Technology Collaboration Programme
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International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in Italy

2021

GSE Gestore Servizi Energetici
RSE Ricerca Sistema Energetico
ENEA
ELETTRICITÀ FUTURA imprese elettriche italiane

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 2021. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

Authors

- **Main Content: Task 1 participants**: Francesca Tilli (GSE), Giosuè Maugeri (RSE), Franco Roca (ENEA), Alessandro Scipioni (Elettricità Futura). Other contributors: Vincenzo Surace, Alessandro Pellini (GSE)
- **Data:** GSE, RSE
- **Analysis:** Francesca Tilli (GSE), Giosuè Maugeri (RSE), Franco Roca (ENEA), Alessandro Scipioni (Elettricità Futura)

COVER PICTURE

Source: Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics, Gestore dei Servizi Energetici, GSE

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ACKNOWLEDGEMENTS

This report received valuable contributions from several stakeholders and experts of Italian photovoltaic (hereafter, PV) market: entrepreneurs, manufacturers of PV modules and other components, installers, Architecture School University IUAV of Venice, Nomisma Energia, and others. They all provided data and views included in this report. Many thanks to all of them.

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 2021 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2021, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

During 2021 around 80.000 PV plants for a new capacity of 938 MW (see note 5 of table 1 and 2) were installed in Italy (see note 5 of table 1 and table 2), of which almost 50% accessing to the so-called Scambio Sul Posto (SSP) mechanism, a net-billing scheme managed by GSE. The number of plants installed in 2021 is higher than the figure of 2020 (55.000 additional PV plants with a capacity of 749 MW. The average capacity of new plants installed in 2021 is equal to 11,8 kW and 10% of the installed capacity in 2021 consists of plants larger than 1 MW.

At the end of 2021 total installed capacity in Italy is 22.594 MW with a number of 1.016.083 PV plants. Small plants with a capacity below 20 kW represent 93% of the total installed plants and 23% in terms of power. The cumulative average power of the plants is 22,2 kW. Ground total PV capacity is equal to 8.050 MW, 36% of the whole capacity installed.

97,6% of PV plants installed in Italy (992.018 out of a total of 1.016.083) are connected to the low voltage distribution grid; 23.927 plants are connected to the medium voltage grid, representing the 54,3% of total existing capacity. Only a small number of PV installations are connected to the high voltage grid, with a capacity of around 1.631 MW, the 7,2% of the total one.

Number and capacity are distributed in a rather different way among Italian regions; at the end of 2021, in two regions of the North (Lombardia and Veneto) is concentrated 30,4% of plants installed in Italy, while one region in the South (Puglia) has the national record in term of regional installed capacity with 13% of the cumulative power.

PV electricity production reached 25.039 GWh in 2021, a growth of 0,4% compared to the previous year. Out of the above-mentioned production, around 12.917 GWh is generated by the industrial sector, 5.516 GWh by the tertiary sector, 2.844 GWh by the agricultural sector and 3.762 GWh by the domestic sector.

Electricity produced and self-consumed in 2021 amounted to 5.179 GWh, 20,6% of total PV systems production and 48,6% of the production of self-consumption plants.

Polycrystalline silicon PV modules are installed on 69,8% of the existing capacity, monocrystalline silicon modules on 24,7% and thin film modules or other materials (which

include a-Si, CIS, CdTe) on 5,5%. Thin-film technology is installed mostly in Sicilia region (south of Italy), representing 11% of the total power installed. Valle d'Aosta and Bolzano Province in the north of Italy are the two regions with the highest percentage of monocrystalline modules.

During 2021 around 35.000 new storage systems were installed, for a cumulative number of almost 77.000.

1.2 Total photovoltaic power installed

Table 1: Annual PV power installed during calendar year 2021 (1) (2)

		Installed PV capacity in 2021 [MW]	AC or DC
	Decentralized (3)	870,22	DC
	Centralized (4)	74,04	DC
	Off-grid		
	Total	**944,26** (5)	**DC**

[1] *Source: GSE*

[2] *Blank box stands for not available data*

[3] *Any PV installation which is embedded into a customer's premises (self-consumption)*

[4] *Any PV installation which only injects electricity and is not associated with a consumer (no self-consumption)*

[5] ***The value indicated in the table results from the difference between the value at the end of 2021 less the value of 2020. It is important to point out that actual installed capacity in 2021 is equal to 938 MW, due to decommissioning and statistic power update***

