Health and climate benefits of shifting from car to cycling

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Outline

Works on Ile-de-France

1. Air pollution and CO_2 from daily mobility: Who emits and Why? Evidence from Paris
   - published in *Energy Economics*
2. Tackling Car Emissions in Urban Areas: Shift, Avoid, Improve
   - published in *Ecological Economics*

Works on France

1. The untapped health and climate potential of cycling in France: a national assessment from individual travel data
   - published in *Lancet Regional Health – Europe*
2. Assessing the Health Benefits of Physical Activity Due to Active Commuting in a French Energy Transition Scenario
   - published in *International Journal of Public Health*
3. Different pathways toward net-zero emissions imply diverging health impacts: a health impact assessment study for France
   - preprint on MedRxiv

Air pollution and CO_2 from daily mobility: Who emits and Why? Evidence from Paris

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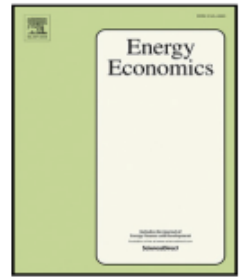

Air pollution and CO_2 from daily mobility: Who emits and Why? Evidence from Paris

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[b] *CIRED, France*
[c] *CNRS, France*

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ABSTRACT

Urban road transport is an important source of local pollution and carbon emissions. Designing effective and fair policies tackling these externalities requires understanding who contributes to emissions today. We estimate individual transport-induced pollution footprints combining a travel demand survey from the Paris area with NOx, $PM_{2.5}$ and CO_2 emission factors. We find that the top 20% emitters contribute 75%–85% of emissions on a representative weekday. They combine longer distances travelled, a high car modal share and, especially for local pollutants, a higher emission intensity of car trips. Living in the suburbs, being a man and being employed are the most important characteristics associated with top emissions. Among the employed, those commuting from suburbs to suburbs, working at a factory, with atypical working hours or with a manual, shopkeeping or top executive occupation are more likely to be top emitters. Finally, policies targeting local pollution may be more regressive than those targeting CO_2 emissions, due to the different correlation between income and the local pollutant vs. CO_2 emission intensity of car trips.

Background: the Paris area

NO_2:

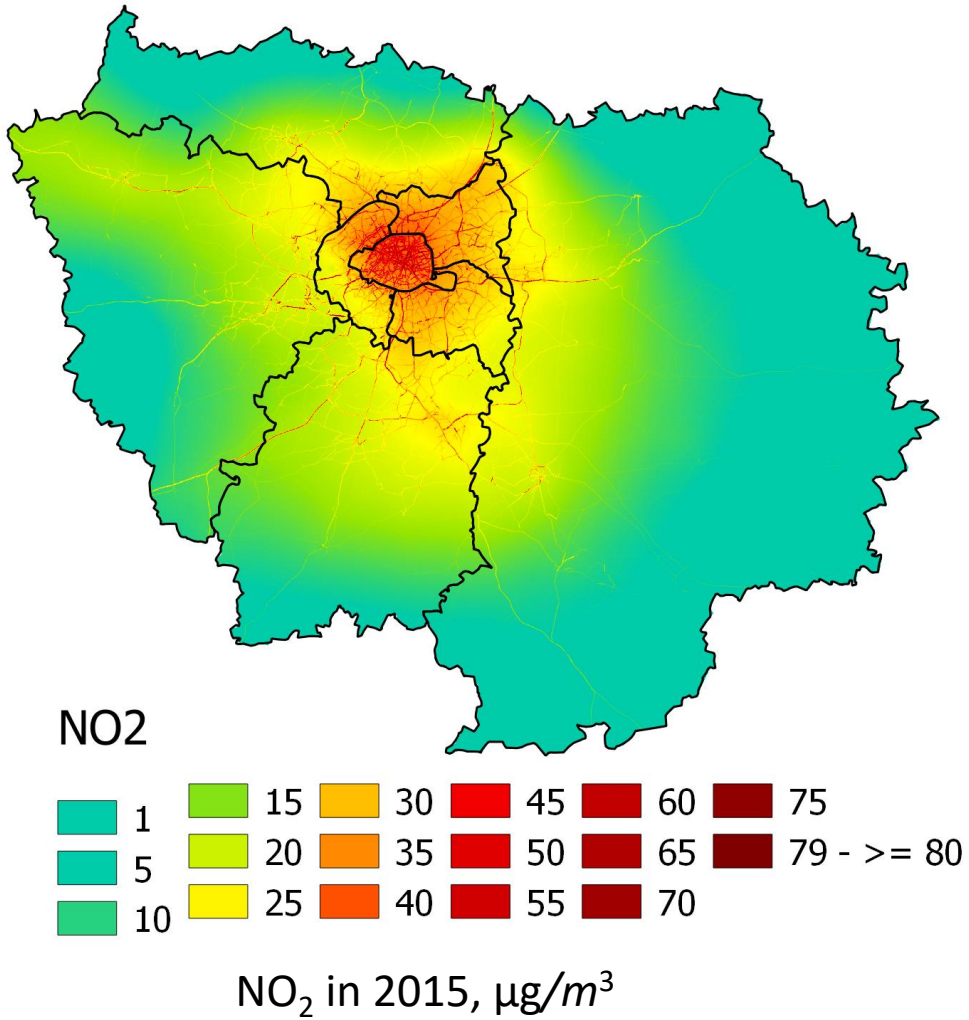
- Legal threshold 40 µg/m^3
- WHO recommandation: 10 µg/m^3
- Road trafic: 53% of emissions

$PM_{2.5}$:

- WHO recommandation: 5 µg/m^3
- Road trafic: 19% of primary emissions

Low-emission zone (ZFE):

- Ban on cars inside A86, based on euro-x class
- Postponed many times



NO_2 in 2015, µg/m^3

Data: Enquête générale transports (EGT)

We use the EGT 2010

- 35,175 individuals from 14,885 households
- On a representative weekday

Our subsample:

- Adults having made at least one trip (N=23,690), 101,950 trips
- One trip may involve several transport modes

Scenario subsample:

