EVS 27
The 27th INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM & EXHIBITION
BARCELONA
17th-20th November 2013

How well can early adopters of electric vehicles be identified?

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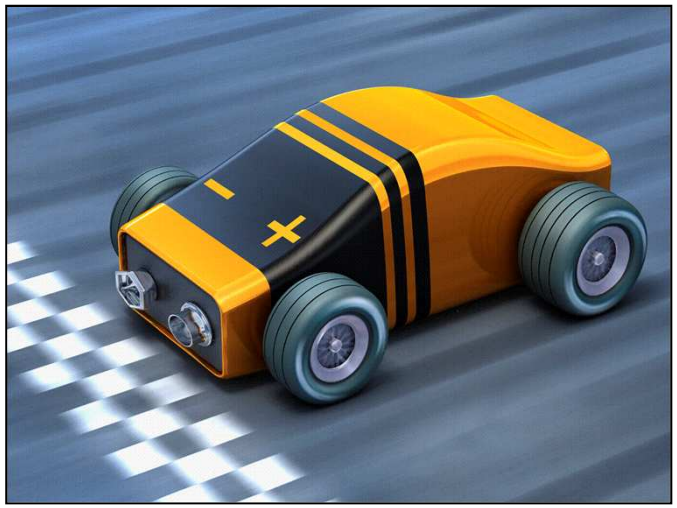

EVS 27: 2013, Barcelona

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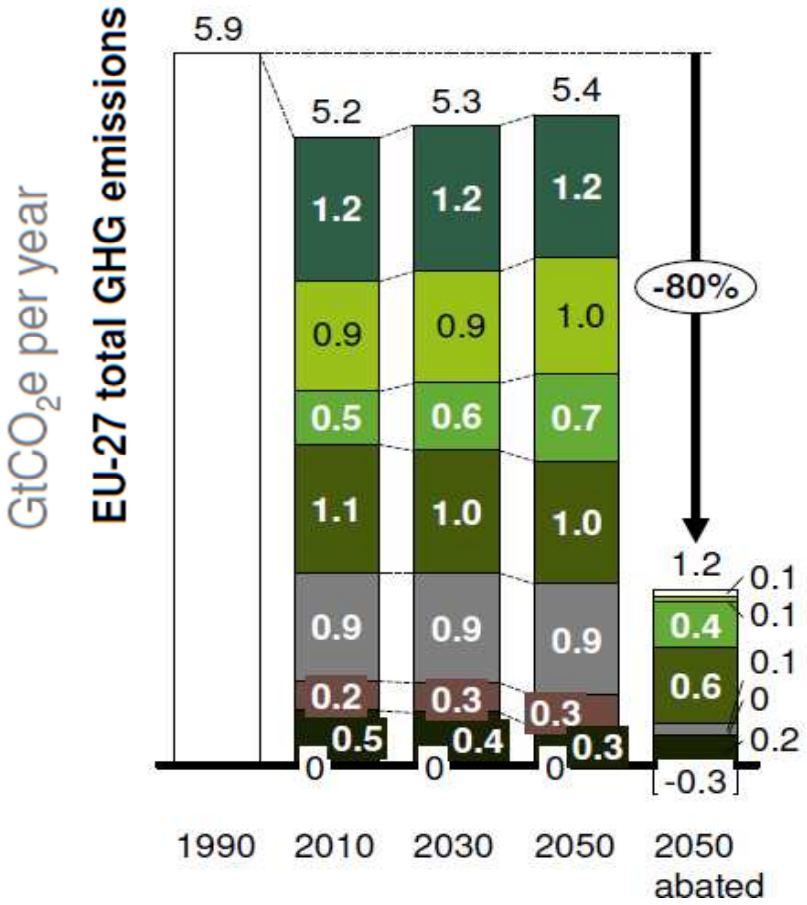
To achieve Europe‘s climate targets, a drastic reduction in transport CO2-emissions is needed



- The EU‘s long term goal is to reduce GHG emissions by 80%
- Power production and road transport have to become almost CO2-free
- This is **impossible with** efficiency gains in **combustion engines**
- New technologies and concepts are clearly needed.
- **Electric vehicles powered by renewable energies** can contribute significantly

Source: www.roadmap2050.eu

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Identification of the first buyers is essential for effective policies and marketing

- **Policy makers are widely supporting electric vehicles**
  - Policies that are applied differ widely, including CO_2-dependent taxes, subsidies, built-up of public charging infrastructure, pilot projects and many more
  - **Identification of the first user groups is essential for effective policies**
  - Also relevant for car makers and effective marketing (common myth: EVs in big cities)

- **Aim: Identify the potential early adopter of electric vehicles on a sound statistical basis**

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Data and Method: Determining the cost optimal vehicle type for a large sample

Data: German national travel survey

25,000 households report travel behaviour

- Nation-wide travel survey including different means of transportation
- Selected trips of 16,600 cars.
- All **car trips over one day** and **annual mileage** are reported
- Additional information on **employment status** (fulltime, part-time, pensioner, not working)
- Additional information on **city-size** by number of inhabitants (6 sizes)

