Final report

1. Project details

Project title	Circular LED-Energy - Intelligent recycling of energy surpluses in lighting
File no.	64019-0609
Name of the funding scheme	EUDP
Project managing company / institution	BMD Trading Denmark, ApS
CVR number (central business register)	36025050
Project partners	Globalgreentech ApS, CVR 35814205
Submission date	28 August 2021

2. Summary

2.1.1 Summary (engelsk):

The main objective of the project was to develop a control of energy in an LED light source, so that it produces both light AND transmits controlled surplus energy to a charging unit. This produces recirculated energy for the light source – saving energy from the electricity grid. A good LED light source produces more light than we can detect and utilize, and therefore this projects purpose was to develop a unit in which it would be possible to compress the light wave flow.

By compressing the light waves, controlled overvoltage would be created, which and stored and circularly released as additional energy to the light source. As a result, the energy consumption of the LED light source would be much lower overall and contribute positively to our carbon footprint.

Prior to the project, we had analyzed the presence of surplus energy, and against this background we had an ambitious objective of improving energy efficiency in lighting. This is not least due to the project's potential scalability to light sources other than those planned in the project and the potentially huge distribution opportunity in Denmark and abroad.

Before to the start of the project, we had estimated in the project application a 15% risk that due to technical complications the project could not be fully realized. Unfortunately, this became a reality. After repeated experiments with various updates of the developed driver and with help of several experts, we had to conclude that not enough energy could be collected to justify a more expensive light source. We could not develop control of the released energy efficiently enough. We therefore chose, in consultation with EUDP, to explore other ways of achieving the project's outcome, and as this did not fall out satisfactorily, we have reached an agreement to discontinue the project.

The project was carried out by two partners, both operating within the lighting industry.

2.1.2 Resumé (dansk):

Projektets hovedformål var at udvikle en kontrol af energien i en LED-lyskilde, så denne både producerede lys OG sender kontrolleret overskudsenergi over på en ladeenhed. Derved produceredes recirkuleret energi til lyskilden – og der spares energi fra el-nettet.

En god LED-lyskilde producerer mere lys, end vi kan registrere og udnytte, og derfor var det projektets formål at udvikle en enhed, hvormed det være muligt at komprimere lysbølgestrømmen. Ved at komprimere lysbølgerne, ville der kunne blive skabt en kontrolleret overspænding, som lagres og cirkulært frigives som ekstra energi til lyskilden. Dermed vil LED-lyskildens energiforbrug samlet set blive langt lavere og bidrage positivt til vores CO2-regnskab.

Forud for projektet havde vi analyseret tilstedeværelsen af overskudsenergien, og vi havde på den baggrund en ambitiøs målsætning om, at forbedre energiudnyttelsen i belysningen. Dette skyldes ikke mindst projektets potentielle skalerbarhed til andre lyskilder end de, der var planlagt i projektet og den potentielt enorme udbredelsesmulighed i Danmark og i udlandet.

Forud for projektets igangsættelse havde vi i projektansøgningen estimeret en 15 % risiko for, at projektet grundet tekniske komplikationer ikke kunne færdigrealiseres. Desværre blev dette en realitet. Efter gentagne forsøg med forskellige opdateringer af den udviklede driver og hjælpe fra flere eksperter, måtte vi konkludere, at ikke nok energi kunne opsamles for at retfærdiggøre en dyrere lyskilde. Kontrollen med den frigivne energi kunne vi ikke udvikle effektiv nok. Vi valgte derfor i samråd med EUDP at afsøge andre veje til opnåelse af projektets resultat, og da dette ikke faldt tilfredsstillende ud, er vi nået til enighed om at afbryde projektet.

3. Project objectives

Overall, this project was about developing a new type of control of the energy in an LED light source so that it both produced light and sends controlled surplus energy onto a charging unit. This produced recirculated energy for the light source – saving energy from the electricity grid. So far LED has served as an energy efficient alternative to traditional lighting, but among LED-solutions there has never been such focus as optimizing performance.

LED lighting is an ever-increasing part of the lighting in our society. On the one hand, the light is of a better quality than, for example, traditional fluorescent lamps, and on the other hand, LED is cheaper because the technology lasts longer and uses less energy. Nevertheless, lighting uses energy, and we wanted to develop a technology that could reduce energy consumption – in several cases quite strongly – AND at the same time make it more attractive to use LED lighting in places where today you do not have the opportunity to use it to the same degree.

LED works best when the light source can get rid of the heat produced. To solve this task, you will most often see LED lamps designed with rough or lattice surface, from which the heat can escape more easily. Here, the consumer (perhaps a food company or a hospital) has a cooling challenge to solve – and more energy is consumed. At the same time, the surface, which is not completely smooth, creates a place where bacteria that are difficult to remove and that can affect the environment can accumulate.

With the project, we wanted to significantly reduce the energy consumption of an LED light source. Our goal was to be able to incorporate the technology as standard into a number of products, which in the future would help reduce energy consumption – and thus CO2 emissions from industry, agriculture, public buildings, road lighting and private housing. A single lamp would not make much difference, but the technology could be so groundbreaking that we will be able to make an impact on a wide range of lighting applications, thus making a significant difference to society's goal of saving energy and reducing greenhouse gas emissions. Not only would society save energy for lighting – also energy for subsequent cooling in production rooms, retail stores, etc., could be saved, where the lighting could otherwise negatively affect with released heat.

At the same time, it would allow better light sources that would be easier to clean in critical production environments and hospitals.

