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FINDIT

Leveraging the Swiss financial sector to finance direct investments in the energy transition

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Zusammenfassung

Heute ist nur wenig über Investitionen in Erneuerbare Energien in die Schweiz (Zuflüsse), aus der Schweiz (Abflüsse) und innerhalb des Landes sowie deren Treiber bekannt. FINDIT wird diese Lücke schliessen, indem es die umfassendste Datenbank für Energieinvestitionen in Verbindung mit Investoreninterviews und Analysen politischer Rahmenbedingungen nutzt. Die Projektergebnisse werden zum ersten Mal eine Übersicht über die Energieinvestitionsmuster in der Schweiz und von Schweizer Investoren im Ausland liefern. Kombiniert mit qualitativen Erkenntnissen über die Einflussfaktoren dieser Muster wird FINDIT Empfehlungen für die Gestaltung der Energie- und Finanzpolitik geben, um den Schweizer Finanzsektor optimal für die Energiewende zu nutzen. Im ersten Jahr des Projekts wurden die erforderlichen Investitionsdaten gesammelt und durch Imputationen aufbereitet, um fehlende Datenpunkte zu ergänzen. Darüber hinaus wurde eine Datenanalyse durchgeführt, um eine Übersicht über die Investitionsströme im Energiebereich für die Schweiz und andere OECD-Länder in den letzten 20 Jahren zu erstellen. Die erste Analyse deutet darauf hin, dass sich die Länder in ihrer Bedeutung als Netto-Investitionszufluss- und Investitionsabfluss-länder erheblich unterscheiden, insbesondere wenn man auch ihre relative Investitionsabflusskraft vergleicht, wobei die Schweiz einer der wichtigsten Akteure ist. Die Ergebnisse der bisher durchgeführten quantitativen Datenanalyse wurden an einer internationalen Konferenz präsentiert und werden später in einem wissenschaftlichen und peer-reviewed Journal veröffentlicht.

Résumé

Aujourd'hui, nous savons peu de choses sur les investissements de l'économie réelle liés à l'énergie en Suisse (flux entrants), hors de Suisse (flux sortants) et à l'intérieur du pays, ainsi que sur les moteurs de ces investissements. FINDIT comblera ces lacunes par l'étude de la base de données la plus complète sur les actifs énergétiques réels associée à des entretiens avec des investisseurs et des analyses politiques. Les résultats du projet fourniront, pour la première fois, un paysage des modèles d'investissement énergétique fait en Suisse et à l'étranger par des investisseurs suisses. Combiné à des observations qualitatives sur les moteurs et les obstacles de ces modèles, FINDIT fournira des recommandations pour l'élaboration d'une politique énergétique et financière visant à mettre le secteur financier suisse au service de la transition énergétique. Au cours de la première année du projet, les données requises sur les actifs réels ont été collectées et préparées par le biais d'imputations afin de compléter les points de données manquants. De plus, des analyses de données ont été menées pour élaborer le tout premier paysage des flux d'investissements énergétiques pour la Suisse et d'autres pays de l'OCDE au cours des 20 dernières années. Les analyses préliminaires suggèrent que les pays étudiés diffèrent de manière significative dans leur pertinence en tant que pays d'entrée et de sortie d'investissements nets, en particulier si l'on compare également leur pouvoir relatif de sortie d'investissements, où la Suisse est l'un des acteurs les plus importants. Les résultats de l'analyse quantitative menée jusqu'à présent ont été présentés lors d'une conférence internationale et seront finalement soumis et publiés dans une revue à comité de lecture.

