Technology Collaboration Programme
by iea

International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in SWITZERLAND

2019

What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Cop- per Alliance are also members.

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What is IEA PVPS Task 1?

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "Trends in photovoltaic applications" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2019. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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COVER PICTURE

PEB (Positive Energy Building) Villa, made of wood and hay – Graben. Source: "Prix Solaire Suisse 2019" https://www.solaragentur.ch/fr/media

TABLE OF CONTENTS

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1 INSTALLATION DATA

The PV power systems market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, PV installations are included in the 2019 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2019, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

The transformation of the Swiss energy system aimed with the "Energy Strategy 2050" is a long-term project. The Swiss electorate accepted a revised Federal Energy Act in 2017 in a popular referendum. This new legislation entered into force on 1 January 2018. The aims are to reduce energy consumption, increase energy efficiency and promote the use of renewable energy (www.energystrategy2050.ch).

Until the year 2017, three elements used to characterize the national regulatory framework for photovoltaic power systems:

- a onetime investment subsidy for systems up to 30 kW
- a feed-in-tariff scheme for systems above 10 kW
- and, applicable since 2014, measures for self-consumption.

With the entry in force of the new Federal Energy Act since the 1st of January 2018, the support scheme for PV systems has changed:

- the onetime investment subsidy is extended to all sizes of PV systems (from 2 kW to 50 MW)
- the feed-in tariff scheme (feed-in remuneration at cost (KEV)) is gradually replaced by a feed-in remuneration closer to the market requirements
- for systems below a capacity of 100 kW, only the onetime investment subsidy will be available
- although the original feed-in tariff support scheme (KEV) can be applied for PV systems up to 2022, due to the long retroactive waiting list (around 35'000 PV projects), only systems announced before June 30, 2012 are expected to benefit from the feed-in tariff support scheme.
- as a new element, different end consumers have the possibility to connect together and to act as a single consumer towards the local energy supplier (collective self-consumption based on physical grid infrastructure). This new measure allows for more flexibility for self-consumption and fosters the integration of PV in the local electricity grid. In 2019 this measure was updated, becoming more flexible and more interesting for investors.

Likely due to this new Energy Act, the number of newly installed PV systems increased by 12% to 267 MW in 2018, and by 22% in 2019 to 325 MW.

While there is little to no market for ground-mounted or agricultural PV (due to constraints on available land and the loss of agricultural subsidies), an increasing number of building integrated and facade PV projects can be observed. This development is still slow, even if we notice technological advancements (colour & shape of modules) as well as by increasing awareness of architects to use PV as a building element (thanks to policies making PV compulsory in new buildings). Likewise, several PV installations on carports have been realised. The vast majority of PV systems installed in 2019 are on-grid (estimated > 99,5%).

Every year the Swiss Solar Prize (https://www.solaragentur.ch/fr/media) is awarded to innovative or highly remarkable PV projects like the villa made of wood shown at the first page of this report. Two other examples for 2019 are given below:

Figure 1:
Above: 643 kW foldable PV installation at the water treatment plant in Coire.
Below: the floating catamaran EMS Mobicat, 30 kW, by BSG
© Solaragentur

1.2 Total photovoltaic power installed

On behalf of the Swiss Federal Office of Energy, Swissolar is mandated to survey the Swiss solar market and publish the annual installed capacity in the Report: “Le recensement du marché de l’énergie solaire en 2019”. The data therein is based on a survey amongst 628 companies active in the PV and solar thermal market. About 95% of installers, importers/distributers and manufacturers are estimated to be covered in this annual market survey.

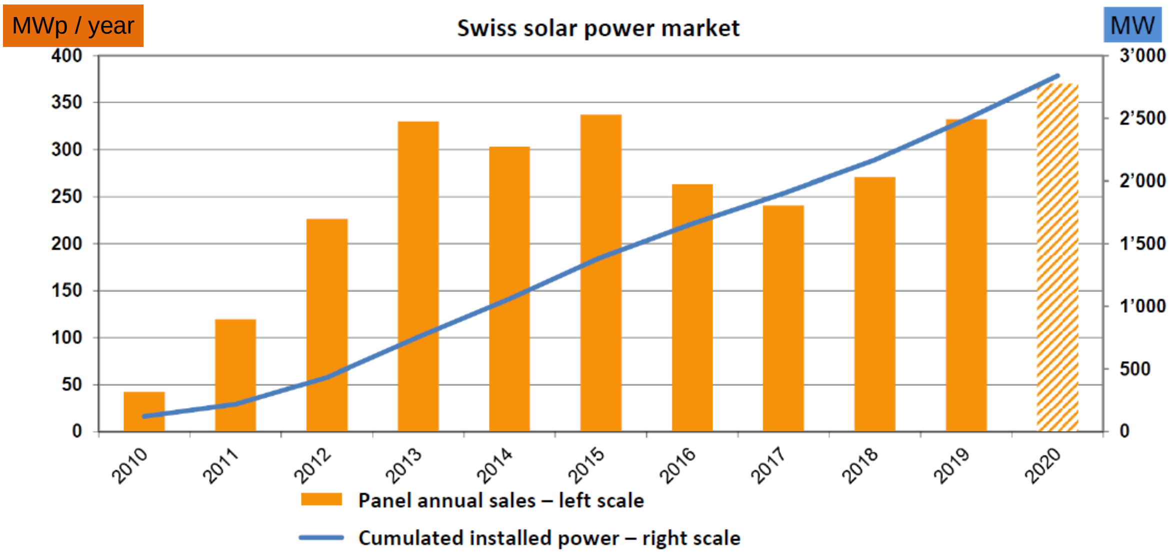


Table 1: Annual PV power installed during calendar year 2019

		Installed PV capacity in 2019 [MW]	AC or DC
PV capacity	Off-grid	0.4	DC
	Decentralized	324.4	DC
	Centralized	No distinction made between centralized and decentralized systems	DC
	Total new	324.8	DC

Table 2: PV power installed during calendar year 2019

			Installed PV capacity [MW]	Installed PV capacity [MW]	AC or DC
Grid-connected	BAPV	Residential	286.3	114.3	DC
		Commercial		49.8	DC
		Industrial		122.2	DC
	BIPV	Residential	38.1	15.2	DC
		Commercial		6.6	DC
		Industrial		16.3	DC
	Utility-scale	Ground-mounted			
		Floating			
		Agricultural			
Off-grid		Residential	0.4		DC
		Other			DC
		Hybrid systems			DC
Total			324.8		

Table 3: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Data are collected in DC
Is the collection process done by an official body or a private company/Association?	The data collection process is done by Swissolar (Swiss Solar Professional Association) on behalf of the Swiss government. It is based on a questionnaire sent to all importers, installers and manufacturers. It is estimated, that about 95% of the market is covered with this survey. To validate the data, there is a compulsory registration for systems above 30 kVA since the beginning of 2013 (Guarantees of origin and electricity labelling). The Swiss Federal Office of Energy has been surveying the solar market in Switzerland for more than 20 years. Due to this long experience the quality of the data has been maintained, thanks as well to all the installers and distributers who are willing to complete the annual questionnaire. The report will be published by the Swiss Federal Office of Energy in July

	2020 and also serves as a basis for the annual renewable energy statistics.
Link to official statistics (if this exists)	Solar Energy market survey (DE/FR): https://www.swissolar.ch/fr/lenergie-solaire/faits-et-chiffres/enquetes-de-marche/ Electricity Statistics (DE/FR): https://www.bfe.admin.ch/bfe/fr/home/approvisionnement/statistiques-et-geodonnees/statistiques-de-lenergie/statistique-de-l-electricite.html Overall Energy Statistics (DE/FR): https://www.bfe.admin.ch/bfe/fr/home/approvisionnement/statistiques-et-geodonnees/statistiques-de-lenergie.html
	The quality and accuracy of the data is expected to be better than +/- 10%.

