From niche to mainstream:
A phenomenological approach to citizen-financed photovoltaic projects

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The energy transition

Shift from fossil fuels to renewables

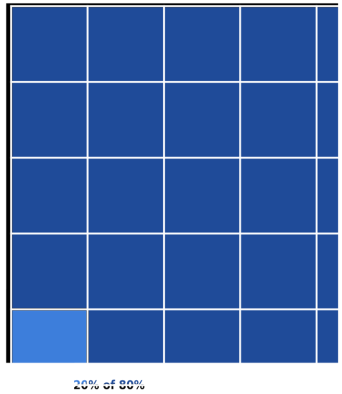
Involving individuals beyond consumption

The energy transition in Switzerland

The Energy Strategy 2050

Federal Act on a Secure Electricity Supply from Renewable Energy Sources

Solar power as the key pillar: 80% of the required expansion until 2035



Ratio: 20% of 80%

- Currently 10 to 20% covered *(Swissolar, 2024)*
- Only ~7% of the estimated rooftop and façade potential used (in 2022)
  (SFOE, 2019; Anderegg et al., 2022; Swissolar, 2024)

Harnessing the PV potential in Switzerland

How can this potential be harnessed?

Expand large-scale PV installations

- Uncertain social acceptance *(Cousse, 2021)*
- Large upfront costs *(Peñaloza et al., 2022)*
- Grid integration *(Mateo et al., 2017)*

Render PV more accessible

- 60% tenants *(Eurostat, 2024)*
- Limited investment capacity

School in Stallikon and retirement home in Ins
Source: Solarify

Citizen-financed photovoltaic (CiFi PV) projects

Geneva football stadium
Source: SIG

Hippie-bus singer Dodo participates in CiFi PV
Source: EWZ

What are citizen-financed PV projects about?

Medical-social establishment Les Baumettes, Source: City of Renens

CiFi PV is about producing renewable solar power,

- through **large-scale PV installations,**
- which are **co-financed** by individual participants,
- and situated **outside their private premises** (on rooftops or ground-mounted).

They can accelerate the energy transition, but…

- In 2019: only **~2%** of the produced solar power

It is necessary to shift from niche to mainstream.

Overarching research questions

- **Why do individuals participate?**
- **Can CiFi PV appeal to the broader population and how?**

Research about CiFi PV participation

Limited amount of studies

Created by Hayashi Fumihiro from Noun Project

Investment behavior lens

- Market-oriented projects by energy utilities and companies
- Household as the sphere of action

EWZ marketing campaign
Source: EWZ

Energy community lens

- Grassroots projects by cooperatives or associations
- Community as the sphere of action

Members of Energie Genossenschaft Schweiz
Source: Energie Genossenschaft Schweiz

Main drivers of CiFi PV participation

OR

Environmental motivations

- Environmental protection
- Climate change mitigation

(e.g., Braito et al. 2017, Kalkbrenner & Roosen, 2016)

Financial motivations

- Low-risk and durable investment
- Attactive returns
- Diversification of portfolio

(e.g., Bourcet & Bovari, 2020, Fleiss et al., 2017)

Is there more to it?

CiFi PV participation as the phenomenon

Main hypothesis: Fragmentary knowledge due to limiting conceptual lenses

Phenomenological approach

Examine the common or shared experiences of individuals *(Creswell & Poth, 2024)*

- Look beyond the dominant conceptual lenses
- Study both types of projects simultaneously

Complementary lens: Energy citizenship

Emerging concept making sense of individuals' engagement in the energy transition

(e.g., Lennon et al., 2025; Hamman et al., 2023; Ryghaug et al., 2018)

- Different definitions with various degrees of normativity
- Encompasses multiple spheres of action

Overarching research goals (RG)

RG 1 Identify **motivations** underlying CiFi PV participation

RG 2 Explore the relevance of the **concept of energy citizenship**

RG 3 Investigate the **appeal and diffusion potential** of CiFi PV projects

A phenomenological approach to CiFi PV participation

	Contribution I	Contribution II	Contribution III
Project developers	**RG 1, RG 2**	**RG 1, RG 2, RG 3**	**RG 1, RG 3**
Participants	Inductive qualitative approach > Interviews	Deductive, inferential statistics > Survey	Deductive, inferential statistics > Two experiments
	Identify participation motivations	**Validate motivations & explore perceived role**	**Examine CiFi PV projects appeal and dissemination**
	Published Sierro, F. & Blumer Y. (2025), Energy Research & Social Science	Published Sierro, F. & Blumer Y. (2024), Energy, Sustainability and Society	Under review Sierro, F. & Moser, C. (Re-submitted, 2025), Energy Research & Social Science

Potential participants
(broader population)

Contribution I: Identifying participation motivations

CiFi PV project developers (PD)	CiFi PV participants (P)

Method: Inductive content analysis based on interview data
Sample size: PD *N = 13*, P *N = 18*

What is it about?

- "Let the data speak": assumed and actual motivations

What are the key findings?

27 motivations across seven categories

Accessibility
Energy transition
Environmental concerns
Financial benefits
Local value creation
Participation
Personal factors

"CiFi PV is just a good thing to do!" ***– Various participants***

The opportunity to contribute individually to accelerating the energy transition through tangible solar power projects aligned with personal values.

Contribution II: Validating and exploring role perception

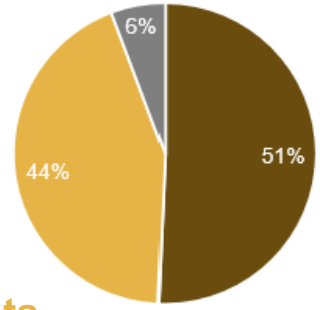
CiFi PV participants

Method: Inferential statistics based on survey data
Sample size: *N = 510*

What is it about?

- Validate motivations and rationale, characterize participants
- Adapted and enhanced motivational attributes scale *(based on Noppers et al. 2016, 2018)*

What are the key findings?



Tenants **Owners**

Financial, environmental, local value creation and symbolic motivations as drivers: Contribute to the energy transition as an energy citizen and environmentalist.

