Symposium on Sustainable Future Mobility

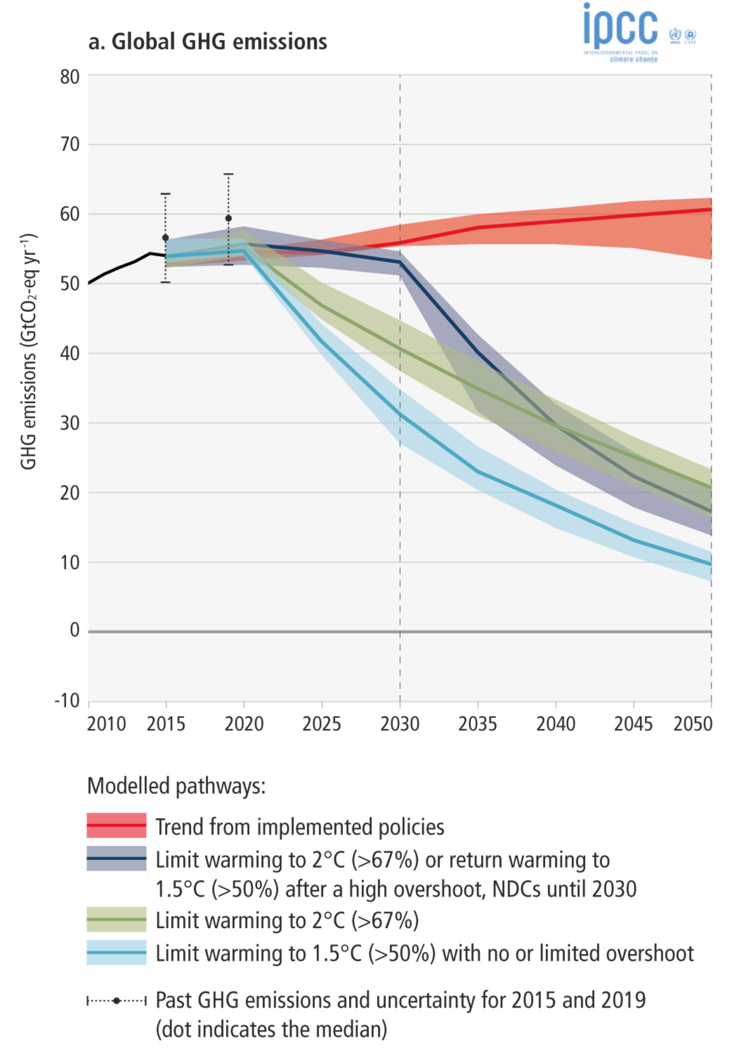
Mobility, Energy, and the Future of Transport emissions