Table 4: The cumulative installed PV power in 4 sub-markets

Year	Off-grid [MW] (including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralized [MW] (Ground, floating, agricultural…)	Total [MW]
1992	1.6	3.1		4.7
…	…	…		…
2000	2.6	12.7		15.3
…	…	…		…
2005	3.3	23.8		27.1
…	…	…		…
2010	4	107		111
2011	4	207		211
2012	4	433		437
2013	4	752		756
2014	4	1057		1061
2015	4	1390		1394
2016	4	1660		1664
2017	4	1902		1906
2018	5	2168		2173
2019	6	2492		2498

Table 5: Other PV market information

	2019
Number of PV systems in operation in your country (a split per market segment is interesting)	Around 102 600 Among the 15'580 new installations in 2019: 5.5% were off grid (and most under 1 kWp), 84% were <30kWp, 7.2% were between 30 and 100 kWp and 3.3% over 100 kWp
Decommissioned PV systems during the year [MW]	No data available
Repowered PV systems during the year [MW]	Approx. 2 MW
Total capacity connected to the low voltage distribution grid [MW]	Approx. 95% Normally up to 1 MVA can be connected to the low voltage grid
Total capacity connected to the medium voltage distribution grid [MW]	Approx. 5%
Total capacity connected to the high voltage transmission grid [MW]	0%

Table 6: PV power and the broader national energy market

	2018	2019
Total power generation capacities [GW]	**21.62 GW total** (15.36 GW Hydro ; 3.33 GW nuclear ; 2.93 GW Thermal & RE)	**22.06 GW total** (15.54 GW Hydro ; 3.33 GW nuclear ; 3.19 GW Thermal & RE)
Total renewable power generation capacities (including hydropower) [GW]	**18.03 GW total** (15.36 GW Hydro ; 2,17 GW PV, 75 MW wind, 422 MW waste)	**18.54 GW total** (15.54 GW hydro, 2.5 GW PV, 75 MW Wind. 422 MW waste)
Total electricity demand [TWh]	57.6 TWh (-1.4%)	57.2 TWh (-0.7%)
Total energy demand [TWh]	830 880 TJ (-2.2%) 230.8 TWh	834 210 TJ (+0.4%) 231.7 TWh
New power generation capacities installed [MW]	+ 267 MW PV + 546 MW hydro	+ 325 MW PV + 186 MW Hydro
New renewable power generation capacities (including hydropower) [MW]	+ 267 MW PV + 546 MW hydro	+ 325 MW PV + 186 MW Hydro

Estimated total PV electricity production (including self-consumed PV electricity) in [GWh]	1’945 GWh	2’178 GWh
Total PV electricity production as a % of total electricity consumption	3.38%	3.81%

1.3 Key enablers of PV development

Table 7: Information on key enablers

	Description	Annual Volume	Total Volume	Source
Decentralized storage systems In [MW,MWh or #]	+ 39.1% of added capacity and +67.5% of total capacity compared to 2018	**Added capacity**: 20’370 kWh (including 90 kWh lead battery) **Added number:** 1’500 (including 10 lead battery)	50’655 kWh (including 1’185 kWh lead battery)	https://www.swissolar.ch/fr/lenergie-solaire/faits-et-chiffres/enquetes-de-marche/
Residential Heat Pumps [#]	Among the added systems, 12’400 (52%) in the range 5-13kW, 7’700 (32%) for 13-20 kW and 3’100 (13%) for 20-50 kW)	+24’000 added systems (it was +22’000 in 2018 so +9.1% increase in added volume))	367’043 (+7%)	https://www.fws.ch/fr/nos-services/statistiques/
Electric cars [#]	Among the added systems, 13’200 (33%) are EV and 22’400 (57%) are hybrids	+39’461 added (+90.2% compared to 2018)	Around 140’000	https://www.swiss-emobility.ch/de/news/aktuell/meldungen/58-Neuzulassungen-2019.php
Electric buses and trucks [#]	A Support program has been put in place until at least 2030 to encourage the use of hybrid or electric buses with national CO2 certificates			https://www.myclimate.org/fr/

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 8: Typical module prices for a number of years

Year	Lowest price of a standard module crystalline silicon	Highest price of a standard module crystalline silicon	Typical price of a standard module crystalline silicon
2005	4.6	4.8	4.75
…	…	…	…
2010	2.2	3.6	3.25
2011	1.3	2.5	2.20
2012	0.85	1.3	1.19
2013	0.8	1	0.95
2014	0.57	0.95	0.86
2015	0.55	0.93	0.84
2016	0.5	0.9	0.80
2017	0.45	0.86	0.76
2018	0.4	0.75	0.66
2019	0.35	0.73	0.64

2.2 System prices

Table 9: Turnkey PV system prices of different typical PV systems

Category/Size	Typical applications and brief details	Current prices [CHF/W]
Off-grid 1-5 kW	A stand-alone PV system is a system that is installed to generate electricity to a device or a household that is not connected to the public grid. (write the typical off-grid application and since in your country)	6.8 (average is 1.2 kW at 8'200 CHF)
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	2.5 to 3.5
Residential BIPV 5-10 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected households. Typically, on villas and single-family homes.	2.75 to 4.75
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1.35 to 2.5
Small commercial BIPV 10-100 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1.5 to 3.75
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1.18 to 1.35
Large commercial BIPV 100-250 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	1.3 to 2
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	0.65 (for 2MW) - 0.9 (for 1MW) to 1.18 (250 kW)
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	N/A
Large centralized PV >20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	N/A

Table 10: National trends in system prices for different applications

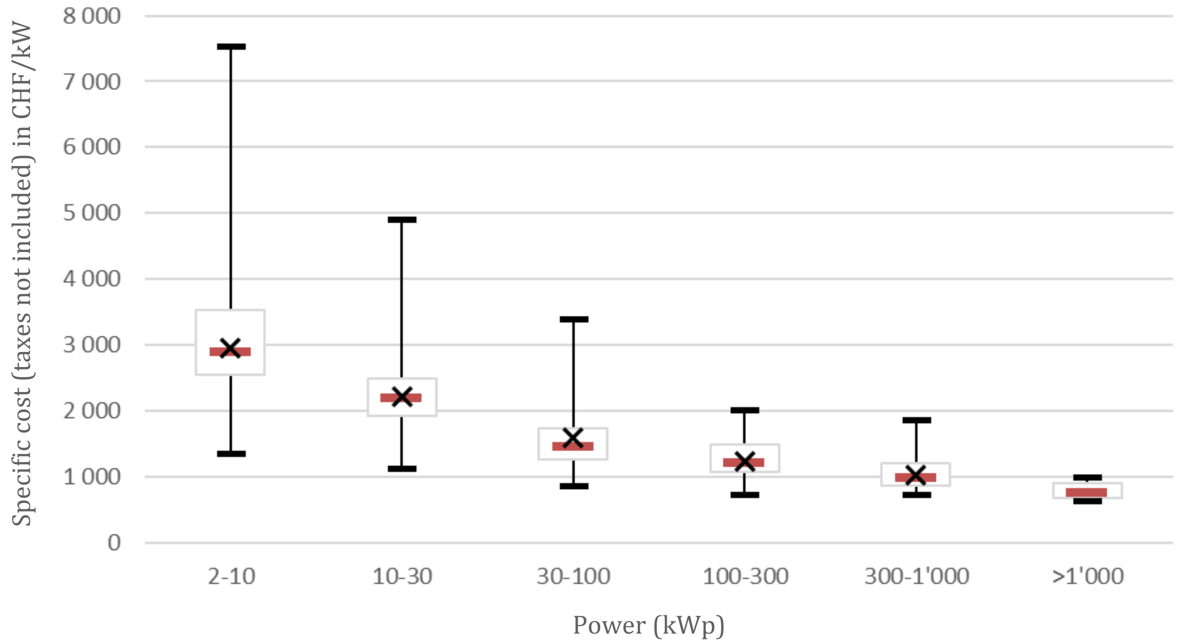
Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW [CHF/W]	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW [CHF /W]	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW [CHF /W]	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW [CHF /W]
2010	7.1 - 6.6	6.6 - 5.5	5.5 - 5	-
2011	-	-	-	-
2012	5 - 4.6	4.6 - 3.4	3.4 - 3	-
2013	-	-	-	-
2014	-	-	-	-
2015	4.8 - 3.5	-	-	-
2016	4.8 - 3.5	-	-	-
2017	4.2 - 3.3	-	-	-
2018	3.6 - 2.6	2.6 - 1.4	1.4 - 1.2	-
2019	3.5 - 2.5	2.5 - 1.3	1.3 - 1.2	-

A survey was published in 2019. It analyses over 2’100 quotes and bills for solar installations (BAPV only) and sort them according to their power range. Over 200 quotes for BIPV were recorded too but that was not enough to build up statistics.

