

Index - Final Report

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1. Final report

The final report must be prepared in English. Please fill in the following sections of the template.

1.1 Project details

Project title	PV Grid
Project identification	Energinet.dk project no.
Name of the programme which has funded the project (ForskVE, ForskNG or ForskEL)	ForskVE
Name and address of the enterprises/institution responsible for the project	Gaia Solar A/S, Hammerholmen 9-13, 2650 Hvidovre
CVR (central business register)	19269280
Date for submission	6-9-2012

1.2 Executive summary

The project started in April 2013 with initial focus on preparing kick-off for all project partners in beginning of May. Following a successful kick-off with collective work-breakdown and mutual presentation of expectations and outcome, the work concerning identification of commercial market drivers (WP2) could begin. The work resulted in the production a market research plan and report analyzing and identifying relevant market drivers. The concretization of market needs and drivers on one side and an overview of sector and industry specific energy consumption profiles on the other made it possible to start identifying potential host-companies.

Following the market research, the project has produced various information and promotional material to be used for initiating the process of recruiting host companies. The material was subsequently tested on selected segments for further iterations and monitoring of penetration.

From second half of 2013 the work has mainly been focusing on the tasks of WP03, WP04, carrying out an iterative process to identify and test solutions and services to the market using the work and assigned personnel of WP02 to carry out contacts to potential customers. Preliminary work include Design roadmap and Technology report to be used to direct the customization of PV-hardware solutions to industry and businesses. Simultaneously a workshop has been held in the scope of WP04 focusing on development of services contributing to increased cost-efficient solutions for companies investing in and integrating PV systems into their energy portfolio.

At the end of 2013 the project experience some challenges in WP03, 04 and 05 with the substance being much more complex and difficult to dissect than foreseen in the initial project plan, which results in a delay of some of the work. The three challenges at this point are:

1. The complexity of finding, documenting and operationalize BoS, service innovations and Non Energy Benefits in WP04 and subsequently WP05. Resulting in a rescheduling for an accelerated time schedule.
2. Negotiation with financial institutions being lengthy causing delayed finalization of financial services.
3. The delayed service plans are making it harder to close projects with potential demonstration users due to the still undocumented value. The economic situation are still making it extremely difficult to get companies to invest in PV, making it harder than expected to find the host companies needed.

Despite this, the first demonstration project is finalized at Berendsen Textilservice, Holbæk in the beginning of 2014. The solution focuses on increasing momentary self-consumption of produced electricity by adjusting existing processes - primarily water heating. Different work related to understanding business segments are conducted in the beginning of 2014 in order to accelerate recruitment of host companies and present a "made-to-fit" PV-package for various business segments. This includes a 1) finalized matrix for business model linking optimizable technical, financial, environmental and marketing services, actions and technologies for testing on host companies, 2) tool for identification of business segments and strategic business units based on data-based segmenting, 3) scenario analysis for solar investment based on own consumption, electricity price, accounting for hourly consumption and production data and 4) study on flexibility potential within smart grid for storage and time-shifting of storage and regional solar variability.

The following service offers are presented at this time (H1 2014) following the finalization of the first demonstration project.

1. LCA analysis audit
2. Dissemination and educational kits
3. Report on use of excess electrical production (DTI)

The difficulties to engage the promised amount of host companies within the time schedule continues throughout 2014. This, in despite of the finalization of both PV-designs in WP3 and the completion of report on cost saving opportunities and strategies to meet commercial market needs in WP4 and presentation of service design in WP5. These deliverables altogether ensure the completion of offers for the targeted segments, and thereby ensure an optimized access to recruitment of host companies.

During summer 2014 the project Smart City Kalundborg (SCK) is terminated due to cooperation problems between primary members of the project and board. The SCK project was one of the primary drivers for initiating PV Grid in order to install 4 MW of PV in a smart grid. With Seas NVE being a partner in both SCK and PV Grid, the solution to this unfortunate externality is to focus on industry and businesses in Seas NVE's grid area in Region Zealand and not only in Kalundborg as planned from the beginning.

