Technical University
of Denmark

DTU

GRØN DYST

Tænk stort. Tænk nyt. Tænk grønt.

Student conference on sustainability, the environment and climate technology. June 22, 2012

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”I think it was very exciting and interesting to see other students’ projects as well. And the fact that there were people from different companies and politicians, made it even more interesting.“

Student, Architectural Engineering, participant from 2010

WELCOME

Dear participant,

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

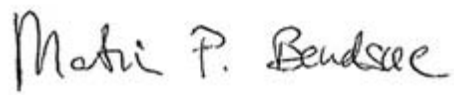
Climate change, deteriorating ecosystems, decreasing biodiversity, poverty and a continuously growing population all contribute to reducing the planet’s resilience and may have catastrophic implications for humanity. Each of these problems has attracted great attention from the international community, 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 other year, the 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 the GRØN DYST student conference for the second time. More than 400 students have registered 150 green projects for the GRØN DYST conference. Amongst them are students from universities in our international strategic partnerships and alliances – KAIST, NTNU, Aalto University, TUM and KU. 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 Morten Østergaard, Danish Minister for Science, Innovation and Higher Education, will visit the GRØN DYST student conference and present the awards. 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 12.30-13.30 IN OTICONSALEN
Lunch tickets can be found in the conference kit.

BBQ:

BBQ FROM 17.30-20.00 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

11:00-11:10
OFFICIAL OPENING OF THE CONFERENCE, DTU LIBRARY
WELCOME BY MARTIN E. VIGILD, DEAN OF UNDER-GRADUATE STUDIES AND STUDENT AFFAIRS

11:10-12:30
PRESENTATION OF THE PROJECTS

12:30-13:30
LUNCH

13:30-14:45
PRESENTATION OF THE PROJECTS

14:45-15:00
COFFEE BREAK, DTU LIBRARY

15:00-15:30
PRESENTATION OF THE PROJECTS

15:30-16:00
CONFERENCE RECEPTION INCLUDING ENTERTAINMENT BY ANDERS LUND MADSEN, DTU LIBRARY

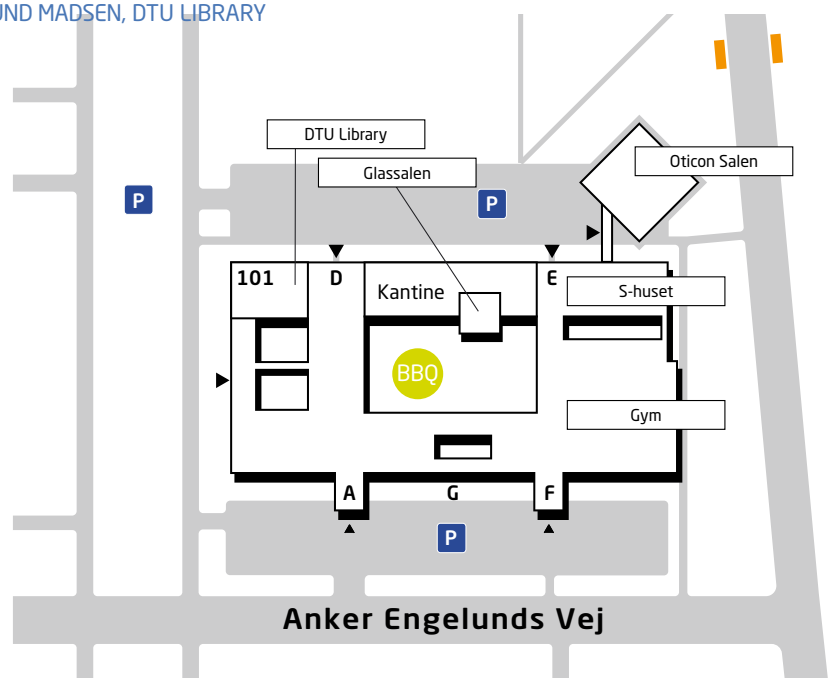
16:00-16:30
MINISTER OF SCIENCE, INNOVATION AND HIGHER EDUCATION, MORTEN ØSTERGAARD, VISITS THE CONFERENCE, DTU LIBRARY

16:30-17:00
AWARD CEREMONY WITH MINISTER OF SCIENCE, INNOVATION AND HIGHER EDUCATION MORTEN ØSTERGAARD, DTU LIBRARY

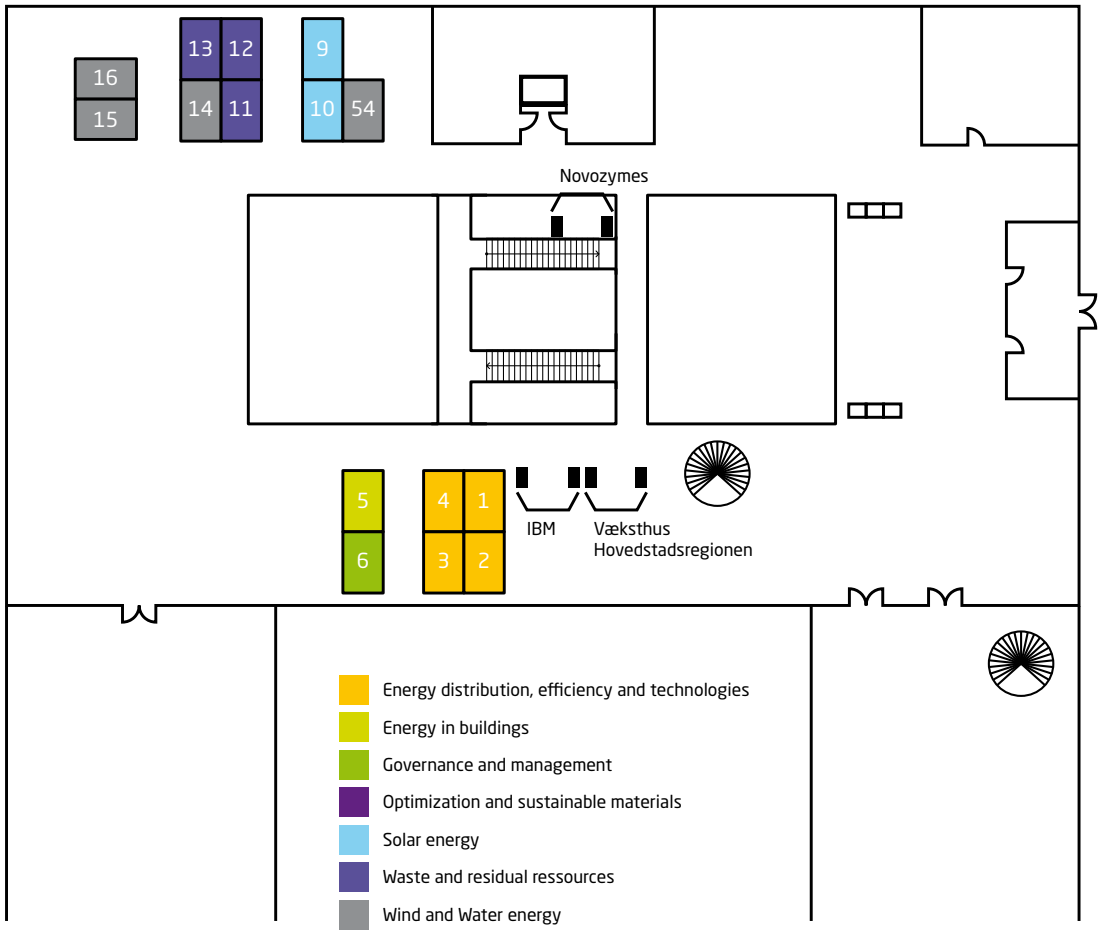
17:30-20:00
BBQ, GRØNNEGÅRDEN

20:00-22:00
DJ IN S-HUSET

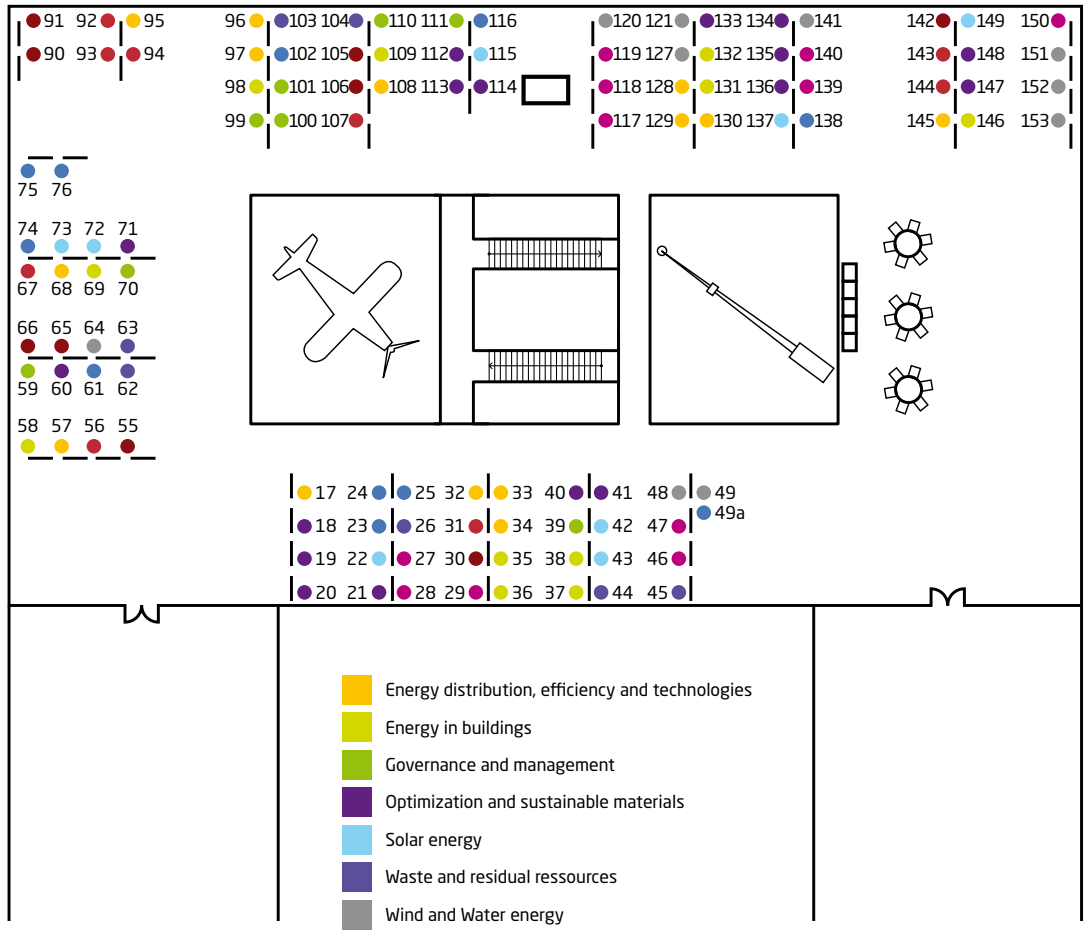
22:00-23:45
CONCERT WITH MALK DE KOIJN, GYM



GROUND FLOOR, DTU LIBRARY



FIRST FLOOR, DTU LIBRARY



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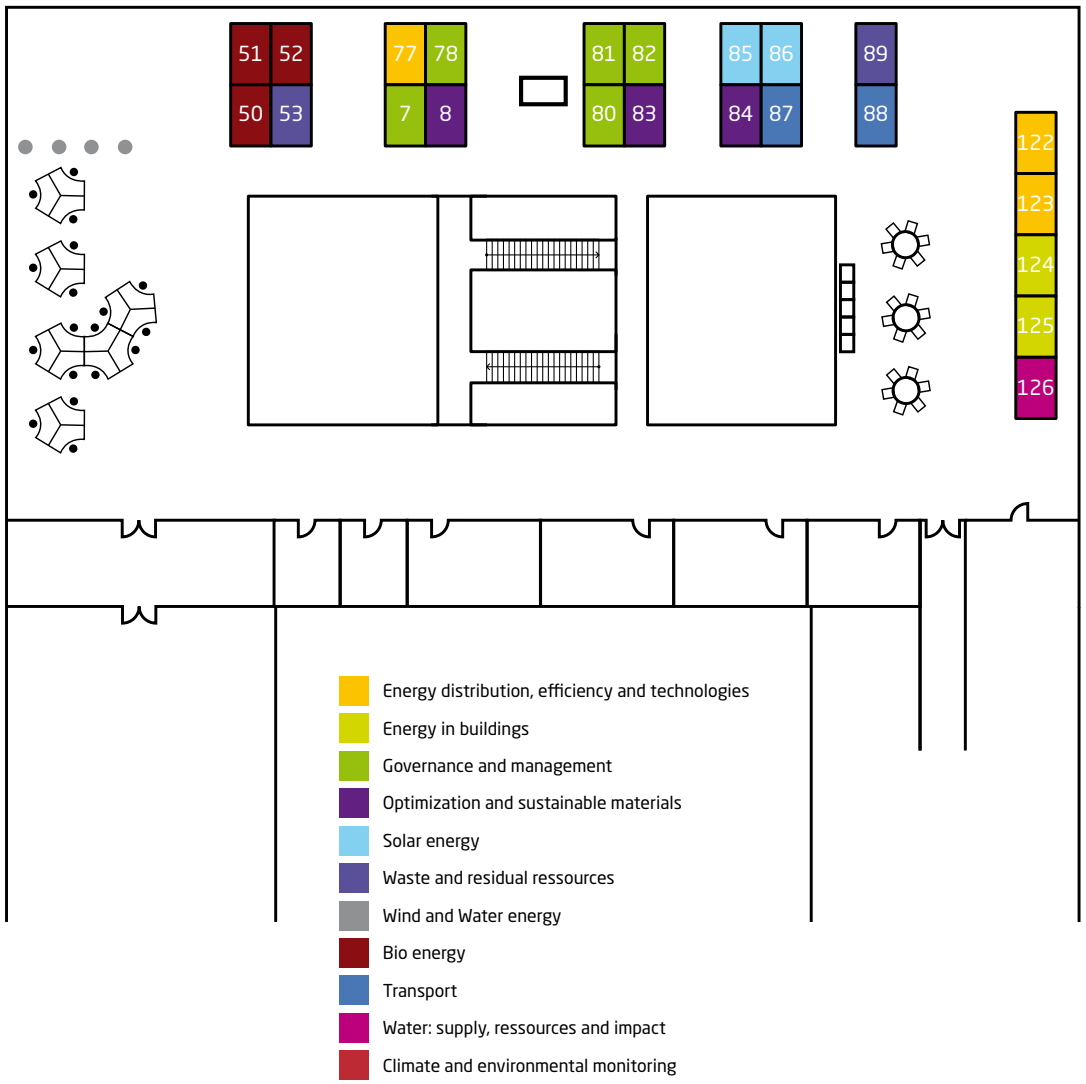

”We have been a part of GRØN DYST from the very beginning and see it as an excellent venue to demonstrate the important role engineers play in tackling global challenges with innovative and sustainable solutions. Not only does our initiative SMARTER PLANET relate directly to this agenda, IBM contributes actively in research work at DTU through projects such as EDISON, I Power and EcoGrid. Our participation in GRØN DYST highlights our ambitions and goals within the field but also allows us to enter into dialogue with talented students on their visions, competencies and possible future careers within IBM.“

Kim Østrup, External Relations Executive, IBM Denmark

JUDGING PANELS 1/2

PANEL 1

Per Clausen
MF
Enhedslisten

Steen Vestervang
Research Coordinator
Energinet.dk

Rasmus Davidsen
Former GRØN DYST
winner, DTU

Vincent F Hendricks
Professor
KU

Hans Larsen
Head of Department
DTU Nationallaboratoriet
for bæredygtig energi

PANEL 2

Pernille Rosenkranz-Theil
MF
Socialdemokraterne

Franck Hansen
Design Engineer
Alfa Laval

Lasse Skovgaard Jensen
Student and Manager
Grøn Vision

Thomas Hamacher
Professor
TUM

Birte Holst Jørgensen
Acting Deputy Head
of Department
DTU Management
Engineering

PANEL 3

Britta Thomsen
MEP
Socialdemokraterne

Henrik Hassing
Head of CleanTech
FORCE Technology

Anita Godiksen
Student and Project
developer
Grøn *Vision*

Massimiliano Capezzali
Deputy to the Director,
Energy Center
EPFL

Lars-Ulrik Aaen Andersen
Head of Department
DTU Fotonik

PANEL 4

Sofie Carsten Nielsen
MF
Radikale

Kristian Lund
Project Consultant
Væksthus
Hovedstadsregionen

Emil Skals
Student and chairman
of the board
Grøn *Vision*

Per Holten-Andersen
President
CBS

Egon Bech Hansen
Head of Department
DTU Systems Biology

PANEL 5

Lars Christian Lilleholt
MF
Venstre

Palle Munch Weidlich
Project Manager
Væksthus
Hovedstadsregionen

Rasmus Dahl
Student, Former
GRØN DYST
participant DTU

Mette Mønsted
Vice-dean
CBS

Christian Thune Jacobsen
Director
DTU Adgangskursus

PANEL 6

Lars Gaardhøj
Member of
Regionsrådet
Socialdemokraterne

Birgitte Brinch Madsen
Chief Technical
Officer
Mærsk

Stephanie Melnik Lemaitre
Student
DTU

Sung-Min Choi
Professor
KAIST

Helle Rootzen
Head of Department
DTU Informatics

PANEL 7

Sofia Osmani
City Councillor
Konservative

Allan Verner Rasmussen
Senior Project
Manager, Lego

Line Steiness Dejnbjerg Jensen
Student and Chairman
Polyteknisk Forening

Alastair Fuad-Luke
Professor
Aalto University

Anker Degn Jensen
Chairman of the
study board
DTU Chemical Engineering

PANEL 8

Gitte Kjær-Westermann
City Councillor
Venstre

Kristine Garde
Business Developer
Copenhagen Cleantech
Cluster

Kim Louise Ettrup
Student and chair
of the social
committee, PF

Thomas Bjørnholm
Prorector
KU

Andrew Burrows
Director
DTU CEN

JUDGING PANELS 2/2

PANEL 9

Dorete Dandanell
City Councillor
SF

Hanne Christensen
Director for
Environment
and Nature
Rambøll

Simon Fisker Strøm
Student
and responsible for Roskilde
Festival projects
Grøn Vision

Stig Wedel
Associate Professor
DTU

Mariann Albjerg
US NASA "Emeritus NASA
Space Exploration"
DTU Space

PANEL 10

Christina Stenberg Lille
City Councillor
Venstre

Kim Østrup
External Relations
Executive
IBM Denmark

Jakob Berg Johansen
Student and Project
developer
Grøn Vision

Ruut Hannele
Peuhkuri
Researcher
DTU

Morten Sommer
Professor
DTU Systems Biology

PANEL 11

Anne Körner
City Councillor
Venstre

Frank A Mathiasen
CIEL Project Manager
DTU Business

Anne Mette Vraa
Student
DTU

Bo Munk Jørgensen
Associate Professor
DTU

Mhairi Workman
Associate Professor
DTU Systems Biology

PANEL 12

Birgitte Hannibal
City Councillor
Venstre

Asger Høeg
Director
Eksperimentarium

Fie Blasen
Student
DTU

Lasse Engbo
Christiansen
Associate Professor
DTU

Michael Havbro Faber
Head of Department
DTU Civil Engineering

PANEL 13

Søren P Rasmussen
Mayor
Venstre

Philippe Scanlon
Senior Consultant
Deloitte

Sven Hermann
Student
DTU

Jan Martinussen
Associate Professor
DTU

Henrik Carlsen
Head of Department
DTU Mechanical
Engineering

PANEL 14

Thomas Norman
Department Manager
R&D, Babcock & Wilcox
Volund A/S

Eddi Søgaard
Former GRØN DYST
participant
DTU

Caroline P. Baron
Senior Researcher
DTU

Lene Kaspersen
City Councillor
and member of
Regionsrådet
Konservative

Mogens Rysholt
Poulsen
Head of Department
DTU Nanotech

PANEL 15

Nickolass Bitsch
Schack
Research Scientist
Novozymes

Charlie Haagendrup
Student
Grøn vision

Peter Heegaard
Professor
DTU

Morten Normann
Jørgensen
City Councillor
SF

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 can not receive an award unless it includes sustainability, the environment or climate technology. Number of ECTS points will be taken into consideration in the overall evaluation of the project.

SERVING THE PANEL OF JUDGES

I was honoured to be asked to serve on the panel of judges that evaluated the master projects at GRØN DYST in 2010. I was asked because I was a student at Sustainable Energy and, at the same time, was the student representative in the organizing committee for GRØN DYST.

Every judging panel included a representative from the political arena, an executive from the corporate world, a prominent researcher, and a student. Member of the Danish Parliament and current Minister for the Environment, Ida Auken, was one of the prominent members on my panel. The tone was rather informal, and during breaks we had time to joke and ask each other questions about our respective professional lives which was very conducive to strengthening the team spirit. We all had equal influence and respected each other's opinions and views when reviewing and judging the various projects.

Being a student myself, it was a rather exceptional experience to sit in judgement of the work of my accomplished fellow students. That I was party to picking the winning GRØN DYST, and thereby awarding prize money to a fellow student, was really something!

Selecting a winner among the GRØN DYST projects was by no means an easy task. The projects each had their own strengths and we had little time to evaluate each entry. My recommendation to the GRØN DYST participants this year is therefore to focus on communicating your core idea in a relatively straightforward and simple way that allows people of diverse professional backgrounds to quickly grasp the nucleus of your project.

Christian Nørr Jacobsen
Energy Consultant, Grontmij

”Being a student myself, it was a rather exceptional experience to sit in judgement of the work of my accomplished fellow students. That I was party to picking the winning GRØN DYST, and thereby awarding prize money to a fellow student, was really something!“

Christian Nørr Jacobsen, Energy Consultant, Grontmij

LEGEND INFO

Level

- Bachelor Level Course / Project
- Bachelor Thesis
- Master Level Course / Project
- Master Thesis

Presentation format

- Free Style
- Laptop
- Poster

Project themes

- Climate and environmental monitoring
- Energy in buildings
- Governance and management
- Optimization and sustainable materials
- Solar energy
- Waste and residual ressources
- Wind and Water energy
- Bio energy
- Transport
- Water: supply, ressources and impact
- Climate and environmental monitoring

ABSTRACTS

Natures Battery

Marc Dose, Frederik Dahl Hougs, Johannes Engell Kamber, Jonatan Märcher-Rørsted, Søren Peter Nielsen

DTU Electro technology, Technical University of Denmark

This project will enable implementation of renewable energy sources in small, isolated energy systems, in this case represented by a small town in Greenland named Sarfannguit. The intent is to subtract the use of fossil fuel as a main power supply and replace it with persistent energy sources.

To maximize the use of energy from renewable sources, a pumped storage system can be used. This system uses surplus energy produced from e.g. windmills to store water in an elevated reservoir, which later can be used to supply additional energy when the renewable sources are insufficient.

Our pumped storage systems contains several commercial products used for electricity production, primarily a hydro turbine, a generator, control and monitoring systems and a pump. All of these components are designed to be assembled and interact in a standard sized ship container. The container will be designed to require minimum maintenance during operation. In addition the container will be implementable in every environment that has access to both renewable energy sources and two reservoirs, one of which is elevated in relation to the other. The final product will be designed as a 'plug and play'-solution, which only need connections to the power system and the two reservoirs, and will therefore require minimum local manpower for implementation. This solution makes it easy to set up pumped-storage in remote areas.

The container will be designed with two separate "rooms", one for energy production and the other for storing energy. The section for production of energy will include the hydro turbine and the generator, while the section for storing energy will include the pump system. In case of machinery break-down it will be possible to repair or replace the module from each section independent of the other module. This design will increase the flexibility of our solution and thereby increase the lifespan of our final product.

By implementing this pumped storage system, we will be able to reduce the amount of greenhouse gasses released into the atmosphere, and in the long run possibly reduce the financial cost of energy production, and thereby making it a favorable solution both environmentally and economically. The design will follow our ambition to make the life-cycle assessment of the solution reflect an environment-friendly agenda. This cradle-to-grave thinking demand a prioritization of re-usability, production-methods and a design tailored for easy replacement of parts and/or upgrading individual machinery.

The future aspects of "plug and play" pumped storage systems as we see them are far reaching. As a concept it would be usable in setting up constant electricity production in remote areas as Greenland or in countries with mountains. Storage capacity is the missing piece in the renewable energy discussion and would make solar-, wind- and water-produced energy a real alternative to fossil fuel.

SmartGrid – An energy efficient way of living

M. Camitz, S. Bardefleth, M. Bach-Pedersen, S. Bergstrand-Poulsen

DTU Mathematics, Technical University of Denmark

If we want to replace the use of fossil fuels with sustainable energy, we have to continue to meet the energy demands of the consumers. One way of doing this is to optimize and control the energy consumption in each household, so that the total consumption is as even as possible during the whole day. The question is, whether it is probable that an average household will be able to redistribute their energy consumption enough for it to have a notable effect on the total energy consumption.

SmartGrid is the energy companies' solution to power shortage. It's an easy way for the supplier to control the energy consumption for a private household. It enables the companies to raise the price of energy when the demand is great and lower the prices during the night when the total consumption is less. Because the consumption is much greater during the morning and evening, it forces the suppliers to make sure there's no energy shortage by increasing the amount of energy made from fossil fuels.

Our project focuses on the advantages of SmartGrid for a normal household with a heat pump. Using MatLab we will model the heat flow in an average house equipped with a heat pump. We will look at the water flow in connection to underfloor heating and strive to control the heat pump, so that it will take advantage of the low energy prices during the night. Our goal is to be able to control the heat pump in a way that allows the household to maintain a comfortable room temperature.
We are hoping to lower the consumption peaks by shutting of the heat pump during these periods of time. This will smooth the peaks out and thereby decrease the total energy demand during these hours. Hopefully this will allow the energy companies to produce less energy from coal power plants and thereby reduce the amount of energy from fossil fuels.

Backlight dimming algorithm on a LED-Display.

Simon B. Jørgensen[1], Mads F. Engels[1], Henrik L. Holm [1]

[1]DTU Department of Photonics Engineering, Technical University of Denmark

In commercialized LED TVs the goal is to reach a better image quality and decrease the power consumption. The final product a user perceived is the backlight brightness and the pixel panel transmittance. In traditional LCD-TVs the backlight brightness is uniform and the dark areas are also lit up by the backlight. This results in poor image quality and power waste problems. Therefore the backlighted LED TV is used nowadays which consists of a backlight panel and a pixel panel (LCD), seen in figure 1. These panels can be controlled by using a locally pixel-compensated backlight dimming algorithm. Backlight luminance is dimmed locally in the dark-image region. On the pixel panel the values are compensated synchronously according to the luminance profile of dimmed backlight. This will result in greater contrasts and less power usage. The implementation and simulation of the algorithm will give us an estimate of how much power the user and the society can save by using this algorithm in backlighted LED TVs.

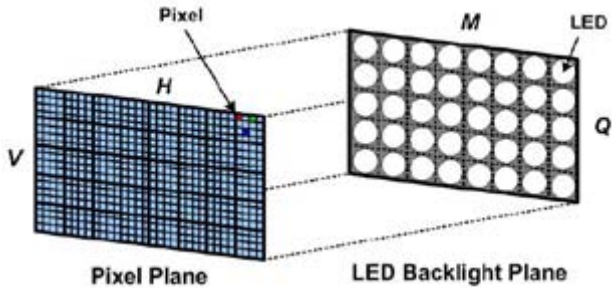

Figure 1: Pixel-panel and Backlight-panel

REFERENCES

Figure 1:
Lee, W., Patel, K., Pedram, Massoud. (2009), White LED Backlight Control for Motion Blur Reduction and Power Minimization in Large LCD TVs, *Journal of the Society for Information Display, 5*. Retrieved April 18th, 2012, Retrieved from http://atrak.usc.edu/~massoud/Papers/white-LED-backlight-control-jsid.pdf.

Measurement & control of personal energy consumption

Loke Bager Kristensen & Jeppe Nørregaard

DTU Elektro, Technical University of Denmark

INTRODUCTION

This project suggests a solution for better utilization of the produced energy, from renewable energy sources. By helping individual energy consumers use energy at times of low demand, it decreases the individuals' energy costs, and reduces the workload on energy sources in times of high demand.

THEORY

Intelligent Home Concept (IHC) is a system made by the electricity company Lauritz Knudsen, integrated in some new houses. IHC enables the owner of the house to wirelessly control the individual electricity outtakes, lights, ventilation systems etc.
Remotely read electricity meters (sometimes called "intelligent electricity meters") enables electricity distributors to remotely read the electricity usage of households.
Also a house owner can view the electricity prices online, at a database updated every day.
Our project merges these three services, and creates a common user interface on Android based smart phones. Through the smart phone interface, the user can set the IHC-controller to turn high energy consuming devices on and off at appropriate times, based on energy prices. Also the device can be used to check for and turn off object when leaving the building. Therefore assisting the consumer towards a more efficient energy consumption.

THE PRODUCT

Our product is an Android based application that connects with an IHC-controller, a remotely read electricity meter and uses the internet for collecting data about energy prices. It enables the user to control devices, based on time of day, energy prices or manually, through the phone.
The product makes it more attractive for consumers to have a more efficient energy consumption, by saving the user money and doing so through a commonly known easy-to-use interface.

FUTURE USE

The product is open for further development, such as:

1. Providing an alarm, to remind the user that a device is still turned on, if the person leaves the building. This could be based either on GPS tracking or WiFi connection or preferably both.
2. By providing services, for electrical device producing companies (such as washers etc.) to easily adapt their devices to the application, other products than the IHC can be included.
3. Solar cells and private windmills could be connected, so that their productivity can be read directly.
4. Etc.

New Primary of Lindegårdsskolen

A.U. Døi, R. V. W. Nielsen and S. R. Svare

DTU Architectural Enginering, Technical University of Denmark

Introduction

Our project is a proposal for a new primary school in Lyngby- Taarbæk municipality. In this proposal our focus has been to optimize the building, focusing on the sustainability and the indoor climate, so that the amount of energy used, is reduced to a minimum. Along with this, we have to make the building as functional as possible, since the school is not only used in school purposes, but will also be used by the public in the afternoon and the like.

Method

To accommodate the needs for the project, we have had to combine design with new technology. On the roof we have solar panels, which can deliver the necessary electricity, and a solar heating system for heating up all the water in the building. On the first floor is almost all the rooms supplied with skylight, so that the need of electric light is almost reduced to zero in the daytime.
The size of the windows in each room is optimized by their orientation, so that the need of cooling is reduced. To reduce the use of drinking water as much as possible, the rainwater is collected in a tank below the ground, ready touse for toilets and a like.
To reduce the need of electric light, we have simulated every room in Velux Visualizer to optimize the daylight factor, without increasing the need of cooling the rooms.

Final Project

In the end, we'll end up with a new primary school, in more ways than just one. New materials, innovative constructions, room layout and the whole idea of, that every inner wall can be removed, are all contributed to make a building as sustainable as possible.

Ozzy and the garbage bin

M. Harboe, F. Søndergård-Gudmandsen, F. Sidenius and P. Trachsel

Communication and IT, Københavns Universitet

The need for gasification

Household garbage holds a great unused gasification potential, which can provide us with fuel, electricity, heat, and enriched soil. There is, however, no option for citizens of the municipality of Copenhagen to send their garbage to gasification, but recent politics and energy plans announce that this will soon be a focus in Denmark. To harvest this great potential, it is requires that all citizens get used to sorting their everyday waste into biological decomposable and non-decomposable garbage to accommodate gasification. Our project is to teach children to do exactly that.

Design addressing young children

Our project targets children of the age 6-10 years old since they will be the citizens and consumers of tomorrow, but also because their young minds are more impressionable to new ideas and habits where as adults often are more set in their ways.

We have designed an interactive garbage bin to be located at school classes from 0.-3. grade. A touch screen is attached to the bin and provide the children with a story about how to sort their garbage and why it is important. This narrative is told by Ozzy the Earthworm (Ormen Ozzy) and is told in pictures, text and sound in an explorable world. We use a mix of small games, a sense of competition, videos, stories, songs, and statistics. Thus do we seek to teach the children about garbage and gasification and to stimulate their sense of curiosity and urge to help. We have sought to design at a level of abstraction and with point of stimulation to best accommodate the users age. These design decisions are based heavily upon several observations and interviews of children in their classrooms, at lunch and using installations at Experimentarium.

