RECHARGE INFRASTRUCTURE PROJECTS: DID THEY REALLY BOOST THE FRENCH ELECTRIC VEHICLE MARKET?

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PSA GROUPE

16th IAEE European Conference

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IAEE International Association for Energy Economics
WWW.IAEE.ORG

University of Ljubljana
SEB School of Economics and Business

SAEE Slovensko Združenje za Energetsko Ekonomiko

Energy Challenges for the Next Decade

#IAEE19LJ

School of Economics and Business, University of Ljubljana, Slovenia

ESSEC Business School

CentraleSupélec

université PARIS-SACLAY

LGi Sustainable Economy
Industrial Engineering Research Department

PSA Groupe

SUMMARY PLAN

- Motivation
- Literature review
- Problem identification
- Data presentation
- Method and results
- Discussions and future works
- Conclusion

MOTIVATION

Thesis Subject

Analysis of the strategies of operators of low-carbon recharging infrastructure: Electric and Hydrogen - *Starting 15 January 2019 – Groupe PSA, CentraleSupélec and ESSEC Business School*

Questions

- What encourage drivers to purchase electric vehicles?
- What are the impact of recharge infrastructure projects on the electric vehicles market?
- Recharge infrastructure Vs. PEV: The electromobility Chicken and Egg dilemma
- A French study case

Study

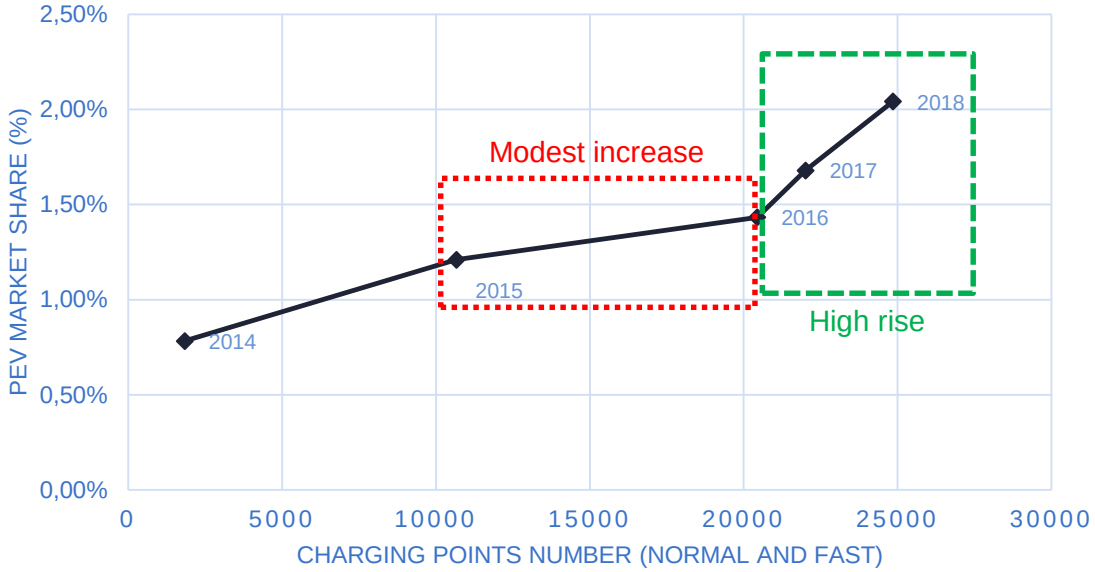
An econometrics study about the PEV sales in France and the impact of the recharge infrastrucutre projects on the driver's choice

