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Executive summary

The overall objective of EDGE is to provide evidence for accelerating the growth of locally sourced decentralised renewable energy in Switzerland from a highly interdisciplinary and transdisciplinary perspective. In year 4, the EDGE consortium completed a second cycle of developing and evaluating new electricity scenarios for Switzerland for 2035 and 2050. We consider very high shares of renewable energy generation, implementing the new renewable electricity targets set by legislation, and using projected electricity sector developments in the neighbouring countries. We also consider potential electricity market integration constraints, which could result from the lack of a framework agreement between Switzerland and the European Union.

The main evidence for this scenario exercise comes from a model inter-comparison with four EDGE models (EXPANSE, FEM, Nexus-e, and OREES) to identify consensus and divergence in technical and cost results. The models agree that the future should see a massive increase of solar PV and wind generators in Switzerland, leading to an overall decrease in net imports but an increase in cross-border exchanges. Peak imports can be avoided and total imports reduced by more than 30% if hydropower is operated optimally, taking into account weather forecasts. However, these scenarios require changes in acceptance, policy and investment preferences, which appears to be socially, politically and economically feasible.

Several other research frontiers in the field of renewable energy were advanced from a techno-economic, financial, governance, policy and other perspective. In particular, the Recommender tool, a platform to support Swiss municipalities that do not yet have an energy strategy in their digital energy planning, was further developed and tested in practice, including the integration of some of the latest EDGE results on individual technologies, including data on wind power resources and the projected mobility demand.

From a policy perspective, EDGE's work on cantonal policy and the social acceptance of renewable energy policies and projects was synthesised to identify two levers that authorities can use to support the transition to renewable energy: (i) unblocking policy and institutional configurations, while facilitating local initiative, and (ii) de-politicizing processes and decisions related to infrastructure projects and policy making, while strengthening evidence-based debates. In terms of knowledge and technology transfer, EDGE outputs received significant media coverage, including RTS and SRF news, as well as articles in NZZ, Le Temps, and other news outlets and hence in this way reached the Swiss politicians, stakeholders and society at large. The final rounds of Energy Drinks for the general public in Zurich and Geneva were organised to present EDGE results in an informal and entertaining way.

Zusammenfassung

Das übergeordnete Ziel von EDGE ist es, aus einer hochgradig inter- und transdisziplinären Perspektive Erkenntnisse zur Beschleunigung des Wachstums dezentraler erneuerbarer Energien in der Schweiz zu gewinnen. Im seinem 4. Jahr hat das EDGE-Konsortium einen zweiten Zyklus zur Entwicklung und Bewertung neuer Stromszenarien für die Schweiz für 2035 und 2050 abgeschlossen. Wir berücksichtigen dabei einen sehr hohen Anteil an erneuerbaren Energien, setzen die neuen gesetzlichen Ziele für erneuerbare Energien um und nutzen die prognostizierten Entwicklungen des Stromsektors in den Nachbarländern. Wir berücksichtigen auch mögliche Einschränkungen bei der Integration des Strommarktes, die sich aus dem Fehlen eines Rahmenabkommens zwischen der Schweiz und der Europäischen Union ergeben könnten.

Die wichtigsten Erkenntnisse für diese Szenarien stammen aus einem Modellvergleich mit vier EDGE-Modellen (EXPANSE, FEM, Nexus-e und OREES), um Übereinstimmungen und Divergenzen bezüglich der technischen und finanziellen Ergebnisse zu ermitteln. Die Modelle stimmen darin überein, dass es in Zukunft zu einem massiven Anstieg von PV- und Windkraftanlagen in der Schweiz kommen sollte, was zu einem allgemeinen Rückgang der Nettoimporte, aber gleichzeitig zu einem Anstieg des grenzüberschreitenden Stromaustauschs führen wird. Spitzenimporte können vermieden und die Gesamtimporte um mehr als 30% reduziert werden, wenn die Wasserkraft unter Beachtung der Wettervorhersagen optimal betrieben wird. Diese Szenarien erfordern jedoch Änderungen bei der Akzeptanz, der Politik und den Investitionspräferenzen, was gesellschaftlich, politisch und wirtschaftlich machbar zu sein scheint.