The prototype

We have placed a prototype of the installation in three different schools in Copenhagen for a period of two weeks. We have also placed a bin without the design and touch screen in three other schools to test if the interactive design offers more encouragement than just a regular plea for the children to sort their garbage.

The children have expressed a great liking for the fictional Ozzy and sympathy for the plea in the narrative. They have done the best of their ability to help collect decomposable garbage for Ozzy and they have also showed more focus upon garbage sorting at home after the two weeks of having the installation at school.

Although our design aims at a long term effect in changing the behavior of children, which we are not able to fully confirm within the durance of this project, we still believe based on our findings that our design do motivate, educate and entertain young children and thereby offers a great mean toward our goal.

To see more of the design visit Ozzy and his friends at www.jagtenpaanoget.dk .

Carbon Currency for a Sustainable Economy

S. B. Slette[1], A. Aggarwal[2]

[1]NTNU, Norwegian University of Science and Technology
[2]NIT, National Institute of Technology, Kurukshetra, India

Introduction

A balance between economic growth and environmental sustainability can solve major global challenges. This paper will adress how to utilize the current economic system to catalyze the transition to a sustainable global economy that promotes a global sustainable development. The implementation of the "carbon currency" will provide an automatic carbon compensation for the total environmental impact of a product or service.

Theory

To secure a transition towards sustainability while the world population increases, we need to utilize the close network of our global economy. Our concept shapes a sustainable global economy with a system in parallel with the current economic model. Exploiting the strengths of the conventional economy, it is possible to gradually phase in a sustainable model where renewable energy is produced at competitive prices. A green economy will enable the production of goods and services that create human well-being and simultaneously contribute to a sustainable global development (*Towards a green economy*, UNEP 2011). By creating six divisions the global economy will be well structured to systematically facilitate sustainability. Renewable energy, clean transportation, green buildings, water management, waste management and land management. The standard green economy divisions will enable financing of new projects and is comparable across borders.

In order to standardize the global economy, we propose introducing a new currency. The "carbon currency" would be an environmental pillar of the national and international trade. A climate-related value is a measure that can be combined nicely with the current implementation of carbon credit, carbon credits and binding emissions limits. By changing the origin of the currency it receives a significant climate-related value in addition to the specific benefits derived from money within trading and social development. The concept of the carbon currency is that CO_2 equivalents form the basis in the new economy. The price of goods and services is the price of the total social and environmental impact the product or service has caused. When the market is controlled by the lowest possible impact on the climate rather than the lowest possible price, consumption will automatically be steered towards a sustainable development, and prices for environmentally friendly solutions is reduced.

The green economy thus operates with transactions between individuals, organizations and nations, according to the normal per-capita adjustment. Transactions can take place between carbon exchange and ordinary money and vice-versa, with a gradual transition to only carbon currency. Such a system will control the economy so that the arrival of new transaction media such as digital currency bitcoins will contribute to future sustainable economy rather than to undermine the world economy and creating great uncertainty in the markets.

Conclusion

Globalization and new technology makes a new economic system available for major parts of the world's population. By linking currency to the climate, developments follow known market models, but instead of over-consumption of resources, the development in the green economy only be operated by sustainable projects and environmentally friendly community solutions.

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CO_2 cooling at Roskilde Festival

B. M. L. Petersen[1], K. M. Lorenzen[1], A.F. Asmussen[1], and L. Landtved[1]

[1]DTU Management Engineering – Design and Innovation, Technical University of Denmark

INTRODUCTION

Cooling takes a lot of energy. It's particularly interesting at Roskilde Festival where all the cooling systems are spread across the festival site. It's one of Roskilde Festival's biggest energy consumers and therefore a huge CO_2 emitter. There lies a great potential in creating a sustainable, climate-friendly cooling system to events like Roskilde Festival. The idea of creating a sustainable cooling system will not only reduce the emission of CO_2 but hopefully also have a long-term effect on the new standards concerning sustainable and climate-friendly cooling at bigger and temporary events.

We want to set up a model of a cooling system with CO_2 as refrigerant and compare it with the existing cooling containers/refrigerators based on other refrigerants. We want to use data from Mærsk Container Industries A/S and compare the energy efficiency of a regular cooling container and a cooling container running on CO_2. With the research from Mærsk Container Industries A/S and our further studies, we want to analyse whether or not it would be a good idea, energetically speaking, to switch to cooling containers running on CO_2.

APPROACH

More precisely, we want to set up detailed thermodynamic models for cooling systems based on the refrigerant R134a.
These models include calculations of the energy consumption and waste heat. We want to estimate a detailed thermodynamic model when CO_2 is the refrigerant, based on the result from R134a as refrigerant. The results would then be compared to Mærsk Container Industries A/S's cooling containers that are based on CO_2. We want to use the collected data about variations in temperature, waste heat and energy consumption from Mærsk Container Industries A/S and DTU, to make an assumption, whether or not it would be economically and environmentally profitable for Roskilde Festival to invest in CO_2 cooling containers.

EXPECTATIONS

We expect that CO_2-cooling have an advantage compared to normal cooling systems, environmentally speaking. We have no idea to what extend this advantage would be though. It's proven to be both environmentally an economically sustainable to switch to CO_2-cooling at the Netto corporation in Denmark. We could imagine ourselves using some of their experience in our work analysis.

The storage of solar heat

N. S. Sigurdarson, G. N. Jacobsen, K. Bjarklev, B. Johansen[1], and E. R. Møller[2]

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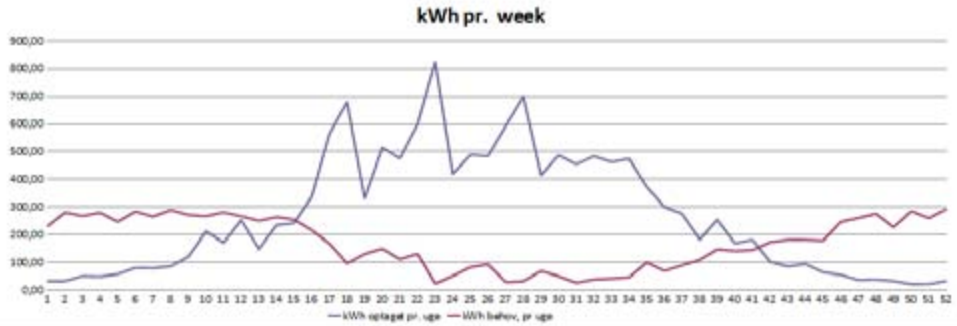
One of the main issues in incorporating weather dependent sustainable energy sources such as solar- and wind power, into the electrical grid, is the irregularity of power production. The peak hours of power consumption in society, rarely coincide with the peak hours of generation of sustainable energy. The full potential of sustainable energy sources is therefor seldom utilized.
In this concern, solar thermal collectors are quite problematic. The need for heating and hot water is largest during the least radiant parts of the day – in the morning, evening and during the night. Most residential solar thermal collectors are connected to large water tanks, in which hot water is stored. These can however, rarely cover an entire households' heating needs, and are most often only used to cover hot water needs. The problem is even more obvious when observing the difference in the heat required and heat generated for an average danish house (built in the 1990's) during an average year, using 25 m^2 of solar thermal collectors.



Our hope is to prove, that it is possible create a system, which stores large quantities of surplus heat from daytime hours - and from periods with very varying weather conditions, which is more effective than systems using water as a heat storing medium.
This is possible by utilizing phase changing materials, which can contain large amounts of latent heat energy, as mediums of heat storage. Using large tanks of for instance *lauric acid* (which is a naturally occurring lipid that melts at app. 44 ºC) could potentially store approximately 2,5 times more usable thermal energy than equivalent water tanks. These tanks would be able to store some of the excess heat energy during peak hours, and provide heat energy when it is needed. In effect, a system such as this could be able to store more energy than water, thereby reducing the amount of wasted heat energy, available during peak hours, considerably.
These systems could be effective in areas with large consumptions of residential hot water, such as Scandinavia, or in areas with very varying temperatures, such as deserts, mountain regions etc, ultimately making solar thermal collectors a more viable source of residential heating, reducing the amount of fossil fuels used for heating.

BACHELOR LEVEL COURSE / PROJECT

FREE STYLE

SOLAR ENERGY

The Mathematics of Flux Calculations on Solar Panels

C. N. Christensen, M. Tomicic, J. S. Bach, E. L. Pedersen, K. B. Joanesarson, G. Saxe
DTU Mathematics, Technical University of Denmark

A solar power revolution

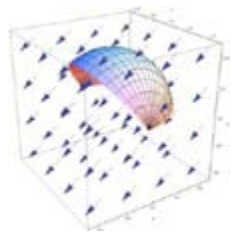
Solar power has always had a reputation for being expensive and a niche market. However in recent years developments in innovation and manufacturing mean that we could be on the threshold of a mass market breakthrough. Solar power could viably provide 20-25% of the world's electricity supplies by 2050 according to a report published by the International Energy Agency in 2010 [1]. Back in May 2011 Mark M. Little, global research director for General Electric Co., said that solar power may be cheaper than electricity generated by fossil fuels and nuclear reactors within three to five years because of innovations [2]. And perhaps most importantly, fresh figures from Bloomberg New Energy Finance show that the price of solar panels fell by almost 50 percent in 2011 – and they are now almost a quarter of what they were in 2008 [3]. In fact, solar power is now the fastest growing industry in America [4]. Being a clean, safe, sustainable energy source, this all makes solar power a technology that can hardly be ignored by all the nations and organizations that has set ambitious goals for green energy.

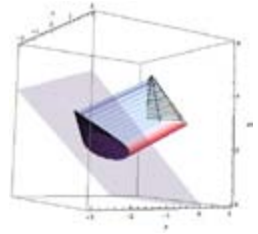
The future of solar power may be curved and 3-dimensional

In 2011 MIT Engineering Professor Jeffrey Grossman and his team set out to investigate the potential of 3D solar panels, inspired by the way trees spread their leaves [5]. Using a computer algorithm the research team "evolved" 3D solar panels all designed to take up the same base area [6]. The efficiency of these dynamic shapes was greater and much less affected by cloudy weather than regular flat panels using the same amount of ground space. And ubiquitous, 3D solar panels are exactly what the maturing industry of thin-film solar cells may be making possible.

Mathematical model, optimization and methods of flux calculation

Our presentation is based on a 3-week project from the 1st-year introductory course in "Advanced Engineering Mathematics" (Mat1). For a given configuration of curvilinear solar panels (perhaps on a building), which will be the optimal orientation for gathering solar energy over day cycle? What is the total energy absorption over a whole day? What problems exist in calculating the flux of energy in a solar panels and which methods exists for different types of surfaces? In designing a curved solar panel, what is the relationship between the curvatures and the efficiency? What things matter and doesn't matter? We have addressed questions of these kinds in our project by using a simplified model of energy absorption on a limited set of surfaces, namely planar surfaces, convex single-curved surfaces and convex surfaces of revolution, represented by parametric equations. We have investigated several methods, some of which are very specific to certain kinds of surfaces and lead to analytic expressions that yield mathematical insight, and some of which are more numerically inclined but generally applicable to a wider class of surfaces.





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Designing a system for household waste management in apartments

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[1]DTU Design and Innovation, Technical University of Denmark

INTRODUCTION

The initial initiative for getting this project done was taken by Mia Makne from Miljøpunkt Nørrebro (an interest organization involved in i.a. waste management) and Søsser Brodersen from DTU. It was created in a special course from February to May 2012 at DTU in collaboration with Miljøpunkt Nørrebro with the supervisors Søsser Brodersen and Rikke Premer Petersen.

THE PROBLEM

The Copenhagen municipality has a goal of increasing the household trash separation in the city, because it is the easiest way to collect the recyclable materials disposed of in all apartments every day. The problem is that many citizens have rejected the idea with an argument of not having enough space for several different trash containers in their tiny apartments. This project strives to find an aesthetic, flexible solution to managing the separation of trash that will fit in most apartments.

METHODS

The work on this project can be divided into three phases, them being: fieldwork and analysis, brainstorm and conceptualization, and detailing. The goal was to create something extremely user-friendly witch is why a group of users were involved through out the process. Through interviews they were questioned about patterns of practice and during brainstorms on solutions, conceptualization and detailing of the final product they were asked to participate, comment on and discuss the ideas during individual sessions and as a collected group in a workshop.

RESULTS

The result of the project has been the concept Clip-On. It is a product that can store several different fractions of trash in the same spot, where there is usually only one, in the cupboard under the sink in the kitchen. The opening of the cupboard is transformed to a pull-out function and on the rails for the door are placed clips that has a frame for stretching out ordinary plastic bags. On top of the plastic bag on the frame can be placed a magnetic sign for communicating which fraction goes where.

CONCLUSION

Clip-On is a very real and applicable solution for waste management in small apartments. It allows the user to dispose of but separate all of his/her fractions of trash in only one spot usually used for that same thing. It is flexible in size, quick and easy to use, the content is easily transported from the kitchen to the courtyard and is hidden when not in use. We believe this product would help motivate more people to separate their waste, because it brings a functionality and aesthetic to household waste management not previously seen.

BACHELOR LEVEL COURSE / PROJECT
FREE STYLE
WASTE AND RESIDUAL RESSOURCES

Waste Management at Events

Frederik C. V. Hansen, Jonathan Rasmussen, Camilla A. Hansen, Marie S. Berggreen, Andreas Nørballe, Mikkel Seibæk and Heida G. Nolsøe

DTU Mechanical Technology, Technical University of Denmark

Due to the increasing popularity of parties, celebrations and events in the streets of numerous cities around the world, there is a rapidly growing challenge in regards to the amount of thrown waste into these public environments. On the basis of this problem, the ambition of our project is to develop a solution for waste handling at events. As a green solution, *DropBucket* is able to keep the environment clean, as well as the surrounding areas by offering efficient and environmentally justifiable waste management.

In depth research, field studies and sociotechnical analysis reveals that the absence of easily accessible and appealing disposal options, is a key factor in the progression of the above-stated problem. Every year, extensive resources are devoted to waste management at events. These are often considered time-consuming and expensive due to the amount of cleanup and comprehensive logistical work, required during the process of waste disposal from the street.

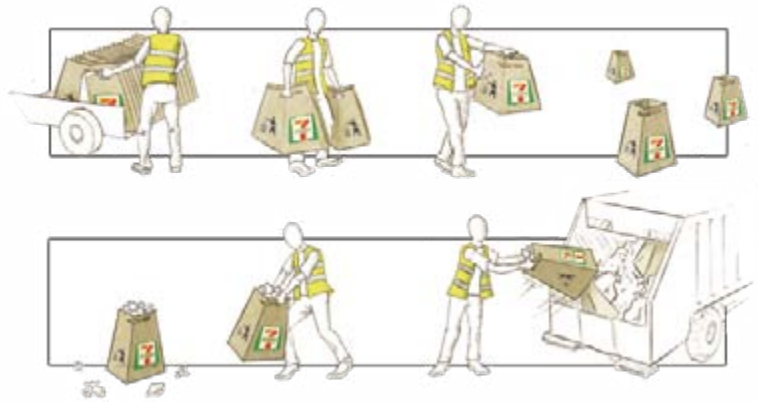

Figure 1 Deployment and Disposal

DropBucket was originally intended and developed for use at events in the streets of Copenhagen Inner City. However, by virtue of its simple design, the solution is easily implemented at events of a similar nature around the world. The concept of *DropBucket* is based around a foldable bin, consisting of a collapsed cardboard structure that unfolds to a pyramid shaped structure when it is deployed. This way, *DropBucket* ensures a rapid and efficient implementation in large numbers, during times when the need for waste handling exceeds the capacity of stationary bins.
In its current state, *DropBucket* is punched from one piece of corrugated cardboard featuring a water resistant liner and thus designed as an inexpensive disposable bin which can be compressed on site and properly deposited after use. Further developments will be based on field testings of new prototypes where special consideration is given to the choice of cardboard type and liner. The key elements of focus will be around strength, stability and environmental footprint.
The fact that *DropBucket* is not emptied after use and is disposed in a compressed state – thus minimizing transportation and emission of greenhouse gasses associated – underlines the profile of this product being a truly green solution.

E.W.E.N.T. – Event Waste Elimination in No Time

Jakob Wulff, Carina Lindahl & Otto Exner

[1]DTU Design Engineering, Technical University of Denmark

INTRODUCTION

The idea of the garbage bag E.W.E.N.T. was developed in the course "Brugerorienteret design" in our first semester at Technical University of Denmark.
E.W.E.N.T. is a waste solution, focusing on special occations and happenings, where the amount of waste is especially heavy. The bin is easily installed or dismounted in less than a minute. Having a light construction, it is consisting of a minimum of material, and the disposable bin is thrown out with the garbage when it has served it's time, which is from one to three days.

THEORY, METHODS AND RESULT

Using the SCOT theory we analyzed interviews and observations and discovered some problems in Copenhagen. From this analysis of our collected material we saw clearly that the capacities of the existing bins were not sufficient enough in specific situations, such as events. The present concept of E.W.E.N.T. was developed through idea generation and concept validations.
The great thing about E.W.E.N.T. is that it can be installed all over the city. With its elastic/strip it can be tied to lamp posts, trees or fences for example - wherever there is a need.
E.W.E.N.T. has a short, but an environmentally conscious LCC. The product is made of polyethylene, often used for disposable material, like disposable cutlery, as the complete combustion results in only CO_2 and H_2O and is easy to mass-produce in an environmentally correct way. The concept can be implemented in the current waste handling system in Copenhagen. Furthermore the advantages of the disposable aspect of E.W.E.N.T. is that it takes up less room and weighs less compared to other bins suitable for events, and it does not have to be transported to stocks, all which minimizes the cost and pollution of transport considerably.

CONCLUSION

E.W.E.N.T. is a garbage solution for special occasions, and is designed to be disposable, without any major environmental effect. It is a solution that will keep the area around the event much more clean, because of its mounting aspect and light weight. Compared to other existing solutions E.W.E.N.T. redefine the way we think about bins, and solves the problems in a new and better way.

Wind-up system for a Lever Operated Pivoting Float-Buoy

A. A. Frederiksen, A. G. Andersen, K. J. Juul, M. L. Bernitt, P. R. Nielsen and R. Katkjær

DTU Mechanical Engineering, Technical University of Denmark

INTRODUCTION

The project that this abstract revolves around is being prepared in connection with the course Project Work (41801) and focuses on the construction of a wind-up system for a Lever Operated Pivoting Float-buoy (LOPF) in cooperation with Resen Waves. The purpose of the buoy is to transform energy from waves in the ocean to electrical energy. The system is put in place to allow for the buoy to move with the waves in the best possible manner, and allow it to be dragged under water in case of a storm. Optimizing how the buoy follows the waves is essential, as it allows for the buoy to create a larger amount of energy. It is the wired connection to the bottom (Figure 1), with the movement of the waves that makes the shaft rotate.

PROJECT

The objective of the project is to develop a system able to draw the buoy closer to the bottom of the ocean, if the water level is low or a storm is coming. This means shortening the wire on Figure 1. The first part of the project focused on the general design of the system and its mechanical properties. A lengthy calculation process was needed to dimension the system to the buoy, because it was important that it fit the requirements. These were: 1. Able to pull the buoy underwater during a storm and 2. Not using too much power. For the system to be able to live up to these requirements, extensive calculations on the gears of the system were needed, and the right motor had to be found. The solution was then graphically rendered in SolidWorks, as work drawings of the systems different parts were needed for fabrication. After the parts have been fabricated, the system is to be tested in a dry environment as well as in the ocean, to see if it lives up to the expectations.

CONCLUSION

The system consists of a motor with a worm gear, driving a planetary gear. The outer shell of the planetary gear is used as the wind-up area for the bottom-connected wire.The conclusion of the project should hopefully be a fully functioning buoy with this wind-up system, which makes it more efficient and keeps it safe during a storm. If it all works, this may become a supplement to the other sustainable energy sources such as wind and solar power.

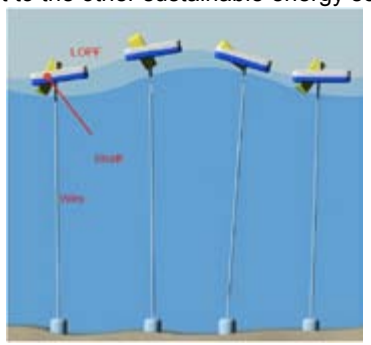

Figure 1. The movements of the LOPF in the waves

Small scale energy harvesting from water sources

Henrik Teglborg
s082629
Physics and Nanotechnology

Supervisors: Docent Erik Vilain Thomsen - DTU Nanotech
Postdoc Thomas Glasdam Jensen - DTU Nanotech

INTRODUCTION

One of the reasons I joined Physics and Nanotechnology was due to my interest in energy – and more specific energy storage. Another fascination of mine is gravity – a still not fully understood force of nature. This made me think of ways to combine these interests to harvest energy from gravity. At first I thought of retrieving energy from falling raindrops but that proved ineffective due to the small mass of a raindrop. A realistic method to harvest more energy would require more water. Then I thought of downspouts for gutters or toilets. The water flow is bigger and therefore has more kinetic energy and potentially more energy to harvest. To realize this idea I set up a 3-week special course to manufacture a device to harvest the energy and look at the efficiency.

THE SETUP

I planned this course to be an experimental course rather than theoretical. I would like to see if a model could in fact make a lamp glow or charge a battery only by water and gravity. In theory it sounds plausible, but many unforeseen factors can appear to make the idea fail completely.
Originally I had two ideas - a turbine or a watermill structure. Due to the constant pressure around us, I will continue working on the watermill structure. I will start with a small scale version – and if there is time within the 3-week period, a full scale model.
If this works then such a machine could be attached to drains/urinals/waste pipes or other vertical fluid systems.

BACHELOR LEVEL COURSE / PROJECT
FREE STYLE
WIND AND WATER ENERGY

Hydropower / Pump Storage

Victor Grabow[1], David Kovacs[1]

[1]DTU Electrical Engineering, Technical University of Denmark

INTRODUCTION

In modern society we see a growing will and need to replace carbon-emitting energy sources with sustainable solutions. A considerable part of these solutions, such as windmills, depend directly upon forces of nature. Thus, while using such energy sources, we won't necessarily see a balance between production of and consumption of electricity. Our project is to even out this unbalance by pumping water to a high place at times with excess energy on the grid, and utilize the resulting potential energy at times with low energy on the grid. Using a hydropower system in such a way is referred to as "Pump Storage".
The system we use was made by students at DTU in 2011 and is in the possession of the Department of Electrical Engineering. We wish to demonstrate a control of the system such that it produces an output at 230 V and 50 HZ +/- 10%, which is the general requirement for usual electronics. Further we wish to enhance the existing system with respect to the flow of water through the pipes and turbine from upper to lower container.

THEORY

We will use theory from fluid mechanics in order to enhance the flow of water through the system. Furthermore we will use theory from literature about control systems.

METHODS

We will work on making a model that describes the system. From this model of the physical system we wish to make a control system that accounts for the resistance connected to the generator and makes sure that a right amount of power is produced.

RESULTS

This part will contain results on improvements we have reached concerning the efficiency of the system and a description of the developed control system.

CONCLUSION

The overall point of this project is to make an efficient model-scale hydropower system that can work as a pump storage unit. This is an ongoing progress that started with students who wanted to model a hydropower system in 2011, and now in 2012, continued by this project that has made a great deal of enhancements on the existing system. In years to come further projects can be developed to make an even more efficient hydropower system that has even more uses.

The parts on Theory, Results and Conclusion will be deepened in the final abstract.

Improving modeled experiments to allow development of new catalysts

R.T. Bøggild-Povlsen[1], Ø.G. Woller[1], and P. Fristrup[2*]

[1]DTU Informatics, Technical University of Denmark
[2]DTU Chemistry, Technical University of Denmark
*pf@kemi.dtu.dk, www.organic.kemi.dtu.dk/Research/PeterFristrup

INTRODUCTION

In order to make sustainable materials like lactic acid based plastics available on a commercial scale, an efficient conversion of the bio-mass is needed. Traditionally lactic acid has been produced from sugars using fermentation, but new methods based on heterogeneous catalysts are being developed[1]. In order to improve the conversion rate, a lot of candidate catalysts need to be tested. Traditionally this has only been possible through physical experiments. In this project we have developed a method to improve the accuracy of the parameterization for a modeling technique called Reactive Force Fields (ReaxFF) that will allow these experiments to be performed on a computer rather than in a lab.

THEORY AND METHODS

A reactive force field like ReaxFF is used to calculate the most likely structure of a molecule by minimizing the energy level in the molecule. The force field is given as input the position of the atoms, but no bonds. These are instead calculated using the given parameters (e.g. the energy level of a C-C bond). The parameters as a whole define all the energy levels of the various bonds, the bond angles and torsions. A parameterization is to define all of these parameters to match the expected energy levels. The parameterization can be viewed as a vector or position in a multidimensional space. By assigning a penalty to each position in this space, we can reduce the problem to a search in the multidimensional space for the position with the lowest penalty. To do this, we use the meta-heuristic optimization called the Particle Swarm Optimization.

RESULTS

In the project we demonstrate that the optimization technique works by performing a parameterization for smaller molecules consisting only of H and C atoms. In the project we also demonstrate that the method can be extended to larger scale parameterizations and develop a parallelized version to reduce the computing time involved with running the optimization.

[1] Holm, M. S, et. al, (April 30th 2010). Conversion of Sugars to Lactic Acid Derivatives Using Hetorogeneous Zeotyp Catalysts, *Science, Vol 328,* 602-603

Nanoimprint - a green technology

Erik V Thomsen (supervisor)

DTU Nanotech, Technical University of Denmark

INTRODUCTION

Micro technology has many applications within the cleantech area. Well known examples are micro fabricated solar cells relying on silicon substrates and fabrication technologies. Such systems have been in use for many years and currently the number of systems in use in Denmark is increasing rapidly.

However, micro and nano technology can help overcome the future challenges in many other different ways. Sensing systems can increase the output of wind turbines and sensors of different kinds can help to save energy. Small Lab-on a chip devices can perform environmental analysis and detect pesticides. Other applications are energy harvesting from vibrations, which can provide energy to embedded sensing systems that can help save energy or monitor for example the conditions of wind turbines.

TOPICS ADDRESSED

This project is the collected effort from four courses at DTU Nanotech:

- 33471 Nano-3W: Experimental Micro- and Nanotechnology
- 33470 Mikro-3W: Experimental Semiconductor Technology
- 33435 LabChip-3W: Experimental Work on Lab-on-a-chip Systems
- 33422 Nanolithography

The topics addressed are:

- Carbon nanotube based system for environmental analysis
- Lab-on a chip device for pesticide detection using gold nanoparticles
- Inorganic electrets for energy harvesting devices
- Application of Colloidal Lithography for Micro-/Nano Surface Structuring
- Use of electron beam and nanoimprint lithography for cleantech

RESULTS

As the projects will be carried out in June 2012 the results cannot be presented yet. However, the results will demonstrate how useful and versatile micro and nanotechnology is.

Carbon nanotube based system for environmental analysis

Erik V Thomsen (supervisor)

DTU Nanotech, Technical University of Denmark

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BACHELOR LEVEL COURSE / PROJECT

LAPTOP

OPTIMIZATION AND SUSTAINABLE MATERIALS

Inorganic electrets for energy harvesting devices

Erik V Thomsen (supervisor)

DTU Nanotech, Technical University of Denmark

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Application of Colloidal Lithography for Micro/Nano Surface Structuring

Erik V Thomsen (supervisor)

DTU Nanotech, Technical University of Denmark

INTRODUCTION

Micro technology has many applications within the cleantech area. Well known examples are micro fabricated solar cells relying on silicon substrates and fabrication technologies. Such systems have been in use for many years and currently the number of systems in use in Denmark is increasing rapidly.

However, micro and nano technology can help overcome the future challenges in many other different ways. Sensing systems can increase the output of wind turbines and sensors of different kinds can help to save energy. Small Lab-on a chip devices can perform environmental analysis and detect pesticides. Other applications are energy harvesting from vibrations, which can provide energy to embedded sensing systems that can help save energy or monitor for example the conditions of wind turbines.

TOPICS ADDRESSED

This project is the collected effort from four courses at DTU Nanotech:

- 33471 Nano-3W: Experimental Micro- and Nanotechnology
- 33470 Mikro-3W: Experimental Semiconductor Technology
- 33435 LabChip-3W: Experimental Work on Lab-on-a-chip Systems
- 33422 Nanolithography

The topics addressed are:

- Carbon nanotube based system for environmental analysis
- Lab-on a chip device for pesticide detection using gold nanoparticles
- Inorganic electrets for energy harvesting devices
- Application of Colloidal Lithography for Micro-/Nano Surface Structuring
- Use of electron beam and nanoimprint lithography for cleantech

RESULTS

As the projects will be carried out in June 2012 the results cannot be presented yet. However, the results will demonstrate how useful and versatile micro and nanotechnology is.

Universal charging from PV

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INTRODUCTION

This project has been a part of the course 31015 Introductory project. The general purpose has been to charge a lead acid battery (12 V or 24 V) from a photovoltaic panel, by the use of a Maximum Power Point Tracking (MPPT) system and a DC/DC converter. Secondly the aim has been to investigate the need for MPPT in reference to the extra cost versus efficiency. This is done by implementing the system on a solar cell lightning column provided by the company Alfred Preiss. Thirdly the criteria of the design have been to make the system as cheap and universal as possible. Hence this PV charging system could be a **proper alternative for diesel/gas generators in countries without central power supply**. Our aim has been the African countries.

THEORY

We have primarily used skills obtained in the course, Power electronics. The first issue was to find the proper type of DC/DC converter. Our goal from the beginning was to make the converter as universal as possible. With this in mind we chose to go for the **Single-ended primary-inductor converter** (SEPIC). A SEPIC converter has the advantage of being able to boost the input voltage or to buck the input voltage, which is exactly what we had in mind for our device. Then we calculated the ideal sizes and properties of the components (inductors, capacitors, Schottky diodes and transistors) from the equations, derived from the circuit analysis and in reference to the theory of Mohan (2012).

METHODS

The SEPIC converter was built by hand step for step. Since we did not have any proper sized inductors, we made them by ourselves.
The MPPT algorithm was written in the C programming language, and was configured on the microcontroller (type of dsPIC3F) by a PICkit device.

RESULTS

Results obtained from the first test drive on the 20th of April 2012.
The test was performed with a regular power supply instead of the actual PV. For seven different input voltages and currents the **average efficiency of the device was 87 %** (our goal 75 – 85 %).

CONCLUSION

So far the device has been working with a higher efficiency than expected, though these results have been obtained with a “false” PV panel. The final results will be obtained in the three-week period in June. Regarding the final results we will hopefully be able to present these on the 22th of June.

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Aerodynamic Truck

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Introduction

A large part of today's transportation of cargo is carried by trucks. In recent years focus has been on optimizing the front end of the truck, and great advances in aerodynamics have been obtained. However, there has been almost no development on the rear of the trailer, which takes up a large part of the drag, due to the turbulent wave it creates behind. Our question; Is there a smart way of letting the air leave the back of the truck, that reduces the total drag, and thereby reduces the fuel consumption and environmental impact? Many creative models have been tested in wind tunnel, and we have come up with a solution that is both practical and very fuel efficient. Our design proposal is estimated to make a total reduction of drag coefficient by around 10%, estimated to give around a 5 % reduction in fuel consumption. With all international trucks fitted with our arrangement, a substantial reduction in the CO_2 emission from long range vehicle transportation can be made possible.

Research

Hours have been spent on idea development, planning and execution of wind tunnel tests. Studies of test data results were performed, and a clear picture of the factors affecting the drag was uncovered. The next step, which might be almost as important, was how to attach the product on to the truck. Both government and EU regulations, but also preferences and restrictions from the cargo carriers had to be taken into account. Many green eco-friendly products fail because of lack of usability and durability. A complicated, inconvenient and troubleful design might quickly be phased out due to the problems it would bring to the operation. We have held interviews with carriers having hands-on experience with operation and loading of trucks to assist us in taking the correct design choices.