LITERATURE REVIEW: EXISTING STUDIES ON PEV ADOPTION

Authors (Date)	Results
Van den Bergh et al. (**2006**)	The number of PEV models available on the market can help the client to be more convinced in this technology (**Germany**)
Hidrue et al. (**2011**)	Levels of education, income, and environmentalism to all be positively correlated to likelihood to purchase an EV (**USA**)
Tran et al. (**2012**)	The availability of the charging stations play a role in the driver's choice
Sierzchula et al. (**2014**)	Socio-demographic variables (income, education level) are not significant Financial incentives and charging infrastructure are significant factors, but they are not enough (**30 countries**)
Fearnley et al. (**2015**)	They studied BEV incentives in **Austria** and **Norway**. They found direct financial incentives to be effective.
Lieven (**2015**)	The installation of fast charging networks on freeways to be a necessity while high vehicle subsidies can be replaced by lower subsidies providing additional charging infrastructure.
Mersky et al. (**2016**)	Being close to recharge infrastructure is the most significant factor (**Norway**)
Li et al. (**2017**)	Factors which influence the client to buy an EV are divided into three main types: demographic, situational and psychological. Main barriers are: Driving range, Charging problem and Purchasing cost (**14 countires**)

PROBLEM IDENTIFICATION

- The relation between recharge infrastructure and purchasing a PEV
- Charging points are not the only factor which pushes clients to switch into electromobility

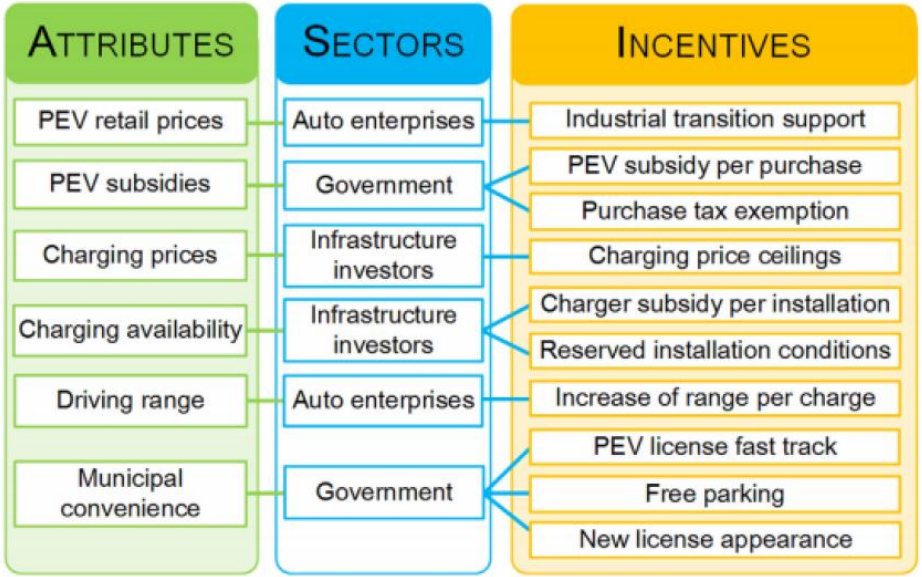


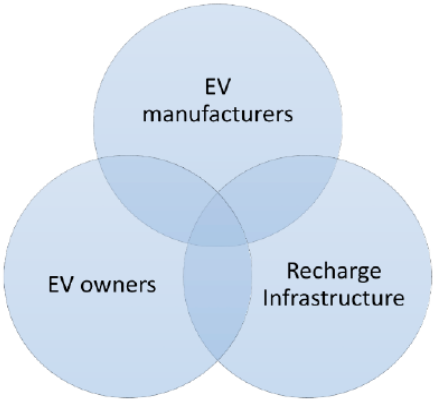
French case (Sources: Groupe PSA and EAFO)

EAFO: European Alternative Fuels Observatory

PROBLEM IDENTIFICATION

- We identify the PEV purchasing problem as a crossing between PEV manufacturers, PEV owners and recharge infrastructure
- *Ji & Huang (2018)* defined the factors which can help us to define the lack of EV market share





Problem identification

SOME EUROPEAN FAST CHARGING PROJECTS

- Many European countries decided to invest in recharge infrastructure to boost their PEV market.

