



MIDLANDS



CITIES



THE ALPS



SWITZERLAND

Cost of capital for renewables and enabling technologies: Measuring the multidimensional heterogeneity in Switzerland

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Swiss Federal Office of Energy SFOE

Sweet Edge is a research project sponsored by the Swiss Federal Office of Energy's SWEET programme and coordinated jointly by UNIGE and EPFL

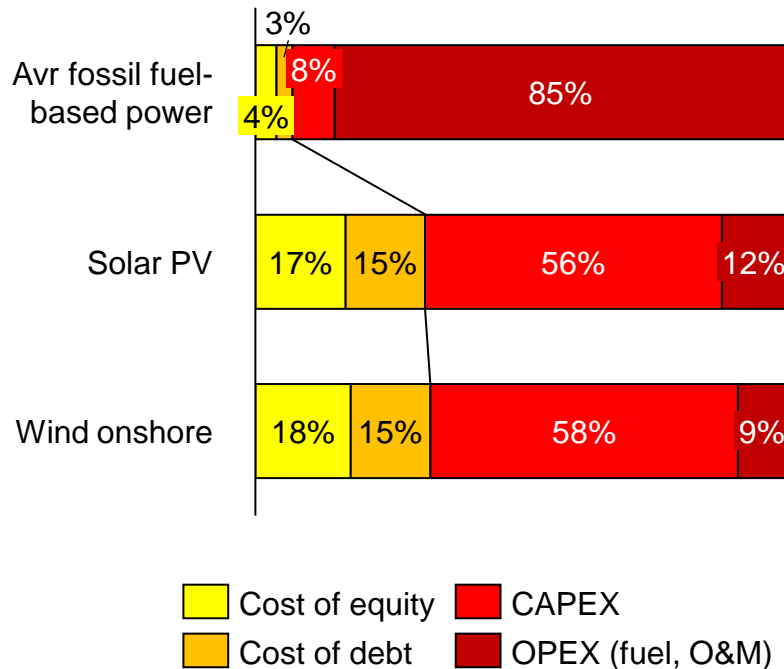
sweet swiss energy research
for the energy transition

EDGE

Why care about costs of capital for renewable energy?

Renewables have high upfront investment...

