CROSS Scenarios and Drivers Definition

Version: CROSS-v2025-06

Adriana Marcucci[a]
Gianfranco Guidati[a]

[a] ETH Zurich

The research published in this report was carried out with the support of the Swiss Federal Office of Energy SFOE as part of the SWEET consortium CoSi

September 26, 2025

Cite as:
Marcucci, A. and G. Guidati (2025). CROSS Scenarios and Drivers Definition, Scenario version: CROSS-v2025-06. SWEET-CROSS.

Contents

List of Tables

List of Figures

Abbreviations

ERA	Energy reference area
EV	Electric vehicles
GDP	Gross Domestic Product
GHG	Greenhouse gas
KlG	Climate and Innovation Act

Chapter 1

Introduction

The **CROSS-v2025-06** scenarios provide an updated set of harmonized scenario definitions for the Swiss energy system, building upon the CROSS-v2022-09 framework (Marcucci et al., 2022). They establish a common set of assumptions for the participating energy system models, enabling consistent assessments of Switzerland's transition towards climate neutrality while facilitating meaningful comparisons across modelling approaches.

The updated scenarios reflect recent developments in Swiss climate and energy policy, most notably the adoption of the Climate and Innovation Act (KlG) and the revision of the Energy Act. Beyond incorporating these legislative changes, the scenario framework explores alternative pathways that capture key uncertainties affecting the Swiss energy transition, including renewable electricity deployment and the pace of transport electrification.

This report documents the development of the CROSS-v2025-06 scenario framework and the harmonized assumptions adopted across participating models. It describes the scenario development process, the rationale for the selected scenario dimensions, and the common assumptions used to ensure consistency across modelling exercises. The underlying Swiss climate and energy policy framework is presented separately in the companion report *Swiss Climate and Energy Policy Framework and Targets* (Marcucci, 2026).

Compared with CROSS-v2022-09, the updated framework introduces three main changes:

1. Climate policy assumptions have been revised to reflect the Climate and Innovation Act (Swiss Federal Council, 2022), including the extension of greenhouse gas accounting to international aviation and the updated treatment of residual emissions and carbon dioxide removal.

2. Energy policy scenarios now incorporate the renewable electricity generation targets and winter electricity import guideline established under the revised Energy Act (UVEK, 2024), together with counterfactual variants without such targets.

3. A third scenario dimension has been introduced to represent alternative rates of passenger vehicle electrification resulting from different charging infrastructure deployment pathways.

In parallel, the harmonized assumptions have been expanded and updated to include common technology investment costs and efficiencies, revised socio-economic drivers and energy service demands, and updated international fuel price assumptions. The principal differences between CROSS-v2025-06 and CROSS-v2022-09 are summarized in Table 1.1.

Table 1.1: Updates in CROSS-v2025-06 scenarios

	CROSS-v2022-09	**CROSS-v2025-06**
Scenario dimensions		

Table 1.1: Updates in CROSS-v2025-06 scenarios (continued)

	CROSS-v2022-09	CROSS-v2025-06
Climate net-zero target		
Years included	2050	2030, 2040 and 2050
Aviation	Not included	Included
Energy market integration	Included	Not included
Renewable and imports target	Not included	Included
Infrastructure development	Not included	Included
Harmonising assumptions		
Population		
Historical	Until 2021 (BFS, 2022a)	Until 2023 (BFS, 2024a)
Projections	A-00-2020, B-00-2020, C-00-2020 (BFS, 2020a)	A-00-2025, B-00-2025 , C-00-2025 (BFS, 2025b)
Number of households		
Historical	Until 2020 (BFS, 2021b)	Until 2023 (BFS, 2024c)
Projections	AM-00-2020, BM-00-2020, CM-00-2020 (BFS, 2021a)	AM-00-2020, BM-00-2020, CM-00-2020 (BFS, 2021a)
Working population		
Historical	Until 2022 (BFS, 2022b)	Until 2025 (BFS, 2025a)
Projections	A-00-2020, B-00-2020, C-00-2020 (BFS, 2020b)	A-00-2025, B-00-2025 , C-00-2025 (BFS, 2025c)
GDP		
Historical	Until 2021 (BFS, 2022c)	Until 2023 (BFS, 2024b)
Projections	BIP-A, BIP-B, BIP-C (SECO, 2022)	BIP-A, BIP-B, BIP-C (SECO, 2025)
Heating and cooling degree days		
Projections	RCP 2.6, 4.5 and 8.5 (CH2018, 2018)	RCP 2.6, 4.5 and 8.5 (CH2018, 2018)
Energy reference area		
Historical	Until 2020 (BFE, 2021)	Until 2023 (BFE, 2024a)
Projections commercial and residential	A-00-2020, B-00-2020, C-00-2020 (BFS, 2020a)	A-00-2025, B-00-2025 , C-00-2025 (BFS, 2025b)
Projections industrial	BIP-A, BIP-B, BIP-C (SECO, 2022)	BIP-A, BIP-B, BIP-C (SECO, 2025)
Energy service demands for space heating, warm water, electricity from appliances		
Historical	Until 2020 (BFE, 2021)	Until 2023 (BFE, 2024a)
Projections commercial and residential	A-00-2020, B-00-2020, C-00-2020 (BFS, 2020a)	A-00-2025, B-00-2025 , C-00-2025 (BFS, 2025b)
Projections industrial	BIP-A, BIP-B, BIP-C (SECO, 2022)	BIP-A, BIP-B, BIP-C (SECO, 2025)
Energy service demands for road transport		
Historical	Until 2020 (BFS, 2021d,c)	Until 2023 (BFS, 2024e,d)
Projections	Transport Outlook 2050 (ARE, 2021)	Transport Outlook 2050 (ARE, 2021)
Demand aviation fuels		
Historical	Not included	Until 2023 (BFE, 2024b)
Projections	Not included	EASA (2022)
Technologies		
Investment costs electricity	Not included	Meili et al. (2025)
Efficiency heat pumps	Not included	Meili et al. (2025)
Efficiency electric vehicles	Not included	Meili et al. (2025)
Import prices of fuels	WEO2021 (IEA, 2021)	WEO2024 (IEA, 2024)
Other assumptions		
Resources		

Table 1.1: Updates in CROSS-v2025-06 scenarios (continued)

	CROSS-v2022-09	**CROSS-v2025-06**
Solar PV	Dujardin et al. (2021),Remund et al. (2019), BFE (2019), and Bauer et al. (2017)	
Wind	Dujardin et al. (2021),Bauer et al. (2017), and Cattin et al. (2012)	
Biomass and waste	Guidati et al. (2021) updated with population and GDP	

Chapter 2

Scenario Development Process

2.1 Overview

The development of the CROSS-v2025-06 scenarios followed a structured three-stage process combining stakeholder input, expert assessment, and model implementation. The objective was to identify a limited number of policy-relevant scenarios that address the most important uncertainties affecting the Swiss energy transition while remaining implementable across the participating modelling frameworks.

The process progressively translated qualitative stakeholder questions into harmonized quantitative scenario assumptions. Figure 2.1 summarizes the overall workflow.

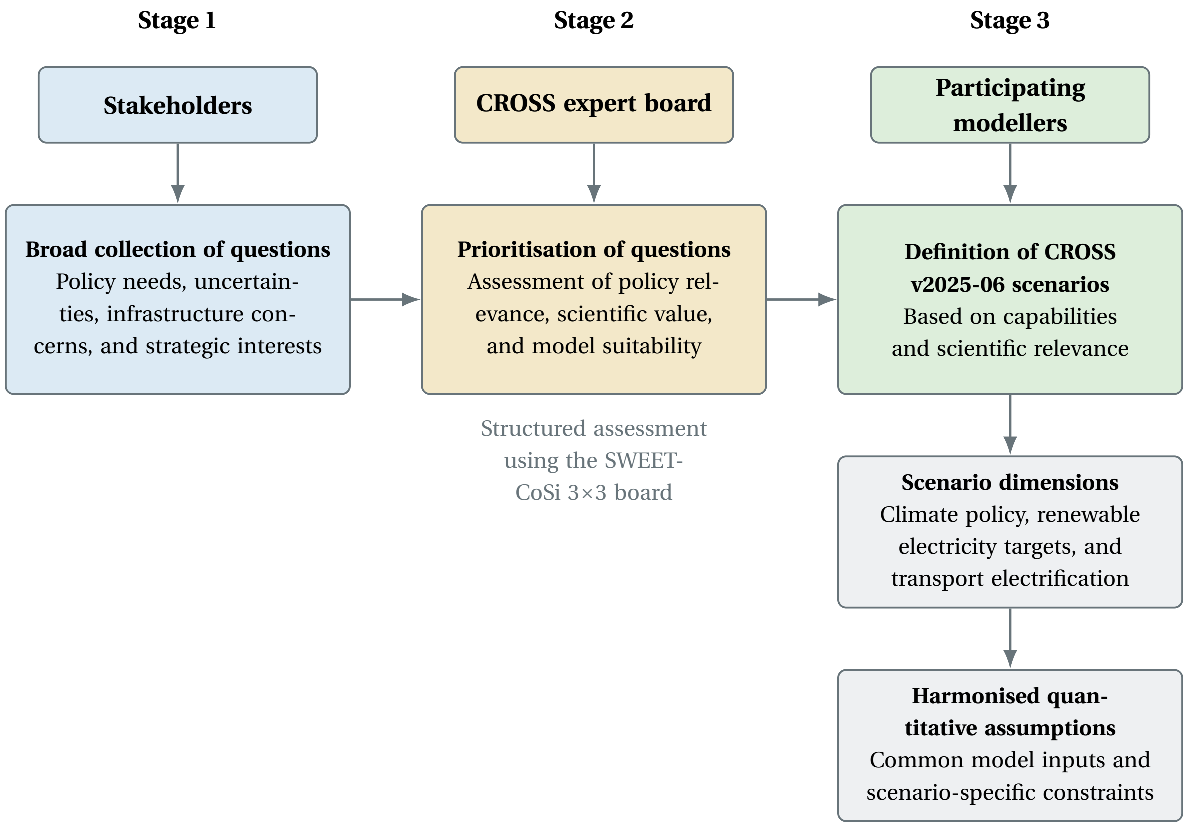


Figure 2.1: Scenario development process for CROSS-v2025-06. Stakeholders generated a broad set of policy-relevant questions, the CROSS expert board prioritised these questions, and the participating modelling teams translated the selected priorities into harmonised and implementable scenario dimensions.

2.2 Identification of stakeholder questions

The starting point of the scenario development process was a broad collection of questions and interests gathered from stakeholders during the SWEET-CoSi project and previous SWEET activities. These discussions generated a diverse set of potential research questions related to climate policy, energy security, infrastructure development, technology deployment, and sector coupling.
Rather than defining scenarios directly, this first stage aimed to identify the policy questions for which quantitative energy system modelling could provide useful insights. The resulting list therefore represented a broad set of stakeholder interests rather than a predefined scenario framework.

2.3 Prioritization of research questions

The collected stakeholder questions were subsequently evaluated by CoSi experts using a structured prioritization process. Candidate questions were assessed according to their policy relevance, scientific importance, and suitability for multi-model analysis. This step ensured that the selected scenarios addressed questions of high relevance while remaining tractable within the available modelling capabilities.
The prioritization resulted in three overarching research questions that define the scope of the CROSS-v2025-06 scenario framework:

1. How does the Swiss energy system develop under the current climate and energy policy framework? This question examines the transformation of the Swiss energy system under the targets established in current legislation and national strategies. It provides the policy-consistent reference against which alternative developments are evaluated.

2. What are the effects of delayed infrastructure development? The successful implementation of the Swiss energy transition depends not only on policy objectives but also on the timely deployment of enabling infrastructure. This question examines the implications of slower deployment of key infrastructures, with a particular focus on carbon dioxide transport and storage infrastructure.

3. How would slower deployment of charging infrastructure and the associated delay in transport electrification affect the Swiss energy transition? Electrification of passenger transport is expected to play a central role in reducing greenhouse gas emissions and increasing electricity demand. This question investigates how slower deployment of charging infrastructure, and the resulting delay in the adoption of battery electric vehicles, could influence the pace of the Swiss energy transition.