The enhanced recruitment area should in principle allow for an easier recruitment of host companies. A large-scale campaign to contact potential companies in the region of SEAS-NVE distribution network are therefore initiated with more than 100 companies contacted in end of 2014 and beginning of 2015. Despite of this dialogue no host companies are recruited at this time. The project team identifies the lack of a financing solution and a very short investment horizon as major barriers.

Regarding the financial model, the focus has been on defining a financial model for companies to invest in PV without upfront cost. In spite of an attractive ROI seen on the lifetime of the PV system, companies still hesitate to invest in PV, mainly due to payback periods longer than 3-5 years for PV systems. Another issue has been to get third party investment involved in investing in a PV portfolio for companies. Challenges to this model is nevertheless, that "elforsyningsloven" states that producer and consumer of electricity generated from a PV system on a company must be an identical legal entity in order to obtain reduction in fees and tolls imposed to electricity bought from the grid. For a third party to invest in the operation of a PV system on a company requires therefore the investor to renounce their ownership and subsequently their mortgage in the system leading to un-security for the investor.

Regarding the long horizon of the investment, typically 8+ years, many businesses compare the investment in PV with other possibilities of energy optimization with shorter payback time. The typical response from contacted companies is that they focus on other types of energy optimization than PV, or simply that the payback time for PV is too long.

As part of the recruitment process and dialogue with potential host companies in early 2015, the project contacted more than 100 companies in order to conduct a short initial interview to clarify their interest in investing in PV. This included their current energy supply portfolio and their possible use of green energy in their total energy consumption as a driver for their efforts to strengthen their CSR and PR efforts and make use of related values to invest in renewable energy. All the companies was offered a case study to examine their possibilities to make a feasible investment in PV – free of charge for the company.

Out of the more than hundred companies contacted, less than 30 companies accepted to complete the initial interview, and out of the 30 companies completing the interview only 3 companies agreed to participate further in the project and act as a case study. These case studies have subsequently been carried out.

In parallel to the above-mentioned work carried out to engage demonstrators, Gaia Solar have been using network, canvas calling and PV Grid website to address companies within the region. The result of this work have given less than ten interested companies, of which two companies have shown great interest.

In short, a lot of work and effort has been put into recruiting companies to demonstrate more than 20 different PV systems across branches of companies. The extensive effort resulted in the recruitment of one more host company – the private educational company Kunsthøjskolen I Holbæk in March 2015. They agreed to demonstrate a PV System, that primarily delivers the energy that the institution consumes momentarily, and for the remaining part tries to accumulate in their geothermal system by controlling the heat pumps attached to the system. Furthermore, Kunsthøjskolen will explore the value of PV by integrating their students and employees in the making of a PV structure for use and display in the yard of the school. The institution will also heavily monitorize their production and use of energy to use the stories internally and externally to communicate their efforts to act in an environmentally respectable manner.

With only two host companies and demonstrations in the beginning of 2015, the project team had put our trust in finding a feasible financial solution to act as door opener for recruitment. With the assistance of a Law Firm specialized in financial leasing and legal arguments, the project investigated and clarified various alternatives to either leasing or financing a PV-system. Despite being solid, robust and honest financing models the options were declined by the Danish Tax Authority.

In early summer 2015 the project had been running for 24 months without being able to achieving the expected results. The project team therefore decided to close down the project

by end of October 2015, based on the following reasons besides the impossible mission in recruiting demonstrators:

1. Closure of Smart City Kalundborg, making it impossible to develop the Smart Grid focus;
2. Lack of financial inticament to market maturity Smart Grid solution;
3. Key project partners' withdrawal from the project due to the shutdown of activities in PV, smart grid and sustainable transition. These are,
 - Danfoss; resigned as a result of the lack of Smart Grid focus, as well as due to their disconnection from the inverter division
 - Deloitte; shutdown focus on sustainability
 - Nykredit, closure of a focus on sustainability
4. the project has been able to identify and develop cost-effective new PV solutions for the corporate segment
5. the project due to lack of financial business model has not been able to attract the expected number of demonstrators.