Mehrere andere Forschungsbereiche im Bereich der erneuerbaren Energien wurden aus technisch-ökonomischer, finanzieller, politischer und weiterer Sicht vorangetrieben. Insbesondere wurde das Recommender-Tool weiterentwickelt und in der Praxis getestet. Das Recommender-Tool ist eine Plattform zur Unterstützung der digitalen Energieplanung für Schweizer Gemeinden, die noch nicht über eine Energiestrategie verfügen. Dabei wurden auch einige der neuesten EDGE-Ergebnisse zu einzelnen Technologien (Windpotentiale und vorhergesagter Mobilitätsbedarf) integriert.

Aus politischer Sicht wurden die Arbeiten von EDGE zur kantonalen Politik und zur gesellschaftlichen Akzeptanz von Politiken und Projekten im Bereich der erneuerbaren Energien zusammengefasst, um zwei Hebel zu identifizieren, mit denen die Behörden den Übergang zu erneuerbaren Energien unterstützen können: (i) das Lösen politischer und institutioneller Blockaden bei gleichzeitiger Erleichterung lokaler Initiativen und (ii) die Entpolitisierung von Prozessen und Entscheidungen im Zusammenhang mit Infrastrukturprojekten und politischen Entscheidungen bei gleichzeitiger Stärkung faktenbasierter Debatten. Was den Wissens- und Technologietransfer anbelangt, so wurde über die EDGE-Ergebnisse in den Medien ausführlich berichtet, u. a. in den Nachrichten von RTS und SRF, sowie in Artikeln in der NZZ, Le Temps und anderen Publikationen, wodurch Schweizer Politikerinnen und Politiker, Interessengruppen und die breite Öffentlichkeit erreicht werden konnten. Die abschliessenden Energy Drinks für die breite Öffentlichkeit in Zürich und Genf wurden organisiert, um die spannenden Resultate von EDGE auf informelle und unterhaltsame Weise zu präsentieren.

Résumé

L'objectif global d'EDGE est de fournir des indications pour accélérer la croissance des énergies renouvelables décentralisées d'origine locale en Suisse, en adoptant une perspective hautement interdisciplinaire et transdisciplinaire. Au cours de la quatrième année, le consortium EDGE a achevé un deuxième cycle de développement et d'évaluation de nouveaux scénarios d'électricité pour la Suisse en 2035 et 2050. Nous envisageons des parts très élevées de production d'énergie renouvelable, en mettant en œuvre les nouveaux objectifs d'électricité renouvelable fixés par la législation, et en utilisant les développements projetés du secteur de l'électricité dans les pays voisins. Nous prenons également en compte les contraintes potentielles d'intégration du marché de l'électricité, qui pourraient résulter de l'absence d'accord-cadre entre la Suisse et l'Union européenne.

La principale preuve de cet exercice de scénario provient d'une comparaison entre quatre modèles de EDGE (EXPANSE, FEM, Nexus-e et OREES) afin d'identifier les consensus et les divergences dans les résultats techniques et les coûts. Les modèles s'accordent sur le fait que l'avenir devrait voir une augmentation massive des générateurs solaires photovoltaïques et éoliens en Suisse, conduisant à une diminution globale des importations nettes mais à une augmentation des échanges transfrontaliers. Les importations de pointe peuvent être évitées et les importations totales réduites de plus de 30 % si l'hydroélectricité est exploitée de manière optimale, en tenant compte des prévisions météorologiques. Toutefois, ces scénarios nécessitent des changements dans l'acceptation, la politique et les préférences d'investissement, ce qui semble être socialement, politiquement et économiquement faisable.

Plusieurs autres frontières de la recherche dans le domaine des énergies renouvelables ont progressé d'un point de vue technico-économique, financier, politique et de gouvernance, entre autres. En particulier, l'outil de recommandation, une plateforme destinée à aider les municipalités suisses qui n'ont pas encore de stratégie énergétique dans leur planification énergétique numérique, a été développé et testé dans la pratique. Cet outil intègre certains des derniers résultats d'EDGE concernant les technologies individuelles, notamment en ce qui concerne le potentiel éolien et la demande de mobilité projetée.

