Annual Report 2025

THE NORWEGIAN PV RESEARCH CENTRE (FME SOLAR)

The Norwegian PV Research Centre (FME SOLAR) is a national research centre for solar power, funded by the Research Council of Norway and the centres partners in the period 2024-2032. The centre has been established to support the development of the broad Norwegian solar industry.

More information is available on the centre's website www.fmesolar.no.

Photo on front page: Erlend Hustad Honningdalsnes (IFE)
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Letter from the Centre Director

This is the first Annual Report published by the Norwegian PV research centre (FME SOLAR). In this report we present our centre, our team and our plans. We also share some of the most important results of our joint efforts in 2025, our first normal year of operation. It has been a productive first year, FME SOLAR is off to a very good start indeed!

The activities in FME SOLAR target some of the most important challenges arising from the unparalleled growth in the deployment of PV power plants globally, as well as challenges associated with the deployment of PV also here in Norway. Work spanning the full breadth of the FME SOLAR activities started up in 2025, and highlights of this work are presented herein.

In 2025, FME SOLAR hired its first batch of PhD candidates and trained 10 MSc candidates. Education of experts in the very important field of PV is one of the most important tasks of FME SOLAR. The published MSc theses are found at the FME SOLAR website together with all other available publications from the centre so far. A list of the resulting theses, publications and presentations is also given in this report for easy reference.

FME SOLAR has high ambitions related to communication and dissemination. In 2025, we launched a webinar series, which rapidly became popular. In addition to PV-specific webinars hosted by FME SOLAR, we started a collaboration with the research centre FME BATTERY and Renewables Norway (Fornybar Norge) on a series of webinars addressing PV + battery energy storage systems. This effort has since been strengthened by the addition of the Federation of Norwegian Industries (Norsk Industry).

For me, an annual highlight of FME SOLAR is the opportunity to meet good colleagues from research, industry and the public sector at the Norwegian Solar Cell Conference (NSCC). The NSCC 2025 conference took place in May, as always in sunny Son, and included a strong scientific program and good discussions.

I am very grateful for the support from the research and user partners of FME SOLAR, as well as to the Research Council of Norway (RCN) for the support and funding crucially enabling the operation of our centre, and look very much forward to the continuation!

Erik Stensrud Marstein
Centre Director, FME SOLAR

What is FME SOLAR?

The Norwegian PV research centre (FME SOLAR) combines the leading Norwegian research groups in the field of solar power (PV) research with a strong cluster of companies, public partners and trade organisations. The centre is jointly funded by the Research Council of Norway and the partners of FME SOLAR. The aim of the centre is to support the broad PV industry, the public sector and society in Norway by providing competence and cutting edge R&D in a very important and rapidly expanding field. FME SOLAR is hosted by the Institute for Energy Technology (IFE) and will be in operation from 2025 until 2032. The centre will be the most important competence and innovation platform devoted to PV during its lifetime. The FME SOLAR activities are based on a total budget of approximately 300 MNOK. More information about the centre financing is found in Appendix 1.

FME SOLAR performs R&D targeting main identified challenges associated with the extremely rapid growth in the use of PV worldwide, as well as selected challenges related to the deployment and operation of PV power plants in Norway. Important research topics include digitalisation, supporting accelerated deployment and integration of PV power plants, the role of PV in a Norwegian and European energy system, performance, reliability and impact of PV power plants operating under Nordic conditions, grid integration of PV systems, sustainable production and recycling of PV materials, as well as new PV applications and disruptive PV technologies.

Education is a key activity in FME SOLAR, and the centre aims at educating 20 PhD candidates and post. docs, as well as 100 M.Sc. candidates. A first batch of 10 M.Sc. candidates defended their theses in 2025.

The activity in FME SOLAR is organised in seven work packages. These are

WP1: PV power plants

WP2: PV in Nordic conditions

WP3: Grid integration of PV power plants

WP4: Production and recycling of PV materials

WP5: Application-specific PV systems and components

WP6: Beyond the horizon

WP7: Education and training

In addition to PhD students and post-docs, a substantial part of the research is performed by experts working among the research and industry partners of FME SOLAR. An important aim of the centre is to support collaboration. In this context, FME SOLAR takes an important role by hosting a series of physical and virtual meeting places for the Norwegian PV community, including the Norwegian Solar Cell Conference (NSCC) and the FME SOLAR webinar series.

For more and updated information about FME SOLAR and ongoing activities, see fmesolar.no.

The FME SOLAR consortium

In 2025 the FME SOLAR consortium consisted of 6 research partners, 3 trade associations, 5 Public Partner and 29 Industry Partners. The centre is hosted by the Institute for Energy Technology (IFE).

FME SOLAR - Centre Partners 2025

Industry partners

Akershus Energi AS
Aneo AS
ASKO AS
Code Arkitektur AS
Endra AS
Energeia AS
Equinor Energy AS
Fred. Olsen Renewables AS
Glint Solar AS
Hafslund Vekst AS
Hydro Renewable Holding AS
Mellom AS
Multiconsult ASA
NorConsult ASA
Ocean Sun AS
Over Easy Solar AS
Pixii AS
Resitec AS
Scatec ASA
Skarpnes AS
Skyfri AS
Solcellespesilalisten AS
Solenergi FUSen AS
Solgrid AS
Statkraft AS
Statsnett SF
TGS Prediktor AS
The Quartz Corp AS
Østfold Energi Solkraft AS

Research partners

Institutt for Energiteknikk (IFE)
Norges Miljø- og Biovitenskapelige Universitet (NMBU)
Norges Tekniske-Naturvitenskapelige Universitet (NTNU)
SINTEF AS
Universitetet i Agder (UiA)
Universitetet i Oslo (UiO)

Trade organizations

Fornybar Norge
Glass og Fasadeforeningen
NHO Elektro

Public partners

Forsvarsbygg
Grønt Hjerte AS
Møre og Romsdals fylkeskommune
Norges Vassdrag- og Energidirektorat (NVE)
OsloBygg KF

Organisation

FME SOLAR has the following organisational structure: The upper decision making body of FME SOLAR is the general assembly, where all partners are represented. The day-to-day direction of the centre is supported by a 9 member executive board currently chaired by Trine Kopstad Berentsen (Fornybar Norge). Professor Erik Stensrud Marstein (IFE) is the director of FME SOLAR. In the daily direction, management and operation of the centre, he is supported by a centre management team consisting of Dr. Kristin Bergum (IFE, deputy director), Merete Estensen (IFE, centre coordinator), Dr. Josefine Helene Selj (IFE, innovation and impact lead) and seven work package (WP) managers. Importantly, all six research partners of FME SOLAR are represented in the centre management team.

The WP managers are responsible for the activities in their respective WPs. The WP content is further described later in this report. The activities in FME SOLAR are structured into the following 7 WPs:

WP1: PV power plants (Lead: Dr. Heine Nygard Riise, IFE)

WP2: PV in Nordic conditions (Lead: Dr. Mari Benedikte Øgaard, UiA)

WP3: Grid integration of PV power plants (Lead: Ass. Prof. Heidi Nygård, NMBU)

WP4: Production and recycling of PV materials (Lead: Prof. Marisa Di Sabatino, NTNU)

