

# SET MATCH



THE OFFICIAL DELFT S.E.A. MAGAZINE



## KAMELEON SOLAR

*...adding aesthetics to solar panels...*

Catch all the details about Color Blast- the tech that combines durability with aesthetic design

*pg. 4*

## Person in Focus

Prof. Zofia Lukszo  
on how *"defining  
your constraints can  
make you happy"*  
*pg. 2*



CURIOUS ABOUT  
THE STRANGE CASE  
OF CANNABIS?

*pg. 9*

## SET Day-Out

Geothermal  
energy plant in  
Poeldijk  
*pg. 12*

## Interview with Prof. Zofia Lukszo

Carlotta Ferri & Srinivasan Gopalan

Prof. Zofia Lukszo works in the Faculty of Technology Policy and Management as full Professor in the Energy and Industry Group. She also teaches the course Energy System Optimization to the SET students in EWI. In the first day of this course, Zofia started her lecture asking the students a quite strange question: 'How can you optimize your happiness?'. With this revolutionary point of view, Zofia discloses a figure in which technology and humanity finds an equilibrium.

**As well as studying applied Mathematics, you have also completed a degree in Philosophy. How do you think this has helped influence your technical career?**

Applied Mathematics is very useful for solving complex engineering problems like with my work on smart grids. However, philosophy is related to more fundamental issues regarding knowledge, values, reasoning, existence and language. It can help you formulate questions about the different aspects of life like "What is important to you?" or "What are the knowledge boundaries?", or "Is beauty objective or subjective?" and in developing sensitivity towards society. So, sometimes philosophy can help in understanding a problem better, be it societal or technical. I feel that this is a nice combination.

**Your PhD was related to optimization of batch processing. How did you transit into the research on smart grids?**

If you are a mathematician, you look at a system, e.g. batch processes or smart grids, through the glasses of mathematics: differential equations, dynamics, changes, in other words: through the glasses of system thinking.

As a system scientist you can easily see many analogies between different systems, including the ways of their modelling, and how to improve them.

**A lot of your research is based on the concept of smart grids. How do you think that we could move ahead in this area?**

We are still facing the challenge of energy transition. Some countries are further ahead than the others in this respect. Coordination at the European level is very useful. To achieve the (European) energy goals for 2050 and beyond, radical changes are needed. At the same time, as for the energy sector, a shift from fossil resources to sustainable, renewable energy accounts also for the transportation sector.

The current transportation system roughly accounts for one-fourth of the total consumption of fossil fuels. I expect that energy and transport systems will be more and more interwoven in the future. Both sectors have not only similar goals but they do need each other to achieve the environmental goals. Decarbonization requires innovations within the entire system: innovative mobility solutions, supported by ICT, are not only designed for efficient transportation but also to support the operation of energy systems. Electric mobility with vehicle-to-grid solutions can support demand side management and fuel cell electric vehicles have the potential to operate as highly flexible dispatchable power plants. I'm fully convinced that only system solutions, where these both domains are investigated concurrently, can give right answers.

## "Energy and transport system will be more and more interwoven in the future"

**Your everyday life must be very full of projects, lectures, and meetings. What do you do in your free time to get rid of the stress and everyday pressure?**

I try not to be stressed. I say this to others as well. There is no need for getting stressed. I am doing my job not because I need to do it but rather because I want to do it. I love my job. I don't give lectures or administer examinations because I feel it is necessary to do it but because I want to do it. Also, work is not the only thing I do. I can enjoy classical concerts, ballet and a good book. In my free time I also enjoy hiking in the mountains and meeting people. Above all, having quality time together with my family - with my husband, our four children and a grandchild - de-stresses very effectively.



Source: [www.tudelft.nl](http://www.tudelft.nl)

**Was the academic career the one of your dreams? What would you like to say to a SET student who wants to follow a career in academia?**

When I searched for a job at a university, I didn't look elsewhere. It was clear to me that I aimed for an academic life. As for the students, their career depends on their personality. When they decide to stay in academia they should be innovative and design their own research program.