➢ Distinguish 24 user groups

Method: Cost-optimal vehicle type

Optimise individual total cost of ownership

- Fuel consumption for inner-city and outer-city driving differ strongly
- Take average trip speed to compute share of inner-city km
- Calculate **total cost of ownership** (vehicle purchase + fuel costs) **for each user** (discount for 8 years at 5%)
- Cost parameters for **year 2020**

➢ **Choose cost optimal propulsion technology**: Gasoline, Diesel, BEV, or PHEV

➢ **Identification of economical EV early adopter from driving data.**

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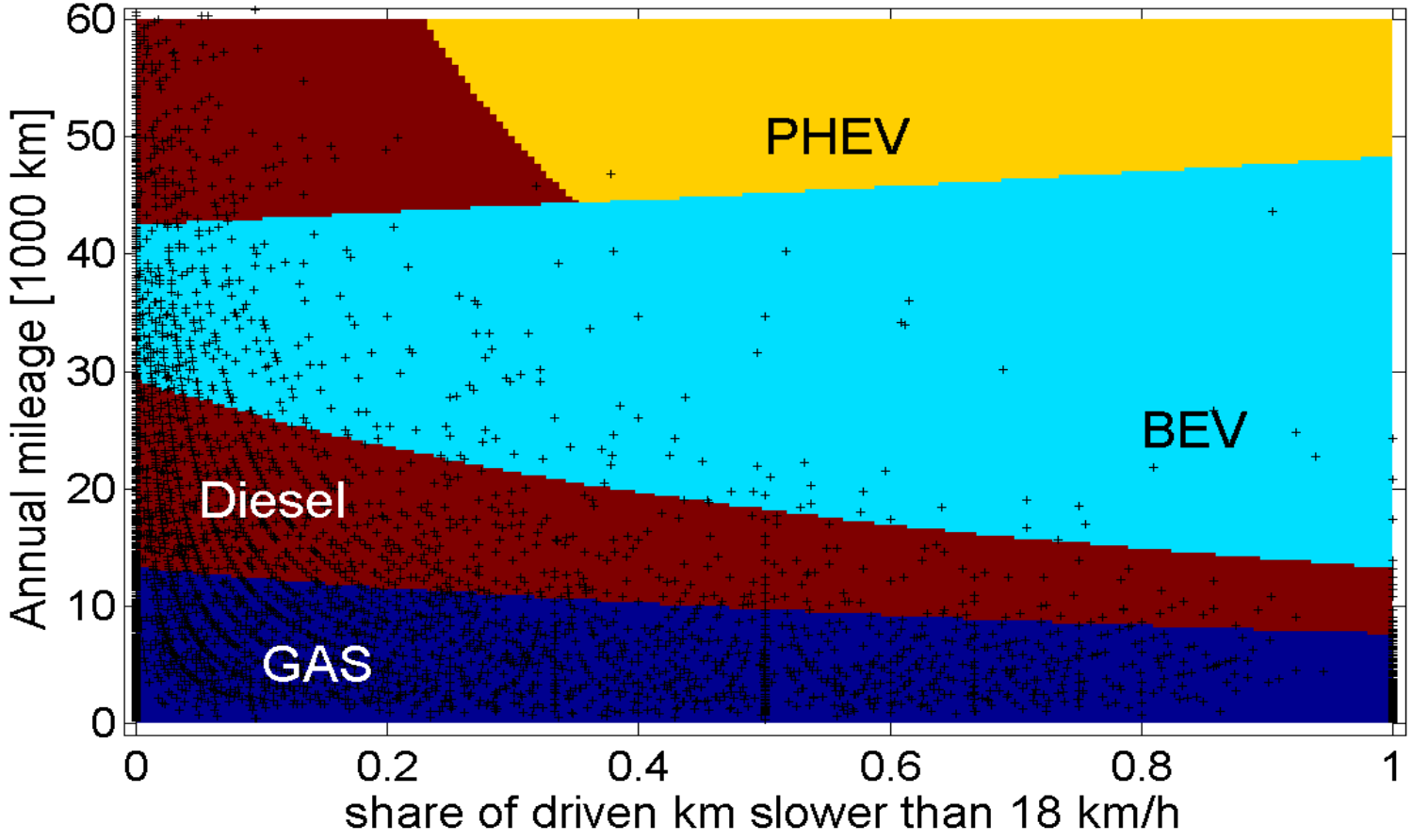
Driving behaviour of users differs widely – the individual needs to be studied

