Willingness to invest in PV homestorage systems - a representative study of German homeowners

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Why PV-homestorage systems?

- **With higher shares of volatile renewable energy, the need for possibilities to store energy and to increase system performance rises (Roberts & Sandberg, 2011)**
- **Private homeowners could play a crucial role in disseminating stationary batteries as energy storage and therefore contribute to a reliable defossilized energy system**
- Yet, the value heavily depends on the extent to which storages are used for grid stability purposes **<->** studies on consumer preferences for homestorage systems show that self-sufficiency and grid independence are of importance to homeowners (Agnew & Dargusch, 2017)
- **Homestorage systems for private homeowners are a relatively „new" technology with (ongoing) discourse on: financial attractiveness, environmental friendliness (IEA, 2020), private vs. community storage (Gissey et al., 2019; Kalkbrenner, 2019), among others**

Research questions

1. What is the influence of different technology attributes on the willingness to invest in PV-homestorage systems?

2. To what extent do individuals value grid independence over providing system flexibility?

Research conducted within the Project „SozioE2S: Open Source Energy System Modelling"
Project Funding: Federal Ministry of Economic Affairs and Energy (BMWi/BMWK)

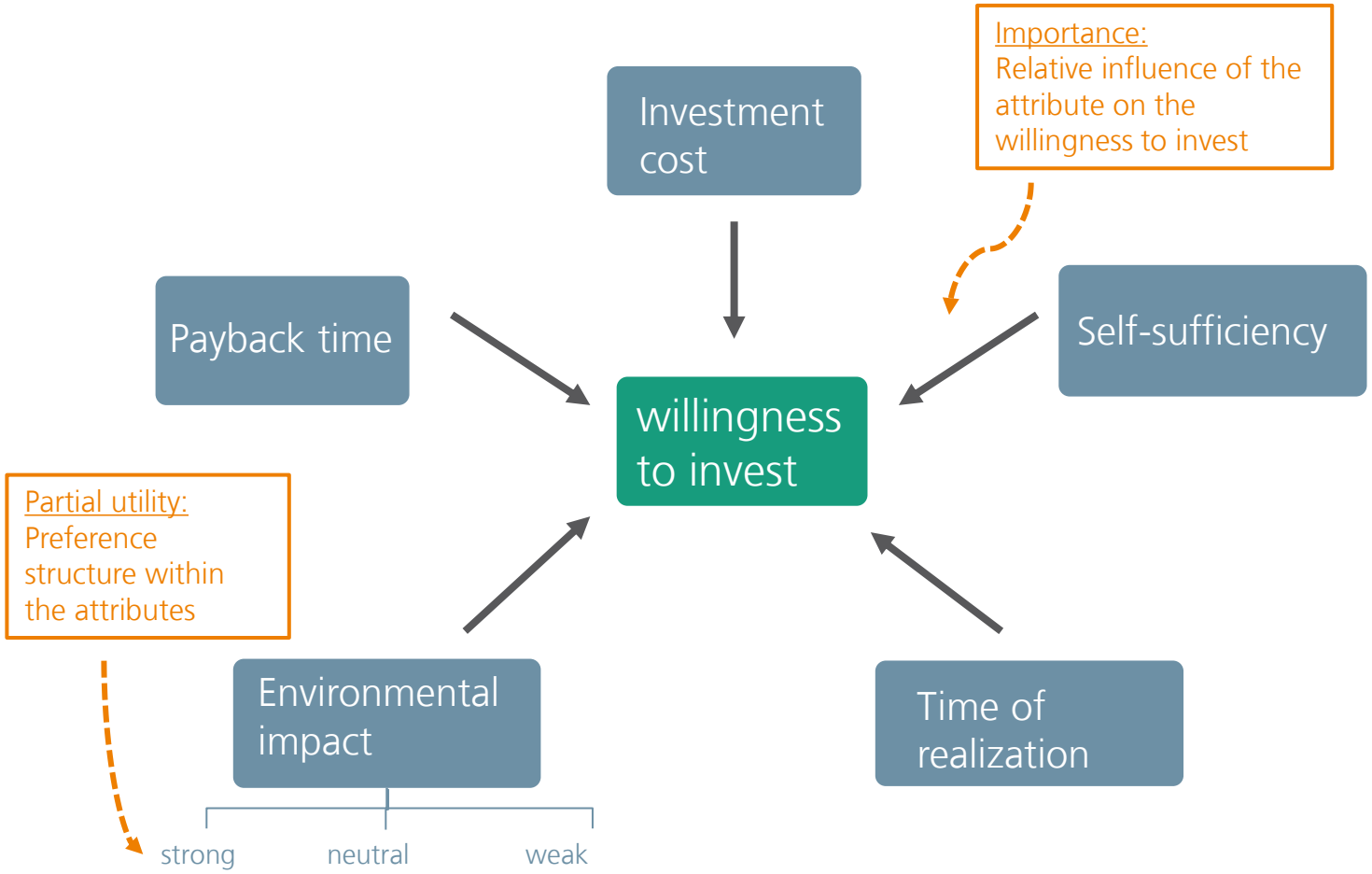
Method

Discrete choice experiment and survey

Combination of questionnaire study and discrete choice experiment

Survey conducted in 2018 by a market research institute (through a panel) with homeowners of single-family detached, semidetached and row houses in Germany

Participants were financially compensated



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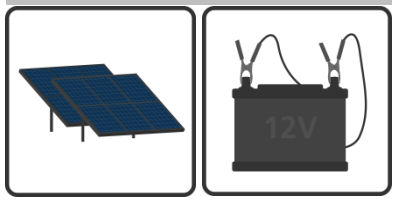
Example of choice cards for PV storage systems

Private investment decision

Which one of these options would you prefer?

Time of realization	Within the next year	After 15 years	In between 7-15 years
Investment cost	1200€	9000€	9000€
Payback time/ IRR	~10 years/~8% return	~10 years/~8% return	~15 years/~5% return
Degree of self-sufficiency	40%	80%	60%
Environmental impact	Materials ecologically harmful, no recycling	Materials partially harmful, partly recyclable	Materials ecologically harmless, fully recyclable

Product



Would you really buy this option? Yes/no

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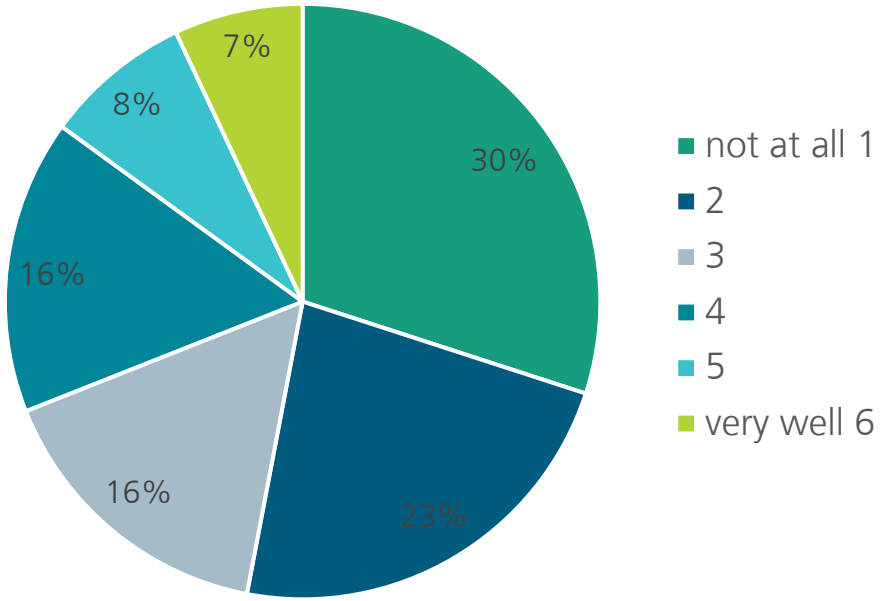
Results

Sociodemographics

- ***N*** **= 1498 houseowner (f = 741, m = 756, diverse = 1)**
- **Quota sample mirroring German population in age, gender, income, education, federal state**
- **Age: *M* = 48,9 (*SD* = 12,4)**
- **N_{woPV} = 1256 (84%), N_{withPV} = 179 (12%), $N_{withPVB}$ = 63 (4%)**