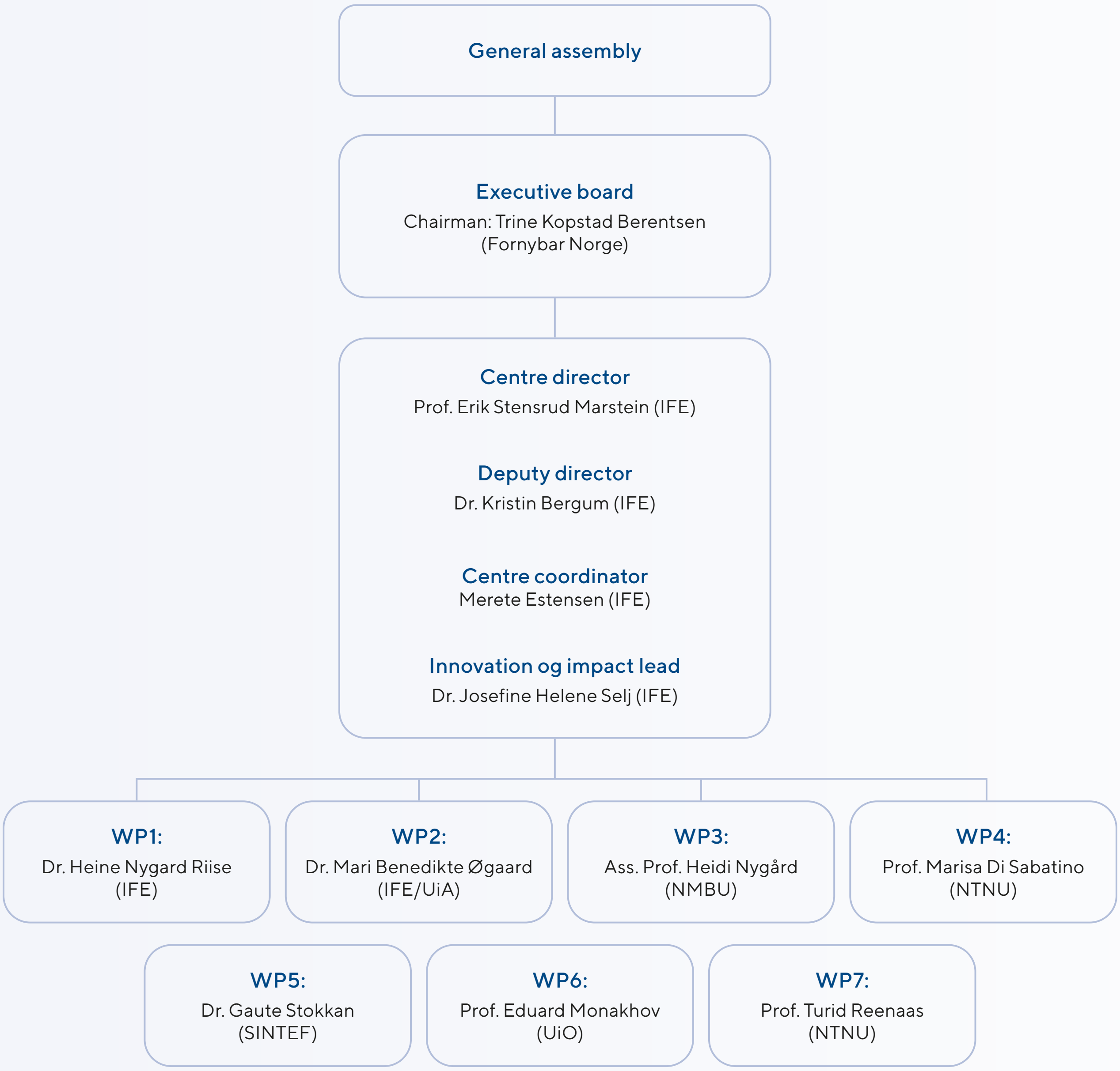
WP5: Application-specific PV systems and components (Lead: Dr. Gaute Stokkan, SINTEF)

WP6: Beyond the horizon (Lead: Prof. Eduard Monakhov, UiO)

WP7: Education and training (Lead: Prof. Turid Reenaas, NTNU)

The Centre Manager Team included members of the Executive board from the Norwegian Solar Cell Conference (NSCC) 2025 at Son Spa. From the left, behind: Marisa Di Sabatino (NTNU), Turid Reenaas (NTNU), Gaute Stokkan (SINTEF), Rudie Spooren (SINTEF), Christian Hadley (The Quartz Corp), Line Nygaard (Statkraft), Heine Nygard Riise (IFE), Kristin Bergum (IFE), Erik Stensrud Marstein (IFE) From the left, in front: Merete Estensen (IFE), Heidi Nygård (NMBU), Tine Uberg Nærland (IFE), Mari Øgaard (IFE/UiA).
Photo: Jon Arne Wilhelmsen

The centre organisation is shown in the figure below:



Dissemination and collaboration

Dissemination

Renewable energy in general is an important topic of broad interest and the subject of much public debate. Solar power (PV) is emerging as a winning technology globally, with record installation rates set year after year. In spite of a slowdown in domestic installations, we see the PV capacity increasing also in Norway. FME SOLAR emphasises dissemination, both by putting important trends and developments on the agenda, but also by supplying updated information on the state of PV technology, research and industry, as well as information of the great potential of PV to contribute to a sustainable future, both in Norway and abroad. To this end, FME SOLAR is visible in scientific journals and at international conferences, as well as in various popular scientific, trade and public media. FME SOLAR arranged 12 webinars and 4 workshops in 2025, covering all WPs. In particular, a webinar series on PV + battery energy storage systems (BESS), in collaboration with Fornybar Norge and the Norwegian research centre for battery technology: FME BATTERY, were well received, and regularly had over 100 participants. The aim of the webinar series and other events hosted by FME SOLAR is to increase awareness, support the development and growth of a broad domestic PV industry by facilitating dissemination of important results from the centre research. The centre regularly publishes the FME SOLAR Newsletter, providing both information on upcoming events, as well as disseminate results from the centre. The newsletter now reach nearly 400 recipients. FME SOLAR also maintains an updated website, fmesolar.no.

A full list of publications and presentations from FME SOLAR in 2025 is given in Appendix 2.

Norwegian Solar Cell Conference 2025 (NSCC 2025)

The most important venue of FME SOLAR is the annual Norwegian Solar Cell Conference (NSCC). This conference was initiated during the operation of the research centre FME Solar United (2009 – 2017) and continued through the duration of the subsequent research centre FME SUSOLTECH (2017 – 2025). Today, NSCC is an established and important annual meeting arena for the PV community in Norway, with participants from the PV industry and research institutions in both Norway and Europe. In 2025, FME SOLAR arranged the NSSC conference at Son Spa.

Research activities in FME SOLAR in 2025

The research in FME SOLAR is a joint undertaking by all partners in the centre. We address important challenges associated with the further growth in PV deployment globally and in Norway, as well as with the associated development of a broad, competitive PV industry. In the following sections, an overview of the main research activities in FME SOLAR is given. A complete list of the resulting publications, including scientific and popular science presentations, as well as thesis works is found at the end of this report in Appendix 2.

Participants from The Norwegian Solar Cell Conference (NSCC) 2025 at Son Spa, Vestby, Photo: Jon Arne Wilhelmsen

PV power plant development and operation

Norwegian companies involved with photovoltaic power plants operate both at home and abroad. Despite the different markets, they share several common objectives: lowering costs, minimising uncertainty, reducing investment risks, and enhancing bankability. In FME SOLAR, WP1 supports these objectives by developing and verifying digital tools for project development, plant operation, and maintenance. Even though the objectives are the same, the means and tools for achieving these are different in Norway and abroad. As of 2025, Norwegian PV power plants are only marginally profitable in regions with the highest solar resource, and there are only a handful of power plants already built. Hence, the domestic industry's imperative is more efficient and cheaper ways of planning and building PV power plants in Norway. On the other hand, PV power plants abroad are consistently competitive with other energy sources, and more than 2 TW of PV power plant capacity has been installed, with a large number of plants already in operation for years. Here, there is a greater need for ensuring cost-effective plant operation.

Figure 1: Vikersund solcellepark on a sunny summer day.
Photo: Erlend Hustad Honningdalsnes, IFE

The work in WP1 is structured into three tasks:

- Task 1.1 Digital tools for project development
- Task 1.2 Digital tools for operations and maintenance
- Task 1.3 Digital tools for production forecasting

Highlights from 2025

Better planning of PV power plants

Accurate planning is a crucial factor for developing good projects and for reducing risks and costs associated with building the PV plants. In task 1.1 , we ask the question. Leveraging the center partner's extensive experience with planning, building and monitoring PV power plants, we are both developing better integrated tools for energy yield assessments and finding more precise and climate-specific values for PV power plant losses and gains. An important step to making better tools is to understand strengths and weaknesses of the state-of-the-art. In 2025, IFE started benchmarking several commercial EYA tools against each other, for greater insights into PV park planning in complex terrain. The work is performed in collaboration with Norconsult, Endra and NMBU. The work will continue in 2026 with aims of reporting results before the summer.

Tools and innovations for operations and maintenance (O&M)

Once the PV power plant is built, O&M must ensure that the performance and lifetime of the power plant is maximized while keeping operational costs at a minimum. FME SOLAR Task 1.2 will develop knowledge and tools that will support efficient operations and maintenance, in turn increasing revenue and lifetime. The task will answer key research questions such as how we can detect and diagnose faults in PV power plants, and how we can automate actions from these insights. A starting point for any data-driven PV power analysis should be to consider the availability of data. To this end, IFE has in 2025 documented previous work that they have performed and mapped out what kind of data is available to the consortium for developing advanced digital tools for O&M. Some of this work was presented in an oral presentation at EUPVSEC, while data for development of digital O&M tools will be available from the FME SOLAR Sharepoint. Further, SINTEF has been working on a novel module design where the substring and cell layout of the PV module can be reconfigured to allow optimal cell connection for any weather condition, a disruptive technology development that has the potential for generating much higher PV performances.

Forecasting tools for PV power plant management

An important task of operating PV power plants is planning for the future, for instance making decisions on revamping that requires long-term expected output, or participating in energy markets and scheduling O&M requiring short-term forecasts of PV performance. In Task 1.3 in FME SOLAR, research will be conducted to understand long-term trends, develop enhanced tools for short-term forecasting, and find optimal ways of utilising the forecasts, in essence exploring how we can forecast PV power plant production precisely. The task has had significant activity in 2025, driven by a strong interest in forecasting solutions and applications among the research partners. SINTEF has proposed a novel technique for forecasting irradiance and PV power based on decomposing the irradiance signal and employing specialized machine learning (ML) forecasting models for each component of the decomposition, hence improving accuracy and explainability on black-box AI forecasting approaches.