- 12,595 individuals who used a car
- 45,897 car trips

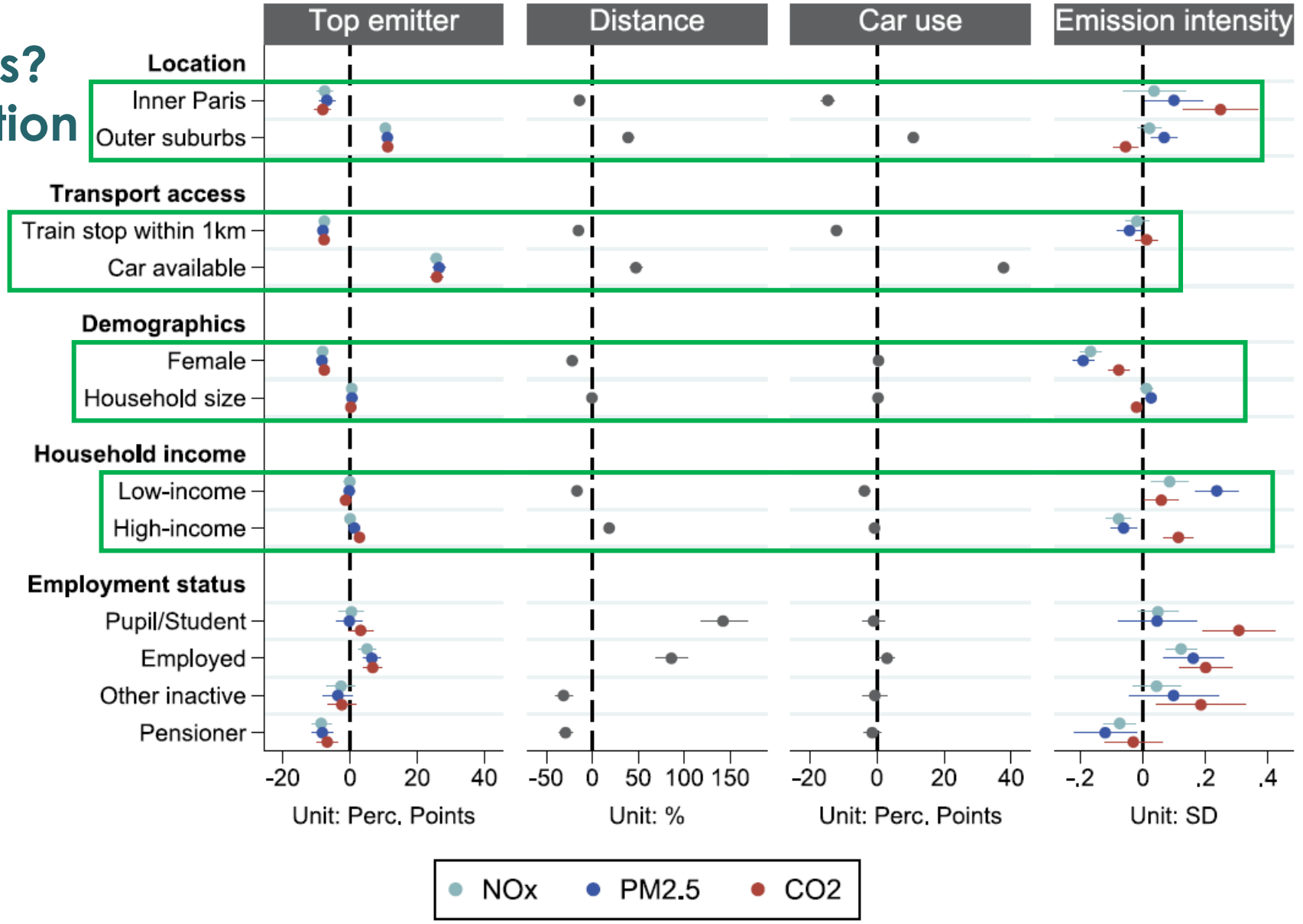
EGT 2020:

- Only 4,800 households
- Modal shares did not change much (cars 38% → 34%)

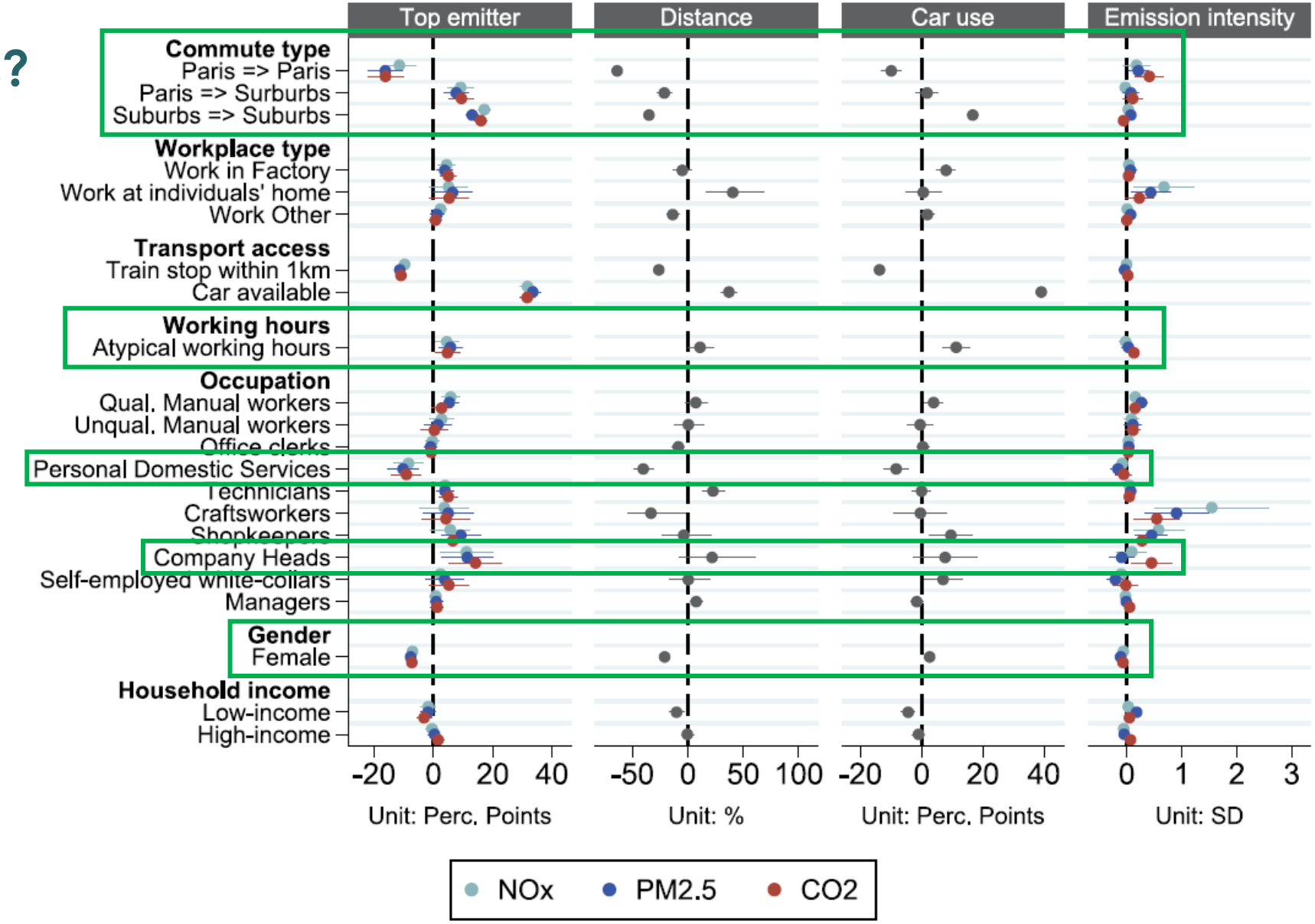
Who are the top emitters? Part 1 – general population

