IEA INTERNATIONAL ENERGY AGENCY

LUT Lappeenranta University of Technology

IEA-PVPS

National Survey Report of PV Power Applications in FINLAND

2014

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

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Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its member countries

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The participating countries and organisations can be found on the www.iea-pvps.org website.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

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 2014. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 INSTALLATION DATA

The PV power system 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 2014 statistics if the PV modules were <u>installed and connected to the grid</u> between 1 January and 31 December 2014, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

The PV market in Finland has been concentrated for a long time on small off-grid systems. There are more than half a million summer cottages in Finland and a big part of those is electrified with an off-grid PV system capable to provide energy for lighting, refrigerator and consumer electronics. The amount of off-grid PV capacity in Finland is estimated to be around 10 MWp. Since 2010, the number of grid-connected PV systems has started slowly to increase. Currently the market of the grid-connected systems outnumbers the market of off-grid systems. The grid-connected PV systems are mainly roof-mounted systems for public and commercial buildings and individual houses.

1.2 Total photovoltaic power installed

The installation data of grid-connected systems was collected by the Energy Authority of Finland by a survey to distribution companies (Table 1). The survey was done in the summer 2015. The price information presented in section 2.2. was collected by the author with two methods: a) by interviewing a major PV system providers operating in Finland, b) by studying the web pages of component retailers and the whole system suppliers operating in Finland. The additional information is presented in Tables 2 and 3.

Table 1: PV power installed during calendar year 2014

AC			**MW installed in 2014 (mandatory)**	**MW installed in 2014 (optional)**	**AC or DC**
Grid-connected The whole capacity installed by 06/2015.	BAPV	Residential	6 MWp totally installed capacity		
		Commercial			
		Industrial			
	BIPV (if a specific legislation exists)	Residential			
		Commercial			
		Industrial			
	Ground-mounted	cSi and TF			
		CPV			
Off-grid		Residential	Data not available		
		Other			
		Hybrid systems			
		Total			

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Both methods: panel nominal power (DC) and inverter nameplate power (AC) are used.
Is the collection process done by an official body or a private company/Association?	The data collection was done from distribution network companies by Energy Authority of Finland.
Link to official statistics (if this exists)	This report.
Comments	The PV data in Table 2 was collected from the distribution network companies by Energy Authority of Finland. The data in tables 3 and 4 in was collected from available official statistics and other available sources by the author of this report.

Table 3: PV power and the broader national energy market.

MW-GW for capacities and GWh-TWh for energy	2014 numbers	2013 numbers
Total power generation capacities (all technologies)	Not available	16.6 GW
Total power generation capacities (renewables including hydropower)	Not available	Hydro power: 3.14 GW Biomass: 1.98 GW Wind: 0.45 GW Waste fuels: 0.06 GW
Total electricity demand (= consumption)	83.3 TWh	84 TWh
New power generation capacities installed during the year (all technologies)		
New power generation capacities installed during the year (renewables including hydropower)	Wind power: 627 MW (+179 MW)	Wind power: 448 (+160 MW)
Total PV electricity production in GWh-TWh	13 GWh	
Total PV electricity production as a % of total electricity consumption	0.02 %	

Table 4: Other informations

	2014 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	Not available
Capacity of decommissioned PV systems during the year in MW	Not available

Total capacity connected to the low voltage distribution grid in MW	6 MWp
Total capacity connected to the medium voltage distribution grid in MW	No systems connected to the medium voltage grid
Total capacity connected to the high voltage transmission grid in MW	No systems connected to the high voltage transmission grid

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Finland is a net-importer of PV modules. The modules are mainly imported from Eastern Asia. The prices were collected from on-line shops. They prices represent the price of multiple panels (~10-30), and are given in Table 5 without VAT.

Table 5: Typical module prices for a number of years

Year	1992						2014
Standard module price(s): Typical							0.85 €/Wp
Best price							0.65 €/Wp
PV module price for concentration (if relevant)							

2.2 System prices

The PV system market in Finland is still small. Hence, there is still variation in system prices in all categories. Also the amount of required installation work and materials varies in rooftop installations. Probably as the number of installations increases the prices will stabilise. The turnkey prices in Table 6 represent some kind price interval for each category. The data for the average are collected from different sources, such as: questionnaire to installers, discussions with installers, from media, and from web pages of installers. The prices represent the situation from second half of 2014 to first half of 2015. In general, the PV system prices have not decreased much during the last two years. A probable reason is the minimum price level for Chinese PV modules regulated in EU.