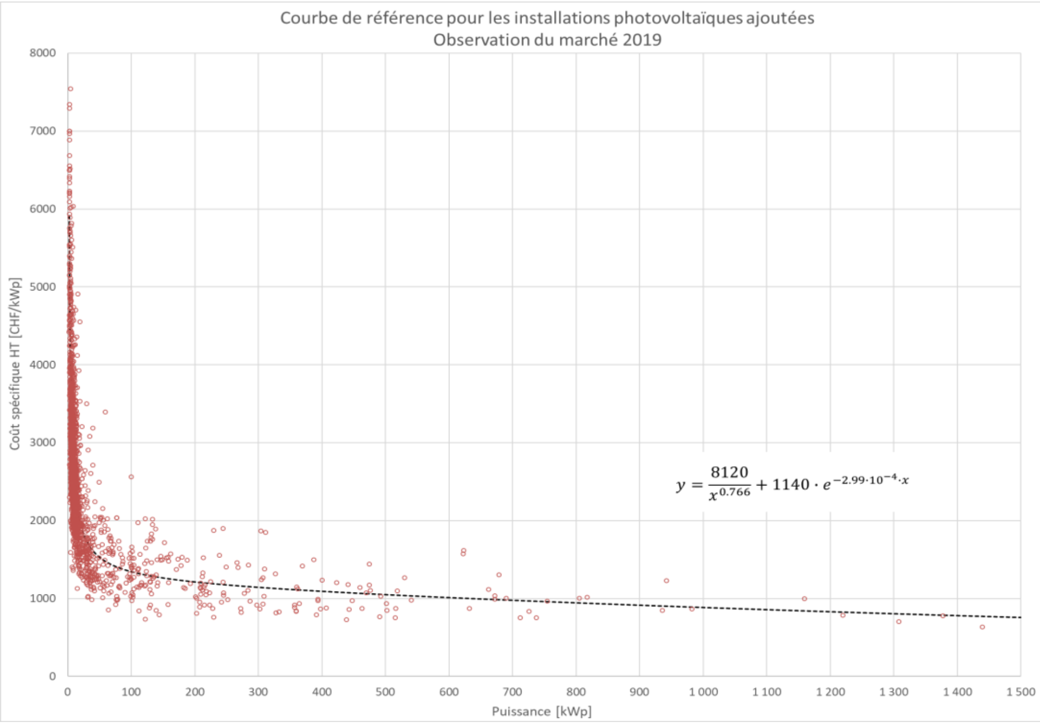
Source : “Observation marché photovoltaïque 2019”

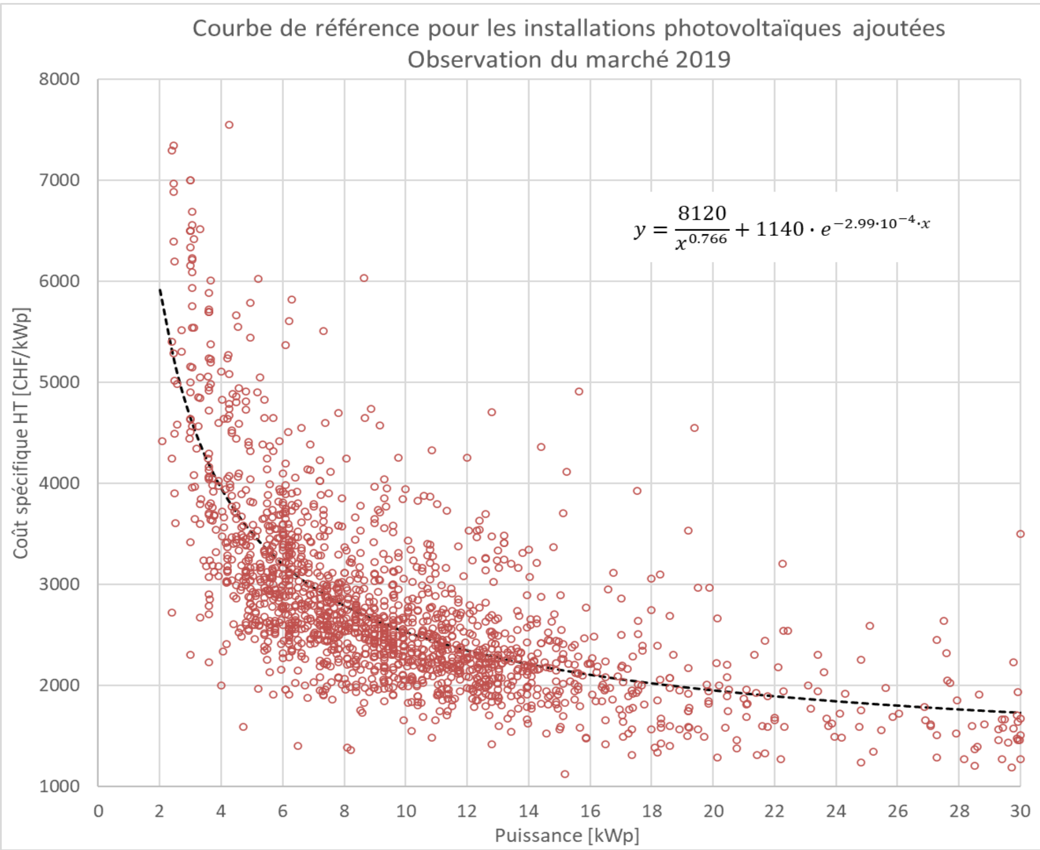
Power	Number of installations	Average Cost	Min	25%	Median	75%	Max
kWp		*CHF / kWp*					
2-10	1’043	2’985	1’359	2’538	2’914	3’528	7’545
10-30	711	2’184	1’129	1’920	2’201	2’493	4’910
30-100	187	1’512	855	1’254	1’466	1’737	3’394
100-300	117	1’254	737	1’064	1’217	1’496	2’022
300-1'000	63	1’045	730	865	990	1’206	1’868
>1'000	5	772	633	670	777	893	1’001

This table can be shown graphically as follows:



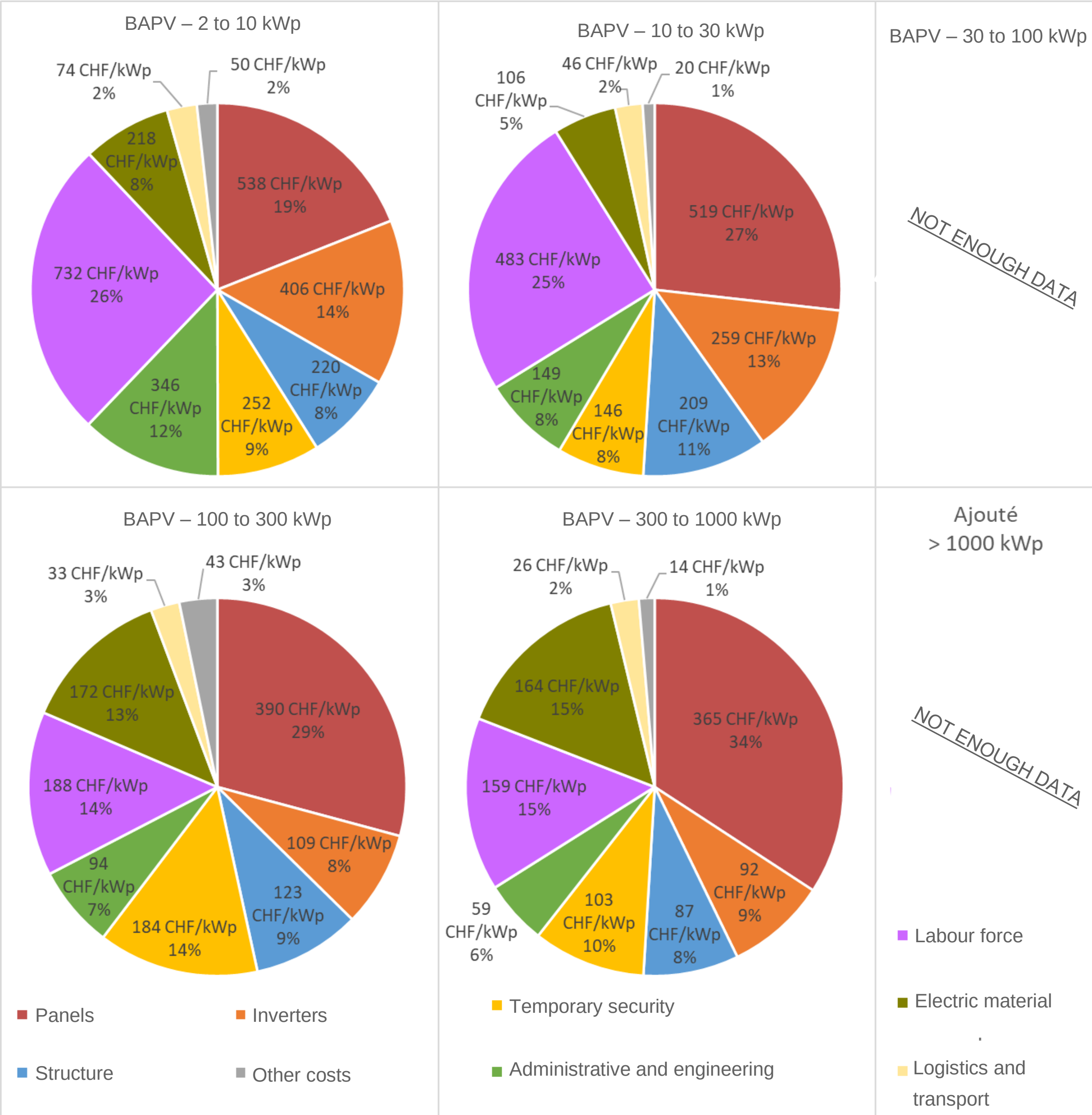
The following are the scatter graphs of all the results (the bottom graph shows only the ones under 30 kWp)