Each cross marks one user; Coloured areas mark cost-optimal vehicle type



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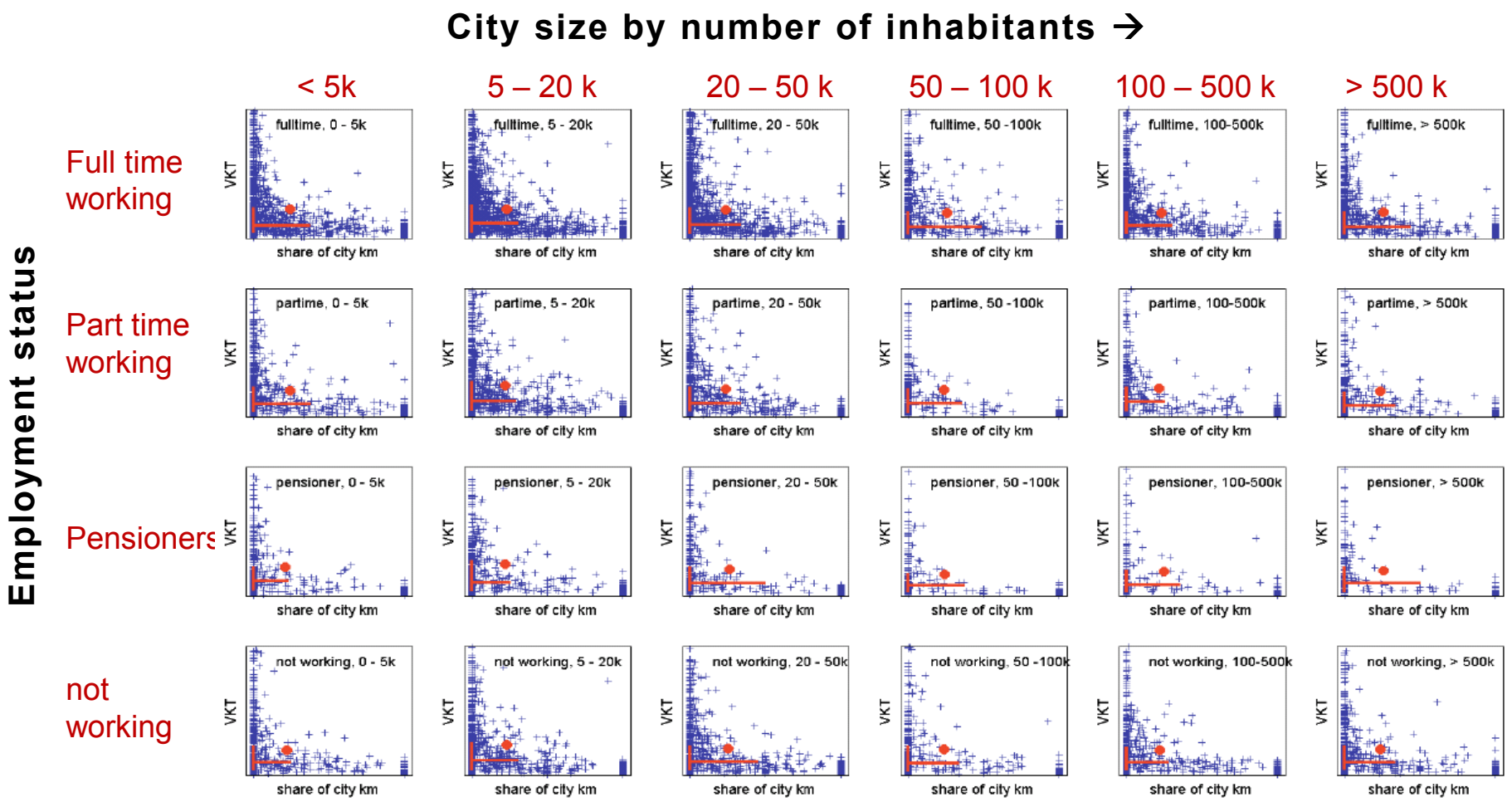
Users even within groups differ widely in their behaviour.



X-axes range from 0 to 1 for the x-axis (km driven with average speed < 18 km/h) and from 0 to 60,000 km for the y-axis. The red dot marks the group average of both coordinates.

