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## Stop thinking, start acting!

**Dutch companies, knowledge institutes and government authorities are working flat out on new technologies and countless innovations in the field of solar power. They are deeds and answers appropriate for the global push for power transition. They are deeds that will not just shape the future of the Netherlands, but the future of the entire world.**

A future in which the Netherlands will hopefully lead with innovations. In which dependency on fossil fuels will decrease. A future in which the Netherlands will globally play a role of crucial importance. The potential is there. The Netherlands does not just have knowledge institutes like the Energieonderzoek Centrum Nederland (ECN) and The Netherlands Organization for Applied Scientific Research (TNO) that enjoy global status, it also has companies like Tempres Systems, Smit Ovens, Scheuten Solar, Rimas, DHV and many others that score high internationally. And that is without even mentioning the promising companies that were started over the last few years like Levitech, SoLayTec, HyET Solar (former Helianthos), RGS Development, TULiPPS Solar, ProxEnergy and Solar Excel. You can read more about them in this special English edition of the only Dutch magazine for the solar industry. The sound journalism and editorial approach of this magazine sketches the full spectrum of the Dutch solar industry.

For many years, the Photovoltaic Solar Energy Conference and Exhibition (PV SEC) has been the platform for presenting innovations for practice. For this year we have chosen the title 'Stop thinking, start acting' for this magazine. Indeed, it is up to the Dutch solar industry to put into practice the many new technologies and corresponding opportunities. After all, there can only really be talk of innovation once the new technical opportunities have led to market opportunities and

sales. The Dutch solar industry – present in great numbers during the PV SEC – will demonstrate during this event that they are able to transform opportunities into business, even in times when the international solar industry is in a downturn. Because there is still a lot of positive news to report on regarding knowledge, abilities and sales. Like the development of new solar tech facilities for Solliance at High Tech Campus Eindhoven and many other things, which you can read all about in this magazine.

There is also a part for the Dutch government to play in the marketing of new technologies through the creation of an industry-friendly home market and the stimulation of innovation. The Dutch government increasingly supports test and demonstration projects within the field of solar power. It can facilitate the acceleration of new technologies that make a sustainable future possible all the sooner. Providing we all continue to innovate and providing we manage to continue to raise the level of the development of knowledge. At any rate, the Dutch solar industry is well on its way.

Now all that remains for me to do is to wish you, on behalf of the entire team behind the Solar Magazine, an enjoyable read of this special PV SEC edition of our magazine and every success at the PV SEC 2012 at the city of Frankfurt. Hopefully, when you reflect on this week, you will remember the Netherlands when you are looking for an innovative partner for your business in the solar industry!

*Edwin van Gastel*  
*Solar Magazine editor in chief and publisher*





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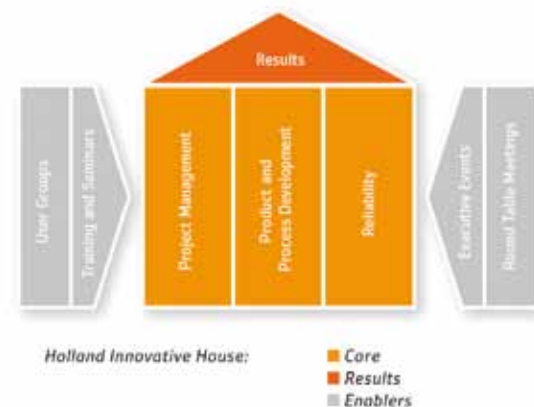
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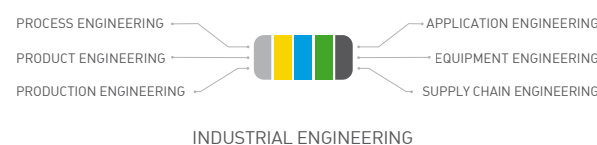


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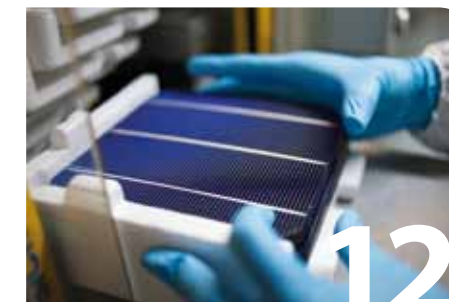
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# Wilro Advanced Technologies launches new CIGS-selenization furnace

Wilro Advanced Technologies has launched a new CIGS-selenization furnace. The company, part of the Glaesum Group, developed the furnace entirely in-house. They utilized the knowledge and services of chiefly Dutch companies and knowledge institutes, including Bronkhorst High Tech Systems, Smink Orbital, the ECN and NLR. ‘Our company’s focus is on the development and manufacture of diffusion furnaces for CIGS-solar cells,’ relates director Jos Koelewijn. ‘The new selenization furnace will be a significant contributor to the development in profitability and the cost reduction of CIGS-solar cells.’ The machine made by Wilro is a so-called batch-furnace, a furnace concept that is utilized successfully by leading manufacturers of CIGS-solar cells around the world. Worldwide there are only a handful of manufacturers of this type of furnace. ‘We are among the absolute top in our sector’, says Koelewijn. ‘Our furnace might not have the highest batch capacity, but it does enjoy an unrivalled high yield and very short cycle. Compared to previous models, the batch capacity of 32 substrates with a dimension of

1250 by 650 millimetres is really more than double. Above all, our cycle time is fifty percent shorter than other batch furnaces. This time is determined by the warm-up and cooling down speed.’ In itself not incredibly complex, claims Koelewijn, but the combination with

high temperature uniformity and gas homogeneity are unique, according to him. ‘Above all, we continue to innovate. We’re currently working on a selenium evaporator and dosage system to further reduce the manufacturing costs of the CIGS solar cells.’



# Start-up Eternal Sun introduces new solar simulator for PV modules

Eternal Sun is one of the many spin-offs that Delft University of Technology produces every year. The company, managed by, among others, Chokri Mousaoui, has developed a new type of simulator with the highest level of accuracy, being AAA. This measured against the international standard and at a considerably lower cost price. ‘The basic principle is that we mix two different types of light and make clever use of mirrors’, says Mousaoui. ‘The lamps provide accuracy in three areas: the light spectrum (colour and wavelength), the uniformity (in other words, the same light falls over the entire solar installation to be measured) and stability over time (in other words, the light intensity doesn’t fluctuate). The technology has been patented and units have been sold.’ Mousaoui is still amazed by the relative ease with which Eternal Sun was able to enter the market for solar simulators. ‘It appears that in the continual series of innovations and the battle for cost price reduction, solar simulators have been forgotten. For

many years, the system with which solar panels have been tested with – flash technology – have hardly changed. The biggest advantage of this technology is the lengthening of the flash. Peculiar really, because new generations of solar panels with thin film, tandem and multi-junctions actually have quite different requirements.

They need a steady state simulator. These new generations of panels respond more slowly to light and, as a result, they need longer exposure for an accurate yield measurement. Above all, we can test sunny side down and in-line. As a result, our solar simulators facilitate a more rapid lead time for the production line.’



# TNO opens Caribbean Office on Aruba

The Netherlands Organization for Applied Scientific Research (TNO) has opened its second official international branch on Aruba: a ‘living lab for sustainable energy’. The agreement between the country Aruba and TNO has a joint objective to make Aruba (a former part of the Kingdom of the Netherlands) a sustainable country. Within the theme, Energy TNO is aiming for an efficient, reliable and sustainable transition from fossil fuels to sustainable fuels and the management of natural raw materials. This ambition dovetails into the objectives Aruba itself has set. The prime minister of Aruba wants to ensure that Aruba becomes a sustainable country that no longer runs almost completely on the single economic motor of tourism.

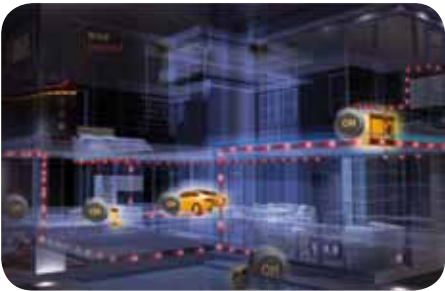


# A more professional landscape for installers in the Netherlands through Solar-Power Masterplan

A large number of parties in the Netherlands, including Agentschap NL, Uneto-VNI and industry association Holland Solar, have worked on the national Solar Power Masterplan for the last eighteen months. The Masterplan comprises a three-stage rocket: a solar power manual, a training programme and certification regulations. The Solar Power manual was presented to the profession during an important trade fair for companies in the installation industry. The officially titled ‘Solar Power, Constructional and Installation technical guidelines for solar energy systems manual’ is a do-book. Readers

get relevant information for all phases of the production process for solar energy applications. It comprises the sections solar heat, solar power and constructional integration. The manual alone does not disseminate all the collected knowledge among the market parties and this is why BDA Dak- & Gevelopleidingen (BDA Group is an Independent firm of consultants that provides training in the field of facades and roofs) have developed seven courses for installers. These courses are concluded with the sitting of a so-called CITO exam, after which the installers are awarded an official certificate.

# The Netherlands starts twelve smart grid pilots



Under the command of central government, twelve places in the Netherlands have been selected for smart grids. In the twelve test beds, distributed across the country, smart grids will be tested in various environments. In a building with three hundred apartments in The Hague, for example, solar panels, heat pumps, washing machines and refrigerators are smart controlled; and the existing smart grid in Hoogkerk will be developed further and five more homes will be added. In Haarlemmermeer, in the glass house horticulture area PrimAviera, a direct current network will be laid using wind and solar power and the newbuild location in Zwolle, the Muziekwijk, with 266 homes will get a smart grid with solar panels and charging points for electric cars. The test beds will make clear how people and companies respond to the new possibilities. Government is then in a better position to determine what technology should be deployed and if rules and regulations need to be adapted.

# Dutch housing associations investigate the feasibility of solar panels for their rental properties

Twenty-two Dutch housing associations examine the possibility of installing solar panels on 360,000 houses. In the long term, it might even be possible for the associations affiliated with the umbrella organisation Aedes to install solar panels, too. This would amount to 2.4 million houses. The consultancy Atrivé is leading the survey and is soon to deliver the business plan ‘Zonnig Huren’. According to Atrivé, there are many

reasons why a really successful and large-scale initiative concerning solar power never seems to get off the ground with housing associations. The scale of projects has been small, resulting in a high purchase price. Furthermore, the majority of systems are for entire complexes (entire buildings), while not everyone is interested. Finally, Atrivé sees difficult organisational issues and obscurities in legalisation as obstacles.





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## Alrack launches Solexus 'credit-card size' junction box and MCU

The Veldhoven-based company Alrack launched two new products for solar power systems last year: a fire protector and a monitoring unit. Both are part of the Solexus range of products. With the different products in the Solexus range, Alrack improves and monitors the performance of solar panels and, at the same time, improves safety. This spring, the company added two new components to the Solexus range: a junction box the size of a credit card and a wireless and more advanced version of the monitoring control unit (MCU) that allows solar panels to be operated from a distance. 'Now that the discussion about the aesthetics of solar panels is increasingly an issue – and at the same time glass-glass panels are gaining popularity – the appearance of the junction box is increasingly important', states Marianne van der Ven from Alrack. 'In the case of frameless glass-glass modules, it isn't nice if the junction box is a distraction. This is

why, in answer to a request from our customers, we developed a credit-card size junction box.' One of the reasons why junction boxes have had such sizeable dimensions until now is that the heat has to be dissipated. Van der Ven: 'Diodes in the junction box give off a considerable amount of heat. We've solved this problem working closely with DSM Engineering Plastics and employing thermally conductive plastic. This material is more expensive than traditionally used materials, but because of its limited size less material is required.' The MCU that has been developed can measure the solar panels comprehensively, from yield to performance and the temperature of the modules. In the case of emergencies, the panels can also be controlled remotely. The MCU has been developed in cooperation with Green Peak based in Utrecht. Van der Ven: 'We utilize these very low-energy wireless RF4CE chips that they developed for remote

controls. In the first instance, the MCU is supplied as an option for existing solar panels. There is a version ready for manufacturers of solar panels that can be integrated in a junction box.'



## Record number of 20,000 visitors at Dutch edition of Solar Days

The Dutch Solar Days – part of the European awareness campaign European Solar Days – attracted a record number of 20,000 visitors this year. The Solar Days had many highlights: from the opening debate to the Solar Tours and the launch of the first interactive solar atlas for the Netherlands by the municipality of Arnhem. The Solar Days started as they did last year with the presentation of the Solar City Award. This year, it was Rotterdam that collected the prize and hosted the opening debate as part of the awards show. One of the most

successful parts of the 2011 edition of the Solar Days was on the programme again this year: the Solar Tours. There were four excursion days visiting interesting Dutch solar power projects. During the days, the wealth of possibilities that solar power and solar heat have to offer took centre stage. Project developers, architects, housing association employees and municipalities and students did not just explore the possibilities, they also got to know each other. The four city trips presented an enormous selection of innovation, applied

technologies and building sectors. The following cities were visited in succession: Amsterdam, Apeldoorn-Deventer-Enschede, Rotterdam and Maastricht-Heerlen-Aachen.

## ProxEnergy reaches the next phase in development

ProxEnergy and Solarcentury have joined forces to create a competitive advantage through the combination of their solar power activities. Solarcentury, established in 1997, is a strong and healthy British company that holds the ambition to expand its activities markedly in the coming years. Since last May, Frans van den Heuvel has been the chief executive officer of Solarcentury. As a major shareholder, he remains closely involved with ProxEnergy and his responsibilities have been taken over by chief technology officer Paul de Jong. The development of smart grid applications at ProxEnergy remains unchanged. An exponent of this is the contribution from ProxEnergy to various demonstration projects for intelligent networks in the Netherlands and beyond.



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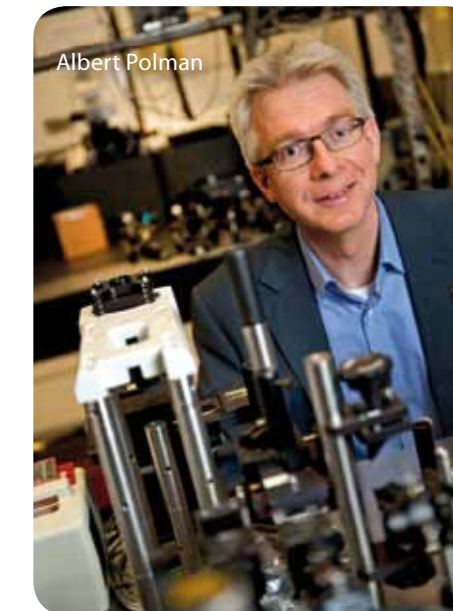
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## ENI Renewable and Non-Conventional Energy Prize for AMOLF managing director

The prestigious ENI Renewable and Non-Conventional Energy Prize 2012 has been awarded to AMOLF managing director Albert Polman and his colleague from Caltech, professor Harry Atwater. They received this prize for their research into efficient solar cells based on a nano-photonics design. The jury judged the candidacy for the prize as 'outstanding and fully deserving the prize'. The research by Polman and Atwater focuses on two important problems in solar cell technology: conventional solar cells do not transform all the sunlight into electricity, and solar cells are relatively expensive as a result of the raw materials. The majority of these problems can be resolved through the better collection and absorbing of sunlight in the solar cell. Polman and Atwater call this light management, a term that is already used globally in solar cell research. Polman and Atwater have demonstrated that, through the use of smart nanostructures in the solar cells,

various colours of light can be better absorbed and the light transformed into electricity far more efficiently.



## Levitech receives ISO 9001 Certification

Levitech has received ISO 9001:2008 Quality Management System (QMS) certification. The successful completion of the audit formally demonstrates Levitech's determination to excel in the worldwide marketing, design, sales, installation, product support and manufacturing of Levitrack and Levitor products used in production of semiconductors, photovoltaics and other microelectronics. Recognized worldwide as the gauge of operational excellence, the certification is awarded to companies that meet the strict quality standards set forth by the International Organization for Standardization (ISO). The certification process is comprised of an extensive audit performed by DEKRA that evaluated Levitech's operations. 'This certification is a direct result of our company's commitment to excellence and efficiency', said Jaap Beijersbergen, CEO of Levitech. 'It is a validation of our ability to manufacture and deliver superior performance.'

## Dutch Institute For Fundamental Energy Research opens its doors



The FOM Dutch Institute For Fundamental Energy Research has officially opened its doors. DIFFER is the successor of the FOM institute for Plasmafysica Rijnhuizen that, for fifty-two years, was the top Dutch institute for research into nuclear fusion. FOM and NWO previously decided to expand their mission. Under the motto Science for Future Energy, DIFFER wants

to grow to become a leading institute for ground-breaking energy research in the coming years. In addition to the existing fusion research, DIFFER has started a new research line into solar fuels, the storage of sustainable power in the form of chemical fuels. The picture shows secretary Halbe Zijlstra at the opening of DIFFER.