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

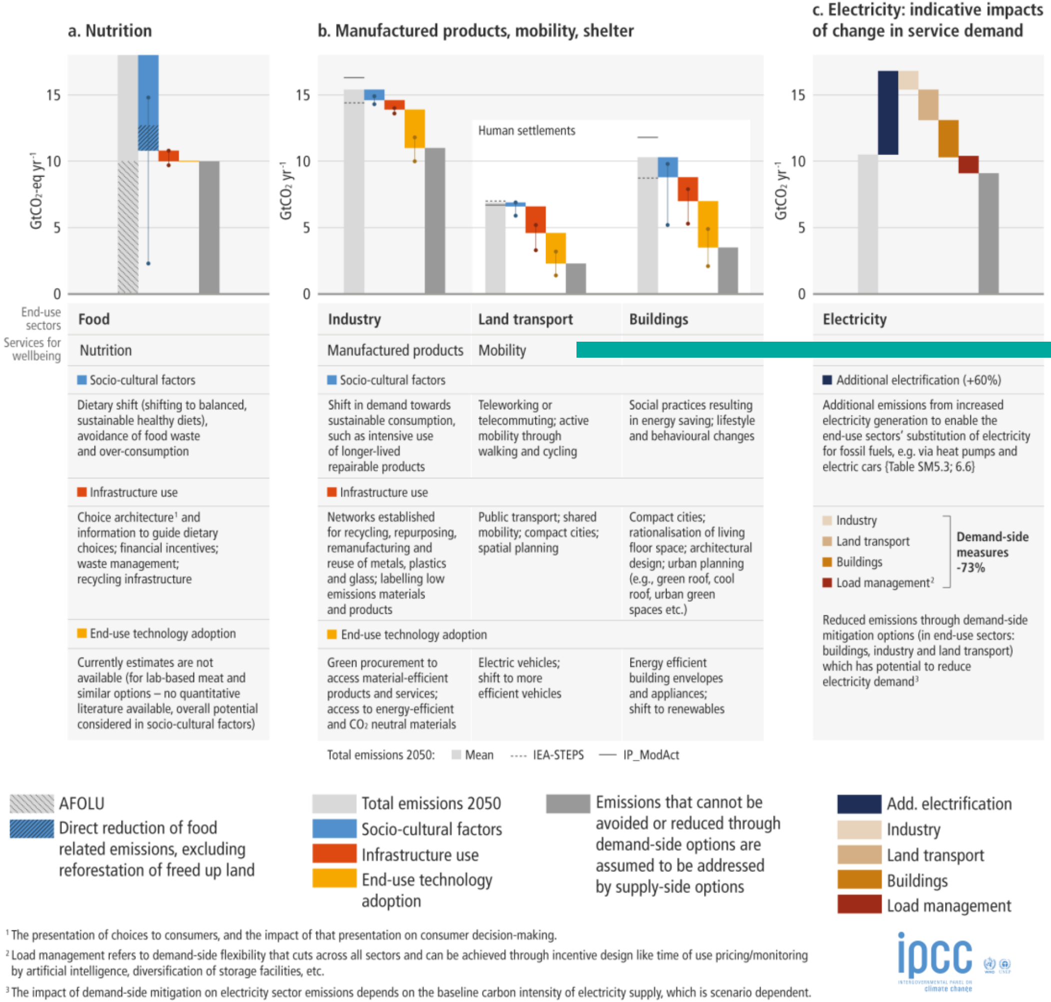


CHALMERS
UNIVERSITY OF TECHNOLOGY

Overall messages – Emissions and temperature rise

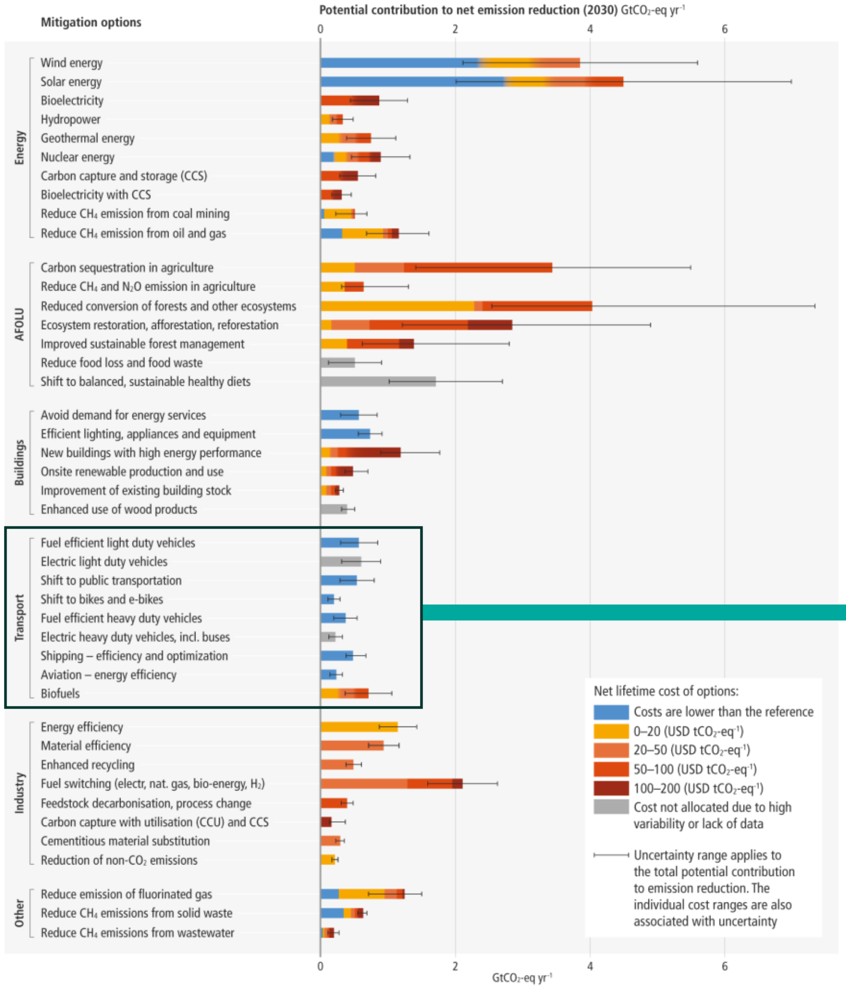
Projected global GHG emissions from NDCs announced prior to COP26 would make it likley that warmng will exceed 1.5C and also make it harder after 2030 to mitigate warming to below 2C

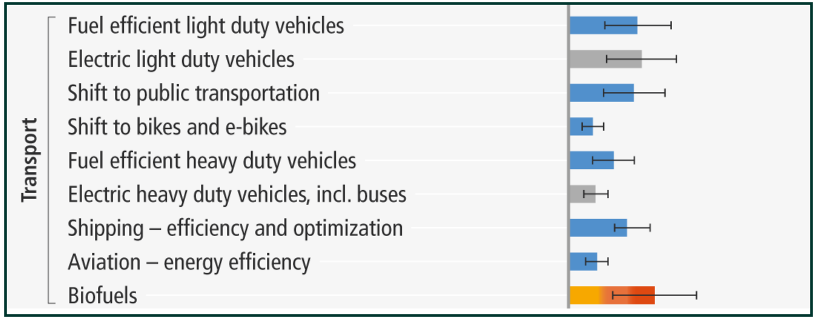
Demand-side mitigation can be achieved through changes in socio-cultural factors, infrastructure design and use, and end-use technology adoption by 2050.