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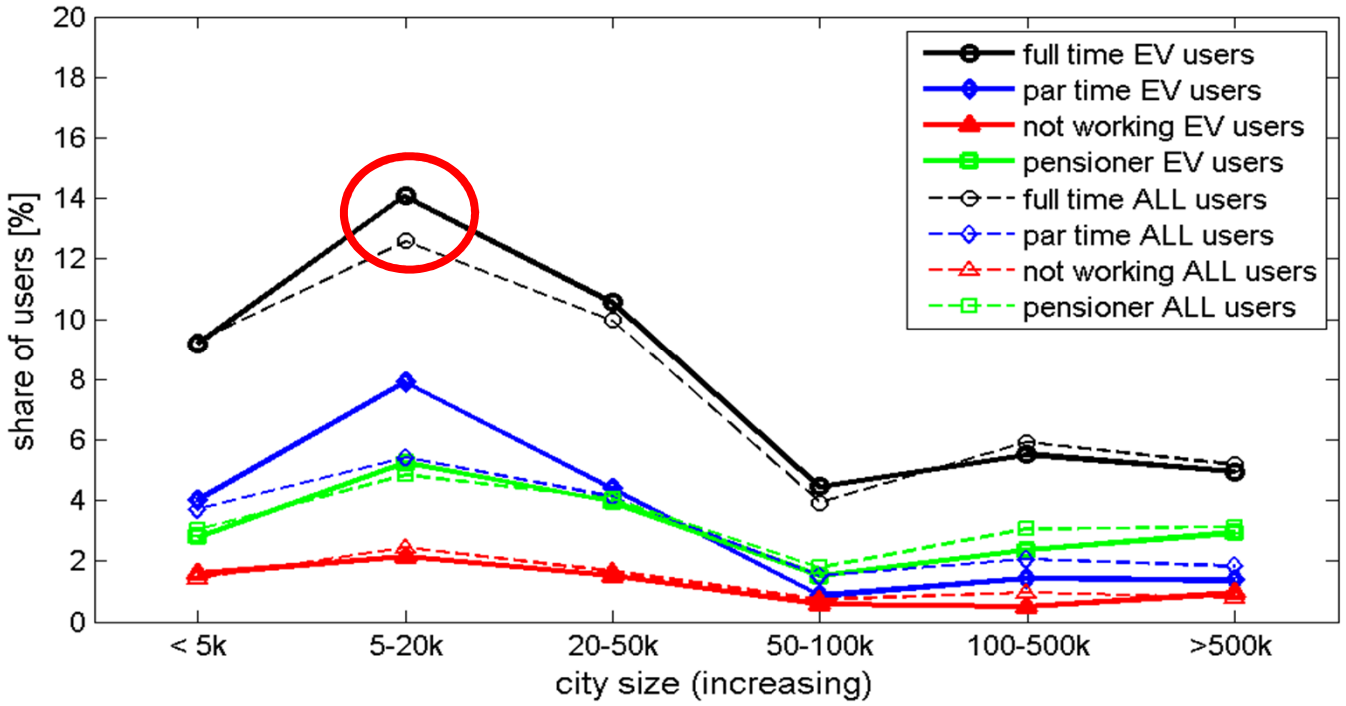
Electric vehicles mainly owned in small to medium city sizes and not in big cities

- Approximately 1,300 of 16,500 vehicles were cost-effective as EVs
- Find share of each group for total car ownership and for EV optimal drivers
- **German EV users mainly full/part time employees in small to medium sized cities**



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Are any of the differences significant?

- Chi-square test of significance for difference of user shares for different sub samples

Individual

Sub sample definition		Statistical significance		
Employment status	City size	Sub sample size	Chi squared	p-value
Full time	5 – 20 k	196	2.24	13.4%
Full time	0 – 20 k	324	1.04	30.8%
Full time	0 – 50 k	471	1.64	20.1%
Part-time	5 – 20 k	110	16.4	$<10^{-4}$
Part-time	0 – 20 k	166	12.49	0.04%
Part-time	0 – 50 k	227	10.44	0.12%

p-value: probability that difference is due to random fluctuations

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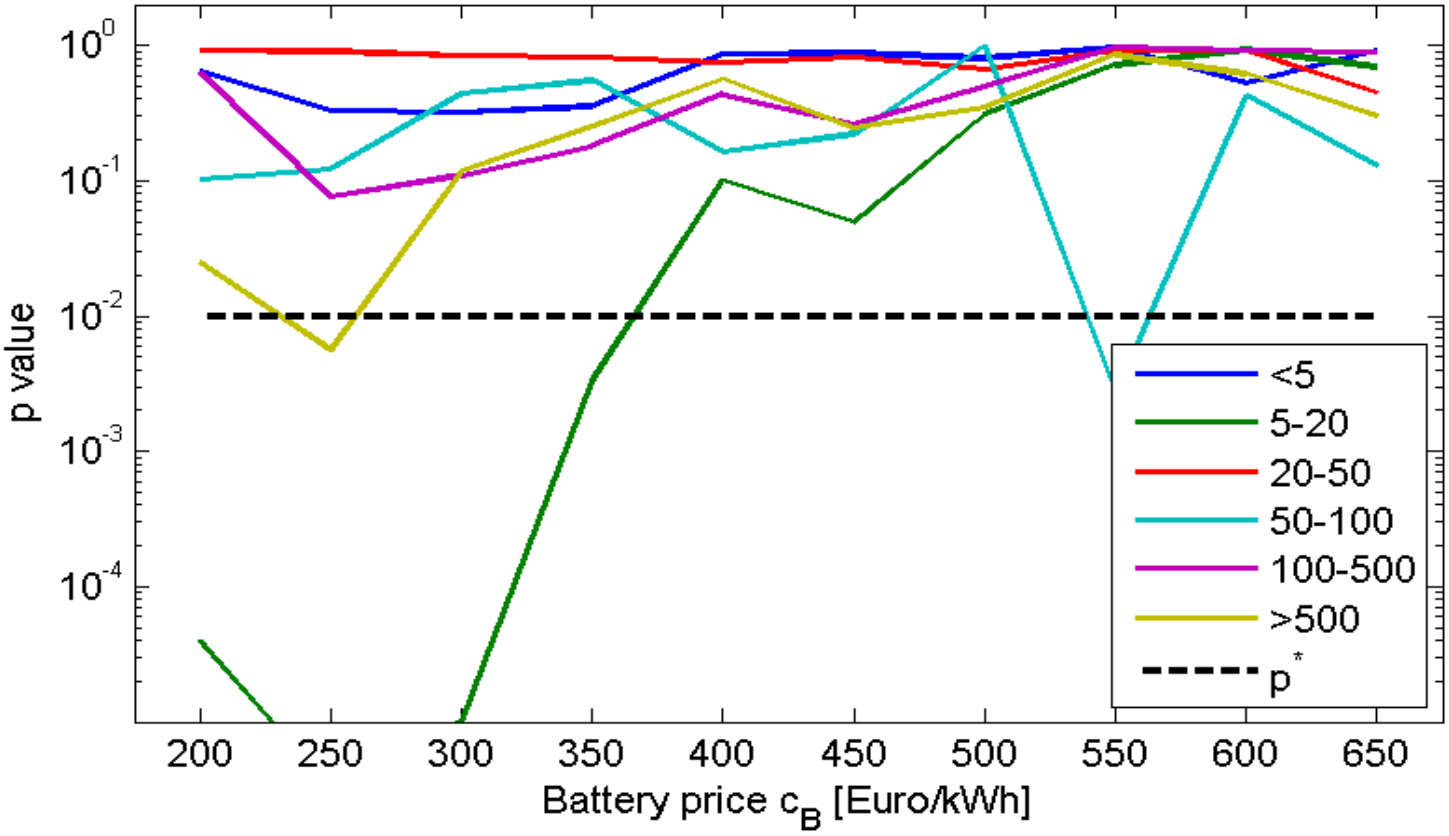
Sensitivity analysis: Significance also depends on **sub**sample size, e.g. costs

