

Symposium on Sustainable Future Mobility

Mobility, Energy, and the Future of Transport emissions

06 May 2022

Sonia Yeh | Chalmers University of Technology | Sweden



Outline

- Key messages from the latest IPCC 6th Assessment report
- Major uncertainties in long-term projections
- Two big research questions in improving demand estimates
- Other research projects in our Transport and Energy System TES group





Overall messages – Emissions and temperature rise

Projected global GHG emissions from NDCs announced prior to COP26 would make it likley that warmng will exceed 1.5C and also make it harder after 2030 to mitigate warming to below 2C Demand-side mitigation can be achieved through changes in socio-cultural factors, infrastructure design and use, and end-use technology adoption by 2050.



³ The impact of demand-side mitigation on electricity sector emissions depends on the baseline carbon intensity of electricity supply, which is scenario dependent.

by artificial intelligence, diversification of storage facilities, etc.

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.

Potential contribution to net emission reduction (2030) GtCO2-eq yr-1 Mitigation options 2 Wind energy Solar energy Bioelectricity Hydropower Geothermal energy Nuclear energy Carbon capture and storage (CCS) Bioelectricity with CCS Reduce CH₄ emission from coal mining Reduce CH4 emission from oil and gas Carbon sequestration in agriculture Reduce CH₄ and N₂O emission in agriculture Reduced conversion of forests and other ecosystems Ecosystem restoration, afforestation, reforestation Improved sustainable forest management Reduce food loss and food waste Shift to balanced, sustainable healthy diets Avoid demand for energy services Efficient lighting, appliances and equipment New buildings with high energy performance Onsite renewable production and use Improvement of existing building stock Enhanced use of wood products Fuel efficient light duty vehicles Electric light duty vehicles -Shift to public transportation Shift to bikes and e-bikes Fuel efficient heavy duty vehicles Electric heavy duty vehicles, incl. buses Shipping – efficiency and optimization Aviation - energy efficiency Net lifetime cost of options: Biofuels Costs are lower than the reference Energy efficiency 0-20 (USD tCO2-eq-1) Material efficiency 20-50 (USD tCO2-eq-1) Enhanced recycling 50-100 (USD tCO2-eq-1) Fuel switching (electr, nat. gas, bio-energy, H₂) 100-200 (USD tCO2-eq1) Feedstock decarbonisation, process change Cost not allocated due to high Carbon capture with utilisation (CCU) and CCS variability or lack of data Cementitious material substitution Uncertainty range applies to Reduction of non-CO2 emissions the total potential contribution to emission reduction. The Reduce emission of fluorinated gas individual cost ranges are also Reduce CH4 emissions from solid waste othe associated with uncertainty Reduce CH₄ emissions from wastewater

GtCO2-eq yr-1

Fuel efficient light duty vehicles Electric light duty vehicles Shift to public transportation Shift to bikes and e-bikes Fuel efficient heavy duty vehicles Electric heavy duty vehicles, incl. buses Shipping – efficiency and optimization Aviation – energy efficiency Biofuels

C.12 Mitigation options costing USD100 tCO₂e or less could reduce global GHG emissions by at least half the 2019 level by 2030 (high confidence).



Latest Carbon Prices

CarbonCredits.com Carbon Prices	Last
Compliance Markets	
European Union	€83.75
California	\$31.12
Australia (AUD)	\$29.00
New Zealand (NZD)	\$75.90
South Korea	\$16.26
Voluntary Markets	
Aviation Industry Carbon Offset	\$5.63
Nature Based Carbon Offset	\$10.63
Tech Based Carbon Offset	\$4.61

https://carboncredits.com/?gclid=Cj0KCQiw37iTBhCWARIsACBt1lzGN9RSgMFrz6XVkRYT vobIHF4vuo9bo4EpChZZJLN9pQEnnJQifGwaAuuTEALw_wcB Q. Why has transport emissions continued to increase given the observed carbon prices?

- Transport emissions are often exempted from carbon markets
- Raising fuel prices are nearly impossible politically
- Consumers are price inelastic toward fuel prices
- Energy efficiency paradox

Three Illustrative mitigation pathways for the Transport sector





Nested nature of activities and modelling across spatiotemporal scales





Three building blocks for modelling the future of transport

Transitions	Policies	Data is the new oil
 Transport systems play a critical role in achieving a sustainable future Several emerging trends maylead to a transition in transport sustainability But the future is highly uncertain, depending on the development of demand, consumer choice and technology 	 Policies can create the conditions that favor these transitions Must be carefully designed with a good understanding of the drivers of behaviors New trends and disruptive innovation bring opportunities and challenges 	New research frontier: Big Data, Machine learning and Al • Many challenges in using Big Data effectively • But, the potentials for drastically improving understanding and management of future systems are limitless!