CHALMERS UNIVERSITY OF TECHNOLOGY

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.





C.12 Mitigation options costing USD100 tCO_2e or less could reduce global GHG emissions by at least half the 2019 level by 2030 (high confidence).

Latest Carbon Prices

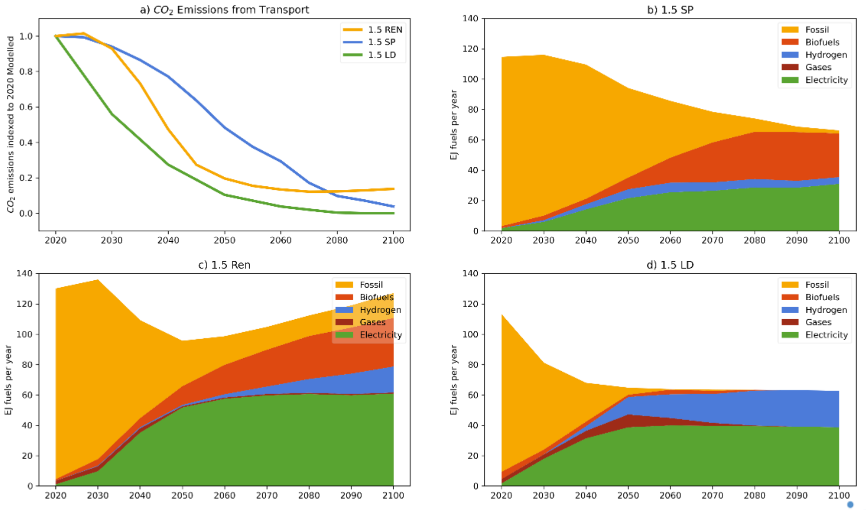
CarbonCredits.com Carbon Prices	Last
Compliance Markets	
European Union	€83.75
California	$31.12
Australia (AUD)	$29.00
New Zealand (NZD)	$75.90
South Korea	$16.26
Voluntary Markets	
Aviation Industry Carbon Offset	$5.63
Nature Based Carbon Offset	$10.63
Tech Based Carbon Offset	$4.61

https://carboncredits.com/?gclid=Cj0KCQjw37iTBhCWARIsACBt1IzGN9RSgMFrz6XVkRYTyobIHF4yuo9bo4EpChZZJLN9pQEnnJQifGwaAuuTEALw_wcB Accessed 1 May 2022

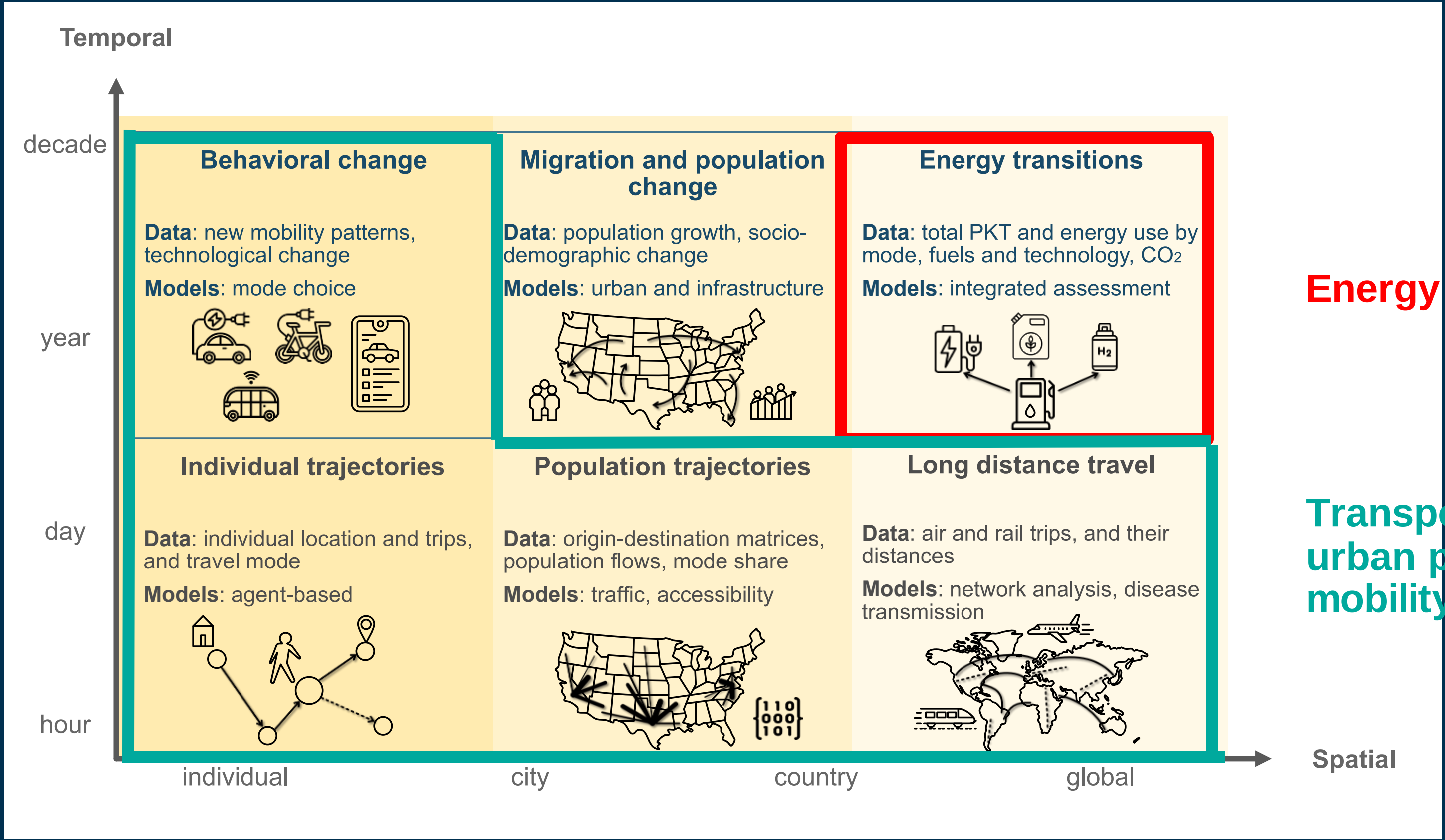
Q. Why has transport emissions continued to increase given the observed carbon prices?