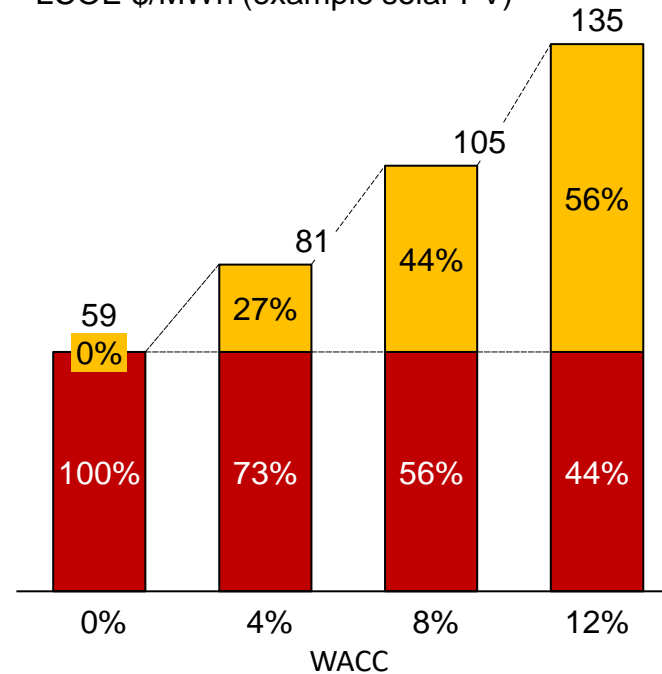
Percentage of LCOE¹



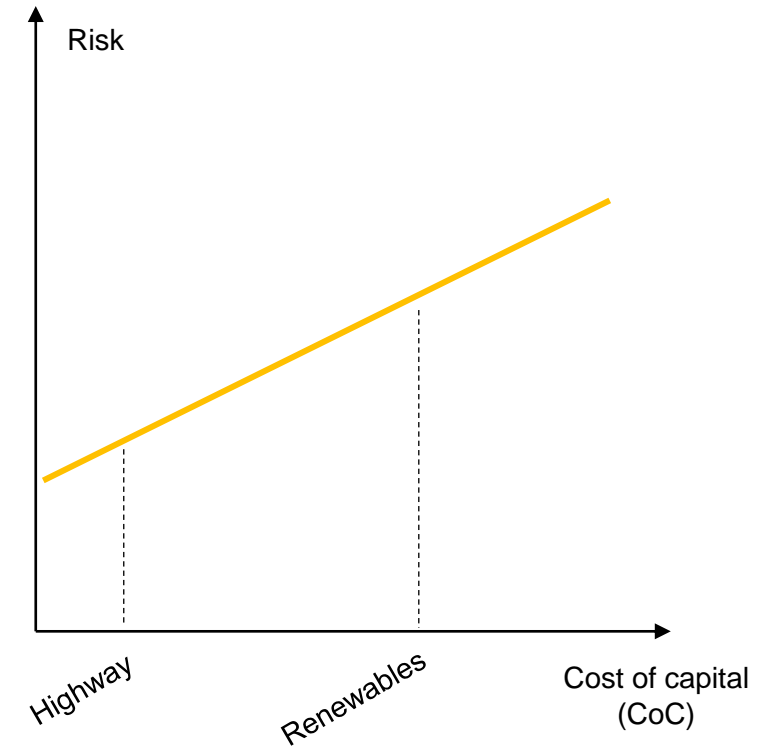
Note: LCOE = Levelized cost of electricity; WACC = Weighted average cost of capital. Assumes 5% cost of debt, 10% cost of equity, European fuel costs. Fossil fuel based power is the average of hard coal and natural gas plants

... LCOE sensitive to costs of capital

LCOE \$/MWh (example solar PV)



... higher risk means higher CoC



The main focus of research on financing and cost of capital for renewables is on large scale technologies



**Research focus on
onshore wind,
offshore wind and
utility-scale solar
(>1MW)**



Decentralized energy systems are composed of multiple low carbon technologies



**Little or no
empirical
knowledge on CoC
for other
technologies**



In many countries only smaller-scale low carbon technologies are feasible



Reasons inhibiting large-scale technologies

- Local opposition
- Regulations
- Geography
- Visual impact
- Etc.



Energy system models use uniform cost of capital values for low-carbon technologies



Vastly different investment risk!



Analysis leading to energy system scenarios that misrepresent investment risk





The costs of capital for low carbon technology differs across three crucial dimensions

... difference between
solar PV and green
hydrogen

Investment risk (e.g., technology risk)