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Anti-cyclical investment characterises the solar industry

# The Dutch PV cluster has recommenced its climb to the top

The years 2011 and 2012 can be labelled the years in which the international solar industry was shaken to its foundations as never before. On the one hand, the price of solar panels reached grid parity in many places around the world, but on the other side of the coin the same drop in prices (stemming from the global overcapacity) caused the demise of countless international manufacturers. The Netherlands has also suffered casualties, but they have risen from the ashes (at least in part). At the same time, there is also positive news from the Dutch PV companies. For example, the research initiative Solliance is running flat out, the thin film production machines made by Smit Ovens are literally selling like hot cakes, as are the ALD machines from Levitech and SoLayTec.

Following the PVSEC last year, the Dutch solar industry was confronted with what initially sounded like disappointing news. It became known that, following a previous management buy-out by the board of the solar cell manufacturer Solland Solar, a large share of the company had to be sold to the Italian Pufin Group, to give shape to the transition to a module manufacturer. Following the sale of the solar cell part, it quickly became apparent that the remaining

business unit would have to dismiss one hundred of the hundred and ten strong work force. The remaining ten employees were left to tie up the loose ends and to try and find investors for the manufacture of the Sunweb panels in the factory in Sittard. When just a few weeks after the reorganisation at Solland Solar it became known that Scheuten Solar was experiencing difficulties and a bankruptcy followed, the Dutch PV sector appeared

to be in the corner where the blows were falling in rapid succession. The turnaround was quickly on its feet when it was announced that Scheuten Solar was to restructure with the Chinese Aiko Solar as the most important shareholder. This brought a strong partner on board with a good financial basis and Scheuten Solar is already ready for combat and has moved to a new head office in Venlo. The climb back to the top appears to be well

on its way for the Dutch solar industry. Not long after the good news about Scheuten Solar, the solar cell manufacturer Helianthos announced at the very last moment to have found a Dutch investor, being Rombout Swamborn. He estimates he will need two years to transform the company into a profitable enterprise. During this period, the yield from the flexible thin film solar cells will have to be raised from six to ten percent and the manufacturing costs reduced by sixty percent. This goal has to have been achieved inside three years. Swamborn is prepared to invest between ten and twenty million euro in this.

### Innovation contract

In spite of the intermediate news of the bankruptcy of Solar Modules Nederland, it looks as though the Dutch PV sector has a promising future ahead since the restructuring of Helianthos. After all, there are successes worth mentioning. The research initiative Solliance is running flat out and it appears as though the Belgian imec and also the Germany Forschungszentrum Jülich are going to join the efforts. Above all, machine builders like Smit Ovens, Tempres Systems and OTB Solar have managed to maintain their positions through their strong innovative character and anti-cyclical investment. All investments are strong in R&D so that the moment the market picks up again they will be in the best position to continue to lead. Two companies that underpin the innovative strength of the Dutch PV cluster are the ALD start-ups Levitech and

SoLayTec. Both are currently experiencing high demand for their ALD machines. And crisis or no crisis, the Dutch solar industry continues to invest in innovation. They have entered a so-called innovation contract with central government, in which the industry commits to investing many millions of euros in R&D projects. Government has also made means available to answer this necessity. With the innovation contract, the industry demonstrates its commitment to innovation projects in the field of silicon (through the Silicon Competence Centre), thin film (through Solliance) and Building Integrated PV (through the Solar Energy Application Centre, SEAC). This anti-cyclical investment is to bolster the equipment suppliers especially, but also to simultaneously give the home market a push through making building-integrated applications available.

Although the Dutch PV companies suffered the absence of a home market for many years – partly due to the falling module prices – it is now getting established. The most recent figures even show that the Dutch PV market will have an installed capacity in 2011 that has grown from 88 to 130 megawatts and in 2012 it is expected to continue to grow to a capacity of almost 200 megawatts. All in all, times have been turbulent for the Dutch solar industry too, but the light at the end of the tunnel has been visible for a while now and the leaders of the pack have already come out into the light.

## Overview of the Dutch solar landscape

### Research Institutes:

- Solliance
- Energy Research Centre of the Netherlands (ECN)
- Foundation for Fundamental Research on Matter (FOM)
- The Netherlands Organization for Applied Scientific Research (TNO)
- Dutch Polymer Institute
- Holst Centre

### Universities:

- Delft, Eindhoven, Utrecht, Nijmegen, Groningen, Wageningen and Amsterdam

### The physical infrastructure contains:

- Avantis European Science and Business Park, Heerlen
- High Tech Campus Eindhoven
- Energy Valley in the North of the Netherlands
- Solar Valley in the South of the Netherlands
- ACRRES

### Leading companies within the Dutch solar industry:

- Eurotron, Mastervolt, Oskomera SPS, Roth & Rau, Puffin Solar, Ubbink Solar, Scheuten Solar, Tempres Systems, Smit Ovens, Philips Innovation Services and OM&T
- Solar start-ups like HyET Solar, RGS Development, Levitech, SoLayTec, ProxEnergy, PeerPlus, Dimark Solar, Alinement and TULiPSS Solar.





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## Dutch Solar Awards: 4 prizes for the best achievements in solar power Prizes for TULiPPS Solar, Scheuten Solar, SoLayTec and Gijs Dingemans

On February 16, 2012 the Dutch Solar Awards were presented at a spectacular awards show in the Conference Centre, High Tech Campus Eindhoven. Awards were presented for the categories Industry Development, Project Development, Young Solar and Solar Thesis. From a field of fifty competitors and twelve finalists, the winners TULiPPS Solar, Scheuten Solar, SoLayTec and Gijs Dingemans emerged.

The Dutch Solar Awards are an important national competition in which Dutch solar companies and experts together measure their performance. The awards have a common goal of focusing attention on solar power and promoting its application. Four prizes were presented in total: the Industry Development Award for the most exceptional innovation, the Project Development Award for the best implemented project using solar power systems, the Young Solar Award for the most promising solar start-up and the Solar Thesis Award for the best thesis. The awards show – held on February 16, 2012 – under the direction of jury chair Wim Sinke, was attended by two hundred representatives from the Dutch Solar Community.

### Solar Thesis Award

The Solar Thesis Award, which rewards the thesis that advances knowledge of solar power the most, was won by Gijs Dingemans from the Eindhoven University of Technology. Dingemans won the award for his dissertation on the passivation of crystalline silicon solar cells. He has supplied answers to significant problems that faced the international solar community regarding extremely thin layers of aluminium oxide.

### Project Development Award

For the Project Development Award the profession itself could exercise its influence through voting for its favourite with an online voting module. From the count of the jury and professional public's votes it was clear that Scheuten Solar was the winner. The company received the award for the solar project they are involved in for Rotterdam Central Station. Scheuten Solar has supplied no less than three thousand glass-glass solar panels for the station roof. These solar modules are being integrated in the glass station roof.

### Young Solar Award

The first Young Solar Award – awarded to solar start-ups – has been won by SoLayTec in Eindhoven. This start-up develops and supplies Atomic Layer Deposition machines for the solar industry. With its technology, SoLayTec accelerated the manufacturing process for wafers from twenty minutes to ten seconds per wafer.

### Industry Development Award

This first award, for best industrial innovation, was given to TULiPPS Solar for its COSMOS PV module technology. TULiPPS Solar has developed a light-weight 'frameless' module with an extremely thin layer of thermally hardened glass and a plastic construction at the rear. This 500 watt peak module will be launched in 2012.





# Tempress Systems introduces PECVD anti-reflective coating and ion implant

**‘With the introduction of a PID-free PECVD solution, an anti-reflective coating and the development of the ion implant technology we have a number of new promising irons in the fire. Above all, the further roll-out of the N-type solar cell is proceeding according to plan.’ An interview with Managing Director of Tempress Systems, Albert Hasper, and Fokko Pentinga, chief executive officer for the parent company Amtech Group.**

Tempress – located in Vaassen in the Netherlands and part of the listed company Amtech Group – has more than forty years of experience in the development and manufacture of diffusion equipment and related processes. Together with the research institute ECN, the company – market leader in solar diffusion production equipment – caused a sensation in the last few years through its introduction of the production machines for the N-type silicon solar cell to the Chinese manufacturer Yingli Solar.

### PECVD

‘But in the last two years, we’ve introduced a lot more innovations’, states Hasper. ‘We’ve expanded our portfolio considerably. On the one hand, through the introduction of a Potential Induced Degradation (PID)-free Plasma Enhanced Chemical Vapour Deposition (PECVD) solution. This technology for the application of anti-reflective coatings was possibly not entirely unexpected by the market.’ Pentinga: ‘We haven’t introduced this technology before, because we were busy with the high demand for our diffusion furnaces. We mastered the anti-reflective coatings some time ago and the market perceives this as a welcome addition to our portfolio. On the other hand, we expanded through the purchase of Kingstone. As already known, this Chinese subsidiary is working on a new technology – ion implantation – that could in the future of the solar industry exploit a new market segment for ultra-high efficiency / low cost solar cells. It is also a technology that supplements our diffusion-furnaces.’

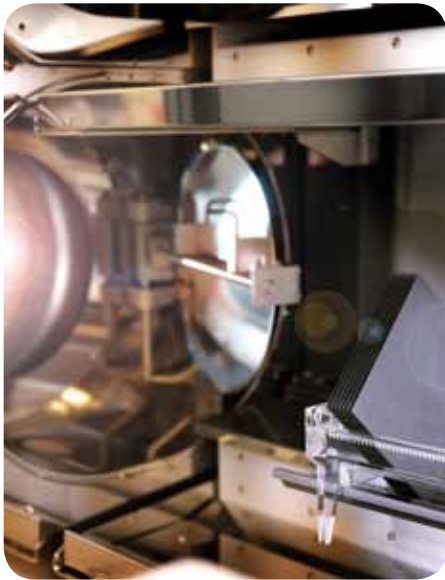
### Unpredictable

In the meantime, it is logical that Tempress too is waiting for the world market to pick

up. Pentinga: ‘We expect this to take place in the second half of next year. This is, however, not a classic consolidation and this is the reason why it is difficult to predict the way in which the market will develop. On the one hand, the equipment suppliers are feeling the pinch from the crisis. On the other, solar parties at the end of the chain are benefiting from the increasing demand. The demand for solar panels continues to grow, partly due to the considerable drop in prices. This drop in prices – and also the strength of China – has been sorely underestimated. No one had expected the prices to drop so quickly and so far.’

### N-type cell

Hasper and Pentinga believe the drop in prices is irreversible. ‘Sooner or later, silver will disappear from solar cells and panels. Silver is currently a third of the total cost price.’ Tempress too is confronted with customer demand for innovation to drive the cost price down still further. ‘We see that the consensus is still that there is a belief in the introduction of the N-type solar cell. For the time being, the market is opting for investment in the P-type solar cell to reduce the cost price. The old P-technology is consequently being milked for all its worth. Inside two years, that process will have been completed, as the cost price of the current manufacturing technology cannot be reduced any further, manufacturers will opt for a new technology like the N-type solar cell. Tempress has a strong financial position which you need in these hard times. Hasper: ‘We continue to invest in innovation as ever before. Naturally, a turnaround in the state of the market in 2013 would be good for us too. This would allow us to run with a ‘plus’ again.’



### Key competences Tempress Systems

- Development and manufacturing of vertical and horizontal diffusion furnaces and related processes, PECVD furnaces for the application of AR coatings and integrated full automation systems
- The product range encompasses R&D, pilot to fully automated production systems.

# Smit Ovens ready for definitive breakthrough in thin-film technology

**‘2012 has to be the year in which a definitive breakthrough in thin-film technology will come about.’ This is what Wiro Zijlmans (CEO of Smit Ovens) said last year just before the PVSEC. Although the market may not yet recognise the positive balance sheet at First Solar as a definitive breakthrough in thin-film technology, it does prove that Zijlmans was right. Thin-film solar cells are firmly planted on the map today. ‘Partly due to this, we’re even witnessing Chinese manufacturers’ interest in thin-film equipment increasing’, says Zijlmans.**

Smit Ovens designs and manufactures thermal-process solutions. The company does this with three solar thin-film technologies: Transparent Conductive Oxide (TCO), Copper Indium Gallium Selenide (CIGS) and Cadmium Telluride (CdTe). For the time being, the majority of customers for Smit Ovens machines are located in Europe and the United States.

### Tremendous opportunities

During the last few years of the three thin-film technologies that Smit Ovens has worked on, CIGS was seen as the one with the greatest potential. The ambitions that Zijlmans stated last year for CIGS have been realised and even exceeded. ‘Above all, the demand for our R&D machines has increased markedly, as both knowledge institutes and manufacturers want to increase their efficiency and drive down the total cost of ownership. We’ll be supplying increasing numbers of such tools – that can also make the subsequent step to mass production – in the coming years. We’re going to continue with anti-cyclical investment. We’re extending our CIGS technology in the direction of Copper Zinc Tin Sulfide (CZTS) and we’re gaining more and more insight into the crystallisation process for CIGS all the time.’

### China

Zijlmans expects that the solar market will again show a significant improvement in the first or second quarter of 2013. ‘And perhaps even more quickly, because up until now everything that is predicted in the solar industry takes place more rapidly than expected. The recovery is explicable, because the underlying demand for solar panels is dominantly present worldwide. Amongst others, First Solar has demonstrated that the



Wiro Zijlmans,  
CEO of Smit Ovens

breakthrough in thin-film technology is not a fairy tale. This company has simply the best total cost of ownership.’

‘So even the Chinese giants are showing more and more interest in thin film’, continues Zijlmans. ‘This has led to us developing more activities in China. Above all, many Asian parties are buying into insolvent American technology houses or European manufacturers.’ Even so, in Zijlmans’ vision it is not a done deal that the manufacture of thin-film PV will take place mostly in China. ‘After all, the cost of personnel in the manufacture of thin-film PV plays a far smaller role, through which the share of transport costs increases in relative terms and the total cost of ownership drops. The advantages of this technology in thin-film products will allow western parties to put themselves back on the map. This will then lead to a greater market share.’

### Key competences Smit Ovens

- Thermal process solutions for high-volume manufacturing
- Thin-film solar solutions:
  - Crystallization for CIGS
  - Selenium deposition for CIGS
  - Activation and deposition for CdTe
- Contact firing
- Glass for solar:
  - TCO for CdTe and thin-film silicon
  - Strengthening and toughening





## Engaging partnerships in competitive markets

In 2012 the San Francisco based Cleantech Group reported a drop on global Cleantech investments from venture funds. This is seen as one of the signs of the turbulence in global markets. Companies are having difficulties in raising funds for projects and production in different stages of development. Despite this setback in global financing, the majority of these investments are being made in solar energy, mobility and energy efficiency.

In 2008 the FME-CWM association together with the Dutch government established Cleantech Holland as the representative for the Dutch technology industry. In 2011 Cleantech Holland moved on as an independent export platform for sustainable technologies. Cleantech Holland has provided and still successfully provides companies and research institutes with an export platform from which exemplary technological and scientific products, services and solutions are offered. International cooperation with our overseas network and business partners increases the scope of opportunities for engagement in foreign projects and tenders. PV and solar energy together with offshore wind, bio-energy systems and smart grids remains our focus areas.

The global use of solar power has enormous potential and receives much attention in our contacts with our global partners. Dutch companies have noticed and are affected by the global headwinds. A number of them have been taken over by foreign enterprises. Not only because of financial opportunity. More importantly these

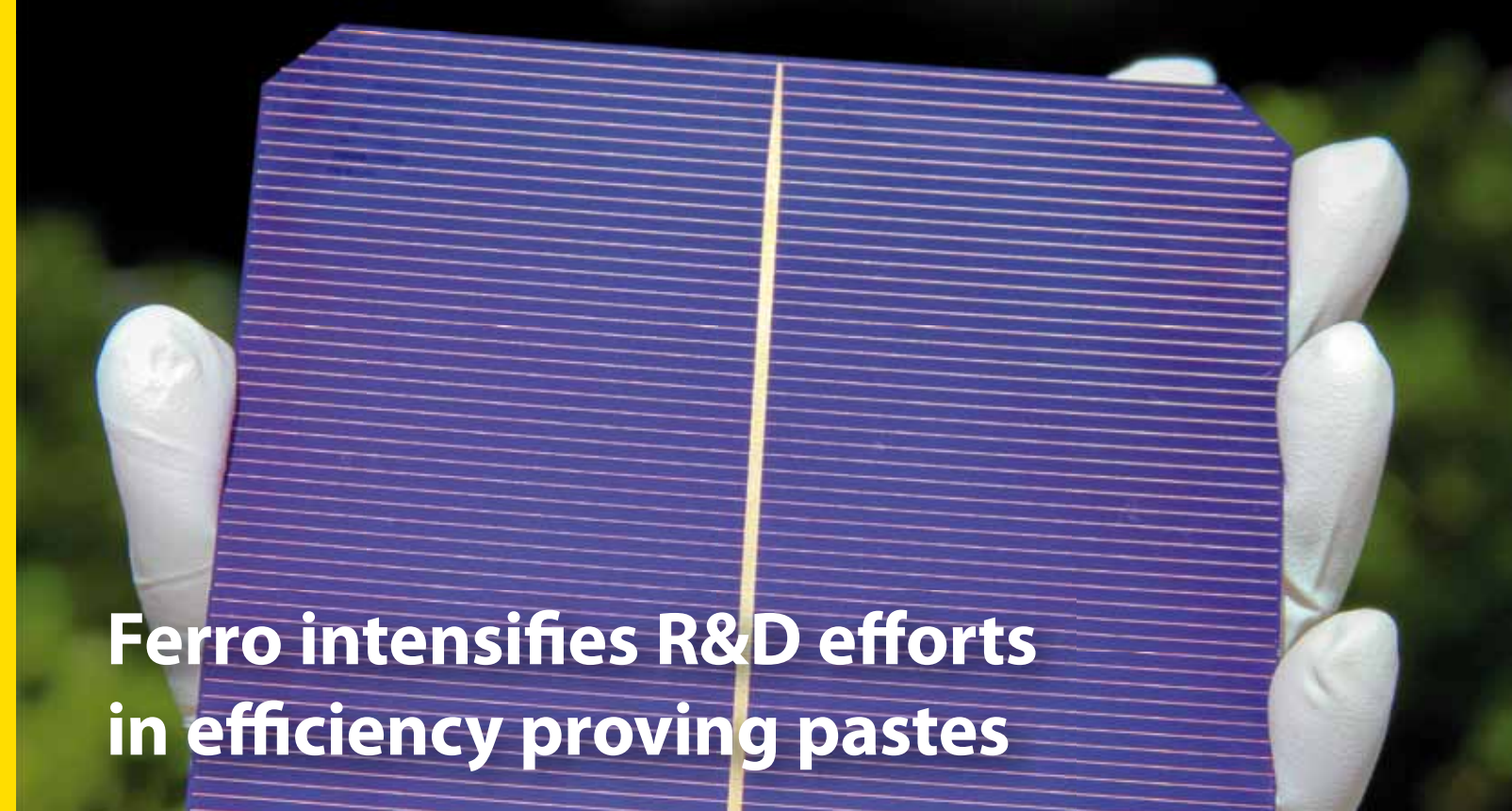
companies have a proved added value to their new owners. Dutch companies still remain in the top global players in their expertise in research & development of products and novel production systems in the use of solar power. Dutch companies have shown resilience and have innovated their business models in order to overcome the present turbulence in the PV-market.