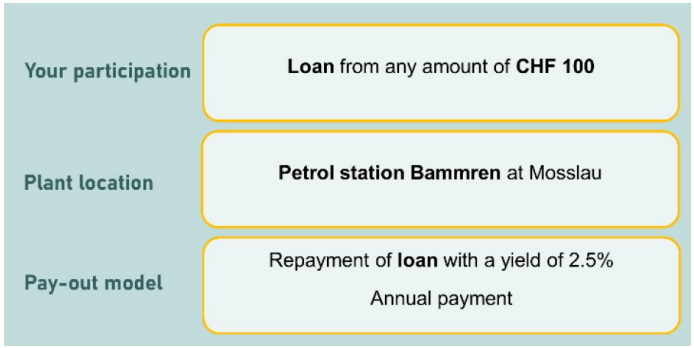
Contribution III: Influencing factors on projects attractiveness

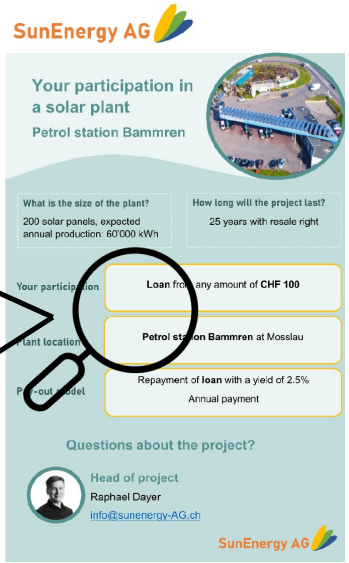
Potential CiFi PV participants
(broader Swiss population)

Method: Inferential statistics based on experimental data
Sample size: *N = 807 / N = 512*

What is it about?

- Explore dissemination potential and the influence of project characteristics
- Enhanced motivational attributes scale *(based on Sierro & Blumer, 2024)*





What are the key findings?

Financial and societal impact motivations as drivers.

Independent of project characteristics around 60% are willing to participate.

Contribution III: Influencing factors on projects attractiveness

Potential CiFi PV participants
(broader Swiss population)

Method: Inferential statistics based on experimental data
Sample size: *N = 807 / N = 512*

What is it about?

- Explore dissemination potential and the influence of motivational framings

What are the key findings?

Independent of motivational framings around 60% are willing to participate.

Overall findings: Yes, there is more to it!

Motivations are multifaceted – they strongly relate to how individuals associate the energy transition with economic, ecological and social sustainability dimensions.

CiFi PV as a manifestation of energy citizenship – it is about the opportunity to individually contribute to the energy transition.

Diversity promises dissemination potential – CiFi PV can appeal to the broader population, attracting individuals with varying sociodemographic, housing, and motivational backgrounds

Key implications for practice

Demand exceeds supply

Only around 5% knew of CiFi PV

Tenants, homeowners, and former CiFi PV participants

Key implications for policy

Created by Fajar Studio
from Noun Project

- Improve access to data on rooftop/surface availability
- Explicit CiFi PV to render it visible
- Assess the impact of the recently adopted Federal Act
  - PV installations of national interest
  - Improved energy storage conditions
  - Local Electricity Communities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Thank you
Questions, comments?
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Survey Study: PCA-Analysis

Theoretical category	Item	Communalities	Loadings factor 1	Loadings factor 2	Loadings factor 3	Loadings factor 4
Symbolism	Differentiating myself from others	0.74			0.84	
Symbolism	Showing who I am	0.78			0.85	
Symbolism	Saying something positive about myself	0.74			0.83	
Finance	Controlling where my money flows	0.56			0.34	0.64
Finance	Making a financial gain	0.77				0.86
Finance	Investing my money safely	0.76				0.85
Local value creation	Financing the implementation of a tangible project	0.61		0.75		
Local value creation	Having an impact together with others	0.61		0.74		
Local value creation	Supporting local actors	0.67		0.8		
Local value creation	Contributing to the sustainable development of my region	0.54	0.39	0.61		
Environment	Protecting the environment	0.74	0.84			
Environment	Fighting climate change	0.85	0.91			
Environment	Reducing CO^2 emissions	0.71	0.83			

Note: N = 510 ; extraction method: principal component; varimax rotation; 4 components extracted, explained variance = 65%; Kaiser-Meyer Olkin = 0.83; Bartlett test of sphericity: $p<0.01$, Cronbach's $\alpha = 0.82$

Survey Study: Hierarchical linear regression model

	Step I				Step II			
Variables	**B**	**SE**	**β**	***p* values**	**B**	**SE**	**β**	***p* values**
Constant	4.114	0.519		< 0.001***	4.115	0.488		< 0.001***
Age	− 0.010	0.004	− 0.133	0.011*	− 0.007	0.004	− 0.100	0.054
Civic Engagement[a]	0.044	0.060	0.033	0.467	0.029	0.056	0.022	0.604
Education[b]	0.113	0.124	0.044	0.366	0.059	0.117	0.023	0.615
Male[c]	0.081	0.122	0.031	0.508	0.103	0.117	0.040	0.379
Income[b]	0.163	0.084	0.098	0.053	0.171	0.079	0.102	0.031*
Tenant	0.117	0.116	0.055	0.314	0.046	0.109	0.022	0.673
Housing cooperative	− 0.638	0.243	− 0.123	0.009**	− 0.643	0.229	− 0.124	0.005**
Political orientation	− 0.079	0.032	− 0.117	0.015*	− 0.066	0.031	− 0.098	0.031*
Project developer1[d]	− 0.521	0.127	− 0.220	< 0.001***	− 0.564	0.122	− 0.238	< 0.001***
Project developer2[d]	− 0.278	0.167	− 0.084	0.097	− 0.150	0.160	− 0.045	0.347
Project developer4[d]	− 0.144	0.217	− 0.032	0.508	− 0.196	0.210	− 0.043	0.352
Project developer5[d]	0.048	0.148	0.017	0.749	− 0.007	0.140	− 0.003	0.957
Environmental attributes					0.172	0.047	0.159	< 0.001***
Financial attributes					0.210	0.051	0.195	< 0.001***
Local value creation attributes					0.227	0.045	0.216	< 0.001***
Symbolic attributes					0.117	0.048	0.109	0.015*
Model statistics	**Model 1**				**Model 2**			
R^2	0.111***				0.226***			
Adjusted R^2	0.087***				0.198***			
R^2 change	0.075				0.113			
Fchange (df1, df2)	4.6 (12, 440)				16.13 (4, 436)			
	N = 453				*N* = 453			

Note: B = unstandardized regression coefficient, SE = standard error; β = standardized regression coefficient; *p < 0.05; **p < 0.01; ***p < 0.001; [a] Coding: 1 = Never, 2 = Sometimes, 3 = Frequently; [b] Coding: 1 = Low, 2 = Medium, 3 = High; [c] Coding: 0 = female, 1 = male; [d] Dummy Coding: 0 = Other project developers, 1 = Project developer 1,2,4 or 5 (Reference category: Project developer 3); The political orientation scale is a continuous variable with higher values corresponding to stronger right-wing orientation (1 = left; 8 = right); Dependent variable: Willingness to participate in future CiFi PV projects

