

Technical University
of Denmark



GRØN DYST

Tænk stort. Tænk nyt. Tænk grønt.

Student conference on sustainability, the environment and climate technology. June 27, 2014



PANAMAH

27. JUNI PÅ DTU

Fredag d. 27. juni

Koncerten er gratis for GRØN DYST deltagere.
For øvrige er billetprisen kr. 60,-
Billetter kan købes i S-huset fra mandag d. 19. maj.
Gå på www.groendyst.dtu.dk og læs mere om dagen.

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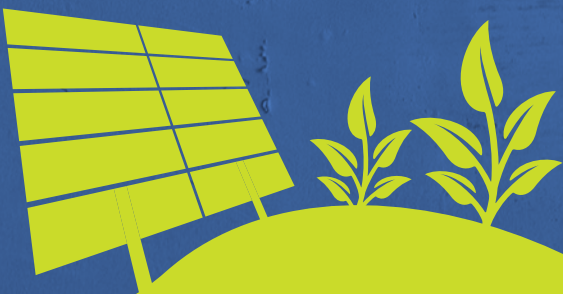
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”

It was interesting to be a part of the jury. As a student member of the jury I got an interesting look into green ideas in other study directions. I thought that there was a really great dynamic in my panel.

We supported each other well in regards to the voting and interviewing of the participants. In general I remember the great atmosphere.

“

Sven Hermann, Student



WELCOME



Dear participant,

Welcome to DTU and welcome to GRØN DYST (Green Challenge) student conference on global sustainability!

Climate change, deteriorating ecosystems, decreasing biodiversity, poverty and a continuously growing population all contribute to reducing the planet's resilience and may have catastrophic implications for humanity. Each of these problems has attracted great attention from the international community, but they have invariably been considered in isolation, with little or no regard to the interactions between them. Besides the need for a political agreement on how to meet the climate change challenge, the development of new technical solutions is required and accordingly, engineers will play a pivotal role in the transition towards a sustainable society. At DTU we take our commitments seriously - thus we incorporate sustainability, environmental issues and climate technology as fundamental aspects in our research and in all our engineering programmes. Consequently, DTU has launched GRØN DYST.

Held every year, GRØN DYST Student Conference is a unique opportunity for DTU students to present their projects to fellow students, their teachers,

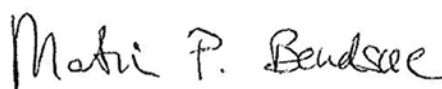
DTU alumni, as well as invited guests, such as business people and politicians. This year we run GRØN DYST student conference for the third time. More than 200 students have registered 120 green projects for GRØN DYST conference. Amongst them are students from universities in our international strategic partnerships and alliances. We are happy to welcome all of you to DTU.

Although GRØN DYST culminates in a conference, it is also an innovative academic challenge for students. Based on their own ideas, students have developed projects addressing different aspects of sustainability, the environment and climate technology and their work will contribute to the development of technological solutions that meet current global challenges and secure a safer and more sustainable future.

We are very happy that Sofie Carsten Nielsen, Danish Minister for Higher Education and Science, will open GRØN DYST student conference. For further information about the programme, please turn to the following pages. We are all looking forward to an enriching day - academically as well as socially.



Martin E. Vigild
Dean of Undergraduate Studies and Student Affairs,
Chairman of GRØN DYST executive committee



Martin P. Bendsøe
Dean of Graduate Studies and International Affairs

LUNCH AND BBQ

LUNCH:

LUNCH IS SERVED FOR THE GRØN DYST PARTICIPANTS
FROM 13.00-14.00

Lunch tickets can be found in the conference kit.

BBQ:

BBQ FROM 18.00-20.00 IN GRØNNEGÅRDEN.

MENU: BURGER
CHICKEN BREAST FILET
GRILLED SAUSAGE
MIXED SALAD AND BREAD
BEER OR SOFT DRINKS

BBQ tickets can be found in the conference kit.



PROGRAM

GRØN DYST - DTU LIBRARY, BUILDING 101

10:00-10:15

OFFICIAL OPENING OF THE CONFERENCE, DTU LIBRARY

WELCOME BY MINISTER FOR HIGHER EDUCATION AND SCIENCE SOFIE CARSTEN NIELSEN AND MARTIN E. VIGILD, DEAN OF UNDERGRADUATE STUDIES AND STUDENT AFFAIRS

10:40-11:30

PRESENTATION OF THE PROJECTS 1ST ROUND, DTU LIBRARY

11:30-11:50

COFFEE BREAK, DTU LIBRARY

11:50-13:00

PRESENTATION OF THE PROJECTS 1ST ROUND, DTU LIBRARY

13:00-14:00

LUNCH

14:00-15:00

PRESENTATION OF THE PROJECTS 2ND ROUND, DTU LIBRARY

15:00-15:20

COFFEE BREAK, DTU LIBRARY

15:20-16:00

PRESENTATION OF THE PROJECTS 2ND ROUND, DTU LIBRARY

16:00-17:00

CONFERENCE RECEPTION INCLUDING ENTERTAINMENT BY PER VERS "IN DANISH", DTU LIBRARY

17:00-17:30

AWARD CEREMONY WITH PETER MOGENSEN, DIRECTOR OF THE KRAKA FUND, DTU LIBRARY

17:30-20:00

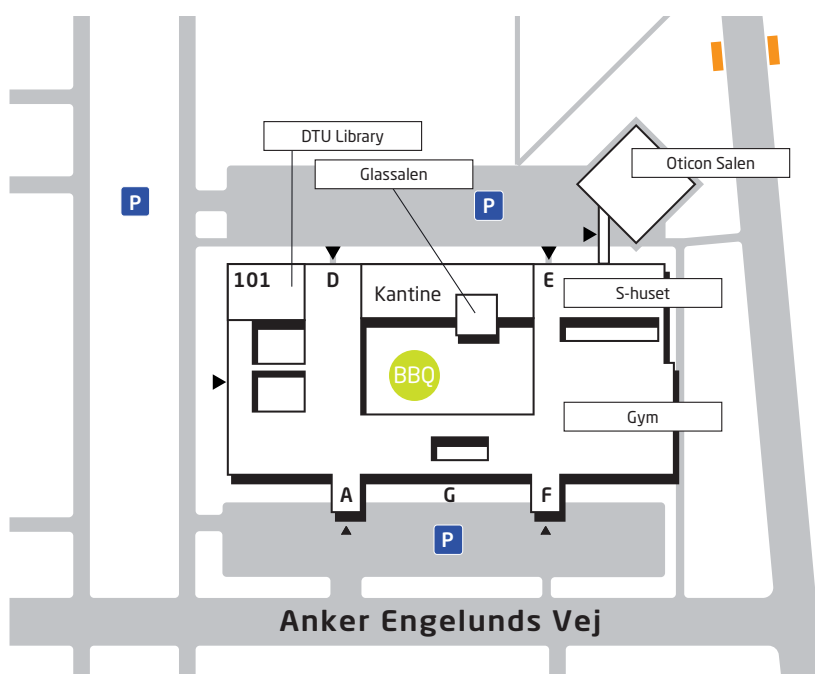
BBQ, GRØNNEGÅRDEN

20:00-22:00

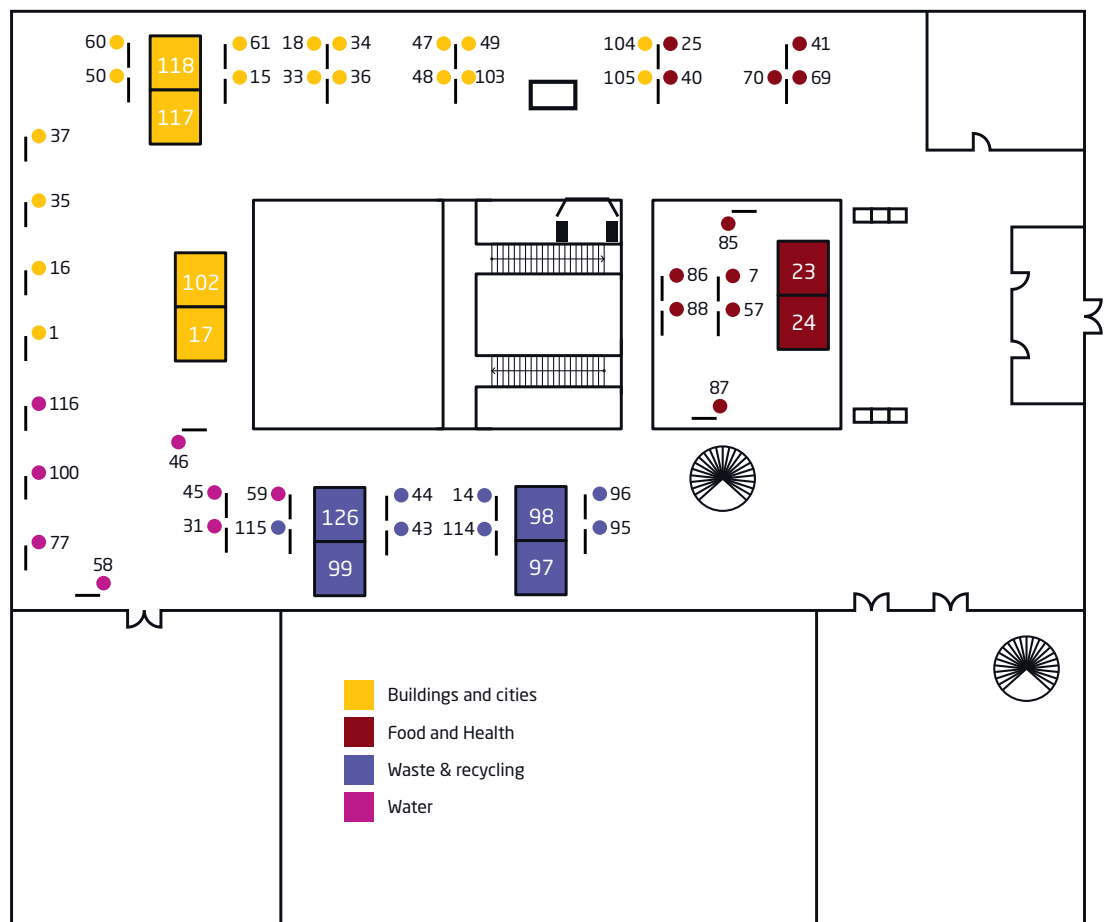
DJ IN S-HUSET

22:00-23:45

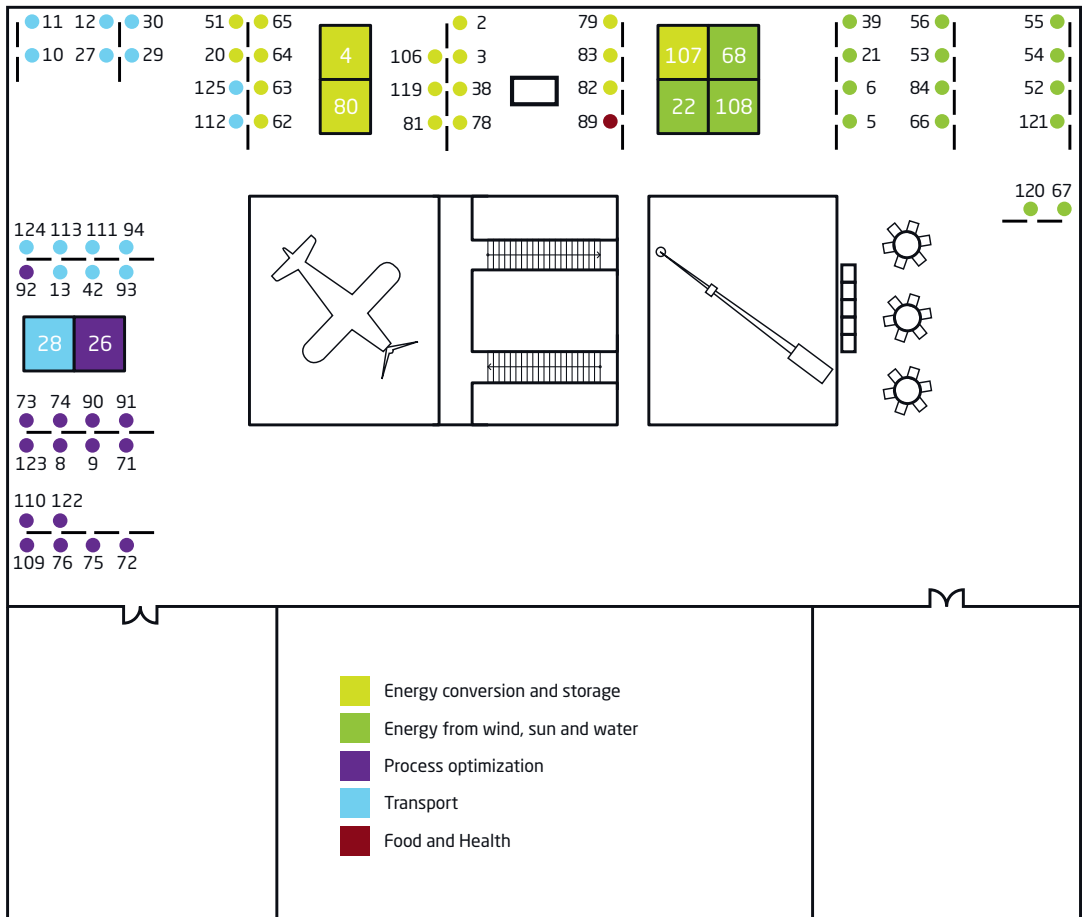
CONCERT WITH PANAMAH, OTICON



GROUND FLOOR, DTU LIBRARY



SECOND FLOOR, DTU LIBRARY



JUDGING PANELS

INTERNAL JUDGING PANELS FOR THE 1ST ROUND

PANEL 1



Lars D. Christoffersen
Director of Center
for Bachelor of
Engineering Studies
DTU DIPLOM

PANEL 2



Jane Hvolbæk Nielsen
Head of department
DTU Fysik

PANEL 3



Jørgen Schlundt
Head of department
DTU Food

PANEL 4



Lars-Ulrik Aaen Andersen
Head of Department
DTU Fotonik

PANEL 5



Henrik Carlsen
Head of department
DTU Mekanik



Erik Vilain Thomsen
Associate professor
DTU Nanotech



Mette Voldby Larsen
Associate professor
DTU Systembiologi



Henning Skriver
Associate professor
DTU Space



Aram Chung
Assistant professor
RPI



Anne Hauch
Senior Scientist, PhD
DTU Energikonvertering



Charlotte Amalie Lindegaard Petersen
Student



Kim Louise Ettrup
Student and
former Chairman
of Polyteknisk
Forening



Andreas Moesgaard
Student and former
boardmember of
Polyteknisk Forening



Martin Kristiansen
Student and Chairman
of academic council
(ELKO-rådet PF)



Anita Godiksen
Student and projekt
developer Grøn Vision



Rasmus Steffensen
Student and
former GRØN DYST
participant

PANEL 6



Søren Salomo
Head of department
DTU Management

PANEL 7



Jens-Peter Lynov
Head of department
DTU Nutech

PANEL 8



Peter Hauge Madsen
Head of department
DTU Vind

PANEL 9



Ulrika Lundqvist
Head of department
Chalmers University of
Technology

PANEL 10



Per Holten Andersen
President
CBS



Hanne Løje
Associate professor
DTU Fødevareinstituttet



Karsten Rottwitt
Professor
DTU Fotonik



Hanna Knuutila
Associate professor
NTNU



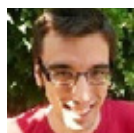
Bo Munk Jørgensen
Associate professor
DTU Fødevareinstituttet



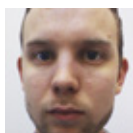
Per Boelskifte
Professor
DTU Mekanik



Jeppe Dahl
Student and Chairman
of academic council
(Miljørådet PF)



*Arnau Verdaguer
Casadevall*
Ph.D. student and
former participant
in GRØN DYST



Asger Gade Andersen
Student



*Stephanie Melnik
Lemaître*
Student



Randi Juel Olsen
Student and
boardmember of
Polyteknisk Forening



Carina Lindahl
Student and former
GRØN DYST participant

JUDGING PANELS

INTERNAL JUDGING PANELS FOR THE 1ST ROUND

PANEL 11



Kurt Andersen
President
RPI

PANEL 12



Stig Irving Olsen
Associate professor
DTU Management

PANEL 13



Prof Er Meng Hwa
Vice Dean
NTU

PANEL 14



Harry E. Hoster
Vice President
TUM

PANEL 15



Lasse Engbo Christiansen
Associate professor
DTU Compute



Kirstine Berg-Sørensen
Associate professor
DTU Fysik



Patrick van Schijndel
TU/e



Peter Vilhelm Skov
Associate professor
DTU Aqua



Michael A. E. Andersen
Professor
DTU Elektro



Imad Abou-Hayt
Associate professor
DTU Diplom



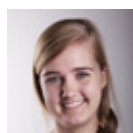
Heida Gunnarsdottir Nolsøe
Former GRØN DYST
participant and Co-
founder of Dropbucket



Loke Bager Kristensen
Student



Lotte Bjerregaard Jensen
Associate professor
DTU Byg



Monika Margrethe Skadborg
Student and former
boardmember of
Polyteknisk Forening



Natasha Mai Yde Larsen
Student and former
boardmember of
Polyteknisk Forening



Sven Hermann
Student

PANEL 16



Stig Wedel
Associate professor
DTU Kemiteknik

PANEL 17



Peter Lund
Professor
Aalto University

PANEL 18



Hans Hvidtfeldt Larsen
Prof. & Associate Dean
for Undergraduate
Studies
DTU Natlab

PANEL 19



Joachim Holbøll
Associate Professor,
Deputy Head of Center
DTU Elektro

PANEL 20



Eva Eriksson
Associate professor
DTU Miljø



Lars Maack
Associate professor
DTU Diplom



Jørn Toftum
Associate professor
DTU Byg



Niki bey
Associate professor
DTU Management



Jason Li-Ying
Associate professor
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*Rasmus Reinhold
Paulsen*
Associate professor
DTU Compute



Mikkel Kolding
Student and former
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Henrik Mikkelsen
Student and former
GRØN DYST deltager



Camilla Wolf Nygaard
Student and former
boardmember of
Polyteknisk Forening



Lasse Skovgaard
Student and manager
Grøn Vision



Jeppe Nørregaard
Student and
former GRØN DYST
participant

JUDGING PANELS

JUDGING PANELS FOR THE 2ND ROUND

PANEL 1



Lars D. Christoffersen
Director of Center
for Bachelor of
Engineering Studies
DTU DIPLOM



Erik Vilain Thomsen
Associate professor
DTU Nanotech



*Charlotte Amalie
Lindegaard Petersen*
Student



Özcan Kizilkaya
City councillor
Socialdemokratiet



Peter Johansen
CEO
Jomitek

PANEL 2



Jane Hvolbæk Nielsen
Head of department
DTU Fysik



Mette Voldby Larsen
Associate professor
DTU Systembiologi



Kim Louise Ettrup
Student and
former Chairman of
Polyteknisk Forening



Anne Jeremiassen
City councillor
I



*Nickolass Bitsch
Schack*
Customer Solutions
Application Manager
Novozymes

PANEL 3



Jørgen Schlundt
Head of department
DTU Food



Henning Skriver
Associate professor
DTU Space



Andreas Moesgaard
Student and former
boardmember of
Polyteknisk Forening



Hans Hvidtfeldt Larsen
Prof. & Associate Dean
for Undergraduate
Studies
DTU Natlab



Ali Abbasi
City councillor
Enhedslisten



Lasse Toft
Områdechef, Byggeri
og Anlæg Øst
Balslev Rådgivende
Ingeniører A/S



PANEL 4



Lars-Ulrik Aaen Andersen
Head of Department
DTU Fotonik



Ulrich Quaade
Head of R&D, phd
Amminex Emissions
Technology A/S



Aram Chung
Assistant professor
RPI



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Rosa Lund
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Scion DTU



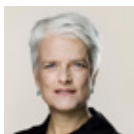
JUDGING PANELS

JUDGING PANELS FOR THE 2ND ROUND

PANEL 7



Jens-Peter Lynov
Head of department
DTU Nutech



Anette Vilhelmsen
MF
SF



Peter Hauge Madsen
Head of department
DTU Vind



Carina Lindahl
Student and former
GRØN DYST participant



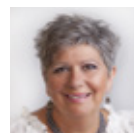
Karsten Rottwitt
Professor
DTU Fotonik



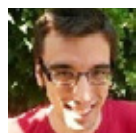
Vinay Venkatraman
Founder and CEO
Leapcraft



Hanna Knuutila
Associate professor
NTNU



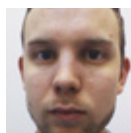
*Lolan Marianne
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Socialdemokratiet



*Arnau Verdaguer
Casadevall*
Ph.D. student and
former participant in
GRØN DYST



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Student and former
GRØN DYST deltager



Asger Gade Andersen
Student



Lone Dybdal Nilsson
Director
Novozymes

PANEL 9



Ulrika Lundqvist
Head of department
Chalmers University of
Technology



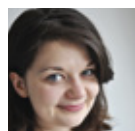
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MF
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John F. Dascher
Investment Manager
INSERO Horsens



*Stephanie Melnik
Lemaitre*
Student



*Rasmus Reinhold
Paulsen*
Associate professor
DTU Compute)

PANEL 10



Per Holten Andersen
President
CBS



Per Boelskifte
Professor
DTU Mekanik



Randi Juel Olsen
Student and
boardmember of
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Kåre Harder Olesen
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Hans Peter Dueholm
FSS Nordic Architect
team leader Distinguished
Engineer
IBM

PANEL 11



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ETEØ Venture ApS



Camilla Wolf Nygaard
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boardmember of
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Kurt Andersen
President
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*Kirstine Berg-
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Associate professor
DTU Fysik



*Heida Gunnarsdottir
Nolsøe*
Former GRØN
DYST participant
and Co-founder of
Dropbucket

JUDGING PANELS JUDGING PANELS FOR THE 2ND ROUND

PANEL 12



Stig Irving Olsen
Associate professor
DTU Management



Musa Kekec
City councillor
Socialdemokratiet



Prof Er Meng Hwa
Vice Dean
NTU



Henrik Brade Johansen
City councillor
Radikal



Patrick van Schijndel
TU/e



Martin Oestberg
General Manager,
Chemicals R&D
Haldor Topsøe A/S



Peter Vilhelm Skov
Associate professor
DTU Aqua



Morten Osted
Country Head
HCL Europe



*Loke Bager
Kristensen*
Student



Joachim Holbøll
Associate Professor,
Deputy Head of Center
DTU Elektro



*Lotte Bjerregaard
Jensen*
Associate professor
DTU Byg



Lasse Skovgaard
Student and manager
Grøn Vision



Sven Hermann
Student

PANEL 14



Harry E. Hoster
Vice President
TUM



*Michael Krautwald-
Rasmussen*
City councillor
Socialdemokratiet



*Lasse Engbo
Christiansen*
Associate professor
DTU Compute



Peter Lund
Professor
Aalto University



Michael A. E. Andersen
Professor
DTU Elektro



Pia Rasmussen
Projektleder,
Energiingeniør
Grontmij



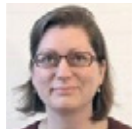
Imad Abou-Hayt
Associate professor
DTU Diplom



Jesper Lomborg Manigoff
Vice President Ultrasound
Engineering & Managing Director BK
Medical



*Monika Margrethe
Skadborg*
Student and former
boardmember of
Polyteknisk Forening



Eva Eriksson
Associate professor
DTU Miljø



*Natashia Mai Yde
Larsen*
Student and former
boardmember of
Polyteknisk Forening



Jeppe Nørregaard
Student and
former GRØN DYST
participant

PANEL 15

JUDGING PANELS

JUDGING PANELS FOR THE 2ND ROUND

PANEL 16



Stig Wedel
Associate professor
DTU Kemiteknik



Ib Carlsen
City councillor
Socialdemokratiet



Lars Maack
Associate professor
DTU Diplom



Henrik Poulsen
manager
Det Grønne
Iværksætterhus



Mikkel Kolding
Student and former
boardmember
of Polyteknisk
Forening



Young-sam Ma
Ambassador Republic
of Korea

”

I was already involved in various outreach activities at Novozymes, hence when a co-worker asked if I would like to be a judge at GRØN DYST 2012, I said yes without any second thoughts.

At the GRØN DYST conference I was part of a judging panel consisting of a handful of people. I think that all the judges were competent and committed people. Prior to the conference I've googled all the innovation projects that I would be involved in judging, so I was well prepared for the conference. This enabled me to ask in-depth questions for the students' projects.

I think it's a super cool event, and I am looking forward to being a judge again in 2014.

“

Nickolass Bitsch Schack, Novozymes - Industri Technology Manager



PRESENTATION FORMATS

Various modes of presentation are available to the participants in GRØN DYST. They can choose one of three ways to present their projects:

Poster presentation

The poster presentation allows students to advertise their work in text and graphics in a persuasive way to passers-by. Unlike the fast pace of a slide show or verbal presentation, a poster presentation allows viewers to study and restudy the information and discuss it with the students one on one.

Laptop presentation

Unlike a standard powerpoint presentation projected onto a large screen, a laptop presentation addresses a smaller audience, typically three to six persons, gathered around the laptop. This allows viewers to discuss the project and results in a small group or even one on one.

Free style presentation

This presentation format allows students to present their projects and the results in any way other way than those above mentioned. Anything goes. It could be a shout out, a theater performance, an exhibition of artifacts, a video show – you name it!



CRITERIA FOR PROJECT EVALUATION

The panels of judges evaluate the projects in accordance with the following criteria:

- To what extent is the project technologically applicable and likely to be realised?
- To what extent is it visionary and/or innovative?
- Is the project well structured and clearly communicated?
- To what extent is the project likely to have a positive environmental or energy impact?

The projects are evaluated on a scale of 1-10, where 1 is the lowest grade and 10 is the highest. The total score is calculated by adding up the individual score from the four criteria. Regardless the score a project cannot receive an award unless it includes sustainability, the environment or climate technology.

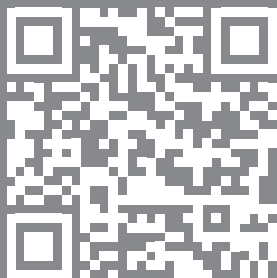


TAKE IT **EVEN** FURTHER!

Next Step: Intensive 2 day workshop
at DTU Ballerup Campus, August 28-29, 2014.

- take your GRØN DYST project further and receive coaching
- learn what is needed to move from idea to business
- get acquainted with business, product, and prototype development


Sign your team up at
groendyst.dtu.dk or
scan the code.




LEGEND INFO

Level

 Bachelor Level Course / Project

 Bachelor Final Assignment

 Master Level Course / Project

 Master Thesis

Category

 Idea

 Concept


Presentation format


 Free Style


 Laptop


 Poster

Project themes


 Buildings and cities

 Energy conversion and storage


 Energy from wind, sun and water

 Process optimization

 Transport

 Waste & recycling

 Water

 Food and health



ACKNOWLEDGEMENTS

Steering Committee

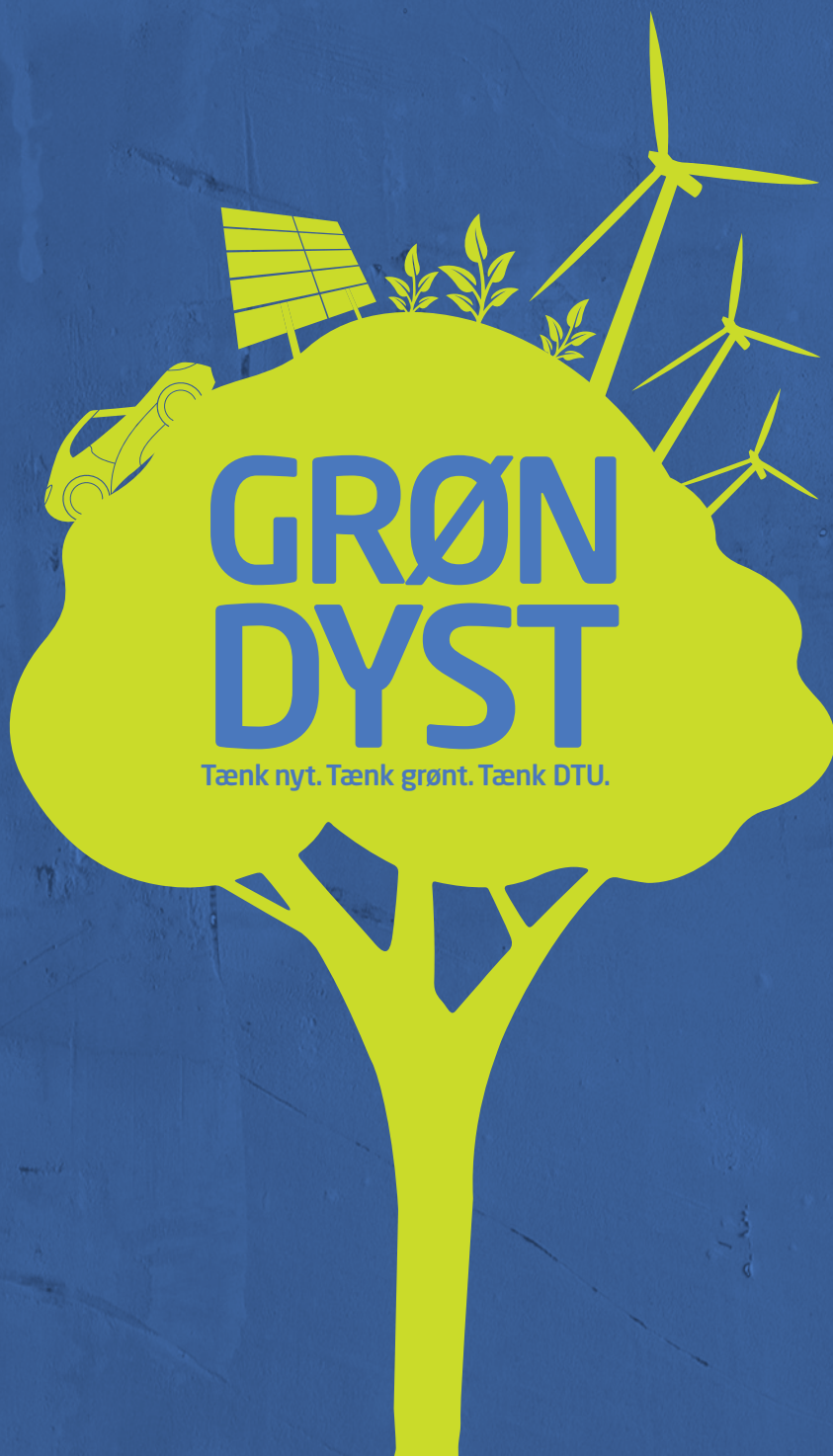
Dean of undergraduate studies, Martin Vigild (president)
Senior Vice President, Innovation and Entrepreneurship, Marianne Thellersen
Deputy Director, Jørgen Jensen
Head of Communications, Tine Kjær Hassager
Head of Office, Gitte Andresen
Head of Office, Trine Eltang

Reference Committee

Associate Professor, Kristian Mølhave (DTU Nanotech)
Associate Professor, Stig Irving Olsen (DTU Management)
Associate Professor, Lasse Engbo Christiansen (DTU Compute)
Associate Professor, Alfred Heller (DTU Byg)
Professor, Rasmus Fehrmann (DTU Kemi)
Director of Center for Bachelor of Engineering Studies, Lars D. Christoffersen
Head of Department, Lars-Ulrik Aaen Andersen (DTU Fotonik)
Academic Management Officer, Catrine Lohmann Larsen (HR)
Study Coordinator, Birte Kronbak Andersen (DTU Space)
Academic Officer, Mette Haagen Marcussen (DTU Systembiologi)
Head of Section, Nils Frederik Turpie (CAS)
Representative from PF, Trine Hagerup
Student Henrik Mikkelsen
Student, Nanna Cecilie Egede Andersen
Student, Maria Annel

A special thanks to Associate Professors Peter Kjeldsen and Kristian Mølhave for categorizing all the abstracts.

ABSTRACTS



The Sustainable Classroom

D.Palasz and N. Lorentzen

DTU Civil engineering, Technical University of Denmark

INTRODUCTION

Between 30 and 40 percent of the total energy consumption in Danish buildings is used for heating, ventilation and lighting. The majority (80-90%) of this consumption comes from buildings built before 1970. More than 50% of students in Danish schools are exposed to a bad indoor climate in the form of high concentrations of CO₂. Because of that, there is great potential in the energy renovation of existing buildings, including schools. Not only will it lead to major financial savings through the use of more climate-friendly building material, but by optimizing the indoor environment, student performance will also be improved.

PURPOSE

The purpose of the project is to choose the most ideal systems and controls within a classroom in order to make it as sustainable as possible. Furthermore it is the intention that the users are able to monitor and control both the indoor climate and the energy consumption, to provide an increased awareness and enthusiastic approach to energy.

The prime focus area is energy consumption and indoor climate, but life cycle analysis is also taken in consideration. The classroom is also intended as a test room where different solutions can be tested and analyzed in energy consumption, environmental impact, indoor environment and user satisfaction.