Once again the Dutch government, industry, knowledge institutes, trade associations and regional development organisations bundle their strengths in the Holland Solar House, presenting the unique selling points and strengths of the Dutch industry as a strong cluster abroad. Companies and knowledge institutes present themselves under a single roof to help others with energy efficiency and the manufacture of sustainable energy.

Collaboration, synergy and alignment are the key factors of the Dutch proposition for the international solar business community. It is then not surprising that foreign companies find Dutch expertise and enjoy working together in different combinations. Association FME-CWM adds value by encouraging companies and research institutes to work together on developing solutions through its policies and offering her assistance through our extensive international network and contacts with the Dutch foreign offices.

FME looks forward to the Cleantech Holland pavilion at this PV-SEC fair as a focal point for starting international collaboration and keeping contact with our foreign partners.

*William Sanchez, Business Development Manager Cleantech Holland*



## Ferro intensifies R&D efforts in efficiency proving pastes

**For as long as anyone can remember, materials manufacturer Ferro has supplied pastes for the manufacture of silicon solar cells. The company supplies pastes for solar cell front (emitter) and rear side contact. 'From the beginning of this industry until today, Ferro has maintained close relationships with its key customers, and we believe that this will also be critical to future success—a future that needs to drive cost/Wp down, either through cost-effective efficiency gains or taking cost out of the system', says Andre Noppe, European Sales Manager Electronics with Ferro.**

'New pastes for standard configurations have a lifespan of six to twelve months as development follows the requirements from the industry in a narrow fashion', continues Noppe. 'For example, at the end of last year, we launched several new front side contact pastes and aluminium rear side contact pastes on the market. Many new developments are taking place especially with regard to paste for passivated rear side cells. On the one hand, wafers have to become thinner to reduce cost and this requires development of aluminium pastes. On the other hand, there is a demand for lead-free pastes that use less silver per Wp.'

### Expansion

'In the knowledge that many competitors are developing alternatives for the use of silver in the manufacture of solar cells, we're also intensifying our R&D efforts', continues Noppe. 'Partly due to the price development, we expect to see silver used less and less. In fact, in a response to sky-high prices of silver the industry quickly reduced their silver

consumption by about almost 50%—and we developed the materials that enabled that. We aim to maintain and possibly even expand our market share in the upcoming years. As far as the innovation processes for our pastes are concerned, further reductions in materials usage and continued improvements in efficiency are our chief objectives.'

### Geographical shift

With the fierce competition in the current market, a shift that was already visible last year has established itself: hardly any European cell makers have survived the current situation of overcapacity. X-Group, Photowatt, Schott Solar are among those companies that have closed up shop. Following that trend, Ferro has focused its resources towards Asia, where the main capacity is located in China and Taiwan. Noppe: 'We have established labs in Suzhou, China and Taiwan, and produce paste in Suzhou. Still the goal here remains the same: maintain relationships with the main players to develop materials required to drive down the cost per Wp.'

**'The goal here remains the same: maintain relationships with the main players to develop materials required to drive down cost per Wp'**



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## High Tech Campus Eindhoven: star location for PV innovation

Shanghai, September 2022, Lia looks out of her bedroom window. It's another sunny day. So Lia knows she will be making money with the electricity her windows generate. What she doesn't know, is that the manufacturing technology for her PV window originated in a chance conversation at a seminar at High Tech Campus Eindhoven, in 2013.

Lia's story may be fictional, but there's no doubting the creative potential of High Tech Campus Eindhoven. Home to over 100 companies and 8,000 researchers, developers and entrepreneurs, it's a place where ideas, expertise and open innovation combine to turn ideas into marketable applications. That's certainly the case for solar and photovoltaic (PV) technologies.

### Solliance

In recent years the Campus has emerged as a national and international focal point for solar innovation. This position was strengthened in 2011 with the creation of Solliance, an alliance dedicated to research and development in thin film PV solar energy (also see page 28). Construction work is already underway on brand-new research facilities on the Campus to house Solliance's activities, which have national and regional government backing. 'There is a triple helix of knowledge institutes, companies and government, that makes this region extremely strong,' quotes Solliance director Hein Willems. 'What's more, while people often talk about open innovation, here it's a reality. There is a level of openness that you don't find in many places in the world.' So how does this openness contribute to turning an idea from creative spark into a marketable application? And how are activities on the Campus helping the PV industry as solar generation strives to become a mature, competitive technology?

### Solar business development

Ideas like the one for Lia's fictional solar windows often begin with a chance conversation or a moment when business insight meets technical expertise – and there are plenty of occasions for those on the Campus. For instance, last year, over 850 technologists, business people and financial specialists attended a series of Solar Technology Business Development workshops. Held at Conference Center The Strip, the workshops were run by a number of organizations. At the workshops, Paul Stassen, CEO of TULIPPS Solar, was there making contact with Twan Smetsers from Chematronics, also located on the Campus. Smetsers has since become a valued business partner assisting Stassen's start-up company with strategy, business development and financing. The idea for the company came from Stassen's 20 year experience in the plastics industry. He realized that the strong, lightweight polymers used in car making were an ideal material for lighter, cheaper, easier to install solar modules. Together with a group of business and technology partners, he turned this idea into TULIPPS' COSMOS module technology (one of the winners in the Dutch Solar Awards 2012, also see page 15.) Replacing aluminum frames with polymers also allows for the use of ultra-thin 2 mm glass which increases light transmittance and energy generation efficiency per unit area.

### Research facilities on site

It's the same story time and again. Whether it's a chance encounter in one of the many restaurants or a discussion at a seminar, the Campus makes it easy for people and ideas to meet. As one researcher says: 'If I want to discuss an experiment, I can simply walk over to the Philips Innovation Services' cleanroom facilities to discuss results with the team there.' On his way there, that researcher may well bump into other solar specialists coming to use the services of Philips Innovation Services that range from nano-patterning with substrate conformal imprint lithography to reliability testing for solar panels. He may talk to a colleague from a multinational company or share a chat with a fellow scientist from one of the start-ups trying out ideas in facilities most small companies can only dream of.

Altogether, this is the great strength of High Tech Campus Eindhoven – the wealth of expertise, entrepreneurial talent and dedicated resources concentrated on one site. The Campus is a place where open innovation and inspiring personal contacts are a daily occurrence. And with the current development of new solar tech facilities for Solliance the cluster will only get stronger. So next time you hear of a breakthrough in solar technology, check where it comes from. There's a strong chance it will be 'made in Eindhoven'.

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## Lamers High Tech Systems ready to facilitate next upturn in solar equipment

**'We have more than ten solar evaporation cabinets in the field and are ready for variations on this theme. As Lamers High Tech Systems, we are able to manufacture cabinets for our customers that make various layers of deposition possible. Our technology is ripe for a large-scale rollout.' An interview with Nico Nieuwland, managing director of Lamers High Tech Systems.**

Over the last few years, Lamers High Tech Systems, in cooperation with various large customers, has specialised in the design, construction and qualification of installations and control systems for high-purity gasses and chemicals. These are sold to the semiconductor, chemical, space and aviation, pharmaceutical, LED and solar industries. Over a year has passed since Lamers High Tech Systems was purchased by the stock-listed company Aalberts Industries. Nieuwland: 'And just as we stated last year, it has proven to be greatly beneficial to us. Where we initially focused on the Benelux area, we now have no boundaries. This calendar year we commenced highly active promotion on the German market. So our market opportunities are far from exhausted.'

### Distribution of Risk

Just like many other high-tech suppliers, Lamers High Tech Systems is currently reaping the benefits of all those years of risk spreading. 'Now the machine builders in the solar industry are confronted with

a hopefully temporary dip, we can count on other markets like semicon and LED', explains Nieuwland. 'In brief, we have the capacity to facilitate other OEMs in machine building. We have made our mark within the solar industry now.'

The gas cabinet that Lamers High Tech Systems presented and developed last year for a number of ALD manufacturers is very popular indeed. 'We already have more than ten cabinets in the field and are ready for variations on this theme', explains Nieuwland. 'As has been said before, we're able to manufacture cabinets for our customers that make various layers of deposition possible. The system is ready for a large-scale rollout. With regard to this, we remain a unique party for OEMs. We make new innovative processes possible for customers through resolving the problems entailed in the distribution of chemicals and gasses. With the solar gas cabinet – which was our first own product – we have demonstrated our ability as a facilitator to develop and build the appropriate and

latest 'dosage and control' equipment for these innovative processes. The valuable molecules can't just be used more qualitatively with our cabinet; there is also less risk of down time.'

Nieuwland concludes: 'We can consequently supply OEMs with components for machine construction and install all the necessary systems for gasses and chemicals in the factories where the machines are to run. Finally, we can also supply the dispensing and vaporisation equipment. We are dependent on the success of the solar industry for our activities in this sector. We grow alongside them as we fulfil our role as a partner. It is our common practice to adapt rapidly to the economic cycle and we shall continue to follow this trend.'

### Key competences Lamers High Tech Systems

#### Turn-key installations:

- Gas & chemical infrastructures, distribution and control panels
- Hook-up of production (vacuum) equipment
- Gas cabinets and other Bulk Chemical Systems

#### (Sub)assemblies for OEMs:

- R&D&E custom & standard products and assemblies
- Purification and assembling under cleanroom conditions
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- Measurement and control equipment for industrial applications







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Enthone's electroplating technologies:

## Lowest cost of manufacturing silicon and thin film solar cells

Enthone Inc. (Cookson Group) is dedicated to reduction in the cost per Wp through development of new plating technologies for manufacturing solar cells. Enthone has leadership position in this segment. Their core competence, electroplating chemicals, can be utilized for both thin film and silicon solar cells.

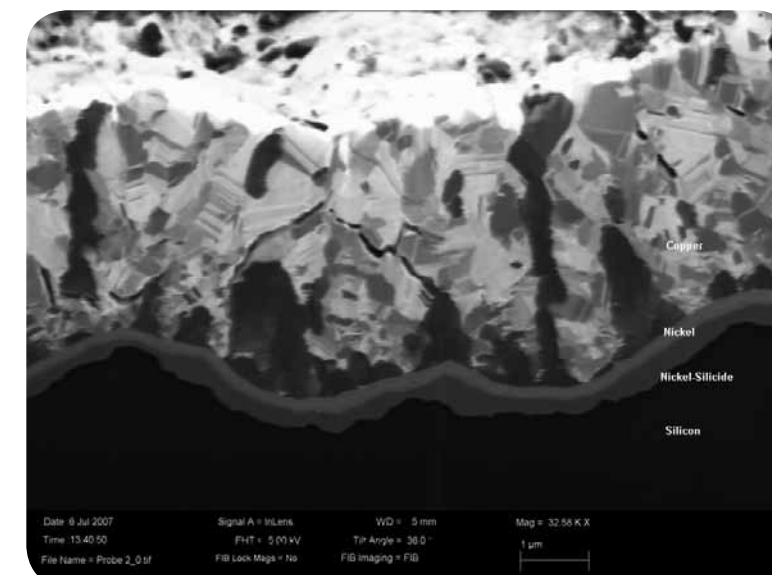
For solar cell manufacturing, Enthone is strongly involved in the development and introduction of electroplating as a viable technology. 'Plating technology is a method that utilizes electricity or electrons to cover an object (in this case solar cell materials) with a layer of metal', explains Jan Hendriks, R&D group leader PV and electronic materials. 'This is how we provide steel with a layer of zinc, nickel or chrome to make it more resistant to corrosion. The principle of galvanic deposition of metals can also be used for thin film and silicon solar cells.'

### Holy grail

'The most common option for applying conductors to silicon solar cells is through screening with silver paste', continues Hendriks. The biggest challenge facing this conventional method is the continued rising of the silver metal prices. 'It's also possible to produce these conductor lines directly to the silicon using electroplating techniques. The advantages of this are improved conductivity thus lower resistances with smaller tracks (increased efficiency) and material (amount and type) reduction (cost). Instead of silver, conductor lines on silicon cells can be electroplated with lower cost metals such as nickel, copper and tin. At the same time, the productivity can be enhanced as electroplating is a continuous production process and the application of silver pastes is a batch-based process. We are in product qualification phase with a number of major global solar cell manufacturers.'

### Future

Electroplating is not exclusive to silicon, but can also be used for thin film solar cells, says Frando van der Pas, Director of Marketing Electronics and PV: 'It doesn't matter if



it concerns copper, indium or gallium or other elements from the 'stack', all of these can be deposited through electroplating. This is far less expensive than the chemical PEVD process and/or the use of vacuum technology. The cost price is well on track and we're also making good headway with the yields, which are currently in excess of ten percent. We are getting close to the target efficiencies required. For further development, we're partnering with other industrial companies who intend to supply turn-key systems using electroplating as a future technique. Furthermore we see plating also as an interesting option in the backsheet production for backcontact cells. Especially in the current solar climate where incentives are being frozen, we think the importance for cost reducing emerging technologies such as electroplating are key for the future. We therefore anticipate volume manufacturing to happen within a couple of years.'

**'Electroplating also as an interesting option in the backsheet production for backcontact cells'**



# COLUMN



## The end of an era (and the start of a new one)

The global PV sector is going through a period of transition and reconstruction. On the one hand we see the establishment of the first major self-sustained markets for PV systems as a result of the fast price reductions over the past few years. This marks the beginning of a completely new era for PV.

One in which market growth is no longer determined by incentives and governments' interventions, even though very large-scale deployment of PV will probably require governments to continue to play a role in creating a level playing field and setting the appropriate boundary conditions. This situation has been looked forward to for many years and now comes earlier than expected. On the other hand it is clear that the PV industry sector is in a deep crisis throughout the world. Europe as pioneer in building the global PV sector and market is faced with other parts of the world taking a major share and playing an important role. This is a painful process and words like 'consolidation' of the industry are mere euphemisms for what it means in practice to those involved.

For many people this is a confusing combination of signals. Telling the right story is therefore crucial to maintain enthusiasm and support. We need to emphasize that there is little doubt

that the current crisis will turn out to be just a small ripple on a robust trend of strong growth during many decades. If PV is to play a significant role in our future energy system (and if PV cannot, which sustainable energy technology can?), the installed capacity needs to increase by more than two orders of magnitude: from the current one tenth of a terawatt-peak (TWp) to tens of TWp's. This is an opportunity of a size almost beyond imagination. The key challenge is to survive the current industry crisis and position oneself to benefit from the continued growth once the crisis comes to an end. Innovation is certainly a key element in positioning, as is continued support from governments and people in these difficult years.

If we abandon the PV sector or lose interest it may be impossible to catch up in the future. We simply cannot afford to do that. Innovations are needed and possible along the entire value chain: from sustainable materials up to dedicated products for the markets of the future, such as technologies for very large scale integration of PV in buildings and the physical infrastructure and in the electricity grid, to mention just a few. No one says it will be easy and competition will be fierce, but the potential gains are huge. Let's go for it!

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# Solliance thin-film PV research gets more and more shape

Two years have elapsed since the start of Solliance. ECN, Eindhoven University of Technology, TNO Holst Centre and imec joined forces in Solliance to bring thin film PV technology to a higher level and support the solar community in the Eindhoven-Leuven-Aachen-triangle region. Together they want to acquire a global market position with international industrial players: an R&D cluster supported by open innovation research programs bringing thin film solar energy technology to excellence.

