Inventions represented at Danish IP Fair 2018
Energy and Environment

This document contains one-pagers for all inventions within Energy and Environment presented at the Danish IP Fair 2018. You can use this document to identify meeting partners at the event. Each invention is marked with a unique ID at the top right of the page. Use this ID to look up and book a meeting with the inventor(s) at the Danish IP Fair website - www.dipfair.dk.

The document will be updated regularly in the period February-April, so ensure to re-visit the website for the newest version.

For further guidelines regarding meeting bookings please consult the menu Matchmaking on the website.
TurbuGrid – a turbulence inducing device
- Significantly improving performance & scalability of air-cooled fuel cells

Value Proposition/USP
Air-cooled proton exchange membrane fuel cells have been commercialized for mobile/stationary applications such as telecom back-up power, and are being considered as range-extenders for battery powered vehicles because of their simplicity. However, wider market use of these air-cooled fuel cells has been limited due to high cost and size restrictions. But not any more!
Proof of Concept tests, has shown that by
• Adding a simple turbulence inducing grid, costing less than 1 USD in mass production,
• Improved power density/efficiency of at least 33,5% for a retro-fitted fuel cell stack is achieved,
• When optimized for mass production cost reductions of a new fuel cell stack by 50%, maybe more, can be attained.

Business Opportunity/Objective/Commercial Perspectives
As scaling and performance of air-cooled proton exchange membrane fuel cells can be improved dramatically, while reducing overall costs of the fuel cell products. This invention of a simple turbulence inducing grid, provides the basis for a market breakthrough, for air-cooled proton exchange membrane fuel cells, both in the current market applications, and opening up for new markets.
The turbulence inducing device enables manufacturers to produce
• Air-cooled proton exchange membrane fuel cells, with much higher rating, and/or
• Smaller foot print fuel cells, with at least same rating as current products, opening up for uses, where space/weight is highly restricted.

Technology Description/Technology Summary
Air-cooled low temperature proton exchange membrane fuel cells (Fig. 1) suffer from low limiting current density, resulting in low power density. A detailed computational fluid dynamics analysis (Fig. 2), has revealed that the underlying reason for the low current density is membrane overheating (Fig. 3). The electrolyte membrane in the center of the fuel cell can not withstand temperatures above 90 °C, which is encountered already at very low current density (around 0.4 A/cm²), severely limiting efficiency and scalability.
The TurbuGrid (Fig. 4) was placed in front of the fuel cell, mixing the air stream passing through the fuel cell (Fig. 5). Thereby eliminating the temperature hot spot inside the fuel cell, and reducing fuel cell temperature, so the current density, power density and fuel cell efficiency could be significantly improved (Fig. 6), thus enabling significant cost savings on new Air-cooled proton exchange membrane fuel cells.

Development Phase/Current State
Proof of Concept has been made in the laboratory on standard, air-cooled stacks from Ballard Power Systems, optimizing the effect of turbulence generating grids, placed at varying distances from the fuel cell stack.

The inventors
Torsten Berning, Associate Professor
tbe@et.aau.dk

Contact Information
Lars Halkjær, Technology Transfer Manager
+45 9940 7343, lah@adm.aau.dk

Seeking
• Licensee / IPR Sale
• Research Collaboration

Patent pending
healthycrop.world
- *Fusarium* resistant GM Soybean, Maize, Rapeseed and Cotton

Towards a pesticide-free agriculture

*Nepenthesin* is a naturally-occurring enzyme in the pitcher secretions of the carnivorous *Nepenthes* plants (to the left). Enhanced expression of Nepenthesin in crops hinders growth and toxin production of *Fusarium* and other fungi. healthycrop.world provides GM crops with this ability, enabling reduced use of fungicides and better farm economic results.

**Value Proposition**

**Commercial Perspectives**
The global seed market grows 7-10% CAGR to reach to ~€100 billion in 2022. “The Big 4” GM crops (see headline) will be then be grown on ~210 million ha constituting a seed value at ~$40-60 billion. We license pre-breeding material that seed breeders worldwide may exploit in their proprietary seeds. Our target is to enter licenses valued at ~2% of the turnover of ~5% of this market.