- 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



Energy system models

Transport behaviour / urban planning mobility

Three building blocks for modelling the future of transport

Transitions

Transport systems play a critical role in achieving a sustainable future

- Several emerging trends may lead to a transition in transport sustainability
- But the future is highly uncertain, depending on the development of **demand**, **consumer choice** and **technology**

Policies

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

Data

is the new oil

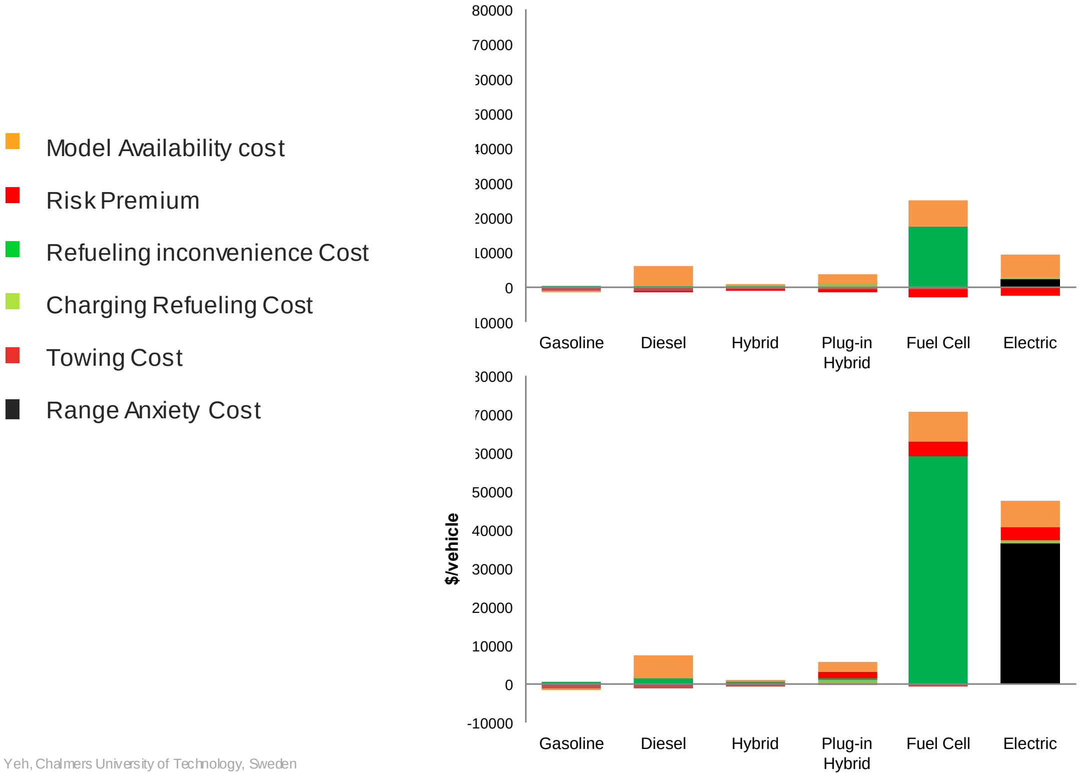
New research frontier: Big Data, Machine learning and AI

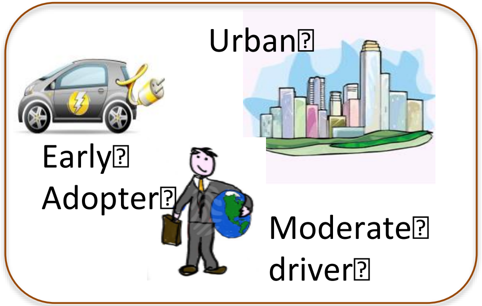
- Many challenges in using Big Data effectively
- But, the potentials for drastically improving understanding and management of future systems are limitless!