The Tail Design

We have come up with an easy to implement, easy to operate system of aerodynamic doors, directly attachable on existing trucks doors. Our findings from the wind tunnel tests showed that plates placed in an accurate angle would delay separation of air behind the truck, reducing the drag significantly. The tests showed that the optimal shape of the tail was a complicated cone, but that the effectiveness of the tail was reduced marginally when approximating the shape with a much easier to create edged design. The stress on the tail is very low, making it possible to use simple materials and manufacturing processes, altogether making the environmental impact on production minimal.

Conclusion

We can conclude that it is both possible and favorable to implement this kind of drag enhancement on today's long range trucks. The advantage is the simple design, simple implementation and simple operation with surprisingly great effect. 15 years ago, no trucks drove with an aerodynamic 'hat' on the drivers cabin, we hope that 5 years from now, no long range truck drives without an aerodynamic tail.

Design of a new concept of product tanker

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General Descriptions

The vessel is built to answer to a continue request of energy-saving and less CO2 emission way of oil transport in the market trend. The Product Tanker with twin podded propulsion alimentated by diesel gensets, respecting the actual TIER. The main features in the design and construction are pointed to a higher safety, less EEDI final index and to less initial and maintenance costs. Due to the common shipyard elevation capacity (supposing a crane which can lift objects weighing 2000 tons, at 20-33 m outreach at 70m elevation and 50tons at 95 m outreach and 43 m elevation), the vessel has to be built in 6 separated main blocks. A continuous single deck from fore to aft is located at D=19m. Twelve (12) cargo tanks of about 22 m length are provided, answering to the request of 55000 m. of liquid with a Cargo specific gravity 0.85 ton/m.. A single accommodation block is located before the cargo tanks, with five decks, 22 cabins and a wheelhouse offering all-round vision located above and after. To ensure safe and good maneuverability characteristic, also having a double podded propulsion, a bow thruster is provided in the forward part. Seven main corrugated transverse bulkheads subdividing the hull below main deck. MDO tank arranged in a side of engine room longitudinal position.

Principle Dimensions and Characteristics

Length Overall LOA : 182.000 m
Length of Waterline (Summer) LWL : 176.100 m
Length between perpendicular LPP : 166.450 m
Length of Subdivision : Approx. 30.000 m
Moulded Breadth B : 32.200 m
Depth D : 19.000 m
Design Draft (Scantling) T : 12.000 m
Summer Draft Ts : 11.990 m
Design Draft Td : 11.900 m
Total Block Coefficient at Td Cb : 0.814
Cargo Tank Capacity about : 56000 m.
Slope Tank Capacity about : 2000 m.

Speed and Endurance

The service speed of about 14 knots in deep and calm weather (Smooth sea with wind force not exceeding Beaufort scale 2) with no current presence.

Propulsion and Maneuvering System

- Podded Propulsion : Approx. 2 * 6000 kw
- Bow Thruster: One (1) Tunnel thruster L-Drive 1100 HP, 66 inch od diameter

Conclusions

The project have developed a new tanker concept, which could be collocate in the actual market situation. An analysis of the last market trend and oil prices have been made to take in account of the possibility and feasibility of the designed construction. The final result is that if new propulsion characteristic are provided, this new product tanker type could be seen as a way to save money in the the liquid transport market and therefore also in oil one.

A new and greener alternative to public transport in Copenhagen

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INTRODUCTION

Traffic is increasing, and within recent years the Danish governments has been focusing more on reducing the traffic in the Copenhagen Region and thereby reducing CO2-emissions from private transport. The Danish parliament passed in to 2009 an agreement called "En grøn trafikpolitik", here it was determined that reduction in CO2-emissions were to be achieved by getting more motorists to use public transport and thereby reducing the traffic and pollution in Copenhagen. To achieve this requires an efficient and reliable public transport that gives users a high level of service.

Benefits of light rail in public transport

This project examines how the implementation of light rail in Copenhagen and the surrounding municipalities can have a positive effect on travel time spent in the Copenhagen Region. Light rail is primarily powered by electricity, making it possible to operate them with renewable energy rather than fossil fuels, which today is the primary energy source for buses. Studies from the French city of Angers, shows that CO2-emissions from light rail can be brought down to 2.4 grams of CO2 per passengerkilometre, when light rail is powered by renewable energy. For comparison, the busiest bus line in Copenhagen 5A, emits 85 grams of CO2 per passengerkilometre and a Chevrolet Spark, the best selling car in Denmark in 2011, emits 90 grams of CO2 pr. passengerkilometre under the assumption of an occupancy of 1.3 persons per car. These comparisons show that there are significant environmental benefits from the use of light rail over buses and private cars.

To evaluate the effects of light rail in Inner and Outer Copenhagen, several different projects have been studied. These studies are based on route calculations to estimate the changes in the transport patterns with the implementation of different light rail systems. Furthermore, the results of the route calculations are used for economic analysis and to assess the profitability of the light rail projects.
The projected light rail systems all have the same objective of improving the public transport, reducing travel times and move travellers from cars to public transport and thereby reducing the overall CO2-emissions. Results of route calculations and economic analysis will be presented at conference, along with the expected improvements to the environment, globally and as well as locally.

Environmental Impact Associated with Unsolicited Mail

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INTRODUCTION

The project was formulated in collaboration with the campaign ”Reklamer Ja Tak” and the purpose of the project is to study how unsolicited mail affects the environment.

A study was conducted based on three environmental myths, in which The Graphic Association of Denmark’s (GA) environmental campaign was based on. The aim is therefore to study the validity of the 3 myths about the environment and unsolicited mail as well as the related claims. Additionally the environmental effect of the electronic alternatives where studied. Furthermore the environmental impact from unsolicited mail and that from the electronic alternatives were compared, in order to assess whether there is an environmental benefit by using the electronic alternatives.

The three aspects discussed in connection with the three myths are:

1. Does paper production cause an environmental burden on the forest?
2. Is there an environmental burden associated with unsolicited mail?
3. The environmental benefits related to the disposal of unsolicited mail.

METHOD

The evidence of the myths where analyzed and compared with other analyzes regarding the unsolicited mail’s impact on environment and climate. The electronic alternative is also analyzed based on current knowledge.

RESULT

It is not sufficient to only account for the extent and development of forestland to conclude whether paper production has a burden on the forests, as this is a complex issue requiring the involvement of many elements. Sustainable forest management includes these elements. However, it has not been possible with the available data to conclude whether Swedish, Finnish or European forests are sustainable. GA changed their climate campaign and replaced "sustainable forestry", with "well-managed forestry", this weakens the myth since well-managed forestry only implies that the forest is subjected to a forest management plan. In Europe, 92% of forest area is subjected to forest management plans.

Production of unsolicited mail involves the use of paper, chemicals, energy and transport, therefore a certain amount of environmental impact is anticipated. Based on the two Life Cycle Assessments (LCA) (Pihkola et al., 2010) and (Larsen et al., 2006), it has been possible to assess the extent of the environmental impacts caused by the annual amount of mails a Danish household received in 2010 (55 kg). It is estimated to be in the range of 50-55 mPE and 70-75 kg CO_2eq regarding the CO_2 emission.

In Denmark, unsolicited mail are used as a resource in both the recycled products and energy production, however, recovered papers in the form of used mail is considered as being of inferior quality due to the amount of ink. 60-70% of the mails are recycled and approximately 28-32% is incinerated. When reused, which can be done up to 7 times, it is possible to produce egg boxes, toilet paper, etc. According to Sanchez and Møller (2011) and Larsen et al. (2010) the benefits of recycling and incineration does not outweigh the environmental burden caused by unsolicited mail. Therefore the production of unsolicited mail is not environmentally beneficial, but involves an environmental impact and consumption of renewable and non-renewable resources.

Deselecting the unsolicited mail can lead some consumers to seek information elsewhere, such as the Internet. According to Sanchez and Møller (2011), though subjected to some uncertainty, if the unsolicited mails are replaced with electronic mails there is an environmental benefit.

The campaign ”Reklamer Ja Tak” has, since the beginning of this project, worked hard towards a change in the current system and this project has provided them with solid arguments for why a change is necessary to reduce the amount of resources and the environmental impact from the unsolicited mail, furthermore the report has concluded that an internet based alternative is the favorite option.

Furthermore the government will now according to the government platform investigate the feasibility of establishing a “Ja tak til reklamer” system.

Storm water handling and flood prevention for community leaders

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CONCEPT

Many Informal settlements experience issues with flooding due to seasonal rain. This has strong negative implication on way of life and also has negative impact on the environment. In certain situations the problem can be alleviated by managing runoff/storm water in the local area.
Sustainable interventions should involve the municipality and/or the local community but due to e.g. the informal nature of the settlements the municipality cannot always get involved.
The purpose of this project is to compile a manual of flood prevention/alleviation interventions that can be executed by the communities in the informal settlements.

The manual restricts itself to simple solution and to a large extent adopts the ideals of SUDS. Thus this manual will not only help to prevent the negative environmental impacts of flooding but it will help to implement more sustainable ways to handle storm water.

Where possible the water will be used to recharge groundwater, grow greenery and supply household with water collected from rooftops. Any solution will be under close scrutiny as to it not causing environmental harm (e.g. contaminates groundwater) or harm to way of life.

BACKGROUND

The manual is intended for Shack Dwellers International (SDI) which is an organization that manages networks of Shack dwellers on a word-wide basis. If the manual is found to be successful it can be recompiled and redistributed to other organizations. The manual is being written as a project under Engineers Without Boarders (EWB) in Cape Town. The manual is DTU project work of David Jonathan Jensen.

MANUAL OUTLINE

The manual will be 8 to 10 pages easily understandable and illustrated. It will be translated into relevant languages (Xhosa, Africans)

Page 1: Information on why it is important to make interventions against flooding. This information is intended to invoke community leaders to get projects going. It is also of use for community leaders when looking to get the entire Community involved.

Page 2: Background on why flooding occurs in form of understandable theory on storm water and runoff. This information will be presented in relation to informal settlements

Page 2-4: An introduction to a project cycle and which steeps to take before construction of an intervention.

Page 4-10: Contains the DIY (Do it yourself) manual part and will be very much like any other handyman manual.

The Reverse Osmosis Concentrate from Water Reuse Process and its Treatment Technologies

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ABSTRACT

The global demand for the fresh water is ever increasing. One solution can be the production of reuse water from wastewater treatment plants. To meet the strict standards for the reuse water, advanced wastewater treatment is necessary. Among the tertiary processes to produce reuse-able water, reverse osmosis has a high potential for its advantages in module construction, small carbon footprint, and requirement of relatively simple process. However this process has a problem of producing concentrate, is very detrimental to the environment if disposed without treatment.

The important characteristics of the RO concentrate are high pollutant load, such as COD, nitrogen, and phosphorus. The Advanced Oxidation Processes may be advantageous for the dissolved organic carbon, for example, ozonation, photo-catalysis, sonolysis and electrochemical oxidation. Among these technologies, electrochemical oxidation has the highest potential for the future for its highest accomplished efficiency and increased energy efficiency due to saline RO concentrate.

The RO concentrate also has potential for the future source of nutrient and salt ions. However its economic advantage must be studied. The treatability of RO concentrate has been focused on dissolved organic carbon. However, nitrogen and phosphorus concentration in the brine are also very significant and thus need to be studied extensively.

In KAIST, there are some research studies to produce reuse-able water and treat the RO concentrate. One is denitrification of the concentrate using membrane biological reactor. Another is reduction of nitrate by using nano-scale zero valent iron parties. There is also another research to understand the impact of salinity on the performance of biological process of the RO concentrate.

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Plastic on the Beach

Andreas Libonati Brock and Ditte Marie Reinholdt Jensen

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Plastic is an organic polymer used for many different products and purposes in modern society. In 2009, 230 million tonnes were produced globally. Many of the additives used in plastic, such as heavy metals, bisphenol A, polybrominated and chlorinated biphenyls are toxic to the environment and also contribute to the persistency of the plastic products.

The governing degradation of plastic is a photochemical process, which is oppressed in the sea since the water shields the plastic from the UV-rays from the sun. This leads to an accumulation of plastic particles and fragments that may create mechanical problems for marine animals as well as induce the leakage of additives. Persistent organic pollutants (POPs) can also sorb to the particles and be released when ingested. So far 267 different species have been proven affected by the marine plastic pollution.

In this study we set out to quantify the amount of macro plastic fragments and microscopic plastic particles in a series of Danish beaches on the northern coast of Zealand. Three beaches (Charlottenlund Fort, Vedbæk Strand and Helsingør Strand) were examined for macro litter using guidelines standardized by UNEP. Sediment samples from six beaches (Dragør Strand, Charlottenlund Fort, Vedbæk Strand, Nivå Strand, Espergærde Strand and Helsingør Strand) were examined for micro particles using density separation with a Sodium PolyTungstate solution and a microscope analysis.

In our study of macro litter we found a total of 368 fragments on 11,230 m^2 divided over the three beaches. Of these 86.8% were plastic litter fragments, whereas worldwide the percentage is between 60% and 80%. Most of the litter had been left in situ and not deposited by ocean currents. In our pilot study of microscopic plastic particles on the six beaches, we found an average of 6 particles per surface sample and 5 particles per core sample (each consisting of approximately 200 g of sediment).

Both of our studies showed a somewhat higher amount of plastic fragments/particles compared to international studies, which might be due to the season (for the macro investigation) and the use of Sodium PolyTungstate instead of a high saline solution (for the micro investigation).

Fermentation of Sugarcane Bagasse Hydrolysate by a widely used Brazilian Industrial Yeast Strain

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[2]Novozymes LA

A considerable effort in research and development has been allocated worldwide in the bioethanol industry in order to convert lignocellulosic sugars from biomass into biofuels. In Brazil the main source of raw material comes from sugarcane plants and much research has been directed towards sugarcane bagasse utilization. Brazil is the world's greatest exporter of fuel ethanol and together with USA (the biggest producer) detains 70% of the production worldwide. Utilization of bagasse-derived sugars would certainly result in a significant advance for this industry and would also bring many savings to the environment.

The sugarcane bagasse is rich in sugars, including pentoses, and is currently the focus of diverse research projects in major scientific poles, however industrially significant ethanol production based on the bagasse has not yet been achieved. As the sugar in the bagasse is mostly stored as cellulose and hemicellulose, many steps are necessary to process it down to fermentable sugars prior to fermentation, such as enzymatic hydrolysis.

Industrial ethanol fermentation is performed using robust *S. cerevisiae* strains, among others CAT-1 strain. This strain was recently sequenced and it has been proved to be very resistant to the harsh environment within the fermenter, where there is constant stress due to low pH, high osmotic pressure, high temperature, contamination and many others. Together with strain PE-2 they represent 70-80% of the commercialized industrial strains for fuel ethanol in Brazil.

In this project we have investigated the susceptibility of CAT-1 strain towards acetic acid, one of the most abundant growth inhibitors present in lignocellulosic hydrolysates. Shake flasks fermentations were performed with different concentrations of acetic acid in standard laboratory media (YPD) and cell viability, growth rate and product yields were analyzed.

Fermentations of eight different sugarcane bagasse hydrolysates were also executed and the performance of CAT-1 was investigated with respect to cell viability, growth rate and product yields. The bagasse came from five different sources and received different pretreatments, and hydrolysis were performed using Novozymes enzymes prior to fermentation. We expect that the results obtained in this project might be useful to assess the decision making process on which hydrolysis conditions would be optimum to the following fermentation step in an industrial scenario.

Soak aways and local storm water drainage

J. W. Pedersen, and N. S. V. Lund

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As a result of climate changes we are experiencing more and more heavy rainfalls as we have seen in Copenhagen the last couple of years. These rainfalls cause great damage on low-lying areas. The sewerage systems in Denmark are not build to handle extreme amounts of rain and therefore we have to come up with an alternative solution. One solution is to use local storm water drainage such as soak aways. This project aims to model how three specifically chosen soak aways handle and hold back rainwater. The project is made in cooperation with Orbicon, Avedøre Spildevandscenter and Rudersdal Kommune.

Efficient Nonlinear Fibers for Fiber Optical Parametric Amplifiers

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INTRODUCTION

Within our modern society we are all continuously requesting more and more capacity in communication systems. Consequently, research within components for future communications systems have, until this point in time, focused on components that secure the possibility of supporting the request for a continued increases in needed capacity.

An important, optical component is the optical amplifier. Based on a demand for capacity, Raman amplifiers and fiber optical parametric amplifiers (FOPAs) that may provide gain at a broader range of wavelengths compared to conventional optical amplifiers based on rare-earth-doped fiber materials, and in addition offer an improved noise performance, are currently very popular. Improved properties are achieved by neglecting the energy efficiency of the amplifiers though.

OUR PROJECT

In this work we focus on the fiber used in the parametric amplifier, see figure 1. The two important fiber parameters are the nonlinear coefficient and the loss. In general, the higher nonlinear coefficient the better, however materials with a larger nonlinearity also exhibit a larger loss.

We consider various proposals for fibers and use numerical calculations to try and optimize the fiber such that the amplifier requires less energy for the same amplification.

LCA	Materials	Production	Use	Disposal
Materials		x		
Energy			x	
Chemistry				
Other				

Table 1 Life Cycle Check table for the project.

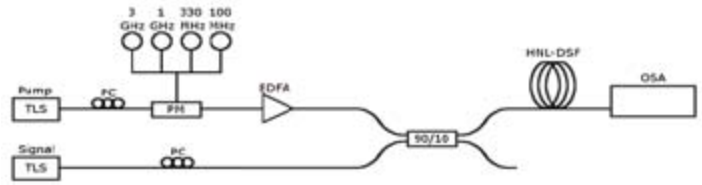

Figure 1 Fiber optical parametric amplifier

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Efficient Raman Amplifiers for Amplification in Optical Communication Systems

K. Ingerslev, J. B. Christensen, L. Jelver, L. Mejling, and K. Rottwitt

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INTRODUCTION

Within our modern society we are all continuously requesting more and more capacity in communication systems as for example more and more consumers use the internet in developing countries and as more and more internet services are becoming available. Consequently, research within components for future communications systems have, until this point in time, focused on components that secure the possibility of supporting the request for a continued increases in needed capacity.

An important, optical component is the optical amplifier, and research within the last decade has focused on optical amplifiers that support increased capacity for example Raman amplifiers and fiber optical parametric amplifiers (FOPAs) that may provide gain at a broader range of wavelengths compared to conventional optical amplifiers based on rare-earth-doped fiber materials, and in addition offer an improved noise performance. These improved properties are achieved by neglecting the energy efficiency of the amplifiers. In simple designs only optimized for capacity, the conventional rare-earth-doped fiber amplifiers provide a gain of a few tens of dB for tens of milliwatts of pump power where a Raman amplifier requires watts of pump power to supply a similar gain.

In the future there is an obvious need not only to be concerned about the capacity but also to address the energy efficiency of optical fiber amplifiers. This includes the amplifier configuration as well as the fiber used.

OUR PROJECT

In this work we focus on the amplifier configuration. We evaluate the quantum efficiency and discuss how close different amplifier configurations are to this limit. We evaluate and discuss the benefit of using a so-called multipass Raman amplifier.

We consider various proposals for the amplifier and optimize the fiber used in the Raman amplifier such that the amplifier requires less energy for the same amplification and without introducing excessive noise. The amplifiers will be simulated in Matlab.

LCA	Materials	Production	Use	Disposal
Materials		x		
Energy			x	

Table 1 Life Cycle Check table for the project.

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BACHELOR LEVEL COURSE / PROJECT
POSTER
ENERGY DISTRIBUTION, EFFICIENCY AND TECHNOLOGIES

Efficient Raman Amplifiers and Fibers for Amplification in Optical Communication Systems

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INTRODUCTION

Within our modern society we are all continuously requesting more and more capacity in communication systems. This is for example due to increased internet traffic where more and more consumers use the internet in developing countries and in addition more and more services are becoming available. Consequently, research within components for future communications systems have, until this point in time, focused on components that secure the possibility of supporting the request for a continued increase in needed capacity.

An important, optical component is the optical amplifier, and research within the last decade has focused on optical amplifiers that support increased capacity for example Raman amplifiers that may provide gain at a broader range of wavelengths compared to conventional optical amplifiers based on rare-earth-doped fiber materials, and in addition offer an improved noise performance. This is achieved by neglecting the energy efficiency of the amplifiers. In simple designs optimized for capacity, the conventional rare-earth-doped fiber amplifiers provide a gain of a few tens of dB for tens of mW of pump power where a Raman amplifier requires watts of pump power to supply a similar gain. One reason for this is that only a fraction of the pump power is used because for low pump power the noise performance in general is degraded, unless novel amplifier configurations are developed.

In the future there is an obvious need not only to be concerned about the capacity but also to address the energy efficiency of optical fiber amplifiers. This includes the amplifier configuration as well as the fiber used.

OUR PROJECT

In this work we focus on the amplifier configuration. We evaluate the quantum efficiency and discuss how close different amplifier configurations are to this limit. We evaluate and discuss the benefit of using a so-called multipass Raman amplifier.

We consider various proposals for the amplifier and optimize the fiber used in the Raman amplifier such that the amplifier requires less energy for the same amplification and without introducing excessive noise. The two important fiber parameters are the Raman gain coefficient and the loss. In general, the higher Raman gain coefficient the better, however materials with a large Raman gain coefficient have a large loss. We will evaluate the energy efficiency of different commercial fibers and discuss optimized fiber designs. The amplifiers will be simulated in Matlab.

LCA	Materials	Production	Use	Disposal
Materials		x		
Energy			x	
Chemistry				
Other				

Table 1 Life Cycle Check table for the project.

A first zero – net energy consumption building for DTU

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INTRODUCTION

Many innovations that turned out to be crucial for sustainable future have sprouted out from academia's grounds. On the other, universities do surprisingly little to be sustainable communities themselves. For instance DTU policy does not require new campus buildings to be low-energy consumption structures (building energy frame 2020). How great it would be if sustainable ideas could be inspired by everyday work place? Following that, an alternative solution is presented: a first zero-net energy building for DTU that would accommodate student of Building Design bachelor. A hidden agenda is to convince that eco-friendly architecture can be fully functional, attractive and suitable for teaching purposes and that in the long term such architecture can stimulate more sustainable lifestyle.

INTEGRATED DESIGN

The design style adopted in our work is referred as an integrated design process. This innovative approach from the very beginning involves multidisciplinary consultants: architects, indoor environment experts and civil engineers. Hence, the concept arises as a consensus between domains that are often contradictory. Computer simulations, mainly on building energy performance, are actively used to support decision-making process.
In result none of the key matter are compromised in our project. The fields that were taken under consideration include: total building energy consumption, building functionality and architectural quality, indoor environment, daylight work conditions, integration of energy saving and energy producing building technologies, sustainable construction solutions, socio-urban campus needs.

OUTCOME

The design outcome is a complete building concept. Not only it doesn't consume any energy – it is fully functional and visually appealing. Excellent working environment is established for all users (space flexibility, air quality, daylight conditions). The zero-net energy consumption was archived by passive means: suitable space design (rooms size and location, enhanced natural ventilation, building insulation) and by active means: wide range of technologies (solar panels, heat recuperation technologies, thermal active slabs). The building itself has minimized embodied energy due to the structural solutions adopted. Furthermore, this initiative would enhance the sense of academic community. Structure is interactive and animates campus life. For instance, stakeholders would be invited to come up with the design proposals for the outdoor workshop. More public space is predicted hence the campus becomes more accessible for pedestrians and bikes and less for cars, in fact encouraging more sustainable lifestyle.

CONCLUSIONS

The project proves that if certain working regime is adopted, functional and sustainable college buildings can be created. Such project could stimulate creativity, sustainable lifestyle and raise one's environmental awareness. It is hoped that this initiative will encourage academic authorities to intensify efforts to become truly sustainable academic community.

BACHELOR LEVEL COURSE / PROJECT
POSTER
ENERGY IN BUILDINGS

Building Energy Design Improvements in Cold Regions

L.H. Nielsen[1], J. Madsen[1], and S. Pavic[1]

[1]DTU Civil Engineering, Technical University of Denmark

INTRODUCTION

From the year of 2035, the building stock in Denmark has to be CO_2 neutral, which puts strict demands on energy consumption in buildings - new as old.
Nearly 40% of our total energy consumption in Denmark goes to the existing building stock.

Together that calls for a need of energy optimizations. Especially in the large stock of single-family houses from the 60-70s, there is an inevitable need for energy renovation in the near future.

Due to the strict requirements in energy renovation of buildings, it is very obvious to investigate alternative methods to optimize energy consumption.

During an exchange program on the C9-university, Harbin Institute of Technology, China, there is a unique opportunity to research on Chinese initiatives upon energy optimization and improvements in the building industry. This research is certainly a very useful inspiration for innovative actions against finding the most sustainable solutions which both optimize the energy consumption but also improves the indoor environment and well-being of the users.

The project will introduce knowledge about Chinese technology. Primarily within the building envelope design and focus on new building materials, usage of low-emission glass and external sun shading curtain.

This cooperation is a fundamental in a highly demanded technology exchange between China and Denmark.

Use of GRP in Daylight Façade Panels

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INTRODUCTION

Due to the strict requirements in energy renovation of buildings, it is very obvious to investigate alternative methods to optimize energy consumption. Fibreglass panels can be used as a façade cladding, with good heat accumulability. By utilizing the sun's heat radiation on facades of small buildings, the heat accumulated result in a higher temperature on the outer edge, and the consumption requirements of insulation can be reduced.

Theory

From the year of 2035, the building stock in Denmark has to be CO2 neutral, which puts strict demands on energy consumption in buildings - new as old.
Nearly 40% of our total energy consumption in Denmark goes to the existing building stock.

Together that calls for a need of energy optimizations. Especially in the large stock of single-family houses from the 60-70s, there is an inevitable need for energy renovation in the near future.

Energy renovations are mostly done, by improving the building's heat loss through increased insulation. With the Danish Building Regulations of 2020's strict requirements for energy improvements, this often results in thicker outer walls, which can be significant disadvantages to the existing construction. Roof overhang, the building footprint and window holes can be negatively affected. The building owner as well as architects, therefore seeks after alternative methods for energy renovations that do not compromise the building's expression.

Such an alternative can be the so-called daylight walls, derived from the theory behind solar walls. Together with the extra insulation, a translucent façade can be mounted. As the sun warms up the unventilated air gap behind the translucent plate during the day, it increases the temperature of the unventilated air gap behind the plate. The outer surface temperature of the insulation increases, and the insulation thickness can be reduced. The daylight walls are often clad with glass, but this project aims to prove that other translucent materials can be used.

Using fibreglass reinforced plastic as the translucent layer, results in a more insulating layer than glass, is more resistant to weather and wind, is fire resistant and also has a remarkable static property so the panels can cover large areas. The accumulative property of fibreglass panels results in a reduced amount of insulation thickness. Energy renovations may become more attractive to house owners, and together we can achieve the target for 2035 faster.

BACHELOR LEVEL COURSE / PROJECT
POSTER
ENERGY IN BUILDINGS

Personal Daylight

J.M. Pærregaard and N.H. Tofting

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INTRODUCTION

Of the buildings designed according to the Danish standardized regulations (BR08), reference year 2008, approximately 70% of the energy consumption is due to electrical powered installations, where as artificial lighting accounts for 20-30%. Heating consists of less than 30%.

This study offers a conceptual solution, which adds value to its users and investors, moreover reducing artificial lighting whilst securing better lighting conditions, in shape of more moderate and consistent daylight distribution.

- A daylight system installed into both new and existing constructions

THEORY

Daylight is collected and lead through the façade via light tunnels and divided into independent ceiling cells. From the cells, the daylight is distributed through two perforated panel, allowing only a certain amount of daylight to pass. The panels are mechanically adjusted by a photovoltaic powered motor, which slides the top panel to secure a distribution value ranging from 100 to 0 percent.
Workzones are established with sensors to measure current light values. From software the user's position is determined and preprogrammed preferred daylight-values are maintained.

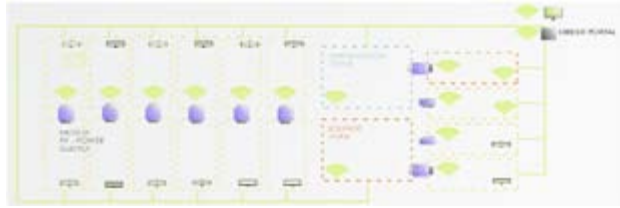

Figure 1 – Wireless system communication map

METHODS

Computer simulation – using a 1:1 virtual environment

Software used for geometric studies: Daylight Visualizer version 2.6
Software used for daylight measurements: IES – Integrated Environmental Solutions

RESULTS

Reference day: Overcast 12am 1. June – destination: Copenhagen
Average lux-value: 388
Max deviation: 13.35%

Overall artificial lighting reduction (7am-7pm): 63%

CONCLUSION

This concept delivers a significant reduction in artificial lighting. Further studies might indicate that less unwanted heating is generated, improved work efficiency is gained and better health conditions among users are achieved.

Involvement and communication with citizens about waste

Charlotte Harritshøj Frausing and Maria Jeanine Annel

DTU Environment, Technical University of Denmark

INTRODUCTION

As focus on waste sorting and recycling of materials increases it is important to encourage citizens to participate and sort the waste in their house. This project will through a qualitative analysis analyse how mediation in sorting household waste is as tailored to the individual citizen as possible. Our partner is Miljøpunkt Nørrebro and the user group for the studies is citizens of Wesselsgade.

THEORY

Human behaviour is investigated in order to understand the motives and motivations resulting in citizen action. For the study of communication and motivation, key words are: citizen involvement, theories of learning and learning styles, and the "myth of information". It is assumed that motivation for sorting waste is divided into three categories: emotion, intellect and instinct. Involvement of citizens and the individual role is an important key to understanding how to address information regarding sorting and handling of waste.

METHODS

A series of interviews in the user group are performed and then analysed. Thereby the differences in information and involvement between the two sides of the street are discovered. The even-numbered side of the street has access to expanded waste sorting (according to Nørrebro wastemodel), and the odd-numbered side has regular access to disposal of waste. Furthermore, examples of well-functional cases with expanded waste sorting in other municipalities are described.

RESULTS

Based on the interviews, the cases and the analysis, a list of recommendations for communication and information is issued to Miljøpunkt Nørrebro. This concludes which type(s) of information that could be the most appropriate way to inform citizen about "Den Talende Miljøstation" and waste sorting in general. The preferred category of information is based on instinct, meaning easy understandable and visually explained, with short description of further handling.

Figure 1 How to sort your waste correctly

Efficient Fiber Optical Parametric Amplifiers for Amplification in Optical Communication Systems

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INTRODUCTION

Within our modern society we are all continuously requesting more and more capacity in communication systems. This is for example due to increased internet traffic caused by an increasing number of consumers of the internet in developing countries but also due to more services that are becoming available. Consequently, research within components for future communications systems have, until this point in time, focused on components that secure the possibility of supporting the request for a continued increases in needed capacity.

An important, optical component is the optical amplifier, and research within the last decade has focused on optical amplifiers that support increased capacity for example Raman amplifiers and fiber optical parametric amplifiers (FOPAs) that may provide gain at a broader range of wavelengths compared to conventional optical amplifiers based on rare-earth-doped fiber materials, and in addition offer an improved noise performance. These improved properties are achieved by neglecting the energy efficiency of the amplifiers. In simple designs only optimized for capacity, the conventional rare-earth-doped fiber amplifiers provide a gain of a few tens of dB for tens of milliwatts of pump power where a Raman amplifier requires watts of pump power to supply a similar gain. One reason for this is that only a fraction of the pump power is used because for low pump power the noise performance in general is degraded, unless novel amplifier configurations are developed.

In the future there is an obvious need not only to be concerned about the capacity but also to address the energy efficiency of optical fiber amplifiers. This includes the amplifier configuration as well as the fiber used.

OUR PROJECT

In this work we focus on the amplifier configuration. We evaluate the quantum efficiency and discuss how close different amplifier configurations are to this limit. We evaluate and discuss the benefit of using a so-called fiber optic parametric amplifier (FOPA).

We consider various proposals for fibers and the amplifier and use numerical calculations to try and optimize the amplifier such that it requires less energy for the same amplification.

