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Forskningsrådet

IEA-PVPS

National Survey Report of PV Power Applications in Norway

2015

PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Prepared by

Øystein Holm

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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 Technology Collaboration 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 Norway's National Survey Report for the year 2015. 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 2015 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2015, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

The market for PV in Norway is split between of grid-connected systems (1,5 MWp) and PV to off-grid applications (0,9 MWp). The main driver for the grid-connected segment is high environmental goals set by property developers who want buildings or operations to reduce their energy-use. The off-grid market is expanded from small systems with 12 V DC battery only to larger hybrid systems with larger battery-capacities, diesel or petrol back-up generators and electrical conversion to 230 V AC.

1.2 Total photovoltaic power installed

Totally 2,45 MWp was installed in 2015, which is 10% more than the volume installed in 2014. This relatively small growth can be explained by low prices for retail electricity combined with weak and fragmented support-schemes for PV. In addition, during 2015 the market development suffered from uncertainties related to the legal framework for prosumers ('Plusskundeordningen') and their right to receive the production-premium Renewable Energy Certificates, RECS ('Elsertifikater').

In January 2015 the regulating body Norges Vassdrags og Energiverk (NVE) framed a proposal which would only issue el-certificates for the amount of electricity actually fed to the grid, and not for the total amount of PV-production including the amount of electricity self-consumed behind the energy meter. This resulted in a high degree of uncertainty among project developers and investors and it was much debated in media and among stakeholders throughout the year. In November, the Parliament instructed NVE to write a new proposal ensuring that the total production from PV-plants of prosumers may be issued el-certificates.

Table 1: PV power installed during calendar year 2014

AC			**MW installed in 2015 (mandatory)**	**MW installed in 2015 (optional but HIGHLY NEEDED)**	**AC or DC**
Grid-connected	BAPV	Residential	1,525	0,7	DC
		Commercial		0,825	DC
		Industrial			
	BIPV (if a specific legislation exists)	Residential	NA	NA	M° Y
		Commercial			
		Industrial			

	Ground-mounted	cSi and TF	NA	NA	M° Y
		CPV			
Off-grid		Residential	0,8	0,8	DC
		Other	0,125	0,125	DC
		Hybrid systems			
		Total	2,45		DC

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	
Is the collection process done by an official body or a private company/Association?	Multiconsult
Link to official statistics (if this exists)	www.ssb.no/ https://www.nve.no/Media/3434/4kvartal2015.pdf
	The main sources of the market data are the suppliers of PV-systems and equipment and from national statistics of trade.

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

MW-GW for capacities and GWh-TWh for energy	2015 numbers	2014 numbers
Total power generation capacities [MW] (all technologies)	NA	33 000
Total power generation capacities [MW] (renewables including hydropower)	NA	32 000
Total electricity demand [TWh] (= consumption)	129	126
New power generation capacities installed during the year [MW] (all technologies)	141	176
New power generation capacities installed during the year [MW] (renewables including hydropower)	141	176
Total PV electricity production in GWh	12	10,4

Total PV electricity production as a % of total electricity consumption	0,009	0,008

Table 4: Other informations

	2015 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	**NA**
Capacity of decommissioned PV systems during the year in MW	**NA**
Total capacity connected to the low voltage distribution grid in MW	**3,2**
Total capacity connected to the medium voltage distribution grid in MW	**0**
Total capacity connected to the high voltage transmission grid in MW	**0**

Table 5: The cumulative installed PV power in 4 sub-markets.

Cumulative installed PV power in 4 sub-markets	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Stand-alone domestic	6,4	6,8	7,2	7,5	7,8	8,1	8,4	8,8	9,3	9,8	10,5	11,3
Stand-alone non-domestic	0,4	0,4	0,4	0,4	0,4	0,5	0,5	0,5	0,5	0,5	0,6	0,7
Grid-connected distributed	0,1	0,1	0,1	0,1	0,1	0,1	0,2	0,2	0,2	0,3	1,7	3,2
Grid-connected centralized	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total [MW]	6,9	7,3	7,7	8,0	8,3	8,7	9,1	9,5	10,0	10,6	12,8	15,3

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Not Available.