D'un point de vue politique, les travaux d'EDGE sur la politique cantonale et l'acceptation sociale des politiques et des projets d'énergie renouvelable ont été synthétisés pour identifier deux leviers que les autorités peuvent utiliser pour soutenir la transition vers l'énergie renouvelable : (i) débloquer les configurations politiques et institutionnelles, tout en facilitant l'initiative locale, et (ii) dépolitiser les processus et les décisions liés aux projets d'infrastructure et à l'élaboration des politiques, tout en renforçant les débats fondés sur des données probantes. En termes de transfert de connaissances et de technologies, les résultats de l'EDGE ont bénéficié d'une couverture médiatique importante, notamment les nouvelles de la RTS et de la SRF, ainsi que des articles dans la NZZ, Le Temps et d'autres organes d'information, touchant ainsi les politiciens, les parties prenantes et la société suisse dans son ensemble. Les dernières séries de "Energy Drinks" destinées au grand public à Zurich et à Genève ont été organisées pour présenter les résultats d'EDGE de manière informelle et divertissante.

Riassunto

L'obiettivo principale di EDGE è quello di fornire conoscenze per accelerare la crescita delle energie rinnovabili decentralizzate a livello locale in Svizzera da una prospettiva altamente interdisciplinare e transdisciplinare. Nel quarto anno, il consorzio EDGE ha completato un secondo ciclo di sviluppo e valutazione di nuovi scenari elettrici per la Svizzera per il 2035 e il 2050. Abbiamo considerato quote molto elevate di produzione di energia rinnovabile, attuando i nuovi obiettivi di elettricità rinnovabile stabiliti dalla legislazione e utilizzando gli sviluppi del settore elettrico previsti nei Paesi confinanti. Inoltre, abbiamo esaminato l'eventualità di una riduzione dell'integrazione nel mercato elettrico, scenario che potrebbe emergere in assenza di un accordo tra la Svizzera e l'Unione Europea.

I principali risultati di questa analisi provengono da un confronto tra quattro modelli EDGE (EXPANSE, FEM, Nexus-e e OREES) usato per identificare il consenso e la divergenza nei risultati tecnici e nei costi. I modelli concordano sul fatto che il futuro sarà caratterizzato da un massiccio aumento della capacità fotovoltaica ed eolica in Svizzera, con una conseguente riduzione complessiva delle importazioni nette, ma un incremento degli scambi transfrontalieri. L'ottimizzazione dell'uso dell'energia idroelettrica, basata sulle previsioni meteorologiche, potrebbe evitare i picchi di importazione e ridurre le importazioni totali di oltre il 30%. Tuttavia, il raggiungimento di questi scenari richiede cambiamenti nell'accettazione sociale, nelle politiche e nelle preferenze di investimento, che sembrano essere socialmente, politicamente ed economicamente fattibili.

Diverse altre frontiere della ricerca nel campo delle energie rinnovabili hanno registrato avanzamenti sotto il profilo tecno-economico, finanziario, della governance, delle politiche e di altri aspetti. In particolare, lo strumento Recommender, una piattaforma progettata per supportare i comuni svizzeri privi di una strategia energetica nella loro pianificazione energetica digitale, è stato ulteriormente sviluppato e testato nella pratica, integrando alcuni degli ultimi risultati di EDGE sulle singole tecnologie per potenziale eolico et previsioni della domanda di mobilità.

Da un punto di vista politico, il lavoro di EDGE sulla politica cantonale e sull'accettazione sociale delle politiche e dei progetti legati alle energie rinnovabili è stato sintetizzato per identificare due leve a disposizione delle autorità per favorire la transizione verso le energie rinnovabili: (i) sbloccare le configurazioni politiche e istituzionali, facilitando al contempo l'iniziativa locale, e (ii) depoliticizzare i processi e le decisioni relative ai progetti infrastrutturali e alla definizione delle politiche, rafforzando al contempo i dibattiti basati su dati concreti. Per quanto riguarda il trasferimento di conoscenze e tecnologie, i risultati di EDGE hanno ricevuto una significativa copertura mediatica, con servizi su RTS e SRF, oltre ad articoli pubblicati su NZZ, Le Temps e altre testate giornalistiche, raggiungendo così i politici svizzeri, le parti interessate e la società in generale. Infine, per presentare i risultati di EDGE in modo informale e coinvolgente, si sono svolte le ultime edizioni degli Energy Drinks a Zurigo e Ginevra, rivolte al grande pubblico.