Project name	# stations/ # sites	Partners	Location
Ionity	400/~2400	BMW, Mercedes, Ford, VW Group	24 countries
Ultra-e	25/~100	Allego, Audi, BMW, Magna, Renault, Hubject	Netherlands, Belgium, Germany, Austria
E-Via Flex-E	14/~60	Enel, EDF, Enedis, Verbund, Nissan, Renault, Ibil	Italy, Spain, France
MEGA-E	39/322	Allego	20 countries
Central European Ultra charging	118/-	Verbund, CEUC, Enel X, Smartrics, Greenway, OMV	Austria, Czech Republic, Italy, Hungary, Romania, Bulgaria and Slovakia
NEXT-E	30/-	E.ON, MOL, HEP, PETROL, Nissan, BMW	Czech Republic, Slovakia, Croatia, Hungary, Slovenia, and Romania
E.ON x Clever	180/-	E.ON, Clever	Germany, France, Norway, Sweden, UK, Italy, Denmark
Instavolt network	-/200	Instavolt	UK
Fastned network	25	Fastned	GerUKmany, Netherlands, UK
Pivot Power and the National Grid	45/100		UK
EnBW	100-1000/800	EnBW and OMV	Germany

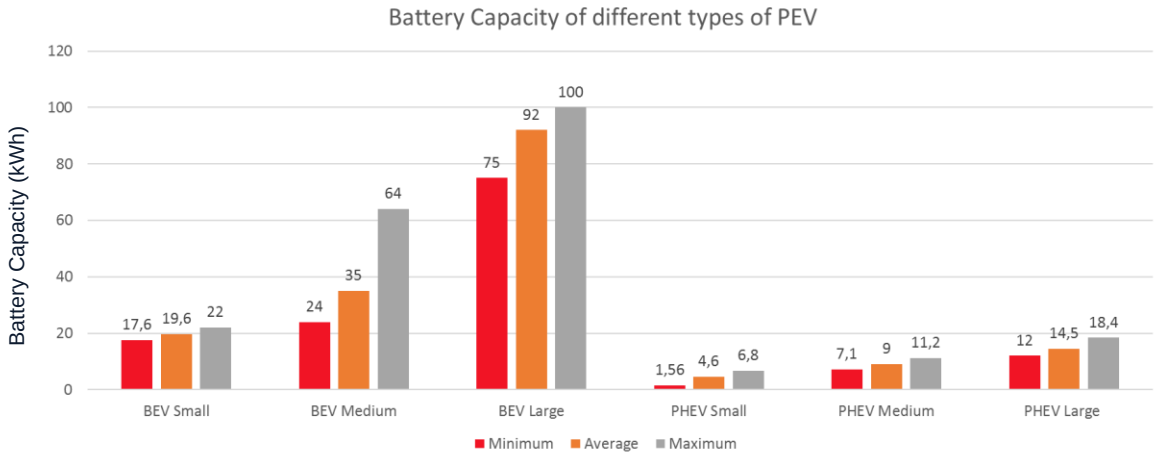
- In France, Corri-Door as well as many fast charging infrastructure projects have been launched in order to encourage clients to purchase a PEV.

Source: Transport & Environment; 2018

DATA FOR FRENCH CASE

Different types of data were collected from different sources:

- **Annual PEV sales** in France (2015 → 2018) from Groupe PSA
  - Collected data for every department
  - Type of the vehicle: pure electric (BEV) or plug-in hybrid (PHEV)
  - Model year
  - Autonomy (km)
  - Battery capacity (kWh)
  - Price (€)
  - Number of annual available models