Table 6: Typical module prices for a number of years

Year	1992					2014	2015
Standard module crystalline silicon price(s): Typical							NA
Lowest prices							NA
Highest prices							NA

2.2 System prices

System prices collected from system suppliers serving the Norwegian market. The system prices show large variations, and the referred are average prices excluding VAT/TVA/sales tax.

Table 7: **Turnkey Prices of Typical Applications – local currency**

Category/Size	Typical applications and brief details	NOK prices per W
OFF-GRID Up to 1 kW		60-100*
OFF-GRID >1 kW		70-150*
Grid-connected Rooftop up to 10 kW (residential)		18
Grid-connected Rooftop from 10 to 250 kW (commercial)		15
Grid-connected Rooftop above 250kW (industrial)		13*
Grid-connected Ground-mounted above 1 MW		
Other category (hybrid diesel-PV, hybrid with battery…)		

*) Assume same level as reported in 2014 – no data 2015.

Off-grid systems offered as complete packages for mountain-cabins normally include batteries, charging controls, modules and mounting-equipment, and may in addition include cables, connectors, lighting-equipment and so forth. There is a growing market for larger capacities, with

hybrid solutions, which may include transformation to 230 V and other components such as micro wind-turbines and diesel-generators.

Table 8: National trends in system prices (current) for different applications – local currency

Price/Wp	1992			2011	2012	2013	2014	2015
Residential PV systems < 10 KW				40-60	20-30	21	20	18
Commercial and industrial					15-20	15	16	15
Ground-mounted*						12	13	13

(* there are no ground-mounted PV-plants in Norway – these prices represent expected price-level.)

2.3 Cost breakdown of PV installations

The cost breakdown is based on the cost structure from one supplier with majority of the installations within the residental system market segment. The average system cost of the total representative data is broken down according to this cost structure. This gives an example of a cost breakdown for this segment, but relatively large variations must be anticipated because of the limited data available, and also significant uncertainty because of the method.

2.3.1 Residential PV System < 10 kW

Table 9: Cost breakdown for a residential PV system – local currency

Cost category	Example (NOK/kW)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	10 700		
Inverter	3 500		
Other (racking, wiring…)	700		
Soft costs			
Installation	3 500		
Customer Acquisition	NA		
Profit	NA		
Other (permitting, contracting, financing…)	NA		
Subtotal Hardware	14 900		
Subtotal Soft costs	3 500		
Total	18 400		

2.3.2 Utility-scale PV systems > 1 MW

Cost data for this segment is not available.

Table 10: Cost breakdown for an utility-scale PV system – local currency

Cost Category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module			
Inverter			
Other (racking, wiring, etc.)			
Soft cost			
Installation Labor			
Customer acquisition			
Profit			
Other (contracting, permitting, financing etc.)			
Subtotal Hardware			
Subtotal - Soft cost			
Total Installed Cost			

2.4 Financial Parameters and specific financing programs

Not available or relevant.

Table 11: PV financing scheme

Average rate of loans – residential installations	
Average rate of loans – commercial installations	
Average cost of capital – industrial and ground-mounted installations	

2.5 Specific investments programs

Not available or relevant.

Third Party Ownership (no investment)	
Renting	

Leasing	
Financing through utilities	
Investment in PV plants against free electricity	
Crowdfunding (investment in PV plants)	
Other (please specify)	

2.6 Additional Country information

Table 12: Country information

Retail Electricity Prices for an household (range), NOK/kWh (incl.VAT)	0,50 – 1,00*
Retail Electricity Prices for a commercial company (range)	0,40-0,60
Retail Electricity Prices for an industrial company (range)	0,20 -0,40
Population (1.april 2016)	5 223 300
Country size (km^2)	323 772
Average PV yield (according to the current PV development in the country) in kWh/kWp	800
Name and market share of major electric utilities.	Grid owners: Hafslund Nett, Agder Energi Nett, Skagerak Nett, BKK Nett, Lyse Nett, Eidsiva Nett, Trondheim Energiverk Nett, NTE, Troms Kraft Nett Power Producers: Statkraft, E-Co, Hydro, Lyse Produksjon, NTE, Trønderenergi, EB

*****The electricity price consists of three parts: electricity, grid, and taxes with large seasonal variation as well as significant variation from year to year.