- The top emitters (20% of the population) contribute ~80% of NO_X, CO_2 & $PM_{2.5}$ from transportation

- Decomposition of emissions in 3 factors:
  - distance,
  - modal choice,
  - emission intensity.



Who are the top emitters? Part 2 – individuals in employment



Tackling Car Emissions in Urban Areas: Shift, Avoid, Improve

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Analysis

Tackling Car Emissions in Urban Areas: Shift, Avoid, Improve

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ABSTRACT

Car use imposes costly environmental externalities. We investigate to what extent car trips could be shifted to low-emission modes, avoided via teleworking, or improved via a transition to electric vehicles in the context of daily mobility in the Paris area. We derive counterfactual travel times for 45,000 car trips from a representative transport survey, and formulate modal shift scenarios including a maximum acceptable increase in travel time. For a daily travel time increase below 10 min, 46% of drivers could shift to e-bike – mostly – or public transit – rarely –, with half of them benefiting from a travel time decrease. Such modal shift would reduce daily mobility emissions by 15% and generate annual climate and health benefits worth €125 million. Factors such as living in the far suburbs, being male, or having a high income, are associated with inability to shift modes. Teleworking two days a week could save an additional 5% of emissions. Holding demand for mobility and public transport infrastructure fixed, greater emission reductions require improving cars' environmental performance via a transition to electric vehicles.

Additional data

Counterfactual travel time data

- Google Console Directions API
- For each trip, gives the time it would take by public transport, cycling, and driving
- E-bikes: multiply cycling time by 15/19

Charging stations for Electric Vehicles

- Aim: identify households with charging station ≤ 500 meters of their home
- Sources: OpenStreetmap, National & municipal open data service

Emission factors

- NO_X, $PM_{2.5}$ & CO_2, Including cold starts for NO_X & $PM_{2.5}$
- Calculated at the journey stage level
- Vehicle-specific emission factor for cars

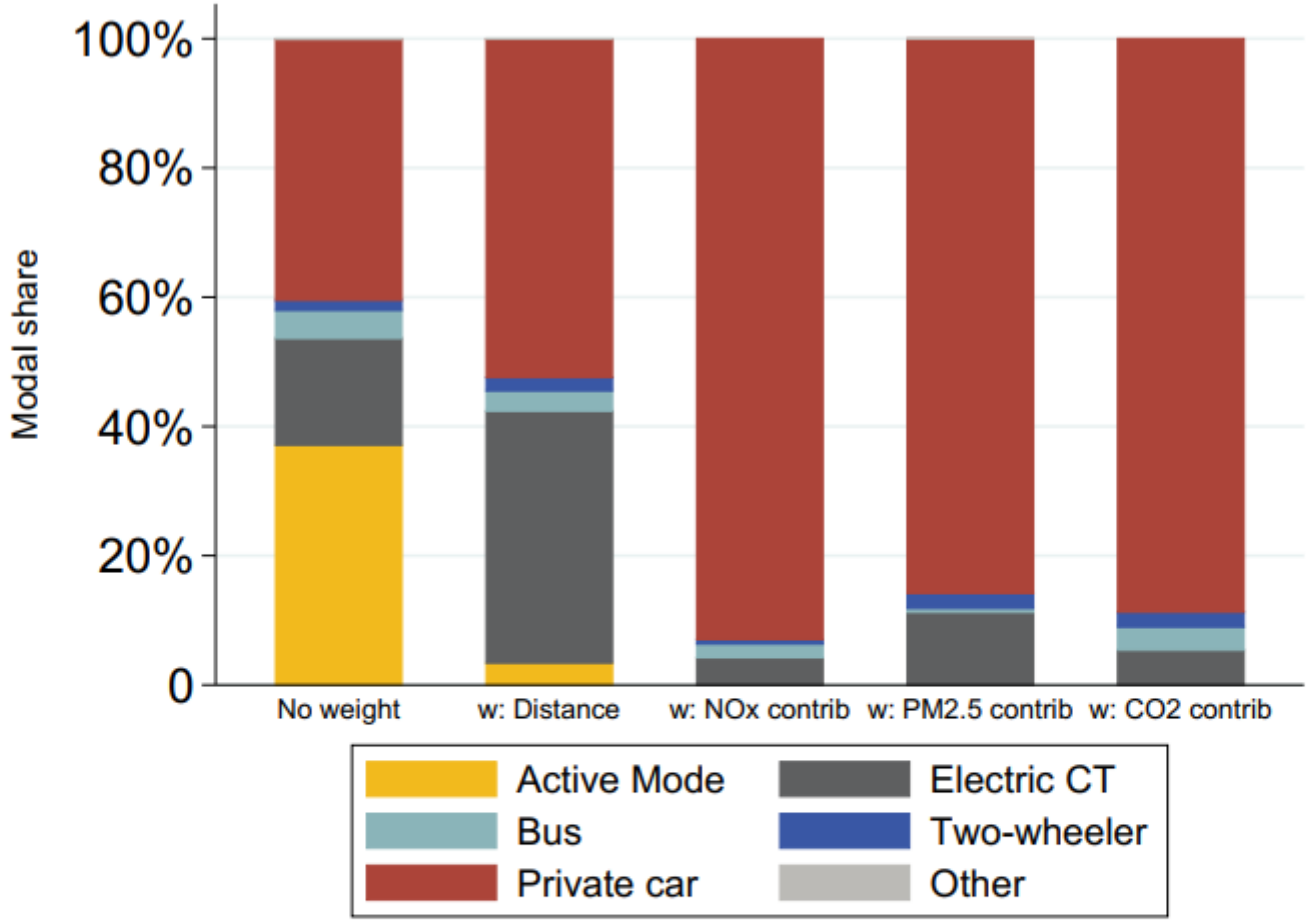


Figure 2: Modal shares in the number of trips, distances travelled and emissions

Note: the first bar chart shows the proportion of each mode in the number of trips, the second shows the proportion as a share of total distances driven, the third as a share of NOx emissions, the fourth as a share of $PM_{2.5}$ emissions, and the fifth as a share of CO_2 emissions. Source: Authors' calculation based on EGT data. Sample: all trips made by individuals aged 18 and over. Individual sample weights included.