Table 2: PV power installed during calendar year 2021 (1) (2)

			Installed PV capacity [MW]	Installed PV capacity [MW]	AC or DC
Grid-connected	BAPV (3)	Residential	890,22	382,28	DC
		Commercial		220,57	DC
		Industrial		287,37	DC
	BIPV (4)	Residential			
		Commercial			
		Industrial			
	Utility-scale	Ground-mounted	54,03	54,03	DC
		Floating			
		Agricultural			
Off-grid		Residential			
		Other			
		Hybrid systems			
Total			**944,26** (5)		**DC**

[1] *Source: GSE*

[2] *Blank box stands for not available data*

[3] *Building Applied Photovoltaic*

[4] *Building Integrated Photovoltaic*

[5] ***The value indicated in the table results from the difference between the value at the end of 2021 less the value of 2020. It is important to point out that actual installed capacity in 2021 is equal to 938 MW, due to decommissioning and statistic power update***

Table 3: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations	Data refer to the sum of PV nominal power
Is the collection process done by an official body or a private company/Association?	Public body for statistical data: GSE
Link to official statistics	www.gse.it www.terna.it www.arera.it

Table 4: The cumulative installed PV power in 4 sub-markets (1) (2)

Year	Off-grid [MW] (including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralized [MW] (Ground, floating, agricultural…)	Total [MW]
2019		13.021	7.844	20.865
2020		13.656	7.994	21.650
2021		14.546	8.048	22.594

[1]*Source: GSE, TERNA*

[2] *Blank box stands for not available data*

Table 5: Other PV market information (1) (2)

	2021		
Number of PV systems in operation in your country	1.016.083	Residential Commercial Industrial	812.610 111.916 91.557
Decommissioned PV systems during the year [MW]	4,9		
Repowered PV systems during the year [MW]			

[1]*Source: GSE*

[2] *Blank box stands for not available data*

Table 6: PV power and the broader national energy market

	Data	Year
Total power generation capacities [GW]	119.781	2021
Total renewable power generation capacities (including hydropower) [GW]	57.979	
Total electricity demand [TWh]	319,9	
New power generation capacities installed [GW]	0,67	
New renewable power generation capacities (including hydropower) [GW]	1,39	
Total PV electricity production (including self-consumed PV electricity) [TWh]	25,04	
Total PV electricity production as a % of total electricity consumption	7,8%	
Average yield of PV installations [kWh/kWp]	1.137	

1.3 Key enablers of PV development

Table 7: Information on key enablers [(1)]

	Annual Value	Total Value	Source
Decentralized storage systems (number)	35.698	76.886	GSE
Residential heat pumps (number)			
Electric cars (number)	69.213	118.034	www.aci.it
Electric buses and trucks (number)	3.488	9.209	www.aci.it

[1] *Blank box stands for not available data*

2 COMPETITIVENESS OF PV ELECTRICITY

The trend of falling prices stopped in 2020 and it started to rise in 2021, mainly due to the shortage of raw materials and the increase in the cost of energy at the end of 2021. In early 2021 the costs of PV modules began to grow, while at the end of the year they were followed by those of inverters, in parallel with a significant increase of the cost of mounting systems, cables, etc., all contributing to the "Hardware Costs" (see table 11 and 12). Instead, the "Soft Cost", meaning design, installation, permitting, etc. rose less, even if with high variability, which take into account the likely effect of some speculative bubbles probably related to other support measures.

2.1 Module prices

Table 8: Typical module prices [€/W] [1] [2]

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
2009	2,30		2,50
2010	1,50		1,70
2011	1,20		1,50
2012	0,70		0,80
2013	0,50		0,60
2014	0,50	0,80	0,55
2015	0,50	0,75	0,55
2016	0,40	0,65	0,48
2017	0,32	0,56	0,40
2018	0,20	0,48	0,35
2019	0,18	0,45	0,29
2020	0,16	0,44	0,30
2021 [3]	0,20	0,52	0,38

[1] *GSE specific survey*

[2] *Blank box stands for not available data*

[3] *Rising prices during 2021*

2.2 System prices

Table 9: Turnkey PV system prices of different typical PV systems [(1)] [(2)]