Full time workers: Significance of difference between expected & observed share



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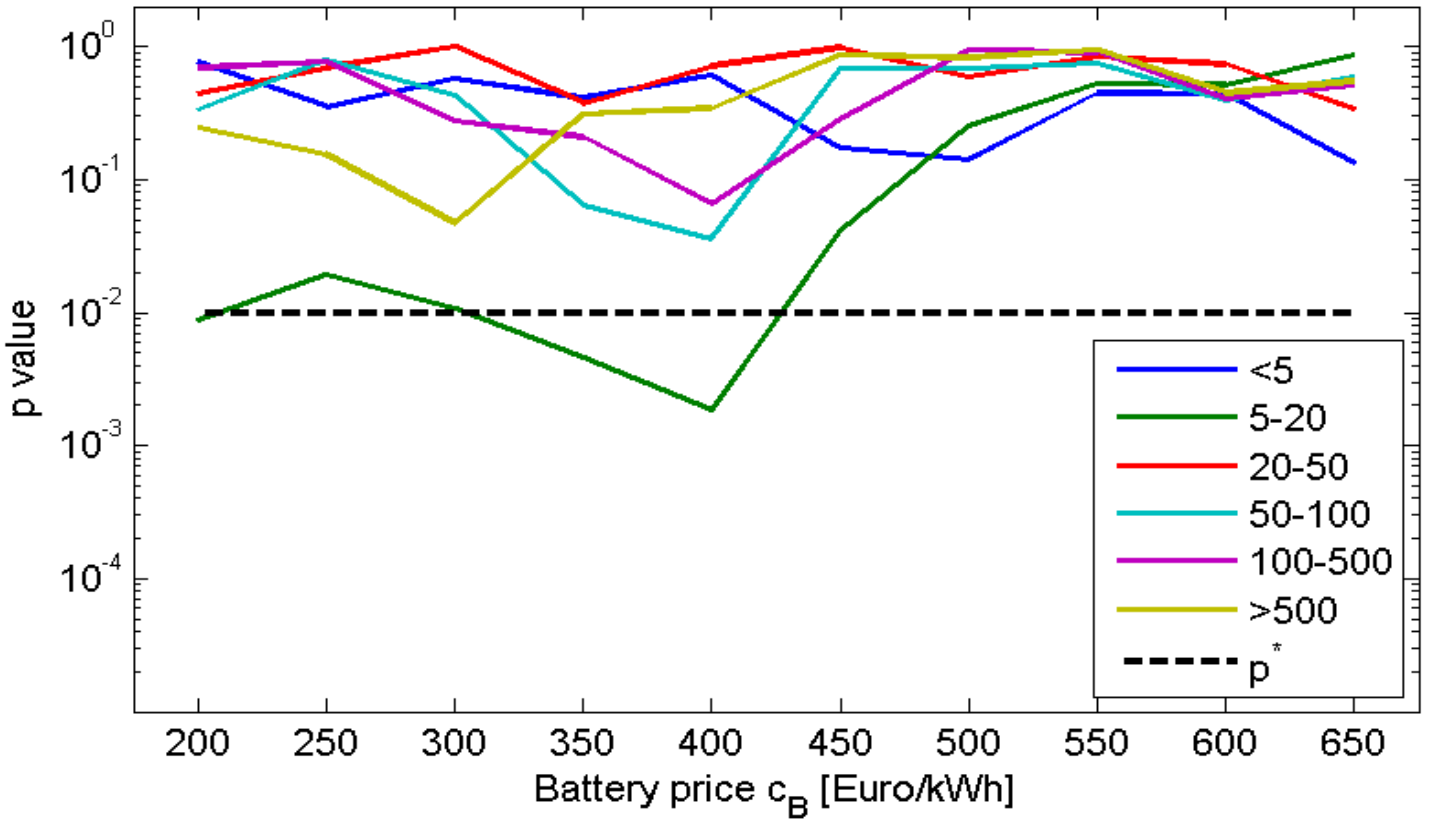
Sensitivity analysis: Significance also depends on **sub**sample size, e.g. costs

