AGRIPHOTOVOLTAICS IN AN URBAN AREA –

AN ECONOMIC ANALYSIS CONSIDERING LOCAL CLIMATE CHANGE RISKS

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Wandel gestalten

PRACTICAL RELEVANCE

Source: https://www.bmel.de/DE/themen/landwirtschaft/flaechennutzung-und-bodenmarkt/flaechenverluste-landwirtschaft.html

Agricultural area loss [1]

Energy transition [2]

Source: https://www.bmbf.de/bmbf/de/forschung/energiewende-und-nachhaltiges-wirtschaften/energiewende/energiewende_node.html

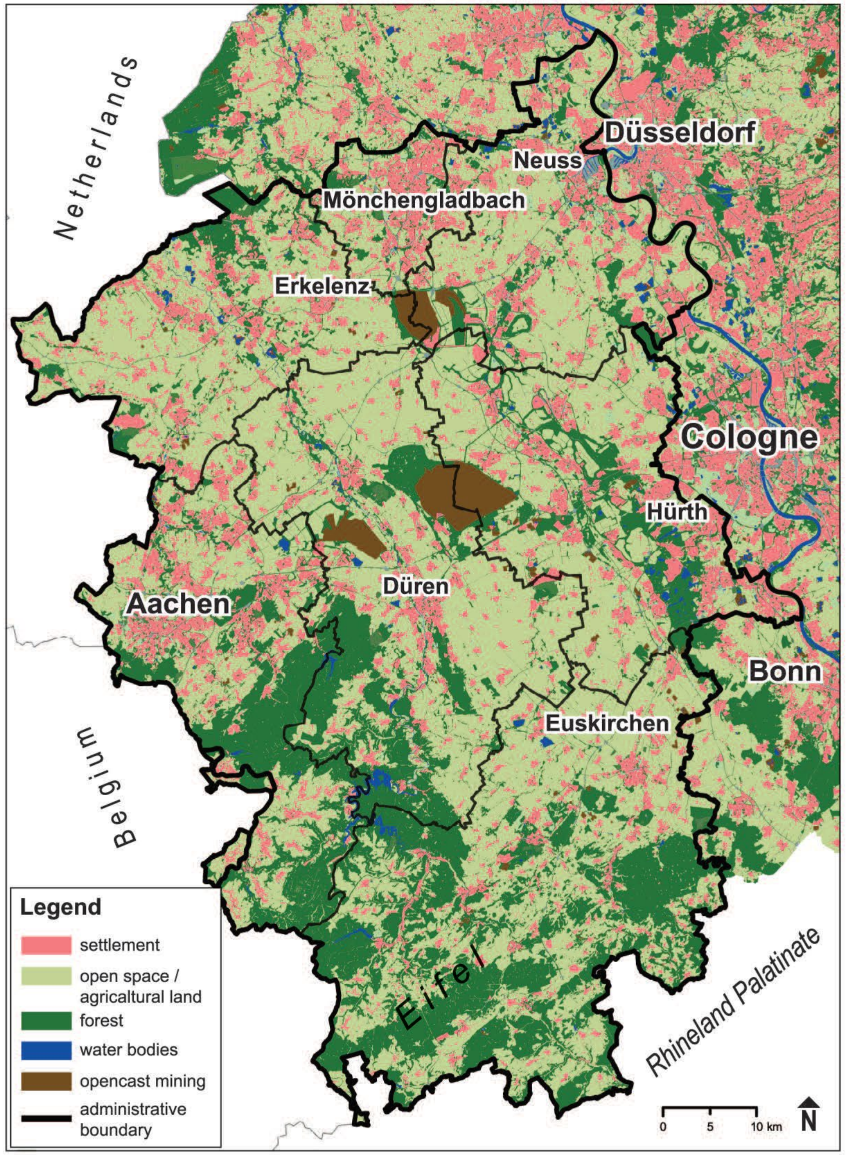
Coal phase out [3]