Modal shift scenarios

Aim: identify car trips that could be substituted with e-bike or public transit, under constraints on

- the travel time difference between car and the substitute mode,
- the type of trip,
- only for e-biking, the individual's age

Analysis at the « trip-chain » level: set of trips between leaving home and coming back

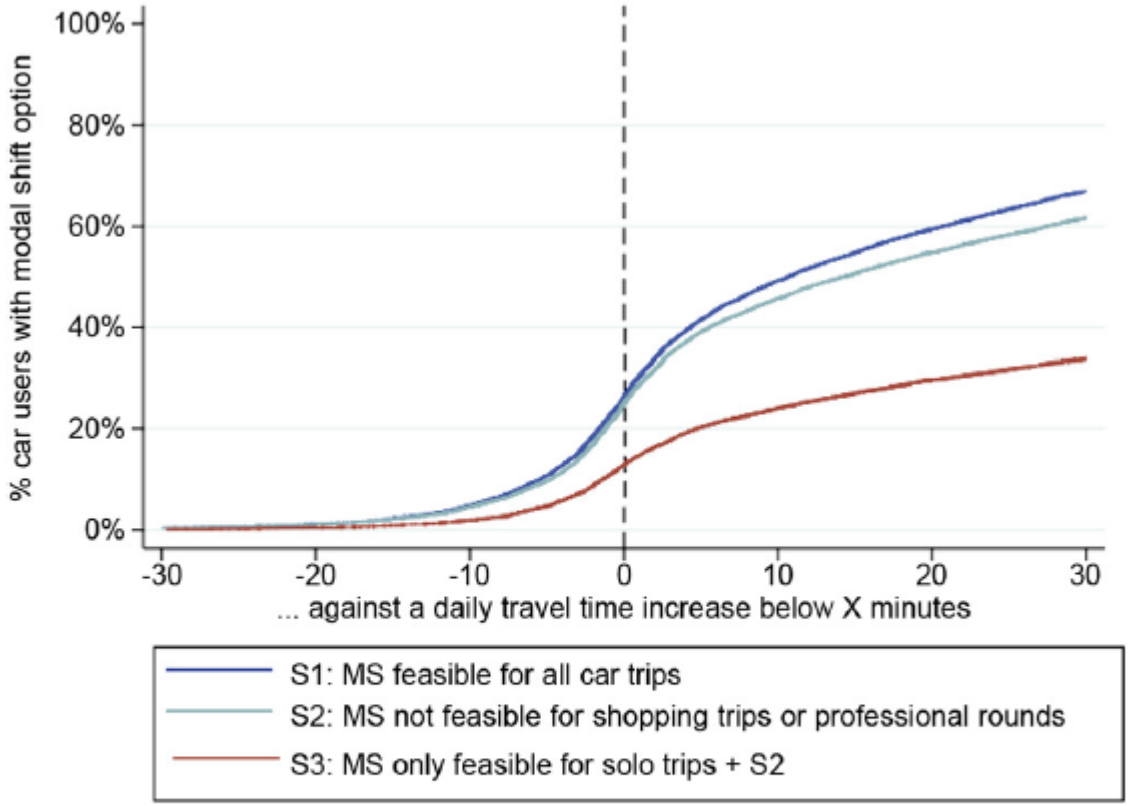
Three scenarios, with increasingly strict constraints

Table 2
The three scenarios considered.

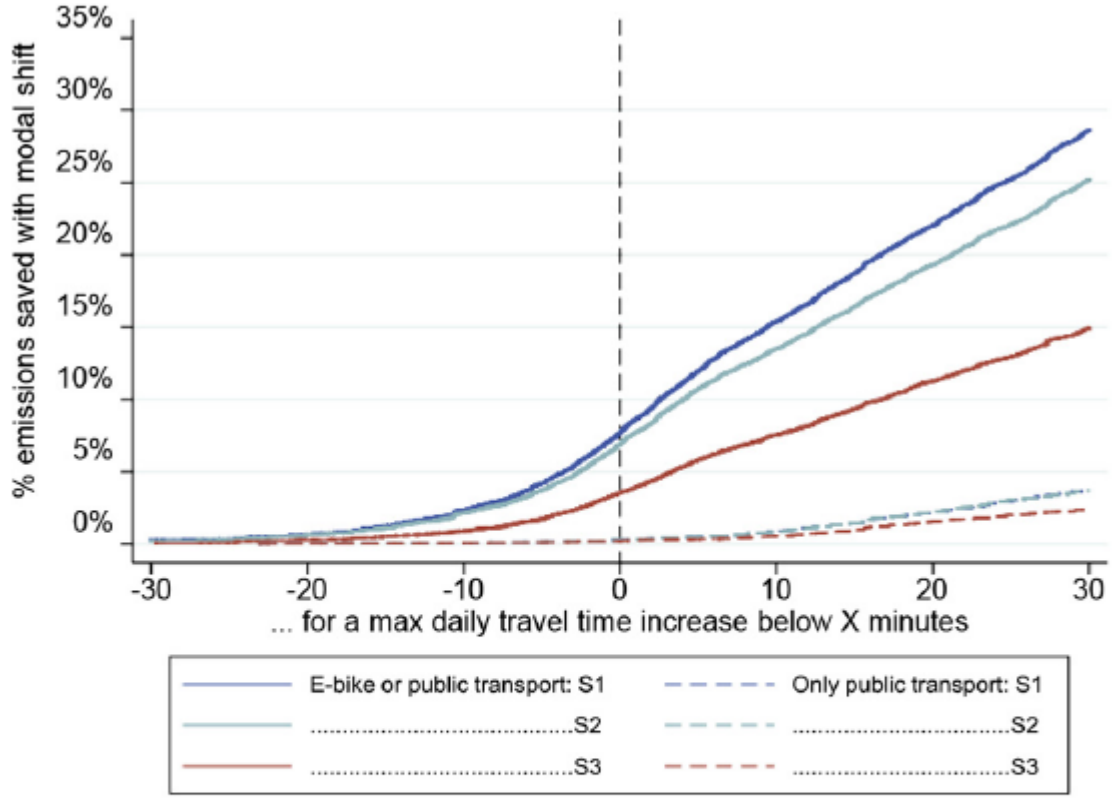
	Scenario 1	Scenario 2	Scenario 3
Trip chains for which modal shift is possible	All	All but those including work-related driving rounds & car trips for grocery shopping	All but those including work-related driving rounds & car trips for grocery shopping & trips with >1 passengers
Age constraint for e-biking	≤ 70	≤ 70	≤ 70

