Schweizerische Eidgenossenschaft
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Innosuisse – Swiss Innovation Agency

Executive Summary

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The SCCERs significantly increased the level of cooperation between the different types of research institutions involved in the programme, i.e. between the ETH Domain, universities of applied sciences and other universities.

Following the reactor disaster at Fukushima Daiichi, the Swiss Parliament approved the Federal Council's Dispatch on the action plan "Coordinated Energy Research in Switzerland – measures for the years 2013–2016"[1]. The goal of the action plan was to strengthen research and development in order to support a fundamental transformation of the Swiss energy system by 2050, with nuclear energy production being phased out. The most important measure introduced by the dispatch was the creation of eight Swiss Competence Centers for Energy Research (SCCERs) covering seven thematic action areas[2] under the Energy Funding Programme. These were intended to bring together researchers from all types of research institutions and received CHF 72m in funding for the years 2013–2016.

In the first funding period (2013–2016), the SCCERs were able to significantly expand their research capacity in the specified thematic areas and thus lay solid foundations for their application for the second funding period (2017–2020). Based on the insights from the first funding period, research strategies were partially adapted, work plans changed and, in some cases, new research groups included. Certain projects were also transferred to industry. As a result, while the proposals of all eight SCCERs were approved for the second funding period, research did not simply continue. From 2017, the Commission for Technology and Innovation CTI, the predecessor organisation of Innosuisse, provided CHF 111.9m in funding to support the continuation of the SCCERs' activities, along with an additional CHF 7.7m for the creation of six projects involving researchers from two or more SCCERs. These Joint Activities (JAs) covered topics at the interface between the thematic areas of the SCCERs and aimed to answer research questions from a more systemic perspective.
In addition to the CTI/Innosuisse funding, the participating higher education institutions (HEI) contributed CHF 251.2m (2014–2020[3]) to the financing of the SCCERs and JAs. Researchers also received CHF 149.4m from competitive federal funds and contributions of CHF 130.2m from

[1] Federal Council (2012): Dispatch on the "Coordinated Energy Research in Switzerland" action plan – measures for the years 2013–2016. Bundesblatt 47, 9017–9064.

[2] The seven action areas were: Efficiency; Grids and their components/energy systems; Storage; Power supply (supply of electrical energy); Economy, environment, law, behaviour; Efficient concepts, processes and components in mobility; and Biomass.

[3] Although the Energy Funding Programme issued its request for proposals in 2013, the SCCERs started their activities in 2014 and only used the funding from that year on.

industry partners and international projects. Overall, a total of CHF 724.6m was available for Swiss energy research under the Energy Funding Programme from 2014 to 2020[4].

Looking at the different SCCERs individually, the **SCCER Future Energy Efficient Buildings & Districts (FEEB&D)** dealt with energy efficiency and CO_2 emissions in the built environment. With regard to single buildings, it developed coloured solar panels, a more efficient insulation material, dynamic glazing for windows, vision-sensing technologies for blinds and lighting control, along with predictive control of multiple energy subsystems. It created a smart and powerful IT tool to define the optimum configuration of decentralised multi-energy systems in specific situations, and a comprehensive spatiotemporal database reporting energy demand and renewable energy potential for Switzerland at high resolution.

The **SCCER Efficiency of Industrial Processes (EIP)** dealt with energy efficiency and CO_2 emissions in industrial applications from two different perspectives, combining methodological work on the potential for economic industrial efficiency with analyses and implementation procedures for energy efficiency and direct solar heat integration. Technological progress was made in increasing energy efficiency in cross-sectoral heat applications and in decreasing CO_2 emissions through advanced adsorption processes. SCCER EIP's research also examined the use of wastewater to reduce energy consumption, e.g. for cooling purposes.

The **SCCER Supply of Electricity (SoE)** analysed possible contributions to the power supply from deep geothermal energy (DGE) and hydropower (HP). Backed up by results from excellent scientific findings, the focus of research on DGE shifted from electricity generation to thermal applications, and important demonstrators were built. A re-assessment of CO_2 sequestration in geological layers revealed a much lower storage potential than anticipated. In the field of HP research, the possibility of a 10% increase in annual production was examined and delivered a number of scientifically sound arguments on which specific efforts are needed to reach this target. Analysis also focused on the flexibility of hydropower use and on concepts with high practical value.