**How do you see yourself ten years down the line?**

You would have come to my last day as a professor. I will finish my career and retire. By that time, I hope to have set in place a research group with strong group dynamics, willingness to support each other and an ambition to effect a change.

**Our final question to you is something that you had asked the students on the first day of your optimization class "How do you manage to optimize your happiness in your everyday life?"**

In my course I teach that optimization is defined by degrees of freedom and an objective function seen as a goal to be reached in the predefined space of constraints. If there are no constraints, your search for happiness can be unlimited; probably you will never reach it. Therefore, my philosophy is quite simple: start with defining your constraints. It will make you happy. In a smaller space it is not so difficult to find something improving your happiness: the little things count - look outside, see the wonderful world and be happy!

## Kameleon Solar - ColorBlast

Stella Chatzisakoula

A very promising newly introduced Dutch manufacturer, Kameleon Solar, has been designing and constructing its own solar panels and materials for each and every different customer and possible application since 2015. The main scope of the company is the designing of products with an inspiring view towards the future, combining both innovative and renewable ideas along with high aesthetic value. In the view of a fully sustainable future, solar energy will play an important role in achieving this ambitious goal. To achieve fully independence of fossil fuels' use, smart cities of the future will fulfill all their electricity demands through the use of renewable energy sources, specifically solar power in the case of Kameleon Solar. In this term, the rooftops of a building may not be sufficient to entirely cover the energy needs of the building. At this point, the introduction of ColorBlast PV panels comes into the energy market as an innovative solar panel for the façade of the buildings.



Source: [www.kameleonsolar.com](http://www.kameleonsolar.com)

The main idea behind the introduction of ColorBlast is to take away the aesthetic concerns of architects and building owners about applying PV to the façade of buildings, while meeting the energy demands of a multi-layer building. Kameleon Solar uses ceramic ink that is deposited and hardened on the outside glass side in custom patterns, to create a homogeneous image. ColorBlast constitutes colored solar panels for the façade, giving a more personal solution mainly from the designer's point of view.

Advantages and options are numerous, namely the 30 years of lifespan and the 50 and more years of color durability. Also, it is worth mentioning the great advantage of designing custom patterns with the goal of achieving higher efficiency of the PV panels. According to the color, the surface coverage and the available cell space, the electrical power that can be achieved ranks between 80 to 150  $W_p/m^2$ . The sizing of such a technology is widely varying according to the needs of each and every single customer of the company. Kameleon Solar can undertake the designing, construction and installation of such a technology along with experienced parties focusing on PV panels.

The overview of such a company in the Netherlands is inspiring and optimistic for the renewable future of the energy sector. The main vision of Kameleon Solar goes hand-in-hand with the ambitions of most students of TU Delft and especially of the MSc SET students that vision a fully renewable future. The field of solar energy is of great interest and Kameleon Solar is a great example of a company visualizing and investing in the further development of renewable technologies considering also solar innovation.

For further information about all the services, materials and products of Kameleon Solar, their website is available, as they are in search of eager, willing and ambitious students regarding solar research. <https://kameleonsolar.com>

## Interview with Chiraag Reddy – Research Intern

**What is your background and specialization you had in TU Delft and how it helped you with what you are currently working on?**

I did my mechanical engineering in India and in TU Delft my major track is solar energy. I have been working and completing my thesis in Kameleon Solar since August 2017. With mechanical engineering you learn the basics about materials, which was useful in the production process, but one can work on his own on that. In terms of TU Delft, everything I know about solar and the courses I had, each one contributed to what I am doing now. These courses were helpful to get to know more about the PV module and how the technology works.

**What is your position in the company and what are you currently working on?**

My position is a research intern and I am working on the color solar modules. So basically my job is to gather as much data as possible from the color modules and play around with different colors and come up with a model predicting modules structure. So if you, as a customer, can think of a design in your head, I can put it into my model and it should give the appropriate color. It gives you options of sizing and with the color module you have a great variety to choose from as well as patterns and designs.

**Can you give us more technical information for the new product, ColorBlast?**

The basic idea behind ColorBlast is that you have a glass, you put a picture on it and from the outside you can see the picture or whatever you want to show. And inside you can still see the sun, because the picture is pixelated into tiny dots. So, Kameleon Solar tried to incorporate that into the solar technology and then our glass manufactory company with a glass printing machine can print any color onto the glass. There is great flexibility, with white, black, red, blue, yellow and green you can design and print any color that you want by mixing these colors.