Summary

Today, little is known about the renewable energy real economy investments from abroad into Switzerland (inflow), from Switzerland to countries abroad (outflow) and within Switzerland and the drivers thereof. FINDIT will address this gap by leveraging the most comprehensive real energy asset database in conjunction with investor interviews and policy analyses. The project results will provide a landscape of energy investment patterns in Switzerland and abroad. Combined with qualitative insights about the drivers and barriers of these patterns, FINDIT will provide recommendations for the design of energy

and financial policy to leverage the Swiss financial sector for the energy transition. In the first year of the project, the required real asset data has been collected and prepared via data-heavy imputations to address incomplete data. Further, data analyses have been conducted to develop the investment flow landscape for Switzerland and other OECD countries over the past 20 years. Preliminary results suggest that countries significantly differ with respect to the relative investment inflow and outflow for the energy transition. Switzerland is one of the most extreme net outflow countries. The results of the quantitative data analysis conducted so far have been presented at an international conference in Utrecht and will be submitted to a peer-reviewed journal in the coming months.

Contents

Abbreviations

BNEF	Bloomberg New Energy Finance
EE	Energy Efficiency
FDI	Foreign Direct Investment
RE	Renewable Energy

1 Introduction

1.1 Background information and current situation

Transitioning towards a net-zero energy system requires a fundamental redirection of finance flows. Accordingly, financial actors can play an important role in this transition (Steffen & Schmidt, 2021). The Swiss financial sector manages roughly 30% of cross-border assets globally. Arguably, these assets are shifted to sustainable investments rapidly with year-to-year growth rates around 30% (Swiss Sustainable Finance and CSP University of Zurich, 2021). Yet, we know little about the asset-level structure of these investments because most academic analyses of sustainable finance focus on securities, such as stocks and bonds (Friede et al., 2015).

The net-zero target by the Federal Council translates into an estimated domestic low-carbon investment need of CHF 13 billion annually, of which renewable energy (RE) and energy efficiency (EE) investments account for roughly a third (Bueren, 2019). Anecdotal evidence points to an important role of Swiss investments in the development of such real assets, however, largely outside of Switzerland. For example, Swiss utilities have invested heavily in RE across Europe. Two of the largest Swiss utilities, Axpo and BKW, have invested in an estimated 1.3 GW of wind and solar PV capacity abroad as of 2019 (SRF, 2019). Compared to these figures, their installed capacity in wind and PV within Switzerland pales, totaling about 5% of the foreign capacity (Axpo, 2022; BKW, 2021). Similarly, Swiss investment managers are among the largest investors in the European energy transition. However, as we lack a structured assessment of such investments in and out of Switzerland by technology and investor type, the impact of Swiss investments on the energy transition - both domestically and internationally - remains unclear.

1.2 Purpose of the project

The FINDIT project aims to support Swiss policymakers in designing a regulatory financial framework conducive to the energy transition. While it is undisputed that the capital managed and invested out of Switzerland can contribute greatly to meeting low-carbon energy investment needs globally, it is unclear, which regulatory conditions work best to achieve this goal. FINDIT will generate novel insights into the investor landscape and possible levers of change along two dimensions: First, it will provide a granular landscape of Swiss domestic and international energy investments and, second, it will link these flows to investor types to create a detailed overview of energy investments by investors based in Switzerland. This overview, combined with a comparison to other developed economies will provide the basis for a sound analysis of policy levers to redirect financial flows in accordance with the energy transition and allow us to develop recommendations for energy and financial policy designs in Switzerland to leverage the cross-border investments out of Switzerland for the global energy transition.

1.3 Objectives

The project addresses three research questions:

1. How do energy investment patterns of Swiss actors develop by technology and over time?
2. What underlying drivers, including sustainable finance commitments as well as financial and energy policy, explain the patterns observed in the landscape?
3. How can Swiss policymakers leverage the domestic financial sector to accelerate the transition towards RE and EE in Switzerland and internationally?

Each research question will be addressed in one of three individual work packages. Anticipated outcomes of each work package are the following:

WP1 Investment patterns: A landscape of energy investment patterns will, providing the first every overview of energy asset investments in Switzerland and abroad by Swiss investors.

WP2 Underlying drivers: Detailed understanding of the drivers of and barriers to low-carbon real asset investments by investor type and technology (such as policy or industry initiatives), including the relative importance of these explanatory factors.
WP3 Policy levers: Overview of current policy landscape (i.e., relevant industry and policy initiatives in the energy and finance sector) as well as insights and recommendations as to which current industry and policy initiatives are likely efficient and effective. Based on this, areas where Swiss policymakers could act to leverage the Swiss financial sector optimally for the global energy transition are identified.

