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Unveiling Consumer Choices for Renewable Methane in Private Transportation: A Discrete-Choice Experiment Approach

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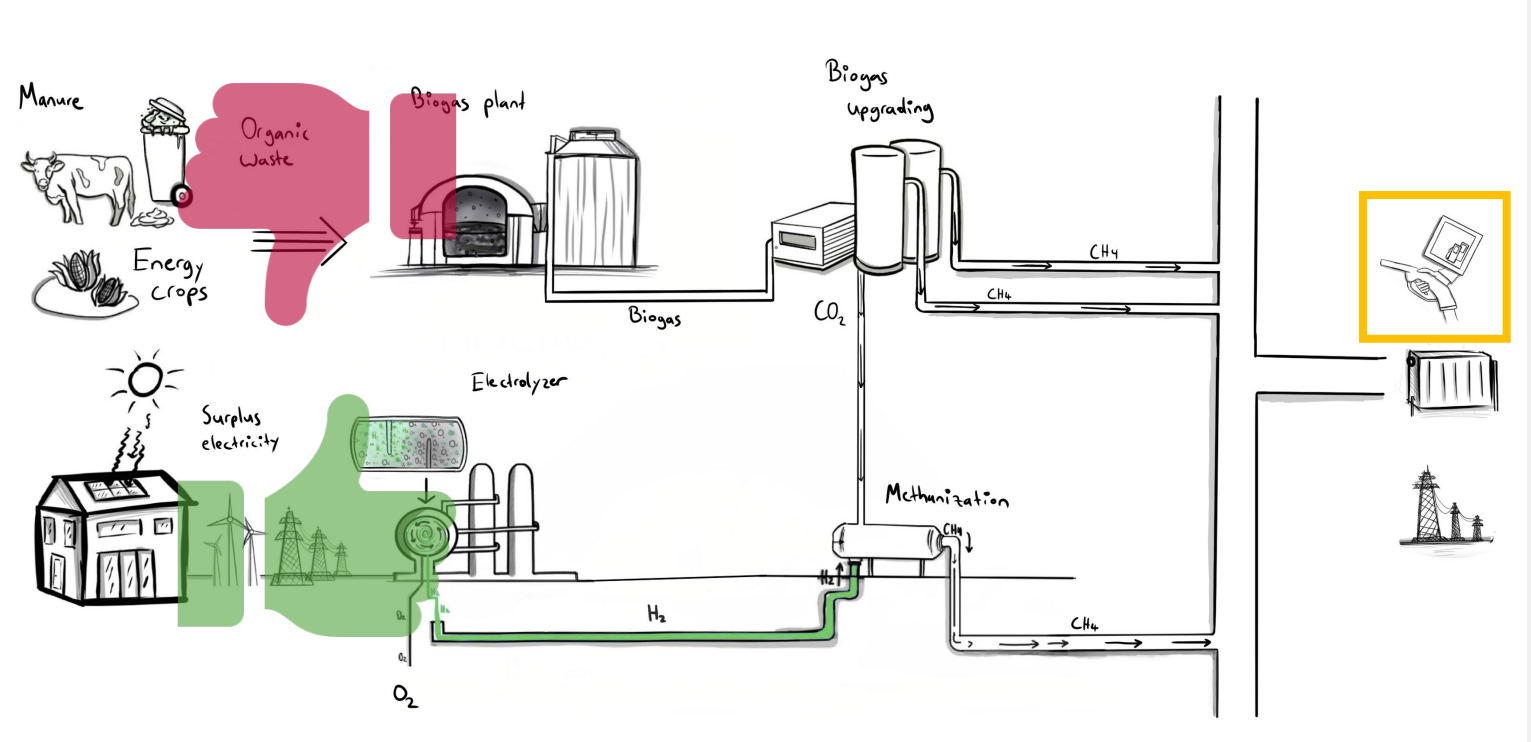
Benedikt Rilling & Prof. Dr. Carsten Herbes

