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Green PE

WP3: EVALUATION AND CASE STUDIES OF THE PILOT DEMONSTRATORS



EUROPEAN
REGIONAL
DEVELOPMENT
FUND

EUROPEAN UNION

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Published in February 2019

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1. Introduction

The purpose of this output is to evaluate the work in the pilot demonstrators in the Green Power Electronics (Green PE) project by analysing their potential impact on the industrial growth in the Baltic Sea Region (BSR) within the areas of renewable energy, e-mobility and smart houses.

In addition, this report presents cases of companies related with the pilot demonstrator activities in various ways and shows in which extent the demonstrators have made impact on their business. The input from the companies was very decisive, from a very early stage, in the selection of the issues to demonstrate in each pilot demonstrator, ensuring the industrial relevance of the activities.

This output is of interest for companies working on electronic design and manufacturing; energy optimization; and applications on energy efficiency within renewable energies, e-mobility and smart buildings. This target group can use this output document as informational basis making decisions about the integration of advanced PE into their business and research & innovation (R&I) strategies.

Further detailed information on the implementation of each pilot demonstrator including results are available in a technical report prepared for each demonstrator - this information is also available on the project's website.

2. The evaluation method

The concept used in the evaluation of the pilot demonstrators was defined at an earlier stage by the pilot leaders and discussed, at two Joint Project Meetings, with the whole consortium.

Each pilot team (total 6 teams) produced a contribution to this document with the following information:

- Brief description of the pilot
- Main results of the pilot demonstrator
- The impact (expected and the outcome) the pilot results had on the target group as described in the output specifications for O3.5 and
- The identification of 'cases'. That means the identification of companies to be studied to exemplify the relevance of the pilot results in their business development.

All contributions were compiled in the present document.

Each 'case study' was to include the following information:

- Description of the company
- Main interest for the company
- The description of how the learnings of the pilot demonstrator impacted the company business

The input from each pilot team was reviewed and evaluated by the WP leader and one another independent member of the consortium to ensure the reliability of the evaluation and included in this document after their approval.

3. Pilot demonstrator: GaN H-bridge inverter with active power buffer

Due to better material features Gallium Nitride transistors offer a number of advantages over state-of-the-art Silicon counterparts but the main gain, from power electronics point of view, is the better Figure of Merit, calculated by multiplication of the on-state resistance and drain-source capacitance. In practice, GaN transistors (majority are High Electron Mobility Transistors - HEMTs) operating in power converter circuits are faster, which lead to lower switching energies. Shorter switching times and lower amount of dissipated energies can be translated into much higher switching frequencies. In consequence, the size and weight of passive components may be decreased due to new, better transistors.

Application of GaN transistors, instead Si counterparts, in a H-bridge inverter strongly affects the size and weight of the passive elements. For a 2 kVA system considered in this pilot demonstrator, increase of the switching frequency to 100 kHz together with unipolar PWM modulation, make possible a decrease of an output LC filter size ($L_f=2 \times 40 \mu\text{H}$, $C_f=1 \mu\text{F}$). Thus, the use of new transistors increases the power density of the power converter.

Unfortunately, the high switching frequency of the H-bridge transistors does not affect the size of the DC-side capacitor, an aluminium electrolytic technology is usually applied here with all advantages (high capacitance per volume, low cost) and disadvantages (weak parameters stability, high losses). Therefore, the DC-side capacitor necessary to reduce low frequency pulsations, is a significant part of the converter when volume and weight are measured.

Very good performance of GaN transistors may be used to eliminate or reduce the DC-side capacitor by the application of an active power buffer. This solution, known in the literature since couple of years, introduces a fast DC-DC converter with a capacitive energy storage to compensate low frequency power pulsation. Two transistors of the DC-DC may be GaN HEMTs, which enables switching frequency well above 100 kHz. Furthermore, when a special control with turn-on at zero current is introduced this frequency may be higher than 500 kHz, which seriously limit size of the necessary inductor to 30 μH . All in all, the active power buffer ensures a good quality of the DC and AC waveforms with a DC-side capacitor decreased to 15 μF only.