Table 6: **Turnkey Prices of Typical Applications – local currency**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW	Typically PV systems that are installed in boats, caravans, summer cottages and include lead-acid battery	5 €/Wp
OFF-GRID >1 kW	Typically PV systems for summer cottages.	4 €/Wp
Grid-connected Rooftop up to 10 kW (residential)	Systems installed to produce electricity in grid-connected houses for self-consumption. These plants are typically roof-mounted.	1.5-1.8 €/Wp

Grid-connected Rooftop from 10 to 250 kW (commercial)	Systems that produce electricity for the self-consumption of commercial buildings, offices and public buildings	1.25-1.5 €/Wp
Grid-connected Rooftop above 250 kW (industrial)	Systems that produce electricity for the self-consumption in industrial sites or large commercial buildings	1.2 €/Wp
Grid-connected Ground-mounted above 1 MW	Utility-scale PV plants which generate electricity for sale in electricity markets.	N/A
Other category existing in your country (hybrid diesel-PV, hybrid with battery…)		

2.3 Financial Parameters and programs

The parameters for different financing schemes for PV in Finland are presented in Table 7.

Table 7: PV financing scheme [1]

PV system acquisition model	Interest rate for external capital
Bank loan	Individuals and municipalities: 0-2 %
Financial leasing (8-12 a, can be continued)	municipalities: 0.7-2 %, others: 10 %
Installment	around 10 %
PPA	around 10 %
Crowd-funding	4-6 %

2.4 Additional Country information

The total electricity use was in Finland in 2014 around 83 TWh. The composition of energy sources in electricity mix is presented in Figure 1. In Finland, the retail electricity price consists of energy price, transmission/distribution, and taxes (VAT + electricity). For small consumers each of these cost component results up about one third of the total price. For large consumers, the energy price is the dominating component in the total price. Additional information about Finland is presented in Table 8.

[1] Karoliina Auvinen, "Comparison of different acquisition models for solar energy in Finland", available at: http://www.finsolar.net/?page_id=1835&lang=fi, accessed 26.11.2015

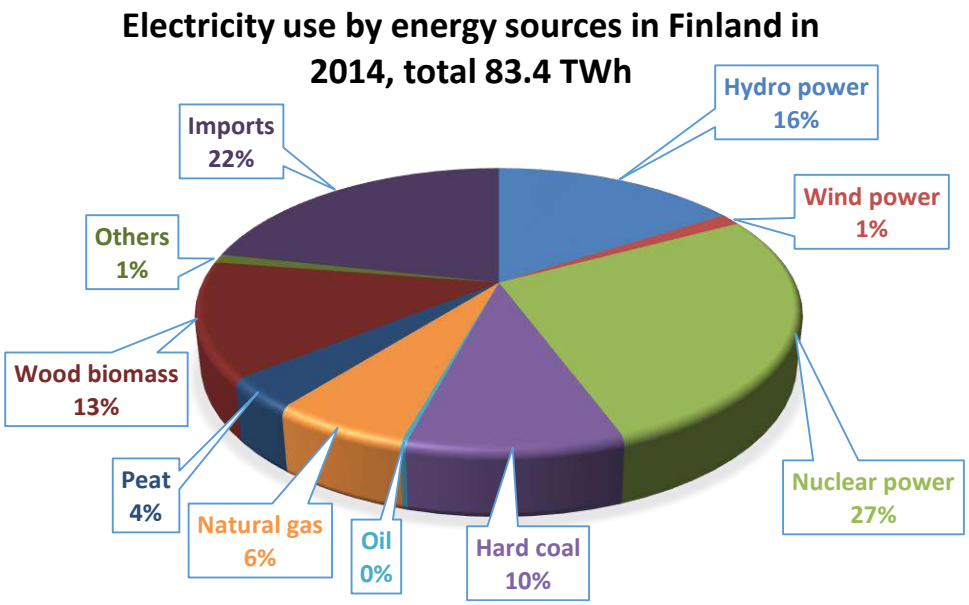

Figure 1. Electricity use by energy sources in Finland in 2014[2].