2.3 Cost breakdown of PV installations

A comprehensive cost survey has been published for 2019 The results are presented in the pie charts below:



The cost breakdown of a typical 5-10 kW roof-mounted, grid-connect, distributed PV system on a residential single-family house and a typical >1 MW Grid-connected, distributed PV systems at the end of 2019 is presented in Table 11 and Table 12, respectively.

The cost structure presented is from the customer's point of view. I.e. it does not reflect the installer companies' overall costs and revenues. The “average” category in Table 11 and Table 12 represents the average cost for each cost category and is the average of the typical cost structure. The average cost is taking the whole system into account and summarizes the average end price to customer. The “low” and “high” categories are the lowest and highest cost that has been reported within each segment. These costs are individual posts, i.e. summarizing these costs do not give an accurate system price.

Table 11: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of 5-10 kW

Cost category	Average [CHF/W]	Low [CHF/W]	High [CHF/W]
Hardware			
Module	0.70	0.59	0.80
Inverter	0.42	0.36	0.48
Mounting material	0.24	0.20	0.28
Other electronics (cables, etc.)	0.24	0.20	0.28
	0.27	0.23	0.31
Subtotal Hardware	1.87		
Soft costs			
Planning	0.36	0.31	0.41
Installation work	0.65	0.55	0.75
Shipping and travel expenses to customer	0.06	0.05	0.07
Permits and commissioning (i.e. cost for electrician, etc.)	0.06	0.05	0.07
Project margin			
Subtotal Soft costs	1.13		
Total (excluding VAT)	3		
Average VAT	7.7%		
Total (including VAT)	3.23		

Table 12: Cost breakdown for a grid-connected, distributed PV systems of 1 MW

Cost category	Average [CHF/W]	Low [CHF /W]	High [CHF /W]
Hardware			
Module	0.36	0.30	0.41
Inverter	0.07	0.06	0.08
Mounting material	0.07	0.06	0.08
Other electronics (cables, etc.)	0.12	0.11	0.14
Security	0.08	0.07	0.09
Subtotal Hardware	0.70		
Soft costs			
Planning	0.04	0.04	0.05
Installation work	0.12	0.10	0.13
Shipping and travel expenses to customer	0.02	0.02	0.02
Permits and commissioning (i.e. cost for electrician, etc.)	0.01	0.01	0.01
Project margin			
Subtotal Soft costs	0.19		
Total (excluding VAT)	0.89		
Average VAT	7.7%		
Total (including VAT)	0.96		

2.4 Financial Parameters and specific financing programs

Table 13: PV financing information in 2019

Different market segments	Loan rate [%]
Average rate of loans – residential installations	0.7 - 1.5
Average rate of loans – commercial installations	1.5 - 3.25 *
Average cost of capital – industrial and ground-mounted installations	1.5 - 3.25 *

* Depending upon secured/unsecured, the specifics of the project and the duration

2.5 Specific investments programs

Table 14: Summary of existing investment schemes

Investment Schemes	Introduced in Switzerland
Third party ownership (no investment)	Yes. More and more companies and utilities offer contracting solutions for PV, either with a fixed contractual percentage of self-consumption (risk bared by the user) or without (risk bared by the investor)
Renting	No
Leasing	Yes. Various business models are explored including leasing options, even for household.
Financing through utilities	Yes. Utilities are getting more active in the PV business. They finance PV installations either for their own portfolio or as contracting solutions for end-consumers. They are actively integrating PV in their business, including buying PV installation companies. Most utilities have now their own PV installations department
Investment in PV plants against free electricity	While this investment scheme has been employed by some utilities (investment per m2 of modules, production corresponding to the investment is deduced from the electricity bill), is it not compatible with the regulation. If still employed, it is mostly against PV green certificates.

Crowd funding (investment in PV plants)	Yes. Similar to above but usually mainly for green certificates, niche market. For investment, mainly cooperative society and crowdlending.
Community solar	Yes. Growing thanks to the new possibilities of collective self-consumption introduced in 2018. Community solar is especially growing for new residential buildings. Another possibility are cooperatives that invest in PV plants and repay the invested capital with a small dividend based on the annual performance.
International organization financing	Not applicable

2.6 Additional Country information

Table 15: Country information

Retail electricity prices for a household [cts CHF/W]	16.9 - 27.8 cts/kWh*
Retail electricity prices for a commercial company [cts CHF /W]	14.4 – 26.3 cts/kWh*
Retail electricity prices for an industrial company [cts CHF /W]	11.7 – 21.8 cts/kWh*
Population at the end of 2019	8 603 900
Country size [km^2]	41 285
Average PV yield in [kWh/kW]	960 kWh/kWp
Name and market share of major electric utilities	Approx. 650 DSOs The 30 biggest DSOs provide electricity to 65% of consumers

* including energy, grid and various regional and national taxes

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

The main driver for PV deployment in Switzerland is the combination of:

- Direct subsidy of about 20-30% of the investment.

The waiting time for getting the subsidy is getting shorter and shorter. It has been reduced during 2019 to less than 1 year for all size of installations, while in 2017 it was 2 years for small installations (< 100 kWp) and around 6 years for larger installations (> 100 kWp up to 50 MWp).

- The right to do self-consumption.

The right to self-consume the PV energy has been extended. In 2019, it has been clarified that it is possible to self-consume even with neighbours form the other side of roads, rivers or railways, if the community has one single connection point to the grid. The price of electricity inside the community has been updated to balance the profits between the investor and the consumers.

If this opportunity is often complicated to use in existing building, new districts are built using one single point of connection to the grid. PV is an enabler for microgrids including sometimes hundreds of customers.

- The obligation for the DSO to buy PV injected electricity (excess PV production)

DSO are obligated to buy renewable energy injected into the grid (until 3 MW). On the other hand, they have a large flexibility to decide the injection price, the law only mentions that this price should be similar to the purchase price of a similar energy. In 2019, this price varied strongly from one DSO to another and lies in the range of 0,04 to 0,15 CHF/kWh.