The selected research questions formed the conceptual basis for the scenario design. In collaboration with the participating modelling teams, they were subsequently translated into a limited set of harmonized scenario dimensions and quantitative modelling assumptions, as described in the following chapter.

2.4 Translation into modelling scenarios

The prioritized research questions were then discussed with the participating modelling teams to determine how they could be represented consistently across the different modelling frameworks.

During this stage, qualitative policy questions were translated into quantitative scenario dimensions and harmonized model assumptions.
The discussions considered both the scientific relevance of the proposed scenarios and the practical capabilities of the participating models. Where necessary, research questions were reformulated to ensure that they could be implemented consistently while preserving their original policy intent.
The resulting scenario framework consists of three independent scenario dimensions that define the CROSS-v2025-06 scenarios. Their implementation and the associated harmonized assumptions are described in the following chapters.

Chapter 3

Scenarios definition

The CROSS-v2025-06 framework defines a set of harmonised scenarios for analysing alternative pathways for the Swiss energy transition. The scenarios combine a policy-consistent reference pathway with counterfactual variants that relax selected climate or energy policy assumptions, as well as an alternative pathway for the deployment of electric-vehicle charging infrastructure.

The Swiss climate and energy policy framework underlying the scenarios is documented in the companion report *Swiss Climate and Energy Policy Framework and Targets* (Marcucci, 2026). The present chapter describes how the relevant policy objectives and infrastructure uncertainties are translated into quantitative scenario assumptions.

The CROSS-v2025-06 scenarios are defined along three dimensions:

1. Climate policy: This dimension is shaped by the Climate and Innovation Act (Swiss Federal Council, 2022), which legally mandates net-zero GHG emissions by 2050, covering all sectors and GHGs, including aviation but does not specify a required share of domestic reductions. We, therefore, consider two variants based on the geographic source of emissions reductions.

2. Renewable and imports target: This dimension models the implementation of renewable electricity generation and winter electricity import targets.

3. Electrification (EV charging infrastructure availability): This dimension models the pace of passenger-transport electrification resulting from the deployment of EV charging infrastructure.

Each dimension contains two variants. Their combination produces eight scenarios, as illustrated in Figure 3.1. The dimensions are designed to be independent, allowing the effect of each assumption to be examined individually and in combination with the others.

3.1 Climate-policy dimension

All CROSS-v2025-06 scenarios achieve the economy-wide GHG pathway defined in the companion policy report (Marcucci, 2026). The scenarios do not vary the national GHG target itself. Instead, this dimension varies the share of the required mitigation and CDR that is achieved within Switzerland or abroad.

Two variants are considered:

- Abroad: A limited share of the mitigation required to achieve the national GHG target may be provided through CDR and permanent storage abroad. The variant nevertheless maintains a high minimum share of domestic reductions.

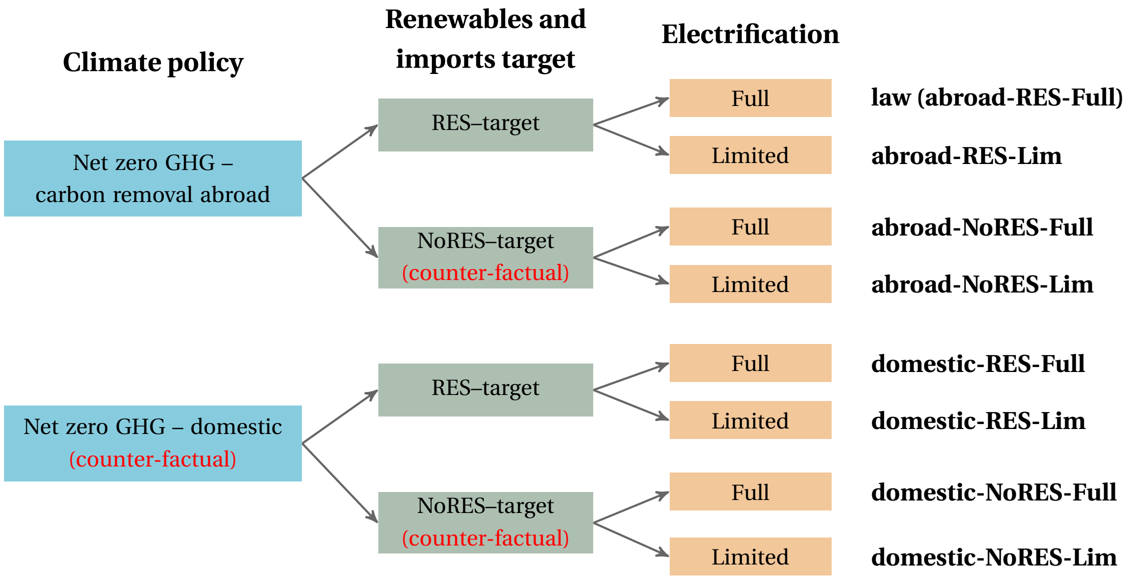


Figure 3.1: CROSS-v2025-06 scenarios overview. Counter-factual scenarios (i.e., those without policy enforcement) are shown in red

- Domestic: Switzerland achieves the long-term net-zero objective through domestic mitigation and carbon dioxide removal. By 2050, no compensation abroad is permitted.

The variants are modelling interpretations of the flexibility provided by the Swiss climate-policy framework. They are not alternative national climate targets: both follow the same economy-wide emissions pathway.

3.1.1 Net-zero target

Following the Climate and Innovation Act (Swiss Federal Council, 2022) and the Swiss Climate Strategy (Swiss Federal Council, 2021), Switzerland's net-zero target is defined –within the scope relevant to energy system modelling– by the following key principles:

1. Definition of net-zero GHG target: Net-zero GHGs refers to balancing GHG emissions and CDR.

2. Carbon dioxide removal: Emissions must be reduced as much as technically possible in all sectors before relying on CDR. Technologies such as carbon capture and storage (CCS) and other forms of CDR are reserved for emissions that are technically hard-to-abate (Swiss Federal Council, 2021, Principle 3).

3. Territorial scope: The target applies to all emissions within Swiss national borders;

4. Coverage of GHGs and sectors: It includes all GHGs (not just CO_2) and covers all sectors in the GHG inventory (energy, industrial processes and product usage, agriculture, land use, land use changes and forestry (LULUCF), waste and others);

5. Inclusion of international transport: Emissions from international aviation and maritime shipping attributable to Switzerland are included, based on the "point-of-sale" principle.

6. Flexibility in international and domestic reduction shares: It does not determine specific domestic and international shares for emission reductions.

7. Total and sectoral reduction targets: Total and sector-specific minimum reduction targets relative to 1990 are defined, as shown in Table 3.1. The 2030 target for the total GHG reduction and the target for agriculture are not part of the Climate and Innovation Act. Instead, the 2030 target is from the Switzerland's First Nationally Determined Contribution (NDC) (BAFU, 2024) and the one for agriculture is from the Climate Strategy for Agriculture and Nutrition 2050 [Abbildung 7] (BLW, BLV and BFE, 2023).

Table 3.1: GHG inventory for 1990, 2000, 2010 and 2023 by category from BAFU (2025a,b); GHG emissions reduction targets from the Climate and Innovation Act (Swiss Federal Council, 2022), Switzerland's NDC for 2030 (BAFU, 2024) and the Climate Strategy for Agriculture and Nutrition 2050 (BLW, BLV and BFE, 2023)

	GHG Emissions ($MtCO_2$ e)				**Minimum reduction (relative to 1990)**		
Category	**1990**	**2000**	**2010**	**2023**	**2030**	**2040**	**2050**
Buildings	16.7	15.8	16.1	9.1		82%	100%
Households (1.A.4.b)	11.8	10.8	11.2	6.2			
Services (1.A.4.a)	4.9	5.0	4.9	2.9			
Industry	15.8	14.9	15.8	11.5		50%	90%
1.A.1. Energy industries	2.5	3.2	3.9	3.2			
thereof: waste incineration plant (1.A.1.a.iv)	1.3	1.6	2.0	2.1			
1.A.2. Manufacturing industries and construction	6.6	6.0	5.9	3.9			
1.B. Fugitive emissions	0.17	0.16	0.15	0.07			
2. Industrial processes	4.2	3.8	4.5	3.3			
5. Waste	2.3	1.8	1.5	1.1			
thereof: Solid waste disposal (5.A)	0.86	0.59	0.49	0.26			
thereof: Wastewater treatment and discharge (5.D)	1.3	1.0	0.84	0.75			
Transport	14.7	15.9	16.3	13.6		57%	100%
1.A.3. Transport	14.7	15.9	16.3	13.6			
Agriculture	7.9	7.2	7.1	6.5	20%	30%	40%
1.A.4.c. Energy usage	0.83	0.81	0.71	0.54			
3. Agriculture	7.0	6.4	6.4	6.0			
Others	0.23	0.17	0.15	0.13			
1.A.5. Others	0.22	0.15	0.14	0.12			
6. Others	0.02	0.02	0.01	0.01			
International aviation	3.1	4.7	4.3	5.1			
Total	55.2	54.1	55.5	40.8			
Total with aviation	58.3	58.8	59.8	45.9	50%	75%	100%

3.1.2 Hard-to-abate emissions

Some emissions in industry, agriculture and aviation sectors are considered technologically hard-to-abate. The projections of residual emissions (emissions after using CCS) for these sectors are summarized in Table 3.2.

The residual-emissions assumptions are derived as follows:

Table 3.2: Sectoral residual emissions. Industry from BFE (2020b), agriculture from BLW, BLV and BFE (2023), and aviation estimated from BAFU (2025)

Sector	Emissions ($MtCO_2$)		
	2030	2040	2050
Industry	0.87	0.80	0.76
2. Industrial processes	2.67	1.30	0.24
5. Waste	0.96	0.68	0.51
Agriculture	6.30	5.51	4.72
Aviation	4.50	3.17	1.73
Total	14.42	10.66	7.21

- Industry: The reduction pathway of the industry sector, as defined by the Climate and Innovation Act (Swiss Federal Council, 2022) includes energy-related emissions (CRF sectors 1.A.1, 1.A.2, 1.B). However, these are addressed within the energy system models that evaluate the CROSS scenarios. Therefore, we do not apply the 90% reduction target from the Act. Instead, we use the 2050 emissions estimates from the Energy Perspectives 2050+ (BFE, 2020b) for the non-energy related emissions:
  - Cement (UNFCCC inventory category 2): The majority of hard-to-abate emissions are geogenic, originating from the chemical transformation of raw materials (e.g. limestone) during clinker production. These emissions can be largely reduced with CCS. To estimate residual emissions, we use projections from BFE (2020b) and assume a 90% carbon capture rate by 2050. Emissions are interpolated linearly between reported 2023 levels and the estimated 2050 value, reflecting a gradual deployment of CCS over time.
  - Waste water treatment and solid waste disposal (UNFCCC inventory category 5): These hard-to-abate emissions are not easily reduced by CCS. We assume the residual emissions in 2050 correspond to the emissions projected in BFE (2020b) and interpolate linearly between reported 2023 levels to the 2050 value.
- Agriculture:Residual agricultural emissions are derived from the sectoral reduction pathway in the *Climate Strategy for Agriculture and Nutrition 2050* (BLW, BLV and BFE, 2023). Emissions are reduced by 20% by 2030, 30% by 2040, and 40% by 2050 relative to 1990 levels.
- International aviation: To estimate the residual emissions from international aviation, we use the aviation fuel demand in Section 6.6. These account for the EU mandate for blending of sustainable aviation fuels. Emissions are calculated using an emission factor of 72.8 tCO_2/TJ, as provided by the Swiss Federal Office for the Environment (BAFU, 2025, Tabelle 1).

