Netherlands

Next-generation solar power

Dutch technology for the solar energy revolution

Next-generation high-tech excellence

Harnessing the potential of solar energy calls for creativity and innovative strength. The Dutch solar sector has been enabling breakthrough innovations for decades, thanks in part to close collaboration with world-class research institutes and by fostering the next generation of high-tech talent. For example, Dutch student teams have won a record ten titles in the World Solar Challenge, a biennial solar-powered car race in Australia, with students from Delft University of Technology claiming the title seven out of nine times.


KLM

Index

The Netherlands, a true solar country

If there's one thing the Dutch are remarkably good at, it's making the most of their natural circumstances. That explains how a country with a relatively modest amount of sunshine has built a global reputation as a leading innovator in solar energy.

For decades, Dutch companies and research institutes have been among the international leaders in the worldwide solar PV sector. Not only with high-level fundamental research, but also with converting this research into practical applications. Both by designing and refining industrial production processes, and by developing and commercialising innovative solutions that enable the integration of solar PV into a product or environment with another function.

In a country in which sunshine isn't a given and where space is scarce, there is a great need for innovation. For many years, Dutch companies and knowledge institutes have organised themselves to work together effectively to bring about innovations that have proven their value far beyond the country's borders.

How can you benefit best from Dutch solar expertise and solutions? In this guide we will help you to answer that question and familiarise you with the Dutch solar PV sector. This guide demonstrates the expertise that organisations in the Netherlands have in the various elements of the value chain, it shows which new applications have been developed with that expertise, and what future opportunities we envisage to give the solar revolution extra impetus.

It is with great pride that we present this guide and invite you to get in touch with us so we can help you achieve your ambitions. Together we can accelerate the solar revolution and make a difference for our world, ourselves and future generations.

Marcel Werther
Top Sector Energy, empowering the new economy

Wijnand van Hooff
TKI Urban Energy and Holland Solar, industry association of the solar PV sector

Kenneth Colijn
Netherlands Enterprise Agency

Rogier Blokdijk
FME the Dutch employers' association in the technology sector

The sunny side of the Netherlands

The global energy transition is gathering pace, and solar energy is one of the driving forces behind it. Smart innovations are needed to maintain this momentum, specifically in order to make solar energy more economical and reliable, and to enable large-scale integration into our built and natural environment.

Solar energy is growing at a rapid pace: in 2019, the worldwide installed capacity exceeded 500 GW, a figure expected to increase by almost 100 GW each year. However, this growth rate will have to triple in order to achieve the climate ambitions laid down in the Paris Agreement. In scenarios published by the International Renewable Energy Agency (IRENA), electricity will be the main energy carrier by 2050 and 86% of it will come from sustainable sources – especially the solar energy.

Achieving this target will require ongoing innovation. Smart technology is needed to substantially lower production costs, to boost efficiency and to develop creative ways of incorporating solar technology into our everyday environment. Dutch companies and researchers are among the global pioneers taking up this challenge.

The Netherlands: pioneer in solar energy

The Netherlands may not be the sunniest country, yet for decades it has been one of the global leaders in both fundamental and applied solar research. The Dutch were among the first to build a fully functioning solar energy system and have developed crucial patents still used by numerous international manufacturers. The Netherlands is home to a vibrant ecosystem of companies and research institutes that covers virtually the entire solar technology chain: from materials to device design, manufacturing equipment, software, high-end solar modules and complete project development.

One of the factors behind the sustained success of the Dutch solar sector is a healthy home market. The Netherlands is a small country, but in terms of the annual installed capacity it is among the top 3 countries in Europe and in the top 10 globally. The Dutch government's CO2 reduction commitments are accompanied by an active innovation policy, and there is a strong tradition of companies and research institutes forming partnerships and consortia.

Through such cooperation, the Dutch solar sector is exploring ways of making solar energy more competitive, for example by developing more efficient production methods and increasing the yield and lifespan of solar technology. In a joint innovation agenda, the Dutch solar sector states that by 2030 the manufacturing costs of solar panels and thin films could be halved, yield could increase by at least 25% and the average lifespan could be extended by at least 10 years.

"A global leader in both fundamental and applied solar research"

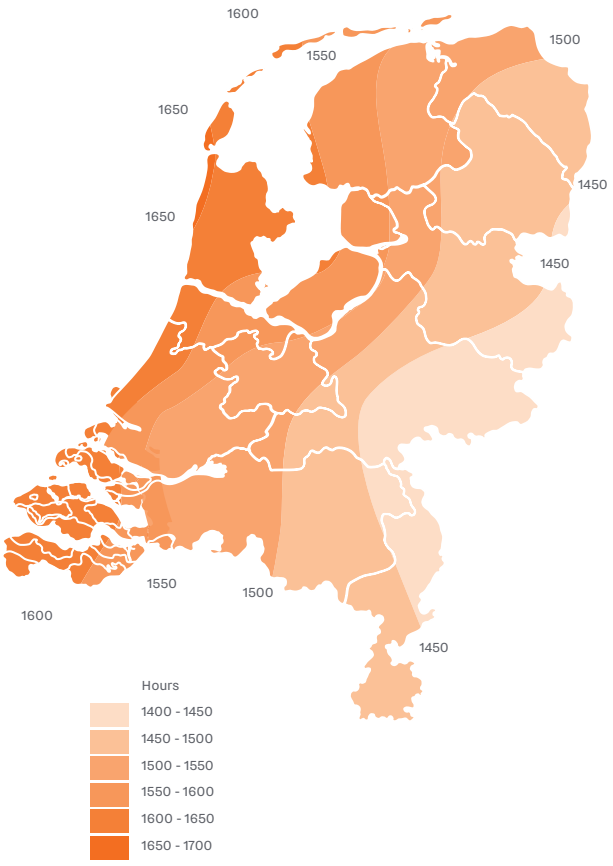
However, the future growth of solar energy is increasingly intertwined with other, new demands and challenges:

- How can we integrate large-scale solar energy into more complex environments, particularly in densely populated areas in which space is limited and expensive?
- How can we ensure that, instead of being a stand-alone solution or an optional extra, solar energy becomes an integral part of the design of buildings, infrastructure and public spaces?
- Can we make solar energy even more sustainable by reducing its ecological footprint, for example by using more sustainable materials and circular design?
- How can we incorporate huge quantities of solar energy into the existing power grid and the overall energy system?

When tackling these and other challenges, the Netherlands benefits from its unique environment and history. Because space is scarce and the natural conditions are challenging, the Netherlands has built up a strong tradition of teamwork and integrated thinking. The Dutch have been manipulating their environment for centuries, reclaiming land from the sea and carefully sharing the available space. The 'polder mentality' of the Dutch has become synonymous with a mindset built around cooperation and shared interests.

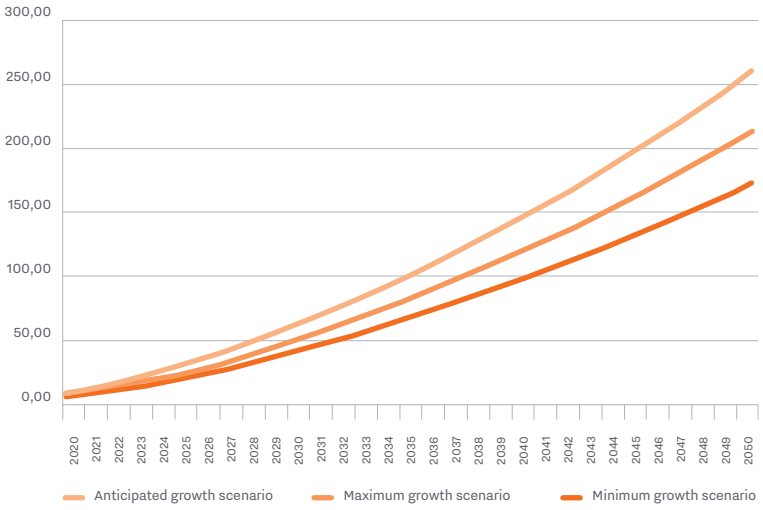
This mindset is alive and well in the Netherlands of today. It ensures that in a relatively small country international partners find a world-class network of solar specialists who in variable configurations contribute towards the growth, efficiency and success of solar projects far beyond the borders of the Netherlands.