THE PROJECT

The project consists of an existing classroom that is being rebuilt with a new demand controlled hybrid ventilation systems, new lighting, CO₂-, daylight- and PIR sensor, energy meter and an operation panel to control and visualize the energy consumption. An intelligent control will ensure that the ventilation, lighting and heating are automatically regulated depending on the need. It will also be possible to control the indoor climate manually through the control panel or a smartphone, with some reservations. It will also be possible to follow the energy consumption by hour/day/month- or yearly basis. Data on energy consumption can be analyzed as the energy will be measured separately in heating, ventilation and electricity. An alarm will be triggered in the building management system if the energy consumption exceeds the maximum expected limit.

EXPECTATIONS

At present, the classroom lights are on almost constantly since most students do not turn them off when leaving the room and the heating is still on while the windows are open. Additionally, there is constant ventilation in all rooms even if there is no-one there. This is the reason why, we expect a large energy-saving from ventilation, light and heat.

By logging data and visualizing the room's energy consumption, it is expected that students become more aware of and interested in the use of energy in daily life.

It is also expected that the learning and activity level will increase hugely as a lower CO₂ level helps learning.

Conversion of Biomass to Fuels and Chemicals

K. N. Salim, S. H. Mushrif

School of Chemical and Biomedical Engineering, Nanyang Technological University

ABSTRACT

Lignocellulosic biomass is an alternate and renewable source of carbon and it can be used to produce fuels and chemicals without putting any stress on the nutritional needs of world population. However, conversion of biomass is technologically challenging since it is a solid material and needs a solvent for liquid phase catalytic processing, and carbon – oxygen bonds need to be cleaved selectively without breaking carbon – carbon bonds. Acid catalyzed dehydration of sugars to intermediates like 5 – hydroxymethyl furfural (HMF) is one of the key reactions in biomass conversion. Since the economic analysis of the process has shown that the cost of HMF is most sensitive to the cost of fructose, high conversion and selectivity to HMF are desired. Experimental investigations have shown that pH of reaction mixture has a significant effect on the conversion and selectivity. It is believed that pH affects the conversion and selectivity in the reaction of fructose to HMF by altering the local arrangement of water molecules around fructose. The local arrangement of water molecules around the sugar can possibly influence the protonation of fructose, which is the first step in the dehydration reaction. Since the protonation of selected oxygens in fructose only leads to the formation of HMF, the site specificity of protonation can alter the reaction selectivity. In the present work, systems of different hydronium ion concentrations i.e. varying number of HCl molecules in glucose – water mixtures, were simulated using ab initio molecular dynamics to study the changes of fructose solvation in water medium as a function of pH. Simulations were performed using the Car – Parrinello scheme, and the planewave pseudopotential implementation of the Kohn – Sham density functional theory. Molecular dynamic trajectories were analyzed using radial pair distribution functions and spatial distribution functions. Our simulation results showed that the local arrangement of water molecules around selected oxygens of the sugar gets significantly altered as the hydronium ion concentration in the system changes. The change in the intermolecular hydrogen bonding in water due to the presence of hydronium ion also alters the sugar – water interaction. The findings of the present work have helped us better understand the effect of pH on the solvation of fructose in water, which has an effect on its conversion to HMF.

Optical Properties of Algae

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INTRODUCTION

Around 25 percent of the biomass in the world is algae's. As organisms they have found ways to harvest energy from the sunlight while preventing harmful wavelengths in the sunlight to penetrate or at least harm the organism. We believe this clever mechanism is obtained through structuring the shell encapsulating the organism. We show predicted and measured reflectivities and transmission spectra from different species of algae's.

THEORY

The shells of algae's have a structure that is unique to each algae. Figure 1 show examples of shells from different species [1].

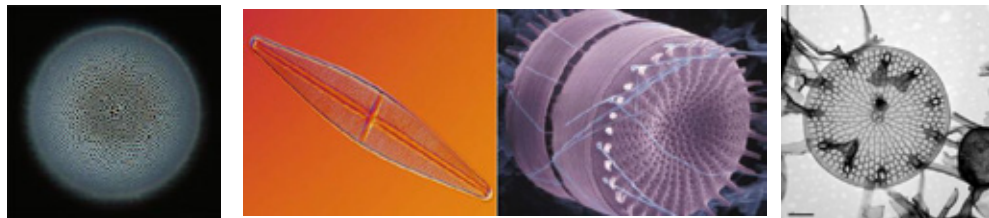


Figure 1: Examples of algeas. The algae to the left will be the one primarily used in the course

The functionality of the structure is not well understood but may be used to focus desired wavelengths onto the organism of specific algae. In recent experiments we have demonstrated that at least some shells of specific species generate multiple focus points of visible light [2]. This is confirmed by numerical simulations. The next step is to study how this functionality depend on wavelength, ad species of algae

DISCUSSION

We demonstrate transmission and reflection measurements performed on various species of algae. We show the formation of multi focus points and discuss the origin of these. The purpose of the shell structure will be discussed and future application of algae's highlighted

REFERENCES

- [1] <http://paleonerdish.wordpress.com/2013/06/10/an-introduction-to-diatoms/>
- [2] <http://plen.ku.dk/english/research/Glyco/evolution/alpha/>

Piezoelectric Polymers for Energy Harvesting

L. Ravnkilde and M. Thane Borre

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INTRODUCTION

Energy is always in demand. And methods for generating energy without the use of fossile fuels is more needed than ever. Therefore we want to make an alternative energy generating method. Our idea is based on Piezoelectric materials. Piezoelectric materials generates a voltage when exposed for an external stress.

Through a 3 week special course we want to perform experiments and finally design fabricate a plate made of piezoelectric polymer PVDF. The concept is then, that the plate should be placed where many people walks. People would then step on the plate, which applies a stress in the implemented piezoelectric polymers and a voltage is generated. It is possible to harvest this generated energy.

THEORY

We are going to combine theory learned in the courses: Micro-1 and Fabrication of micro- and nanostructures. Besides this we are going to use theory from articels found on the subject.

Method

The polymer we wish to use is PVDF in its electric active beta-phase. PVDF in alpha phase is possible to buy from a danish company called LINATEX. We are going to convert the alpha-phase PVDF to beta-phase through a method called polling, which consist of heating the material and then applying an electric field. When the beta-phae is obtained we are going to attach electrodes to the polymer. A circiut should then be established for harvesting the generated energy. And finally the device should be coated in a form of packaging, which prevent damages but will allow the stress in the piezoelectric polymer.

Results

The project will be carried out in the 3-week course period in June 2014 and no results is therefore yet obtained.

CONCLUSION

We will throughout a special course in the 3-week course period in June 2014 make a energy harvesting device. The device contains piezoelectric polymers, which generate a voltage when bended.

Shape Analysis of Solar Panels

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INTRODUCTION

Solar panels are a promising source to CO₂ neutral and climate friendly energy. Today solar panels are often applied to the roofs of houses when they are not merely placed angled on a supporting structure on the ground constituting so called solar farms. However, solar panels are rarely used in modern cities, as the ordinary rectangular shape is not easily incorporated in the design of city skyscrapers. The vision behind this project was to help spread the use of solar panels to cities by analyzing a variety of alternative shapes of solar panels and developing tools to evaluate the energy efficiency of the panels.

The goal was to develop effective and easily applied methods for depicting the energy efficiency of solar panels of various geometric shapes. In ambitious and comprehensive construction projects, this framework would apply as an easy tool to consider energy optimization in the early stages of design planning. This is an important instrument for architectural offices as it could be used as a guideline for architectural planning.

METHODS

The general assumption of the project was that inward solar flux through any solar panel was proportional to the energy output of the solar panel. This assumption can be easily corrected by applying the actual efficiency of the solar panel.

The project developed a series of methods for modeling the energy output for solar panels based on depicting the sunlit and shadowed areas of the solar panels. It was found that the calculations rapidly became very demanding for even the simplest of shapes. For specific types of geometrically shaped solar panels a simpler method was derived and applied. However, the limitations of this method made it necessary to broaden the applicability of the model to a wider range of geometric shapes. This was achieved by applying Gauss's theorem to closed convex surfaces. The resulting method proved to be effective and much more general in applicability, as all convex surfaces could be modeled and computational time was reduced.

RESULTS

It was found that for closed convex surfaces the inward flux could be computed as the area of the shadow of the surface on a plane perpendicular to the sun.

The computational power and time required for this analysis of any solar panel, that is a closed convex surface, is very limited and thus very applicable.

Solar Powered Absorption Refrigerator

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This study examines the possibility of using a solar collector to power an absorption refrigerator for cooling of food or medicine in regions with little to no access to electrical power. The study attempts to find the optimal configuration of the solar collector and absorption refrigerator pair. This is done by setting up a mathematical model for the system and iterating the model to find the optimal point of operation. It is found that the most efficient conversion of solar power to cooling power is achieved with a driving temperature of 100 degrees Celsius at a pressure of 0,313MPa. The efficiency at this point was found to be 11%. Furthermore we have tried to compare the mathematical model with a practical experiment. Due to measurement uncertainties the comparison remains inconclusive.

The Ideal Hospital Room

J. Fabricius, E. Edelmann Nielsen, A. Kucukavci, A. Vinther Jakobsen, M. Rosenbech, K. Mortensen, L. Rinne Toh og M. Bech Voigt

DTU Architectural Engineering, Technical University of Denmark

The project is focusing on the ideal hospital room for patients as well as the staff of the hospital. The vision is to provide, by healing architecture, a good, healing environment for the patients so e.g. the hospitalization time for the patient is reduced, and to provide a good and comfortable work environment for the staff.

Several studies have shown that patients and staff feel more comfortable if the daylight and artificial light has a certain intensity and that the indoor climate provides a certain comfort. To achieve the results above, the following things have been considered:

- Optimization of facades in terms to visibility, daylight and shadows
- Optimization of the indoor climate
- Optimization of interior of the hospital room, artificial light and acoustics.

Therefore the project has been design to find the most optimal size and location for windows and shades, so patients and staff get the best everyday stimulations.

Furthermore the project has tried to achieve the best and most stimulated color spectrum of the artificial light and the lowest possible reverberation time.

In terms of the indoor climate the integration of personalized ventilation in textiles has been researched. Furthermore, studies of floor heating and ceiling cooling have been made referring to optimization of the indoor climate at the hospital room.

Color Effects on Nano Structured Surfaces

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For years plastic has been used for all kinds of applications due to its versatile properties. As focus on sustainability has increased, the ability to melt and recycle plastic materials has become increasingly important. This is already largely done in the production of e.g. plastic bags where the quality is perhaps compromise, but a cleaner product will enhance the possibility of using recycled plastic in a variety of products.

The general aim of this project is to develop a more sustainable alternative to one of the most widely used additives in plastic; *coloring by pigmentation*. The idea is that color decorations as we know them are to be replaced by the visual effects of periodic nano structures on the plastic surface. In particular, we envision making nano imprint an integrated part of the injection molding process and thereby eliminating both the additive itself and also reducing the sequences of production steps that might also cause additional transportation and thus further benefit the environment.

This study deals with the color effects of periodically spaced cylindrical PMMA structures. It has previously been found that aluminum coating is necessary in order to obtain clearly visible color effects, as these arise due to localized surface plasmons on the resulting aluminum disks. In principle, this jeopardizes the vision of a single material. However, the tiny proportion of aluminum (layer of 20 nm) in the product will not impact the reusability before numerous cycles (100 cycles from rough estimates).

Samples with periods of 160 to 240 nm and E-beam exposure doses of 30 to 180 $\mu\text{C}/\text{cm}^2$ were characterized optically and the reflected spectrum was found to depend strongly on the diameter as the resonance frequency of the localized surface plasmons is highly dependent on the height-to-width ratio of the Al disks.

The viewing angle dependency of the color, on the other hand, is related to the period, as small periods result in more constant color effects, as disturbances due to diffraction are found outside the visible range.

Energy Fingerprint

Morten T. Egholm

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INTRODUCTION

If we become aware of our power consumption in our homes, the knowledge will lead to a wiser use of energy, with a lower total consumption as a result.

That statement is the starting point of this project. We will try to develop an easy method to visualize the distribution of the power consumption in our homes on appliance level.

In most domestic homes today, the electricity consumption is only read once a year in conjunction with the annual billing. This does not provide a picture of how the consumption is distributed between the different appliances in the house.

The goal of this project is to make it possible to generate a list of the most consuming appliances in the respective home, only by measuring the total electricity consumption of the household. This list holds the total consumption of e.g. the dishwasher of a given period of time and the number of times the appliance has been operated in that period.

THEORY

Each electrical appliance has a unique pattern of how the electrical energy is used when operating the appliance. Some machines have several patterns, e.g. a washing machine with quick-, normal- or eco-program, but they are all unique for that type of machine.

Finding these patterns in the total electricity consumption can be difficult, because all these patterns are mixed up when the different appliances are used at the same time.

METHODS

We have logged the consumption in a nonintrusive way, by counting the impulses, given by the LED on the main meter of a household. In our test case; 1000 impulses pr. kWh.

We have also logged the appliances with the highest consumption of the house, to collect the patterns of as many appliances as possible.

Then we have used a mathematical method that recognizes patterns in a signal, to build the algorithms for finding the patterns from the different appliances in the total consumption.

CONCLUSION

It was quickly clear that it was possible to find the most unique patterns in the signal of the total consumption, using the individual patterns, that was logged from the different appliances. The challenge is to find the appliances that do not vary so much in the unique patterns, or has a very low consumption.

Our experiments, at this point, indicate that it will be possible to identify more than half of the total consumption this way, if more development is done on the project.

Thereby, it seems like a method that could give the consumer a better view of their electricity consumption, and give them better tools to save energy.

Community Based Electric Power Generation through Bicycles Dynamos' Usage

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The opportunity of power generation by the use of storing energy surplus from bicycle dynamos was pursued. During daylight hours dynamos generate light of virtually no use, the main goal of this project is to store this energy; which would later be offloaded onto a power grid and available for consumer use. In this research power usage from the city of Oldenburg in Lower Saxony, Germany is compared against the amount of green energy generated using method. Oldenburg is currently among the top energy-wasters in Germany, with a consumption per-capita of +15.5% more than the German average [Statistisches Bundesamt, 2013]. Projected calculations for 50% of the population in Oldenburg [www.oldenburg.de, 2014] generating 1 Ah per-day using this method would result in 2.07% of the city's current consumption being generated through bicycle dynamos. The same calculation for a city with a lower consumption rate such as Dresden would see 3% of their energy consumption being generated through bicycle power usage. This research also covers a future projection of the system in which users could track their power generation through the Internet and optimally acquire monetary rewards in their electric bills.

Improving Traffic and Transportation at The Technical University of Denmark

J. T. Hølleddig, A. B. Mortensen, A. M. Axelsen and C. A. Flach

DTU Traffic and Transport, Technical University of Denmark

INTRODUCTION

The Technical University of Denmark is the largest technical university in Denmark. With 14.000 people commuting to Lyngby Campus it is crucial for the transportation network to function at its best. At present the public transport to and from DTU is far from perfect, therefore it is important to optimize the transportation to, and on DTU Campus. As Denmark and DTU are the frontrunners of green technology in Europe the image as a green and accessible University is important.

RESEARCH

This project looks at how the transportation from and to DTU could be improved, so that more people either use public transport or their bicycle in an attempt to become greener. Furthermore the project investigates how travelling within the campus could be improved to save travel time, improve safety and generally make it more appealing to move around on campus. Lastly the project looks at how the city centre and surrounding areas are used, and how the students and employees could benefit more from the facilities offered.

METHOD

Data is collected through a quantitative survey sent out to all the student and employees at DTU. The survey is put up on 'Portalen' and is sent out to personal email addresses. A site analysis has also been completed focusing mainly on the DTU campus, where improvements to the transportation possibilities and safety have been discussed.

IDEAS

The central thesis is to create a more open campus, with more room for cycling and improved routes between the four blocks. This is achieved by making more space for bicycle parking or better bike paths. Another way to open up the campus is to create more access points between the blocks.

There are plans to build a light rail through Lyngby with a possibility of it reaching DTU. This has also been researched and it has been discussed how this would affect the transportation possibilities for the student and employees. The light rail would also become a major asset for the further cooperation between Lyngby campus and Ballerup campus.

RESULTS

As the results depend on the survey, we cannot present any since the survey has yet to be answered. However, it is expected that the results will show several methods in which to improve the mobility both internally and externally at DTU.

Sail Milling

***S. Reinert, N. H. Iversen, S. D. Pedersen, E. C. M. Hølmkjær,
J. R. Johannesen, A. R. Christensen, T. B. Andersen, H. B. Juul-Nyholm***

DTU Mechanical Engineering, Technical University of Denmark

INTRODUCTION

The group has been requested by Hundested Propeller A/S (HP) to verify and expand their calculations on "sail milling". The idea is to utilise the potential energy source in the water flowing past a controllable pitch propeller when a sailing vessel is powered by its sail. Thereby reducing the fuel consumption and the CO₂-emissions.

Some preliminary estimates has been made by HP, based mainly on propeller diagrams. However, the estimates are expected to be subject to great uncertainties, due to the propeller being optimized for propulsion, rather than milling.

PROJECT CONTENTS

This project includes a scale experiment, a 3D analysis of the vortex system around the propeller blades, a Blade Element Momentum analysis, and estimates based on data for standard Wageningen propeller series. Furthermore, OSK Shiptech has agreed to model the experiment with CFD.

The purpose is to determine the relationship between relative velocity and power generation through a combination of several models and compare the result to the estimates made by HP. The possibility of optimizing the efficiency through expansion of the blade pitch range will also be explored.

The possible complications related to this project include the risk of cavitation and increased noise and vibration levels in the milling condition. It is not expected that any of these points will prove to cause major, unsolvable problems.

RESULTS AND FURTHER PERSPECTIVES

As the project is not finished at the deadline of this abstract, the results are not yet known. Given the successful result, sail milling will be a viable, environmentally friendly way of generating power aboard sailing vessels, at the cost of a minor loss of speed.

The method may even be possible to implement on fuel powered vessels when these are in the process of slowing down. This can provide a green source of electricity aboard the vessel, taking advantage of the kinetic energy accumulated in a vessel at speed. Energy that is otherwise wasted.

Simulation of a Fuel Cell

Siyong Kim

KAIST Chemical & Biomolecular Engineering,
Korea Advanced Institute of Science and Technology

Proton Exchange Membrane Fuel Cell(or Proton Electrolyte Membrane Fuel Cell, PEMFC) is one of the energy solutions that does not generate greenhouse gases and any pollutes. The sources that a fuel cell uses are hydrogen gases and oxygen gases and the only product is water. No need to worry about being exhausted of sources and no need to worry about pollutes. Furthermore, a fuel cell has an important advantage compared to an internal combustion engine in terms of efficiency. While the average efficiency of internal combustion engines is around 20%, that of fuel cells is 80%. A fuel cell is still competitive compared to a solar cell which is another promising energy converter; its highest efficiency is 11.1% and 10.6% for the case of an inorganic cell and an organic cell respectively. Additionally no moving part in a fuel cell increases mechanical attraction. Not only no noise is sounded but also the mechanical stability becomes high.

Due to its several advantages shown above, fuel cell would be the most promising energy converter in the future. Since application to vehicles could solve problems, many automotive companies concentrate on developing fuel cell cars. From this year(2014), Hyundai starts to lease fuel cell car(ix35 hydrogen fuel cell car) and the lease price is \$499/month with unlimited and free charge of hydrogen gas. Once fully charged of hydrogen gas, this fuel cell car goes 600km and the maximum velocity is 160km/h. The performance of conventional car is not fully reproduced in this car but surely this is not a bad start. Within 5 years, Hyundai plan to sell fuel cell cars. Toyota expects the price of a fuel cell car in 2020 might be competitive with a conventional car. Especially in Europe, there is a high environmental tax, fuel cell car would be more attractive.

Fuel cell car operated in high temperature(120°C) is desired because of high performance, removal of poison and half size of radiator compared to in low temperature(80°C). Several points should be considered if fuel cell is operated in high temperature. First, Nafion(long side-chain perfluorinated sulfonic acid) losses proton conductivity so it should be replaced to Aquivion(short side-chain perfluorinated sulfonic acid). Second, water evaporates and this leads to a serious decrease of proton conductivity. How to manage water in this temperature is one of important problems.

Simulation of a fuel cell will give the answer to this question. Many modeling and simulation exist but most of them are about steady-state condition while dynamic condition commonly happens in automotive condition. Only few researches showed modeling in dynamic condition and all of them concerned in low temperature where H₂O existed as water. Here I consider the condition of high temperature. The equation found by Springer is importantly used in this research.

$$\sigma = (0.005139\lambda - 0.00326) \exp\left[1268\left(\frac{1}{303} - \frac{1}{T}\right)\right]$$

where $\lambda = 0.043 + 17.18a - 39.85a^2 + 36a^3$ and $a = \frac{P_w}{P_{sat}}$,

Management of Organic Waste at DTU Lyngby Campus

M. M. Steingrimsdottir, S. V. Afshar and I. Bruhn

DTU Environment, Technical University of Denmark

INTRODUCTION

Universities have ethical obligation to act responsibly to act responsible towards the environment; they would be expected to be a leading player in the process towards environmental protection and recycling of resources. Determined in the Resource Strategy, DTU wants to recycle 40 pct. of the waste produced by 2015. As an educational institution where students spend the majority of their day, DTU has a high amount of waste production everyday, including food waste. At the moment, the food waste is incinerated together with all the domestic waste, even though the energy potential of organic waste is higher if it is used to produce biogas. This will require a sorting system, where the food waste is sorted out at the source, stored and transported separately. These additional processes will lead to higher CO₂ emissions during the handling process. To determine if segregation and recycling of food waste is feasible, a CO₂ assessment of a waste handling system where food waste is sorted out at the source and transported to a biogas plant needs to be completed.

METHODE

In this project, the focus is on S-huset and library, because those are the places where students spend a lot of time. Those places are expected to have a high amount of food waste production, because they are located close to the cantina. Moreover, if there is going to be implemented a sorting system in the library and s-huset, it will reach out to the students and have an impact in their behaviour towards sorting waste.

The aim with this project is therefore to characterize the domestic waste produced in the S-huset and the library in order to find the amount of food waste produced. Furthermore, the biogas potential in the organic waste is to be determined with a BMP test. This will be the background for a CO₂ assessment on a waste handling system where food waste is segregated and processed into biogas.

RESULTS

40% of the food produced in the S-huset and the library is food waste, which is equal to (insert amount of waste here). Based on the results from the characterization, we expect a sorting system to be feasible for S-huset and the library at DTU Lyngby Campus. Since the project is not ended yet, we can't make any conclusions.

100 percent Energy Independent Living

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Technical University of Denmark – Electrical Power

THE IDEA

The idea behind the project is to develop energy independent houses and spread the production of energy out to households all over Denmark. This will provide greater supply options and eliminate the risk of major blackouts. The idea is to develop an energy independent home by combining already existing technologies to produce renewable energy. Furthermore we will look into the benefits of smart grid in residential areas and how to store the produced energy.

THE METHOD

We have decided to start in small scale and will focus on the technical requirements for one energy independent house. We imagine the house being part of a small neighborhood of 10 houses. All the houses are equipped with various technologies to produce renewable energy and will be connected by smart grid.

The energy produced during the day will be stored for later use due to the fact that energy consumption is generally low during the day while people are at work. When the demand for energy increases the stored energy will be returned to the houses.

During the project we will look at different ways to store energy. Is it better to equip every household with a small storage tank or should the whole neighborhood be equipped with one large storage tank? And what sort of energy is most suitable for this kind of storage? Hydrogen, methane, methanol, ethanol?

We will also follow new trends and developments in laboratories all over the world.

THE PROSPECTS

We believe that this idea can be integrated in existing towns and cities all over the world. Even though the expenses are high during the installment of energy independent houses the investment will pay it self relatively quick. The dimensions are easy to adjust and most of the components can be placed underground.

Consumption of Electricity by Vending Machines

*A. Snitkjær, D. Ibrisimovic, F. Nielsen,
F. R. Jørgensen, P. C. Illum and S. C. Friis*

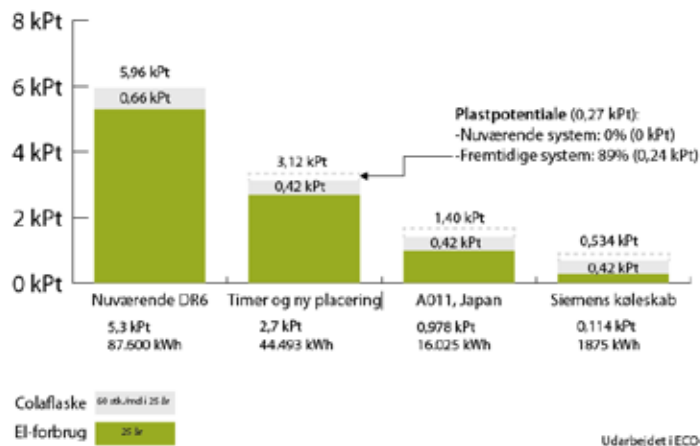
DTU Mechanical Engineering, Technical University of Denmark

ABSTRACT

The project has been completed in December 2013 and performed in Danish. The second page of this summary is a guideline in Danish for Campus Service at DTU to improve the handling of vending machines at DTU. Though the focus of the project has been national as well.

In Denmark there are estimated to be more than 20.000 soda vending machines and each of them consumes in the scale of 3.500 kWh every year. The short term potential for improvement alone will be able to reduce the electricity consumption by a factor of two. The outcome of the project has been a solution for implementing a service/system. The documentation is a brief final report containing 13 pages together with an article published in the Danish scientific newspaper "Ingeniøren" and a five minutes video posted on youtube.

ENVIRONMENT IMPROVEMENT POTENTIAL



FAKTOR

Short term: 2
(timer & placement)

Long term: 4
(new automat)

Future: 10
(instacool)

LINKS:

Article:
<http://ing.dk/artikel/en-sodavandsautomat-drikker-stroem-som-en-trevaerelses-lejlighed-164833>

Video:
<http://www.youtube.com/watch?v=z4YiNZ6thp0>

Integrated Thermal Bridge Window Glade

D. Mortensen, D. Palasz and N. Lorentzen

DTU Civil Engineering, Technical University of Denmark

INTRODUCTION

In the year of 2035, the building mass in Denmark has to be CO₂ neutral, which puts demands on energy consumption/loss in buildings - new as old. That calls for an innovation of energy optimizations. Due to the strict requirements in new buildings and energy renovation of buildings, it is very obvious to develop alternative methods to optimize energy consumption.

PURPOSE

- To minimize the linear thermal transmittance between the building shell and a window or a door.
- Removes the possibility by thermal bridges and by that removes the conditions of energy loss, condensation, mold and rot, in the construction (joints) between the window or door and the surrounding construction (material).
- To make the workflow easier and thereby reducing the construction costs in renovation and new buildings.
- The long term idea is to establish standard dimensions and enable recycling of windows and doors.
- Fast interim closing of buildings and by that minimizing the construction time.

VISUALIZATION/THE PROJECT

"Mock-up" model and presentation of the solution.

CHALLENGES/ASSUMPTIONS

- There will be manufactured molds, but then there is no greater challenge because the work process is made easier.
- Reinforcement of the material. Already exist, can be improved.
- The construction of the final mock-up, requires providing of material, cooperation with the producer or our own production.
- Calculation of the final U-value and strength. It requires that the material is procured or production ready.
- Investment for development. Very limited, cooperation agreement or funding for molding mock-up.
- The production investment is limited, but requires a slight change in the production and logistic.

Visual Nudging of User Behavior

Morten T. Egholm¹ and Bekim Maksuti²

¹DTU Electro, Technical University of Denmark

²DTU Construction and Infrastructure, Technical University of Denmark

INTRODUCTION

At DTU Ballerup Campus, the classrooms are available 24 hours a day for the students. Some students forget to turn off the lights when they leave the room, and often the light is on all night because of this. This is the waste of energy we will try to reduce.

The natural solution to this problem is to install PIR sensors to control the ceiling lights, but this has not yet been done in all rooms at Ballerup Campus, and will not be done in all rooms, because this is an expensive solution.

Campaigns with posters and flyers have been one of the main used methods to try to change this behavior of the users, but with no convincing results so far.

Sadly, we as consumers are becoming more and more immune to these types of information's, maybe because of the massive information-exposure in our daily life.

We need a method which has a better eye catcher effect.

THEORY

"Nudging" is a relatively new method, used for changing user behaviors, using indirect suggestions and positive reinforcement. It is used with great success in many different contexts and it is a method created to help the user to make the desired/right choice. Nudging changes the structure for the cognitive memory which helps with future decision making. It is based on rationality and not on inappropriate desire.

METHODS

To achieve this nudge effect on the users, we have developed a sign, made of acrylic plastic. It has the shape of a light bulb, and is approx. 20 cm high. The sign is placed right above the light switch at the exit door inside the classroom. It lights up for about 2 seconds when someone approaches the door. The bulb-sign has imprinted the text "Turn off the light, please". The shape (light-bulb), light and placement of the bulb-sign is designed to achieve the nudge effect.

To measure the effect of the bulb-sign, we developed an electronic logging system. It was sensing if the ceiling light was on and if there where motion in the room (people in the room). First we did 3 weeks logging of 3 classrooms to have a reference. Then we placed a bulb-sign in each of the 3 classrooms and kept logging the behavior with the bulb-sign installed.

CONCLUSION

The logging system showed a 51% waste of energy in the reference period. This means that half of the time the light was on, there were no movement in the classrooms.

With the bulb-signs installed the logging system showed that the waste was reduced by half, now the waste was 25%.

The bulb-signs thereby showed a clear impact on the users.

We presented the solution to Lisbet Michaelsen and Anders Gerhard, at CAS BMS, DTU Lyngby. They ordered 60 bulb-sign from us, produced at DTU, and used them in the "Brug Fingeren"-campaign last fall at both Lyngby Campus and Ballerup Campus.

SMEG – Sustainable and Mobile Energy Generator

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DTU Electrical Engineering, Technical University of Denmark

In today's modern society, we face a need to reduce the use of fossil fuels and thus we see an increased focus on sustainable and environmentally friendly technologies as part of the solution.

Our contribution to this global development is to develop a sustainable "Green" mobile off-grid generator, which could prove superior in numerous applications:

- Emergency backup for remote off-grid institutions (military, humanitarian aid, research centers)
- Repurpose used battery pack from electric vehicles
- Balance the power grid infrastructure when on-grid
- A platform to showcase the state of technological advancements in the field of sustainable technologies

Initially we expect a finished product to deliver and hold enough power and energy to support a stage at the Summer Festival in Copenhagen Harbor (our partner during the development).

In order to design a mobile system, we have to look for lightweight, robust and cost-efficient technologies. In recent years, the industry has mostly been focusing on advancing technologies to harvest sun and wind energy. Thus, our design relies on an intelligent storage solution supplied by solar panels and small wind turbines in combination with an energy management system.

By measuring data at the DTU Annual Commemoration Day, we will be able to estimate desired energy capacity and power transfer capabilities of the energy storage for the energy management system. Our prototype consists of a Tesla Smart ED battery for electric vehicles, which we analyzed and reconfigured extensively.

We have yet to finish our analysis of the battery pack and to determine how to intelligently store the energy obtained from the photovoltaic and wind turbine system, but we expect to have a finished design to showcase at the GRØN DYST conference day.

Furthermore, we hope that our project will inspire future students at DTU to engage themselves in the development of green technologies.

Solar Panel Positioning Software

M. D. Bennike and R. R. Vind

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INTRODUCTION

This project aims to provide an easy and accurate method to position a solar panel at the most optimal angle and tilt. The solution is based on a Mobil application that utilize the GPS and accelerometer in a modern mobile phone to enable the user to position their solar panel quick and easy, no matter where they are located without requiring an internet access.

The aim is also to make the app as versatile as possible; to make it usable both on mounted panels on roofs as well as small panels used for outdoor activity.

Another aspect we would like to focus on is the steady rise of smartphones in 3rd world countries where consistent electricity supply is rare. With this app the efficiency of solar panels in such areas could be greatly improved, resulting in greater independence from faulty national electricity grids.

	<i>Fixed</i>	<i>Adj. 2 seasons</i>	<i>Adj. 4 seasons</i>
% of optimum	71,1%	75,2%	75,7%
Percentage of optimal output based on times adjusted per year ¹			

The gain of around 6% from fixed to adjusting 4 times per year presumes that the fixed panel has the correct orientation and tilt, something which this app will help with.

THE APPLICATION

The prototype application is developed on the Windows Phone platform.

It works by taking the GPS input and the current time and date from the phone, to determine the most optimal angle for the panel. When the user places his phone on top of a solar panel, the app utilizes the build-in accelerometer of any modern phone in order to help the user align the solar panel in the most optimal angle, using GPS-data, time and date as well as alignment of the phone.

FUTURE DEVELOPMENT

We would like to be able to extend development to both Android and iOS in order to reach a greater range of consumers. Another big improvement we would like to take on in the future is the design of a mobile tracking device which a user can fit a solar panel onto, and have the device autonomously track the sun.

This could either require constant connection to a smartphone, via. USB, Bluetooth or even WiFi, or be a closed system with its own sensors.

¹ Table 1 - Charles R. Landau Software Engineer, <http://www.solarpaneltilt.com/>

Bio-Inspired Sun-Tracking Device

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Introduction

The target of development is to use a bio-inspired design approach, looking at nature's own mechanisms to come up with a simpler and more reliable way of tracking the sun. We find a non-electronic and mechanically simple sun-tracking device to be highly applicable in developing countries amongst others, driving greener development.

Theory

We will be using thermal expansion-theory and radiometry. And we will also be touching the field of fluid mechanics in our proceeding work.