Experiment 1: Provider preferences for CiFi PV

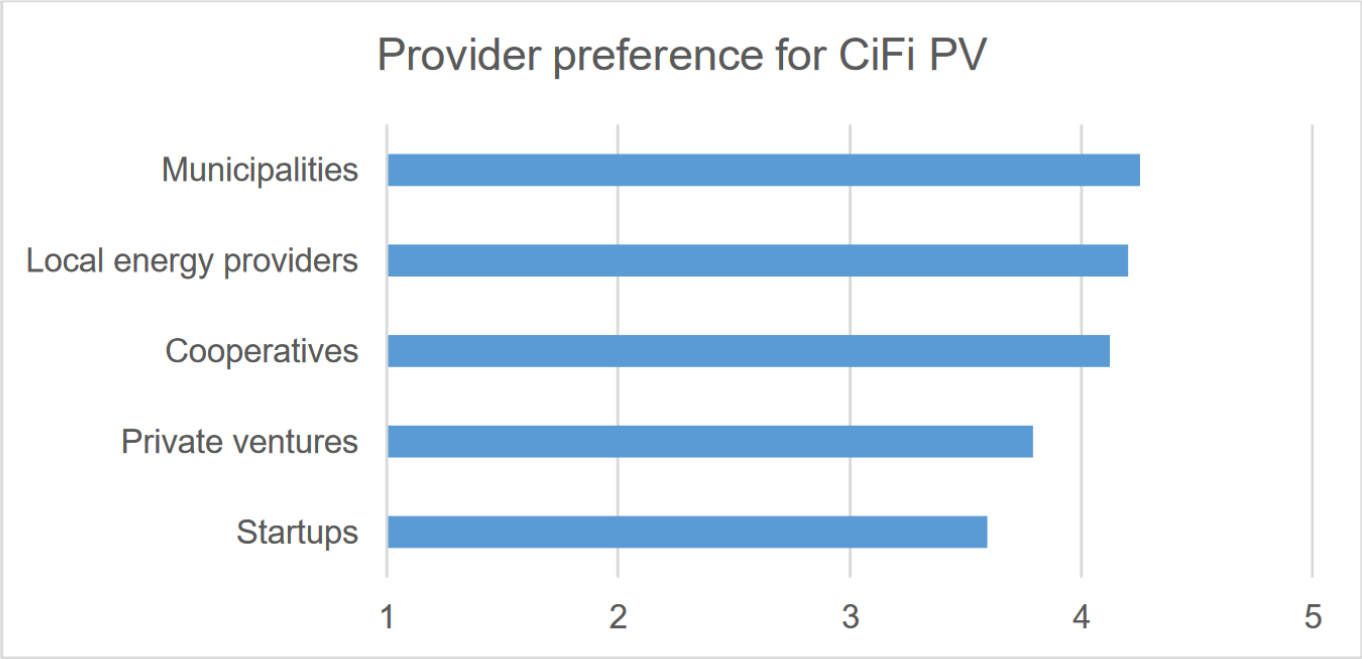


Abbildung 12. *Eignung eines Anbietertyps für GFP-Projekte. «Wie sehr stimmen Sie den folgenden Aussagen betreffend gemeinschaftlich finanzierten Solaranlagen zu? Ich finde es sinnvoll, wenn [Anbietertyp] solche Solarprojekte anbieten.» N = 808.*

Experiment 2: Motivational framings

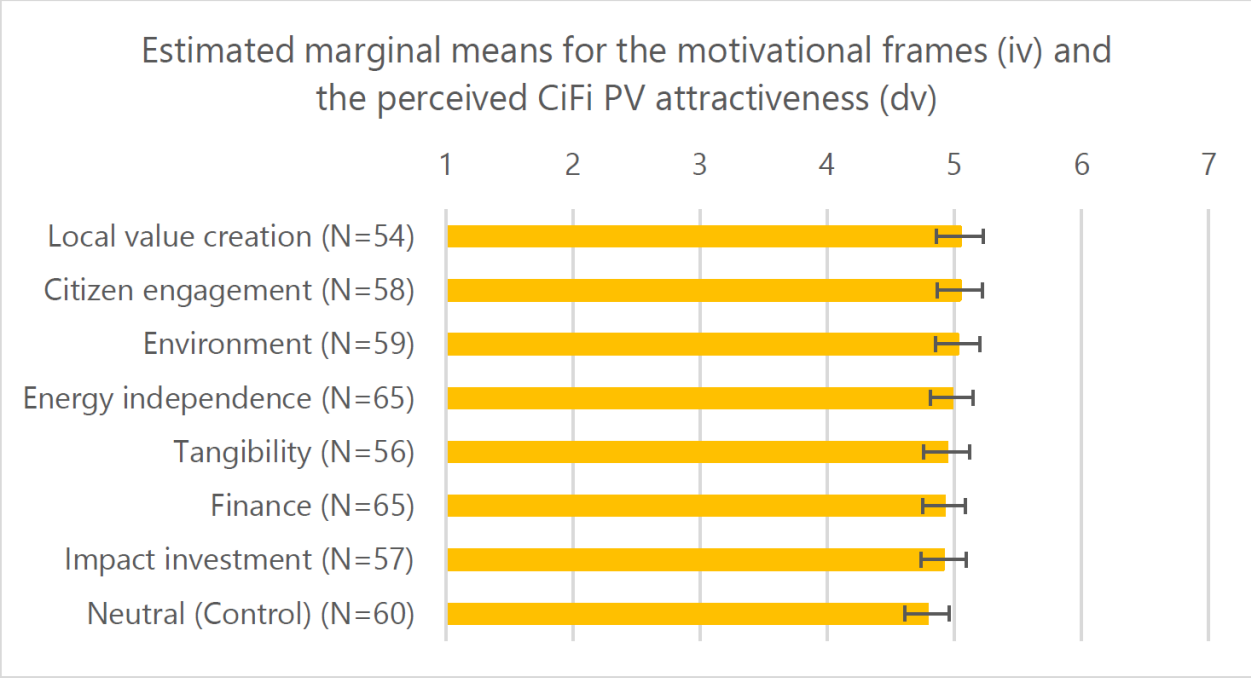


Figure 11: Estimated marginal means and standard deviation for the motivational frames and the perceived project attractiveness.