Annual total hours of sunshine in the Netherlands

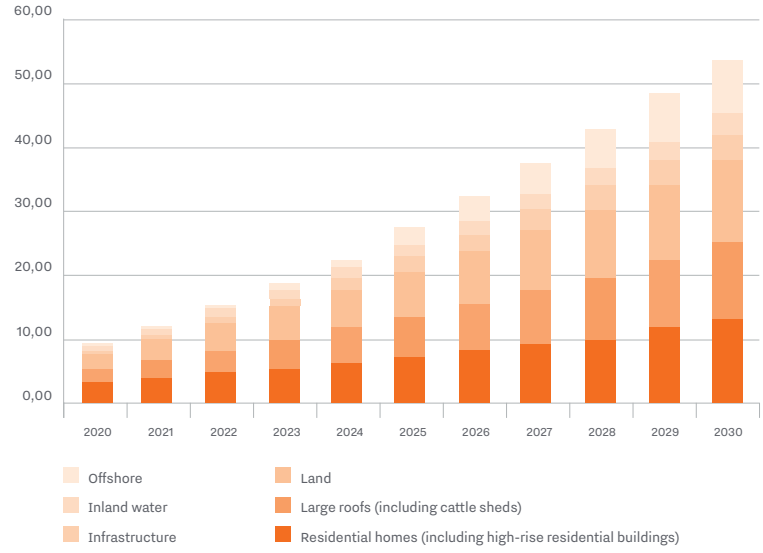


Source: Royal Netherlands Meteorological Institute (KNMI)

Growth scenarios installed PV capacity in the Netherlands



Expected growth PV capacity by type (in GWp)



200 TWh

The potential annual yield of solar electricity in the Netherlands is 73% greater than the country's current total electricity consumption

The Dutch government aims for:

- **42 TWh** of renewable electricity by 2030, including 7 TWh from small-scale (solar) installations in the built environment
- **a 30% drop** in the cost price of solar electricity by 2025

Breeding ground of PV technology

At Eindhoven's High Tech Campus, research institutes Solliance and Holst Centre are working on technologies for organic and flexible solar cell production technology.

The solar technology of the future combines high efficiency and a lower cost with greater versatility, higher reliability and minimal environmental impact. Dutch companies and research institutes will help to shape this future with fundamental innovations and proven solutions that are used well beyond the borders of the country.

"A global leader in both fundamental and applied solar research"

In terms of technological innovation, the Netherlands is a world leader. It ranks in the global top 10 for patents filed and the number of patent applications per capita is the second highest in the world. A substantial part of that innovative strength is concentrated in the PV technology chain, where the Netherlands benefits from the presence of global players in materials science and semiconductors, and from a strong tradition in high-value process technology.

Together, Dutch companies and research institutes cover the entire value chain of solar technology (see the infographic on p. 28). They have a prominent track record in the crucial first steps in the chain (design, materials, components and manufacturing equipment) as well as in developing new applications and innovative end-to-end solutions.

Next generation PV

Dutch researchers and companies are highly specialised in the development of new concepts and technology that increase the efficiency of solar cells. From surface passivation to the development of bifacial solar cells: Dutch researchers laid the foundations for these innovations almost 30 years ago. More recently, Dutch specialists have made substantial progress in the development of tandem structures, in which several types of solar cells are combined. This technology offers opportunities to significantly increase the efficiency of solar cells, to reduce costs and to minimise the amount of space required for solar energy generation.

The Netherlands also has specific expertise in thin-film photovoltaics. Much of this expertise is brought together in the joint venture Solliance, in which universities, research institutes and dozens of companies convert promising technologies and research into practical applications and production processes, assisted by large-scale laboratory and testing facilities.

Smart production technology

Solar cell and panel manufacturers around the world use machines and production lines built by Dutch companies. In close collaboration with research institutes and testing facilities, these companies develop production methods for 'new' types of solar cells. They also focus on making existing production processes more efficient, by increasing their output, reducing waste and thus minimising the cost price of solar cells.

To mention just one example: Dutch innovations in layer deposition for crystalline silicon cells have increased the production capacity of systems tenfold in just a few years, from a few hundred to more than 5,000 wafers an hour. Dutch expertise in thin-film technology paves the way for large-scale (roll-to-roll) production at increasingly lower costs.

Truly sustainable solar technology

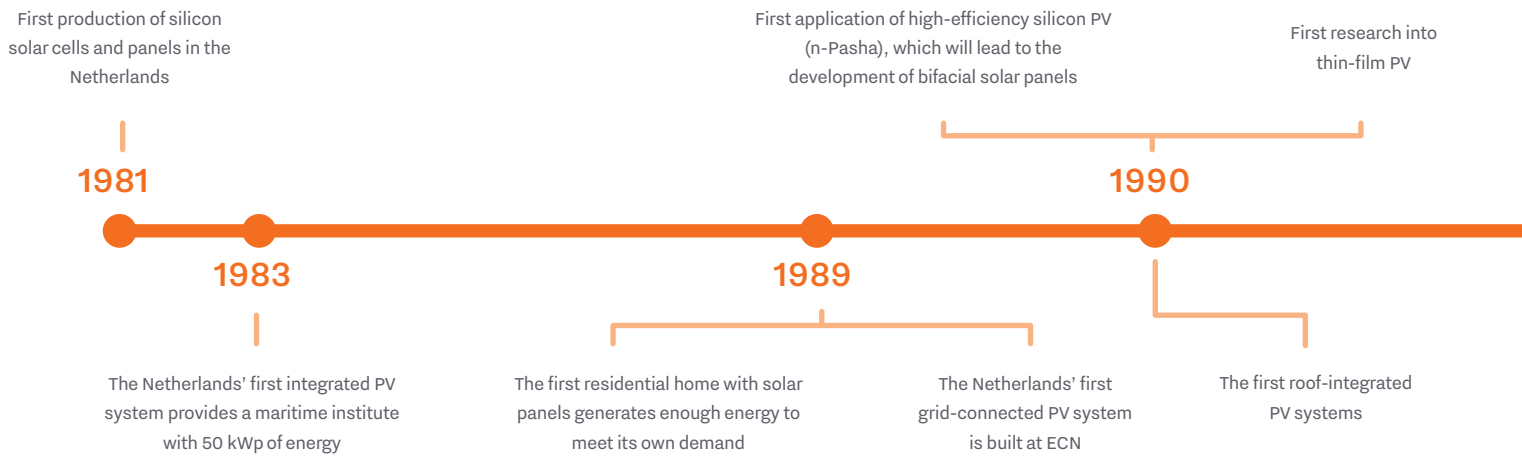
PV technology is an enabler for making the energy supply more sustainable – but how sustainable are the solar cells and panels themselves? Dutch companies focus explicitly on innovations that reduce the ecological footprint of solar technology. For example, by increasing the lifespan of PV technology and by developing components and (encapsulation) materials that can easily be disassembled and recycled at the end of a system's lifecycle.

As well as making PV technology more sustainable, such innovations often boost performance and efficiency. For example, Dutch materials scientists have developed a new generation of back sheets for PV panels, which are not only 100% recyclable and fluorine-free, but are also more resistant to extreme weather conditions and offer very high optical reflection.

Breaking the 30% barrier

By combining a newly developed perovskite solar cell with an industrial bifacial crystalline silicon solar cell, researchers at ECN part of TNO and its Solliance partners have managed to create a bifacial tandem solar cell with an unprecedented efficiency of 30.2% – a third higher than the current generation of state-of the art industrial solar cells.

40 years of Dutch solar innovations



Innovative materials

Dutch multinational DSM pioneered the development of anti-reflective coatings, which boost the efficiency of solar panels by over 3%. The technology has since been enriched with anti-soiling features, which maximise yield and reduce the amount of water and consumables needed for cleaning.

Production technology experts

Dutch research and 'spatial ALD' equipment developed by machine manufacturers such as Levitech and Solaytec, have helped to convert the traditionally very slow atomic layer deposition (ALD) process into a continuous workflow capable of processing thousands of wafers per hour.

Smit Thermal Solutions' equipment, as pictured above, allows solar manufacturers to deposit semiconductor layers on large substrates, even up to and beyond 2m^2 in a vacuum environment, with temperatures of up to 600 degrees Celsius.

1995

Start development of back-contact silicon cells and modules, and of silicon nitride coatings for industrial production of silicon solar cells

2005

Research, development and industrial application of 'spatial ALD' for surface passivation

Building work starts on City of the Sun, the world's first large-scale energy-neutral residential area

2015

Research and development of tandem technology (silicon/thin-film and thin film/thin film)

2019

The world's first real offshore PV system

Integrating PV into our environment

1. Dutch companies such as Exasun and BEAUSolar have developed integrated PV roof modules which can completely replace existing roof tiles.

2. HyET Solar produces flexible and extremely lightweight thin-film silicon solar cells on long foil substrates, which allow up to 90% of a roof surface to be used.

3. Solar Visuals' high-tech PV modules can incorporate any photo print, image or pattern – including that of a brick wall.

4. At Eindhoven University of Technology's campus, a consortium of eight companies has developed a new type of PV building module, made of coloured composites and integrated thin-film solar cells.

5. ZigZagSolar developed a unique energy-harvesting architectural façade, with fully optimised sun- oriented PV panels supported by reflecting panels.

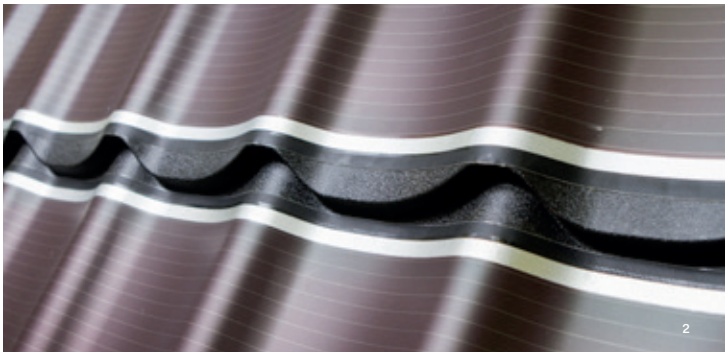
Integrated PV solutions

The limited space available in and near urban areas encourages multiple land use. Dutch companies are at the forefront of integrating solar technology into infrastructure, buildings or agricultural settings. For example, floating solar farms are being developed in more and more challenging environments.

