehicle stock in 2DS and variants



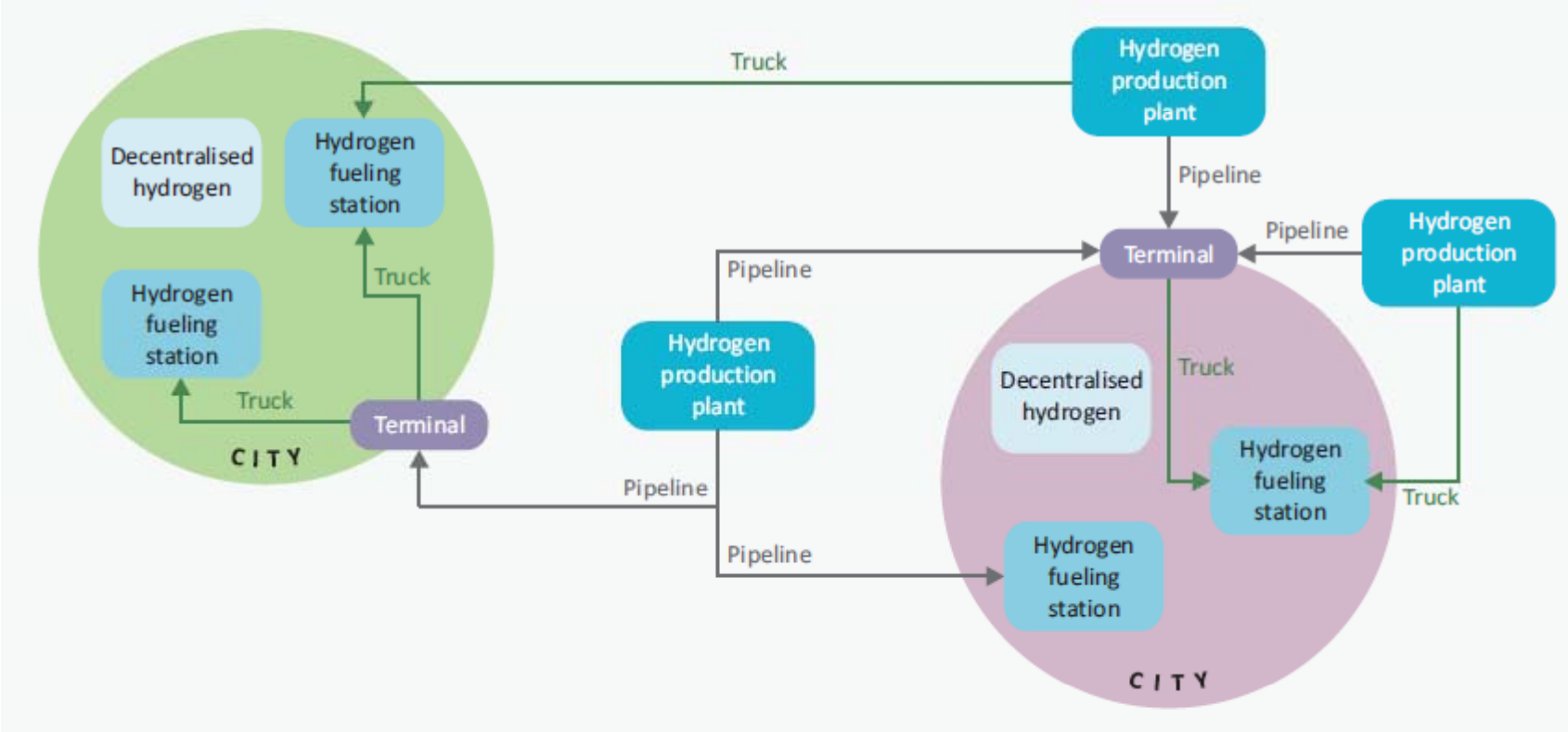
- 2DS passenger transport integrates technological and behavioural aspects: Avoid/Shift/Improve
- ETP 2012 discussed different technology portfolios with respect to energy use, emissions and costs based on varying the shares of FCEVs vs. PHEVs