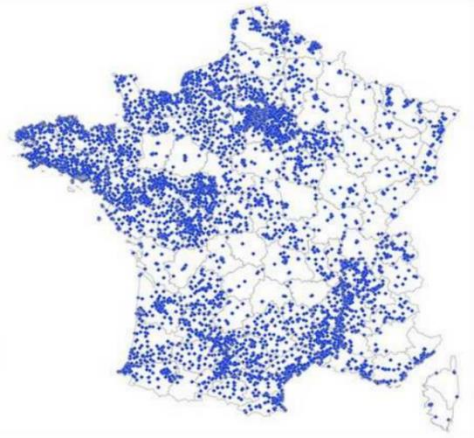


Types of PEV models in France

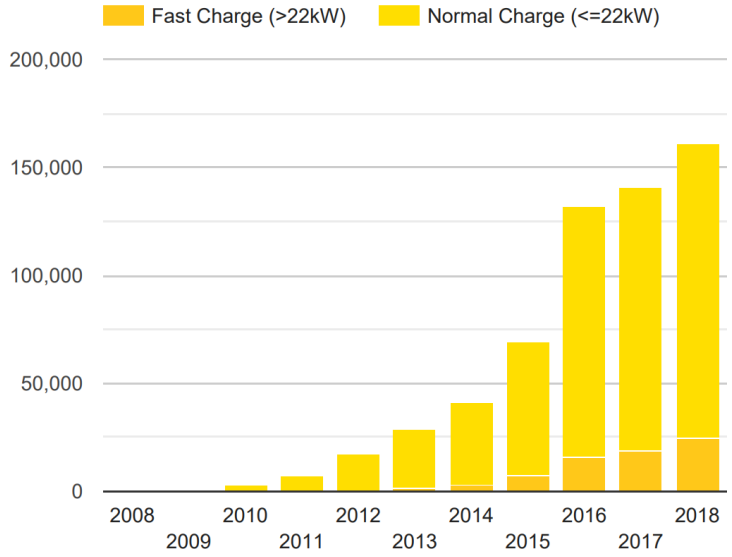
DATA FOR FRENCH CASE

Different types of data were collected from different sources:

- **Recharge Infrastructure** in France (2015 → 2018) from www.eafo.eu and www.data.gouv.fr
  - Number of installed normal charging points in France with power < 22 kW
  - Number of installed fast charging points in France with power > 22 kW



Source: Territoire d'Energie

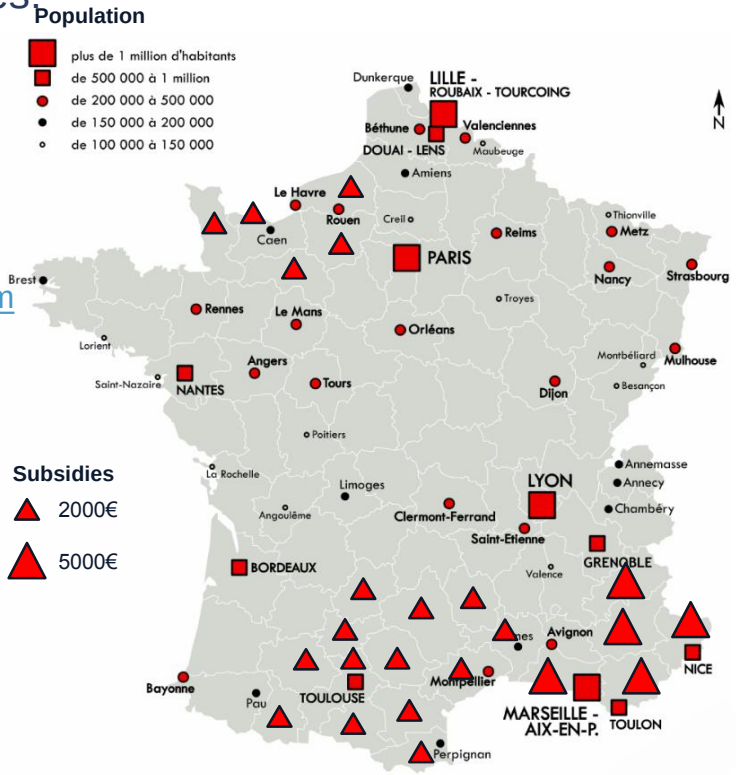


DATA FOR FRENCH CASE

Different types of data were collected from different sources:

- **Externalities** in France (2015 → 2018)
  - Density per department (pp/km²) from www.insee.fr

    Different levels of urbanity
  - Local subsidies per department (€) from www.automobile-propre.com
    - Two levels of local subsidies 2000€ and 5000€ additionally to the national subsidy (5000€)
    - Subsidies are considered constant throughout the period of this study