This development leads to an intensive cross-pollination of technology and applications. Entirely new value chains are created, in which suppliers of PV technology join forces with architects, contractors and installation companies, and with organisations responsible for infrastructure and public spaces.

Examples of focus areas for Dutch PV specialists include:
- the production of high-quality, semi-finished products that can be incorporated into integrated applications, such as individual cells, unwrapped films and specific types of plastic and glass;
- high-end building components with integrated solar cells (building-integrated PV, or BIPV);
- innovations that simplify the aesthetic incorporation of solar into public spaces, such as new materials and films that offer greater freedom in terms of colour, shape, flexibility and size.

"New value chains for integrated solar applications"



2

3

4

5

Reliability and efficiency during the entire lifecycle

For a strong business case, it is important that anticipated energy yields are well-substantiated. Dutch companies and research institutes have developed advanced calculation models, measuring equipment and simulation setups. Based on extensive meteorological datasets and analysis of local conditions (such as shadow effects and light reflection), these solutions enable project developers to predict potential yields with more and more accuracy.

Whether potential yields are actually delivered also depends on the quality and reliability of the PV technology used. Dutch companies support end-to-end monitoring with advanced measuring equipment and software, from the moment components leave the factory to post-installation checks and monitoring throughout the system's lifespan.

Solar simulators, climate chambers and testing equipment by Dutch company Eternal Sun are used by the world's leading research laboratories and solar panel manufacturers to test performance and reliability with ever greater degrees of accuracy.

Dutch solar expertise hits the road: Lightyear recently unveiled the world's first fully solar-powered car, the first commercial models of which are scheduled for delivery in 2021

Integrating solar into our environment

The growth ambitions for solar energy around the globe are enormous. At the same time, in more and more places, project developers are encountering space constraints or resistance from residents. An increasingly urgent question is, therefore, how we can achieve optimum integration of solar energy into our surroundings.

At Eindhoven's High Tech Campus, research institutes Solliance and Holst Center are working on technologies for organic and flexible solar cell production technology.

While in some areas large-scale generation under ideal conditions is possible, more and more solar capacity will have to be achieved at less straightforward locations – particularly in and around densely populated urban areas where demand is high and concentrated – but where space is scarce.

As the second most densely populated country in the world, the Netherlands has an impressive track record in terms of creative spatial solutions and multiple land use. The Dutch have built the world's largest greenhouse horticultural area as well as Europe's largest port, situated side by side in the heart of the Randstad metropolitan area. The Netherlands combines one of the densest and most heavily used railway networks in the world with a position as the second largest food exporter. All of this in a society which places great emphasis on aesthetic quality, the quality of life in public spaces and the protection of environmentally sensitive habitats.

If even the Dutch can find space for large-scale solar power generation in such a complicated environment, this offers opportunities for urbanised areas elsewhere. What ideas, innovations and proven solutions does the Netherlands have to offer the world?

Solar in the built environment

When integrating solar technology into the urban environment, buildings are a logical starting point. Huge numbers of solar panels are installed on roofs throughout the world each year. Nevertheless, we still only utilise a fraction of the potential offered by buildings. The next step is full integration of PV into roofs and façades.

To make better use of buildings, new solutions are needed. The Dutch solar sector's innovations for the built environment focus on high-quality design, technology and construction.

Beautiful design

In urban environments, there is a growing demand for inconspicuous or even invisible solar technology. While it may be possible to install solar panels in places that cannot be seen from the street, this severely reduces the potential yield. Solar cells are therefore increasingly integrated into prefab building modules, roof tiles, windows and façades. Solar collectors underneath roofs or façades enable solar energy to be used directly for heating and cooling, without negatively impacting the appearance of a building.

Another approach is to create solar technology that does not need to be camouflaged but actually enhances the visual appearance of a building. In a country famous for 'Dutch Design' and bold architecture, it is not surprising to find many companies experimenting with new shapes and applications, such as solar panels, solar films and BIPV modules in different colours or incorporating images.

Smart solutions

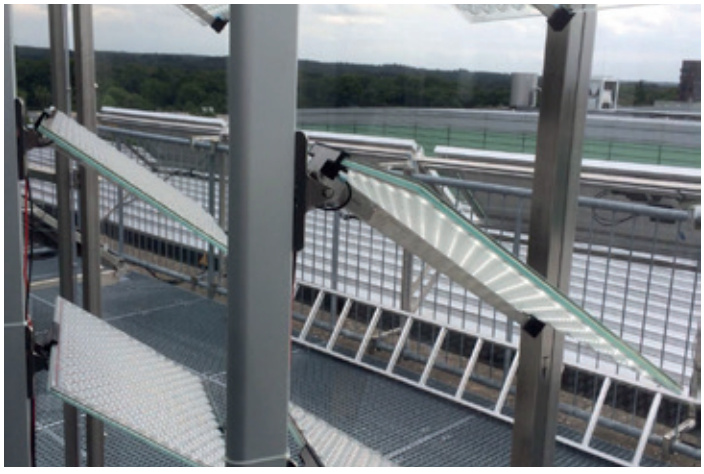
Other innovations focus on ways of maximising the generation capacity on and around buildings. Especially south-facing façades offer a huge potential. To take advantage of this potential, Dutch solar companies work with architects and other parties to design completely new, integrated modules. From the inception phase, this enables energy generation to be combined with other important construction aspects such as ventilation, cooling and roof and façade sealing.

The yield of BIPV installations can also be increased by improving the underlying technology. Examples of solutions developed by Dutch companies are flexible BIPV systems that compensate for shadow or the failure of individual cells, and smart software that continually monitors the functioning of systems.

High-quality construction

Especially if PV technology transforms from stand-alone systems to fully integrated modules, it is crucial to guarantee a high level of reliability and quality. Users of Dutch BIPV solutions can be sure of compliance with the very strict and exacting Dutch as well as European legislation in areas such as fire safety, construction quality and indoor climate. To ensure that BIPV modules deliver the anticipated yield, Dutch companies develop their solutions in close cooperation with research institutes, where the performance of prototypes is monitored every second using very advanced equipment.

Solinso's black PV roof tiles integrate seamlessly with regular roof tiles, and can generate the same amount of energy per square metre as standard monocrystalline solar panels.



In Kameleon Solar's coloured solar modules, cells become invisible from a distance of more than 5 metres. The technology has been used to incorporate stunning images and to create interactive, energy-producing façades.

Wellsun's sun-tracking façade panels produce solar energy (with an efficiency of 30%), control natural lighting, act as a heat barrier and, at night-time, can be used as a media wall.

Solar landscapes

Large-scale solar energy generation can be relatively simple – provided there is an abundance of useable space. If not, then smart solutions are needed, for example to facilitate multiple land use.

In densely populated areas it is crucial to ensure public support for large-scale solar energy projects. A consortium of Dutch companies, public authorities and research institutes is investigating innovative strategies, for example by developing new ways of visually integrating solar farms into the landscape, and by studying the (long-term) ecological impact of solar farms.

The same consortium also focuses on the options for combining solar farms with other types of land use. Agriculture in particular offers promising opportunities, as long as solar panel arrays do not interfere with crucial factors such as soil quality, rain infiltration and the incidence of light.

Bifacial potential

A key innovation in this area is the emergence of bifacial solar panels, in which Dutch companies and researchers have developed a high level of expertise. Bifacial panels are highly efficient, because they absorb energy on both sides directly, but also capture diffuse and reflected light. These are key advantages in an agricultural setting: it means that they generate attractive yields even in an upright position, making it easier to incorporate these panels in, for example, horticulture and nurseries.

To enhance the potential yield of bifacial panels further still, Dutch companies have combined them with smart automation and sun-tracking systems. This ensures that panels are always at an optimal angle to the sun, and can be moved to an upright position if necessary for cultivation of the soil by agricultural vehicles or for irrigation purposes. All in all, innovations of this kind can increase the efficiency of solar panels by up to 30%.

Getting to grips with the yield

For a well-founded business case, a watchful eye is needed on the anticipated yields. In cooperation with research institutes, Dutch companies and project developers have access to advanced calculation models. Constantly updated parameters are added to these models for an increasingly more reliable result. For example, Dutch scientists carry out research into the impact of the albedo effect, which determines how much light is reflected by the environment. Different colours of grass or crops in the surrounding area, or possibly snow, have a direct impact on the yield of solar farms.

