Transport facing the challenge of energy transition

Explorations between the past and the future, technology and sufficiency, acceleration and slowdown

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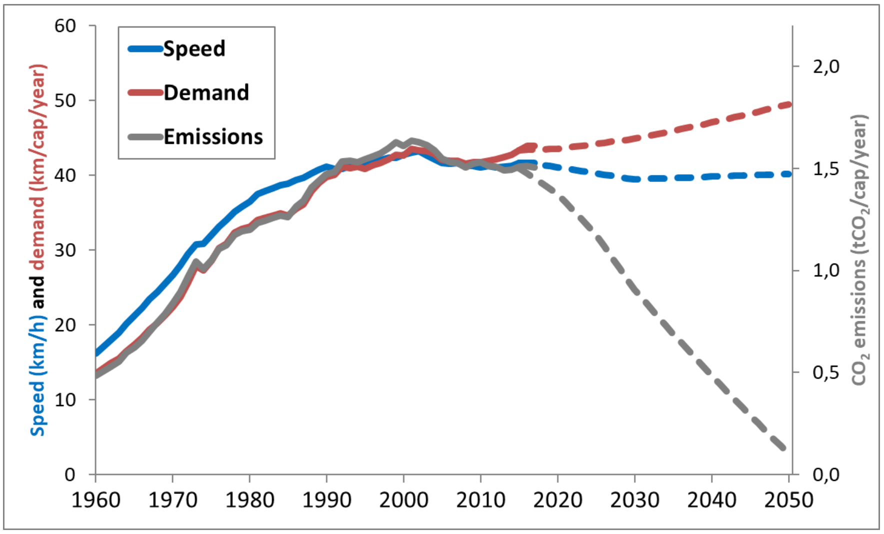
<u>Scope:</u> passenger and freight transports, in France, mainly from 1960 to 2050.
<u>Main challenges of the energy transition for transport:</u> climate change, a systemic issue of global scope; **air pollution**, a local public health issue; **oil dependence**, a resilience issue.
<u>Problem:</u> How to align the transport sector with the objective of **carbon neutrality** in France by 2050?
<u>Thesis outline:</u> chapters 1 and 2 explore **transport emissions trajectories** from 1960 to 2050 (between past and future), chapter 3 focuses on passenger mobility **speed** (between acceleration and slowdown), and chapter 4 deepens the analysis of **levers** and **public policies** (between technology and sufficiency).

The 4 key takeaways and contributions to the literature



Evolution of average speed, distances and individual emissions from 1960 to 2050
CO_2 emissions including biofuels, 2015-2050 projections based on the SNBC (see point 3 below)

1) Historical link between speed, distances and CO_2

The 3 curves on the left are very close from 1960 to 2017.
The average **speed** of travel has increased sharply and has led to an increase in **distances** traveled per person, due to a constant transport time of approximately 1 hour/person/day.
At the same time, the average emissions per km only marginally decreased, explaining the link between transport demand and **CO_2 emissions**.

2) The peak of the 3 variables in the early 2000s

The increase in speed, driven by a modal shift from walking towards the car, peaked in the early 2000s, under the effect of the slowdown of the car fleet growth, fuel prices increases, and speed gauges on the roads.
The **end of the acceleration of mobility** led to a cap on distances per person (excluding international air travel), and a slight drop in emissions per person, because for 25 years, emissions per km have been falling at the rate of **-0.5%/year**. The effect of **environmental public policies** in these trends appears to be very weak.

3) The bet and the challenge of a strong decoupling between demand and emissions by 2050

The national low-carbon strategy (SNBC in French) targets a sharp drop in emissions in the coming years, while kilometers per person continue to increase, showing a strong decoupling compared to the past.
The strategy thus plans a reduction in emissions per kilometer of -3.8%/year over 2015-2030 (compared to -0.5%/year for the previous 25 years), mainly through progress in energy efficiency which in reality has slowed down between 2015 and 2019, pointing to the risk of exceeding the next carbon budgets. After 2030, the strategy still relies heavily on technological advances, through the reduction in the carbon intensity of energy.
These observations on decoupling are also valid for the climate strategy of freight transport.

4) The need to combine a strong ambition on technology AND sufficiency

Technological progress is essential to reach the transport climate targets. However, they are insufficient, and face significant barriers, linked in particular to the cost of technologies, the pace of their diffusion, sometimes the limited resources for scalability, or the increase in other environmental impacts.
Sufficiency can help to remove these barriers. Although public policies show little ambition, a strong push on sufficiency policies would allow approximately a division by 2 of energy consumption, compared to the trend.
The barriers here regard most specifically acceptability, behaviors or employment impacts in some sectors.
In addition, many changes in sufficiency go in the direction of slowing down mobility.