Table 8: Country information

Retail Electricity Prices for an household (average)	0.15 €/kWh[3] (includes levies and taxes VAT)
Retail Electricity Prices for a commercial company (average)	0.1 €/kWh (includes levies and taxes other than VAT)
Retail Electricity Prices for an industrial company (average)	0.072 €/kWh[3] (includes levies and taxes other than VAT)
Population at the end of 2014 (or latest known)	5 471 753[4]
Country size (km^2)	390 903 km2
Average PV yield (according to the current PV development in the country) in kWh/kWp	800-1000 kWh/kWp
Name and market share of major electric utilities.	The largest distribution companies, share of customers (total 3.4 million)[5]: 1. Caruna Oy, 18.7% 2. Elenia Oy, 12 % 3. Helen Sähköverkko Oy, 10.7%

[2] Statistics Finland, Energia 2014, available at: http://pxweb2.stat.fi/sahkoiset_julkaisut/energia2014/html/suom0000.htm, accessed 20.11.2015

[3] Source: Eurostat energy price statistics, available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_price_statistics#Further_Eurostat_information, accessed 31.10.2014

[4] Statistics Finland, available at https://tilastokeskus.fi/tup/suoluk/suoluk_vaesto_en.html, accessed 27.7.2015

[5] Energy Authority, Sähköverkko tekniset tunnusluvut, 2013.

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.

3.1 Direct support policies

The support measured for solar PV in Finland are presented in Table 9.

Table 9: PV support measures (summary table)

	On-going measures	Measures that commenced during 2014
Feed-in tariffs (gross / net?)		
Capital subsidies for equipment or total cost	Yes	
Green electricity schemes		
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)		
PV requirement in RPS		
Investment funds for PV		
Income tax credits	Yes	
Prosumers' incentives (self-consumption, net-metering, net-billing…)	Yes	
Commercial bank activities e.g. green mortgages promoting PV		
Activities of electricity utility businesses	Yes	
Sustainable building requirements	Yes (Building energy efficiency)	

3.2 Direct Support measures

3.2.1 Support measures existing in 2014

3.2.1.1 The national direct capital subsidies

The Ministry of Employment and the Economy grants investment support for the energy production. This energy support is particularly intended for promoting the introduction and market launch of new energy technologies[6]. So far, the Ministry has granted 30 % investment subsidy of the total costs of grid-connected PV projects. The total sum for all investment subsidies was around 80 million euros in 2014 and part of this was granted to solar PV projects. The decision for the investment subsidy is made based on applications. Only companies, communities and other organizations are eligible for the support. For agricultural sector there is also available an investment subsidy for renewable energy

[6] Energy Support from the Ministry of Employment and the Economy, available at https://www.tem.fi/en/energy/energy_support, accessed 27.7.2015

production from the Agency of Rural Affairs. The subsidy is 35 % of the total investment. However, only the portion of investment used in agricultural production is taken into account.

3.2.1.2 Guarantees of origin

Guarantees of origin are certificates which guarantee that the sold electricity is produced from renewable energy sources. The electricity sales company marketing renewable energy has to be able to guarantee the origin of electricity. The registry for the certificates is maintained by nation-wide high voltage grid owner and operator Fingrid Oyj. The system started on 1.1.2015.

3.2.1.3 Prosumers' development measures

Self-consumption of PV electricity is allowed in Finland. However, the current net-metering scheme is realtime and majority of installed electricity meters do not net-meter between phases. The hourly-based net-metering for individual consumers is under active discussion and will be possibly implemented. Both the consumption and the generation of electricity is metered with the same energy meter owned by the electricity distribution company. Several energy companies offer two-way electricity contracts for the prosumers.

Energy tax

Electricity generation with nameplate power less than 100 kVA is liberated from the payment of electricity tax. The tax liberation is also valid for larger plants 100 kVA – 2 MVA if the yearly electricity generation is less than 800 MWh.