Experiment 2: Motivational framings

Frame	Main advantages	Motivational phrase
Environment	Citizen-financed solar projects have a positive impact on the environment: they contribute to low-carbon and renewable energy production.	Do something for the environment and opt for renewable energy!
Finance	Citizen-financed solar projects are attractive investments. They are low-risk and offer a higher return than a bank account.	Invest your money safely and profitably!
Energy independence	Citizen-financed solar projects promote Switzerland's energy independence by reducing the need to import electricity from abroad.	Promote our energy independence!
Local value creation	Citizen-financed solar projects promote local value creation: local installation companies benefit from orders, and roof owners benefit from cheap solar power.	Support local businesses and organizations!
Civil society engagement	Citizen-financed solar projects send a political and economic signal: the Swiss population wants a faster expansion of renewable energies.	Set an example!
Tangibility	Citizen-financed solar projects enable investment in specific projects: Where the money goes and what happens to it is clear from the outset.	Make a concrete project possible!
Impact investment (combined frame)	• Citizen-financed solar projects are attractive investments. They are low-risk and offer a higher return than a bank account. • They enable investment in specific projects: Where the money goes and what happens to it is clear from the outset. • They are positive for the environment: they contribute to low-carbon and renewable energy production. • They promote local value creation: local installation companies benefit from orders and roof owners benefit from cheap solar power.	- Gain attractive returns - Enable a concrete project - Create ecological and local added value
Neutral (control group)	No text on main advantages => Directly to the offer	Your participation in a solar plant

Experiment 2: Motivational framings

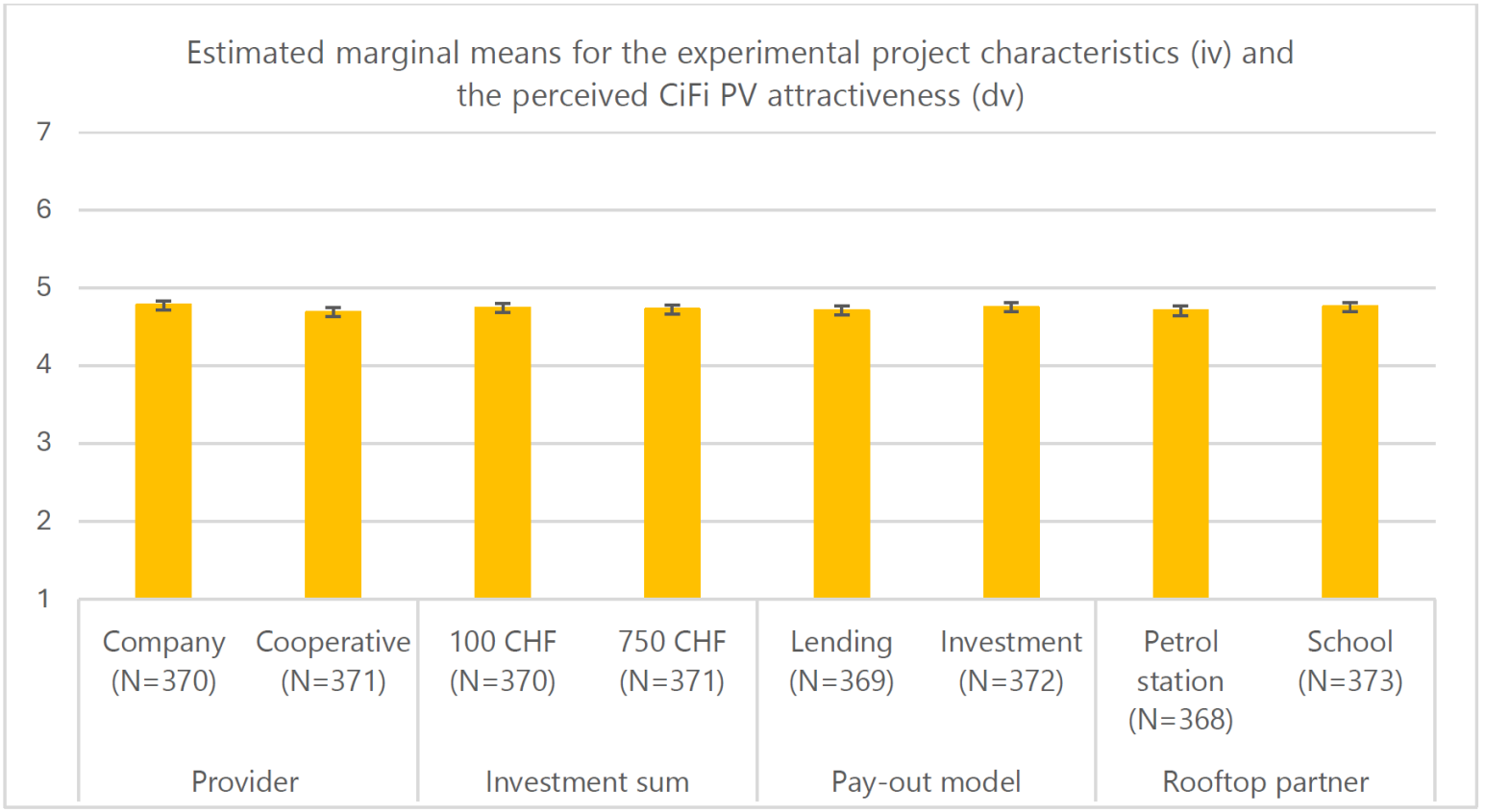


Figure 9: Estimated marginal means and standard deviation for the project characteristics and the perceived project attractiveness.

Experiment 1

SunEnergy AG

Ihre Beteiligung an Solaranlage

Tankstelle Bammren

Wie gross ist die Anlage?

200 Solarpanels, erwartete Jahresproduktion: 60'000 kWh

Wie lange dauert das Projekt?

25 Jahre mit Rückverkaufsrecht

Ihre Beteiligung	**Investition** ab beliebigem Betrag von **100 CHF**
Anlagestandort	**Tankstelle Bammren** in Mosslau
Auszahlung	Rückzahlung **Investition** mit Rendite von 2.5% Jährliche Auszahlung

Fragen zu diesem Projekt?

Projektleiter

Raphael Dayer

info@sunenergy-AG.ch

SunEnergy AG

Experiment 2

Do something for the environment and opt for renewable energy!

Solarproject Bammren

What is the size of the plant?

200 solarpanels, expected annual production: 60'000 kWh

How long will the project last?