Designed, built and experimentally verified the GaN-based 2kVA H-bridge converter demonstrates the potential of the new power semiconductor technology in the renewable energy area. The converter is smaller and lighter due to the increased switching frequency, but the active power buffer eliminates bank of aluminium electrolytic capacitors from the DC side. Instead, the high-frequency active power buffer is applied and - according to the obtained results - offers the same quality of the waveforms as in a standard inverter. Therefore, the power density of the designed inverter rises but the reduction of the possible problems with electrolytic capacitors should be also underlined.

Evaluation and Case Studies of the Pilot Demonstrators

3.1. Impact of the pilot demonstrator

The results of this pilot demonstrator will have a significant impact on the target group, specifically stakeholders operating within renewable energy, production of power supplies as well as drives for e-mobility segments. The main bullet points of the current outcome can be defined as follows:

- The advantages of GaN-based components over those based on SiC, in 600 V applications working at high switching frequency to design compact and very light advanced power electronics working at high power density and high energy efficiency, have been clearly demonstrated.
- Development of PE products with GaN components is within capabilities of a typical SME but the driving force is in the biggest companies located in photovoltaics, automotive, aviation, space and military segments.
- Outdated energy conversion systems operating for many years in many industries are a great opportunity when looking for a market for new products.
- The stimulating force may be national programs supporting electric installations exploiting renewable energy sources and working with highly efficient micro inverters in houses.

3.2. Follow-up activities

Today's cost of PV inverters on the level of 0.2 - 0.5 USD/W depending on total power is a serious challenge for new designs. It is clearly seen that on the one hand the target market for the growth of wide bandgap power semiconductors is a global market and on the other hand fully customized power supplies where the weight, power density and costs of cooling systems are critical figures. The factor often considered in the general analysis is the availability and lead time of GaN-based semiconductor devices. The availability is strongly correlated with fluctuations generated by big players on e-mobility markets and results from a limited number of manufacturers. Stakeholders still treat this technology as a technical novelty and growing business with great prospects for the future, but raising doubts about its maturity and, above all, reliability. The cooperation between science and industry favours the development of real demonstrators, thanks to which it is difficult to undermine and argue with the technical advantages of proposed solutions, cutting off at this stage from costs analysis, and primarily looking at competences and potential. The visited companies show interest in employing specialists in their R&D teams for advanced power electronics.

3.3. Case studies of the pilot demonstrator

3.3.1. Case study #1: Semicon Sp. z o.o

Description of the company

Semicon Sp. z o.o. is an EMS company located in Warsaw, Poland. SEMICON Sp. z o.o. was established in 1987 and since then it has been present on electronic market. They are an official distributor of well-known manufactures of electronic components. Semicon also specializes in laser modules production as the biggest manufacturer in Poland. They offer PCB's assembly in the SMT and THT technology. Semicon employs 90 people.

Evaluation and Case Studies of the Pilot Demonstrators

They base their activities on ISO 9001:2008, ISO 14001:2004, ISO 13485:2012, AQAP 2110:2009, ISO 13485:2012/AC:2012.

Main interest of the company related to the pilot demonstrator

Semicon has been in cooperation with Polish advanced power electronics manufacturer as an EMS provider. They are looking for new products and technologies for implementation using R&D team and well equipped SMT/THT lines. They would like to adopt the power electronics as own product line for the renewable energy sector.

Impact of the pilot demonstrator on the company business

The demonstrator strengthened the company's technical expertise and produced favourable results which encourage Semicon to consider GaN-based power electronics for future series production of its inverters for wide range of applications, including power supply systems.

3.3.2. Case study #2: RAFAKO S.A.

Description of the company

Belonging to PBG Group the largest European boiler manufacturer, RAFAKO S.A. offers complete power generation units including units for supercritical steam parameters. The company offers design and manufacture of a wide range of boilers, including PC boilers and fluidized bed boilers as well as flue gas cleaning systems including FGD, SCR plants and dedusting plants.