„How well informed do you think you are about PV homestorage systems?“



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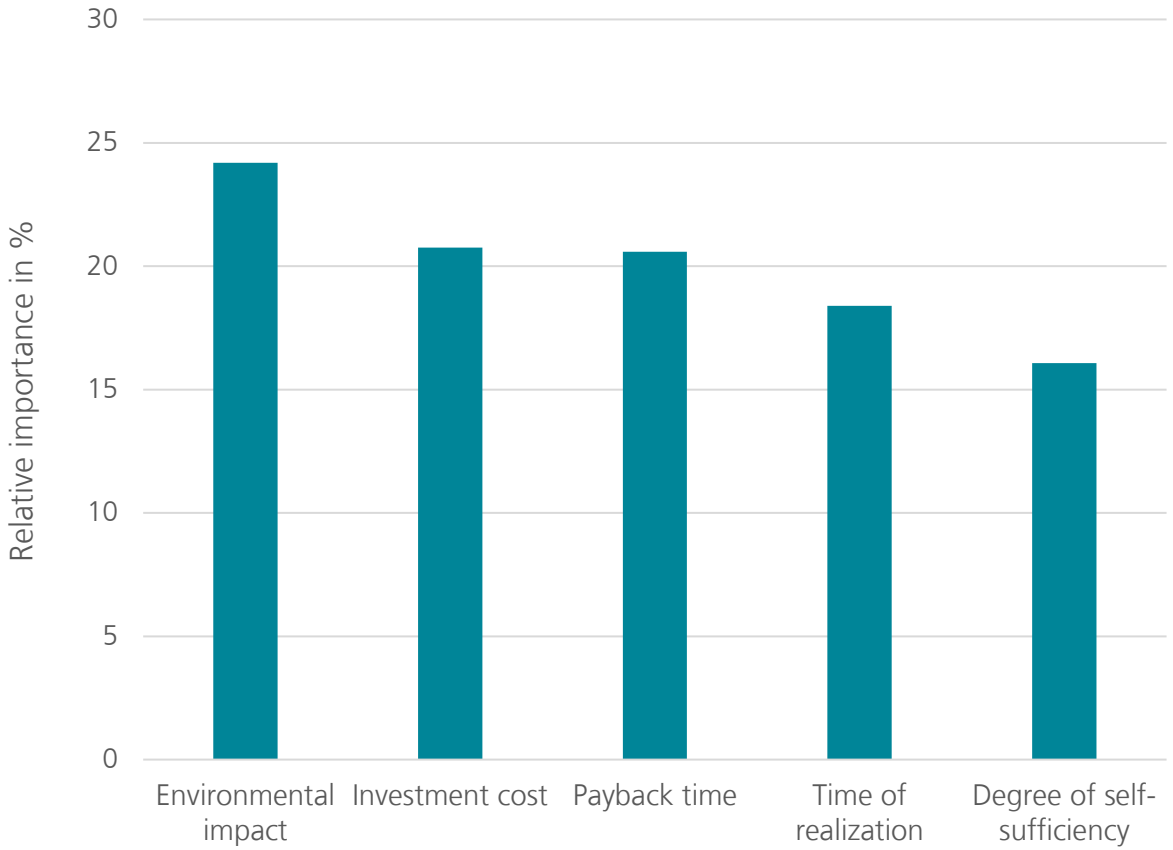
Results

Discrete choice experiment – attribute importance



- **Environmental impact of PV homestorage systems is important to potential customers**
- **In our sample recyclability and harmless materials revealed to be of highest influence on willingness to invest among all attributes**
- **Degree of self-sufficiency was the least important attribute for the willingness to invest**