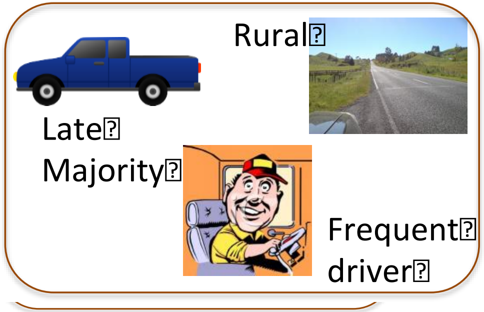
Major Uncertainty I: Consumer Choice

- **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







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

1. Electric vehicles, trucks, ships, airplanes
- Emissions, efficiency benefits
- Range, cost concerns

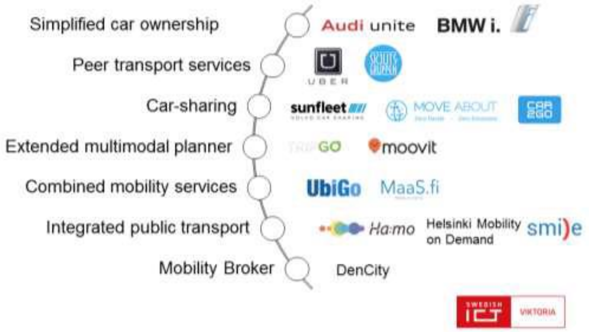
2. Mobility as a service (MaaS)
- Car/ride/bike/scooter sharing

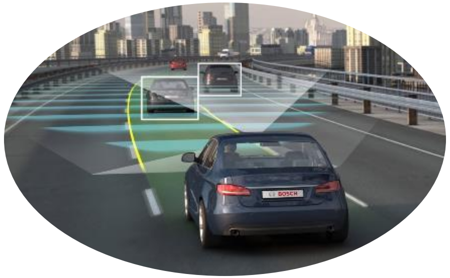
3. Autonomous vehicles
- Safety, traffic benefits
- Unknown impact on total travel demand
- The end of private vehicles?
- More parking space?
- Shared or not shared?

Policy led transition

Consumer led transition

Industry led transition





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

CHALMERS
UNIVERSITY OF TECHNOLOGY

1. Electric vehicles, trucks, ships, airplanes

- Emissions, efficiency benefits
- Range, cost concerns

Industry led transition

2. Mobility as a service (MaaS)

- Car/ride/bike/scooter sharing

Policy led transition

3. Autonomous vehicles

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

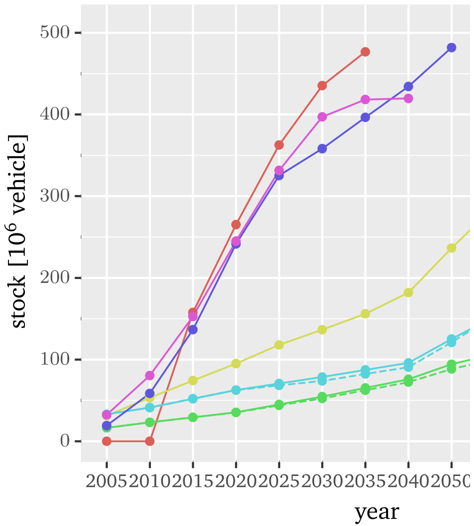
Consumer led transition

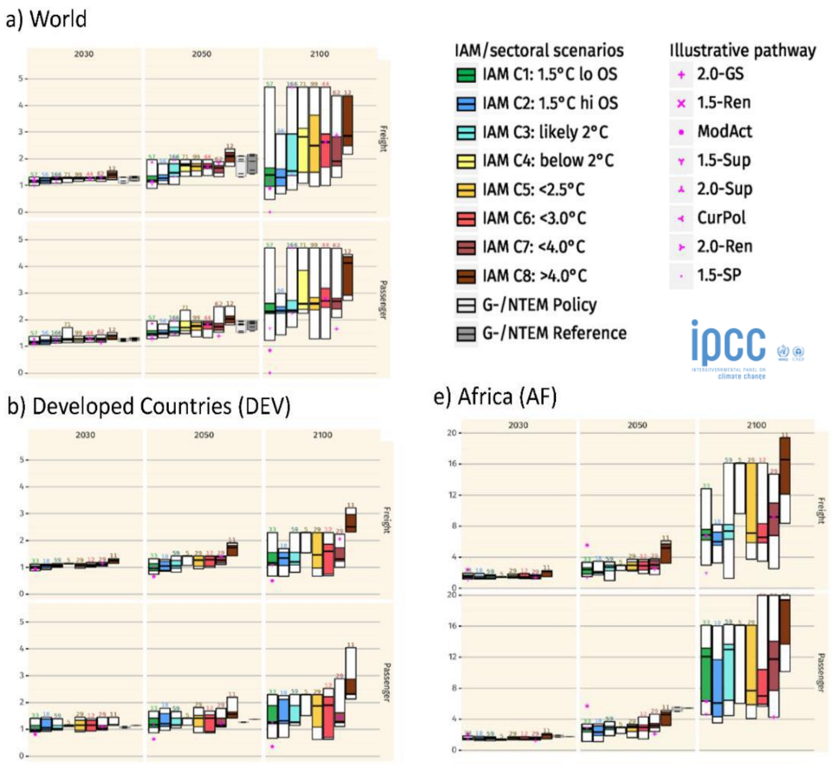
4. Artificial intelligence (AI)