25 years with resale right

Your participation	Investment from 500 CHF
Plant location	School building Bammren at Mosslau
Pay-out model	Repayment with a yield of 2.5% Annual payment

Questions about the project

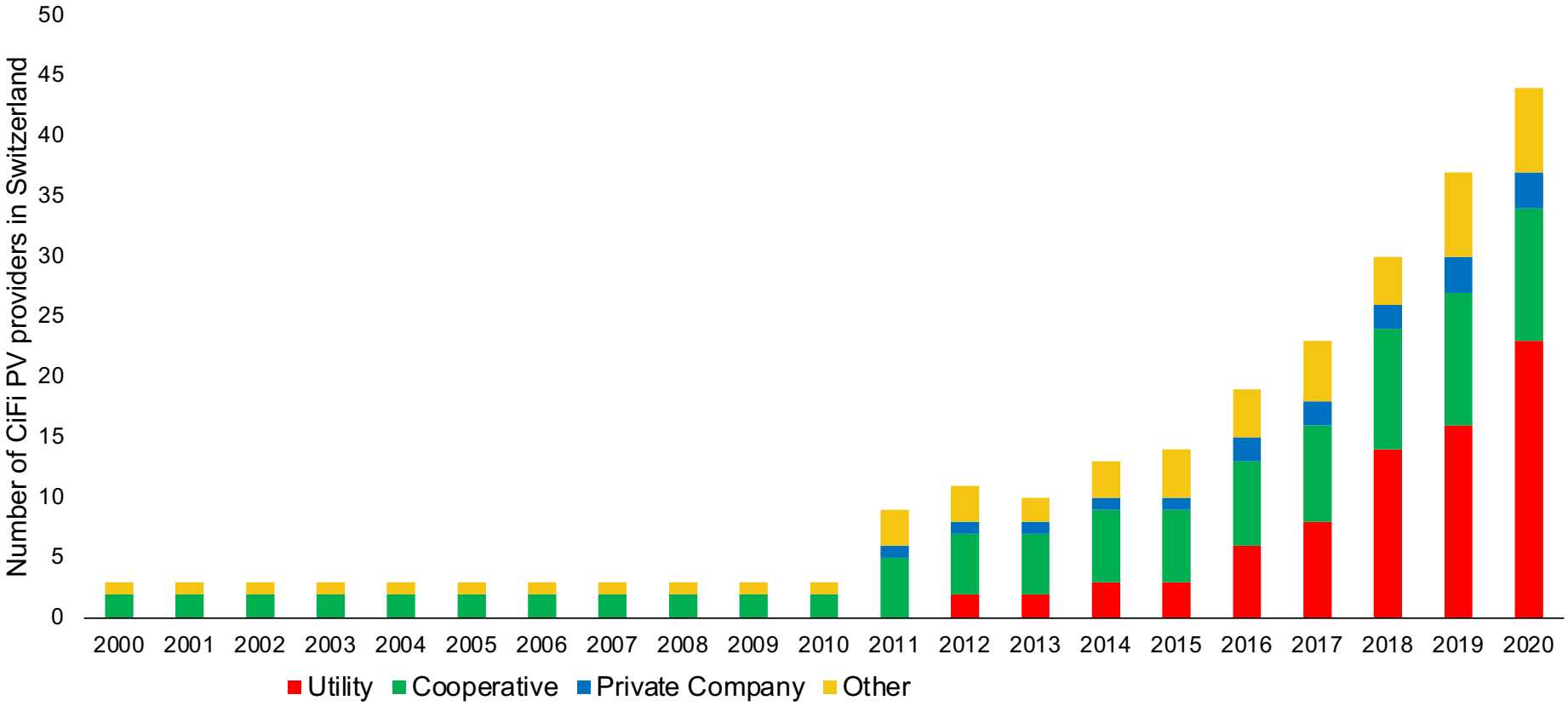
Head of project

Raphael Dayer

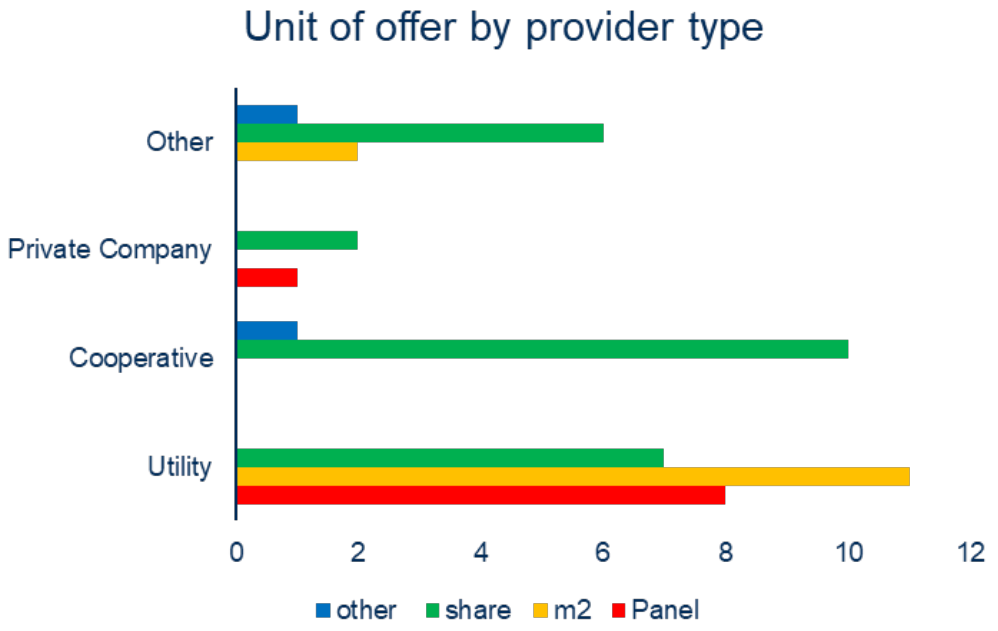
info@sunenergyAG.ch

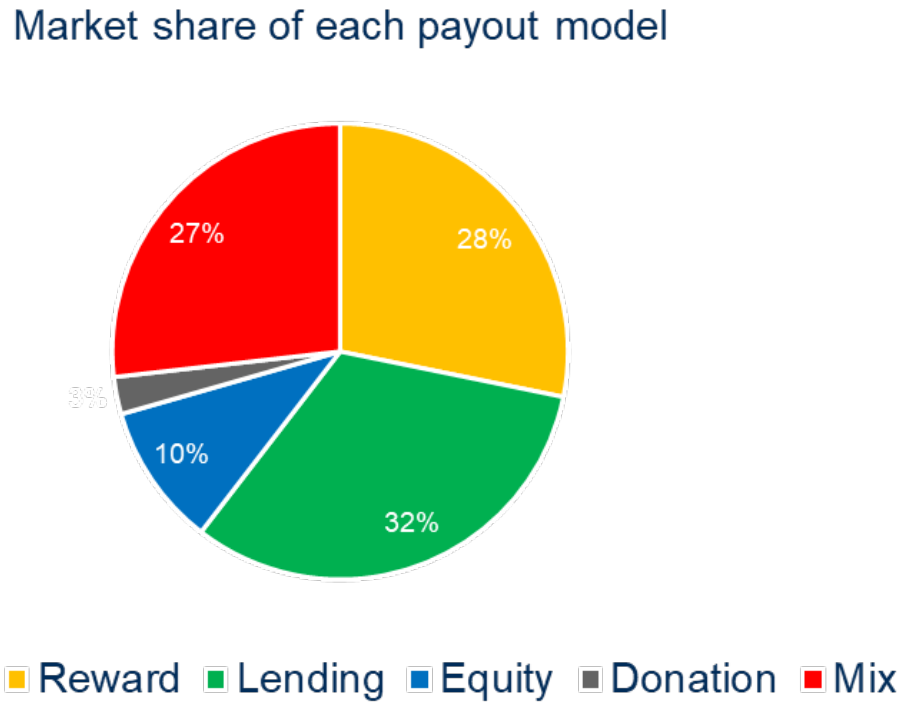
SunEnergy AG

Swiss CiFi-Market is growing



Diverse project characteristics





EU directives and CiFi PV projects

EU Internal Electricity Market Directive (2019/944)

EU Renewable Energy Directive (2018/2001)

Market-oriented CiFi PV projects: not regulated

Citizen energy community (CEC)
Grassroots-oriented
Not locally bound
Non-autonomous
Technology-neutral

Renewable energy community (REC)
Grassroots-oriented
Locally bound
Autonomous
Renewable technologies

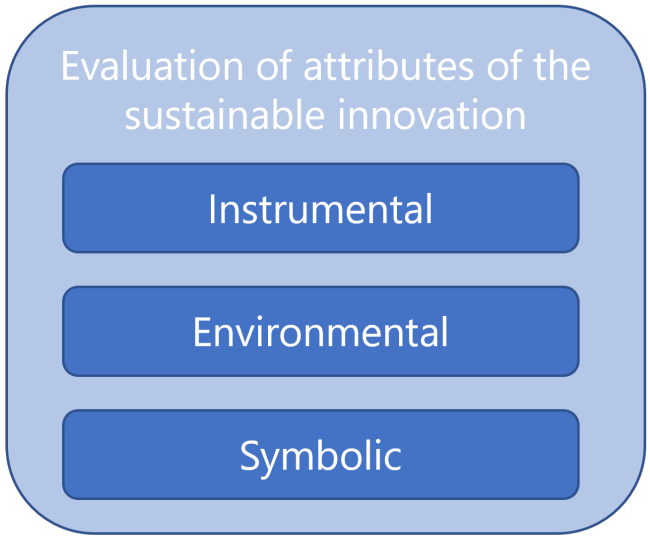
Common features