1st dimension

Investors have different risk
profiles and return expectations

Investor types

2nd dimension

Project financing vs. balance
sheet finance

Financing types

3rd dimension



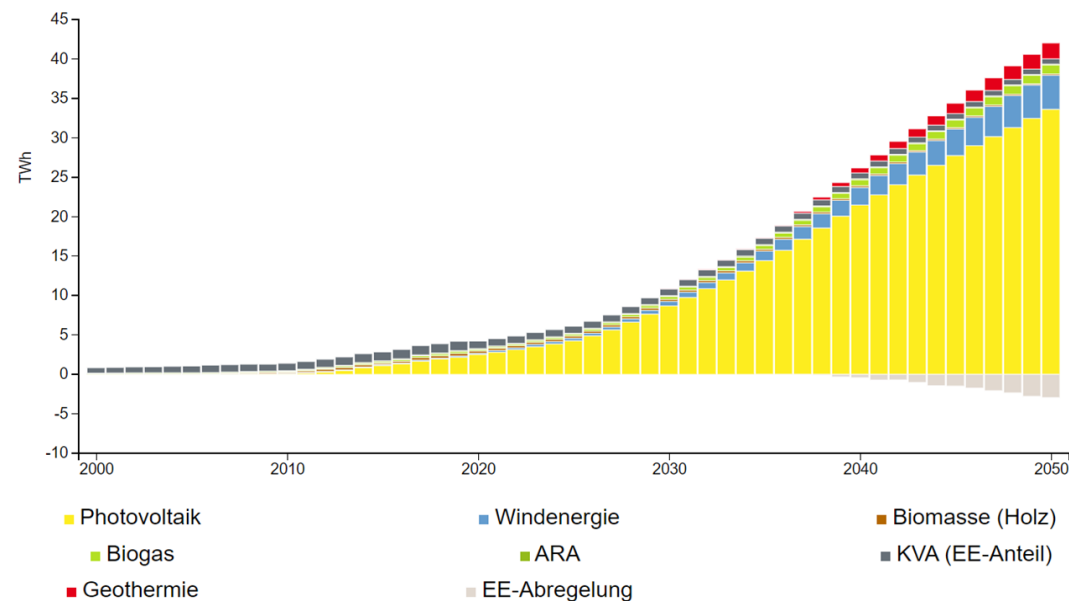
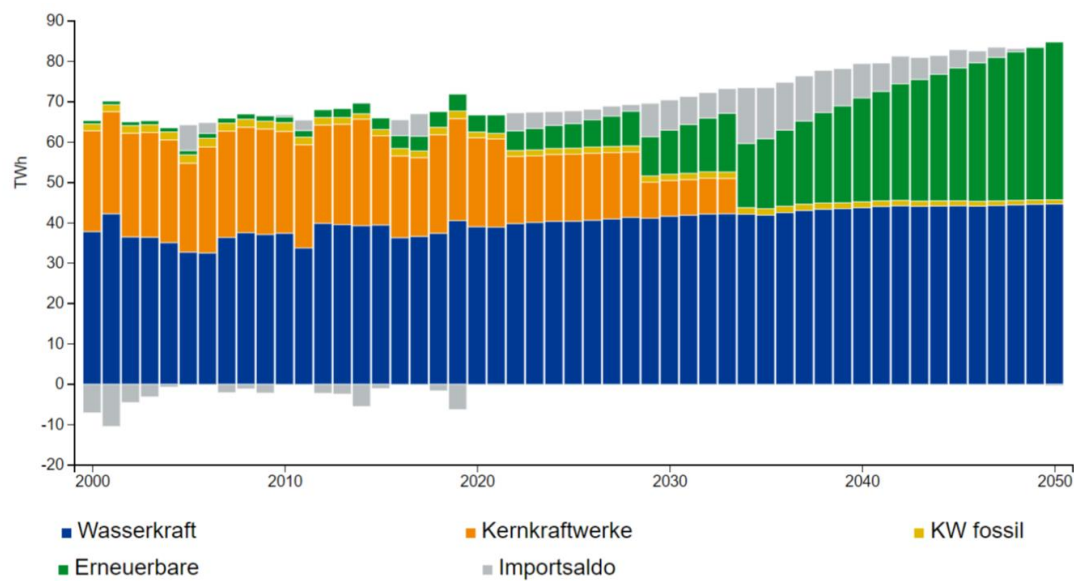


Research questions

1. What are the CoC for various low carbon technologies?
2. How do the CoC differ between investor types?
3. What financing structures do the different investors apply?