3.1.3 Derivation of the energy-system emissions constraint

The emissions constraint applied to the participating energy system models is derived from three components:

1. Economy-wide GHG reduction target: Defined by Switzerland's NDC (BAFU, 2024) and the Climate and Innovation Act (Swiss Federal Council, 2022). The legally binding targets are:

- 50% reduction by 2030
- 75% reduction by 2040
- 100% reduction by 2050, all relative to 1990 levels

2. Domestic and foreign emission reduction: The Long-Term Climate Strategy (Swiss Federal Council, 2021) does not define a specific split between domestic and international emission reductions for the 2050 net-zero target. However, Article 2a of the CO_2 Ordinance (Swiss Federal Council, 2025) establishes an interim rule for the 2030 target, requiring that at least 75% of the necessary emissions reductions must be achieved within Switzerland. Accordingly, we define two variants for the emissions reductions abroad. In both variants, by 2030 we follow the 75% target from domestic emissions set by the CO_2 Ordinance. After 2030, each variant defines a different development:

    - Domestic variant: Assumes that the net-zero emissions target by 2050 is to be achieved solely with domestic measures, i.e., a 100% domestic reduction quota.
    - Abroad variant: Allows partial use of CDR measures abroad to reach net-zero in 2050, while maintaining a minimum domestic reduction share of 85%.

3. Residual GHG emissions: the exogenous residual emissions described in Section 3.1.2.

For every year, the maximum domestic GHG emissions are first derived from the economy-wide target and the assumed domestic mitigation share. The exogenous residual emissions are then subtracted from this quantity. The remainder defines the maximum emissions available to the modelled energy system:

$$E_t^{\text{energy}} = E_t^{\text{domestic,max}} - E_t^{\text{residual}},$$

where E_t^{energy} is the energy-system emissions constraint, $E_t^{\text{domestic,max}}$ is the maximum permitted domestic GHG emissions, and E_t^{residual} is the exogenously specified residual emissions in year t.
A negative value for E_t^{energy} implies that the modelled energy system must deliver net carbon dioxide removal sufficient to compensate for residual emissions outside the modelled energy sectors.
The resulting emission constraints for the energy sector are summarized in Table 3.3. In both variants, we assume that Switzerland has access to carbon storage abroad (Section 3.1.4).
The cost of compensation abroad is represented using carbon-price estimates from global net-zero scenarios. Riahi et al. (2021) report an interquartile range of 200–900 US2010/tCO_2 and an average of approximately 500 US2010/tCO_2.

3.1.4 Carbon transport and storage abroad

Recent studies found that CO_2 storage potentials in Switzerland are low (Diamond et al., 2019) and to achieve net zero emissions, storage alternatives must be found abroad. Estimates for the storage potential in the North Sea amount to more than 100 $GtCO_2$(IOGP, 2019). In CROSS, we assume that Switzerland has access to the storage potential in the North Sea. For the CROSS scenarios, the accessible storage potential abroad is treated as unconstrained. CO_2 transport and permanent storage are represented using an exogenous cost of 100 CHF/tCO_2 based on BFE (2020a, Abbildung 15).

Table 3.3: Emissions reduction constraints

	Domestic			Abroad		
	2030	**2040**	**2050**	**2030**	**2040**	**2050**
GHG emissions reduction target (in % relative to 1990)	50	75	100	50	75	100
GHG Target ($MtCO_2$)	29.2	14.6	0.0	29.2	14.6	0.0
Domestic reduction quota (%)	75	85	100	75	80	85
Maximum GHG domestic emissions ($MtCO_2$)	36.5	21.1	0.0	36.5	23.3	8.7
Maximum GHG compensation abroad ($MtCO_2$)	**7.3**	**6.6**	**0.0**	**7.3**	**8.7**	**8.7**
Residual GHG emissions ($MtCO_2$, Table 3.2)	14.4	10.7	7.2	14.4	10.7	7.2
Maximum energy-related emissions ($MtCO_2$)	**22.0**	**10.5**	**-7.2**	**22.0**	**12.7**	**1.5**

3.2 Renewable electricity and winter-import dimension

This dimension examines the effect of the renewable electricity generation targets and winter electricity import guideline set out in the Swiss Energy Act (UVEK, 2024).
To assess the implications of these policy guidelines, we assess two variants:

- RES-target: The models implement the minimum generation levels for electricity from new renewable sources and the winter net-import guideline.

- NoRES-target: A counter-factual scenario that excludes these policy targets, allowing the system to evolve without specific renewable or import constraints.

Table 3.4 summarizes the renewable electricity and winter-import constraints for the two variants in this dimension.

Table 3.4: Variants for the renewable and imports targets. The targets for the RES-target variant are from the Energy Act (UVEK, 2024)

	RES-target		NoRES-target	
	2035	**2050**	**2035**	**2050**
Minimum electricity generation from new renewables (solar, wind, biomass, and geothermal; hydropower excluded)	35 TWh	45 TWh	-	-
Winter electricity net imports		Up to 5 TWh	-	-

3.3 Passenger-transport electrification dimension

This dimension explores how slower-than-expected deployment of EV charging infrastructure and the associated delay in passenger-transport electrification affect the Swiss energy transition. While the electrification of passenger transport is progressing steadily, there are uncertainties regarding the pace at which supporting infrastructure (e.g., public and private chargers, grid capacity) can be deployed.

The scenario does not impose different technological performance assumptions for electric vehicles. Instead, it varies the maximum share of passenger-transport final energy demand that may be supplied by EVs. This upper bound acts as a proxy for the availability of public and private charging infrastructure and the associated grid connections.
Two variants are defined:

- Full: Charging infrastructure is deployed sufficiently rapidly to permit complete electrification of private passenger transport by 2050.
- Lim: Charging infrastructure is deployed more slowly. The maximum contribution of EVs to passenger-transport final energy demand is therefore limited to 40% in 2040 and 60% in 2050. These limits are based on the findings from BFE (2023, p.16).

The upper bounds are reported in Table 3.5. The 2024[1]. value is based on the observed vehicle stock, while the 2030 value assumes a continuation of the recent EV stock-development trend.

Table 3.5: Final energy demand by EVs as a share of final energy demand in passenger transport

	Maximum share (%)			
	2024	**2030**	**2040**	**2050**
Full infrastructure (*Full*)	6.3	15	60	100
Limited infrastructure (*Lim*)	6.3	15	40	60

3.4 CROSS-v2025-06 scenarios overview

The three binary dimensions generate eight scenarios. Each scenario combines one climate-policy variant, one renewable and winter-import variant, and one passenger-transport electrification variant.
The policy-consistent reference scenario combines the Abroad climate-policy variant, the RES-target variant, and the Full electrification variant. The remaining combinations are used to isolate the effects of alternative mitigation geographies, the removal of renewable and winter-import constraints, and slower charging-infrastructure deployment.
Table 3.6 summarises the quantitative assumptions associated with each dimension. The complete scenario matrix and scenario naming convention are presented in Figure 3.1.

[1]The 2024 value is based on https://www.bfs.admin.ch/bfs/en/home/statistics/mobility-transport/transport-infrastructure-vehicles/vehicles/road-vehicles-stock-level-motorisation.html

Table 3.6: CROSS-v2025-06 scenarios

Climate policy	Domestic			Abroad		
	2030	2040	2050	2030	2040	2050
Maximum GHG domestic emissions ($MtCO_2$)	36.5	21.1	0.0	36.5	23.3	8.7
Maximum GHG compensation abroad ($MtCO_2$)	7.3	6.6	0.0	7.3	8.7	8.7
Energy-related emissions target ($MtCO_2$)	22.0	10.5	−7.2	22.0	12.7	1.5
Renewable and imports target	RES-target			NoRES-target		
		2035	2050		2035	2050
Minimum electricity produced with new renewables (solar, wind, biomass, and geothermal. Excluding hydropower) (TWh)		35	45		-	-
Winter electricity net imports (TWh)			5		-	-
Electrification	Full			Limited		
	2030	2040	2050	2030	2040	2050
Maximum share of EVs in final demand of passenger vehicles (%)	15	60	100	15	40	60

Chapter 4

Macro-economic drivers

These variables **have been updated** relative to the CROSS V2022-09 scenarios.

Population and economic growth are uncertain drivers that affect energy demand. In this chapter, we present reference values and ranges for these variables which are based on official projections (Table 4.1). We also include the assumptions of CROSS v2022 (Marcucci et al., 2022) the EP2050+ (BFE, 2020b).

Table 4.1: Macro-economic drivers

	2010	2020	2030	2040	2050	2010–2050[a]	Reference
Population (Million)							
Reference	7.9	8.7	9.4	9.9	10.2	0.66% p.a.	A-00-2025 (BFS, 2024a, 2025b)
High	7.9	8.7	9.7	10.5	11.2	0.89% p.a.	B-00-2025 (BFS, 2024a, 2025b)
Low	7.9	8.7	9.2	9.3	9.2	0.40% p.a.	C-00-2025 (BFS, 2024a, 2025b)
CROSS-2022-Ref	7.9	8.7	9.4	10.0	10.4	0.70% p.a.	A-00-2020 (BFS, 2020a)
EP2050+	7.8	8.7	9.5	10.0	10.3	0.68% p.a.	EP2050+ (BFE, 2020b, Tabelle 1)
Number of households (Million households)							
Reference	3.5	3.9	4.3	4.6	4.8	0.84% p.a.	AM-00-2020 (BFS, 2024c, 2021a)
High	3.5	3.9	4.3	4.8	5.1	1.02% p.a.	BM-00-2020 (BFS, 2024c, 2021a)
Low	3.5	3.9	4.2	4.4	4.5	0.65% p.a.	CM-00-2020(BFS, 2024c, 2021a)
CROSS-2022-Ref	3.5	3.9	4.2	4.5	4.8	0.82% p.a.	AM-00-2020 (BFS, 2021a)
EP2050+	3.5	3.8	4.2	4.5	4.6	0.76% p.a.	EP2050+ (BFE, 2020d)
Working population (full-time equivalent)							
Reference	3.7	4.2	4.6	4.9	5.0	0.71% p.a.% p.a.	A-00-2025 (BFS, 2025a,c)
High	3.7	4.2	4.7	5.1	5.4	0.94% p.a.	B-00-2025 (BFS, 2025a,c)
Low	3.7	4.2	4.5	4.5	4.4	0.43% p.a.	C-00-2025 (BFS, 2025a,c)
CROSS-2022-Ref	3.7	4.3	4.4	4.6	4.7	0.59% p.a.	A-00-2020 (BFS, 2020b)
EP2050+	3.8	4.1	4.3	4.4	4.4	0.40% p.a.	EP2050+ (BFE, 2020b, Tabelle 1)
GDP ($BCHF_{2017}$)							
Reference	611.3	703.6	875.0	1032.4	1190.6	1.68% p.a.	BIP-A (BFS, 2024b, SECO, 2025)
High	611.3	703.6	895.7	1093.7	1305.3	1.91% p.a.	BIP-B (BFS, 2024b, SECO, 2025)
Low	611.3	703.6	854.4	967.6	1068.0	1.40% p.a.	BIP-C (BFS, 2024b, SECO, 2025)
CROSS-2022-Ref	603.0	695.6	846.4	981.6	1125.1	1.57% p.a.	BIP-A (SECO, 2022)
EP2050+	603.0	713.0	805.0	893.0	968.0	1.19% p.a.	EP2050+ (BFE, 2020b, Tabelle 1)

[a] Average yearly growth rate between 2010 and 2050

Data available at https://sweet-cross.ch/data/macroeconomic-drivers-cross/2025-06-06/

4.1 Population

The CROSS-2025 population assumptions (Table 4.1) are based on the estimations from the BFS (2025b): a reference estimation (A-00-2025) and the 2 variants (B-00-2025 and C-00-2025). We use historical data until 2024 from the BFS (2024a), and projections after 2025 from BFS (2025b). The number of households is based on the projections of the BFS (2021a), we take the historical data from BFS (2024c) and update with the growth rates in BFS (2021a). To calculate the working population, we use the historical data from BFS (2025a) and the projections from BFS (2025c).

4.2 Gross domestic product

The CROSS GDP assumptions (Table 4.1) are based on the projections from the State Secretariat for Economic Affairs (SECO, 2025), which are linked to the BFS (2025b) population projections. We use the historical data from BFS (2024b) for 2010–2023.