In scenario 2, for a daily travel time increase below 10 min,

- 46% of drivers could shift to e-bikes – mostly – or public transit – rarely
- with half benefiting from a travel time decrease.
- Such a modal shift would reduce daily mobility emissions by 15%.



(a) Share of car users that can shift and corresponding daily travel time increase



(b) Share of emissions saved and associated increase in daily travel time: low contribution of public transport

Fig. 5. Share of car users able to shift and emissions saved by scenario.
(Source: EGT data with individual sampling weights. MS: modal shift; S1: Scenario 1; S2: Scenario 2; S3: Scenario 3.)

OECD, 21 March 2024

The untapped health and climate potential of cycling in France: a national assessment from individual travel data

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The untapped health and climate potential of cycling in France: a national assessment from individual travel data

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[e]Centre International de Recherche sur l'Environnement et le Développement (CIRED), Centre National de la Recherche Scientifique (CNRS), Nogent-sur-Marne, France
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Summary

Background Promoting active modes of transportation such as cycling may generate important public health, economic, and climate mitigation benefits. We aim to assess the mortality and morbidity impacts of cycling in a country with relatively low levels of cycling, France, along with associated monetary benefits. We further assess the potential additional benefits of shifting a portion of short trips from cars to bikes, including projected greenhouse gas emissions savings.

Methods Using individual data from a nationally representative mobility survey, we described the French 2019 cycling levels by age and sex. We conducted a burden of disease analysis to assess the incidence of five chronic diseases (breast cancer, colon cancer, cardiovascular diseases, dementia, and type-2 diabetes) and the number of deaths prevented by cycling, based on national incidence and mortality data and dose–response relationships from meta-analyses. We assessed the corresponding direct medical cost savings and the intangible costs prevented based on the value of a statistical life year. Lastly, based on individual simulations, we assessed the likely additional benefits of shifting 25% of short (<5 km) car trips to cycling.

Findings The French adult (20–89 years) population was estimated to cycle on average 1 min 17 sec $pers^{-1}$ day^{-1} in 2019, with important heterogeneity across sex and age. This yielded benefits of 1,919 (uncertainty interval, UI: 1,101–2,736) premature deaths and 5,963 (UI: 3,178–8,749) chronic disease cases prevented, with males reaping nearly 75% of these benefits. Direct medical costs prevented were estimated at €191 million (UI: 98–285) annually, while the corresponding intangible costs were nearly 25 times higher (€4.8 billion, UI: 3.0–6.5). We estimated that on average, €1.02 (UI: 0.59–1.62) of intangible costs were prevented for every km cycled. Shifting 25% of short car trips to cycling would yield approximatively a 2-fold increase in deaths prevented, while also generating important CO_2 emissions reductions (0.257 MtCO2e, UI: 0.231–0.288).

Interpretation In a country with a low- to moderate-cycling culture, cycling already generates important public health and health-related economic benefits. Further development of active transportation would increase these benefits while also contributing to climate change mitigation targets.

A lever to decarbonize transportation…

This machine also fights physical inactivity:

- In Europe: ~10% of all deaths attributable to physical inactivity

The health and climate benefits of cycling, France 2019

- **Objective** : assessing the **mortality** and **morbidity** alleviated by cycling:
  - All-cause mortality
  - 5 chronic diseases
- …but also the **CO_2 emissions** prevented

- **Data** : 2019 *Enquête mobilité des personnes* ("People's mobility survey")

Dose-response function by Kelly et al (2014) :

100 min/week of cycling
→ 10% reduction in all-cause mortality

- **Method**: Health Impact Assessment

Cycling distribution and burden alleviated

Average : 9min / week

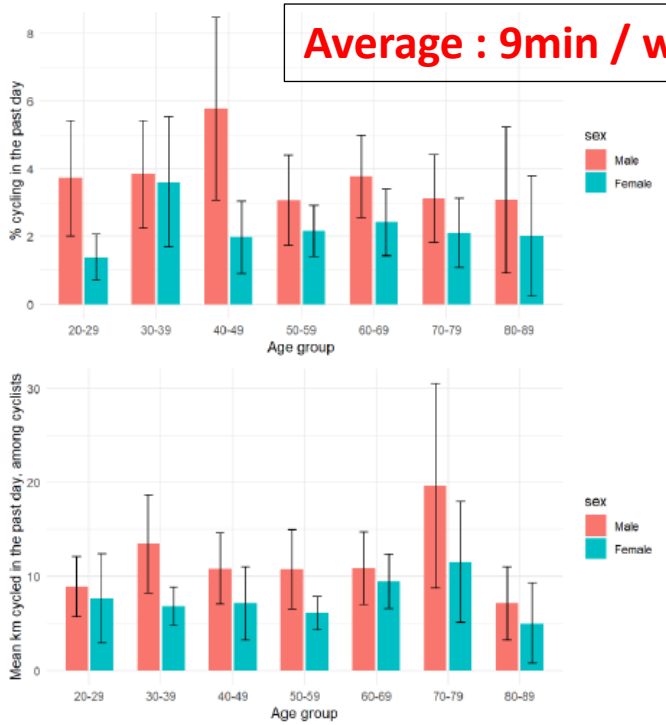

Figure 1: Proportion of the French adult population reporting any bike trip any cycle trip a day, accounting for differences in weekends and weekdays (top), and mean distance cycled (km) in the past day among those reporting any bike trip (bottom) according to sex and age. *Enquête mobilité des personnes,* France, 2019.
Black lines represent 95% confidence intervals.