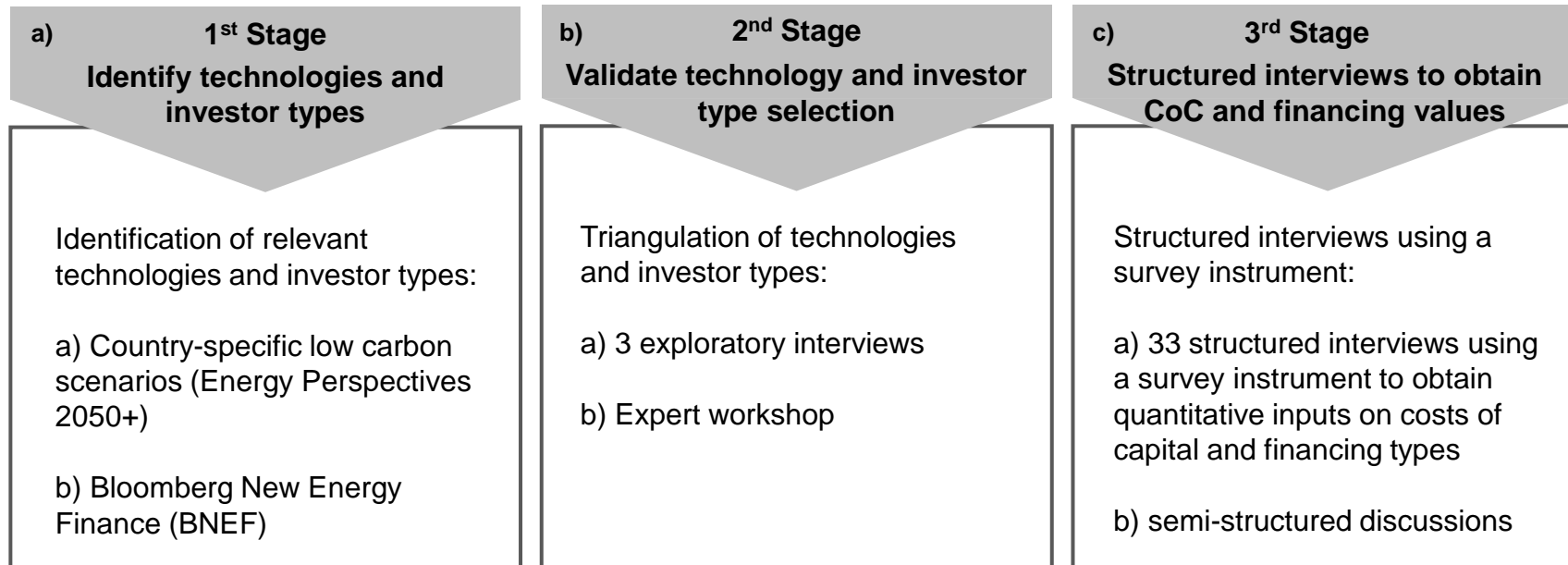


Research case