- Efficiency, new usages, new *technology* /*service*

Major Uncertainty III: Demand growth

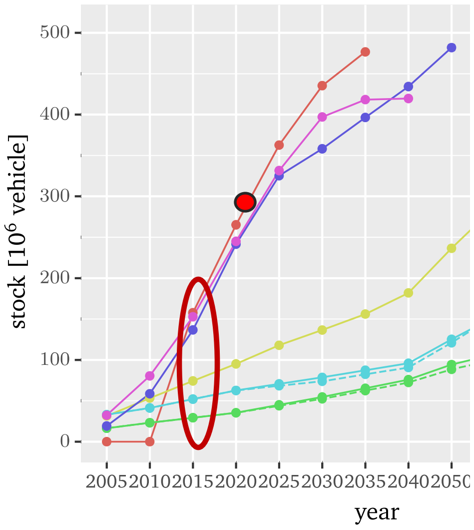
- Huge uncertainty about China: China's LDV stock
- Will there be 90 million cars or 500 million cars in China by 2050?

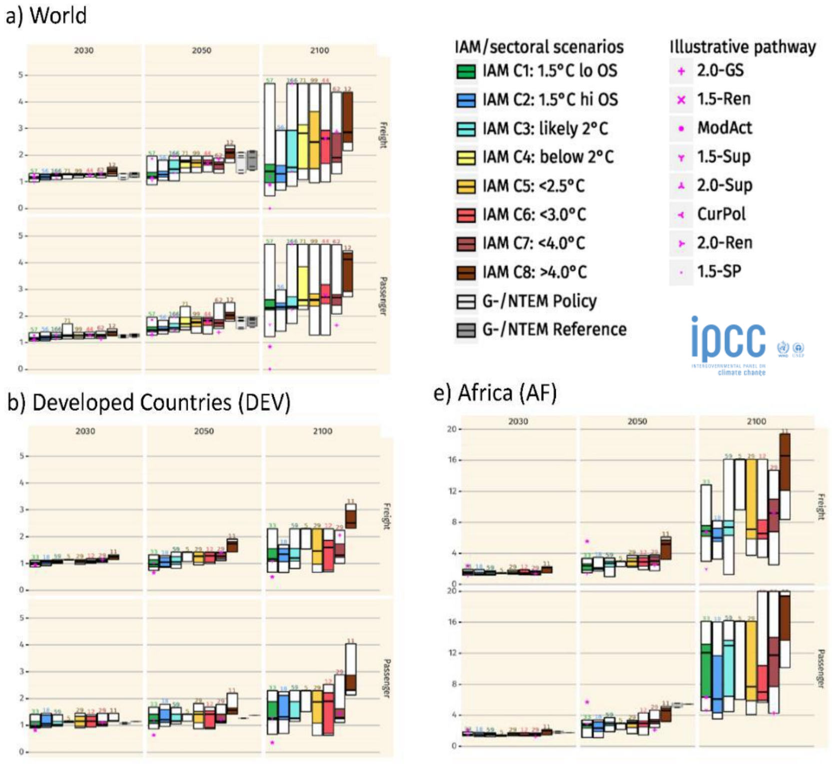




Major Uncertainty III: Demand growth

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

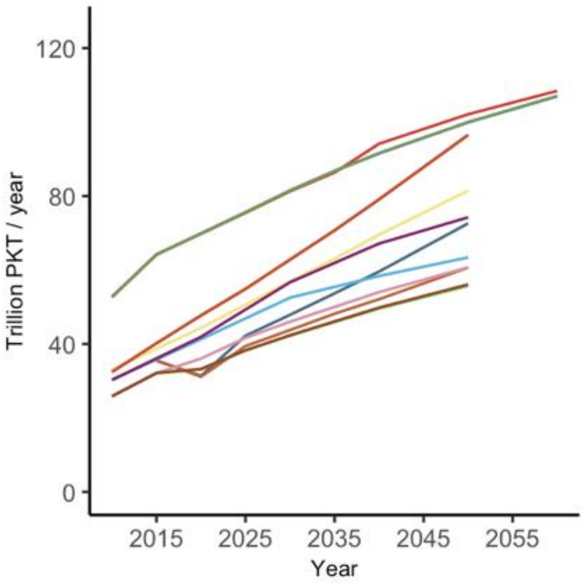


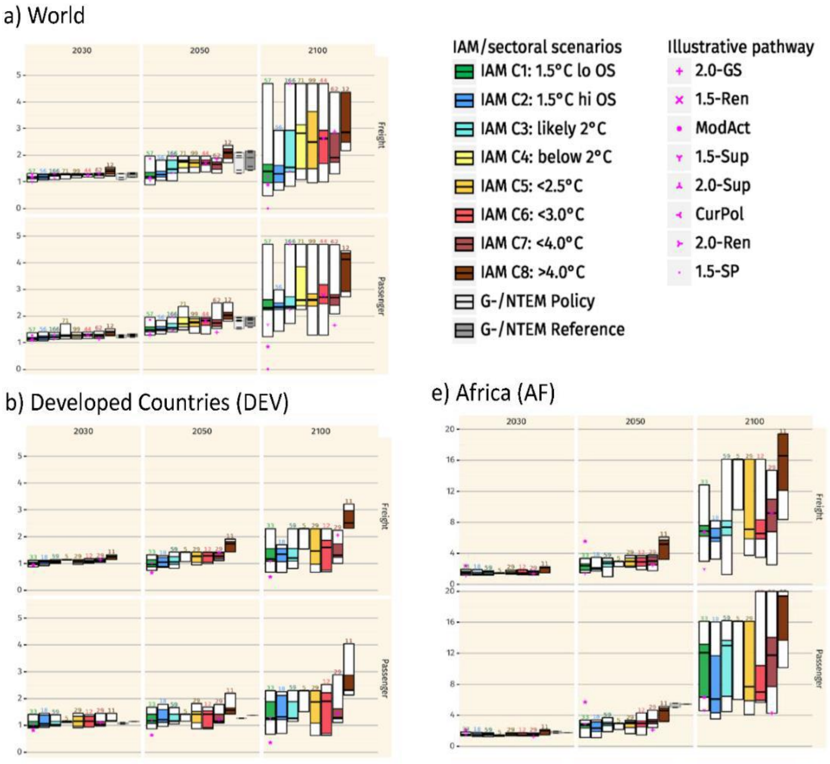


Sonia Yeh, Chalmers University of Technology, Sweden

The variations in the base years are just as large as

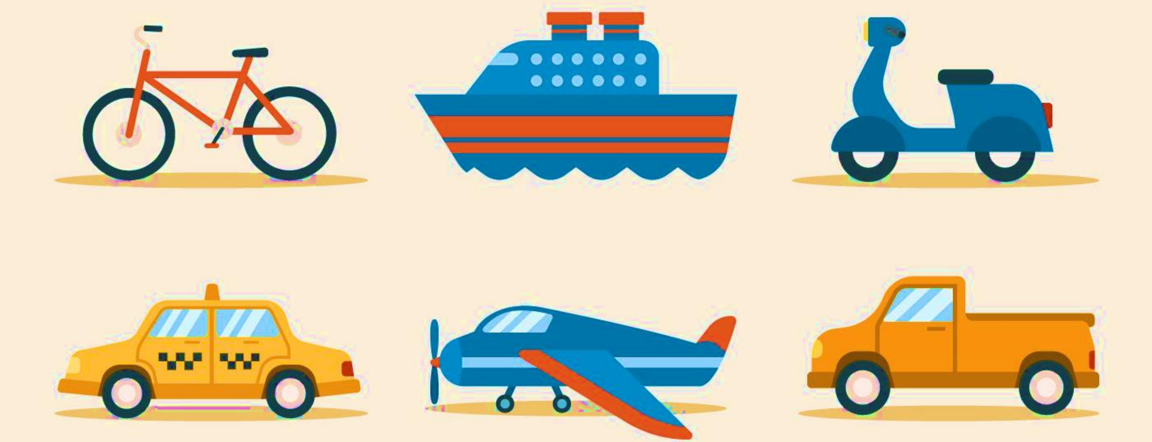
- the projected change in 40 years from a single model, and