**What are your findings about the efficiency of this panels compared to regular PV cells?**

It is still too early to say exact numbers, but on preliminary tests with basic colors, some colors have efficiency losses of relatively 8%. So if you have a module of 20% efficiency, then efficiency will drop to around 18.5%. Efficiency also depends a lot on color. Blue and white perform really well. Blue is the best and the most popular option now in Kameleon Solar with a drop of 7% losses. Black has significantly more losses than other colors.

**Do you consider it an innovative product that may contribute to maintain your position as a frontrunner in the solar sector?**

Kameleon Solar is not a mass manufacturer, we build custom modules and most of the work is done by hand. The market base is small, so innovation is the only way one can go ahead. It is almost impossible to compete with the Chinese or market in terms of price, these companies can provide module at a much lower price compared to a European manufacturer. We basically build with quality over quantity. Therefore, even with comparison with other similar technologies, it is like comparing two completely different products.

**Is Kameleon Solar interested in getting involved with students for research in solar energy?**

Kameleon Solar is always interested in working with the university. When we need a specific module where customization is needed, university is necessary. There has also been a lot of thesis projects in cooperation with Kameleon Solar.

**Your future plans include expanding into other European countries? Is solar energy the future?**

So far the production is limited to the Netherlands. But if the company continues this way, there will be a lot of space both in Europe and internationally.

Solar is going to be important as an abundant energy source with implementation possibilities on a large-scale. The Netherlands is trying to increase both wind and solar in their energy portfolio, with first target in 2020. But no matter how much progress is made, it is never enough.

## Interview with Esperanza Mata Perez

Andrew Keys

Founded in 2006, the TU Delft Solar Boat Team is one of 12 Dream Teams at TU Delft and is completely run by a group of 26 students from a range of faculties. The team designs and develops hydrofoil boats powered entirely by solar energy. The hydrofoils lift the hull out of the water thus decreasing water resistance drastically. As a result, the boats can reach astounding speeds using a relatively low amount of power. Each year the team competes in both National and International competitions. We caught up with Esperanza, a first year Masters student of SET, who works part-time for the Solar Boat Team.

### What made you want to get involved in a Dream Team?

I was not actually aware of the Dream Team's before coming to Delft. During the introduction programme, there was a tour organized around the Dream Hall and some of my friends were going, so I just tagged along. I was really amazed at all of the different projects going on and I instantly knew that I wanted to be part of one.



Photo Credits to Doris Van Den Heuvel

### Why did Solar Boat appeal to you?

My main interest of course lies in sustainable energy and so I was interested in the Solar Boat, Nuon (solar car), and Forza (hydrogen racing car). I think the Solar Boat appealed to me most because the concept to be the most innovative. The concept of a hydrofoil solar boat was completely new to me so accepted the challenge.

### What was the application process?

The team were advertising for someone to work in the electronics department and because my background is in electromechanical engineering, it seemed perfect. The application process itself was fairly standard, I sent them my CV and a motivation letter and then they invited me for an interview and fortunately they liked me! People usually apply in the previous year, and so I was actually the last person to be taken on board which felt a little daunting at first but everyone was very welcoming from the beginning.

### What is your role?

I belong to the electronics department, but as the other members, I have a wide variety of tasks. First I had to decide the solar cells type we wanted to use, and to design the solar deck layout and the connections. For this task my background in Electromechanical Engineering was very helpful. After the solar modules were ordered, I focused on helping my teammates with the energy box. The energy box basically is a sealed box that contains most of the devices of the electronics system of the boat, like for example the Energy Management System and the Battery Management System.