**Technology Description**
The invention provides a GM plant with a recombinant DNA construct comprising a gene encoding for Nepenthesin - an enzyme having aspartyl protease activity. Enhanced expression of Nepenthesin confers enhanced fungal disease resistance (*Fusarium* and *Aspergillus*) by inhibiting the fungal production of phytase, an enzyme essential for releasing phosphate required for fungal growth. The result is hindered growth of the fungi and reduced toxin production. As the mechanism is via “starvation”, the risk of fungal resistance is low.

**Development Phase**
The invention has Proof-of-Concept based on transgenic model Barley (*Hordeum vulgare*). This includes documentation for the characteristics of the Nepenthesin-encoded Barley, the phytase-mediating effect of the transgenic plant, as well as the plant’s ability to resist inoculation with *F. graminearum* and *F. culmorum* including absence of toxins (deoxynivalenol, nivalenol and zearalenone). A business and development plan has been complied, and a team of scientists and business executives are eager to get this invention on market.

**The inventors**
Henrik Brinch-Pedersen, Professor
Zelalem Eshetu Bekalu, Postdoc

**Contact Information**
Jan Mousing
Business Manager
+45 51337395
Jan.mousing@au.dk

**Seeking**
- Funding/Investors
- Licensee
- Partner/Research Collaboration
- IPR Sale

Nepenthesin and other proteases [.......] ID: TECH-2017-631-027. Priority date 20 September 2017
A Two-terminal Active Inductor Device

Value Proposition/USP
• The invention offers a two-terminal active inductor device, with demonstrated capability to achieve variable inductance, potentially reducing the cost, size and weight by 50% compared to a passive capacitor of same rating.
• To end-user, the two-terminal active inductor will look the same as a conventional inductor, as it has two terminals, so it can easily replace existing inductor in any product.
• The two-terminal active inductor device can be produced with wireless connection. And as the inductance can be programmed online, manufacturers are enabled to optimize production, and reduce the number of product variants.

Business Opportunity/Objective/Commercial Perspectives
• Inductors is a 5 billion dollar industry by 2022 from "Global discrete inductors market report" by Global Industry Analysts, Inc, 2016.
• The invented variable active inductor can directly replace passive inductors in general AC and DC power electronic applications.
• Producing these new two-terminal active inductor device, requires standard electrical production skills. The products can easily be implemented in current production facilities. Or form the basis of a startup.

Technology Description/Technology Summary
• This active inductor has two terminals with no need for additional connection, making it possible to be packaged as a conventional inductor.
• Significantly reducing the required inductance and increasing the energy density, while improving the performance, efficiency, reliability, and reducing the overall cost.
• Further, the inductance can be programmed online.

<table>
<thead>
<tr>
<th>Passive</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inductance</td>
<td>100 %</td>
</tr>
<tr>
<td>Cost</td>
<td>100 %</td>
</tr>
<tr>
<td>Size</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Development Phase/Current State
Proof of concept has been achieved in a partial functioning prototype. A programmable two-terminal active inductor is implemented for the DC-link filter of a 960 W three-phase diode rectifier. The required energy storage of the active inductor in this application is 42 % of the passive inductor to fulfill the same specification, while current ripple for both can be limited to 20 %.

The inventors
Huai Wang, Asso. Professor hwa@et.aau.dk
Haoran Wang, PhD Fellow hao@et.aau.dk

Contact Information
Lars Halkjær,
TTO Manager, +45 99 40 73 43
lah@adm.aau.dk

Seeking
• Funding/Investors
• Licensee
• IPR Sale

Patent Pending

Energy and Environment
A Two-terminal Active Capacitor Device

**Value Proposition/USP**
The invention offers a two-terminal active capacitor device for DC and AC applications, with demonstrated capability to achieve variable capacitance, more than doubling capacitor lifetime, or potentially reducing the cost, size and weight by 50% compared to a passive capacitor of same rating. To end-user, the two-terminal active capacitor device will look the same as a conventional capacitor, as it has two terminals, so it can easily replace existing capacitors in any product. Finally, the two-terminal active capacitor device can be produced with wireless connection. And as the capacitance can be programmed online, manufacturers are enabled to optimize production, and reduce the number of product variants.

**Business Opportunity/Objective/Commercial Perspectives**
- Capacitors is a 25.7 billion dollar industry by 2020 from “Global discrete capacitors market report” by Global Industry Analysts, Inc, 2015.
- The invented variable active capacitor can be used to replace passive capacitors in general power electronic applications, especially for AC and DC-link applications, online damping for stability, adaptive energy buffering, etc. Thereby making it applicable for major market segments includes power supplies, power transmission and distribution, drives, inverters, motors, etc.
- Producing these new two-terminal active capacitor device, require standard electrical production skills. The products can easily be implemented in current production facilities. Or form the basis of a startup.