LCA	Materials	Production	Use	Disposal
Materials		x		
Energy			x	
Chemistry				
Other				

Table 1 Life Cycle Check table for the project.

Bio-Based Production of Advanced Materials

Anders Bech Bruntse, and Casper Nørskov Enghuus

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In 2009, Angela Belcher's research group published a paper on self-assembly at the nano-scale. They used M13 phages as a mean to fabricate biologic, genetically engineered, high-power lithium-ion batteries. They used what we consider to be a brute-force engineering approach. Their method consisted of subjectively manufacturing a phage library where the pIII or pVIII surface proteins have an insertion sequence, consisting of identical amino acids. Using a phage display she was able to select a single phage with the highest binding affinity towards various inorganic materials. To create "evolution" on her sample, she modified the insertion sequence by changing every other amino acid with a different, yet homologous one. Her research indicates that the biochemical proteins have the ability to bind any compound, as long as proteins are taught through evolution. Due to continuous, extensive artificial synthesis of new insertion sequences and the subjectivity of her method, we doubt if Belcher's strategy is the most efficient approach as she limit the degree of evolution due to the restricted variation– compared to the possible biological diversity.

An evolutionary strategy would be to create a random, objective protein variation followed by a selection in a cyclical process, until a sufficiently effective property is achieved. Site-directed evolution, a synthetic method for DNA-variation in isolated regions has somewhat addressed the issue. However, any approach based on synthetic biology implies completely random mutations whereas real evolution converges towards an optimal solution.

Being able to apply a site-directed evolutionary step directly to a phage may prove a fast, cost-effective, and environmentally friendly method to optimize phage surface-proteins to bind to chosen compounds. We thus seek to introduce a new PCR strategy, the Variation of Isolated Regions PCR, able to introduce site directed evolution during PCR.

Our proposed method is further improvement of Belchers methods based on self-assembling biological proteins by combining this with a series of well-established biological reactions, several used for a different purpose than intended by established microbiological protocols. According to Lars Jelsbak Associate Professor, DTU Systems Biology, it is highly probable that the combination of steps will be successful, as each single-step of our 6-step method is experimentally confirmed. A proof-of-concept for the method will be undertaken in July 2012.

The method enables using phages, as well as other biological systems, for self-assembly of nano-scale materials. This creates enormous perspectives as it provides the opportunity for creating simpler, smaller, and better structures. Self-assembly simplifies the building process, reduces the labor required, and the risk of errors. The size of nano-scale structures reduces unnecessary use of materials, creating a product with the same function, but at an extremely reduced scale. The structures have also been experimentally verified to have amplified physical and chemical properties, for instance, phages assembled into nano-scale, dye-based solar cells are highly efficient, increasing efficiency by 30% compared to its normal sized, dye-based counterpart.

A further advantage of the evolutionary biotechnological approach in creating materials is that proteins can be adapted to non-covalently bind inorganic compounds. Several of the interactions created through Belcher's experiments were not known to ever have existed in nature. This enables the possibility of creating new enzymes and proteins that can be adapted to creating non-organic, value-added compounds in biorefining, thus leading to a move away the petroleum based refinery with its non-renewable or toxic chemicals.

In conclusion, our method is highly probable to be successful and serves as a platform for evolution-based and optimized, biological nano-materials for high-performance applications. The method has a minimal impact on the environment and is both fast and cost-effective. In addition, it can be applied to many areas of biotechnology for additional uses.

Bio-inspired Sunlight Collection

***K. Bjarklev*[1]**

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INTRODUCTION

Much of the indoor illumination happens at daytime, which means that the sunlight is not used optimally. The sun would be able to supply enough light in most cases, so there would be much to gain in respect of reducing CO_2-emissions, if this light could be collected more efficiently.

Today many houses and office buildings are constructed in a way, so it is not possible to use the full potential of the outdoors light. In many cases, this means that electrical light must be used to get enough illumination indoors, though it might be midday and the sun is at its brightest.

The goal will be to design a low-price collector that gathers sunlight at one point, independently of the direction of the sun.

THEORY

This project has been based on the bio-inspired design approach, where inspiration from biological phenomena is used, so that it takes advantage of the millions of years of trial and error that has happened in nature.

METHOD

The method to carry out the bio-inspired design was the problem solving top-down approach. The method chosen divides the design process in various steps, focusing on processing biological phenomena, so that the best ones can be chosen, and later these mechanisms are synthesized in one concept; this method has been suggested by T. Lenau et al. (2010).

RESULTS AND FURTHER WORK

The result reached at this moment is a design concept, based on a combination of the constructions of the eyes of a deep-sea shrimp and that of a cephalopod. Simple models have been built, which have shown that each part of the concept is likely to function. The further proceeding of this project will be building a throughout model, that proves that the complete construction will be able to focus light in a single point independently of the position of the sun.

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Geothermal heat pump combined with a hybrid solar energy system

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This project focuses on optimization of the thermal part of a geothermal heat pump which is supplemented by a solar energy system that produces both electricity and heat.

The geothermal or ground source heat pump consists (GSHP) of a water/water heat pump connected to a ground loop. Even a very energy efficient GSHP is still an expensive heating system because of the high energy taxes. Therefore this project focuses on optimizing the thermal performance of the GSHP for a minimal electrical consumption and additionally has the possibility of covering the rest of a households electrical consumption by means of solar cells. This project is based upon simulation and numerical analysis in Engineering Equation Solver (EES).

The solar energy system consists of PVT-panels (Photo Voltaic Thermal) which is hybrid panels with solar cells that is cooled by a liquid. By cooling the solar cells, the electric efficiency will increase because of the solar cells negative temperature dependent characteristic of 0,4 – 0,5 %/°C. Without any cooling the solar cells easily reaches temperatures as high as 70 °C which limits the efficiency to around 15 %. With ground cooling the temperatures can be held at 40 °C or lower, and results in an electrical efficiency up to about 20 %. On an annual basis the electrical output will be increased with 15 – 20 %.

The heat that is removed from the solar cells can be utilized, even though the temperature level is much lower than what is used in the household, eg. hot water supply. This is done by accumulating the heat in the ground as a result of circulation of the fluid from the ground loop (up) through the solar panels. Depending on the soil conditions it is possible to store the solar heat at least 1 – 3 months. The stored heat can contribute positively to the efficiency of the heat pump which directly results in a decreased need of external supply of electricity and hot water for either heating or domestic hot water usage.

By dimensioning the energy system correctly it is possible for a household to be self-sufficient with both heat and electricity. The normal water supply is still needed, just as it will be necessary to be on the grid to store the produced electricity for later use.

Facts:

- Geothermal heat pumps are one the most energy efficient heating sources on the market, but due to high taxes on electricity it is not a cheap system in use.
- Due to restrictions in the maximum size in the electrical output of a solar energy system it is interesting to optimize on the annual production of the system to cover as much of the households electrical consumption as possible.
- Relatively small difference in the construction cost with and without cooling of the solar cells.
- Geothermal heat pump combined with a hybrid solar energy system secure independency of energy prices for at least 25 years.
- Increased electrical efficiency minimizes the need of roof space for the solar panels.

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The Copenhagen Waste-bag Project

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INTRODUCTION

This abstract is a short introduction to our project about waste management in Copenhagen. We have chosen to develop a new trashcan for street waste in Copenhagen, and through our research we concluded that the most efficient and cheapest way to handle waste on the street is to collect it in a plastic bag. Our job was now to design a durable, cheap and efficient tripod for the plastic bag, there visually can fit into the environment. In this abstract we will describe the solution we came up with and how we ended up with that result.

THE WASTE-BAG

Problems concerning the public garbage system in Copenhagen were uncovered during our fieldwork and research phase. In order to obtain a better understanding of the whole system, we contacted the two main actors involved – "Center for Renhold" (the cleaning department) and "Center for Bydesign" (department concerned with the overall look and appearance of the city).
The first mentioned presented us for problems concerning the garbage cans in the center of Copenhagen and in the city districts Nørrebro, Østerbro and Vesterbro. The problems here lay in the process of emptying the garbage cans which involved some safety concerns about the ergonomics of the system, but also the handling of the waste bags which potentially could contain needles and other sharp objects, making it potentially infectious for those handling the bags.
The other actor, "Center for Bydesign" expressed some concern involved with more practical solutions, rendering them less attractive from a more visual/design oriented point of view. These interesting tensions between the two main actors are the main focus in this project.

LIFECYCLE

The trashcan's lifecycle starts with the extraction of iron ore, which is processed in to low-carbon steel. The steel is processed into different components including to rods of the same shape and size, a ring and a slightly longer rod. The parts have been divided to gain the maximum advantages in the industrial production of the trashcan. The trashcan has a rather long lifespan, and is seen as a permanent solution. This lowers the demand for the ease when disposing the trashcan.
The value and function of the trashcan depends on bags being mounted on the metal ring of the trashcan. So the biggest demands are for the bags of the trashcan, which should be cheap and biodegradable. This is to secure the minimum amount of economic and environmental costs

CONCLUSION

The Copenhagen Waste-bag would not only considerably reduce the time it takes to clean trashcans. It adds a design-element that encourages people to take part in the struggle for a better environment. With no protective shell this type of trashcan can limit the amount of cleaning necessary, to an absolute minimum. All in all, this project really proves that helping the environment might be achieved by an educative design combined with thoughtfulness off ones surroundings.

Tip n' roll

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Introduction

The concept of the garbage system, Tip N'Roll, ended as our final design in 'Brugerorienteret Design'. The idea is to minimize the amount of garbage on the streets, by increasing the volume of the garbage can. This may sound easy, but with the regulations set by the Factories Inspectorate (Arbejdstilsynet) it's a problem to empty the cans. Our solution is a system with a special designed sack truck. The sack truck has multiple functions; it is the key to remove the garbage can from its base, it transports the garbage can to the garbage van and it still enables the garbage personnel to use the bin-emptying system on their trucks.

Theory, Methods and Result

From the SCOT theory, we discovered some problems in Copenhagen. From an analysis of our collected material we realised that the capacity of the bins was not sufficient enough in specific areas.
The great thing about Tip N'Roll is that the garbage man does not have to empty the garbage can 5-6 times a day, but now only 2-3 times, and less garbage will end on the streets due to the three times more space in Tip N'Roll.
Tip N'Roll is a solution that lasts for a long time. With the base in fibre concrete, the garbage can in ABS and the sack truck in steel the system doesn't have a direct impact on the environment. And if someone vandalizes the system, only the garbage can has to be replaced.
The solution is implementable; the system can use the current small garbage trucks because the sack truck is designed to fit.

Conclusion

Tip N'Roll is a solution that helps the environment, not only by minimizing the garbage on the streets, but also by minimizing the amount of fuel used on garbage collection. Furthermore it improves the working environment.

Catalytic Reduction of Nitrate in Drinking Water

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DTU Chemistry, Technical University of Denmark

Pollution of drinking water by nitrates is globally a large and growing problem as mineral fertilizers are becoming accessible to an expanding population. The problem arises from fertilizer being washed out of the soil and into ground and surface waters making it unsuited for drinking. In Denmark clean and safe drinking water is provided by rich groundwater resources. Polluted wells can often be retired in exchange of new, deeper, clean wells. Areas with surface water in the drinking water supply do not have that opportunity and the pollution is typically resolved by reverse osmosis. Drawbacks of this technique are the production of waste, high energy consumption and re-ionization of the water to make it fit for drinking water. Another available method for nitrate removal is bio-reduction but it can be problematic in drinking water supplies due to bacterial spill-over (Barrabés & Sá, 2011).

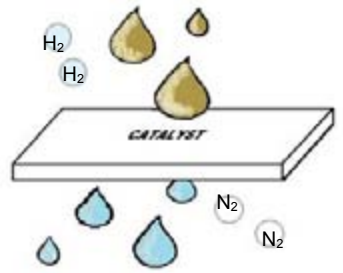

Figure 1 Water purification by catalytic reduction

An alternative method to provide clean drinking water is the catalytic reduction of nitrate to nitrogen using either hydrogen or formic acid (Barrabés & Sá, 2011). The reaction proceeds in the liquid phase at temperature and pressure of ground water and utilizes a solid catalyst with metal particles for instance palladium and tin. When formic acid is used as a reductant it forms H_2 and CO_2 in the reaction.

In this project a palladium and tin catalyst was examined. To investigate the dependence of the amount of active phase the catalyst was prepared with four different metal ratios. The catalyst activity was tested in a bubble column under flow of hydrogen and CO_2. Each catalyst was tested in model drinking water with nitrate, model drinking water with nitrate and chloride and polluted drinking water obtained from a well in North Zealand. Samples were analysed for nitrate and the unwanted reaction products nitrite and ammonia.

Conversion of nitrate was found for each of the four catalysts in each of the three examined media. Formation of nitrite and ammonium was not detected during the reaction. The optimised catalyst was found to fully reduce nitrate within reasonable time and practical applicable process conditions.

In conclusion, efficient nitrate to nitrogen reduction was accomplished with a solid palladium-tin catalyst without the formation of unwanted or environmentally harmful products. The major contribution to the carbon footprint of the process stems from the use of hydrogen. This can be circumvented by applying hydrogen generated from waste biomass as the source of hydrogen.

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Greywater handling in energy plus house

M. S. Laursen

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INTRODUCTION

Greywater derived from clothes washing can be used for irrigation provided it is treated in a special bacteria-cleaning system. A mock-up model is described.

Content and structure

The idea of using a greywater treatment system for the SDE house derived after observing a few house owners in Denmark using willow trees for evaporating both black-and greywater. Closed willow tree systems normally go under the designation: “vent free basin installation”, which indicates that the system is enclosed to avoid surface runoff, a potential health risk for residents according to an announcement of the Danish Environmental government.

In this mock-up model greywater stored in a 160 L tank, placed below the garden terrace, is pumped through a particle filter and UV-light to a 1 m^3 raised bed filled with soil and planted with willow trees or reeds. The raised bed can evaporate 1 L of greywater daily and excess water runs to a non-potable water box in order to avoid potential spreading of bacteria and to be used for irrigation of other parts of the garden. During the contest week the greywater must be devoid of soap whereas the plants will need fertilization.

Conclusion

This mock-up model could be produced in full scale as a vent-free basin installation requiring an area of 50-100 m^2 basin installation/person able to evaporate both grey –and blackwater. A full-scale installation has the advantage of being free of wastewater tax-payment as well as a relief of pressure on the sewage systems, which is an advantage in countries suffering from heavy rain.

RENEWABLE ENERGY: FEATHER SKYLINE, SI

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INTRODUCTION

Sustainable energy conversion and beautiful aesthetics is not a contradiction. The new millennium is the heyday of wind, water and solar power, and energy converting structures are thus obligated to act as the educational interface between natural energy sources and the consumer. By engaging energy consumers physically in the process of converting energy the structure conveys an understanding of natural energy systems. But how can sustainable energy be an experience? How can we “aestheticize” cutting edge energy conversion methods? How can this energy production device reflect the power, dynamic and diversity of natural forces or in other words potential energy resources?

MERGING ENERGIES: WIND, SUN

The answer can be found on Staten Island, NY. This fifth borough of New York City has the image of being the suburban leftovers from the economical and cultural high-roller party on Manhattan. During post-war decades the island was mostly known as landfill for the New York City area. This era ended in 2001 after the debris from the World Trade Center was deposited her. For the past decade the four mounds of Freshkill Landfill have been capped and the area started transforming into a vast recreational parksite.

The new parksite of Freshkills Landfill offers great opportunities of exploring sustainable energy production in a large scale. However, the meteorological conditions of the New York area are far from constant. Greywater replaces sun, which replaces wind – and so forth. Creating an optimized energy producing structure requests the designers to take into account the ever-changing weather conditions and thus combining different, individual energy production methods. FEATHER SKYLINE is an example of how such strategy can be realized. It reflects the current meteorological conditions. A carbon skeleton with piezoelectric elements enables the structure to move by catching the wind in the solar sails mounted between the carbon rods. The structure is lit by shimmering LEDs to show the real-time variations of energy production. Carbon rods and the solar sails are only the visible part of the energy system: The structure is connected to a methane gas energy storage system, which is creating by using the existing decomposition management system that produces natural gas, providing electricity to more than 20,000 households in the New York area. Furthermore, the installation is tangled in the features of a smart grid, thus allocating energy to according to current consumption.

HUMAN INTERACTION

The hope is that Staten Island will gain a strong identity with its own landmarks – its own iconic skyline like that of Manhattan. The dynamics of the structure tells its own story of how energy is produced – and will be a story of how future energy production is not only a question of kWh, but also has to address equally aesthetics and human experience. Pure necessity or technological vision: Energy production can be beautiful.

Power transforming in isolated Hydro Electric system

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INTRODUCTION

Hydropower is an interesting technology, which can be used to store water, for later transforming it to energy, which can be used for example in ones homes. All over the world, there exist large installations where water is stored in a reservoir, and are used when needed; such installations can be dammed water or pumped-storage.
The amount of energy that potentially can be stored in these pumped-storages is large, and the effect can be up to 87%, and some places have seen peak power up to 4 GW[2]. The water is supplied potential energy through for example wind power and a pump, when the water drops down again, over a turbine, it creates electric energy.

PROJECT

The theory/idea behind this project, is that by pumping water up to a given height, by using green technologies, for example wind or sun, we can save electric energy on to the time, where the other technologies doesn't produce enough electricity to supply the users.
In this project we focus on the part of this process, where the water have been transformed to electric energy again, but this electricity doesn't necessarily have a voltage of 230V, and frequency on 50Hz, without those properties, it could be dangerous to supply to a normal house
Besides this, the project also is about controlling the amount of used water.

METHOD

The method that will be used, is first transforming the electric three phased AC output of the turbine generator, to single phase DC, using rectifiers.
By using a capacitor as a bank, the DC is kept more stabled, where after the voltage is bucked down, to the final voltage, and here it should also have been made into 50Hz AC, but because of problems with time, and with economy, this part has been replaced with an inverter, so the final voltage is the required input of the inverter, which in return give us 230V at 50Hz AC electricity.
The water which is sent to the turbine, is controlled by the amount energy in the capacitor bank, through a regulator system.

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RESULTS

Because this project is part of course 31015, Introductory project – Electrotechnology, the project isn't finished at the given time, put will be finished before the end of the competition in June.
So far we have designed, and gotten hold on the parts we need, so we only have to build and test the project

CONCLUSION

This project doesn't directly produce green energy, but makes it possible for small energy sources to save the unneeded energy, and use it, when needed, plus the project relies only on well-known technologies, which makes it realizable.

Utilisation of the Pistoning Effect to optimize Tunnel Aerodynamics

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INTRODUCTION

In Europe about 40 single-tube tunnels with two-way traffic can be counted with a total length of about 200km below the ground. In these types of tunnels huge air velocity gradients occur due to collisions between the forthcoming air streams of the two lines. These swirls cause an increased driving resistance, leading to a higher fuel consumption and emission of carbon dioxide.
Aimed at reducing this aerodynamic drag of vehicles in tunnels our project deals with integrating partition elements to decrease this driving resistance. Furthermore, we make use of the so-called pistoning effect which could contribute to a fewer fuel consumption as well. This effect should be investigated as well as the impacts on a cleaner and safer drive.

THE PROJECT

Using aerodynamic simulation methods and fluid dynamic calculations we focus on the one hand how the relative velocity can be reduced by accelerating the air flow through the pipe, and on the other hand how reducing the swirls in the middle of the tunnel can reduce the fuel consumption. On a material aspect we deal with the selection of an appropriate building material for a partition wall which should fulfill several legal obligations regarding fire protection and construction design aspects.
Based on these results, suitable existing tunnels in Europe are chosen that allow the integration of our partition wall. With these case studies we aim at creating a detailed tunnel model where exact calculations can be performed.

IMPACT

Counting all possible European tunnels which are convenient for our project`s application a significant reduction of the CO2-production can be reached. Besides, separated lines may result in a reduced accident rate, according to statistics from European tunnels. E.g., among other aspects, drivers are not disturbed by forthcoming car headlights. With our project, we optimize existing tunnels in a relatively simple way to contribute to a significant and sustainable reduction of CO2.

Lignin depolymerization and catalytic conversion to liquid fuels

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INTRODUCTION

Lignin received from DONG Energy's refinery needs to be depolymerized for valorization. The depolymerization was carried out in a batch reactor with elevated temperature and high hydrogen pressure. These yielded conversions up to 84 % and with methanol as the main product.

THEORY

In recent years there has been a lot of focus on bringing down CO_2 emissions and being independent of fossil fuels. A solution to this is to use biofuel. 2nd generation biofuels are based on lignocellulosic biomass which is found in various amounts in almost all plant material. This consists mainly of three compounds cellulose, hemicelluloses and lignin. To valorize 2nd generation biofuels it will be necessary to find a way to utilize lignin to its full potential.

METHODS

It is the objective of this project to contribute to the development of a process through which lignin from bio-refineries can be converted into high value added products such as liquid fuels and chemicals. The experiments are conducted in a high pressure batch reactor at high temperatures under hydrogen pressure. A ruthenium catalyst is used to find optimal conditions by varying pressure, residence time and temperature. It is thought to investigate different catalysts later on.

RESULTS

Solvent	T (° C)	P (bar)	Catalyst	Conversion (w/w%)	Residence time (h)
Water	300	135	none	75	4
Water	250	135	Ru/C	56	4
Water	300	135	Ru/C	71	4
Water	300	135	Ru/C	83	18
Water	325	160	Ru/C	84	4
Methanol	230	135	Ru/C	31	4
Methanol	260	90	Ru/C	66	4

Table 1 – Results

CONCLUSION

It is possible to convert the lignin received from DONG Energy in satisfactory amount. The main product is methanol but further measurements are necessary to quantify this. This is a great result although a distillation is needed to isolate the methanol.

BACHELOR THESIS
FREE STYLE
BIO ENERGY

Bioconversion of biofuel derived waste into value-added products

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INTRODUCTION

With the expanding production of biodiesel, glycerol – a by-product of biodiesel production – is produced in larger amounts than the current market demand. Therefore glycerol is being treated as a waste product at biodiesel production plants, as some cannot afford purification of glycerol, while others do not find purification economically viable. Establishment of a glycerol-based production platform for value-added products could make biodiesel production more economically viable, and also improve the life cycle balance of the process. *Yarrowia lipolytica* is a yeast capable of rapidly converting glycerol into either single-cell oil or commodity chemicals and has been investigated in this project as a possible cell factory for glycerol biorefineries.

Biodiesel formation by new waste-free catalytic process

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INTRODUCTION

The study present a new way to produce 2nd generation biodiesel as Fatty Acid Methyl Ester (FAME) made from meat industry waste. 2nd generation biodiesel is produced from sustainable sources like agricultural residues or other waste products from biomass. Compared to 1st generation biodiesel it is much more environmentally friendly since it does not take up farmland that could otherwise have been used for growing edible crops such as grains. Industrial methods for FAME production uses inorganic bases that cannot be reused and generates huge amounts of unusable inorganic salts as byproduct.

METHOD

The concept of this production method is to reuse the catalyst by means of polarity changes. Instead of using an inorganic hydroxide based catalyst, an organic base has been used. An organic solvent can then be used to extract the catalyst. Solvent and catalyst can afterwards be separated by changing the polarity of the liquid. The process can then be reversed, changing the polarity back and the catalyst can be reused in the reaction.

RESULTS

The used organic base produces FAME just as efficient as when using inorganic bases like in conventional industrial processes. By using an organic solvent it is shown that the catalyst can be extracted and by polarity changes it can be separated for reuse.
A number of organic solvents have been tested and identified for extraction.

CONCLUSION

The homogeneous catalyst can be reused by selective extraction in a number of steps, thus drastically reducing the need for new purchases for each production batch. Furthermore the salts generated by conventional procedures are avoided, thereby eliminating unusable byproducts.

Future waste management

Maria Jeanine Annel and Charlotte Harritshøj Frausing

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INTRODUCTION

As the quantity of waste keeps increasing and our resources are at risk of running low or even to be lost permanently, it is necessary to review our waste management system. This project will focus on which technologies are available for treating certain fractions of waste: organic, plastic and metal, with two parameters in mind: material reuse and energy extraction. When technologies are identified, they will be compared from the following factors: purity of fraction, staffing needs, environmental gain, user-friendliness and involvement of citizens.

THEORY

In order to review the technologies available, terms like technology assessment and multi-criteria analysis will be taken into consideration. Furthermore, our assessment criteria are weighted individually and will, when combined with a score for each technology (1 – worst, 5 – best), give a basis for comparison of our five selected technologies: composting, biogasification, Material Recovery Facilities (plastic), incineration and EAF (iron and steel).

METHODS

A literature study of what the fractions consists of has been made, since there are many municipals in Denmark already separating organic, plastic and metal from household waste. Furthermore a study of technologies has been made. The analysis of the technologies along with a multi-criteria analysis will be the basis of our comparison.

RESULTS

The results of our analysis show, that a great deal of energy and CO_2-emissions can be saved or avoided, when sorting and recycling household waste. The multi-criteria analysis is shown in Table 1. Along with the report, a brochure designed to inform citizens of Copenhagen on the requirements of the technologies will be provided.

Parameter → / Technology ↓	Purity (1,4)	Staffing needs (1,2)	Environmental gain (1,8)			User-friendliness (1,6)	Involvement of citizens (1,4)	Total score	Rank
			CO_2	Energy	Material				
Compost	4	4,5	5	1	5	3,5	3,5	**28,1**	**3**
Biogasification	4,5	4	5	2	4,5	4	4	**30**	**2**
MRF	3	3,5	3,5	4,5	4	2	1,5	**20,9**	**5**
Incineration	5	2	1,5	3	1	4,5	5	**26,9**	**4**
EAF (metal)	5	4	4,5	5	4,5	4,5	4,5	**33,7**	**1**

Table 1. Multi-criteria analysis of waste management technologies.

Experimental study of the dynamic response of a TLP Wind Turbine model

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The model studies in this project show that the dynamic response of a floating TLP wind turbine depends very much on the mooring configuration, and shows the necessity of choosing a configuration that is flexible and thus able to absorb loads from wind and waves. It was found that the use of inclined mooring lines reduces the motion of the nacelle dramatically and allows harsher wind and wave conditions before the structure motion becomes critical. Today's offshore wind turbines are mounted on piles that are drilled into the seabed which limits the sites suitable for offshore wind farms to shallow waters. Many places in the world coastal waters are very deep, and in order to install offshore wind turbines here, they must be floating.

This project investigates the dynamic effects of different mooring configurations applied to a floating TLP wind turbine model in various wind and wave climates.

The TLP wind turbine keeps itself buoyant by means of a Tension Leg Platform (TLP) which is comprised of a cylindrical floater and four spokes forming a cross at the bottom of the floater. From each spoke a tendon is drawn to an anchor on the seafloor and given a pre-tension in order to keep the TLP stable. The experimental study is based on a 1:200 scale model of a TLP wind turbine that is equipped with a generator and where the floater and the nacelle are fitted with accelerometers. Data from these devices forms the basis for a dynamic analysis giving accelerations of the wind turbine as well as power and rotational speed of the generator. The waves are generated in a wave flume, while the wind is created by an open wind tunnel that was designed and built as part of the project.

Defining φ as the angle between the upstream spoke and the direction of waves and wind, three different mooring configurations were tested, where all three were tested at $\varphi = 45°$ and only one at $\varphi = 0°$. All configurations were tested in five different irregular wave climates as well as in a range of regular waves. In figure 1 the cumulative probability distribution of the nacelle displacement in the wave direction (surge displacement) is shown for irregular waves generated from a JONSWAP wave spectrum with a significant wave height of 19.43 m and a peak period of 21.90 s. Here it is distinct that the mooring configuration having 4 inclined tendons is by far the most stable configuration. This can be explained by the fact that the surge eigenfrequency of this configuration is low compared to the other mooring configurations and falls below the frequencies in the wave spectrum that contain noticeable energy.

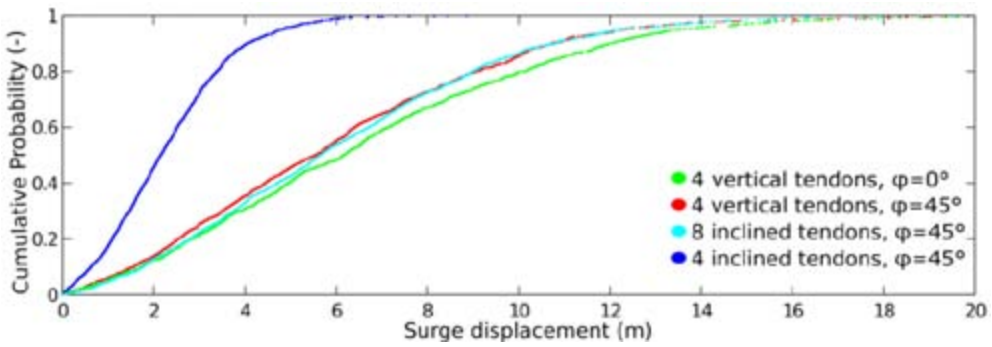

Figure 1: Cumulative probability of full scale surge displacement.

Development of GPU-accelerated MIKE 21 solver

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ABSTRACT

In today's world the focus on environment and climate is higher than ever. Especially the change in rivers and coastal areas has crucial impact on peoples lives all over the world. The world saw in 2004 the devastating effect of a tsunami killing over 230,000 people in fourteen countries bordering the Indian Ocean. The tsunami had waves up to 30 meters high and the world donated more than $14 billion U.S. dollars in humanitarian aid. Having efficient tools to try and predict such events has potential to save hundreds of thousands of lives and billions of dollars. It is therefore essential in today's modern society.

DHI have developed a 2D free-surface flow numerical engine called MIKE 21 HD (hydrodynamic module) in order to simulate water movements. This application can simulate water movement in lakes, estuaries, bays, coastal areas and seas, based on rain, tidal variation, wind etc, but also including prediction of tidal hydraulics, wind and wave generated currents, storm surges, waves in harbours, dam-breaks and tsunamis. MIKE 21 HD uses a set of hyperbolic partial differential equations that describe the flow below a pressured surface in a fluid. These equations are solved numerically on a rectangular grid, using a finite difference method (FDM). The solution scheme that is used is the Alternating Direction Implicit (ADI) method. The simulation speed of the program is very important because it determines how big and how many problems can be solved in a given amount of time. Sometimes in order to get accurate understanding of the changes in a given area, hundreds of simulations have to be run. Therefore improving the computing speed has the potential to increase the kind and size of optimization problems where MIKE 21 HD is applicable and thereby open new market segments for DHI. This means that the project is both very relevant and that a satisfying result with certainty will be applied by DHI.

For this reason the focus of the project is on improving the simulation speed while maintaining the accuracy of the program. This will be done by implementing the program to run on a graphics processing unit (GPU) to exploit the massively parallelism of the architecture. In order to do this a parallel solution scheme must be developed and different parallel algorithms must be developed and tested in order to utilize the potential of the GPU. The technology for doing this is relatively new. In 2006 NVIDIA published CUDA to run on NVIDIA's CUDA-enabled GPUs as the world's first solution for general-computing on GPUs. This means that very little research has been done in this domain and the project is therefore highly innovative.

Throughout the project it has become clear that there are two different approaches that are beneficial according to the size of the grid. This is because for small grids there are less "work" to be performed by the hardware and therefore it is important to utilize the fast internal memory of the GPU to improve performance speed. This also means that in order to solve the tri-diagonal systems for each line in the grid, a new algorithm has to be used. We found a modified version of parallel cyclic reduction to be beneficial for small grids and a modified version of the more common Thomas algorithm for larger grids.

The different approaches resulted in approximately 25x speedup when using the GPU compared to the CPU, independently of the problem size. This means that a simulation that before took a day now can be performed in less than an hour!

This is a very significant improvement and a very satisfying result. Future work now involves implementing the developed solution schemes in MIKE 21 HD so the performance gain will be utilized in real life.

Controllable low voltage transformers and low voltage grids with high photovoltaic contingent

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Introduction

Both the resources of conventional energy are soon ending and their pollution make it necessary to reduce and stop their consumption. Therefore photovoltaic and wind energy are used to replace coal and nuclear power stations. But the grids are designed for the big power plant and the loads far away from them. Especially rural grids are not designed to transport energy which is mostly produced in these areas and transported via the high voltage grid towards the industrial centers. Because of the inverse and fluctuating load flow these grids are overloaded and must be improved. This is very expensive.