Chapter 5

Climate change

These variables **are consistent** with those used in the CROSS V2022-09 scenarios.

We consider three variants for temperature change in Switzerland based on the CH2018 scenarios (CH2018, 2018): No climate change mitigation (RCP 8.5), concerned climate change mitigation efforts (RCP 2.6), and a mid of the way variant (RCP 4.5). In the RCP8.5, climate-influencing emissions increase and hence global warming continues. The RCP 2.6 assumes immediate mitigation action so that the Paris Agreement target of limiting temperature increase to 2 °C is achieved and the increase of greenhouse gas emissions is halted within the next 20 years. The implications of these global CO_2 pathways for temperature increase in Switzerland were estimated by CH2018 (2018). Figure 5.1 presents the yearly average temperature increase for the three RCPs including the range and median of the 68 simulations available for each RCP.

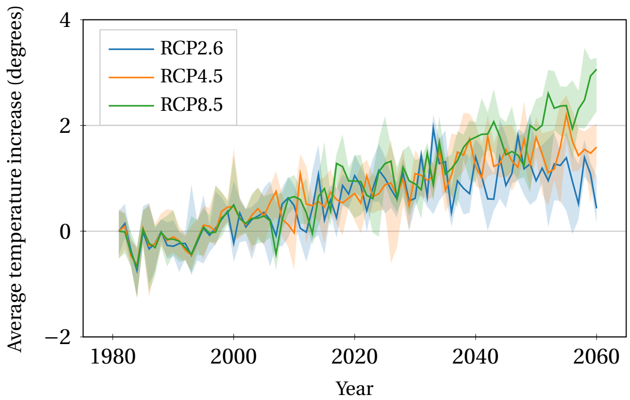


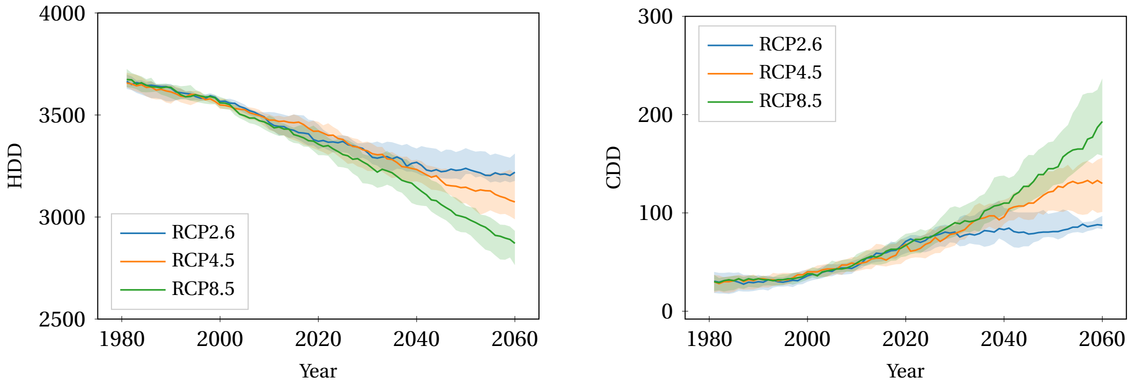
Figure 5.1: Temperature increase in three variants for global climate change. Based on CH2018 (2018), Berger and Worlitschek (2019)

Data available at https://sweet-cross.ch/data/climate-data-ch-2018/

We consider the effect of global climate change developments on heating and cooling demand and hydropower.

5.1 Effect on heating and cooling demand

Heating and cooling demands are directly affected by outside temperatures. We estimate the changes in heating degree days (HDD)[1] and cooling degree days (CDD)[2] due to climate change. Berger and Worlitschek (2019) calculated future HDDs and CDDs of the three RCP variants for the temperature increase in all models in CH2018 (2018). They used a GIS-based approach combining the spatial distribution of temperature (and therefore HDDs) and population. Figure 5.2 presents the median and the first and third quartiles of the HDDs and CDDs calculated by Berger and Worlitschek (2019).



(a) Heating degree days (b) Cooling degree days

Figure 5.2: Population weighted cooling and heating degree days in RCP 8.5, RCP 4.5 and RCP 2.6 (Berger and Worlitschek, 2019)

> Data available at https://sweet-cross.ch/data/climate-data-ch-2018/

In CROSS, we estimate HDDs by taking the historical measured data from Berger and Worlitschek (2019) and applying the growth rates of the median values for each RCP variant. The resulting HDDs are shown in Table 5.1, we also compare to the HDDs in the EP2050+ scenarios BAU (Business as Usual)(BFE, 2020c) and Zero Basis (BFE, 2020d). Using these HDDs, we provide estimations for residential heating demand in Section 6.1.

[1]We use the most common definition of HDD 20/12. For every day at which the average temperature is below the heating limit $T_l = 12\,°C$ we compute the difference of that temperature to an assumed building interior temperature $T_i = 20\,°C$.

[2]Cooling degree days are the number of degrees that a day's average temperature is above a certain threshold ($T_{max} = 18.3\,°C$).

Table 5.1: Heating degree days

Variant	2010	2020	2030	2040	2050	2010–2050
RCP2.6	3770	3351	3296	3248	3219	−0.39% p.a
RCP4.5	3770	3350	3255	3166	3080	−0.50% p.a
RCP8.5	3770	3353	3254	3141	2993	−0.57% p.a
EP2050+, Zero Basis (BFE, 2020d)	3586	3191	3105	3054	3030	−0.42% p.a.
EP2050+, BAU (BFE, 2020c)	3586	3182	3089	2997	2928	−0.51% p.a.

Data available at https://sweet-cross.ch/data/heating-degree-days-cross/2022-09-30/

Chapter 6

Energy service demands

From the harmonized drivers in Chapter 4, we calculate the future energy service demands in the different end-use sectors with a reduced-form econometric model based ((Panos et al., 2021) and Marcucci et al. (2021a)). We determine:

- space heating demand in the residential and commercial sectors from the future energy reference area (ERA), specific heating demand and climate change. We use population as explanatory variable to calculate the ERA in the residential and commercial sectors and GDP for industry;

- process heat demand using its relationship with economic development (GDP);

- warm water and electricity demand (appliances, motors, etc., without heat pumps or electric vehicles) follows population in the residential sector and GDP for the industrial and commercial sectors;

- passenger and freight transport demand based on the Transport Outlook 2050 (ARE, 2021); and

- aviation demand based on population and the projections from the (EASA, 2022).

All the demands estimated in this section correspond to end-use energy demand (EUD). These demands should not be confused with final energy consumption (FEC). FEC is defined as "the energy which reaches the final consumer's door". In other words, the FEC is the amount of input fuel needed to satisfy the (EUD) in energy services. As an example, in the case heat production with a gas boiler, the FEC is the amount of gas consumed by the boiler; the EUD is the amount of heat produced by the boiler, i.e. the heating service needed by the final user.

6.1 Space heating end-use demand

These variables **have been updated** relative to the CROSS V2022-09 scenarios.

To estimate the space heating demand in the building sector, we require development of the building stock, energy efficiency improvements and climate change. In this section, we calculate the space heating demand and possible changes due to climate change. However, we do not account for energy efficiency improvements which are normally modelled as investment decisions in the energy system models.

6.1.1 Building stock

The ERA is the effective heated surface of a building. In CROSS, we use the historical data from BFE (2024a, Tables 11 and 19). We subtract the ERA of second homes and holiday houses from the residential sector and added them to the commercial sector[1]. To extrapolate the residential ERA to the future, we assume an increasing ERA with population with a logarithmic function for both residential and commercial sectors. For the industrial sector, we use the GDP as the explanatory variable. The resulting ERAs are shown in Table 6.1.

Table 6.1: Energy Reference Area by sector (Mm2)

	2010	2023	2030	2040	2050	2010–2050
Residential (Mm2)						
Reference	428.4	509.2	546.1	576.1	597.7	0.84% p.a.
High	428.4	509.2	562.8	616.1	659.2	1.08% p.a.
Low	428.4	509.2	528.7	533.1	530.2	0.53% p.a.
CROSS-2022-Ref	423.6		535.5	573.9	600.5	0.88% p.a.
EP2050+ (BFE, 2020d)	423.8	501.7	537.9	573.8	594.1	0.85% p.a.
Commercial (Mm2)						
Reference	213.0	248.6	264.3	277.5	287.0	0.75% p.a.
High	213.0	248.6	271.7	295.1	313.9	0.97% p.a.
Low	213.0	248.6	256.7	258.6	257.4	0.47% p.a.
CROSS-2022-Ref	206.1		244.3	257.3	266.2	0.64% p.a.
EP2050+ (BFE, 2020d)	205.9	235.1	243.7	250.9	251.6	0.50% p.a.
Industry (Mm2)						
Reference	87.4	95.1	100.5	106.6	111.8	0.62% p.a.
High	87.4	95.1	101.4	108.7	115.1	0.69% p.a.
Low	87.4	95.1	99.7	104.2	107.8	0.53% p.a.
CROSS-2022-Ref	87.4		98.5	104.1	109.2	0.56% p.a.
EP2050+ (BFE, 2020d)	75.7	65.6	65.4	65.0	64.3	−0.41% p.a.

Data available at https://sweet-cross.ch/data/era-cross/2025-06-06/

Since the heating demand depends on the age of the buildings, we distribute the total ERA in Table 6.1 across building types and ages. For this, we use historical values from Schluck et al. (2019), in the residential sector; and Wüest Partner (2019), Jakob et al. (2019), in the commercial sector. Following Müller (2006), Sandberg et al. (2016) and Sartori et al. (2016), we assume that the survival rate of the buildings follows a Weibull distribution (See Marcucci et al. (2021b) for details on the estimation). The projected building stock for the residential sector including single family houses (SFHs) and multi family houses (MFHs) and the different construction periods are shown in Table 6.2. Since the current building stock is same for all variants, the only difference between them is for the buildings built after 2017. Each building type has a specific demand. We use the specific demand for the existing stock from Schluck et al. (2019) and Streicher et al. (2020). For the future building stock, we assume that the buildings will comply with current *minenergie* standards[2] with a specific energy demand that decreases with time as shown in last column in Table 6.2.

[1] All second homes are treated as holiday houses.

[2] Norm SIA 380/1

Table 6.2: Residential ERA (Mm2) and specific useful energy demand (kWh/m2/year) by building type and construction period

	Energy reference area (Mm2)						Specific demand
Construction period	2018	2020	2030	2040	2050	2020–2050	(kWh/m2/year)
Single family houses							
<1920	41.7	41.4	39.6	37.3	34.6	−0.60% p.a.	93.0
1920-1945	22.0	21.8	20.6	19.0	17.0	−0.82% p.a.	104.4
1946-1960	20.8	20.6	19.9	18.8	17.3	−0.59% p.a.	110.3
1961-1970	18.8	18.7	18.2	17.3	16.2	−0.48% p.a.	109.2
1971-1980	24.9	24.9	24.3	23.5	22.2	−0.38% p.a.	89.8
1981-1990	27.6	27.6	27.2	26.5	25.4	−0.28% p.a.	76.2
1991-2000	24.5	24.5	24.2	23.7	22.7	−0.25% p.a.	75.3
2001-2010	23.7	23.7	23.5	23.1	22.1	−0.23% p.a.	62.5
2011-2017	13.6	13.6	13.6	13.4	13.1	−0.13% p.a.	44.5
>2017							40 in 2020, 25 in 2050
Reference	1.7	1.8	16.8	26.7	36.3	10.57% p.a.	
High	1.7	1.8	21.0	36.8	51.7	11.88% p.a.	
Low	1.7	1.8	12.4	16.0	19.5	8.30% p.a.	
Multi family houses							
<1920	37.7	37.7	37.5	37.2	36.6	−0.10% p.a.	77.4
1920-1945	21.8	21.8	21.7	21.6	21.4	−0.06% p.a.	81.4
1946-1960	27.9	27.9	27.8	27.3	25.5	−0.30% p.a.	73.1
1961-1970	37.8	37.8	37.8	37.5	36.3	−0.14% p.a.	78.5
1971-1980	34.1	34.1	34.1	34.0	33.5	−0.06% p.a.	73.0
1981-1990	27.6	27.6	27.6	27.6	27.4	−0.02% p.a.	72.5
1991-2000	25.7	25.7	25.7	25.7	25.6	−0.01% p.a.	60.3
2001-2010	30.3	30.3	30.3	30.3	30.3	0.00% p.a.	47.3
2011-2017	25.3	25.3	25.3	25.3	25.3	0.00% p.a.	29.5
>2017							35 in 2020, 20 in 2050
Reference	7.0	5.3	50.4	80.2	109.0	10.57% p.a.	
High	7.0	5.3	62.9	110.3	155.1	11.88% p.a.	
Low	7.0	5.3	37.3	48.0	58.4	8.30% p.a.	