Regional structural change [4]

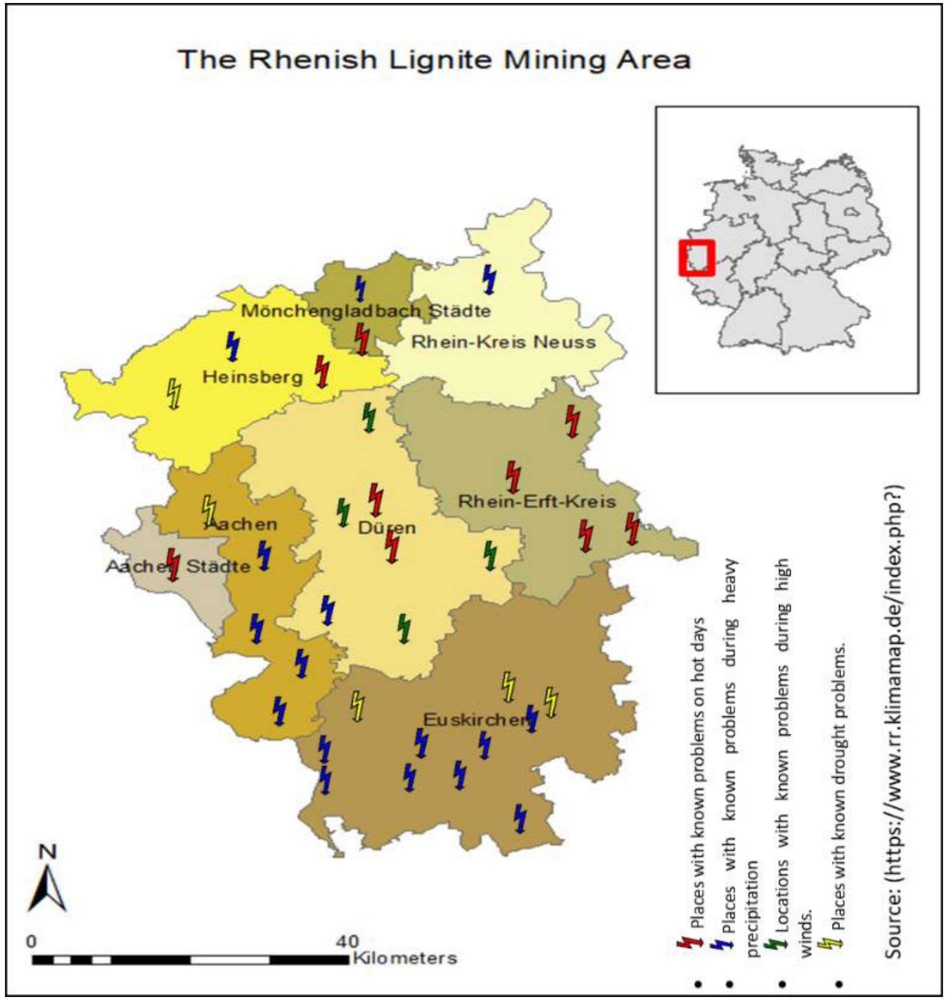
Source: https://taz.de/Kohleausstieg-in-Europa/!5379460/

source: https://landesplanung.nrw.de/leitentscheidung-braunkohle/rheinisches-revier

PRACTICAL RELEVANCE



Becker, Othmer, & Greiving (2022)



Source: own graphic adapted from © Bioökonomierevier; geo data derived from DIVA

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STUDY APPROACH - A regional feasibility study on potential Agri-PV systems in arable farming in the Rhenish Lignite Mining area