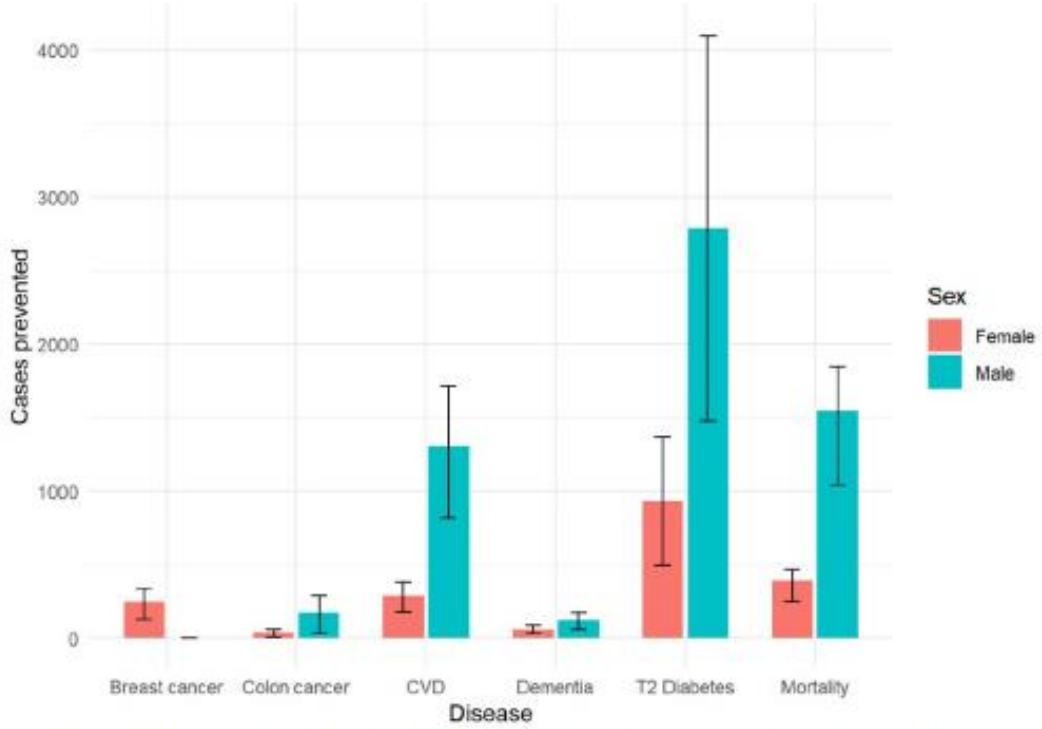

Figure 2: Chronic diseases and mortality prevented by the physical activity due to cycling in France among adults aged 20-89 years, 2019.
Black lines represent 95% uncertainty intervals.

1,919 (UI: 1,101-2,736) **deaths prevented**
5,963 (UI: 3,178-8,749) **diseases prevented**

Health, climate and economic benefits

Table 3: Climate, health and health-related economic benefits of cycling in France, 2019, and estimated impact of a modal shift scenario.

Outcome	Baseline estimates (Uncertainty interval, UI)	Incremental effect of shifting 25% of short (<10km) car trips to cycling (in addition to the baseline estimates) (UI)
Yearly km cycled (billion)	4.640 (3.284-5.996)	5.550 (4.222-6.884)
CO_2 emissions prevented (Mto)	0.575 (0.407-0.743) [1]	0.688 (0.524-0.854)
# of deaths prevented	1919 (1101-2736)	4,704 (2,689-6,721)
# of chronic diseases prevented	5,963 (3,178-8,749)	8,509 (5,205-11,813)
# DALYS prevented	35,135 (22,693 – 48,791)	57,4650 (34,983-78,733)
Medical (tangible) costs prevented (million €)	191 (98-285)	267 (178-393)
Intangible costs prevented (billion €)	4.75 (3.02-6.49)	7.56 (4.65-14.47)

Intangible costs are estimated based on the value of a statistical life year (VSLY).

[1] As compared to a counterfactual where individual would have done the same trips driving instead of cycling

Unit monetarized value :

1.02€ for every km cycled

Health, climate and economic benefits (2)

Modal shift scenario: 25% of short car trips (<10km) shifted to bike

Table 3: Climate, health and health-related economic benefits of c
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[1] As compared to a counterfactual where individual would have done the same trips driving instead of cycling

- **0.7 Mto CO_2 prevented**
- **Intangible costs prevented: 7.6 billion €**

OECD, 21 March 2024

Assessing the Health Benefits of Physical Activity Due to Active Commuting in a French Energy Transition Scenario

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Assessing the Health Benefits of Physical Activity Due to Active Commuting in a French Energy Transition Scenario

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Objectives: Energy transition scenarios are prospective outlooks describing combinations of changes in socio-economic systems that are compatible with climate targets. These changes could have important health co-benefits. We aimed to quantify the health benefits of physical activity caused by active transportation on all-cause mortality in the French negaWatt scenario over the 2021–2050 period.

Methods; Relying on a health impact assessment framework, we quantified the health benefits of increased walking, cycling and E-biking projected in the negaWatt scenario. The negaWatt scenario assumes increases of walking and cycling volumes of +11% and +612%, respectively, over the study period.

Results: As compared to a scenario with no increase in volume of active travel, we quantified that the negaWatt scenario would prevent 9,797 annual premature deaths in 2045 and translate into a 3-month increase in life expectancy in the general population. These health gains would generate €34 billion of economic benefits from 2045 onwards.

Conclusion: Increased physical activity implied in the negaWatt transition scenario would generate substantial public health benefits, which are comparable to the gain expected by large scale health prevention interventions.