The 5 decarbonization levers: what lessons for public policies?

The **national low carbon strategy** identifies 5 drivers to decarbonize the transport sector. Their past trends, their potential by 2050, as well as the associated public policies are mentioned below for each transition lever. For the main changes mentioned in the prospective scenarios, the table at the bottom of the page summarizes qualitatively: the associated **emissions reduction** potential, the social and environmental **benefits and impacts** (consumption of resources, congestion, noise, physical inactivity, road safety, etc.), and the ease of **implementation** (costs, acceptability, behaviors, speed of implementation, etc.) of these changes.

CO_2 = Transport demand × Modal shift × Load factor × Energy efficiency of vehicles × Carbon intensity of energy

Transport demand	**Past:** transport demand has been the main driver of emissions. **Potential by 2050:** growth in trend-based scenarios, up to -10 to -25% for ambitious scenarios. **Public policies:** it is above all a question of changing the objective, to aim for the moderation of demand, and no longer its support at all costs and for all modes; need for actions on land use planning, behaviors, reduction in traffic of modes that are difficult to decarbonize.
Modal shift	**Past:** mainly contributed to the increase in emissions through the shift to road transports. **Potential by 2050:** -20% on emissions, provided that total demand is moderated; greatest potential on bicycles and rail transport (night trains, freight, etc.). **Public policies:** besides support for low-carbon modes, a strong modal shift requires constraints (taxation, speed, infrastructure, etc.) on air travel, cars and heavy goods vehicles.
Load factor	**Past:** increased for most modes, but decreased for cars due to the growth in car ownership. **Potential by 2050:** a direct potential of approximately -15%, but subject to rebound effects. **Public policies:** carpooling should be developed as a priority for daily commutes in rural and peri-urban areas, where the rebound effects on demand and modal shift would be weak.
Energy efficiency	**Past:** main factor driving emissions reductions for the majority of transport modes. **Potential by 2050:** main lever in the short term through efficiency gains for internal combustion engines, which are increasingly difficult to reach; then progress via electrification of vehicles. **Public policies:** in addition to technical progress to be encouraged, it is necessary to implement sufficiency measures by reducing the weight of vehicles and speeds on the roads.
Carbon intensity of energy	**Past:** little progress, as oil remains predominant; biofuels growth without any significant benefit. **Potential by 2050:** major lever in all ambitious scenarios; some technologies (electricity, biogas, hydrogen, biofuels) are still uncertain for many modes (air, heavy goods vehicles, maritime in particular); importance to analyze the overall life cycle of the technologies developed. **Public policies:** to maximize benefits, prioritize electrification towards light vehicles (bicycles, light cars, intermediate vehicles) and combine it with sufficiency measures.

Qualitative analysis of the impact of various changes on CO_2 emissions, transport externalities, and ease of implementation

Impact	
dark green	Positive
green	Positive
light green	Positive
yellow	Neutral
orange	Negative
red	Negative
?	Uncertain

	Transport demand					Modal shift							Load factor		
	Densification	- Urban sprawl	Teleworking	Proximity	Local prod. & cons.	+ Buses & coaches	+ Train	+ Biking	- Planes	- Cars	+ Rail & river freight	- Road freight transport	Carpooling	Carsharing	Trucks load
CO_2 EMISSIONS	light green	light green	light green	light green	light green	yellow	green	green	dark green	green	light green	green	green	light green	yellow
EXTERNALITIES	yellow	light green	yellow	green	green	green	green	dark green	green	green	green	green	green	green	yellow
IMPLEMENTATION	yellow	yellow	light green	green	green	yellow	yellow	light green	orange	orange	yellow	yellow	yellow	yellow	yellow

	Energy efficiency					Carbon intensity							
	↓ vehicle mass	↓ speed, intercity	↓ speed, urban roads	Eco-driving	Engine efficiency	Electric	Biofuels	Gas	Biogas	Hydrogen	Carbon tax	SUFFICIENCY	TECHNOLOGY
CO_2 EMISSIONS	green	green	light green	light green	green	dark green	light green	yellow	green	light green	dark green	dark green	dark green
EXTERNALITIES	green	green	green	green	light green	yellow	orange	yellow	yellow	yellow	light green	dark green	yellow
IMPLEMENTATION	yellow	yellow	yellow	yellow	light green	light green	light green	light green	yellow	yellow	orange	yellow	yellow

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