2 Description of facility

Not applicable

3 Procedures and methodology

Throughout the entire project we use a mixed method approach. The first work package is based solely on quantitative data analysis and focuses on the collection, preparation, and descriptive overview of the data. In the second work package, the quantitative analysis will be extended with additional aspects, especially in terms of diving deeper into specific aspects and patterns of varying investor types. Qualitative methods, including a literature review and interviews with investors in Switzerland and additional case study countries will be used to develop a detailed understanding of investment drivers and their relative importance. Work package three will then bring the quantitative and qualitative insights from the first two work packages together and add an additional dimension via desktop research and further interviews with key stakeholders in Switzerland. This will allow the project to provide insights and recommendations as to how Swiss policymakers could leverage the Swiss financial sector more optimally to support the global energy transition.

So far, the core contribution of work package one has been finalized and a comprehensive dataset of international financing flows over the past 20 years has been developed – not only for Switzerland, but across all OECD countries. To do so, we carried out the following key activities:

1. Data collection and selection

As an initial step we sourced all available data on asset financing from both Bloomberg New Energy Finance (BNEF) and IJ Global – two of the most comprehensive databases available. We then conducted a comparative analysis on these datasets, evaluating their respective strengths, limitations, and potential for integration. Upon evaluation, it was evident that BNEF offered the more extensive and comprehensive view on the financing deals for the purpose of our research. The assessment was conducted based on investment values and number of transactions reported per database – an example of the checks done (for debt investments into Solar in selected countries) is provided here in Figure 1.

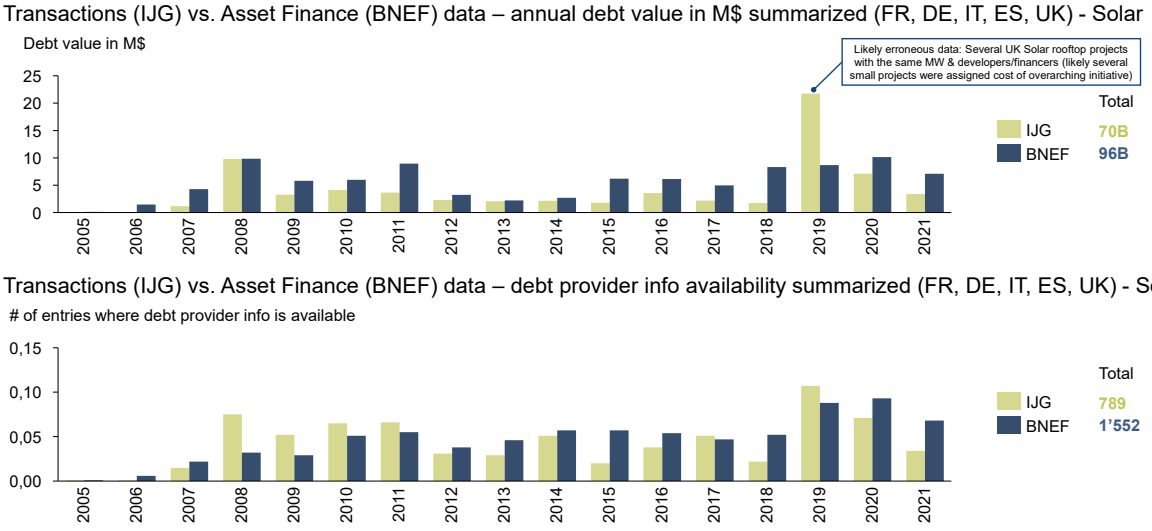

Figure 1: Sample of data availability checks during data collection and selection between IJ Global and BNEF database (pictured here for Solar and a small selection of key European markets)

Further, merging the two datasets did not prove feasible, as deals could not be matched sufficiently to ensure that no double counting would take place. We therefore opted to rely exclusively on the BNEF datasets.