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 for PV installations

3.1.1 New, existing or phased out measures in 2015

3.1.1.1 Description of support measures excluding BIPV, and rural electrification

With nearly all power-production from hydropower, Norway has not defined any national goals when it comes to implementation of PV technology.

Enova SF, a public agency owned by the Ministry of Petroleum and Energy, was established in 2001 as an instrument to improve energy system efficiency and increase renewable energy production. Enova offers support schemes in the areas in which the greatest effect in the form of saved, converted, or generated clean energy can be achieved.

In 2015 Enova introduced a new right-based support for a range of energy efficient technologies for households including PV. PV is supported with 35% of the investment within an upper support-limit of 10 000 NOK, plus 1250 NOK per kWp for systems up to maximum 15 kWp. Depending on the system-size and price, the support will typically be in the range 10% to 30%. For the commercial building segment, some of the projects that Enova supported under the demonstration support program in 2015 was so-called “plus energy buildings” or “Zero Emission Buildings” in which the use of PV was a central part of the concept among several other energy-efficiency measures.

New renewable power generation capacity from wind and hydropower will receive support from the Nordic el-certificate market. This bilateral agreement and common market for Renewable Electricity Certificates (RECS) between Norway and Sweden was established in 2012, but it is not effective for PV in Norway. The RECS-market has a minimum entrance fee of minimum NOK 15 000,- (~1850 €) which is an effective barrier for small PV-systems. RECS are traded with floating prices and is at the moment worth 0,13 NOK/kWh (~1,4 €c/kWh). During 2015 the market development suffered from uncertainties related to the legal framework for prosumers (‘Plusskundeordningen’) and their right to receive the production-premium Renewable Energy Certificates, RECS (‘Elsertifikater’).

The regulator Norges Vassdrags og Energiverk (NVE) framed a proposal which would only issue RECS for the amount of electricity actually fed to the grid, and not for the amount of PV-production that is self-consumed behind the energy meter. In November 2015, the Parliament instructed NVE to write a new proposal ensuring that PV-plants can recieve el-certificates for the total production. Because of this, the market for PV on large commercial and industrial buildings halted during 2015, but can be expected to grow going forward when the new legislation is in place.

For households in Oslo the climate-fund of the municipality of Oslo extended a limited demonstration-project with 40% investments support for PV. The budget for this project was limited to 4 mill.NOK in 2015.

3.1.1.2 *BIPV development measures*

Environmental qualities or aspects seem to become an increasingly important market parameter for stakeholders in the Norwegian building and construction sector. Enova has a strong focus on energy efficient buildings. BIPV and innovative energy solutions can be included in projects that can obtain support for a portion (normally in the range 20-50%) of the extra cost for energy qualities beyond the required building standard. More information about Enova and the annual report for 2015 can be found here: https://www.enova.no/about-enova/about-enova/259/0/

3.1.1.3 *Rural electrification measures*

N/A

3.1.1.4 *Support for electricity storage and demand response measures*

As for BIPV, Enova supports ambitious building-projects that are testing new and innovative energy solutions such as batteries and DSM-solutions. Projects can obtain support for a portion (normally in the range 20-50%) of the extra cost for energy qualities beyond the required building standard.

Table 13: PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2015 - residential	On-going measures Commercial + industrial	Measures that commenced during 2015 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2015 – ground mounted
Feed-in tariffs						
Feed-in premium (above market price)						
Capital subsidies		Enova-subsidies in the range 10-30% of a PV-investment.	Enova-subsidies of BIPV and innovative energy solutions in the range of 20-50% of the investment.			
Green certificates	(RECS) High entrance fee a barrier for PV. So far, no PV-plant is		RECS High entrance fee a barrier for PV. So far, no PV-plant is		RECS High entrance fee a barrier for PV. So far, no ground-	

	registered for RECS.		registered for RECS.		mounted PV-plant is built.	
Renewable portfolio standards (RPS) with/without PV requirements						
Income tax credits						
Self-consumption						
Net-metering						
Net-billing						
Commercial bank activities e.g. green mortgages promoting PV						
Activities of electricity utility businesses						
Sustainable building requirements						
BIPV incentives						
Other (specify)						

3.2 Self-consumption measures

Self-consumption is allowed for residential plants under the 'Plus-customer scheme' (Plusskundeordningen) provided that the customer is a net consumer of electricity on a yearly basis. At the moment the Plus- customer scheme is voluntary for the parties the utilities, but it is under revision at the moment and a new and compulsory scheme is expected to be implemented in the near future.