Main interest of the company related to the pilot demonstrator

RAFAKO is a globally recognised manufacturer of steam generators and equipment for power, combined heat and power and incineration plants. And power is only a small step away from electric. RAFAKO has always been tracking new market trends and innovative projects in its core business segment, while opting for environmentally-friendly solutions. The company has been evolving and searching for new growth directions, preferably linked to power generation. It has never operated in the automotive market but having closely watched the electric mobility trends for a couple of years, the Management Board has resolved to set up a unit and then an entire team responsible for the e-bus project. Built for two years now, the team consists of IT, electronics and mechanical engineering specialists with extensive experience in the automotive and transport markets. Over the past two years, RAFAKO has carried out in-depth research of the bus market and forged relationships with design and research firms as well as key automotive manufacturers. Their interest in electric buses was chiefly prompted by a growing demand for this type of products and the continued market expansion that has been seen recently, both in terms of demand and available technologies.

Manufacturers are plentiful, but so is demand, with both the leaders and other players, including RAFAKO, having an opportunity to ride the growth wave, where securing the first contracts and credentials is key. Therefore, the company is monitoring and analysing demand from this new, rapidly growing market, while working to establish contacts with municipalities to pave the way for potential partnerships in identifying market requirements and bus testing, having already signed letters of intent with several interested municipalities.

At the same time, RAFAKO employs proven and reliable solutions to make sure RAFAKO brand is associated with premium quality and robust safety standards.

Evaluation and Case Studies of the Pilot Demonstrators

In a few months, three prototypes with appropriate market configurations will be ready for testing in various traffic conditions, including a school bus version being an alternative to the old-type vehicles used to transport schoolchildren.

Impact of the pilot demonstrator on the company business

RAFAKO has very limited experience with advanced power electronics based on wide bandgap semiconductors. They would like to adopt the Green PE project outputs and competences of Warsaw University of Technology team to establish a new project for customized inverters for electric buses.

4. Pilot demonstrator: Bi-Directional battery charger/conditioner based on SiC components

The pilot demonstrator is aimed at developing and manufacturing a demonstrator unit for a grid-connected battery conditioner with capability of utilization in a range of mobile applications. The bidirectional feature of the unit allows for both charging and discharging a high voltage Li-Ion and Lithium Iron Phosphate (LiFePO) batteries with minimized energy losses. This enables energy efficient conditioning of the batteries during daily charging, battery stack manufacturing and potentially for the grid support in smart grid installations.

To provide a high conversion efficiency, the unit is designed so that it does not include galvanic isolation and uses SiC power modules configured as a 2-level switching, 4-quadrant active rectifier, with the batteries connected across the DC-link. An electronic circuit for control of grid and battery inrush currents during connection and disconnection is included.

United-SiC's UJ3C and UF3C silicon carbide FETs were used. They are based on a unique cascode configuration (two-stage amplifier that consists of a common-emitter stage feeding into a common-base stage) and high performance G3 SiC fast junction gate field-effect transistors (JFETs) co-packaged with a cascode optimized MOSFET to produce the only standard gate drive SiC device on the market today. The high switching speed, fast body diode, high temperature operation, low RDS(ON) and ruggedness of SiC FETs (cascodes) make them an excellent solution for all switching circuit topologies.

Two generations of these modules have been tested, and already the first generation has demonstrated that the switching frequency can be increased, without sacrificing efficiency, which leads to a more compact design, thus increasing the power density of the unit. Also, the SiC devices showed significantly more symmetric switching times, compared to silicon insulated-gate bipolar transistors (IGBTs), which allows for less dead time in the Pulse Width Modulation (PWM) control signals. As a result, the distortions originating from the dead time non-linearities were reduced significantly.

It was very important to check out the performance improvements related to the new SiC modules released in Q2 2018. Computer modelling has given about 50% reduction in both switching and conduction losses by changing from the 1st to 2nd generation of 1200V SiC modules. In practise, somewhat smaller improvement values (due to EMS issues, voltage ringing, etc.) were expected, and in the prototype/demonstrator version, 25% to 30% reduction in total losses was achieved.

Evaluation and Case Studies of the Pilot Demonstrators

4.1. Impact of the pilot demonstrator

The results of this pilot demonstrator will have a significant impact on the target group, specifically SMEs operating within e-mobility segment. The main aspects of the actual outcome can be formulated as follows:

- The advantages of SiC-based components over those based on Si, in application to battery chargers/conditioners, have been obviously demonstrated.
- It has been also shown that development of Power Electronics (PE) products with the advanced components is within the capabilities of a typical SME.
- Any support from governmental organizations will certainly motivate and speed up the process of transition to the advanced components by SMEs.
- The market of the advanced components is very dynamic, and therefore, SMEs development must always analyse possible business impact of the future generations of the components.