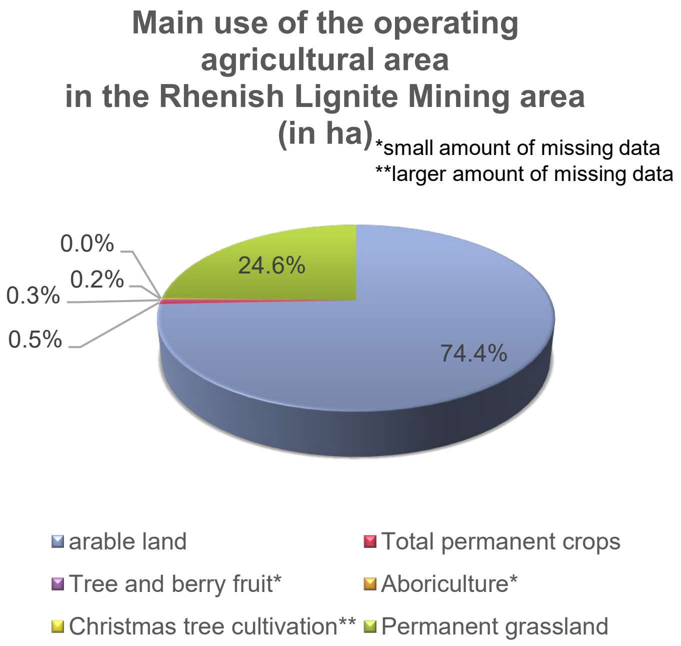
To what extent are Agri-PV systems economically attractive for farmers in the Rhenish region and under which conditions would the economic attractiveness increase?

- **considering the current economic situation of Agri-PV-**

  systems owned by farmers
- **adopting the economic baseline to include the full potential of Agri-PV in the feasibility and to generate potential profitable scenarios**
- **to determine the current situation of Agri-PV as a business model by calculating the economic viability of small area Agri-PV systems of 2 ha owned by the farmers**

STUDY FRAME

The Rhenish Lignite Mining area - Agricultural structure and suitable APV designs



Source: data from the chamber of Agriculture NRW 2020

- The agricultural sector is dominated by arable farming with crop rotation
- Vertical systems are one suitable desings with regard to the biggest area potential [21]
- An area of 2 ha was considered
- Farmer as owner: „ all in one hand“ business model

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METHODOLOGY – DATA COLLECTION

Cost assumptions for vertical systems

Parameter PV	Vertical	Unit
Capacity	700	kWp/ 2ha
Annual electricity production	**999,8**	**kWh/kWp**
Investment costs (CAPEX I)	700	€/kWp
Capital Costs (CAPEX II)	204,033.99	€
Total Investment Costs (CAPEX I & II)	**694,033.99**	**€/ 2 ha**
Annual operational costs	**5,390**	**€/ 2 ha**

- Cost estimations are difficult to obtain as most estimations are based on research plants

CONSIDERED PAYMENT STRUCTURES

01

Governmental fed-in tariff in Germany according to EEG

Fix price for 20 years

0.07€/kWh

02

Representive **payment structure outside EEG** in accordance to exchange price

fluctuations between 0.03-0.21€/kWh from 2020 to 2023

0,09ct/kWh average in 2023

03

Sensitivity analysis concerning payment quantum

0.07 – 0.28€/kWh

04

Subsidy for **CAPEX**

25% of initial investment costs

TIME PREFERENCE – DISCOUNTING THE FUTURE

- Positive time preference: preference to consume certain goods rather today than in the future
- Negative time preference: preference to postpone consumption into the future
- Time preference of 0: equal valuation of presence and future

$$A \succ B \Leftrightarrow U(A) = \sum_{t=0}^{T} w_t \cdot U(a_t) > U(B) = \sum_{t=0}^{T} w_t \cdot U(B_t)$$

- Standard discounted utility model:

$$U(A) = \sum_{t=0}^{T} \frac{U(A)}{(1+i)^t}$$

- positive time preference: (i > 0) , negative preference (i < 0) , or an indifferent time preference (i = 0) .
- Applied discount rate: range between 0-10% to reflect different assumptions regarding the risk of climate change affecting agricultural yields