IFE has developed, demonstrated and documented a methodology for exploiting the spatial variation of PV power output over a large PV plant to forecast cloud movement the next few minutes. The method utilizes the 1-minute mean aggregated PV power output to estimate cloud motion vectors (CMVs) and is demonstrated on 8000+ individual stringsets in a 150+ MWp PV power plant. In the method, the entire ~5 km2 PV power plant acts as a highly resolved irradiance sensor, as visualised in Figure 1. The CMVs are used as input to a cloud speed persistence PV power forecast which is benchmarked against a smart persistence PV power forecast. Forecasts issued for the entire power plant achieve an overall forecast skill of 0.16 at a forecast horizon of 1-minute, outperforming more traditional forecasting methods based on all-sky imagers. The work is published in the journal Solar Energy.

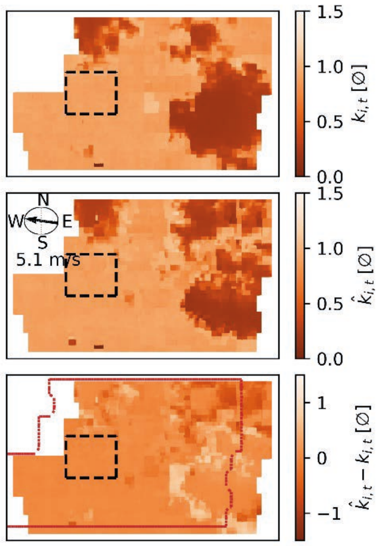


Figure 2: Clear-sky index maps generated from string-level PV power output

PhD and MSc students working on PV power plants

Nikolas Recke

Nikolas Recke is a PhD student employed at UiO and is exploring distributionally robust optimization of virtual power plants (VPP). His research aims to develop a framework that robustly accounts for uncertainty in forecasting, energy measurements and energy prices, improving VPP planning and operation.

Martin Helge Johansen completed his MSc thesis at UiA in 2025. The thesis examined the relationship between global horizontal irradiance forecasts and actual solar production from tilted photovoltaic installations.

Solveig Pettersen completed her MSc thesis at NMBU in 2025. The thesis analyzed Light Induced Degradation in bifacial PV modules using photoluminescence imaging.

Contact: Heine Nygard Riise (heine.riise@ife.no).

PV in Nordic conditions

Photovoltaic (PV) system performance and reliability are greatly impacted by operating conditions, which depend on local climate, latitude, and surrounding environment. Much of the existing research on PV performance and reliability, as well as validation of PV performance models, originates from more mature PV markets located farther south, where climatic conditions can differ substantially from those in the Nordic region. Environmental and social impacts of PV systems may also vary across regions, limiting the direct transferability of knowledge. More knowledge is needed on how PV systems perform in Nordic conditions, and on how PV systems impact the local environment and the public opinion. There is also a need for development of methods and models for accurately predicting performance in these conditions.

In FME SOLAR; WP2 supports the goal of de-risking the targeted rapid growth of PV power in Norway and enables value creation and innovation in this space. It will provide developers, operators, and public authorities with high-precision data and new knowledge related to the performance, reliability, and social and environmental impact of PV power plants subjected to Nordic conditions. The work package includes the following tasks:

- Task 2.1 Performance and reliability of PV installations in Nordic conditions
- Task 2.2 Snow impact and modelling
- Task 2.3 Ground-mounted PV plants in Norway

Highlights from 2025

Towards a state-of-the art modeling framework

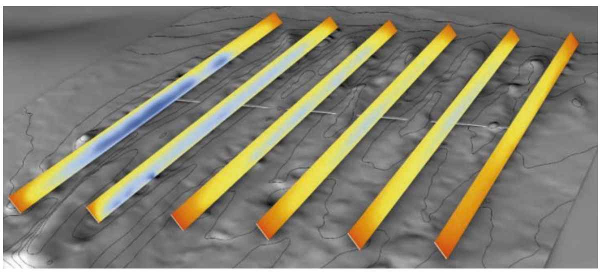
In 2025, the main focus of WP2 was modeling of PV power production in Nordic conditions, in preparation for the deliverable D2.1: State-of-the-Art Modeling Framework for PV Power Production in Norway. A workshop was organized to establish the state of the art in PV production modeling for Nordic conditions and to identify knowledge gaps and industry needs. A user partner questionnaire was also distributed to map research needs and challenges related more broadly to Nordic conditions.

Several initiatives were also undertaken to improve PV system modeling in Nordic conditions, with a particular focus on improving irradiance modeling. Within the task on snow impact, the main activities involved measurements of snow-related effects and modeling of snow losses in ground mounted systems. In the task addressing ground mounted PV power plants in Norway, the focus was to identify the main challenges related to interactions between land types and the construction and O&M of PV power plants. This work has been supported through events at Arendalsuka and meetings with relevant stakeholders.

Modeling of snow-related production losses

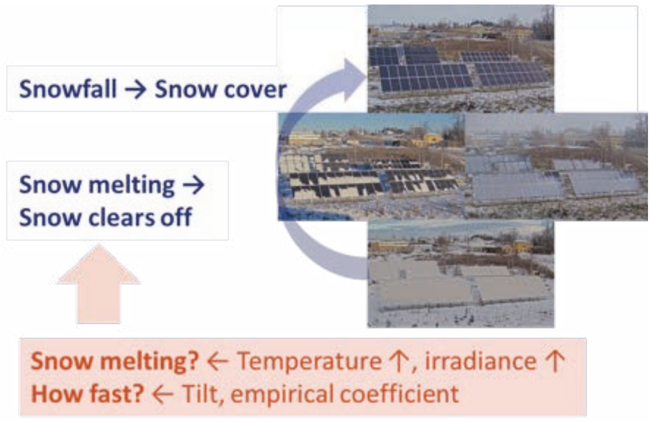
NMBU developed a framework for PV yield modeling in complex environments based on ray tracing. In their presentation at NSCC, they presented an example where they modeled the shading caused by snowdrifts at Isfjord Radio, Svalbard.

Snow drifts measured at Isfjord Radio, Svalbard.

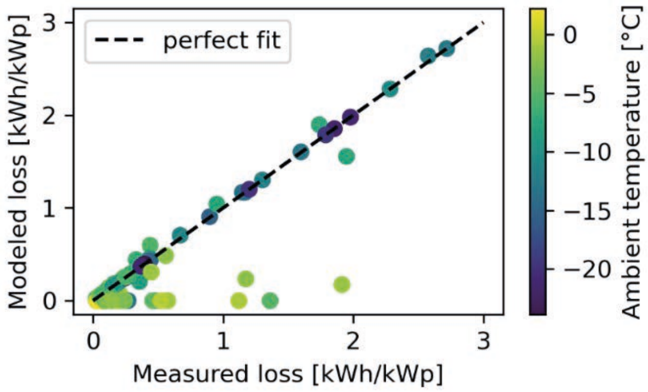


Resulting irradiance.

IFE tested a snow-loss model that has previously shown reliable results for roof-mounted systems on ground-mounted installations. For ground-mounted systems, the model also accurately predicted daily snow losses on most days, with higher uncertainty on days with temperatures around 0 °C.



Overview model.



Modeled versus measured daily losses

PhD and MSc candidates working on Nordic conditions

Binod Prasad Sapkota

Binod Prasad Sapkota, is a PhD candidate employed at NMBU aiming to systematically examine how people in Norway perceive and evaluate different solar PV developments, providing knowledge that can support socially accepted and sustainable energy planning

Hedda Victoria Kielland, MSc candidate NTNU, "An experimental investigation of wind driven rain tightness of building-integrated photovoltaic systems"

Papri Mitra, MSc candidate UiA, "Validation of snow losses modelling and experimental quantification for PV modules"

Contact: Mari B. Øgaard (mari.b.ogaard@uia.no)

Grid integration of PV power plants

The integration of PV power plants into power grids is emerging as one of the key challenges in enabling large scale deployment of renewable energy. As PV penetration increases across Europe and globally, variability in solar generation, limited dispatchability, and evolving grid conditions introduce new requirements for secure, reliable, and cost efficient grid operation. Understanding how PV interacts with both local distribution grids and the broader transmission system is essential for maintaining system stability, optimizing grid utilization, and ensuring that the transition toward a decarbonized energy system is both technically and economically viable.

This topic is also important for Norway, where future energy scenarios include a substantial increase in PV deployment alongside existing hydropower resources, new green industries, large electrification efforts, and evolving regulatory frameworks. Effective grid integration practices support better planning, lower investment risks, and enable PV to act not only as a generator but also as a grid supporting asset.