4.2. Follow-up activities

Follow-up activities need to investigate lower costs for the device and commerciality of the device. Currently SiC devices are primarily available as the industry standard TO247 package but power modules with SiC chips are coming, although still very limited. With a bigger variety of power modules with SiC chips it is expected that the price for the device will be lower which in turn will make the device more competitive on the market.

4.3. Case studies of the pilot demonstrator

4.3.1. Case study #1

Description of the company

Company (confidential) within the e-mobility sector that works with the development of new electrical cars, busses, or trains.

Main interest of the company related to the pilot demonstrator

When developing new e-mobility devices, it is necessary to charge and discharge the battery package in an iterative process to test the functionality of the system. Currently this is a process with a lot energy waste as the energy on the batteries are discharged through resistors.

Impact of the pilot demonstrator on the company business

The pilot demonstrator showed that it was possible to reuse the otherwise waste energy and put it back into the grid with very little losses in return. The system can therefore be used by all system integrators to create a more sustainable test and development process. Moreover, the other benefit is a cheaper development process due to the reuse of energy.

5. Pilot demonstrator: SiC motor drive inverter for racing cars

The efficiency of power electronics is particularly important in mobile vehicle applications where the electric propulsion energy is stored on-board and gets converted into mechanical work. The efficiency of this process carries a direct effect on the vehicle range and outright performance. It is particularly relevant in high performance applications, where the system output is pushed right to its limits.

This pilot demonstrates that adoption of wide bandgap semiconductors in electric motor drive inverter improves the system efficiency as compared to a traditional silicon-based solution.

The demonstration platform is a purpose built all-electric racing car, which produces in excess of 1 MW power output and has set historic records at an international motorsport event. A motor drive unit from this car (input operating voltage ≤ 800 Vdc, peak output phase current ≤ 450 Arms) was used as a baseline and it got upgraded to a SiC-based power electronics module. Back-to-back comparison was performed on an electric motor dynamometer and it showed an increase in inverter efficiency from 92 % to 96 % at the chosen steady-state test conditions. These gains would allow downsizing the energy storage system and the inverter liquid cooling system on the vehicle, both of which would enhance the outright vehicle performance and its competitiveness.

The outright performance gains are most likely to prove relevance in competitive and demanding environments like motor racing. On the other hand, the efficiency gains are directly applicable in any mobile vehicle application as they provide means for increasing the vehicle range and reducing the battery charge time for a set drive cycle.

5.1. Impact of the pilot demonstrator

The target group for this pilot demonstrator consists of companies and organisations in the BSR that work on electric vehicle power electronics design and manufacturing. It is expected that companies and organisations involved in this pilot, or receiving information about it, will use the results as basis for informed decisions about the integration of advanced PE solutions into their business and R&I strategies.

The impact expected on the target group is higher competence among decision makers and innovators, which eventually opens possibility to include new products and services in their portfolio and increase their international competitiveness. Increased dialogue between technology developers and integrators will speed up the innovation process by enabling a faster identification of barriers and finding solutions to them.

5.2. Follow-up activities

The pilot has demonstrated clear gains that are readily available through adoption of advanced PE solutions. Companies and organisations involved in the pilot activities have increased their knowledge about the possibilities of advanced PE in e-mobility applications and identified some limitations that still exist and must be addressed through further work.

Evaluation and Case Studies of the Pilot Demonstrators

Specific activities to be carried out include developing a motor drive with a full SiC power module and downsizing the unit. Adoption of advanced PE in series production requires improving their commercial availability and reducing the cost.

5.3. Case studies of the pilot demonstrator

5.3.1. Case study #1: SIA eO

Description of the company

SIA eO is a specialist engineering company that develops, integrates and commissions high performance electric and hybrid vehicle drive train systems. These include lithium ion battery packs, motor generator units and their drive controllers.

Main interest of the company related to the pilot demonstrator

SIA eO adopted a SiC-based power electronics module to its motor drive unit to study the benefits and limitations. The company wished to explore the potential gains in efficiency and outright performance which are both critical in high performance applications.