Methods

The idea was first brought about in a biomimetic course focused on the solutions to problems already found in nature. In the development, we aimed at producing a working prototype as a proof of principle.

Results

The biggest environmental impact reduction, derived from our life cycle check, is in the usage phase of the product. The bio-inspired device uses zero amount of external energy to function! Compared to other sun tracking devices, we save 5.8% of the total output of the solar device from the zero energy use (Salsabila Ahmad, et al 2012). A bio inspired sun tracker implemented on a 6000w solar cell device, will save up to 7,9% of the energy consumption of a home of two average Danish persons. Furthermore a normal car mechanic will be able to repair the device and the most complicated parts can be made in a normal machine shop (turning, milling, welding etc.) and thus expanding the product life expectancy in undeveloped areas. Also easing the implementation of the device in such a part of the world considerably, facilitating a local power supply in third world countries.

References

Salsabila Ahmad et al. / Procedia Environmental Sciences 17 (2013) 494 – 502

Energy optimization of refrigerating containers

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INTRODUCTION

Refrigerated (reefer) containers are used for transportation and temporary storage of food and other temperature sensitive products. During the period of Roskilde Festival more than 100 food stalls prepare and serve food for hungry festival participants. To secure the hygienic standards most of the food stalls utilize refrigerated containers as large refrigerators. These containers consume large amounts of precious energy. This project aims at optimizing the energy consumption of these containers, hereby making them more environmentally friendly and sustainable. An experimental study will be conducted in collaboration with Roskilde Festival.

THEORY

Refrigerated containers for outdoor venues are usually exposed to sunlight and a reasonably warm summer air. Even though reefer containers are well isolated, a heated surface will still increase the container's power consumption.

A thermodynamically system will strive for mechanical, thermal and chemical equilibrium. The container will therefore strive to obtain equilibrium by equalizing pressure, temperature and relative humidity with its surroundings. This can be exploited by applying water to the surface, where it will evaporate and extract energy from its surroundings whereby the temperature of surface decreases, much alike what sweating does for the human body. The evaporation process can be made even more efficient by the use of a hydrophilic surface. Water on a hydrophilic surface, such as TiO_2 , will cause the angle of contact to decrease, hence causing the water to spread as a thin layer instead of forming droplets.



Cooling container with irrigation system

CONCLUSION

The theoretical results shows that by applying a continuous thin layer of water to the roof of the container will cause the energy flow from the surroundings into the system, to be reduced by up to 50% and reducing the power consumption by up to 75% on a summer day. The energy flow depends on the weather conditions such as the relative humidity, temperature, wind speed and the sun irradiance. Furthermore a thin layer of water will evaporate faster than droplets and thereby increase the potential of evaporation.

Utilizing a thin layer of water to reduce the absorbed heat can be used in other applications such as for buildings and high-rises in order to combat the urban heat island phenomenon.

Pesticide Spraying with UAVs in Agriculture

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Pesticides used in agriculture are commonly considered as a burden, and recently further restrictions to the spraying volume have been made to protect the environment. An Unmanned Aerial Vehicle (UAV) is a solution to minimize the amount of pesticides when applying poison to weed and fungi-infected crops.

Utilizing UAVs as a supplement to traditional trailed sprayers carries many advantages, e.g. they can work at the most optimal hours of the day regarding wind conditions and humidity, and expensive man-hours are not a cost. Because of total mobility, UAVs can spray on rough grounds and avoid tramlines, thus having the smallest possible impact on the crops. But most important is that only weed- and fungi-infected areas are sprayed with pesticides, keeping the crucial pesticide volume to a minimum.

As a proof of concept we want to present a spraying and refill mechanism that could be used with an UAV. A system for automatic battery shifting will also be presented in order for the solution to be fully autonomous. Only mechanical aspects of aerodynamics and vibrations will be taken into account because of limited time, so some of the electrical problems might not be completely solved.

The agriculture is a traditional field but during the last decade there has been quite some development in the adaption of new technology, e.g. mapping methods for classifying weed species are already a reality and software for cooperation between UAVs are fully available and under further development.

Thus in the future, seeing the farmer managing the protection of his crops is not completely science fiction.

Sustainable lake-cooling

Caroline Rossing, David Bond, Nicklas Funk, Mathias Bahrenscheer

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WHAT?

This project was developed in the course 'Thermodynamic modeling' with Brian Elmegaard as our supervisor and the basic idea is to use the difference in temperature from the underground or in this case, a lake, and the surroundings above, to cool a container and its contents. The concept was developed with use at the Roskilde Festival in mind, since there is a large, deep lake, which is a relic of the area's time as a gravel pit.

A limited part of the lake serves as bathing lake and with 20,000 daily bathers a huge success. However, we believe that the lake has even more potential.

The cooling of canned beer is done today, by large refrigerated containers connected to the grid; the single most energy-consuming activity at the Roskilde Festival. This can be done smarter - with a solution that uses the festival environment, for a more energy-efficient cooling, based on the cold water from the lake's bottom.

How?

Instead of immersing the beers down in to the lake, we will bring the cold water up to the beer. We intend to do this by pumping the cold water, into a well insulated container using a submersible pump. In the container the water will circulate in a pipeline and the surface of the tubes would then provide for a heat exchange. Finally the heated water will flow down into the lake again.

It should be noted that we are working on the assumption that the container must be able to cool twenty degrees warm beer to about ten degrees.

CONCLUSION

So far, we have determined our cooling need required to cool down a container full of beer (69000 beers), the necessary mass flow of water, the necessary length and dimensions of the pipes to attain the needed heat transmission, and the necessary power and type of pump required for this (a Grundfos Magna 3 (50/100)).

All things considered, this way to create refrigeration, should be upwards ten times more energy efficient than the currently used method (standard refrigeration containers).

The calculations for the above have all been approved by our supervisor.

Sharing knowledge at DTU

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INTRODUCTION

This project deals with how students and educators at DTU can share knowledge in a more efficient and sustainable manner. Students are now using both digital platforms and at the same time printed paper. This is not beneficial considering the separation of communication media and also raised environmental impact caused by the printing system. This system is again not structured in an optimized way which again cause an unnecessary use of resources. Instead of just reducing the negative environmental impacts from printed paper including; power, paper and toner this project aims to turn the situation around and focus on what printed paper represents: the sharing of knowledge. It is also a fact that DTU as an institution want to be among the best regarding educational practice, while also embracing new ways to be more efficient and sustainable.

METHOD

This concept has been based upon an Life cycle check and MEKA on the present use of printed paper and related technology at DTU. This was followed by a schematic overview of the different stakeholders and their related activities. The stakeholder's contribution was taking into consideration though interviews and observations. All of this has been used to make qualified estimations on environmental and social impact which has made the framework for development of this concept.

CONCEPT

The digital and the physical (printed paper) platform for translation of knowledge are being used at the same time. This leads to an unnecessary high use of resources among students and educators in relation to the use of printed paper and the related technical network. The noticed trend is that both students and educators are moving from the physical to the digital platform but not simultaneously and it is happening in a very incoherent manner. The concept tries to increase the academic level among students at DTU and at the same time improve the knowledge sharing between students and educators but also the shared knowledge internal between different departments of DTU; LearningLab, IT-service, students and educators. This concept also deals with the issue of reducing the high use of resources related to the printed paper and the related technical network. It is important that somebody is made responsible for knowledge sharing and doing this in a sustainable manner. This responsibility will be placed on a taskforce containing employees from both LearningLab, IT-service, educators and also students. Basically there is no need to hire help from outside - there is just a need for some reorganization. All of this will lead to coherence all through DTU regarding knowledge sharing both the digital and physical platform. LearningLab is responsible for teaching students and educators in knowledge sharing methods and printing. IT-service is responsible for the main technical system and the digital platform. Each institute have their own technical support which is in charge of the local set up within the data bars. A new task force consisting of students, educators and employees from both of the groups mentioned above is responsible for *good knowledge sharing*. With the involvement of key stakeholders though the taskforce we make sure that these stakeholders share relevant knowledge on the subject and that they get a higher degree of ownership towards the concept.

Facilitation of green commuting through electrical

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INTRODUCTION

Due to DTU's relatively remote location, there are a high number of daily commuters to and from DTU. This is associated with a massive amount of transportation, which causes a high environmental impact. This environmental impact gives motivation to investigate whether it is possible to change people's travel behavior, so that the environmental impact associated with transportation to and from DTU is minimized.

METHODS

Based on studies from the Danish Ministry of Transport and information from Danish energy and transportation companies the average emissions per person for the four most used transportations methods (car, bus, train and bicycle) were derived.

The distribution of commuters on the four transportations methods is based on a study made by DTU Transport and a survey with response from more than 700 students and employees.

GREEN WHEEL DEAL

Green Wheel Deal is a product service system based on an existing product where people connected to DTU can subscribe to an electrical rear wheel, which can be applied on any common type of bicycle. The wheel transforms a normal bicycle into an electrical driven bicycle that is controlled by a smartphone. DTU students and employees subscribes on DTU campusnet and can pick up the wheel at the HQ located at DTU or at any of the collaborating bicycles shops in Lyngby or Copenhagen. In the event of a malfunctioned wheel the customer can quick and easy exchange the broken wheel for another one free of charge at any of the pick up points.

CONCLUSION

A conservative estimate based on the answers from the survey is that 30% of the commuters using car, bus or train convert to the product service system. With this estimate it will be possible to reduce DTU's commuting related emission of CO₂, NO_x and particles, with 26%, 30% and 24% respectively. Furthermore it is possible to offer the product service system at a considerable lower price than the expenses related to commuting by car, train or bus. This will render Green Wheel Deal even more attractive, especially to student living on a budget.

Power from Vehicle Movement on Bridges

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BACKGROUND

The quest for non conventional sources of electricity is a continuous one and any idea that sounds feasible and can generate electricity without fossil fuel is always welcome. Further, if such electricity can be sourced without actual consumption of any materials and without any adverse effect on the environment, it is an additional bonus.

This note elaborates a source of electricity that is very unique and original.

GENERATION OF ELECTRICITY

The generation of electricity takes place when a loop of wire or disc of copper is made to rotate between the poles of a magnet. In this process, mechanical energy is converted into electrical energy. This is the most popular method of generating electricity.

CONCEPT OF POWER FROM VEHICLE MOVEMENT ON BRIDGES

Infrastructure development has been a major factor in India's growth story. An important aspect of this has been the construction of highways and other roads across several parts of the country. Considering the vastness of the country, such highways have also needed many bridges across rivers and low lying areas. The bridges along high ways as they are constructed in modern times consist of RCC / Pre-stressed concrete deck with joints on piers (Expansion Joints) to allow for thermal expansion. These gaps are filled with expandable materials to accommodate thermal expansion / contraction.

In the proposed system, this gap will be filled up by a special rubber that will have special elastic properties. Every time a vehicle moves on the bridge and passes over the rubber in the gap, the rubber strip is pushed downwards and comes up again due to this elasticity. This up-down movement of the rubber strip when converted to rotary motion can be used to generate electricity.

CONSTRUCTION OF BRIDGES

Bridges are constructed with columns and beams that support the slabs. These slabs could be concrete slabs or asphalt slabs. Depending upon the span of the bridges, certain numbers of slabs are used. While laying the slabs, certain gap is maintained between slabs. This gap allows for expansion / contraction and the gaps run across the width of the bridges. Generally, these gaps are filled with asphalt which moulds itself to the available gap.

BENEFITS OF THE PROPOSED SYSTEM

The proposed system for generating electricity has the following advantages: Eco friendly – There is no consumption of any natural resource and no generation of any harmful pollutants. These systems can support small communities around the source of electricity generation. Since highways criss-cross the country and pass through very remote areas, it is possible to provide electricity to remotely located communities where transmission could pose problems.

Utilization of Bicycle Break Energy

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INTRODUCTION

With increasing focus on the environmental issues of our planet, the beneficial ways of bicycle transportation has never been more topical. Especially in flat European countries like Denmark and Holland, the bicycle is very applicable for trips both of short distances as well as longer distances like 10 kilometers or even 20 kilometers. In the search of making the bicycle an even more attractive alternative to the car for transportation, this project seeks to find a way to store the energy used for braking when stopping the bicycle, and utilize this energy when starting again. The solution should be entirely or almost entirely mechanical, as mechanical solutions tend to be favorable when it comes to implementation, maintenance, and so on.

THEORY

Different technologies for storing energy mechanically include springs - both linear and torsion springs - and flywheels. The different possible solutions come with different advantages and disadvantages, and among the critical focus points are weight, strength, volume, friction and effectiveness. Since this project is made as a part of the DTU course '41801 Fagprojekt' which stretches from January to June, the solution has yet to be definitively decided.

METHODS

Literature studies have been made amongst the group members individually in order to make most of the effective work hours. These studies have included researching springs, flywheels, clutches, cables, gears, materials, and so on. Furthermore, experiments have been conducted in order to determine the common acceleration and deceleration when riding bicycles. Forces, torques, etc. have been calculated using the laws and formulas of physics. Regarding shape and design of the mechanism, the method of systematic product development has been utilized.

RESULTS

As before mentioned, this project is an ongoing process and hence no actual results have come of our studies yet.

Two Wheeled Balancing Robot

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INTRODUCTION

In today's modern world there are several different types of personal transportation. One of the more interesting ones is the two-wheeled balancing robot. It seems fascinating that this vehicle is able to keep upright while having a person driving it. The goal of this project is to build a similar vehicle. We will build the mechanical structure; design and build the electronic hardware and write the code for the microcontroller.

METHODS

The angle of the robot is usually determined using an accelerometer and a gyroscope. The measurements from the sensors are effected by noise, which makes the use of a filter necessary. We will use a Kalman filter implemented on a microcontroller. A PID-controller uses the input angle to output a signal to the motor driver. To monitor the data from the robot and the state of the system, an Android smartphone will be used to display values sent from the microcontroller. To make the tuning of the PID-controller efficient and easy, it is desirable to be able to adjust the PID-values while the robot is running.

LEGISLATION AND SAFETY

The robot is in the category of "electric one-axle vehicles" for which there has not yet been made any final legislation. Until the end of 2014 they are regarded as bicycles with a speed limit of 20 km/h (Trafikstyrelsen 23.12.2011).

To ensure a safe ride on the robot we will implement several safety features:

- Automatic stop when user dismounts
- Ensuring that the robot don't fall due to the motors reaching max speed
- Limit turning radius as the robot speeds up

The goal is to make the robot reliable and safe to ride and to minimize the risk of an accident.

GREEN IMPACT

The robot should be used for personal transportation over short distances instead of taking the car or going by moped. If this is achieved, the product will have a positive green impact. It is driven by electricity and is charged from normal power outlets. Powering the robot will thus be as green as the electricity while it will also be saving fossil fuel.

REFERENCES

Trafikstyrelsen 23.12.2011. Forlængelse af forsøg med elektrisk drevne en-akslede køretøjer (Segway o.l.). Retrieved 21.05.2014 from:

<http://www.trafikstyrelsen.dk/~media/Dokumenter/01%20Syn%20og%20koeretoer/03%20Regler%20om%20koeretoer/01%20Regler%20om%20koeretoer/Meddelelser/1964.ashx>

Modelling of Water Tank

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Everywhere in the world people, face problems related to water. In some places massive amounts of precipitation produce, disastrous floods while other regions gets so little rain that it can be difficult to obtain enough drinking water. In Denmark, we do not experience problems with getting drinking water because we have fair amounts of precipitations throughout the year. In the northern parts of Algeria, the average annual rainfall is almost the same as in Denmark, but the rain is more unevenly distributed with a dry period in the summer and a rainy winter. In this project, the effect of a rainwater storage tank is investigated with emphasis on the tank's behavior in the Danish and North Algerian climate. The tank collects water from the roof of the house, which then is used in the house for toilet flushing, and thereby replaces water of drinking water quality. The investigation of the behavior of the tank is done by making a rather simple water balance model in both MATLAB and Excel. Data used in the models is daily precipitation data from the European Climate and Dataset database for the last 30 years. Variables in the model are the roof area and tank volume ratio, the daily water usage in the household and the precipitation patterns. The outputs are the amount of water in the tank every day, the amount water overflowed from the tank, and the amount of water supplied to the tank in case of draught. The results are displayed in graphs showing the impact from the tank/roof ratio and water consumption on overflow and additional water supplied in both countries. From the results, it is clear that persons wanting to implement a rainwater tank should take the water consumption of the house into account, because inadequately sized tanks lead to a higher amount of either overflow or added water than necessary, thus reducing the costs and the environmental benefits. It is evident that the roof area/tank volume ratio is more important in Algiers in order to reduce the drinking water usage and prevent overflow from the tank, meaning that it pays off to invest in a bigger tank. In Copenhagen, the influence from the tank/roof ratio is less important and mostly makes a difference for houses with very high water consumption. This means that in the Copenhagen area it would be more of a waste to invest in a very large tank than in Algiers, where added volume to the tank results in reduced overflow and drinking water consumption. The reduction in drinking water consumption is bigger in Copenhagen than in Algiers due to the mere evenly distributed rain. The rain distribution is also the reason why the overflow in Copenhagen is generally higher than in Algiers. It is concluded that the tank can help both countries saving drinking water, but is less efficient as a solution to prevent floods, because the uncertainty of the amount of water in the tank makes it a very unreliable solution.

Alternative Ashes in Concrete

A.K. Huntley and R.K. Mathiasen

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INTRODUCTION

The ZeroWaste project students have been involved in classifying, testing, upgrading and developing new use of ashes, first of all focusing on sewage ash from sewage water treatment plants where the future global phosphate-shortage is taken into consideration since sewage ashes contain considerably large amounts of phosphor.

MAIN APPROACH

The ZeroWaste group at DTU Byg has developed methods for cleaning the ashes for pollutants (as heavy metal) and valuable materials (as phosphor), so the use of the ashes will have no environmental risk. In order to show, that cleaning the ash for heavy metals and phosphor, is indeed beneficial, phosphate has been added to a reference-mix, and tested for strength. As the phosphate affects the concrete in a negative direction, it will show how the cleaning-process is not only beneficial for the environment, but also for the compressive strength. The remaining ash can, however, not directly be used in concrete, bricks, road building or other applications as there may be problems with difficult mixing and mix designs, increase of porosity and loss of durability, strength development and final strength etc. The authors have in their project works focused on using ash in concrete and has shown that up to 20 % of the cement and up to 10% of the sand can be replaced with the sewage ash. This process reduces the water requirements, maintains the strength of the mix fairly well and still allows the mix to set and develop strength with the same speed as traditional concrete.

MAIN RESULTS

A range of ashes has been screened and used for concrete and mortar production and shows very promising results: There is at the moment no doubt that all the produced sewage ash can be applied in the concrete production and that the ground ash can replace a similar amount of cement.

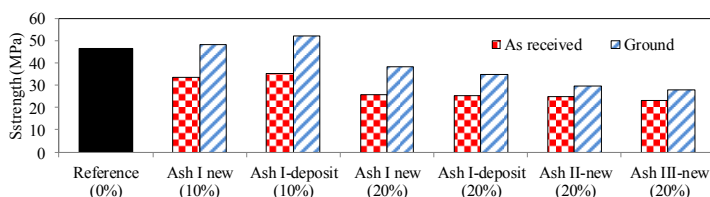


Figure 1 A few results with replacement of cement and/or sand in the mix.

The LCA must be completed later, when the process is fully known, however, it should be mentioned that grinding of ash is the only energy consuming procedure and is expected to require less energy than the grinding of the traditional cements clinker. The concept of cleaning the ashes and upgrading them to be a renewable source of environment-friendly materials for concrete or other building materials is seen as a winning approach: It can replace cement and reduce sand consumption and still maintain or improve the quality of the building materials. Furthermore it will be possible to extract reusable phosphor during the cleaning process of the ash, which is both an environmental benefit as well as an economical.

Strengthening Capacity to Address Climate Change for Small and Medium-sized City Development: People's Republic of China

Joohye Lim, Hwasoo Yeo

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INTRODUCTION

This is a research report that was done under guidance of Asia Development Bank (ADB), for sustainable urban development in People's Republic of China. In PRC, rapid urbanization is expected to accompany rapid increase of greenhouse gas emissions and accordingly serious environmental problems. The central government of the PRC was seeking for ways of low carbon development (LCD) to manage such problems, and had some notable efforts in reducing GHG emissions in large cities such as Beijing and Shanghai. However, small and medium-sized cities are far behind in terms of sustainable urban growth, while such cities are expected to get better and to expand very rapidly. Thus, the study was done to pursue LCD strategies to be suggested to PRC government, and the work was divided into four teams, such as urban management, land use and transport planning, energy, and waste and resource management. In this paper, KAIST team took land use and transportation planning. Along with national (Chinese) expert project coordinator, the study team attempts to increase SMC's energy efficiency while decreasing carbon emission per unit GDP. The aim of this study is to assist government in addressing climate change and urban LCD by strengthening the capacity of SMCs

THEORY AND METHOD

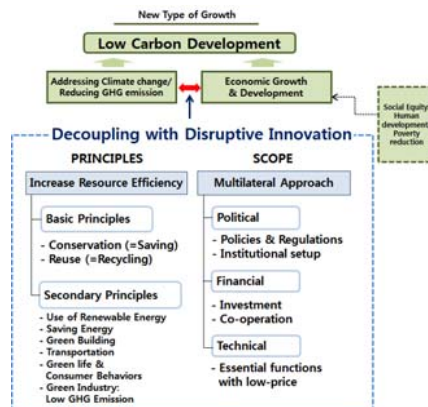


Figure 1 Concept of LCD

As shown in Figure 1, the first step was to re-define LCD. Especially in terms of land use and transport planning, we did in-depth research about the national trends, major barriers for LCD, review about policy review of LCD and GHG emissions in PRC. Then, according to newly defined LCD, we chose selection criteria of good practices to benchmark, which included financial support, residential participation. Then according to framework of selection criteria, among 100 practices, we could defined best-fitting practices for LCD in PRC.

Ecological Corridors: Essential for a green future?

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The ever-increasing population creates the need for more homes and larger industrialized areas. This fact is relevant to virtually all cities in Scandinavia today, but may come at the expense of important wildlife habitats and ecosystems, which are in danger of habitat fragmentation. In this project, we therefore focused on ecological corridors, or wildlife corridors, and looked closer at the importance of the wildlife corridors in Trondheim.

The fragmentation of ecosystems is a known problem for biodiversity in the whole world. Roads, settlements, or other forms of human interventions, create artificial barriers between habitats. As a result, different populations no longer meet, and gene flow is reduced by making it more difficult to find an unrelated mate. In addition, it becomes harder for migrating animals to find new resources or re-colonize areas where species have gone extinct. One solution to this problem could be found in ecological corridors. They function as transitions between fragmented nearby habitats and promote the distribution and migration of individuals, and thus the exchange of genes. In Trondheim, there are particularly two corridors of importance: The Leinstrand corridor and the Leirelv corridor. These link the two big hiking areas near the city that are used for recreational activities. The passages are also subject to strong pressure from developers, and construction interests are threatening the sites. Because of this, we wanted to know how important the biodiversity, which is at risk if the corridors are to be removed, in the hiking areas and in general, is for most people. We hypothesized that citizens might not be aware of the function and importance of the area, and our goal therefore was to inform hikers and other nature lovers.

During this thesis, we found that wildlife corridors in Trondheim are of vital importance for migratory species such as moose and deer, bats, and the critically endangered hazel hen. To identify how most people feel about biodiversity in relation to construction needs we conducted a survey that was distributed via social media and email, and answered by over 350 people between 16 and 67 years old. Of those, only 1.52% stated that residential development is always more important than biodiversity. The corridors have been shown to be a crucial factor in avoiding habitat fragmentation between the eastern and western parts of Trondheim, and are not only important for the conservation of animal and plant life, but also for recreation and hiking for the people living in the city. It is therefore particularly desirable to preserve these areas and invest in residential densification in places that do not endanger sensitive natural habitats. Our conclusion was that the people living in Trondheim, and the driving force behind private development plans, needed to be informed of the function of the Leinstrand-, and Leirelv corridors. We therefore designed an educational poster that hikers and residents around Leinstrand and Leirelv might find informative and interesting. Furthermore, we are planning an article in the local newspaper to make people aware of the issues, so that hopefully more informed choices can be made.

Sewage Sludge Ash in Reinforced Concrete

J. S. Andreasen and L. Jørgensen

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The production of cement is responsible for 5 % of the global CO₂-emissions (Development, International Energy Agency and World Business Council for Sustainable, 2009). It is thereby desirable to reduce the amount of cement used by replacing it, or part of it, with another material. Today the concrete industry is experienced in using fly ash from coal combustion. This project investigates how addition of incinerated sewage sludge ash (ISSA) to concrete affects the corrosion environment for reinforcement bars.

This project used ISSA from Lynetten treatment plant. Relevant properties of the ISSA are investigated such as pH, Water Solubility, Water content, Content of organic materials, Electrical conductivity, and particle size. Furthermore the content of heavy metals and soluble anions in the ISSA was investigated. Tests were carried out on mortar samples as the mortar has smaller aggregates (<4mm) and therefore is more homogeneous than concrete. The castings were carried out according to the recipe from DS/EN 196:2005 (w/c-ratio: 0.5). Three types of mortar samples were used: Reference samples, samples where 10 % of the cement were replaced, and samples where 5 % of the sand was replaced. The mortar samples were investigated for changes in diffusion of chlorides, capillary suction, density, porosity, and samples with reinforcement were placed in an air-saltwater-cycle for investigating changes in chloride-induced corrosion. Generally the lab-test did not indicate critical properties for the ISSA from Lynetten. There was however found a content of heavy metals, which compared to the demands in the Danish legislation 1662 (Danish Ministry of the Environment, 2010), falls in category 2 hence its use is restricted for certain civil works. The properties of ISSAs generally seemed to vary between different batches from the same sewage sludge plant. Most of which can possibly be explained by differences in the efficiency of the combustion. The test on the mortar samples yielded the following conclusions. The tests regarding density and diffusion of chlorides did not indicate any changes. The porosity indicated a little tendency that replacing cement with ISSA might lower it slightly. The tests for capillary suction showed an increase when cement was replaced. Visual inspection of the samples with reinforcement did not show signs of corrosion after 2 months in the air-saltwater-cycle. Potential measurements suggested at first that the samples with ISSA would corrode faster. After 20 days this was however no longer evident.

This project has not found critical evidence that addition of ISSA to concrete will increase the risk of corrosion significantly. However there was found a high content of heavy metals and a significant variation between batches of ISSA from the same treatment plant. This needs to be handled before commercial use. However if handled, there is found no arguments against replacing cement with ISSA in this project. Thereby the cement industry is a possible consumer of waste from the sewage treatment plants and it is at the same time possible to reduce the CO₂- emissions from the cement production.

BIBLIOGRAPHY

- Danish Ministry of the Environment. (2010, December 21). *www.retsinformation.dk*. Retrieved 11 12, 2013, from <https://www.retsinformation.dk/Forms/R0710.aspx?id=134831>
- Development, International Energy Agency and World Business Council for Sustainable. (2009). *www.iea.org*. Retrieved May 15, 2014, from <http://www.iea.org/publications/freepublications/publication/Cement.pdf>

Sewage Sludge Ash in Concrete – Studies of Usability

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ABSTRACT

Of both environmental and economic reasons, the usability of ash from sewage sludge, sludge ash, is interesting to examine. If sludge ash can be used as a substitute for cement or sand, in the manufacture of concrete, both the environmental impact from transport and deposit of sludge ashes in other countries can be eliminated. Furthermore the reduced need for cement, which is a heavy environmental cost, means a cleaner concrete and can save the concrete manufacturer material costs. Earlier waste products as coal fly ash and microsilica, which came from power plants and as a byproduct from metal alloying, are now used in concrete in order to optimize it. This means that they have changed status from a waste product, which is an environmental impact, into a useful product which improves the properties of the concrete.

The characteristic qualities of sewage sludge ashes must be determined because, the content of salt, and the quantity of heavy metals are really important as the salt might cause corrosion in a reinforced concrete structure and heavy metals might be dangerous and therefore harmful to the neighboring environment. . Earlier studies have showed that the sludge ash in some cases acts like a pozzolane. In addition to the ordinary aggregates in concrete, pozzolanes can be added and this might have an impact on the strength, the degree of packing and the water/cement ratio.

In order to determine the content of heavy metals and chlorides were an Ion Coupled Plasma (ICP) apparatus and an Ionchromograph (IC) used. The sludge ash impact on the strength development was tested according to DS/EN 196-1. Several mortar specimens with different content of sludge ash were tested. Some specimens had milled sludge ash added in order to investigate the improvement of the packing of the concrete, if any.

The chloride content in the sludge ash was measured to 96.53 mg/kg. This means that the mortar specimens with the highest amount of sludge ash had a chloride content of 0.003 %, which was below the limits given in DS/EN 206-1 at 0.1-1.0 % for armed concrete. The amounts of heavy metal were determined to be in usage category 2 according to the Danish Environmental Protection Agency (DEPA). This means that the sludge ash has limited usage within construction.

The strength development shows that by replacing up to 10 % of the sand with the milled sludge ash, the compressive strength increases by approximately 25 % after 28 days of hardening compared to a reference mortar. By replacing 10 % of the cement with the milled sludge ash, the mortar specimen achieves the same compressive strength as the reference mortar after 28 days of hardening.

The sludge ash meets the requirements for usage category 2, from DEPA, regarding the heavy metal content. The chloride content for the sludge ash complies the requirements from DS/EN 206-1 regarding armed concrete.

By replacing cement or sand with milled sludge ash was the compressive strength at the same level or approximately 25 % above the reference. This could indicate that the milled ash increases the degree of packing or has a pozzolanic effect. This study shows that the sludge ash could be the next waste product used in concrete.

Biogas fueled Solid Oxide Fuel Cells

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Due to the increasing amount of renewable energy in the power network different energy conversion and storage technologies are needed to balance the fluctuations in the grid. One attractive storage medium is fuel derived from biomass. However, given that biomass is a raw resource one should bear in mind that food production has first priority. Hence fuel derived from biomass, like biogas, has to be used in an efficient way. Whereas in commercial biogas power plants biogas is burned off with low efficient combustion engines, solid oxide fuel cells (SOFC's) could be a more efficient alternative. Furthermore most biogases are unattractive for combustion engines due to their low heating values. With SOFC's, which can be operated at temperatures between 700°C and 1000°C, it is possible to convert hydrogen or carbon containing fuels, as for example biogas, directly into electricity and the side product heat in a highly efficient way (see fig. 1).

Biogas consists mainly of CH_4 (50-70%) and CO_2 (30-50%) and some traces of other gases such as sulfur compounds. Due to the nickel containing anode of the SOFC internal reforming of CH_4 is possible and thus a direct feeding of biogas. To prevent carbon formations during this process an additional reforming agent like CO_2 (which biogas already contains) or steam has to be considered.

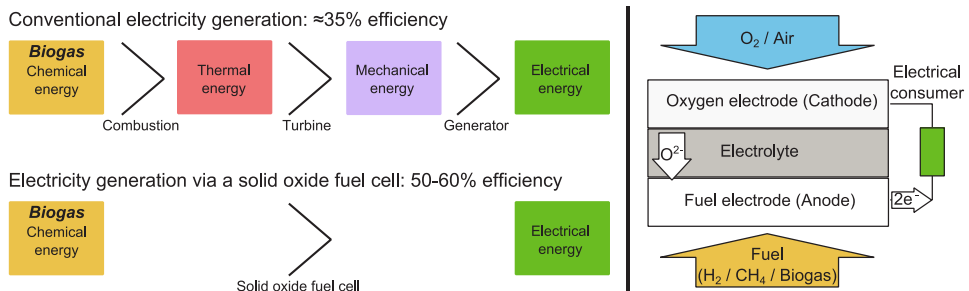


Figure 1: Electricity generation options from biogas (left). Working principle of a SOFC (right).

Experimental results (fig. 2) show that it is possible to operate a SOFC with pre-mixed biogas and the use of the internal reforming process of CH_4 .

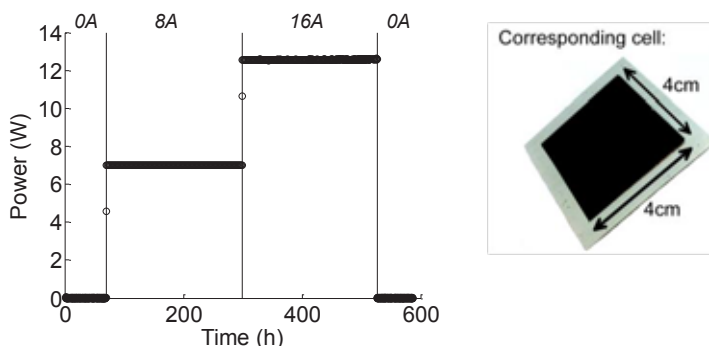


Figure 2: Power of a pre-mixed biogas (60% CH_4 , 40% CO_2) fueled SOFC with a current up to 16A at 850°C. Anode gas composition: 50% biogas, 40% H_2O and 10% H_2 . Cathode gas: Air.

Demand Response to Integrate Wind Production in Power Systems

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ABSTRACT

One of the major challenges faced by current power systems is the integration of renewable energy sources contributing fluctuating energy and one of the solutions is using flexible demand response to shift demand to periods with lower demand or periods with high penetrations of renewable energy. This report has focused on the potential of demand flexibility arising from the high thermal inertia of well- isolated buildings and we have proposed an optimal power flow model including traditional fossil-based thermal generated power, wind power production units, a DC load flow to represent a transmission system and a thermal model of flexible customers' houses. This model allows us to determine the optimal amount of flexible demand required to integrate a given amount of renewable energy production at the minimum cost. We can also determine the optimal location of this flexible demand in the transmission network.