In WP3 in FME SOLAR, we investigate how PV can be deployed at scale in ways that support grid stability, efficient grid utilisation, and long term energy security. The work is structured around three core tasks:

- Task 3.1: The role of PV in Norway and Europe
- Task 3.2: Distribution grid integration
- Task 3.3: Transmission grid integration and hybrid PV power plants.

Across these tasks, we address key research questions related to how PV can contribute to Norwegian climate goals, how grids should be developed to accommodate large scale PV, and how profitable, grid supporting PV power plants can be designed and operated.

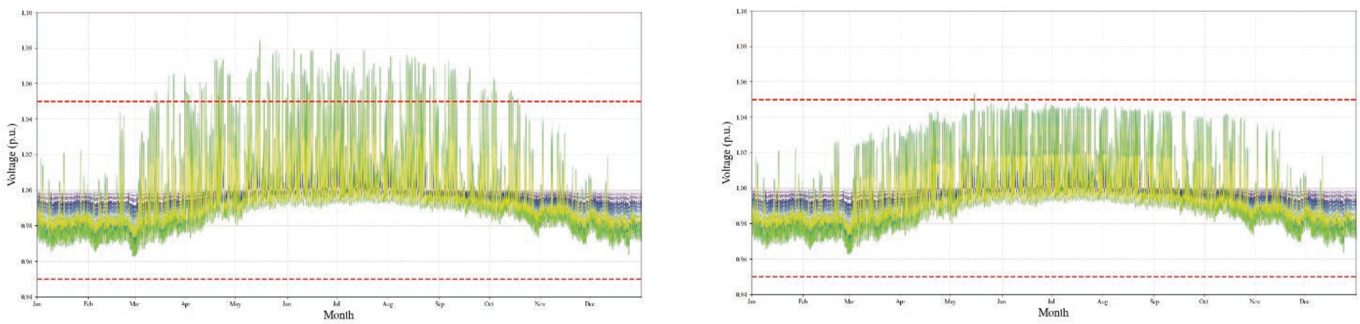
Highlights from 2025

In 2025, IFE developed a methodology for classifying land areas in Norway suitable for PV power plants deployment. This methodology forms the foundation for scenario development in FME SOLAR, where NTRANS scenarios are used to model future PV deployment. The first set of scenarios have been developed and analyzed and will be refined on an annual basis throughout the project period.

NMBU has investigated mitigation strategies for voltage variations caused by solar power in Norwegian 22 kV distribution grids. Year long time series simulations show that existing technologies—battery storage and inverter based reactive power control—can effectively reduce overvoltages and thermal constraints, thereby enabling higher PV hosting capacity without major grid reinforcements. Reactive power control appears to be the most cost efficient measure, while battery storage provides complementary benefits for thermal relief.

There has also been considerable activity related to PV and battery energy storage systems (BESS), particularly through IFE's involvement in IEA PVPS's Task 13 activity on the reliability of PV + BESS. In addition, FME SOLAR launched a dedicated webinar series on PV + BESS in collaboration with FME BATTERY and Renewables Norway. This rapidly became popular and the initiative will be continued into 2026.

Another topic of focus has been hybrid PV + wind power plants, with focus on opportunities for hybrid systems in Nordic markets. Dialogue with user partners was initiated, laying the foundation for further development of use cases in the coming project period.



Voltage profiles in a representative 22 kV radial feeder. Green curves represent nodes near a PV plant. Overvoltage issues in the reference case (left) are largely removed with reactive power control (right).

PhD and MSc candidates working on grid-integration of PV

Johannes Gerhardus Venter

Johannes Gerhardus Venter is a PhD student employed at NMBU using mathematical modeling of power system stability to improve network resilience through network design, aimed to hinder cascading failures in interconnected networks.

Thomas Richards

Thomas Richards is a PhD student at UiO, exploring how alternative land-use strategies for solar PV deployment can support Europe and Norway's energy transition while balancing environmental and societal priorities.

Ine Erlandsen Grimsrud (NMBU) – "Connection with conditions as a facilitator for co-localization of power production and consumption"

Jone Odden (NMBU) – "Mitigation of voltage variations caused by solar power in high-voltage distribution networks using batteries and inverter control"

Nina Sørmo Moe and Maren Nærland (UiA) – "Impacts on Norwegian LV Distribution Grid from EU's solar rooftop initiative"

Contact: Heidi S. Nygård (heidi.nygard@nmbu.no)

Production and Recycling of PV materials

An important goal of FME SOLAR to support the development of a competitive domestic and European photovoltaic (PV) manufacturing value chain. WP4 in FME SOLAR addresses key challenges related to the production, characterisation, digitalisation, and recycling of PV materials, with the aim of improving resource efficiency, material quality, and sustainability across the entire value chain.

The research and development activities in WP4 are carried out in close collaboration between leading research groups (NTNU, SINTEF, IFE and UiO) and industrial partners (TQC and RESITEC) with strong competence in PV, quartz and silicon kerf loss recycling. WP4 is organised into four main tasks:

- Task 4.1: Advanced Material characterisation
- Task 4.2: Cz Si Production
- Task 4.3: Recycling
- Task 4.4: Digitalisation

In Task 4.1 the work is related to development and application of advanced characterisation methods to improve understanding of material properties, defects, and degradation mechanisms in PV materials. Task 4.2 contains research on Czochralski (Cz) silicon production aimed at improving crystal growth processes, material quality, and production efficiency for photovoltaic applications. In Task 4.3, development of processes and strategies for recycling PV materials, contributing to increased material recovery and supporting circular solutions within the PV value chain takes place. In Task 4.4 the focus is application of digital tools, data-driven approaches, and machine learning to support improved monitoring, modelling, and optimisation of production and recycling processes.

Figure 1. Group photo from of the Workshop on Recycling and ML participants in Trondheim

Together, these activities aim to strengthen the knowledge base and technological capabilities required for sustainable PV material production and circular resource use.

Highlights from 2025

First Workshop on Recycling and Machine Learning

The first workshop on Recycling and Machine Leaning was organised in Trondheim on June 3rd and 4th with about 20 participants. The workshop gave an overview of the current status of recycling of EoL panels with some key challenges, and introduced two ongoing European projects focusing on recycling, namely Retrieve and APOLLO. Research on silicon kerf loss recycling from the previous FME, FME SuSoltech, was also presented by a PhD candiate. An introduction to machine learning (ML) and the use of AI tools on PV-related processes was also given. The workshop ended with a site visit to the PV system called Alpha Centauri at SINTEF.

Recycling of discarded PV modules, and finite element modelling of a Cz-system

In 2025 IFE focused on two tasks in WP4: Recycling of discarded PV modules, and finite element modelling of a Cz-system (SiSim).

The finite element modelling (FEM) activity in WP4 was originally planned with the objective of developing a detailed FEM model for crystal pulling in a specific Czochralski (CZ) process. The focus of the activity has been shifted toward impurity transport in the melt prior to crystal pulling.

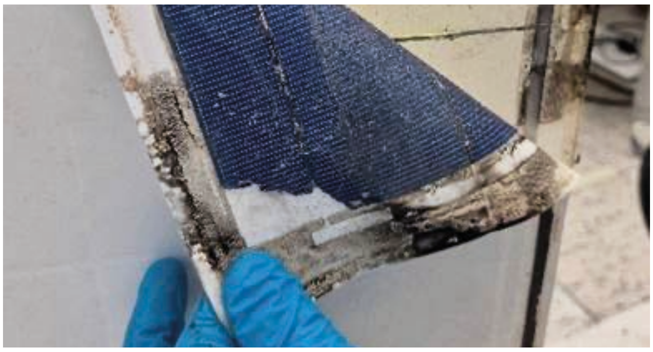


Figure 2. Pulsed laser delamination of one solar module was tested at IFE with the help of SYLSTAD AS and VDlaser AS

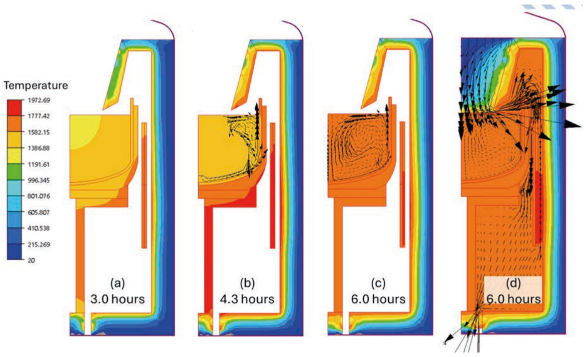


Figure 3. Temperatures and velocities (melt and argon) during melting of polysilicon (Czochralski).

All model development has been carried out in collaboration with HEU-Retrieve. Although experimental validation is still pending, the model in its current form is capable of simulating temperature distribution, fluid flow (both melt and argon gas), and impurity transport during the melting of polysilicon bricks in a quartz crucible.

Further work on the model in FME SOLAR is planned as a collaboration with Fraunhofer ISE within the EU project, where access to relevant process data and measurement data will enable verification and validation of the developed model.