The reminding period from summer to October 2015 has been used for dissemination and wrap up of the project. At central activity has been presentation of the project results on Building Green 2016 in October, being the largest trade fair for sustainable and energy efficient buildings in Denmark, and thereby perfect venue and platform for dissemination.

1.3 Project results

The overall scope of the project has been to address and overcome the barriers for commercial PV to achieve its potential. This has been done by addressing the following four underlying issues:

1. Identify critical barriers and assigning possible solutions. It is hypnotized that a basis for commercial PV investment can be created through simultaneously exploring perspectives for enhancing the return-of-investment, targeted information and dissemination activities for commercial end-users and relevant stakeholders, and finally addressing infrastructural and legislative barriers that could hinder market uptake. An essential aspect of this project will be to improve the return-of-investment (ROI) for PV. Current conditions for commercial investment in PV systems create payback times, far from the span (5-6 years) necessary to revitalize the market. Exploration, demonstration and realization of new concepts for collaboration, finance, business, energy utilization and building integrated photovoltaic can all improve return-of-investment for commercial PV.
2. Test and suggest a solution to the handling of large amount of PV locally. When the amount of commercial PV increases, it poses a potential risk for the energy infrastructure (e.g. flicker and harmonist fluctuations), and there is a need to address this issue. Part of the project will be to realize 4 MW PV and BIPV systems on industrials buildings in order to test the impact in the energy infrastructure.
3. Enhance the efficiency of BIPV for the commercial marked and demonstrate the potential. We expect to find that one of the barriers could be the efficiency of BIPV. In order to achieve national sustainability ambitions, energy-neutral buildings and realizing building codes, BIPV is often the most economical solution to meets these goals, compared to alternatives as low-temperature-heating, underground heat storage, central-heat-recovery-from-ventilation etc. BIPV is also able to compensate for unique

building design with lower energy-efficiency, where price and functionality do not relate to payback time, whether it is glass or marble facades, skylights etc.

4. Target information, training and dissemination activities for commercial market stakeholders.

The following description of the project results is therefore structured according to the above standing four issues and how the project has succeeded in answering this problem statement.

Identify critical barriers and assigning possible solutions.

Purpose: Activities have focused on exploring perspectives for enhancing the return-of-investment and addressing infrastructural and legislative barriers that could hinder market uptake.

- A series of services has been conceptualized in order to optimize the investment in PV for commercial market. These services include:
 - Consulting services – 1) identification of flexible power consumption, 2) technical energy analysis and 3) automatization of processes. The purpose of these services is to enhance the self-consumption of the produced PV-energy.
 - Technology services – 1) thermic storage in water, 2) storage via air-pressure, 3) storage in gyro, 4) storage in ice-bank and 5) offsetting processes. The purpose of these services is to either find use for the produced energy or offset processes and use the energy later.
 - CSR services – 1) Annual CSR report, 2) CSR product label, 3) Environmental report – light version and 4) Reduced environmental footprint. The purpose of these services is an opportunity for the company to differentiate itself from competitors with a green profile.
 - Financial services – 1) Leasing, 2) Mortgages, 3) Bank loan and 4) ESCO. The purpose of these services is to provide an attractive financing solution for PV-systems that are appealing to companies.
- Policy brief for politicians and Dansk Solcelleforening – pp document as appendix.
- Results and findings regarding financing services and financing business models have been shared with The Danish Green Investment Fund thereby accelerating their investments in and understanding of solar systems as investment.
- The works with financing solutions have also resulted in the new started cooperation between Gaia Solar A/S and SustainSolutions offering financing of solar systems to housing associations.

Test and suggest a solution to the handling of large amount of PV locally.

Purpose: Realization of 4 MW PV and BIPV systems on industrial buildings in order to test the impact in the energy infrastructure.