Table 16: Summary of PV support measures

Category	Residential		Commercial + Industrial		Centralized	
Measures in 2019	On-going	New	On-going	New	On-going	New
Feed-in tariffs	Yes. Prices depend on the local DSO Generally above market price and must be similar to the purchase price of a similar energy	-	Yes. Prices depend on the local DSO Generally above market price and must be similar to the purchase price of a similar energy	-	-	-
Feed-in premium (above market price)	Yes, but with cap, huge waiting list	Further reduction of premium	Yes, but with cap, huge waiting list	Further reduction of premium	-	-

Capital subsidies	Yes for PV systems from 30 kW to 50 MW also, around 20-30% of investment cost	-	Yes for PV systems from 30 kW to 50 MW also, around 20-30% of investment cost	-	-	-
Green certificates	Yes. Most utilities pay between 0.8-5 ct/kWh for green certificates (so-called guarantee of origin)	Trend to include a share of PV certificate in the standard product of the captive customers (up to 100 MWh/year)	Yes Most utilities pay between 0.8-5 ct/kWh for green certificates (so-called guarantee of origin)	Trend to include a share of PV certificate in the standard product of the captive customers (up to 100 MWh/year)	-	-
Renewable portfolio standards with/without PV requirements	-	-	-	-	-	-
Income tax credits	Yes Cost for PV system is deductible for house owners in existing building	-	-	-	-	-
Self-consumption	Allowed and encouraged	-	Allowed and encouraged	-	-	-
Net-metering	Few utilities	-	Few utilities	-	-	-
Net-billing	Few utilities	-	Few utilities	-	-	-
Collective self-consumption and virtual net-metering	Allowed	Facilitated collective self-consumption. Balanced benefits between investors and tenants	Allowed	Facilitated collective self-consumption. Balanced benefits between investors and tenants	-	-
Commercial bank activities e.g. green mortgages promoting PV	Few	-	Few	-	-	-

Activities of electricity utility businesses	Utilities engage more and more in PV. Some have their own installation subsidiaries; others promote PV with attractive schemes for storing surplus production or through contracting solutions. The new rules for collective self-consumption allow for more potential businesses (metering and billing services within a self-consumption community)					
Sustainable building requirements	In some cantons: new constructions must install 10W PV per square meter of heated area	Additional cantons applying the requirement	In some cantons: new constructions must install 10W PV per square meter of heated area	Additional cantons applying the requirement	-	-
BIPV incentives	Yes	Reduction of the incentive	Yes	Reduction of the incentive and limit to 100 kW	-	-
Other – storage	Some cantons subsidize local storage units	-	Some cantons subsidize local storage units	-	-	-

3.1 National targets for PV

The transformation of the Swiss energy system aimed at with the “Energy Strategy 2050” is a long-term project. Electricity production from photovoltaics is one of the key pillars in the strategy for the future Swiss electricity supply and should contribute – according to the official scenarios – with roughly half (11,1 TWh) of the net addition in renewable electricity production until 2050 (24,2 TWh).

The 2019 annual installations rate is almost sufficient to reach the 2050 goal, so the pressure to create new incentives for PV market is low. However, most experts agree that the 2050 goal for renewable energy production and in particular for photovoltaics is not ambitious enough and insufficient to replace the aging nuclear power plants and to meet the growing demand for electricity to decarbonize the buildings and mobility sector. Several studies indicate that the annual growth rate of PV installations should be increased by a factor 4-5.

The Swiss Federal Office of Energy has announced in September 2018 that the PV potential on Swiss roof was about 50 TWh. It represents about 90% of the annual consumption of Switzerland. The evaluation is based on the national maps for PV roof (www.toitsolaire.ch) and on a selection of the most suitable roofs. The tool is online for all Switzerland and is translated in English. It is possible to have an evaluation of the approximate PV potential of every single roof in Switzerland. Since April 2019, it also includes the potential of façades.

The communication of this potential by the government is very positive to illustrate the potential major role of PV as a main electricity source in Switzerland. However, it has also the consequence of pushing PV only on buildings and maintain low opportunities for PV deployment on ground or on other infrastructures.

On the basis on this national map for PV roof, some cantons developed their own improved solar cadastre to determine more precisely the potential in their territories.

3.2 Direct support policies for PV installations

3.2.1 Description of support measures – Feed-in tariffs and one-time remuneration

On a national level there are two main support measures:

- **One-time remuneration** (direct subsidies) for installations between 2 kW_{DC} and 50 MW_{DC} covering around 20-30% of the initial investment (around 300 CHF/kWp). This support scheme was introduced in 2014 for installations up to 30kW and extended in 2018 to 50 MW.
- **Feed-in tariffs premium** for installations larger than 10 kW_{DC}. This support measure was introduced in 2009 (another support scheme called "Mehrkostenfinanzierung" existed before). Due to limited funding it was decided that only project having been announced before June 30, 2012 would be eligible for feed in tariffs. Project announced after this date would however be eligible for the one-time remuneration.

Both support measures are financed through a levy on the electricity consumption. In 2018, this network surcharge was increased from 1.5 ct/kWh to 2.3 ct/kWh.

In 2019, the following subsidies applied on a national level for building attached PV:

Feed-in tariffs premium as a function of commissioning date (and is shown in cts of CHF)

	1.1.2018-31.3.2019	1.4.2019-31.3.2020	From 1.4.2020 onwards
BAPV <100 kW	11.0	10.0	9.0
BAPV <1000 kW	11.0	10.0	9.0
BAPV >1000 kW	11.0	10.0	9.0

These feed-in tariffs are subject to limited availability, and most projects are now pushed to choose the one-time subsidy.

One-time remuneration as a function of commissioning date:

BAPV	1.4.2018-31.3.2019	1.4.2019-31.3.2020	From 1.4.2020 onwards
Base contribution (CHF)	1400	1400	1000
Additional contribution (CHF / kW)			
< 30 kW	400	340	340
< 100 kW	300	300	300
> 100 kW	300	300	300

3.2.2 BIPV development measures

The one-time remuneration scheme is approximately 15% higher for BIPV then BAPV for PV installations smaller than 100 kW. This difference is being reduced, especially from 2020 onwards.

One-time remuneration as a function of commissioning date:

BIPV	1.4.2018-31.3.2019	1.4.2019-31.3.2020	From 1.4.2020 onwards
Base contribution (CHF)	1600	1550	1100
Additional contribution (CHF / kW)			
< 30 kW	460	380	380
< 100 kW	340	330	330
> 100 kW	For systems larger than 100 kWp, the one-time remuneration is the same as the one for BAPV		

In addition to the federal subsidies for BIPV, some communities give also incentives for PV facades (e.g. bonus of 50% compared to roof-top).

Also, several innovative BIPV projects (such as using specifically designed modules for protected buildings or resulting in energy self-sufficient buildings) have been supported by a special fund for pilot and demonstrator projects from the government. BIPV project are also pushed by constraint for building permit process in buildings having a cultural value.

3.3 Self-consumption measures

Table 17: Summary of self-consumption regulations for small private PV systems in 2019

PV self-consumption	1	Right to self-consume	Yes, since 2014
	2	Revenues from self-consumed PV	Savings on electricity bill (which is 2-3 times higher than feed-in tariffs), almost 90% of the bill is directly or indirectly related to energy (kWh), making self-consumption very profitable
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	No, some DSO charge for installing a bi-directional energy meter. It is currently being debated to attribute a larger part of the grid fee to power and not to energy in order to increase the contribution of self-consumers to grid cost
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Depending on DSO (range of 5-15 cts/kWh, average price around 10ct/kWh), often including the revenue for green certificates.
	5	Maximum timeframe for compensation of fluxes	Real time (standard metering timeframe of 15 minutes)
	6	Geographical compensation (virtual self-consumption or metering)	Local with the same user of collective self-consumption.
Other characteristics	7	Regulatory scheme duration	The compensation scheme for excess electricity is adjusted every year (with the exception of the national feed-in tariff, which is fixed over 15 to 25 years)
	8	Third party ownership accepted	Yes, most utility are now active to propose PV contracting and self-consumption to their large customers
	9	Grid codes and/or additional	Until 2018, some utilities applied a different tariff structure for prosumers (power metering). From 2018

		taxes/fees impacting the revenues of the prosumer	onward, only one tariff structure is allowed for prosumers with an annual consumption smaller than 50 MWh and with a connection to the grid below 1 kV
	10	Regulations on enablers of self-consumption (storage, DSM…)	In some cases, heat pumps or resistive heating systems are remotely controlled by the DSO, but not necessarily in a way that optimizes self-consumption. DSM is common for industries to avoid power peaks, but can be used to optimize self-consumption as well. Thanks to more solutions available for DSM, more and more single household owners with PV systems take an interest in those in order to increase self-consumption. Specific recommendations exist for connection and metering of storage systems
	11	PV system size limitations	No PV size limitations
	12	Electricity system limitations	No
	13	Collective self-consumption, solar communities and similar measures	Collective self-consumption has been allowed by most DSOs, of which there are more than 500, since 2014. Previously, self-consumption was restricted to consumers in the same building or within the same perimeter of land. In this context, the DSO was also responsible for billing every customer. With the new legislation that has come into force on January 2018, collective self-consumption is improved significantly: different end-consumers have the possibility to connect together as long as their land is contiguous and that the public grid is not used i.e. it is a single grid-connection, acting as a unique connection point towards the DSO. The internal metering is then under the responsibility of the consortium. This also allows the consumers to have access to the free electricity market, an additional strong incentive, if the new self-consumption consortium has an electricity consumption above 100 MWh/year. Collective self-consumption has also been improved to create investment security for third party ownership in case of a building occupied by tenants. Under specific conditions, the tenant has the obligation to purchase the collectively produced PV electricity

3.4 Collective self-consumption, community solar and similar measures

Collective self-consumption has been allowed by most DSOs (Switzerland has more than 600 DSOs) since 2014, but it used to be restricted to consumers of the same building or within the same perimeter of land. In this context, the DSO was also responsible of billing every customer.