Machine learning and Structure loss in the Cz silicon process

In Task 4.2, SINTEF worked on expanding the use of machine learning (ML) as a tool for statistical analysis of structure loss. The work resulted in the publication "Correlating Structure Loss and Operational Conditions in Czochralski Silicon Ingot Growth Using Machine Learning" presented at the SiliconPV conference in Oxford (UK) in April 2025.

The work on ML and structure loss was of interest for the German manufacturer of Cz process equipment PVA-Tepla, who have since joined FME SOLAR effective from January 1st 2026. During the fall of 2025, SINTEF and PVA-Tepla collaborated in the development of different strategies for detection of structure loss online, work that continues in 2026.

In parallel, close collaboration between SINTEF and NTNU continued through the preparation of the PhD position in which Nicolle Tello Diaz was employed.

PhD Student working on Production and recycling of PV materials

Nicolle Tello Díaz

Nicolle Tello Díaz is employed at NTNU as a PhD student and is currently working on her thesis: "Impurity flow in recycled silicon solar cells", analyzing the impurities in the crucible-silicon melt system. An important part of this project is to investigate their role, concentration, and distribution when recycled materials are used, with one of the main expectations being to identify the effects of persistent impurities on solar cell efficiency, yield, and overall manufacturing throughout.

Contact: Marisa Di Sabatino (marisa.di.sabatino@ntnu.no)

Application specific PV systems and components

Solar PV systems are deployed in a wide variety of forms. They range from large scale PV power plants harvesting solar energy at the lowest possible cost using standard components, to special uses where the components, the installation, the operation practice or the location differ significantly from standard routine. The motivation of the latter is to realise opportunities not accessed by the standard solutions, and the main driving force is limited access to area. Energy demand-driven area conflicts are among the main challenges encountered in our transformation to a carbon neutral society. Development of robust solutions for accessing less conflicted areas or to encourage dual area usage is therefore of the highest importance for securing widespread deployment of PV power plants in the years to come. In WP5 in FME SOLAR. we focus on three application-specific PV power plant technologies, each of which is covered in a separate task:

- 5.1 Agri-PV
- 5.2 FloatingPV (FPV)
- 5.3 Building-integratedPV (BIPV) & Infrastructure-integratedPV (IIPV)

Highlights from 2025

Building Integrated PV (BIPV)

If solar panels serve dual functionality of supplying electricity and keeping the building protected from the weather, the system is defined as being building integrated PV. Moreover, BIPV systems often provide improved aesthetics over the application of standard PV modules on buildings. The first aspect aims at reducing the system cost by avoiding one extra building skin layer, the second increases attractiveness, but may come at the expense of the aim of the first.

Addressing BIPV functionality as a building element, SINTEF has started developing models of the influence of installation of BIPV on the hygrothermal state of the roof construction, which will be continued in 2026. Continuing a long lasting focus on the aesthetic possibilities provided by coloured solar cells and modules, SINTEF and IFE published a review report entitled Feasibility assessment of methods to produce coloured PV modules for building integration.

Floating PV (FPV)

Floating PV accesses water bodies, either inland or ocean, being capable of avoiding our most intense activity and the potential related area conflicts. The application can access grey areas (i.e. areas already severely affected by human influence) and also provide power for specific locations, e.g. fish farming. Particular technological challenges exist, related to wind, wave and water, and cost reduction remains an important priority. The constant movement of the PV modules in FPV applications impacts the incident irradiance on the panels, resulting in a power loss referred to as wave-induced loss (WIL). In 2025, IFEs previous work on WIL modelling, has been expanded upon by Nils E. C. Taugbøl in his master's thesis entitled "Modelling wave-induced losses on floating photovoltaic systems". In this work, the WIL model was improved to incorporate realistic and site-specific inputs for sea state parameters and irradiance conditions. This enables the model to be utilized in concrete Energy Yield Assessments for FPV at new sites. Additionally, efficiency measures in the code were implemented to enable simulations for a full year. Using the updated model, WIL for 2023 was simulated for three nearshore sites along the Norwegian coast.

The IEA PVPS Report: Floating Photovoltaic Power Plants: A Review of Energy Yield, Reliability, and Maintenance, was finalized and published in April 2025. It was subsequently presented at the 5th annual floating solar PV forum in Amsterdam in May 2025 and at the Norwegian Solar Cell Conference, May 2025. SINTEF has focused on the physical challenges experienced by FPV systems: wave induced motion of connected multi-bodied floating structures requires complex modeling, and a longer term development of such models has started in 2025.

AgriPV plants at NMBU, Photo: Erlend Hustad Honningdalsnes

AgriPV

While AgriPV is quickly becoming an attractive alternative to traditional large scale deployment of solar power, the solution certainly does not target areas of low usage conflicts; most countries, Norway being a case in point, have high priority for area use for food production and accordingly strict protection of the use of such land for other purposes. The allure of AgriPV is that the co-location of PV structures with the agricultural activity in many cases has very little negative effect on actual food production yield, and in some cases even positive effects can be observed. Thus it is possible to develop business models where both user classes benefit and profit from the access to common land.

2025 has seen the introduction of two AgriPV research sites in Norway; while the existing plant at Skjetlein high school in Trondheim was restored after storm damage, a new site was inaugurated at NMBU. The sites are both vertical, bifacial systems but represent different climates and crops. Both were realized as a collaboration between industry and research institutes. NTNU and SINTEF published the first crop yield results from Norway, showing that over three different growth seasons no significant difference in biomass production was observed between the AgriPV system and a control plot. IFE has continued development of extensive microclimate models, with a particular focus on effects of vertical PV modules as wind shelters. The studies indicate that the positive effect of wind shelters on humidity and temperature in many instances can offset negative shade effects on crop yield in Norway. SINTEF has developed a techno-economic model for AgriPV, accounting for the cash flow of both components of an AgriPV system, currently applied to systems in East Africa, but it is currently being transferred to Norwegian and international applications. Lastly, a Nordic AgriPV research network has been developed and has had several encounters, through the initiative of SINTEF.

PhD and MSc students working on Application Specific PV systems and components

While no PhD position is directly funded under this topic, Thomas Richards at UiO from WP3 has a strong connection to AgriPV.

Nils Enric Canut Taugbø, MSc candidate at UiO, "Wave-induced loss for floating photovoltaics"

Eivind Venaas, MSc candidate at NMBU, "Planlegging av sensorer for overvåking av klima mellom solcellepanelene i et APV-anlegg ved NMBU"

Magnus Randers Thorsen, MSc candidate at NMBU, "Modellering og beregning av miljøforårsaket mismatchtap for solcellemoduler ved hjelp av strålesporingssimuleringer"

Contact: Gaute Stokkan (gaute.stokkan@sintef.no)

Beyond the horizon

FME SOLAR includes WP6, which is intended for active R&D in selected areas to explore the potential for new scientific and technological developments to disrupt the PV industry. In the first years, the work will have a particular focus on the breakthrough concepts for high-efficiency solar cells, such as silicon-based tandem solar cells and intermediate band solar cells. Besides the disruptive innovations in solar cells, disruptive developments in digitalization and energy storage, as well as business models will be explored to impact the future trajectory of the PV industry. As part of the activity we publish the annual FME SOLAR roadmap for PV technology. The roadmap will assist in setting the longer-term objectives for research, competence building, innovation, and industry projects. This task will also investigate the opportunities and challenges imposed by the innovation system in Norway on the development of the domestic PV industry.

Highlights from 2025

Novel Materials for Si-based tandem cells

The activity started with employment of Harald Fredriksen Høiland for the PhD position at UiO in summer 2025. His supervisor is Prof. Ola Nilsen. The PhD project is focused on synthesis and characterization of spinel oxide materials as a potential absorber for Si-based tandem cells. In 2025, we started investigations of the Zn-Fe-O spinel material. The method used for the synthesis was Atomic Layer Deposition (ALD) that is a scalable large-area technique (Fig. 1), well known to the industry. The studies started with establishing growth parameters for the spinel system. Presently, thin film deposition using Fe(acac)3, DEZ (diethylzinc) and Ozone or water (Fig. 1a) produced several samples that are currently being characterized (Fig. 1c). Based on the results of the characterization we will conclude on the viability of the Zn-Fe-O material system as the absorber. Initial measurements indicate promising properties, and the developed procedures provide a solid basis for further experiments and continued development of the system. Another precursor for Zn, Zn(acac)2, will be tested. Zn(acac)2 can turn out to be a more promising candidate since it has similar growth rates as Fe(acac)3, which can provide a higher control of the stoichiometry compared to what DEZ would have given. Further, we are testing the growth using in-situ thickness monitoring, which drastically increases the rate of data provided as multiple experiments can be run during one deposition.