Sun and shade

Solar arrays can be integrated into existing farmland, but they may also be the catalyst for introducing crop farming on currently unused land. For example, energy company Engie is developing a 30 MW project in which the space underneath solar panels will be used for growing shade-tolerant crops. In close cooperation with scientists and horticultural experts, the project team is researching the ideal height and positioning of solar panels and which crops would perform best on this particular location.

Hybrid energy parks

Along the Haringvliet estuary, Vattenfall is building its largest hybrid energy park to date. By combining 124.000 solar panels with a wind farm and powerful battery systems, the hybrid setup minimises the total non-production times, enables more efficient use of network infrastructure and reduces the overall cost of renewable electricity.

Solar infrastructure

The Netherlands has a very dense and first-rate road network, an internationally unparalleled cycling infrastructure, and a high-quality public transport system. Integration of PV technology into such infrastructure offers unique opportunities to generate large-scale solar energy and make the transport system more sustainable.

When it comes to finding ways of combining solar energy generation with other types of land use, infrastructure offers some key advantages. By definition, roads and railways converge on (and connect) densely populated areas with a high energy demand. In fact, the infrastructure itself is used intensively, which means there is a large demand for 'on the spot' energy: from electric vehicles to railway stations and infrastructure. And since infrastructure is often designed according to similar specifications, innovative concepts for integrating solar energy can relatively easily be reused and scaled up.

Roads and roadside infrastructure

For years, Dutch companies and researchers have worked on the integration of PV technology into infrastructure. In particular, a lot of experience has been gained in PV noise barriers and several solutions are available for wide-scale implementation. Proven solutions are also available for roadsides, where existing technology has been adapted to take into account the specific, elongated shape of roadside solar farms and traffic safety concerns. Now Dutch companies are widening the scope of their innovations to include other roadside infrastructure such as crash barriers, as well as the road itself. Solar cells have already been incorporated in bicycle lanes and pilot projects are underway in which PV-integrated road surfaces are being tested for heavier traffic.

Dykes, dams and bridges

However, infrastructure encompasses more than roads and railways. Dutch companies also have experience with installing solar panels on former landfill sites, and on dykes, dams and bridges.

When exploring and developing such new applications, not only do Dutch companies benefit from cross-pollination with scientists and researchers, but also from the strong involvement of the authorities responsible for managing infrastructure. Municipalities and provinces initiate pilot projects, and water authorities have identified the thousands of kilometres of dykes in the Netherlands as a unique opportunity to become net energy suppliers by 2030. The National Waterways and Highways Agency (Rijkswaterstaat) is the co-initiator of a consortium in which Dutch companies and researchers pool their knowledge and innovative strength for the benefit of the energy transition in the Netherlands and abroad.

1. In Delft, construction of the Netherlands' first energy-neutral railway station has started. An innovative roof, consisting entirely of PV modules, will power lifts, lighting and ticket machines.

2. A consortium of Dutch companies and researchers built the world's first bicycle lane with integrated solar panels close to Amsterdam. In follow-up projects, the concept is being extended to road surfaces for heavier traffic. The potential for solar roads is substantial: currently, the expected electricity yield per 100 metres of solar road surface is around 30,000 kWh per year.

3. In the province of Noord Brabant, a 400-metre-long solar barrier with integrated bifacial panels is being tested. The integrated design is expected to lower the cost of solar noise barriers by 20% (compared to fitting panels to existing barriers).

Floating solar

If land becomes scarce, there is always water. Floating solar farms are not new, but Dutch companies are at the forefront of refining the technology, assessing its potential yield and ecological impact – and adapting the concept into new and ever more challenging environments.

Water management and offshore construction are successful export products for the Netherlands: throughout the world, Dutch expertise plays a key role in many challenging marine engineering projects. It is therefore not surprising that the Netherlands has enthusiastically embraced the concept of floating solar farms. It has a highly developed domestic market, thanks in part to the Dutch government's active role as a 'launching customer' and the availability of the right policy frameworks, permit systems and opportunities for subsidies. Floating solar farms with good yields have already been built at a variety of locations, including sand extraction lakes, water treatment plants and water reservoirs. Through a national consortium, Dutch companies, knowledge institutes and water authorities aim to achieve 2,000 hectares of floating solar farms by 2023.

Reliability and ecological impact

Technological innovations by Dutch companies focus on the quality and reliability of the required technology, which becomes even more crucial as the scale of floating solar farms throughout the world increases. In addition, the Netherlands leads the way in researching the ecological impact of floating solar farms, for example, on water quality and biodiversity. Such insights make it easier to identify locations where solar energy can be harvested for years to come, without adverse effects on the environment.

Robust solutions

Possibly the most crucial factor in the long term is that Dutch companies are exploring the opportunities for floating solar farms beyond the relatively easy, calm inland water bodies. Urbanised areas with a high energy demand are often located on the coast or in river deltas, where there is a large amount of useable space but where wind, waves and the tides combine to create a very challenging environment.

However, through joint research and ambitious pilot projects, the Dutch are increasingly able to to come up with robust solutions. Around the periphery of the Rotterdam Port area, experiments have taken place with floating (and in some cases sun-tracking) solar farms, at a location with waves of up to a metre high. At the same location, preparations are underway for the construction of a floating solar farm that is expected to cover 100 hectares. Elsewhere in the Netherlands, preliminary research is focusing on large inland water bodies (also with waves of more than a metre in height) and even offshore floating solar farms.

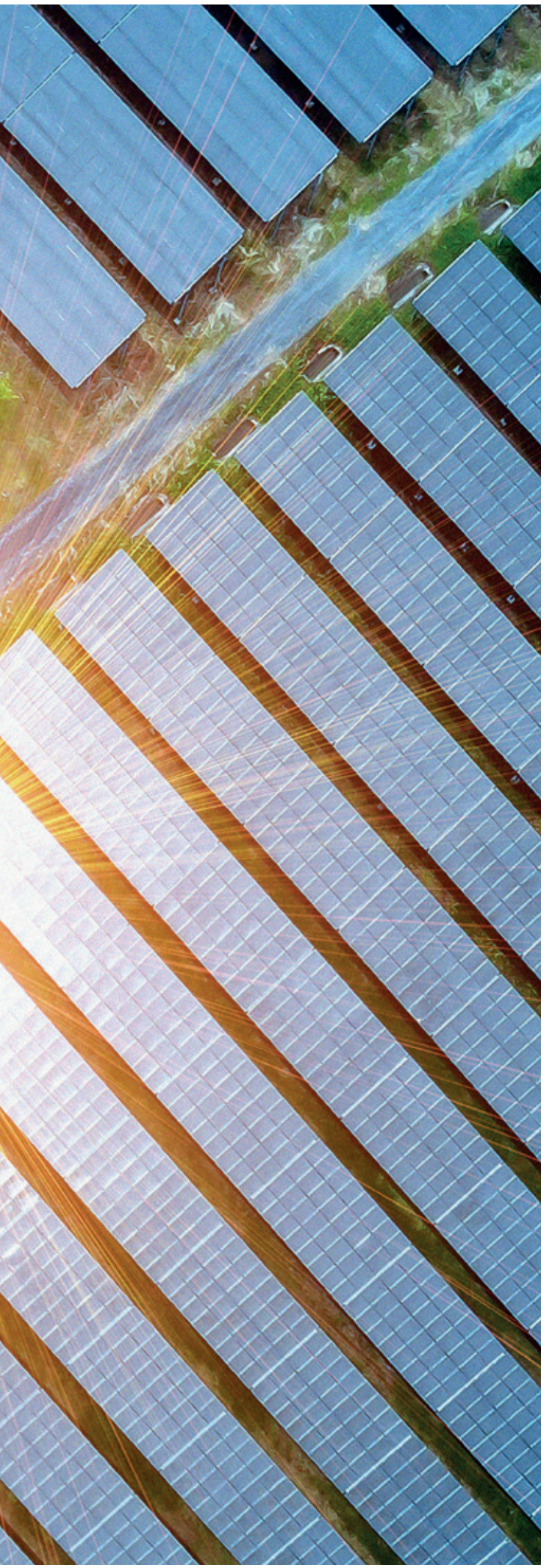
Solar-tracking floating PV

Based on extensive experience built up with floating solar modules near Rotterdam harbour, Floating Solar is developing the world's largest solar-tracking PV system in a reservoir next to a water purification plant. To minimise ecological impact, the 73,500 solar panels will be arranged to form 15 individual islands. The islands' design and construction has a transparency factor of 80%, ensuring that plenty of light reaches the water's surface. Special Weather Risk Management technology will minimise the risk of damage by automatically repositioning solar panels during storms.

Conquering the waves

A group of six Dutch companies and research institutes have started the design, construction and operation of the world's first offshore floating solar farm. Additional scientific research will be performed to compare the electricity production of floating solar at sea in comparison to land – the power yield of photovoltaic solar modules is expected to be about 15% higher.

Five benefits of doing business with the Dutch



1. Quality and reliability

The Dutch combine first-class technical expertise and innovative strength with a commitment to delivering high-quality, reliable products and solutions. Working with Dutch technology means you can be certain of compliance with the highest (European and international) standards.