Under this scheme the utilities handles the transactions related to the power fed to the grid from distributed micro-generators such as PV-systems. PV-electricity fed to the grid is compensated by the current hourly spot-price in the power-market Nordpool (http://nordpoolspot.com/).

The Nordic electricity market has split power and grid cost and taxes are added end-use. Electricity fed in to the grid is hence given an energy sur-charge based on marginal losses in the grid. This charge could be even positive or negative (+/- 1,8 cEu/kWh). Normally this means additional compensation for distributed PV because distributed production reduces the marginal losses related to power transmission and distribution.

. Mandatory

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Yes, avoided cost of electricity from the grid (including grid-cost and taxes).
	3	Charges to finance Transmission & Distribution grids	Tariff for marginal losses (cost or income)
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Yes, normally the hourly spot-price
	5	Maximum timeframe for compensation of fluxes	
	6	Geographical compensation	
Other characteristics	7	Regulatory scheme duration	
	8	Third party ownership accepted	Yes
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	NOK 15 000 registration fee for prosumers (<100 kW)
	10	Regulations on enablers of self-consumption (storage, DSM…)	
	11	PV system size limitations	Maximum 100 kW injected into the grid from 'Plus-customers'.
	12	Electricity system limitations	
	13	Additional features	

3.3 Tenders, auctions & similar schemes

3.4 Direct Support measures

3.5 Financing and cost of support measures

Enova is financed via funds allocated from the Energy Fund. These funds must be used in as cost effective way as possible in order to achieve the goals that the authority sets.

The Energy Fund is financed via a small additional charge to electricity bills of 0,01 NOK/kWh. In addition, the Energy Fund has been allocated the proceeds from "The "Green Fund for Climate, Renewable Energy and Energy Efficiency Measures". The Green Fund's capital this year is 35 Billion NOK, however further funds will be added in the course of next years. 5 Billion NOK will be added in 2014 and 2015.

Renewable Electricity Certificates (RECS) are also financed by a small additional charge to electricity bills which with the current RECS-prices gives a surcharge of 0,0253 NOK/kWh.

3.6 Indirect policy issues

All households will get new smart (two-ways) energy meters installed within 2019. The new meters will register the consumption on an hourly basis and communicate metering data automatically to the system operator. The customer will get access to clear information of power consumption and prices and the meters can also enable additional functionality and services. Differentiated power distribution tariffs are used for commercial large customers, and they are under preparation also for households, but not implemented yet.

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

The Norwegian Research Council (NRC) funds industry oriented research, basic research and socio-economic research within the energy field, including renewable energy sources.

The total NRC-funds for PV-related R&D projects were appr. 67 MNOK (7,2 MEURO) for 2015. Most of the R&D projects are focused on the silicon chain from feedstock to solar cells research, but also related to fundamental material research and production processes. A growing supply business is also filling out the portfolio of projects.

The Norwegian Research Centre for Solar Cell Technology has completed its sixth year of operation (www.solarunited.no). Leading national research groups and industrial partners in PV technology participate in the centre. In 2015, the 13 centre partners were Dynatec, Elkem Solar, IFE, Mosaic Solutions, Norsun, Norwegian Crystals, NTNU, the Quartz Corporation, REC Silicon, REC Solar, Semilab, SINTEF and the University of Oslo. The research and industry partner activities span the entire value chain for the fabrication of crystalline silicon solar cells, from silicon feedstock production to solar module assembly. Combined, the partners form an active Centre with unique access to world class competence and research infrastructure spanning the entire production value chain.