Background and research question

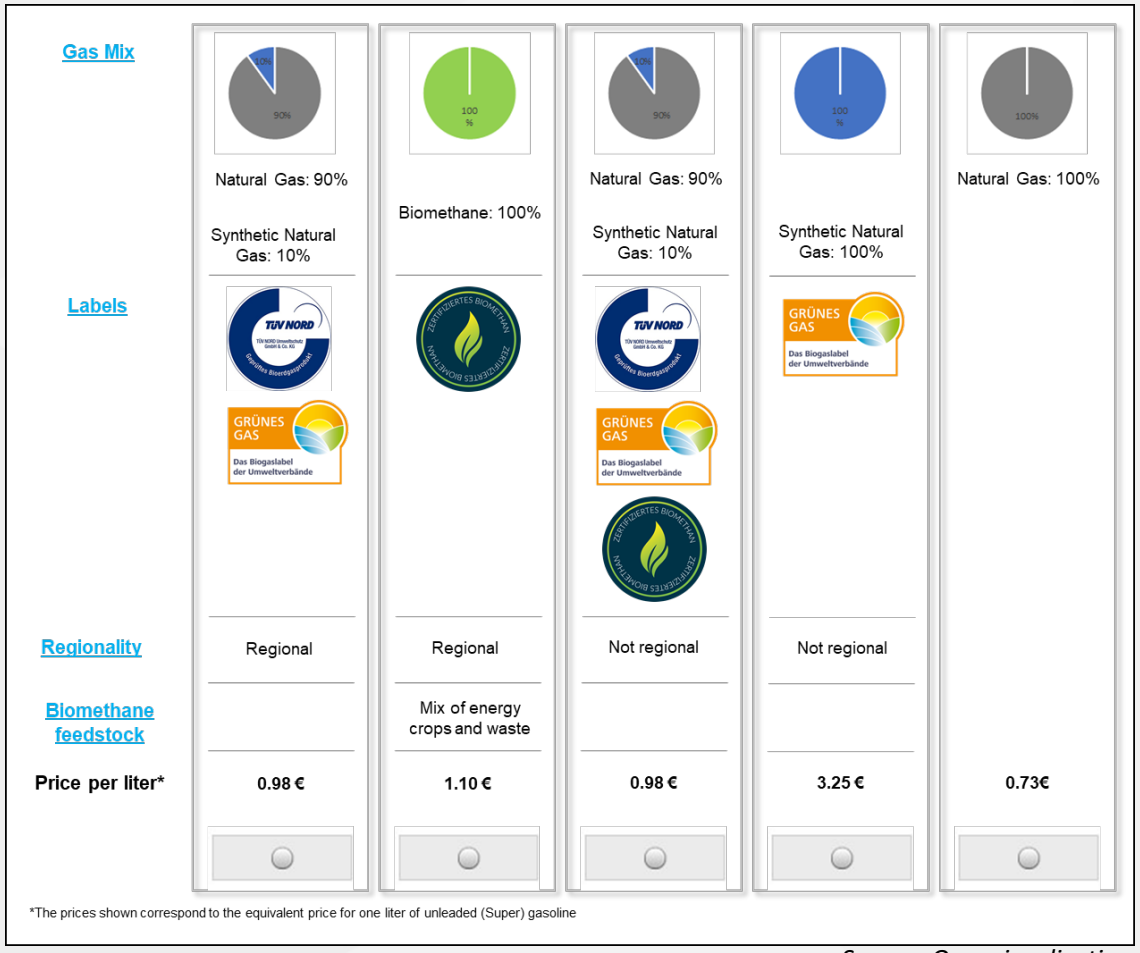
- Renewable gases offer great potential with regard to CO_2 emissions, import dependencies and energy security
- Focus: CNG market in Germany
- Successful adoption depends on consumer preferences and their willingness to use these alternatives
- ***RQ: How important are different attributes of renewable gas products to consumers in motorized private transportation?***
- German CNG market as “e-fuels case study”?!