4. Project implementation

In connection with the project application, we assessed the risk of not being able to reach the technical target as about 15%. At the time, we were optimistic, because we felt that the scope of the project was within our competences to bring you goals, and the analyses we had conducted in advance – and discussed with both partners and suppliers, were very promising. The surplus energy was certainly present, and with the possibilities for control inherent in driver-building, we had to be able to programme the driver out of the difficulties that might arise. We tried that from various ancles, but we could see that the potential for the power collection became too volatile and that the capture unit we expected to form the heart of the recirculation did not work sufficiently synchronously with the capture options. Perhaps on the drawing board and based on the assumptions we had before the project started, but when we had to measure the effect of real saving on energy, the results became too poor. We corrected and adjusted according to all the parameters we could manipulate, but we only made very limited progress.

We were at a crossroads and we had to decide whether to complete the project with a <5% impact, only to carry out the project, and we informed EUDP of our deliberations. We explored all the possible options that could bring the result to a better position, but unfortunately we did not succeed with a significant result. An improvement in the energy use of the light source must be constantly measured against the cost of a ready-to-sell device, and the result was unfortunately that the light source would be unsellable. At the same time, society was shut down due to COVID-19, and our own situation became uncertain, as it became for all other companies around the world. Contact with our suppliers became fragmented and deliveries of equipment for

normal operation were significantly delayed. This meant uncertainty about our core business and we just had to be patient. But for obvious reasons, we both companies had to look very critically at how much risk we could justify taking on. Several of our normal customers shut down completely and it shifted our normal turnover. One of our test partners shut down production (greenhouses) and the completion of the project would thus require a modified test set-up.

We discussed this with our EUDP sparring partner. We also discussed the possibility of changing the main purpose of the project to a different angle, but this was assessed too far from the project's original focal point. The conclusion was that we have evaluated the project costs as of February 2021 and that the project has then been shut down.

5. Project results

The first calendar year of the project was carried out, where the technology we worked on showed very promising results, despite the fact that it proved harder to achieve the same savings on powerful LED as previously demonstrated on weak LED. We continued to work on ways to get even more energy savings, both coded but also by dividing the light source into several parts (fewer LED diodes per circuit) and using voltage doubling, as well as optimizing the electronic circuit so that the loss here in was as little as possible. Combining additional optimizations in the circuit would also make it easier to patent the invention.

The optimism was intact, because at the same time we already felt commercial interest in the project. In this early stage, the driver was built up and the installation was implemented in the first test devices (light sources), from which we could conduct measurements on power. These internal tests could generate data for further loop in development, and the driver was gradually adjusted according to the results obtained. We were still confident that we would reach the finish line satisfactorily, and there we began the mechanical construction of the light sources to be tested in the living environments.

The main thesis of the project was to exploit that LED lights are light based on a digital energy that makes a diode glow. In the same way that you create a burst of waves when making MP3 files, we wanted to develop a method that could create a burst of LED diode's energy supply without affecting the light quality. By doing this, we meant to create a controlled high frequency surge that, under normal circumstances, would be released as heat – but which we would control onto a charging device: A battery or an electric capacitor. The quality of the lighting would be the same, since the small wave fractures that are created happen much faster than the eye can perceive. Thus, a combination of much higher brightness in short flashes, obtained by emitting high brightness in short pulses "spikes" and by being able to collect excess energy, for use in the next "spike". In this way, we should be able to achieve a visual brightness at a significantly lower consumption and heat. This should theoretically be achieved by the optimal combination of high frequency pulses and capacitor of the right size for temporary storage of excess energy, for the next spike.

We received great indications of the technology and the possibilities in it, from the associated technical partners and advisors – and several of these showed interest in investing in the project with relatively large financial offers.

Despite the fact that the theory and declarations were present – however, we have not been able to achieve the expected large energy savings in the physical setups. In connection with optimizing pulses and frequency, the loss in brightness followed almost linearly the saving on energy and heat. In addition to our own forces, experiments, tests and research, we have had various different experts attached who unfortunately have also

not been able to help us to redeem the technology in practice. Against this background, we see the need (and obligation) to stop the EUDP development project, in a form based solely on this technology.

6. Utilisation of project results

Despite the fact that the project's results could not be realized by us, it is our opinion that the theoretical basis for the project's launch is intact. Unfortunately, our project will not be commercialized and the interested companies that followed our development will not be able to take advantage of our work. But is the idea "stone dead"? Perhaps, but we do not think so, because the theoretical foundation is intact. Nevertheless there is a longer way to go than what we small businesses could achieve. We believe there is potential for a major player (one of the industry's largest) to develop a solution that can improve energy efficiency in LED Lighting from “our” principles. However, we suspect that it requires a development budget of a much larger scale than what we could invest, so we are (both companies) cleared up to discontinue the project, although of course it is also a disappointment. Should the opportunity arise that in the future our companies could provide another actor with the considerable knowledge we have gained in the project process, we will of course strongly consider that.

The project did not reach a stage where we were ready with a saleable light source. Therefore, considerations about market conditions etc. are unfortunately not relevant.

7. Project conclusion and perspective

At this point, the project - as preliminary described – seems without any next step. We have gained a lot of knowledge, but we could not reach a point where storage and reuse of the over supply could show significant energy savings. That is unfortunately our main conclusion, but we will keep investigating the “art” of LED, and we still believe, there is a fair chance to reach a result in the years to come. Nevertheless at this point, the EUDP-project is halted, and we will continue on our own, trying different ancles in the future development. Perhaps in a partnership with a larger company, as we of course will be in the search of additional financial funding.