DIFFERENTIATING THE COSTS OF CAPITAL FOR LOW-CARBON TECHNOLOGIES

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Overview

Until now, the literature on low-carbon infrastructure financing has mainly investigated the CoC of large-scale projects like onshore wind farms and utility-scale solar PV (above 1MW) [1,2]. These studies have empirically and qualitatively analyzed the investment risk drivers that impact CoC [2,3]. While the current research focused mainly on large-scale solar and wind energy and their investment risks, our empirical understanding of the CoC for low-carbon technologies remains limited across several crucial dimensions.

First, knowledge of CoC for multiple small-scale low-carbon technologies is missing. These include rooftop solar PV, small hydro, heating infrastructure including heat pumps and district heating grids, and novel technologies such as green hydrogen. Even so, these technologies are frequently central in energy system models [4]. Knowing their CoC would enable researchers to use the technology-specific CoC rather than applying uniform CoC values - as is currently the case [5] - thus improving the quality of energy scenarios. Second, fully understanding the CoC and financing for these technologies requires knowing who invests in them. Investors have different return expectations, depending on their risk premiums for price risk and various business model setups [6–8] and previous investment activities [9]. Third, different financing practices, including project and balance sheet financing, significantly impact the sources of debt and equity investors have access to and, by extension, their CoC [10].

Our study addresses these knowledge gaps by providing a systematic empirical account of the CoC for different low-carbon technologies differentiated across investor types and financing practices. We structure our analysis along the identified research gaps and answer the following research questions: How do the CoC differ between various low-carbon technologies? What financing arrangements do investors apply for these technologies, and how do these differences impact CoC values?

Methods

To understand the CoC of the different technologies, we choose Switzerland with a variance of active markets and investors in low-carbon technologies. The small country's size and geographic limitations, the strong local opposition to large-scale projects and legal hurdles to installing ground-mounted PV (s), and the division of the Swiss power systems along municipal lines (s) make Switzerland primarily a market for small-scale technologies. We conducted 33 semi-structured interviews with financing professionals regarding their Swiss investments, risk drivers, cost of capital (WACC), technology-specific financing structures, and debt sources. Overall we collected 170 CoC estimates for eleven technology types.

Results

First, we show significant differences in CoC values between the surveyed technologies, ranging from 3.2% for small-scale solar PV systems to 8.4% for green hydrogen, as shown in Figure 1. Our results imply a risk cascade of multiple risk premiums that materialize in higher CoC. These risks include technology risks that are lowest for solar PV and highest for technologies like biomass and green hydrogen. Permitting risks also play a significant role. In the case of onshore wind, they lead to a substantial risk premium, making it the technology with the second highest CoC in Switzerland. Furthermore, our interviewees reveal a significant impact of revenue risks. For instance, in the case of biomass energy, these concern the extent of heat output with contracted sales to end customers.

Second, our results indicate considerable variation in financing types and debt sources. Investors usually finance larger projects, such as onshore wind plants and biomass, via project financing and bank loans. In contrast, smaller projects such as rooftop solar PV, heat pumps, and district heating networks are usually financed via balance sheets and a combination of household savings, bond issuance, and corporate loans. Third, we demonstrate the difference between the CoC of different investor types. Swiss utility companies typically have the lowest CoC for most technologies in our sample. Partially, this is because Swiss utilities are state-owned, giving them access to cheaper capital. Moreover, they predominantly use balance sheet financing, enabling them to access other cheaper debt sources via bond markets. On the other hand, our results imply financial investors and project developers prefer to isolate individual projects and their risks via project financing.

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Conclusions

In conclusion, we find significant differences in CoC between the different low-carbon technologies and highlight the need to differentiate these in energy system models. Furthermore, we find substantial differences in CoC between individual investor types. Besides their use in energy system models, understanding these differences could be crucial for structuring technology-specific de-risking policies.

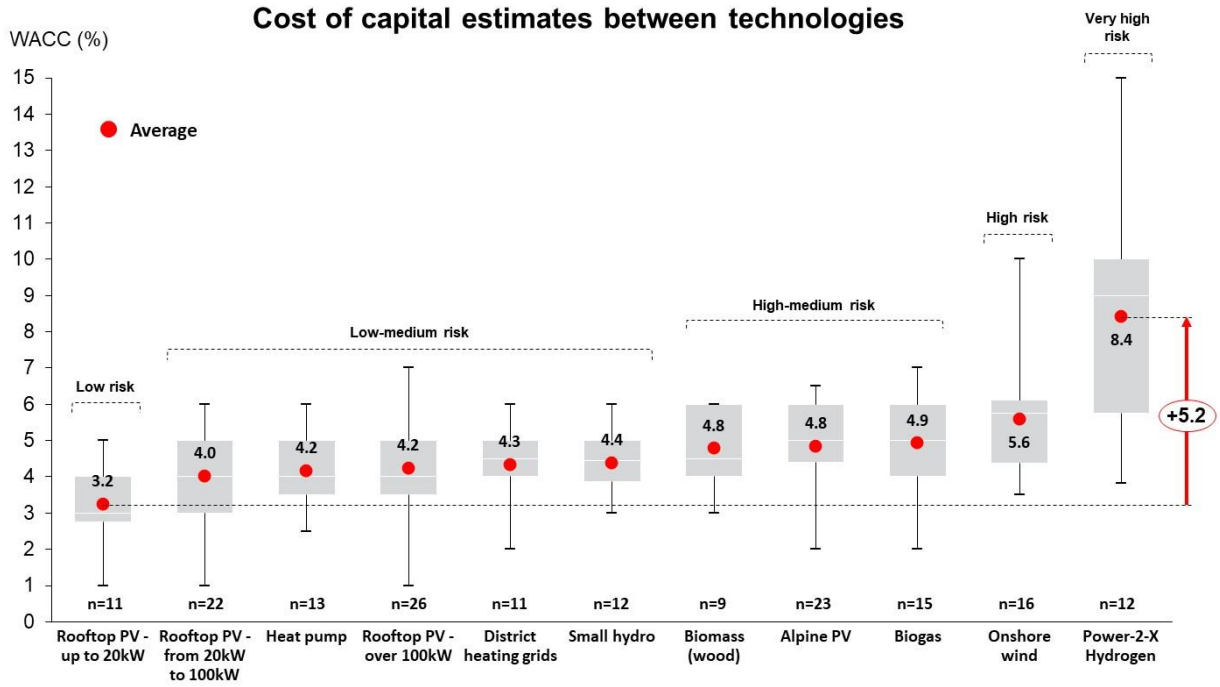

Figure 1: Cost of capital differences between the surveyed technologies

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