Data available at https://sweet-cross.ch/data/era-cross/2025-06-06/

6.1.2 Space heating end-use demand – before energy efficiency measures

The specific demands is the last column in Table 6.2 assume a theoretical constant climate. To estimate the heating demand in the different climate scenarios, we assume a linear relationship between the HDD (Table 5.1) and the heating demand. Table 6.3 presents the end-use demand[3] for space heating for the constant climate cases and the three RCP scenarios. We also include an estimation of the end-use demand from the final energy consumption in the BAU and Zero Basis scenarios of the EP2050+ (BFE, 2020c,d), assuming an efficiency of 86%.

[3] We calculate end-use demand from the final energy statistics (BFE, 2024a), assuming an efficiency of 86%.

Table 6.3: Space heating end-use demand (TWh)

	Climate	2010	2023	2030	2040	2050	2010–2050
Residential (TWh)							
Residential							
Reference	Constant	46.4	32.7	38.3	38.5	37.9	−0.50% p.a.
	RCP 2.6	46.4	32.7	37.2	36.8	35.9	−0.63% p.a.
	RCP 4.5	46.4	32.7	36.9	36.0	34.5	−0.73% p.a.
	RCP 8.5	46.4	32.7	36.7	35.6	33.4	−0.81% p.a.
High	Constant	46.4	32.7	38.8	39.6	39.5	−0.40% p.a.
Low	Constant	46.4	32.7	37.7	37.2	36.0	−0.63% p.a.
CROSS-2022-Ref	Constant	46.0	37.3		38.3	37.8	−0.49% p.a.
EP2050+, BAU		45.8	37.9	36.0	33.3	31.0	−0.97% p.a.
EP2050+, Zero Basis		45.8	37.9	35.7	32.0	29.3	−1.11% p.a.
Commercial (TWh)							
Reference	Constant	21.1	14.3	17.0	17.2	17.2	−0.51% p.a.
	RCP 2.6	21.1	14.3	16.5	16.5	16.3	−0.64% p.a.
	RCP 4.5	21.1	14.3	16.3	16.1	15.7	−0.74% p.a.
	RCP 8.5	21.1	14.3	16.3	15.9	15.2	−0.82% p.a.
High	Constant	21.1	14.3	17.2	17.8	18.0	−0.39% p.a.
Low	Constant	21.1	14.3	16.7	16.6	16.3	−0.64% p.a.
CROSS-2022-Ref	Constant	21.7	16.0	16.2	16.5	16.4	−0.69% p.a.
EP2050+, BAU		19.4	14.7	12.9	11.2	10.1	−1.62% p.a.
EP2050+, Zero Basis		19.4	14.1	11.8	9.5	8.2	−2.13% p.a.
Industry (TWh)							
Reference	Constant	4.6	2.5	2.8	2.6	2.4	−1.65% p.a.
Reference	RCP 2.6	4.6	2.5	2.7	2.4	2.3	−1.78% p.a.
Reference	RCP 4.5	4.6	2.5	2.7	2.4	2.2	−1.88% p.a.
Reference	RCP 8.5	4.6	2.5	2.7	2.4	2.1	−1.96% p.a.
High	Constant	4.6	2.5	2.8	2.6	2.5	−1.58% p.a.
Low	Constant	4.6	2.5	2.8	2.5	2.3	−1.74% p.a.
CROSS-2022-Ref	Constant	5.6	3.2	3.1	2.9	2.8	−1.72% p.a.
EP2050+, BAU		5.2	3.0	2.5	2.0	1.6	−2.90% p.a.
EP2050+, Zero Basis		5.2	2.9	2.3	1.7	1.3	−3.41% p.a.

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

6.2 Warm water end-use demand

This variable **has been updated** relative to the CROSS V2022-09 scenarios.

The drivers for the projection of warm water demand are population for the residential and commercial sectors and GDP for the industrial sector. We use the historical final energy statistics (BFE, 2024a) to calibrate the model and we calculate useful energy demand assuming an efficiency of 80%. Table 6.4 presents the resulting demand. We also include an estimation of the end-use demand from the BAU and Zero Basis scenarios of the EP2050+ (BFE, 2020c,d), assuming an efficiency of 80%.

Table 6.4: Warm water end-use demand (TWh)

	2010	2023	2030	2040	2050	2010–2050
Residential (TWh)						
Reference	7.0	7.1	7.0	6.8	6.6	−0.13% p.a.
High	7.0	7.1	7.2	7.2	7.2	0.10% p.a.
Low	7.0	7.1	6.8	6.4	6.0	−0.39% p.a.
CROSS-2022-Ref	6.9		7.0	6.9	6.8	−0.04% p.a.
EP2050+, BAU	6.7	7.1	7.3	7.3	7.3	0.21% p.a.
EP2050+, Zero Basis	6.7	7.0	6.8	6.6	6.4	−0.11% p.a.
Commercial (TWh)						
Reference	3.3	2.5	2.3	2.1	1.9	−1.30% p.a.
High	3.3	2.5	2.3	2.2	2.1	−1.08% p.a.
Low	3.3	2.5	2.2	1.9	1.7	−1.57% p.a.
CROSS-2022-Ref	2.7		2.3	2.2	2.1	−0.67% p.a.
EP2050+, BAU	2.5	2.0	1.8	1.8	1.9	−0.68% p.a.
EP2050+, Zero Basis	2.5	1.9	1.8	1.9	1.9	−0.68% p.a.
Industrial (TWh)						
Reference	0.69	0.52	0.48	0.45	0.42	−1.23% p.a.
High	0.69	0.52	0.50	0.47	0.46	−1.00% p.a.
Low	0.69	0.52	0.47	0.42	0.37	−1.50% p.a.
CROSS-2022-Ref	0.65		0.39	0.37	0.37	−1.44% p.a.
EP2050+, BAU	0.81	0.47	0.39	0.31	0.25	−2.90% p.a.
EP2050+, Zero Basis	0.81	0.46	0.36	0.26	0.20	−3.44% p.a.

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

6.3 Process heat end-use demand

This variable **has been updated** relative to the CROSS V2022-09 scenarios.

Process heat is thermal energy supplied at a level higher than space heating of warm water. It is mostly used in specific industrial sectors with a small contribution in the commercial sector. We relate process heat demand to GDP. We use the historical final energy statistics (BFE, 2024a) to calibrate the model. We assume that industrial process heat corresponds to the categories *Prozesswärme, Sonstige* and *Antriebe, Prozesse* in BFE (2024a, Table 28) and we calculate useful energy demand assuming an efficiency of 70%. Table 6.5 presents the resulting demand.

Table 6.5: Process heat end-use demand (TWh)

	2010	2023	2030	2040	2050	2010–2050
Commercial (TWh)						
Reference	0.58	0.63	0.66	0.70	0.75	0.65% p.a.
High	0.58	0.63	0.67	0.75	0.82	0.88% p.a.
Low	0.58	0.63	0.64	0.66	0.67	0.38% p.a.
CROSS-2022-Ref	0.47		0.58	0.65	0.73	1.13% p.a.
EP2050+	0	0	0	0	0	–
Industrial (TWh)						

Table 6.5: Process heat end-use demand (TWh) (continued)

	2010	2023	2030	2040	2050	2010–2050
Reference	18.3	16.3	15.6	14.9	14.4	−0.60% p.a.
High	18.3	16.3	16.0	15.7	15.8	−0.38% p.a.
Low	18.3	16.3	15.2	13.9	12.9	−0.87% p.a.
CROSS-2022-Ref	17.7		16.5	17.0	17.9	0.03% p.a.
EP2050+, BAU	17.6	16.8	16.5	16.4	16.2	−0.21% p.a.
EP2050+, Zero Basis	17.6	16.3	15.2	14.0	13.0	−0.75% p.a.

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

For models that disaggregate process heat demand by temperature ranges, the following distribution can be applied: 25% below 100 °C, 25% between 100–200 °C, and 50% above 200 °C.

6.4 Electricity demand from electric appliances

This variable **has been updated** relative to the CROSS V2022-09 scenarios.

In the electricity demand from electric appliances we include cooking, lighting, ICT, cooling, processes (refrigerators, dishwashers, etc), electric motors, air conditioning and other appliances [4]. It is important to note that this electricity demand does not include electricity use to produce the end-use demand of space heating, industrial heat or transport, it only accounts for appliances.

The drivers used for the projections are population in the residential and commercial sectors and GDP in the commercial and industrial sectors. Table 6.6 presents the resulting demand.

Table 6.6: Electricity demand from electric appliances (TWh)

	2010	2023	2030	2040	2050	2010–2050
Residential (TWh)						
Reference	13.2	12.1	11.7	11.1	10.6	−0.54% p.a.
High	13.2	12.1	12.0	11.8	11.7	−0.31% p.a.
Low	13.2	12.1	11.4	10.4	9.6	−0.80% p.a.
CROSS-2022-Ref	12.7		11.5	11.2	10.9	−0.38% p.a.
EP2050+, BAU	12.2	11.4	11.6	12.3	12.7	0.10% p.a.
EP2050+, Zero Basis	12.2	11.4	11.3	11.6	11.6	−0.13% p.a.
Commercial (TWh)						
Reference	15.9	14.2	14.0	13.7	13.3	−0.44% p.a.
High	15.9	14.2	14.3	14.5	14.6	−0.21% p.a.
Low	15.9	14.2	13.7	12.8	12.0	−0.71% p.a.
CROSS-2022-Ref	16.3		15.8	15.1	14.1	−0.35% p.a.
EP2050+, BAU	16.7	16.8	17.0	16.6	15.1	−0.25% p.a.
EP2050+, Zero Basis	16.6	16.2	15.1	13.2	11.5	−0.91% p.a.

[4] From the *Analyse des schweizerischen Energieverbrauchs 2000 – 2023 nach Verwendungszwecken* (BFE, 2024a) we include the following categories by sector. Residential: *Klima , Lüftung, HT*; *I&K, Unterhaltung*; *übrige Haustechnik*; *Kochen*; *Beleuchtung*; *Waschen & Trocknen,Kühlen & Gefrieren*;*Geschirrspülen*; and *sonstige Elektrogeräte*. Commercial: *Beleuchtung*; *Klima, Lüftung, HT*; *I&K , Unterhaltung*; *Antriebe, Prozesse*; and *sonstige*. Industrial: *Beleuchtung*; *Klima, Lüftung, HT*; *I&K, Unterhaltung*; *Antriebe, Prozesse*; and *sonstige*

Table 6.6: Electricity demand from electric appliances (TWh) (continued)

	2010	2023	2030	2040	2050	2010–2050
Industrial (TWh)						
Reference	15.1	13.4	13.2	12.9	12.7	−0.42% p.a.
High	15.1	13.4	13.5	13.7	14.0	−0.19% p.a.
Low	15.1	13.4	12.9	12.1	11.4	−0.69% p.a.
CROSS-2022-Ref	15.4		13.5	12.9	12.3	−0.55% p.a.
EP2050+, BAU	15.5	13.8	13.7	13.4	12.9	−0.46% p.a.
EP2050+, Zero Basis	15.5	13.2	12.1	10.8	9.7	−1.16% p.a.

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

6.5 Transport demand

This variable **has been updated** relative to the CROSS V2022-09 scenarios.