Theory

In high voltage grids there are tap controllers in use to control the load flow. With these tap controllers used in low voltage grids excess voltages can be avoided and the girds didn't need to be improved. In load situations (when the load flows from the building connection lines towards the transformer) the voltage at the transformer is reduced. Therefore there is no excess voltage at the end of the grid. If there is less photovoltaic input the voltage at the transformer rises and avoids low voltage at the critical point of the grid.

Methods

Some typical and some extreme grids were defined. Load profiles were generated by a load simulator, photovoltaic profiles were measured and scaled to some reference power plants (bigger ones are located at farms). Few tap controllers (different number of steps and switching range) were used. The simulation was done with DigSiLent.

Results

The typical grids are never really critical and can be controlled with every tap controller both in the spring and the summer simulation. The extreme grids are problematic. They need a wide step range and a medium pitch. If the difference of the taps is too small, there are many switching acts necessary. This reduces the life time of the tap controller. If the pitch is too high, there are problems with flicker. Small and long grids are much more problematic than bigger and interconnected grids.

Conclusion

Tap controllers are a good and cheap method to improve grids, especially rural ones with high photovoltaic input. But if the tap controller works without communication (voltage measurement at some critical points) and there is a high photovoltaic input the tap controller has to be chosen properly. It is always a trade-off between the durability of the tap controller and the fluctuation of the voltage.
Some real tap controllers are installed in few grids to validate these results. The industry wants to improve the number of switching operations to improve the voltage stabilization being able to use a smaller pitch.

Optimal Insulation

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Advisors: Mathias Stolpe & Anton Evgrafov, Department of Mathematics, DTU

In this thesis, an optimal control optimization problem concerning the optimal placement of heat sources is solved with numerical methods. The problem is constrained by a partial differential equation and point-wise constraints and discretized with the finite element method and optimized in Matlab with a one-step factorization and an iterative interior point method. The resulting optimal heating distribution is placed as circular areas close to the windows when the penalty is reasonably high and as a thin lining along the boundary when there is no significant penalty and no windows. The number of windows drastically increases the number of necessary amount and the shape of the heating.

A similar problem is then solved as the optimization of a thin layer of insulation around a domain. This is likewise constrained by a partial differential equation and a sensitivity analysis is carried out to identify the gradient used in the interior point algorithm. The problem is discretized with finite elements and solved in Matlab. The optimal distributions show a inverse relationship between the proximity to a heat source and the level of insulation necessary. Both results show a more energy-efficient way of heating a house with a more modern approach than radiators. The focus in the thesis is on the mathematical modeling of the problem and less on the physical implementation since it is written as a bachelor project at the Institute of Mathematics at DTU.

Wicked Sustainability

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ABSTRACT

Technology systems are not just increasingly important physical and structural elements of an increasingly humanized earth characterized by complex human systems. Because technologies are connected to the economic, social, and cultural systems, they enable, and in turn are enabled by, just adds extraordinary levels of complexity. So to turn this complex world into a sustainable world would it be sufficient to make even more devices although green?

I would say: It's necessary but far from adequate or sufficient.

We need to redefine the contested concept: "Sustainability" Since philosophers are especially good at providing conceptual clarification, they are an especially good group of people to turn to for enhanced understanding of wicked problems, especially ones like sustainability that are, at bottom, rooted in normative disputes.

My contribution to 'Grøn Dyst' is driven by my wonderings regarding the seemingly easy solutions we present to the problems, which follow, from our increasingly more complex way of living in the world. As I noted above the global policymaking fails to address the fact that; the coupled global systems of atmosphere, ocean, biology, economy and equity are being addressed by constructs such as "carbon footprints". This, I would say, is adequate demonstration of failure to understand and respond ethically to adaptive complex systems - especially ones of which humans are an integral part. My project is an attempt to analyze and give a redefined understanding version of ethics. In this matter ethics is to be understood as the tool we use to decide what to do - to do the right, valid and sound thing. Establishing process is just as important in many ways as explicitly ethical framings at a particular point in time. In the Danish language we use the same word for "soundness" of a logical sequent as we do when discussing sustainability. It has long been a problem in ethics that technological advances render previous ethics outdated. Nonetheless people think that we have an ethics which is working and which our law systems are based upon. This is obviously not a true assumption.

Flue gas DeNOx with SILP

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ABSTRACT

The main component of atmospheric air is nitrogen. During combustion at high tempatures, nitrogen can undergo oxidation, thus making nitrous oxides (NOx gasses). This occurs frequently when atmospheric air is used as oxygen supply for combustion processes, whether it be in coal, biomass or oil fueled power plants, combustion engines for transportation, or other combustion processes.
Especially the NOx gasses, NO_2 and NO are toxic, and harmful to the environment. These gasses make acid rain, and contribute to depletion of the ozone layer.
This project focuses on flue gas DeNOx from smaller sources, such as diesel engines. Processes are already in use for DeNOxing flue gas from power plants and gasoline engines. For gasoline engines, a three way catalyst is used, this cannot however be applied to diesel engines, due to a much higher oxygen content in the exhaust gas. The process used in power plants is called SCR (Selective Catalytic Reduction) and uses concentrated ammonia and a catalyst to reduce the NOx gasses into harmless nitrogen. The process demands a big reactor, and concentrated ammonia, which is both a major health risk and environmental risk in case of accidents.
This project explores the opportunity of installing an efficient DeNOx unit in the exhaust of a diesel engine, thus cleaning the flue gas. The DeNOx unit will consist of a SILP (Solid Ionic Liquid Phase) absorber. The SILP absorber is made up of porous particles and an ionic liquid, in this case $[BMIM]NO_3$. The porous surface creates a large surface area on which the reaction can occur.
The SILP uses the excess air and water in the flue gas, to convert the NOx into nitric acid, which is captured and stored in the ionic liquid. Tests were conducted by exposing a SILP reactor to a simulated flue gas mixture. The NOx concentration was monitored by a UV-VIS Spectrometer.
The spectrometer was set to obtain a spectrum at wavelengths from 250 nm, to 200 nm. At these wavelengths it is possible to monitor NO and NO_2 simultaneously. The results clearly state that it is possible to remove all of NO and NO_2 for a significant period of time.
When the maximum capacity of the SILP is reached, it is possible to simply desorb the nitric acid from the SILP, by heating it to a temperature above 80ºC, in a stream of gas. The capacity of the ionic liquid in the SILP is around 1.05 moles of HNO_3 per mole of ionic liquid, at room temperature. Even though the maximum capacity of the ionic liquid is lowered at higher temperatures, the conversion of NOx to nitric acid becomes faster.
The SILP is reusable, and there is no apparent drop in capacity when reusing the SILP. The nitric acid that is produced from the reaction can be obtained, and used in the chemical industry. Nitric acid is one of the most produced chemicals in the world, and this technology will thus be able to both reduce the NOx emission from transportation, while lowering the amount of nitric acid produced in the chemical industry each year.

Smartphone application for optimizing charging patterns of electric vehicles

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This project will deal with the development of a generic application for smartphones that will make it easier for the user to optimize the charging behavior for electric vehicles and use of their electric vehicles. The charging process is a great challenge, therefore if the general population begins to adapt the electric vehicle in big scale. Users will typically charge their vehicle after coming home from work, which will result in heavy loads on the power grid. An intelligent charging behavior will reduce the CO^2 emissions and the costs of charging the battery of the electric vehicle. User guidance will help the user to decide whether a trip is possible with an electric vehicle or a conventional vehicle is needed, given the distance of the trip and battery size of the electric vehicle.

The charging optimization in this project is based on mathematical methods presented in a paper published at DTU [1] intended for use in the EDISION electric vehicle aggregator. This model uses day-ahead energy spot prices in order to predict the most optimal charging patterns.

Since this application is intended to be generic, several existing smartphone applications on the market made for electrical vehicle management has been analyzed. This analysis has concluded which features are most typical for this kind of application.

It became clear in the analysis that the must have features include statistics, notifications, general vehicle settings, charging stand information/location and power management. In addition to these features, charging stand reservation and Vehicle-to-Grid management/information (communication with the power grid to sell demand response services by either delivering electricity into the grid or by throttling their charging rate) would also be useful features in such an application. An additional feature implemented in this prototype is a trip planning feature. The electrical vehicle has today a limited range compared to the conventional vehicle, and if a user owns an electrical vehicle it will most certainly be in addition to a conventional vehicle. This application will help the user to decide whether it's possible to carry out a planned trip with the current battery capacity available. While driving conditions like air-conditioning and stereo turned on are important inputs to decide whether the trip is possible since these conditions drains significant amounts of the battery. The environmental and economic benefits of electrical vehicles compared to conventional vehicles will be presented to the user during the planning process.

In this project is made a prototype of such an application, intended to be adapted for any electrical vehicle.

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DOI: 10.1109/ISGT.2012.6175718

Changing the management of special waste, a Life cycle assessment

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Introduction

In Denmark automotive shredder waste, copper-chromate-arsenic (CCA) impregnated wood waste and PVC waste is currently landfilled. This project uses an life cycle assessment approach to evaluate on this practise by comparing it to incineration as an alternate scenario, with the goal of determining the optimum treatment method.

Results

The life cycle assesment was created using the software EASEWASTE, to compare landfilling with incineration. The landfilling scenarios is created by using sources from scientific literature on emissions of leachate, while the alternate scenario incineration is based on an existing EASEWASTE model that is modified using data from a study on the FASAN incinerator testing combustion of different waste fractions

For PVC waste it was found that landfilling PVC causes very few impacts to the environment, as the PVC waste remains mainly inactive. PVC incineration, showed a typical impact scenario for incineration, savings in the categories global warming, acidification and nutrient enrichment, but loads in the human toxicity categories. However dioxin releases from PVC combustion, which is known to be a major problem, was not accounted for. In comparison the incineration is the more environmentally friendly option, but this may be changed by accounting for the extra dioxin release or a change in marginal energy source.

CCA impregnated wood waste landfilling causes major impact in the human toxicity via soil and ground water pollution categories. These big impacts are caused by the release of the arsenic that was originally used to preserve the wood. Incinerating CCA treated wood waste, causes almost the same impacts as incinerating PVC. Sensitivity scenarios run on the two management options could not change the overall conclusion that incineration was an environmentally far better option.

The major impacts from the landfilling of automotive shredder waste, was in the stored ecoxicity categories, especially in the stored ecotoxicity via water category. Incinerating the shredder waste causes an unusual high effect in human toxicity via water, besides the typical effects from incineration. In conclusion the incineration seems to be the better alternative, but only as long as the marginal energy source is coal, and the spreading of the stored toxicity is not given a high priority.

Another major concern that affects the results for all three fractions, is the utilization of bottom ashes from the incinerator. If the spreading of the contaminants left in the ashes is considered a major problem this may influence a decision on the preferred waste management technology.

Conclusion

The three cases studied in this project shows that incineration, using the current waste to energy plants, may be a good alternative for managing of some problematic waste fractions. The major uncertainty in this conclusion is on the release of dioxin and the marginal energy source, and therefore incineration must be seen as a temporary solution for these fractions.

Use of sewage sludge ash in concrete after phosphorous recovery

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[1]DTU Civil Engineering, Technical University of Denmark

Phosphorous is a vital element for human beings as well as for animals. The mines from which phosphorous is extracted are almost emptied. Scientists estimate that there will be a grave shortage of phosphorous within the next 40-100 years. It is therefore important to find alternative sources from which phosphorous can be extracted. A secondary source might well be sewage sludge ash, as it contains about 10-20% phosphorous.
Sewage sludge ash is transported to Norway for deposition. This is a waste of a phosphorous source and an expensive and bad environmental solution. It is a far better thing to extract phosphorous from the sewage sludge ash and use the residue in the concrete. Furthermore - *not* taking ash to Norway means less CO_2 emission because of shorter transport.
Scientific research shows that sewage sludge ash can be used in concrete. By acid washing the sewage sludge ash most of the phosphorous can be recycled.
This project will examine whether it is possible that ash washed in acid can be used as replacement for cement in concrete. It is a fact that 20% of the cement can be replaced by ash washed in acid. All in all an up to now unused secondary source of phosphorous and the mineral residue will be used in concrete.
When waste water is cleaned, filtered and burnt by high temperature we have a product called sewage sludge ash.
When iron is used the ash gets a reddish colour, aluminum a neutral color. This project uses iron based ash, “Avedøreaske” and aluminum based ash, “Lundtofteaske”.
Sewage sludge ashes are washed with 2 types of acid: H_2SO_4 and HNO_3
“Avedøreaske” and “Lundtofteaske” are both tested for pressure. A mould made of morter is made *with* and without crushed ashes, and with different amounts of ash according to the cement they replace. These moulds are tested for strength and compared with each other and with references.
Tests are made in order to show the amount of elements in the ashes. By examining the ash before and after the acid wash it is possible to establish what has happened to the ash, for example how much phosphorous has been removed.
Provisional conclusion: Ash washed in acid can be used in concrete. This concrete, however, has diminished strength and must therefore only be used in cases where very strong concrete is *not* a necessity. The ash ought to be washed in acid so that the recovered phosphor in the ash can be recycled.
“Avedøreaske” might create a problem because it gives the concrete a reddish colour. “Lundtofteaske” with its neutral colour it is preferable. Also because:
No or little deposition is needed, Recycling of phosphorous and CO_2 reduction because of shorter transport of the ash.

Beam modeling of wind turbine blades

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INTRODUCTION

This project investigates the modeling of wind turbine blades as beams with different kinds of beam elements. The wind turbine blades are investigated with respect to static deflections and with respect to the first three free eigenfrequencies. In the investigations both a modified version of a classical beam element is used as well as a statically determinate beam element which is better at handling beams with varying cross section parameters.

WHY IS IT A GREEN PROJECT?

The project itself might not seem like a very green project – for instance it does not directly affect the overall carbon footprint. It is a very green project though – indirectly! It will be possible to design a wind turbine blade all on paper - with respect to the structural properties. Therefore the project has a lot of green perspectives. It CAN improve the material consumption, since it will no longer be necessary to produce a wind turbine blade and then test it in a “trial and error”-way as it has been and partly still is in the wind turbine industry. The project is therefore green – maybe not in a direct way, but it has some very green byproducts that could help the world with the current climate problems.

FOR THE TECHIES

The standard beam elements have been modified, so the stiffness matrix is no longer predefined from length, bending stiffness etc. Instead a three-dimensional beam element is modified so that it makes numerical integration and determines the stiffness matrix in that way. The element then contains information of moment of inertia with respect to the axes, axial stiffness etc. in distinct points of the element. If two points are known, linear interpolation is used and if multiple points are known then cubic spline-functions are used to interpolate the data.
The statically determinate beam elements have been suggested before by Jan Høgsberg and Steen Krenk. This kind of element is ideal because it is analytical correct even though the cross section parameters are not – opposing to the standard beam element, which is only analytically correct when the cross section parameters are constant. The same method of interpolating the data is used for the statically determinate beam element as for the standard beam element.

CONCLUSION

The project is at the current time (May 2012) still running and all of the data have not been analyzed yet, so the total improvement of the elements is still not fully determined. Some of early conclusions are clear though – the modified standard beam element is able to calculate the correct first eigenfrequency of a 62.5 meter long wind turbine blade with an error margin of less than 0.8% when using only 3 elements and 40% of the structural data for the blade. And that is a time saver when calculating on bigger constructions, a whole wind turbine and so on. Indeed very interesting. So come say hi to us in June and hear how it all ends – and how we hopefully can help the world become greener in a smarter way!

Development of Concepts for Handling Firewood for Wood-Burning Stoves
Reducing Cases of Burning Moist Firewood

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INTRODUCTION

Burning moist firewood is a common problem, which leads to particle emissions and loss of energy in the firewood, both due to low combustion temperatures. The main problem is that it is difficult for many users to estimate the correct moisture-content of the firewood. Often the users do not store the firewood properly, keeping the firewood from drying fast. Two concepts were developed to solve these problems in order to reduce the number of cases with users burning moist firewood. The dry firewood provides up to 25 % more energy, making the use of wood-burning stoves more sustainable and less polluting.

ABSTRACT

Burning moist firewood most often happen in the group of users of wood-burning stoves, who does not have the stove as their primary source of heat. This group of users buys their firewood from retailers in amounts of 2 m^3 as either “air dried”, containing about 25 % water, or “oven dried”, containing about 20 % of water. The users find it difficult to estimate the correct moisture content of their firewood, which leads to burning moist firewood. It adds to the problem that the firewood is often not stored properly: covered from rain with a roof, lifted off the ground and with plenty of air-circulation. This was concluded through user-interviews, visits and analysis of the data collected on field work. To obtain a combustion temperature high enough to reduce the emission of particles, the firewood should contain less that 18 % water, but optimally about 15 % water.

The first concept is short pieces of firewood. Regular pieces are 0.35 m long, but these will be 0.15 m. Results of drying-tests, performed for Copenhagen University by A. Bergstedt, show that short pieces dry faster than long pieces, but they also absorb moisture faster, which emphasizes the importance of proper storage. Storage and doubt-issues are solved by the other concept; The Cassette. The Cassette will isolate the firewood from moisture, drying it actively by circulating dry air around it. The moisture content will be measured by either moisture-content of the air in the cassette or the total weigh of the firewood. LED’s will show when the firewood is ready to be burnt: Red for too moist, green for dry enough.

Calculations show that drying 2 m^3 firewood, from containing 25 % water to 15 % water, will provide the user with up to 25 % more energy when burning the firewood. By only burning dry firewood, the users will only have to buy 2 m^3 instead of 4 m^3 to cover their required amount of energy, 2400 kWh/season, since 2m^3 of beech containing 25 % water will provide about 2120 kWh and 2 m^3 of beech containing 15 % water will provide 2650 kWh (more than the energy needed for one season).

This way the user can halve the amount of firewood that must be bought every season. The amount of particles emitted by burning firewood will be lowered in general and the users will be able to use their wood-burning stoves in a more sustainable way by using less firewood.

Continuous Enzymatic Production of Biodiesel in CSTRs in Series

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The demand for biodiesel (BD) is growing as a result of increased focus on reducing greenhouse gas emissions. However, today most biodiesel is produced from edible vegetable oils such as rapeseed oil. In order to use more sustainable raw materials new processes has to be developed, since the traditionally chemical catalyzed processes has difficulties handling the high free fatty acid (FFA) content of low grade oils, such as used cooking oil, algae oil or jatropha oil.

An enzymatic catalyzed reaction could solve the problems handling high FFA content feedstock and would furthermore result in lower costs e.g. fewer process steps, and improved glycerol quality. To date, soluble liquid lipases have not drawn much attention in the scientific literature, unlike their immobilized counterparts, because of the requirements to reusability to make the process cost-effective. However, soluble enzymes are cheaper, and not inactivated by glycerol and colloids [1]. In this study soluble liquid lipases have been used to catalyze the transesterification of rapeseed oil with ethanol into fatty acid ethyl esters (BD). Since BD is produced in huge quantities a continuous production is necessary and a suitable process layout could include several continuous stirred tank reactors (CSTRs) in series. In order to determine the optimal configuration of three CSTRs in series, reaction kinetic data has been collected in batch experiments and based on a Levenspiel plot the reactor volumes have been calculated. The calculations have been validated experimentally and the steady-state conversions in the three reactors found to be 61%, 80% and 93% respectively, with a total residence time of 24h. A way to make the productivity of the enzymes higher is by recirculating the aqueous phase containing the enzymes, but this is only worthwhile if enzyme activity is retained. It was found that 78% enzyme activity was preserved even after four reuses of the enzymes, proving that recirculation of the aqueous phase is possible and should be further investigated in an effort to make the enzymatic biodiesel process profitable.

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Experimental Determination and Modelling of Reaction Kinetics for the Desorption of CO2 from Aqueous MEA

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ABSTRACT

The world's ever growing need for energy, and the rising standard of living in developing countries like China and India puts a great strain on the climate of the Earth. Also, the growing need for energy in already established industrial nations like the United States and Russia adds to the pressure on the climate. Carbon dioxide, released by the burning of fossil fuels, is a major contributor to the rising emission of greenhouse gasses and must be reduced in order to mitigate the climate changes. One technology that can be applied to capture the CO_2 is post-combustion capture. The advantage when using post-combustion as a way to reduce CO_2 emissions is that it is applicable to the majority of already existing coal fired power plants. This means, that post-combustion presents us with the greatest near-term potential for reducing emission, because it can be retrofitted to existing power plants. The post-combustion capture of CO_2 is most often done by reversible absorption with aqueous amine, because CO_2 and amines react to form water soluble compounds. The amine-CO_2 solution is then passed through a desorption unit, where the CO_2 is separated from the amine, which is in turn regenerated and recycled.

A major issue, however, is the reduced efficiency of a power plant with a post combustion CO_2 capture unit. The capture unit itself requires a significant amount of energy, which would increase the cost of electricity by as much as 20%. This is caused by the great amount of heat required for solvent regeneration, CO_2 compression and purchasing of construction materials. It is therefore of great importance to develop carbon capture units that are energy effcient and relatively simple to construct. This project focuses on the desorption part of a post-combustion carbon capture unit. The long-term goal is to provide an effective design proposal for the implementation of a desorber into the existing CO_2 absorption section of the carbon capture pilot plant at The Technical University of Denmark (DTU).

Experiments with a heated pressure cell and subsequent mathematical modelling have been utilized to investigate the reaction kinetics of desorption of carbon dioxide from an aqueous monoethanolamine (MEA) solution. Through 43 experiments using 30 wt% MEA with an approximate CO_2 loading of 0.3 a mathematical mass balance model based on the carbamic acid reaction mechanism has been constructed in order to evaluate the reaction kinetics. The experiments cover a pressure range from 1 bar abs. to 5 bar abs. and a temperature span from 353 Kelvin to 393 Kelvin. The amount of CO_2 in the exit gas from the pressure cell was measured and the Barium chloride method was used to analytically determine the concentration of CO_2-MEA complex in the aqueous mixture before and after each experiment. The key findings in this project are; the reaction order and reaction rate coefficient for the liquid phase reaction.

Prior to the collection of experimental data a versatile and simple experimental setup for measuring the desorption of CO2 from various solutions of different alkanolamines was constructed. The majority of the results obtained from kinetic data indicate a reaction order of approximately 1. However, some data for lower temperature experiments (363 K) indicates a higher reaction order of magnitude 3. The reaction rate constant was found to increase with temperature from 5.72E-5 at 353 K to 1.4E-3 at 393 K, but to be unaffected by the pressure.

Analysis and Optimization of Heating and Ventilation Systems for the Industry

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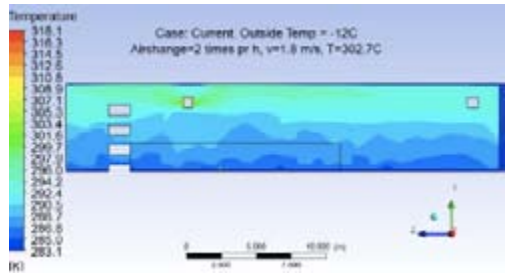
INTRODUCTION

The project has been created in collaboration with Aasted ApS and Force Technology. The project has focused on how to improve the heating systems in factory facility with outdated heating systems (heating the ventilation air) to reduce waste of energy in an economical beneficial manner for the facility owner. The project has been two faced: Firstly, it has addressed how to select a new heating system for the site. It has investigated different possibilities, how these possibilities compare economically and in energy efficiency, and solution for the facility has been proposed. Secondly, the project has investigated how the fresh air will be distributed in an optimal manner in the manufacturing facility by using Computational Fluid Dynamics and experiments. The project is also generalized to alike situations.

THEORY

In this project mainly three theories are used: The theory of indoor environment, the theory of heat transfer and the theory of computational fluid dynamic. A large part of this project is based on analytical heat transfer calculations. These are based on Fourier's law of conduction, Newton's law of cooling and Stefan-Boltzman's law of radiation.

RESULTS



Figur 1: Temperature distribution on existing facility simulated with CFD

As the results show, there is a notable vertical temperature difference, where the cold air is located in the bottom of the room. This is also what we have been measuring in a room with similar dimensions and heating system.

CONCLUSION

It is not possible to develop a simple model for choosing heating and ventilation systems. It has been shown that heating and ventilation should be based on occupied zones. It was proposed that the specific facility should adopt radiation heating combined with fresh air ventilation in high levels.

Stress-skin element - SDE

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The College Climate Campaign

Mads Øhlenschlæger

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In recent years consumers are using more electricity, water and gas in their everyday life. Especially younger people use more than an average person; according to studies up to 20 % more (Rasmussen, 2012). A campaign in 3 DTU-dormitories addressed this problem, trying to reduce the consumption for around 1000 people living in the three dormitories P.O.P, Bergsøe and Trørød. The overall goal of the campaign was a reduction of 15 %. The most important goal though was to encourage the residents to think about environmental issues. By doing so in their own home, the hope was that they would bring the learnings with them in their future career, which is an engineering career for most residents. Another goal was that the campaign should be a kick-starter for other dormitories wishing to do the same. With potentially 40.000 residents living in dormitories in Denmark, spreading a project like this could have an enormous impact on consumption, which is the easiest way to save energy.

The campaing was, amongst others, supported by some of the biggest engineering firms in Denmark, such as Dong Energy, Rambøll, Alectia, Haldor Topsøe and Grontmij. Furthermore Lyngby-Taarbæk- and Gladsaxe Municipality supported the project, along with Tuborfondet.

The result of the campaign was a reduction in the use of electricity, water and gas, averaging 11 % compared to the year before. The overall conclusion is that an energy saving campaign made by students for students is an effective tool for reducing the consumption.

Greener Sunscreen

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PERSPECTIVES

Sunscreen is a global product produced and applied in large quantities. Even small reductions in material utilization make an environmental difference. In sunscreen, physical filters often consist of titanium dioxide (TiO_2). Replacing the bulk form of TiO_2 with its nanoform can induce such a material reduction. However, TiO_2 nanoparticles exist in the main crystal structures anatase and rutile. Concern has risen that anatase and rutile possess inherent adverse properties. It is crucial to select the least harmful structure to reduce the impact on human and environment.

APPROACH

The use of TiO_2 in products for surface treatment has revealed a side effect of TiO_2 acting as a self-cleaning agent. UV exposure induces the ability of TiO_2 to degrade organic material as algae on window glass. These properties have caused concern about the impact of sunscreen particles on humans and thereby accelerated toxicology studies on nano-TiO_2. In attempt to clarify the toxicological properties of anatase and rutile, *umu*C genotoxicity tests on *Salmonella typhimurium* are performed. The *umu*C test is a relevant tool as the test proceed in three important phases; exposure, growth and inhibition. To simulate environmental conditions for sunscreen utilization, the *umu*C test is combined with UV exposure, which to date is an unpublished technique.

CONSEQUENCES

The *umu*C tests assessed anatase as more genotoxic than rutile. A mixture with high fractions of anatase and low fractions of rutile approximated the toxicity of pure anatase. Tests with coated crystal structures indicated the same trend but with reduced toxicity. The effect became more significant when combined with UV. In fact, the combination of UV and nano-TiO_2 was capable of severe inhibition in growth of biomass even for exposure in 30 seconds only. Low concentrations of nano-TiO_2 appeared more genotoxic.

Replacement of bulk TiO_2 in sunscreen with nano-TiO_2 is a necessary action to reduce material consumption. However, the nano-crystal structure anatase TiO_2 is more toxic than the structure rutile. Especially exposure with UV enhances the effects and sunscreen is established to protect against UV sunlight; an unavoidable combination. Thus, for physical filters in sunscreens, rutile should substitute anatase to diminish adverse effects on humans and the environment without compromise on protection efficiency. The study verifies science on human toxicology must not be disregarded as a sustainable and necessary technology.

Energy Harvesting from Sunlight in Window Panes

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Patterned nanostructures can be implemented in windows to reduce the amount of heating in buildings due to sunlight, and thereby reducing the energy required for air conditioning. IR-light is solely a source of heating, and so instead of using energy to cool overheated rooms due in part to IR-light, it would be advantageous to harvest the energy in the IR-light. Many other designs are already addressing the idea of reducing heating of rooms due to sunlight by adding functionality to windows, such as adding anti-reflective coatings to reflect all non-visible light. But it would be smarter to use the sunlight instead of just reflecting it. With this in mind transparent solar cells have been demonstrated, but with lifespan much lower than the lifetime of windows. This project explores the idea of an intelligent window utilizing a smart pattern of grating couplers to redirect IR-light from incident solar light. A grating coupler is a simple 2D grating structure on a guiding layer which is designed to couple incident light of specific wavelength into the plane of the guiding layer. By imprinting grating couplers and wave guides onto window surfaces, it is possible to partially redirect IR-light from incident sun light. This does not only reduce heating and need for air conditioning, but also harvests the light by guiding the coupled light to solar panels at the sides of the window panes. The solar panels would also be efficiently used since guiding the light increases the intensity, by confining it spatially in a small waveguide. A grating coupler structure is quite durable under proper isolation, and is a potential alternate solution to the issue of light control in rooms. A disadvantage though is that the design is quite rigid. The coupling efficiency is highly dependent on the angle of incidence of the light, and therefore the position of the sun. Unless this could be accounted for, the grating couplers would only be 'active' a few hours a day. So reconfigurability with regards to the coupling angle would be a major improvement. Having a layer of liquid crystals could be the answer to achieving reconfigurability, since liquid crystals have a refractive index which is tunable by an applied voltage. The coupling angle is determined, among other parameters, by the refractive indices of the different material layers in the grating coupler structure and therefore liquid crystals could be used to optimize the coupling angle with regards to the position of the sun. Employing liquid crystals could also enable an on/off function, switching the coupling off in wintertime. One could imagine an automatically optimized thermally actuated (intelligent) system that activates when the sunlight has a threshold intensity, and then regulates the coupling angle to always maximize the redirection of IR-light. Further benefits of grating coupler systems designed for IR-light are that such systems are mass producible micrometer sized structures. A large scale production should be possible using different parallel production techniques such as UV lithography or nano imprint lithography and other well known techniques. With these techniques waste is greatly reduces while simultaneously being treated properly and not being spilled to the environment as hazardous material. One advantage is also the possibility to construct self-contained or closed systems, with the window as the power source. The system could include electrical devices such as air conditioning systems or an energy storage unit. A closed system would allow an easy installation in everyday homes. It might even be possible to connect the window to the electric grid of the house and have energy production to the household. Every year 11 billion dollars are used for air conditioning alone in the USA, and this corresponds to about 100 million tons of carbon dioxide emissions each year. Thus there is plenty of room for new and innovative solutions, which could be turning windows into heat controlling, energy saving and energy generating devices by implementing grating couplers in them.

Solar Cavity Receiver for a Stirling Engine

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In this Bachelor thesis a solar cavity receiver together with a parabolic concentrating mirror has been designed for a Stirling engine, which traditionally runs on gas or bio-fuels. These design changes make it possible to run the engine on solar energy. This Dish-Stirling system has been designed with cost in mind, so it could be used in third world countries, thus cheap materials and production methods have generally been preferred over high performance and efficiency.

In this thesis, a thorough analysis of the concentrator, the receiver, and the cavity is made. The analyses was based on heat transfer, thermodynamics, and geometry calculations. These analyses resulted in a final design, which was compared to the existing gas-fired engine. An analysis of storage options was carried out, along with an economic analysis, in order to determine whether it is economically justifiable to invest in a Dish-Stirling system.

The final design of the receiver is seen in Figure 1. The tubes have been designed to capture all the incoming radiation from the sun.

Figure 1: The final receiver design

An economic analysis where the Dish-Stirling technology is compared to the photovoltaic technology was carried out. It was found that both technologies require subsidies to be economically justifiable, and that they are very similar with respect to pay-back period. In this relation examples of possible buyers was given and the perspectives of the Dish-Stirling technology were investigated. The analysis showed that the technology has great potential in small-scale decentralized energy production, for example in rural villages in third world countries.