Fuel demand by scenario and fuel type



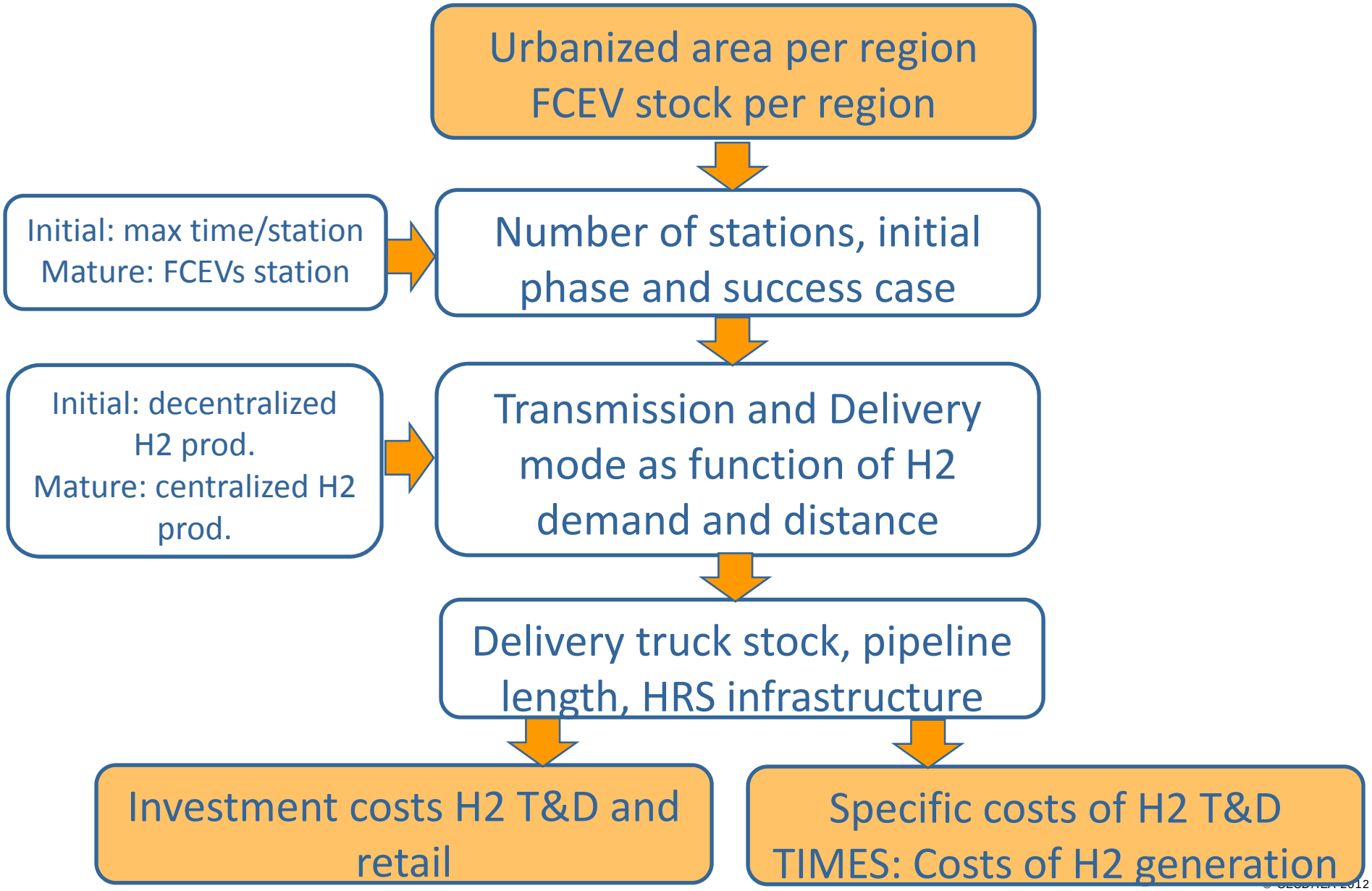
- To reach the emission target, in the 2DS energy use in the road transport sector needs to be reduced by almost 50% compared to the 4DS, going back to 2010 levels whilst vehicle stock is more than doubling
- The increased use of FCEVs can liberate more biofuels for use in other transport sectors

H_2 transmission, distribution, retail



- Finding an economic pathway for H_2 infrastructure roll-out along with demand is crucial
- The analysis of hydrogen T&D and retail infrastructure requires spatial resolution in the model – difficult to achieve