Category/Size	Typical applications and brief details	[€/W]
Residential BAPV < 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.	1,25 - 1,60 *(2021 Q1)* 1,32 – 1,80 *(2021 Q4)*
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.	1,20 – 1,36 *(2021 Q1)* 1,30 – 1,50 *(2021 Q4)*
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.	1,03 – 1,25 *(2021 Q1)* 1,10 – 1,37 *(2021 Q4)*
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	0,86 – 1,08 *(2021 Q1)* 0,95 – 1,15 *(2021 Q4)*
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.	0,75 – 0,85 *(2021 Q1)* 0,83 – 0,95 *(2021 Q4)*
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.	0,53 – 0,74 *(2021 Q1)* 0,60 – 0,84 *(2021 Q4)*

[1] *GSE specific survey*

[2] *Excluding VAT*

Table 10: National trends in system prices for different applications [€/W][(1) (2) (3)]

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system < 10 kW	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW	Centralized PV Grid-connected, ground-mounted, centralized PV systems 10-50 MW
2011	3,60		2,70	2,80
2012	2,60		1,80	1,70
2013	2,20		1,40	1,20
2014	1,67		1,40	1,03
2015	1,60		1,32	0,96
2016	1,55		1,22	0,88
2017	1,44		1,10	0,80
2018	1,41	1,20	1,08	0,69
2019	1,34	1,15	1,00	0,63
2020	1,33	1,15	1,00	0,62
2021[(4)]	1,44	1,36	1,10	0,71

[1] *GSE specific survey*

[2] *Blank box stands for not available data*

[3] *Excluding VAT*

[4] *Rising prices during 2021*

2.3 Cost breakdown of PV installations

Table 11: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of <10 kW [1] [4]

Cost category	Average (€/kW)	Low (€/kW)	High (€/kW)
Hardware [4]			
Module	0,44	0,40	0,52
Inverter	0,16	0,15	0,18
Mounting material	0,30	0,27	0,35
Other electronics (cables, etc.)			
Subtotal Hardware	**0,90**	**0,82**	**1,05**
Soft costs			
Planning[2]			
Installation work	0,09	0,07	0,11
Shipping and travel expenses to customer	0,03	0,02	0,03
Permits and commissioning[3]	0,10	0,08	0,11
Project margin	0,32	0,26	0,37
Subtotal Soft costs	**0,54**	**0,43**	**0,62**
Total (excluding VAT)	**1,44**	**1,25**	**1,66**
VAT	10%	10%	10%
Total (including VAT)	**1,59**	**1,38**	**1,83**

[1] GSE specific survey

[2] Planning cost are included in the other soft costs

[3] Including financing

[4] Rising prices during 2021

Table 12: Cost breakdown for a grid-connected, ground-mounted, centralized PV systems of >10 MW [1] [4]

Cost category	Average (€/kW)	Low (€/kW)	High (€/kW)
Hardware [4]			
Module	0,24	0,20	0,29
Inverter	0,08	0,07	0,09
Mounting material	0,14	0,13	0,15
Other electronics (cables, etc.)			
Subtotal Hardware	**0,46**	**0,40**	**0,53**
Soft costs			
Planning[2]			
Installation work	0,04	0,03	0,05
Shipping and travel expenses to customer	0,02	0,01	0,02
Permits and commissioning[3]	0,03	0,02	0,04
Project margin	0,16	0,14	0,17
Subtotal Soft costs	**0,25**	**0,20**	**0,28**
Total (excluding VAT)	**0,71**	**0,60**	**0,81**
VAT	10%	10%	10%
Total (including VAT)	**0,78**	**0,66**	**0,89**

[1] GSE specific survey

[2] Planning cost are included in the other soft costs

[3] Including financing

[4] Rising prices during 2021

2.4 Financial Parameters and specific financing programs

Table 13: PV financing information in 2021(1)

Different market segments	Loan rate [%] (2)
Average rate of loans – residential installations	3,0 – 5,3
Average rate of loans – commercial installations	2,0 – 3,0
Average rate of loans – industrial and ground-mounted installations	1,5 – 2,0

[1] GSE specific survey

[2] Ten years loans

2.5 Additional Country information

Table 14: Country information

Retail electricity prices for a household [€c/kWh]	23,10 (1) – 26,16
Retail electricity prices for a commercial company [€c/kWh] (2)	22,97 - 34,23
Retail electricity prices for an industrial company [€c/kWh]	13,46 – 19,90
Liberalization of the electricity sector	After more than two decades from its start, the process of liberalization and reform of the Italian electricity sector is still unsettled. The energy crisis with rising prices that started in 2021 became more intense in 2022 and has already force the government to postpone to 2024 the full liberalisation of the final consumer marked. More changes are likely to follow that could reverse in the next future liberalisation with a stronger intervention of the authorities or of the government.