2. An international outlook

The Dutch have been doing business abroad for centuries. They understand what it takes to work successfully across borders and cultures, and are regularly ranked as having the world's most proficient non-native English skills.

3. High-tech excellence

The Netherlands has a long history in high-tech innovation. In terms of the number of patents per capita, it ranks second in the world. It is home to world-class research institutes in PV technology, global players in semiconductor technology and excellent machine manufacturers.

4. Joint innovation

The Dutch excel in creating flexible, fast-moving networks of specialist companies and research institutes. The Netherlands is home to dozens of 'field labs' in which such networks translate fundamental research into innovative solutions and test them in real-life pilot environments.

5. Easy access to specialist expertise

Whether you are looking for solar applications on land, water, infrastructure or building-integrated PV, the Netherlands has organised its expertise into national consortia. These networks offer fast and easy access to the right technology providers, researchers or combination of specialists.

Dutch solar expertise in brief

R&D

AMOLF / University of Amsterdam
Delft University of Technology
Eindhoven University of Technology
Solliance
TNO Energy Transition
University of Groningen
University of Twente
Utrecht University

MATERIALS

DSM
C-Coatings
Sabic
SPG Prints
Yparex

PRODUCTION EQUIPMENT

ASM
Besi / Meco
Eurotron
Lamers HTS
Levitech
Morphotonics
Rimas
Smit Thermal Solutions
Tempress
VDL ETG

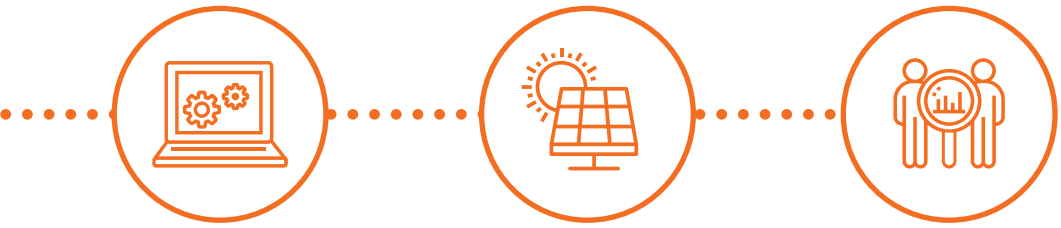
CELLS, FILMS AND (INTEGRATED) MODULES

BEAUSolar
Compact Solar
EXASUN
HydroPV Technologies
HyET Solar
Kameleon Solar
SolaRoad
Solinso
TULiPPS
Wellsun

Dutch solar expertise covers virtually the entire chain, from fundamental research into next-generation PV technology to the construction and management of large-scale solar farms. Below you will find a summary of some of the country's key players by type of expertise.

To find out more about the latest developments in Dutch solar technology and the right partners for your particular requirements, please contact info@tki-urbanenergy.nl, internationaal@fme.nl and/or redesk@rvo.nl.

For companies and research institutes highlighted in orange, short profiles and portfolio descriptions have been included in the following pages.



TEST AND MEASURING EQUIPMENT

Eternal Sun
Hielkema Test Equipment
XYZTEC
ReRa Solutions
Celsian
Kipp & Zonen

COMPONENTS

Heliox
Femtogrid
Victron Energy
Esdec
Van der Valk Solar Systems
Bosch Rexroth
ZigZagSolar

PROJECT DEVELOPMENT, ENGINEERING & CONSULTANCY

BIPV
DNV
Chint Solar
Eneco
Green IPP
GroenLeven
LC Energy
LightsourceBP
Naga Solar
Powerfield
Pure Energie
Royal Haskoning DHV
Royal Dutch Shell
Solarcentury
Solar Fields
Solartechno
Statkraft
Sunprojects
Sunrock
Tomorrow Energy
TP Solar
Vattenfall

Supporting next-generation solar

Energy is a necessity of life for people all over the world and global demand for energy is increasing rapidly. One of the greatest challenges of our time is to provide reliable, affordable and renewable solutions for all. Besides increasing demand for energy, we also have to prepare for global climate change. Climate change requires a different kind of energy supply and calls on us to develop new solutions and systems for a durable supply of clean energy.

The Netherlands has made substantial strides in the areas of renewable energy and energy efficiency, attaining a leading position in the solar energy revolution. The solar energy sector contributes substantially to Dutch national revenue, exports and employment.

Approaching complex energy issues

The Dutch energy sector enjoys a strong global position. This success is founded on a typically Dutch quality: the willingness to share knowledge within tight-knit alliances between industry, research, NGOs and government. This has made us a frontrunner in public-private research and open innovation partnerships and is how we prefer to approach complex energy issues.

Effective and clean solutions

This cooperative approach is manifest in our solar energy solutions, which offer complete, effective and coherent products and services geared to what people and companies truly need. The Netherlands regularly paves the way from knowledge to skills to new products and services, leading to integrated, sustainable and effective PV technology solutions to meet energy demand.

Win-win solutions

The Dutch energy sector is an ideal partner with experience, knowledge, products and services in the field of solar energy. The Dutch offer solutions to deal with complex energy supply and demand, both in developed and developing countries. Cooperating and doing business with the Netherlands means all parties invest in a win-win solution. Citizens, companies, research institutions, investors and governments can all work together to achieve results that make a difference.

The Solar Energy Guide showcases innovative Dutch organisations operating in the solar energy sector. It is with great pride that we present these organisations to you.

Manon Janssen
Chair Top Sector Energy

TOPSECTOR ENERGIE
Empowering the new economy

BIPV Nederland
Mr Ruud Derks
High Tech Campus 21
5656 AE Eindhoven
The Netherlands

+31 (0)6 13 62 05 68
www.bipvnederland.nl
info@bipvnederland.nl

BIPV Nederland is a business association for partners active in the BIPV world. Typical partners are BIPV producing and selling companies, knowledge institutes and universities and associations active in the energy sector. BIPV Nederland's mission is relating to 'smart and beautiful building with solar energy'.

DNV GL
Utrechtseweg 310
6812 AR Arnhem
The Netherlands

+31 (0)26 356 91 11
www.dnvgl.com
contact.energy@dnvgl.com
@dnvgl_energy
@dnvglenergy

DNV GL is empowering decisions and actions based on expertise and trust. Our power and renewables experts around the globe combine their technical, digital and in-depth industry knowledge to help customers take decisions and actions based on expertise and trust.
We offer independent advice and expertise spanning energy generation, including onshore and offshore wind and solar PV, transmission and distribution, grids, storage, e-mobility, as well as energy management, energy markets and regulations. Our aim is to help improve our customers' business performance and build a safe, reliable, efficient, and sustainable energy supply.

We analyse and understand the facts and data that shape the energy system and we help identify and manage the opportunities and risks involved. Our work crosses borders, sectors and technologies, and our independent expertise covers testing, inspection, certification, advisory, cyber security, software, digital solutions and energy management. Our open industry platform, Veracity, in combination with data quality and analytics, supports business-critical activities across the energy value chain. Together with our customers, we create impact for a safer, smarter and greener energy future for all.

DSM Advanced Solar
Ms Annet Hoek
Urmonderbaan 22
6167 RD Geleen
The Netherlands

+31 (0)6 53 70 81 68
www.dsm.com/solar
info.samesunmorepower@dsm.com
@dsm-advanced-solar

Royal DSM is a global purpose-led, science-based company active in Nutrition, Health and Sustainable Living. DSM's purpose is to create brighter lives for all. With its products and solutions, DSM addresses some of the world's biggest challenges while creating simultaneously economic, environmental and societal value for its stakeholders, customers, employees, shareholders, and society-at-large. DSM and its associated companies deliver annual net sales of about €10 billion with approximately 23,000 employees. The company was founded in 1902 and is listed on Euronext Amsterdam. In the solar industry, we apply our 100-year plus track record in materials sciences innovation to create a range of unique, sustainable technologies and products that reduce the Levelized Cost of Energy (LCoE) - supported by extensive research and outdoor testing at test sites across the globe. Our Anti-Reflective and Retrofit Anti-Reflective coatings for PV modules lead the industry by enabling a 3% power gain compared to untreated glass; and the technology has now been extended to create an Anti-Soiling coating that harnesses more energy by reducing soiling losses in arid climates. Meanwhile our Endurance and Conductive backsheets are redefining the way manufacturers safeguard their modules by delivering both enhanced protection, reduced electrical losses, and higher energy gain. Same sun. More power.™

Energy Storage NL
Mr Stefan Olsthoorn
Zilverstraat 69
2718 RP Zoetermeer
The Netherlands

+31 (0)79 353 11 00
www.energystoragenl.nl
info@energystoragenl.nl
@energystoragenl

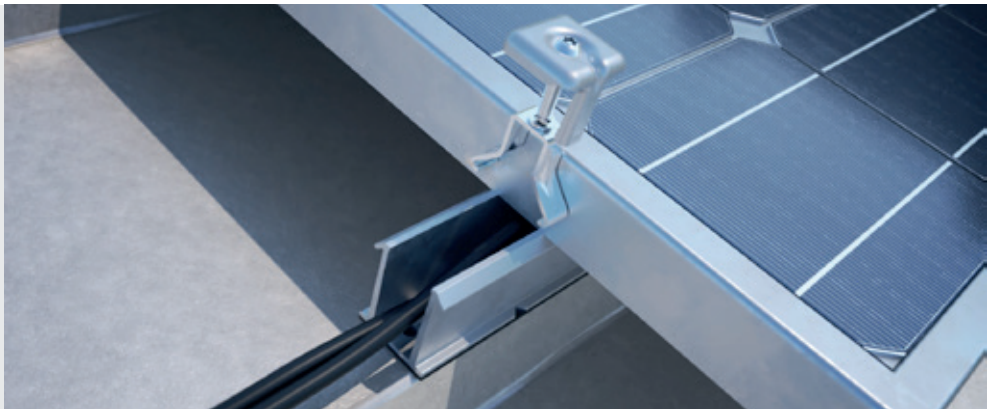
Energy storage is a key technology for the future. The importance of storing renewable energy is rapidly increasing in the transition towards a fully sustainable and clean energy supply. Energy storage and energy conversion technology is vital for a sustainable, reliable and affordable energy system.