Modelling of an Advanced Waste Heat Recovery System for a Marine Diesel Engine

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The temperature of the exhaust gas of a marine diesel engine is generally between 250-500C^{o}. This heat is usually used to heat water for different heating purposes onboard the ship, however a vast amount of the energy in the exhaust gas is never used. Some modern ships uses a Rankine steam process to generate electricity to the ship from the waste heat in the exhaust gas, however the Rankine process is not ideal for such low temperatures.

The use of the Kalina Cycle for waste heat recovery is therefore investigated.
The thermodynamics and processes of the Kalina Cycle are described in detail, and a suitable configuration for waste heat recovery on marine diesel engines is presented. Configurations to improve the efficiency and thereby increase the electrical output are suggested and analysed as well.
By using the Kalina Cycle for waste heat recovery the overall efficiency of the energy system onboard the ship can be improved, thereby reducing emissions and reducing the fuel cost.

The Kalina systems are simulated in two cases; Case 1 where the exhaust gas has a lower temperature limit of 160C^{o} due to a high sulphur content in the fuel and Case 2 where the fuel is assumed without sulphur resulting in no lower limit of the exhaust gas temperature. This is done to show how changing from Heavy fuel Oil (HFO) to a fuel with lower sulphur content (such as natural gas) could result in higher efficiencies of the energy system and again reduce emissions further.

Simulations results were compared to results from a dual pressure Rankine waste hear recovery system. This showed that the Kalina system has a clear advantage over the Rakine system as it is more suited for lower temperatures.

The traditional engine system has an efficiency of 50.19% without a waste heat recovery system.
The Kalina cycle as waste heat recovery can increase the overall efficiency of the engine system, running on HFO, from 52.76% to 53.80% an improvement of 1.04 percentage points compared to a engine system using a Rankine waste heat recovery system. The highest efficiency was obtained for Case 2 where the Kalina system resulted in an efficiency of 55.22%; an improvement of 5.03 percentage points compared to the traditional engine system.

The improvements to the overall efficiency of the energy system will result in a significant emission and fuel cost reduction.

Optimizing rudders to minimize fuel consumption

Martin Hjorth Simonsen

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[2]DTU Mechanical Engineering, Technical University of Denmark
[3]FORCE Technology

More than half of all transportation of goods is done by ship. The reason being this way of transportation is much more cost effective and less polluting than other means of long distance transportation. Even so great focus should be taken on minimizing the effect this form of shipping has on the environment. As a minimal reduction in emissions will result in a great relative reduction. Many measures of minimizing fuel consumption have already been taken, but many have yet to be explored.

The goal of this project has been to minimize the force affecting rudders by optimizing rudder specifications. More specifically by altering three main variables of the rudder, as the general profile of rudders have been greatly optimized by the flight industry. This was to be done so the ships maneuverability still meets the requirements presented by the UN organization IMO.

The project has been carried out in collaboration with FORCE Technology.
The manoeuvring and calculation of the force acting on the rudder has been done by simulations using the DENMark1 model, a simulation program developed by FORCE Technology. For the means of optimization the force has been calculated at maximum velocity only. An optimization method has been utilized to find the specifications of the rudder resulting in minimal force. Further analysis of the results have then been made to conclude in which extend these specifications may be altered, still giving a near minimal force acting on the rudder.

The tests have been done on two different kinds of rudders, one conventional type and one flap rudder. From their original specifications the force acting on the rudders could be minimized by approximately 40% for the conventional type rudder and approximately 55% for the flap rudder. The further analysis of the rudders with optimal specifications has shown that two out of three specifications may be altered together within certain bounds without significantly increasing the force acting on the rudder.

In conclusion there is with certainty room for optimization, but further research should be done in a greater variety of sailing conditions to obtain a larger perspective on exactly how much the force acting on the rudder can be minimized. The final program is though tuned to be able to find the optimal rudder specifications given other sailing conditions.

BACHELOR THESIS
POSTER
TRANSPORT

Pneumatic Regenerative Braking System for Vehicle

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ABSTRACT

Throughout the later years there has been an increasing focus on the development of technologies which can reduce the need for fossil fuel without limiting the yielding capacity. Cars have a great deal of the focus about the use of oil. With 10% of the world's populations owning a car and expectation of the world car park tripled in 2050[1] it is crucial to limit the use of fuel for vehicles. The efficiency improvement of vehicles is how to limit the losing of energy (e.g. braking, idle and external energy demanding utilisation) and especially the loss of energy while braking and idling is staked to 40% of the total energy use. Several of these hybrid techniques are continuously under development and they "competes" against each other with the purpose of limiting the need of fossil fuel and to run a vehicle with best overall efficiency. Equal for all hybrid technologies are that they avoid the loss of energy.

Pneumatic hybrid vehicle (PHV) is a technique that could work without adding advanced and expensive materials or components – thereby it would be simpler and cheaper. The option to use air as thrust giving fuel has no pollution and letting a compressor inverting brake energy into compressed air stored in air tank - it would be free to run. With automakers downsizing their engines to reduce engine friction, the kinetic regenerated compressed air has better circumstances as thrust giving fuel. To store compressed air and use it in e.g. four-stroked ICE, it won't have any combustion gasses while running on compressed air. Therefore, to achieve higher efficiency the engine would have to run as two-stroke. To control this, the valve control is a complex matter [4] duo to the shift from combustion and pneumatic mode. Research by L. Guzella et al.[2] has shown fuel improvements up to 35% on gasoline engine approximately the same efficiency as electric hybrid but by far less cost and less complex technique. By implementing the pneumatic technique in the ICE the interaction would be smooth and less complex and costly as with flywheel, electric and fuel cell - thereby improves the driveability for the hybrid vehicle.

Downsizing improves fuel consumption 12-17%[3] and lowers emissions by basically fitting a smaller engine with a turbocharger. A side effect from turbocharged downsized ICE's is turbo lag at lower revs. With storage of compressed air, turbo lag can be minimized thus, downsizing and pneumatic hybrid shows promising.

The result of pneumatic hybrid is: No external implementation exept pressure tank, made by easy recyclable materials as: cast iron and aluminium, low costs.

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Nobuhiro Ito, Tohru Ohta, Ryuji Kono, Satoshi Arikawa and Takaki Matsumoto

Reaching the Frontier – a Green Approach to Space Travel

J. D. Stets[1], M.R. Peris[1], J.P. Bjerre[1], J. Dubuc[1], D. Tcherniak[1], P. Eysturskard[1], M. Strømsted[1] and M.B. Pedersen[1]
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INTRODUCTION

NASA has recently discovered that the concentration of antimatter particles trapped in the Earth magnetic field is 1000 times larger than previously known. The population of these high energy particles is constantly regenerated by reactions of cosmic rays with particles in the upper part of the Earth atmosphere.

When an antiparticle collides with a normal particle, both particles are converted into pure energy which makes antimatter the most efficient fuel source known. Using antimatter as a rocket propellant would save large amounts of rocket fuel, which is not only known to be highly pollutive, but is also a limited resource on Earth. A few milligrams of antimatter would be enough to send a spacecraft to Mars and back in a month, and provide a step stone for the humanity to enter the interstellar flight era.

ABSTRACT

The discovery made by NASA opens up for a discussion on how the antimatter can be gathered and used. During this project we have done the preliminary design of a small scale spacecraft for antimatter collection.

It is impossible to store or capture antimatter by normal means, which involve physical contact. Therefore, our spacecraft makes use of magnetic and electrostatic fields. A strong magnetic field is generated by superconducting coils, this magnetic field is used to alter the trajectory of the high velocity antimatter particles thereby increasing their flux though the spacecraft. Electrostatic fields in combination with thin foil layers placed around the spacecraft are acting as an energy degrader, which slows down the particles and transfers them into the trapping area around the superconducting coils. The thin foil layers and the direction of the electric field lines are oriented in a special way, which ensures that as big as possible amount of antimatter particles is trapped, while normal matter is filtered away.

The superconducting coils are passively cooled by a system of radiators combined with flexible parabolic heat-shields, which change shape depending on the orbit position of the spacecraft. After the initial charge up of the superconducting coils they go into persistence mode, where the energy is trapped inside the coils. Therefore almost no additional energy is required to sustain the magnetic field. This makes it possible to power the entire spacecraft by a small solar power array.

This project shows that it is possible to create an antimatter collection spacecraft with today's technology. This project concerns a small spacecraft; however, the design is scalable, which allows for larger antimatter collection ships, making green interstellar flight possible within a foreseeable future.

Characterisation, Dimensioning and Manufacture of Bio-Composites

Andreas Okholm, Mathias Rask, Frederik Skovgaard

INTRODUCTION

This report has been submitted to the Department of Wind Energy at the Technical University of Denmark in partial fulfillment of the requirement for the special course "Characterization, Dimensioning and Production of Bio-Composites" at special course at DTU RISØ.

In the report the focus is on the rheological properties of bio-resin and the structural properties of the nature fiber reinforced (NFRP) composites. And the parameters around the process of making a high performance part for the automotive industry in comparison to a similar part made of carbon fiber.

Through flow and viscosity experiments it was found that the generation Entropy Resins bio-resin is comparable to HT2 epoxy system available from R-G. Furthermore studies of the bio-resins temperature related properties reveals that higher than room temperature infusion conditions provide a noticeable boost to its flow performance with regards to vacuum infusion.

Both a flow and finite element model is used to evaluate whether the final design is. The flow model developed can also be used to determine the maximum infusion length.

Lastly a prototype bio-wheel was constructed in flax fiber and balsa wood, with the characterized bio-resin. Which has no end-of-life issues and has a much small environmental impact than the CFRP-version.

Nano-metal Esterification

Simon Suhr Borkenfelt, Jesper Brandt Rasmussen, Nanette Zahrtmann, Trine Marie Hartmann Arndal, Anne Margrethe Loft Andersen

DTU Chemistry, Technical University of Denmark

Esters constitute an abundant functional group in natural and synthetic organic compounds. This makes esterification one of the most important processes in the formation of organic products and platform chemicals. Simple esters are synthesized from alcohols and acids at elevated temperature and pressure using harmful drying agents leading to difficult waste streams. The alcohols and acids for synthesis can be produced from aldehydes by heterogeneous and homogeneous processes (Anthony G. Abatjoglou, 2011) and the direct esterification of aldehydes could thus circumvent these intermediate operations.

This project is an attempt to design a direct synthesis of esters running at room temperature and normal pressure with a solid catalyst and without the formation of by-products. The aim is to reduce both energy consumption and the use of harmful chemicals in the synthesis of organic chemicals. This is achieved by the use of solid nano-metal catalysts, most commonly gold, that enable oxidation of aldehydes, e.g. from biomass, to esters using only oxygen and alcohol as reactants.

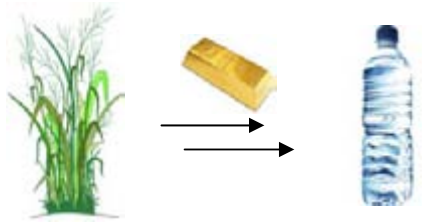

Figure 1 From biomass to consumer goods

Catalysts with three different metals are prepared and tested for the oxidation of benzaldehyde into its corresponding ester, methyl benzoate, as sole product. Apart from gold nano-catalysts also platinum and palladium catalysts are prepared and tested. The catalytic testing is carried out in a liquid mixture of methanol and benzaldehyde in the presence of a surplus of oxygen at normal temperature and pressure. Samples are taken at selected times and analyzed by Gas Chromatography.

Conversion and selectivity towards the product are found for each of the tested catalysts. Preliminary results show conversions up to100 % and yields up to 90 %. This indicates that the optimized catalyst is able to fully convert benzaldehyde into methyl benzoate under mild reaction conditions without the formation of by-products and within reasonable time.

In conclusion, efficient esterification can be accomplished with a solid nano-metal catalyst without the use or formation of unwanted or environmentally harmful products. The major contribution to the carbon footprint of the process stems from the use of oxygen. This can be minimized by applying atmospheric air in the reaction. Further work in terms of catalyst characterization, preparation optimization, and operational optimization is needed in order to fully investigate and understand and commercialize the catalytic systems presented.

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A solar powered reusable booster rocket

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To decrease harmful emissions from rocket launches and create a genuine low cost launch-on-demand space infrastructure, I propose using beamed solar power energy from Concentrated Solar Power (CSP) plants to power the first stage of a reusable Launch Vehicle (LV).

By focusing mirrors from a high capacity CSP plant onto a flight trajectory path, it is possible to create a moving high energy region that can be collected by the LV using a heat exchanger. This eliminates the need for toxic propellants currently in use on other LVs. The concept allows for complex parts to stay on the ground, simplifying the space plane design and increasing the likelihood for greener, cheaper and more space launches.

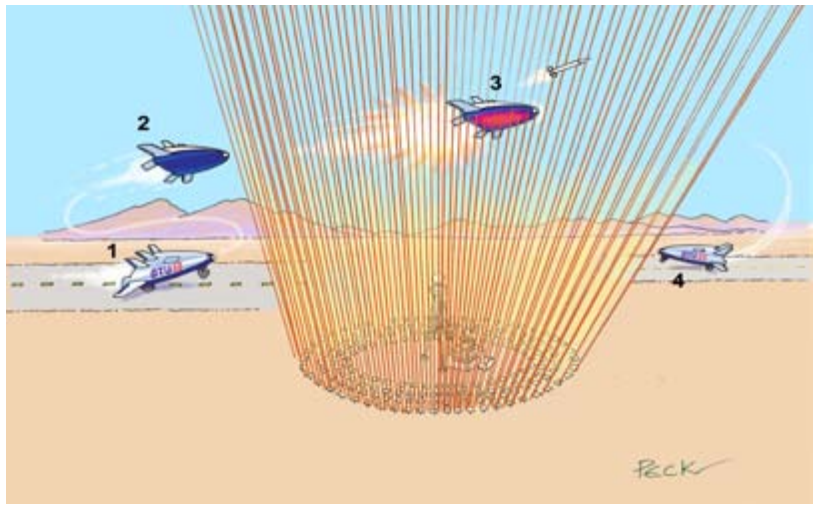

Figure 1: (1-2) LV takes off like a normal airplane and climbs to a fixed initial trajectory point. (2-3) LV collects beam energy and converts thermal energy into thrust, accelerating to a cutoff point. (3-4) LV releases expandable orbital 2nd stage. LV then returns to the airfield like a normal airplane.

The project is a proof of concept, focusing on verifying two crucial elements in the launcher infrastructure;

- Identifying potential sources of energy losses in the system to estimate the efficiency.
- Investigating the total velocity boost capability of the system by performing a multivariable optimization

Solar Powered Audio System

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INTRODUCTION

On music festivals such as Roskilde Festival, many of the guests bring their music systems. This can be anything from an old fashioned transistor radio to a car stereo system. In common for all of these systems are that they are powered by batteries, of which many are abandoned by the guests when they leave the festival.
Besides offering a solution to reduce the required battery mass, this project also offers a convenient and self-sufficient music system powered by photovoltaic panels, using state of the art, highly efficient audio amplification techniques.

THE SYSTEM

The festival guest requires their audio systems to be functionally many hours a day for periods exceeding a week. A traditional battery powered solutions this gives the festival guest 2 options:

- Bring enough pre-charged batteries to power the system for the entire period.
- Bring at least two batteries and find somewhere to charge the battery not in use during the festival.

Both of these solutions are inconvenient and requires a relatively large battery mass.

By using a combination of a photovoltaic panel and a battery, this project can not only eliminate emissions, but also drastically reduce the total battery mass, since the system at no time needs to store more energy than the amount required to power the amplifier during a single night.
This is a much more convenient solution for the user. Not only is the mass of the overall system reduced, but the only thing the user has to do to maintain power on the system is to position the system out of the shadow. This can, of course, be done without having to turn off the music.
As en extra convenience for the user the system is also equipped with USB ports for charging mobile phones during the day.

The electronics in the system is designed with focus on high efficiency. The audio power amplifier is a highly efficient Class-D topology and care is taken to operate the solar panel around is optimum operating point. The USB charging system is powered bt a highly efficient switch-mode buck convereter.

Energy efficient and reliable operation of railway switches and crossings during winter - the fixed link across Great Belt as case

Rikke Holm Christensen and Peter Tofte Philipsen

DTU Transport, Technical University of Denmark

INTRODUCTION

During winter times ice and compressed snow can cause problems with the operation of the switches, which can cause delays spread in the railway network. Removing ice or compressed snow is crucial to operation during winter times, but the current methods are inefficient and energy consummating. This project will have the fixed link across the Great Belt as case, but most of the solutions, can be applied to the national railway network, if not already existing there. On a yearly basis, A/S Storebælt uses 900.000 kWh on heating their 37 switches, meaning that there is a lot to be saved, if heating and removing the ice and snow can be made more effective.

THEORY

The chunks of ice will most frequently come from underneath the trains. When going through switches, the vibrations can cause chunks of ice, coming from underneath the trains to fall off and into the switch, preventing it from operating reliably. Today, the switches are heated by heating units placed on the foot of the rails, by clips. The fixed link across the Great Belt has 37 switches located in Nyborg, Korsør and on Sprogø, and the structure of the system entails that either all or none of the heating units at one station are switched on.

METHODS

There are several methods for avoiding ice and snow in the railway switches. In the project we investigated a few of these methods. The systems investigated are

- System 80, currently in use on the fixed links across the Great Belt
- System 2000, currently in use on most of the national railway network
- A Swedish induction system that A/S Storebælt is currently considering

These systems are also considered in some combinations with surveillance of the switches in order to remove ice or snow, only when necessary.

RESULTS

The induction system on combination with increased surveillance will definitely make operation of the switches more energy efficient, as the heat will only be turned on, when necessary. Up to 70% of the switches are not used during daily operations, and since the induction system can heat just one side of the switch, up to 85% of the time a heating element is on, can be saved, if the heat is only turned on, when necessary.

CONCLUSION

There are definitely improvements to be made on the energy consumption used by A/S Storebælt for ensuring that the operation of switches is energy efficient and reliable. Our estimated energy conservation is approximately 500.000 kWh per year at the Great Belt.

Solar Powered Airship for Cargo Transportation

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INTRODUCTION

Cargo transportation is known as one of the main sources of CO2 pollution on earth. A green solution to this problem is to use a solar powered airship to transport goods from one point to another. Besides its green operation, the airship will be especially beneficial when transporting goods to and from deserted and hard-to-reach areas.

ABSTRACT

The demand for cargo transportation is rising as the international markets are opening, and more and more goods are shipped across borders all over the world. One of the critical CO2 pollution sources comes from cargo transportation, whether it is by truck, ship, airplane or train. As the logistic networks are expanded they are also made more efficient. However, making the cargo transportation more efficient will never change the fact that cargo transportation today mostly is driven by fossil fuels, which is a limited resource on earth.
A green solution to this problem is to use a solar powered airship. The airship is only driven by solar cells attached on the outside of the airship body, and it is equipped with a battery that makes it possible also to operate at night time. The propulsion and handling comes from high efficient DC motors that are controlled by a central computer. The airship is designed to operate at a height where it does not disturb the air traffic nor is visible from ground. The airship is traceable at all times, which makes it easy to monitor. In the project a small airship is considered but the design is easily scalable. This would be a step towards moving modern cargo transportation in a sustainable direction.

Integrating Waste Control at Major Events Through Application of Fun Theory

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INTRODUCTION

The project was based off the 'Roskile Entrepreneurs' initative that wanted to better the waste handling at Roskilde Festival. The purpose was a change of attitude towards how the guests perceive the waste they produce at the festival in order to minimise the local environmental impact of the event. To meet this purpose a mechatronic interactive environment was designed and built at one of the Agoras at Roskilde where trash could be traded for events.

THE PROJECT

The project added to the realm of 'Fun Theory' with the dogma that people will do a task if it is fun to do. By corporating art and design into a trash can, the task of collecting and handing in waste from the festival was rewarded with funny events.The trash can 'Trashy the Robot' was constructed off second hand building materials, as well as about 90% recycled electronics. By Designing and prototyping a mechatronic system of microcontrollers, infrared sensors, an old computer, and two old LCD screens, the robot would thank people when they put trash in his mouth. He would look at people with two animated eyes at the LCD displays as well as trigger random events with light, smoke, and sound. See Figure 1.

RESULTS AND DISCUSSION

The Robot was a success in getting attention to the need for waste handling. Guests went to their camps and cleaned up only to put the waste in Trashy's mouth. The area around Trashy was crowded all evening due to the light and event when people put waste in it. The concept of integrating waste handling into the entertainment is a whole new way of understanding 'green' and a way of handling the overall impact of major event. This can be rolled out to other major events that produce trash, like Distortion, sports events, and concerts.

Figure 1: Trashy the Robot in action late Thursday at Roskilde Festival

Biodas – From Waste to Energy

K. H. Krøjgaard and L. A. Hartvig

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Introduction

Waterless toilets have gradually been replaced by the water closets in developed countries throughout the 20th century. This has led to challenges regarding the wastewater treatment and comprehensive sewerage system construction. The few places left in Denmark without sewers are found in the old allotment gardens. This project is concerned with the investigation and development of an alternative toilet to the water closet that will fit into the conditions of allotment gardens. This implies a solution, which will be attractive for the users as well as an improvement for the environment. The project was carried out in the course *Holistic Design,* DTU E11, in collaboration with Jurgis Ratkevicius and Thomas Den Heeten.

Theory

The thesis behind this project is that the use of water for flushing toilets is a waste of clean drinking water as well as a degradation of the value in human waste. The idea with the waterless toilet is to protect the environment through reduced water consumption and pollution but also a possibility for reusing the energy in the waste more optimal. A long term perspective for the project is to develop popular waterless toilets, which are feasible in a country of high sanitation level.

Methods

The project was carried out with starting point in reports about toilet conditions in allotment gardens and field work where personas and criteria were specified leading to the project requirement specification. A combination of systematic and creative concept development led to 7 concepts, which was narrowed down to the final concept Biodas through use of criteria weighting and Pugh's matrix. Concept specification using CAD modeling and a physical model complemented with a business plan and system overview.

Results

The final concept Biodas consists of two main parts: 1) The toilet collects the human waste and other organic household waste in a container. This is done through a "drawer" function and a bowl cover to move the waste from the seat to a container underneath, which should also minimize the smell and cleaning. The container must be emptied by the owner every 10 days for 2 persons. 2) The system, which the toilet is a part of, revolves around the waste transportation, treatment and energy yield. The waste is treated in a biogas plant, which converts the energy in the waste into biogas and possibly electricity. The energy production efficiency depends very much on the plant size, which would make it more profitable for several allotment unions, the entire municipality or region to share it.

Conclusion

The project ended with a mock-up of the Biodas toilet, a business plan for the Biodas Company and a short report to convince the municipality to subside the Biodas. To get the Biodas on the market, we want to first concentrate on the toilet itself, getting funding to make a proper prototype and testing it with allotment garden users. Second, the biogas system should be further developed in collaboration with biogas experts.

MASTER LEVEL COURSE / PROJECT

LAPTOP

BIO ENERGY

Assessment of a novel alder biorefinery concept to meet typically conflicting demands of short term economic feasibility and long term environmental sustainability

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Abstract

Biorefineries are developed to produce the same commodities that present day oil refineries produce, and ideally they should replace old non-sustainable technologies and production patterns with novel highly efficient solutions with focus on long term perspectives and sustainability criteria. However, the short term considerations of a free market is often conflicting with long term sustainability concerns and to make a biorefinery embrace the concepts of climate change mitigation, fossil fuel depletion, long term sustainability and economic feasibility all at once is no easy task. When balancing the potential pathways and products of such a concept several competing requirements must be taken into account. These include feedstock production and availability, resource use, waste production and handling, process efficiency and integration, product requirements and necessity, potential markets, concept robustness and development perspectives, overall carbon balance and net energy yield.

In the present work a biorefinery concept based on alder tree plantations on degenerated or marginalized soils is developed, to illustrate how it is possible to comply with all the before mentioned requirements. The proposed concept is a state-of-the-art biorefinery based on alder, producing the following 5 end products:

- Heat and power from the wood
- Highly specialized value-added products in the form of diaryl heptanoids produced from the alder bark
- Process chemicals produced from the leaves in the form of ethyl acetate and ethanol
- Bio-SNG and fertilizers produced from process residuals
- Replenished soils and increased carbon sinks from long-term process operation.

The alder is chosen as feedstock due to the nitrogen-fixating symbiosis of alder trees and Frankia bacteria, which provide many benefits in terms of soil regeneration, reduced fertilization requirements, and prolonged photosynthesis and growth period. The alder has other beneficial characteristics as well making it a very interesting choice for biorefinery feed stock purposes.

The biorefinery concept is described with focus on alder management and productivity issues, and an assessment of the main products and production processes, process integration, and sustainability issues. The proposed biorefinery concept embraces the need for co-production of value added products in the energy generation, short- and long term sustainability issues, resource use and re-use, and overall process carbon balance.

The proposed biorefinery concept represents a potential outline of an upcoming extended work within alder biorefinery in DTU and is based on extended literature review and unpublished results.

Intelligent Surveillance with Autonomous Underwater Vehicles

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Introduction

Monitoring fish stocks and other sea-related tasks can be done with small autonomous underwater vehicles (AUV), instead of big ships, which are cheaper to employ and use less fuel. We consider designing a software framework for an AUV, which makes it easy to deploy.

Monitoring of fish stocks and oxygen levels

Currently monitoring such parameters requires larger manned ships by sailing back and forth over the area. This can take several weeks which makes the result somewhat outdated when they are done. By replacing the ship with several AUVs we save fuel, money and can cover a larger area in shorter time by having them swim in a coordinated fashion. It also leaves the researchers available for analysis of the data. We believe automated coordination is useful in other cases as well and that we can generalize the methods for achieving such.

Tracking movement of sea nutrition

When placing windmills it is important to avoid putting the foundation at sources of sea nutrition which are vital to the local biological life. An AUV can track the nutrition from specific sources to see how important the source is. For various reasons, tracking with divers and ships is very difficult.

Methods

In this project we solve these tasks at a high level using logical planning instead of the traditional guidance, navigation and control (GNC). The existing AUVs have systems that are able to use GNC for simple movement between points in space and our method simplifies the input for such systems. Rather than specialize an AUV from scratch for each task, we introduce methods for specifying any task at a high level of abstraction. This simplifies the employment of a system of AUVs.

Realisation

As our project is only concerned with the software of the AUV, the necessary materials are the same as the existing AUVs. They are expensive to produce but can be equipped with tools to make the it clearly visible, in case something goes wrong. This way the AUVs do not have to be replaced and they do not accumulate as trash on the sea floor. It is an open task to decrease the production cost on each physical unit and implement the lower level GNC.

Related Work

AUVs are often discussed in the international magazines Hydro International and Sea Techonology. The Kongsberg Hugin is widely popular but to our knowledge there is limited research in the automated coordinated movement between multiple AUVs.

MASTER LEVEL COURSE / PROJECT
LAPTOP
CLIMATE AND ENVIRONMENTAL MONITORING

NoiseMap

Andrea Cuttone[1], Lasse Seligmann Reedtz[1], Morten Georg Jensen[2]

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[2]DTU Management Engineering, Technical University of Denmark

Introduction

Noise pollution is becoming a problem, especially in large cities. Studies show that in daily life, 70% of people are exposed to average noise levels during a day that can cause long-term hearing damage (Flamme et. al., 2012). Many local, national and international organizations have strong interests in gathering data on noise exposure. NoiseMap is a personal informatics system for Android mobile phones that measures the level of ambient noise, and allows the user to reflect on how much noise he is exposed to.

Results

A working prototype for NoiseMap was developed as part of the course “02827 Mobile Application Prototype Development“. The main target audience of NoiseMap are:

- private citizens that want to monitor and minimize their exposure to noise
- local, national and international organizations that need to perform noise pollution measurement in cities and buildings

NoiseMap collects audio data from the microphone and location data from the GPS. This data is processed to provide different types of feedback to the user:

- Immediate noise exposure: the application displays the current ambient noise level in dB, a visual indication (a colored bar), a description of the level of risk (e.g. noisy area), and a suggested action (e.g. move away)
- Noise map: the noise level measurements are coupled with location data to create a map of noise intensities. This noise map is overlaid on a Google Maps
- History: the audio levels trends are showed as a graph over time
- Statistics: the data is grouped by time and dB levels and displayed using different graphs

A particular effort has been made to ensure that the phone microphone provides measurements with the highest accuracy possible.

Conclusion

Extensive testing of the application has been performed both by the authors and by external users. The application is able to provide valuable information regarding noise exposure and can be used to reflect on a number of elements:

- what are the areas with most noise pollution
- which times of the day or week is the noise exposure highest
- when does the immediate or cumulated noise exceeds healthy levels

Further work includes more precise measurements, additional visualizations and the possibility to submit the measurements to a shared noise map.

Effect on future sea level around Denmark from the melting of the Greenland Ice Sheet.

Geomatics Lab

Ole B. Andersen, S. A. Khan.

DTU Space,

Introduction.

Sea level change has great impact on flooding in a future climate. This will cause increased flooding, rain and inundation in many populated areas of Denmark and design of future cities should develop new solutions to handle an increased sea level around Denmark. How accurate can current sea level rise be determined from satellite and what will be the effect of increased melting of the Greenland Ice sheet on sea level rise. The ongoing accelerated melting of the Greenland ice sheet is not included in the IPCC 4 assessment report on future sea level rise.

Case

The project focus on determining the present-day sea level rise from satellite altimetry and attempts to make prediction of future sea level rise for the next 10-20-50 years. This is based on current knowledge of the melting of the large icecaps in the World. Most prominently the Greenland Ice Sheet, but also the Antarctic ice cap might have considerable effect. Establishment of a model for ice sheet melting based on in-situ and remote sensing data over Greenland will be used to derive the scenario.

Result.

Since the project is a part of the three week course “Geomatics Lab” in June 2012, obviously no results have been obtained so far, but existing research shows that current sea level rise estimates must take into account a possible accelerated melting of i.e. Greenland in a warmer climate.

Re-Charged

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DTU Mekanik, Technical University of Denmark

INTRODUCTION

The business idea of Re-Charged is to make a self-chargeable AA battery, the AA-Live battery. This will utilise the kinetic energy of motion to generate an electrical current charging the Lithium-ion battery. Using an energy harvesting element, it will be possible to produce the AA-Live battery with only a slightly reduction of capacity compared to standard batteries.

This would be of value to all who are environmental conscious, as it will decrease CO2 emissions and decrease battery waste. The value proposition when the AA-Live battery is use together with products in motion is immense. Imagine a Wii-controller or a wireless pc-mouse where the batteries are never to be changed. The business idea is to introduce the AA-Live on a niche market where the value proposition is even greater than that of a normal user. This is because the industry of batteries is highly affected by scale of production and a start-up will not be able to compete on price. This niche market will be hikers and mountaineers seeing the AA-Live battery as part of their safety equipment. The idea is novel and patentable, with the use of a combination of existing technology. The team consists of four mechanical engineers with some business skills.

There are no existing products on the market that solve the same customer pain as we intend to solve. We introduce the product as a part of safety equipment for hikers and mountaineers, and they have a greater value proposition from AA-Live, than from existing products. For most rechargeable batteries, a external charging device is need. For many cases this is acceptable, but for hikers and mountaineers, this means extra weight, due to the need of extra batteries. An existing solution for hikers and mountaineers is a solar powered charging device, but it is unreliable due to the need of sunlight.

The technologies in our AA-Live battery is separately well-known, but a combination of them in a AA-sized battery is new and unique, and therefore the idea is novel and patentable.

The business is run with a low risk model. The production of the AA-Live battery is outsourced witch reduces the need for investment to 16 mil. The potential customer base is 120 mil., form witch 1.2 mil. is expected to buy the product in the The production price is expected to start at 180 DKK, and fall to 80 DKK when the first 50.000 units is sold. This is the tradeoff from the outsourcing.

First 5 years. The sales price is 124.5 DKK, this gives an annual turnover after the 5th year of 77 mil. DKK.

Green Model for Optical Networks

Alberto Muñoz

DTU Photonics, Technical University of Denmark

INTRODUCTION – *POWER CONSUMPTION IS SKYROCKETING*

In the current Internet, the demand for bandwidth is increasing exponentially. ICT already accounts for 2 to 4% of the worldwide carbon emissions and by 2020 this share will double; projections indicate ICT will be the major power consumer by 2025. This growth rates are unsustainable and hinder economies based on know-how societies.