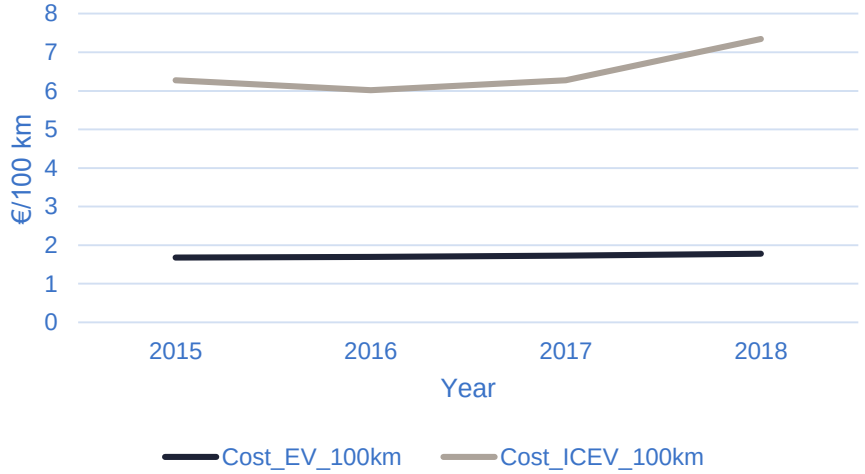


INSEE: Institut National de la Statistique et des Etudes Economiques (*National Institute of Statistics and Economic Studies*)

DATA FOR FRENCH CASE

Different types of data were collected from different sources:

- **Externalities** in France (2015 → 2018)
  - Price of 100 km traveled using an ICEV (€)
    - Price of diesel from www.statista.com
    - ICEV consumption rate (5L/100km) from ADEME
  - Price of 100 km traveled using an ICEV (€)
    - Price of electricity from www.statista.com
    - EV consumption rate (10kWh/100km) from ADEME



ADEME: Agence De l'Environnement et de la Maîtrise de l'Energie (*Environment and Energy Management Agency*)

METHOD: PANEL DATA REGRESSION OF VARIABLES ON PEV SALES SHARES

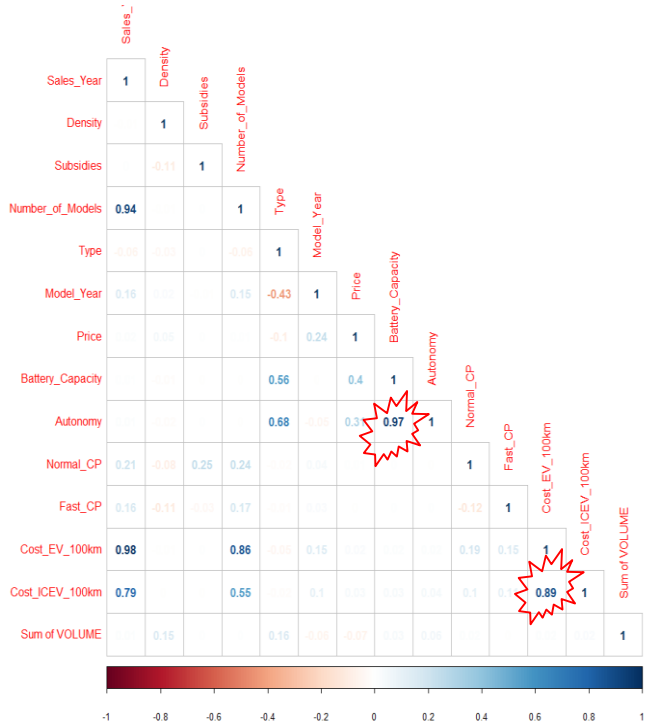
- Data were cleaned before analyzing
- We identified the correlation between the variables:
  - Autonomy and Battery capacity are highly correlated

    → Elimination of Battery capacity variable
  - Cost EV for 100 km and Cost ICEV for 100 km are highly correlated

    →Elimination of Cost EV for 100 km

$$Log(Sales_{i,j,t}) = \alpha + \beta_1 Vehicle\_Price_i + \beta_2 Autonomy_i + \beta_3 NormalCP_{j,t} + \beta_4 FastCP_{j,t} + \beta_5 CostICEV100km_t + \beta_6 Subsidies_j + \beta_7 Density_{j,t} + \beta_8 Number\_of\_Models_t + \beta_9 Model\_Year_i + \varepsilon$$

i for the vehicle,
j for the department,
t for the year of sales,
ε the error term