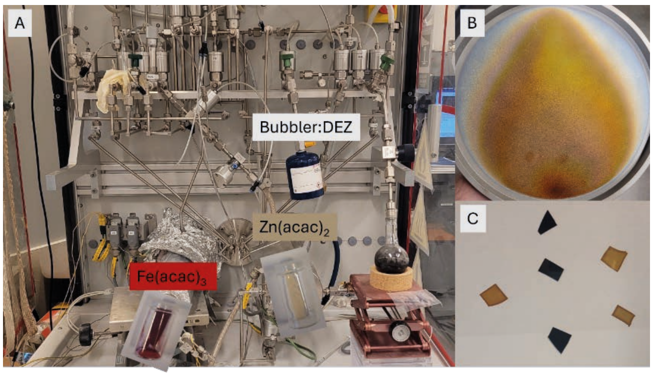
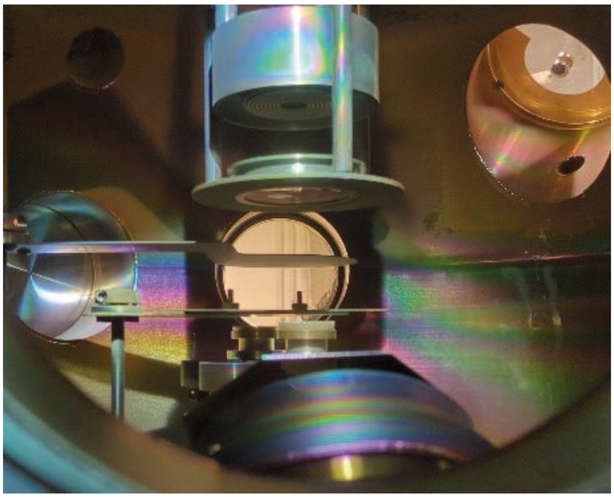


Figure 3: A) The ALD setup with the precursors that are pulsed one at a time into the reactor chamber. B) The lid of the reactor chamber showing lateral distribution of the synthesized material, and the orange color indicating a bandgap promising for an absorber. C) The films deposited on sapphire (left side), on Si (in the middle) and on fused silica (right side).

Materials for intermediate band cells

The activity started with employment of Eskil Vik for the PhD position at NTNU in the fall of 2025. His supervisor is Prof. Turid Reenaas. In 2025, the group has been working optimizing the dopant concentration for Cr + N co-doped TiO2 thin films for intermediate band solar cell applications. For such applications, a high doping level is needed to introduce an appreciable number of states within the band gap of TiO2, but low enough to allow growth of highly crystalline films. To this end, thin films grown using pulsed laser deposition (PLD) were characterized to determine the impact of doping level on the crystallinity, topography and optoelectronic properties of the films. Four master's students contributed to this work. A threshold doping level was found, above which the deposition routine produced



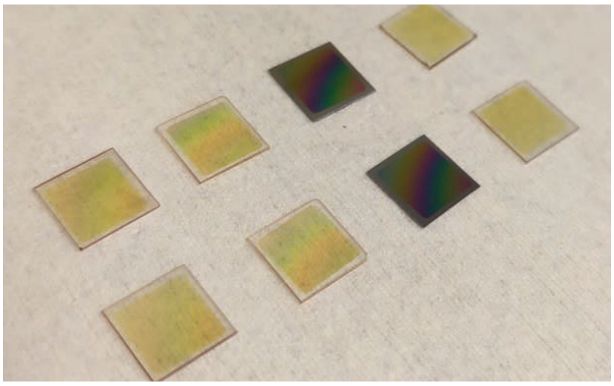


Figure 2. Left: PLD chamber with a target (white pellet in the middle) and the sample holder above. Right: Thin films of Cr + N co-doped TiO2 on transparent substrates and on Si. The yellowish color of the films indicates absorption in the visible light.

amorphous rather than crystalline films. However, the highest doping levels also showed promising optical absorption.

Workshop on materials for very high efficiency solar cells

In collaboration with the Centre for Materials Science and Nanotechnology (SMN) at UiO, FME SOLAR arranged a workshop on the 17th of November on "Materials for solar cells beyond Shockley- Queisser", a very successful hybrid workshop that attracted attention worldwide, with over 130 signing up for the workshop. The workshop provided an overview of the work in Norway on solar cell materials research, where the aim is to go beyond the Schockley-Queisser limit. The presentations featured work on the discovery, exploration and characterisation of oxides, nitrides and perovskites. The two PhD candidates working in this activity in FME SOLAR, Eskil Vik and Harald Fredriksen Høiland, gave presentations titled "Oxide-based materials for intermediate band solar cells" and "Spinel oxides for photovoltaics – as made by ALD", respectively. In addition, MSc student Viktor Bilstad (UiO) presented "Bandgap tuning of CuxZn1-xO by ALD".

PhD students working on Beyond the Horizon

Eskil Vik

Eskil Vik is a PhD student employed at NTNU and is investigating new, sustainable materials suitable for use in an intermediate band solar cell, capably of going beyond the Schockley-Queisser limit.

Harald Høiland

Harald Fredriksen Høiland is a PhD student employed at UiO and is exploring spinel oxides for tandem solar cell application. These materials are stable and non-toxic, offering a potentially sustainable alternative to perovskites.

Contact: Eduard Monakov (eduard.monakhov@fys.uio.no)

Education and training

FME SOLAR is set up to be the most important supplier for research, competence, capacity, and skills to support the PV development in Norway. Close to all segments of the PV industry call for skilled people, and demand is expected to grow also in Norway. Education and training is an integrated part of the activities in WP1 -WP6, which are developed to address important industrial challenges that require specific skillsets, increased capacity, and new knowledge.

One important strong point of FME SOLAR is the fact that the four universities in Norway with the largest technology portfolios are partners in the centre. These provide PV-related education and training. To coordinate these efforts, FME SOLAR contains a separate WP therefore contains a separate WP for researcher training and recruitment: WP7 Education and training. The activities in WP7 are set up to support the development of educational programmes in PV and to support the education of at least 20 PhD and PD candidates and 100 M.Sc. candidates. FME SOLAR facilitates and funds student and staff exchange, and arrange dedicated meetings for PhDs and post.docs. In addition to the PhD and postdoctoral positions funded either through the FME SOLAR grant or as own-effort from the research partners, a substantial number of MSc students also perform their thesis work in the centre. 10 M.Sc. candidates performed their thesis work in FME SOLAR in 2025, spread across 5 out of 6 of the technical WPs. Efforts to include MSc students into the centre include dedicated MSc student webinars, visibility on our website, and significantly reduced admission at the NSCC conference. This has led to a significantly increased participation of MSc students at the NSCC. The full list of PhD and MSc candidates associated with FME SOLAR is found in Attachment 3.

In 2025, a group of FME SOLAR partners headed by the University of Agder successfully applied for and received funding to develop two national courses for PV professionals targeting ground-mounted PV power plants and PV in buildings in Norway. Also in 2025, the development of a Nordic summer school in PV in collaboration with the Swedish PV research centre SOLVE and DTU in Denmark was initiated. The first summer school will be hosted in 2026.

Contact: Turid Reenaas (turid.reenaas@ntnu.no)

FME SOLAR funding and costs in 2024 and 2025

(All figures are given in 1000 NOK)

Funding	Amount
The Research Council of Norway	12,322
Research Partners	2,904
Industry partners	12,327
Public partners	1,554
Total funding	29,107

Costs	Amount
The Host Institution, IFE	8,530
Research Partners	11,070
Industry partners	8,013
Public partners	1,104
Equipment	390
Total Costs	29,107

List of publications from FME SOLAR in 2025

Presentations in mass media:

1. Håper batteriløsninger kan redde solkraftmarkedet, Erik S. Marstein, intervju, NrK Innlandet, 05.01.2025
2. Forsker advarer: Norge henger etter i den globale solkraftrevolusjonen, Erik S. Marstein, ITB aktuelt / Elektro 24/7, intervju, 12.01.2025
3. Verden blir soldrevet – himla fort, Erik S. Marstein, Titan.uio.no, intervju, 28.02.2025
4. Mer areal brukes til golfbaner enn til sol- og vindkraft i flere land, Erik S. Marstein, intervju, Forskning.no, 19.03.2025
5. Verden blir mer og mer soldrevet, Erik S. Marstein, intervju, Forskning.no, 27.03.2025
6. Solkraft i Norge og FME SOLAR, Erik S. Marstein, artikkel, Glass- og fasade, 01`2025
7. Slik rammer finansstormen solbransjen, Erik S. Marstein, intervju, Energi og klima, 10.04.2025
8. Mystiske funn i solkraftanlegg skaper uro, Erik S. Marstein, sitat, nrk.no, 31.05.2025
9. Solkraft kan bli Norges neste store eksporteventyr, Erik S. Marstein, artikkel, EnergiAktuelt, 14.08.2025
10. Solceller penere, Helge Malmbekk, invervju, Dagsrevyen 21.09.2025 Dagsrevyen - NRK TV