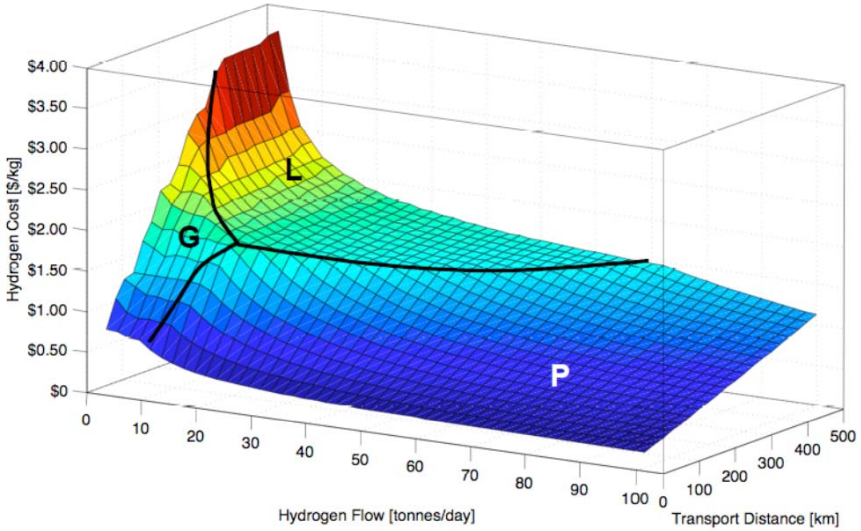
Infrastructure model



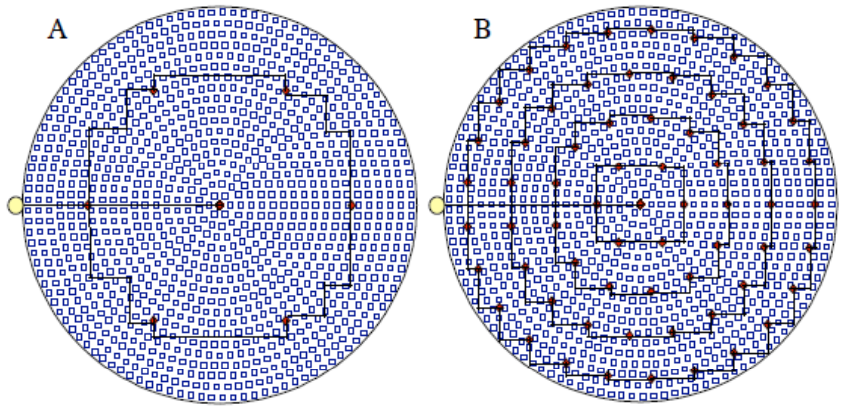
Infrastructure model

- **Ogden et al, 2007:**

Transmission mode & costs



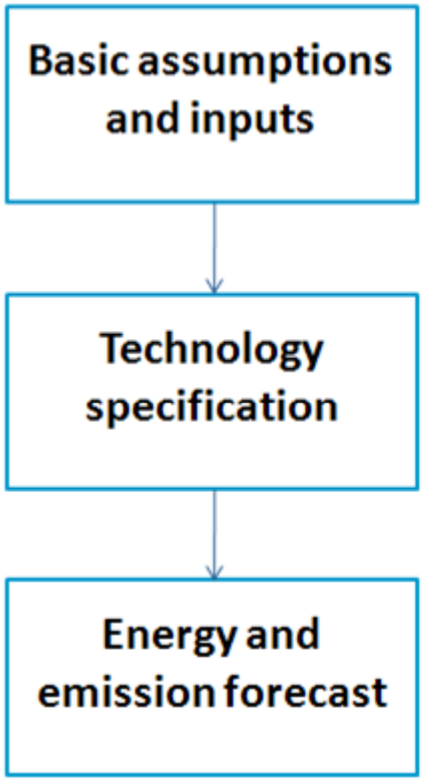
City distribution pipelines



- **H_2 transmission, distribution and retail infrastructure :**
  - **Gaseous trucking**
  - **Liquified trucking**
  - **Pipeline transport**
  - **Refilling stations**

Buildings model

Modeling framework



End use, energy sources, data and assumptions in the buildings model

End-uses	Technologies/energy	Key variables
Space heating	Coal	Urban population
Space cooling	Light fuel oil, Kerosene, Liquefied petroleum gas	Rural population
Water heating		Gross domestic product
Lighting	Heavy fuel oil	Number of households
Residential cooking	Diesel	Residential floor area
Residential appliances	Natural gas	Services floor area
Service equipment	Electricity	Share of floor area heated
	Commercial heat	Share of floor area cooled
	Modern biomass	System efficiency
	Traditional biomass	Fuel shares
	Solar	Useful energy intensity
	Heat pump	Appliances penetration rate
	Hydrogen	Appliances unit energy consumption
	Geothermal	CO_2 emission factors

Industry model

- Spreadsheet-based sector models
- 5 industry sectors modeled in detail: iron and steel, cement, chemicals and petrochemicals, pulp and paper and aluminum
- Low- and high-demand variants for materials production
- Time steps:
  - ETP 2012: 2009 to 2050, 5-years step
- Regions/countries
  - ETP 2012: 36 world regions/countries

Thank you very much!