1 Work programme overview

The overall objective of EDGE is to provide evidence and actionable suggestions to fast-track the growth of locally-sourced decentralized renewable energy in Switzerland, and contribute to the Swiss Energy system being designed and operated in a technically and economically optimal, as well as save way, so that Switzerland is well positioned in the European markets by 2035 and 2050, when ambitious shares of renewable energy have been reached. Pathways towards largely electrified and multi-carrier energy systems are examined by analysing electricity, mobility, and heating sectors. In particular, the EDGE consortium aims to move beyond generic designs and national-level analysis of decentralized renewable systems in Switzerland to a regionalized analysis, providing high-resolution spatially-explicit energy modelling and social data analysis to derive region-specific insights for the Swiss cities, midlands, and the Alps.

The EDGE consortium also delivers collaborative, highly interdisciplinary and transdisciplinary expertise, ranging from technology development to systems modeling, political and social science, management, economics, sustainability science, and energy practice, in order to identify the most efficient directions to unlock the full potential of decentralized renewable energy. EDGE brings together 18 research groups with 19 cooperation and 36 support partners from industry, public administrations, associations, and other sectors. It is jointly led by Prof. Michael Lehning (EPFL/WSL) and Prof. Evelina Trutnevyte (UNIGE).

Finally, the research component of EDGE is combined with specific case studies and implementation projects covering the diversity of Swiss regions, including the urban municipalities of Aarau, Sirnach and the municipalities from Sisslerfeld (Eiken, Münchwilen, Sisseln and Stein), rural midlands municipalities of Wittenbach, Winterthur and St. Prex, and Alpine projects in Sedrun, Savognin, Muttsee, La Stadera and Samedan. The mutual learning from these case studies and implementation projects ensures feedback loops between theory and practice, and strengthens the ability to use the results to define realistic pathways for successfully implementing a nearly or fully renewable Switzerland by 2050.

The EDGE work plan consists of ten work packages that cover:

- WP1, WP2, WP3 conduct analysis of energy supply and demand, grid capabilities, business models and finance, as well as governance for Switzerland as a whole and specifically for the Swiss cities, midlands, and the Alps;
- WP4, WP5, and WP6 cover case studies and implementation projects in cities, midlands, and alpine settings respectively;
- WP7 develops country-wide scenarios and transition pathways for a nearly or fully renewable Switzerland by 2050 to investigate the impact of high shares of renewable generation on the transmission, centralized generation and storage, transport sector, and European interconnection;
- WP8 works on policies, market design, market instruments, measures to mobilize finance and social acceptance, and distributional impacts in order to foster the uptake of decentralized renewable energy;
- WP9 and WP10 represent project management and knowledge and technology transfer.

In summary, the EDGE consortium aims to be the reference point for scientific analysis and collaboration between science and practice on the integration of very high shares of renewable energy generation in Switzerland, taking into account the regionalised approach.

2 Progress of activities

In year 4, the EDGE consortium completed a second cycle of developing and evaluating electricity scenarios for Switzerland in 2035 and 2050 with very high shares of renewable generation. This time, EDGE focused on the interplay between the new renewable electricity targets (45 TWh in 2050), winter import targets (5 TWh/year) (SFOE, 2025), various electricity sector developments in the neighbouring countries, and potential electricity market integration constraints in the case of a lacking framework agreement between Switzerland and the European Union.

The main evidence behind this scenario exercise comes from a model inter-comparison (Van Liedekerke et al, 2025) with four EDGE models (EXPANSE, FEM, Nexus-e, and OREES), that contributed to the Swiss state of the art by identifying consensus and divergence of technical and cost results between the different models for a specific policy-relevant question of electricity market integration.

The model inter-comparison was then further complemented with other analyses for a more complete, interdisciplinary picture. First, the importance of Swiss renewable energy investment outflows to neighbouring countries were discussed in the context of energy interdependencies between Switzerland and the EU. Second, in order to reveal the interactions between Switzerland and the rest of the World through trade flows and international resource and carbon emission markets, the computable general equilibrium model GEMINI-E3 was used to simulate decarbonization pathways leading Switzerland to its net-zero emissions target by 2050 and to estimate the costs of this transition with different assumptions about climate action in the rest of the World. Finally, public opinion data from the population surveys was used to shed light on how recent changes and discussions have influenced public preferences on technology acceptance and EU collaboration in the field of energy. This work formed the basis of the second Renewable Energy Outlook for Switzerland, that was published in May 2025.