Through the work of this report we are able to conclude that flexible demand response through thermal inertia of well-isolated buildings can to a great extend be used to reduce wind power production imbalances. Although for low wind penetration levels flexible customers do not add too much value while medium wind penetration levels only provide a small amount of flexibility therefore only a small amount of flexibility provided by all the customers is needed to integrate this amount of wind penetration. Generally, that the more flexible customers are, the more wind penetration can be integrate using only thermal inertia in buildings, and for high wind penetration levels customer flexibility is very much needed to utilize the entire power production. Furthermore, the value of having flexible customers depends on the flexibility of existing thermal power generating units, the wind penetration level and the willingness of the customers to deviate from the comfort temperature.

Adding Structural Resolution to Edges in Protein Interaction Networks to Distinguish Driver and Passenger Mutations in Cancers

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AVAILABILITY OF DATA

During the last decade, we have had revolution in cancer research, thousands of tumors have been collected at Hospitals, and their genomes have been sequenced. By comparing the genome of the cancer to the genome of the patient, it is possible to discover differences, which are unique for the cancer cells. There is a possibility that these differences are mutations that have occurred, and are responsible for driving the disease in the tumor.

ANALYSIS

Cancer is a disease where biological networks have been perturbed, due to many mutations. In order to try to understand how biological networks are affected by mutations, we have decided to focus on deleterious single nucleotide variants (dSNVs) causing missense mutations, occurring in protein-protein interacting sites, for protein pairs with existing three dimensional structure.

Environmental Benefits and Burdens of Urban Agriculture Relative to Conventional Agriculture

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INTRODUCTION

Urbanization is a growing reality on a global basis. According to WHO 70% of the world's population will be living in urban areas by 2050 [WHO, 2014]. Furthermore the world population is growing and the increasing number of mouths to feed requires land capacity for food production. The production of food in a sustainable way already presents great problems and the challenges will only increase in the future when both the changing climate, the growing population and urbanization should be taken into account [Kulak et al., 2012]. The current (urban) food system represents a linear model. The resources go in, are consumed and go out of the city without recycling, drawing a line from farm to waste disposal. By moving agriculture into the cities a circular food distribution system is created, where the food is produced and consumed in the same place and where waste is recycled and utilized in the process. Urban agriculture is assumed to be a promising way of ensuring food supply in the future, but until now the implications of urban agriculture concerning the environment and human health have only been cursory studied.

PROJECT

The goal of this project is to generate a comparison of urban agriculture and conventional (rural) agriculture by evaluating the similarities and differences.

The different types of urban agriculture systems are divided into four archetypes covering all from rooftop greenhouses to allotment gardens. These archetypes are then compared to similar types (i.e. producing the same or similar crops) of conventional agriculture.

The project is divided into two phases. The first phase and the primary objective of the project is to compare the inputs (pesticides, fertilizer etc.) and outputs (grey water, yield etc.) to/from the agricultural systems. The impacts of the different inputs and outputs on the surrounding environment are then estimated yielding a rough picture of what happens when e.g. waste streams and emissions are moved from rural areas into an urban environment. The second phase is an evaluation of the potential effects on human health posed by crops produced in an urban environment. Phase two will be undertaken by evaluating crop uptake of selected pollutants in soil and air (through a literary study) combining it with knowledge about the human diet. This will give an estimate of the potential human health challenges posed by farming in polluted urban areas. Lastly the two phases are compared allowing a multi-angle discussion of the pros and cons of urban farming.

As the project will be handed in on the 11th of July 2014 results cannot yet be presented.

REFERENCES

- [WHO, 2014] WHO (2014). Urban population growth. http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/.
- [Kulak et al., 2012] Kulak, M., Graves, A., and Chatterton, J. (2012). Reducing greenhouse gas emissions with urban agriculture: A Life Cycle Assessment perspective. *Landscape and Urban Planning*, 111:68–78.

Evaluating Sustainability of E-waste Treatment in Korea based on Life Cycle Assessment (LCA) Method

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INTRODUCTION

Electronic waste, so called E-waste is one of the fastest growing wastes in the world. It is very critical to properly treat E-waste, since they contain toxic materials such as mercury, lead or cadmium. When they are incinerated, noxious hormones and toxic materials that can cause cancer and genital troubles are produced. They also cause soil pollution when they are dumped to the landfill. In this regard, a proper treatment and recycling are required. In this research, we focus on the End of Life (EoL) stage of E-waste and evaluate sustainability of E-waste treatment in Korea, using Life Cycle Assessment (LCA) method.

CONTENTS

Every year, approximately 20~50 million tons of E-waste are produced worldwide. The amount of E-waste in Korea in 2008 is shown in Table 1.

<i>Product</i>	<i>Average life span (years)</i>	<i>Waste quantity (2008)</i>
TV	7.83	3,361,000
Refrigerator	7.69	3,930,000
PC	3.94	3,790,000
Mobile phone	2.53	18,275,000
Printer	4.21	1,345,000

Table 1 E-waste production in Korea

In Korea, the government has introduced Extended Producer Responsibility (EPR), which states that the producers of the product are responsible for taking back their products from the end users, in order to promote recycling. Recycled products not only prevent people from the toxic materials, but also bring economic benefits. From the recycled cellphone, for example, 16 usable metals including gold and palladium are extracted. One recycled cellphone value 2,500~3,400 won.

<i>Metal</i>	<i>Content and value estimated for a mobile phone</i>	
	<i>Weight (g)</i>	<i>Value</i>
Copper	16	\$0.03
Silver	0.35	\$0.06
Gold	0.034	\$0.40
Palladium	0.015	\$0.13
Platinum	0.00034	\$0.01

Table 2 Weight and value of precious metals in a mobile phone

In this paper, we evaluate the sustainability of one type of electronic waste, particularly in the end of life stage. We then compare the recycled E-waste and discarded E-waste. It is expected that the result will support private and public E-waste treatment companies.

Algal Biomass Production from Wastewater

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The aim of this study was to test methods for optimizing algal cultivation in photobioreactors and assess the prospects for sustainable production of algal biomass using effluent from an industrial scale biotech production facility.

Common methods for treating nutrient-rich wastewaters using bacteria, is a process associated with high costs and very little useful bi-products. Nutrients are metabolized and lost to the atmosphere as gasses. There would be great potential for a treatment process that allows for capturing and reuse of the valuable nutrients instead of letting them go to waste. Algal cultivation has long been known for high biomass yield per surface area compared to land grown crops, and has the advantage of not needing soil to grow. But algal biomass remains a niche product, mainly due to high capital cost of facilities and costs of operation, including fertilizers. The idea of combining wastewater treatment and algae production as well as the increasing global demand for fuels and food, have revived optimism about the prospects of producing sustainable algae products, including bio-fuels, animal feed and high value products, at competitive prices in the not so far future. Yet further research and development is needed to achieve this goal.

Lab experiments were carried out in flat panel (14mm) and pond simulating photobioreactors (PBR) with the microalgae *C. Sorokiniana*, grown on wastewater. The effect of wastewater (nutrient) concentration and light input intensity on the algal growth, as well as the efficiency of the algae to use these under different conditions, was tested in both batch and continuous cultivation experiments. A key parameter is the dilution rate, which during the continuous cultivation has a large effect on growth rate, culture density and thus productivity of the reactor. The dilution rate was optimized for both high and low light inputs by deceleration-stat experiments where the dilution rate was gradually decreased over the experiment. This method has earlier been proposed, but has never been applied to real wastewater cultivation.

Maximum productivity in the flat panel PBR's with a light input at full sunlight intensity (2100 $\mu\text{mol photons/m}^2/\text{s}$) was found to be 5 g/L/day or 70 g/m²/day, comparable to some of the highest values for land grown crops. At 200 $\mu\text{mol photons/m}^2/\text{s}$, the maximum productivity was 1.6 g/L/day or 22.4g/m²/day. The pond simulating PBR, demonstrated a maximum productivity of 0.2 g/L/day or 42 g/m²/day with a light intensity of 2000 $\mu\text{mol photons/m}^2/\text{s}$. Yield of biomass per mol of photons was highest at low light intensities in the flat panel reactors with a maximum of 1.2 g/mol photons equivalent to that which has been demonstrated using optimized synthetic medium. Nutrient analysis indicate that phosphate could be a limiting factor, and thus that productivity could be further increased by adding phosphate to the wastewater.

The methods applied seem to be effective at optimizing and measuring important parameters for algal biomass cultivation, including dilution rate and produced data can be used as a useful tool in assessing the environmental and economic feasibility of large scale algae productions. Results show that the tested wastewater is well suited for algal cultivation, giving hope for the economic feasibility of commercial scale production.

From Banana Waste to Lactic Acid – A Sustainable Future

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INTRODUCTION

Bananas are one of the world main food crops, with more than 100 million tons bananas produced worldwide annually. This massive production generates enormous amounts of bio-waste. Novel approaches are needed for handling waste from the production. In addition there is a need for innovative ways of utilising the earths resources to secure a sustainable future. The generated waste residues have a fairly high content of sugars mainly sucrose, fructose and glucose. In that way it makes up a potential good feedstock for production of value added products.

Lactic acid bacteria (LAB) are naturally able to utilize these sugars present in banana waste and additionally LAB can be found in a wide variety of environments. Therefore we hypothesised that it would be possible to find LAB able to utilise the sugars, degrading the bio-waste and simultaneously produce lactic acid. With the use of LAB the problem with disposing of the bio-waste could be alleviated and lactic acid produced at the same time. Lactic acid is traditionally used in the food industry and is gaining ground in the production of biodegradable plastic leading to an increased demand for lactic acid.

RESULTS

We have isolated and identified several suitable LAB with the ability to utilize bio-waste from banana cultivation as a feedstock for production of lactic acid. These LAB will enable a novel and efficient way of turning bio-waste with low economic value into value added products such as lactic acid. The strains have been characterized and selected for their ability to utilize the specific agricultural feedstock. Furthermore enzyme-treatment of the banana feedstock has been conducted, significantly increasing the concentration of free glucose. The best candidates capabilities were analysed by measuring the pH and the lactic acid content in growth cultures.

APPROACH

An isolation procedure favouring LAB have been developed to isolate possible candidates for further research. The candidates and known model strains were tested on solid and in liquid media containing banana-feedstock as sugar source. Through these tests the most promising strain was identified. In addition an experiment resembling on-site fermentation will be conducted showing that it is feasible to use the technology in developing countries. Throughout the experiments we have strived to use a very simple set up to accommodate the production standards in developing countries.

CONCLUSION

We have proved that existing LAB exhibit promising abilities in utilizing the banana-biowaste for lactic acid production. We have identified several promising strains but our own isolated strain *Lactobacillus sakei* subsp. have shown a high lactic acid yield from banana-waste. At the moment the experimental work is still in progress and the final conclusion on the studies is sill to be drawn after the experimental work is completed.

Simulation Protocol for Optimization of Energy - Efficient Membrane Filtration Modules

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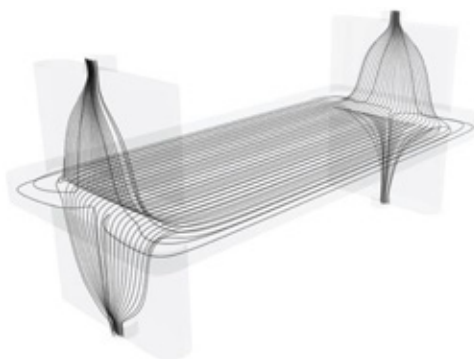
The aim of this project was to design a protocol for simulating fluid flow in Forward Osmosis (FO) filtration modules. This was motivated by the need for a robust tool, which could be used to determine optimal geometries for filtration modules.

FO is an osmotically driven filtration process, that relies on a large osmotic pressure difference across a semi-permeable membrane, to extract pure water from contaminated solutions. It is an emerging technology with a great number of potential applications, and unlike the broadly applied Reverse Osmosis (RO) filtration process, it requires no external pressurization, which makes it potentially more energy-effective.

In its field of research, this work stands out because it aims at analyzing the FO flow problem in 3D, whereas previous efforts have mainly been focused on one- and two-dimensional analysis. The protocol employs Computational Fluid Dynamics (CFD) methods, using the open source software package OpenFOAM, to produce simulations that replicate flow conditions inside the filtration module during operation. A previously validated CFD model, specifically developed for simulation of FO filtration in OpenFOAM, was implemented.

The protocol enables designers to "pick out" flow characteristic information such as velocity, pressure and salt concentration at every location of the module, throughout time. Moreover, it enables visual inspection of the flow conditions, which can be used to produce readily comprehensible images and animations, e.g. to communicate results to a non-scientific audience.

To illustrate its use in research, the protocol is applied to a number of ideal cases in order to determine relationships between generic parameters. Its technological practicality is furthermore demonstrated using the commercial Sterlitech CF042 module as a simulation case. The results yield unexpected relationships between generic parameters, and illustrate clearly the need for improvement of commercial FO membrane filtration modules, which should send a strong message to manufacturers and designers.



Updating of linear reservoir models for urban runoff

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A linear reservoir model has been made to imitate the rainfall-runoff relationship for the Ballerup catchment due to a need for better predictions of the flow in urban drainage systems. In order to make flow predictions it is important to keep the model up to date by continuously assimilating data into the model, which is done by using two different statistical methods, respectively Maximum A Posteriori estimation and the Ensemble Kalman Filter. Hereby flow predictions are made ½-4 hours into the future during a total time period of four months and are evaluated by using the Nash Sutcliffe Efficiency.

Design Study of Green Walls – an Analysis of Green Walls Effect of the Indoor Environment

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The focus of this project is to determine from experiment if green walls have an effect on the pollution degree from carbon dioxide (CO₂) in single-person offices and how to design the most effective green wall. Minimizing CO₂ pollution in offices is important because peoples decision-making are affected when the CO₂ concentration is above 2000 ppm. Therefor it is in the companies' best interest to minimize CO₂ concentration in the indoor air. Plants have been seen as an energy efficient way of achieving a better indoor environment, because they reduce the pollutants in the air. Furthermore they can be used as a recreational tool for the employees to enhance their work effort.

Since green walls have two proposes it matters how the design looks and works. It is important that the plants have the best growing conditions, such as the right amount of light, water, temperature, nutrients and a good growing media. Color, scent, size and quantity have to be considered as well.

The experiment shows that the plants do reduce the amount of CO₂ in a single person's office without mechanical or natural ventilation. The effect is greater with high concentration of CO₂. The air changes are shown in the table below.

	With plants	Without plants
Test 1	0,107	0,093
Test 2	0,111	0,090
Test 3	0,117	0,093

Table 1 Result from experiment. (ach)

During the experiment the humidity was above the recommended 35-50 %, therefor it is necessary in the design to minimize the ratio between the growing surface and number of plants to reduce the vaporization. The before stated requirements are fulfilled in the design below. The design relies on solar driven or rechargeable battery pumps to water the plants.



Picture 1 Final design

Investigation of the Use of Unburnt Clay Bricks in Load Bearing Structures

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INSTRUCTION AND BACKGROUND

The project aims to investigate the use of unfired clay bricks in supporting structures. The unfired clay bricks are sensitive to moisture. In light of this, this study will aim to evaluate the moisture dependent strength-properties of the unfired clay bricks. The study will also contain concrete proposals on how the building envelope can be built with unfired clay bricks. The study will give several suggestions on how the unfired clay bricks, should be handled as a building material. This includes how the structure is protected from the weather in the construction phase.

MANUFACTURING AND ENERGY CONSUMPTION

The manufacturing of concrete and fired bricks is bound by heavy energy consumption. We need to find new building-materials, which do not demand a lot of energy to manufacture. According to [1] the energy consumption in the manufacturing and construction of a 140 m² house is 98% less for unfired clay bricks than a house build of concrete and fired bricks. This of course has huge implications of carbon-foot-print of such a structure.

INDOOR CLIMATE AND LEVELS OF RELATIVE HUMIDITY

Buildings today are more closed with respect to moisture-transport, than buildings historically have been. This is mainly because of the high demands on insulation-properties. However, this can lead to moisture-related problems, such as bad indoor climate, or even desiccation of the structure itself. The unfired clay brick has very good moisture-transport properties and is totally breathable. This means that moisture trapped in the construction can be transported to the free air. The indoor climate is never too humid or too dry. This of course has positive implications on the energy needed for ventilation-installations, which then becomes more or less obsolete. In the end we have saved energy in the manufacturing of the materials for housing, and we have saved energy in running the building, when taken into use. We use 40% off all consumed energy on buildings, so there is a lot to save.

UNFIRED CLAY BRICKS IN LOAD BEARING STRUCTURES

The study shows, that unfired clay bricks are more than capable of taking the loads subjected to it, when building normal living size houses, villas, etc. This gives good confirmation of what was already known based on practical experience. The code of conduct for designing masonry structures is Eurocode 6, which the unfired clay brick has been fitted into. This gives a tool for architects and engineers to design new and modify existing structures in accordance with the design code.

REFERENCES

[1]: Gregersen, T., & Kristiansen, E. Ubrændt lerjords byggetekniske egenskaber., DTU BYG 2010

Sustainable Electric Supply for Future Arctic Housing

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INTRODUCTION

This project, conducts a study of the potential in a renewable energy system for a new artic housing project, in the capital of Greenland, Nuuk. The project introduces a sustainable hybrid solution, consisting of solar and wind energy.

THEORY

A Photo Voltaic system is chosen because it is proven to have a high efficiency in colder climates due to the low temperature. Furthermore, the low maintenance level of a PV-system is desirable due to the relatively low availability of technicians in Nuuk. Wind turbines have a more stable power output over the course of a year, and is therefore seen as a good match for the more seasonal depended output produced by a PV-system.

METHOD

The investigation of the produced energy is conducted on a yearly, monthly and weekly basis. The production from each sustainable source is compared to an estimated average consumption of a New Arctic Household.

RESULTS

Results show that on a yearly and monthly basis 100% of the energy demand can be by covered by the hybrid solution. However, on a weekly basis one week fail to produce the required energy demanded by the consumption.

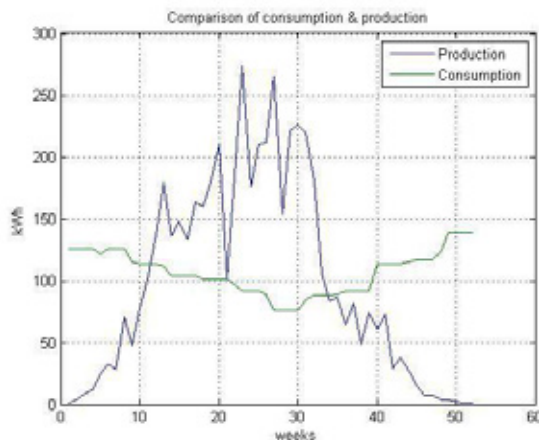


Figure 1 Comparison of consumption & production of hybrid

CONCLUSION

The results shows to be sustainable in an environmental perspective, when investigating the economics surrounding the project; the investment turns out to have payback time that cannot be reached within the limits of the expected lifetime for both the wind turbine and hybrid system. This is largely due the fact that the energy supplier in Nuuk (Nukkissiorfiit) does not purchase the surplus energy produced by the hybrid system

Vierkous — A concept for sustainable harbor redevelopment

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Figure 1 Overview Vierkous

The area Vierhavens (Four Harbors) in the port of Rotterdam is currently losing his function as a harbor. The objective of this project is to redevelop a mixed use area that is self-sufficient in food, water and energy. Vierkous is a symbiosis between existing pier and four new nature reserves. In 1912, the construction of the Vierhavens meant the ending of a lush tidal area: the Westkous.

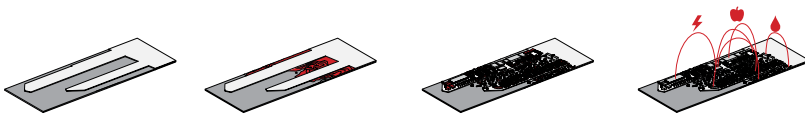


Figure 2 Concept

In the new proposal, the old harbors will silt and four new estuaries will arise. This special nature reserves will supply the neighborhood of food and will clean their wastewater. Nutrient cycles are closed at the scale of the neighborhood. The hard concrete piers and soft estuaries create a sharp contrast between city and nature, but are inseparable and connected by a network of public spaces and buildings. This juxtaposition symbolizes the dependence between humanity and nature.

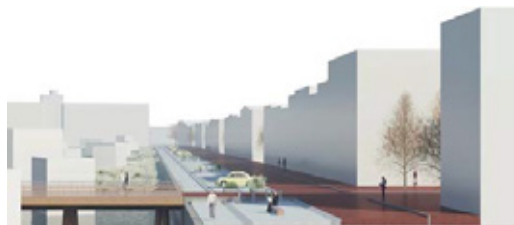


Figure 3 Artist impression of border between pier and estuary

Heat Storage in Phase Change Materials

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In climate debates there are great focus on finding new renewable energy sources and further development on the existing technologies. This focus strives from the desire to get independent of fossil fuels. A not as well known factor, but a key element in renewable energy, is energy storage, which gives the ability to save energy, for when it is needed. How can we get wind power when the weather is calm or how do we get hot water or electricity from solar panels when it is cloudy or night? We can't! Oil and coal can be stored and used when needed, but this cannot be done with wind, wave or solar energy. The reliability of these forms of energy, and thereby the independence of fossil fuels, can only be a reality when energy storage devices can balance the time difference in energy production and energy consumption.

An interesting technology in energy storage is *latent heat storage* which can store heat energy due to a phase shift. This allows energy to be stored as sensible heat until the phase shift temperature is reached, and after this point additional latent heat. In this way the energy storage becomes much more efficient. Some types of materials which can be used as latent heat storage materials includes salt hydrates and combinations of salt hydrates called eutectics.

Most of these substances are measured and developed by an experimental approach which is both time consuming and very expensive. An alternative to this approach is using a thermodynamic model, which can, if the model is accurate enough, be used to predict relevant thermodynamic properties, including relevant information as melting temperature and heat of fusion.

This project is about the eutectic salt hydrate consisting of $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$. This eutectic system has a melting temperature at around 59 degrees Celcius and is therefore suitable as a heat storage material in application which have an operational temperature at this point. This is because the material melts at this temperature and the energy required to make the phase change is released at this temperature. It makes this eutectic applicable in heating water in households, where the hot water is around this temperature. This great operational temperature has made this eutectic salt hydrate very interesting in connection with private solar panels, but actually very few published experiments has been made of the system. This project was about testing the eutectic salt hydrate to verify the old and contradictory data which has been published. More over some parameters in the model called the Extended UNIQUAC model, was improved. This model is of many considered as the best model to describe electrolytes and is therefore the obvious choice for this type of project. The results obtained by the improved parameters was significantly better.

Development of a one-pot process for functionalization and cross-linking of polydimethylsiloxane (PDMS)

Helene Hummelmoose

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INTRODUCTION

Novel green technologies delivering large quantities of energy are needed for a sustainable future. The dielectric electroactive polymer (DEAP) technology is one of such with the potential of becoming a disruptive technology within wave harvesting. For this to be realized polymer materials with better performances and especially with higher energy densities are required. This project aims at improving the energy density significantly.

For the material to the DEAP an elastomer is used, often PDMS. This elastomer is sandwiched between compliant electrodes, this system then becomes a capacitor. When a voltage is applied on the electrodes they will squeeze together because of electrostatic forces, and thereby the elastomer thickness will decrease because of the incompressibility (Figure 1).

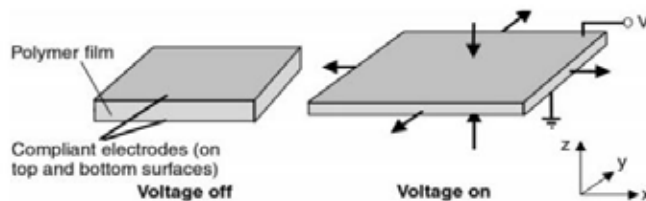


Figure 1 Working principle of DEAP. When the voltage is turned on the electrodes will squeeze together, the thickness will decrease and the area will increase

The incompressibility and the elasticity of the material are exploited. If the stretched DEAP film is charged with a voltage and then relaxed, the voltage will increase. For wave harvesting the waves are being used to the stretching of the films.

OPTIMIZATION OF THE PDMS FILM

The amount of energy is limited by the energy density of the material, which scales linearly with the dielectric permittivity. Therefore, to increase the energy production the dielectric permittivity can be increased. This can be done by adding dipoles to the PDMS network. The way this is done so far is in a two-step process that is not that industrially minded. Therefore, in this project the target is to develop a new one-pot process, where the functionalization and cross-linking of the PDMS are done in the same step. The commercial network XLR630 is used due to its good mechanical properties.

It has been possible to increase the dielectric permittivity from 2.9 to 3.74 at 100 Hz, with $\tan \delta$ at $6.32 \cdot 10^{-3}$, for a film with 50 w% of the commercial network. That leads to an increase of the energy that can be processed with 29 %. To make the films stronger, it is possible to make thin films, silica particles have been added. For this film the electrical breakdown was measured to 72.7 V/ μm . The reproduction for this procedure was unstable, because the films broke, because the adding of the silica particles make the network weaker. It can then be concluded that it is possible to make the films in a one-step process, but the conditions in the amount of the chemicals and temperature have to be more controlled.

Flux Pinning in Thin Films of High Temperature Superconductors for Use in Wind Turbines

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FROM GLOBAL ENERGY DEMAND TO FLUX PINNING

While the global demand for energy continues to grow, the world's depots of fossil fuels decrease. Logically, scientists have researched in different ways of creating sustainable energy. Dams, solar power and wind energy are all different ways of extracting power from nature. Having neither mountains nor many hours of annual sunshine, Denmark is, however, a flat country with many kilometers of coast line and calm weather, and therefore is perfectly suited for wind energy. Because of these facts, Denmark has always been a pioneer within the wind industry, building the world's first off-shore wind energy park in 1991. In recent years, wind turbines have grown dramatically in size and capacity. Scientists predict that in order to make wind energy a more suitable alternative to fossil fuels, the wind turbines have to become even larger. The major problem with these super wind turbines, however, is the weight of the nacelle, of which a heavy part is the gear box.

In order to avoid having a gear box in the wind turbine, a direct driven generator has been proposed, where superconductors play an important role. Energy losses due to Joule heating will be eliminated and high temperature superconductors are capable of working in high magnetic fields (several Teslas). The alternative to superconductors are permanent magnets, but the required amount would become expensive and inaccessible, while superconductors can be made from easily accessible elements. However, using superconductors also pose considerable challenges; low temperature cooling systems are required and the superconductors need to be of high quality.

High temperature superconductors is a relatively new field of study, with the first discoveries made in the 1980s [1, 2]. Having found materials with superconducting properties at relatively high temperatures, the issue of optimizing other properties arose. A pinning center is an irregularity in the crystal, which destroys the superconducting properties. Here the magnetic field lines can penetrate without causing further damage to the superconductor. In 2005 Misko *et al.* found that a gradient in density of pinning centers could increase the critical current density (J_c) in a magnetic field [3]. Pinning centers had been known to optimize superconductors, but with this new information, scientists have been equipped with a new tool to make superconductors more suitable for wind turbines.

Since Misko *et al.* first predicted that different pinning densities throughout the superconductor could improve superconductors; many attempts have been made in order to show this property experimentally. Different methods to create the desired pinning patterns experimentally include *Molecular Beam Epitaxy* and *E-beam Lithography*. These methods are, however, both very expensive, making them less attractive for industrial production. This project investigates different options of creating simple gradients in the pinning center density.

REFERENCES

- [1] Bednorz, J. G., and K. A. Müller. "Possible High T_c Superconductivity In the Ba-La-Cu-O System". *Zeitschrift Für Physik B - Condensed Matter* 64.2 (1986): 189-193.
- [2] Wu, Ashburn, Tormg, Hor, Meng, Gao, Huang, Wang, and Chu. "Superconductivity At 93 K In a New Mixed-Phase Y-Ba-Cu-O Compound System At Ambient Pressure". *Physical Review Letters* 58.9 (1987): 908-910.
- [3] Misko, Vyacheslav, Franco Nori, and Sergey Savel'Ev. "Critical Currents In Quasiperiodic Pinning Arrays: Chains and Penrose Lattices". *Physical Review Letters* 95.17 (2005): -.

Passive Solar Tracking for Energy and Lighting Applications

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INTRODUCTION

Solar tracking systems – that allow solar energy systems to adjust their position in accordance with the movement of the sun across the sky - are used to optimize the energy output from solar energy systems, increasing the energy yield by up to 80 %. Yet, tracking systems are more or less only used in large scale energy parks, due to the high cost, complex installation, and the long time it takes to achieve a return of investment. This project - conducted in collaboration with Velux A/S and DTU MEK - entails the development of a simple, inexpensive, passive solar tracking concept that does not require an external power source, for use in photovoltaic-, solar thermal-, and daylighting systems, in an effort to improve their performance.

THEORY AND METHODS

To ensure simplicity allowing for low potential manufacturing costs, the focus of the project was concentrated on finding a way of creating passive sun-following movement. This was done through actuation that is entirely powered and controlled by the angle of incidence and intensity of sunlight. As such, the aim was to utilize the relative temperature difference, between sunlight and shade that occurs due to the continuously changing intensity-, and angle of incidence of sunlight, both daily and seasonally. In order to create actuation as a reaction to relative changes in temperature, a solid thermal expansion principle as seen in thermal expansion systems such as thermometers and linear thermal microactuators was used as a basis.

Through a biomimetic engineering design approach, a functioning passive tracking principle was developed, based on bimetallic actuators and sensory surfaces inspired by self-organizing plants. Biomimetics were a key source of inspiration for the mechanical design, as there are several examples of solar tracking in biological systems, such as flowers and plants. This is a characteristic known as heliotropism.

Finally, the system was dimensioned through the use of:

- A numerical mathematical model estimating the optimum patterns of movement
- Static mechanics based on *Finite Element Analysis* to ensure continuous movement and reliability
- Thermodynamic models to simulate the thermal expansion (and therefore movement) of the system under different weather conditions.

Results and perspectives

The final (fully dimensioned) tracking system allows for biaxial tracking movement through rotation around two axes of movement, making full, year round solar tracking possible. Numerical simulations over annual solar movement and the expected tracking lag and imprecision, have shown that the passive tracking system could run on a relative temperature difference (between sunlight and shade) of between 10-15°C, which is achievable even during the winter. The simulations also showed a possible gain in energy output of between 43-87 % in solar energy systems, depending on the system type, and the conditions in the surroundings.

Scrap-Savonius – Small Scale VAWT for rural Tanzania

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INTRODUCTION

Our concept is a windmill built out of recycled scrap metal and auto parts, which can provide free electricity for people living under difficult circumstances and replace traditional biomass sources like firewood and charcoal that accounts for largely the majority, as a source of energy in East Africa.

A SOLUTION

85+ % of the population in Tanzania lives in the countryside away from the cities, thus also disclosed from the electricity grid, which is very scarcely spread out. Their main source of energy in rural areas comes from firewood and charcoal for lighting, heating and cooking, which poses a threat to the local environment. Implementing the scrap metal windmill will not only provide electricity to otherwise excluded households, but also help decrease CO₂ emission and the environmental degradation that's been increasing for the last decade. In a sunny region like most of the areas around equator, the use of solar cells would be obvious. But, they're tough to repair and if the wind is there, wind turbines are actually cheaper pr. kW. We've taken that fact and our observations through a monthly research trip to Tanzania, and compiled it into a concept that can address the above-mentioned scenarios and issues.

SCRAP-SAVONIUS CONCEPT

Our concept is a small-scale wind turbine based on the savonius principle, mainly containing recycled auto parts and scrap metal – alas local components. The concept also comes with a plan in collaboration with local partners, to educate locals to maintain it, which makes it revolutionary in implementing technology in less developed regions.

A VAWT compared to a HAWT has several advantages that makes it suitable for Tanzania.

- Low cut-in speed
- Simple structure
- Based on standard mechanical principles
- Electronics are based at the foot
- Easy to de-assemble and reuse parts
- Due to low-tech principles, many regular mechanics can repair it with little to none supervision

The only downside is that it generally generates less power than a HAWT, which our research showed doesn't matter since it'll still generate enough power for basic needs like light and cell phone charging. Due to the benefits of the Savonius principle, we can take advantage of the presence of adequate mechanical skills and large amounts of recycled materials. Hence making it cheap, easy to repair and therefore suitable for rural Tanzania. We call it the Scrap-Savonius concept, and when fully evolved, has the potential to not only heighten the standards of living for many people around the globe, but it will also be expanding knowledge about technology, and create work flow, in regions with typically low economical flow.

Thin Black Silicon Solar Cells

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INTRODUCTION

Solar power is an already well-established renewable energy type, which is used in many places globally. Commercial solar cells are typically made of silicon, due to the amount of knowledge concerning silicon semiconductor technology.

Even though scientific research has come up with many possible solutions for increased efficiency of solar cells, they are in general very complicated to fabricate, and as a consequence more expensive than conventional cells, rendering it impossible for such a solar cell to be competitive on the solar cell market.

One way of making a competitive cell could be by material savings, and thereby being able to offer the same efficiency and power, for a lower price.

Today for solar cells, the largest expense in fabricating the cells is the silicon cost. This will for a 200 μm cell correspond to about 81 % of the total cost.