Source: Own visualization

Methodology

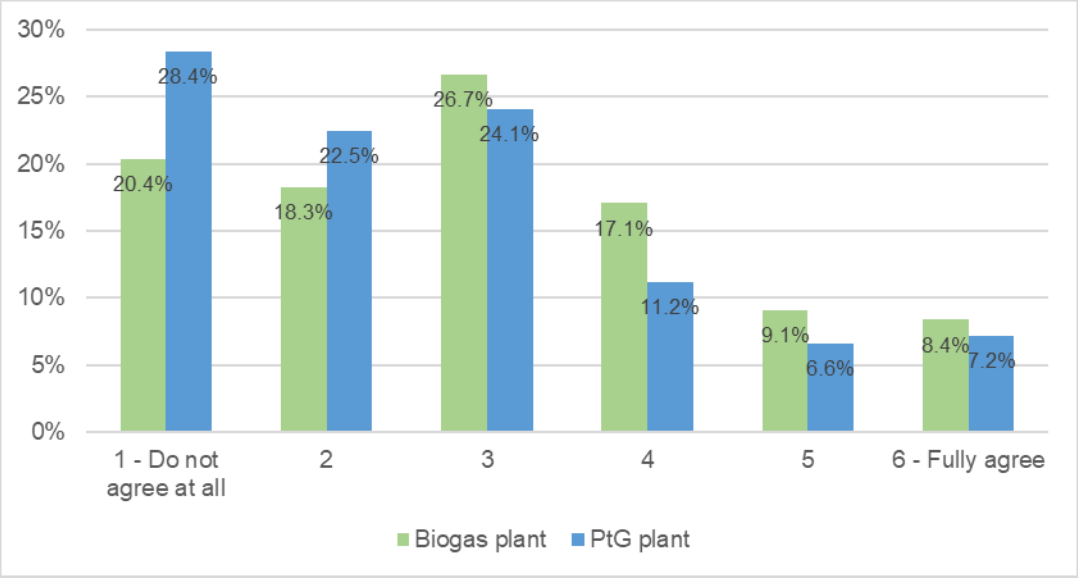
- Discrete-Choice-Experiment
- Calculation of an equivalent price
- Production of an explanatory video: check here
- Data collection in May and June 2021 via national panel
- **573 respondents, i.e. active 6,303 choices**
- Hierarchical Bayes (HB) estimation approach to calculate part-worth utilities on a pseudo-individual level to determine consumer preferences (Hein et al., 2020; Orme, 2010; Rossi, 2014)
- Model performed well (Côté et al., 2022; Hille et al., 2018):
  - Pseudo-R^2: 0.52
  - RLH: 0.46



Source: Own visualization

Results 1: Knowledge

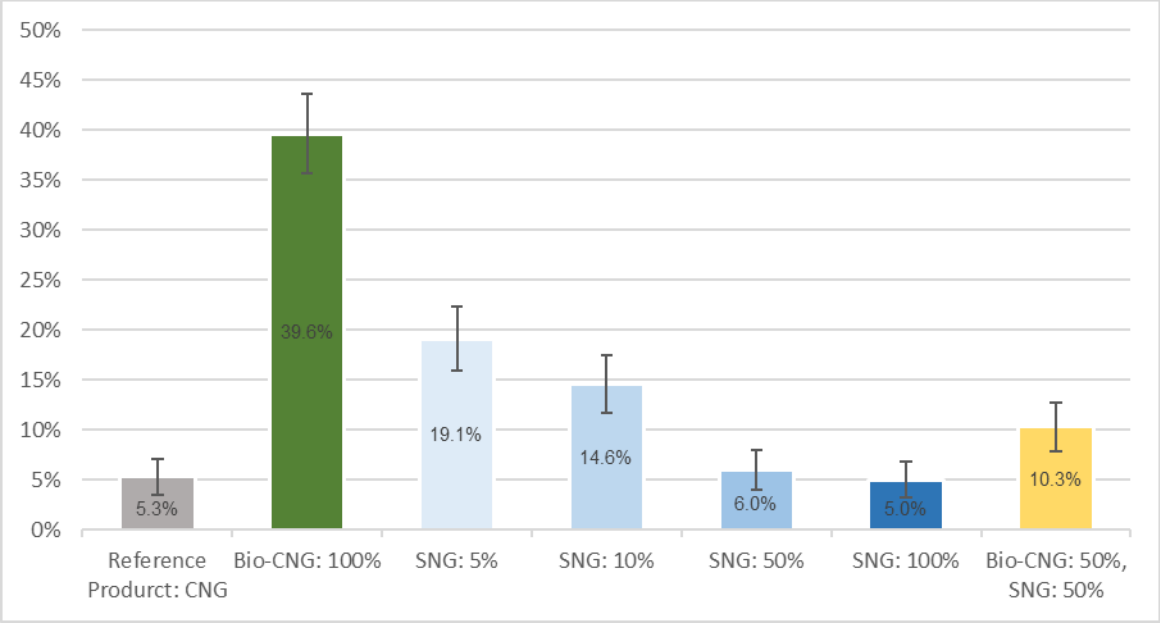
- CNG- and LPG-drivers are slightly overrepresented in the sample
- Almost 2/3 know about the possibility to replace CNG with renewable alternatives (i.e., Bio-CNG)
- Clear knowledge gaps for the two underlying technologies (i.e., biogas and PtG)
- More pronounced for PtG