- *Grassroots-oriented*
- *Not locally bound*
- *Non-autonomous*
- *Photovoltaics only*
- *Open and voluntary participation*
- *Ownership and control by actors without a primary activity in the energy sector*
- *Primary purposes: social and environmental benefits*

Citizen-financed (CiFi) PV
Market-/grassroots-oriented
Locally bound/not bound
Autonomous/non-autonomous
Photovoltaics only

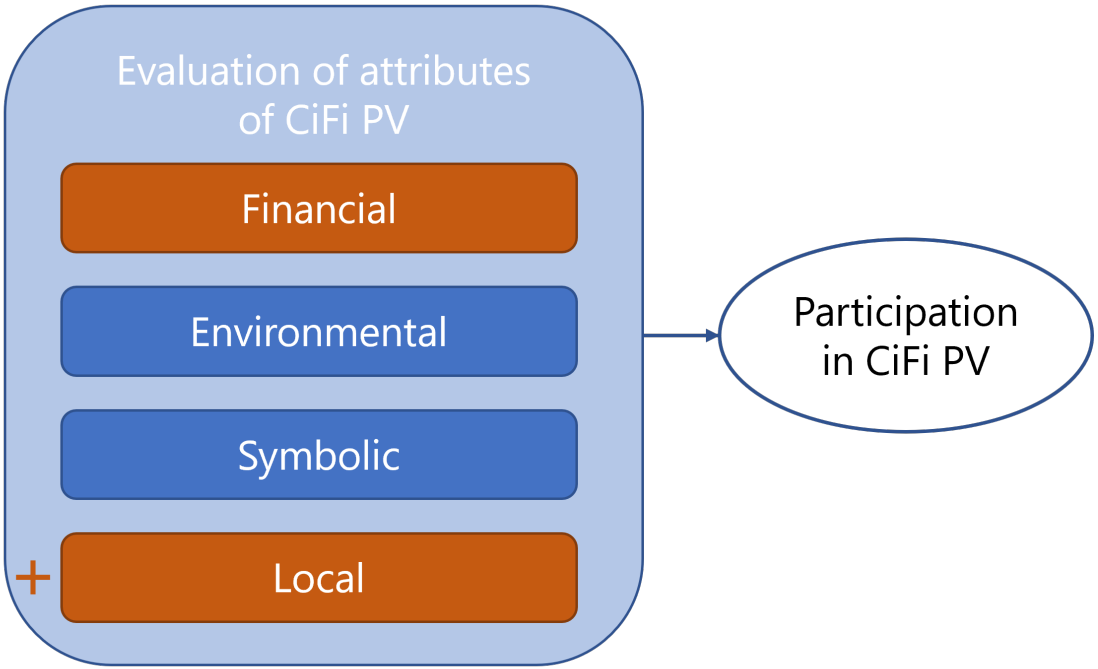
Common features
- *Grassroots-oriented*
- *Locally bound*
- *Autonomous*
- *Photovoltaics only*
- *Open and voluntary participation*
- *Ownership and control by actors without a primary activity in the energy sector*
- *Primary purposes: social and environmental benefits*

Motivational attributes scale

Original scale by Noppers et al., 2016



Adapted and extended scale by authors



Confirmatory PCA, Cronbach's alpha = 0.82

For being a part of this journey

For listening to me

Thank you!