OPEN ACCESS

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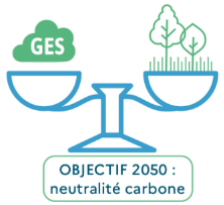
Net-zero emission scenarios



Scenarios describing various combination of changes in socioeconomic systems that are compatible with carbon neutrality

Explicit details on the evolutions required in the main sectors in order to reach carbon neutrality in 2050

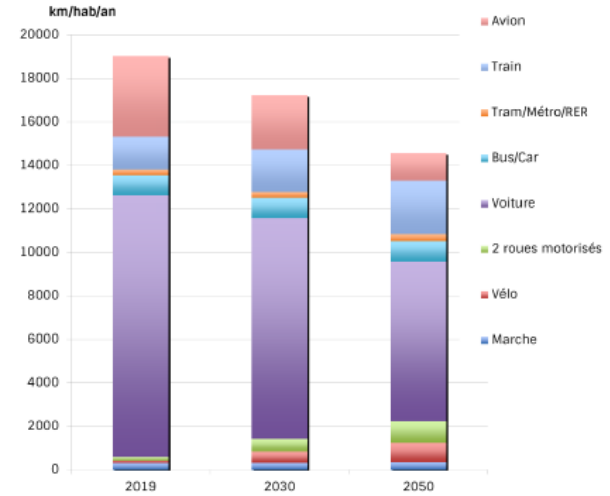
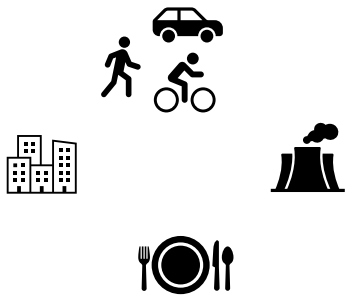


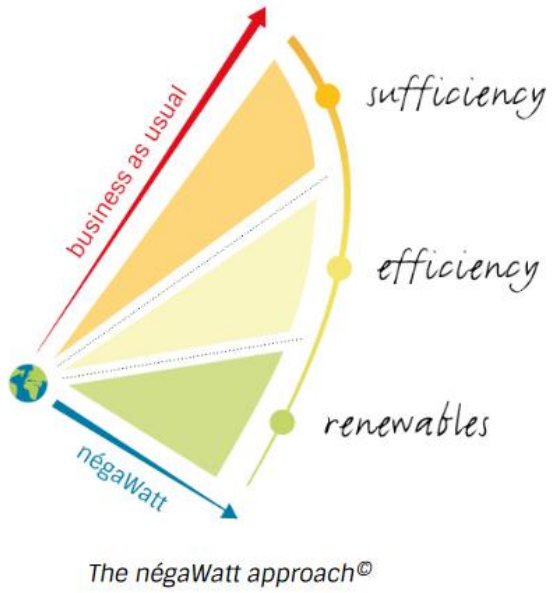
Figure 11 - Nombre de km/habitant/an par mode de déplacement dans le scénario négaWatt, en 2019, 2030 et 2050



Various health co-benefits

Health impact assessment

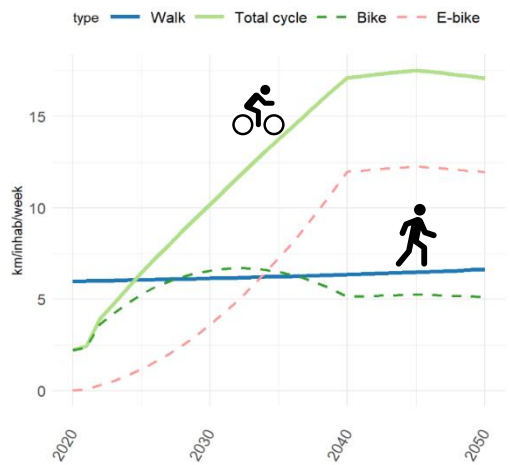
Active transportation and physical activity in the *negaWatt* scenario



The négaWatt approach©

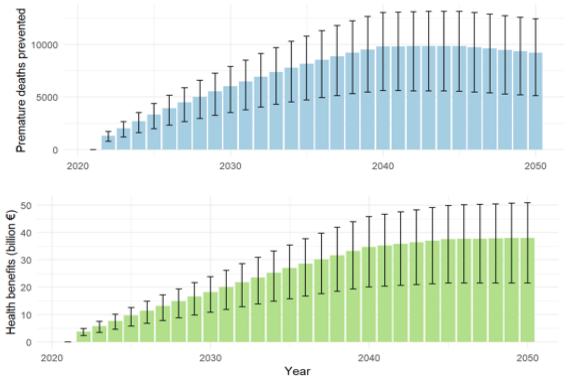
Dose-response function

- 100min cycling/week= mortality reduced by 10%
- 168min walking/week= mortality reduced by 11%



Large health and economic benefits in 2040

- ~10,000 deaths prevented each y.
- >3 mo. gain in life expectancy
- ~35 billion € /y. of intangible costs prevented



Barban et al, *Int. J. Public Health* 2022

Different pathways toward net-zero emissions imply diverging health impacts: a health impact assessment study for France

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Different pathways toward net-zero emissions imply diverging health impacts: a health impact assessment study for France

Léo Moutet, Aurélien Bigo, Philippe Quirion, Laura Temime, Kévin Jean

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Abstract

Background In the transport sector, efforts to achieve carbon neutrality may generate public health cobenefits by promoting physical activity.

Objective This study aims to quantify the health impacts related to active transportation based on four different scenarios leading France toward carbon neutrality in 2050.

Methods The French Agency for Ecological Transition developed four consistent and contrasting scenarios (S1 to S4) achieving carbon neutrality by 2050 as well as a business-as-usual (BAU) scenario that extends our current lifestyles until 2050, without reaching net-zero. For each of these *Transitions2050* scenarios, we distributed the mobility demand for walking, cycling and e-cycling across age groups. Relying on the health impact assessment framework, we quantified the impacts of the corresponding physical activity on all-cause mortality. The impact of each of the carbon neutrality scenarios was determined by comparison with estimates from the BAU scenario.

Results In S1 and S2 scenarios, volumes of active transportation are projected to increase to fulfil the World Health Organisations recommendations by 2050, while they increase slightly in S3 and decrease in S4. S2 scenario reaches the highest levels of health cobenefits, with 494,000 deaths prevented between 2021 and 2050. This would translate into a life expectancy gain of 3.0 months for the general population in 2050, mainly driven by e-bikes. S1 would provide smaller but important health benefits, while these benefits would be modest for S3. On the contrary, S4 implies 52,000 additional deaths as compared to the BAU scenario, and a loss of 0.2 month in life expectancy.

Discussion Different ways to decarbonize mobility in a net-zero perspective may achieve very contrasting public health cobenefits. This study illustrates how the public health dimension may provide a relevant insight in choices of collective transformation toward net-zero societies.

And with various net-zero scenarios ?

S1 FRUGAL GENERATION

Significant changes in the way we travel, keep warm, eat, buy and use equipment will occur to achieve carbon neutrality only with natural sinks (forests and soils), thus preserving the associated ecological services.

S2 REGIONAL COOPERATION

To achieve carbon neutrality, society relies on a progressive but steady change of the economic system towards a sustainable path combining sufficiency and efficiency.