Our idea is to save material and cost of the solar cell by making the solar cells thinner, which will lead to less pollution due to the optimized use of silicon. By implementing the surface structuring known as black silicon for minimizing reflection, we at the same time expect to have a higher efficiency than conventional solar cells.

Conventional solar cells have a surface structure defined by a KOH etch, which etches as deep as 30-40 μm . With the RIE black silicon etch we will at most etch 1 μm away, resulting in a significant material saving.

In the end, we expect to only use $\frac{1}{4}$ of the silicon used in conventional cells.

OUR PROJECT

Our project is our bachelor thesis, and concerns fabricating these special solar cells, as well as characterizing their electrical capabilities.

We want to test the efficiency of solar cells from 10 μm and up, however there is no effective manufacturing of silicon wafers this thin at this point. Hence, for our project, we will need to thin silicon wafers down to the desired thicknesses, in order to demonstrate the need for the thin wafers.

When finalized, the solar cells will be tested in a new measurement setup at DTU Nanotech, which is able to measure efficiency while changing the angle of incidence of the incoming light upon the solar cells.

The project falls into the 'concept' category.

Zero-Energy Brewery

Peter Yde Jantzen & Jean-Daniel Cramer

DTU Byg, Technical University of Denmark

In association with DTU Foods desire to attain a new building, dedicated to their brewery division, we are designing an unconventional, flexible and inviting small zero-energy building, where the generic energy designs of the building contribute to a green beer-production. The goal is to obtain a building with as low an energy consumption as possible (zero-energy building), accommodate the functions that DTU Food demand, a great indoor climate and have a significant and inviting aesthetic expression.

Eco-efficiency Assessment of Urban Water Supply Systems in Nordhavn

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This project presents an eco-efficiency assessment (EEA) of alternative water supplies in the new city district Nordhavn in Copenhagen. The development of Nordhavn is one of Scandinavia's largest development projects, with the overall vision of creating a sustainable and innovative city district.

The eco-efficiency assessment tool

The EEA combines an environmental lifecycle approach with an economic performance using value chain modeling. The aim is to assess the economic and environmental progress by introducing new technologies in the water supply system in Nordhavn. A concept or a technology that has both an increased environmental performance and economic performance is considered as an eco-innovation.

The proposed alternative urban water supplies for Nordhavn

The concepts used in the EEA were inspired by the existing water supply in Copenhagen and experiences for alternative water supplies. The water resources were distributed to two water use categories; potable purposes (drinking and cooking, bath, cleaning and dishwashing) and non-potable purposes (toilet flush and laundry), depending on the water quality demands.

- Concept 0: groundwater is used for all purposes
- Concept 1: rain- and stormwater for non-potable purposes and groundwater for potable purposes and as makeup water.
- Concept 2: recycled grey wastewater as non-potable water and groundwater for potable purposes and as makeup water.
- Concept 3: a combination of Concept 1 and Concept 2. Rain- and stormwater and water recycled grey wastewater covers the non-potable water demand and groundwater covers the potable water demands.

Results and conclusion

The eco-efficiency indicators considered in this project were climate change, eutrophication and water resource depletion. The results showed that alternative water supply Concept 3 has significantly larger eco-efficiency than the baseline (Concept 0) for all indicators. Both concept 2 and 3 are considered eco-innovations. The most crucial element in the eco-efficiency assessment was the difference in the climate change potential due to the benefits of using warmer recycled grey wastewater for non-potable purposes. The eco-efficiency for the climate change indicator for Concept 3 was 3.8 times higher than the baseline (Concept 0), mainly due to these benefits.

By applying the eco-efficiency assessment in Nordhavn and in similar city developing projects, a wide decision-making perspective is given. The water supply strategy will not be limited to one specific actor or goal, but considers several actors, environmental impacts and economic aspects.

Improvement of fog harvesting materials for potable water generation in arid regions

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INTRODUCTION

Half of the world's population has limited access to drinking water and in 2025 2.3 billion people will have no constant fresh water supply. In coastal areas with scarce precipitation but a frequent occurrence of fog, fresh water can be harvested from the fog. This means that the wind carrying fog is pushed against vertically set-up fog meshes. The fibers of the fog mesh intercept the fog droplets, the droplets coagulate and with reaching a significant mass, they pour down the mesh to a collecting channel and from there to a storing tank. The "Raschel"-type meshes currently in use in several fog harvesting projects around the world show several disadvantages such as a low yield and inadequate mechanical stability. The main goal of this project therefore is to identify a fog harvesting material with improved characteristics, in this case, the highest yield.

MATERIALS AND METHODS

Five different materials which may be suitable for fog harvesting were examined using experiments and modeling techniques. They range from very simple meshes used e.g. for shading to three-dimensional structures that were specifically designed for this purpose. The experiments were conducted in a climate chamber where fog was sprayed on the different materials and the yield efficiency, along with the pour-off characteristics and rest water amount were measured. Additionally, the yield was calculated from hydrodynamic theory.

RESULTS

In the experiments, all materials showed an initially rising yield followed by a steady state. Both of these states were different for every material with the highest yields being achieved by meshes with a three-dimensional structure. There was a strong agreement between the measured and modeled values, which additionally showed that there is a correlation between the openness of the meshes, the mesh fibers sizes and the yield. The models also allow investigating the effect of varying natural conditions (e.g. wind speed and fog droplet size) on expected yield. Depending on these conditions, the ranking of the different materials was shown to change.

CONCLUSION

The work done in this project contributes to the optimization of fog harvesting, a sustainable form of potable water production applicable in many arid regions. Additional tests are needed to assess the durability and chemical stability of the materials, as well as practical applicability. The German Wasserstiftung, along with several other charities and Technische Universität München as an advisor, operates a 54m² fog collector in Morocco, where these aspects are investigated. Later on, this facility will be expanded to supply several nearby villages with potable water.

Adaptive Public Art and Pavilion for vibrant public life in Arctic area

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INTRODUCTION

Kiruna is the northernmost town in Sweden. There is a plan to move the old Kiruna city and then build a new Kiruna city. When we interviewed the inhabitants, they expressed the wish for meeting places. The green challenge is that how this public space is adaptive to the summer and extreme long and cold winter and satisfies the demand and use of the inhabitants here. The public art here should offer the inhabitants a flexible space for their public life, namely a warm place in winter and an attractive space for diverse activities. This project is to find possible attractive public art that could be applied in this space both in winter and summer and cater to the local needs.

THEORY & METHODOLOGY

There are different ways for the public life study. In 1971, Whyte started his pioneering project, *The Street Life Project*, in which he implemented basic observational studies of the human social activities in the small public space, sometimes with a time-lapse camera. *The Social Life of Small Urban Spaces* (Whyte, 1980) illustrates vividly the reasons why some places are more attractive to people and others are not. Besides, when observing the pedestrian behaviors in the traditional European cities, Gehl “add a dimension that interviews with people about the reason for their being in the city” (Gehl & Savarre, 2013). They build up a method and tool system for public life studies in the book *How to Study Public Life*. In this project, we interviewed several inhabitants here to get a clear picture of the local needs for the public life here. Also the main effort was made to observe the public life and human behavior here. Data of the demography is collected and analyzed for design.

RESULT

Interviews shows that people want an outdoor dancing place in winter and they want to build a close relationship with the young people in the meeting place. Besides, the inhabitants love to hang out in winter and can stand the temperature. When searing for similar programs and adaptive designs, we find a lot of interesting information and reference projects. In the context of Kiruna, a wooden pavilion, with a warming hut is a nice place for dancing in winter and a flexible open space for diverse activities in summer. In addition, enlightened by excellent ideas of public art from artists, we also like to apply light art in Kiruna.

CONCLUSION

The adaptability of public art and pavilion can create a more dynamic and attractive public space for potential public life. Not only is the technology important for the public space design, but also the inhabitants' demand and their use of the space.

Prevention against Alpine Natural Hazards: Sustainable chalet management

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The key aim of the project „Prevention against Alpine Natural Hazards“ was to combine the interdisciplinary topics of geodesy, geoinformatics and land management. Developing efficient data models to store relevant information of buildings can be a very useful and sustainable method to analyze and assess existing and planned objects. On basis of a data model combining geometries and formal attributes an assessment of the management of two chalets was carried out in September 2013. The alpine region Hornbergle was thereby in the focus.

In the field geoinformatics the data from the survey were integrated in the existing CityGML data model utilizing ETL (Extract, Transform, Load) software. The data model was enhanced by adding Application Domain Extensions (ADE) to represent the survey data that was not supported by the standard CityGML schema. All chalet located in the survey area were shown through simple geometries based on digital terrain models and measurement data of electronic total stations. The following solar radiation analysis showed results for the direct irradiation from about 1.300 to 1.500 kWh/m².

In the field land management the topics of electricity, heat, waste and water management were analyzed and recommendations verbalized. At 'Singer Hütte' a PV-System with grid connection is recommended. Solar heat and wood pellets should provide additional and ecological heat supply. For waste and wastewater is, apart from avoiding, no improvement potential possible. At the 'Schneetalalm' we recommend a fuel exchange from diesel to plant oil for the generator. Additionally the existing photovoltaic electricity should heat in a cartridge heater the combined-storage-tanks. Waste should be avoided where possible. The rainwater use for cleaning purpose and toilet flush would relieve the spring discharge and should be considered.

Bio-ethanol Dehydration in a Heat Pump Aided Extractive Dividing-wall Column

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INTRODUCTION

Large-scale production of bio-ethanol fuel requires energy demanding separation steps to concentrate the diluted streams from the fermentation step and to overcome the azeotropic behavior of the ethanol - water mixture. In the present work, a novel heat pump aided extractive dividing-wall column (H-E-DWC) is designed to substitute the conventional separation approach which consists of three distillation columns performing several tasks with high energy penalties.

THEORY

Heat pump systems can be used to upgrade the low quality energy in the condenser to drive the reboiler. In this work, the vapor compression technology is used to upgrade the heat by compressing the vapor distillate or a working fluid.

Dividing-wall columns is one of the process intensification technologies, which can separate three or more chemical compounds in just one column, hereby reducing the costs and energy consumption in industrial scale.

METHODS

This study proposes an innovative distillation setup - based on a novel H-E-DWC, which is able to concentrate and dehydrate bioethanol in a single step, by integrating all units of the conventional sequence into only one distillation column. Aspen Plus is used to simulate the H-E-DWC which is shown in Figure 1. The energy consumption of the conventional separation approach, E-DWC, and H-E-DWC is compared through simulation.

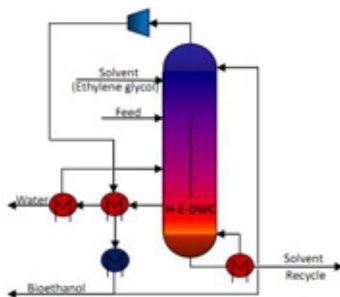


Figure 1. Heat pump aided extractive dividing-wall column (H-E-DWC) to bioethanol dehydration

RESULTS

In this work, a mixture of 10.0 wt% ethanol and 90.0 wt% water is concentrated to 99.6 wt% and 99.8 wt%, respectively. Compared to the conventional separation approach, simulation results from Aspen Plus show that 66.6% of the cold utilities and 49.9% of the heat utilities are saved by using H-E-DWC.

Ion Batteries

Students from NTU-RPI-DTU Innovation workshop

ABSTRACT

Development of Lithium and Sodium ion batteries is essential for portable electronics and electrically powered transportation. An important aspect of the batteries performance is control of the lithium and sodium ion intercalation into the electrode materials. In this project you will look at this process and how it limits performance and how it can be improved. One aspect will be looking into ways of getting detailed information on the nanoscale processes by imaging and spectroscopy.

Lithium Air Batteries

Students from NTU-RPI-DTU Innovation workshop

ABSTACT

Lithium air batteries are one of the most promising battery systems for transport applications, but also an challenging system to create. This project aims at studying the processes involving Lithium peroxide on carbon electrodes. One aspect is to find novel ways to image the process to improve our understanding of them.

Micro- and Nanostructured Carbon Electrodes for Capacitive Energy Storage

Students from NTU-RPI-DTU Innovation workshop

ABSTRACT

At last years innovation workshop, several projects looked into supercapacitor structures, and this project will follow up in this, with emphasis on comparing capacitive performance of bulk electrodes with those of lithographically defined structures such as interdigitated electrodes. You should consider different ways of creating the electrodes such as structures made of grapheme or from pyrolysed polymers. In this project you should perform a literature review on the methods used for creating supercapacitors and propose possible ways to improve the current state of art based on simple test experiments.

Improved Efficiency of Wind Farms by Alternating Mast Height

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INTRODUCTION

This project is experimental and investigates the performance of twelve model wind turbines in a wind tunnel. When wind turbines are placed in a wind farm, the power production falls dramatically, because the wind turbines create wakes and thereby 'shadow' each other. This project aims to improve the efficiency of wind farms, by giving the wind turbines alternating mast heights. In this way the wake-to-wake interaction is decreased which leads to a better performance of the wind farm as a whole.

WHY IS IT A GREEN PROJECT?

This is a green project because it aims to optimize the performance of wind farms. In order to face a greener future society, it is essential to become less dependent on fossil fuels in the electricity generation and here wind energy represents one alternative. However, if wind energy is to become an important contribution to the generation of electricity worldwide, it is necessary to optimize wind farms both onshore and offshore. Today, wind turbines placed in a wind farm produce much less power than single wind turbines placed remotely from each other. This is because the wind turbines in front 'shadow' the subsequent wind turbines, such that the front row of wind turbines extracts the biggest share of the energy in the wind. This project investigates if alternating mast height could be one of the steps to meet this challenge in wind farm efficiency.

HOW WAS THE STUDY CARRIED OUT?

The study is experimental and was carried out at the wind tunnel facility at Portland State University, Oregon, USA. The experimental set-up consists of twelve model wind turbines, only differing in mast height of either 12cm or 18cm, placed in rows of four by three wind turbines. To investigate the effect of alternating mast height, five different configurations were tested in the wind tunnel: One configuration with all same mast height and four with alternating mast heights. The power production was measured in the five configurations by the use of a torque sensing system installed in each model wind turbine. Additionally, the velocity field was investigated by the use of stereographic Particle Image Velocimetry.

CONCLUSION

In this study, we have found that by alternating the mast height, the efficiency of the model wind farm is increased between 20-40%. This result suggests that the shadowing effect is less pronounced in a model wind farm with alternating height. This was supported by the stereographic Particle Image Velocimetry results, which show a decreased wake-to-wake interaction in the configurations with alternating mast height. In other words, alternating mast height in a wind farm can lead to bigger wind farm efficiency and could bring us one step closer to a future still more based on green energy.

On Experience of Smart Grid Projects in Europe and the Swedish Demonstration Projects

J. Gustincic and K. Konstantinos

Chalmers

Our project was conducted under the supervision and guidance of Professor Lina Bertling. Our work was equivalent to a 15 credit course, which we could later use as part of our education, instead of two 7,5 credit optional courses. The report of the project was published as an internal Chalmers publication.

Our findings could be used by any stakeholders around smart grid development, such as energy companies, IT companies specializing in the field, research institutions or countries, who want to assess the current technological state of smart grid projects throughout Europe. Project managers can evaluate whether their own smart grid project lacks a specific technology or whether they could implement new technologies that are used in other European projects or simply evaluate where their project stands among others in Europe in terms of technological development. It could also serve as an example for future attempts of a construction of an inventory that includes all the technologies used in smart grid projects.

Below, one can find the abstract of our report, which explains briefly what the background and scope of it are, as well as the methodology and approach that we followed. Some of our results are also presented in the last paragraph.

Renewable energy sources are expected to play a significant role into the future power system. The variable and at many cases not easily predictable production of electricity will pose a threat on the reliability and efficiency of the current electricity grid. Hence, there is great need of measures that will be able to handle these fluctuations of the production systems. Transforming the current grid to become a more intelligent system that could predict the variations as well as exploit hours with lower demand and, hence, lower electricity prices is one way to deal with the problems caused by the technology shifting. New projects that address those issues are constantly under deployment in recent years. In Sweden today there are three large demonstration projects, the Sustainable City Hyllie, Smart City Gotland and the Stockholm Royal Seaport.

Our paper investigates the technologies used in the three projects, how the goals that were set in the beginning of each project are being fulfilled, as well as the ways that the different actors are coping with the challenges and problems faced. The approach that was used includes a comparison of the projects with other successful finalized projects carried out throughout Europe. The methodology was divided in three smaller steps. The first step was the collection of data about all the technologies and all the investigated projects in Europe and Sweden. The second step was to construct a table where a significant number of technologies used by the projects were listed alongside with an indication on whether the implementation of the technologies is finished or ongoing. The results for the ongoing Swedish demonstration projects were iterated and checked by conducting interviews with key people inside the projects.

Some of our results include a comparison of the Swedish projects with a selection of similar European ones. The Swedish projects seem more extensive utilizing a broader range of technologies and are still ongoing, whereas all of the investigated European projects have been concluded. The most commonly used technologies in Europe are Information & Communication Technologies (ICT) and demand-side management. On the other side, algorithms for the optimization of the power system are only implemented by one German project. Regarding individual projects' comparison, the Hyllie project is expected to use a larger number of technologies, if by the end of the project, all the planned ones will be implemented. Smart Grid Gotland mainly focuses on wind power technology and ways to exploit larger levels of penetration into the system by using HVDC cables and storage facilities. Finally, the Royal Seaport includes less advanced technologies mainly because of the structure of the electricity mix in Stockholm. For that reason, a virtual power plant (VPP) or energy storage are not cost-effective solutions and hence not considered at all. However, it is a unique project in the sense of studying whether renewable electricity production can provide the necessary electricity in the case of instantaneous peak loads due to large cruise vessels entering the port.

Integration of Wind Generation in Electricity Markets under Uncertainties

Tiago Soares, Reid Simon, Qi Wang and Caroline Persson

DTU Compute, Technical University of Denmark

INTRODUCTION

The challenge of lowering the emission from greenhouse gases is one of the most important topics in today's society. It is not rocket science, that an increased integration of renewable energy will result in a more sustainable and healthy environment compared to today's use of fossil fuel. Renewable energy sources act by nature different from traditional coal power plants, and uncertainties often influence the power generation. This project faces the problems of uncertainty in the wind power production, when clearing the electricity market with a high penetration of stochastic production.

THEORY

Clearing of the electricity prices are an optimization problem where the total cost of generation is minimized, or equivalent social welfare is maximized. A market operator takes care of price clearing in the electricity. Dependent on the strategy a market operator has the outcome of the estimated optimal production and reserve capacity will turn out different.

Methods

A comparison of different strategies for minimizing the total production cost under uncertainties in a two-stage electricity market. The strategies are as follows:

1. Deterministic approach
2. Stochastic Model optimizing expected wind power generation
3. Robust Model optimizing the worst-case scenario

Results

	Deterministic (worst-case realization)	Stochastic (expected)	Robust (worst-case)
Energy dispatch costs	950	1578	950
UC costs	23	23	15
Reserve costs	630	197	312
Total day-ahead	1603	1797	1277
Energy redispatch costs	840	-520	720
Load shed costs	0	26	0
Total balancing costs	840	-494	720
Total aggregate costs	2443	1304	1997

Table 1: Results for each approach on a small case example

Conclusion

The three approaches give different results, and each reflect a strategy for the risk in the electricity market. Further results show that the approaches differ in sensitivity and outcome for different scenarios of the realized wind generation.

Inertial focusing and collecting of small particles

Students from NTU-RPI-DTU Innovation workshop

ABSTRACT

Water-borne viral diseases pose high risks for public health worldwide. Very low concentrations of dangerous viruses in the water can cause severe disease. For detection of this small amount of viruses in water, it is important to increase the concentration.

In this project, you will work on finding a method to up-concentrate and collect the smallest possible particles in aqueous solution. Inertial focusing is an up and coming technology and will be the desired technique utilized during this project. Inertial focusing allows for high throughput sorting of micro (and nano?) particles at high (1-100) Reynolds numbers. The project will include experimental testing, including fast prototyping of a polymer based microfluidic system and flow analysis with fluorescence microscopy.

SERS Detection of Melamine

Students from NTU-RPI-DTU Innovation workshop

INTRODUCTION

In recent years toxic melamine has been added to various dairy products in order to boost the apparent protein content at a low cost.

Surface enhanced Raman spectroscopy has been shown to be a possible method for rapid detection of malicious melamine additives to dairy products.

Using state of the art Raman effect enhancing substrates developed at DTU Nanotech, we aim at developing a rapid method of detecting trace levels of melamine in various test solutions as well as dairy products.

Covalent organic polymer for CO₂ capture

Dong Ah, Ko

Graduate school of EEWS, Korea Advanced Institute of Science and Technology

The climate change caused by carbon dioxide is an indispensable adjunct to the means of industrial development. This being so, substantial scientists from all over the world are focused on capture & sequestration of CO₂. Hence, lots of materials already prepared as a solution for CO₂ problems. Especially, liquid absorbent MEA (Monoethylamine) which contain amide functional group is most commonly used for CO₂ capture in these days. However, flue gas is heterogeneous and temperature is up to 40°C. This occur the corrosion and thermal degradation of MEA to be loss, decrease the efficiency of capturing the gas (8-35%) and, unable recycle by chemically irreversible change. Therefore in this research we design the materials which keep the benefit of the MEA, CO₂ capturing capacity, and improve their drawbacks.

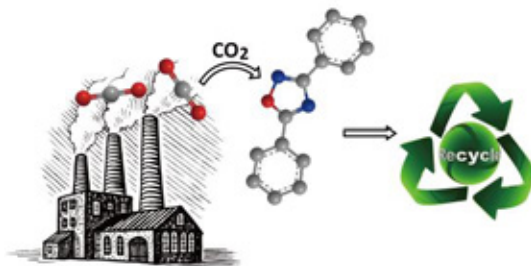


Figure 1. Porous solid adsorbent, covalent organic polymer, capture the CO₂ selectively from flue gas and recycle easily.

To present new sorbent, we need to consider about several things. Affinity to capture the carbon dioxide (Zulfiqar et al., 2011), possible to selectively pull the target gas (Patel et al., 2013) and, suitable cost and be a green chemistry. Here, we synthesize solid adsorbent covalent organic polymer (COP) which inspired from adsorbing mechanism of tree and lung in human body. This solid adsorbent captured 59mg/g of CO₂ at 1bar and is comparable with MEA (60mg/g of CO₂). Also, without expensive or harmful catalyst it can be synthesized simply by organic compound. Heat of adsorption shows 26 kJ/mol which means this COP is easy to regenerate and recycle for CO₂ capture. Additionally, COP shows high selectivity, captured 61 times of CO₂ than N₂, and thermal stability up to 450°C.

From this research, we show that new idea of CO₂ adsorbent, COP, can alter conventional adsorbent by bio-mimic green chemistry. Furthermore, capturing capacity and stability can be improved more with tethering on the solid wall or impregnating metal ion or amine in the pore of structure.

- Patel, H. A., Je, S. H., Park, J., Chen, D. P., Jung, Y., Yavuz, C. T., & Coskun, A. (2013). Unprecedented high-temperature CO₂ selectivity in N₂-phobic nanoporous covalent organic polymers. *Nat Commun*, 4, 1357. doi: 10.1038/ncomms2359
- Zulfiqar, S., Karadas, F., Park, J., Deniz, E., Stucky, G. D., Jung, Y., . . . Yavuz, C. T. (2011). Amidoximes: promising candidates for CO₂ capture. *Energy & Environmental Science*, 4(11), 4528. doi: 10.1039/c1ee02264d

NO_x Reduction with Copper in Zeolites

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NO_x, in the form of NO or NO₂ is a common pollutant in flu gas from the burning of fossil and bio fuels. The negative effects of NO_x pollution are quite severe. Acid rain and degradation of the ozone layer are only some of the consequences of this air pollutant.

One of the methods used to diminish the pollution of NO_x is selective catalytic reduction, SCR. This phenomenon is the reduction of NO_x into nitrogen, through a reaction with ammonia. This reaction is facilitated by various catalysts the most common being vanadium on titanium. The problem with these catalysts is, they are quite expensive because they are based on rare metals, with a limited supply and usually carcinogenic.

This is not the case with zeolites. Zeolites are based on aluminumsilicates, which are among the most abundant materials in the upper layers of the earthcrust. These zeolites are doped with copper, which performs the catalytic reaction. Due to zeolites quite porous nature, a lot of the ammonia can be stored inside the zeolite pores, so they do not go to waste when the stoichiometric requirements are not met.

A possible implementation of the zeolite based catalysts could be in automobile vehicles. Since they have a natural capacitance for ammonia the waste will be lowered. Also, the copper only fills a very small portion of the zeolite, so in more complex pollution situations, other catalysts can be combined, to provide a variety of reactions in the same volume.

Optimization of Cloud-RAN deployment using Integer Programming

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INTRODUCTION

The mobile data traffic is increasing with a very high rate due to the rise of smartphones and tablets. The only way to overcome such a large traffic volume is to increase the capacity in the network by deploying more base stations. This means, that the mobile operators are facing a challenging future as the cost to build, operate and upgrade the Radio Access Network (RAN) is becoming more expensive. Due to a very competitive market, the Average Revenue Per User (ARPU) is constant or even decreasing. It is therefore in the mobile operators' interest to find new solutions on how to reduce cost in order to maintain a profitably business.

It is estimated that Information and Communication Technologies (ICT) accounts for 2-4% of the worldwide carbon emissions and is expected to double in 2020. The mobile network has a big part in this and is therefore relevant when talking Green Energy. In the mobile network, base stations accounts for 58% of the power consumption. This means that the increasing number of base stations in the network will be a major problem when trying to lower carbon emission in the future.

THEORY AND METHOD

A promising solution to the above challenges is C-RAN (Cloud-Radio Access Network), which is a novel mobile network architecture. C-RAN is using distributed Remote Radio Head (RRH) and centralized Baseband Unit (BBU) architecture. C-RAN has the potential to support extremely dense mobile network deployments enhancing the network capacity while offering cost savings and lower power consumption on baseband resources.

This project will look into solutions on how the operators can optimize new green field deployments in terms of Total Cost of Ownership (TCO). In order to minimize the TCO, an Integer Programming (ILP) model is made. The model is optimizing the allocation of RRHs to the BBU pools, when looking at different mobile network deployment scenarios. The model takes into account that all cells are having different traffic profiles and that different types of base stations can be used.

By using this model, the power consumption in the mobile network will greatly decrease, as fewer base stations will be needed compared to a traditional mobile network deployment.

RESULTS AND CONCLUSION

The results show that C-RAN may be a possible solution to the future challenges in the mobile network. It is offering cost savings when deploying new networks and lowering the power consumption in the network by aggregating baseband resources. However, the findings also show that C-RAN is mostly beneficial for urban deployments with densely placed cells.

Photo-catalytic Preferential Oxidation of Carbon Monoxide in Hydrogen

T. Østergaard

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INTRODUCTION

Due to issues such as metropolitan pollution, energy crisis and global warming, attention has increased on fuel cell systems. Fuel cell powered systems has expectedly low environmental impact, and are a cornerstone to the hydrogen society.

The PEM-fuel cell is fueled with clean hydrogen, today produced from the so-called steam-reforming process, where hydrogen is extracted from natural gas.

Besides hydrogen, a side-product of CO is also made, which is reduced to 1% by a water gas shift reaction. When the hydrogen later is used in a fuel cell, even trace amounts of CO will poison the catalyst in the fuel cell and thereby prevent the hydrogen from reacting. Thus if hydrogen is to be a viable fuel for a cleaner society, a cheap and efficient purification method must be provided.

A way of removing these trace amounts of CO from the hydrogen is by illuminating certain photo-catalysts with UV light and thereby oxidize the CO molecules to CO₂. As a gas mixture of hydrogen and CO are in contact with an illuminated photo-catalyst, both gases can be subject to oxidation, and if the catalyst is not strongly preferential towards oxidizing CO, much hydrogen would be lost during the purification process. This project have investigated a purification method relying on preferentially oxidizing the CO (CO-PROX) by photo-catalysis.

METHOD

Experiments are performed in a so called μ -reactor with different TiO₂ nano-particle catalysts. The μ -reactor gives the opportunity of making both qualitative and quantitative measurements on tiny amounts of catalyst material with a fast time-response. Thereby making it possible to monitor the photo-catalytic reactions in-situ.

The CO-PROX using TiO₂ has been investigated under different reaction conditions, all pointing towards strong selectivity. Especially a modified TiO₂ catalyst was found to be a very promising candidate for CO-PROX. This is of course only if the reaction is applicable to larger industrial production systems.

PERSPECTIVE

During his work as Ph.D. student, Morten G. Nielsen (DTU Physics) worked on a cylinder reactor for photo-catalytic oxidation of a certain gas over TiO₂. This reactor forms a macroscopic system compared to the μ -reactor (nL) and are capable of illuminating m²'s of catalyst area and gas flows of 1000's of m³ pr. h. Under proper conditions, the gas was entirely removed, showing scalability of the TiO₂ catalyst from μ -reactor to macroscopic system, thus bridging the gap between lab testing and installing a pilot plant.

This might be a generic trend for TiO₂ nano-particle catalysts and the experimental CO-PROX results therefore look very promising for commercial applications in real industrial hydrogen production plants.

Methanol Reforming for Hydrogen Production

D. Li, H. Chen, L. Liang, S. Liu, H. Wu, S. Wang

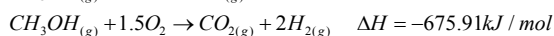
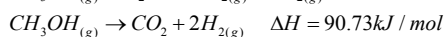
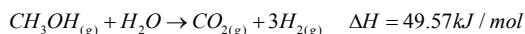
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INTRODUCTION

Today in China, the use of fossil fuels in vehicles has caused several environmental problems, such as emission of particulate matters (PM), NO_x, SO_x and so on. As an ideal energy carrier, hydrogen has advantages of high energy density, high conversion efficiency and being harmless to the environment. Thus, hydrogen-based fuel cell becomes a good choice of power source for vehicles. Traditionally, hydrogen is produced from electrolysis of water, which consumes much electricity, and produces a mixture of oxygen and hydrogen which needs to be separated through expensive and complicated technologies. Consequently, it is desirable to find better ways to produce hydrogen. Hydrogen production from methanol reforming has the advantage of generating high-concentration hydrogen with low energy consumption. However there are challenges in design reactor for methanol reforming, such as uneven distribution of temperature in the reactor, low efficiency of heat exchange and large reactor size. Therefore, it is necessary to design an improved reactor to address these challenges.

THEORY

Methanol reforming is an alternative method to produce hydrogen. This technology converts the mixture of CH₃OH and H₂O into H₂ and CO₂, through the following reactions:



METHOD

In this project, a reactor for methanol reforming is designed through simulation, which is conducted by some simulation software, such as aspen or PROII. The designed reactor integrates reforming chamber, combustion chamber, vaporization chamber, heat exchange chamber and pre-heating chamber together. Therefore the gasification, preheating, catalytic combustion and auto-thermal reforming of methanol processes are integrated, in order to decrease the needed volume of the reactor and improve the efficiency through optimizing heat exchange.

RESULTS

With ZrO₂/Pt/Al₂O₃ and Zn/Cr/La/Al₂O₃ monolithic catalyst, our simulation results indicate that the concentration of hydrogen produced in this reactor can reach 70%. Besides, the hydrogen producing rate is around 1.5 m³/kg (CH₃OH), and the energy consumption is below 3kw.

CONCLUSION

A reactor for methane reforming is designed through simulation. By integrating several processes into one reactor, we find the reactor can produce higher-concentration hydrogen and consume less energy, compared to the conventional approach.

3D Carbon Electrodes

Students from NTU-RPI-DTU Innovation workshop

ABSTRACT

We are developing three-dimensional scaffold structures in carbon (3D carbon scaffolds) formed from different polymer precursors and in various dimensions, using UV-lithography or 3D printing followed by pyrolysis. We and others have found that depending on the original polymer precursor used, the resulting carbon scaffold has different conducting and/or catalytic properties. These 3D carbon scaffolds could among other things be suitable for biofilm formation in biofuel cells (as both anode and cathode) and as catalysts in fuel cells. The suggested projects thus proposes to develop various polymer precursor templates using 3D printing/UV lithography, their subsequent pyrolysis, and investigation of their conductive behavior in a biofuel setting.

Optimization of wellfield operation in a variable power price regime

E. Sleire¹

¹DTU Space, Technical University of Denmark

Supervisors: Peter Bauer-Gottwein – DTU Environment
Raphael Schneider – DTU Environment

INTRODUCTION

The idea behind the project is to see how one can couple the highly variable power prices of the Danish electricity-market with a model of wellfield operations to minimize the cost of pumping groundwater into storage.

From the stochastic price regime, it is possible to use Stochastic Dynamic Programming (SDP) to create a set of decision rules which determine whether it would be economically beneficial to pump or not, depending on the time of the day, the amount of water in storage and the price level. This is as an alternative to present practice of constant pumping.

THEORY & METHODS

A wellfield has a characteristic relationship between energy footprint of the pumped water and the pumping rate. The pumped water can to a certain extent be stored for some time, and there will be a given demand every hour. As with the demand, the power prices are also an hourly variable, with both deterministic and stochastic components. The volatile nature of the Danish electrical market comes from high penetration of intermittent wind power.

For management of groundwater pumping in this semi-stochastic environment, Stochastic Dynamic Programming (SDP) can be used. Here SDP will be used together with operational data from the Sønderlø Wellfield to see if it can yield a more cost-effective performance structure.