**Technology Description/Technology Summary**
- This active capacitor has two terminals without any additional connection, making it possible to be packaged as a conventional capacitor.
- It is potentially reducing the cost, size and weight and improving the reliability performance.
- The active capacitor can be used for both DC and AC applications.
- Further, the capacitance of the active capacitor can be programmed online.

**Development Phase/Current State**
Proof of concept has been achieved in a laboratorial prototype. A case study has demonstrated a programmable capacitance from 5% to 100% of maximum value. For a 500 W single-phase application, it is around 36% cost reduction with a target of 30 years of lifetime, compared to an optimal passive capacitor solution, while both DC-link voltage ripple can be limited into 5 %.

**Contact Information**
- Lars Halkjær, TTO Manager, +45 99 40 73 43 lah@adm.aau.dk

**Seeking**
- Funding/Investors
- Licensee
- IPR Sale

---

**Figure 1. Applications of capacitor.**

**Figure 2. An active capacitor prototype uses 16.9% energy storage of a passive capacitor to fulfill the same design specifications.**

- **High cost-effectiveness**
- **Ease of manufacture and assemble**
- **Modular, scalable**
- **Online tuning of parameters**

---

<table>
<thead>
<tr>
<th>Passive</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitance</td>
<td>100 %</td>
</tr>
<tr>
<td>Cost</td>
<td>100 %</td>
</tr>
<tr>
<td>Size</td>
<td>100 %</td>
</tr>
</tbody>
</table>

---

**The inventors**
- Huai Wang, Asso. Professor hwa@et.aau.dk
- Haoran Wang, PhD Fellow Hao@et.aau.dk
- Frede Blåbjerg, Professor fbl@et.aau.dk

**Patent Pending**
Control of N$_2$O Emissions by Aeration
- for a greenhouse gas neural wastewater treatment plant

Value Proposition/USP
Through manipulation of aeration, the control technology will reduce N$_2$O emissions from wastewater treatment plants (WWTPs) without significantly compromising C and N removal performance. By incorporating the control technology into the SCADA (supervisory control and data acquisition) system, WWTPs will be able to visualize real-time N$_2$O emissions and achieve significant N$_2$O emissions and carbon footprint reduction. According to Frost & Sullivan, process control technology accounts for 15 billion USD market in global water service and utility sector.

Business Opportunity/Objective/Commercial Perspectives
Potential customers are water companies and wastewater treatment facilities which are seeking or will seek practically feasible control technologies for N$_2$O emissions to reduce carbon footprint. The control technology will also minimize potential energy waste in the form of excessive aeration, thus reducing operational cost whilst ensuring satisfying treatment performance.

Technology Description /Technology Summary
Both N$_2$O emissions and effluent quality are considered as control objectives. The control technology uses real-time measurements of influent and effluent characteristics as well as temperature in the aerated treatment tank as input for the fuzzy logic controller. Based on the predefined control rules by mathematical modelling in conjunction with expert knowledge, the fuzzy logic controller generates output regulating aeration in the treatment tank.

Development Phase/Current State
The control technology for N$_2$O emissions has been patented and is now being tested at Avedøre WWTP. The control technology is being tailored for the SCADA system of Avedøre WWTP and will be evaluated comprehensively and improved progressively. The testing is expected to finish on July 31, 2019.

Further control technologies will be developed based on the performance of the patented control technology during the full-scale testing phase.

The inventors
Boiocchi R, Gernaey K, Sin G*
*Associate Professor at DTU
Process and Systems Engineering Center
gsi@kt.dtu.dk

Contact Information
Gürkan Sin
Building 229, Søltofts Plads, Technical University of Denmark, 2800 Kgs. Lyngby
Tel: +45 4525 2980, E-mail: gsi@kt.dtu.dk

Seeking
- Funding/Investors to support further development of new control strategies
- Partner/Research Collaboration to test/demonstrate control strategies
- IPR Sale

Intellectual property currently owned 100% by DTU (Patent No. 81602701DK00)
Since electrical energy from renewable sources does not match the instantaneous needs (non-dispatchable), it is necessary to develop storage systems. Redox flow batteries are devices made up of an electrochemical stack, where electrical energy is converted into chemical energy (charge) and vice versa (discharge).