Energy Storage NL represents over 70 Dutch companies and organizations that develop, manufacture and apply innovative energy storage and conversion technologies (electrical, thermal, chemical and mechanical). Our ambition is to help create sustainable business case for energy storage and conversion technology, as well as a level playing field for a flexible energy supply.

Our activities include efforts to bring energy storage to the attention of politicians, media, professionals in related disciplines and the wider public. We initiate and contribute to projects and studies and add Dutch input to the European activities of EASE. And through regular meetings with a sophisticated network consisting of manufacturers, developers, academics, research institutions, energy companies and system operators we bring together key players in the field of energy storage.

Esdec BV
Mr Erik Valks
Londenstraat 16
7418 EE Deventer
The Netherlands

+31 (0)85 070 20 00
www.esdec.com
info@esdec.com



ESDEC
INNOVATIVE MOUNTING SYSTEMS

Since 2004 Esdec supplies universal mounting systems for roof-mounted PV installations, both for flat and pitched roofs. With over 15 years of experience and over 9GW of solar panels installed, we have developed into an international market leader. Esdec was founded by installers, so convenience for the installer has always been the priority in the design of our products. Our mounting systems consist of light, sturdy components that can be mounted quickly and easily.

We believe it is important that all our products apply the latest technological developments. That is why we combine international expertise and continuously invest in innovation and R&D.

Our mounting systems are extensively tested and meet the strictest safety standards.

In recent years, ESDEC acquired the American companies Ecofasten, Iron Ridge and Quick Mount PV. With these acquisitions, we are now also the market leader in the U.S. in the segment of residential PV. From 2020 on, we will continue to focus on growth in Europe, in countries like Germany, France and Sweden. We aim to increase the knowledge in the market and fulfil the growing demand for expert installers. Therefor we regularly provide (on line) training courses for partners and installers in our Innovation Centre. Every year, we train > 1000 installers

FME
Mr Rogier Blokdijk
Zilverstraat 69
2718 RP Zoetermeer
The Netherlands

+31 (0)79 353 11 00
www.fme.nl
internationaal@fme.nl
@fme_nl

FME POWERED BY DUTCH TECHNOLOGY

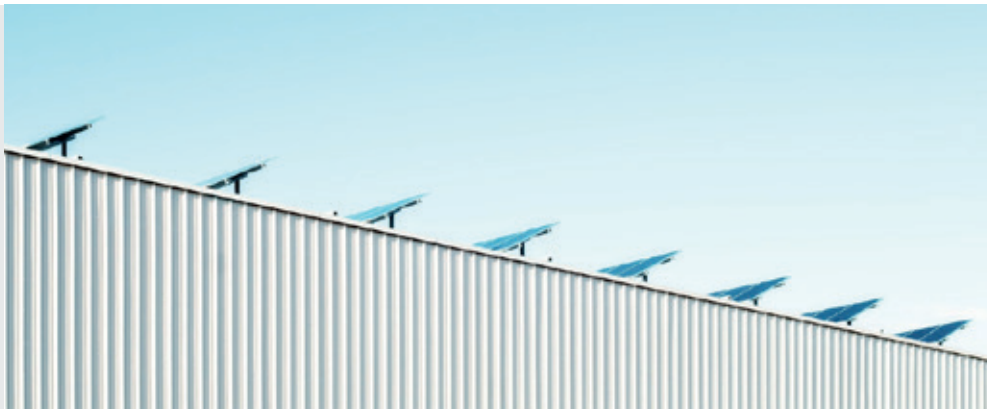
FME is the Dutch employers' organisation in the technology industry. The 2,200 affiliated companies include technology start-ups, trading companies, small and medium-sized industrial enterprises as well as large industrial conglomerates. Our members are active in the fields of manufacturing, trade automation and maintenance in the metal, electronics, electrical engineering and plastics sectors. Around 400 members are active in the renewable energy sector including solar. FME members employ a total of 220,000 people, have a combined turnover of € 91 billion and their exports total € 49 billion. FME members therefore account for one-sixth of all Dutch exports.

FME has 45 affiliated trade associations. FME mobilises and connects partners in the technology industry to meet the big challenges society faces, both today and in the future. In doing so, we increase our members' individual and collective earning power.

Technology provides answers to some of society's most pressing questions and challenges. Our mission is to help shape those answers by mobilising and connecting technology companies with each other and society as a whole. We are committed to a future-proof world: prosperous, healthy and inclusive

Holland Solar
Mr Wijnand van Hooff
Arthur van Schendelstraat 550
3511 MH Utrecht
The Netherlands

+31 (0)30 232 80 08
www.hollandsolar.nl
info@hollandsolar.nl
@HollandSolar



Holland Solar, founded in 1983, is the key organisation for professional solar energy experts, companies and institutions in the Netherlands. Members are active in both solar thermal energy and solar photovoltaics, comprising the complete chain from R&D and production until consultancy and installation. The activities of Holland Solar are aimed at serving the interests of its members, by supporting and promoting the application of solar energy in the Netherlands, ensuring the quality of solar energy applications.

HydroPV Technologies
Mr Ir. M.M. Romijn
't Hoenstraat 27
2596HZ The Hague
The Netherlands

+31 (0)70 346 44 28
www.hydropv.eu
info@hydropv.eu

HydroPV Technologies Floating PV systems for convenient generation of electricity and conservation of water optimised for hot sunbelt countries with high solar irradiation.

HydroPV Technologies has signed a joint R&D development program with MASEN in the NOOR area in Ouarzazate, Morocco. The annual solar irradiance in this area is 2650 kwh per square meter per year and we expect annual electricity yields of 500 kwh per square meter of PV module area and an extended PV module lifetimes thanks to the cooling effect of the water.

Apart from saving up to 40,000 m3 of water per hectare per year, about 3,600 solar panels can be installed per hectare of water surface with a capacity of 1.5 megawatts or 4,000 megawatthours per year of photovoltaic power generation.

With the HydroPV Technologies Floating PV Systems on 10 percent of the Inland water surface of the Netherlands, the total current fossil Electricity production of the Netherlands could be generated with non-fossil clean solar energy without any emission of CO_2, NO_x or Black Soot Particulate matter and with more yield through more solar radiation from cleaner air.

Levitech BV
Mr J. Beijersbergen
Versterkerstraat 10
1322 AP Almere
The Netherlands

+31 (0)36 538 76 79
www.levitech.nl
info@levitech.nl
@levitech

Levitech is a global player in production solutions for the IC and photovoltaic industries. A spin-off of ASM International, Levitech was established in 2009 around its core product, the Levitor® system. This system is based on a revolutionary patented technology and used in the semiconductor industry for Rapid Thermal Processing (RTP).

The Levitor 4300 and Levitor 4200 are leading-edge 300mm and 200mm tools for advanced RTP processes in high volume. The Levitrack™ ALD system is a state-of-the-art production solution for the solar industry and is based on the innovative concept of precursor separation in space, instead of time, in combination with the unique floating wafer and conductive heating technology used in the Levitor RTP products. For more information, visit Levitech's web site at www.levitech.nl

Morphotonics BV
Mr Rob van Erven
De Run 4281
5503 LM Veldhoven
The Netherlands

+31 (0)40 401 19 63
www.morphotonics.com
info@morphotonics.com

Morphotonics B.V. (www.morphotonics.com) develops and sells roll-to-plate (R2P) OEM production technology for imprinting nano- or microstructures on large area substrates. Our cutting-edge technology and machines have unique features that radically improve our customers' products in the display and solar industry. We enable holographic or 3D imaging in smartphones or AR/VR displays and substantially increase the energy efficiency of solar panels. For PV modules in general a durable light trapping or anti-reflection texture can be applied on the outside of the module. For bifacial modules the AR textures can be applied on both sides of the module, trapping the light within the glass-glass sandwich like is currently being demonstrated within the Dutch Polaris project.