[1] Consumption up to 5.000 kWh per year

[2] Nomisma Energia estimate

3 POLICY FRAMEWORK

Table 15: Summary of PV support measures

Category	Residential		Commercial + Industrial		Centralized	
Measures in 2021	On-going	New	On-going	New	On-going	New
Feed-in tariffs	-	-	Yes	-	Yes	-
Feed-in premium (above market price)	-	-	-	-	-	-
Capital subsidies (1)	Yes	-	Yes	-	-	-
Green certificates	-	-	-	-	-	-
Renewable portfolio standards with/without PV requirements (2)	-	-	-	-	-	-
Income tax credits	Yes	-	Yes (6)	-	-	-
Self-consumption (3)	Yes	Yes	Yes	Yes	Yes	-
Net-metering	-	-	-	-	-	-
Net-billing (4)	Yes	-	Yes	-	Yes	-
Collective self-consumption and virtual net-metering (5)	Yes	-	Yes	-	-	-
Sustainable building requirements	Yes	-	Yes	-	-	-
BIPV incentives	-	-	-	-	-	-

[1]At a regional level; most of tenders are for PV on public administration buildings and for small / medium-sized enterprises (SME)

[2] No obligations for utilities to obtain a minimum percentage of their power from renewable energy sources

[3] On-going measure, real time self-consumption. New measure, collective self-consumption and energy community

[4] Up to 500 kW

[5] Virtual net metering under some condition (paragraph 3.4)

[6] Specific national tax relief

3.1 National targets for PV

The Integrated National Energy and Climate Plan foresees a strong increase of RES electricity share in consumption, rising from 34% in 2017 to about 55% by 2030.In 2021 the share is around 36%. The main contribution is expected from PV production, with a target of cumulative

PV capacity of about 52 GW by 2030 and a corresponding electricity production of 73 TWh/year. With the approval of the European 'Fit for 55' package by the European Parliament and the Member States, it is expected that these targets will be exceeded, leading by 2030 to a cumulative PV capacity installed exceeding 70 GW.

3.2 Direct support policies for PV installations

The 2019 decree (MD of July 4th, 2019) aims at supporting, in the period 2019-2021, energy from new, refurbished and upgraded plants from “mature” RES: PV over 20 kW, onshore wind, hydro and sewage gas for a total capacity of about 8 GW (of which 7,4 GW new). Competitive auctions (for capacities over 1 MW) for groups of technologies and registries for smaller plants (with a capacity up to 1 MW), with some competitive elements are foreseen. The support for the plants with a capacity up to 250 kW is a Feed-In Tariff, and over 250 kW a sliding Feed-in Premium, so-called “two-ways mechanism”: the producer receives an incentive equal to the difference between a reference tariff and the hourly zonal price of energy. There are also additional remunerations: for plants installed on buildings (P≤100 kW), on self-consumed energy (if self-consumption exceeds 40% of yearly net production), and for PV plants replacing asbestos. At the end of 2021, most plants are still enrolled in the registers foreseen by the decree; it can be estimated that this capacity will be installed and commissioned in the years 2022-2024.

Tax credit measures (available for small size plants up to 20 kW and for storage devices), together with a net-billing scheme (Scambio Sul Posto, SSP), and a specific national tax relief for medium commercial/industrial installations, are further measures to support PV market.
Concerning SSP, Italy switched from a net-metering mechanism to a net-billing scheme for systems below 500 kW in 2009, in which electricity fed into the grid is remunerated through an “energy quota” based on electricity market prices and a “service quota” depending on grid services costs (transport, distribution, metering and other extra charges). Market prices are applied for the electricity injected into the grid as an alternative to SSP. Real time self-consumption is allowed for all PV system sizes.
A tax credit measure has been introduced in 2020 (so-called Superbonus 110%) for interventions in the field of building energy efficiency, installation of PV systems and infrastructures for charging electric vehicles. PV has to be coupled with building energy efficiency intervention in order to access the support.

An important contribution came from regional policies, such as, i.e., tenders for capital subsidies for PV plants, sometimes together with other RES or building energy efficiency interventions or storage systems.