Impact of the pilot demonstrator on the company business

The demonstrator strengthened the company's technical expertise and produced favourable results which encourage SIA eO to consider SiC-based power electronics for future series production of its motor drive controller.

5.3.2. Case study #2: SIA e-Mobility

Description of the company

SIA eMobility leads development of a range of electric drive minibuses for passenger transportation. The company works with an international group of technical partners to offer bespoke electric minibuses for municipalities and private customers.

Main interest of the company related to the pilot demonstrator

SIA eMobility has expressed interest in sourcing SiC-based motor drives for their vehicles to increase the range and/or reduce the battery charge time.

Impact of the pilot demonstrator on the company business

SIA eMobility now appreciates the power electronics technology roadmap developed within the Green PE project and the way they can adopt the innovations to improve their product and respond to customer requirements.

5.3.3. Case study #3. SIA Sivers

Description of the company

SIA Sivers is an engineering consultancy, providing its services in hardware and software development for electric vehicle embedded systems.

Main interest of the company related to the pilot demonstrator

SIA Sivers was looking to familiarise with the hardware specifics and integration requirements of SiC-based power electronics.

Impact of the pilot demonstrator on the company business

Increased technical competence which is likely to be used in future development of electric motor drives and battery charger units.

6. Pilot demonstrator: Power electronics for smart houses

Locally-produced solar electricity is one of the solutions to create and use uncarbonated energy. This pilot demonstrates that

- it is advantageous to avoid converting electricity back and forth between AC and DC
- lightning and many appliances can consume DC directly
- energy can be stored locally in batteries, allowing:
 - delayed consumption of locally-produced energy
 - island operation reducing vulnerability and enabling electricity supply in case of power outage.
- these solutions can be safely implemented in a family house.

The solar system installed in a family house becomes more efficient, autonomous and consuming the energy in-house in the first place, reducing the transactions with the power grid. Moreover, the system makes the inhabitants less vulnerable and more independent in case of power outages, increasing resilience in society and reduces variations in power and voltage in the local grid, securing stability in the grid.

The pilot demonstrator - villa was originally equipped with 20 solar panels with a capacity of about 5000 kWh per year and 14 solar collectors to warm up water. Within the pilot implementation the house was provided with energy storage capability (charging and backup battery solution); an additional DC appliance network working together with the existing AC grid.

Battery is connected to both 230 AC and DC 350 V supporting lighting, communications equipment and appliances. Some electrical equipment is operated directly from a battery without conversion to AC.

The system makes the solar system more efficient, autonomous and consuming the energy in-house reducing the transactions with the power grid. Less purchased and less sold kWh indicate a higher degree of self-sufficiency and are in line with the project objectives.

This demonstrator used commercially available Si-based power electronics equipment to demonstrate the concept proposed. Additional improvements expected by using wide band gap technology are evaluated in the other pilots and can be integrated for further energy savings.

The pilot demonstrator team consists of:

- project partners: the building organisation 'Sustainable Smart Houses in Småland'; Natek Power Systems, providing the power electronics steering system; RISE, project management and technical support
- external service providers: UPN, developing the power electronic solution implemented; Elajo, providing the electrical installation and the family living in the demonstration house

Evaluation and Case Studies of the Pilot Demonstrators

6.1. Impact of the pilot demonstrator

The target group for this pilot demonstrator consists of companies in the BSR, working on electronic design and manufacturing, energy optimization and applications on energy efficiency for smart buildings. We expect companies involved in this pilot or receiving information about it to use its results as basis for informed decisions about the integration of advanced PE solutions into their business and R&I strategies.

The impact expected was to increase the competence of companies in the target group, promoting the inclusion of new power electronic solutions in their portfolio and increasing their international competitiveness. Increased dialog between technology developers and integrators was to speed up the innovation process by enabling a faster identification of barriers and bottlenecks and solutions to them.

Companies involved in the pilot activities as project partners, associated organisations or external service providers have increased their knowledge about the possibilities of the new developed concept to increase energy efficiency in smart buildings, identified bottlenecks and found solutions to make the system work. In addition, they can see interesting follow ups to the pilot activities broadening their markets. Potential integrators of the technology have had the possibility to network with experts in the subject and develop their competence.