The prototype of the Recommender tool has been further developed and used to provide regional information for the design of electricity and multi-energy systems with very high shares of renewable technologies within Switzerland. Examples include communities where the planning data of the Recommender tool have been used to support the planning of PV integration (Turgi), the planning of thermal grid expansion and the usage of waste heat (community in vicinity of Berne), the provision of heat for industry as well as the valorisation of waste heat (Sisslerfeld), the integration of wind energy (Malters/Schwarzenbach) and the continued energy planning in Sirnach. In (starting) collaborations with cantonal offices (Argovia and Lucerne), the quality of public data about buildings (media release here) and the energy models have been improved. The Recommender tool is an online tool to be released openly for public use so that any of the more than 1’700 Swiss municipalities, that do not yet have a detailed energy plan, can get readily prepared public energy data and can identify options for a higher integration of renewable energy. In year 4, the further public datasets that form the basis of the Recommender tool were collected, improved, and validated, as well as complemented with new datasets coming from EDGE, in particular data on solar PV (Alpine and agri), wind power resource, projected mobility demand, and distinction between local and national renewable energy sources. The underlying model of the Recommender tool can now also select the optimal set of technologies and operation in hourly resolution over the course of a specific year, based on a user-selected combination of key performance indicators (e.g., available technologies, resources, emissions, and costs). From multiple field tests (for example in St. Prex, Sisslerfeld, cantons of Aargau and Lucerne) with prospective end users, feedback about the usability, missing key features as well as the inconsistent approximations have been collected to inform further development. Furthermore, other more specific

investigations have been completed in EDGE on estimating the agri-PV potential, on evaluating the minimum necessary electricity storage capacities per municipality under specific assumptions on maximum curtailment, and on assessing the potential for local energy communities in rural Swiss areas. EDGE advanced the modelling of the demand for electrified transport charging in Switzerland, conducted analyses of the loadability and planning of distribution networks, evaluated different smart inverter control functions for PV grid integration, and estimated the value of accurate weather forecasts on the system so as to gain insights into how high shares of decentralised renewables can be scaled up and integrated with existing infrastructures and future demand.

To evaluate options for promoting renewable energy uptake in Switzerland, a broad range of activities was initiated to represent the diversity of options. In terms of policy design, a comprehensive analysis of past cantonal policies was completed to derive best practice recommendations for an upcoming policy brief. The modelling of emission savings potentials, costs and distributional impacts of different policies and policy mixes for the decarbonisation of the Swiss residential sector was further developed to take into account the distributional impacts on different types of key actors (e.g., homeowners, tenants, landlords, installers, utilities, government budget). In terms of finance, new data has been collected to improve the cost estimates for ground-mounted, wall-mounted, and floating solar PV in the Swiss Alps and for visually integrated and visually non-integrated facade PV in Swiss cities. Also, the discrepancy between perceived economic viability of rooftop PV and actual viability was investigated. In terms of business models, analyses were conducted on corporate power purchasing agreements and on the rolling storage for corporate fleets. Regarding technology and policy acceptance, data from the first EDGE population survey was further analysed with a detailed look at Swiss cities. The second EDGE survey is being developed, involving four research groups from social sciences and modelling. To mobilize key actors, participatory case studies were organized related to municipal energy planning and Swiss alpine photovoltaic projects in Winterthur, St. Prex, Savognin and Sedrun. Finally, a voluntary exercise was undertaken to integrate technology acceptance data from the first EDGE population survey into the spatially-explicit EXPANSE model to pilot a methodology for a more systematic integration of acceptance data into EDGE models.

To demonstrate typical local renewable energy systems in case studies and implementation projects, the municipality of Wittenbach continues to be the case of choice for the Swiss midlands. Our activities to foster faster PV expansion in the municipality started in the second half of 2022. First results were therefore to be expected starting from late 2022 to start of 2023 (effects and activities are continuing to this day). An almost threefold increase in PV installations in a targeted group of potential adopters could be achieved, doubling the total PV installations in Wittenbach. Further progress was made on the potential use of agricultural PV installations, with a focus on dual use and proximity to existing infrastructure. The potential was found to be large but under-utilised and blocked by current legislation. The Wittenbach case and its analysis of the demand-supply dynamics also showed that smart grids should be the target of grid infrastructure improvements rather than microgrids. While it was initially intended to evaluate the success of the measures through a short survey in Wittenbach, it was later found that the response rate was too low to understand the process and that it was unclear if the respondents had fully understood and meaningfully addressed the questions regarding the impact of EDGE. As an alternative, and to ensure that EDGE can make use of the assessments, the relative PV expansion in Wittenbach was analysed in comparison to all other Swiss municipalities since January 2023. According to the latest Pronovo data, Wittenbach has therefore increased the utilization of its roof potential by 9.2 percentage points during this period. The mean increase across all other municipalities is only 5.5 percentage points. This provides a strong indication that the measures taken in Wittenbach have been effective.