3.2.1 BIPV development measures

None

3.3 Self-consumption measures

Table 16: Summary of self-consumption regulations in 2021

PV self-consumption	**1**	*Right to self-consume (real time)*	Yes
	2	*Revenues from self-consumed PV*	Savings on the electricity bill
	3	*Charges to finance Transmission, Distribution grids & Renewable Levies*	No
Excess PV electricity	**4**	*Revenues from excess PV electricity injected into the grid*	Net-billing, based on energy and services; indirect sale through a dedicated withdrawal and, in case of collective self-consumption and solar community, an incentive is granted on the shared energy [(1)]
	5	*Maximum timeframe for compensation of fluxes*	Net billing scheme, energy fluxes are calculated on a yearly basis. Collective self-consumption and energy communities, energy fluxes are calculated on an hourly basis (see paragraph 3.4)
	6	*Geographical compensation (virtual self-consumption or metering)*	On site. Meter aggregation and virtual net-billing are allowed for some specific cases, i.e., Municipalities of up to 20.000 inhabitants and the Ministry of Defence. In 2019/2020 a new measure, concerning energy communities, has been introduced for renewable plants with capacity < 200 kW
Other characteristics	**7**	*Regulatory scheme duration*	Real time self-consumption, unlimited. Net-billing is yearly renewed, even if a gradual phase out is foreseen starting from 2023
	8	*Third party ownership accepted*	Yes, with condition
	9	*Grid codes and/or additional taxes/fees impacting the revenues of the prosumer*	None
	10	*Regulations on enablers of self-consumption (storage, DSM…)*	Yes (tax credit for storage, coupled with PV)
	11	*PV system size limitations*	Self-consumption, none. Net-billing, up to 500 kW
	12	*Electricity system limitations*	None
	13	*Additional features*	None

[1] Managed by GSE. Concerning sale, the producer may choose between GSE dedicated withdrawal and market sale

3.4 Collective self-consumption, solar community and similar measures

Meter aggregation and virtual net-billing are allowed for some specific cases, i.e., Municipalities of up to 20.000 inhabitants and the Ministry of Defence.

The Italian Parliament approved in 2019/2020 a measure about self-consumption, allowing final consumers/RES producers to group together in order to share electricity locally produced by new RES plants with a capacity ≤ 200 kW. The Decree of 16 September 2020 completed the regulatory framework on energy communities and self-consumers; on December 2020, GSE made available the website to send the preliminary request to access to incentives (alternative to net-billing scheme) foreseen for two categories of prosumers:

- RES consumers acting collectively in a group located in the same building
- RES energy communities

A group of RES self-consumers acting collectively consists of at least two RES self-consumers. The PV plant may be owned and/or managed by a third party.

In the energy community, members may be private persons, small and medium-sized enterprises, local or regional public administration authorities. The main features of the RES energy communities are listed below:

- the withdrawal points of consumers participating in the community, as well as the entry points of the related plants, must be located on the LV electricity grids underlying the same MV/LV transformer substation;
- the consumption users included in the community remain connected to the existing public distribution network and they are not physically connected but virtually;
- relations between consumers are regulated through a private contract by identifying a delegated person responsible for the allocation of shared energy and any other tasks;
- it is possible to exit the configuration at any time, possibly by paying contractual fees.

Two different contributions are granted for 20 years:

- a premium tariff for the shared electricity (100 €/MWh for the group of prosumers, 110 €/MWh for energy communities). The shared electricity is the lowest value, calculated on an hourly basis, between the electricity fed into the grid and the electricity withdrawn from the points of connection;
- a contribution which is the sum of transmission fee and the highest value of the variable distribution component for consumers/loads in low voltage. Moreover, for a group of self-consumers acting collectively, an additional contribution, due for avoided network losses is granted.

It is also possible to request the withdrawal for the electricity injected to the grid managed by GSE. Moreover, the access to 50% of tax deduction is allowed. For PV plants under 20 kW, in addition, the access to the 110% tax deduction scheme is possible under the condition of not accessing to the premium tariff and of delivering the electricity injected to the grid to GSE.

At the end of 2022, GSE registered 24 RES consumers acting collectively in a group located in the same building and 12 energy communities, for a total capacity of around 800 kW.

3.5 Tenders, auctions & similar schemes

In Italy RES producers can stipulate private PPA but there are not specific regulation/or measures that could boost this development.