‘The owner of the High Tech Campus in Eindhoven creates a building dedicated for Solliance’, Hein Willems (director of Solliance) opens the interview. At this very moment the foundations are being dug for this new building that we are to take into service in the second quarter of 2013. We did not wait till the building is ready. On the contrary we have realised, together with industry and with the financial support of the Province of Noord-Brabant, already working baselines on Thin Film Si and CIGS and records on Organic PV cells and CZTS. We are also in negotiations with the Forschungszentrum Jülich about joining us.’

Hein Willems,  
director of Solliance

### Distinguishing features

‘Solliance’s main theme will always be to propel the solar sector to a world-class industry through facilitating highly advanced cooperation between companies and knowledge institutes and world-class facilities in the field of research on thin-film PV’, according to Willems. ‘We’re already well on our way to profiling ourselves as a world player within the region Eindhoven-Leuven-Aachen. Cooperation with other European regions is in our view also important for the competitiveness of the industry. That is why we became member of the recently established Solarrok network of eight strong PV regions in Europe.’ The Solliance research programme is focused on three main themes within the domain of ‘thin film’. Successively, this concerns Thin-Film Silicon solar cells; CIGS/CZTS-solar cells; and Organic solar cells. ‘Thin-film PV is increasingly considered as a new opportunity to set yourself apart in a specialised market like that of Building Integrated PV (BIPV)’, states Willems. ‘We at Solliance want to make not only an important contribution to increasing the efficiency of the process steps in the manufacturing processes but also in finding new materials and new cell concepts. A typical target for all the types of cells is a cost below 0,5 € per Wp. At the end the impact of Solliance and the success we derive from this is attributed to the creation of new jobs in the industry.’

In order to secure a program that reflects the industry’s needs, Solliance established an Industrial Advisory Committee, with representatives from: Umicore from Belgium and in the Netherlands from Smit Ovens, NV BOM, Brainport Industries, OM&T, Philips Innovation Services, Scheuten and VDL ETG. Together with all these companies,

Solliance attempts to transform the acquired fundamental knowledge from across the entire chain of thin-film PV into products.

### Campus

As already mentioned, Willems hopes that he and his team can move into the new building on the High Tech Campus Eindhoven in the second quarter of 2013. An increasingly sizeable PV-cluster is amassing here. ‘We are part of the solar cluster core on this knowledge-intensive business park and as such we are at the centre of industry. Our building can be extended modularly in the future but, in the first instance, it will involve three pilot lines, being Thin-Film Silicon, Organic PV (OPV) and CIGS. The pilot lines will be based on industrial equipment. As mentioned before the Thin-Film Silicon and CIGS lines are already fully operational at temporary locations. The expectation is that the OPV line will be operational in the new building in 2013, too.’ Willems has high expectations of the team of Solliance researchers. They are all highly qualified, have unique knowledge in the field of Thin Film PV and have a broad range of expertise. Together with the brand new laboratory infrastructure I strongly believe that in close corporation with the technicians of the industry they will make the difference.’

### Key competences Solliance

Solliance will take off to reach the international top, having the full range of expertise’s: from development of materials, thin film cells & modules over industrial equipment and processes to dedicated applications.

# SoLayTec introduces modular platform InPassion ALD

In a time in which most machine builders in the solar industry are affected by the global crisis, the Eindhoven start-up SoLayTec flourishes as never before. The company has already sold six of its InPassion LAB machines for depositing Al<sub>2</sub>O<sub>3</sub>. This process development tool for spatially separated ALD will get a mass production variant with the machine InPassion ALD at the end of 2012.

Since last year, Rena GmbH has been a SoLayTec major shareholder. The company has seen the interest in spatially separated ALD technology and the machines increase hand over fist in the last two years. ‘And currently, partly because of this, we’re involved in taking an important step to the next phase for our company’, explains marketing and sales manager Roger Görtzen. ‘We’ll be launching InPassion ALD, our mass production tool, at the end of 2012. During this calendar year, we’ve been very involved with driving down both the cost price and lead time for this tool as far as possible. We have, for example, developed our new deposition unit with a throughput of 360 wafers per hour including a double injectorhead resulting in a deposition rate of 1nm/sec and we developed our new evaporation cabinet. The organisation of our supply chain is also far advanced.’

### InPassion

In the meantime, the sales of the InPassion LAB are in full flight. One of the world’s most respected knowledge institutes – the Solar Energy Research Institute of Singapore (SERIS) – purchased one last spring. SERIS and metal supplier AkzoNobel have entered a three-year research contract with SoLayTec to realise the integration of Al<sub>2</sub>O<sub>3</sub> in new cell concepts. Görtzen: ‘This contract is not just an opportunity for us to enter the Asian market, but also renews the confirmation of the future of Al<sub>2</sub>O<sub>3</sub>. In the meantime, six international parties (four knowledge institutes and two Asian manufacturers) have purchased an InPassion LAB and we’re ready to take the next step to launch the mass production tool – now called InPassion ALD.’ New here is the possibility that SoLayTec has created to allow InPassion ALD to be expanded modularly. ‘Working with the difficult times in the solar industry, customers



InPassion ALD, for Al<sub>2</sub>O<sub>3</sub> deposition up to 3,600 wph

can start with the purchase of one or more modules and, at a later stage, expand this to six modules for each production line’, says Görtzen. ‘The InPassion ALD will definitely be launched at the end of 2012.’

### Market potential

‘The InPassion ALD is a flexible solution that allows the user to vary the thickness of the layer without having to change the machine hardware’, continues Görtzen. ‘Due to the fact that the entire machine is modular in construction, the customer has a choice of two variations. The number of modules opted for is of importance here: six or ten. This indicates the maximum output of 2,160 or 3,600 wafers an hour respectively. Above all, during the weekly cleaning or other service, the machine doesn’t have to be completely shut down. This is because this can be done for each module individually. Enabling us to guarantee a very high uptime for the machine. It’s looking more and more likely that ALD will be a really tremendous success in the coming

### Key competences SoLayTec

Ultrafast Atomic Layer Deposition for Al<sub>2</sub>O<sub>3</sub>, benefits:

- Lowest Cost of Ownership
- Less process chamber cleaning compared to PECVD
- Deposition at edge of non-coated side < 1mm
- High uptime because of modular design, production during cleaning
- Flexibility in layer thickness
- Atmospheric pressure
- Easy ramp-up from lab (100wph) to fab (3,600wph)



# Newly merged Royal Haskoning DHV helps solar industry reduce costs

**‘Our customers are getting more and more concerned about the downward spiral in the total cost of ownership of their manufacturing facilities, but are also anxious about making manufacturing processes more sustainable’, claims Ad Schrijvers, business development manager at Royal HaskoningDHV.**



At the beginning of this year, engineering firms DHV and Royal Haskoning announced their merger plans to create Royal HaskoningDHV. Recently completed, the formation of Royal HaskoningDHV has created a major player in the business with sales exceeding seven hundred million euros, and an employee strength of 8,000 professionals. The company is involved in the areas of delta technology and mobility right through to the design of airports.

**Large scale projects now possible**  
Speaking on both companies’ individual strengths before the merger, Schrijvers says. ‘In the last few years, there has been an increase in demand for solar factories in Lithuania, India and Belgium. As a

single entity, Royal Haskoning has little track record in the area of solar factories, while DHV is an expert in the area. On the other hand, Royal Haskoning is active in the engineering and supervision of the construction of solar parks. Now with our forces combined, we have a broader scope of expertise, and are specialised in the design of process and property-linked utilities, the corresponding architecture and the supervision of the construction process for solar manufacturing facilities.’ According to Schrijvers, the merger between Royal Haskoning and DHV will pay dividends for the company in the solar market. ‘The merger, together with our increased capabilities, has opened new doors for us to accept larger-scale, international projects. In addition, both parties benefit from each other’s networks in markets which the other was not active in. For DHV, this concerns solar in the Middle-East and South America. A new emerging economy like Brazil, where sustainability plays a major role, is a potentially very lucrative market.’

**Terrestrial heat**  
Even though the solar industry is suffering from considerable slack, Royal HaskoningDHV is currently involved in an extremely provocative project in Lithuania. ‘Together with an equipment manufacturer, we’re working on a new and extremely sustainable factory. The facility will run largely on terrestrial heat tapped from over 100 sources that are around 100meters below ground’, explains Schrijvers. ‘What makes this so remarkable is that, it isn’t just sustainability that has driven the decision here, but also the

favourable total cost of ownership.’ With regards to the total cost of ownership, Schrijvers perceives that a crucial point highlighted for the solar industry. ‘All major market parties are currently focusing on reducing further the total cost of ownership. Together with the development of high-efficiency solar cells, these are among the handful of factors with which manufacturers are differentiating from competitors.’ In the meantime, Royal HaskoningDHV is specialising in developing the technology for the factory of our future. An example is the exploration of organic PV (OPV). ‘Technologies like this are still relatively expensive’, Schrijvers admits. ‘But ultimately, this could be the technology of our future. With its very inexpensive manufacturing process, this will, in time to come, replace costly raw materials like silicon, which is used in current methods.’

## Key competences DHV

- Consultants in feasibility studies, concept development and exploitation issues
- Design of process systems and supply of utilities
- Management of construction and environmental licenses
- Total Design Management from architectural creation through to hook-up of process equipment
- Supervisory and construction management during the execution of the manufacturing facilities

# GreenTech Engineering supports companies from lab to fab

**On the 1st of January 2011, the Netherlands PV cluster once again witnessed the founding of a start-up. Marcel Grooten established the engineering and service provider GreenTech Engineering. The company aims to support the industrialisation of technology in for example the PV industry. ‘In other words, facilitating the challenging step from lab to fab not solely for lots of solar start-ups, but also for known PV companies who regularly encounter difficulties here’, according to Grooten.**



**‘Within five years we want to expand from the current start up into a service providing company with forty to eighty employees’**

Grooten has an impressive track record in the PV industry. In 2010, he decided to leave OTB Solar and start his own company. ‘The PV industry is an excellent example of one of the sectors on which we are focusing with GreenTech Engineering, in addition to the semicon, LED and automotive markets’, explains Grooten. ‘Solar is a market in which new technologies are constantly being introduced. Putting new technology into flawless production is always a challenge. Industrialisation is not only a necessity for the start-ups, but also for the OEMs and their suppliers. This is our client base to whom we provide industrialisation competency.’ Within five years, Grooten wants to expand from the current start up

into a company with at least forty to eighty employees. ‘We will act as competency provider for existing companies and as an established industrialisation partner for techno start-ups. As an engineering service provider, we have the ability and ambition to tackle and deliver turnkey industrialisation projects. Especially during downturns in industry, investing in new technologies and the industrialisation is of perfect timing. Temporary demand is low so companies willing to prepare for the next round can line themselves up to run on pilot level and debug initial issues that are common in implementation of any innovation. As demand will rise again production at high productivity and yield is within reach.’



# HIGH TECH CAMPUS EINDHOVEN

“The smartest square km in the Netherlands”

Foto © Holst Centre

## Solar energy

Traditionally, systems and technology involving semiconductors on thin film have been strong fields on High Tech Campus Eindhoven. This knowledge and expertise are extremely valuable assets for the development of solar energy systems, because they offer crucial research answers.

Several players in the solar energy business such as ECN, SunCycle, Solliance, TULIPPS Solar and KIC InnoEnergy already enjoy the advantages of being located at the Campus. With knowledge providers such as Philips Innovation Services and Holst Centre, the expertise is enriched. Finally, the state-of-the-art technical facilities complete the high tech ecosystem in the field of solar.

High Tech Campus Eindhoven is an R&D ecosystem of more than 100 companies and institutes, and some 8,000 researchers, developers and entrepreneurs, who together are working on developing the technologies and products of tomorrow. The preferred work approach at the Campus is Open Innovation. This means that Campus companies share knowledge, skills and R&D facilities in order to achieve faster, better and more customer-oriented innovation.

The companies on the Campus focus on such fields of technology as High Tech Systems, Microsystems, Embedded Systems, Med Tech and Infotainment. Taking these domains as their starting point, they create global innovations, most notably in the application fields Health, Experience and Energy. The international community of the Campus shares a common drive for creating innovative solutions that make human life healthier, more pleasant, easier, more interesting and which contribute to a sustainable world. This makes the Campus a place where entrepreneurial spirit, high-end research and creativity can flourish and lead to successful new products for global business.

**For more information: [www.hightechcampus.com](http://www.hightechcampus.com)**



High Tech Campus Eindhoven

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## Solar Excel ready to deliver solar cell sheet on commercial scale in spring of 2013

**Just a few short weeks ago, the Dutch start-up Solar Excel put the production machines in its pilot plant into service that can manufacture a highly innovative light management sheet for solar cells. With the opening of the pilot plant, the first commercial products can be delivered next spring.**

The solar cell sheet from SolarExcel is to be applied directly to solar cells or panels. Through the application of the sheet, manufacturers no longer need to apply an anti-reflective coating or layers as they do now. 'This saving is immediate for the manufacturer', says CEO Ben Slager. 'Applying an anti-reflective coating is a relatively expensive process. Our sheet can reduce the reflection to between zero and half a percent. This allows manufacturers to completely do away with other anti-reflective methods in their manufacturing process.'

### Roll-to-roll

The sheet works on the principle that the key is the ability of the sheet to optimise the wave length of the incidental light specifically for any type of solar panel. The German research institute Jülich tested the operation of the SolarExcel sheet extensively, confirmed it and has published several times about this technology. Slager: 'The more oblique the angle that the light enters, the higher the reflection. Where the light enters at an extremely oblique angle, our added value is greatest. We not only prevent reflection, but we transform the light into a more favourable spectrum and this throughout the entire day as the sun shines.' From the site in Venray, where the pilot plant can manufacture three to four hundred thousand square meters of solar cell sheet, the company's second development phase has also come to a conclusion. 'Whereas the pilot plant manufactures in batches, we're going to the second phase of roll-to-roll manufacture', states Slager. 'This step makes mass production possible. For the roll-to-roll process, all the technological challenges have been overcome. This is the result of – in contrast to our batch production – the fact that existing equipment only had to be



*The Solar Excel factory in the city of Venray*

modified to meet our demands. We have also managed to reduce the thickness of the foil structure in this manufacturing process from 1 millimetre to 100 mu, dramatically reducing the quantity of material required in manufacturing.'

### Durability tests

Now that the manufacturing process is ready, Solar Excel has had a considerable number of manufacturers test its sheet on large solar panels. Slager: 'We've applied large sheets and they are currently undergoing durability tests. All the responses have been positive until now. The various tests will be concluded in the next six months, after which we'll be delivering the first commercial products in the spring of 2013. The coming calendar year will be all about ramping up the production volume. It is our ambition in the coming years to convince five of the top twenty panel manufacturers to use our sheet. An important advantage is that our technology

is suitable for new and existing types of solar panels. It can be used with thin-film and crystalline silicon solar panels.'

## Key competences Solar Excel

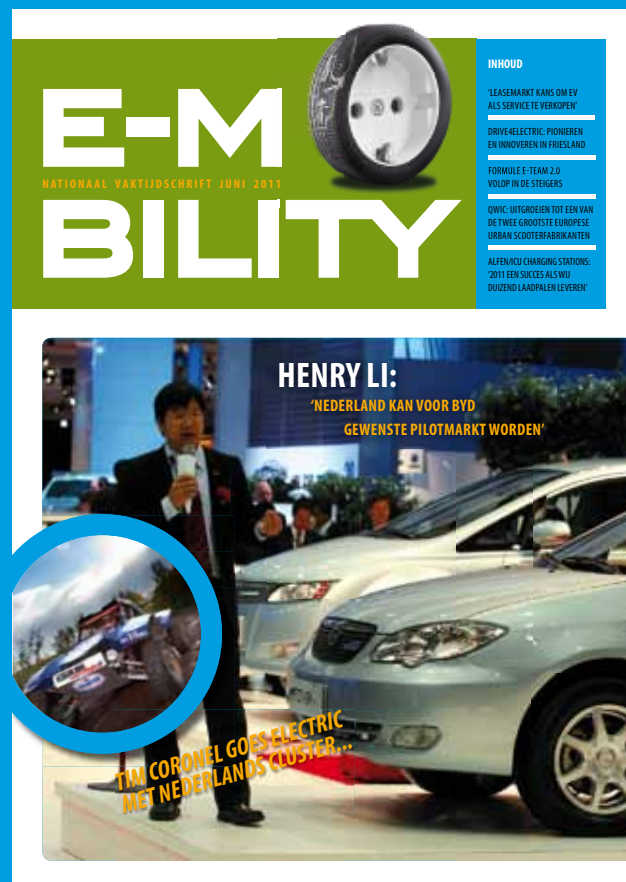
SolarExcel offers a high-performance light management sheet, which can be placed on top of the glass cover plate of a PV panel. This offers the following most important advantages for PV panels:

- All losses due to reflection are eliminated.
- The performance under less than optimum angles increased significantly.
- Compensation of sub-optimum orientation of a PV panel.
- Real cost savings in PV panel design/manufacture.



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## RGS Development near enough ready for pilot production of RGS

Once again this year in the North-Holland town of Broek op Langedijk they have made significant advances in the development of Ribbon-Growth-on-Substrate (RGS) silicon wafer technology. 'For example the manufacturing process has - to a large extent - been stabilised, through which the yield of wafer production has now reached over ninety percent. This positions us to provide the first pilot factory with our technology in 2013.' An interview with Axel Schönecker and Maarten den Heijer from RGS Development.