The alpine production case studies have shown very interesting results for large and small wind turbines, which can produce more or less energy than expected, depending on the exact site characteristics. For example, small wind turbines can benefit from increased turbulence over complex terrain at low wind speeds. All turbines benefit from low winter temperatures and an existing snow cover. For large turbines, it is essential to consider the influence of very small-scale terrain on exact siting. With regard to alpine PV production, the analysis of the Muttsee plant has shown that the expectations for high alpine PV plants can be met by actual production installations, as long as careful design avoids damage from snow and other impacts. EDGE has been involved in developing tools for improving alpine design and assisting implementation partners in their planning.

For the knowledge and technology transfer, the usual EDGE activities such as newsletters, social media (LinkedIn, X/Bluesky), and Youtube videos continued. The two final Energy Drinks events for the general public in Zurich and Geneva were organized to present EDGE results and engage the population with EDGE topics in an informal, entertaining way. The publication of the first Renewable Energy Outlook and other EDGE research publications also received relevant media coverage, including RTS and SRF news as well as articles in NZZ, Le Temps, and further news outlets.

3 Highlights of outputs

Given the EDGE objective to develop new Swiss scenarios with very high shares of renewable generation, the second EDGE inter-comparison examined scenarios of achieving existing targets of new renewable electricity, analysing their impacts both on the national electricity system and the cross-border electricity flows (Van Liedekerke et al, 2025). Four electricity system models (EXPANSE, FEM, Nexus-e, and OREES) were used to model new Swiss renewable generation targets, market integration constraints, and winter import limitations, in the context of various European electricity developments. The results, summarized in Figure 3.1, highlight that a renewable energy generation target of 45 TWh is feasible and achievable in several distinct ways. However, significant subsidies are required to support the necessary expansion of renewable energy.