THEORY – *INNOVATIVE IDEAS TO REDUCE POWER CONSUMPTION*

All wireless and wired networks (i.e. WiFi, ADSL...) work over core network, which are large point to point optical connections - a core network is the central part of the telecom hierarchy and interconnects large cities. A core network has an *oscillating traffic* during day and night. At night, traffic may be even less than 10% of day traffic, whereby we are wasting resources and causing unnecessary power consumption. I propose to implement the following innovative ideas to decrease power consumption in low traffic demand periods:

- Enabling optical bypass, avoiding wasteful processing in intermediate nodes.
- Turning off underused linecards and rerouting the traffic to running links.
- Rerouting traffic powering off links with sparsely used optical amplifiers.
- Sharing optical amplifiers among channels.

METHODS – *FROM ONE IDEA TO ONE RESULT*

First of all, I designed a theoretical ring-mesh model which serves as a solid basis to study different topologies – the model is compatible with standard growth, redundancy protection and over subscription features. This model was tested with network traffic and its performance measured in term of power consumption. Relative savings of 28%, are achieved confirming our approach is tackling the issue in the right direction. I then extended the study to a commercial network - the Deutsche Telekom Network core system [Figure 1], which contains the Hamburg hub connecting Denmark with continental Europe. I ran the developed routing model with the Dijkstra algorithm, and considered the previous power consumption savers.

Figure 1. Deutsche Telekom Network

RESULTS – *SAVING MORE THAN 50% POWER CONSUMPTION*

I observed that in low traffic demand scenarios some links could be turned off and optical amplifiers pooled by different channels. Permuting among different scenarios, I observed that in low demand scenarios savings of 43% may be reached for the whole network and savings of 51% for a particular communication between two nodes.

CONCLUSION – *SAVING ENERGY AND MONEY*

The designed model could have an impact that leads to save around 34 million dkk per year.

MASTER LEVEL COURSE / PROJECT
LAPTOP
ENERGY DISTRIBUTION, EFFICIENCY AND TECHNOLOGIES

Digital Control in Piezotransformer-based Converters

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INTRODUCTION

Converters are today used in nearly all electronics from battery management in cell phones and laptops to fuel cell supplies to supply in a car.
The demand for smaller and more efficient converters are increasing as the trend of electronics in general is going towards smaller size and larger processing power.
In the struggle to obtain smaller converters, the switching frequency of the converters should be increased, resulting in high switching losses.
To decrease these switching losses, resonance converters have been a popular choice to obtain zero voltage switching leading to great improvement in the efficiency while still maintaining small converter sizes.
In resonance converters piezoelectric transformers (PTs) have proven very useful as 1 PT can replace both magnetic transformer and resonance circuit leading to magnetic-less converters with a 4 times higher power density while still maintaining high efficiency. Ultimately, this leads to converter designs where efficiency is high and where component count and use of metals are low.

BACKGROUND

Figure 1 1) Iron core transformer, eff~85% 2) Isolated Switch Mode Converter, eff~92% 3) Piezotransformer-based converter, eff~98%

PT-based converters offer benefits such as electric isolation, less risk of fire, low noise, high power density, thin structure and the option to leave out bulky and expensive magnetics.
One of the greatest challenges when using magnetic-less, PT-based converters are control of the converter, which often demands many components in order to achieve good performance. This project has investigated the demands and simulated the performance of a digitally controlled converter.

RESULTS

The results have proven to show that control of PT-based converters can be done using digital control with close to equal performance. This is evaluated to increase flexibility of the converter use and decrease the component count – leading to even greater reduction in size and material use while still maintaining high efficiency.

Zero Energy Building for DTU Building Design Bachelor

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Introduction

The new building for the new bachelor line of DTU Building Design is designed as a net zero energy building in the architectural context of the university. Besides energy consumption the project has a large focus on the Life Cycle Analysis of materials, indoor climate and total economy cost efficiency, while still aiming for high architectural standards in the experience of the facades, the area and internal flows and proportions.
The proposal can be seen as an opposition for the chosen new building 127 by Christensen og Co., which conceptual design has been made in the same period as the one for this project, but only compiling to the current building regulation. The project therefore shows the level of skills present at the department of Architectural Engineering and proposes a more ambitious strategy to the many new buildings needed at DTU in the coming years.

ReflectMe

M. Karahan, M. Olgun, and N. Marashi

DTU Digital Media Engineering, Technical University of Denmark

INTRODUCTION

In the recent years a paradigm shift has occurred within the tools available for living a self-aware life. Mobile sensing is no longer a concept practiced by scientists, and everyone with a smartphone can use mobile applications and sensors to track various aspects of their everyday life.
We have developed an application concept that goes beyond tracking numbers and displaying statistics. Our smartphone application will be capable of determining the user's context of transportation and able to examplify how the choice of transportation is having impact on the user's health, economy, and how it is affecting the environment.

PROBLEM STATEMENT

We want to develop a mobile app, which uses mobile sensing as a tool to help, or even force the user to reflect on what impacts the choices for means of transportation is having on his or her life, and on the environment.
We want to analyze how the collected data can be integrated into everyday measure units, and visualized in order to create the most effective impact, and force the user to reflect and take actions.
In connection to this, we want to investigate how we can make the application aware of the transportation context, and how we can use the context awareness in creating an engaging user experience, both in the sense of immediate feedback, as well as long-term feedback.

USERS AND USAGE

The app is targeted towards users, who can chose between automotive and manual means of transportation, and who want to know the exact trade-offs by switching from one to another. The focus is primarily on automobiles, motored bikes and public transportation vs. bicycles and walk.

How It Works

Value is given to the user by providing measurements in common, understandable units, and more noticeably by exemplifying what the direct impacts of her decisions are. Examples such as: "It takes a tree 38 days to convert the CO2 you have emitted today into oxygen", or "You have burned the same amount of calories as are in 3 BigMacs by cycling today", upraise the user's engagement level and provokes reflection and taking action.

Users will also be able to compare and compete with friends and family via social media integrated apps, which also creates awareness amongst the user's network regarding the impacts our choices on how to transport ourselves has on our health, economy, and environment.

Sustainable Facilities Management in Novo Nordisk

Fie Kring Jørgensen

DTU Management, Technical University of Denmark

INTRODUCTION

Facilities management (FM) is found in all organizations, large as well as small. The activities within FM are widespread and have, in many ways, impacts on environment as well as climate every day. It is therefore relevant to work out a framework for companies to use in order for them to analyze the company's FM activities and find ways of improving the sustainability in these activities.

THEORY

The theory used in this case is mainly regular FM theory and sustainability theory with main focus on environmental and climate impacts.

However, also theories about companies' corporate social responsibilities (CSR) are supposed to play a part in the final framework.

METHOD

In the specific case with Novo Nordisk information about the company's FM and sustainability profile was collected through the Internet, followed by semi-structured interviews with people within the relevant areas.

The interview were made in the three organizational levels, operational, tactical and strategic, to create a complete picture of the understanding of sustainable FM throughout the organization.

At the operational level the research is focused on the realization strategies and barriers/possibilities in FM processes including suggestions for innovation and sustainable improvements.

At the tactical level the research is related to the role the FM department plays in relation to the sustainable profile of the organization. Also the relations to the HR department and whether or not the department is pro- or reactive when it comes to sustainability are being investigated.

At the strategic level attention is on the overall sustainability strategy for the organization, followed by analysis of how this corresponds to the FM practices.

RESULTS AND CONCLUSIONS

Since the project and research is still ongoing, there is yet no results and conclusions. However, the general impression is that not much of the organization's sustainability profile is related to the FM activities, and that there therefore are lots of possibilities for suggestions for sustainable improvements in the department.

MASTER LEVEL COURSE / PROJECT

LAPTOP

GOVERNANCE AND MANAGEMENT

Impact Assessment of Sustainability Initiatives: Evaluation Methods

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Aalto University, Finland

ABSTRACT

Sustainability initiatives planning and implementation is a complex process that demands better decision-making capabilities. Improving decision-making capabilities call for impact assessment of different initiative in a given reference scenario. Impact assessment supports decision-makers to structure better policies for the future either by evaluating the outcome of existing policies or by anticipating the possible outcome of the initiative. The aim of this course work is to categorize available impact assessment methods in the case of sustainable initiatives besides their merit analysis.

Development of Foldable Micro Electric Vehicle

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P3 Digicar Division of Future Vehicles, KAIST, Daejeon, Korea

INTRODUCTION

The vehicle population density within major cities has suddenly increased, making road transportation and CO2 emissions management a much more difficult task. With the development of 'Fold-able micro Electric Vehicles', it will provide agility as well as lesser parking space in urban traffic conditions. Currently a prototype development of foldable electric vehicle is undergoing. The vehicle will provide similar functions like other foldable vehicles, but will provide the user the ability to remotely fold, park, and view any telemetry data of the vehicle through their smart device. The smart device also functions as an instrument panel. The vehicle will be developed to be a reliable, easy-to-use and eco-friendly electric vehicle, which will provide a new plan towards “car sharing”.

Theory

Figure 1 shows the layout of the components of the Foldable Micro Electric Vehicle in a general block diagram format. Since the research is still under progress, the diagram is still in its preliminary stage.

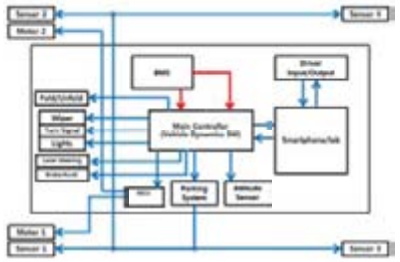

Figure 1 General Block Diagram of the Foldable Electric Vehicle

Conclusion

As shown in Table 1, with the substitution of electric vehicles from conventional vehicles (including hybrids), it will dramatically reduce emissions. With its folding abilities, the vehicle size can be reduced to a smaller size than the micro vehicles that are in the market today.

Vehicle	MPG	CO2 equiv. emitted (lb/mi)	CO2 Reduction with FEV
Standard	22	1.14	93%
VW Golf TDI	37	0.72	89%
Toyota Prius	55	0.45	82%
FEV	62mi./charge	0.081	

Table 1 Greenhouse Gas Emission Reduction with FEV substitution (1)

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Sugar Beet By-product Turned into Healthy Food

M.S. Andreasen, C. Gravgaard, C.A.M. Holbek, M. Knudsen, C.G. Møller, and S.H. Rasmussen

DTU Food, Technical University of Denmark

ABSTRACT

For the 2012 edition of EcoTrophelia, the authors of this abstract have developed a tasty food snack based on sugar beet pulp, a by-product from sugar production from sugar beets.

The Healthy Snack

The developed product is some kind of a bread stick. It consists of pulp mixed with rye flour and a little salt. The sugar left in the pulp and the added salt give the product a well balanced taste suitable for more situations, both as e.g. cereals or as snacks. Beets are known for their high content of fibers. Fibers are healthy to humans due to the satiety effect they provide.

Business Aspects

Sugar production in Denmark is located on the South-East islands Lolland and Falster. This region is lacking economical growth, why it would be naturally to invest and place the production of this bread stick here. Further, the main raw material would be close by. It is expected to be a sustainable business due to the intensified focus on healthy and tasty food. Currently, sugar beet pulp is dried and then used for cattle feed. The process is energy-intensive and expensive. Therefore it is really value-adding to turn the pulp into human food.

Environmentally Friendly

Turning animal feed into human food is sustainable in this situation, where the raw material is not even used fully across the globe. The tremendous amounts of energy used for drying the pulp to feed pellets are also better spent on the baking of this bread product. Since the product has a low water content and thereby low water activity there are only few requirements for a packaging material. This allows choosing an eco-friendly material with only few considerations on barrier properties etc.
Finally, this new resource utilization will direct growth to a Danish region often connected with stories about industry shutdowns, high unemployment rates and socially low resourced families. A new business venture like this would therefore provide a very positive social impact on the environment.

Beet Snappers

The snack product is named Beet Snappers. Analyses have shown a sustainable market potential in the EU with expectations on increased consumer demands on eco-friendly foods. This product cannot claim to be organic. But it will, have low environmental impact compared to comparable products due to:

- Vast animal feed supply turned into human food
- A production chain where, an evaporation step is skipped, saving energy
- The positive social impact when creating new jobs and growth

The important steps considered in the LCC performed are the material and manufacturing stage. Use and disposal are hard to quantify since they take place in the human body.

Sustainable Production of Bio-based Succinic Acid

António Lima Grilo

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The undeniable request for new synthetic routes for bulk chemicals production, which today, are mostly oil-derived, has arrived together with the urgent need for finding renewable feedstocks. Industrial biotechnology is often regarded as a potentially environmentally friendly alternative technology to replace traditional chemical synthesis of several commodity chemicals from petrochemical based oil refineries, contributing to a more sustainable chemical industry.

During the last decades of the 20th century, biotechnology and biochemical engineering have brought to light sugars as alternative raw-materials to produce a wide range of biobased chemicals aiming for a place of their own in the world chemical market. It is therefore natural that the United States Department of Energy (US DOE) has identified several biobased chemicals as market opportunities for reducing fossil fuel dependency in the chemical industry. These 15 compounds have in common their versatility, as they are often building blocks for other added value chemicals.

Succinic acid, a dicarboxylic acid, has been used as a precursor for many industrially important chemicals as shown in Figure 1. Over the last decade, much progress has been made on the development of a bio-based process for succinic acid production that can ultimately become competitive with the conventional chemical process. And therefore it was identified as one of the top candidates as an alternative to oil-derived bulk chemicals.

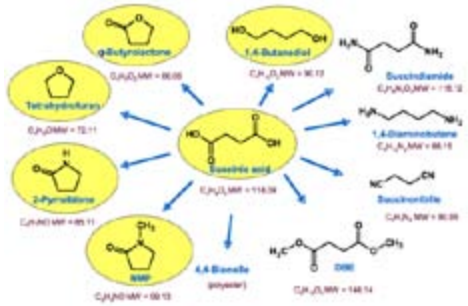

Figure 1 — Succinic Acid derivatives identified by the US DOE

The scope of this work is to show how succinic acid can be produced in a cost-effective way from glucose by fed-batch fermentation using recombinant *Corynebacterium glutamicum ΔldhA-pCRA717* (Okino, et al. 2008). This project presents and discusses the impact of a wheat flour by-products based route to produce succinic acid. An upstream/downstream process has been designed and optimized for a 10% world market share (18000 ton/year) and the land footprint was determined.

References

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Biogas produced from biodegradable Waste

N.M. Nystrup[1], A. Lukic[1], F.R. Razzaq[1]

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ABSTRACT

Last year as a part of sustainable lab at the Roskilde Festival, our team investigated the potential for producing biogas from discarded food waste at the festival as a sustainable energy source. The subject of the 2011 Roskilde festival was poverty in Africa; the slogan was if it can be done at the Roskilde festival it can be done in Africa. With that in mind our team wanted to proof biogas could be produced under very low tech conditions from food waste, this is a prerequisite for implementing the technology in remote places in Africa where a sustainable heat and electricity is mostly needed.

Our investigation was showed that the festival discards a proximally 13 tons of biodegradable waste each year and the cost of waste management is high both economically and environmentally for the festival, most types of waste could successfully be converted to energy though biogas technology, in Africa the amount of biodegradable waste could provide a sustainable energy source at remote locations.

This year we propose a follow up investigation on a larger scale, we want to figure out what challenges there is both practically and economical in order to implement biogas production as a sustainable alternative to waste. We will do this by implementing biogas production from biodegradable waste at the Roskilde festival in cooperation with DTU Environment and DTU Risø

Didehydroxylation – a new approach for conversion of biomass

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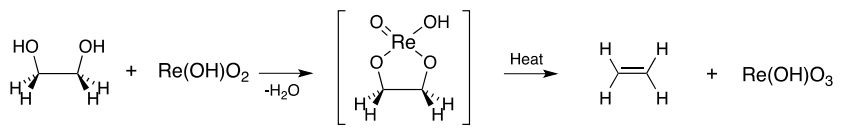
INTRODUCTION

The available amounts of fossil fuels are rapidly diminishing while the consumption is continuously growing. Thus it is necessary to find a new source of fuel. Recently the focus on using biomass as a renewable source has increased, but while the industrial production of second generation biofuels is the best possible scenario, it does not come without challenges. First and foremost, developing a cost-effective process for conversion of biomass is a necessity. One challenge is to decrease the ratio between oxygen and carbon in the biomass in order to increase the energy density. In this project a series of initial didehydroxylation experiments has been carried out to determine the reactivity of different styrene diols as a function of their substitution pattern.

DIDEHYDROXYLATION

The osmium-catalyzed dihydroxylation of an alkene using OsO_4 is a well-studied reaction whereas the didehydroxylation of a vicinal diol using $Re_2(CO)_{10}$ just recently attracted attention.[1]

Figure 1

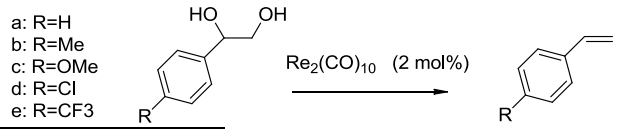


The reaction could occur via mechanism similar to the one for the dihydroxylation, just reverse. First the rhenium catalyst is oxidized to its active form, $Re^{V}(OH)O_2$ (fig.1), after which it reacts with the two hydroxy groups of the diol, forming an intermediate rhenium complex while releasing two water molecules. The alkene is then released, leaving rhenium in oxidation state VII. Rhenium is then reduced back to Rh^{V} by oxidation of 3-octanol.

HAMMETT STUDY

The reactivity of the different *para*-substituted diols (fig.2) has been investigated by determining the relative reactivities of the didehydroxylation reactions. The reactions have been followed using both GC and HPLC as well as ^{1}H-NMR in order to follow both the formation of the product and the disappearance of the reactant. Several different reaction conditions have been examined, but all used 3-octanol as a reductant for rhenium, making the reaction catalytic. The influence of the different *para*-substituents on the reactivity and reaction mechanism of the didehydroxylation can then be evaluated by the construction of a Hammett plot.

Figure 2



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The crustal uplift determined at the Jakobshavn glacier (West Greenland) using ATM and GPS data

I. S. Muresan[1], F.D. Frumosu[1], and S.A. Khan[2]

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[2]DTU Space, Technical University of Denmark

The Greenland ice sheet has experienced record melting in recent years. In order to estimate the ice loss we can make use of the earth's natural elasticity to weigh the ice. Ice bends down the bedrock so when the ice melts away, the bedrock rises measurably in response. Throughout this abstract we present both a predicted and observed crustal uplift for the Jakobshavn glacier using ATM data (Airborne Topographic Mapper) from NASA ATM flights during 1997, 2005 and 2010 supplemented with data provided from continuous Global Positioning System (GPS), measurements made on bedrock between 2005-2010.

In order to compute the crustal uplift in response to the ice mass loss of the Jakobshavn area from the GPS stations, the convolution of the gridded thinning rates has been computed with the vertical-displacement Green's function as described in [1].

Several manipulations of data were required in order to achieve a good prediction of the crustal uplift. In this sense the programs Matlab and Geogrid-Gravsoft were used along with some Fortran executable files. Furthermore, the GPS data which presents the difference in uplift is provided processed as a difference of data from the permanent GPS stations KAGA, ILUL and QEQE relative to the AASI station (Figure 1). Also, in order to compare the predicted uplift from ATM data with the observed uplift from GPS data the post-glacial rebound (PGR) rates have been subtracted.

Figure 1. Greenland GPS permanent stations

The results obtained for the predicted crustal uplift for KAAS is 11.62 mm/yr while the observed value was 16.321 mm/yr, for ILAS 1.74 mm/yr and 1.53 mm/yr, for QEAS -0.189 mm/yr and 1.15 mm/yr. That being a difference of 4.701 mm/yr is found for KAAS, 0.21 mm/yr for ILAS and 1.339 mm/yr for QEAS. The uncertainties associated both with the ATM and GPS results are 0.8 mm/yr for ATM and 0.5 mm/yr for GPS. The total ice mass loss in km^3 of water predicted from the ATM data concerning the Jakobshavn area is -88.815 between 2010 and 2005 and -83.599 between 2005 and 1997.

It seems fair to state that this differences, between the predicted and observed rates, may also be due to the fact that not all the errors have been taken into account when computing the observed results and also due to the fact that, perhaps, ice is melting in Greenland much faster than predicted.

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C-Light

***A. D. V. Nielsen*[1]**

[1]DTU Design and Innovation, Technical University of Denmark

THE PROBLEM

In Africa, Asia, and Latin America 1.5 billion people live without the benefit of electricity. The result is a lack of light from when the sun sets until the sun rises. Solutions such as kerosene lamps and open fire are used for light but these light solutions are of low light quality, expensive in oil consumption, have a high environmental impact, have a bad influence on people's health and increase the risk of fire accidents. The exact amount of oil burned in kerosene lamps is difficult to estimate, but the Lumina project presume that $38 billion is spend on lighting for the poor, equal to 190 megatons of CO_2 emissions.

The lack of light do not only limit people in their doings but it clearly effect children's school competences. Based on UNICEF statement there is a need for light for these children to get an education. Furthermore it has been observed from studies with implementation of LED light in Malawi that the average study hours per day raised from 1.45 hour to 2.71 hour by having free light provided.

THE C-LIGHT

The design of the C-Light is based on a bachelor project conducted in collaboration with UNICEF and a business plan for the C-Light in the course Knowledge based entrepreneurship. Based on the need discovered by UNICEF, IKEA made the Sunnan Table lamp but this product is not donated to children any more. The C-Light has been developed based on research of the context in which the children are living and with special focus on their need, social relations, ergonomic dimensions and environment. The selection of materials and components has been done with a focus on the environmental effects in their life cycle. The lamp is concealed in order to make it more robust for the daily use and to shell the electronic component and battery from leaking if the lamp is disposed in a land field. The lamp can also be burned efficiently by incineration.

The C-Light is a small, robust and concealed lamp, designed for schoolchildren in developing countries. It has two charging options and two lighting function. It can be charged by a solar cell placed on the top of the lamp or by shaking the lamp which generate power via the induction principal. The C-Light has a lantern function in the top which spread light in which children can do homework at the same time as other family members using the light for other doings and the C-Light have a flash light function in the bottom for navigation

THE FUTURE

C-Light supports children's daily life, including school work, and other duties. This will affect the education of the children by providing more opportunities to do homework. The C-Light will give the children's families more room in the budget by reducing the expenses on lighting and the quality of the light will be more continuous. Indirectly will the C-Light reduce the environmental impact because the light will come from the sun or be generated by shaking and not from burning oil. This will furthermore reduce the risk of respiratory diseases from inhaling gases from burning kerosene and lower the risk of fire accidents.

Building $116^{3/4}$: design of a net-zero energy building

R. Bukholt, A. Dogbeh, L. E. Mazzeo, and M. H. Rasmussen

DTU Civil Engineering, Technical University of Denmark

INTRODUCTION

The new bachelor education in building design has made new installations for teaching and workshops necessary to complement building 117. Our challenge is to elaborate strategies to design a building containing those facilities by focusing into making a net-zero energy building. By combining the use of innovative and low-energy consuming systems and an optimized architecture, we expect to reach minimal running energy consumption per student. Our goal is to go further than what is set by the future 2020 Danish energy frame. This building is thought to show the potential of new low-energy designs on DTU Campus.

PROJECT DEVELOPMENT

After gathering information and defining the functional requirements linked to the new education, we have, in a first phase, performed iDBuild simulations to do a primary optimization of the different rooms' geometry and indoor climate. This phase has raised some indoor environment problems to solve, especially high cooling loads driven mainly by occupants and equipment. This led us to consider innovative and low-energy HVAC (Heat, Ventilation and Air Conditioning) solutions in a second conceptual design phase.

We have designed the building to use as much as possible natural and passive means to regulate the indoor environment:

- Natural ventilation driven by the stack effect in the central atrium
- Optimization of the solar gains during the heating and cooling seasons
- Harvesting of natural resources (solar electricity and heating, ground-source energy)

The use of Thermally Active Building Systems (TABS) for heating and cooling, combined with a concrete structure, is an energy efficient way to condition the building environment. It is ideal for night cooling, reduces the electricity consumption of ventilation and uses the property of embedded energy in concrete. Using displacement ventilation in high rooms (ateliers) is a highly efficient ventilation process, which specific fan power is lower than that required by the 2020 energy frame.

After a study to support sustainability with low-carbon footprint and minimal strain on resources, and at the same time comply with the requirements linked to the energy systems, a concrete structure has been decided. The building envelope itself uses "Fiberline"-type materials. In accordance to the current DTU buildings layout, the building $116^{3/4}$ is a modern and optimized design. Software are used for instance to optimize the "niched" windows layout according to the visual environment requirements.

CONCLUSION

The design of building $116^{3/4}$ intends to demonstrate how high sustainability standards can be integrated in the pursuit of a good learning environment at DTU. The project is also meant to be a base for further expansion of DTU green campus.

Wild for Water

O. M Sjølie, L. G. Sletta, S. E. Minothi, K. Rutlin, A. Skoglund and S. R. Nielsen

[1]Technoport 2012, Sharing possibilities
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Did you know that if the ice in Antarctica would melt, it is believed that the sea would rise by 70 meters? (Solem & Letnes, 2007) And did you know that South Sudan has a lot of water resources, however, 30% of the population has to walk more than 30 minutes to get fresh water? (European Commission, 2012) Water is our most valuable resource and we are all equally depending on a supply of fresh water to survive.
Our team wanted to create an educational online game to raise the awareness of children and young adults (5th, 6th and 7th grade, 11-13 years old) about water issues concerning people all around the world.

"Wild for Water" provides information about water in a pedagogically adequate way and covers many of the learning goals of the intermediate stage in primary school. Users can explore an interactive world map and read about the water situation in various countries, answer questions and provide water resources to the countries. Good distribution of the right resources will be rewarded with points

The game has been tried out at two schools and evaluated by both students and teachers. Based on the evaluations from the 5th graders, it turns out that "Wild for Water" increased the fun component for the pupils during learning. By using digital tools to create an interaction between the learner, the computer and the information embedded, "Wild for Water" is a creative alternative to the traditional whiteboard teaching. Young students can be able to achieve knowledge about the water situation in several parts of the world and will hopefully be curious to study water issues in a wider perspective.

We believe this is vital in order to heighten upcoming generations' level of global understanding. Confronting young students with this type of knowledge might give future world citizens and potential decisionmakers inspiration to study these important matters in a wider perspective.

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MASTER LEVEL COURSE / PROJECT
POSTER
GOVERNANCE AND MANAGEMENT

Electricity Treasure Hunt

M. H. Jakobsen[1],and A.D.V. Nielsen[2]

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[2]DTU Design and Innovation, Technical University of Denmark

INTRODUCTION

The project is developed during this spring semester 2012 in the course 'Holistic design of systems'. We have been working with the electric energy system in relation to private consumption. The problem is that the private consumer has an estimated overconsumption by 10% of electricity. By gaining awareness of own electricity consumption, the private consumer can reduce their electricity consumption with 10% without compromising their current life style. Based on this knowledge, the research question of this project has been: *How can household consumption of electricity be visualised, realised and possibly changed by engaging the public with information and activities*?
The developed concept solving this is the 'Electricity Treasure Hunt'. The target group is private consumers, e.g. a family, single person etc.

ELECTRICITY TREASURE HUNT

The goal of the Electricity Treasure Hunt is twofold. The Treasure Hunt should create *awareness* on the private electricity consumption as well as *maintenance* support of the gained awareness. The different steps in the Electricity Treasure Hunt concept are shown below:

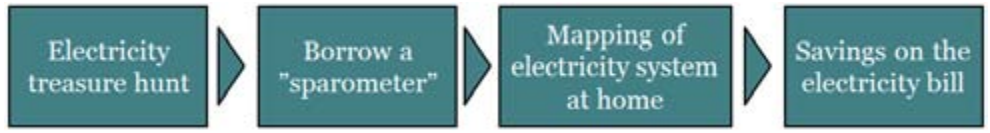

Figure 1 The activities in the concept

A physical treasure hunt with free access is placed in the public area. The treasure hunt consists of five interactive installations there should be engaging, explorative, reflective to own household and fun to experience. The participant gain awareness and knowledge of the system of practices around electricity consumption in the household. The challenge has been to link the gained awareness to the actual household. After finishing the physical treasure hunt, the participant(s) can borrow a "sparometer". They can map the electricity consumption of each product in the household. To support this measuring at home, a virtual supporting platform is included in the concept. Research shows that this will reduce the electricity consumption with 10%. The documentation of 10% reduction is a crucial point when it comes to the business plan, there are based on founding's, partnerships with electric companies, and sponsorships from other interests.

Topology optimization of beam structures

Aleksander Hamdan

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INTRODUCTION

An engineer, who is designing structures, is always trying to design a structure with the highest possible stiffness to weight ratio. For beam structures the objective is to maximize the stiffness for a prescribed amount of material. To do so a program using the Finite Element Method (FEM) is designed, with the possibility of using simple beam elements and Timoshenko beam elements. The Timoshenko beam theory is used to allow for transverse shear deformation. The two beam theories are compared to each other and to solutions obtained using truss elements, to examine, which effect beam bending has on the structure. A further expansion of the program is the implementation of the topology optimization theory for beam structures.

TOPOLOGY OPTIMIZATION

The method that is used is to lower the density of the elements that has no or close to zero stress in the element, and recalculate the structure, until the optimized solution is made. A detailed explanation on topology optimization can be found in Bendsøe and Sigmund (2003). The simplified flow chart for topology optimization is:

- Set the initial material distribution and the total material volume
- Loop over a defined number of iterations
    - Solve the finite element problem
    - Compute design sensitivities and update design
    - If difference between new and old density is small, break loop.
- End loop

The optimization, using the FEM program, of beam structures can help the engineer to design a structure that has the stiffness for a prescribed amount of material. If an engineer has to find the optimum solution of a structure by using a design domain of 10x10 nodes by examining all possibilities, it would will be an unrealistic task, do the number of elements in the domain.
The reduction of material in the structure means that less energy and waste of the resources of the Earth will be used on producing the structure. If a vessel or container, which uses beams in the structure, will be using less energy of moving itself, and therefore can transport more goods and lower the $CO_2/\,(kg \cdot km)$ - value.

CONCLUSION

The use of topology optimization can help the engineer to design a structure which has the highest stiffness by using a defined amount of material. The correct boundary conditions should be set for a given problem, and the FEM program made in this project has only the possibility to examined one load condition.

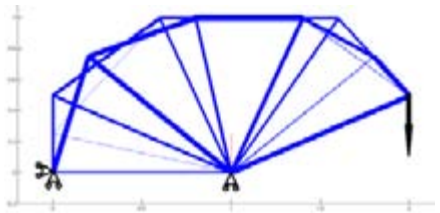

Figure 1, Optimized structure, A. Hamdan (2012)

Improvement of Air Bearings Load Capacity and Stability using Mechatronics

Jonas Syders Knudsen

DTU Mechanical Engineering, Technical University of Denmark

INTRODUCTION

This project concerns experimental investigation and improvement of a controllable air lubrication in a hydrodynamic bearing. The traditional choice of lubrication in a hydrodynamic bearing is oil, but as the modern turbo machinery applications demands operation at higher rotational speeds, greater reliability and clean environment, air lubrication is a great alternative. When comparing air and oil lubrication air is both cleaner and cheaper which in many ways makes it competitive to oil.

One of the major concerns in hydrodynamic bearings are the relatively low damping of vibrations. This means that operational speeds close to the critical rotational speeds of the system becomes very dangerous, as the resonance enhancement can become very large. The damping in a air bearing is even lower than in a oil bearing which makes the concern even larger. Moreover another disadvantage of air lubricated bearings is the low load capacity. Both problems, vibration instability and low load capacity, are addressed in this project. Such problems are compensated via controllable lubrication (mechatronics).

The project includes experimental modal analysis of the rotor for different input signals to the air bearing. Moreover the optimizing of the active control mechanism for the air bearing is initiated. Improvement of the active control system will be the purpose of a master thesis which will be conducted in continuation of this project.

THEORY & METHODOLOGY

The theory involved in the project is used to analyze experimental data and is linked to the following subjects: Machine dynamics, mechanical vibrations, fluid mechanics, instrumentation, control techniques and signal processing.