Part time workers: Significance of difference between expected & observed share



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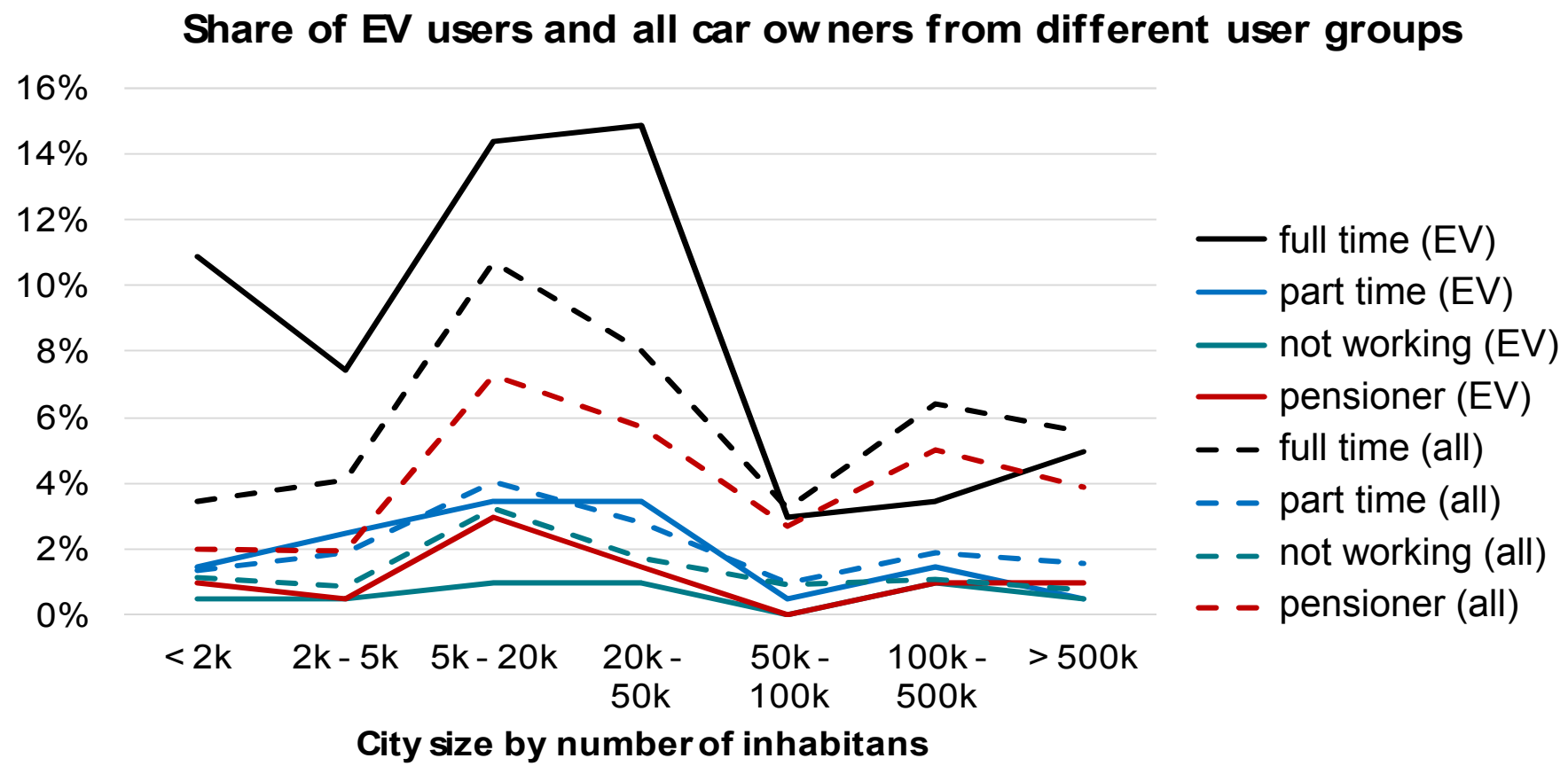
Comparison with other data: 6,500 driving profiles over one week from Germany



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Conclusions and discussion

- **Potential early adopter** of electric vehicles in Germany from an economical perspective **are full-time and part-time employees from small and medium sized cities**
- Economical early adopter in Germany do not live in big cities
- These findings consider only the total cost of ownership but are robust and consistent with broader studies on early adopter of EVs in Germany (Plötz et al. 2013)
- **Policy implication**: Public charging infrastructure in Germany is not pressing since garages are widely available in smaller cities in Germany

Thank you for listening!