The transport demand is based on the Transport Outlook 2050 (ARE, 2021). To calculate the three variants of the transport demand, we use the historical data from the BFS (2024e,d) and the ARE growth rates in the reference, high and low variants. Tables 6.7 and 6.8 present the passenger and freight transport projections from the different scenarios. Motorized personal transport corresponds to the categories personal cars, motorcycles, mopeds and fast e-bikes and other private.; Passenger rail corresponds to trams, trolleybuses and trains; and Road freight corresponds to trucks and light duty vehicles.

Table 6.7: Passenger transport demand (Billion passenger-kilometer)

	2010	2023	2030	2040	2050	2010–2050
Motorized personal transport						
Reference	90.9	93.8	95.7	94.5	91.2	0.01% p.a.
High	90.9	93.8	98.2	100.5	100.2	0.24% p.a.
Low	90.9	93.8	93.2	88.6	82.4	−0.25% p.a.
CROSS-2022-Ref	90.9		107.4	107.7	104.8	0.36% p.a.
EP2050+	90.9	106.0	109.3	113.5	115.2	0.59% p.a.
Buses						
Reference	2.5	2.9	3.1	3.4	3.6	0.93% p.a.
High	2.5	2.9	3.2	3.6	4.0	1.17% p.a.
Low	2.5	2.9	3.0	3.2	3.3	0.67% p.a.
CROSS-2022-Ref	2.5		3.2	3.6	3.9	1.10% p.a.
EP2050+	3.0	3.7	3.9	4.2	4.3	0.90% p.a.
Passenger rail						
Reference	21.1	24.3	25.5	28.0	29.9	0.87% p.a.
High	21.1	24.3	26.2	29.8	32.8	1.11% p.a.
Low	21.1	24.3	24.9	26.3	27.0	0.62% p.a.
CROSS-2022-Ref	21.1		25.6	28.5	30.7	0.94% p.a.
EP2050+	20.2	25.2	26.7	28.8	30.1	1.00% p.a.

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

Table 6.8: Freight transport demand (Billion ton-kilometer)

	2010	2023	2030	2040	2050	2010–2050
Road						
Reference	16.9	16.2	17.0	18.7	20.2	0.45% p.a.
High	16.9	16.2	17.4	19.8	22.2	0.68% p.a.
Low	16.9	16.2	16.6	17.5	18.1	0.18% p.a.
CROSS-2022-Ref	16.9		18.0	19.6	21.2	0.57% p.a.
EP2050+	16.9	18.6	19.5	21.2	22.5	0.72% p.a.
Freight rail						
Reference	9.8	9.9	10.9	11.9	12.8	0.66% p.a.
High	9.8	9.9	11.2	12.6	14.0	0.89% p.a.
Low	9.8	9.9	10.7	11.1	11.4	0.39% p.a.
CROSS-2022-Ref	9.8		11.7	12.5	13.5	0.80% p.a.
EP2050+	9.9	12.8	13.7	14.1	14.7	0.99% p.a.

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

6.6 Aviation demand

This variable **is newly defined** and was not part of the CROSS V2022-09 scenarios.

We estimate aviation demand based on the consumption of aviation fuels, using historical data from the Swiss Energy Statistics (BFE, 2024b, Table 17e). For the future projections, presented in Table 6.9, we consider the following:

- Traffic growth scenarios from the European Aviation Environmental Report (EASA, 2022, p. 7), which provide projections for arrival and departure flights across EU27+EFTA airports. The report outlines three scenarios with respective annual growth rates from 2019 to 2050 of 0.897%, 1.572%, and 0.284%.
- Aircraft efficiency improvements as assumed by the Swiss Federal Office of Civil Aviation, which projects an annual increase in fuel efficiency of 0.5% (Swiss Federal Council, 2024).
- Sustainable Aviation Fuel (SAF) blending obligations as set by the ReFuelEU Aviation Regulation (European Parliament, 2023). We assume that aviation fuels will not be produced domestically in Switzerland but will be imported in accordance with this regulation. The SAF blending mandate begins at 2% in 2025 and increases progressively to 70% by 2050.

Table 6.9: Aviation fuel demand (TWh)

	2010	2019	2023	2025	2030	2040	2050	2010–2050
Total demand of aviation fuels (TWh)								
Reference	17.1	22.5	19.9	19.8	20.3	21.2	22.0	0.63% p.a.
High	17.1	22.5	20.2	19.8	21.3	23.7	26.3	1.08% p.a.
Low	17.1	22.5	19.7	19.8	19.5	19.1	18.7	0.22% p.a.
Demand of sustainable aviation fuels (TWh)								

Table 6.9: Aviation fuel demand (TWh) (continued)

	2010	**2019**	**2023**	**2025**	**2030**	**2040**	**2050**	**2010–2050**
Reference			0	0.40	3.2	9.1	15.4	
High			0	0.40	3.3	10.1	18.4	
Low			0	0.39	3.0	8.2	13.1	

Data available at https://sweet-cross.ch/data/end-use-energy-demand-cross/2025-06-06/

Chapter 7

Resources

7.1 Solar PV and wind

These variables **are consistent** with those used in the CROSS V2022-09 scenarios.

In CROSS 2025, we consider three variants for solar PV and wind as shown in Table 7.1. Those potentials were estimated in the CROSS 2022-09 scenarios (Marcucci et al., 2022). The potentials for solar PV are based on Dujardin et al. (2021),Remund et al. (2019), BFE (2019) and Bauer et al. (2017). The potentials for wind are based on Dujardin et al. (2021),Bauer et al. (2017), and Cattin et al. (2012).

Table 7.1: 2050 solar PV and wind potentials

	2050 potential (TWh/a)		
	Reference	**High**	**Low**
Solar PV			
Rooftop	40	50	30
Facades	4	8	0
Mountains	3	30	0
Total	47	88	30
Wind	4.3	15	1.7

7.2 Biomass and waste potentials

These variables **have been updated** relative to the CROSS V2022-09 scenarios.

We updated the biomass and waste potentials with the CROSS 2025 assumptions on GDP and population described in Chapter 4 (Table 7.2 depicts the reference variant).

Table 7.2: Energy potential of biomass and waste categories in the reference variant (PJ)

		Energy Potential (PJ)					
Category	**Feedstock**	**2015**	**2023**	**2025**	**2030**	**2040**	**2050**
(A) Wood	Forest wood						
	Continued stock increase	17.1	21.9	23.0	26.0	26.0	26.0
	Moderate stock reduction	17.1	29.0	31.9	39.4	39.4	39.4
	Large stock reduction	17.1	25.2	27.2	32.3	32.3	32.3
	Wood from landscape	2.3	3.7	4.0	4.8	4.8	4.8

Table 7.2: Energy potential of biomass and waste categories in the reference variant (PJ) (continued)

		Energy Potential (PJ)					
Category	**Feedstock**	**2015**	**2023**	**2025**	**2030**	**2040**	**2050**
	Wood residues	7.4	7.6	7.6	7.7	7.7	7.7
	Waste wood	9.1	12.5	13.3	15.4	16.1	16.6
(B) Manure	Animal manure (dry)	2.5	15.2	18.4	26.3	26.3	26.3
(C) Green waste	Collected organic waste	3.3	4.3	4.4	5.1	6.7	8.3
	Agricultural byproducts	0.09	1.4	1.8	2.6	2.6	2.6
(D) Sewage sludge	Fresh sewage sludge (dry)	4.9	5.2	5.3	5.5	5.8	6.0
(E) Mixed fossil/ organic waste	Imports	4.2	2.0	1.4	0.00	0.00	0.00
	Exports	5.9	2.5	1.8	0.00	0.00	0.00
	Other waste fraction	22.8	23.9	25.2	28.8	34.0	39.2
	Municipal waste	31.4	31.8	30.3	30.4	29.9	28.9

Data available at https://sweet-cross.ch/data/biomass-potentials-cross/2025-06-06/

7.2.1 Waste incineration plants (IPCC category 1.A.1.a.iv)

Waste incineration plants are a special category where we need special considerations.

- Emissions from waste in 2050: 4 $MtCO_2$ are emitted by waste incinerators, 1.5 $MtCO_2$ (37%) of biogenic origin and the remaining 2.5 $MtCO_2$ is fossil-based (Swiss Federal Council, 2021, p. 49). Since carbon capture and storage can be used in waste incinerators, assuming 90% capture rate, 3.6 $MtCO_2$ can be captured. Given that the biogenic portion is captured by the biomass while growing, the net emissions (when using CCS) are the fossil fraction minus the total CO_2 captured: -1.1 $MtCO_2$.
- Lower heating value (LHV): According to the VBSA (2020) the LHV for waste is between 11 and 12 MJ/kg. We assume a LHV of 11.5 MJ/kg.
- Amount of waste in 2050: The CO_2 content of waste (VBSA, 2020, Eq. 1) is calculated following:

$$C_{\text{total}}\,[\text{g/kg}] = 264 + \big(LHV\,[\text{MJ/kg}] - 10\big) \times 98/5,$$

  we can, therefore, estimate the total amount of waste that goes to the waste incinerators (from the 4 $MtCO_2$ in BFE (2020b)) to 3.7 Mt (or 42.8 PJ).

7.3 Imports and exports

7.3.1 Oil, gas, biofuels and hydrogen

These variables **have been updated** relative to the CROSS V2022-09 scenarios

Table 7.3 presents the assumptions for import prices of oil, gas, biofuels and hydrogen. The import price of oil and gas are based on the 2024 World Energy Outlook (WEO2024) (IEA, 2024). Hydrogen prices are from Meili et al. (2025).

Table 7.3: Import price of energy carriers (CHF/GJ). Prices are based on the WEO 2024 (IEA, 2024). The table also includes the prices in the CROSS-v2022-09 (Marcucci et al., 2022) and the BAU and Zero basis scenarios in the EP2050+

	2017	2020	2023	2030	2040	2050	2020–2050	Reference
Oil								
Reference			13.4	11.8	10.3	9.5	−1.27% p.a.	Announced pledges (IEA, 2024)
High			13.4	13.0	12.6	12.3	−0.33% p.a.	Stated policies (IEA, 2024)
Low			13.4	6.9	4.9	4.1	−4.3 % p.a.	Net zero (IEA, 2024)
CROSS-2022-Ref		6.9		9.6	9.0	8.3	0.64% p.a.	Marcucci et al. (2022)
EP2050+, BAU	8.2	11.7		15.0	17.5	21.9	2.10% p.a.	BFE (2020c)
EP2050+, Zero Basis	8.2	11.4		11.3	10.1	7.0	−1.60% p.a.	BFE (2020d)
Gas								
Reference			11.5	5.7	4.9	4.9	−3.08% p.a.	Announced pledges (IEA, 2024)
High			11.5	6.2	7.2	7.3	−1.66% p.a.	Stated policies (IEA, 2024)
Low			11.5	4.2	3.9	3.8	−4.02% p.a.	Net zero (IEA, 2024)
CROSS-2022-Ref		4.0		5.0	4.9	4.9	0.7 % p.a.	Marcucci et al. (2022)
EP2050+, BAU	5.5	6.8		7.8	8.5	9.6	1.20% p.a.	BFE (2020c)
EP2050+, Zero Basis	5.5	6.7		7.2	7.3	5.1	−0.92% p.a.	BFE (2020d)
Hydrogen								
Reference		94.4		77.2		62.8	−1.35%p.a.	Meili et al. (2025)
High		131.9		108.1		87.8	−1.35%p.a.	Meili et al. (2025)
Low		66.1		54.2		43.9	−1.36%p.a.	Meili et al. (2025)

Data available at https://sweet-cross.ch/data/import-prices-cross/2025-06-06/

7.3.2 Electricity imports

These variables **have been updated** relative to the CROSS V2022-09 scenarios and were provided by SWEET-Recipe

Net transfer capacities (NTCs) indicate how much physical line capacity is available to transfer electricity across the interconnector tie lines between two countries after taking security aspects into account; thus, NTCs are less than the built capacity.

Table 7.4 depicts the net transfer capacities between Switzerland and its neighboring countries from the European Network of Transmission System Operators for Electricity (ENTSO-E). 2020 values from the 2022 European Resource Adequacy Assessment (ENTSO-E, 2022, Target year 2024) are estimated based on the 2030–2050 projections from the Ten Year Network Development Plan (TYNDP), 2024 edition (ENTSO-E, 2024).