Regional tenders support RES, (building) energy efficiency, storage systems, energy communities and electric vehicles.

For FiT tenders, see paragraph 3.2.

3.6 Other utility-scale measures including floating and agricultural PV

The Law Decree 76/2020 allowed the access to support mechanisms for PV systems built on abandoned/degraded areas even if classified as agricultural. All other types of PV plants in rural areas cannot access to public incentives.

3.7 Social Policies

The municipality of Porto Torres (Sardinia region), in cooperation with GSE, introduced in 2017 the so called reddito energetico, energy income project: the municipality allocated public resources to purchase PV systems, sold on loan to families in energy poverty conditions, to benefit them from PV self-consumption, reducing their energy bills. The revenues of the net-billing (Scambio, Sul Posto, SSP) feed a public fund, in order to support the purchase of PV plants for other families.

After this pilot project, many other municipalities and regions are carrying out similar support mechanism.

3.8 Retroactive measures applied to PV

Law 116/2014, implementing Law June 2014, n.91, defined new procedures related to incentives granted to electricity produced by PV plants under all Feed-in schemes (I, II, III, IV and V Conto Energia), among which the so-called spalma incentivi. From January 1, 2015, tariffs (bonuses included, if any) for plants with a capacity over 200 kW were adjusted according to one of the following options:

- incentives granted for 24 years, instead of 20 years, with a tariff reduction on the remaining period;
- incentives granted for 20 years with a tariff adjustment, a reduction for the first period and an increase for the second one;
- incentives granted for 20 years with a tariff reduction.

3.9 Indirect policy issues

In 2021 administrative simplifications have been introduced for RES plants authorizations (Legislative Decree 77/2021, Legislative Decree 199/2021), as it follows:

- simplified procedures for large plants in the suitable areas are foreseen in compliance with regions, together with the extension to different categories of large plants (up to 20 MW for PV systems built in particular sites, up to 10 MW in suitable areas and for agricultural plants and floating), and with modification of the environmental integrated authorization criteria (capacity increased to 10 MW);
- simplified procedure for small BIPV plants increased up to 50 kW.

3.9.1 Rural electrification measures

The decree of February 14, 2017 grants subsidies to electric RES and thermal plants in small Italian geographical islands not connected to the mainland electricity grid, with an area greater than 1 km^2, located more than 1 km from the continent and with a resident population of at least 50 people.

The mechanism foresees a 20 years feed-in tariff for the electricity fed into the grid (GSE is also in charge for withdrawal and for the sale the electricity on the market). For self-consumed electricity (real-time consumption) a feed-in premium is applied. Moreover, a bonus for PV replacing asbestos is foreseen.

This support is alternative to the net-billing scheme, or dedicated withdrawal, or other public incentives.

3.9.2 Support for electricity storage and demand response measures

At the end of 2021, almost 77.000 storage systems were installed in Italy for a total nominal capacity of 409 MW. The capacity of PV plants with storage is equal to 464 MW. Storage systems are mainly concentrated in regions with a high number of installations (north of Italy). Tax deduction for storage (mainly) coupled with PV plants is foreseen, together with regional tenders.

3.10 Financing and cost of support measures

The Feed-in Tariff scheme of 2005-2013 set the financial cap of 6,7 BEUR in terms of yearly payments. The cost of the incentives for the Feed-in Tariff / Feed-in Premium is covered by a component of the electricity tariff paid by all final electricity consumers. The economic resources for the RES decree (2019-2021) are covered in the same way.

4 INDUSTRY

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

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

Table 17: PV cell and module production, production capacity information for 2021 (1) (2)

Cell/Module manufacturer	Technology	Total Production [MW]		Maximum production capacity [MW/yr]	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
Eclipse Italia	sc-Si, mc-Si		80,00	0	150,00
EXE s.r.l.	mc-Si				70,00
Enel Green Power SpA – 3SUN	Si-HJT			200,00	200,00
FuturaSun	sc-Si, mc-Si				
Gruppo STG	sc-Si, mc-Si		3,36	0	23,00
PEIMAR	sc-Si, mc-Si				500,00
Solbian	sc-Si PERC c-Si HJT mc-Si				2,4
SPS ISTEM	mc-Si				75,00
Sunerg Solar	sc-Si, mc-Si				100,00
Trienergia srl	sc-Si, mc-Si		4,65	0	24,00
Verditek Solar Italy	sc-Si, mc-Si				
Total			**88,00**	**200,00**	**1.144,4**

[1] *RSE specific survey*

[2] *Blank box stands for not available data*

In 2021 the total annual production reached by the surveyed companies is 88 MW, for a total production capacity of 1.144,4 MW/year.