Major Uncertainty I: Consumer Choice







- Vehicle cost
- Fuel cost
- Refueling station
 availability
- Range Anxiety cost
- Model availability

- New technology risk
 premium
- Towing capability
- Supply chain logistics
- Willingness to pay

Barriers translate to real and perceived costs for consumers

80000

70000







- Model Availability cost
- Risk Premium
- Refueling inconvenience Cost
- Charging Refueling Cost
- Towing Cost
- Range Anxiety Cost



Major Uncertainty II: technology/ behavioral transitions (2010-2020)

1. Electric vehicles, trucks, ships, airplanes

- Emissions, efficiency benefits
- Range, cost concerns

2. Mobility as a service (MaaS)

• Car/ride/bike/scooter sharing

3. Autonomous vehicles

- Safety, traffic benefits
- Unknown impact on total travel demand
- The end of private vehicles?
- More parking space?
- Shared or not shared?

Policy led transition

Consumer led transition

Industry led transition



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4. Artificial intelligence (AI)

Efficiency, new usages, new <u>technology</u> /<u>service</u>

Industry led transition

Policy led transition

Consumer led transition



Major Uncertainty III: Demand growth

- Huge uncertainty about China: China's LDV stock
- Will there be 90 million cars or 500 million cars in China by 2050?









e) Africa (AF)





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IAM/sectoral scenarios	Illustrative pathway
AM C1: 1.5°C lo OS	+ 2.0-GS
📕 IAM C2: 1.5°C hi OS	× 1.5-Ren
🔲 IAM C3: likely 2°C	 ModAct
IAM C4: below 2°C	¥ 1.5-Sup
HAM C5: <2.5°C	* 2.0-Sup
HAM C6: <3.0°C	 CurPol
📕 IAM C7: <4.0°C	> 2.0-Ren
IAM C8: >4.0°C	· 1.5-SP
G-/NTEM Policy	
G-/NTEM Reference	

e) Africa (AF)





The variations in the base years are just as large as

- the projected change in 40 years from a single model, and
- the range of variations in the future projections among models

Ea















arios.

Two big research questions in improving demand estimates:





How much will we travel in 30-50 years, globally?

How much do we travel today, globally?

Sonia Yeh, Chalmers University of Technology, Sweden



- Sound simple
 - The basis of any relevant disciplines: transport planning, infectious disease, infrastrcture development, energy supply, and climate mitigation policies.
- Are challenging and ambious



Existing gaps

- Insufficient data available to comprehensively characteristise today's global travel demand consistently across global regions; and
 - simulate individual mobility patterns based on unconventional data sources
- Insufficient theories to extrapolate today's global demand to the next 30 years.
 - estimate the travel demand at the macro level, aggregating individual trips to the population level.
- Research innovation is needed to understand the future of travel demands by bringing together mobility research at various scales.



Advances in Transport Modeling

Understand how we move from today to the future

• Describing, predicting and simulating emerging trends and patterns of **mobility** at various scales: city, region, country and global.

Identify effective policy solutions to get us from where we are today to where we want to be in the future

 Developing quantitative tools to evaluate policy options that support energy transitions Making projections is hard!

Prescribing solutions is even harder!!



Overall messages - Policies

- There has been a consistent expansion of policies and laws addressing mitigation since AR5.
- At least 18 countries have sustained production-based GHG and consumptionbased CO2 emission reductions for longer than 10 years.
 - Reductions were linked to energy supply decarbonisation, energy efficiency gains, and energy demand reduction, which resulted from both policies and changes in economic structure.



- H2020 STORM: modeling 100% electrification infrastrcture for long-haul trucks
 - Synthetic truck tours



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- H2020 STORM: modeling 100% electrification infrastrcture for long-haul trucks
 - Synthetic truck tours
 - · Impacts on the grid



Break locations (45 min parking) and **rest** locations (9 hours) aggregated to 25*25 km squares 24

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Synthetic Sweden Mobility (SysMo) model

Agent-based modeling

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- Synthetic Sweden Mobility (SysMo) model
 - Agent-based modeling
 - Follow the parking!

Work parkin-charing (intermediate)



Parked cars for Other (need charging): hour of day - 0

Other parkin-charing (fast)



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