Income tax

Owning of a PV system is not regarded as a business activity (1535/1992, TVL). Individuals can produce electricity for the own household use without paying taxes. For individual persons, the income from the surplus electricity sales is considered as a personal income. However, the individual person is able to subtract the depreciation and yearly system maintenance cost from the sales income. As a result in most cases there will not be no income from a roof-top PV system.

Tax credit

Individual persons are able to get a tax credit for the work cost component of the PV system. The sum is 45% of the total work cost including taxes. The maximum tax credit for a person is 2400 €/a. The tax credit is subtracted directly from the amount of taxes that have to be paid. The tax credit can be applied only when the PV installation is done as a retrofit.

3.2.1.4 BIPV development measures

There are no measures for BIPV development in 2014 in Finland.

3.2.1.5 Rural electrification measures

Finland has a reliable and well-developed power grid. Practically all permanent housings are connected to the electric grid. The off-grid sites are mostly summer cottages.

3.2.1.6 Other measures including decentralized storage and demand response measures

Currently there are no national measures for decentralized storage nor demand response. However, the research and development is active in companies, universities and research organizations on this field.

3.2.2 Support measures phased out in 2014

No support measured were phased out in 2014.

3.2.3 New support measures implemented in 2014

No new support measures were implemented during 2014.

3.2.4 Measures currently discussed but not implemented yet

Hourly-based net-metering for prosumers is currently under study.

3.2.5 Financing and cost of support measures

The support mechanisms for PV do not directly affect the electricity price in Finland. The investment subsidies given to companies, public entities and agrculture are covered from the state budget. Hence, they increase slightly the overall tax rate. The tax credits given to prosumers reduce the amount of taxes paid to the state.

3.3 Indirect policy issues

The hourly net-metering for prosumers is currently under discussion and study. If implemented it will probably increase the installation rate of residental PV systems. Another affecting factor is the energy efficiency regulation for housing. Solar PV systems can be installed to improve the energy efficiency class of the building.

3.3.1 International policies affecting the use of PV Power Systems

3.3.2 The introduction of any favourable environmental regulations

3.3.3 Policies relating to externalities of conventional energy

3.3.4 Taxes on pollution (e.g. carbon tax)

3.3.5 National policies and programmes to promote the use of PV in foreign non-IEA countries

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

Finnish R&D on solar PV is done at several universities. Academic applied research related to solar systems, grid integration, power electronics, and condition monitoring is done at Aalto University, Lappeenranta University of Technology, Tampere University of Technology as well as at Metropolia, Satakunta and Turku Universities of Applied Sciences.

In addition, there is also active research on silicon solar cells at Aalto University, on high-efficency multi-junction solar cells based on III-V semiconductors at Tampere University of Technology and on roll-to-roll printing or coating processes for photovoltaics at VTT Technical Research Centre of Finland. There are also research groups working on dye-sensitized solar cells (DSSC), OPV and ALD-technologies at Helsinki, Aalto and Jyväskylä Universities.

The research work in universities is mainly funded by the National Agency of Technology and Innovations (Tekes) and Academy of Finland. Tekes also funds company driven development and demonstration projects. The largest R&D company in the field of solar PV is ABB. Other major players are for instance Valoe(PV manufacturing lines, back contacts), Luvata (solar wires), Salo Solar (PV manufacturing), Vacon (inverters) and Beneq (ALD passivation).

4.2 Public budgets for market stimulation, demonstration / field test programmes and R&D

There are no specific budget lines or allocations or programs for solar energy R&D&I in Finland. PV is funded as a part of the quite open energy programmes. The average public spending on PV has been around 3 M€ annually during the last few years (Table 10). The Academy of Finland is funding basic research, with an estimated annual contribution around 0.5 M€ and Tekes - the Finnish Funding Agency for Innovation is funding applied research, innovation and demonstrations with around 2.5 M€ annually.

Table 10: Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test
National/federal	2 M€	1 M€
State/regional		
Total	3 M€	

5 INDUSTRY

5.1 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 11 below.