METHOD: PANEL DATA REGRESSION OF VARIABLES ON PEV SALES SHARES

- Autonomy, population density, diesel price and chargers are strongly significant and have positive impact on the local PEV sales
- Price, number of available models and model year are significant and have negative impact
- Subsidies are not significant

Charging infrastructure are highly correlated to the PEV market

	Model Pooled panel data regression
Intercept	7.566e+01 (8.6e00) ***
Vehicle_Price (in Euros)	-6.95e-6 (4.69e-7)***
Autonomy (in km)	1.509e-3 (1.06e-4)***
Normal_CP	9.46e-5 (6.877e-5)***
Fast_CP	9.28e-4 (2.78e-4)***
Cost_ICEV_100km (€)	1.097e-1 (2.719e-2)***
Subsidies (€)	3,2408e-5 (9,485e-6)
Density (pp/km²)	1.06e-4 (4.31e-6)***
Number of models	-2.058e-3 (2.38e-3)
Model Year	-3.72e-2 (4.28e-3)***
N	10125
Year fixed effects	Yes
Department fixed effects	Yes
Vehicle fixed effect	Yes
R^2	9.78%
Adjusted R^2	9.7%
P-value	< 2,2e-16

Regression results

*Signification codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'*

INTERPRETATION OF RESULTS ON PEV SALES SHARES

Main conclusions:

- The EV market will be boosted if improvements are made on the technical part of the PEV
  - More battery capacity and light materials will lead to higher autonomy
  - Release new models on the market with affordable prices : learning by doing

- Clients are intrested in charging points. Normal and fast ones can boost the market → the necessity to invest in the recharge infrastructure

- More taxes on diesel can convince the driver about electromobility

- **The model can be defined as follow:**

$$Log(Sales_{i,j,t}) = \alpha + \beta_1 Vehicle\_Price_i + \beta_2 Autonomy_i + \beta_3 NormalCP_{j,t} + \beta_4 FastCP_{j,t} + \beta_5 CostICEV100km_t + \beta_6 Subsidies_j + \beta_7 Density_{j,t} + \beta_8 Number\_of\_Models_t + \beta_9 Model\_Year_i + \varepsilon$$

DISCUSSIONS AND RECOMMENDATIONS

- The model is robust within the variations of some variables:
  - We did two robutness tests:
    - Replacing the variables by a modified version of them
    - Eliminating each variable to know the impact on the model
  - Results show that:
    - Changing the infrastructure variables have a modest impact on the model → French PEV owners prefer to charge at house
    - Drivers are intrested in the autonomy and the price of the vehicle
    - Obviously, the density can caraterize the PEV purchasing degree and has the highest impact on the model
- Recommendations
  - PEV manufacturers: to boost this type of technologies
  - Recharge infrastructure operators: to inestigate about the clients' needs
  - Policy makers and the government:
    - To facilitate the installation of private chargers
    - To re-examinate the local subsidies

FUTURE WORK

- Future works:
  - More detailed data should be added in order to extend a « **bottom-up** » model
    - GDP (Gallagher and Muehlegger, 2011; Sierzchula et al., 2014),
    - All types of local incentives,
    - Renewable energy production (Li et al.; 2017),
    - Percentage of citizens who vote with the green party (per department),
    - Family sizes, education level, ages (Egbue and long; 2012),
    - More detailed information about charging points: sockets, type, etc.
    - The variation within the same year (months or seasons), etc.
    - Four years is not enough to conclude

CONCLUSIONS

- We studied the PEV purchasing activity in the French market in order to identify the reasons that encourage clients to buy these types of vehicles
- The data were agrregated from different sources: Groupe PSA, EAFO, DATA gouv, INSEE, etc.
- The study concluded about the significancy of chargers, price, autonomy of the vehicle, subsidies and model year.
- The last added taxes on the fuel did generate the « Gilets Jaunes », but did have an impact on the EV market
- Adding more variables will boost the model and will enlarge the scope of the study
- Recharge Infrastructure is not the only factor that boost the EV market

THANK YOU FOR LISTENING!

Questions?