As is well known, the major advantage of Ribbon-Growth-on-Substrate is the great reduction in the loss of materials. This technology casts silicon from the liquid state directly into thin wafers. In this manner, RGS Development can manufacture twice as many wafers from the same quantity of raw materials and at half the cost.

### Balance

'Over the last few years, we've made great advances in the yields with our machine', begins Schönecker. 'Whereas last year we had managed to reach fifty percent, we're now above ninety percent.' 'On top of that, we will be able to produce larger volumes by the end of the calendar year', adds Den Heijer. 'Next to this, we work on a significant reduction of impurities which will improve the efficiency of our solar cells'.

'In 2013, we want to start up a pilot production line', continues Schönecker. 'In doing so, we've entered the technology demonstration phase. The first talks have been held to select partners for the pilot production phase. We're looking for a party with a background in technology. On the longer term, we will also take the first step to larger and thinner wafers here, as things look at the moment: 210 x 210 mm in size.'

### Market entry

'We're still more than confident that our goal of market entry in 2015 is completely realistic', says Den Heijer. The focus on cost reduction in the solar industry forms a very strong driver for the introduction of



Ribbon-Growth-on-Substrate. Den Heijer and Schönecker even believe that they will be able to take advantage of the current market situation. 'Wafers grown directly on a substrate is currently enjoying a complete revival in the solar industry. It is one of the breakthrough technologies which enable a complete next level of cost efficiency. For the time being, it's difficult to say if we really lead the competition in the substrate grown wafer field, but it is certainly clear that we're on the right track and in 2015 we'll have a major presence on the commercial market.'

### Key competences RGS Development

Ribbon-Growth-on-Substrate (RGS), benefits:

- Twenty times higher manufacturing capacity for each line in comparison with conventional technology
- Two hundred percent more wafers from the same amount of silicon
- Fifty percent less power consumption for each wafer
- Fifty percent lower investment for each wafer capacity



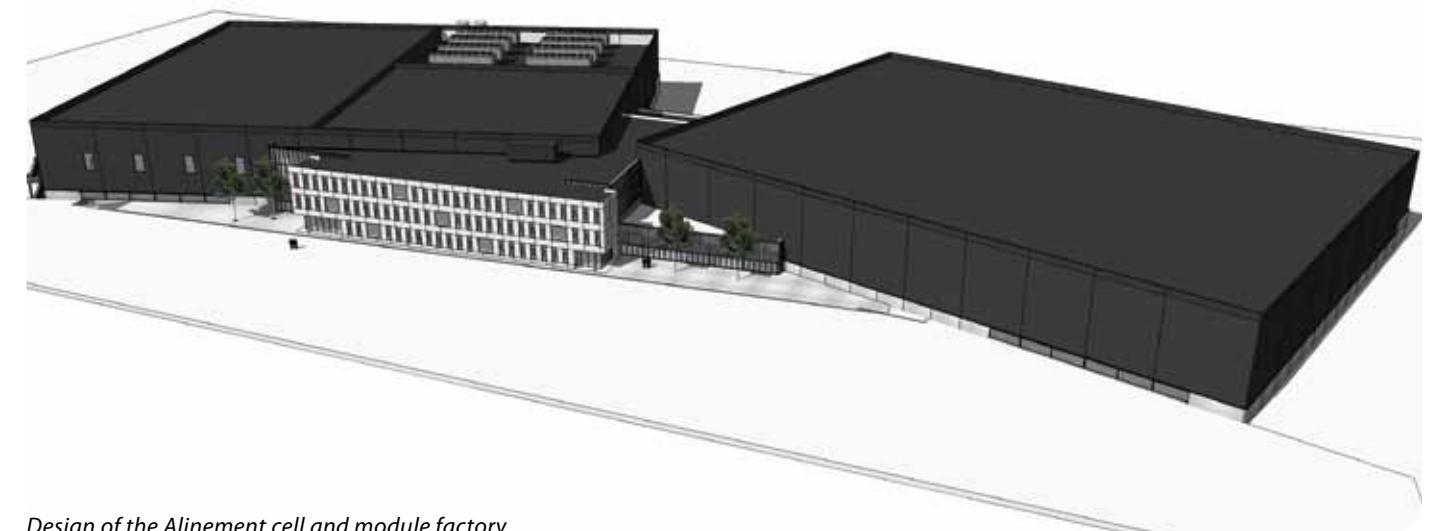
# SOLLIANCE

An R&D cluster bringing thin film solar energy technology to excellence



## Cell and module factory Alinement to start manufacture in 2013

The Dutch entrepreneurs Jac Hanssen and Henk Koerselman are currently pulling out all the stops to find an investor to build the hypermodern cell and module factory Alinement. From next year, they want Alinement to manufacture both PV cells and modules in a single factory. 'The manufacturing has to start in 2013 or we'll have lost the momentum', state both directors.



*Design of the Alinement cell and module factory*

At the end of 2010, Henk Koerselman and Jac Hanssen first announced that their new company Alinement had signed a 'memorandum of understanding' with two foreign technology partners: the German equipment builder Roth & Rau and the Canadian module maker Day4Energy. Roth & Rau will supply a cell production line based on hetero-junction technology. This Roth & Rau production line will be combined with Day4Energy's advanced module manufacturing technology. Introducing extremely high efficiency to the next generation of crystalline silicon solar panels.

### Return-on-investment

At the end of last year, it appeared as though an agreement with an Indian investor was on the cards for Alinement, but as a result of the crisis that subsequently filtered through to the solar industry the investor had second thoughts. Nevertheless, Hanssen and Koerselman continued to search for investors for Alinement. 'Above all, the links with our technology providers have

only strengthened', says Hanssen. 'They've even managed to dramatically improve the technology. We'll have the benefits of the anti-cyclical investment that is currently taking place among equipment suppliers.' Koerselman adds: 'As a result, the return-on-investment for our project has improved, but it remains tricky to incite investors.' Even so, Alinement is currently in talks with three potential investors. Surprisingly enough, these are Dutch investors. Hanssen: 'Above all, we're looking across China for investors. We have even entered into NDAs with two Chinese companies. The WABO permit (general provision of environmental law act permit, i.e. building and environmental permit) has been extended by the municipality of Heerlen and the European Science & Business Park Avantis.'

### High efficiency

According to Hanssen and Koerselman, Alinement has to be up and running in 2013. 'If it doesn't start in 2013, it'll be too late for Alinement and other parties will be focusing on high-efficiency solar cells. Because, at the

moment, investments in new solar factories might be negligible, as the market offers a better perspective the industry will move to a higher level. We want and have to be one of the most prominent players with an extremely high-efficiency product.'

### Key competences Alinement

- Alinement will construct an integrated manufacturing line for
- PV cells and modules;
- Based on Roth & Rau's hetero-junction cell technology and
- Day4 Energy's technology;
- Alinement will produce a highly efficient (>20%) and low-cost solar module;
- the production will start in 2013 with a capacity of 80 MWp and expansion to 500 MWp/a.



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# Bronkhorst continues to renew its portfolio

Bronkhorst is the European market leader with its portfolio of mass flow, pressure and vapour controllers. The company hopes to be able to introduce a number of innovations to the growing solar market in the coming years and, in doing so, set forth the current growth.

Within the solar industry, Bronkhorst is the supplier of thermal and Coriolis mass flow controllers. These instruments measure the flow of various gases and/or liquids for manufacturing processes in solar factories. All instruments are equipped with an onboard PID-controller that can control a valve or a pump. The combination of a sensor, a PID controller and an actuating device makes

it possible to dose a very accurate quantity of gas, liquid or vapour that is needed in the manufacturing process in question. In solar factories, this concerns a wide range of gases, from argon to ammonia, silane and hydrogen selenide and liquids like tin chloride, TriMethylAluminium and DiEthylZinc. 'Our sales have doubled every seven years since our establishment. Knowing that the solar market, which is so important for us, is to experience a gigantic boost in the coming five years, we set forth this ambition', Armand Bergsma from Bronkhorst adds. 'In turn', says Bergsma 'the solar industry mainly expects products that are robust and continue to function seamlessly and in a reproducible manner'. Bronkhorst, together with system

builders like Lamers High Tech Systems, belongs to a selection of companies whose paths cross when building almost every new solar application or new machine. 'So, for example, we supply a product with Lamers that is essential for the operation of various solar cell manufacturing machines', says Bergsma. 'Our instruments play a key role in the manufacturing of solar cells. It's our ambition to optimize, together with our customers and system builders, the gas panels in solar factories with a whole series of innovations in the coming period. We're past masters at simplifying gas and precursor dosage and, in doing so, generate major cost reductions. Especially in the area of vapour dosage, there are large steps to be taken.'




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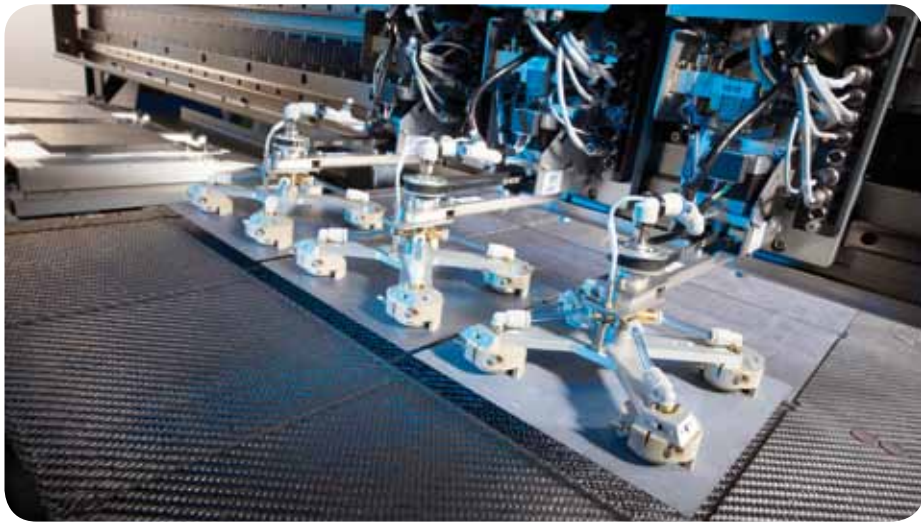


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# OTB Solar changes company name to Roth & Rau B.V.

At the end of August, the integration of OTB Solar, established in Eindhoven (NL), and Roth & Rau AG was completed. As part of the completion, OTB Solar changed its name to Roth & Rau B.V.. Even as the solar market experiences a downturn, the company has maintained the same level of R&D investments in Eindhoven to realize its strategic goals. 'The three most important topics are continuous development of new technologies, extensive specialization, and seeking joint ventures along the value chain', states CEO Claus Lichtenberg.



support for further improvement and optimization of existing equipment. 'We have previously launched a plug-and-play solution that allowed an additional layer of silicon oxide (SiOx) in combination with silicon nitride (SiNx) to be added to the solar cells, increasing the efficiency by 0.3 percent. Now that the larger solar manufacturers are delaying investments in new equipment, we help them with innovative upgrades to existing equipment to reduce the cost of ownership even further and increase the cell efficiency. We expect the market to pick up again in the second half of 2013, and we will be ready for the expansion of our market share.'

The key competence of Roth & Rau B.V. in Eindhoven is the supply of process equipment for the manufacture of solar cells (see box for details). Over the last decade the DEP<sub>x</sub> machines, which deposit an anti-reflective coating using plasma-enhanced chemical vapour deposition (PECVD), have been established as a leading product in international solar cell manufacturing.

During the past year Roth & Rau B.V. has managed to acquire an increasing share of adjacent markets with product platforms that were initially designed and used in solar applications. 'In upcoming markets like MEMs and OLEDs we were able to double revenues this year. In order to increase our footprint outside the photovoltaic sector, we are looking for partners with whom we can jointly venture into new applications and markets. The growth of our sales in these markets enabled us to survive the crisis among the equipment suppliers in the solar industry. The broadening of our portfolio is a necessity, since

it is impossible to absorb the ups and downs of the solar market. If you are only active in one market you are fully dependent on the cyclicity and volatility of that market. Roth & Rau B.V. started to actively approach new market segments several years ago and we are now benefiting from this.' In the meantime, the company continues to maintain its investment in R&D, according to Lichtenberg. An important technology on Roth & Rau B.V.'s roadmap is inkjet printing. 'In the coming year, we will be able to launch a new inkjet platform that will make manufacturing of solar cells with a contact finger width of sixty micron possible. Ink jet printing will experience a tremendous boost once this first high volume industrial application of inkjet printing is released in the solar industry.'

**Upgrades**  
Lichtenberg explains that his company is not just working on new technologies, but that customers are also being offered

Key competences  
Roth & Rau B.V.

- Solutions for automatic solar cell manufacturing
- DEP<sub>x</sub> - the world's highest SiNx deposition rate. Plasma Enhanced Chemical Vapor Deposition Equipment with highest Silicon Nitride and Silicon Oxide deposition rate
- PiXDRO - industrial inkjet systems from innovative, flexible research tools to high performance production solutions for accurate multi-layer and multi-function printing.
- AUTOMATION - Robust automation solutions for superior equipment performance. Roth & Rau automation products are based on a transparent modular design which ensures high flexibility and superior tool performance.



# HIGH-TECH SOLAR SOLUTIONS

TNO.NL

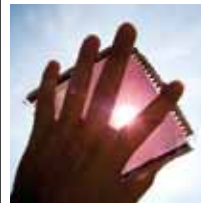
**TNO** innovation  
for life



**MEET TNO EXPERTS  
AT THE EU PVSEC  
IN THE SOLLIANCE BOOTH  
F12/HALL 3.0**

Our aim today is to help suppliers and end-users in the photovoltaic sector, to produce cost-effective, robust solar equipment and technologies. With a focus on thin film CIGS, TNO offers the combination of materials technology, process development and modelling, and developing high-end equipment with industrial partners.

TNO is a partner of the Solliance initiative, a R&D cluster bringing thin film solar energy technology to excellence.  
**More information: [tno.nl/thinfilmttechnology](http://tno.nl/thinfilmttechnology)**



## CelSian Glass & Solar ready to take the solar industry to a higher level

At the beginning of 2012, the TNO Glass Group was transformed into CelSian Glass & Solar. The company has twenty plus members of staff and operates in the worldwide solar industry. In the coming years, the company has the ambition to deliver important innovations in new and existing PV technologies.

'As CelSian Glass & Solar, it's our ambition to employ our expertise in the field of glass for the solar industry,' opens Roeland Brugman (Director Sales & Marketing). 'The optimisation of the manufacturing process of ultra-clear sheet glass for solar applications is a good example of this. This type of glass is used within the solar industry for thin-film and other applications. Another spearhead for our efforts in the solar segment forms the three-dimensional process simulation of complex deposition processes. This is utilized, for example, in the manufacture of thin-film PV. In addition, we've been involved in the optimisation of existing industrial manufacturing processes for glass for as far back as anyone can remember and, in the last few years, with that of solar-grade silicon.'



Roeland Brugman, Director Sales & Marketing CelSian Glass & Solar

### Key competences CelSian Glass & Solar

- *X-Stream*: Industrial 3D simulation software for ALD/CVD processes, glass and silicon production
- *Operation Support Systems*: Advanced Process Control & 3D Monitoring
- *Energy saving*: savings measures for glass furnaces and energy benchmarking
- *Process optimization*: design and improvement of energy intensive and multi-physics processes
- *Industrial measurements*: for process analysis and optimization
- *Laboratory experiment facilities*

### Crystallisation

'Our core business is the development and optimisation of power-intensive processes', continues Brugman. 'The thirty years of experience with processes for the melting and shaping of glass is called upon here for the optimisation of silicon production for solar cells. In the case of silicon, we have high-tech sensors to monitor the crystallisation process and to measure it real time from the liquid to the solidification phase.' According to Brugman, X-Stream – their

own Computational Fluid Dynamics (CFD) process simulation software – is employed to analyse the details of complex deposition processes too, like those utilized in thin-film PV technology. Brugman: 'Through exposing the critical processes in the manufacturing process with the process simulation, machine builders can improve the equipment considerably. Process simulation for thin-film applications is an important tool for our national and international machine builders and producers.'

Brabant Development Agency



### Contact

BOM New Business Development  
Michel Weeda  
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### New Solar Business Development

The Brabant Development Agency (BOM) joins relevant parties in the solar value chain to develop initiatives and projects to build a strong international PV cluster. Industry partners include NTS Group, OM&T, OTB Solar, Smit Ovens, Solaytec, Tulipps, VDL and more. BOM is business development partner for Solliance (ECN, Holst Centre, Imec, TNO, TU/e).

### Brabant Development Agency

BOM offers access to its network with the local SME's, national industry and European business communities as well as with universities, research centers and financial institutions. BOM initiates and accelerates innovative projects, spin outs and multiparty deals and has its own financial instruments including equity share-holdings.