Reports, lectures, articles, presentations in meetings/conferences for public sector, business, and industry:

1. Zerbst solarpark, Fredy Ernesto Canizares Nino, Statkraft, Presentation NSCC 2025, 21. Mai Son Spa.
2. Reliability of PV + BESS, Erik S. Marstein, Elmia Solar, Jönköping 05.02.2025
3. Reliability of PV + BESS, Erik S. Marstein, IEA-PVPS Task 13 meeting, Roma 25.02.2025
4. The solar (PV) industry, Erik S. Marstein, FME Conference, Trondheim, 03.04.2025
5. How PV is leading the green transition, Erik S. Marstein, ITS Lunch seminar 25.04.2025
6. The state of the PV industry in 2025, Erik S. Marstein, NSCC 2025, Son, 20.05.2025
7. Solbransjen som eksportindustri, Erik S. Marstein, Arendalsuka, 13.08.2025
8. Solenergi for fremtiden: Insentiver for høsting på næringsbygg, Erik S. Marstein, Paneldiskusjon, Arendalsuka 12.08.2025
9. Solkraft som eksportnæring – hvor står vi? Erik S. Marstein, Paneldiskusjon, Arendalsuka 13.08.2025

10. A fast and accurate raytracing approach for assessing performance of mono-and bifacial PV modules in complex irradiance, Arnkell J. Petersen & Iver Frimannslund, NSCC 2025, 21. Mai, Son Spa

11. Analyzing and modeling snow loss in ground-mounted PV systems, Mari Øgaard, NSCC 2025 21. Mai, Son Spa

12. Introduction to FME SOLAR, Mari Øgaard, Reneable Energy Day, UiA, foredrag, Grimstad, 06.06.2025

13. Samfunnet trenger mer strøm, men er vi villig, og i stand til å ta i bruk energikildene som finnes? Tore Vehus, Arendalsuka 12.08.2025

14. Short-Term PV power forecasting using time-series decomposition and machine learning: A case study in Trondheim, Norway, Berhane Darsene Dimd and Alfredo Sanchez Garcia, NSCC 2025, 21. Mai, Son Spa

15. Optimizing the Performance of Bifacial PV Modules Through Ground Albedo Enhancement, Dounia Dahlioui, Anne Gerd Imenes, Ingar Alvaro Høye, NSCC 2025, 21. Mai, Son Spa

16. The impact of snow deposition on photovoltaic power output, Mattia Manni, Alessandro Nocente, Marisa Di Sabatino, Gabriele Lobaccaro, NSCC 2025, 21. Mai, Son Spa

17. Machine Learning Correction of Horizontal Irradiance for Solar Production Forecasting, Martin Helge Johansen, poster presentation, 20. Mai 2025, Son

18. Short-term PV power forecasting using spatially resolved production data, Magnus Moe Nygård, oral presentation, 20. Mai 2025, Son

19. Matproduksjon og solernergi = sant, Erlend Hustad Honningsdalsnes, Arendalsuka 13. august 2025

20. Managing Overvoltages in the Distribution Grid Caused by Solar Power Generation, Jone Odden, Poster, NSCC 20. Mai 2025, Son

Publications in referred journals:

1. Data Quality Analyses for Automatic Aerial Thermography Inspection of PV Power Plants, V. Lofstad-Lie, A. Simonsen, T.F. Nygaard and E.S. Marstein, IEEE Journal of PV (2025) DOI: 10.1109/JPHOTOV.2025.3587297

2. Parametrization of I-V characteristics of solar cells via asymptotics solutions of the super-ellipse model, Jose Tirado-Serrato, Alfredo Sanchez, Serguei Maximov, Solar Energy, p 113797, 300, 2025

Presentations from international scientific conferences:

1. Analyzing and Modeling Snow Loss in Ground-Mounted PV Systems, Mari B. Øgaard, Erling W. Eriksen, Sigrid Rønneberg, Heine N. Riise, Oral, EUPVSEC, Bilbao, 2025

2. Optimalization of PV plants in snow rich areas, Thomas Thiis, Arnkell J. Petersen, Jan Potac, Matthias Henkies, Iver Frimannslund, oral presentation, 9th European African Conference on Wind Engineering (EACWE2025), oral presentation Trondheim 18.06.2025

3. A comparison of machine learning and calibrated physical models for solar energy analysis in snowy regions, M. Manni, A. Nocente, G. Lobaccaro, Conference proceedings, CISBAT2025, Lausanne September 3rd - 5th 2025

4. Finding the Needle in a 100 MWp Haystack, Marie Syre Wiig, Magnus Moe Nygård, Bjørn Aarseth, Erik Marstein, Oral, EUPVSEC, Bilbao, 2025

5. Quantifying the benefits of hybrid PV-wind power plants, Erik S. Marstein, EUPVSEC, Bilbao, 26.09.2025

6. Assessing Cold-Weather Reliability of PV + BESS, Erik S. Marstein, EUPVSEC, Bilbao, 23.09.2025

7. Deep Learning-Based Solar Irradiance Decomposition Models for Nordic Regions, Alfredo Sanchez Garcia, Berhane Darsene Dimd, poster, EUPVSEC, Bilbao, 2025

8. Nature-Inclusive Operation and Maintenance of PV Parks – An Expert Elicitation of PV Performance and Ecological Impacts, Heine Nygard Riise, Anne Catriona Mehlhoop, Nathan Roosloot, Magnus Moe Nygård, Erling Ween Eriksen, Harsha Walpita, Mari Benedikte Øgaard, Marie Syre Wiig, Marija Vukovic, poster, EUPVSEC, Bilbao, 2025

9. Performance Evaluation of Installed Bifacial PV Modules: Towards the Ground Albedo Enhancement, Dounia Dahlioui, Steve Schading, Ingar Alvaro Høye, Tore Sandnes Vehus, poster, EUPVSEC, Bilbao, 2025

10. Towards a cost-priority number for module replacements informed by energy yield time series and infrared thermography data, (Nygård et al.) poster, EUPVSEC, Bilbao, 2025

Reports, lectures, presentations at technical meetings:

1. FME SOLAR in a nutshell, Erik S. Marstein, FME SOLAR Webinar series, 04.03.2025

2. Design and optimization of hybrid PV + wind power plants, Erik S. Marstein, IEA Wind Task 50 WP3 meeting (online), 01.04.2025

3. Batterisystemenes rolle, Erik S. Marstein, FME SOLAR Webinar series, 28.05.2025

4. Reliability of PV + BESS, Erik S. Marstein, FME SOLAR Webinar series, 10.06.2025

5. How PV is leading the green transition, Erik S. Marstein, Solcellespesialisten seminar, Fredrikstad, 22.08.2025
6. How PV is leading the green transition, Erik S. Marstein, UiO førsteårsstudenter, Sundvolden, 04.09.2025
7. Cloud motion detection and short-term photovoltaic (PV) power forecasting using spatially resolved production data, Magnus Moe Nygård, FME SOLAR Webinar, 11.03.2025
8. Short-term PV Power Forecasting Using Time-Series Decomposition and Machine Learning, Alfredo Sanchez Garcia, FME SOLAR Webinar, 11.03.2025
9. Sky imager information for forecasting, Erling Ween Eriksen, FME SOLAR Webinar, 11.03.2025
10. Introduction to recycling through the silicon solar cell value chain. Marisa Di Sabatino, workshop on Recycling and Machine learning, Trondheim 3.6.2025
11. Recycling of silicon kerf: challenges and possibilities, Tinotenda Mobaiwa. workshop on Recycling and Machine learning, Trondheim 3.6.2025
12. Recycling of EOL panels. Jonas Låstad, workshop on Recycling and Machine learning, Trondheim 3.6.2025
13. Introduction the HEU Retrieve project, Rune Søndenå, workshop on Recycling and Machine learning, Trondheim 3.6.2025
14. Recycling end-of-life PV modules: Hands-on experience, Per-Anders Hansen, workshop on Recycling and Machine learning, Trondheim 3.6.2025
15. Machine learning in CZ process and structure loss, Alfredo Garcia, workshop on Recycling and Machine learning, Trondheim 3.6.2025
16. Digital Product Passport, Rune Søndenå, workshop on Recycling and Machine learning, Trondheim 3.6.2025

Communication efforts for relevant target groups:

1. Bakkemontert solkraft i Norge: Hvorfor går det så sakte? Arrangement: Arendalsuka, Arrangører IFE, FNI, Greenstat, Norconsult, Fornybar Norge. 12.8.25
2. Solkraft som eksportnæring Hvor står vi? Arrangement 13. august 2025: Arendalsuka. Arrangører: Fornybar Norge, Satec, Multiconsult, IFE
3. The Norwegian Solar Cell Conference (NSCC) 2025. Son 20-21 Mai. Arrangør av FME SOLAR

MSc theses:

1. Impacts on Norwegian LV Distribution Grid from EU's Solar Rooftop Initiative, Nina S. Moe, Maren Nærland, Master thesis UiA 2025. AURA: Impacts on Norwegian LV Distribution Grid from EU's Solar Rooftop Initiative

2. Tilknytning på vilkår som fasilitator for kolokalisering av kraftproduksjon og kraftforbruk, Ine Erlandsen Grimsrud, Master thesis, NMBU 2025, Brage NMBU: Tilknytning på vilkår som fasilitator for kolokalisering av kraftproduksjon og kraftforbruk

3. Håndtering av spenningsvariasjoner forårsaket av solkraft i høyspente distribusjonsnett ved bruk av batterier og omformerstyring, Jone Odden, Master thesis, NMBU 2025, Brage NMBU: Håndtering av spenningsvariasjoner forårsaket av solkraft i høyspente distribusjonsnett ved bruk av batterier og omformerstyring

4. Modelling wave-induced losses on floating photovoltaic systems, Nils Enric Canut Taugbøl, Master thesis 2025, UiO/IFE.