RESULTS (PRELIMINARY)

Preliminary simulations have found that there is a possible saving of 19 % of cost with a perfect foresight, and 11.4% of this by using adapting pumping. More results will follow from further analysis performed during June.

CONCLUSION

There is clearly an economic incentive for implementing a more adaptive pumping strategy of groundwater; Moreover, the power generation will move to the renewable sources, making power prices on the wholesale market even more variable. This method follows one of the ideas of the “smart grid” philosophy, i.e. making power demand more flexible in order to be able to fully use varying electrical power supply from a renewable and uncertain power source.

Biocatalysis in the Pharmaceutical Industry

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This project aim to review the current status within the field of biocatalysis. We identify key areas that crave improvements and thereby this project facilitate expansion of the technology among pharmaceutical companies in the future.

Due to a very comprehensive manufacturing process, with many complex processing steps, the production of pharmaceuticals is the most waste generating chemical production process with a waste production of 25-100 kg waste/kg product.

Biocatalysis is the implementation of enzymes in the production process and it enable manufactures to reduce the number of steps and make the reaction more effective, which means that less mass of raw materials need to be used. Additionally the waste produced become more environmentally compatible as enzymes primarily work under mild conditions, and there is no need for hazardous reagents. With enzymes as biocatalysts it is possible to produce complex pharmaceutical products, containing multiple chiral centers, with reduced waste generation and furthermore avoid the use of toxic solvents and reagents.

Biocatalysis is a promising technology that can lead to a greener production process, but much effort has to be made to implement it and convince the pharmaceutical companies that this innovative step not only contribute to a greener production, but will also save them both money and time. This can in turn enable them to produce affordable drugs to the developing world and reach people in need.

After reviewing the field of biocatalysis we can conclude that among future improvement in the field are:

- Development of commercially available enzyme libraries to cut down the resources related to protein engineering carried out by the pharmaceutical company
- Standardized procedures that make the technology easier to implement
- Development of modelling techniques to reduce the costly and time consuming experimental work

“The Red Gold” that will fuel the Arctic

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Center for Arktisk Teknologi, Department of Civil Engineering

INTRODUCTION

In Sisimiut, Greenland, is located one of the world's largest shrimp industries. The factory is the main source of people's livelihood in the municipality and the shrimp trading contributes to approximately 50% of the total income in Greenland. Sisimiut plant receives 20,000 tons of shrimps per year; however, only 1/3 of this amount is edible. The rest (shrimp shells and tails) is discharged into the sea, threatening the fragile arctic marine environment. Several treatment options have been introduced in the past, which were proved disadvantageous, both economically and environmentally. This project focuses on the feasibility of biogas production from the shrimp by-products, an unexploited valuable resource, as an alternative solution.

THEORY

Biogas is produced during the anaerobic degradation of organic matter by different types of microorganisms. It consist mainly on methane and CO₂ and it can be used as a fuel for heating and electricity generation or it can be refined to natural gas standard and used in the same way. Biogas is considered as a renewable energy carrier that can replace fossil fuels and subsequently, reduce global warming.

METHODS

Experimental measurements have been made in order to identify the biogas potential of the shrimp by-products. The procedure involves mesophilic (37 °C) anaerobic digestion in batch-type reactors. Afterwards, the results were evaluated with a feasibility analysis facility in order to identify the economic viability of the project. In addition, a Life Cycle Assessment was performed to state the environmental impacts.

RESULTS

Methane yield of the shrimp by-products was estimated at approximately 400 ml CH₄/gr of organic matter, which was above the average biogas production of different substrates that are used in commercial plants in Denmark.

The shrimp industry in Sisimiut requires high amount of heat, which corresponds to more than the half operational costs. Thus, the biogas was planned to cover the heat demand of the factory that currently uses light oil.

The economic evaluation of the project demonstrated a positive Net Present Value and an Internal Rate of Return of 14%, which exceeds the usual preferences of the investors. The estimated biogas production was predicted to replace 63% of light oil consumption in the factory and decrease approximately 35% of the total operational costs.

Finally, the LCA showed that a great amount of CO₂ emissions can be avoided from fossil fuel substitution and the shrimp by-product handling can minimize the risk of marine pollution.

Fabrication of Solid Oxide Fuel Cell Cathode by Inexpensive Inkjet Printing

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DTU Energy Conversion, Technical University of Denmark

INTRODUCTION

Solid Oxide Fuel Cell (SOFC) is an energy conversion device consisting of porous electrodes and a dense electrolyte in-between which converts a gas fuel into electrical power with high efficiency (figure 1).

A few micron-thick (1-2 μm) dense yttria-stabilized zirconia (YSZ) electrolyte has been recently fabricated by inkjet printing on a $9 \times 9 \text{ cm}^2$ green NiO/YSZ substrate in our facilities using a modified photo inkjet printer (figure 2). The resulting cells were tested and compared to those obtained on fuel cells fabricated by tape cast electrolyte, showing superior performances. With an objective of continuing improving SOFC performances, development of a cathode layer by inkjet printing is being studied in this project.

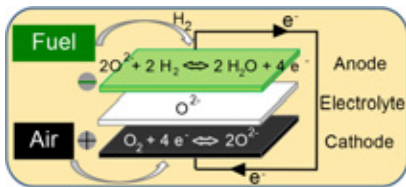


Figure 1: principle of a SOFC



Figure 2: Modified photo printer

CHALLENGES

Inkjet printing inks developed within this project are water-based, and hence exhibit a high surface tension. When printing onto surfaces such as sintered half-cell (electrolyte + anode), covering issue might happen if the ink surface tension is not optimized, leading to poor performances of the cell.

In this project, influence of surface tension of Lanthanum Strontium Cobalt ink (LSC) on the homogeneity of the printed film has been studied. Several solvents mixtures and surfactants have been investigated in order to reduce the ink surface tension hence optimizing the covering of the substrate surface.

Financing energy sustainability through crowdfunding

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INTRODUCTION

As people are becoming increasingly aware of the environmental problems related to the use of fossil fuels to generate electricity, they have begun seeking ways to support energy sustainability. We propose that crowdfunding as an emerging funding mechanism, is applied to harness resting capital and increase general interest in green energy. The methods of crowdfunding (Belleflamme, Lambert & Schwienbacher, 2013), i.e. engaging small-scale investors, could be employed not only to fund sustainable energy projects but also to increase general energy awareness, reduce local NIMBY (Not In My Backyard) resistance to e.g. wind turbine projects and also distribute the ownership of energy.

The goal of this initiative is to study the feasibility of the crowdfunding concept and design a web service for its implementation. This will include e.g. studying functionalities of debentures and related consumer behavior.

METHODS

Debentures are used as the main financing instrument. A debenture is an acknowledgment of debt from the issuing company to the owner of the debenture. The debt is paid according to the terms written on the debenture, i.e. as a fraction of profit from sold or saved energy.

To allow as many people as possible to participate in funding projects, we need to enable a wide scale of debenture "prices". A flexible and automatic way of creating these legal documents is thus required. In practice, this can be implemented using a web service. This web page would allow the project owner to automatically issue a debenture to the investor and also function as a secondary market for trading the financial documents.

The web page should have several energy sustainability projects open for funding simultaneously. These projects do not have any geographical limitations, as long as the necessary legal framework exists in the target country.

After the desired amount of crowdfunding is reached, the project funding is closed on the web page and no more debentures are issued. When the project is up and running the crowdfunders are paid periodically according to the debenture terms.

REFERENCES

Belleflamme, Paul, Thomas Lambert, and Armin Schwienbacher. "Crowdfunding: Tapping the right crowd." *Journal of Business Venturing* (2013).

Klenergy

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²DTU Sustainable Energy Engineering, Technical University of Denmark

³Industrial Engineering, Employee in AR System Company, Spain

INTRODUCTION

Klenergy is an idea based on the future of the hydrogen technology. The concept is to create self-sufficient energy from renewable energy (solar panel, wind energy, bioenergy) using the hydrogen technology instead of conventional batteries. The end result of this process is on-site generation of energy for your house, infrastructure and facilities. Every step of the process is designed to be sustainable for the environment. The hydrogen itself is extracted from plain water, the only residue produced when consuming the hydrogen is water. With this process we aim to satisfy our society's growing energy needs and at the same time reduce the environmental impact on our world only residue useful for the electrolysis process.

WHY KLENERGY

Klenergy came out from an energy necessity. How can we store all the energy that the sun and the wind produce for all the year? Klenergy is the most efficient solution to solve this big problem. We provide the tool to save and make money in the same time for energy companies, wind/solar farm, energy brokers and private households. We are helping those entities who produce power from sun and wind to become more efficient. Klenergy is aimed at challenging the current way to store energy and satisfying the global energy needs. The key point is connect our battery-on-grid anywhere and go big scale to sell energy when people need it and when is convenient. We are making a battery-like device that can store electric power. This way we make sure to get all the energy out of the wind and the sun when it is blowing and shining and then use it when people need it later at peak times. We have found the most efficient way to store electric energy that is, at the same time completely environmental friendly using Hydrogen as battery. Aside from this, hydrogen can be produced from domestic resources, eliminating the need to import foreign oil, natural gas or coal. This helps the local economy and government; every energy dependent household increases a state's political and economic independence

How is the role of technology?

The hydrogen technology that we use is the future of energy. Klenergy stores and then produces clean energy without any emission. We eliminate the capacity limitations of battery based storage technologies with our system based on hydrogen storage. This process works by using the surplus energy generated from solar panels and wind turbine (the surplus comes from the hours in which the facility's demand is lower than production) in order to produce hydrogen through a process of electrolysis. The hydrogen is kept in a deposit which varies in size depending on different energy needs. The key part of this process is carried out by the fuel cells which generate energy from the hydrogen with water as the only byproduct. We are working on developing a prototype to generate 300-1000 Watts of power.

Oil Companies Watch Out: Biofuel Production from Salt Water Plants and Fish Waste

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²DTU Sustainable Energy, Technical University of Denmark

INTRODUCTION

The idea presented is the enzymatic production of biodiesel and biogas from *Salicornia bigelovii* and fish waste. *S. bigelovii* and a fish farm would be cultivated in conjunction with one another using salt water as the main water resource. *S. bigelovii* would then be harvested to produce biodiesel and bioethanol. The bio-waste and fish waste would be used to produce biogas.

PROCESS OVERVIEW

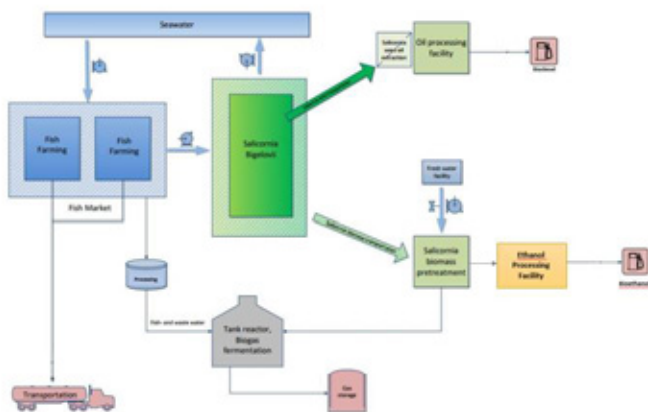


Figure 1. Overview schematics

Seawater is pumped to the fish ponds, then the nutrient rich water is used as fertilizer for *S. bigelovii* and the resulting waste water is used in the production of biogas. Fish is sold as a product and the fish waste is used in the generation of biogas. The seeds from the halophytes are extracted and sent to a processing facility to produce biodiesel. The remaining biomass of the plants is then sent to a pretreatment facility before being used to produce bioethanol. A small amount is used in the biogas reactors. The biogas tank reactors digest the substrates and the biogas is used to power part of the facility.

SUSTAINABILITY

The enzymatic biodiesel and biogas processes have a lower environmental impact and energy use when compared to more traditional biodiesel processes. *S. bigelovii* grows in salt water on arid land and therefore does not compete with food and feed crops. Due to the usage of the fishery waste water to grow *S. bigelovii* no fertilizer input is needed. In addition *S. bigelovii* absorbs more carbon than what is emitted during the growing and harvesting process and increases the net sink of carbon stored in the soil.

Small Vertical Axis Wind Turbine Design

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The Small Vertical Axis Wind Turbine Design participates in the European Wind Turbine Design Contest (EWTDC). This is a contest between universities regarding the design and construction of a small wind turbine. NHL Leeuwarden organizes the event. During the academic year, 5 university teams participate in the contest through two stages with a final experimental evaluation. The first stage involves wind turbine design with a maximum swept rotor area of 2m^2 . Once the committee accepts the design, the second stage involves the students in the turbine's manufacturing. The final event, the 2nd to 4th of July, consists out of several wind tunnel tests at TU Delft, in order to judge the best design, followed by a symposium in Leeuwarden.

The EWTDC contest does not restrict the students to a specific type of turbine to be designed. Given the master study focused more on horizontal axis wind turbines, vertical axis type was the chosen approach. However, there is a large research gap between these two turbine types. For this reason, many variables had to be considered, i.e. VAWT topology, number of blades, airfoil type, control methodology, efficiency, etc. This is indeed a green project, as vertical axis wind turbines have great benefits. Whether offshore or inland, VAWT's are not resource intensive (tower) and harvest wind energy, independent of its incoming direction (less components).

The methods used for the design, involved a self-developed BEM code. However, before any programs in Matlab were written, discussions with researchers at Riso and DTU professors took place. Some first assumptions were done with BEM, in order to determine the appropriate aerodynamic properties for the VAWT design. Later on, simulations using HAWC2, an aeroelastic code developed at DTU, enhanced the process and allowed the team to evaluate various designs and their performance. Indeed the scale of the VAWT posed other challenges as airfoil data is needed for low Reynolds numbers. Literature resources and performed wind tunnel tests provided the needed information. With these simulation results, work will continue in order to finalize the criteria to be considered during the second and last stage, construction. With the VAWT prototype, testing will determine whether some more adjustments will be required before the wind tunnel tests to be performed at the competitions location.

Being DTU's first time to compete in such event, one of the many goals is to compete yearly and win the contest, just like other wind energy related projects, ingoing at DTU. The continuous development of this project is also intended to improve the performance and the design of VAWTs, where innovations are a possibility. For now, after the construction phase and the final wind tunnel tests, the team will be able to evaluate results and compare the assumptions made, during the design phase, with both blade-element-momentum theory and the aeroelastic code used.

Covering system for orchards that reduce the use of pesticides, while producing solar energy

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ABSTRACT

In fruit and berry production the biggest problem farmers face year after year is the attack of fungus diseases. Up to 95% of an apple production can be infected in a year by the scab disease. Conventional farmers use great amounts of pesticides to reduce this number, while organic farmers have no defense. A new research conducted by Marianne G. Bertelsen, senior researcher in the Department of Food Science at Aarhus University, shows that sheltering the apple trees from the rain can reduce the infection rate to near 0%. By sheltering the trees, the leaves are able to dry faster, preventing the scab from spreading. At the same time the implementation of large fields of solar panels for electricity production faces some ethical issues. Occupying land that could have been used for food production can result in rising food and land prices and can, in extreme situations, lead to famine in poor parts of the world. The idea of this product was to combine these two issues. By covering orchards with shelters containing solar panels, the farmers could reduce their use of pesticides, while producing solar energy.

To develop our product we first interviewed all the relevant stakeholders to understand their needs and the issues they faced. Multiple ideation, conceptualization and evaluation methods were employed to reach a shelter solution that was inexpensive and easily installable. In parallel, a business plan was formulated with the user in mind. In the end the final design was backed up by a mechanical analysis in SolidWorks and economical calculations.

Our product consists of a lightweight construction that may be mounted on the poles already in the orchards to support the trees. The covering surfaces are made from thick see-through plastic with stripes of semitransparent polymer solar panels that are both flexible and cheap. The product is compact in transportation, easy to install and it is estimated that farmers will earn revenue from our product after only 6 years. Overall, this product not only offers multiple benefits for the farmers, but can also be seen as a technological example setter, for the integration of food and energy production in an innovative and sustainable manner.

REFERENCES

Bertelsen, M. G. (2013) *Tag over æblerne: Er det vejen frem for usprøjtet æbledyrkning?* Retrieved January 26 2014, from http://pure.au.dk/portal/files/56801119/_bler_under_tag_Marianne_sept2013.pdf

Design of Mobile, Water Recirculation Container for Live fish Transportation

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Abstract

Transportation of live fish requires continuous regular monitoring of good water quality status on parameters supporting survival such as O_2 , and the one that impairs life such CO_2 , NH_4 , NO_2 and NO_3 , the by-products of fish respiration which continuous supply of fresh O_2 or replacement of fresh water leading to discharge of deteriorated water which can be lethal to other organisms as it is to fish. In this Project, Application membrane filtration as advanced separation technology and water pump are used to design mobile container fitted with water recirculation system that will allow in-line treatment of waste water to reusable water from and to the fish container. A pump with a capacity of at least a head of 50 kPa is used to transport water from the tank to the treatment chamber in which a hydrophobic microfilter (MF) membrane polymer with $0.5\mu m$ pore size is fixed ahead of biological digester with bioelements that help to trap organic wastes, the driving force of separation is pressure difference outside and inside membrane and concentration difference between waste water and reusable water. This container will be environmentally friendly and sustainable means of transportation of aquatic organisms where CO_2 , NH_4 , NO_2 and NO_3 are treated within the system resulting to reusable water for long term use with zero discharge.

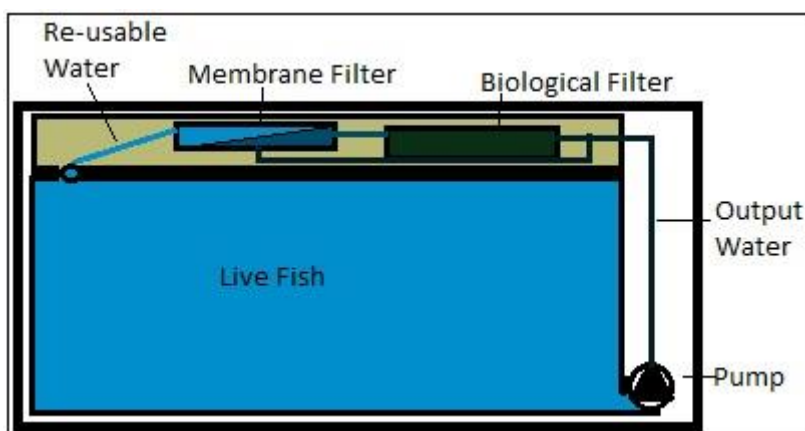


Figure Sketch of Mobile, water recirculation container systems
(Diagram: J.P.H. Kinyage, 2014)

Key words: *Fish transportation, water recirculation, membrane separation, water quality*

DTU Edible

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INTRODUCTION

To create a sustainable future, one first has to create a sustainable mindset. And as with many technical and environmental efforts to reduce our consumption of goods and energy, a solution is only efficient when followed by a subsequent change of mentality amongst the users.

The idea is here to directly change the mentality amongst the users by forcing an attack on their alienation from nature. This is achieved by making them all first-hand direct users of the actual nature on DTU campus, switching over to planting a purely edible greenery selection and basically transforming DTU into an edible campus.

OVERVIEW

Human learning is always strong when we are given visualizations, and even further intensified more when we are given pure hands-on experience. Most of the greatest inventions and design revolutions of mankind have always been coupled with a rigid observation and understanding of nature.

As a campus on a huge area with a living green environment, this area could itself be put to use to create a more intimate atmosphere between all the users of DTU and the campus itself.

The project would be to analyze the total area and map it for potential replacements in the current planting with an all-edible selection of trees, shrubberies, flowers and roots. Furthermore the project should include a cost- and effort-analysis.

CONCLUSION

As students native to agricultural backgrounds, we have found the complete agricultural and forage-related analphabetism as shocking as it is ominous.

Society as a whole needs to think outside the box in its ways to make students and inhabitants feel as a partaking element of a sustainable future, and by completing such a transition to an edible campus DTU will put itself foremost as being an innovative university working towards sustainability.

Fighting the Bite – Sustainable Antivenom Production

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DTU Chemistry, Technical University of Denmark | Copenhagen Business School

TACKLING THE WORLD'S MOST NEGLECTED TROPICAL DISEASE

Globally, more than 5.5 million people are bitten by venomous snakes per year, leading to 125,000 deaths and 4 times as many amputations. The problem is most prevalent in Sub-Saharan Africa in rural communities.

Current antivenoms are obtained from immunised horse blood and are, therefore, not compatible with the human immune system. The antivenoms cause severe side effects (incl. serum sickness and death) in up to 81% of patients due to their immunogenicity. Additionally, current antivenoms lack efficacy and it is estimated that more than 99% of the antibodies and other proteins in antisera are non-specific and have no therapeutic effect on the snake venom. Hence, large quantities of antisera are needed for administration to the patient in order to deliver enough of the 1% potent antibodies.

In addition to safety and efficacy issues related to current antivenoms, the production method for antivenom is highly unsustainable, both environmentally and economically. In order to treat all snakebite victims on a global level, it is estimated that 17,000 horses would be required annually. These horses need to go through a 1-1.5 year long immunisation protocol which, together with the very high costs of husbandry, constitutes a heavy financial burden. This results in prohibitively high priced antivenom for low-income markets such as sub-Saharan Africa. From an environmental point of view, current methods of production annually result in an astounding 200,000 tonnes of waste and more than 35,000 tonnes of CO₂ (equivalent to 1.65 million trees). As a result of the safety, efficacy and cost issues, less than 2% of all snakebite victims in Sub-Saharan Africa are receiving antivenom treatment.

SUSTAINABLE PRODUCTION ENABLES BROADER ACCESS TO ANTIVENOM

By using recombinant biopharmaceutical technology, we will replace current antivenoms with a more financially and ecologically sustainable alternative, based on recombinant humanised antibodies that specifically target the medically relevant toxins in snake venoms. This targeted therapy has the potential to be more efficacious and much safer, since humanised antibodies *are* compatible with the human immune system. Furthermore, using cost-competitive fermentation as the production method completely eliminates the need for production animals which substantially lowers the cost of production, and, in turn, reducing the cost of care by 90%. In Africa alone this will provide over 750 million people with access to antivenom; a drastic improvement compared to the current 10 million. Seeing this in a green perspective, our proposed solution has the potential to reduce production waste by 97% and to cut production time down to 4% of the current requirement.

The snake antivenom industry is ripe to enter the era of modern biopharmaceuticals – and we will make it happen.

REFERENCES

Brown, N. I. (2012). Consequences of neglect: analysis of the sub-Saharan African snake antivenom market and the global context. *PLoS neglected tropical diseases*, 6(6), e1670.

Rapid Diagnostics in Health Care and Agriculture

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PROBLEMS WITH ANTIBIOTIC RESISTANCE IN BACTERIAL INFECTIONS

Excessive use of antibiotics are responsible for the rise of antibiotic resistance in bacteria. When these bacteria cause infections, treatment options are very limited and this creates a major issue in the general health care. One of the problems, giving rise to resistance is the tendency of medical doctors and veterinarians to administer antibiotics without the use of precise diagnostic tools. The resulting treatment with broad-spectrum antibiotics is causing resistance and has given rise to multi-drug resistant bacteria, now spreading at hospitals and beyond. Lowering non-specific antibiotic treatment and thereby resistance, will create a more sustainable future in treatment of bacteria infections.

QPCR LAB-IN-A-CHIP AS A RAPID DIAGNOSTIC TOOL

The use of rapid diagnostic tools is one way to lower incorrect use of broad-spectrum antibiotics. If rapid diagnostic tools are used, specific antibiotics that target the bacteria causing the infection can be used, thus lowering the risk of antibiotic resistance evolving. We use known qPCR and lab-on-a-chip technology in a new way, to implement a simple assay that can rapidly identify multiple bacteria at your local medical practitioner and thus ensuring correct treatment.



Figure 1. qPCR lab-on-a-chip

IMPACT

- Correct treatment of infectious diseases
- Quicker detection of potential epidemics
- Lowering of broad-spectrum antibiotic treatment, and thus lowering of antibiotic resistance in bacteria
- Securing the possibility to treat infectious diseases with antibiotics in the future, and thus ensuring a sustainable health care

Reducing Power Consumption of LED Screens by Backlight Dimming

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Motivation

As the world community becomes increasingly aware of the repercussions of the increased CO2 emissions, the need to tackle this dilemma on all levels of development is apparent.

In modern televisions the picture is often produced by a RGB pixel plane, producing the colors and a white light plane (LED plane) producing the backlight needed to illuminate the color plane. The idea is, through smart algorithms, to decrease the need for unnecessarily high backlight for dark areas of an image, and thus gain increased power savings. This in turn results in an extended bonus by improved contrast between light and dark.

"Advanced backlighting technology using LED-based light sources and segmented control can create a vibrant viewing experience, while also significantly reducing power consumption in LCD TVs by as much as 80%".¹

Theory

Backlight dimming can be categorized into dimensions, with each dimension reflecting the complexity of the algorithm used, from 0d to 2d.

- **0d**: dimming of the entire backlight uniform across the display
- **1d**: dimming across a single axis.
- **2d**: dimming done across two axis (horizontal and vertical) is classified as 2d

Within this definition there is a sub-definition referred to as 1.5d dimming technique. This type of dimming is relevant when working on hardware with the LED backlights positioned at the edge of the main screen and not behind the pixel plane. 1.5d allows for the LEDs on either side of an edge in a single axis to be controlled individually, increasing the controllable dimming zones.

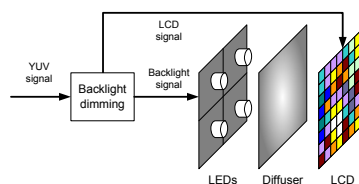


Figure 1: Depiction of physical backlight representation

Hardware

The hardware used during the project is a B&O television with its 16 LED backlights, positioned on each vertical side (8 on each side) pointing at the centre. To measure the power usage a power meter is used.

Goal

During the project I set out to prove that implementing 0d and 1.5d dimming techniques decrease the end power consumptions, as a prove of concept.

¹ de Greef, P., Groot Hulze, H., & van der Heijden, H. (2.29-2008.). *eetimes.com*. Retrieved 30.04-2014 from http://www.eetimes.com/document.asp?doc_id=1273804

Systematic Design of Process for the Sustainable Production of Anhydrous Isopropanol from Propylene

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Introduction

The compound isopropanol (IPA) is an important chemical used as feedstock and solvent for a large range of chemical compounds. The demand of IPA in some parts of the world is expected to increase in the near future. Therefore, the chemical process design of IPA is relevant to investigate, improve and optimize both concerning cost efficiency and environmental impact. Reducing the environmental impact and making the process more sustainable while satisfying the process specifications are the main focuses in the optimization of the base case design to obtain a more sustainable process.

Methods

This project comprises a preliminary conceptual process design of a plant facility producing anhydrous IPA from propylene via direct hydration. The process of completing the design is performed using a PSE approach. This is a systematic top down approach which decomposes the design problem into 12 tasks. The last tasks concern optimization of the plant design by targeting bottle-necks and sustainability issues using computational simulation tools.

Results

The computational tool SustainPro is used to identify bottle-necks of the process in order to make the process more sustainable. The identified bottle-necks are:

1. Energy Consumption
2. Distillation column designs

A heat exchanger network system (HENS) was developed to evaluate whether energy consumption and waste can be reduced to improve sustainability issues for the process.

The following results and savings are obtained from the HENS analysis:

	<i>Duty [MW]</i>	<i>Cost [\$ / y]</i>
<i>Base Case</i>	113.4	6.0
<i>HENS Case</i>	82.3	4.8
<i>Savings</i>	31.1	1.3
<i>Savings [%]</i>	27.4	20.9

Table 1 Results of HENS analysis

From the HENS analysis it can be seen that utilities can be reduced resulting in increased profit and a more sustainable process with less environmental impact.

Conclusion

By using the computational software SustainPro a Life Cycle Analysis was made and bottlenecks were identified. The profitability and sustainability of the process can be increased considerably by performing heat integration.

Sustainable Production of VCM from Ethylene through a Hierarchical Approach

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INTRODUCTION

Vinyl chloride monomer (VCM) is an important chemical as it is the key component for production of the plastic PVC. The annual worldwide production of VCM is roughly 42.7 million tons and is expected to increase in the coming years. This makes optimization of the VCM production interesting and potentially profitable. Equally important, even small environmental progress in this process would have great beneficial impact on the environment, and increase the sustainability of the extensive VCM production.

CONTENT

A systematic hierarchical decomposition method is applied to design a sustainable and environmentally friendlier plant for production of VCM from the raw materials ethylene and chlorine. The method consists of 12 sequential tasks, which take into account all stages of conceptual design. Tasks 1-4 cover the consideration of qualitative aspects of the process flowsheet and preliminary calculations. Tasks 5-8 determine the detailed process simulations, equipment sizing, costing, economic evaluation, sustainability and LCA assessment of the designed process. In task-9 (the economic analysis), the base case design is investigated for improvements with respect to heat integration and process optimization. In the final task-12, a sustainability and LCA analysis is performed to assess the environmental impact of the process design. The analyses are performed on the key sustainability and LCA measures such as sustainability metrics for environment, economic and social; carbon footprint; safety index. In addition, a commercial simulator is used for process simulation (for verification of design), ICAS for property prediction and analysis of design options, and ECON for cost and economic analysis, which is based on the Guthrie method. The 12-tasks design method helped to perform the process design related work systematically and efficiently, where first design decisions were based on collected information and then verified through simulations. This procedure can be applied to design and/or analysis for new or existing chemical or biochemical processes. The process design of a VCM producing plant was performed as part of a MSc-level course on process design at the Department of Chemical and Biochemical Engineering at DTU.

Conclusion

The annual profit of base case is estimated to be about 30 million US\$ with a payback time of 5 years for production rates of 1.9 MM. tons/year of VCM. The capital and operating costs are divided into the individual cost items in order to provide easy overview of equipment and utilities that contribute significantly to these costs. It is found that the distillation columns are the most expensive equipment contributing to capital costs, and raw materials are the main contributor to the total operating cost. This information is used as target for process improvement by heat integration and process optimization, thus increasing the annual profit and reducing the payback time. The environmental impact analysis identifies impact due to the release of chemicals and points to the need of better control mechanisms through the sustainable/LCA analysis. The LCA analysis has illustrated how the process can become more sustainable, which has led to the environmentally improved design.

Energy Ships: Transition to the Hydrogen Economy

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BACKGROUND AND PROBLEM FORMULATION

The energy ship is a novel concept proposed by Platzer et al. which seeks to address the global energy crisis in a way that is clean but without the baggage associated with almost all current renewable energy sources (low energy density, grid connectivity problems etc.). In this concept, hydrogen is produced by electrolysis of ocean water, the required power for which is provided using wind energy captured by the sails propelling the ship. The ship is intended to operate in the North Atlantic Ocean which has high average wind speeds of over 9 m/s. This hydrogen is stored in cylinders on-board the ship before it is eventually transported to land where it can be used to generate clean energy.

ADVANTAGES AND ORIGINAL CONTRIBUTION

The major advantage of this concept is that while the system can benefit from many of the regulations aimed at increasing the diffusion of renewable energy sources especially off-shore wind, it side steps many of the accompanying problems (prohibitive costs for deep water wind turbines, problematic grid connection due to turbulent nature of wind energy and required infrastructure to transport generated electricity on-shore). At the same time, the system is not without its own share of problems, especially the low density of hydrogen leads to prohibitively high storage costs.

Due to this limitation, we diverge from the monolithic model presented by Platzer and develop the concept of an autonomous (or semi-autonomous) worker ship swarm model that can move about independently in search of the optimal wind speeds. We envision this system to drastically reduce the amount of hydrogen we need to store on board. We compare the proposed system with the original model via a thermodynamic analysis to make explicit the differences between the two systems as well as discover possible candidates for optimization.

RESULTS AND FUTURE WORK

Based on the work so far, we have found that this system has the potential to substantially offset the carbon footprint if utilized in large numbers. The thermodynamic analysis has also revealed that the proposed swarm model yields an efficiency improvement of about 5% over the original monolithic model. Furthermore, a multi-criteria analysis has been conducted to identify the ideal market for deployment of such a system (including considerations such as carbon reduction commitments, proximity to transatlantic trade routes and national legislation).

Having already concluded the thermodynamic analysis, in the next step we intend to identify the gain in power by employing the swarm model instead of the monolithic model by conducting simulations based on real world data. We also intend to dimension both systems in terms of commercial technology available currently to conduct a complete cost-to-benefit ratio and calculate the overall energy return on investment (EROI).

Optimization of Distribution to Retailers of Newspapers and Magazines

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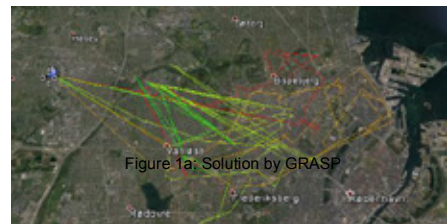
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INTRODUCTION

The transport sector, which includes everything from bike taxis to air transport plays a vital role in any society. Because of the fact that the transportation cost makes up approximately 70% of the production cost for a newspaper (Arnsted, 2014), a distribution optimization creates an option to reduce the transportation cost at A/S Bladkompaniet and furthermore reduce the impact on the environment. Hence, the project will end up with designing a solution model to reduce the cost of distribution.

METHOD

The solution is designed by two metaheuristics: GRASP and Simulated Annealing (SA). They have been developed in JAVA within Eclipse. Furthermore, OpenStreet Map and Graphhopper is used as geographical data. Both in GRASP (as a Hill Climber) and SA, three neighborhoods are searched according to the best-improvement principle. GRASP is used to obtain an initial solution and the SA does the work of searching for better solutions. A parameter analysis is performed to determine which parameter combination to use within SA and some test runs are performed to determine the order of neighborhoods to search within.