The research activities were originally grouped into six work packages, five of which involve competence-building: mono- and multi-crystalline silicon, next-generation modelling tools for crystallizing silicon, solar-cell and solar panel technology, new materials for next-generation solar cells, and new characterization methods. The sixth is a value-chain project that will apply the findings of the other five work packages to produce working solar cell prototypes. A seventh work package was added in 2014 and the focus of this WP is the production of solar grade silicon. The center has excellent lab facilities for this type of research and it includes equipment for free-space reactors, rotating reactors and fluidized bed reactors. The total Centre budget is 374 MNOK over the duration of the Centre (2009–2017), and for 2015 the total funding was 40 MNOK.

There are seven main R&D groups in the universities and institute sector of Norway:

- IFE (Institute for Energy Technology): Focus on polysilicon production, silicon solar cell design, production and characterization and investigations of the effect of material quality upon solar cell performance. A solar cell laboratory at IFE contains a dedicated line for producing silicon-based solar cells. Additionally, a characterization laboratory and a polysilicon production lab, featuring three different furnace technologies have been established.

- University of Oslo (UiO), Faculty of Mathematics and Natural Sciences: The Centre for Materials Science and Nanotechology (SMN) is coordinating the activities within materials science, micro- and nanotechnology.

- NTNU (Norwegian University of Science and Technology) Trondheim: Focuses on production and characterization of solar grade silicon as well as next generation solar cell technology

- SINTEF Trondheim and Oslo: Focus on silicon feedstock, refining, crystallisation, sawing and material characterisation.

- NMBU (Norwegian University of Life Sciences): Focus on fundamental studies of materials for PV applications and assessment of PV performance in high-latitude environments.

- Agder University (UiA): Research on silicon feedstock with Elkem. Renewable Energy demonstration facility with PV-systems, solar heat collectors, heat pump, heat storage and electrolyser for research on hybrid systems.

- Norut (Northern Research Institute Narvik): Development of silicon based solar cells and includes the whole production chain from casting of silicon to solar cell modules. Testing of PV-systems under arctic conditions.

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

Table 14: Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test
National/federal	43 mill.NOK	24 mill. NOK
State/regional		
Total		

5 INDUSTRY

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

Elkem Solar is based on the so-called metallurgical route; Elkem Solar has invested in a silicon production plant in Kristiansand in southern Norway. With a design capacity of 6 000 tons of solar grade silicon per year, the plant started to ramp up production during 2009. The production technology is now tested and verified, and according to Elkem, it enables the company to produce silicon with just 1/4 of the energy consumption compared with traditional technology.

Following a standstill during 2012 and 2013 Elkem Solar started up its production of solar grade silicon in 2014. Elkem Solar increased the production to 6 500 tonnes in 2015.

Norwegian Crystals was established in the former REC Wafer production facility for mono crystals in Glomfjord. The capacity of the factory has been ramped up to a production of 350 MW corresponding solar cell power. The main products of Norwegian Crystals are mono crystalline silicon blocks (60%) and monocrystalline silicon wafers (40%) for the international market.

NorSun manufactures high performance monocrystalline silicon ingots and wafers at its plant in Årdalstangen in the western part of Norway. Annual production capacity of monocrystalline silicon ingot blocks at the company's facility in Norway is around 1000 tonnes or 350 MWp of corresponding solar cell power. Around 800 MT of these silicon ingot blocks are processed further at the company's facility in Norway into monocrystalline silicon wafers of around 280 MWp of corresponding solar cell power. In 2014/2015, market conditions have improved and the factory was running at full capacity while a number of cost reduction improvements were implemented.

The **QUARTZ Corp's** high purity quartz is used in a number of ways during the manufacturing of c-Si cells and modules, including in crucibles, quartz glass for tubes, rods, and windows, and silicon metal, the base material for all c-Si PV modules. 60-70% of the turnover comes from supplying materials to the solar industry, and all the products are exported –mainly to China.

Table 15: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	Total Production	Product destination (if known)	Price (if known)
Elkem Solar	Silicon feedstock	6500 tonnes		
Norwegian Crystals	sc-Si blocks/wafers	350 MW		
Norsun	sc-Si ingots	1000 tonnes		
Norsun	sc-Si wafers	280 MW		

Describe briefly the overseas activities of any key companies also operating in other countries.

5.2 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.

There is no module production in Norway.

Total PV cell and module manufacture together with production capacity information is summarised in Table 9 below.