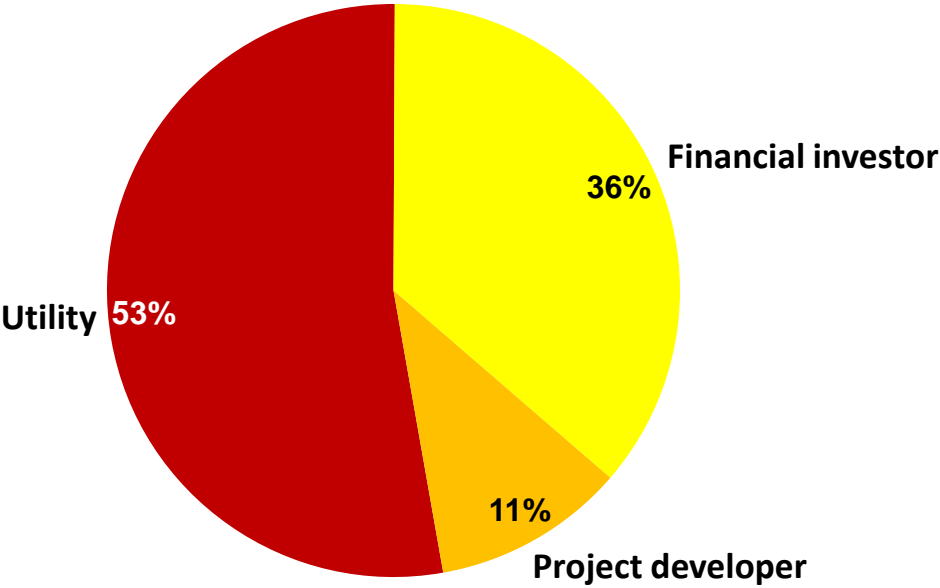
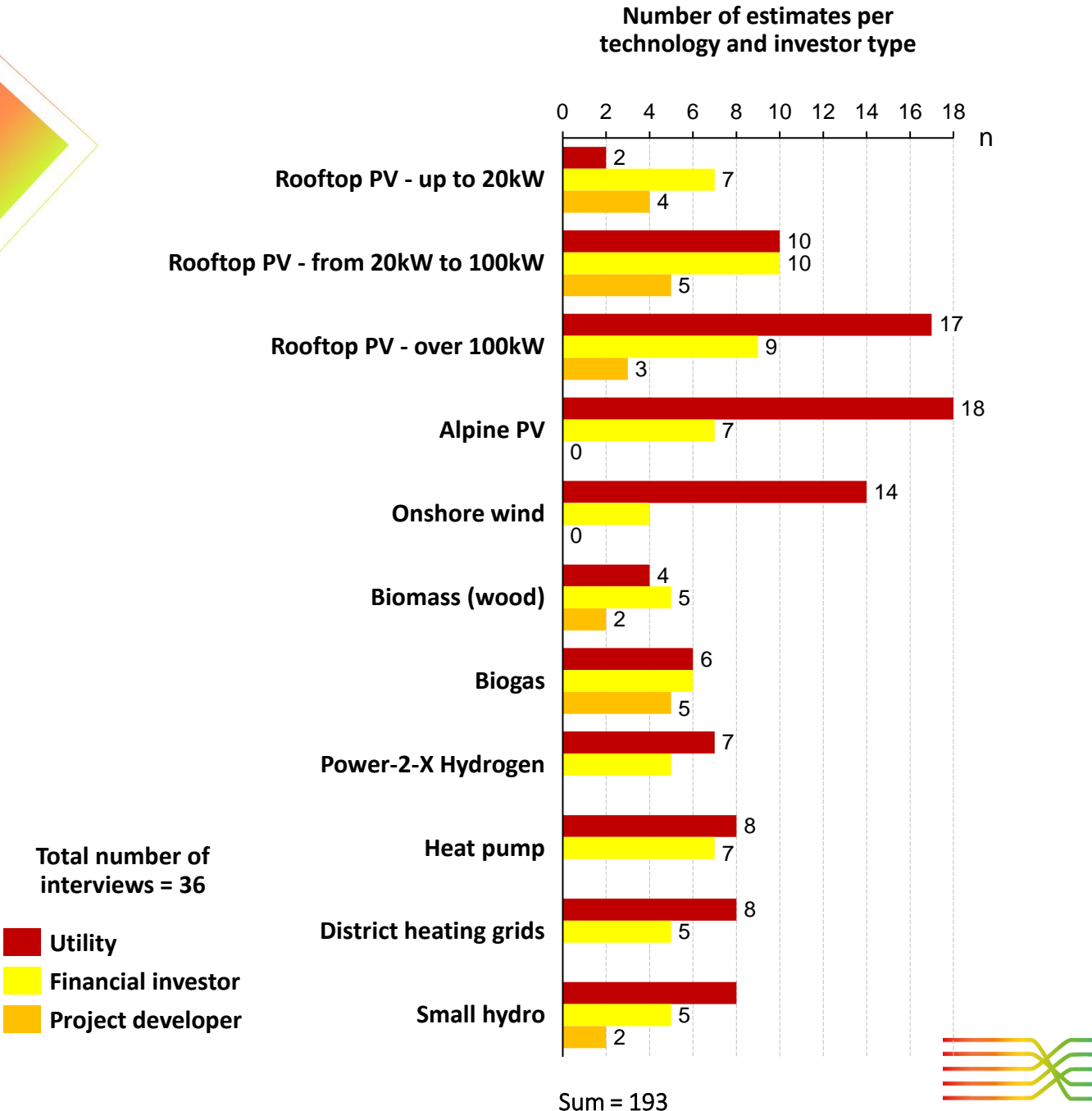