## TU Delft Solar Boat Team

I looked for a motor relay and a solar relay, as well as for a shunt that met all our requirements. I also helped in looking for a motor controller. We happened to find a very good one but it did not have proper cooling, so I designed a water cooling plate with SolidWorks that will be attached to the controller once we manufacture it. Apart from the motor controller, also the battery needs proper cooling, so I had to look for a system based on fans and radiators to make sure the temperature will not go up a certain point and damage the system. Finally, using SolidWorks I designed the box itself with and I assembled all the elements inside with the connections in order to optimise the space. All the elements have already been ordered so I am excited waiting for them to arrive! Now that the design phase is finished, I will focus on programming the motor controller.

### How much time do you dedicate?

I am generally in the office every day, for probably around 4 hours each day. The requirement for part-time team members is a minimum of 15 hours per week. However, approaching the design phase deadline, everyone had to work for a bit longer than usual. It can be difficult to manage my time sometimes, especially because I am taking a Dutch language course alongside, but working at solar boat doesn't feel like a chore at all. It is often more useful to be in the office than attending some lectures!

### Are there any upcoming events that you are looking forward to?

The design presentation has just passed and it was something I was really looking forward to.



Source: TU Delft Solar Boat Team

Now I am looking forward to installing the PV panels that I ordered, it's rewarding having your work physically present and working. This year we are taking part in the Dutch Solar Challenge and finally there is the Monaco Solar Challenge in July which everyone is very excited about.

### Do you have any advice for other students thinking of being part of a Dream Team?

I would say definitely do it! I find it is better to learn things first before being taught it in class. For example, PV systems and electronic components are much easier to understand after you have already used them. It also helps to see the purpose of why you learn certain things and where they are applied in practice. Even though you apply to a specific department in a team, you get experience of the entire project. Now I have a much better gauge on the financial aspect of the project which I feel is important to have with any job. Before joining remember you must be motivated and willing to devote your time to it and in that case, you will have a great experience!

## The North Sea – the future offshore power grid

Lizet Ramirez

After the Netherlands signed the Paris Agreement to keep the global warming below 2°C, several plans and actions were taken by the Dutch government to transit to a sustainable energy system using renewable resources. By 2050 The Dutch government, in accordance with the EU, aims to reduce the CO<sub>2</sub> emissions by 90%. During last year, only 6% of the energy consumption came from renewable resources. Thus, the big question on how to reach this ambitious goal is still present. Even though solar and wind prices are continuing to decrease, the Netherlands' geographical and climate conditions promote that the North Sea might be the beginning of a new grid.

At the Europe Wind Conference held in Amsterdam last November, Mel Kroon, CEO of TenneT, made known the company's master plan to build a power hub connecting Netherlands, UK, Norway, Denmark, Germany, Belgium and France. Kroon holds the vision that 180 GW of offshore wind could be installed in the North Sea region, supplying electricity with offshore wind power plants of the size of 1 to 2 GW each. The majestic construction is planned in three phases to be developed in the period 2019-2050. TenneT's proposal consist on an artificial island of approximately 6km<sup>2</sup> with the capacity to connect 30 GW of offshore wind. The project is estimated to cost 1.5 billion euro and it's expandable to one or two extra modules.

Due to the long distance to shore, the island will transfer electricity using High Voltage Direct Current (HVDC) with voltages up to 1.3 kV.



Source: [www.tennet.eu](http://www.tennet.eu)

The island will be designed to provide also flexible solutions with the inclusion of storage methods and power-to-gas conversion, with hydrogen possibly playing a role. The project is currently also evaluating the possibility to use the current gas offshore infrastructure and oil platforms to use the power in the most optimal way.

Other players besides TenneT seem to have clear that the creation of an offshore grid supplied mainly by wind will be the future of electricity for the North Sea countries. In 2015, The International Architecture Biennale Rotterdam (IABR) presented the short film *2050: An Energetic odyssey*. This video is intended to provoke stakeholders and see how the transition to a 90% free CO<sub>2</sub> system is possible with the installation of 25,000 turbines of 10 MW.

TenneT and IABR hold two visions of the big changes to come in the North Sea and the way electricity is produced. Even though they may differ in the way they take action, they agree on something: cooperation between countries will trigger this revolution and is needed soon.