# DataLyzer acquires dominant market position with SPC software



September 2012  
PV SEC Frankfurt

**The demand for Statistical Process Control (SPC) software from within the solar industry is increasing rapidly. The software is intended for statistical process management, which boils down to improving processes by detecting, understanding and controlling the sources of variation. The Eindhoven-based DataLyzer International is one of the leading suppliers of SPC software. In the last 2 years the functionality has been enhanced and now the DataLyzer software suite has FMEA, calibration and OEE completely integrated.**

As a result of the tremendous demand for SPC software, the selection has increased dramatically in the last few years. DataLyzer is one of the most popular SPC programs. The software from the Eindhoven-based DataLyzer International is used by more than 3000 companies worldwide. DataLyzer is the standard program for AMD, STMicroelectronics and Coca Cola, but companies like Bosch, GM, Philips, GE, Solland Solar and Scheuten Solar also use it. DataLyzer works closely with the Dutch supplier of solar module lines, Rimas. DataLyzer's most recent achievement was the opening of a branch in India to serve the growing market in the subcontinent.

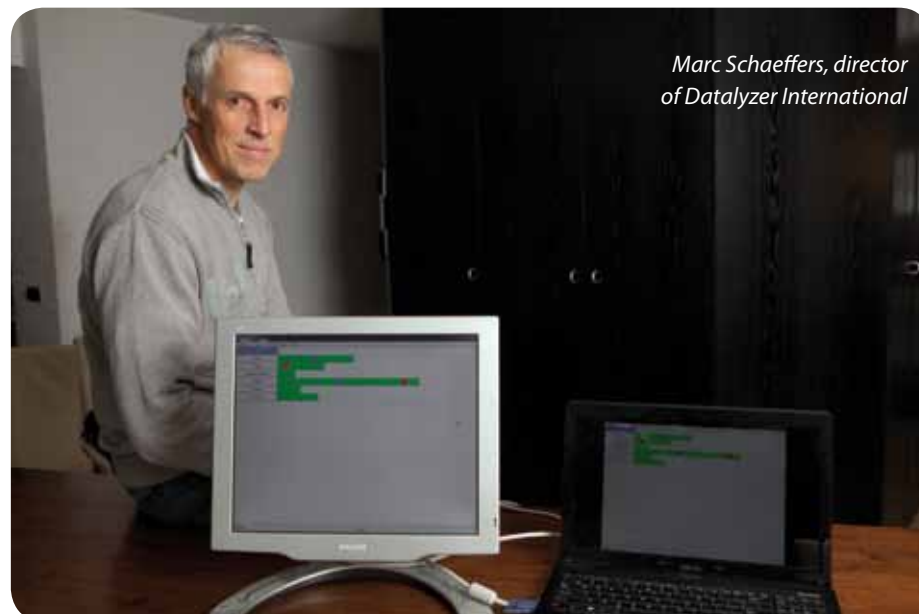
## Mass production

'Traditionally, we are the largest supplier of this type of software within the semiconductor industry', says managing director Marc Schaeffers. 'There isn't a single factory anywhere in the world in this industry that can produce without applying SPC. The step from the semiconductor to the solar industry was a logical one for us. As a consequence of the pressure on prices and the necessity for strict quality control, the importance of statistical process control in this sector is increasing. On top of this, throughout the chain, there is a demand for improved quality and productivity control through the application of SPC and OEE, from the raw materials producer to the cell and module manufacturer. The solar industry is a classic example of mass production and, as a result, is perfectly suited for the application of SPC. Logistics within the solar industry are relatively simple

so a major investment in MES systems is unnecessary. A good SPC system is perfectly adequate and far better value for money, especially when it has all the functionality integrated to manage and reduce breakdowns.'

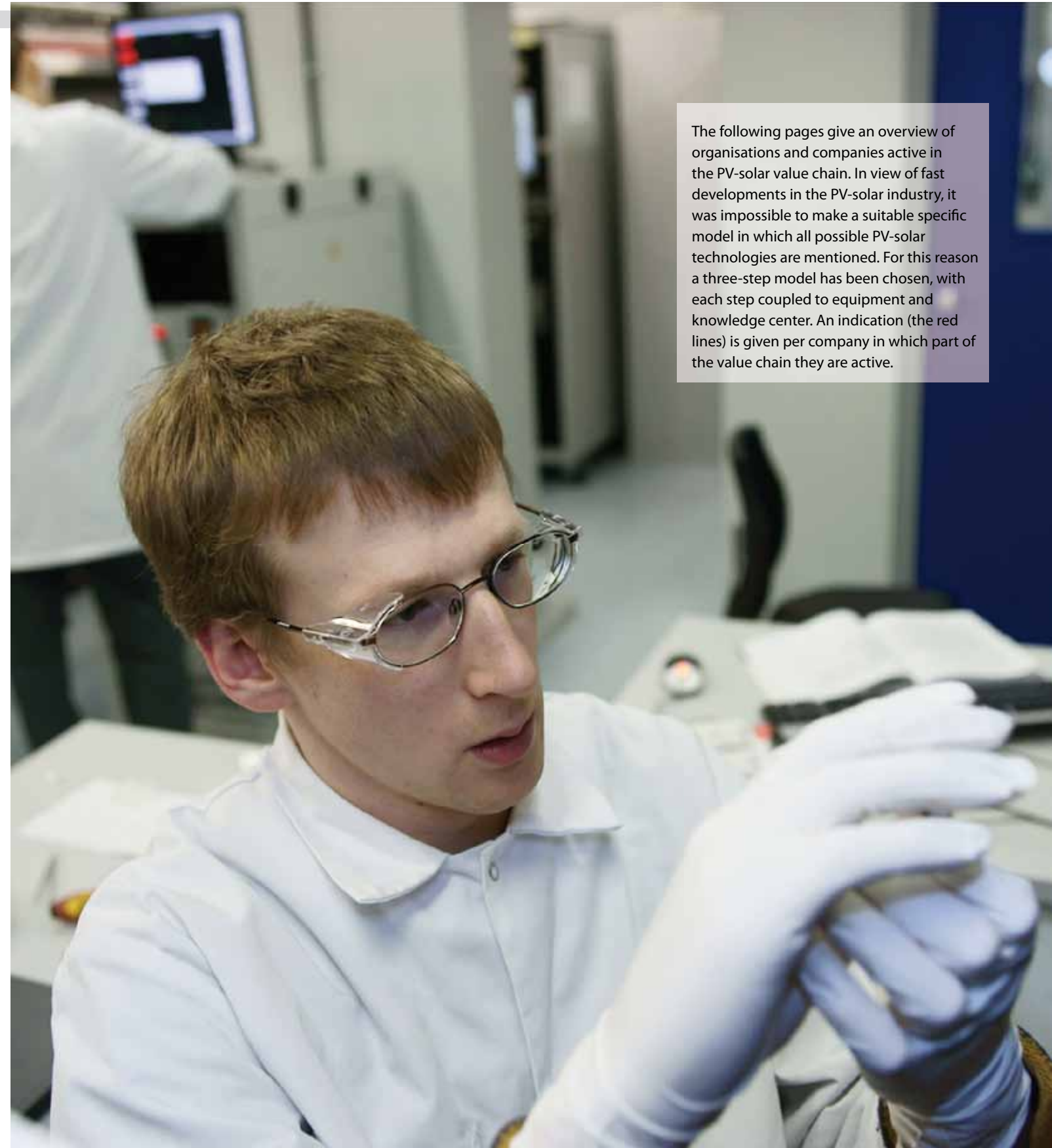
In the coming years, DataLyzer international wants to grow to market leadership in niche markets, and Schaeffers believes that continual innovation is one of the essential factors for success. 'It's based on this vision that we fostered, the ambition to participate in innovation with the solar industry. Thanks to more than twenty-five years of experience and development, our SPC software is perfectly suited to rapidly providing improved results in various projects.'

**'Logistics within the solar industry are relatively simple, a major investment in MES systems is unnecessary'**



Marc Schaeffers, director of DataLyzer International

The following pages give an overview of organisations and companies active in the PV-solar value chain. In view of fast developments in the PV-solar industry, it was impossible to make a suitable specific model in which all possible PV-solar technologies are mentioned. For this reason a three-step model has been chosen, with each step coupled to equipment and knowledge center. An indication (the red lines) is given per company in which part of the value chain they are active.







Welcome to the  
27th EU PVSEC 2012

# 27th European Photovoltaic Solar Energy Conference and Exhibition

The most inspiring Platform for the global PV Solar Sector



Photo © Messe Frankfurt GmbH

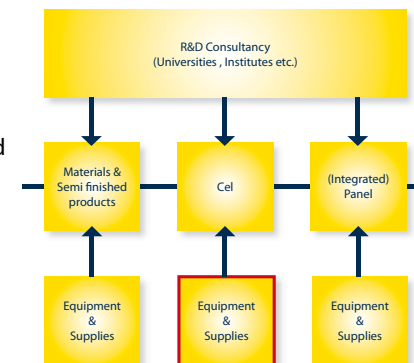
Messe Frankfurt, Germany

Conference 24 - 28 September 2012 • Exhibition 25 - 28 September 2012

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## A-B-T bv

A-B-T bv is a flow specialist with a broad portfolio of flowmeters, based on different measuring principles, and therefore in the position to provide a solution for any flow application. For PV-technology both high end and low cost MFC's are offered, as well as VA-meters, electromagnetic, turbine, ultrasonic, vortex, coriolis and laser based flowmeters for low flow applications. Customised products with special materials, process connection, construction, etc. are also possible.



## A-B-T bv

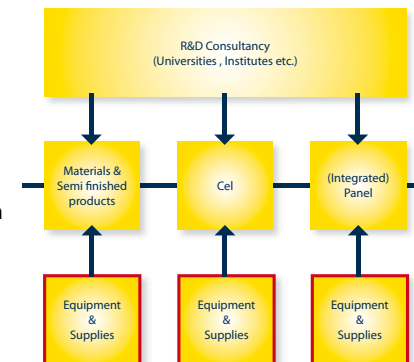
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## Bionics Instrument Europe BV, a New Cosmos group company

Bionics Instrument Europe, a group company of New Cosmos Electric Co., Ltd., can provide you with a complete range of portable and fixed gas detectors for the detection of toxic, corrosive and flammable gasses suitable for all applications in the PV Industry. Bionics Instrument Europe is well known for their application knowledge and a gas detector range famous for high selectivity, reliability and low operation cost.



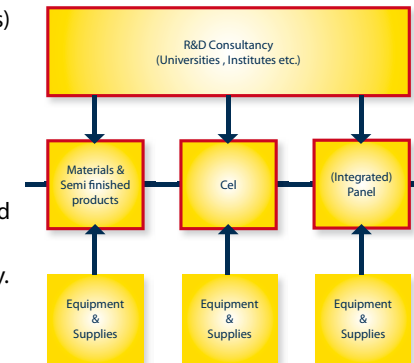
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## Alinement

Alinement (Netherlands) plans an integrated manufacturing line for PV cells and modules based on Roth & Rau's PV cell and hetero-junction technology and Day4Energy's PV cell and module technology. With this combination of new technologies and manufacturing equipment, Alinement will produce highly efficient (>20%), low-cost solar modules. Alinement will start production with a capacity of 80-100 MWp/a and expand to 500 MWp/a at industrial park Avantis, Heerlen, Netherlands.



## Alinement

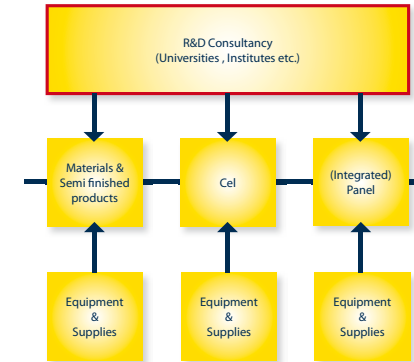
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## New Solar Business Development The Netherlands

The Brabant Development Agency (BOM) joins relevant parties in the solar value chain to develop initiatives and projects to build a strong international PV cluster. Partners include companies such as Fujifilm, Philips, NTS Group and academia such as Imec and Eindhoven University of Technology. BOM has helped hundreds of foreign companies initiate or expand operations in Brabant. We provide high quality services free of charge to any organisation interested in establishing solar activities in Brabant. Please feel free to contact us.



**Brabant Development Agency (BOM)**  
Michel Weeda

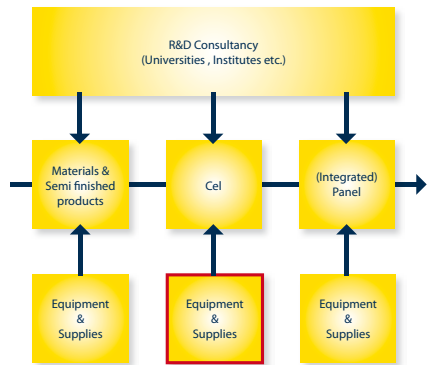
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Bronkhorst High-Tech BV

Bronkhorst High-Tech BV has 30 years experience in designing and manufacturing precise and reliable mass flow and pressure meters and controllers. In solar cell fabrication Bronkhorst mass flow controllers are applied for highly accurate, repeatable and fast control of process gases and liquids. Our 'CEM'-System (Controlled-Evaporation-Mixing) is an accurate and efficient vapor flow control system that can be applied for atmospheric or vacuum processes, e.g. for coating on polymer films or thin metal foils for flexible PV cells or depositing silicon nitride passivation layers for multi crystalline solar cells.

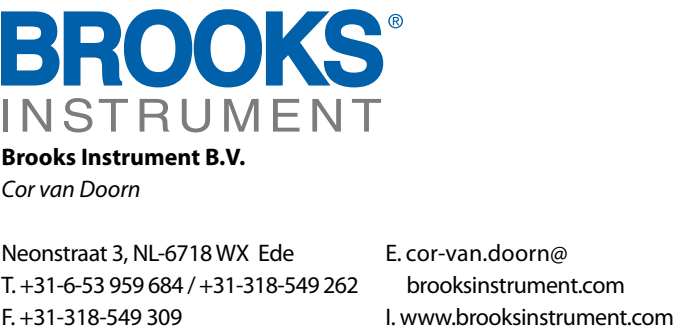
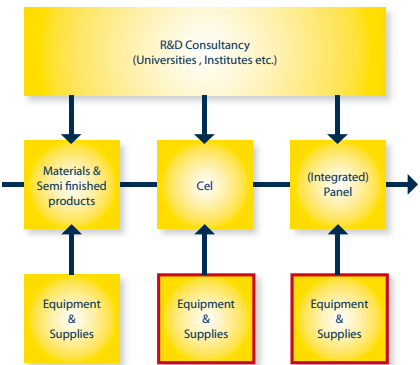


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Brooks Instrument B.V.

Brooks Instrument provides the broadest array of flow products in the market in industries as diverse as solar, bio pharmaceuticals, oil and gas, fuel cell, chemicals, medical devices, analytical instrumentation, and semiconductors. Our award-winning meters and controllers consistently rank at the top of their category for accuracy, reliability, and user preference. With our experience on the needs for solar panel production we address the right balance of accuracy and cost of ownership for your flow equipment. Our latest product targeted for this market, GF40, will help you reduce inventory cost and simplify logistics by it's multi-gas and multi-range functionality.

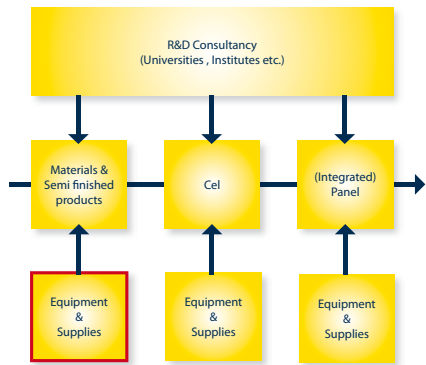


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Cortexon

Electronic enclosures are subject to strict requirements regarding form, functionality, cooling and EMC-protection. Based on many years of experience and knowledge Cortexon develops and produces the best solution for customer's needs. Besides innovative, customer specific electronic enclosures Cortexon offers added value, such as assembly of electronic components, logistic services and lifecycle control of integrated products.

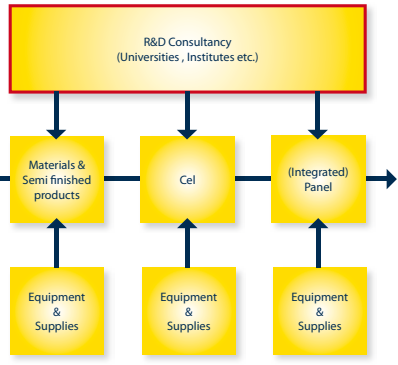


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ECN

The Energy research Centre of the Netherlands (ECN) is the largest research institute in the Netherlands in the field of energy. It holds a strong international position in the fields of solar energy, wind energy, policy and strategy studies, biomass, energy efficiency and environmental research. We develop knowledge and technology, with and for the market, to enable a transition to a sustainable energy system. With its energy research, ECN focuses on a sustainable energy system: safe, reliable and environment-friendly. ECN also conducts research on future opportunities and economic backgrounds in the field of energy.



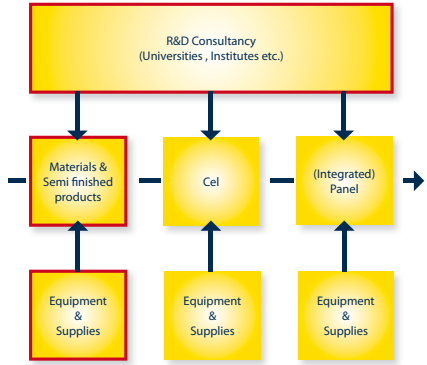
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CelSian Glass & Solar B.V.