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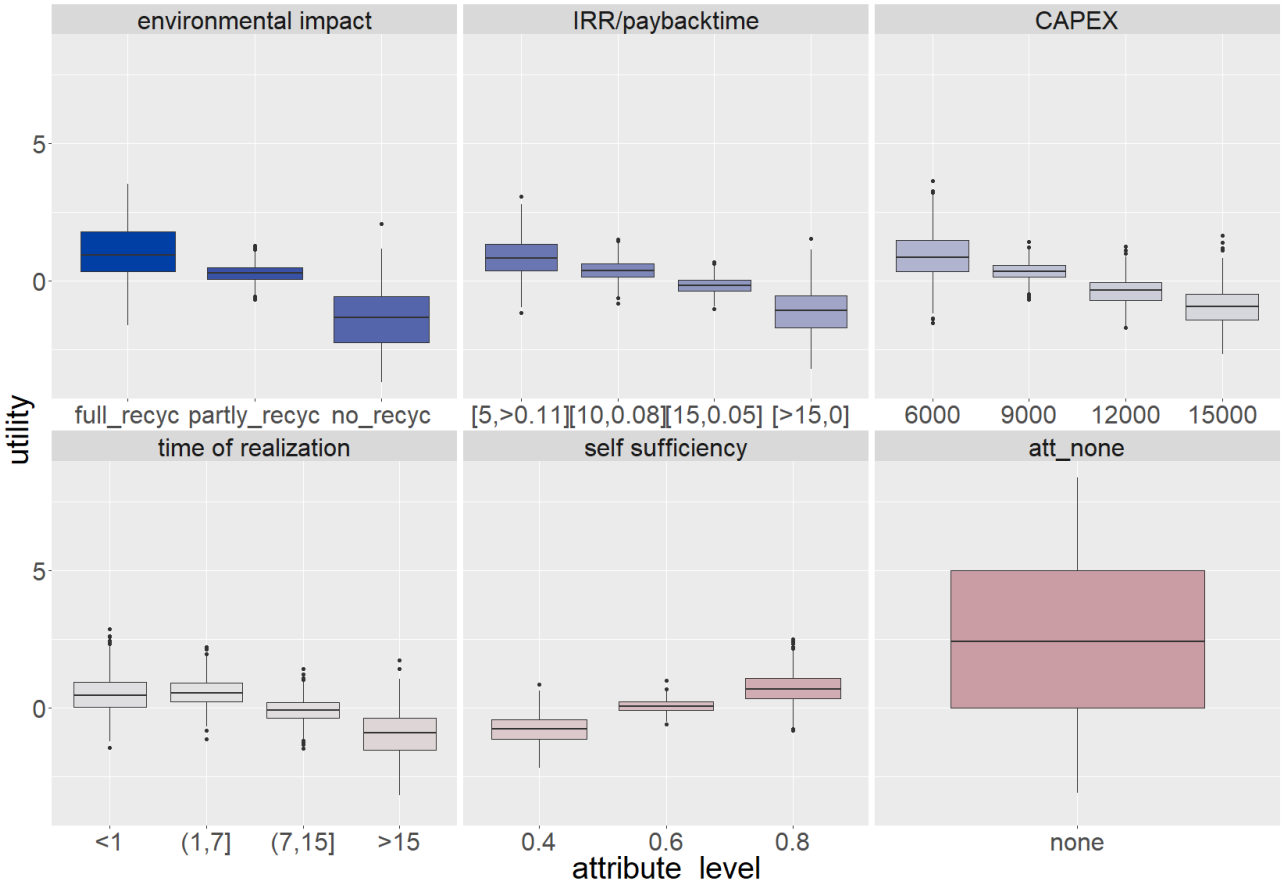
Results

Zero-centered indidivual partial utilities of PV-homestorage systems



- **Full recycling and harmless matierials revealed a higher utility to participants than less environmentally-friendly materials**
- **Shorter payback times, lower investment costs and higher degrees of self-sufficiency were related to higher utilities**

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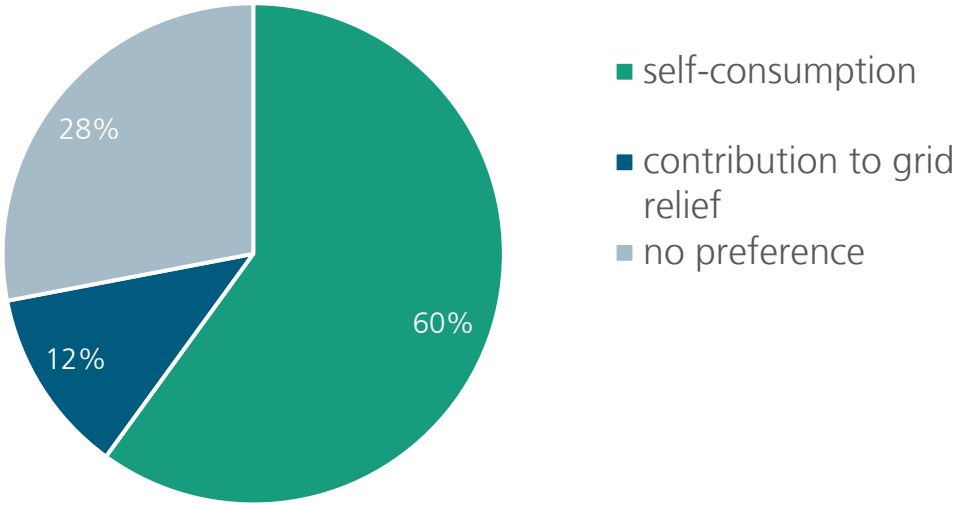
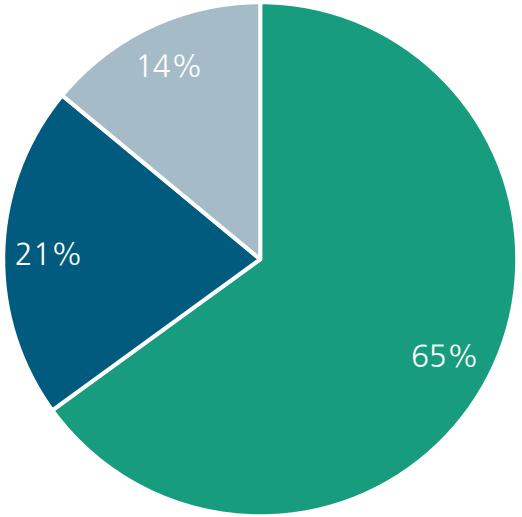
Results

