Modex EnSAVes

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

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How to integrate real-world user behavior into models for the market diffusion of alternative fuels in passenger cars - an in-depth comparison of three models for Germany

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Agenda

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1. Motivation
2. Research focus and methodology
3. Market diffusion models ALADIN, ASTRA, and TE3
4. Simulation results
5. Conclusions

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Motivation

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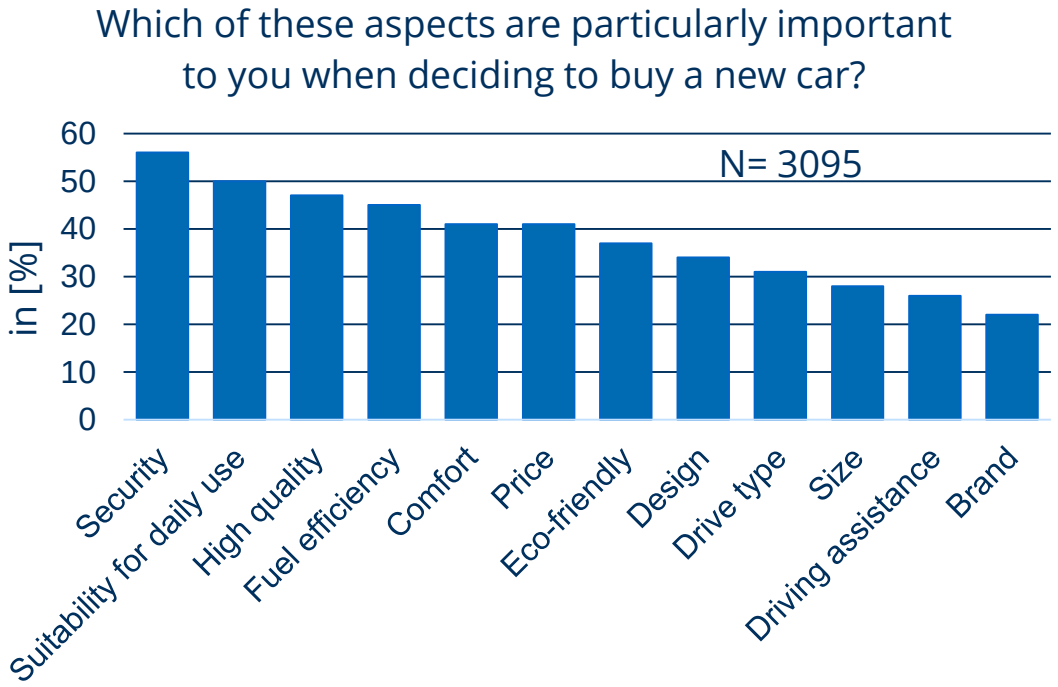
- Due to the CO_2 mitigation potential, the future market diffusion of alternativ fuels in the passenger car sector is of great interest.
- Indiviudal behavior/preferences have a major influence on the purchase decision of car buyers.
- The decision to buy a car is not totally objective and also reacts to non-cost-related aspects.

What is the most important (individual) aspect when deciding to buy a car?



The integration of individual user behavior makes

- the modelling of car market evolution challenging,
- the formulation of car purchase decisions in market diffusion models complex,
- but is decisive.

https://de.statista.com/prognosen/999760/deutschland-kaufkriterien-fuer-autos

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Research focus and methodology

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Research focus

Analysing the integration of real user behavior into market diffusion models and the related impacts.
Comparison of three different market diffusion models ALADIN, ASTRA, and TE3

Comparing the modeling approaches with focus on the integration of user behavior.

Simulation

Applying the market diffusion models
ALADIN ASTRA TE3

Defining two scenarios

Scenario 1
Using a harmonized dataset

Scenario 2
Using a dataset that allow some changes to the harmonized assumptions that suit best to each model

Result comparison

Comparison of the individual model results with regard to
- New passenger car registrations until 2030
- Passenger car stock until 2030
- Final energy consumption until 2030

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Market diffusion models ALADIN, ASTRA, and TE3