Methods



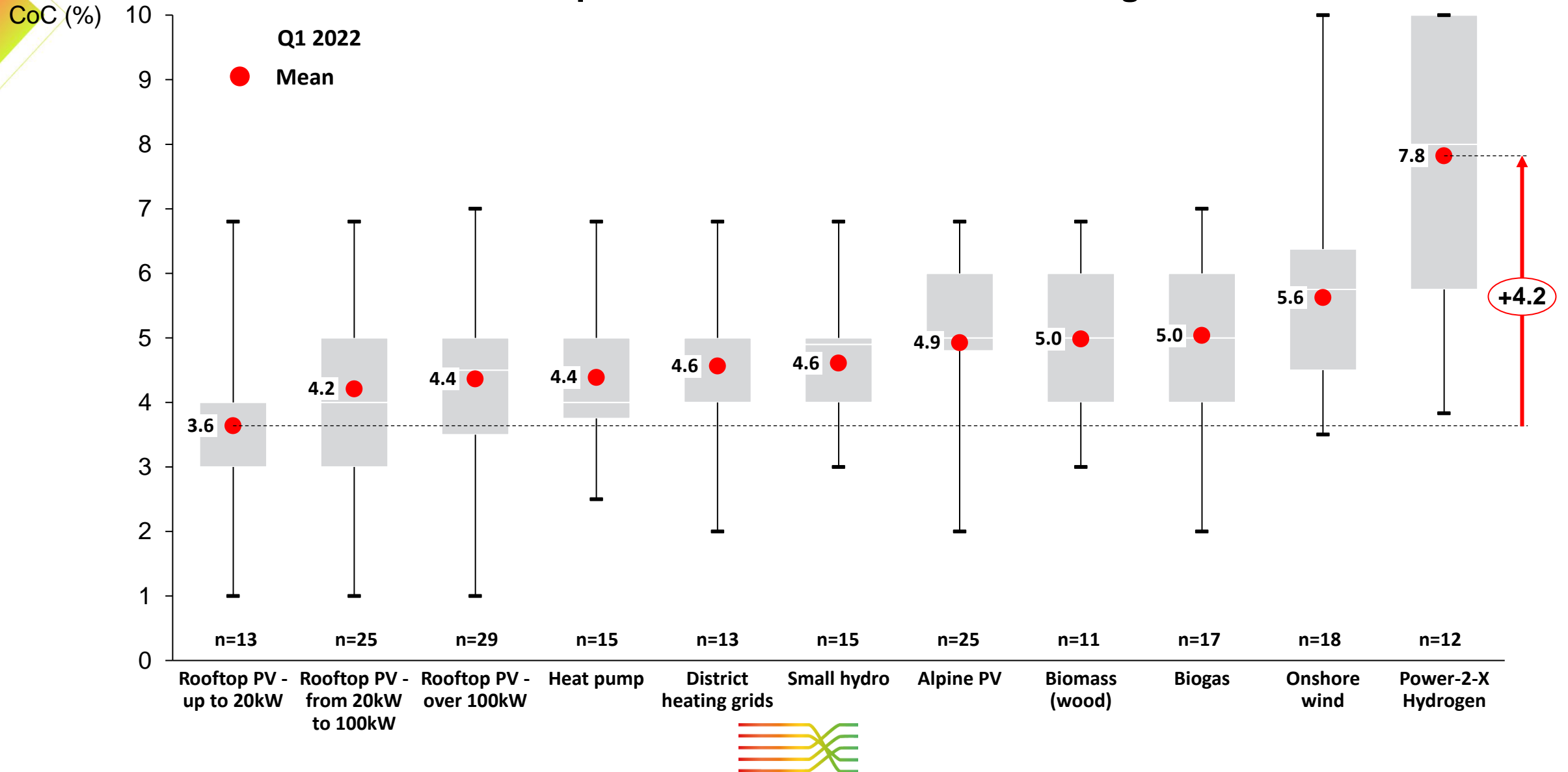
Collected cost of capital estimates



n – estimate. One interviewee can provide multiple estimates

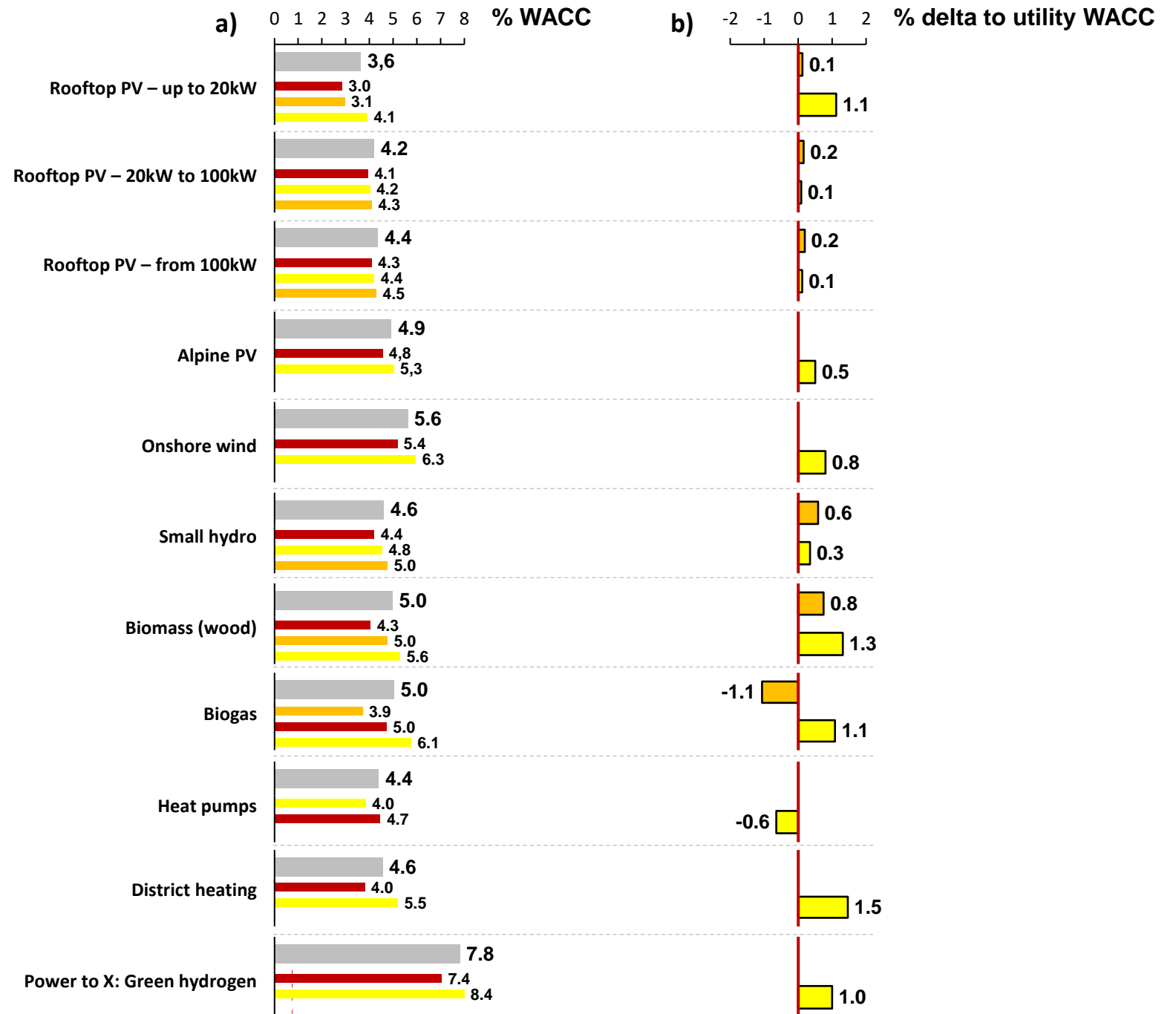
Results