The Italian photovoltaic industry is continuously growing, in fact, in addition to maintaining realities with expertise in specific markets, think for example of integrated photovoltaics (i-PV)

in buildings (BIPV or BAPV) or in electric mobility (VIPV), it aims at the development of innovative technologies of high-efficiency modules.

Among the companies specializing in products for i-PV, SOLBIAN focuses on the production of flexible photovoltaic modules that are particularly suitable for sailboats or electric mobility applications; photovoltaic modules can be customized in terms of size, power, and color.

The STG Group offers Building-Applied Photovoltaics (BAPV) and Building-Integrated Photovoltaics (BIPV) solutions; the Energy Glass - STG Group brand designs and manufactures BIPV products with transparent or opaque glass that is used as a building block. The products can be customized in terms of size, power, transparency and colors.

Trienergia, based in Mantua, offers photovoltaic modules in triangular (21 cells) and rectangular (42 or 60 cells) shapes, designed to make the most of triangular roofs. Their PV modules use MWT (Metal Wrap Through) back-contact cells that are bonded using a conductive glue on a conductive backsheet with Ebfoil.

Enel Green Power (EGP), based in Catania, focuses its market on large-scale photovoltaic systems and exports its product worldwide. The photovoltaic technology developed is bifacial heterojunction, and major achievements were made in 2020: the previous record of 24.63% was improved with a new efficiency of 25% for a heterojunction solar cell with an active area of 213 cm2, based on the M2 silicon wafer format. EGP is currently investing to create a 3GW line of cells and modules by 2023.

FuturaSun, which is headquartered in Padua and has its main production facilities in Asia, recently announced that it will start a PV module production line with an annual capacity of 1 GW by 2023.

In the field of CPV (concentrated solar power) Solergy and Sungen have been experimenting with both mirror and lens systems, passively or actively cooled. Specifically, Solergy has developed CPV systems on trackers with lens concentrators; Sungen has developed HCPVT (high-concentration PV thermal) prototypes.

4.2 Manufacturers and suppliers of other components

Relevant national PV inverter manufacturers both for small-scale and utility-scale applications, are Elettronica Santerno S.p.A, Elpower s.r.l, Borri S.p.A, Fimer S.p.A, Friem S.p.A., Reverberi Enetec s.r.l, Nidec ASI S.p.A., Riello Solar Tech - RPS S.p.A., and Siel S.p.A. In the framework of energy storage systems, also for residential applications, relevant national companies are Aton, Fiamm, Reverberi Enetec, SIEL.

Other Italian companies such as Bitron Electronic, Loccioni Group, offer technology solutions that, combined with photovoltaic systems, are able to maximize the energy self-consumption and interact with local energy management systems.

In Italy the UVAM experimental project offers the possibility for owners of a PV plant and a storage system to share them providing services to the electricity grid, thus forming an aggregate of systems within circumscribed geographical areas.

In this framework, Evolvere, a company of Eni Plenitude group, has developed in recent years devices for Smart Home and Smart Energy, which enable the prosumers - an electricity

consumer producing PV electricity to support his/her own consumption (and possibly for injection into the grid) - to monitor energy flows and to reach maximum efficiency and flexibility in home management.

In the field of supporting structures for PV modules, relevant Italian companies specialized in the development of single-axis trackers for PV utility-scale applications are Convert Italia SpA, Comal, REM Tec, Soltigua e SUNRACKER. Among these, Convert Italia SpA, Comal, REM Tec also offer tracker systems for agrivoltaic applications.

