Electricity sector overview

The main sources of electricity in Switzerland are hydropower and nuclear power, respectively accounting for 56.4 and 37.9 per cent of the total production, which amounted to 69,633 GWh in 2014. Production from thermal power plants accounts for 3.5 per cent of the total, while the remaining 2.2 per cent comes from other renewable sources (biomass, wind, biogas, photovoltaic) (Figure 1). The total consumption for 2014 was 61,787 GWh. However, electricity supply during winter depends on imports (between 2,000 and 4,000 GWh in the past 11 years).

In 2011 Switzerland decided to gradually withdraw from the use of nuclear energy. Consequently, a long-term energy policy (Energy Strategy 2050) was drafted in order to guarantee a secure electricity supply. This strategy focuses on increasing energy efficiency, expanding renewable energy use, undertaking an active foreign energy policy and, where necessary, electricity production from fossil fuels. Renovation and expansion of the grid infrastructure is also among the objectives of the strategy, since most transmission lines are more than forty years old, and not designed to handle high numbers of decentralized producers feeding electricity into the grid. The electrification rate is 100 per cent.

Currently, 604 hydropower plants with a capacity of at least 300 kW operate in Switzerland. Approximately 45 per cent of the hydropower production (25 per cent of the total electricity production) comes from run-of-river plants and 55 per cent (32 per cent) from storage plants. The alpine areas of the country (namely cantons Uri, Graubünden, Ticino and Valais) generate the most hydro-electricity. The hydropower market is worth around CHF 1.8 billion (approximately US$1.85 billion), and therefore constitutes an important part of the Swiss energy industry. Nonetheless, the federal government...
wants to further promote the use of hydropower. The Energy Strategy 2050 plans an increase of hydropower efficiency and new production equal to 1,500 GWh (3,200 GWh under optimal economic and social conditions).\(^4\)\(^9\)

Moreover, new pumped-storage installations are planned to increase energy storage and production flexibility. In 2014, the cumulated capacity of hydropower plants under construction was 2,464 MW. These plants will add 416 GWh to the national electricity generation.\(^7\)

The importance of other renewable sources in the Swiss energy mix is expected to increase, especially because the new energy strategy primarily ascribes increments of renewable energy production to solar and wind technologies. However, while wood and biomass, ambient heat, small hydropower (SHP) and wind are already available and are economically attractive options, photovoltaic and geothermal potentials will not be fully exploited within thirty years, primarily for economic reasons.\(^1\)\(^3\) In Switzerland electricity is exchanged on a market. Therefore, a single tariff system is not applied.

### Small hydropower sector overview and potential

Switzerland’s definition of SHP is up to 10 MW.\(^4\)\(^4\) Installed capacity of SHP in Switzerland is approximately 859 MW (2010 estimate). The available potential (estimated to prepare the Energy Strategy 2050) is officially reported in terms of production, and it amounts to 1,300 GWh. Data available in the 2013 and 2016 World Small Hydropower Reports indicate a 13 per cent increase of the installed capacity (Figure 2).

![FIGURE 2](image)

Small hydropower capacities 2013-2016 in Switzerland (MW)

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed capacity</th>
<th>Potential capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>760</td>
<td>N/A</td>
</tr>
<tr>
<td>2016</td>
<td>859</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Sources: SFOE,\(^1\)\(^3\) WSHPDR 2013\(^2\)\(^9\)

Note: The comparison is between data from WSHPDR 2013 and WSHPDR 2016.

The overall number of SHP plants in operation in the country is not precisely known, due to a lack of statistics on installations smaller than 300 kW.\(^4\)\(^8\)

Estimates from 2010 report 1,378 plants, with overall installed capacity of 859 MW and annual production of 3,770 GWh.\(^5\) This represents 5.7 per cent of the national electricity production and 10.1 per cent of the hydropower share.\(^5\)\(^4\)\(^3\)

Among these small plants, an estimated seven hundred have installed capacity below 300 kW and account for only 1 per cent of the hydropower production.\(^5\) This group represents the remaining of a high number of small installations (about 7,000) operating in Switzerland at the beginning of the 20th century, which could be refurbished and contribute to the growth of small hydroelectricity production. However, the most suitable sites are already utilized (in fact, 461 plants have been built or refurbished since 2006 due to the introduction of a feed in tariff).\(^1\)\(^7\) and controversies on the convenience of exploiting the remaining potential are ongoing.