The application of such textures can be carried out cost-effectively by nano-imprinting. This technology can dramatically reduce the LCOE as it significantly increases the kWh output of modules especially during the morning and evening hours and for the backside performance of bifacial PV panels (diffuse light conditions), next to an overall higher optimum due to an optimal PV panel front side, back side and solar cell optimization which can even be customized for a certain panel type or mounting system.

The Netherlands Enterprise Agency (RVO.nl)
Mr Kenneth Colijn
Prinses Beatrixlaan 2
2509 AC The Hague
The Netherlands

+31 (0)70 379 80 00
english.rvo.nl
redesk@rvo.nl
@NLEnterprise

Netherlands Enterprise Agency

The Netherlands Enterprise Agency stimulates entrepreneurs in sustainable, agricultural, innovative and international business. It aims to improve opportunities for entrepreneurs, strengthen their position and help them realise their international ambitions with funding, networking, know-how and compliance with laws and regulations. As a government agency, it operates under the auspices of the Ministry of Economic Affairs and Climate Policy, and its activities are commissioned by the various Dutch ministries and the European Union. The Netherlands Enterprise Agency runs a number of programmes and supports business initiatives with various grant schemes.

Energy and Climate is one of the agency's key topics. The Dutch government is investing billions of euros in energy efficiency, sustainable energy and CO_2 reduction. In line with this, the Netherlands Enterprise Agency supports Dutch and international entrepreneurs and researchers in developing sustainable projects related to energy, climate and the environment. Innovation and public-private partnerships are key to the Dutch approach: the government, private sector, and academia co-operate on topics such as sustainable energy technologies, green materials, built environment, sustainable mobility, chain efficiency, sustainable electricity, new gas, and greenhouses as a source of energy.

Smit Thermal Solutions BV
Mr Michael van der Gugten
Luchthavenweg 10
5657 EB Eindhoven
The Netherlands

+31 (0)40 258 15 81
www.smit-ts.nl
info@smit-ts.nl

SMIT THERMAL SOLUTIONS

Smit Thermal Solutions is a leader in innovative thin film applications for cost-effective high-volume mass production equipment. Furnace pioneers for nearly 80 years, our in-house ''out-of-the-box'' solutions maximize throughput while minimizing your ''cost of ownership.'' We understand your market and the need for efficient, durable and cost-effective in-line or batch type thermal solutions to gain a competitive advantage. You can rely on our made-to-measure solutions for your custom-designed processes.

- Deposition techniques: VTD, APCVD, CSS and PECVD.
- Deposition of active layers for Thin Film using different vacuum and atmospheric techniques such as CSS and VTD.
- Functional layers in silicon wafer applications.
- Thermal activation and annealing in controlled process atmospheres.
- Decorative and functional layers using thermal processes and/or s-ALD technology.
- Selenization and crystallization for CIGSe layers in S2S and R2R.
- Drying and sintering for printed electronics and Perovskites.

Solarcentury Benelux BV
Ms Elske Idzenga
Pettelaarpark 10
5216 PD Den Bosch
The Netherlands

+31 (0)88 500 89 00
www.solarcentury.com
elske.idzenga@solarcentury.com
@SolarcenturyNL

It is Solarcentury's mission to provide a solution against climate change by realizing solar energy projects worldwide. With more than 1500 MW of solar panels – comparable to the electricity consumption of half a million people – our company is the market leader in Europe. Part of our international and the Benelux activities operate from our location in Den Bosch where we work with a team of more than 20 people on large-scale solar farms.

With a sustainable, landscape integrated design of our solar farms we are realizing an increase in biodiversity. We develop our projects in close cooperation with local residents, who have the option to participate financially as well. Solarcentury is experienced in the entire process from project development, engineering, construction, financing to the long term operation and maintenance of solar farms. Solarcentury remains the single point of contact for its relations throughout the entire development and operational period.

In 2006, Solarcentury set up the charity SolarAid to help combat climate change and poverty in developing countries – Kenya, Tanzania, Malawi, Uganda and Zambia – by providing access to solar energy while at the same time reducing the unsafe use of kerosene lamps. Solarcentury donates 5% of its net profit to SolarAid, providing more than 10 million people in Africa with access to safe and sustainable solar energy to date.

Solarfields Nederland
Ms Esther Terpstra
Leonard Springerlaan 19
9727 KB Groningen
The Netherlands

+31 (0)85 303 08 50
www.solarfields.nl
info@solarfields.nl
@SolarfieldsNL
https://twitter.com/SolarfieldsNL

Improving the world with sustainable energy is what Solarfields represents. We are a producer of renewable energy with the realization of large solar systems in the Netherlands. We are proud to be market leader in large land-based solar plants.

Solarfields works in a professional way, with great care for the environment. Our first 6 solar plants have been realized and we will build many more in the upcoming years.

We develop our projects on various locations, such as ground, roofs, old landfill sites and parking lots. All with the aim to produce clean energy for the Netherlands. We apply the latest technologies, thus offer the best solutions.

Sustainability is in the DNA of Solarfields and our employees. Our dedicated team operates from 3 locations in the Netherlands. We develop our own projects from scratch to operation. We additionally offer financing solutions for third party projects.

SolaRoad BV
Mr A. de Bondt
P.O. Box 1
1633 ZG Avenhorn
The Netherlands

+31 (0)6 51 24 29 50
www.solaroad.nl
info@solaroad.nl

SolaRoad BV (The Hague, The Netherlands) develops, produces and markets road pavements that harvest solar energy and convert it to electricity. State-of-the-art solar technology is integrated into robust, prefabricated concrete elements. SolaRoad pavements, combining infrastructure with solar energy production, turn roads into large, decentral solar plants: invisible, inaudible, durable, and vandalism proof.

Electricity from our pavements can be used to power a range of applications, including public lighting, traffic management systems, households, and electric vehicles.

In The Netherlands, a road section of 10 m SolaRoad pavement produces an estimated 3500 kWh per year, enough for one household, or 25.000 electric vehicle kilometers. The green electricity is generated without claiming extra space, without disturbing environment or nature, simply by multifunctional use of the roads that we build and use anyway.

SolaRoad has been successfully applied in bike roads in The Netherlands and in France since 2014.

Solartechno Europe BV
Mr Marco Ghirardello Eng. MBA
Suite 250, Kapteynstraat 1
2201 BB Noordwijk
The Netherlands

+31 (0)20 334 01 20
www.solartechno.com
info@solartechno.com
@solartechno

Solartechno is a specialist in solar power systems, supplying custom-made turn-key off-grid systems for customers in the Middle East, Africa and Europe. We design smaller systems using an innovative plug-and-play modular battery pack that integrates Lithium-Ion cells and related electronics directly on the back of each photovoltaic panel. For larger systems we use both new and recycled lithium battery cells. Recycled cells are sourced from Japanese car manufacturers and retain an electricity storage capacity or more than 80% of their initial capacity, at a very low cost. Cells are certified to operate at temperatures of up to 60°C. Our larger systems can be preassembled into a container making it easy to install them on location.

Our expertise is in powering buildings as well as a variety of industrial and agricultural installations such as farms and telecom base stations and antennas. Very often we integrate our system into an existing power supply based on a diesel genset. This allows customers to lower the operational cost of running the diesel genset.

Solartechno can handle the entire project life-cycle, from the technical-financial feasibility study, through to the definition of the technical specifications and system installation, including on-site training. In addition to off grid systems we can also provide consulting services to investors.

Sunprojects
Mr Hans Lambrechts
Laan van Kronenburg 14
1183 AS Amstelveen
The Netherlands

+31 (0)88 203 34 00
www.sun-projects.nl
info@sun-projects.nl
@Sunprojects_nl

As an innovative EPC Sunprojects is specialized in realizing large turn key solar projects. Started out as a family business we have been installing PV since 2005, on solar fields, on water and on top of roofs of companies, factories, retail centers, educational facilities and large sports accommodations. In total we've installed well over 150 MW of solar, in The Netherlands and Belgium, as well as in France, Romania and Portugal.

Tempress Systems
Mr Rob de Jong
Radeweg 31
8171 MD Vaassen
The Netherlands

+31 (0)578 699 200
www.tempress.nl

Tempress: The expert source in horizontal diffusion – and CVD furnace equipment. Ranging from small batch laboratory systems up to fully automated high volume manufacturing equipment. Besides the furnace equipment, we develop state of the art PV Cell Technology in order to provide our customers with best in class processes to manufacture high efficiency PV Cells.

TKI Urban Energy
Mr Wijnand van Hooff
Arthur van Schendelstraat 550
3511 MH Utrecht
The Netherlands

+31 (0)30 747 00 27
www.tki-urbanenergy.nl
info@ tki-urbanenergy.nl
@TKIUrbanEnergy

TKI URBAN ENERGY
Topsector Energie

TKI Urban Energy focuses on speeding up the Dutch energy transition by enabling energy-related innovation in the built environment. We do so by creating connections. We connect companies and research institutes by creating networking opportunities, bringing together supply and demand, and by helping to create project consortiums. We connect with expertise: by keeping consortiums up to date with the latest developments, by enabling and commissioning research and by informing policy makers about current ideas and developments in the urban energy sector. And we connect with funds: we help innovators and researchers identify potential sources of funding and subsidy.