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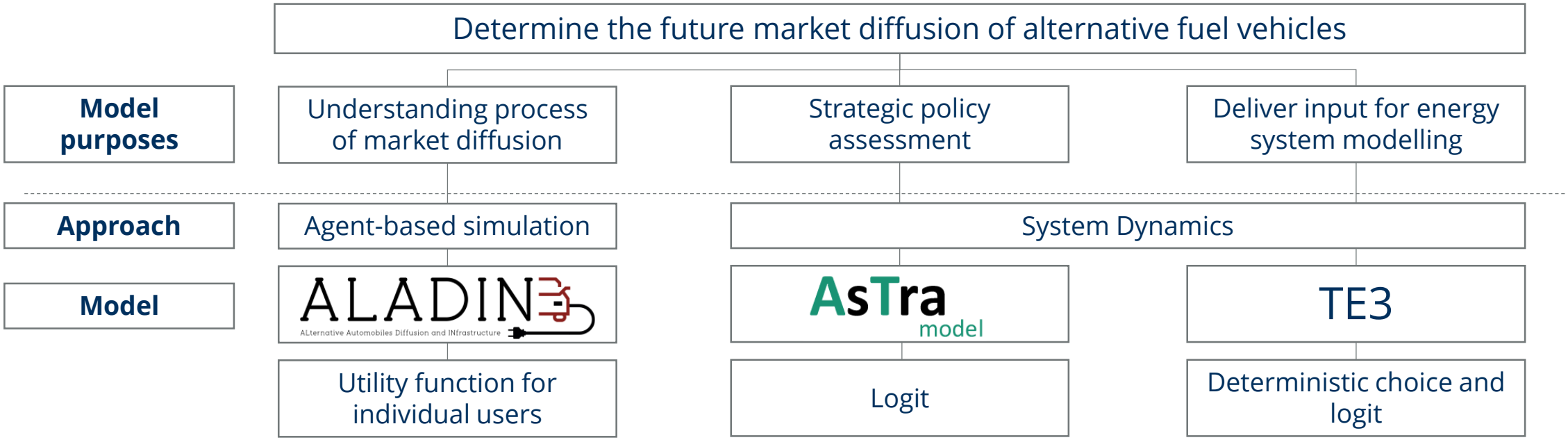
- Three models, two approaches, one target : Determining the future market diffusion of alternative fuel vehicles.



Different approaches to integrate real-world user behavior

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- Integration of the user behavior into the models using different user groups and different car attributes.

Attributes	ALADIN	ASTRA	TE3
Vehicle size classes	3	7	1
Drivetrains modeled	6	9	9
Buying decision	Utility function for individual users	Logit	Deterministic choice and logit for some
User distinction	3 user groups (private/ fleet/ company) with ~7000 driving profiles	2 user groups (private/commercial)	4 user groups with 2 types of sales
User behavior integration	Infrastructure cost, WTPM*, limited vehicle availability	Refueling cost function, limited vehicle availability	Complexity of choice varies by user group

* WTPM – willingness to pay more

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Simulation Input (Scenario 1)

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- Scenario 1: Input parameter for the harmonized dataset

Input parameter	ALADIN	ASTRA	TE3
Energy costs [kWh/km]	X	X	X
Vehicle data			
Investment for vehicle [EUR_{2018}]	X	X	X
OM costs [EUR_{2018}\km]	X	X	X
Taxes [EUR_{2018}]	X	X	X
Energy consumption factors [kWh\km]	X	X	X
Battery capacity [kWh]	X	X	X
Framework parameters			
Annual car registrations	X	O	X
Policy measures (purchase price reduction) [EUR_{2018}]	X	X	X
Amortization period and residual value [EUR_{2018}]	X	X	(-)
Duration of use [a]	(X)	O	(X)
Charging infrastructure	(X)	(X)	(X)
Driving profiles	(X)	(-)	(-)
Vehicle availability	(X)	(X)	(-)*

used in model: X, not used in model: -, endogenously calculated in model: O
not harmonized parameters are printed in brackets
***powertrain availability is included, but not powertrain model availability.**

Results Scenario 1: New passenger car registrations

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Please estimate the share of new registrations of alternative fuel vehicles in 2030.

Results Scenario 1: New passenger car registrations

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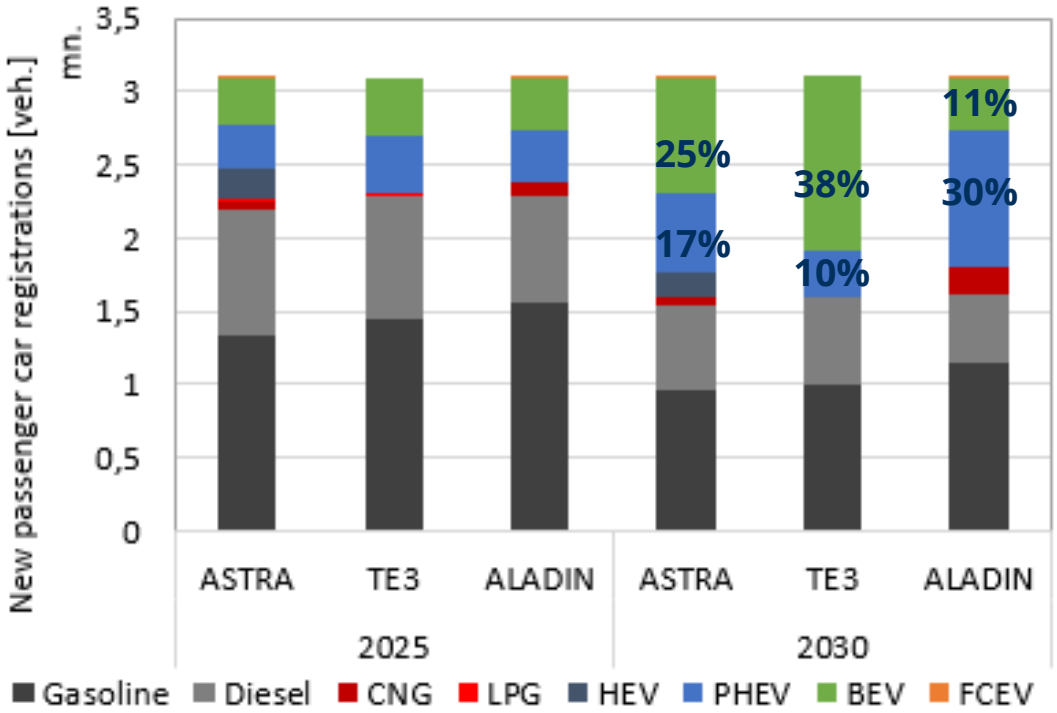