2. Data preparation

The data variables required for the analysis are spread across three different datasets provided by BNEF. We therefore had to merge these datasets, namely the asset finance, project, and organizations data. During this integration, we implemented manual controls as required to ensure data consistency and accuracy.

To enable a categorization of different investor types, we developed a categorization framework to distribute investors into utilities, project developers as well as financial investors both from the finance industry and the "real economy". A further distinction of investors based on their ownership structure will follow in the second work packages (see "next steps").

Although BNEF provides good coverage of financing deals, there are several instances of missing data. Given some gaps are found for important variables relevant to our analysis (i.e., date of close, investor industry, investment values, and debt shares), we conducted imputations based on known values in the data as part of the data preparation process. For missing dates of close (used to define the year of the deal) as well as debt shares (required to identify investment amounts per investor) we used a simple group averages method to impute the missing information. To impute dates of close, we determined all deals where both date of close as well as date of announcement (a second variable available in the raw data). We then grouped them by technology and calculated the average number of days between such date of announcement and the date of close for each of the groups. For deals where the date of close was missing, we then added these average number of days to the known date of announcement according to the technology of the deal. A similar process was used for the missing debt shares. However here, we formed averages by technology, country, and year. For some deals with missing debt shares it was not possible to form a corresponding group from the "known" data. In such cases we either formed averages by technology and country or just by technology and applied those average debt shares to the

respective deals. For the identification of missing investment values we had to develop a more comprehensive imputation method, as simple averages or regression methods did not warrant satisfactory results. While trying out different methodologies (e.g., regressions, neuronal networks), we finally selected a random forest model. A random forest model is a machine learning algorithm that creates decision trees by randomly selecting subsets of the training data and features. It trains each tree independently, and when making a prediction, it aggregates the outcomes from all the trees in the ensemble to reach a final decision. This type of model is well-suited for imputations of missing data, handles mixed data well, will adapt to interactions or nonlinearity, and is known to reduce over-fitting (even for high-dimensional data), resulting in highly generalized and accurate models (Cutler et al., 2012). The data fit of our model was tested by randomly retaining 20% of the data as a test dataset. The final model used was able to achieve an R^2 of 75%.

To account for the uncertainty introduced by imputing several key variables and ensure robustness of results, we sourced not only the estimate, but also corresponding standard deviations for each of the imputed values both for the debt shares as well as the investment values. These were then subsequently used in Monte Carlo simulations for several of the subsequent analyses. The distributions of the Monte Carlos simulation allowed us to calculate and show 95% probability ranges for the key output variables.

3. Data analysis

In a final step, we used the dataset constructed in step 2 to conduct analyses on in- and outflows of renewable energy financing in OECD countries over time and by technologies.
Technologies considered include wind onshore, solar PV, wind offshore and biomass & waste (largest technologies in the dataset, covering 89% of deals reported). A small share of additional technologies is grouped into “other” and includes solar thermal, small hydro, and marine as well a small share of wind and solar projects that could not be identified in detail (make up 3.3% of investment value in the final OECD dataset). We considered deals that took place between 2004 and 2022 as BNEF was established in 2004 and 2022 is the last full year available at the time of the analysis.

Any deals that were abandoned, postponed/cancelled and in active planning (29 “in active planning” deals all without a known date, so could not be mapped) were not considered. In addition, all types of deals (i.e., new build, acquisition, and refinancing) were used for the analysis as our interest lies in overall capital flows, not only newly developed projects. Finally, deals where no investor could be identified, due to missing investor fields or where investors were listed as “not reported” or “private”, also had to be excluded, as no investment source country can be identified (for equity investors this encompasses 4.4% of investment values in the dataset across all countries globally, for debt investors 73%).

4 Activities and results

A selection of key results and findings have been categorized according to activities described above:

2. Data preparation

Due to the importance of the investment value variable in our analyses, significant effort was spent in identifying the optimal imputation method for missing datapoints. As mentioned above, several estimation methods were fitted and tested before identifying the random forest model as method of choice. Figure 2 shows the comparison of a linear regression model with the random forest model.