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The **SCCER Biomass for Swiss Energy Future (BIOSWEET)** aimed to contribute to greater use of low-value biomass in the Swiss energy system given the technological, economic, environmental, systemic and societal challenges involved. Its successful work tackled aspects related to

[4] This figure also includes the CHF 3m received by the SCCERs FURIES and Mobility in the context of the Digitalisation action plan (For more information see the webpage of the State Secretariat for Education, Research and Innovation)

biochemical and thermochemical conversion options for organic material, bringing them to higher technology readiness levels (TRLs). The scientific results achieved included various methods for providing biomethane, innovative combustion plants for heat provision, new approaches for the production of liquids (chemicals and fuels) and exciting insights into the future role of biomass within the Swiss energy system.

The **SCCER Future Swiss Electrical Infrastructure (FURIES)** worked on future power grid technologies enabling the seamless and sustainable powering of Swiss homes, businesses and communities, based on traditional and new renewable energy resources. The SCCER-FURIES delivered substantial and relevant scientific and technological results regarding new concepts, components and system solutions for the future power infrastructure. Its large-scale demonstrators and laboratories proved attractive to collaborators from industry and the public sector and will continue to serve as research platforms.

In the future energy system, storage options for both short-term and seasonal storage will become very important. The **SCCER Heat and Electricity Storage (HaE)** focused on five topics that may become crucial for the future energy system, namely Thermal Energy Storage, Advanced Batteries and Battery Materials, Hydrogen Production and Storage, Catalytic and Electrocatalytic CO_2 Reduction, and Assessment of Energy Storage. Significant progress was achieved in all topics, ranging from scientifically outstanding results to patents, demonstrators and prototypes. Many of the results were achieved in close cooperation with industry partners, in some cases leading to the creation of startup companies.

The **SCCER Efficient Technologies and Systems for Mobility (Mobility)** applied an interdisciplinary approach that addressed and integrated technical, economic and user-related topics. Particular achievements included the establishment of a new research platform for battery systems, cooling concepts for fuel cell research, lightweight thermoplastic composite technologies, spatial planning and energy infrastructures, and research into the social and economic dynamics of mobility systems. The SCCER Mobility also developed the Smart Mobility Data Platform and identified important elements for cutting CO_2 emissions in the mobility system.

The **SCCER Competence Center for Research in Energy, Society and Transition (CREST)** was set up to cover the key non-technical aspects of the energy transition. Its goal was to deliver recommendations for policies and business strategies that will induce the transformation of the energy system and steer energy supply and demand. Specifically, research activities focused on policies, institutions and firm strategies for facilitating the integration of a larger share of "new" renewables, options for reducing household energy consumption, regional and company-level strategies to support the diffusion of novel solutions, and transition pathways for the Swiss energy system.

Turning to the JAs, **JA Scenarios & Modelling (JASM)** combined the modelling capabilities of all eight SCCERs to develop a set of scenarios for the transition of the Swiss energy system towards a net-zero emissions system over the next few decades. These simulations provided guidance on what can be achieved with current and planned policies and the additional measures that would be needed to achieve the ambitious goals of Swiss energy and climate policy. The results are clear recommendations for the further use of certain technologies, the forced use of systems still under development and systemic recommendations for future energy supply strategies. In particular, they show the need for accelerated electrification, carbon capture and negative emissions, and the promotion of hydrogen.

The objective of **JA Integrated development processes for hydropower and deep geothermal projects: regulatory, political and participatory perspectives (JA IDEA-HDG)** was to provide recommendations on how project development processes (public engagement), the legislative framework and governance structures could be enhanced to resolve conflicts between stakeholders and thus increase investment in HP and DGE projects. JA IDEA-HDG also developed policy recommendations on how to address citizens using appropriate information and steer the policy debate.

JA Socio-economic and technical planning of multi-energy systems (JA RED) created methods and guidelines for the planning of future multi-energy systems, including an analysis of the energy demand at building level and integration into district models taking grid restrictions into account. JA RED also demonstrated how stakeholders can evaluate their potential business models for these multi-energy systems and provided corresponding tools.