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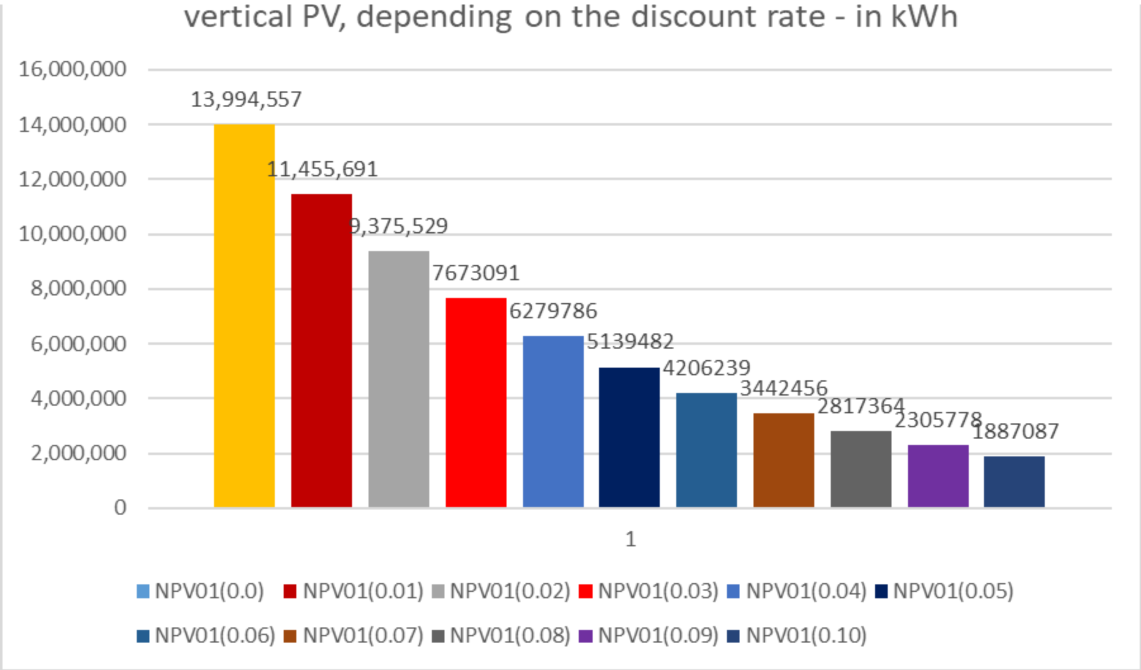
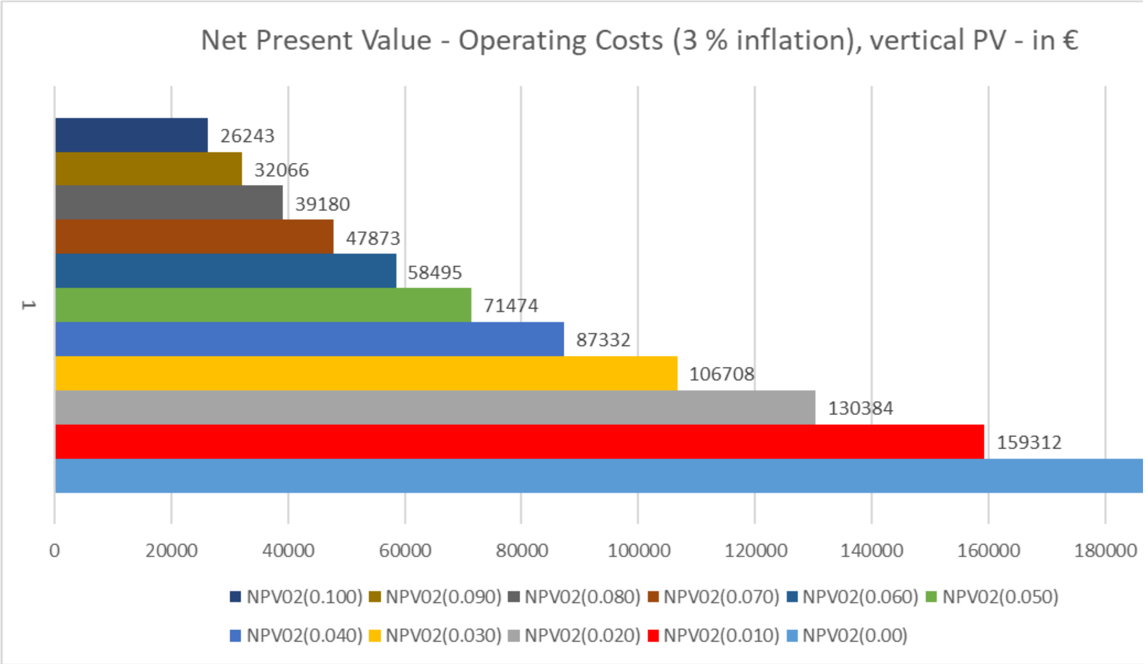
RESULTS – VERTICAL SYSTEMS