Key results:

- All models show large market shares of EV in Germany
- Ratio between PHEV and BEV differs significantly in the individual models especially in 2030.
- Gas vehicles are only represented in small shares.

Perspective user behavior:

- General replacement due to cost benefits. Modelling of user behavior (e.g. brand loyality) can have a decisive impact.
- Due to falling (battery) costs of BEV and expanding charging infrastructure, ASTRA and TE3 show a significant increase in BEV sales shares.
- ALADIN identifies the assumed PHEV to be economically beneficial for many driving profiles, leading to high PHEV sales.
- Actually the most cost-effective alternative. Lack of charging infrastructure & lack of vehicle choice leads to small shares.

Note: HEV are explicitly modelled in ASTRA and TE3.

Results Scenario 2: New passenger car registrations

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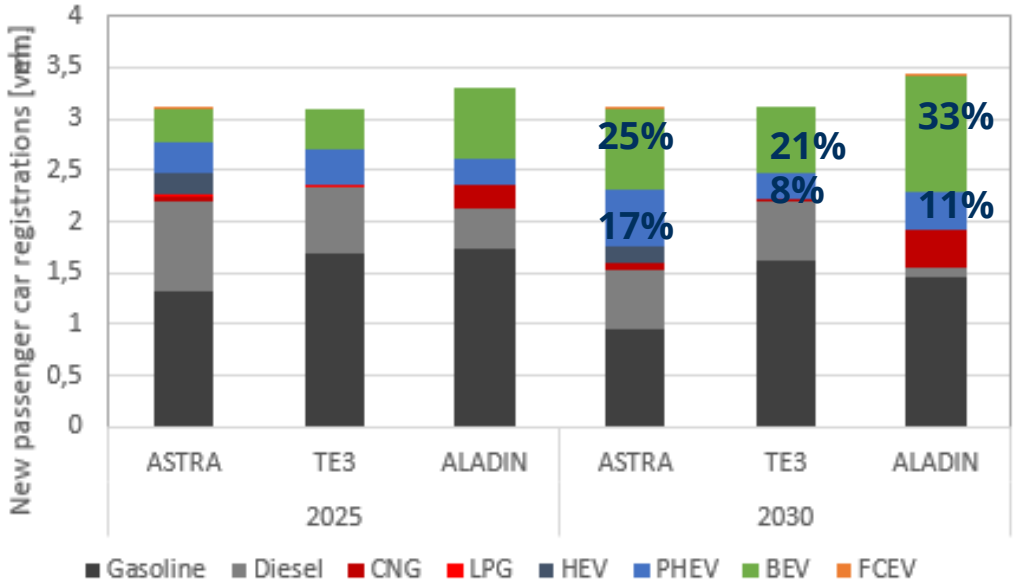

Key result:

- Changed shares of alternative drives

Perspective user behavior:

- More detailed analysis of different user groups with different driving behavior in ALADIN leads to a higher share of EV compared to Scenario 1.
- Consideration of different types of buyers (e.g. habitual buyers), the share of EVs decreases compared to Scenario 1.

Modifications:

- Model-specific input data.
- ALADIN contains its own assumptions for vehicle investments and uses the car registrations provided by ALADIN and their user-specific distribution.
- In TE3, the user behavior of the different consumer groups is changed.

- Partially changed ratio of PHEV and BEV
- In ALADIN the ratio of PHEV and BEV is changed (compared to Scenario 1) due to the consideration of de individual driving profiles and its own assumption for vehicle investments.

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Conclusion: Main drivers of results and lessons learned

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Main drivers:

	ALADIN (ALternative Automobiles Diffusion and INfrastructure)	AsTra model	TE3
	Utility function for individual users	Logit	Deterministic choice and logit
User behavior integration	Infrastructure cost, WTPM, limited vehicle availability	Refueling cost function, limited vehicle availability	Complexity of choice varies by user group
Strength	Individual driving profiles	Integrated assessment model with feedback loops	Different behavioral groups
Explanatory focus	understand the effects on individual users	capture multi-disciplinary cause and effect chains	understanding (non-monetary) consumer behavior

Lessons learned:

- All models have their specific use case, depending on the purposes of the models.
- For a model comparison, a balance must be found between the best possible calibration of the individual models and a unified data set for comparability of the results.
- Some basic model assumptions such as range anxiety should be reassessed and refined continuously in the models.

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Thank you for your attention!

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