As a Dutch technology and knowledge provider, CelSian Glass & Solar B.V. (former TNO Glass Group) assists companies in optimizing their glass and solar production and reinforces the innovation of the needed manufacturing equipment and their final end products. CelSian is globally well-known for their fundamental knowledge on energy intensive and complex multi-physics processes. Industrial producers and the related suppliers of raw materials and machinery are supported by means of:

- Contract research
- Technological innovations
- Industrial services
- IP & software licenses
- Laboratory & pilot facilities
- Knowledge transfer



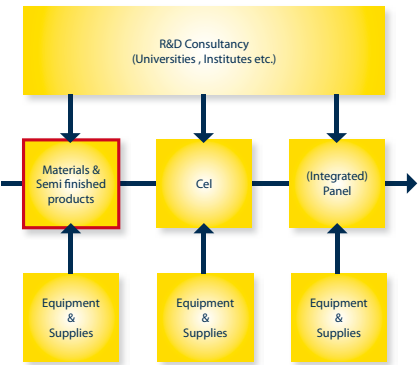
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Roeland Brugman, Sales Director

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Ceratec Technical Ceramics BV

Ceratec has specialized in industrial components constructed from technical ceramics since 1983. Ceratec's strength lies in the total formula of problem analysis, development, prototyping and production. **Material Properties:** the special properties of technical ceramic materials make them highly suitable for industrial components. **Engineering:** Ceratec provides professional support in the area of material selection, economical design and backup for incorporation of ceramic components. **Production:** Ceratec has modern production facilities for processing technical ceramics. **Custom made Products:** Ceratec develops and manufactures technical ceramic products for customer-specified applications.



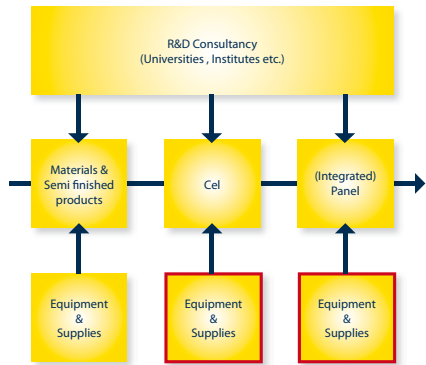
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EKO Instruments

EKO Instruments has 85 years of experience in PV evaluation system and radiation sensor development and production. Making use of cutting-edge technology yields measurement equipment with unprecedented performance and reliability. For example, EKO's new heavy-duty sun tracker STR-32G combined with the MS-700 spectroradiometer series and collimator tubes, or the new fast-response pyrheliometer MS-56, yields state-of-the-art PV evaluation system solutions. We will be pleased to discuss your PV evaluation ideas with you and to demonstrate EKO's latest instruments and measurement systems during PVSEC at our booth no. D26 (hall 3.1).



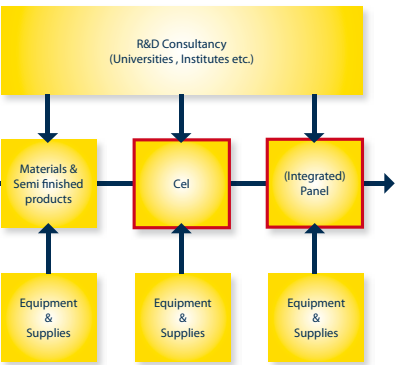
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Enthone Inc.

Enthone Inc. is a business of Cookson Electronics (www.cooksonelectronics.com). The company is a global and leading supplier of high performance specialty chemicals and coatings. Enthone manufactures, markets and distributes its functional, decorative and electronic processes that are used in printed wiring board, semiconductor, photovoltaic, automotive, energy, aerospace, jewelry, and plumbing applications. For photovoltaic applications Enthone's technology development is focused on reducing cost and improving performance through specifically designed electroplating processes for Silicon and thin film cell manufacturing, as well as back-sheet production. For more information, please visit www.enthone.com.



Enthone  
Frando van der Pas, Director of Marketing

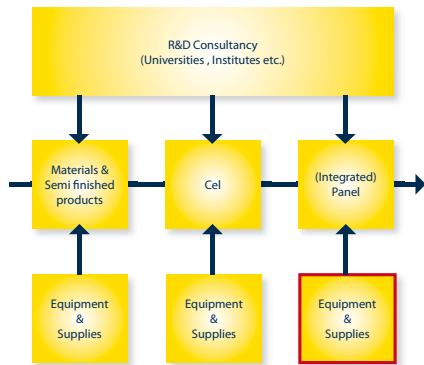
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### Eurotron B.V.

Front-end manufacturing equipment for backside contact solar PV modules. Capacities ranging from 30 upto 90 modules per hour. Suitable for MWT, EWT and IBC cells.



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### Femtogrid Energy Solutions BV

Femtogrid provides smart solutions for renewable energy systems that improve the system's performance, reliability and safety. Our distinguishing trademark is the combination of smart electronics, so-called Power Optimizers, per energy source with a parallel system approach. This generates up to 30% more energy harvest per installation. Firstly, we focus on solar installations up to 25 kWp, and secondly on the combination of solar and urban wind energy over one inverter. Our solution for solar installations consists of Power Optimizers per module, DC cabling, inverter, and monitoring. Add our wind Power Optimizer to generate a true hybrid installation. Our solution is now available via our dealers.



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### Holland Innovative

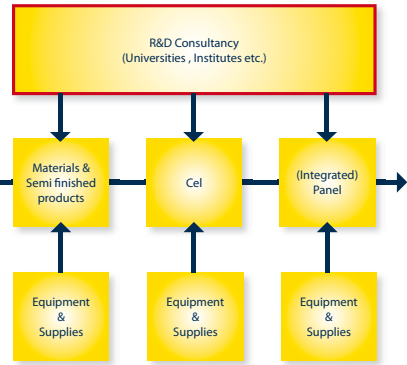
Integration of Six Sigma, Project Management and Reliability! Holland Innovative is leading when it comes to supporting organizations in product & process improvement, reliability engineering and project management. In Solar industry we actively participate in development project teams and running-in activities of solar production facilities worldwide. **Always a solution!** For yield improvement, production process development, reliability design or any other complex process, our multidisciplinary professionals of Holland Innovative will offer a sustainable and reliable solution! Challenge us!



**Holland Innovative**  
Henk van Haren

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### HTR BV Rubber and Foam

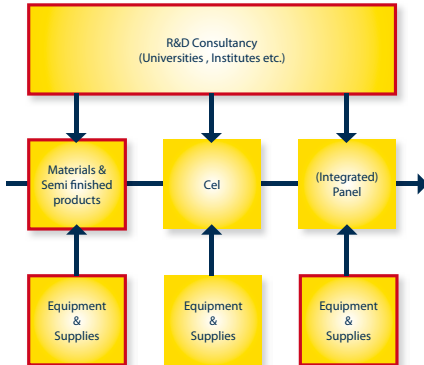
HTR BV Rubber and Foam is an almost 60 years old manufacturer and supplier of rubber and foam parts. Profiles, mouldings, hoses, thermoformed foam and converted parts (die cutting, kiss cutting, lamination, self adhesives etc.) are our product groups. We supply products made out of all rubber qualities like EPDM, Cr, Nbr, NR, silicone, Viton etc. HTR does already supply many products in the solar industry and has developed several special designed profiles. HTR does also offer product design on rubber/foam parts as well as the complete engineering and production. HTR is based in The Netherlands, Germany, Turkey and India.



**HTR BV Rubber and Foam**  
Ferry van de Pasch

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### Greentech Engineering - DRIVING INNOVATION INTO OPERATION

Greentech Engineering is executing industrialization projects. Our core activity is managing and conducting the product generation process into operation. Our company is offering consultancy, engineering services, project realization, specific equipment and process engineering. Addressing production challenges, yield improvement and supply chain engineering are part of our services. Greentech Engineering approaches the operational challenges in the high tech industry through combined expertise on;

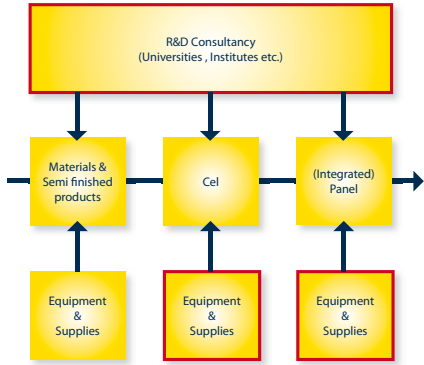
- Process Engineering
- Product Engineering
- Production Engineering
- Application Engineering
- Equipment Engineering
- Supply Chain Engineering



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### High Tech Campus Eindhoven | "The smartest square km in the Netherlands"

High Tech Campus Eindhoven belongs to the 17 percent largest science parks worldwide and has been designated by the Dutch Ministry of Economic Affairs as 'campus of national significance'. High Tech Campus Eindhoven is an R&D ecosystem of more than 100 companies and institutes, and some 8,000 researchers, developers and entrepreneurs, who together are working on developing the technologies and products of tomorrow. The preferred work approach at the Campus is Open Innovation. This means that Campus companies share knowledge, skills and R&D facilities, creating innovative solutions that make human life healthier, more pleasant, easier, more interesting and which contribute to a sustainable world.



High Tech Campus Eindhoven

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Cees Admiraal

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### Inteqnion Solar BV

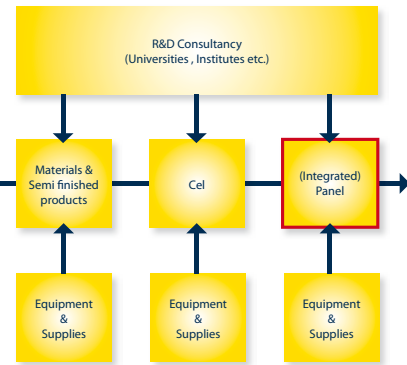
Inteqnion Solar BV develops and markets commercial PV solar systems. As a part of the PV solar system, Inteqnion Solar BV develops and markets innovative roof elements, in which PV and PV/thermal solar modules are integrated. Inteqnion Solar BV is part of the 102 years old Dutch Ottevanger Group of companies, an international operating group active in the milling machinery industry (see: www.ottevanger.com).



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### Lamers High Tech Systems

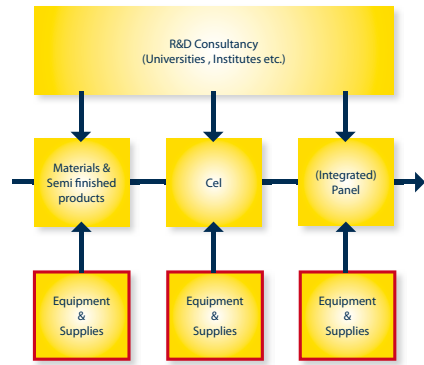
Lamers High Tech Systems is a leading supplier to technology driven markets for over 25 years. Main activities in the solar market are: *Turn key installation consisting of:* Gas & chemical infrastructures (SS or Plastics; Gascabinets and Bulk Chemical systems; Hook up of production equipment incl. vacuum; Hot commissioning, qualification & validation. *Subassemblies for OEM's:* R&D&E of custom & standard products and assemblies; Purification and assembly under clean room conditions (>1000 m2); Bulk Chemical systems for POCL3/BBR3; Stand alone Evaporator Systems for DEZ, TMA, TTC; High Purity vacuum & process piping; Contamination (RGA, TOC, etc), particle and moisture analysis.



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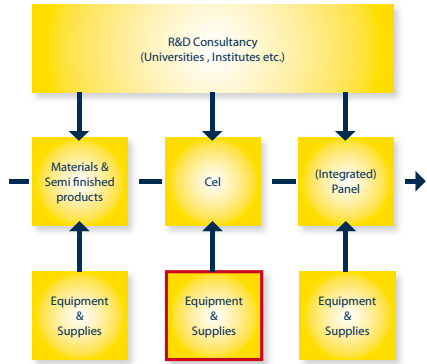
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I. www.lamersHTS.com





Meco Equipment Engineers BV

Meco has more than 30 years experience with designing and manufacturing plating equipment for various industries such as solar, semiconductor and connector. Meco supplies, installs and services its plating machines worldwide with a current installed base of > 650 plating machines. For the solar industry Meco delivers plating machines for depositing the absorber layers (Copper, Indium and Gallium) of CIS and CIGS thin film solar cells and plating machines for metallization of crystalline solar cells. Applications include plating on printed seed layers, direct plating onto silicon, plating of Interdigitated Backcontact Cells and plating of bifacial cells (HIT).



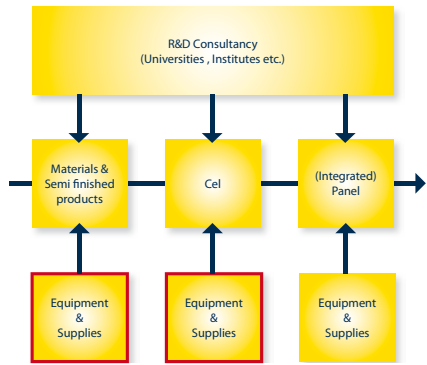
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Mogema BV

Mogema is a supplier of mechatronical systems, with over 50 years of experience. With over 180 employees, an advanced machine shop, specific know-how in accurate machine operations, welding and (cleanroom) assembly. Herewith Mogema is the right partner for development and production of high level components, accurate machine frames and integrated modules like vacuum systems. Mogema is a division of Aalberts Industries NV, a Dutch stock listed company. Within Aalberts Industries Mogema has a large network of specialists for production- and surface treatment. Herewith Mogema always has the right partners to manage you complex projects.



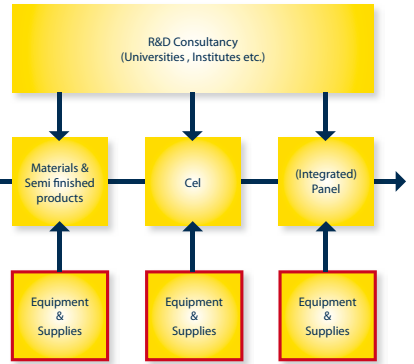
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Mevi Group BV

Mevi can offer engineering, manufacturing and assembly of parts, modules and machines. We are a creative and skilled team and realize tools and machines for various purposes, from concept up to installation. We are a vertical integrated organization and control the complete supply chain which benefits the customer in quality, manufacturability and lead time. High precision milling (0,3 um) repeatability and clean room facilities help to get the requirements you need.



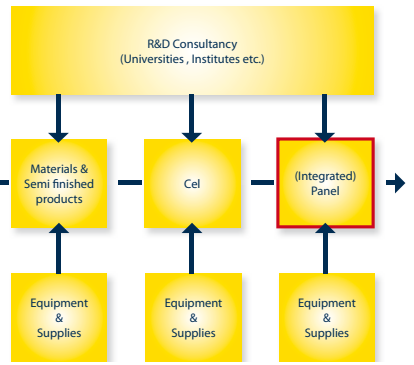
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Nedap N.V.

Nedap is a manufacturer of intelligent technological solutions for relevant themes. Sufficient food for a growing population, clean drinking water throughout the world, smart network sustainable energy are just a couple of examples of themes Nedap is working on. Always focused on technology that matters. Nedap's innovative and entrepreneurial business practices are built on more than 80 years of experience. Nedap's PowerRouter is more than just an inverter, it is a fully integrated energy management system. Generated solar energy can be used by loads directly, stored in batteries for later use or fed back into the grid. You're in charge!



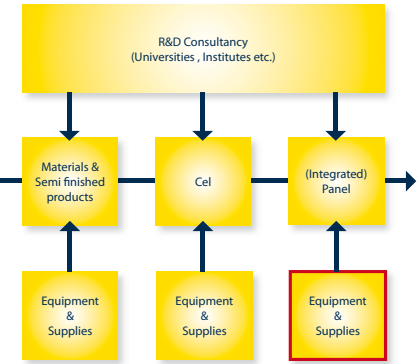
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Phoenix Contact bv

Phoenix Contact is a worldwide manufacturer of components, systems and solutions in the area of electrical engineering, electronics and automation. Phoenix Contact produces with a high vertical range of manufacture all over the world; not only screws, plastic and metal parts, but also highly automated assembly machines are build inhouse. Product innovations and specific solutions for individual customer requests are developed at the locations in Germany, China and the USA. Numerous patents underline the fact that many developments from Phoenix Contact are unique in their own. In close cooperation with universities and science, future technologies like e-mobility and environmental technologies are explored and integrated into products, systems and solutions for markets.



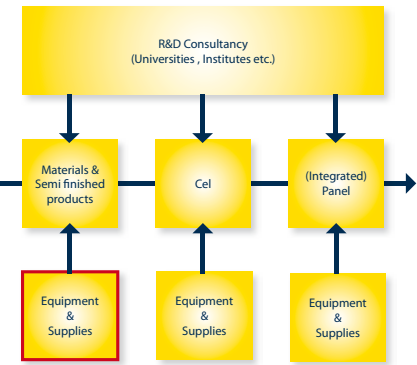
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RGS Development B.V.

