SWEET Call 1-2020

DeCarbCH activities overview

1 Abstract

The DeCarbCH project addresses the colossal challenge of decarbonisation of heating and cooling in Switzerland within three decades and it prepares the grounds for negative CO_2 emissions. The overall objective of the project (with the ultimate target of net zero emissions) is to facilitate, speed up and de-risk the implementation of renewables for heating and cooling in the residential sector (for various scales and degrees of urbanization) as well as for the service and the industry sector

- by providing guidance on which combinations of technologies to implement where, to which extent and when
- by developing, piloting and demonstrating combinations of commercially viable technologies thereof, consequently helping to drive down the cost of renewable heating and cooling in all sectors
- by conducting model-based analyses that support planning, inter alia by the development of scenarios representing the supply, distribution and demand of renewable heating and cooling services
- by quantifying the value of both renewable heating and cooling as well as of negative CO_2 emissions
- by providing evidence-based guidance on how to enable the implementation of renewable heating and cooling by policies and by legal measures as well as by engaging with the relevant actors and ensuring the necessary level of acceptance.

The DeCarbCH project focusses on three main components, i.e. i) advanced renewable energy and transformation technologies, ii) thermal grids (for heating and cooling) and iii) energy storage. For these, we establish optimal combinations (in technical, economic and environmental terms) as well as necessary and desirable conditions for their implementation.

A solution-oriented, interdisciplinary approach is applied for the project as a whole and within each work package. The work packages deal with subsystems (e.g. WP3 on grids in combination with renewables and energy storage, WP4/WP10 on industry and WP5/WP11 on primarily standalone renewable energy-driven system solutions), they represent case studies (WP6 for Zurich and WP7 for Romandie) or they apply specific approaches (legal and socio-economic integration in WP2/WP9 and energy system modelling in WP1/WP8), leading to recommendations for policy makers and other stakeholders.

Keywords: *Decarbonisation, renewables, thermal grids, heating, cooling, negative emission technologies, systems.*

2 Workpackages/projects

2.1 WP01: Thermal Energy System Modelling at the Mesoscale: developing spatially resolved decarbonization pathways for thermal energy (start: M1, duration: 48 months)

WP01 will develop system-level modelling of thermal energy service provision to explore decarbonisation pathways with different technical, economic, and policy assumptions and constraints. It aims to quantify the value of both renewable heating and cooling as well as of negative CO_2 emissions. To achieve this, it will deliver a dataset on thermal energy resources and technologies as well as models with specific focus on higher spatial resolutions that are needed to model location-constrained technologies such as district heat networks. These will be linked with whole energy system models.

2.2 WP02: Understanding legal and socio-economic integration of clean heat and cooling solutions (start: M1, duration: 48 months)

In a first phase, the focus of the socio-economic analysis will lie on the network of actors that compose the energy system on a local level. A solid understanding of the needs and interests of the different actors and the relationships between them will form the basis for a context-sensitive evaluation of solutions for a future heating and cooling system. In addition, research will focus on the innovation system and identify what is required to accelerate the commercialization and integration of new and emerging technological solutions. In the last phase of the project (from 2025 on), the focus will be on elaborating a roadmap for coordination of policy, technological development and energy planning in order to accelerate the transition towards a net-zero heating and cooling system.

2.3 WP03: Technologies, design, and operation of thermal grids for future energy planning (start: M1, duration: 48 months)

Work package 3 develops technical solutions for future thermal grids and required ancillary services like thermal storages. It further develops a solid understanding of new thermal grid concepts, temperature reduction strategies and underlying control algorithms to form a base for future energy planning. For fast dissemination and multiplication, the solutions to those challenges will be simplified in a local energy planning tool and made available to energy consultants, planners, site managers and the public in cooperation with the educational activities of “Verband Fernwärme Schweiz” and university programs. The local energy planning tool will be applied in the case study of WP06. The technology solutions developed will be implemented in third-party funded P&D projects.

2.4 WP04: Energy demand profiles of industry and the potential for renewables integration and negative emissions (start: M1, duration: 48 months)

WP04 will adopt process integration methodology to characterize process energy demands, at company and sector level. Using these profiles, identification and assessment of integration opportunities for renewables, after implementation of economical energy efficiency measures, will be conducted. Additionally, quantification of opportunities for excess heat usage and substitution of fuels/heat with negative emission technologies to fulfil the residual heating demand will be assessed. Practical tools and methods will be developed for practitioners to ensure high implementation potential in the Swiss industry.

2.5 WP05: Combination of renewables, heat transformation and storage for medium and high temperature heating as well as cooling (start: M1, duration: 48 months)

This work package will focus on the optimum combination of existing and forthcoming technologies to reach medium and high-temperatures as well as cooling at different power levels. These solutions for carbon free heating and cooling will consider the possible temporal (storage) and spatial (transport) mismatch between supply and demand of real world situations. The outcome will be technical solutions for a high level of renewable energy and efficiency measures with suggestions for an accelerated market introduction.