As can both be seen by the R^2 as well as the visual representation, the random forest model proved to be a superior method in estimating the missing investment value datapoints.

3. Data analysis

To describe the investment landscape in Switzerland and the remaining OECD countries, we conducted four types of analyses. First, we aggregated investments over all years and technologies and mapped flows of financing between different countries via Sankey diagrams. In a next step, we ranked all countries according to absolute net outflows and added an additional information layer by identifying the relative share of inflows and outflows. We then compared the renewable energy financing flows to financing flows of the general economy and finally did some investor type deep dives. Since the results are still to be published in an academic journal, those are not yet included here.

Simple linear regression

Dependent variable: transaction value in $M
Independent variables: country, total capacity in MW, technology, year, transaction type (new build vs. acquisition etc.), financing type (e.g., balance sheet)

R^2 value: 0.23

Random forest

Dependent variable: transaction value in $M
Independent variables: country, total capacity in MW, technology, year, transaction type (new build vs. acquisition etc.), financing type (e.g., balance sheet)

R^2 value: 0.75

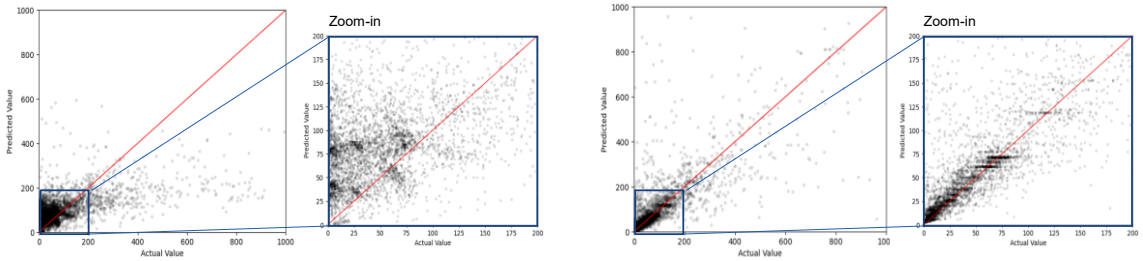

Figure 2: Model fit comparison between regression and random forest models for the imputation of investment values of renewable energy financing deals

5 Evaluation of results to date

The first part of the project contributes to the renewable energy finance research domain in providing a novel and robust methodology of imputing missing investment data and thus closing significant gaps in the data available for such research. Issues identified and methodology used will be shared back with BNEF to support the development of a better baseline of data availability in the field. BNEF is a database broadly used in research and financial decision making. While we cannot share the final raw and imputed datasets (this does not refer to results and generated with this raw data, such as figures and graphs etc.) publicly due to contractual obligations from our BNEF license, we will publish the code that researchers can use if they have access to the raw data and, additionally, we hope that BNEF will consider taking up some of the proposed data imputation steps.

As a result, this project develops a comprehensive landscape of cross-border renewable energy financing in OECD countries. Based on the prepared data and initial results, a broad range of subsequent research can be conducted even beyond the scope of this project.

Further, the project is so far fully on track with regards to the timeline put forward in the proposal.

6 Next steps

In the upcoming year, we will focus on the deliverables of work package 2 and start diving deeper into the role of different types of investors and the drivers for their investment choices. This will include the following steps:

1) Compile additional investor characteristics to be added to the raw data – most importantly the ownership structure (i.e., public or private company)
2) Perform case selection
3) Identify factors of influence for energy investments (e.g., energy policy environment, size of financial sector, breadth of financial industry commitments, financial policy regulations) both via literature review as well as exploratory interviews
4) Conduct investor interviews and collect potential additional data (e.g., policies in case study countries)
5) Analyse inverview data and additional sources to develop descriptive overview of key drivers and barriers of (cross-border) renewable energy investments

7 National and international cooperation

Not applicable

8 Communication

The first findings of the project have been presented at the internal International Sustainability Transitions Conference 2023 in Utrecht this August.

9 Publications

Not applicable

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11 Appendix

Not applicable