With the new legislation that has come into force on January 2018, collective self-consumption is improved significantly : different end consumers have the possibility to connect together, especially since 2019 since they can do it even though they are separated by a river, a road, or a railway (as long as their land is contiguous and that the public grid is not used i.e. it is a one single grid connection) and to act as a unique connection point towards the DSO.

The internal metering is then under the responsibility of the collective. This also allows the consumers to have access to the free electricity market (additional strong incentive) if the new collective consumption is above 100 MWh/year Collective self-consumption becomes an enabler of a new step of market liberalization for small customers. It has also been improved to create investment security for third party ownership in case of a building occupied by tenants (under a set of conditions, the tenant has to purchase the collective PV electricity).

These collective self-consumption models are being continuously improved. The Swiss solar association, Swissolar, published recommendations for collective self-consumption https://www.swissolar.ch/fr/rcp/. For example, the framework providing a calculation method for a fair price for self-consumed electricity for the tenants (in relation to the price for grid electricity), which still benefits the investor, has been put in place in 2019.

This new measure allows for more flexibility for self-consumption and fosters the integration of PV in the local electricity grid.

This measure is also an incentive for batteries and several new building or collection of new buildings are built as a self-consumption community.

The previous model where collective self-consumption is managed by the DSO and every customer remains a customer for the public grid remains an option. It is sometimes chosen if no entity wants to carry the billing risk.

Several new buildings are however built with this new opportunity of being one single customer.

This building has 54 flats and consists of a single connection point to the grid.

The building has a 94 kWp PV installation and a 100 kWh Tesla Power Pack, and the PV electricity is sold to every tenant at a lower price than the grid price, with a dedicated app enabling real-time monitoring.

More general information and examples can be found on the Suisse Energie platform: https://pubdb.bfe.admin.ch/fr/publication/download/7964

3.5 Tenders, auctions & similar schemes

There are no tendering schemes for PV systems in Switzerland.

There are however several auction platforms for selling/buying green certificates (guarantee of origin). The price for those certificates has constantly dropped over the past years.

3.6 Other utility-scale measures including floating and agricultural PV

No specific utility-scale measures are in place in Switzerland.

A PV pilot plant has been installed end of 2019 in the Swiss Alps, situated at 1 810 meters above sea level on the hydro reservoir "Lac des Toules". The production is expected to be up to 50% higher due to the use of bifacial modules with high albedo in wintertime and the higher irradiation. Challenges are the extreme climatic conditions (snow, ice, strong winds, temperature variations) as well as seasonal variances in water levels (0 to 50m).

Depending on the results, the current 400 kW installation might be upgraded to around 12 MW and would cover about 35% of the lake surface.

Source : http://www.solaireflottant-lestoules.ch/

3.7 Social Policies

Public buildings are often considered for PV installations. It is mainly due to the fact that law or recommendation mention that public authorities have to put themselves on the spotlight and show the example.

3.8 Retrospective measures applied to PV

The new energy act applied from January 2018 has also led to a certain number of retrospective measures for existing plant in opposition to the several supportive measures for new deployment.

- Owners of existing large PV plants (above 500 kWp) have to commercialize their energy on the market instead of receiving a fixed feed-in tariff. The impact is however limited because the tariff is calculated every 3 months according to the average market price. The main idea is that large PV installations should sell their energy to the market like other sources of energy.
- The existing PV plants in the waiting list for the premium feed-in tariff have to accept a 20% cut in the announced subsidy, or to choose the one-time renumeration. This makes some PV plant less profitable than expected. It has been chosen to support more PV installations with the given amount of support available.
- Existing PV plants that have been registered for the waiting list for the premium feed-in tariff after June 30, 2012 will not be able to benefit from the feed-in tariff subsidy scheme. They can only have the one-time renumeration. Some farmers having invested in PV installations suffer from this measure, because in this context, self-consumption is not sufficient to pay off the PV plant.

3.9 Indirect policy issues

3.9.1 Rural electrification measures

No specific rural electrification measures are in place in Switzerland.

3.9.2 Support for electricity storage and demand response measures

There is no support scheme for electricity storage on a national level, however some cantons (Thurgau, Appenzell Ausserrhoden and Vaud) have introduced direct subsidies for local storage solutions and it is expected that other cantons will follow.

In canton Vaud, 440'000 CHF were allocated for 70 storage solutions, much less than last year. The support covers 35% maximum of the investment cost (and max 50'000 CHF) and came with certain conditions: storage must not be connected to grid or used for mobility, must be a back-up solution in case of power outage, PV System must be big enough and storage not too big. Canton Vaud did not continue that support scheme in 2020.

Some municipalities give additional subsidies corresponding to around 10% of the investment cost.

The situation regarding tax deduction is unfortunately different from one canton to another. In most canton, the investment in batteries for increased self-consumption can be deducted if installed at the same time as the PV installation. Others allow to deduct it even if installed later.

There are ongoing discussions of some DSO for introducing new tariff designs that would allow for partial recovery of the investment costs if the owner of the storage system is willing to let the DSO party manage the storage unit. More and more utilities are also offering solutions for virtual storage. For a fee (fixed or per kWh) the owner of a PV system can use the DSOs grid as a virtual storage for his PV production and use it at a later stage (basically a net-metering solution).

3.9.3 Support for electric vehicles (and VIPV)

There is no direct national support scheme for electric vehicles in Switzerland.

Fully electric vehicles do not pay the automobile duty of 4% and of course, since they do not run on fossil fuels, there is not petroleum tax to pay (as such, EVs do currently not contribute to road infrastructure). Electrical vehicles also often pay reduced vehicle taxes, but there are large differences from one canton to another.

On the 11th of September 2018 the Swiss Government has launched a tender for the installation of fast charging stations on 100 service stations along motorways. Grid connection will be pre-financed by the government and repaid by the operator through concession fees.

Some communities give financial incentives for the installation of local charging stations (e.g. 20% subsidy). Since 2017, Swiss eMobility (Swiss Association for Electric Mobility) awards each year a prize (golden plug) to communities and cities with exceptional effort to push electromobility.

https://thedriven.io/wp-content/uploads/2019/04/55164.fr_.en_.pdf

On the 15th of November 2018, a gathering was organized between representatives from the car and electricity sectors and officials from the confederation, the cantons and cities. The purpose was to draw a roadmap of measures aiming to get to 15% the part of "rechargeable"

cars in Switzerland (100% electric vehicles or rechargeable hybrids). Those measures were put into effect starting 1st of January 2019 and are all listed here :
https://roadmap2022.brainstore.com/de/roadmap_elektromobilitaet_2022/massnahmen

3.9.4 Curtailment policies

For PV installations over 3MWp or production over 5000 MWh per year, the DSO is not bound to buy the injected energy, which restricts the number of such installations.

It is often difficult to obtain a permit to install PV systems elsewhere than on buildings because of the territory management laws currently in place, thus limiting the size and number of the installations.

Grid reinforcement and curtailment policies are so far rarely necessary because most development is made with the goal of having enough self-consumption. Therefore, some PV installations are not even exploiting the full roof potential of building to have a better LCOE.