For supporting me

For encouraging me

For discussing with me

For being amazing people

ETH zürich

Phenomenological approach

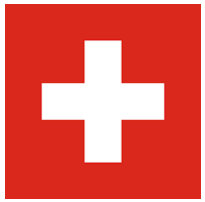
- Growth primarily in small-scale PV installations
- Large-scale PV less socially accepted
- Large upfront costs
- Limited accessibility for tenants

Significant untapped potential

Key implications for policy

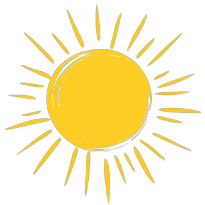
Created by Fajar Studio
from Noun Project

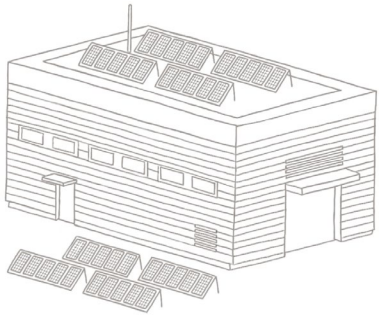
- Include market-oriented CiFi PV
- Clarify policy goals: Energy citizenship as an actionable concept?



- Improve access to data on rooftop/surface availability
- Explicit CiFi PV to render it visible
- Assess the impact of the recently adopted Federal Act

Key actors: Focus on CiFi PV participation





Project developer

Market-oriented projects: utilities, companies
Grassroots projects: cooperatives, associations
Either one: municipalities, cities

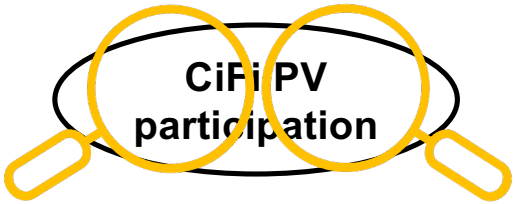
Rooftop or surface owner

Can be the same as the developer

CiFi PV participants

Co-financing individuals

What drives participation in CiFi PV projects?

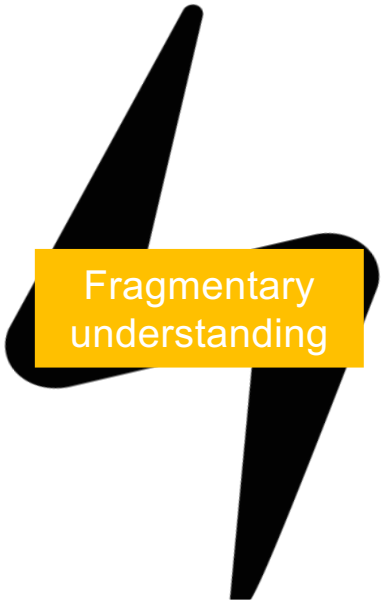


Energy community lens

- Focus mainly on grassroots projects
- Individuals as active participants
- Community level as the sphere of action
- Strong focus on environmental goals and motivations

Mainstreaming potential
- Limited

Main motivational driver:
Environmental concern



Investment behavior lens

- Focus mainly on market-oriented projects
- Individual as passive consumers
- Household level as the sphere of action
- Strong focus on economic goals and financial motivations

Mainstreaming potential
- Considerable

Main motivational drivers:
Financial or environmental concerns

UNLOCK-PV Research project

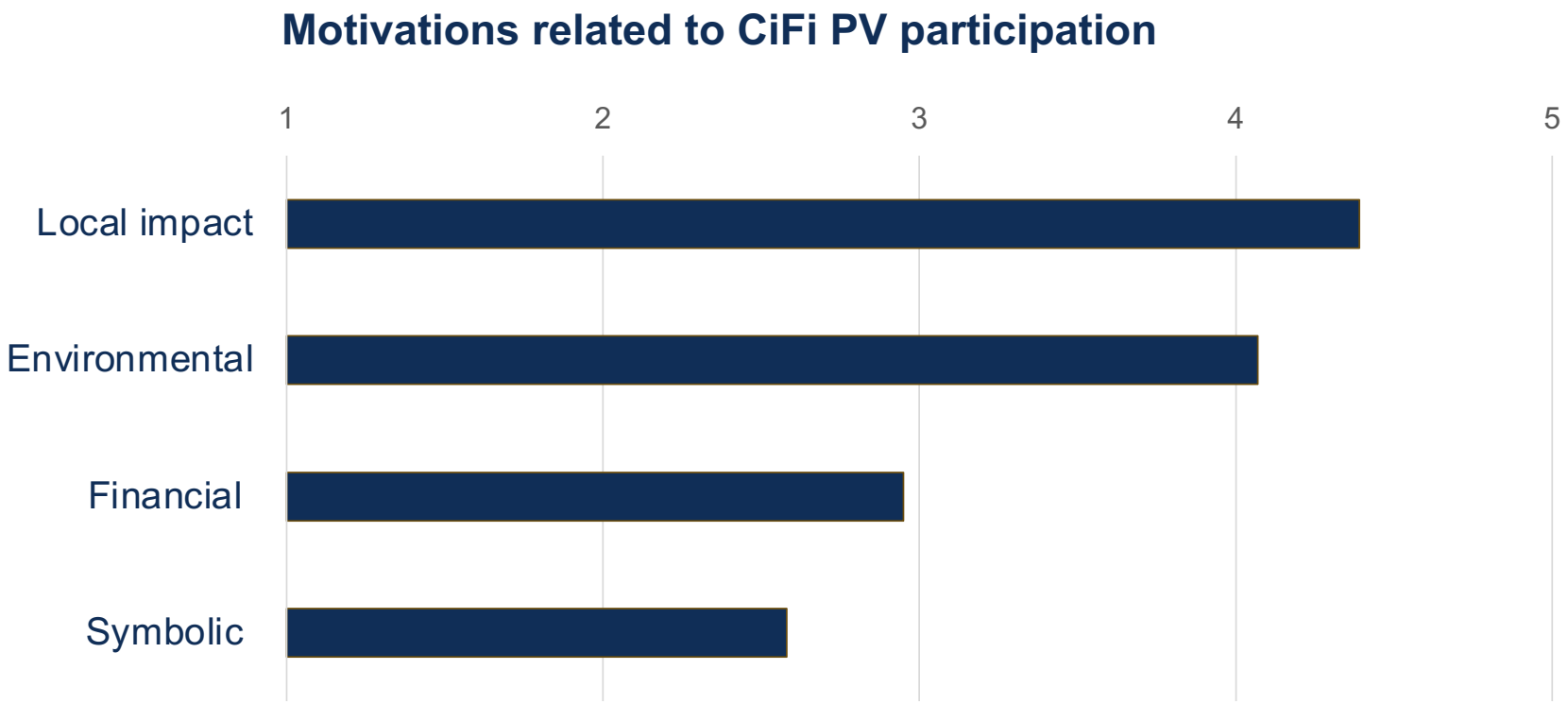
Unlock the potential of CiFi PV to accelerate the energy transition

- Expansion potential, barriers & drivers, participation motivations
- Multi-perspective: providers, early adopters and potential adopters
- From 2020 to 2023, EWG project financed by SFOE
- ZHAW & Econcept

Why is the Swiss case interesting?