5 PV IN THE ECONOMY

5.1 Labour places

Table 18: Estimated PV-related full-time labour places in 2021 (1)

Market category	Number of full-time labour places
Research and development (not including companies)	
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products and installations	
Other	
Total	6.169 (2)

[1] Blank box stands for not available data

[2] GSE data concerning permanent jobs, in terms of FTE (Full Time Equivalent), directly and indirectly related to O&M activities on existing PV plants

5.2 Business value

Table 19: Rough estimation of the value of the PV business in 2021 (VAT is excluded) (1)

Sub-market	Capacity installed [MW]	Average price [€/W]	Value of PV business in 2021 [€]
Off-grid			
Grid-connected	938 (2)	1,122	1.052.436.000

[1] Blank box stands for not available data

[2] 938 MW is the actual installed capacity in 2021 (see note 5 of Table 1 and Table 2)

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

Italian electricity sector went through a deep reform over the last 20 years that changed it from a vertically integrated monopolistic structure to a liberalized market. The process started in 1999 but the complete liberalization was decided only in August 2017 and it is expected to be fully completed after 2024, when the tariff system will be eliminated also in the domestic sector. After the energy crisis of 2021/2022 some important changes are likely and the possibility to postpone again after 2024 the full liberalization of the domestic sector due to the sharp rise of electricity tariffs.

The former monopolist Enel still holds relevant market shares in all segments, especially in the domestic sector and in distribution. Enel is a private stock company where the state holds a 24% stake.

Generation, transmission and distribution are separated. Generation is a free activity where the first six groups industrial companies (Enel, Eni, Edison, A2A, EP Produzione and Iren) hold 49.3% in 2021 of the national gross production while the rest is scattered among several players.

Transmission is a regulated activity held by the transmission system operator (TSO) Terna, a stock company with the state holding a 30% stake; distribution is a regulated activity where e-distribuzione (Enel group) is the first operator with around 85% market share, followed by the other three major operators (Unareti, Areti, Ireti) that hold another 9%.

Retail activity is free, but with regulated tariffs for the domestic sector (for customers who decided not to switch to the liberalized market) until 2023. The 10 major retail operators hold 71% of the market, with Enel holding an overall 34,5%. Some companies with activities in production, distribution and retail are former municipalities owned by local authorities.

The Energy Authority (Italian Regulatory Authority for Energy, Networks and Environment - ARERA) was created in 1995 and regulates the electricity sector following directives from the Italian Government and the Parliament.

6.2 Interest from electricity utility businesses

Italian electricity utilities are strongly involved in the PV sector and in innovative projects.

6.3 Interest from municipalities and local governments

Public Administration owns, at the end of 2021, 19.583 PV plants, for a capacity of 805 MW (3,6% of the total capacity installed in Italy). At the end of 2021, 74% of Italian municipalities owns at least one PV plant installed.

7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

At the end of 2021 small plants with a capacity below 20 kW are mainly defining the Italian PV market (93% of the total number and 23% in terms of power), accessing to the net-billing scheme and tax deduction measures. Since 2017 Italy is experiencing also private PPA agreement for RES plants, although there is not a specific regulation/or measure increasing their success. It is worth to mention a secondary market of managing and acquisition of large (incentivized) plants.

PV social acceptance issue has to be faced, since after the booming market of the past years which allowed the installations of around 18 GW of capacity, an increasing opposition from population and local authorities is reported, mostly for ground plants. On the other side, concerning small plants, in the last years a new “PV on the roof” attitude increased, related to a sustainability culture (started during past FiT Law) in which self-consumption has a central role, with an important connection to social programmes like, i.e., energy community or energy income (see paragraph 3.4 and 3.7). Even BIPV plants installations are growing again from 2017 after the booming effect of the 2,5 GW of the past FiT era.

7.2 Prospects

In the ambitious target of 55% of electricity from RES set in the Integrated National Energy Climate Plan presented to the European Commission, PV expected to contribute the most with capacity of around 50 GW by 2030. This target could be also increased taking into account the REPowerEU package which is under discussion at EU level.

The Italian PV market continues to grow year after year, even if with different numbers from 2005 – 2013 Feed-in Tariff era. The results of the provisions of Ministerial Decree of July 4th, 2019 will became evident from 2022 on, and it can be reasonably said that PV technology will be most of the capacity accessing incentives.

New regulation on permitting will help, during time, to overcome this very deep-rooted problem in Italy.

Major development of energy communities is expected, with a growing awareness on PV, RES and building energy efficiency topics. Italy is the country with the highest concentration of heritage buildings and medieval towns that make difficult, sometimes, the refurbishment and PV installation. PV is generally considered still today only and simply as a technological plant and, in order to overcome this attitude, it is necessary to boost the topic of “PV and the building”, meaning BAPV but mostly BIPV, that with particular solutions could become, finally, a building element.

A massive information campaign (like that during past FiT era) about the need/importance to install PV to reach 2030 goals and to achieve energy independency could help PV deployment and social acceptance, through also new business models based on existing measures.