- the range of variations in the future projections among models





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?

- 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* avaiable to comprehensively characterstise 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.*

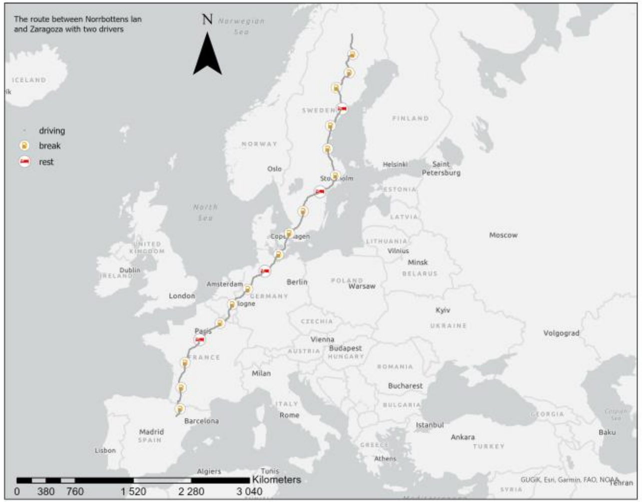
- *At least 18 countries have sustained production-based GHG and consumption-based CO2 emission reductions for longer than 10 years.*
    - *Reductions were linked to energy supply decarbonisation, energy efficiency gains, and energy demand reduction, which resulted from both policies and changes in economic structure.*