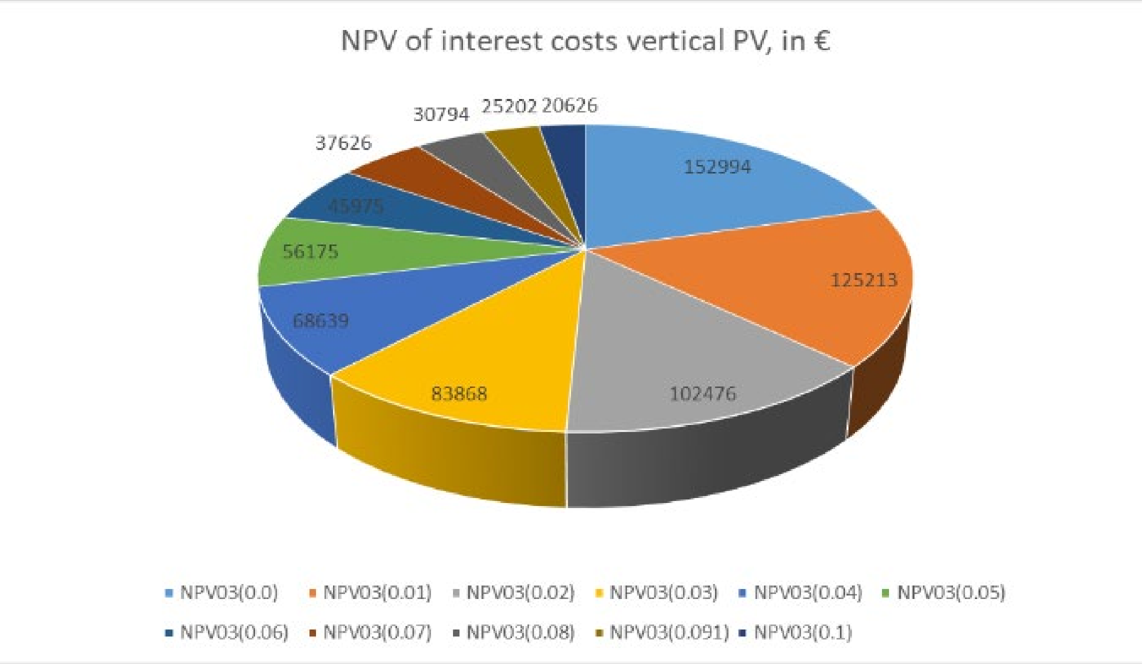
NPVs

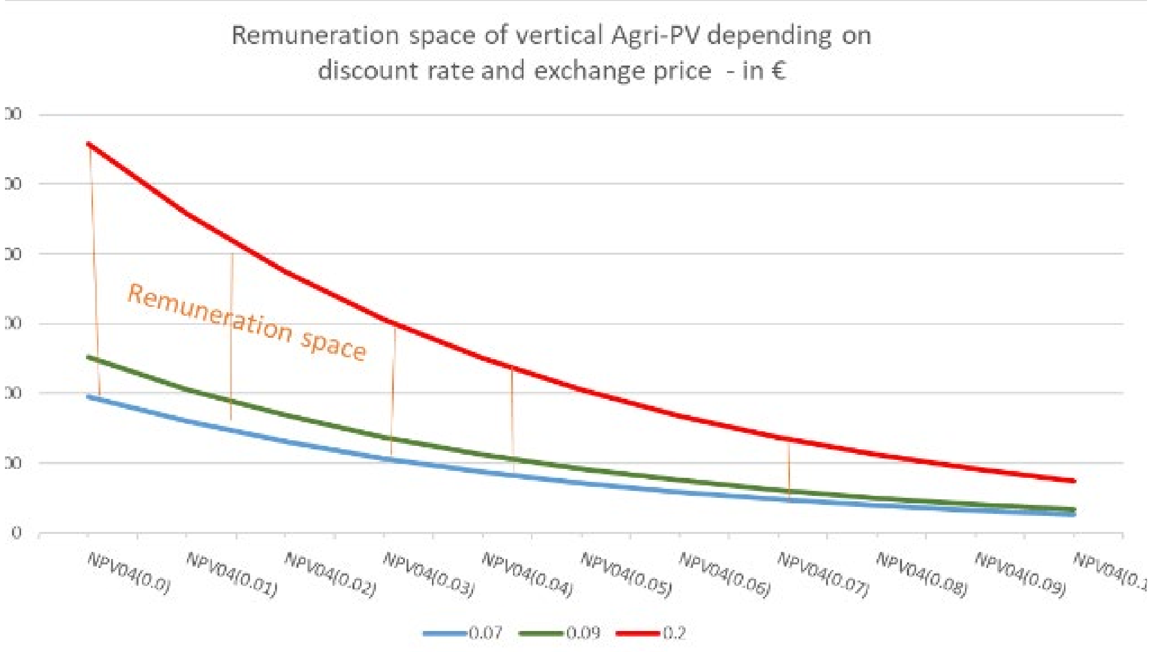




RESULTS – VERTICAL SYSTEMS

NPVs

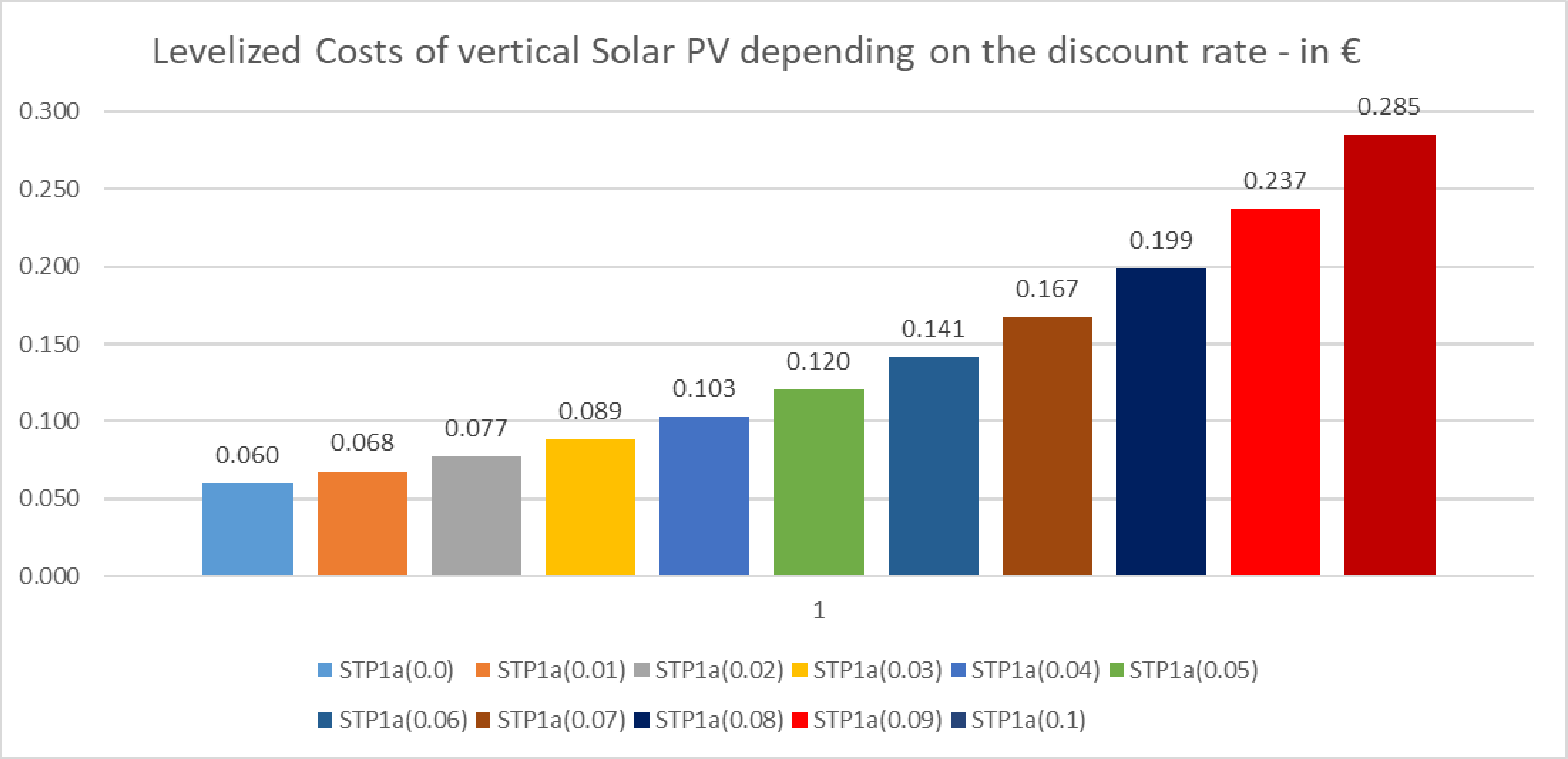




FEASIBILITY RESULTS – VERTICAL SYSTEMS

LCOE

$$LCOE_{AgroPV} = \frac{\text{CAPEX I} + \text{NPV CAPEX II} + \text{NPEV OPEX}}{\text{NPV Solar Energy Production}}$$



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RESULTS

Profit Margin

Profit margin depending on electricity price and discount rate

	PM (0.07€/kWh)	PM (0.09€/kWh)	PM (0.20€/kWh)	PM (0.2848€/kWh)
DB(0.0)	141966	421857	1961200	3148000
DB(0.01)	27211	256279	1516100	2487000
DB(0.02)	-66705	120767	1151800	1946000
DB(0.03)	-143568	9862	853733	1504000
DB(0.04)	-206474	-80904	609733	1142100
DB(0.05)	-257958	-155189	410040	845781
DB(0.06)	-300092	-215985	246608	603226
DB(0.07)	-334576	-265741	112852	404714
DB(0.08)	-362799	-306463	3384	242249
DB(0.09)	-385896	-339790	-86205	109285
DB(0.1)	-404800	-367065	-159527	465

Source: Own calculation, 2023 IEK-STE 2023

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RESEARCH OUTLOOK

- Same calculations for high-mounted systems
- Agricultural yield scenarios will be added
- Validation of the model by exert interviews

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