JA Coherent Energy Demonstrator Assessment (JA CEDA) brought together the most important results from a number of recent (multi-)energy demonstrator projects and fostered closer links between their research teams by building a common, easy-to-use and well-organised platform to support data exchange, communication and coordination. The concrete deliverable was the CEDA database, comprising archetypes of 27 different energy technologies and associated data provided by the various demonstrators and processed to make them more generic. Initial case studies were carried out to demonstrate the benefits of this approach.

JA White Paper on the Perspectives of Power-to-Product (P2X) Technology in Switzerland (JA P2X) produced a White Paper that assesses both the technical potential and the economic and legal conditions for technologies that convert (green) electricity into gases, liquids or heat that can be stored on a long-term basis and used as feedstock for many kinds of energy use or for the production of chemicals. "X" often stands for hydrogen, synthetic gases such as methane, synthetic fuels such as diesel, gasoline or kerosene, or heat. The White Paper shows that several processes need to become more mature (higher efficiency, greater stability, lower costs) before they can be implemented in the energy system. It also shows that significant changes are required to the legal framework before these technologies can become competitive. A long-term perspective will stimulate development but requires immediate action.

Finally, **JA The evolution of mobility: A socio-economic analysis (JA Mobility)** focused on the role of behavioural aspects in the mobility sector with the aim of better understanding the mobility behaviour of the Swiss population and identifying measures – both incentivising and regulating – for reducing the mobility-related consumption of fossil energy. This included aspects such as home working, car ownership, ride-sharing or online shopping. The highly interconnected workstreams created a comprehensive and coherent picture of mobility behaviour, its importance for energy consumption and how it can be controlled, thereby providing direct starting points for political action and the concrete design of behaviour-influencing measures.

Over the period since the SCCERs were first created in 2014, an average of 1,300 researchers worked on solutions and concepts for Switzerland's future energy system. These included some 70 innovative products, services and processes that are now already used in practice. Researchers also built and operated more than 340 prototypes, pilot plants and demonstrators. These helped showcase research results and acquire 973

additional projec significantly increased its involving non-academic public or private partners. The SCCERs also supported the transformation of the energy system by providing courses for both students (831) and practitioners (361).

Over the duration of the Energy Funding Programme, the SCCERs became well-established competence centers encompassing academia and partners from industry, the public sector and international partners. The SCCERs significantly increased the level of cooperation between the different types of research institutions involved in the programme, i.e. between the ETH Domain, universities of applied sciences and other universities. This cooperation brought about two important outcomes, namely the coalescence and improved coherence of Swiss energy research activities and very successful networking both among the participating research institutions and with implementation partners, public institutions and policymakers. This in turn greatly increased the visibility and awareness of Swiss energy research activities and its manifold infrastructures, both in Switzerland and to an increasing extent abroad. As a result of these efforts, international collaboration clearly progressed throughout the Energy Funding Programme, particularly in the second funding period. This international collaboration is a key contributor – for example through increased resources, cross-fertilisation and benchmarking – to the excellence of research and the speed at which new solutions can be developed and implemented.

The research infrastructure was extended considerably in the second SCCER funding period thanks to new energy technology demonstrators and more research activities with higher TRLs. These developments contributed to an increasing number of cooperations with trade and industry and provided further excellent opportunities for new partnerships with public and private enterprises. World-class basic research was also conducted in a large number of scientific and technological fields, helping fill the research pipeline with new, longer-term activities that offer a high level of potential.

Economic, societal and political aspects were tackled in a systematic way, but there is still potential for further development in these areas given their crucial contribution to the energy transition.

A stronger and much-needed systemic approach was observed over the seven-year lifespan of the SCCERs, particularly with regard to technical issues and interactions between different forms of energy generation, transformation, transport and storage. Economic, societal and political aspects were tackled in a systematic way, but there is still potential for further development in these areas given their crucial contribution to the energy transition. The impact of digitalisation was also addressed in increasing depth, particularly in the SCCER-FURIES and the SCCER Mobility, with additional funds made available in 2019 through the Digitalisation action plan.

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