RESULTS

After the parameter analysis the parameter combination with 1,750 as start temperature and 0.96 as cooling parameter is selected. The test runs show the best order of neighborhoods are first by moving a retailer from one route to another, then do a swap of two different retailers from two different routes and finally change the position of a route within the same route. Figure 1 and 2 shows respectively the solution by GRASP and SA. It's clear that the cost is reduced by SA and the trucks do not cross routes and visit retailers disorderly as in the GRASP solution. The cost is reduced by nearly 9% and considering the distribution takes place every day, the impact is huge.

CONCLUSION

By using metaheuristics it's possible to reduce the cost, so both A/S Bladkompaniet can earn more and reduce the environmental impact.

REFERENCES

Arnsted, L. H. (2014). Chief of Planning, A/S Bladkompaniet



Figure 2: Solution by SA

Fuel Production from Cruise and Passenger Ship Waste

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Increasingly demanding environmental regulations and onboard waste production require immediate action from cruise companies. Firstly, the International Maritime Organization has established very strict emissions reduction goals, leading companies to use cleaner (and more expensive) fuels, and/or shifting to dual-fuel engines or gas turbines. Furthermore the size of the average vessel continues to increase, leading to larger amounts of waste that must be disposed of properly. Thus, the cruise ship industry faces several environmental challenges requiring novel solutions.

This project examines the feasibility of using the waste generated on cruise ships for producing fuels *onboard*, thereby attending two environmental problems of cruise ships. Five thermochemical processes for producing biofuel are reviewed: pyrolysis, hydrothermal liquefaction, gasification, hydrothermal gasification and arc-plasma gasification. These alternatives have been used for producing second generation biofuels but, to the best of our knowledge, they have not been considered for waste treatment or fuel production on ships. Our initial estimations indicate that all processes would reduce fuel costs, thus suggesting that initial investments would be recovered. Furthermore, public image of cruise companies will greatly benefit from inclusion of green technologies in their ships and additional savings could arise from reduced fines for pollution and reduced onshore discharge fees.

From an environmental point of view, onboard biofuel production would decrease consumption of fossil fuels and provide a proper treatment method for wastes. Also, secondary emissions (such as those deriving from oil and wastes transportation onshore) would diminish by including the proposed technology. Finally, by employing the considered waste streams as feedstock for providing energy in the ship, the industry would be one step closer to sustainable cruising.

Conversion of Waste Cooking Oil into Biodiesel

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INTRODUCTION

About 20 million tons of waste cooking oil (WCO) are produced in China every year. The present method of converting WCO to biodiesel suffers from the problems of low economic efficiency and low product (quality). In fact, most of the WCO are illegally used for producing edible oil, which seriously harms the public health. This project is aimed at utilizing WCO to produce high-quality biodiesel to facilitate an effective use of the waste and minimize the environmental effect.

METHOD

This project uses ASPEN to simulate and optimize the WCO conversion process with heat integration, followed by performing economic analysis. The three-dimensional graph of the factory of the conversion process is drawn by LUMION. The sustainability of the proposed process is analyzed by LCA (life cycle assessment) and the FSPs (four sustainable principles).

RESULT

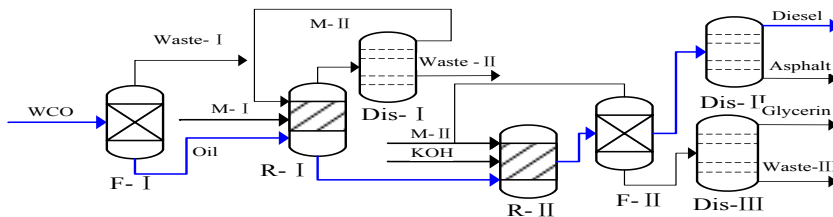


Figure 1 F-I: material pretreatment, R-II: esterification, R-III: transesterification, others are separation and purification

The designed process for converting WCO to biodiesel is illustrated in Figure 1. The simulation results indicate that the process could successfully produce high-quality biodiesel (ester content: ≥ 96 wt.%) and co-product, glycerol, by using waste oil and methanol as the raw material and enzyme produced by Novozymes. Waste water from these processes is collected by tanks and recycled to minimize pollution. The cost of utilities is reduced about 20% by heat integration and the low price of WCO, which makes the process economic feasible. Through the assessment of LCA and the FSPs, the process is proven to be eco-friendly due to the excellent biodegradability of the high-quality biodiesel as well as the low emissions when using the fuel.

CONCLUSION

A sustainable and economic feasible process for converting WCO to high-quality biodiesel is designed through ASPEN simulation. The proposed approach can alleviate the energy shortage and reduce the harmful effect of WCO on the environment as well as public health.

One Man's Trash is Another Man's Treasure

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INTRODUCTION

The project attempts to design and develop a holistic system design that concerns abandoned bicycles in Copenhagen and the actors related to it. The system consists of subsystems, in which abandoned bicycles are collected and subsequently either recycled or reused. The project has been carried out in collaboration with Copenhagen municipality whose goal is to turn Copenhagen into the first carbon neutral city in 2025.

ANALYSIS

A life cycle check has been carried out to evaluate which of the different scenarios; reuse, recycle and abandon are most environmentally friendly. The user cases have been analysed over a period of three bicycle lifespans corresponding to 3 x 37800 km. Cf. Figure 1.

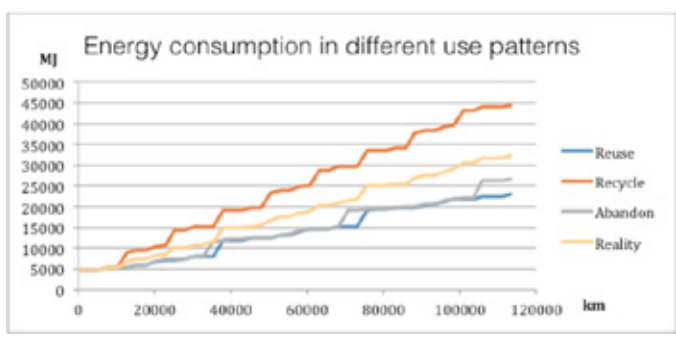


Figure 1 Energy consumption in different use patterns

On the figure, the step-wise increments are due to manufacturing of new bicycles, which is found to be the most energy consuming process in the lifecycle, while the steady continuous increase is due to manufacturing of spare parts. When a bicycle is abandoned, it loses 2520 km of the bicycle lifespan due to harsh weather conditions resulting in higher energy consumption as the bicycle is scrapped before the actual end of the bicycle lifespan. Combining the three scenarios, a scenario called 'reality' is created. Ways to lower the gradient of the reality curve is therefore by encouraging people to reuse more bicycles directly as well as reusing more of the abandoned bicycles. Currently there is an uneven distribution between reusing bicycles and recycling bicycles, as most are scrapped. This is mainly caused by a lack of consistency in the system cycle and absence of collaboration between sub-systems.

THE SOLUTION

An app is developed to create a consistent cycle by introducing a common platform for messages and knowledge sharing between the stakeholders. In addition, the app creates an overview of the agreements between the subsystems and optimizes processes. Furthermore, non-profit organizations will take part in the system, receiving donations of bicycles. The intention of the non-profit organisations is to perform workshops in which citizens are taught how to repair bicycles to extend the lifespan and encouraging the reuse of these.

reBicycle, the Road to a Sustainable Façade System

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IMPACT

Every year more than 20.000 ton of plastics are burned in Copenhagen alone, meanwhile the Municipality of Copenhagen wants the city to be CO₂ neutral in 2025. In order to succeed, plastics (and other materials) should be reused instead of burned. For each ton of reused plastic, the total CO₂ emission is reduced with 2-3 ton.

METHOD

By collecting metal scraps from construction sites and worn out bicycle tires it has been possible to develop a flexible and versatile façade- and fence-system. The system consists of weaved bicycle tires, fixed to a framing system made from leftover reinforcement bars. Besides the sheltering effect the system also possesses great aesthetic values. The weaved bicycle tires gives a tasteful urban look – and the reflexes on the bicycle tires creates inspiring patterns when light is directed towards the system.

Sustainability

Upcycling and sustainability are two cornerstones in the reBicycle project. Adding functionality to disposable materials and giving them new life - while keeping the energy usage at a minimum is the key to the product.

Vulcanized rubber is the main component in the system. Since it is a thermoset, then it can't be reused (remelted) in a conventional way. However, it can be used in other ways - and therefore it is an obvious choice for an upcycling product.

In Table 1, the Life Cycle Check shows how little energy and virgin materials that are needed for the reBicycle system.

LCA	Materials	Production	Transport	Use	Disposal
Materials	<ul style="list-style-type: none"> - Vulcanized rubber (reused bicycle tires) - Recycled reinforcement bar - Bolts - Iron tube - Iron plate 	<ul style="list-style-type: none"> - Assembly of consoles - Assembly framework - <i>Grouting of iron tubes / Mounting on wall</i> 	<ul style="list-style-type: none"> - Truck - Packaging 		<ul style="list-style-type: none"> - Vulcanized rubber melted in a catalytic process at nearest incineration plant - Remelting of iron for reuse
Energy	<ul style="list-style-type: none"> - Mining and extraction of iron 	<ul style="list-style-type: none"> - Welding of consoles - Welding of framework - Workshop electricity 	<ul style="list-style-type: none"> - Fuel for truck 		<ul style="list-style-type: none"> - Detaching the rubber from the iron framework
Chemistry	<ul style="list-style-type: none"> - Electroplating of bolts and nuts 		<ul style="list-style-type: none"> - Used fuel 		
Other	<ul style="list-style-type: none"> - Gathering of materials 	<ul style="list-style-type: none"> - Tools used 	<ul style="list-style-type: none"> - Truck driver 		<ul style="list-style-type: none"> - Tools used

Table 1 Generic LCC Table

Treatment and Reuse of Dairy Waste Water by Membrane Technology

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INTRODUCTION

From all dairy productions there is a lot of waste water which contains lipids, proteins and lactose remains. By filtering the waste water it is possible to reuse the clean water and to convert the other compounds into useful bio-products. For example, through acid treatment, the sediment (Casein) will be used as additive for animal feed. Through ultrafiltration, the filtrated lactalbumin can be used as additive for food. After nano-filtration, the remained solution, which contains a large amount of lactose and lipids, can be transformed into biogas by fermentation.

EXPERIMENT

The experiments are conducted at Institute of Process Engineering (IPE), Beijing, China in collaboration with DTU. In this study, 2.38 g/L milk powder solution was used to simulate dairy waste water. The experimental procedure is illustrated in Fig.1. An acidic pretreatment is implemented to extract the majority of the caseins. Afterwards the full purification by ultrafiltration (Ultracel PES10 membrane) and nano-filtration (NF270 and NF90 membranes), the chemical oxygen demand (COD) of the final permeate is tested.

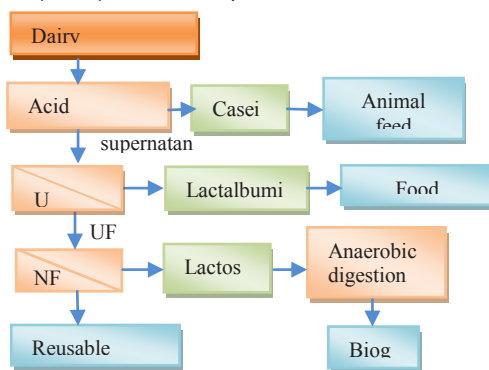


Fig.1 The experimental flowsheet

RESULT AND CONCLUSION

Table 1 The COD value of different samples

	After Acid treatment	UF Retentate	UF Permeate	NF270 Retentate	NF270 Permeate	NF90 Retentate	NF90 Permeate
COD(mg/l)	1874	2154	800	3824	292	3903	215

The COD values of the different samples are shown in Table 1. It is seen that after nano-filtration by NF270 and NF90 membranes, the COD value in the waste water is reduced to 292 mg/l and 215 mg/l, respective. Based on the results, we conclude that the method can successfully convert dairy waste water into reusable water and valuable bio-products.

Use of computer simulations for data interpretation and design of the FLUTe® Activated Carbon Technique (FACT) for monitoring groundwater contamination

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In investigation and monitoring of contaminated sites and delineation of contamination plumes and flow paths in groundwater aquifers, the ability to adequately determine the inherent hydrogeological heterogeneities (different geological settings and fractures) is essential prior to choosing and designed remedial actions. The FLUTe Activated Carbon Technique® (FACT®) is a new way to do multi-level sampling (measurements from different depths using the same borehole) which has shown to have great potential (Cherry, Parker & Keller, 2007). The method seems to be cost-effective, versatile, have low detection limits, and have other advantages over the currently preferred methods.

At this time, there is a lack of knowledge and approaches to interpret obtained data and this is an obstacle to the widespread adoption of the technology. Moreover, there is ample room for improvement and optimisation of the system design. In this project, the limitations and possibilities of data interpretation were evaluated using a simple 2D model in COMSOL Multiphysics®. Field monitoring data obtained at a field site in Denmark were interpreted using the model and used to benchmark the method.

The model revealed that there is a non-linear correlation between the contaminant concentration at the site and the sorbed mass on the FACT® strips, which leads to difficulties in the data interpretation (Beyer, 2012). The relationship between the aqueous and sorbed concentrations can be explained if the hydrogeological properties of the aquifer are taken into account. The sorbed mass depends not only on the aqueous concentration, but also on aquifer parameters such as the porosity and the hydraulic conductivity. This fact is relevant in particular when the technology is applied in fractured media since the hydraulic conductivity can change several orders of magnitude within a short distance (Shapiro, 2011).

Combining the knowledge of the hydrogeological properties and the sorbed mass on the activated carbon strips leads to an improved interpretation of the contaminant concentration and distribution with depth. Furthermore, this study showed that the technology could be used for detailed investigation of the hydrogeological features affecting the contaminant transport (e.g. fractures) when the concentration data is available. The model indicated that the currently preferred design and operational method could be optimised, which would result in a reduction of material consumption and time needed to obtain satisfactory results.

References

- Beyer, M. (2012). *DNAPL characterization in clayey till & chalk by FACT (FLUTe activated carbon technique)*. Lyngby, Denmark: Master Thesis at Technical University of Denmark.
- Cherry, J. A., Parker, Beth L., & Keller, C. (2007). A New Depth-Discrete Multilevel Monitoring Approach for Fractured Rock. *Ground Water Monitoring & Remediation*, 27-2, pp. 57-70
- Shapiro, A. M. (2011). The challenge of interpreting environmental tracer concentrations in fractured rock and carbonate aquifers. *Hydrogeology Journal*, 9-12.

Assessment of the Urban Microclimatology using the Thermophysiological UTCI Method and on-site Measurements – some Case Studies

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In our everyday life, we spend a great deal of our waking time outside – between the buildings, during pedestrian or recreational use. The urban space is a scene for social interaction: Pedestrians walking down the street, people sitting on park benches, business people gathering around the bus stop or having a walk-and-talk meeting, couples sipping coffee on a café terrace, children playing at the playground. The character of life between the buildings changes from one social context to another, but architects, planners and engineers have defined a variety of criteria for the evaluation of the quality of urban space with regards to their different professional experiences. Urban climatology is an approach to the design of these urban spaces. Several studies have investigated how inhabitants interact with the urban space, but unfortunately, urban design has not been combined with climate-responsive design parameters this regulatory input is needed. The design of outdoor spaces requires an understanding of the local environment. This has traditionally been the role of planners and architects, who have relied on intuition, personal experience, and previously built projects.

With this project aims is to setup an approach to properly measure and analyze on public areas with regard to the UTCI scale; the parameters are limited to the local physical quantities of wind velocity, ambient temperature, mean radiant temperature, sky view factor, humidity etc. – all of which are constrained to the geometric properties of the studied areas.



The study cases are three well-known areas in the City of Copenhagen (Sluseholmen, Islands Brygge and recreational square at the Codan building). The method in order to do the assessment is a recollected data from Urban Environment Registration at the locations, measuring the microclimate of the area. The UTCI method is used to Cross-analyze in regards to recreational use of the areas. Wind tunnel studies and CFD simulations are useful in the performance of wind and irradiation in the area, providing more cross-analysis and information to reach a more substantial assessment.

The assessment is focus in simplifying the urban environment, to make a standardization of the microclimate parameters influencing the human comfort within an urban space quality.

Implementation of the Sustainability Concept

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INTRODUCTION

In 2012 Denmark launched the DGNB certification system. The implementation of DGNB in Denmark is, however, meeting some challenges. Research had focus mainly in the technicalities of the system. But social constraints are also extremely important, and have not been addressed in research. This thesis focused on the stakeholders' perceptions of the DGNB certification system in Denmark. The goal was to understand how DGNB is perceived and how sustainability is being interpreted by different stakeholders. And finally to assess how do that influence the introduction of sustainability concepts in the sector.

THEORY

The successful implementation of the system is related with its acceptance by the organisations that constitute the field. The position of the organisations within the introduction of the system must be carefully understood in order to manage their expectations and needs. The Stakeholders' theory was chosen as the best theory to study the perceptions of the stakeholders.

METHOD

The theory was used in a higher scale than normally used. As the subject of study was the field (Danish construction sector) it was more relevant to assess the perceptions and interests of the organisations dealing with DGNB – in this study defined as stakeholders. The stakeholders' perspectives were gathered through the conduction of interviews. The information was analysed by applying two models of stakeholders' theory: *Framework for Stakeholders' Mapping* and *Power/interest Matrix*, regarding the implementation of the DGNB certification system in the sector.

RESULTS AND CONCLUSION

The interviews revealed that Stakeholders perceive DGNB certification system as the most complete system available to evaluate buildings.

Furthermore, stakeholders stated that the system is complex and time consuming, Because of that stakeholders are addressing the system essentially to evaluate the new building. DGNB is not influencing the building's design in a high level, as it could do. Stakeholders address the DGNB certification system as a checklist. The system assists stakeholders, making sure important criteria are considered in the building. This is not in line with the purpose of implementing DGNB. DGNB is a certification system that should be considered during the design phase of the building. It must be used to support the decision-making process. If introduced in the building design the system could be used to improve the building's performance. This means that, as it is being applied now, great opportunities are being missed. DGNB is a great system to move towards a sustainable sector. However, it is not being applied as its best.

It is my perception that the existence of different interpretations is a result of the overlapping of the stakeholders' interests with the project mission. The stakeholders' interests differ and so they pursue different results from the system. The effort that each stakeholder is willing to make to implement DGNB is not equal.

NSA Screening Tool for Multiple Stakeholders

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INTRODUCTION

An urban system can be regarded as a system consisting of smaller building blocks such as neighbourhoods. The sustainability of an urban system is hence closely connected to the sustainability of neighbourhoods. Neighbourhood Sustainability Assessment (NSA) tools have multiple potential benefits for urban development such as a holistic evaluation and in some cases quantification of potential economic, social, environmental, and institutional impacts, quality assurance, improved cross-functional teamwork, improved processes etc. Nevertheless there are as yet a reluctance encountered from investors and municipalities in terms of applying NSA tools for developing neighbourhoods due to e.g. cost, complexity. Even a sustainability pre-certification is according to the existing NSA tools comprehensive, time consuming and not necessarily economical rewarding in the short run. Due to these obstacles related with the deployment of NSA tools even at entry level (pre-certification) are jeopardizing sustainable development of urban sub-systems and sustainability is therefore at risk of being neglected in urban development projects.

METHODS

Case studies and literature studies will provide information on sustainability criteria in the pre-design phase of neighbourhood development. Criteria will initially be extracted from the recently introduce DGNB New Urban District standard, which has been adapted by the Green Building Council Denmark for Danish regulations and norms, to provide information to the screening tool.

IDEA

The idea is to develop an open source digital screening system for the pre-design phase of neighbourhood developments which addresses relevant sustainability criteria and indicators ideally from various certification schemes, however initially primarily based on the DGNB system.

A questionnaire based assessment setup is provided for the stakeholders to provide an assessment focus and thereby to assist the stakeholders in prioritising their sustainable targets. Further will the questionnaire provide an evaluation of the stakeholder's political sustainability preferences and to be used for calculation of sustainability criteria weighting factors, thus providing a subjective importance of the individual criteria which can range from e.g. 1 to 10. The screening tool will through the questionnaire setup further provide an indication of sustainability focus in the pre-design phase of urban development through a prioritisation template for each stakeholder. Thereby will the tool provide the involved stakeholders with knowledge about each other's prioritisation and can e.g. build consensus among the stakeholders to attain a common sustainable agenda for the project specific for the neighbourhood being developed.

A flexible screening solution can help enhance stakeholder impact, and thereby the stakeholder's interest and willingness to adapt a NSA tools in the further process of the project. The screening tool can furthermore be used to weight and prioritise sustainable aspects and thereby consider project specific and stakeholder prioritising, if acknowledged by third party NSA tool developers.

Sewage Sludge Ash in Concrete – Risk of Corrosion in Reinforced Concrete

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Incinerated sewage sludge ash (ISSA) is interesting to investigate, regarding concrete mix design. ISSA reduces CO₂ emission of cement production. Leaching of a mortar sample with ISSA yields less heavy metal, which will lead to a greener environment. We performed various experiments with ISSA, examining its effects on the compressive strength of concrete and the risk of corrosion in various conditions. The results indicate that ISSA can be advantageous to use in a mortar sample, producing higher strength, better economy and environmental benefit. In terms of corrosion, we found no indication of inconvenience for utilizing ISSA in reinforced concrete.

Economic Evaluation of Implementing Power to Gas in a Sustainable Energy System

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INTRODUCTION AND PURPOSE

In a future energy system integrating more renewable sources while simultaneously reducing the use of fossil fuels in the energy as well as the transport sector will be one of the biggest challenges. The possibility to produce renewable gas by using surplus electricity can help tackling both problems. With a high share of volatile electricity generation like wind power the need for energy storage in order to balance production and demand increases. Via electrolysis hydrogen can be produced in times of high generation and low demand, taking advantage of lower electricity prices. The hydrogen can either be used directly or further be converted to methane gas, which can be utilized as a renewable alternative to natural gas, in the mobility or heating sector or for converting the gas back to electricity in times of high demand and low generation. [1]

METHOD AND RESULTS

The aim of this ongoing master thesis project is to analyze the economic value and the effects on the power grid of implementing power to gas (PtG) in the Danish energy system. A mathematical model is developed to investigate the optimal dispatch of existing power generation units in combination with power to gas, taking into account power flows and network constraints. Also the existing gas infrastructure and the economics of selling synthetic methane (or hydrogen) are considered.

The total system costs and the sensitivity to different parameters are modelled for various scenarios resulting in conclusions on:

- The impact of the implementation of PtG on the total system costs, including effects on reduced fuel and start-up costs of generation units.
- The possibilities to increase integration of renewables by using PtG in order to avoid congestion and/or investment in new required transmission lines.
- The effect of different locations and capacities for a PtG unit on total costs and power flow.

ENVIRONMENTAL IMPACT AND REALIZATION

For a target of a fossil fuel independent Denmark in 2050 PtG could play an important role. Since alkaline electrolysis and chemical methanation already are mature technologies and research on biological methanation and other techniques for electrolysis are promising, it is essential to investigate the economic and technical aspects in order to find the most efficient usage of power to gas in a sustainable energy system. [2]

REFERENCES

- [1] C. Baumann, R. Schuster, & A. Moser. (2013). *Economic Potential of Power-to-Gas Energy Storages*.
- [2] Lukas Grond, Paula Schulze, & Johan Holstein. (2013). *Systems Analyses Power to Gas: A technology review (Deliverable 1: Technology Review)*. DNV KEMA Energy & Sustainability.

Microbial Removal of Pesticides in Rapid Sand Filters for Treatment of Drinking Water

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In Denmark approximately 100% of the population is supplied by groundwater. However, the water supply is threatened by pesticides, since these were detected in 24% of the Danish groundwater in 2012 (GEUS, 2013). The Danish water treatment is simple and consists of aeration of anaerobic groundwater, followed by filtration in primary and secondary rapid sand filters. Since none of these treatment steps are known to remove pesticides from the water, the general strategy is to close pesticide contaminated wells, or dilute contaminated water, which is expensive and unsustainable. Pesticides can be removed from water by advanced technologies such as activated carbon filtration (Heijman et al., 2002). However, the environmental sustainability and cost-effectiveness of these processes remain uncertain. Recent investigations have shown that the herbicide MCPP was removed in the secondary rapid sand filters at Kerteminde waterworks (Hedegaard et al., 2014). If pesticides can be removed in the filter sand, it is of large commercial interest due to the environmental and economic sustainability of this treatment method. This study aimed at investigating the microbial pesticide removal kinetics, potential and processes in rapid sand filters for drinking water treatment. Microcosms were set-up with filter sand and water from Sjælsø Waterworks Plant II, Denmark, and ^{14}C -bentazone (0.1–2.4 $\mu\text{g/L}$). At all the tested concentrations it took less than 30 minutes to remove bentazone to 50% of the initial concentration by a microbial process (Hedegaard and Albrechtsen, 2014). This removal rate was relevant for the system since the contact time of water in the full-scale filter was 56 minutes. Increased oxygen availability enhanced the removal of bentazone. It was investigated whether the bentazone removal was a cometabolic process of methane or ammonia oxidizing bacteria. In this case removal could possibly be regulated by controlling methane and ammonium concentrations in the filters. Varying concentrations of methane and ammonium was added to the microcosms. When methane was applied in concentrations of 7.4 mg/L, 75% of the bentazone was left in the water phase after two hours, while only 49% was left when methane was not added. The same tendency appeared for ammonium. Hence, addition of methane and ammonium decreased the removal of bentazone. This study showed very promising perspectives for removing pesticides from contaminated groundwater by using rapid sand filters. Utilising rapid sand filters to treat contaminated groundwater is a very economic and environmentally sustainable technical solution to secure a safe drinking water supply.

REFERENCES

- Thorling, L., Brüsch, W., Hansen, B., Larsen, C. L., Mieby, S., Trolborg, L., Sørensen, B. (2013). Groundwater monitoring 2013 – Groundwater status and development 1989-2012. Retrieved from; www.grundvandsovervaagning.dk (14.03.29)
- Heijman, S. G. J., Siegers, W., Sterk, R., Hopman, R. (2002). Prediction of breakthrough of pesticides in GAC-filters and breakthrough of colour in ion-exchange-filters, *Water Science and Technology: Water Supply*, 2 (1), 103-108.
- Hedegaard, M. J., Albrechtsen, H.-J. (2014). Microbial pesticide removal in rapid sand filters for drinking water treatment – Potential and kinetics. *Water Research*, 48, 71-81.
- Hedegaard, M. J., Arvin, E., Corfitzen, C. B., Albrechtsen, H.-J. (2014). MCPP removal in full-scale rapid sand filters at a groundwater-based waterworks. *Submitted to Water Research in March 2014*.

Semitransparent Organics Solar Cells

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CONTEXT

70% of world population is expected to live in cities by 2050 and in order to address world increasing energy consumption new solutions and effective strategies must be found. The concept of smart cities serves as foundation to turn cities of today into the sustainable cities of the future. Nowadays most of energy consumed in cities is produced outside urban areas and, even if environmental and security of supplies concerns have increased, it is hard to implement decentralized renewable energy systems in such context. One very important reason is the physical lack of space.

CONCEPT

The implementation of silicon photovoltaic is inspiringly contributing to increase the share of renewable energy, year by year. Nonetheless, silicon solar cells are bulky and opaque, and therefore particularly suited only for roof installation and not for other challenging building integrated solutions, like building windows. Organic solar cells are a thin film technology that uses photoactive layers with thicknesses in the range of 100 nm. This allows the active layer to be intrinsically semitransparent. This type of solar cells normally look opaque to the human eye because a metallic top contact is present, which efficiently collects the generated current. In a semitransparent device the top opaque electrode is substituted with a suitable transparent contact. Semi transparent organic solar cells have the potential for interesting applications, such as integration into windows for buildings, cars and screens of electronic devices.

PROJECT DESCRIPTION

The project was aimed to fabricate and characterize efficient semitransparent organic solar cells. The top transparent contact represents the most challenging aspect for the fabrication of efficient semitransparent organic solar cells. After having investigated electrodes involving conductive polymer PEDOT:PSS in combination with evaporated metal grid and thin metal layers sandwiched between two dielectrics, considerable attention has been given to silver nanowires (AgNws) electrodes, due to their fascinating properties. There are different suitable materials that can be used in combination with the metal nanowires to obtain a good top contact. These are needed to fill the void in the nanowires network, in order to enhance lateral conductivity, leading to lower sheet resistance and hence better charge extraction. Therefore different composite transparent electrodes with different optical and electrical properties and consequently different performances in the solar cell are possible. This regards not only the specific materials used in combination with the metal nanowires, but also how they are processed. After further investigation of the promising PEDOT:PSS – AgNws composite electrode, a single layer that combines the function of top transparent electrode and hole transport layer has been obtained. This was done by mixing the two aforementioned materials together and processing in one step, instead of processing them on top of each other.

Optimised NO_x Abatement Strategy Using Ionic Liquids

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NO_x formation as a side product of high temperature incineration is inevitable when air is used as oxygen source. The harmful effects of NO_x gasses are well documented and include acid rain, ozone layer depletion and severe health effects (induces cell mutation and respiratory diseases among others). Due to these harmful effects, emission limits are decreasing rapidly both on land and at sea. Therefore, it is becoming increasingly important to find a viable solution to the emission concerns.

The most widely used method for NO_x removal is Selective Catalytic Reduction (SCR). SCR is very efficient but also has limitations especially for mobile units due to an immense size of the installations. Furthermore, SCR uses ammonia to reduce the NO_x to N₂. Ammonia is a potential pollutant if it is released to the environment. Ammonia is also toxic and very corrosive adding a serious health risk to the use.

Previous work carried out by my colleagues and I introduced an alternative method in which the NO_x gasses are absorbed and oxidised to nitric acid using ionic liquids (ILs). This way fossil fuel resources used to produce ammonia is saved and a potent pollutant is turned into a valuable product of commercial grade.

The end product of the process, nitric acid (HNO₃), is one of the most produced chemicals on a global scale, with annual production reaching 60 million tonnes in the U.S. alone. Nitric acid is produced from ammonia, which is oxidised to NO and then oxidised further to HNO₃. Therefore, directly oxidising NO in the flue gas would save 2 moles of ammonia for each mole of HNO₃ produced, giving a superb overall nitrogen atom efficiency.

This project presents a newly invented and patent pending design in which NO is oxidised and absorbed in two separate steps. This tandem reactor setup utilises supported ionic liquid phase (SILP) where the IL is dispersed on a porous support material. The dispersion increases the reactive surface area by several orders of magnitude and different supports can also help promote different components of the IL, thus increasing the efficiency of each single step.

Invention of the tandem process was spurred on by the discovery that absorption and oxidation in a single step has a second order dependence in NO. This means the NO concentration is squared when calculating the reaction rate (rate of formation of HNO₃). Since NO_x is present at rather low concentrations in a flue gas (~500 ppm), a second order dependence is very undesirable.

Splitting the processes into a pure oxidation step (preoxidation) and a pure absorption process should circumvent the second order dependence on NO and maybe even decrease it below one in the absorption process, which is the most space demanding of the two. Furthermore, it allows us to use supports which are specialised for each single step, thus improving the overall efficiency.

When the absorber in step two of the process reaches the maximum of its capacity, the HNO₃ is desorbed simply by heating it above 120°C. The operating temperature for the absorber should be around 30-50°C, while preoxidation should be carried out at around 100°C. In both cases, the operating temperature is significantly below the one used for SCR (300-350°C), which should decrease the energy cost of NO removal significantly.

The efficient use of the space and also the waste to value incentive should make this deNO_x solution very attractive for mobile pollution sources such as the maritime industry. The maritime contribution to global NO_x emissions is very severe and by some estimated to be well above 20% of the total emissions.

Environmentally friendly chromium plating system

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INTRODUCTION

Chromium plating is an indisputable “design classic” that is not easily replaced. Unfortunately the conventional plating process is based on hexavalent chromium, Cr(VI), which is both carcinogenic and mutagenic. To prevent toxic mist formation in production, persistent and bio-accumulative PFOS are used. Cr(VI) will be banned from production by 2017. Furthermore, chromium is always plated on top of a nickel coating system, which acts as a sacrificial anode. This provides corrosion resistance, but can cause nickel dermatitis.



Figure 1: Examples of the widespread use of chromium plating, often for decorative use.

THEORY

This project presents a coating system comprising a non-toxic trivalent chromium, Cr(III), layer on top of an extremely corrosion resistant tin-nickel alloy coating with negligible nickel release. Between the coating and the substrate material (brass, steel, aluminium, plastics, etc.), a copper layer is deposited. Compared to present coatings, this system provides:

- Elimination of Cr(VI) in production
- No need for toxic mist suppressants (PFOS) and extensive precaution systems
- No risk of nickel dermatitis from surface/skin contact
- Reduced layer thickness → reduced material consumption and processing time
- Reduced energy consumption in production
- Improved corrosion resistance

The coating is a greener, healthier and cheaper coating than the present alternative. Given the extensive use of chrome plating worldwide today, the positive effects are considerable.

METHODS

The strengths of the developed coating have been documented to convince chromium platers, especially in the automotive industry. In this process, patents and scientific articles on the corrosion properties of the coating have been written and visits to sub-suppliers of parts to the automotive industry in Germany and USA has been a natural part of the work carried out in the last months.