New technologies allow harvesting hydraulic energy on existing infrastructure (e.g. fresh and waste water networks, tailrace channels). The exploitation of these sources benefits from social acceptance, and the required engineering advances (e.g. development of new turbines) are supported by the federal authorities and favoured by existing industrial competences in this field.\(^4\)\(^8\)

The available potential of small scale hydropower was estimated during the preparation of the Energy Strategy 2050. Under present conditions, it amounts to 1,300 GWh; the overall SHP production would thus reach 5,100 GWh in 2050.\(^9\) If improvements of economic (e.g. financial support) and social conditions (higher acceptance of small plants by the community) occur, the available potential would increase to 1,600 GWh.\(^4\)\(^9\)

The Small Hydropower Programme of the Swiss Federal Office of Energy aims to promote the exploitation of this potential, connecting all the stakeholders and working closely with trade and industrial associations.\(^1\)\(^5\)

### Renewable energy policy

The Swiss energy policy is defined by the energy and water articles in the Federal Constitution, the Energy Act, the CO₂ Act, the Nuclear Energy Act, the Electricity Supply Act, the Water Protection Act, the Hydropower Act and the Federal Act on Hydraulic Engineering.\(^1\)\(^8\) In particular, the regulatory framework for renewable energy is defined by the Energy Act, while the Water Protection and Hydropower Acts intervene in the field of hydropower exploitation. Other relevant regulations are the Fishery Act, the Spatial Planning Act, the Environmental and Forestry Protection Acts and the Nature and Cultural Heritage Act.\(^1\)

Energy Strategy 2050, which recently adopted after the decision of withdrawing from nuclear energy, is a milestone in Swiss energy policies. As mentioned, this strategy focuses on the exploitation of energy potential from increased energy efficiency, hydropower and new renewable energy sources.\(^4\) The Swiss Energy Programme is the instrument specifically developed to implement energy and climate objectives of the Federal Government and cantons. In particular, cantons determine strategies for the building sector, sustainable energy supply, energy planning and energy efficiency mobility, and promote efficient use of energy and waste heat by means of incentives. Targets on growth of renewable energy production have been set by the Renewable Energy Action Plan.
Electricity production from renewable energy sources is promoted by the Federal Government through two main economic instruments: feed-in remuneration at cost and one-off investment grants. The feed in tariff at cost bridges the gap between market price and cost borne by producers of electricity from renewable sources. This tariff is available for hydropower (up to an installed capacity of 10 MW), photovoltaic (starting from an installed capacity of 10 kW), wind and geothermal energy, biomass and biological waste, and is applicable for 20 years (10 years for biomass power plants). Tariff rates are regularly reviewed to take into account technological progress and increasing maturity of new technologies. The reviewed tariffs only apply to new production facilities.10 The actual feed in tariff depends on specific features of the plant, for instance the hydraulic head, type of plants (in or out-stream, installed on wastewater or freshwater supply networks), date of request of the feed-in tariff, starting date of operation or yearly production. One-off investment grants, instead, aim to foster electricity production in small photovoltaic systems (from 2 up to 30 kW) by subsidizing a maximum of 30 per cent of the investment costs. Grants are paid out up to an allocated amount of funds.11 In addition to the described mechanisms of financial support, non-financial measures have been set in the Energy Act, such as priority dispatch (i.e. supply companies must purchase electricity from independent producers).

Barriers to small hydropower development

Economic and social/environmental barriers for the development of small scale hydropower are effectively addressed in Switzerland, e.g. through the cost-based feed in tariff and the involvement of communities in establishing rivers that will be affected by exploitation.4 A water platform promoting dialogue among stakeholders was also initiated,17 and research efforts aimed to address rising questions receive support from the Federal authorities.18

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21. Acknowledgments: The author gratefully acknowledges Martin Bölli (ISKB - Swiss Small Hydropower Association), Benno Frauchiger (Swiss Federal Office of Energy), Pedro Manso and Bettina Schaefl (École Polytechnique Fédérale de Lausanne), Cécile Münch-Alligné (HES-SO Valais-Wallis), Ivana Logar, Martin Schmid, Stefan Vollenweider and Christine Weber (Eawag – Swiss Federal Institute of Aquatic Science and Technology) for their comments and suggestions.