## The strange case of cannabis...

Thomas Spruit & Casper Eijkens

As you may or may not know, cannabis is **not** legal in the Netherlands. In contrast to its famed image, possession of weed in the Netherlands is punishable. However, the new cabinet, Rutte III, wants to experiment with a more legal form of hemp: *staatswiet*. Buying cannabis in the Netherlands is possible because of a regulation called *Gedooftbeleid*. *Gedogen* (verb) in the context of the law means to tolerate, in a sense. Any activity regarding cannabis is criminal, but it is not being punished when the activity moves between certain boundaries. Carrying 5 grams of cannabis is not a criminal offense and you are allowed to grow up to 5 marijuana plants at home. It's like your professor still letting you in his lecture even though you're late.

*Gedogen* happens when various desires are in contradiction. The *Rijksoverheid*, the part of the Dutch government operating on a national level, wants to protect the public health by prohibiting cannabis on the one hand: cannabis is proven to increase chances of psychological problems and can be addictive. On the other hand, legalizing cannabis would take trade away from organized criminality, gaining back control and regulation.



Source: [www.leafly.com](http://www.leafly.com)

The current regulation of cannabis is a mess. In order to sell cannabis legally, one needs a license which allows to store a maximum of 500 grams. This quantity is tiny in terms of selling cannabis, so a continuous replenishment of 5 grams per time is needed. The replenishment has to come from many different growers, since there is a limit on the number of plants an individual may possess. This makes selling weed legally practically impossible, inducing shops to buy from an illegal source- the very thing that the government wanted to prevent.

Illegal trading of cannabis has many downsides. First of all, the level of the active agent in cannabis, THC, is not tested. THC levels in illegally grown cannabis nowadays are considered too high. Additionally, fungi, viruses, and pesticides also are not tested on, which is dangerous for products for human consumption.

The new cabinet wants to experiment with *staatswiet*, cannabis produced under supervision of the state. It is a sign that sparks some hope. The war on drugs is costly, the government will take trade away from organized criminality and will thus earn more tax. However, many coffee shop owners are still not happy: *staatswiet* might not be strong enough, inducing consumers to look elsewhere for better quality. I would like to end with the words of the famous Dutch band Doe Maar, who opt for a passive but positive attitude. Let us see where that will take us!

"Dus laat maar gaan  
Dat gaat wel goed  
Dat wordt prachtige  
Nederwiedewiedewiet"

"See which way the  
wind blows  
It's gonna be alright  
That'll be beautiful  
Nederweed-uh-weeed-  
uh-weed"

## Renewable energy to those who need it most

Carlotta Ferri

In the last weeks the lucky names of the committee members for the project 'Campus2camp' have been announced. Anurag Bhambhani, Manolis Tsioukanis, Roos van Riggelen, Karthik Badarinath, Gamze Unlu, Shivam Srivastava and Maria Miranda will work on a social initiative in a refugee camp settled in Lesvos, Greece. This project is led by the student association TU Delft Energy Club (EC).

Rahul and Dhruv, former member of the EC, are talking with me about this new and last initiative of the board. I start asking them how the project was launched: 'I know that the idea came from a friend of Marnix (former member of the EC as well), right?'. Rahul tells me about the initial plan to organize a solar project. 'However, a new idea was triggered by Marnix's old roommate, who actually worked in many refugee camps as volunteer'. Marnix tells me later, that she came back with amazing stories and invited them to join the experience. 'I did not have the time for that' he admits, 'but I felt challenged by this idea: why couldn't we do something useful for these people as EC?'.

Dhruv explains me the steps that followed: they contacted many organisations and Movement on the Ground, set in the small camp of Kara Tepe in the Greek island of Lesvos, was the one that responded very positively. 'They were very happy to see such enthusiasm from the Club' he continues, 'They are constantly looking for volunteers, resources and then suddenly young engineers were offering their support!'.

I ask them what exactly is the problem in the refugee camp and Rahul explains me that temperatures over there reach extremes in summer and winter and that the camp do not have the money to purchase electricity.

This means that in most of the cases the cooling and heating systems are missing. 'This will be the main goal' he summarizes, 'to create a fully sustainable system to supply the camp demand of thermal energy'.