Self-consumption vs. grid relief

Which mode of operation do you prefer?
(all participants)



Which mode of operation do you prefer?
(participants already owning a homestorage system)



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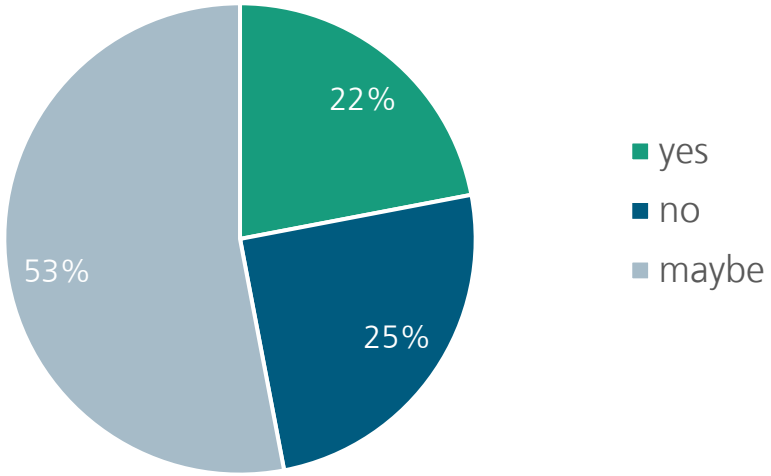
Results

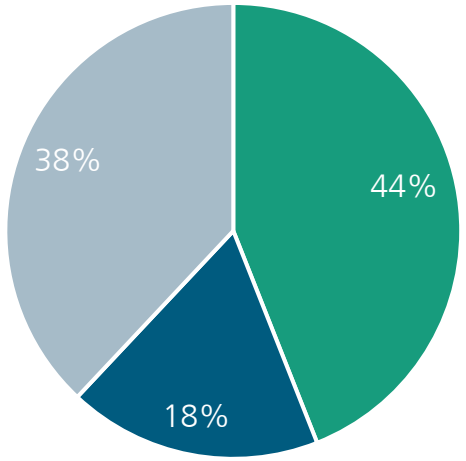
Provision of flexibility

„Would you allow your photovoltaic battery storage system to be operated by third parties so that you can contribute to the flexibility of the system with your system?“

Flexibility provision
(all participants)



Flexibility provision
(participants already owning a homestorage system)



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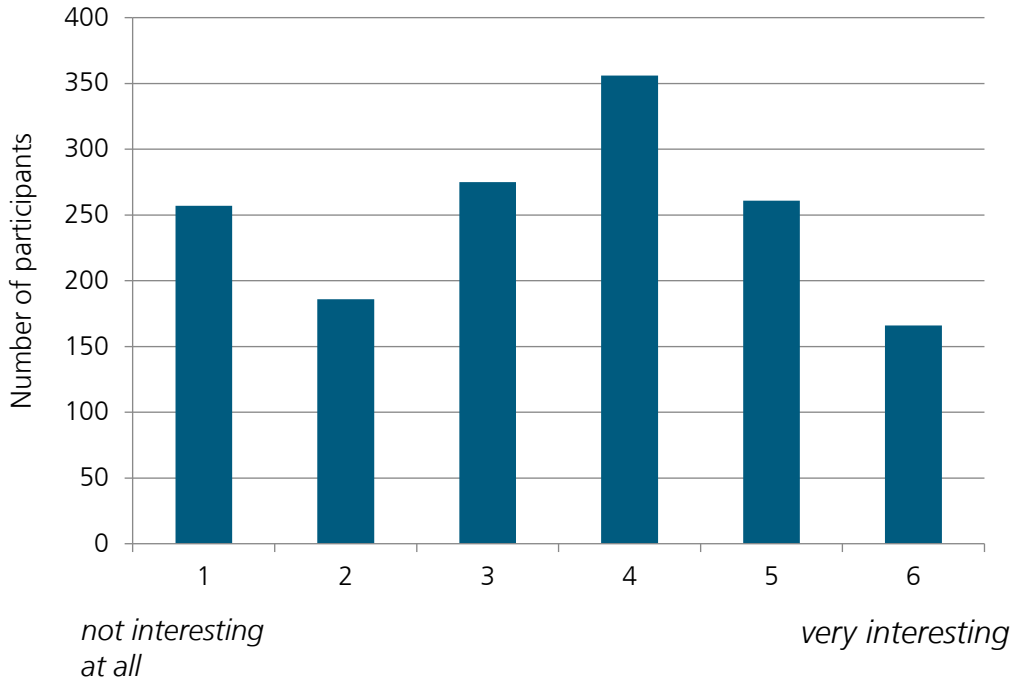
Results