In a long-term perspective, it is discussed that the incentive (mainly the one-time renumeration) should focus on promoting reduction of the AC-DC ratio of PV installations in order to reduce the need of complicated curtailment policies.

3.9.5 Other support measures

Minergie, a leading building standard organization, supported by the cantons as well as the Swiss Federal Office of Energy and the building industry, revised its building standards in 2016. PV has become quasi-mandatory to fulfil the requirements for the nearly zero energy standards. Since for a Minergy labelled building, only 40% of the grid-injected electricity can be counted for the overall energy requirements, there is an additional incentive to optimize self-consumption (DSM, battery).

These voluntary building standards helped to pave the way for the coming new building standards de-fined by the cantons (10 Watt PV per square meter of heated area in new buildings).

Since 2015, the Swiss government has published a recommendation for the energy policies in cantons. These regulations should include a requirement for PV in every new building. In some cantons (e.g. Vaud), requirement of including about 10 W PV per square meter of heated area for new buildings is already implemented, others are expected to adapt their cantonal energy acts accordingly in the coming years. It is also recommended to include 10% renewable energy when the heating system has to be retrofitted. PV can be an option among others.

A negative measure hindering PV development are the restrictions on installing PV systems in some cities (for example for places listed as UNESCO World Heritage), enforce restrictions on installing PV systems on roofs (color of modules/frames, module layout) and sometimes purely reject ridge, orientation, or even pure rejection), which also hinders PV development.

National researches (Extract from the PVPS Annual report 2019)

The Swiss Federal Office of Energy (SFOE) runs a photovoltaic RTD programme that involves a broad range of stakeholders. The programme is part of the long-standing coordinative activities by the SFOE to support research and development of energy technologies in Switzerland, where funds deployed in a subsidiary manner aim to fill gaps in Switzerland's funding landscape. Grants are given to private entities, the domain of the Swiss Federal Institutes of Technology (ETH), universities of applied sciences and universities.

The focus of the photovoltaics programme lies on RTD from basic research, over applied research, product development, pilot and demonstration projects. On average, the volume of the programme (including pilot and demonstration) is in the order of 10% of the total public support for photovoltaics research in Switzerland, which is in the order of 36 MCHF per year (including roughly 30% from European projects). As of January 2020, there are 86 ongoing photovoltaic projects, 29 funded through SFOE, 12 by the Swiss Agency for Innovation, 17 by the Swiss National Science Foundation and 28 as European projects (https://pv.energyresearch.ch/projects).

3.10 Financing and cost of support measures

National PV incentives (one-time remuneration and feed-in tariff) are financed by a network surcharge which is paid on a kWh-basis by all electricity consumers. Under certain conditions, companies for which electricity cost exceeds 10% of their gross value can be reimbursed (large consumers).

On January 2018, the network surcharge has been increased from 1.5 ct/kWh to 2.3 ct/kWh. This corresponds to a burden of 103.5 Swiss francs per year (67.5 in 2017) for an average household with a consumption of 4'500 kWh.

In 2019, the following amount has been paid for the two incentive measures:

- One-time remuneration: 228 Million CHF (to 12'900 small installations and 640 larges ones – a thousand more large installations were promised to receive the remuneration later in 2020)
- Feed-in tariffs: 187 Million CHF

4 INDUSTRY

4.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

There is no feedstock, ingots and wafers production in Switzerland

4.2 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

Total PV cell and module manufacture together with production capacity information is summarised in Table below.

Table 18: PV cell and module production and production capacity information for 2019

<table>
<tr><th rowspan="2">Cell/Module manufacturer (or total national production)</th><th rowspan="2">Technology (sc-Si, mc-Si, a-Si, CdTe, CIGS)</th><th colspan="2">Total Production [MW]</th><th colspan="2">Maximum production capacity [MW/yr]</th></tr>
<tr><th>Cell</th><th>Module</th><th>Cell</th><th>Module</th></tr>
<tr><td colspan="6">Wafer-based PV manufactures</td></tr>
<tr><td>Megasol Switzerland *</td><td>Mono Perc</td><td>-</td><td>55 MWp</td><td>-</td><td>80 MW</td></tr>
<tr><td rowspan="3">3S Solar Plus (Meyer Burger) **</td><td>sc-Si, mc-Si</td><td>-</td><td>No data provided</td><td>-</td><td>45 MW</td></tr>
<tr><td>PVT hybrid</td><td>-</td><td>No data provided</td><td>-</td><td>N/A</td></tr>
<tr><td>Bifacial (Meyer)</td><td>-</td><td>No data provided</td><td>-</td><td>N/A</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Thin film manufacturers</td></tr>
<tr><td>Flisom</td><td>Flexible CIGS</td><td>-</td><td>No data provided</td><td>-</td><td>15 MW pilot line</td></tr>
<tr><td>Totals</td><td></td><td>0</td><td>55 MWp</td><td>0</td><td>140 MWp</td></tr>
</table>

* Megasol has also a production facility of 130 MW capacity in Ningbo, China, for standard high-performance modules, they produced 120 MW in 2019. In Switzerland they installed a production line (40 megawatts expanded to 80 megawatts in 2016) in Deitingen SO since 2013, which specializes in glass-glass modules and small series / custom-made products.

** 3S Solar Plus began taking over Meyer Burger's solar systems business on the 1st of June 2018

There is no cell production in Switzerland, except for pilot lines for new technologies such as SmartWire connection Technology SWCT (Meyer Burger) or CIGS (Flisom)

Swiss manufactures are specialised in BIPV products. 3S Solar Plus (previously Meyer Burger) produces its famous Megaslate module (a roofing material consisting of roof tiles, pv tiles and thermal tiles.) as well as hybrid (PV and solar thermal) collectors, while Megasol produces at their manufacturing site in Switzerland custom-made special modules (size, shape and colour).

(Extract from the PVPS Annual report 2019)

Last summer, a memorandum of understanding for a strategic collaboration between the Swiss technology provider Meyer Burger and the REC Group, a leading European brand of solar panels, has been signed. In fall 2019, the REC Group started mass production of its new Alpha modules manufactured on Meyer Burger Heterojunction (HJT) and SmartWire core equipment. The produced modules feature the world's most powerful 60-cell solar panel and best-in-class power out-put of 380 Wp. It was also announced, that REC plans to increase its 600 MW HJT/SmartWire manufacturing capacity to multiple GW (detailed information is outstanding). In exchange for adequate exclusivity protection for specific HJT and SmartWire Connection technologies, REC would be prepared to enter into a profit sharing agreement with Meyer Burger.

4.3 Manufacturers and suppliers of other components

Switzerland has a strong industry for BOS-components. Among them are the following companies:

Inverters:

Studer Innotec manufactures inverters and chargers for stand-alone and storage solutions, mostly for remote sites without grid access all over the world.

Junction Boxes/Connectors:

Stäubli Electrical Connectors (former Multi Contact AG) is the leading manufacturer of cables and connectors for PV Systems. They claim that over 200 GW of PV is connected using their connectors and to have market share of 50% with module connectors.

Cables:

Huber & Suhner and Heiniger AG have been offering a variety of dedicated PV cables for several decades.

Supporting Structures:

Montavent offers mounting systems for profiled metal and corrugated roofs.

ALUSTAND has mounting structures for tilted and flat roofs.

Ernst Schweizer produces in-roof mounting systems (Solrif) as well as structures for flat and pitched roofs. They also produce solar thermal collectors for roof-top and façade applications.

Storage Batteries:

Leclanché develops and produces energy storage systems with large format lithium-ion cells and has specialised on storage systems based on Lithium titanate technology.

Components for customized PV modules:

Solaxess develops a nanotechnology-based film for producing white and coloured solar panels without visible cells or connections

SwissInso produces coloured solar glass (Kromatix TM) by plasma processes for Building integrated PV

5 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

5.1 Labour places

Table 19: Estimated PV-related full-time labour places in 2019

<table>
<tr><th>Market category</th><th>Number of full-time labour places</th></tr>
<tr><td>Distributors of PV products</td><td rowspan="2">4’200*</td></tr>
<tr><td>System and installation companies</td></tr>
<tr><td>Electricity utility businesses and government</td><td>500[#]</td></tr>
<tr><td>Other (including maintenance)</td><td>500[#]</td></tr>
<tr><td>Research and development (not including companies)</td><td>200[#]</td></tr>
<tr><td>Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D</td><td>200[#]</td></tr>
<tr><td>Total</td><td>5’600</td></tr>
</table>

* adapted from calculations from Pius Hüsser (Coordination Office Solar Education Switzerland), based on data from Sabine Perch-Nielsen (EBP)

[#] estimates

5.2 Business value

Table 20: Rough estimation of the value of the PV business in 2019 (VAT is excluded)

Sub-market	Capacity installed [MW]	Average price [CHF/W]	Value [million CHF]	Total [million CHF]
Off-grid	0.4	6.8	2.7	2.7
Grid-connected distributed	324.43	1.78	578	578
Grid-connected centralized			-	0
Value of PV business 2019*				580.7

*Table 20 does not take into account export and import of PV related products as well as other PV related services.