Cost of capital estimates between technologies

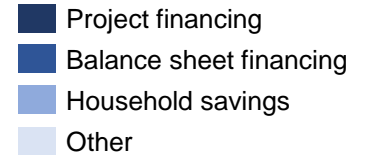


Results

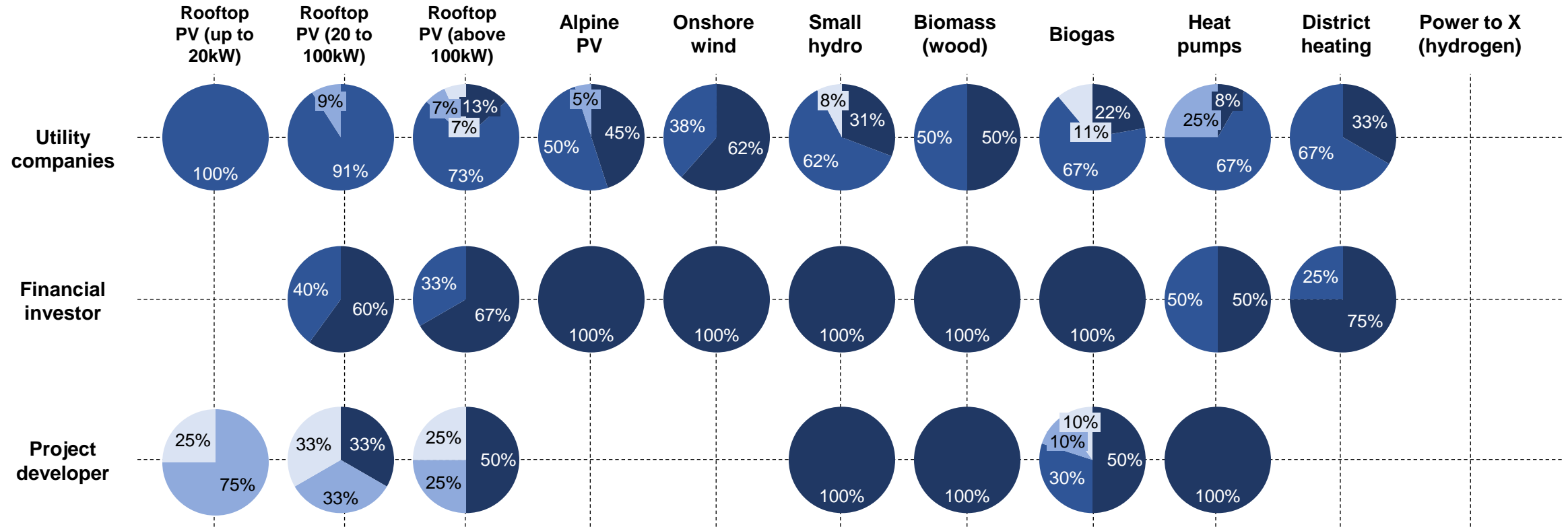
Differences in costs of capital between investor types