TKI Urban Energy acts as an intermediary between the public and private sector and takes the lead in defining the Netherlands' national innovation programme. For international companies, researchers, governments and manufacturers, TKI Urban Energy is the gateway to Dutch energy innovations for the built environment. We provide them with up-to-date information on current research, the latest innovations and the general development of the Dutch energy transition. If you are interested in building partnerships with Dutch technology providers, TKI Urban Energy can help you idenytify and access the right people with the right expertise.

TNO Energy Transition
Mr Maarten Wijdekop
Westerduinweg 3
1755 LE Petten
The Netherlands

www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-ubiquitous-solar-energy
maarten.wijdekop@tno.nl
@TNO_Research

TNO innovation for life

TNO Energy Transition is a business unit of the Applied Research & Technology institute TNO, its Solar Energy research group has been world leading since its start in 1990 (as ECN).

TNO works with companies and universities to develop new technology for solar cells and modules, for crystalline silicon, thin film PV (Perovskites, CIGS) technologies and combinations thereof in tandem architectures. TNO's focus is to realise further cost reductions, performance increases and improved integration of PV in our living environment.

With its research partners, TNO is exploring the possibilities for completely new, highly efficient solar cells architectures and module designs, and facilitating new applications for solar energy.

Van der Valk Solar Systems
Mr Denis de Vette
Zwartendijk 73
2681 LP Monster
The Netherlands

+31 (0)174 212 223
www.valksolarsystems.com
info@valksolarsystems.com
www.linkedin.com/company/valk-solar-systems/

VAN DER VALK
SOLAR SYSTEMS

Van der Valk Solar Systems is an established developer and producer of solar mounting systems and is currently active in 13 countries. It has main offices in Monster (the Netherlands), Sandwich, Kent (the UK) and Madrid, Spain. Its dedicated team has answers to every technical question, design or project. As it holds large stocks, the systems for flat roofs, pitched roofs and open fields can be dispatched in days within Europe. Van der Valk Solar Systems is specialised in commercial and residential projects. Its customers are mostly wholesalers and major installers (EPC)

Benefits of Van der Valk Solar Systems:

- Solar mounting systems for pitched roofs, flat roofs and open fields
- Competitive prices
- Innovative systems developed in line with global norms
- Reliable partner with its own modern machinery, large stocks and reliable logistics partners
- Personal approach and good service by assigning a permanent contact person
- System supplier since 1963
- Large flexibility in solutions, for example high(er) roofs (standard is up to 25m)
- Systems are fitted for earthing and lightning protection (NEN1010)
- Free to use calculation tools: ValkPVplanner and ValkKITSplanner
- Easy and quick mounting thanks to premounting of essential components
- Various systems can also be supplied as ready-made kits

Victron Energy BV
De Paal 35
1351 JG Almere
The Netherlands

+31 (0)36 535 97 00
www.victronenergy.com
sales@victronenergy.com

victron energy
BLUE POWER

Victron Energy develops and manufactures electric power conversion products for battery-based energy systems. Founded in 1975 by Reinout Vader, Victron Energy is based in Almere-Haven in The Netherlands. In the last 45 years, Victron Energy has grown from a one-office technology company to become an international enterprise with nearly 1000 different products sold worldwide. Our solutions play a key role in solar energy systems, recreational and commercial boating, overland transportation as well as industrial settings.

The product range includes sinewave inverters, sinewave inverters-chargers, solar chargers, battery monitors, DC/DC converters, remote monitoring & control solutions, battery chargers and even more. Victron Energy enjoys an unrivalled reputation for technical innovation, reliability, and quality, enabling it to become a world leader in the supply of power solutions. Our network of distributors, authorized dealers and service partners covers more than 100 countries.

Wellsun
Mr Stan de Ridder
Molengraaffsingel 12
2629 JD Delft
The Netherlands

+31 (0)15 278 95 89
www.wellsun.nl
info@wellsun.nl
@lumiduct

wellsun
welcome the sun

At Wellsun, we believe that improving the energy performance of the building environment should be a great experience. Only then will people have the motivation to do what needs to be done. Only then can we accelerate and create the momentum that leads to change. Only then can we change the world. Wellsun has developed the Lumiduct which makes livable, transparent, and energy producing buildings become reality. The Lumiduct enables full glass façades, like the project at Mondial Movers, which generate more energy than closed walls completely covered with traditional solar panels.

The Lumiduct saves energy and creates an ideal indoor climate by selectively shielding the intense, direct light which is responsible for glare and heating up of the building, and turns it into electricity. At the same time, the Lumiduct is transparent for the soft, diffused light which is then experienced as pleasant daylight.

With the Lumiduct, the building comes to life. During the day, the façade is activated by the brilliant transparent solar panels, enabling the building to generate and save energy. At night, the façade is activated by the integrated LEDs making it possible to create a beautiful atmosphere and communicate with the community. The Lumiduct creates awareness and makes living in and around the building a great experience.

ZigZagSolar
Mr Wim van de Wall
Daalakkersweg 2
5641 JA Eindhoven
The Netherlands

+31 ()0)6 40 20 80 02
www.zigzagsolar.com
wim.vandewall@zigzagsolar.com
@zigzagsolar

ZIGZAGSOLAR

ZigZagSolar offers special kits for building solar facades. ZigZagSolar offers engineering, training and guidance. We support challenges in architecture, facade technology, building physics, energy efficiency and quality. We have an international presence. ZigZagSolar is based on patented technologies and proprietary simulation tools. ZigZagSolar supports you in the design and realization of superb solar facades. Thanks to proven reflection technologies the yield can be 28% better. ZigZagSolar performs best in the hours of solar scarcety. ZigZagSolar: Guaranteed – Affordable – Economic – Elegant – Energy.
Our mission: make cities a better place to live in. We are a high-tech company with a clear focus on technical perfection and flawless execution. ZigZagSolar works on 8 SDG's.

Main objectives are:
- Bring affordable clean energy to cities; financially attractive solutions
- Fight air pollution, climate change, power cuts and the use of generators
- Save energy and create circular solutions for energy efficient buildings
- Make cities look good

ZigZagSolar offers technologies for cold facades, warm facades, curtain walls, structural glazing, windows, solar thermal, photovoltaic and PVT. ZigZagSolar offers matching add-ons like surge protection, lightning arrestors, monitoring, etc. ZigZagSolar harvests solar energy and offers high thermal insulation. ZigZagSolar is integrated in the largest solar facade in the BeNeLux. ZigZagSolar guarantees the performance of its products.

This is a joint publication by:

Netherlands Enterprise Agency (RVO)
Croeselaan 15
P.O. Box 8242
3503 RE Utrecht
The Netherlands
T +31 (0) 88 042 42 42
E redesk@rvo.nl
W www.rvo.nl

FME
P.O. Box 190
2700 AD Zoetermeer
The Netherlands
T +31 (0)79 353 11 00
E internationaal@fme.nl
W www.fme.nl

TKI Urban Energy
Arthur van Schendelstraat 550d
3511 MH Utrecht
The Netherlands
T + 31 (0)30 747 00 27
E info@tki-urbanenergy.nl
W www.tki-urbanenergy.nl

Top Sector Energy
Ministerie van Economische Zaken en Klimaat
Directoraat-generaal Klimaat en Energie
Bezuidenhoutseweg 73
P.O. Box 20401
2500 EK Den Haag
The Netherlands
W www.topsectorenergie.nl

This publication was edited by Claire Hooft Graafland, Sonja van Wolfswinkel, Kenneth Colijn (RVO), Wijnand van Hooff (TKI Urban Energy), Marcel Werther (Top Sector Energy), Rogier Blokdijk (FME). Concept development, copywriting and design by Fortelle.

Photo credits
Mathieu Verhoeven (cover), Nuon / Jorrit Lousberg (p. 2/3), BIPV (p. 4), NL Agency (p. 8), Solliance / Holst Centre (p. 10/11), Smit Thermal Solutions (p. 13, top), DSM Advanced Solar (p. 13, bottom), BEAUSolar (p. 14, top), Solliance (p. 14, middle left), Solar Visuals (p. 14, middle right), PV OpMaat (p. 14, bottom left), ZigZagSolar (p. 14, bottom right), Eternal Sun (p. 15, top), Lightyear (p. 15, bottom), Marco van Middelkoop / Aerophoto-Schiphol (p. 16/17), Solinso (p. 19, top), Kameleon Solar (p. 19, middle row and bottom right), Wellsun (p. 19 bottom left), ENGIE (p. 21, top and middle left), Vattenfall (p. 21, middle right), Prorail (p. 23, middle left), Solaroad (p. 23, middle right), Marcel van den Bergh (p. 23, bottom), GroenLeven (p. 25, top), Floating Solar (p. 25, middle left).

Netherlands

TOPSECTOR ENERGIE
Empowering the new economy

Netherlands Enterprise Agency

FME POWERED BY DUTCH TECHNOLOGY

TKI URBAN ENERGY
Topsector Energie