S3 GREEN TECHNOLOGIES

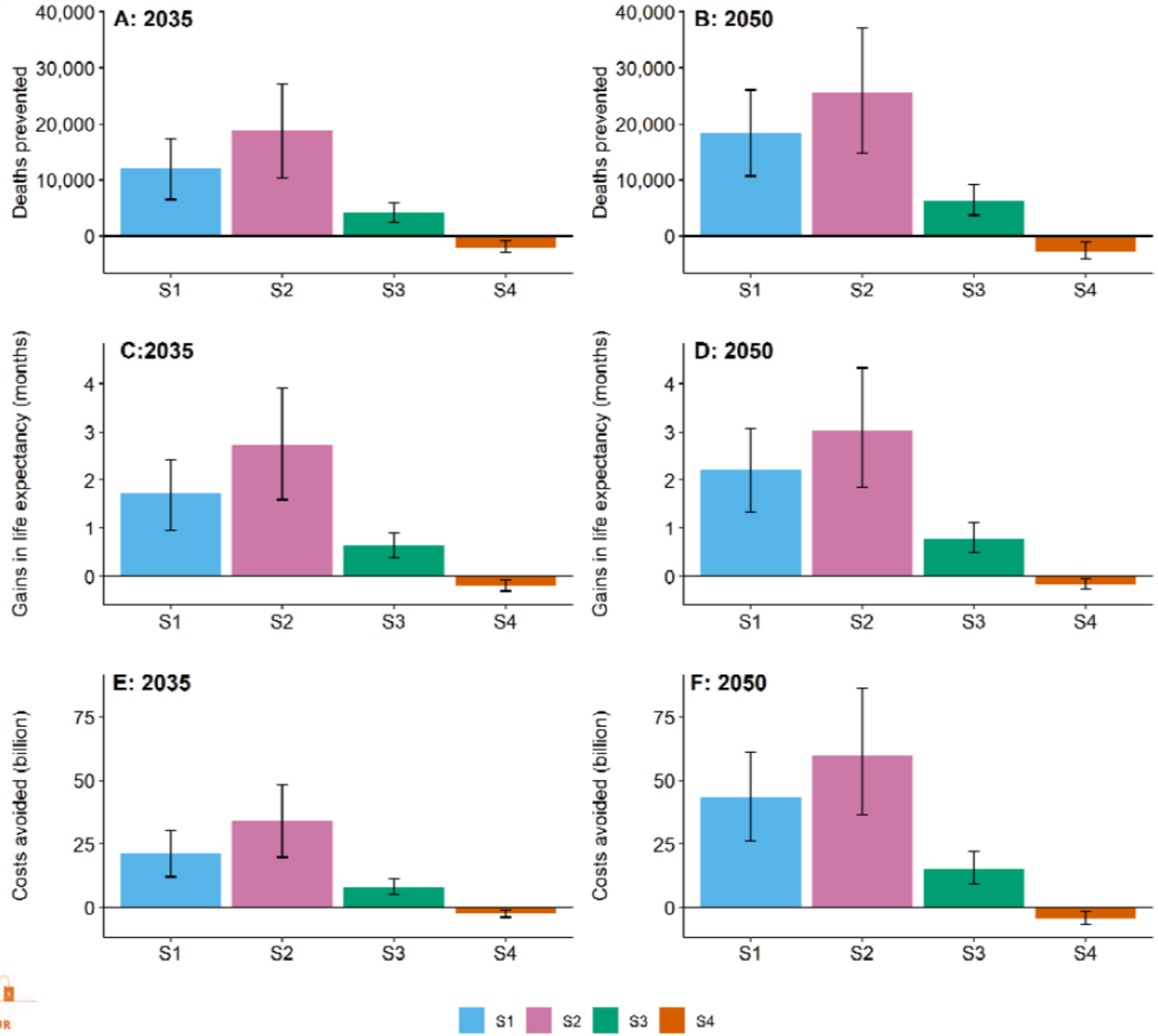
Technological development provides more of the answers to environmental challenges than changes towards more sufficient consumption patterns.

S4 RESTORATION GAMBLE

Society places its trust in its ability to manage and even repair social and ecological systems with more material and financial resources to maintain a liveable world. Carbon capture and storage technologies, which are essential, are uncertain and consume electricity.

Credit: @ADEME - Transition(s) 2050 - Illustrations : S. Kiehl

Transition(s) and health impact : physical activity



LA SOCIÉTÉ EN 2050

S1 GÉNÉRATION FRUGALE

S2 COOPÉRATIONS TERRITORIALES

S3 TECHNOLOGIES VERTES

S4 PARI RÉPARATEUR

Thanks for your attention

Also 2 articles for the general public

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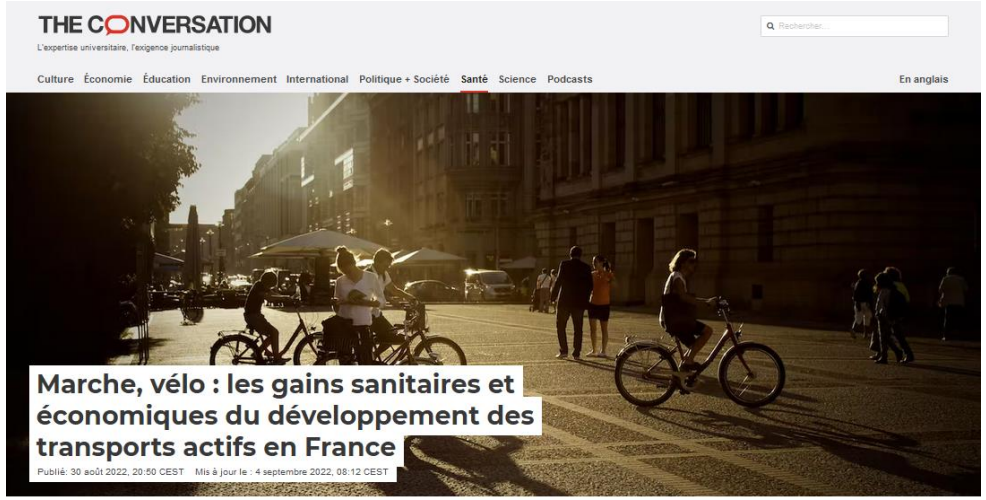

https://theconversation.com/marche-velo-les-gains-sanitaires-et-economiques-du-developpement-des-transports-actifs-en-france-189487
https://theconversation.com/le-velo-meilleur-atout-pour-reduire-la-pollution-et-les-temps-de-trajet-lexemple-de-lile-de-france-219509