Movement on the Ground is already working on an initiative, called 'camp2campus', where they are providing education platforms in Kara Tepe. 'So, we decided to call the new social initiative of the EC 'campus2camp': we bring students out of the campus to experience the real work on site' Dhruv adds. 'How does this project represent your mission and vision as EC?' is my next question. Dhruv considers it as a diamond of experience for the involved students. 'In fact, the question will not only be how to set up a solar panel, but they will also need to consider the economic aspect, social factors that could benefit or prohibit the system operation.

This experience may be very useful if they will decide to move in the sector. So for them it is clearly a great opportunity', he explains, 'For us as EC, well, we want to empower students to make the change!'. 'The aim is not to come out with fantastic technology and make a profit from that' Rahul adds, 'but to be able to use this technology along with our knowledge and experience to improve the life of others'.

I see them so passionate and ask why a completely new students team was established for this initiative only. They explain me that there will still be an overlap with the EC. Syed (actual member of the EC) will be the link with the Campus2camp committee and will support them with contacts and network of the board.

## The project of Lesvos – A step forward to improve the life of thousands of refugees

Nevertheless, Rahul and Dhruv unanimously agree that their aim was to give the opportunity also to other students to get involved in such a project. 'And that is the dream', Dhruv confesses, 'that the committee will become autonomous and stable and that it will pick up more and more problems like this and solve them.

For sure, after this initiative, the EC will continue to look for this kind of activities'. I admit we are moving to a much deeper topic so I dear to ask: 'How do you see renewable energy related to the dramatic situation of Lesvos's refugee camp, in terms of human dignity and rights?'. 'We consider energy as one of the basics for human needs', Dhruv answers, 'and we as engineers have to provide it, especially in this dramatic situation'.

Rahul tells me that one of the project's objectives is to train the camp inhabitants to maintain the system autonomously, so that they will teach future generations of refugees.

'When you contribute for the benefit of the place where you and your family live, you are also interested and motivated in what you are doing', he argues. 'They cannot simply wait, they constantly need to work to improve the system in which they are living or it will get deteriorated'.

About this topic, we agree that the energy solution will be just a very little step forward to improve the lives of thousands of refugees. 'But at the end you are empowering them in two ways', Rahul concludes, 'in improving their presence situation but maybe also in working for a better future in their home countries'.



Source: [www.energyclub.nl](http://www.energyclub.nl)

# Visit to the geothermal energy plant in Poeldijk

**Stella Chatzidakoula**

An excursion with a group of 19 SET students was held on the 7<sup>th</sup> of December to the geothermal energy plant "Aardwarnte Vogelaer", hosted by the consultancy company AAB NL with the help of Franks Schoof, the chairman of Platform Geothermie, the branche organization of geothermal energy in the Netherlands.

At first, a presentation of AAB NL was given by Diederik Roosegaarde Bisschop, who is Project Manager in Geothermal Energy, and Sven Koreneef, who is an Energy Consultant. The presentation was based on the current contribution of geothermal energy in the Netherlands. The presenters answered all the questions of the students, who were very interested in the geothermal field and in some more specific technical aspects of this renewable energy source. After an informative discussion, we got a tour around the facilities of the geothermal energy plant 'Aardwarmte Vogelaer', which is located in Poeldijk. Currently, the geothermal plant supplies approximately 18 MW of heat to 14 horticultural companies. The hosts gave an insight into how the process of the plant operated and explained many of the different pieces of equipment.



The students took some pictures of the facilities of the plant and some group pictures with the presenters. Finally, the group went back to Delft discussing about the implementation possibilities of geothermal energy in the future.

*Photo Credits to Stella Chatzidakoula*

## ***DID YOU KNOW...***

**Stella Chatzidakoula & Carlotta Ferri**

Why birds do not get electrocuted when they stand on a power line? This is because both feet are on the same line? If part of its wing or one foot touches another power line while its other foot is still on the first line, a circuit would be created and electricity would flow through the body of the bird, causing electrocution.

Solar Powered Aircrafts truly exist? NASA has been working on a series of solar powered unmanned aircraft since the 1980's. Pathfinder, Pathfinder Plus and Helios Prototype, is the result of NASA's efforts to use solar power for long duration high altitude flights.