6.2. Follow-up activities

Several follow-up activities have arisen from the pilot demonstrator:

- Follow-up projects to improve the energy efficiency and to lower costs are being discussed.
- The Swedish Energy Agency has shown interest in a following project to further analyse the potential of the islandic capability and micro-grids involving more than one building to enable energy supply to neighbourhoods in case of energy outage.
- Elajo has got a new order to implement a DC-grid in industrial buildings. Elajo has got an eye-opener as a result of the Green PE project. They therefore now promote DC solutions to the industry, and they have several orders from industrial companies to change AC installation to DC including battery backup.
- Sustainable Smart Houses in Småland is discussing possibilities to continue with similar or expanded projects in Växjö city.
- UPN works on the possibility to lower costs in future installations. UPN is installing three similar solutions as the one in Växjö in houses around the Stockholm area.

6.3. Case studies of the pilot demonstrator

6.3.1. Case Study #1: UPN Uninterruptible Power Networks

Description of the company

UPN is a micro-company specialized in the development of uninterrupted power networks (AC - DC) enabling solar energy as source of reserve power.

Evaluation and Case Studies of the Pilot Demonstrators

Main interest of the company related to the pilot demonstrator

The company was responsible (as external service provider) to develop, design and implement the system with DC-capability, energy storage and islandic capability. They have a strong interest in developing further the concept of mini-grids to maximize the use of locally produced energy.

Impact of the pilot demonstrator on the company business

The pilot demonstrator has contributed to increased competence and has identified new capabilities to be developed and integrated in their portfolio.

6.3.2. Case study #2: NATEK Power Systems

Description of the company

NATEK Power Systems (project partner) is a SME company specialized in electronics design and manufacturing of power supply solutions and other customized electronics. The company is based in Älmhult, Sweden with 25 employees and a revenue of 4 million Euro.

Main interest of the company related to the pilot demonstrator

NATEKs' main interest was to develop and manufacture the main control unit to optimize the DC adaption in the house demonstrator. As an electronics manufacturing company, NATEK has a strong interest in scaling up number of control units.

Impact of the pilot demonstrator on the company business

The pilot demonstrator has contributed to increased competence within control engineering methods related to smart housing technology. Interests have been shown by UPN to make a customized control unit for a larger system.

6.3.3. Case study #3: Sustainable Smart Houses in Småland

Description of the company

The Sustainable Smart Houses in Småland (project partner) is a construction company with focus on low energy need and low carbon dioxide emissions.

Main interest of the company related to the pilot demonstrator

Using batteries together with solar cells is totally in line with the company's efforts to reduce purchased energy and optimize the use of renewable energy.

Impact of the pilot demonstrator on the company business

The pilot demonstrator showed that use of batteries and supplementary grids already during the erecting phase of new buildings are essential and profitable. The company wants to include that in future projects. They also find it necessary to include academy and research in order to achieve further improvements/efficiency in the process. The pilot demonstrator can lead to the possibility to have an own product and in any case, it improves their skills and experience (benchmarking).

6.3.4. Case study #4: Elajo El & Energiteknik AB

Description of the company

Elajo (external service provider) is one of Swedish leading electricity and energy companies with about 600 employees with focus on effective use of energy.

Evaluation and Case Studies of the Pilot Demonstrators

Main interest of the company related to the pilot demonstrator

Elajo was involved in the original installation of the electrical system in the demonstration house, when it was constructed, a few years before this pilot demonstrator implementation. They wanted to further develop their capability including DC-grids in their competence.

Impact of the pilot demonstrator on the company business

Elajo developed stronger knowledge about the integration of DC-grids in normally AC-equipped buildings and go on offering this competence for industrial establishments (see above).

6.3.5. Case study #5: Netpower Labs

Description of the company

Netpower provided power electronic devices until it joined Comsys in October 2017. Now both companies together have about 20 employees. The aim of the joined enterprise was to become leaders of the technology development for next generation el-grids.

Main interest of the company related to the pilot demonstrator

Netpower provided some of the Si-based power electronic devices for the pilot and worked on the development of technology in close collaboration with UPN since long time ago.

Impact of the pilot demonstrator on the company business

Comsys is developing wide band gap-based power electronic solutions for el-grids as part of their activities.