Results



Differences in financing types between investors and technologies



*in case of missing charts we collected less than two inputs



Discussion and conclusions

Key findings

1. large variance in CoC between technologies – 4.2 percentage point (pp) between small-scale rooftop PV and green hydrogen – **differentiate between technologies CoC in energy system analysis**
2. major variation in CoC within single technology categories – 6 pp difference for single rooftop PV categories, implying to **differences between business models.**
3. onshore wind markup indicates to **importance of local market maturity**, not just technology maturity (CH versus DE)





Discussion and conclusions

The generalizability of the findings to other countries

- the risk stacking from solar PV to more complex technologies similar to other studies (solar generally has lower risk than wind)*
- utilities in other markets also mainly use balance sheet financing**

Swiss specific aspects

- legal uncertainty and permitting time for onshore wind specific to CH
- small average project sizes limit involvement of banks in financing



*Steffen (2020), Egli et al. (2018), Roth et al. (2021), European Economics (2018)

** Steffen (2018)

Thank you for the attention!

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About the SWEET EDGE project and support slides



SWEET-EDGE project

EDGE wants to fast-track the growth of locally sourced decentralized renewable energy in Switzerland.

The project aims to ensure that by 2035 and 2050, when ambitious shares of renewable energy are reached, the Swiss energy system is designed and operated in a technically and economically optimal and secure way, and that it is well positioned in the European markets.

[Home - SWEET EDGE \(sweet-edge.ch\)](https://sweet-edge.ch)



Research partners

EPFL



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Implementation partners



SIEMENS



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Our objectives in SWEET EDGE

Understand the **financing landscape** for renewable energy in Switzerland

- **Investors:** who invests in which technologies and regions?
- **Types of finance:** what financing sources and structures are used?
- **Costs of capital:** what are the costs of capital for individual technologies?

Inform the EDGE **energy system modeling**

- **Model discount rate:** what discount rates should our EDGE energy system model use?

Derive **policy implications** for provision of capital at low cost

- **Financing needs:** after the EDGE model derives the total investment needs required to decarbonize Switzerland, derive conclusions on who will provide this capital (financing needs)
- **Policy implications:** what can policymakers do to make capital cheaper?





Interview overview

- approximately **45 min**
- open questions
- data and anonymization
 - Chatham House Rule applies ^[1]: No statement will be linked to a respondent or institution
 - recording or note taking with option for subsequent review by participant
 - you can withdraw during the interview or any time prior to the publication of the results
- the interviews are held either in English or German

[1] When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.” - See more at: <https://www.chathamhouse.org/about/chatham-house-rule>



Interview questions and topics

Alps, Midlands, Cities

Investor type

- Commercial bank
- Public bank
- Pension fund
- Insurance company
- Private equity
- Project developer
- Technology provider
- Utility
- Household
- Family-owned farm
- Association
- Energy foundation
- Municipalities
- Other

Financing structure

- Project financing
- Balance sheet financing
- Other

Cost of capital

- WACC
- Cost of debt
- Cost of equity
- Loan duration
- Other

Solar PV

- Rooftop PV
- Alpine PV

Onshore wind

Biomass

- Agricultural (e.g biogas)
- Woody (e.g pyrolysis)

Power-2-X

- Electrolyser (H_2)

Small hydro

Heat pumps

District heating

QUESTIONS

Market

1. In which **Swiss regions** and **tech** are investments taking place?
2. Which **investor types** invest into these technologies?
3. What **revenues** or **remuneration** do these projects have?

Financing

4. Could you estimate the **costs of capital and financing conditions** for technologies in CH?

([see online survey](#))