- Press release targeting potential host companies and Kalundborg municipality
- Participating in workshops held by Smart City Kalundborg to create synergy between the projects
- Meeting held with Kalundborg Municipality Company network
- Partner recruitment of potential host companies accelerated with updated recruitment material

- Contacted more than 150 companies, continued dialogue with more than 50 companies and demo-prospects for an estimated 11 MW.
- 2 host companies signed up and realized 0,364 MW of installed PV in total in the project.

Enhance the efficiency of BIPV for the commercial market and demonstrate potential.

Purpose: Tasks has focused on enhancing the efficiency of BIPV for the commercial market via a series of activities.

- Unfolding and describing the role of PV in Green Building Certifications (guideline).
- Industry building- and segment based PV-concept design (appendix describing a series of PV-solutions for businesses and industry utilizing multifunctional aspects in order to optimize the business case for BIPV and PV-solutions).
 - Detailed description of Zig Zag Solar façade system and PV-parking solution for detail and shopping industry based on dialogue with potential demonstrators.
- LCA-report for PV as building material compared to other materials (BIPV is able to compensate for unique building design with lower energy-efficiency, where price and functionality do not relate to payback time, whether it is glass or marble facades, skylights etc.).

Target information, training and dissemination activities for commercial market stakeholders

Purpose: The focus of this activity has been to strengthen the position of PV as an energy saving option and good investment for business and industry and provide the necessary material and information to stakeholders to support this decision.

- Lecture held at Kunstakademiets Arkitektskole (May 2013)
- Presentation of PV Grid in relation to Smart City Kalundborg project-team and stakeholders (spring 2013)
- Release of Partner- and competence catalog for the project (Autumn 2013)
- Lecture held at TI (Autumn 2013)
- Presentation on DI seminar (November 2013)
- PV Grid Brochure and factsheet information material (spring 2016)
- Launch of PV Grid web platform for recruitment and post-project propagation of results on national scale (Spring 2014)
- Presentation at Energiens Dag – Stevns (May 2015)
- Presentation at SIR conference, Slagelse (September 2015)
- Presentation and seminars on Building Green Seminar 2015 (October 2015)

1.4 Utilization of project results

The results from the project fall into two different categories. One is results and findings intended to strengthen market and framework conditions that can support commercial investment in general, by addressing the barriers defined in the project. These include:

- **Guideline on PV contribution to sustainable building certificates.** This report has been distributed to architects, engineers and building owners in order to feature the benefits of PV to attain these certifications.

- **New financial service, business models and solutions.** A central part of the project has been the exploration of new financial services as an important driver for PV uptake

among commercial players. A series of legal documents, tax clarifications, economic calculations and thorough descriptions has been created in order to evaluate and prioritize different financial solutions against each other and exploit new types of finance solutions for the Danish commercial market. Utilization of these results have included:

- Dialogue with financial institutions Nykredit, Nordea, Leasing Fyn and other leasing companies about PV suitability as leasing object, including statement and legal report from tax authority. The conclusion was that PV-system was suitable as a leasing object, but leasing was not possible because that "elforsyningsloven" states that producer and consumer of electricity generated from PV system on a company must be an identical legal entity in order to obtain reduction in fees and tolls imposed to electricity bought from the grid.
- Dialogue with The Danish Green Investment Fund (Danmarks Grønne Investeringsfond). The Fund is an independent state loan fund with the purpose of co-financing economically viable projects that facilitate and support the sustainable development of our society including renewable energy projects at privately held companies. PV Grid initiated contact with fund in summer 2015 and have transferred and provided them with general understanding of solar PV and the legal documents, clarifications and financial models and calculations. The result of this has been an accelerated introduction to PV and thereby enhancing the possible investment in PV-systems for industry.
- Dialogue and partnership with the company SustainSolutions offering a financial solution to both commercial players and housing associations. Based on the exploration of new financial models – which have been lead by the PV Grid partner Smith Innovation – these learnings have contributed to the establishment of a the new company SustainSolutions. The company is able to offer financed turnkey solutions within ventilation, LED and solar PV (with Gaia Solar) based on an ESCo-inspired business model. The expected market for the solution is primarily housing associations and secondary businesses. Typically industry and businesses demand shorter pay-back times than the solution can offer.