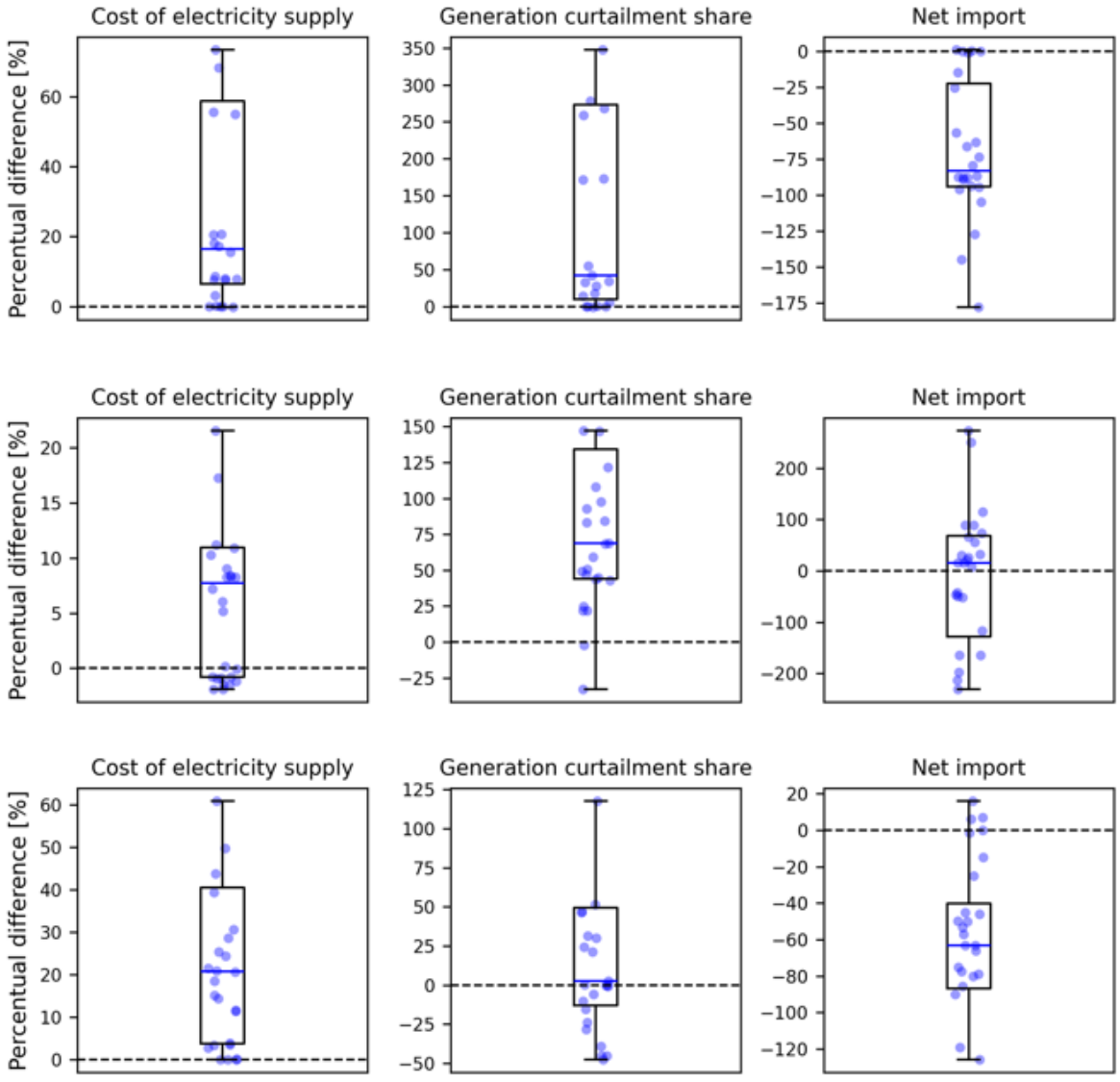

Figure 3.1 Impact of three policy measures (renewable electricity target, market integration reduction, and net winter import limit from top to bottom) on cost of electricity supply (CAPEX + OPEX), generation curtailment share, and net imports as percent variation. The results of the scenarios with the active

policy are compared to those without the policy. Extreme values are omitted for better readability, but are considered in the computation of the median value (blue lines). The high variability of the results is attributed to the differences in the scenarios and the models, which represent the uncertainty around the effect of a policy. The expected outcome is summarized with the median value.

Additionally, Switzerland and its neighbouring countries would benefit from a full market integration as it leads to lower electricity supply costs and reduced curtailment of renewable generation. Finally, with limited net winter imports, Switzerland must rely more on wind and gas generation to meet its winter electricity demand domestically. While technically feasible, this approach increases electricity supply costs and depends on technologies with lower public acceptance.