Table 11: Production and production capacity information for 2014

Cell/Module manufacturer (or total national production)	**Technology** (sc-Si, mc-Si, a-Si, CdTe)	**Total Production (MW)**		**Maximum production capacity (MW/yr)**	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
1		a	1	b	
2		c	d	e	f
3 etc					
Total	mc-Si		*n/a*		*25*
Thin film manufacturers					
1		x	*x*	y	*y*
2					
Cells for concentration					
1		g		h	
TOTALS		**a+c+x+g**	**1**	**b+e+y+h**	**25**

5.2 Manufacturers and suppliers of other components

Some manufacturers and suppliers of other components for PV systems located in Finland are presented below. The list is complete.

5.2.1 ABB Oy

In Finland ABB is one of the biggest company investing in R&D. For solar PV systems ABB develops and produces utility-scale PV inverters in Helsinki. Correspondingly, special transformers, protective relays, contactors, as well as control, monitoring and automation products for electricity distribution grids are developed and manufactured in Vaasa.

5.2.2 Beneq

Beneq provides technology for ALD (Atomic Layer Deposition) that can be used both in chrystalline and thin film solar cells.

5.2.3 Ensto Oy

Enso Oy is located in Porvoo. For solar PV systems it manufactures different enclosing solutions such as combiner and junction boxes.

5.2.4 Finnwind Oy

Finnwind Oy is located in Lempäälä. In addition of selling turn-key PV systems it sells and manufactures mounting systems for PV modules.

5.2.5 Luvata Oy

Luvata manufactures a copper-based flat wire used to connect silicon cells electrically and to carry out current in crystalline silicon and thin-film photovoltaic modules.

5.2.6 Naps Solar Systems Oy

Naps manufactures complete off-grid PV systems consisting of solar modules, control units, batteries and all necessary accessories.

5.2.7 Salo Solar Oy

Salo Solar Manufacures chrystalline silicon-based PV modules in Salo.

5.2.8 Vacon Oy

Vacon Oy is located in Vaasa, and is a frequecy converver manufacturer. The company was bought by Danfoss in 2014. Vacon develops and manufactures utility-scale PV grid converters.

5.2.9 Valoe Oy

The Valoe Oy is located in Mikkeli. It provides solar module plants and lines to local manufacturing partners. The Valoe's solar modules are based on conductive back sheet (CBS) and metal wrap through technology (MWT). The company originally bought the technology from Sunweb in 2013.

6 PV IN THE ECONOMY

6.1 Jobs

Table 17: Estimated PV-related labour places in 2014

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	
System and installation companies	
Electricity utility businesses and government	
Other	
Total	

6.2 Business value

Table 18: Value of PV business

Sub-market	**Capacity installed *in 2014* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	*X*	*Y*	*a = X x Y x 1 000 000*	
Off-grid non-domestic			*b*	
Grid-connected distributed			*c*	
Grid-connected centralized			*d*	
				a+b+c+d
Export of PV products				*e*
Change in stocks held				*f*
Import of PV products				*g*
Value of PV business				***a+b+c+d+e+f-g***

If possible, please provide some brief comment on the industry value chain in your country or provide references to articles, reports dealing with this topic.

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

Currently, the Finnish power system consists of power plants, the nationwide transmission grid, regional networks, distribution networks and electricity end-users. The Finnish power system belongs to the inter-Nordic power system together with power systems in Sweden, Norway and Eastern Denmark. In addition, there are direct-current transmission links from Finland to the Russian and Estonian power systems. These power systems are managed separately from the inter-Nordic power system. Correspondingly, the inter-Nordic power system is connected to Continental Europe by DC links.[7]

The backbone of the Finnish power systems is the nationwide transmission grid. It is the high voltage network which covers whole Finland and consists of 4500 km of 400 kV lines, 2300 km of 220 kV lines, 7500 km of 110 kV lines and 113 substations. The largest power plants, industrial plants and regional electricity distribution networks are connected to the transmission grid. The transmission grid is managed by Fingrid Oyj. The State of the Finland is the main owner of Fingrid with 53% of ownership. The transmission grid serves electricity producers and consumers enabling electricity trading on the inter-Nordic power system level. The majority of electricity consumed in Finland is transmitted through the transmission grid. In addition to the ownership Fingrid is responsible for the system supervision, operation planning, balance services, grid maintenance, construction and development and promotion of the electricity market.[7]

The electricity distribution networks, local and regional, are owned both by municipal and private utility companies. The number of distribution network is around 80. Each distribution grid company has a licence to operate alone at a certain area. Because they are monopolies their operation is monitored and regulated by the Energy Authority (Energiavirasto). The electricity trading companies, their number is about 60-70, are separated from the electricity distribution companies.