Table 7.4: Annual net transfer capacities (GW) from ENTSO-E (2022, 2024)

			TYNDP24 scenario					
	Historical	**Reference grid**	**Distributed Energy**			**Global Ambition**		
From-to	**2020**	**2030**	**2035**	**2040**	**2050**	**2035**	**2040**	**2050**
Switzerland–Austria	1.2	1.2	1.4	1.5	1.7	1.2	1.2	1.2
Switzerland–Germany	4.0	4.2	5.3	6.3	6.3	5.0	5.0	5.0
Switzerland–France	1.4	2.2	2.2	3.2	3.2	2.2	3.2	3.2
Switzerland–Italy	3.9	5.8	5.8	5.8	5.8	5.8	5.8	5.8
Austria–Switzerland	1.2	1.2	1.4	1.5	1.7	1.2	1.2	1.2
Germany–Switzerland	2.7	4.4	6.0	7.0	7.0	5.7	5.7	5.7
France–Switzerland	3.7	4.5	4.5	5.5	5.5	4.5	5.5	5.5
Italy–Switzerland	1.9	3.1	3.1	3.1	3.1	3.1	3.1	3.1

Data available at https://sweet-cross.ch/data/net-transfer-capacities/2025-06-06/

Chapter 8

Technologies

These variables **are newly defined** and were not part of the CROSS V2022-09 scenarios.

In the CROSS scenarios v2025-06, we harmonise the investment costs and efficiencies of selected technologies.

8.1 Investment costs

The investment costs were estimated based on historical data and learning rates derived from multiple studies. A comprehensive description of the estimation methodology and the investment costs for 2020, 2030, 2040 and 2050 can be found in Meili et al. (2025).
Table 8.1 reports the 2050 values used in the harmonisation dataset. The reference case represents the central estimate, while the low and high cases characterize the uncertainty range.

Table 8.1: 2050 Investment costs for electricity, heat and hydrogen technologies (Meili et al., 2025)

Technology	**Size**	**Inv. cost (CHF/kW)**		
		Reference	**Low**	**High**
Electricity production (cost per kWe)				
Solar PV	0–10kWp	1526	825	2227
	10–30kWp	1024	603	1446
	30–100kWp	654	325	983
	100–300kWp	690	371	1009
	300–1000kWp	568	350	786
Wind onshore		1871	1497	2246
Hydropower RoR	< 10MW	6337	3931	8743
Gas turbine	100–500MW	1089	717	1750
Geothermal	Binary cycle	3365	2356	4711
	Flash steam	3780	2402	5159
Electricity storage (cost per kWe)				
Li-Ion battery	Large scale	76	53	106
	Small scale	670	469	938
	Utility scale	969	396	1542
Heat production (cost per kWth)				
Air source heat pump	5 kWth	6027	3170	4462
	10 kWth	3355	1766	2488
	20 kWth	2432	1284	1806

Table 8.1: 2050 Investment costs for electricity, heat and hydrogen technologies (Meili et al., 2025) (continued)

Technology	**Size**	**Inv. cost (CHF/kW)**		
		Reference	**Low**	**High**
	70 kWth	1372	722	1019
Ground source heat pump	5 kWth	6257	4384	8761
	10 kWth	4255	2974	5957
	20 kWth	3481	2437	4874
	70 kWth	2598	1817	3634
	100 kWth	2581	1809	3617
	200–500 kWth	1749	1222	2452
Wood-pellets boiler	5 kWth	4957	3467	6943
	10 kWth	3682	2577	5154
	20 kWth	1921	1340	2680
	70 kWth	684	478	956
	100 kWth	704	487	984
	200 kWth	505	352	713
	350 kWth	388	271	551
	500 kWth	343	244	487
Wood-chips boiler	70 kWth	932	653	1305
	100 kWth	825	571	1270
	200 kWth	590	417	1152
	350 kWth	417	290	590
	500 kWth	390	272	553
Gas boiler	5 kWth	4800	3360	6720
	10 kW th	2570	1800	3600
	20 kWth	1320	920	1850
	70 kWth	480	340	680
	100 kWth	430	300	600
	200– 500 kWth	240	170	340
Oil boiler	5 kWth	6110	4280	8550
	10 kWth	3290	2300	4600
	20 kWth	1700	1190	2380
	70 kWth	620	430	860
	100 kWth	600	420	840
	200–500 kWth	370	260	520
Solar thermal	10 m2	1562	1091	2189
	50 m2	897	627	1253
	100 m2	791	552	1111
	200 m2	727	504	1015
District heating	5 kWth	1752	1230	2450
	10 kWth	1416	988	1984
	20 kWth	1388	969	1938
	70 kWth	1146	801	1602
	100 kWth	1086	760	1520
	200–500 kWth	995	697	1384
Hydrogen production				
Electrolyser (CHF/kWAC)	5 MWAC	1222	855	1711
	100 MWAC	890	623	1246

Table 8.1: 2050 Investment costs for electricity, heat and hydrogen technologies (Meili et al., 2025) (continued)

Technology	**Size**	**Inv. cost (CHF/kW)**		
		Reference	**Low**	**High**
Steam reforming with CCS (CHF/kWH2)		1490	1043	2086

Data available at https://sweet-cross.ch/data/technologies-investment-costs-cross/2025-06-06/

8.2 Efficiencies

For the CROSS scenarios v2025-06 we harmonise the efficiencies of heat pumps and electric vehicles. Efficiencies of both heat pumps and electric vehicles depend on various parameters.

- The efficiency of EVs depends on the external temperature. In winter, the efficiency is reduced due to heating needs, lower recuperation and higher rolling resistance. The efficiencies provided in Table 8.2 are for EVs at moderate ambient air temperatures with summer tyres.
- The coefficient of performance (COP) of heat pumps is strongly affected by the temperatures of the heat source and the heat sink. Meili et al. (2025) presents a detailed methodology to calculate the electricity needs for air source and ground source heat pumps depending on the temperature of the heat source and sink. In Table 8.2 presents an average seasonal performance factor.

Table 8.2: Efficiencies in CROSS scenarios (Meili et al., 2025)

Technology	**Efficiency**		
	Reference	**Low**	**High**
Passenger vehicles (kWh/100 km)			
Small private EVs at moderate temperature and with summer tyres	19	14	23
Heat pumps – Average COP			
Air-source heat pump	2.7	2.3	3.4
Ground-source heat pump	4.42	4	4.8
Water-source heat pump	4.6	4.3	4.9

Bibliography

ARE, 2021. Schweizerische Verkehrsperspektiven 2050. Bundesamt für Raumentwicklung (ARE). URL: https://www.are.admin.ch/are/de/home/mobilitaet/grundlagen-und-daten/verkehrsperspektiven.html.

BAFU, 2024. Switzerland's First NDC (2021–2030) – Updated Submission. Bundesamt für Umwelt.

BAFU, 2025. CO2-Emissionsfaktoren des Treibhausgas- inventars der Schweiz. Bundesamt für Umwelt. URL: https://www.bafu.admin.ch/dam/bafu/de/dokumente/klima/fachinfo-daten/CO2_Emissionsfaktoren_THG_Inventar.pdf.download.pdf.

BAFU, 2025a. Evolution of Switzerland's greenhouse gas emissions since 1990 (April 2025). Bundesamt für Umwelt. URL: https://www.bafu.admin.ch/dam/bafu/en/dokumente/klima/fachinfo-daten/THG_Inventar_Daten.xlsx.download.xlsx/Evolution_GHG_since_1990_2025-04.xlsx.

BAFU, 2025b. GHG inventory 1990-2023. Bundesamt für Umwelt. URL: https://www.bafu.admin.ch/bafu/en/home/topics/climate/state/data/climate-reporting/ghg-inventories.html.

Bauer, C., Hirschberg, S., Bäuerle, Y., Biollaz, S., Calbry-Muzyka, A., Cox, B., Heck, T., Lehnert, M., Meier, A., Prasser, H.M., Schenler, W., Treyer, K., Vogel, F., Wieckert, H., Zhang, X., Zimmermann, M., Burg, V., Bowman, G., Erni, M., Saar, M., Tran, M., 2017. Potentials, costs and environmental assessment of electricity generation technologies. Paul Scherrer Institut.

Berger, M., Worlitschek, J., 2019. The link between climate and thermal energy demand on national level: A case study on Switzerland. Energy and Buildings 202, 109372. URL: http://www.sciencedirect.com/science/article/pii/S037877881931120X, doi:https://doi.org/10.1016/j.enbuild.2019.109372.

BFE, 2019. Schweizer Hausdächer und -fassaden könnten jährlich 67 TWh Solarstrom produzieren. URL: https://www.bfe.admin.ch/bfe/de/home/news-und-medien/medienmitteilungen/mm-test.msg-id-74641.html.

BFE, 2020a. Energieperspektiven 2050+ – Exkurs Negativemissionstechnologien und CCS – Potenziale, Kosten und Einsatz. BFE. URL: https://www.bfe.admin.ch/bfe/en/home/policy/energy-perspectives-2050-plus.html.

BFE, 2020b. Energieperspektiven 2050+. Kurzbericht. BFE. URL: https://www.bfe.admin.ch/bfe/en/home/policy/energy-perspectives-2050-plus.html.

BFE, 2020c. Energieperspektiven 2050+. Szenarienergebnisse WWB. BFE. URL: https://www.bfe.admin.ch/bfe/en/home/policy/energy-perspectives-2050-plus.html.

BFE, 2020d. Energieperspektiven 2050+. Szenarienergebnisse ZERO Basis. BFE. URL: https://www.bfe.admin.ch/bfe/en/home/policy/energy-perspectives-2050-plus.html.

BFE, 2021. Analysis of energy consumption 2000–2020 by specific use (Analyse des schweizerischen Energieverbrauchs 2000 – 2020 nach Verwendungszwecken). BFE. URL: https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/analysis-of-energy-consumption-by-specific-use.html.

BFE, 2023. Verständnis Ladeinfrastruktur 205 - Wie lädt die Schweiz in Zukunft?. Bundesamt für Energie. URL: https://www.laden-punkt.ch/de/werkzeuge/verstaendnis-ladeinfrastruktur-2050/.

BFE, 2024a. Analysis of energy consumption 2000–2023 by specific use (Analyse des schweizerischen Energieverbrauchs 2000 – 2023 nach Verwendungszwecken). BFE. URL: https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/analysis-of-energy-consumption-by-specific-use.html.

BFE, 2024b. Schweizerische Gesamtenergiestatistik 2023. BFE. URL: https://www.bfe.admin.ch/bfe/de/home/versorgung/statistik-und-geodaten/energiestatistiken/gesamtenergiestatistik.html.

BFS, 2020a. Szenarien zur Bevölkerungsentwicklung der Schweiz und der Kantone 2020-2050. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/asset/de/px-x-0104000000_102.

BFS, 2020b. Szenarien zur Entwicklung der Erwerbsbevölkerung 2020–2050 – Erwerbsquote und Erwerbsbevölkerung nach Staatsangehörigkeit (Kategorie), Jahr, Geschlecht, Beobachtungseinheit, Alter und Szenario-Variante. Bundesamt für Statistik. URL: https://www.pxweb.bfs.admin.ch/pxweb/de/px-x-0301000000_101/.

BFS, 2021a. Anzahl Privathaushalte nach dem Szenario AM–00–2020, 2020–2050. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/asset/de/16344849.

BFS, 2021b. Private households by canton and household size, 2010-2020. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/bevoelkerung/stand-entwicklung/haushalte.assetdetail.18845791.html.

BFS, 2021c. Transportleistungen im Güterverkehr, je-d-11.05.01.02. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/gueterverkehr.assetdetail.18864273.html.

BFS, 2021d. Verkehrsleistungen im Personenverkehr, je-d-11.04.01.02. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/personenverkehr/leistungen.assetdetail.19904693.html.

BFS, 2022a. Demographic balance by canton, 1971–2021. Bundesamt für Statistik.