5. Enhancing PV Production Forecasts Incorporating Self- and External Shading Effects, Martin Helge Johansen, Master Thesis, UIA 2025, AURA: Enhancing PV Production Forecasts Incorporating Self- and External Shading Effects

6. Modeling of Temperature for Mono- and Bifacial Photovoltaics in Nordic Conditions, Tone Alsvik Finstad, Master Thesis, NTNU/IFE 2025.

7. Modellering og beregning av miljøforårsaket mismatchtap for solcellemoduler ved hjelp av strålesporingssimuleringer, Magnus Randers Thorsen, Master thesis, NMBU 2025, https://nmbu.brage.unit.no/nmbu-xmlui/handle/11250/3205719

8. Planlegging av sensorer for overvåkning av klima mellom solcellepanelene i et APV-anlegg ved NMBU, Eivind Venaas, Master thesis, NMBU 2025, https://nmbu.brage.unit.no/nmbu-xmlui/handle/11250/3207495

List of personnel working in FME SOLAR in 2025

Key researchers working in the Centre

Name	Institution	Main research area
Erik S. Marstein	IFE	Centre Director
Josefine Selj	IFE	Innovation and impact
Kristin Bergum	IFE	Deputy Centre Director
Marie Syre Wiig	IFE	PV Power Plants
Marit Ulset	IFE	PV Power Plants
Heine Riise	IFE	Work package manager, PV Power Plants
Magnus Moe Nygård	IFE	PV Power Plants
Erling Ween Eriksen	IFE	PV Power Plants
Elin Dypvik Sødahl	IFE	PV Power Plants
Christoph Seiffert	IFE	PV in Nordic conditions
Mari Benedikte Øgaard	IFE	PV in Nordic conditions
Iver Blix Loennecken	IFE	PV in Nordic conditions
Ville J. Olikkonen	IFE	Grid integration of PV power plants
Stine Fleischer Myhre	IFE	Grid integration of PV power plants
Dag Lindholm	IFE	Production and Recycling of PV Material
Rune Søndenå	IFE	Production and Recycling of PV Material
Per-Anders Hansen	IFE	Production and Recycling of PV Material
Ørnulf Nordseth	IFE	Application-specific PV systems
Gaute Otnes	IFE	Application-specific PV systems
Sigrid Rønneberg	IFE	Application-specific PV systems
Gaute Stokkan	SINTEF	Work package manager, Application-specific PV systems
Alfredo Sanchez Garcia	SINTEF	PV Power plants
Berhane Darsene Dimd	SINTEF	PV Power plants
Gorm Idar Johansen	SINTEF	PV Power plants
Xiang Ma	SINTEF	PV in Nordic conditions
Alexander G Ulyashin	SINTEF	PV in Nordic conditions
Jens Hanson	SINTEF	PV in Nordic conditions
Lars Gullbrekken	SINTEF	PV in Nordic conditions
Igor Sartori	SINTEF	Grid integration of PV power plants
Ingeborg Roe	SINTEF	Grid integration of PV power plants
Nagarajan Somi Ganesan	SINTEF	Production and recycling of PV Materials
Birgit Ryningen	SINTEF	Production and recycling of PV Materials
Eivind Øvrelid	SINTEF	Production and recycling of PV Materials
Kai Tang	SINTEF	Production and recycling of PV Materials
Arne Karstein Røyset	SINTEF	Production and recycling of PV Materials
Richard Randle-Boggis	SINTEF	Application-specific PV systems

Name	Institution	Main research area
Tore Kolås	SINTEF	Application-specific PV systems
Virgile Delhaye	SINTEF	Application-specific PV systems
Bjørn Christian Abrahamsen	SINTEF	Application-specific PV systems
Øyvind Ygre Rogne	SINTEF	Application-specific PV systems
Marit Stange	SINTEF	Beyond the horizon
Heidi S. Nygård	NMBU	Work package manager, Grid-integration of Power Plants
Ingunn Burud	NMBU	PV Power plants
Erling Holden	NMBU	PV in Nordic conditions
Thomas Thiis	NMBU	PV in Nordic conditions
Leonardo Rydin	NMBU	Grid-integration of PV power plants
Espen Olsen	NMBU	Application-specific PV systems
Marisa Di Sabatino	NTNU	Work package manager, Production and Recycling of PV material
Turid Reenaas	NTNU	Work package manager, Education, Beyond the horizon
Morten Kildemo	NTNU	Beyond the horizon
Gabriele Lobaccaro	NTNU	PV in Nordic conditions, Application-specific PV systems
Bjørn Petter Jelle	NTNU	PV in Nordic conditions, Application-specific PV systems, Beyond the horizon
Mattia Manni	NTNU	PV in Nordic conditions, Application-specific PV systems
Jafar Safarian	NTNU	Production and Recycling of PV material
Mari Benedikte Øgaard	UiA	Work package manager, PV in Nordic conditions
Rade Ciric	UiA	PV Power plants, grid-integration of PV power plants
Joao Leal	UiA	PV Power plants
Tore Vehus	UiA	PV in Nordic conditions
Dounia Dahlioui	UiA	PV in Nordic conditions
Rune Strandberg	UiA	Application-specific PV systems
Eduard Monakhov	UiO	Work package manager, Beyond the Horizon
Sabrina Sartori	UiO	Grid-integration of PV power plants
Mathias Hudoba de Badyn	UiO	PV Power plants
Marianne Zeyringer	UiO	PV Power plants
Alexander Azarov	UiO	Production and recycling of PV Materials
Ola Nilsen	UiO	Beyond the Horizon
Holger Von Wenckstern	UiO	Beyond the Horizon
Øystein Prytz	UiO	Beyond the Horizon
Henrik Sønsteby	UiO	Beyond the horizon
Bilal Babar	UiO	PV in Nordic Conditions

PhD students with financial support from the FME SOLAR budget

Name	Nationality	Period	Sex M/F	Topic
Johannes G. Venter	South African	02'25-02'28	M	Mathematical modeling of power system stability
Nikolas Recke	German	02'25-02'28	M	Distributionally Robust Model Predictive Control for Virtual Power Plants
Nicolle Telle Diaz	Colombia	10`25-09`28	F	Impurity flow through the silicon solar cell process
Thomas Richards	British	08`25-08`28	M	Modelling Alternative Land-Use Strategies for Solar PV Deployment
Binod Sapkota	Nepal	09`25-08`28	M	Social acceptance of PV in the Nordics
Harald F. Høiland	Norwegian	09`25-09-28	M	Material for tandem
Eskil Vik	Norwegian	10`25-09`28	M	Materials for high efficiency solar cells

MSc candidates in FME SOLAR

Name	Sex	Topic	Supervisor
Ine Erlandsen Grimsrud	F	Grid integration of PV power plants	Heidi S. Nygård (NBMU) and Bjørn Thorud (Aneo)
Jone Odden	M	Grid integration of PV power plants	Heidi S. Nygård (NBMU) and Nils R. Ruud (Østfold Energi)
Magnus R. Thorsen	M	PV Power Plants	Arnkell J. Petersen and Iver Frimannslund (NMBU)
Nils E. C. Taugbøl	M	Application-specific PV systems and Components	Vilde S. Nysted (IFE), Josefine Selj (IFE) and Morten Hjorth-Jensen
Eivind Venaas	M	APV System	Espen Olsen (NMBU)

Name	Sex	Topic	Supervisor
Nina S. Moe	F	Grid integration of PV power plants	Kristine Askeland (Lnett), Rade Ciric (UiA), Joao Leal (UiA)
Solveig Pettersen	F	PV Power Plants	Ingunn Burud (NMBU)
Tone Alsvik Finstad	F	PV Power Plants	Magnus M. Nygård (IFE), Turid Reenaas NTNU)
Martin Helge Johansen	M	PV Power Plants	Rune Strandberg (UiA)
Maren Nærland	F	Grid integration of PV power plants	Kristine Askeland (Lnett), Rade Ciric (UiA), Joao Leal (UiA)

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