Table 16: 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		b	
2		c	d	e	f
3 etc					
Total					
Thin film manufacturers					
1		x	*x*	y	*y*
2					
Cells for concentration					
1		g		h	
TOTALS		**a+c+x+g**	**d+x**	**b+e+y+h**	**f+y**

5.3 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain. Please briefly comment on the nature of this industry in your country, paying particular attention to recent trends and industry outlook, under the headings of:

- PV inverters (for grid-connection and stand-alone systems) and their typical prices
- Storage batteries
- Battery charge controllers
- DC switchgear
- Supporting structures

Eltek is a world leader in high-efficiency power electronics and energy conversion. - See more at: http://www.eltek.com/detail.epl?cat=23290#sthash.I2qknDhu.dpuf

6 PV IN THE ECONOMY

6.1 Labour places

Table 17: Estimated PV-related labour places in 2015

Research and development (not including companies)	165
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	800
Electricity utility businesses and government	
Other	31
Total	966

6.2 Business value

A rough estimate of the value of the PV-business given below, which is based on the market volume and price information provided. The industry has not been willing to share information of the value of their exported products, hence the value of export is based on the total turnover for the production companies Elkem Solar, Norsun and Norwegian Crystals.

Table 18: Value of PV business

Sub-market	**Capacity installed *in 2015* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	0,8	*80*	*64 000 000*	
Off-grid non-domestic	0,125	110	*13 750 000*	
Grid-connected distributed	0,7	18	*12 600 000*	
Grid-connected centralized	0,825	15	*12 375 000*	
				102 725 000
Export of PV products				*1 836 000 000*
Change in stocks held				
Import of PV products				
Value of PV business				***1 938 725 000***

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

Short description of the electricity industry landscape Norwegian Water Resources and Energy Directorate (NVE) is responsible for managing domestic energy resources, and is also the national regulatory authority for the electricity sector.	The Norwegian power sector is characterised by a large number of stakeholders within different areas of activity. The sector is organised around generation, grid and trading of power. Public bodies are considerable owners in the sector; for example, about 90 per cent of Norwegian hydropower production is owned by public entities

7.2 Interest from electricity utility businesses

The utilities showed some interest in PV for the domestic market during 2015, first of all by partnership in various research projects related to smart-grid. For example Fredrikstad Energi's 'Smart-Grid Hvaler'* focusing on implementation of 8000 two-way / smart meters (AMS) and distributed solar power (PV). But also by monitoring and analysing activities for understanding the impact of PV in the residential market, and to understand the consumers view and expectations to smart-grid solutions and related components including PV.

Some utilities launched marketing programs for PV towards the residential market.

*Establishment of the Norwegian Smart Grid Centre (NSGC, http://smartgrids.no/) was recommended by Energy21 in 2010, represents 48 stakeholders, and priorities are set by a steering committee.

7.3 Interest from municipalities and local governments

Oslo is member of C40 (http://www.c40.org/) and has already in place sound solutions and a strong political focus. Oslo's strategy promotion of electrical vehicles, collective transport, and combination of waste material-recycling and waste-to-energy solutions have created significant interest internationally. The municipality of Oslo implemented a demonstration-project for PV with 40% subsidy of the system cost with a total budget of 2 mill.NOK in 2014, which was extended to 4 mill.NOK in 2015.

8 HIGHLIGHTS AND PROSPECTS

The Norwegian Government has adopted a “technology neutral” strategy for increased production of renewable energy. There are no particular targets for solar power deployment.

The political strategies for future energy policies formulated in the Energi21-document includes solar power as one of six key areas. Each of these areas is characterised by significant potential, major challenges and tremendous opportunity. These are areas in which Norway enjoys competitive advantages in future energy markets, thanks to its natural energy resources, substantial technology and competency base, and widespread industrial experience. Among the strategy’s six priority focus areas, the Energi21 board recommends devoting special attention to Hydropower and Flexible energy systems. These two areas represent the very foundation of Norway’s energy system and are vitally important for current as well as future value creation.

In addition to these two strategic core technology-areas, Solar power together with Energy efficiency, offshore windpower and Carbon capture and storage are recommended for strategic focus going forward. The Energi21-documets can be downloaded here: http://www.energi21.no/prognett-energi21/Documents/1253955410595

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