Self-assessed knowledge about the functionality of a biogas and PtG plant ("I know how a biogas/PtG plant works"; n=573

Results 2: Preference Shares

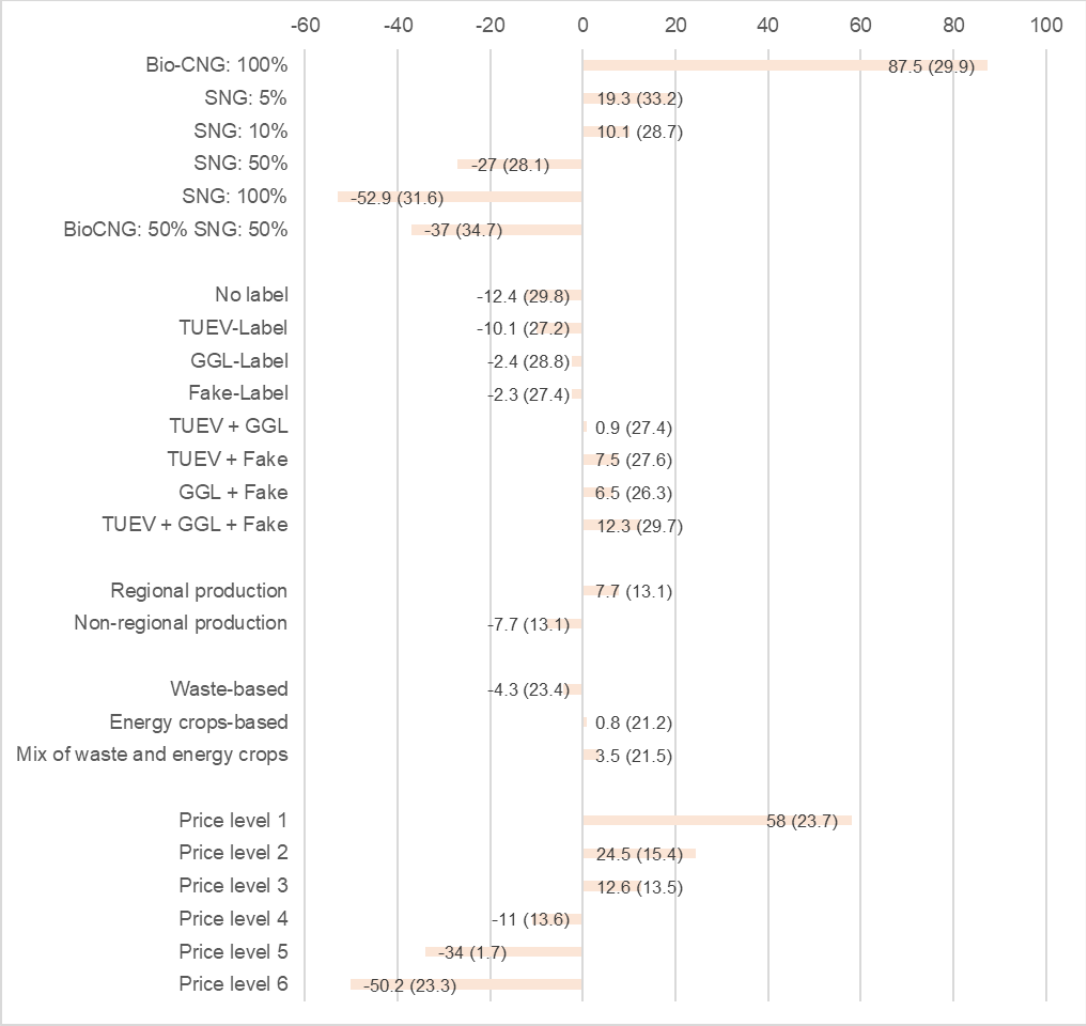
- Fictional scenario with 0% price increase
- **Bio-CNG is preferred** over any SNG share
- Preferences for SNG decline with increasing share in the product and in the mix product
- Bio-CNG appears to make SNG more attractive