The advantage of redox flow batteries compared to conventional batteries is that the electrochemical energy is stored in liquid electrolytes. The storage capacity of a redox flow battery relies on the volume of electrolyte instead of the device’s volume, while its power relies on the size of the battery, giving much flexibility.

Here, the solar charging process takes place via photoelectrodes that absorb sunlight and transform the electrolytes to their charged electrochemical form. This technology will materialize in a device for charging the redox flow battery directly from sunlight, with a high level of efficiency.

Value Proposition
A solar rechargeable redox flow cell is a multi-functional device that can simultaneously capture and store solar energy cost-effectively, thereby giving it applications in domestic behind-the-meter and off-grid energy storage systems. The main advantage lies in its integrated nature (one device) which can be superior to comparable multi-step technologies.

Business Opportunity
This technology is of interest to redox-flow battery manufacturers and solar panel manufacturers. The technology could be licensed if these companies want to develop their own device or cooperation in R&D can be achieved to develop a new redox flow battery solution with this technology embedded. For solar panel manufacturers this could be a move to expand their market and to create a device to recharge redox flow batteries, allowing incorporation of these batteries into superior products.

Technology Summary
The present invention discloses a process for charging a redox flow battery directly from sunlight, through chemical conversion. It also relates to a solar rechargeable redox flow cell and its operation. This process can be described as the use of photoelectrodes which absorb sunlight and upgrade electrolytes to their charged electrochemical form. This technology will materialize in a device for charging the redox flow battery directly from sunlight.

Development Phase
The technology readiness level (TRL) of the technology is 3 (experimental proof-of-concept). The technology is co-owned between Aarhus University and University of Porto.

The inventors
Anders Bentien, Associate Prof.
Adélio Mendes, Full Prof.
Luísa Andrade, Assistant Researcher

Contact Information
Conny Lund Tegtmeier
TTO Manager Aarhus University
+45 40 17 97 49
clt@au.dk

Seeking
- Product development (R&D) collaboration
- Licensing agreement

European patent granted, n. 3105811, granted in 2018. USA patent in request n. 15/117,634, filed in 2016.
LED LigaLight
Cutting the Edge of Light Pollution

Existing stadium lamps cause significant light pollution outside the stadiums to the great annoyance of nearby neighbors and harm to the surrounding wildlife. LED LigaLight is cutting the edge of this light pollution by limiting the light to the stadium where it is needed – and nowhere else. The precisely controlled light is made possible by the use a series of finely cut prims designed specifically for stadiums. The prisms are powered by energy efficient LEDs and controlled by a built-in IOT solution.

From Football to Tennis, Playgrounds, City-parks, Wildlife Protection, Logistics and Parking-areas.

The technology can easily be traversed from football stadiums into other outdoor sports areas like tennis courts, equestrian areas (horses) as well as golf courses, motorsports and ice hockey. Recreational areas like city-parks and playgrounds, old town squares and centers, camping parking lots and wildlife protection station could also benefit from a precise, pollution free illumination. Potential industrial applications include light for logistic terminals in harbors, airports and railroads as well as greenhouses, farming areas and food and beverage production or high-end electronics, where precise light solutions are needed.

A Cutting Edge Sustainable Technology

The technology has been developed in a joint EU project between DTU and the private startup company NorthLED. The core technology consists of 3 things in a combined and tested solution:
1. Precisely cut and concentrated illumination modules (Prisms and Lenses)
2. First grade electronic elements and components from world-class vendors
3. Intelligent, user-friendly IOT based operations and interoperability which can adapt to local
4. circumstances and conditions like e.g. the weather, the actual usage and system performance/efficiency.

Will You be Part of the Expansion?

LED LigaLight has succesfully been installed in a football stadium in Roskilde, and two additional stadium projects have been won. The company now wants to accellerate the growth by inviting investors to participate in the expansion. The funding will be used for pentrating the stadium markets in Denmark & Northern Europe and to establish a viable business plan for the recreational and industrial markets.

The inventors
Henrik Chresten Petersen, DTU
Kenneth Saxskiold, NorthLED

Contact Information
Kenneth Saxskiold-Nørup
Partner
+45 30892427
Kenneth.saxskiold@northled.dk

Seeking
- Funding/Investors
- Partner/Research Collaboration