The Finnish electricity market was deregulated in 1995. Each electricity consumer is free to select the electricity provider. Currently, practically all electricity users have remote readable hourly-basis electric energy meter. The hourly system price of electricity is formed day-ahead based on supply and demand in the Nordic electricity retailing market Nordpool. Due to bottlenecks in power transmission capacities there are several price areas. Hence, the area prices may differ from each other.

7.2 Interest from electricity utility businesses

Some utility companies have started to marked turnkey PV systems as a product for residential houses and commercial buildings, such as Fortum Oyj, ESE Oy, Helsingin energia, Mäntsälän Sähkö Oy, and Oulun Energia Oy and Vattenfall Oy. They either make the installations by themselves or they have contracts with installation companies.

Several utility companies have announced offers to buy surplus electricity from micro-PV plants. On July 2015 there were more than 10 utilities making offers to buy surplus electricity country-wide and several smaller utilities operating only locally. In general, the utilities pay the Nord Pool Spot Finland area price[8] of the surplus electricity without VAT 24%, which is roughly one third of the retail electricity price.

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[7] The power system in Finland, available at: http://www.fingrid.fi/en/powersystem/general%20description/Power%20System%20in%20Finland/Pages/default.aspx, accessed 28.7.2015.

[8] Nordpool spot prices, available at: http://www.nordpoolspot.com/#/nordic/table, accessed 27.7.2015

7.3 Interest from municipalities and local governments

Several municipalities, have installed their own PV systems and are, for example, planning new housing areas such that roofs will be aligned towards south and there are no shadowing obstacles. There is also a Finnish project Carbon Neutral Municipalities (http://www.hinku-foorumi.fi/en-US), which is coordinated by Finnish Environment Institute. The municipalities involved in the project are committed to large CO2-emission reductions. A tool for this is the promotion of PV installations in the area of municipality.

8 STANDARDS AND CODES

Grid connection and installation

The PV inverter grid code accepted by Finnish distribution companies is compliant with German VDE-AR-N-4105:2011, which enables the usage of almost all PV inverters on the market. The technical requirements of grid-connected PV systems are given in the following national standards:

- SFS 6000-7-712 Low-voltage electrical installations. Part 7-712: Requirements for special installations or locations. Solar photovoltaic (PV) systems
- SFS-EN 62446 Grid connected photovoltaic systems. Minimum requirements for system documentation, commissioning tests and inspections
- SFS-EN 61724 Photovoltaic system performance monitoring. Guidelines for measurement, data exchange and analysis
- SFS-EN 50438 Requirements for micro-generating plants to be connected in parallel with public low voltage distribution networks

Building permits

The building codes related to PV installations are not harmonised in Finland. There is a big spread at municipal level. For example, cities in Helsinki area do not require any building permit for a roof-top PV plant. On the other hand some smaller cities may require permit even for a small roof-top PV plant. In household size plant, the preparation and applications building permit may add even 10 % to system costs. The project delay caused by the application of the building permit is more than a month.

9 HIGHLIGHTS AND PROSPECTS

During the year 2014 the capacity of grid-connected PV started to significantly increase in Finland. Key reasons for this were probably:

- The acceptance of PV inverters with German VDE-AR-N-4105:2011 grid code in all distribution network companies
- Price level of PV systems
- Investment subsidy for companies, and public entities
- Frequenct public discussion about solar PV

Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25°C, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for

reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication system in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, electricity utility businesses etc.

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is EUR.

PV support measures:

Feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh that may be higher or lower than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams

Compensation schemes (self-consumption, net-metering, net-billing…)	These schemes allow consumers to reduce their electricity bill thanks to PV production valuation. The schemes must be detailed in order to better understand if we are facing self-consumption schemes (electricity consumed in real-time is not accounted and not invoiced) or net-billing schemes (the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle). The compensation for both the electricity self-consumed and injected into the grid should be detailed. Net-metering schemes are specific since they allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes 'green power' schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development