http://finans.borsen.dk/artikel/1/305404/pensionsselskab_investerer_300_millioner_i_energi_renovering.html
www.sustainsolutions.dk

- **New CSR service.** An essential driver of PV-system has been CSR policy and strategies, typically in larger enterprises. A part of the PV Grid project has been to explore this driver in order to be able to quantify the value of PV as part of a given company's CSR activity and value in terms of investment. The project has collected these findings in the report "Who Cares Wins" from January 2015. The report has been distributed to a series of companies and are used as documentation of some of the tacit aspects of an investment in PV.

- **New PV ambassadors.** When looking at the partnership behind the PV Grid project, the project have contributed to a deeper understanding of PV-systems, that directly or indirectly have resulted in a positive impact and strengthening of investment in PV. Looking at **GXN (3XN)**, PV has become an essential driver and aspects in building projects. The exploration of BIPV concepts focused on specific segments have resulted in an ability to match the right PV-solution to the client. The partner **Smith Innovation** has created a new company Sustain Solutions offering financed energy solutions – including PV to companies and housing associations. **Danish Technological Institute** has developed new possible service offers from exploring the possibilities of load shifting and storage of PV-energy. **Seas NVE** has positioned themselves as ambassador for PV-systems and solutions offering industry and companies' prospects and calculations.

1.5 Project conclusion and perspective

In retrospective the PV Grid project have had a good birth, a tough life and respectful funeral. The project was initiated early 2013 shortly after the change of the annual net metering scheme in late November 2012. This change had a massive impact on especially the residen-

tial market, but all markets for PV was affected by this change. The market size was reduced from 400 MW in 2012 to approximately 42 MW in 2015. The consequence has been that the market for PV in Denmark was strongly reduced from the middle of 2013, where a booming pipeline of PV projects from 2012 had been completed. The result has been the bankruptcy of more than 100 PV-suppliers and estimated loss of +5000 jobs related to PV in Denmark.

This situation has made it even more difficult to convince the commercial market to invest in PV, partly due to the negative debate related to PV and partly due to the worsening of the general business case for PV. This said, the project team and efforts have been optimistic in addressing barriers and assigning solutions that might change the market for commercial PV.

These are the conclusions of the project:

- The majority of the companies we have talked with have had preconceived standpoint on acceptable payback time of investments maximum could be 3-5 years. This is the “typical” payback time for most other energy optimization, which the investment in PV has to compete with. We expect a steady growth in PV-investment in the next couple of years (2016-2017) among industry and businesses that already have implemented energy savings with shortest payback time (lowest hanging fruits).
- Closure of Smart City Kalundborg, made it impossible to develop the Smart Grid focus and utilize the potential business models related to smart grid that was expected to optimize the business case for PV.
- The decision whether to invest in PV is a decision that takes long time. The estimated lead time from first meeting till the PV system is installed often takes more than a year. The project has worked to address this process and potentially reduce the decision time by segmented information and deeper understanding of the particular industry and business. This has led to improved economy and calculations, but not enough to have an effect, which is reflected in the project’s failure to sign up host companies.
- The efforts concerning optimized services and segmented PV-hardware solutions made in the project has not created the expected impact on the business case. The primary driver for industry and businesses alike has been payback time. This said, we expect both CSR, Green Building certifications, BIPV cases and the financial solutions to be part of future PV business cases for industry and businesses. A recent example is The Danish Green investment Fund and their focus on PV for industry.

1.6 Annual export of electricity (only ForskVE)

The PV Grid project has established two PV-systems.

Berendsen Textile Service:

- Of the 300.000 kWh produced every year, 30.000 kW are annually exported to the grid. Since installation in May 2014 the total export of electricity to the grid has been approximately 50.000 kWh.

Kunsthøjskolen Holbæk:

- Of the 60.000 kWh produced every year, 0 kW are annually exported to the grid.

1.7 Updating Financial Appendix and submitting the final report