CONCLUSION

A new green and healthy chromium coating system, which eliminates carcinogenic, mutagenic, persistent and bio-accumulative substances in the production, and potential dermatitis development from prolonged surface/skin contact, has been developed.

Feasibility Test on Renewable Energy and EV taxi

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ABSTRACT

Korea depends heavily on oil imports. Thus, in Korea, efficient energy management is imperative. For this reason, the current Korean administration is striving to improve its energy infrastructure with the construction of stable energy supplies and reliable systems the implementation of energy policies, such as smart grids, Electric vehicles and the diffusion of renewable energy generation sources. In line with this logic, my research consists of two related parts; first one investigates the relationship between innovation of energy sustainability and paradigm change in conservative industry; second one investigates relationship between energy sustainability and environmental optimization in grid sector.

In my first research project, I examined the economic feasibility of Electric Vehicle taxi by using B/C analysis and Conditional Value Method to examine the intangible and tangible advantages of adopting Electric Vehicle as a taxi. This study not only measured the profitability of local taxi enterprise, but also measured the intangible benefits that local citizen and government could acquire through the EV taxi adoption by using conditional valuation method and survey.

In my second research project, I examined the economic, environmental, and technological feasibility of hybrid systems by simulating a system composed of renewable energy, an existing grid system, and a diesel generator on Jeju Island in Korea. This study finds that the most economically feasible hybrid system is a grid-connected wind turbine-photovoltaic-battery-converter hybrid system. Given the economic feasibility of this hybrid system, implementing it would decrease the price of electricity in Jeju. Both the implications and limitations of this study will be discussed in the last section of this paper.

Improving the Performance of a Sail-assisted Cargo Vessel

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INTRODUCTION

The shipping industry is known to be one of biggest contributors to pollution and global warming. Fortunately, shipping authorities have come up with stringent regulations aiming at large reductions in CO₂, NO_x and SO_x. These require double digit efficiency improvements rather than one or two percents. To comply with these regulations and to satisfy shareholders, suffering from high oil prices, sail-assist is proposed as a solution to save fuel. To convince investors that wind-assist is beneficial for the environment as well as their bank account, there is a need for reliable predictions on fuel savings. In this research, a methodology is developed that can give trustworthy figures on fuel savings and margins of profit and provides more insight into the hull form of a sail-assisted cargo vessel.

THEORY

A sail-assisted cargo vessel works by the forward force induced by engine and sails. The larger the force from the sails, the less power is required by the engine and thus the larger is the fuel saving. However, the sails also produce a force in lateral direction, called the heeling force. This force is counteracted by an equal and opposite force induced by the hull: side force. The hull form and dimensions determine how much resistance is associated with producing this side force and thus how much additional power is required from the engine. The dimensions of the hull also have an effect on the costs of building it: a longer vessel is more expensive. As in many engineering problems a hull that performs well in terms of kilonewtons performs badly in terms of euros. The question then is what hull dimensions provide the optimum compromise.

METHODS

A combination of existing methods has been used in order to assess the total costs of a number of vessel variations. First, the hydrodynamic performance of the hull is determined by use of Computational Fluid Dynamics (CFD). This data is used for a routing simulation that uses historic weather data in order to simulate a vessel's operation during twenty years. From this, the fuel consumption can be determined. Finally, the fuel costs and the building cost are combined to provide a figure for the economic performance. By systematically assessing a set of variations an optimum hull can be found and it can be compared to a conventional cargo vessel with the same capacity.

RESULTS

The simulation shows that the extra investment in the rig is compensated by the fuel savings and cost reductions of 28% can be achieved, leading to higher profit and lower emissions.

CONCLUSIONS

It is concluded that for a roundtrip between Gibraltar and Miami and for a given average speed, sail-assist is a good alternative for conventional cargo vessels, both in terms of economics and emissions.

Sustainability of Carbon Ferries

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The main purpose of this study was to analyse the sustainability of carbon fibre reinforced polymer (CFRP) ferries in Denmark. Sustainability of the composite shipbuilding industry has been determined by an interdisciplinary approach combining life cycle thinking with strategic models and methods.

A comparative Life Cycle Assessment (LCA) analysis was made to assess the environmental impacts from a high speed catamaran ferry build in carbon fibre reinforced polymer versus a high speed catamaran ferry build in aluminium. Both catamaran ferries were capable of operating the same route between Harstad and Tromsø in Norway and were built in accordance to the high speed craft code. The hulls of the CFRP ferries were built in 2009–10 by a Danish shipyard Tuco Marine Group which has been the focus company in this case study.

The results showed that the operation stage had the biggest environmental impacts mainly caused by the extensive fuel consumption of both ferries. A comparison between the construction stages of each ferry was made to see which processes and materials accounted for the largest impacts during production. A number of limitations and assumption was made especially for the aluminium modelling.

It was found that a lightweight CFRP ferry could be beneficial for the environment, the economy and the society. However, it depended on the specific route and ferry and whether the extra investment needed for buying a CFRP ferry was offset by the lower fuel consumption and maintenance costs during the lifetime of the ferry. Furthermore it was found that environmental break-even occurred after 3 month while economic occurred after 4 years.

Porter's Five Forces and PEST analysis were used and supplemented with the results obtained in the LCA study. The strategic analysis showed that market potential and perspectives of a CFRP ferry in Denmark do exist, but under different conditions than the Norwegian high speed ferries. The main competitive parameters in the industry were identified to be cost, trust, time, and references, and their influence on a sustainable development were discussed.

The interdisciplinary approach made it possible to focus on patterns of sustainability, where the LCA gave a quantitative measure of alternatives. The LCA could not be used in the search for potential markets for a CFRP ferry, here the PEST analysis were of help. The interdisciplinary approach could be used for actors considering being more sustainable, and the approach could assist in finding and prioritizing areas of focus.

Strategic Waste Management in Chr. Hansen

Eleonora Tu

DTU Environment, Technical University of Denmark

BACKGROUND

In today's society, waste management plays a crucial role as current levels of waste generation are unsustainable long-term and represent a risk for the ecosystem and the society. This issue was addressed on European level through specific legislation, and also on national and local level. Research has also contributed with tools and approaches that can be applied to improve and monitor waste management strategies. Despite many private companies being committed to sustainable practices, it is often hard for them to apply those tools in practical situations, as waste is seldom the focus of a business.

THE PROJECT

This project focuses on the application of Life Cycle Thinking (LCT) to advise on strategic waste management in the Danish company Chr. Hansen, and specifically its facility in Avedøre (Copenhagen). Chr. Hansen A/S is an international bioscience company that develops and produces a range of natural ingredients that are used in the food, nutritional, pharmaceutical and agricultural industry. Chr. Hansen's waste management challenges concern the characterization of the waste fractions, the handling methods and methods of disposal.

Non-organic solid waste management in Avedøre was addressed by employing the Life Cycle Assessment (LCA) methodology to highlight opportunities in the solid waste stream. It was found that some fractions hold greater environmental benefits compared to others when diverted from incineration. A priority list of the waste fractions was suggested and considerations on costs and ease to address these fractions were also included. Based on the difficulties encountered, especially in acquiring data, it was also recommended to integrate a more consistent tracking of waste in the system.

Constraints on waste handling and sorting exist, and it was found that some fractions would require a disproportionate and costly effort or a radical redesign of the process to be separated from the waste stream. These fractions therefore cannot be tackled for the moment, for example organic waste product. This is also a key aspect when considering approaches such as the circular economy.

METHODS

After reviewing the current waste management ambitions in the European and Danish legislation, sustainability approaches and tools specific to waste management were also reviewed, including the concept of LCA, LCT, circular economy and industrial ecology. The activities taking place in Chr. Hansen Avedøre were studied to understand the processes and the waste produced.

Data regarding the composition of waste currently sent to incineration was collected on site and through estimation based on mass flow. It was possible to characterize only about 40% of the total waste. The waste contractor provided information regarding the disposal of the fractions.

Based on the data collected, different scenarios were modeled with the dedicated waste-LCA software EASETECH in order to evaluate the potential of different fractions.

Sustainable Phosphorus Recovery from Sewage Sludge

A.B.S. Sørensen

DTU Environment, Technical University of Denmark

A SUSTAINABLE TECHNOLOGY IS REQUIRED

Phosphorus is a vital nutrient for plant and animal production, and the use of phosphorus for agricultural land application is crucial to achieve a high crop production. The amount of the global phosphorus reserve is very uncertain with estimates as short as 48 years [MST, 2013]. Thus, there is a need for securing this vital limited resource. Denmark is dependent on phosphorus import and recycling. A solution is to recover the already used phosphorus from sewage sludge from wastewater treatment plants (WWTPs). The application of sludge as fertilizer in agriculture is practiced at some places, however this usage is limited because of reasons like pollutants in the sludge and hygiene. Therefore, phosphorus recovery in a more pure form is preferable. Additionally, this solution leads to economic savings and environmental benefits because of the reduced usage of chemicals to achieve the stringent limits on phosphorus in the effluent from the WWTPs and reduced scaling problems.

A METHOD FOR PHOSPHORUS RECOVERY FROM SLUDGE

The idea is to develop a sustainable technology to recover phosphorus as struvite, also called MAP, from reject water from digester and dewatering from secondary sludge, see Figure 1.

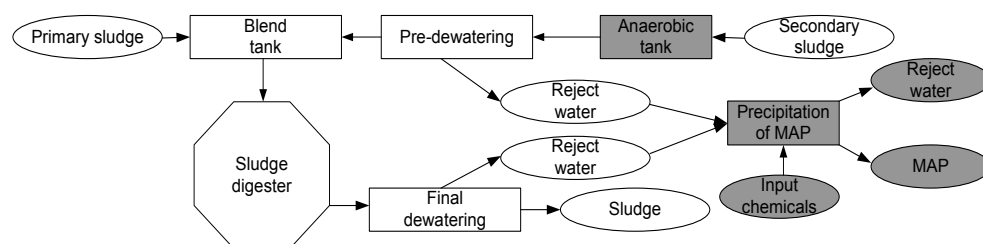


Figure 1: A part of a sludge treatment system in Denmark in a simplified version, adding the grey boxes, which represent the processes of the vision for a sustainable recovery of phosphorus.

In the anaerobic process, phosphorus is released as orthophosphate, and is removed with the water in the pre-dewatering treatment. The phosphorus content from the sludge may be recovered as struvite, which can be used directly for land application as a fertilizer with a good bioavailability, and only a small amount of pollutants included.

To develop this method, more knowledge is required regarding phosphorus's speciation in the sludge before and after the digester and conditions necessary to assist and enhance the struvite formation.

The timing for developing a sustainable solution for securing the limited resource is right and this technology will have a positive impact on the environment in several aspects.

REFERENCE

MST, 2013. *Livcyklusvurdering og samfundsøkonomisk analyse for anvendelse af spildevandsslam* – Miljøprojekt nr. 1459, Miljøministeriet Miljøstyrelsen (MST), Copenhagen

Improving Biological Treatment of Drinking Water

F. B. Wagner

DTU Environment, Technical University of Denmark

INTRODUCTION

In Denmark, drinking water is not disinfected with chemicals such as chlorine, which makes the product water sustainable, environmentally friendly, and safe for the consumer. Thus, as no disinfection is used, unwanted microbial growth in the water distribution system needs to be controlled by keeping nutrient concentrations during distribution low. Ammonium (NH_4^+) is one nutrient of concern, and is typically removed in biologically active sand filters, during water treatment. The removal process is called nitrification, conducted by microorganisms which need nutrients to metabolize the NH_4^+ . Hence, if nutrients are already too low during treatment, NH_4^+ removal can be incomplete, subsequently endangering water quality during distribution. The aim of this project was to investigate if addition of selected nutrients to biological sand filter columns could improve biological NH_4^+ removal from drinking water.

METHODS

Sand for the biologically active sand filter columns was collected from a real (full-scale) drinking water filter in Denmark with NH_4^+ removal problems, to test if one or more of the selected added nutrients were limiting nitrification at the water works. Studies were conducted in laboratory- and in pilot-scale; influent water to columns contained NH_4^+ . In lab-scale, four columns were used. One column was operated as a control without addition of extra nutrients; the other columns were operated under different configurations of nutrients. Subsequent to the lab-scale study, nutrients which resulted in increased nitrification in lab-scale columns were added to a pilot-scale column, to test the stimulation at larger scale.

RESULTS

In lab-scale columns, the addition of the nutrient phosphorus in form of phosphate (PO_4^{3-}) showed a substantial effect on NH_4^+ removal. In a column with added PO_4^{3-} , removal of NH_4^+ during the experiment was on average 42 % higher than in the control column. PO_4^{3-} addition was therefore also tested in pilot-scale. The pilot column was first operated without addition, and showed incomplete NH_4^+ removal, like the full-scale filter from which sand was taken. As predicted in the lab-scale study, subsequent addition of PO_4^{3-} increased the NH_4^+ removal quickly. After 18 days of PO_4^{3-} addition, NH_4^+ removal in the pilot column was complete, corresponding to an increase in removal rate of 130 %, compared to the initial operation phase without nutrient addition. NH_4^+ removal continued to be complete, even 1 ½ months after stop of PO_4^{3-} addition, when monitoring of the pilot column was stopped. In lab- and pilot-scale studies, all added PO_4^{3-} was entirely retained in the filter columns.

CONCLUSIONS

Addition of the microbial nutrient PO_4^{3-} to biological sand filter columns with sand from a full-scale filter could clearly improve NH_4^+ removal. As results strongly suggested PO_4^{3-} limitation of nitrification at the respective water works, the municipality where the water works is located in, granted permission for addition of PO_4^{3-} to the full-scale filters at the water works (first granted permission ever in Denmark). Generally, the relevance for water utilities is high, as improved biological treatment can ultimately circumvent the use of chemicals for disinfection of the water, ensuring sustainable drinking water production.

Integrated smarthouse application

Asger Jon Frounberg, Michael Kjeldsen

DTU, Department of Photonics Engineering

In order to utilize the full potential of the smart grid. It is important to enable the consumer to act upon price changes. Since the price, in general, are low compared to the estimate price per hour the consumer makes, this process should be automated, in order for the consumer to gain a economy advantages. Furthermore, it would allow the consumers to change their consumption without having to take active decisions and to do this at a speed where the system can play a role in stabilizing the smart grid, in times of over or under production of electricity.

The system are built from a central IT controller, that receives data from a range of different electrical installations or sensor when available. This information is used to plan the consumption of electricity or other utilities in order to maximize the saving for the consumer. The second part of the system is a central server unit that is used for sending messages or receiving remote commands.

In order to secure, the consumers' confidence it is deemed important to give the consumers access and overview of a system that is transparent in the decisions made. It is important that the consumer is conscious about the system is saving them money but that the system is not wasting the consumer's time with minor decisions.

When the system is monitoring the consumption, relative simple to use the system for other purposes includes other services. This include everything from rising alarms if fires or gas is detected, detect inactivity or death and help people with dementia by reminding them what they were doing or turn of the gas for them.

The system can help with a variety of problems for the modern family and help them improve their living condition, by taking care of small operation. At the same time, it can insure savings for the consumer as well as the society and increase security and comfort. It further more can provide the energy sector with a greater view on what is going on in the grid, and the expected consumption for the coming hour or day.

Product- and Business Development of StratiFlex™

M. Spanggaard

DTU Civil Engineering & DTU Engineering Management, Technical University of Denmark

Building and maintaining thermal stratification in hot water storage tanks offer great energy- and cost saving potentials, e.g.:

- Solar thermal heating systems; end users can save up to 25 % in auxiliary energy
- Electrical heated water tanks; end users can save up to 50 % in energy cost

Potentials which are insignificantly released today due to lack of proper technology.

An innovative and efficient stratification technology was invented at DTU in 2005. Several research projects have attempted to develop the technology into a marketable product. An accelerated long term durability test late 2013 put an end to the expectations. The technology will never be applicable to systems enclosing lime containing water.

The aim of this present project is to:

- Invent a new highly efficient and durable stratification technology
- Develop the technology into a commercially attractive product
- Plan and startup a business based on selling the new stratification device

December 2013 a groundbreaking new technology was invented, offering superior stratification, potentially becoming the most cost-efficient stratification device on the market!



Figure 1 Prototype of StratiFlex™

A long term durability test equivalent to more than 10 years of operation has demonstrated a continuous high efficiency despite massive expose to lime sediments. The component materials are PTFE and stainless steel making the product exceedingly resistant to aging. The current prototype called the StratiFlex™ has a higher efficiency than any other product on the market. The product is scalable as well as adaptable to any size and type of system.

The company EyeCular Technologies has been registered, an ELFORSK project granted and an investment from CAPNOVA May 2014 has secured the next years of growth. A 0-series production is estimated late 2014 and global market launch anticipated spring 2015 at the "ISH" fair in Frankfurt together with our most likely first customer, TWL-Technologie.

For further information please visit www.eyecular.com.

Fabrication of solid oxide cells by ink-jet 3D printing

David Marhauer-Nimb

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INTRODUCTION

With increasing wind and solar energy production energy storage becomes increasingly important. Solid Oxide Cells (SOCs) can be used for energy storage since they offer efficient conversion of electricity to fuel and fuel to electricity. Today material costs and lifetime issues prevents a widespread deployment of the SOC technology. However, 3D printed SOCs can potentially result in significantly cheaper and more robust cells. The aim of the project is to construct an SOC electrolyte and electrode backbone using a PiXDRO 3D inkjet printer. First a printable suspension/ink must be created, which is compatible with the print head requirements in terms of viscosity, surface tension and particle size. When a proper ink is made, an electrolyte is printed and on top of this a porous backbone. This backbone can then be impregnated with an electrocatalyst after sintering to make a functional electrode.

THEORY

A single SOC have a cell voltage around 1 V. In order to reach a suitable voltage for power electronics SOCs are connected serially in a stack. Normally the SOCs are stacked individually with interconnect layers between the cells to avoid gas mixing. If Ink-jet printing can be used to print the entire SOC stack and the stack is sintered in one piece it can improve the contact between the various interfaces between the different layers in the stack. In particular, the cells and interconnect layers do not need to be pressed together to establish an electric contact. As a consequence inkjet manufacturing could possibly help avoiding graduate loss of electric contact and thereby increase the stack lifetime. Further the SOC support layer can be omitted since the cells need not to be handled individually. This can significantly reduce the material usage and thereby decrease manufacturing cost.

METHODS AND EXPERIMENTAL

The electrolyte and electrode backbone is made of yttria-stabilized zirconia (YSZ). A detailed knowledge about ink rheology is required to make inks with sufficiently small, well-dispersed and suspended YSZ particles such that the particles do not agglomerate sediment and eventually clog the inkjet print head. Polyvinyl Pyrrolidone (PVP) was identified as an effective dispersant for nano-YSZ particles in isopropanol/water solvent. The right amount of dispersant that matches the surface area of the particles was found and the solid loading was chosen to optimize the ink viscosity. A ratio of 20/80 wt% (or 25/75 vol%) isopropanol/water was found to optimize the surface tension relative to the print head requirement.

CONCLUSION

In conclusion, the possibility of reducing the manufacturing cost and increasing the robustness of solid oxide fuel cells by using 3D printing is explored in this project. Very thin electrolytes can already be produced using inkjet printing, and the print heads can use many different materials, making the process very versatile. If successful, 3D printing could drastically improve the SOC technology and thereby bring us one step closer to a green society.

Optimizing the Power Rating of Substation Transformers for an Offshore Wind Farm

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DTU Management Engineering, Technical University of Denmark

ABSTRACT

One of the main challenges of the offshore wind energy industry is to reduce the cost of electricity. Among the crucial components of a wind farm are the substation transformers because of their high cost, size and vital role in the power transmission chain. Therefore the objective of this master project is to create a procedure and software tool to select and optimize the offshore and onshore substation transformers' power rating for a given offshore wind farm. The scope of this work will be the UK market since it is leading the offshore wind policies and practices nowadays.

The objective function of the optimization is the cost of capital investment (CAPEX) of the transformers and substation plus the power losses of the wind farm due to planned and unplanned unavailability of the system, electrical losses and power self-consumption. The CAPEX depends on the power rating of the transformer and on the required size of the substation to house the transformers. On the other hand, the power losses are highly dependent on stochastic variables such as wind speed, equipment reliability and maintenance accessibility due to weather conditions. In order to tackle the high complexity and variability of the system, Discrete Event Simulation (DES) is used. This will give the required flexibility to test different combinations of unknown parameters in order to perform a sensitivity analysis for a more informed selection of transformer rating.

Using DES allows simulating the output of the system during events that change its operation. For example, random failures or scheduled outages can be assigned to the equipment over the life time of the project. This, along with the variation of the wind speed, gives different power outputs. By performing several iterations it is possible to narrow down the average cost of losses for a specific transformer rating configuration, but also to attain a probability distribution to derive confidence intervals. There are different software options for DES; in this project it was decided to use Matlab/Simulink because of its vast functionality, availability and the flexibility of programming blocks.

The result of the project is a robust, generic and flexible methodology that allows the user to evaluate the optimum rating size of substation transformers for an offshore wind farm. The input of the model is a wind speed time series, reliability parameters of the equipment and wind farm equipment parameters and layout. The output is the difference between the increment on substations CAPEX and the variation of power losses costs. The results of the multiple lifetime iterations are summarized with the mean value, the 90%, 95% and 99% percentile and the probability of losses equal to investment. Having confidence intervals based on the distribution function of the costs provides better information for design decision making and the possibility to reduce the lifetime costs of future offshore wind farm developments.

Wind Turbine Upscaling and Thick Airfoil Implementation – Measurements and Simulations

K. B. Rose

DTU Wind Energy, Technical University of Denmark

Interest in the wind turbine industry originally spawned from the oil embargo in the 1980s and ever since has increasing the efficiency and lowering the cost of energy (COE) been aspired by wind turbine designers and manufactures. This continues to be the primary target of the wind turbine manufactures today, who must lower the current COE of wind energy by 40% by 2020 to stay competitive. This project investigates one of the most critical challenges in reaching this target; innovative blade design.

The possible power output from a wind turbine, is given by the so-called power expression

$$P = \frac{1}{2} C_p \rho A V^3$$

where C_p is the power coefficient, ρ is the density of air, A is the area swept by the rotor and V is the wind speed. It is seen that even the best improvement in the blade design and thereby an increased power coefficient, would increase the power output only modestly compared to an increase in the swept area. This fact is well recognized by the industry and has led to a continuous upscaling of wind turbines from the first commercial 50 kW rated wind turbines, to the 8MW rated turbines in operation today.

While increasing the power output and thereby lowering the COE, the increase in rotor diameter and blade length, does bring about some technical challenges. Innovative blade design is of increasing importance in obtaining feasible turbine blade designs, to withstand the heavier weight and larger loads acting on the blades. The demand for a stronger structure, initially calls for thicker and stronger structures at the root of the blade, a design that has no impressive aerodynamic performance. Combining a strong structure with a good aerodynamic performance has become a major challenge for wind turbine rotor design and thick airfoils designs (thickness > 35% chord) meet this requirement are of high value. During wind turbine rotor design, rotor aerodynamics is often represented by blade element momentum method, where the aerodynamic forces on the blades are represented by airfoil polars, i.e. lift and drag coefficients. These can be estimated by CFD or by dedicated wind tunnel measurements. Good knowledge exist measuring airfoil data, however with some uncertainty for very thick airfoils. Further the accuracy of CFD predictions are of even poorer accuracy. The challenges estimating these data include highly instability and very unpredictable three-dimensional flow structure. Proper correction methods are therefore of great importance and have investigated thoroughly in the project to optimize the design of wind turbine blades through the exploitation of thick airfoil designs.

Detektor til reducere af Out of Stock event f

J. Hyldig

DTU Engineering Management, Technical University of Denmark

ABSTRACT

Projektet går ud på at jeg har lavet nogle algoritmer baseret på POS-data, som reducerer af *Out Of Shelf* event i en butik, for derved at kunne hæve *On Shelf Availability*(OSA) i en given butik. Det grønne element kommer ind i projektet ved at der f.eks. 1/3 af de gange af en forbruger oplever *Out Of Shelf* i en butik, så har butikken rent faktisk varen ude på lageret. Dette betyder at butikken ikke for solgt varerne indenfor holdbarhedsdatoen, og må efterfølgende kassere varerne, med kæmpe resurse spild til følge. Hvilket medfører store økonomiske tab for butikkerne og leverandørerne.

Det anden element er når en kunde oplever Out Of Shelf, så vælger flere af kunderne ofte at skifte butik. Denne unødvendige ekstra transport imellem butikkerne vil i flere tilfælde være forureningsgivende.

Green Self Organizing Networks in Mobile Communication

Amin Morshed

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ABSTRACT

Self-Organization is a dynamic system which can automatically evolves to the dynamics of its environment [1]. This process is done or being applied in many fields such as physics, entropy, chemistry, biology, cybernetics, networks and etc. [2]. One of the areas which is under extensive evaluation and research is in Cellular networks. This is done due to the rampant growth of bandwidth usage in mobile networks and stabilized constant revenue in this field. This report evaluates the strength and weakness of the current solutions and provides a general understating of this process for anyone who wants to have an abyssal research in this field as his/her starting point. The main part of the report will be creation of such system.

REFERENCES

[1] Ashby, W. R. (1947). Principles of the self-organizing dynamic system. Journal of General Psychology, 37, 125–128.

[2]F. Dressler, “A study of self-organization mechanisms in ad hoc and sensor networks,” Elsevier Computer Communications, pp. 3018–3029, 2008

Development of Wireless Dynamic Electric Vehicles

V. Prasanth

DTU Chemistry, Technical University of Denmark

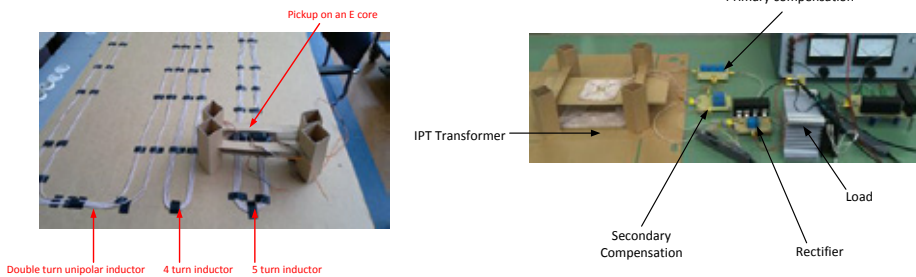
INTRODUCTION

Reduction or elimination of the large battery in EVs is an important step towards the acceptance of EVs. To that end, wireless inductive power transfer can charge both stationary and moving vehicles through electromagnetic induction. Development of stationary and dynamic powering of EVs can yield excellent range extension and can reduce the price of EVs by 30-40% due to the reduction in battery pack requirements.

MOTIVATION

1. Reserves of Li for **Li-ion batteries** are largely concentrated in **South America**, about **80%** of global reserves, this can be a source of potential political problems.
2. **Regenerative braking** can be implemented which increases the energy efficiency of the car by recovering up to **30%** of the energy lost due to braking.
3. Renewable energy if utilized at the points of production would directly reduce the **transmission losses** associated with the transport of electricity over large distances (as high as **7%** in Denmark in 2011) and improves energy efficiency.
4. Vehicles can be used as **local energy storage** so as to minimize variability of Renewable Sources and the generated power could be fed back to the grid during peak electricity demand. This is the function of Plug-in EVs and can help in demand side management by peak shaving of load demand.

EXPERIMENTAL SETUP



RESULTS

Higher frequency operation yields better efficiency of power transfer (100-500 kHz). Overall system efficiency as high as 80% for dynamic powering and 90% for stationary charging possible with SiC.

Creating a Virtual Platform “Sekhi” by Mapping Transport Systems to Facilitate Sharing Community

Prashanth Sekhar and Zhiyu Tang

Technology, Management & Economics, Chalmers University of Technology

PROBLEM

A need to make the existing society to focus on sustainable travelling by creating a sharing platform with their existing resources.

APPROACH

Creating a virtual mapping platform “Sekhi” of transport systems and then enabling a sharing system in that virtual platform.

SEKHI

Sekhi, is a platform based on virtual mapping of system entities of transport systems. Entities are all modes of transport like cars, bikes and other vehicles. The virtual mapping is enabled by locks in system entities. We are designing a business model for “Sekhi” and analyzing the multitude usage of the virtual platform in our master thesis.

Main idea was built upon looking on how could the existing transport system built up to a virtual mapping arena and used sustainably thereafter. The most common entity that could be modified and utilized with respect to technology change and adaptability is the locks present in all modes of transportation. Present scenario in advancement of locks is having smart locks with geo-tracking systems and sensors, the system usage of the transport entity could be maximized. This maximized usage could be translated into a virtual platform where all entities become actors and these actors (cars or bikes) could be shared in system for a sustainable life. Thereby creating a sharing platform with the existing transport system resources without creating any infrastructure change.

Present system of creating a bike sharing is to invest in infrastructure whereas not using existing bikes. And car sharing system is where people manually enter about the availability of cars for sharing, but what if car being the main entity itself says that it is available to be shared. Sekhi enables all these drawbacks in present system to be fulfilled.

Sekhi could be further connected with freight transportation in urban area, thereby creating a link between personal transportation and freight transportation. Sharing platform could be used for delivery of goods when the transit locations are identified by the platform. During the commute, goods could be delivered without additional transportation need, thereby decreasing the traffic in the urban area.

Value Proposition

- Anti-theft module for bikes and bike sharing system
- Combined Transportation Card (Car + Bikes + Public Transportation + Taxis)
- Crowd Sourcing Urban Delivery
- Boxes in bus stops activated using smart locks and used for delivery, transit of goods

Waste management in rural India

L.F. Vestergaard

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INTRODUCTION

The project takes place in the village Joygopalpur in West Bengal in India. Today there is no waste management system present to deal with the continuous increase of plastic that comes into the village every day and therefore no means to handle the waste. By making a collection system it becomes possible to give the plastic value. By melting it into building blocks in a sun grill using solar power, the plastic is recycled. This concept solves the waste problem in the village, creates local jobs and gives the inhabitants houses that are able to withstand the monsoon.

THE PROBLEM

Today they are disposing of the plastic by burning it in their stoves or in their gardens or simply handling it as organic waste and thereby throwing it in the nature. This has caused an increase in the cases of lung diseases in the area. When throwing it in the nature it also causes problems by clogging the pipes that are made to prevent flooding in the area. Furthermore, the area is a river delta and with the tide coming in everyday the plastic lying around is brought directly into the sea.

METHOD

In order to get a thorough understanding a participatory approach was used. It is important to make sure, when working within a different culture, that the users' needs and values are taken into account. Workshops, interviews and personas have been used to obtain this. An Awareness Film was made to increase the inhabitants' understanding of the importance of waste management.

THE PRODUCT

A prototype of The Block has been made from recycled plastic. This gives an idea of how the block can be used in real life. The Block's force is being measured in a lab at DTU, to make it can be used for building houses. The block will be used as a kind of fundament for the houses, which will be covered with clay, in order to maintain the look they have today. By using these blocks after the monsoon the house will still be there with the roof on and they will no longer need to build it up from scratch as they do today. Today in Nairobi in Kenya, they are doing something similar, but with machines and therefore on a much larger scale. This is not possible in the rural areas of India, because as soon as you have to transport the soft plastic it loses its value. The unique idea here is to make it in a micro perspective in the villages by using solar power.

CONCLUSION

This project can help a lot of people and have an impact on the environment and it is already in motion. It will have a positive effect on the waste lying around, create more local jobs and help the inhabitants so they can build houses that do not dissolve in the monsoon. This project is new and innovative because it sees the problems within the big picture, but solves it in micro perspective. This is seen as a pilot project, but the idea is that it shall be expanded to the rest of the rural India.

I DID NOT EXPECT TO WIN GRØN DYST (GREEN CHALLENGE) 2012

Peter Langelund Thomassen won the 2012 GRØN DYST first prize in the category of best bachelor project. Peter entered the student conference on his own with a project in which he examined the possibility of installing an efficient DeNOx unit that cleans the exhaust gases in the exhaust of a diesel engine that cleans the exhaust gases.

Peter explains, "I was in the process of writing my bachelor thesis when my supervisor asked me to participate in the GRØN DYST in 2012 with my project. I was not preparing myself that much prior to the GRØN DYST student conference. I looked through the rules and stuff, but otherwise I did not do that much preparation up to the big day. The most important thing was that I prepared a laptop presentation. "

DTU has trained me to do presentations

"Of course I was a little nervous right before I had to do my presentation. But on the other hand, being a student at DTU you have done this several times - to produce different types of presentations for others in all sorts of contexts. The way we have group work here at DTU, has trained me to have to do presentations," Peter explains.

"I do not think it was difficult to explain the judges about my project. The panel of judges also seemed genuinely interested in my project. That was actually a positive and pleasant experience," Peter says.

I will participate in GRØN DYST 2014

"I had not really expected to win. I knew that my project had some potential. But it was not because I wanted to win the first prize that I chose to participate. My positive experiences with GRØN DYST in 2012 did motivate me to participate again 2014. This time I participate in the master category," Peter says and adding: "The evening section of the GRØN DYST programme with barbeque and concert was a really nice way to finish on. It was just a really cool event".

Sustainability and climate change are high on the global agenda. Engineers play a central part in a sustainable development of society. Engineers from DTU can and must continue to contribute to the development of technological solutions that respond to the global challenges. Therefore DTU has initiated GRØN DYST.

www.groendyst.dtu.dk



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