Ongoing research projects in our Transport and Energy System TES group

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

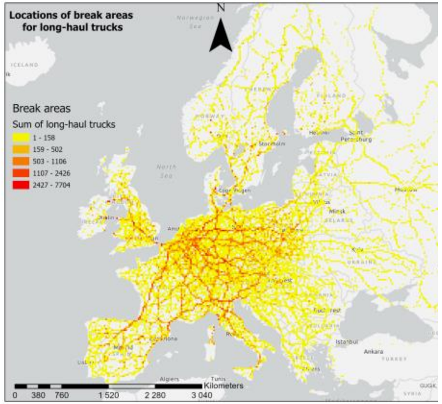
Ongoing research projects in our Transport and Energy System TES group

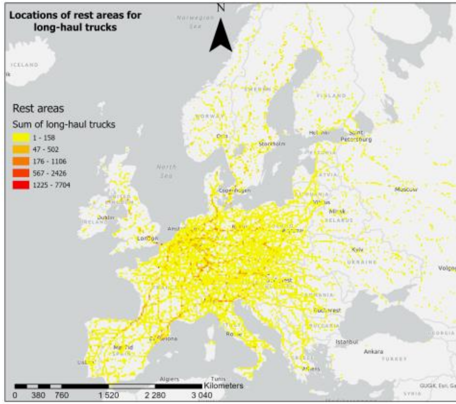
- **H2020 STORM: modeling 100% electrification infrastrcture for long-haul trucks**
  - Synthetic truck tours



Ongoing research projects in our Transport and Energy System TES group

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



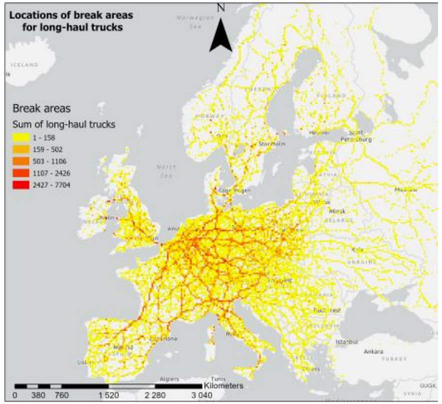


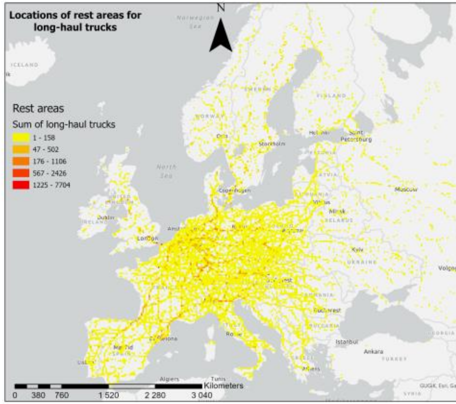
Break locations (45 min parking) and **rest** locations (9 hours) aggregated to 25*25 km squares

Ongoing research projects in our Transport and Energy System TES group

- **Synthetic Sweden Mobility (SysMo) model**
  - **Agent-based modeling**

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





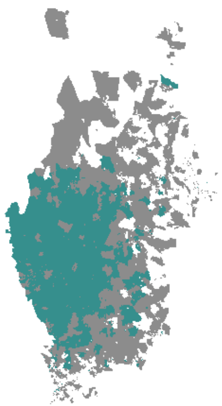
Break locations (45 min parking) and **rest** locations (9 hours) aggregated to 25*25 km squares

Ongoing research projects in our Transport and Energy System TES group

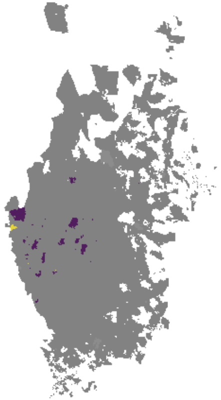
- Synthetic Sweden Mobility (SysMo) model
  - Agent-based modeling
  - Follow the parking!

Work parkin-charing (intermediate) Other parkin-charing (fast)

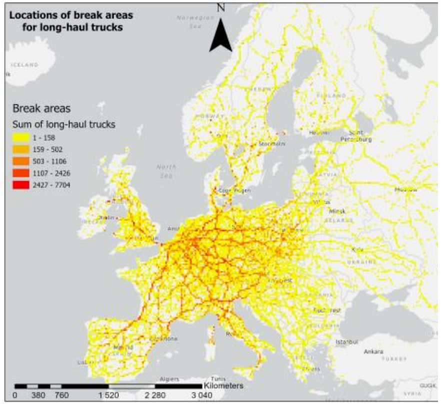
Parked cars for Work (need charging): hour of day -

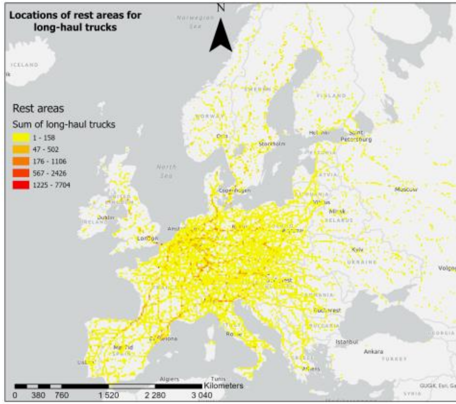


Parked cars for Other (need charging): hour of day - 0



- 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

AVANCEZ

1829

CHALMERS

UNIVERSITY OF TECHNOLOGY