BFS, 2022b. Employed persons (domestic concept) total number and in full-time equivalents by gender and nationality, gross and seasonally adjusted values. Quarterly and yearly averages (1960–1974, 1975–2022). Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/arbeit-erwerb/erhebungen/ets.assetdetail.22985591.html.

BFS, 2022c. Gross domestic product: production approach (1995–2021). Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/volkswirtschaft.assetdetail.23184098.html.

BFS, 2024a. Demographic balance by canton, 1971–2023. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/asset/de/px-x-0102020000_101.

BFS, 2024b. Gross domestic product: production approach (1995–2023). Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/en/home/statistics/catalogues-databases.assetdetail.32257464.html.

BFS, 2024c. Private households by canton and household size, 2010-2023. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/en/home.assetdetail.32408794.html.

BFS, 2024d. Transportleistungen im Güterverkehr, je-d-11.05.01.02. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/gueterverkehr.assetdetail.33129477.html.

BFS, 2024e. Verkehrsleistungen im Personenverkehr, je-d-11.04.01.02. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/personenverkehr/leistungen.assetdetail.32866969.html.

BFS, 2025a. Employed persons (domestic concept) total number and in full-time equivalents by gender and nationality, gross and seasonally adjusted values. Quarterly and yearly averages (1960–1974, 1975–2025). Bundesamt für Statistik. URL: https://www.bfs.admin.ch/bfs/de/home/statistiken/arbeit-erwerb/erhebungen/ets.assetdetail.35367422.html.

BFS, 2025b. Szenarien zur Bevölkerungsentwicklung der Schweiz und der Kantone 2025-2055. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/asset/de/px-x-0104000000_101.

BFS, 2025c. Szenarien zur Entwicklung der Erwerbsbevölkerung 2020–2055 – Erwerbsquote und Erwerbsbevölkerung nach Staatsangehörigkeit (Kategorie), Jahr, Geschlecht, Beobachtungseinheit, Alter und Szenario-Variante. Bundesamt für Statistik. URL: https://www.bfs.admin.ch/asset/de/px-x-0301000000_101.

BLW, BLV and BFE, 2023. Klimastrategie Landwirtschaft und Ernährung 2050 - 1. Teil: Grundsätze, Ziele und Stossrichtungen. Federal Office for Agriculture (BLW), Federal Food Safety and Veterinary Office (BLV), Federal Office for the Environment (BFE). URL: https://www.blw.admin.ch/de/klimastrategie-landwirtschaft-und-ernaehrung-2050.

Cattin, R., Schaffner, B., Humar-Maegli, T., Albrecht, S., Remund, J., Klauser, D., Engel, J.J., 2012. Berechnung der Energiepotenziale für Wind- und Sonnenenergie. Meteotest - commissioned by Bundesamtes für Umwelt (BAFU).

CH2018, 2018. CH2018 – Climate Scenarios for Switzerland. National Centre for Climate Services.

Diamond, L., Herwegh, M., Holliger, K., Madonna, C., 2019. Deep underground heat reservoirs, Joint NRP70 project "Hydropower and geo-energy". Universität Bern, University of Lausanne and ETH Zurich. URL: https://nfp-energie.ch/en/projects/960/.

Dujardin, J., Kahl, A., Lehning, M., 2021. Synergistic optimization of renewable energy installations through evolution strategy. Environmental Research Letters 16, 064016. URL: https://doi.org/10.1088/1748-9326/abfc75, doi:10.1088/1748-9326/abfc75.

EASA, 2022. European Aviation Environmental Report. European Union Aviation Safety Agency. URL: https://www.easa.europa.eu/sites/default/files/eaer-downloads//230217_EASA%20EAER%202022.pdf.

ENTSO-E, 2022. European Resource Adequacy Assessment. ENTSO-E. URL: https://www.entsoe.eu/eraa/2022/.

ENTSO-E, 2024. TYNDP 2024 Final Scenario Report. ENTSO-E. URL: https://2024.entsos-tyndp-scenarios.eu.

European Parliament, 2023. Regulation (EU) 2023/2405 of the European Parliament and of the Council of 18 October 2023 on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation), OJ L, 2023/2405,. Swiss Federal Council. URL: https://eur-lex.europa.eu/eli/reg/2023/2405/oj.

Guidati, G., Marcucci, A., Damartzis, T., Burg, V., Schildhauer, T., Giardini, D., Kröcher, O., 2021. Biomass and waste potentials and conversion pathways for energy use in Switzerland. JASM and WSL. doi:10.3929/ethz-b-000540915.

IEA, 2021. World Energy Outlook. IEA. URL: https://www.iea.org/reports/world-energy-outlook-2021.

IEA, 2024. World Energy Outlook. IEA. URL: https://www.iea.org/reports/world-energy-outlook-2024.

IOGP, 2019. The potential for CCS and CCU in Europe. TechReport to the thirty second meeting of the European Gas Regulatory Forum 5-6 June 2019. International association of oil and gas producers. URL: https://ec.europa.eu/info/sites/info/files/iogp_-_TechReport_-_ccs_ccu.pdf.

Jakob, M., Catenazzi, G., Forster, R., Egli, T., Lemon, T.K., Looser, R., Melliger, M., Nägeli, C., Reiter, U., Soini, M., Sunarjo, B., 2019. Erweiterung des Gebäudeparkmodells gemäss SIA-Effizienzpfad Energie. TEP Energy – Bundesamt für Energie (BFE). URL: https://www.tep-energy.ch/docs/2016_GEPAMOD_GPM_SIA_Effizienzpfad_Schlussbericht.pdf.

Marcucci, A., 2026. Swiss Climate and Energy Policy Framework and Targets. Version: 2026-07. SWEET-CROSS. URL: to-be-updated.

Marcucci, A., Dujardin, J., Panos, E., Yilmaz, S., 2022. CROSS scenarios and drivers definition. Version: CROSS-v2022-09. SWEET-CROSS. URL: https://doi.org/10.3929/ethz-b-000677193.

Marcucci, A., Guidati, G., Giardini, D., 2021a. Swiss Hourly Energy Scope: Documentation. ETH Zurich - JASM. doi:10.3929/ethz-b-000540917.

Marcucci, A., Panos, E., Guidati, G., Lordan-Perret, R., Schlecht, I., Giardini, D., 2021b. JASM framework and drivers definition. ETH Zurich, Paul Scherrer Institute and U. Basel - JASM. doi:10.3929/ethz-b-000540916.

Meili, K., Philippen, D., Haller, M., Bohara, K., Dimri, N., 2025. CoSi Modelling assumptions. OST.

Müller, D.B., 2006. Stock dynamics for forecasting material flows—Case study for housing in The Netherlands. Ecological Economics 59, 142 – 156. URL: http://www.sciencedirect.com/science/article/pii/S092180090500460X, doi:https://doi.org/10.1016/j.ecolecon.2005.09.025.

Panos, E., Kober, T., Kannan, R., Hirschberg, S., 2021. Long-term energy transformation pathways - Integrated scenario analysis with the Swiss TIMES energy systems model. PSI - JASM. doi:10.3929/ethz-b-000509023.

Remund, J., Albrecht, S., Stickelberger, D., 2019. Schweizer PV-Potenzial basierend auf jedem einzelnen Gebäude. Meteotest and Swissolar. URL: https://www.swissolar.ch/fileadmin/user_upload/Tagungen/PV-Tagung_2019/Medien/190325Solarpotenzial_CH_JanRemund_lang.pdf.

Riahi, K., Bertram, C., Huppmann, D., Rogelj, J., Bosetti, V., Cabardos, A.M., Deppermann, A., Drouet, L., Frank, S., Fricko, O., Fujimori, S., Harmsen, M., Hasegawa, T., Krey, V., Luderer, G., Paroussos, L., Schaeffer, R., Weitzel, M., van der Zwaan, B., Vrontisi, Z., Longa, F.D., Després, J., Fosse, F., Fragkiadakis, K., Gusti, M., Humpenöder, F., Keramidas, K., Kishimoto, P., Kriegler, E., Meinshausen, M., Nogueira, L.P., Oshiro, K., Popp, A., Rochedo, P.R.R., Ünlü, G., van Ruijven, B., Takakura, J., Tavoni, M., van Vuuren, D., Zakeri, B., 2021. Cost and attainability of meeting stringent climate targets without overshoot. Nature Climate Change 11, 1063–1069. URL: https://doi.org/10.1038/s41558-021-01215-2, doi:10.1038/s41558-021-01215-2.

Sandberg, N.H., Sartori, I., Heidrich, O., Dawson, R., Dascalaki, E., Dimitriou, S., Vimm-r, T., Filippidou, F., Stegnar, G., Šijanec Zavrl, M., Brattebø, H., 2016. Dynamic building stock modelling: Application to 11 european countries to support the energy efficiency and retrofit ambitions of the eu. Energy and Buildings 132, 26–38. URL: http://www.sciencedirect.com/science/article/pii/S0378778816304893, doi:10.1016/j.enbuild.2016.05.100.

Sartori, I., Sandberg, N.H., Brattebø, H., 2016. Dynamic building stock modelling: General algorithm and exemplification for Norway. Energy and Buildings 132, 13 – 25. URL: http://www.sciencedirect.com/science/article/pii/S037877881630487X, doi:https://doi.org/10.1016/j.enbuild.2016.05.098.

Schluck, T., Streicher, K.N., Mennel, S., 2019. Statistical modelling of the energy reference area based on the Swiss building stock. Journal of Physics: Conference Series 1343, 012031. doi:10.1088/1742-6596/1343/1/012031.

SECO, 2022. Szenarien zur BIP-Entwicklung der Schweiz, 2022-06-15. Staatssekretariat für Wirtschaft. URL: https://www.seco.admin.ch/seco/de/home/wirtschaftslage---wirtschaftspolitik/wirtschaftspolitik/Wachstumpolitik/szenarien_bip-entwicklung_schweiz.html.

SECO, 2025. Szenarien zur BIP-Entwicklung der Schweiz, 18.03.2025. Staatssekretariat für Wirtschaft. URL: https://www.seco.admin.ch/seco/de/home/wirtschaftslage---wirtschaftspolitik/wirtschaftspolitik/Wachstumpolitik/szenarien_bip-entwicklung_schweiz.html.

Streicher, K., Allan, J., Murray, P., Bollinger, A., Marcucci, A., 2020. Energy Efficiency from buildings retrofitting. U. Geneva, EMPA and ETH Zurich - JASM. doi:10.3929/ethz-b-000540991.

Swiss Federal Council, 2021. Switzerland's Long-Term Climate Strategy. URL: https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/emission-reduction/reduction-targets/2050-target/climate-strategy-2050.html.

Swiss Federal Council, 2022. Bundesgesetz über die Ziele im Klimaschutz, die Innovation und die Stärkung der Energiesicherheit. URL: https://www.fedlex.admin.ch/eli/fga/2022/2403/de.

Swiss Federal Council, 2024. Carbon-neutral flying by 2050. Swiss Federal Council. URL: https://www.newsd.admin.ch/newsd/message/attachments/86230.pdf.

Swiss Federal Council, 2025. Ordinance on the reduction of co_2 emissions (co_2-verordnung). URL: https://www.fedlex.admin.ch/eli/oc/2025/248/de. revised by the Federal Council on 2 April 2025; effective retroactively from 1 January 2025.

UVEK, 2024. Vorlage für eine sichere Stromversorgung mit erneuerbaren Energien. URL: https://www.uvek.admin.ch/uvek/de/home/uvek/abstimmungen/vorlage-sichere-stromversorgung.html.

VBSA, 2020. Monitoring-Bericht zur CO2-Branchenvereinbarung für das Jahr 2020. Betreiber Schweizerischer Abfallverwertungsanlagen. URL: https://vbsa.ch/fakten/downloads/.

Wüest Partner, 2019. Entwicklung Energiebezugsflächen EBF 1990-2019, jährliches Update. URL: https://www.bfe.admin.ch/bfe/en/home/supply/statistics-and-geodata/energy-statistics/analysis-of-energy-consumption-by-specific-use.html.