The ribbon-growth-on substrate (RGS) silicon wafer technology is a unique silicon casting technology for the next generation of photovoltaic wafers. Compared to today's crystal growth and cutting wafer technology, the silicon yield is increased from about 40% to more than 90%. This allows a strong decrease in wafer manufacturing costs. Due to the high productivity, RGS is a key technology for enabling the high growth rates of the PV sector in the future. The development of this technology into a commercial wafer manufacturing technology is the mission of RGS Development BV.



**RGS Development B.V.**  
A. Schönecker & M. den Heijer

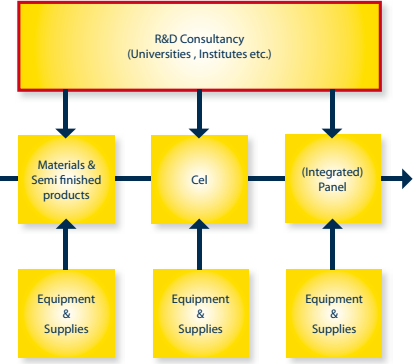
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ReRa Solutions

ReRa Solutions has built up many years of experience in the development of complete PV Measurement Systems (IV-curves, Quantum Efficiency, Lifetime). Besides complete systems and equipment, We offer consultancy, software and measurement equipment design. This unique combination resulted in excellent measurement systems which will facilitate the further research on solar cells. The knowledge of solar cell measurement interpretation is what makes us unique. Products:

- Tracer: all-in-one software solution for IV curve measurements;
- SpeQuest: Quantum Efficiency measurement system for all types of Spectral Response measurements incl. Multi-junction;
- Lifetime measurement for Organic cells;
- (Customized) Probestations and reference Cells.



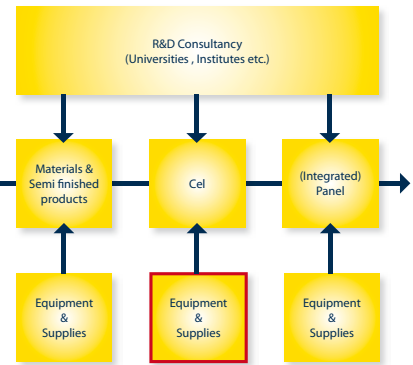
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Roth & Rau B.V.

Roth & Rau AG has been one of the world's leading suppliers of production equipment and innovative production technologies for the photovoltaics industry for more than 10 years. In its photovoltaics segment, Roth & Rau focuses on providing production systems for crystalline silicon solar cells as well as thin film solar modules. Roth & Rau in Eindhoven is a leading manufacturer of integrated process modules, automated wafer handling systems, and industrial ink jet printing tools.



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Royal HaskoningDHV

Royal HaskoningDHV is a leading independent, international project management and engineering consultancy service provider. Specializing in planning and transport, infrastructure, water, maritime, aviation, industry, energy, mining and buildings, each year we contribute to the delivery of some 30,000 projects around the world on behalf of our public and private sector clients.

We provide multidisciplinary services to realize the best sustainable cost-effective photovoltaic production facilities. With over 25 years in realizing a variety of industrial sites worldwide you will benefit in particular from the fact that Royal HaskoningDHV was involved in the realization of several photovoltaic sites in Germany, Belgium, Lithuania, Spain, India and the Netherlands. We are convinced that, together with a strong commitment to our customers and our ability to manage the different participants in the project, this is our key to your success.



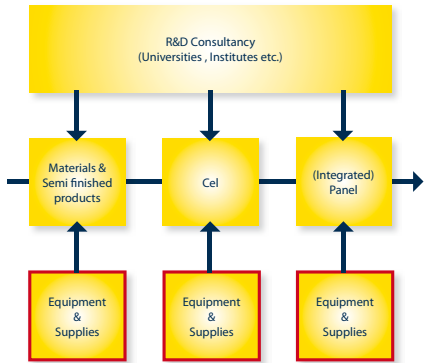
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SMC Worldwide leading experts in automation

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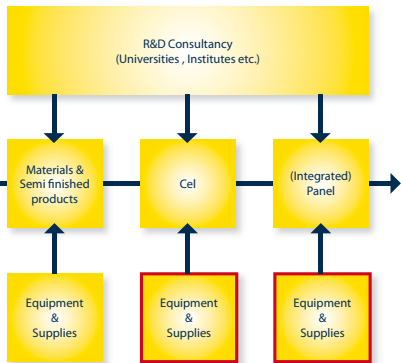
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Sioux – Increase solar cell efficiency

For more than 15 years Sioux is an important partner and supplier for R&D, Sioux has a workforce of 300 engineers experienced in technical software, remote solutions, industrial mathematics and electronics. We are also specialized in embedded in-product software development for manufacturing, semi conductor an solar related industries. Sioux capabilities range from motion control, image processing, machine connectivity for the semi conductor front end production equipment (wafer scanners) to back end equipment (wafer inspection, laser dicing, PCB production and SMT, application of inkjet). Solar is an important part of our project portfolio, e.g. centered around atomic layer deposition to increase solar cell efficiency.



Source of your development!



Sioux  
Arnoud de Geus

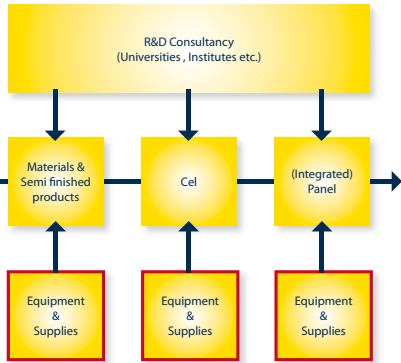
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Smit Ovens

Cost-effective thermal processes for thin-film photovoltaic production. Smit Ovens is a leader in thermal processes for high-volume thin-film solar cell production. We deliver innovative, high throughput solutions based on smart designs and processes. These cover:

- CIGS:** Deposition of elemental selenium; selenization; crystallization; RTP (Rapid thermal processing); activation; conditioning.
- CdTe:** Deposition; activation; conditioning.
- a-Si/μ-Si :** Conditioning; Pre-heating.
- TCO:** FTO - atmospheric pressure CVD; ZnO - atmospheric pressure CVD.



SMIT OVENS  
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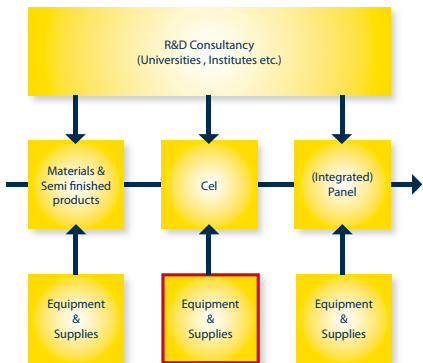
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SoLayTec

SoLayTec – ‘A total solution for Al<sub>2</sub>O<sub>3</sub>’. Our mission is to enable our worldwide customers to reduce the cost per watt peak of c-Si cells modules by developing and supplying Ultrafast ALD equipment as OEM. This equipment incorporates the latest technologies: spatial ALD and motion of the solar cells by applying the floating principle. Because of the modular concept, the SoLayTec equipment is easily scalable from development tool for your process development requirements into a fully integrated Al<sub>2</sub>O<sub>3</sub> ALD deposition tool for high volume production (from Lab to Fab 3,600 wph). Please visit us at the RENA booth 3.0/C20.



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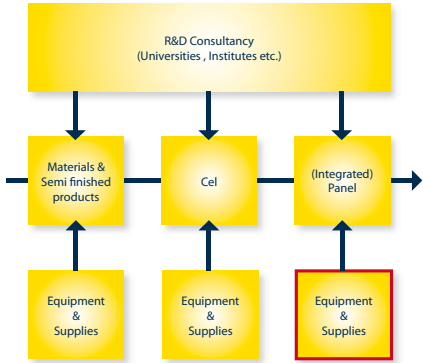
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Sunbeam

Sunbeam offers a new and innovative approach for mounting solar panels on flat rooftops. We deliver a system:

- with the fastest and most simple installation imaginable;
- that is suitable for any make or brand of modules and any project configuration;
- that is lightweight, yet very stiff and strong.

And all of this at a very competitive price level. We don't just supply the materials, we are highly committed to helping you in successfully realizing your projects. We can support in defining the layout, ballasting scheme, and perform shadow and yield analyses. Sunbeam, the professional PV mounting system.



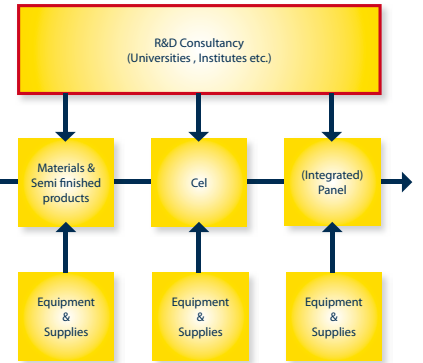
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Solliance

Solliance offers participation in its research and will open up its lab facilities to new entrants, either from industry or in research. On the basis of clear Intellectual Property (IP) agreements, each industrial partner can participate in this research effort, or alternatively, hire equipment and experts to further develop its own technology. Solliance can help you to find partners, on the basis of its network. Solliance would like to assist you in the design of joint projects and, if necessary, act as a broker between prospective partners. Projects may be (co)funded by the EU or through national programs, and Solliance can offer help and expertise in drawing up applications.



Solliance  
Hein Willems

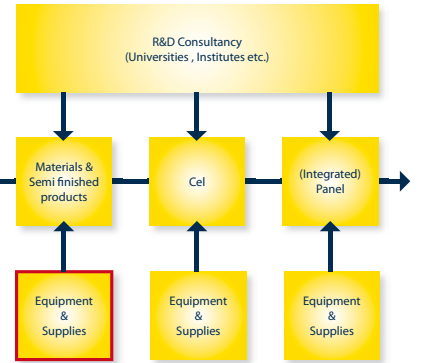
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Technobis Mechatronics BV

Technobis Mechatronics is specialized in carrying out complete development trajectories to come from an idea to a successful turnkey special product, prototype or series product. Technobis Mechatronics successfully operates in the solar market for several years now. Technobis

Mechatronics is a supplier of handling systems for silicon solar cells and is specialized in handling silicon solar cell wafers at high speeds (one wafer per second) in harsh environments as high temperature (1000 °C) and vacuum environments. Also systems used to handle peripherals for the manufacturing of silicon wafers at high temperatures have been developed and delivered by Technobis Mechatronics.



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## TMC Solar

TMC is the independent partner, supporting customers with our multi-disciplinary technical expertise and managing skills, to staff projects on the development and industrialization of photo-voltaic (related) products and equipment, and to provide consultancy related to the application of solar energy. By offering fast access to high-level technical and (project-) management expertise, TMC enables customers to keep their critical projects on track and their innovation power competitive. Our professionals combine excellent technical skills with strong entrepreneurial behaviour. TMC Technology, part of TMC Group NV (listed on the Amsterdam Stock Exchange), is Point-One member and participates in various Dutch national PV programmes.



### TMC Technology

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## TUD – Delft University of Technology

Research in the Photovoltaic Materials and Devices group at Delft University of Technology is aimed at the development of low-cost and high-efficient silicon-based solar cells. The group has unique expertise in: i) fabrication of silicon wafer-based and thin-film solar cells, ii) processing thin-film materials with various PV-related functionalities, iii) nanostructure engineering of thin silicon films, iv) light management in thin solar cells, v) integrated optical and electrical modeling of solar cells. This expertise is supported by an advanced technological infrastructure including deposition machines and measurement equipment. The broad interdisciplinary research in the group combines material science, technology development, process engineering, and design of devices with a strong valorization value of prototype devices. PVMD group is a reliable partner for research and technology transfer.



**Delft University of Technology - Photovoltaics Materials and Devices group** - Department of Electrical Sustainable Energy - Prof. dr. Ir. Miro Zeman

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## TNO

TNO is an independent innovation organisation. TNO connects people and knowledge to create innovations that sustainably boost the competitive strength of industry and the welfare of society. TNO's more than 4000 professionals work on practicable knowledge and solutions for the problems of global scarcity. TNO focuses its efforts on seven themes: Healthy Living, Industrial Innovation, Energy/Geological Survey of the Netherlands, Mobility, Built Environment, Information Society, and Defence, Safety and Security ([www.tno.nl/themes](http://www.tno.nl/themes)). TNO is a partner of Solliance. Solliance is a R&D cluster bringing thin film solar energy technology to excellence.



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## TULiPPS™ Solar B.V.

TULiPPS™ Solar B.V. has invented a new technology for building lightweight glass PV modules. This unique, lightweight solar PV module technology and installation method (COSMOS™) harnesses the benefits of tough, long-lasting automotive-grade composites with the design flexibility and manufacturing efficiency of plastics to solve challenges common to conventional roof-mounted PV modules such as high cost, heavy weight, and installation time associated with traditional PV modules. The COSMOS™ module technology can be used for both silicon and thin film modules and allows efficient installation on flat and pitched roofs. Especially interesting is the possibility to manufacture exceptionally large and lightweight PV modules.



### TULiPPS Solar™ B.V.

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- Automation handling solutions have high throughput and uptime and low breakage rates

Visit us at the Meyer Burger booth:  
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25 - 28 September 2012, Frankfurt  
Hall 3.0, Booth E2

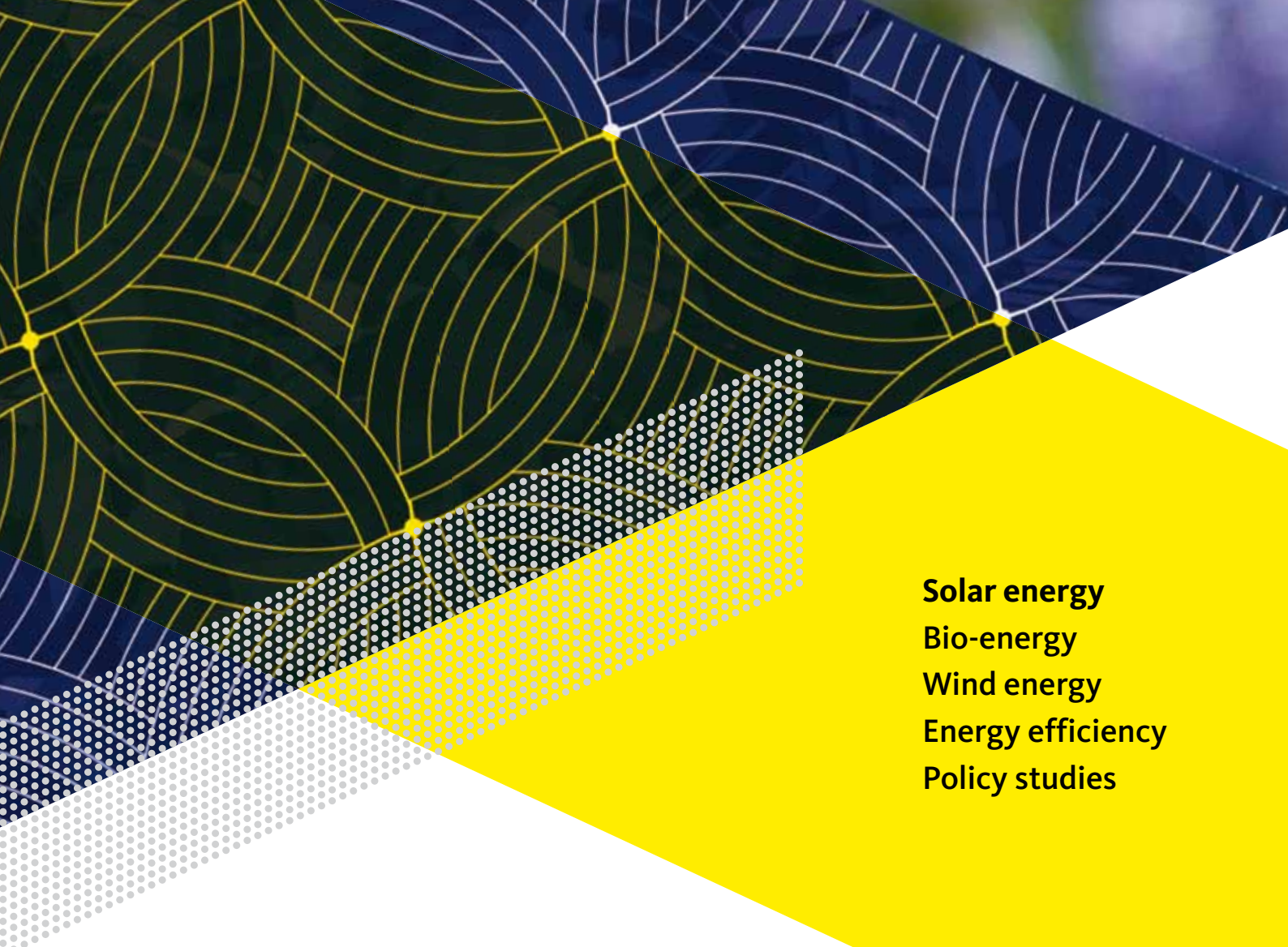


A member of Meyer Burger Group

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**27th EU PVSEC: Visit us in Hall 3.1, Booth F14**

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