- Affluent population
- Niche market with expanding offers
- Various types of CiFi PV offers
- Participatory democracy

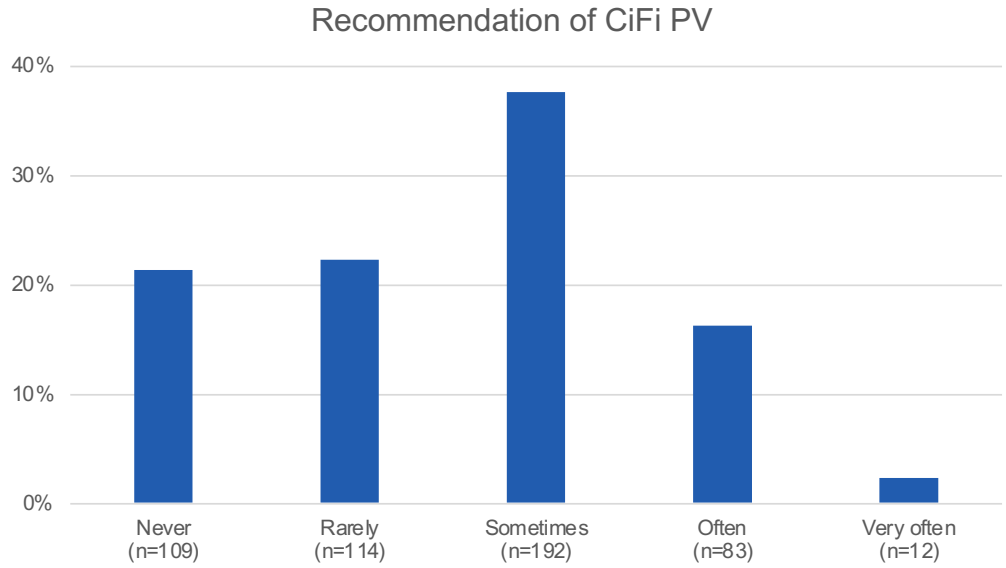
More than money: local & environmental impact

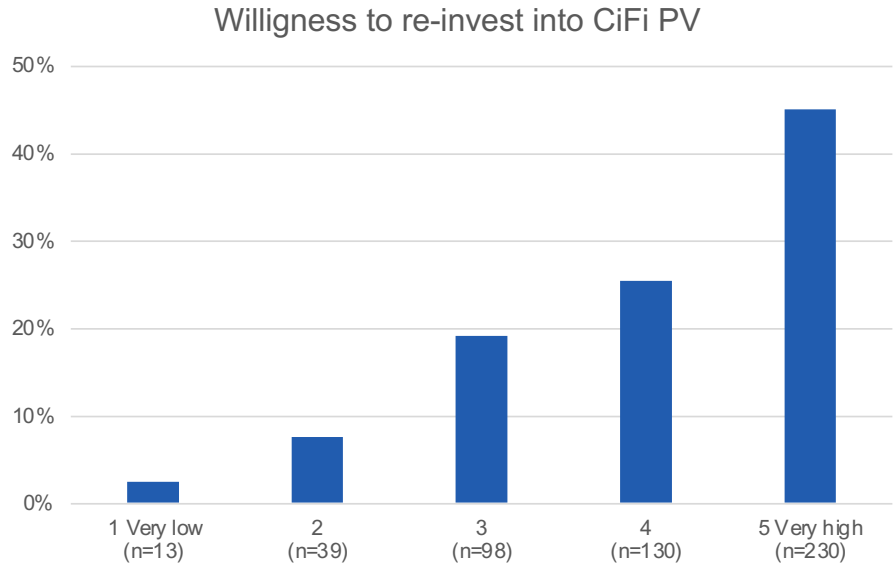


Example: «Through my CiFi PV participation, I support local actors.» - 1 Completely disagree to 5 Completely agree

Limited dissemination by early adopters

- Investment behaviour is a private matter
- Stereotypically “left-ish”, but early adopters form the entire political spectrum
- Few recommendations, but high willingness to re-invest





Comparison with Swiss Household Energy Demand Survey data

In comparison with the Swiss average citizen (SHEDS 2018/2021), early adopters are:

+ politicially slightly more left-leaning
+ higher biospheric and lower hedonic values
+ above average income
+ more engaged in associations
+ … specifically in environmental, local or political associations

Three types of early adopters

	The local ecologists	The indifferent	The allround fans	
	n = 184	n = 105	n = 221	
Age	58.6 b	55.2 b	47.7 a	30.8 (2,503) ***
Male°	72.3 a	77.7 ab	81.3 b	$\chi 2$ (2) = 4.6
Cooperative°	4.9 a	5.7 a	6.3 a	$\chi 2$ (2) = 0.4
Tenant°	39.7 a	36.2 a	50.2 b	$\chi 2$ (2) = 7.4 *
Owner°	55.4 a	58.1 a	43.4 b	$\chi 2$ (2) = 8.6 *
Monthly income	4.5 a	4.6 a	4.6 a	0.5 (2, 464)
Level of education	6.1 ab	5.8 a	6.2 b	3.7 (2,498) *
Political orientation	3.3 a	3.8 b	3.6 ab	3.6 (2, 501) *
Recommendation of offer	2.5 b	2.3 b	2.8 a	8.7 (2, 507) ***
Readiness to reinvest	4.1 a	3.4 b	4.3 c	24.2 (2, 507) ***
Altruistic	4.2 b	3.9 a	4.2 b	14.0 (2, 507) ***
Egoistic	2.3 b	2.4 b	2.7 a	19.5 (2, 507) ***
Biospheric	4.6 a	4.1 b	4.5 c	24.5 (2, 507) ***
Hedonic	3.4 b	3.4 b	3.7 a	11.7 (2, 507) ***