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

The electricity system in Switzerland is organised on 7 network levels, from the high-voltage transmission network (level 1) down to the low-voltage distribution to the end-consumer (level 7).

Swissgrid is that national transmission grid operator at level 1 (comprising of 380 kV and 220 kV transmission lines) and is responsible for grid stability and frequency control.

Switzerland's supply of electricity to end users is secured by more than 650 DSO companies. Many of them are also responsible for supplying water and gas. In some cantons and municipalities, a single vertically integrated company is responsible for these supply tasks, while in other cantons a variety of companies share this responsibility. Some of the utilities may have only a few hundred of customers, while others have more than 100’000 customers.

In terms of grid-interconnection of PV, there are national regulations and recommendations, but each DSO may have its specific technical interconnection conditions. There is however a tendency for harmonisation and simplification, both in administrative and technical terms.

DSOs are required to accept electricity from a PV power plant up to 3’000 MWh per year and there is a minimal tariff that has to be paid, calculated based on the DSOs procurement and generation cost.

6.2 Interest from electricity utility businesses

An increasing numbers of electricity utilities are entering the PV business. Especially larger utilities that have their own (non-solar) electricity production facilities have been under increasing financial pressure, due to falling electricity prices on the European market, and are therefore expanding their business activities. Due to the private-public status of most of the utilities (they are typically owned by the communities and the cantons) this development is not always well seen by the traditional PV installing companies

The following PV business models are implemented by electricity utilities

- Investment in their own PV plants for their production portfolio
- Establishment of subsidiary units for engineering and installation services (sometimes including acquisition of PV installations companies)
- Offering contracting solutions for PV power plants, selling the PV electricity to the end-consumer
- Providing services for metering and billing within the newly possible (from 2018 onwards) self-consumption communities
- Virtual battery solutions, batteries on district level and EV charging stations

In order to intensify the exchange between the traditional solar sector (represented by Swissolar, the professional association) and the traditional grid stakeholders (represented by VSE/AES, the Swiss utility association), experts from both sectors meet regularly in working groups in order to revise recommendations for grid connections, metering requirements, battery exploitation schemes, etc.

6.3 Interest from municipalities and local governments

Municipalities and cities are key stakeholders in pushing the development of PV in their jurisdiction. On the one hand, they becoming more and more aware of their own huge potential (on infrastructure owned by the local government such as schools, public buildings, etc.) and therefore invest themselves in PV power plants. On the other hand, they can create favourable conditions (simplified administrative procedures, for example) and grant additional local subsidies for solar, storage or EV in order to push the development.

Municipality are often pushing also collective self-consumption, and promoting it for new urban developments

There is a label called “Energy City” and “Energy Municipality” which is awarded to cities and municipalities that live and implement a sustainable municipal energy policy. Energy cities promote renewable energies, environmentally friendly mobility and rely on the efficient use of resources.

One example is the canton of Geneva that has set the target to produce 100 GWh of PV electricity by 2025.

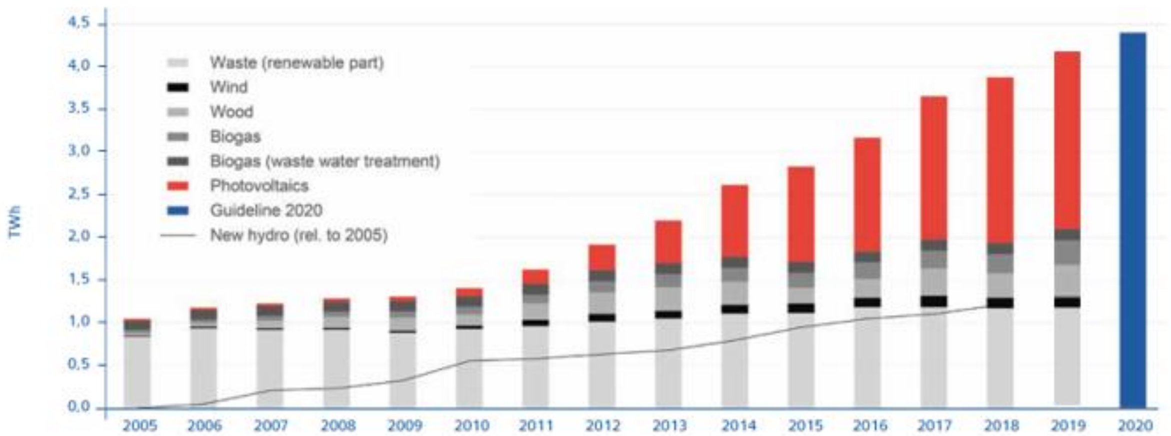
7 HIGHLIGHTS AND PROSPECTS

(Mainly extracted from the PVPS Annual report 2019)

The current Swiss energy policy describes how Switzerland can withdraw from nuclear power (36% of total power production) on a step-by-step basis and gradually restructure the Swiss energy system by 2050. These moves are to take place without endangering Switzerland's currently high level of supply security and its affordable energy supply. The strategy calls for a significant increase in energy efficiency, the increased use of renewable energy and the reduction of energy-related CO2 emissions. The corresponding energy legislation was accepted in a popular referendum in May 2017 and entered into force in January 2018.

In the climate sector, and with reference to the reduction of use of fossil energy, the focus is now on the next stage of the Swiss climate policy which is currently being debated in Parliament and which involves national implementation of the Paris Convention by 2030. In summer 2019, the Swiss government also decided that the net greenhouse gas emissions shall be reduced to zero by 2050. Simultaneously, the administration was asked to draft a corresponding long-term climate strategy for 2050.

In the fall of 2019, the Swiss government expressed its determination to fully liberalise the electricity market which should ensure that innovative products, services and the process of digitalisation will penetrate the market. As an accompanying measure, it was proposed at the same time to increase the incentive to invest in domestic renewable energies. Guide values for the expansion of hydropower and new renewable energies for 2035 should be declared binding. Accordingly, the investment contributions currently limited to 2030 will be extended until the end of 2035. A guideline is also determined for the period up to 2050. If the effective expansion of renewable energies falls too far below the defined expansion path, additional measures can be requested. Especially in the photovoltaics sector, competition shall be intensified by the one-off remuneration for large photovoltaic systems being newly determined through tenders. The administration is commissioned to submit a consultation proposal for the revision of the Energy Act.



Electricity production from photovoltaics is one of the key pillars in the strategy for the future Swiss electricity supply. According to a recent study by the Swiss Federal Office of Energy (SFOE) based on data from a solar potential cadastre (http://www. sonnendach.ch) and meteodata, Swiss houses and factories could generate up to 67 TWh of photovoltaic power per year (current power consumption is around 60 TWh). These are 50 TWh from rooftops in combination with an additional potential of 17 TWh on facades. Thereby, only larger surface areas with economically useful insulation have been considered.

A new monitoring report of the "Energy Strategy 2050" in 2019 shows that the increase in renewable power production in Switzerland is on track to reach the 4.4 TWh benchmark for 2020 (see graph above – the value for 2019 is 4.19 TWh). The contribution from photovoltaics is thereby above the long-term scenarios. The total installed capacity 2019 was 2.5 GW with a plus of 325 MW compared to 2018, which is close to the 2015 record of 333 MW. The capacity addition in 2019 is 25% higher than in previous years (the average for 2016 2017 2018 being 260 MW). Reasons are additional new opportunities (since 2018), such as the collective grid connection of various end consumers to increase self-consumption and flexibility. In addition, an existing long waiting list for onetime investment subsidies has been strongly decreased in 2019.

Technology Collaboration Programme

by iea