Neighbourhood storage

„Would you be interested in participating in a joint electricity storage system in the neighbourhood?“



- M_{total} = 3,45 (*SD* = 1,59)

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Discussion

- **Environmental friendliness and recyclability are relevant factors for the attractiveness of PV homestorage systems, in our choice experiment even more important than investment costs**
- **Participants valued higher degrees of self-sufficiency but many were open to provide system flexibility, especially amongst homeowners already owning a homestorage system -> need for business models**
- **Limitations exist**
- Only few of the participants indicated to be well informed about homestorage systems (which might bias results); no real-world implications of a choice experiment; results dependent on level values
- **Nevertheless: Overall, homeowners not only have the potential, but, to a great extent, also have the willingness to contribute to a reliable defossilized energy system, especially when environmentally harmless materials are used**

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Literature

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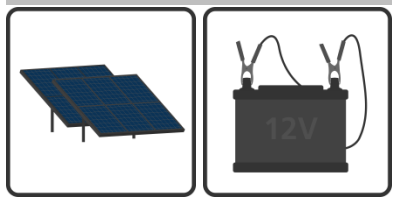
Attribute levels

PV storage system

Attribute	Level	
Time of realization	Short-term (1-2 years))	
	Mid-term (in 3-7 years)	
	Long-term (in 8-15 years)	
	More than 15 years	
Investment cost	PV+ Battery Storage	Only storage
	6.000 Euro	2.000 Euro
	9.000 Euro	5.000 Euro
	12.000 Euro	8.000 Euro
	15.000 Euro	11.000 Euro
Payback time and IRR	PV+ Battery Storage	Only storage
	ca. 5 years / >11% IRR	ca. 5 years / ~8% IRR
	ca. 10 years / ~8% IRR	ca. 8 years / ~5% IRR
	ca. 15 years / ~5% IRR	Payback within lifetime but no return on invest
	Payback within lifetime but no return on invest	bigger 10 years; negative IRR
Degree of self-sufficiency	40%	
	60%	
	80%	
Environmental Impact	Uncritical materials, full recyclable	
	Partly critical materials, partly recyclable	
	Critical materials, no recycling	

Model logic

Private investment decisions – example PV homestorage system

Technology	Attributes	Empirical data
	❑ Time of realization ❑ Investment cost ❑ Payback time IRR ❑ Degree of self-sufficiency ❑ Environmental impact	❑ Discrete Choice Experiment ❑ Conjoint Analysis ➢ Attribute Utilities ➢ Importance

Adoption

$$U_{ti} = \beta_{time}\, x_{time,t,i} + \beta_{Invest} x_{Invest,t,i} + \beta_{payback} x_{payback,t,i} + \beta_{self\_sufficiency} x_{self_{sufficiency},t,i}\, \epsilon_{ni} + \beta_{environ} x_{environ,t,i} + \epsilon$$

$$V_{ti} = \beta_{time}\, x_{time,t,i} + \beta_{Invest} x_{Invest,t,i} + \beta_{payback} x_{payback,t,i} + \beta_{self\_sufficiency} x_{self_{sufficiency},t,i}\, \epsilon_{ni} + \beta_{environ} x_{environ,t,i}$$

$$P_{ti} = \frac{\epsilon_{ni} \exp(V)}{\sum_{j=1}^{J} exp(V)}$$