Preference Shares for 0% price increase (n=573), error bars indicate 95% Confidence Intervals

Results 3: Utility values

- Importance scores:
  - Gas Mix most important attribute (41.5 %)
  - Price and labels almost equally important
  - Regionality and feedstock clearly less important
- Bio-CNG is clearly favored over SNG
- So are low price levels (no surprise)
- Labels:
  - “More, the merrier” effect
  - Confusion caused by fake label



Zero-centered mean utility values from the HB mode, standard deviations in brackets (n=573)

Conclusions

- Fuel market still characterized by insecurity and knowledge gaps (Linzenich et al. 2019, 2023)
- Shift in public perception: Reservations about biomass-based fuels appear to have diminished (Rilling et al., 2024; Agency for Renewable Energies, 2022)
- “Food vs. fuel” vs. import dependencies and energy security?
- Consumer preferences are well reflected in the market supply in Germany
- CNG market as good example for:
  - Low-involvement product in a voluntary market
  - Steered by market-based policies towards significantly lower CO_2 emissions
  - Without noticeable consumer backlash as, e.g. observed for the introduction of E10 (Tosun, 2019)
- Channeling SNG (i.e., an e-fuel) into private transportation should be considered carefully

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Thank you for your attention!

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https://www.hfwu.de/benedikt-rilling/

Literature

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Back-Up: DCEs´ theoretical assumptions

- Consumption theory according to Kevin Lancaster (1971): Features or characteristics (=attributes) of products and services are demanded by consumers, not the product itself
- Random Utility Theory according to McFadden (1986): Consumers make their decisions on the basis of the utility they derive from the various product characteristics. This utility is to be maximized:

$$U_{in} = V_{in} + \varepsilon_{in}$$

Back-Up: Product attributes and levels

Attributes		Attribute Levels
(1) Gas-Mix	Bio-CNG Share	50% 100%
	SNG Share	0% 5% 10% 50% 100%
	CNG Share	0% 50% 90% 95% 100% (Reference Product)
(2) Labels		No label, TÜV, GGL, Fake, TÜV + GGL, TÜV + Fake, GGL + Fake, TÜV + GGL + Fake
(3) Regionality/ Proximity		No regional production Regional production
(4) Biomethane Feedstock		Energy Crops, Waste, Mix of energy crops and waste
(6) Yearly Price		→ Various product-specific price increases

Back-Up: Price levels

Level	Bio-CNG: 100%	SNG: 5%	SNG: 10%	SNG: 50%	SNG: 100%	Bio-CNG: 50%, SNG: 50%	Reference Product (100% CNG)
1	0.73	0.73	0.73	0.73	0.73	0.73	0.73
2	0.92	0.77	0.77	0.92	1.10	0.92	
3	1.10	0.81	0.81	1.10	1.47	1.10	
4	1.47	0.86	0.88	1.83	2.93	1.47	
5	1.83	0.88	0.98	1.99	3.25	2.15	
6	2.20	0.92	1.11	2.63	4.52	2.59	

Back-Up: Labels

GRÜNES GAS
Das Biogaslabel der Umweltverbände

TÜV NORD
TÜV NORD Umweltschutz GmbH & Co. KG
Geprüftes Bioerdgasprodukt

ZERTIFIZIERTES BIOMETHAN
ZERTIFIZIERTES BIOMETHAN