Biere, Dallinger, Wietschel (2009). *Ökonomische Analyse der Erstnutzer von Elektrofahrzeugen*. Zeitschr. f. Energiewirtschaft 33.

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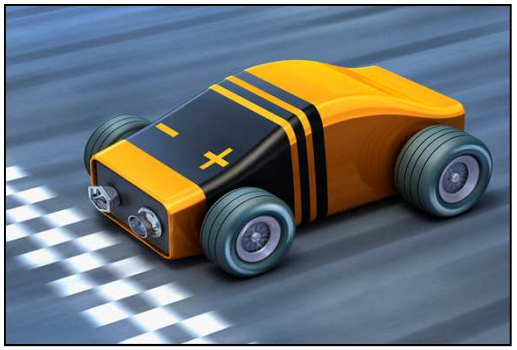

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Assumed technical and economical parameters for Germany in 2020

- Four vehicle types
- Distinction between in-city and out-of-city driving (average speed below/above 18 km/h)
- Prices for 2020: increasing fuel prices, decreasing battery prices

Group	Parameter	Unit	Gasoline	Diesel	PHEV	BEV
Technical	Inner city fossil fuel consumption	l/100 km	8.5	6.3	7.0	-
	Inner city electric energy consumption	kWh/100 km	-	-	18.2	18.2
	Out of city fossil fuel consumption	l/100 km	5.7	4.5	6.2	-
	Out o city electric energy consumption	kWh/100 km	-	-	20.7	20.7
	Battery capacity	kWh	-	-	10.0	24.0
Economical	Investment for vehicle w/o battery	Euro	23,276	25,656	25,620	21,885
	Electric driving share	-	0	0	60%	100%
	Battery price incl. VAT	Euro/kWh	-	-	400	400
	Fossil fuel price	Euro/l	1.90	1.79	1.90	-
	Electricity price	Euro/kWh	-	-	0.24	0.24
	Pay back period	a	8	8	8	8
	Interest rate for investment	-	5%	5%	5%	5%

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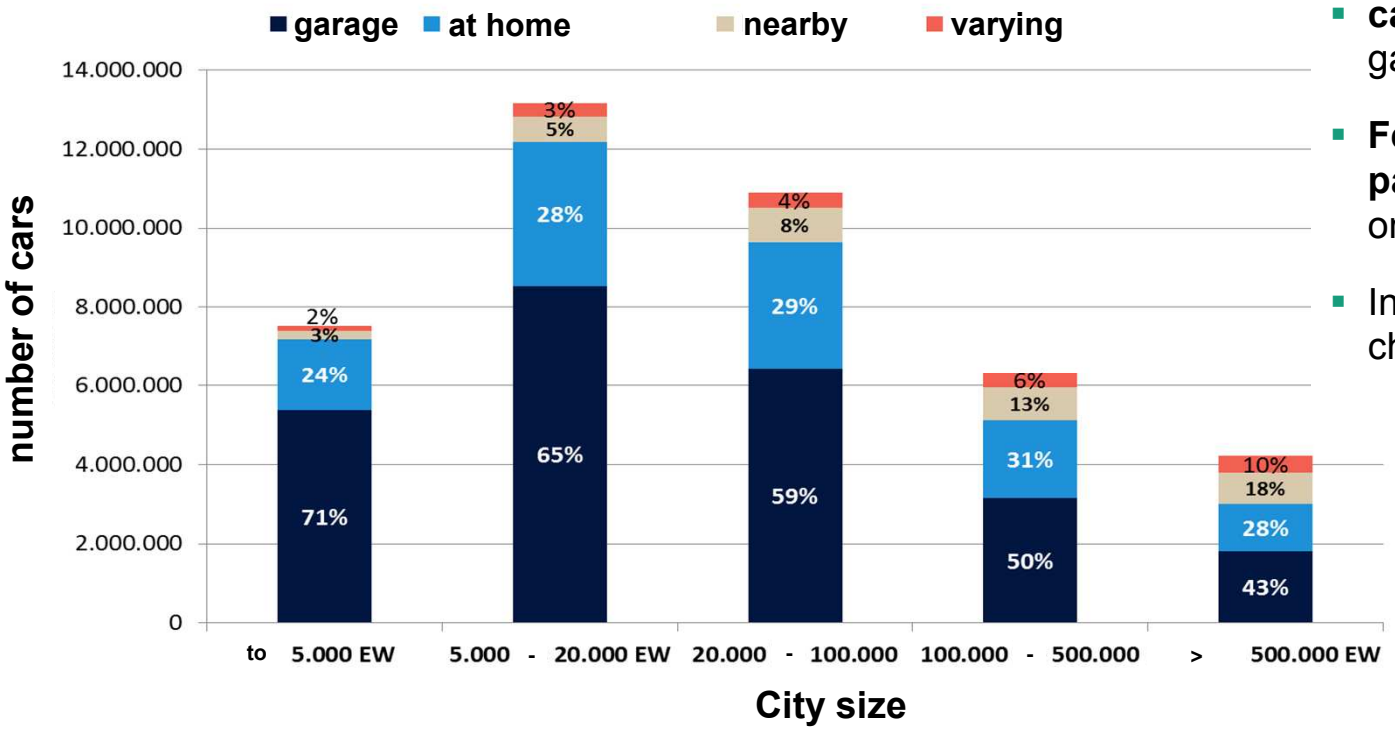
Most people could charge at home easily