7. Pilot demonstrator: Solar energy test station

This pilot demonstrates that:

- it is advantageous to use solar energy also in the Nordic countries, where during the wintertime there is not much the sunlight available, but in contrast, summertime will produce a lot of solar energy.
- the summertime produced solar energy is important to cover increasing cooling costs in modern buildings.
- the new generation of wide band gap materials-based inverters produce comparable results to traditional inverters. For the expected better performance, they need a year or two additional product development.

This pilot demonstrator provided the Physicum (building of the Institute of Physics, University of Tartu) with five solar energy test systems. The photovoltaic (PV) capacity of each of them is 3240W. Panel directions SW and NE. Three systems are equipped with traditional Si-based inverters. Two others are available for inverter / microinverter comparison tests. The pilot provided also the uncertainty certified measurements systems and storage capacity for time-series of PV-produced energy values. The Physicum's test ground already had a weather station, measuring among other parameters the temperature, irradiation flux and precipitation. The amount of snowfall is also possible to estimate from collected data. The measured data are stored in server and mostly available back to year 1999.

The pilot team consists of the following project partners

- University of Tartu (Estonia), Ubik Solutions (Estonia), Christian-Albrechts University in Kiel (CAU, Germany)

Evaluation and Case Studies of the Pilot Demonstrators

7.1. Impact of the pilot demonstrator

The target groups of this pilot are:

- companies working on electronic design, manufacturing and energy optimization of PV-systems in the BSR. They can use the Physicum's test station as an independent test ground for their product.
- companies interested to use PV-produced energy in their premises. They can use the Physicum's test stations PV-time series and weather station data to evaluate the advantages of a possible new PV station in their premises and get a manufacturer-independent cost-benefit analysis for this installation.

Both target groups can use the pilot demonstrators results as informational basis for informed decisions about the integration of advanced PE into their business and research & innovation (R&I) strategies.

7.2. Follow-up activities

The pilot demonstrator has tested the efficiency of new generation inverters compared to traditional ones. These tests should be continued for longer time, to be able to make also conclusions about the reliability of tested products.

Another follow up activity could be to buy and test a new generation wide bandgap (WBG)-inverter for a reference also from the market. During the project duration it was not possible. When real commercial products will be available, further new efficiency comparisons and reliability tests could be carried out.

Additionally, it is planned after the project's end to compare the PV produced energy and the efficiency of the existing Si based PV inverters with the demonstrator from CAU at the same amount of PV modules at the same time at Tartu Physicum's test area.

7.3. Case Studies of the pilot demonstrator

7.3.1. Case study #1: Ubik Solutions

Description of the company

Ubik Solutions OÜ (project partner), founded in 2011, is a SME company specialized in manufacturing of electrical equipment. The company is based in Tallinn, Estonia with 5 employees.

Main interest of the company related to the pilot demonstrator

Ubik Solutions used the Physicum's test station as an independent test ground for their Optiverter products based on wide band gap materials.

Impact of the pilot demonstrator on the company business

During the test period due to related improvements in Ubik's laboratories, the efficiency of Optiverter increased by about 40%.

Project Facts

- 17 project partners: research institutions, companies and technology transfer organisations
- Duration from 2016 to 2019
- Budget: EUR 3.1 million
- European Regional Development Fund
- Interreg Baltic Sea Region Programme
- Led by University of Southern Denmark

Project Partners

- University of Southern Denmark (Denmark)
- Applied Research Institute for Prospective Technologies (Lithuania)
- Christian Albrechts Universität Kiel (Germany)
- CLEAN (Denmark)
- Converdán A/S (Denmark)
- Kaunas Science and Technology Park (Lithuania)
- Kaunas University of Technology (Lithuania)
- Latvian Technological Center (Latvia)
- NATEK Power Systems AB (Sweden)
- Polish Chamber of Commerce for Electronics and Telecommunications (Poland)
- Renewable Energy Hamburg (Germany)
- RISE Research Institutes of Sweden AB (Sweden)
- Sustainable Smart Houses in Småland (Sweden)
- Ubik Solutions OÜ (Estonia)
- University of Latvia (Latvia)
- University of Tartu (Estonia)
- Warsaw University of Technology (Poland)