Out With The Pipe, In With The Plug

On the Economics of the Energy Transition in the Automobile Sector

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Quentin Hoarau

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RITM - Université Paris-Saclay
Climate Economics Chair - Université Paris-Dauphine

Context and motivations

Environmental Footprint of the Automobile Sector

- CO2 emissions from automobile constitute 50% of emissions of transport and 15% of total emission. They have been increasing since 1990
- Local pollution ozone and particles. Public health safety in cities

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Difficulties in the transformation of the sector:

- Limits in the improvement of combustion engines and technological trade-off between abatement of air pollutants and CO2
- Lack of stringency of regulations
- Increase in car size and weight

The Technological Option: Electrification of Vehicles

Electric mobility has taken off in the 2010's:

- From 100k in 2010 to 10M EVs in 2020
- Sharp decline in cost of lithium batteries
- Strong policy support
- Ongoing challenges: cost, infrastructure, life-cycle emissions

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Electrification happens in an quickly evolving power system:

- Decarbonization: photovoltaic, wind...
- Decentralization : distributed energy resources and prosumers
- Digitalization
- Deregulation

Structure of the thesis

- Chapter 1: General introduction
- Chapter 2: Stranded to be? Diesel ban in cities and used car markets
- Chapter 3: Coordination of abatement and policies in interconnected sectors *(with Guy Meunier)*
- Chapter 4: Interactions between electric mobility and photovoltaic energy *(with Yannick Perez, published in Renewable and Sustainable Energy Reviews)*
- Chapter 5: Network tariff design with prosumers and electric mobility: who wins, who loses? *(with Yannick Perez, published in Energy Economics)*

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Stranded to be? Diesel ban in cities and used car markets

Context:

- Several decades of diesel promotion in Europe fadded with increasing public awareness on air pollution in cities
- Many local governments are implementing policies to restrict city access to the most polluting cars.
- Several French cities have announced the implementation of "Low Emission Zones", based on a national car labelling scheme ("critair") that discriminates diesel engines.

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Research question

- Do vehicle owners anticipate the implementation of driving restrictions in their city ?
- How does it translate in the used-car market ?

Stranded to be? Diesel ban in cities and used car markets

Methods:

- Empirical analysis of used car markets in France
- Constitution of a data base based on used car ads from an online platform and completed with car specs and geographical data.
- Ad-hoc proximity indicator based on distance between the seller location and the LEZ city center

Stranded to be? Diesel ban in cities and used car markets

Main results

- Diesel and old vehicles face a significant malus in cities implementing a driving restriction policy. Malus amount for around 1000€ in Paris area, and 500€ in planned LEZ
- Sellers of cars in second-hand markets seem to anticipate driving restrictions.

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Coordination of abatement and policies in interconnected sectors

Motivations:

- Several low-carbon technologies requires inputs from polluting sectors
- Debates on the life-cycle environmental footprint of EVs
- Marginal Abatement Cost Curves (MACC) as a guide of policy design

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Research question

- Should abatement and policies be coordinated across interconnected sectors?

Coordination of abatement and policies in interconnected sectors

Methods:

- Partial equilibrium model
- Two sectors upstream/downstream
- Two technologies in each sector : polluting/clean
- Downstream clean technology requires upstream good

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- Two sectors upstream/downstream
- Two technologies in each sector : polluting/clean
- Downstream clean technology requires upstream good
- Social optimum and comparative statics with the social cost of carbon
- Different policy instrument : first-best taxes, second-best subsidies, uncoordinated subsidies
- Numerical application

Coordination of abatement and policies in interconnected sectors

Main results

- Optimal allocation and transition can be planned with practical LCA-adjusted MAC
- Unexpected configurations where the upstream pollution may increase to allow the downstream decarbonization
- Second-best subsidies must include LCA considerations. Benefits from policy coordination can outweigh the cost of using subsidies instead of pigovian taxes

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Interactions between electric mobility and photovoltaic energy

Context and motivations:

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Research question

What are the determinants of the synergy between electric vehicles and photovoltaic generation?

Interactions between electric mobility and photovoltaic energy

Methods:

- Literature review
- Development of a systematic framework that describes EV/PV systems
- Distinction between technical and economic properties

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Main results

- Synergy relies on very particular spatial and technological configurations
- Economic conditions, such as electricity pricing and business models, are overlooked in the literature

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Network tariff design with prosumers and electric mobility: who wins, who loses?

Motivations:

- Traditional grid operations challenged by PV and EVs
- Prosumers pose threats to grid cost recovery
- Unless regulation changes, there could be significant crossed-subsidies between users
- Tariff structure to shift from energy to capacity tariffs

Network tariff design with prosumers and electric mobility: who wins, who loses?

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Research questions

- What is the impact of increased EV penetration on tariff in the prosumer context?
- Who wins and who loses from the different potential tariff designs?

Network tariff design with prosumers and electric mobility: who wins, who loses?

Methods:

- Calibrated numerical non-cooperative game between regulator and network users (based on (Schittekatte et al 2018))
- Four class of users with EVs, PV and battery : prosumers, EV owners, regular users...
- Different penetration scenarios
- Different tariff structures: energy (€/kWh), capacity (€/kW), flat (€)

Network tariff design with prosumers and electric mobility: who wins, who loses?

Main results

- Energy tariff incentivize DER adoption for prosumers, but EV penetration compensate the induced effect on tariffs
- Switching towards capacity tariffs based would greatly disadvantage EV owners while keeping incentives for prosumers
- Switching towards flat tariffs would disadvantage prosumers while lowering costs of EV owners

Conclusion, transversal considerations and future works

In conclusion, this dissertation was about:

- Unintended effects of policies
- Distributive issues in the energy transition
- Sectoral interaction

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- Unintended effects of policies :
  - Chapter 2: malus on diesel cars as a results of driving restriction announcements
  - Chapter 3: costs of lack of coordination between policies
  - Chapter 5: strategic behaviors of prosumers
- Distributive issues in the energy transition
- Sectoral interaction

Conclusion, transversal considerations and future works

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- Distributive issues in the energy transition :
  - Chapter 2: owners old diesel vehicles disadvantaged
  - Chapter 5: winners and losers from tariff design
- Sectoral interaction

Conclusion, transversal considerations and future works

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- Distributive issues in the energy transition
- Sectoral interaction :
  - Chapter 3: allocation of efforts across sectors
  - Chapter 4: technological interactions
  - Chapter 5: interactions of technologies through electricity pricing

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Future works:

- LEZ and used car markets: improve statistical robustness and build a panel (future collaboration with Edouard Civel)
- Strategic environmental policy in supply chains

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Thank you for your attention

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