2.6 WP06: Case Study 1, City of Zurich (start: M6, duration: 72 months)

The work package aims to apply, test validate and improve approaches, tools and results developed in other workpackages to concrete locations in Zurich. With the city of Zurich planning the real transformation of a district towards carbon neutrality, we will have a unique possibility of not only testing and monitoring our findings, but also exploring real situations in the complexity of a built city. Therefore, we will define topics like the speed of transformation, subsidy schemes for the implementation for thermal grids and the role of the industrial/commercial sector. This empirical work will offer insights into the barriers and success factors of strategies to support the transition. It will also allow to understand the opportunities of applying the strategies to other cities.

2.7 WP07: Case studies Romandie: strategies and potentials of temperature reduction on existing district heating networks (start: M7, duration: 41 months)

While reduction of DH temperature is a priority for integration of renewable heat, it is constrained by the temperature level of the individual substations. This is of particular concern for existing buildings due to the high distribution temperatures and the challenges related to any measures implemented within inhabited spaces. Several techniques for temperature reduction at substation level have been proposed or are currently under investigation but their actual implementation in existing DH substations depends to a large extent on pre-existing conditions. Furthermore, the actual benefit of temperature reduction at the level of the DH network as well as interaction between temperature reduction strategies and other energy policy measures, need to be analysed in specific case studies. Within this WP, these issues will be tackled by means of case studies on existing DH systems, in urban and rural context, requiring close collaboration with our cooperation partners.

2.8 WP08: Scenario and modelling, pathways, tool development, policy recommendations (start: M49, duration: 48 months)

This work package carries forward the work in WP01 with several goals: i) to further drive implementation of findings related to policy making; ii) to increase the potential impact by developing end-user focused tools that can support decisions makers; iii) to continuously update the energy model to reflect ongoing technical and policy trends, and to provide feedback to policy makers in the form or updated pathways and policy recommendations; iv) to extend the pathway projection time horizons (2060+).

2.9 WP09: Legal and socio-economic integration of proposed solutions (start: M49, duration: 48 months)

WP09 will analyze the proposed solutions by research partners and assess the legal and socio-economic consequences they may pose. The aim is to reduce legal and socio-economic barriers for a timely implementation of the proposed heating / cooling technology combinations. Therefore, WP09 will develop a roadmap with a time horizon of 2050, i.e. a detailed schedule of the actions necessary to achieve the

set net-zero emission targets for the heating and cooling sector, based on the latest technological developments and dedicated legal and socioeconomic research.

2.10 WP10: A multi-criteria assessment suite to support decision making of renewables integration in industry (start: M49, duration: 48 months)

WP10 will identify and develop key methods and tools to support well-reasoned decision making for the cost-effective integration of renewables in industry. The WP will develop a multi-criteria decision making tool to assist the transition towards renewable heating and cooling. The tool includes i) the technical, operational, and economic aspects of opportunities for renewables integration, ii) the key criteria in developing business models for the implementation of the integration opportunities of renewable heating and cooling, and iii) development of complex and customized solutions for the industrial company, site, or large-scale system.

2.11 WP11: Lab scale thermal-grid indifferent testing of a prototype for heating and cooling (start: M49, duration: 48 months)

The aim of this work package is to develop, test and evaluate system-level solutions for heating at medium and high temperatures (up to 160°C) as well as for cooling and long-term storage, consisting of a combination of different renewable energy sources and having low or even negative CO_2 emissions. The system will be thermal-grid-independent and can be operated as a stand-alone system and, if available, use grids as heat sources or sinks. The solution (combined energy system and storage developed in WP05) will be tested under realistic conditions (temperature, load profile demand etc.). The goal is to optimize a combined energy-system prototype with regard to technological and socio-economic aspects in order to demonstrate the resulting mature system solution in the subsequent P&D WP.

2.12 WP12: Generation of negative CO_2 emissions (start: M1, duration: 48 months)

Recent scenarios show that Switzerland needs negative emission technologies to reach the net-zero climate target. The proposed work package studies the various options (gasification, fermentation, combustion) in the context of concrete case studies with customers and technology suppliers. It has strong interactions with the scenario analysis in WP01 and the industrial heat supply in WP04 and WP10, and it lays the foundation for a subsequent P&D project WPPD5.

2.13 WPPD1-5: Pilot & Demonstration projects

Five P&D projects are planned for the second half of DeCarbCH. The indicative topics are listed below

WPPD1	Real Transformation of a specific area in Zurich
WPPD2	Increase in utilization of waste heat from incineration plant / Reduction of carbon emissions
WPPD3	Enabling implementation of renewables for industrial heating and cooling / Demonstrating enabled renewable heating and cooling (solutions) in industry
WPPD4	Renewable energy cube providing carbon-neutral heating and cooling for industry and service sector
WPPD5	Demonstration of negative emission technology

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