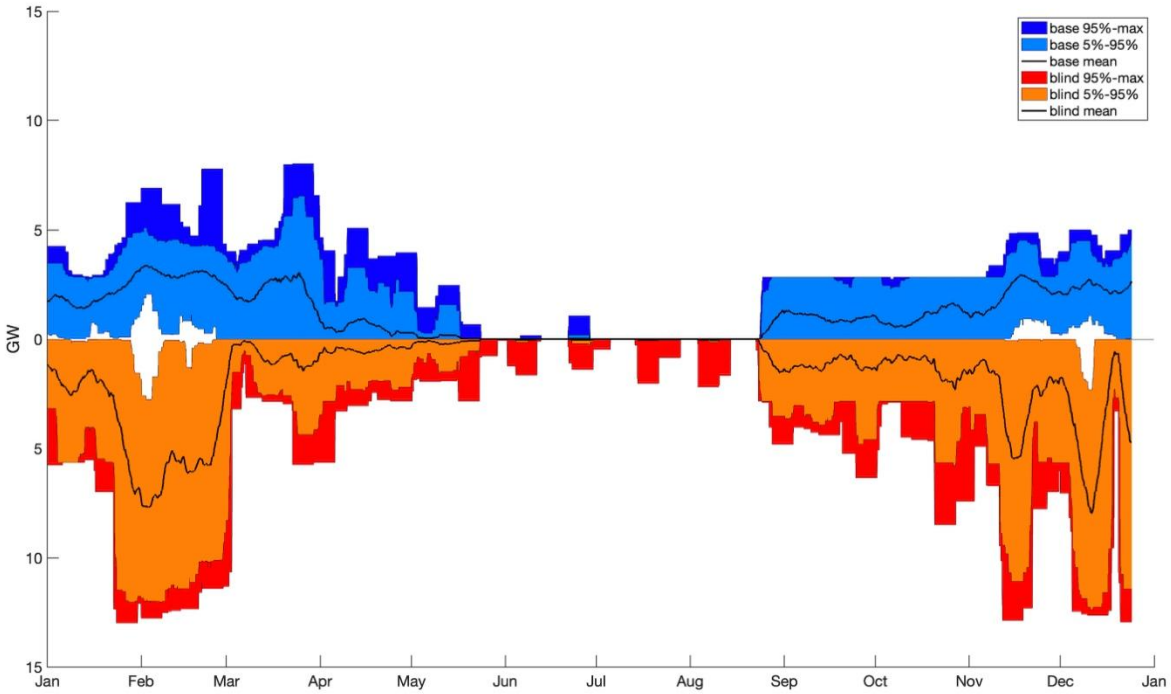

Figure 3.2 Time series of required import of electricity to Switzerland for the scenario of 45 TWh wind and solar generation in 2050. The blue colours represent an optimal operation of the hydropower installations, considering the weather forecast (base), while the red colours represent an assumed weather persistence for the coming 7 days.

Operating an electricity system with a high share of renewable generation is known to be challenging due to the fluctuating nature of production. Switzerland, with its hydropower backbone, is well prepared to integrate high levels of wind and solar PV. The OREES model has shown how demand and supply matching can reduce an imbalance in the grid when hydropower is optimally used based on the known (forecast) weather for the next seven days (Figure 3.2 Time series of required import of electricity to Switzerland for the scenario of 45 TWh wind and solar generation in 2050. The blue colours represent an optimal operation of the hydropower installations, considering the weather forecast (base), while the red colours represent an assumed weather persistence for the coming 7 days.). This information complements the general finding of the intercomparison study on the need for increased

cross-border electricity exchanges in a future world of renewable energy, and quantifies in particular a reduction in peak import requirements. Incentives should be considered to promote the operation of hydropower with the aim of achieving an overall balance between supply and demand.

For the policy design, EDGE research on cantonal policy and the social acceptance of renewable energy policies and projects (Wen et al, 2024) was synthesized to identify two levers that authorities can use to support the energy transition: deblocking policy and institutional configurations, while facilitating local initiative, as well de-politicizing processes and decisions related to infrastructure projects and policy making, while strengthening evidence-based debates. First of all, cantonal policymakers in the past showed limited ambition to prioritize subsidies and harmonize taxing solar PV, using the well-known federal blame-game structure of arguing about competences. Regarding wind energy, the authorization procedure for larger wind turbines needs a substantial reform, too. This calls for a debate on the most salient issue of local autonomy regarding municipal decision-making in infrastructure projects of national interest. Second, greater championing of local initiatives and innovative support schemes would be valuable, e.g., on medium-sized (100kW-1MW) wind turbines in industrial zones, on biogas plants where many cantons remain inactive, or on incentivizing efficiency. Cantons and municipalities could further create opportunities through crowdfunding, local benefit (co-)creation, minimum transparency and participation rules, and local energy communities. Finally, to reduce politics and the number of legal cases, recommendations entail concrete action or improved communication, while taking the preferences of different social groups into account. Regarding concrete actions, cantons or municipalities could serve as neutral arbiters in round tables on large and small projects. In this capacity, they would take professionalized opposition politics into account. Concerning communications with the general population, it is important that there is an alignment between the specific goals and the measures designed to reach them. Communicating and debating in trade-offs has also been shown to be beneficial for constructive discussions. Targeted communication is also relevant, as different social groups value different attributes of a renewable energy project. Regarding subsidies on the municipal level, there is evidence that people do not know about them and do not factor them in regarding their evaluation of the financial attractiveness of a solar project.

Finally, a joint effort was undertaken to incorporate EDGE survey data (N=6,203) on acceptance into the spatially explicit EXPANSE to model socially acceptable Swiss electricity supply scenarios (Wen et al, 2024). The results revealed an enormous sensitivity of scenario results to methodological choices, when 119 different methods were applied to implement acceptance in the model, to aggregate survey data, to quantify acceptance or resistance scores, and to translate survey data into model parameters. The sensitivity was especially high for a couple of key technologies, such as solar PV, onshore wind power, nuclear power, and interconnection in Switzerland. Despite such high sensitivity, all methods were shown to lead to scenarios with higher shares of renewable technologies, especially solar PV and sometimes wind power, when acceptance data is integrated in a cost-optimization model.

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