Where do you park at night?



- **ca. 60%** of all car users park in a garage
- **Few people searching for parking :**
  only 11% do not park at home
- Installation of charging would be cheap and easy in a garage

source: own calculations based on “Mobilität in Deutschland” (2008)

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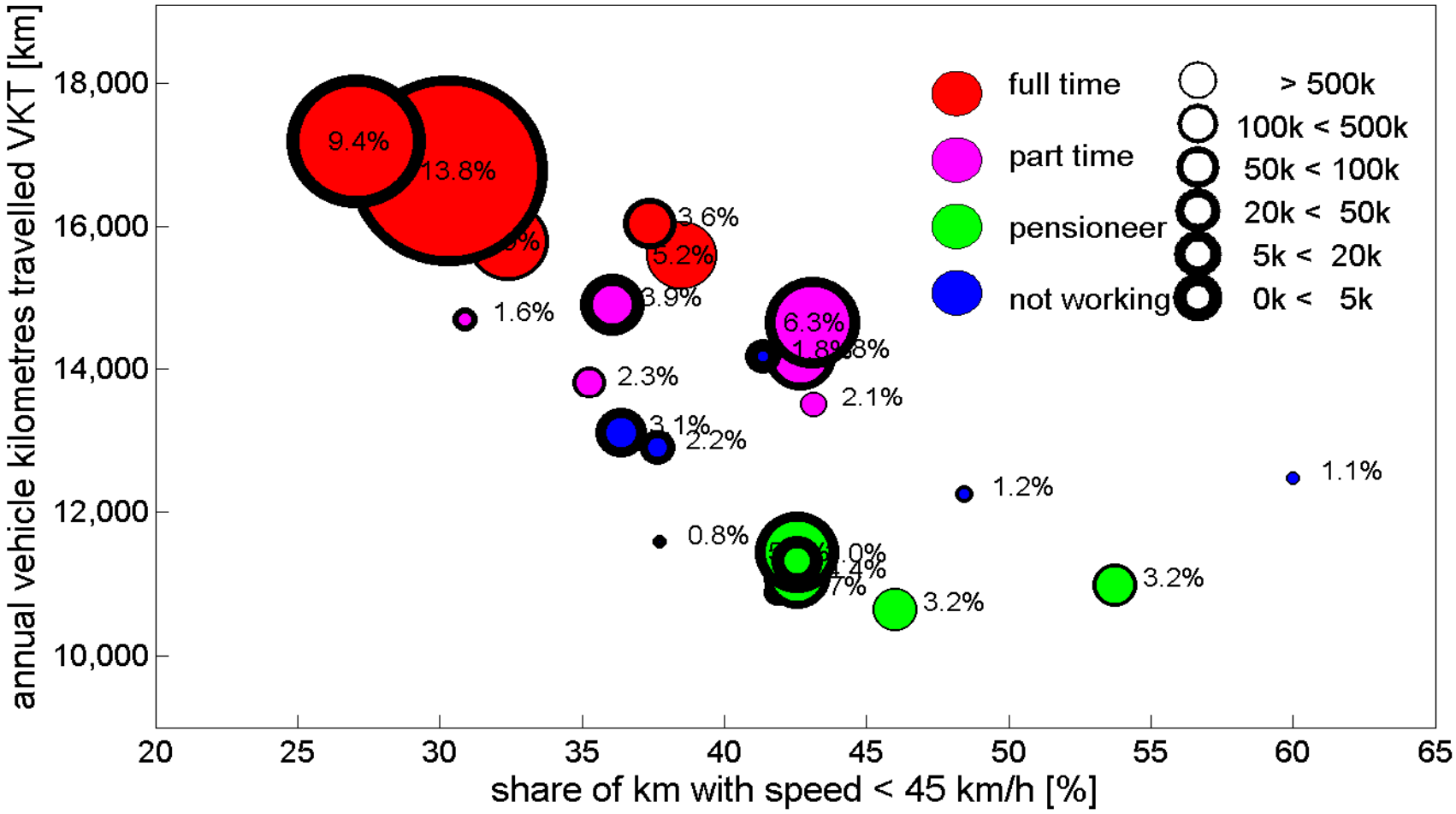
Summary statistics of vehicle users



Percentage denotes share of all German vehicle users

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