The experimental investigation uses a test rig already designed and improved by S. Morosi, I. Santos and others. The experimental setup is a simple supported overhung rotor with a disc mounted at one end of the rotor. The overhung rotor setup is widely used within machine dynamics and corresponds for example to a part of a wind turbine, a compressor and a pump.

To measure the vibrations of the rotor two displacement sensors are mounted at the location of the disc. To control the pressurized air injection into the bearing, two piezo actuators is applied at the inlet of the air bearing.

RESULTS AND CONCLUSION

By combining mechanics, electronics and informatics new machine components can be designed to operate sustainable and eco-friendly by changing the lubrication fluid in hydrodynamic bearings from oil to air. Through this study some of the disadvantages of air lubrication have been minimized. Through active control of the inlet flow in an air bearing, load capacity and operating speeds have increased.

Graphite based carbon nanostructures

- With focus on its usefulness in the industry and in the production of solar cells

Onur Deniz Uysal and Bjørn Langbjerg Larsen

DTU Nanotech, Technical University of Denmark

ABSTRACT

This report is about two of carbons allotropes, graphite and graphene. It will be about some of its special properties and characteristics. Because of this, it will necessarily be a study of these two interesting materials on a nanometer scale. Carbon has several other allotropes including diamonds, fullerenes and carbon nanotubes. Allotropes are different structural forms of the same element and can have quite different physical and chemical behaviors. Fullerenes and carbon nanotubes are also interesting when looking at it from a nanotechnology point of view but these are not focused upon in this report. It touches upon the use, the problems and the exciting potential it contains. It was concluded that these carbon nanostructures have the potential to make a larger impact on many industries.

LCC	Materials	Production	Use	Disposal
Materials	Carbon Nanostructures	Chemical Vapor deposition, other	Biomedical, Electrical, nuclear	Free existing, will be in cycle of nature
Energy	Energy Efficient		Energy Transport	
Chemistry	Carbon Allotrope			
Other				

Table 1 Generic LCC Table

Seemee – Solar Solutions

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INTRODUCTION

Seemee provides a solution to the problem of advertising on bikes in low light conditions. The Seemee system provides a controllable light source powered by renewable energy through solar cells which advertisers can use to improve advert visibility at night time. The system can also power front- and backlights and thereby target the private bike market.

THEORY

The system utilize solar cells to charge a rechargeable battery through the day, whereby at night the system will be charged and ready to light up commercials and cyclist with low powered LED's

RESULTS

The electronics is still under development, but the lit commercial plate has been installed on a bike to test visibility at nighttime. The system appears well integrated into the bike and gives a good clear view of the commercial even in very low light conditions.

CONCLUSION

As it is not presently possible for the citybike bike schemes to light up their ads as this would demand too much maintenance and time changing batteries, there is a market for the product. As the group has been in contact with different bike scheme providers we are fairly confident that there is an interest in our product.
Furthermore the product could be a good alternative for the private customers who want a system that is installed and then demands no further work to function.

Cost and CO_2 reduction potential in implementation of app controlled charging of electrical vehicles in a Danish Smart Grid

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Electrical vehicles in connection with an electric Smart Grid in Denmark have been proposed as a possible way to reduce the use of fossil fuel in the transport sector and utilize the energy from wind turbines in periods with low electricity demand. The aim of this study is to asses the potential of using electrical vehicles as energy storage in Denmark. Furthermore the study tries to evaluate the influence of incorporating incentives for consumers to switch from internal combustion vehicles to electrical vehicles by introducing an app for user control of vehicle charging.

The idea of a Smart Grid is to make different appliances use electricity when it is most suitable and efficient with regard to price and fluctuations in both production and demand. A way to achieve this is to store e.g. the surplus energy from the wind turbines when their production is high and the demand for electricity is lower by charging the batteries of electrical vehicles. When the demand for electricity increases at a later instant the batteries are discharged delivering electricity back to the grid.

To asses the potential in a Smart Grid in Denmark a linear model of the system is formulated in order to optimize the operation of power producing units and charging/discharging of electrical vehicles. The model is formulated based on empirical determined driving patterns, power plant specifications and operation costs, and several constraints with respect to production limits, availability of cars, buffer levels etc.

In connection with simulation of the model the functional design and requirements to a smart phone app is made to take the irregular driving demands required from users into account. The results are compared to the results obtained assuming regular predictive driving patterns.

Assuming the entire car fleet of personal cars in Denmark is switched to electrical vehicles with a predictive driving pattern the model results show that the weekly production cost of electricity increases from approximately 23 mill. € to 30 mill. € - a rise of 7 mill. € per week. However, the switch from internal combustion engines vehicles to electrical vehicles reduces the use of gasoline to zero which represents a cost saving for consumers and hence society of 55 mill. € per week. The corresponding CO_2 emission associated with electricity production increases with 90,000 tonne per week. The reduction in CO_2 emission associated with substitution of the gasoline fuel with electric power is approximately 135,000 tonne per week. Thus, the net CO_2 emission reduction is around 45,000 tonne or 33% of the emission associated with passenger car transportation.

If not all passenger cars, but only one car in families with two cars is switched to electrical vehicles, and if more app controlled user flexibility is implemented in the model the cost savings and emission reductions are decreased, but still the outcome is favorable for the society and more sustainable than practice of today.

The Blue Lagoon: Design of an alternative drinking water supply for Copenhagen

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Copenhagen and the surrounding municipalities face serious water supply challenges due to the combined effects of population growth, urbanization, pollution, and political pressure from the EU Water Framework Directive. The Blue Lagoon has been identified as a possible solution to these challenges that would improve both the self-sufficiency and long term sustainability of the city's water supply through the utilization of an internal resource that is currently considered as a waste product. In addition, the lagoon would provide an environmental benefit through reduction of the nutrient load that is currently released from wastewater treatment plants during normal flow and overflow events. The Lagoon could also be a valuable component of an improved storm water management system.

Presently, water is abstracted from groundwater resources, used, treated, and then pumped to either the Øresund or Køge Bugt. The Blue Lagoon would reuse the waste stream that is currently discharged and recycle the resource back into the urban water cycle [Figure 1]. An artificial lagoon would be used to mix effluent from wastewater treatment plants with seawater, and then used as a source for a Reverse Osmosis (RO) water treatment plant. In addition to improving self-sufficiency and sustainability, this configuration would reduce the salinity (TDS) of the source water for the RO plant and reduce the economic and energy burden when compared to conventional desalination of seawater.

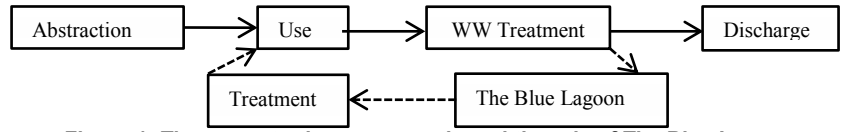

Figure 1- The current urban water cycle and the role of The Blue Lagoon

Data regarding possible flow sources to the lagoon was compiled and combined with other information in a model to evaluate possible lagoon configurations, resulting water quality and whether or not the lagoon would meet requirements that had been established. In addition, an economic analysis was conducted to further assess lagoon configurations and the economic viability of the lagoon compared to direct desalination of water from Køge Bugt.

Results indicate that connection to one or two treatment plants would provide a constant supply and excess lagoon volume for dilution with seawater while still achieving a 35-80% reduction in TDS in the feed stream to a RO plant. No configurations met the water quality standards that had been set for the lagoon. Additional treatment processes are necessary to reduce the average total phosphorus concentration in treatment plant effluent streams from approximately 0.5 mg/l to 0.04 mg/l. Economic evaluation revealed that the operational cost of producing water via the lagoon would be 0.003 to 0.018 DKK/m^3 cheaper than direct seawater desalination.

Through efficient lagoon configuration, dilution of wastewater effluent is achieved, while still reducing TDS in the feed stream to the RO plant. More investigation is necessary to fully evaluate The Blue Lagoon; however none of the results of this project indicate that this concept is a "pie in the sky". On the contrary, there is ample evidence to indicate that this is a viable solution that would provide a reliable, high quality, sustainable, and self-sufficient water supply for the city of Copenhagen and the surrounding municipalities.

Proposed Forced Air Triple Chamber Solar Distiller of Humidifier-Dehumidifier Type

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INTRODUCTION

The Humidification/Dehumidification type still (SDHD) humidifies air mass and subsequently removes its humidity. It is not often seen in production except in small stills where it has gainedacademic attention. According to Alnaimat (2012) (5) it is the most efficient type of still. Goosen (2000) (6) ascribes a 30% efficiency to the SDHD type. As it requires little maintenance, the SDHDstill is both reliable and cheap to run.

PROPOSED DESIGN

The proposed design is based on a desalination system as shown (drawings to be supplied) which maximizes output per day. Sea water and solar energy are the input. Output is fresh water and brine (or, optionally, crystallized salt).

Consulted articles suggest the following for improvement for distilling efficiency:

- Flow through basin instead of a single fill per day (Yakav 7)
- Cooling of the condenser area/unit (Tiwari 8)
- Use of heat retaining material on the basin surface (Tiwari 8)
- Multiple wick water feed increases overall performance by 4% (Orfi 9)
- Double basin design increases single basin design output by 52% (Kabeel 10)
- Preheated water (Alnaimat 11)

Overall, the conclusion from the consulted literature is, that efficiencies can be stretched. The final “tuned” distiller is an amalgamation of the improvements listed above and is a compromise between basic design and potential improvements to output. It follows that production level is dependent on ambient heat, humidity and solar irradiance (sec 4.2). According to Hermosillo (2012) theoretical efficiency of a still which incorporates these improvements is in the 50-85% range, in the laboratory. Hermosillo's claim has to be quantified and improved by field testing of variables, as they are too many for a conclusive predetermination theoretically or in the laboratory. In the field, input of heat is subject to change due to the sun's daily movement and the seasonal variations. Hermosillo also controlled the humidity retention by an air mass which, in the field, constantly changes due to temperature and pressure. Proposed additional improvement to the production process consist of the following additional features:

- A cooling unit inside the condenser to draw humidity
- A water pool/heat compressor which retains heat beyond the sun hours

The design is simple enough for small scale production. It improves on the efficiency of a still and will be usable where no electrical service or piping exist. The introduction of forced air and a cooling unit will result in increasing the movement of air mass in order to draw out the maximum heat utility and by changing the temperature of the air on the downdraft to draw out the vapor will yield improved results. Next step: field testing is necessary. The design is intended to be pre-packed as a ready to ship pallet for ease of shipment and reduction of shipping costs.

Electro-Responsive Hydrogels for a Facile Desalination

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The scarcity of potable water is one of the severe problems of the 21st century. Since more than a quarter of the world’s population lives close to the ocean, the desalination of saline water has been considered as a possible solution of water scarcity.[1] Several technologies for desalination are currently utilized including multi-stage flash(MSF) distillation, reverse osmosis(RO), and electrodialysis(ED),[2] however these large-scale desalination technologies typically use large amounts of energy and highly sophisticated equipment, making those unsustainable in many regions.

Hydrogels are hydrophilic cross-linked polymers which have high capacity of absorbing and retaining water inside the structure. The cross-linked polymers in contact with liquid swell and form hydrogels due to the osmotic pressure difference between the inside of the gels and the surrounding liquid, so that hydrated ions (i.e. salt) in the liquid can be separated as hydrogels absorb water molecules.[3] Furthermore, these cross-linked polymers can change their volume from swollen form to shrunken form in response to the repeated stimulation such as light irradiation[4], electric field application[5], pH change[6], and temperature change.[7] When the swelling of hydrogels are equilibrated, a certain amount of water inside of the gels can be released and recovered under the external stimulation.

Herein the synthetic methods of stimuli-responsive polymers, especially electro-responsive polymers, and their application to desalination which consumes much lower energy than the conventional desalination technologies will be introduced. The small-scale kit will be designed and presented in terms of point-of-use desalination.

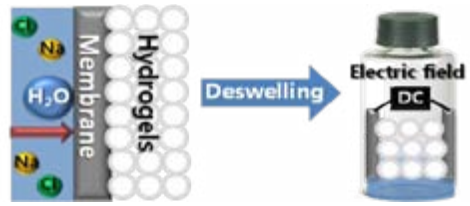

Figure 1 Schematic diagram of the application of stimuli-responsive hydrogels to desalination

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A Flag Diffuser for Small Wind Turbines

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INTRODUCTION

Small Wind Turbines are very popular for eco-communities and isolate villages. Particularly, one of these models uses a diffuser to improve the power generation and the cut-in wind speed, reaching until three times the rated power of the same wind turbine without it. Currently, many small wind turbines still remain with the traditional concept design for many reasons; however, for most of them the diffuser concept could be installed like an additional accessory improving their original performance. The main idea in this project is to design a very light (self-inflatable) fabric diffuser that could be installed in some conventional small wind turbines. By using fabric as primarily material, the weight and aerodynamic loads over the existing wind turbine will be minimized while increasing its energy output.

LOADS CALCULATION OVER THE FLAG DIFFUSER

The main difficulty to apply a static analysis to the mechanical model is its flexible characteristic, because the angle of attack for each section of the diffuser is not constant anymore. For that reason, a Matlab code was implemented in order to obtain the correct diffuser deformation until the static loads over the diffuser reach the equilibrium. This process consists in a constant iteration of small changes for the design angle of attack and the geometry through over the 360 degrees. Then, the new lift and drag loads are calculated and compared with the reactions and weight loads, estimating the next changes for the angle of attack until the equilibrium state converges. Finally, knowing the behavior of the diffuser's shape, it was possible to determine the best airfoil section and design angle of attack as function of the wind speed. The NACA 63_3-618 (Figure 2) was one of the most suitable for this project due its characteristics that can produce lift even for negative angles of attack. Therefore, eight degrees for the designed angle of attack resulted as the best parameter for a high diffuser performance with an average wind speed of 7 m/s, that is a common operational wind speed rate for small wind turbines.

PROTOTYPE DESIGN AND CONSTRUCTION

The Flag diffuser prototype is built of Nylon fabric with a weight density of 48 gr/m^2 and supported by steel structure as seen in Figure 1. It will be tested in a 80x80 cm "open wind tunnel" at a maximum wind speed of 7 m/s to analyze the behavior of the self inflatable diffuser shape and to measure the wind speed profile inside of it and its drag force. These measurements will be compared with the Matlab numerical code.

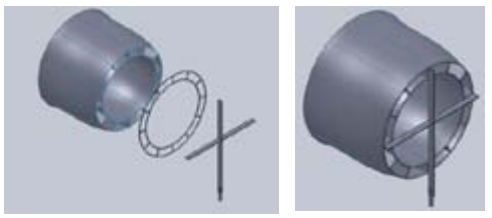

Figure1. Flag diffuser prototype

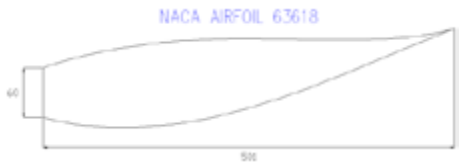

Figure 2. NACA 63_3-618 Wing Section

Planning a Wind Farm in Oaxaca-Mexico

E. M. Khomartash[1], E. Klupsch[2], C.M. Gallardo[3] L.A. Gonzales[3]

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INTRODUCTION

The Oaxaca region, located in the south-east of Mexico between the Mexican Gulf and Pacific Ocean, is well known due to its incredible strong winds, able to overturn more than 30 trucks every year. The idea to take advantage of this energy source is analyzed by designing a 200 MW onshore wind farm in this area.

WIND RESOURCE ANALYSIS

The main reason of this windy resource is the presence of a mesoscale phenomenon that is related with the natural corridor "Civela Pass" through the mountains in "Sierra Nevada" in the middle of the Atlantic and Pacific oceans, this especial geography leads the behavior of the "Trade winds" that come from the Atlantic to the Pacific, where they are constrained and speeded up, occasioning a quasi-unidirectional (70% of times came from the North/North-West) and bimodal Weibull distribution of the wind stream (mean wind speed of 11m/s).

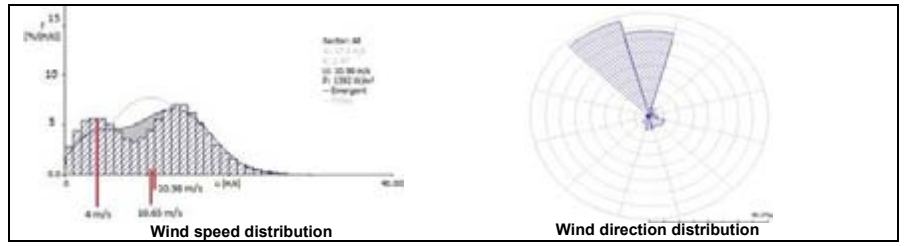

Figure 1. Wind resource data

WIND FARM PLANNING METHODOLOGY

Referring to the existing wind resource data including: topographic, orographic and climate analysis information, all the inputs files for WAsP software were given in order to estimate the Annual Energy Production (AEP) and Sensitivity to some parameters like roughness and air density in two different wind farm layouts; however, besides the technical aspect, the local conditions such as: environmental impact, grid access, visual impact and noise production were considered.

RESULTS AND CONCLUSION

Finally, after analyzing the wind resource data and accomplishing all the technical and environmental restrictions for the best layout alternative, it was obtained a net AEP of 1193.8 GWh and a Net Present Value (NPV) of 92,639,550 EUR for a 20 years life time project. Additionally the payback period is only 9.33 years. In conclusion, the Oaxaca Wind Farm becomes very profitable due to its excellent wind resource; furthermore, by implementing this project 8,300,000 tons of CO_2 will not be emitted to the atmosphere, reducing global warming effect.

Modelling of power system containing demand response

Dario Sacchetti

DTU Energy Conversion

INTRODUCTION

Large penetration of fluctuating energy sources like wind power will create a stability problem in the electric power system, which might in part be solved by introducing a flexible (e.g. price controlled) electricity demand.

The purpose of this project is to obtain a basic understanding of the dynamics of a power system containing a significant fraction of flexible demand indirectly controlled by an electricity price signal. This includes clarifying what the price signal should do for the system and investigating how a price-signal can be generated so that it fulfills the requirements.

The inputs to a price-signal generator will presumably be an appropriate combination of load and production, both present and forecasted values, as well as the power system response to previous price changes. Different scenarios may then be simulated by varying system parameters, input data and off course the properties of the price generator and demand response.

Development of a micro PEM fuel cell using glass bipolar plates

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INTRODUCTION

In this project, a novel micro PEM fuel cell is developed using glass (Foturan) as the substrate material for bipolar plates. Typical macro scale fuel cells with power levels higher than 100W use graphite as their bipolar plate material due to graphite's high electrical conductivity, low cost, and low density. But due to limitations in fabrication methods, graphite cannot be used in micro manufacturing applications. Silicon has been the most widely used substrate material to fabricate the bipolar plates for micro fuel cells owning to its well-defined MEMS process in the electronic field. However, MEMS processing of silicon can be limiting due to high fabrication cost. Foturan is a patented material which is photosensitive and thus can be chemically etched via lithographical means. It is highly chemically resistant, has a comparably low fabrication cost compared to silicon, and is also suitable for mass production. A fully compact single cell has been fabricated and tested (below) successfully using Foturan and has proven the viability of stacking micro fuel cells for portable electronic applications.

EXPERIMENTAL

Bipolar plates were fabricated by first a lithography step, a following heat treatment step, chemical etching step, and then a thermal bonding step. To enhance electrical conductivity, silver was deposited onto the top of bipolar plates by sputtering. Al-electrodes were then inserted and UV-bonded. The MEA used was cut from typical MEA standards sold off-the shelf. Testing of the single cell was done using 99.9% pure hydrogen and Air to enhance forced-flow inside the cell.

RESULTS & CONCLUSION

Below shows the fabricated micro fuel cell fully packed (left) with the performance evaluation curve of it (right, I-V-W curve). It has been shown that the power density obtained (154mW/cm^2) was comparable to the state of the art performance of ongoing micro fuel cell research.

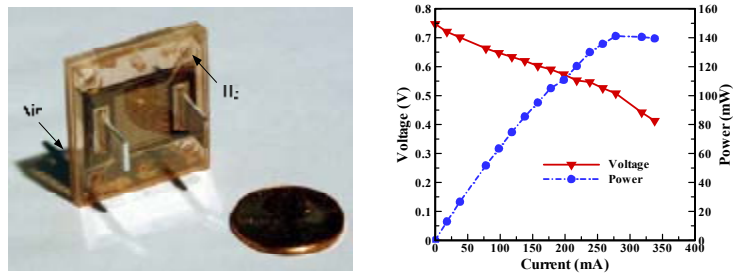

Fig. 1 Fully integrated micro PEM fuel cell (left) and the corresponding I-V-W curve (right)

Solar Sustainable Heating, Cooling and Ventilation of A Net Zero Energy House

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ABSTRACT

Buildings play a key role within the 20/20/20 goals of the European Union since they consume 40% of the energy within the member states (European Commission, 2010).Therefore an urgent and efficient transition is necessary in order to reach to the almost “passive house” level.
Present Masters project, Solar Sustainable Heating, Cooling and Ventilation of A Net Zero Energy House, consists of the entire HVAC (Heating, Ventilation, and Air Conditioning) concerns of the DTU’s house, the FOLD, for the competition Solar Decathlon Europe 2012. Yet, this Masters project extends further in order to contribute to the future low energy housing targets and challenges. This is only possible with precise dimensioning and excellent interplay within the components that comprise the house.
In this project, various innovative options are being investigated, namely, utilization of ground as a heat source/sink via a heat pump and for free cooling when possible, photo-voltaic/thermal (PV/T) panels and phase change materials (PCM).
PCM, if installed in the house, increases thermal mass of the building. Increasing building thermal mass is particularly relevant for a small individual houses, since the weight of the structure has tendency to decrease (wooden framework houses). Higher thermal mass means smaller temperature drift in the building, which is directly related to energy consumption for heating and cooling purposes.
Also one significant aspect is that the heating and cooling of the house will be addressed by the embedded pipe system rather than a conventional system with ventilation taking care of these needs. In this case, ventilation is only used in order to adjust the humidity and remove sensory pollution in order to provide a comfortable indoor environment. The relevant values for the system have been investigated by means of hand calculations and by means of commercially available softwares.
For example, a combination of embedded pipe system and phase change material was simulated by dynamic building simulation software. The results show reasonable energy saving, up to 30%, for cooling season in Spain, using embedded pipes and PCM system compared to only embedded pipe system.
The house is designed to comply with the EU’s 2020 goals of 75% less energy consumption based on 2006 values (European Commission, 2009). Yet, this house is self-sufficient from the electricity production/consumption point of view. Once this house is built, tested and optimized at a single-family house scale, further possibilities can be investigated in order to apply a similar strategy to the entire building block. Once this is achieved, it will lead to a considerable amount of primary energy savings and consequently avoided/reduced greenhouse gas emissions.

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Optimize energy supply and energy use in DTU-Solar Decathlon House, with emphasis on benefits of using PVT compared to PV

Pavel Ševela

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ABSTRACT

It is useless begin with a list of numbers telling how much energy our society uses, how many tons of CO_2 produced every second to try and scare society and hope that everything suddenly change. People won´t change anything themselves if they won´t really want it. And the message of our project is to build an efficient, inexpensive and friendly house with sexy design which people simply will want.
The Solar Decathlon Europe is an international competition organized by the Ministry of Housing of the Government of Spain. During the final phase of the competition each of 20 university teams assembles their house in Madrid in Spain, where the houses are open to the general public, while undergoing the ten contests of the competition, reason for which this event is called Decathlon.
Apropos. Key purpose of this Master thesis is to optimize energy flows, decrease energy use in the building and utilize produced energy the most efficient way. The optimal energy solution must be found with a respect both to competition rules but also to live of the house after the competition.
In the Solar Decathlon house the only energy source is the sun. But there are several sources of energy use (heat pump, fans, pumps, lighting, dishwashing, cooking, washing, etc). There is often a mitchmach between the time of energy demand and supply. The project will optimize energy balance through test of PV and PVT, theoretical calculations, energy certification of the house and measurements on the built Solar Decathlon house at DTU campus.
A strong emphasis is paid to innovative and astonishes Scandinavian design for equipment consuming energy. ASKO HWC appliances use heat instead of electricity as a main source of energy. These brand new products can save up to 85% of electricity meanwhile the free heat is generated in solar thermal panels.
Seldom used PV-T technology establishes positive electrical energy balance with surplus higher than 10kWh per 12 days. Significant growth of efficiency of electricity generation is caused by cooling the cells to optimal temperature by system of embedded pipes on the backside of photovoltaic panels.
To increase the energy autonomy of the Fold house a concept using electro-mobile as a battery backup is developing in collaboration with several companies.
Low pressure losses thermal part with Tichelmann connection is using drain back tank system. This clever combination allows usage the same system with a ordinary water without any chemicals without concern of boiling or freezing risk in any climates around the world. Low energy consumption and environmental friendliness behavior is like a extra bonus.
The DTU is first time participating Solar Decathlon competition thus it is big challenge for each team member same as for associated companies and sponsors. Keep your fingers crossed…

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A Novel Method converting Bentazone-contaminated Groundwater into Clean Drinking Water

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The safe and healthy Danish drinking water is threatened by pesticide contamination. Pesticides are found in 20 to 25 % of the drinking water abstraction wells (Thorling, et al., 2011) and previously 150 wells have been closed each year due to contamination (Brüsch, 2007). This has significant economic and environmental costs for Society in terms of identification of uncontaminated areas and installation of new wells, besides higher carbon dioxide footprint caused by deeper wells and longer transportation of water. Bentazone is the second most frequently found pesticide in the drinking water wells. In the last ten years the part of the Danish aquifer contaminated with Bentazone has increased to 5 % (Thorling, et al., 2011). It is a pesticide used in the agriculture thus it is spread in large areas making a diffuse contamination that cannot be controlled or removed at the source.

This project present a novel method for clean-up of pesticide contaminated chalk aquifers by natural microbial degradation enhanced by addition of oxygen. It is a solution for in-situ decontamination of the areas used for groundwater abstraction. Laboratory experiments are conducted mixing natural chalk and groundwater from locations around Copenhagen. It is investigated if bentazone is degraded by organisms naturally present in groundwater from bentazone contaminated aquifers. Furthermore it is examined if the removal rate is governed by the amount of oxygen present in the aquifer.

The enhanced remediation of bentazone-contaminated groundwater wells can be carried out simply by supplying the chalk aquifer with oxygen. The solution is economical, social and environmentally beneficial as:

- The present wells can be used for future abstraction of safe and clean drinking water.
- The method is based on natural occurring processes using no xenobiotic chemicals.
- The clean-up will improve the general state of the groundwater aquifer reducing the negative impacts from the use of pesticides.

Further work is ongoing to show that the oxygen concentration in an aquifer can be increased sustainably by intelligent pumping of the wells. The aim is to utilize naturally occurring oxygen infiltrated with rainwater. As an advantage the existing wells can be used in order to keep the costs low and save environmental resources.

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Nonlinear finite element analysis of buckling driven delamination growth in wind turbine blades

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ABSTRACT

Wind turbine blades are made of light and strong composite materials. Low weight core materials are used as well as strong fiber materials. The different material components are typically laminated or bonded together by polymer adhesives. Inside the composite structure various types of damages and cracks such as buckling driven delamination can occur. Delaminations are defects and can be defined as areas without bonding between adjacent layers. Structures with delaminations subjected to compressive loading, like for example the load carrying box girder of a wind turbine blade, may buckle and this can reduce the strength of wind turbine rotor blades significantly. Hence delaminations are considered as one of the most critical failure types that can occur in composite structures.

For better, lighter and more reliable constructions it is necessary to understand the evolution of damage. Numerical analyses are excellent suitable to intensify this understanding. Usually a fine discretization has to be used to simulate the delamination growth accurately. Therefore, delamination modeling in large scale is challenging and computation time costly.

A less computational expensive procedure for the numerical analysis of buckling driven delaminations in wind turbine blades is presented and leads to new findings in the field of delamination growth. Cohesive zone elements based on a continuum damage mechanic approach are used to model large scale delamination growth and to analyze the effects of defects on the structure. For this purpose nonlinear finite element analyses (NLFEA) of buckling driven delaminations in the load carrying part of a novel 10 MW wind turbine blade are investigated and compared with experimental and numerical data of small scale panels.

Summarizing the analysis of buckling driven delamination growth shows two different kind of buckling modes, local and global buckling modes. It can be concluded that initial delaminations close to the surface and with larger initial delaminated area tend to cause a local buckling, whereas deeper and smaller delaminations are likely to cause global buckling. Additionally, two different kinds of delamination behavior can be assigned to local and global buckling modes. In local buckling modes the sublaminate buckles and delaminates from the basic laminate, which causes a significant decrease of the critical buckling load. In contradistinction to the local buckling behavior, the numerical simulation shows that global buckling behavior does not have a significant effect on the strength.

Furthermore the analysis shows that delaminations with local buckling mode behavior seem to be triggered by a combination of normal (mode I loading) and shear stresses (mode II loading), whereas delaminations related to global buckling modes are mainly caused by shear stresses. Moreover local delaminations growth during the local buckling occurs gradually as contrasted with global buckling that occurs at higher energy levels instantly.

Keywords:

- Buckling
- Cohesive element
- Crack growth
- Delamination propagation
- Nonlinear finite element analysis
- Wind turbine blade

Ammonia Poisoning in Low Temperature Fuel Cells

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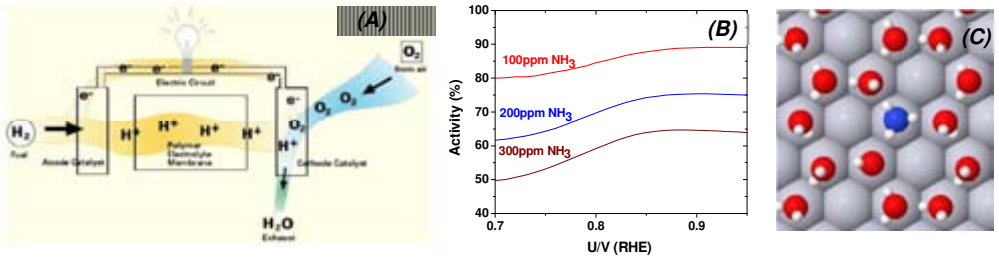
To slow global warming down it is of utmost importance to develop alternatives to fossil fuels that enable for a reduction of CO_2 levels. One of the possibilities for that ambitious –but absolutely necessary– goal is the use of fuel cells, devices that take energy from the conversion of hydrogen and oxygen into water (Fig. A), being a zero emissions source of energy. In particular, low temperature fuel cells would represent a non-polluting alternative for both stationary and automotive applications [1], but development is slowed down by difficulties in storing and transporting hydrogen. To overcome that challenge ammonia could be used as hydrogen carrier, taking advantage of an already existing infrastructure and an extensively studied synthesis [2]. However, any traces of ammonia on hydrogen derived from NH_3 will severely degrade the fuel cell performance to impractical levels [3].
Initial reports suggested that the cause of the performance decrease in the presence of ammonia was a membrane resistance increase, but more recent work established that these losses only account for a 10% of the total [3]. It remains as an open question whether the performance loss could be related to poisoning of the reactions occurring at the catalysts.
We studied the effect of ammonia on the catalysis of the hydrogen oxidation reaction (HOR) and oxygen reduction reaction (ORR) on a platinum catalyst using a rotating ring-disk electrode setup. While HOR was not affected by ammonia, strong poisoning occurred in the ORR (Fig. B), explaining the majority of the losses taking place in a fuel cell. On the basis of these observations, a theoretical model to give a microscopic interpretation was developed (Fig. C). The simulations revealed that the reason for the poisoning was ammonia blocking the platinum catalyst, which consequently stopped the desired ORR. Using the theoretical model, it was possible to screen through different catalysts and identify suitable candidates not showing ammonia poisoning effects. Such a catalyst was successfully tested experimentally, potentially leading to a patent. Additionally, we emphasized that the method used to mitigate ammonia poisoning can be generalized to other poisoning effects.



*(**A**)* Schematic representation of an operating polymer electrolyte membrane fuel cell. *(**B**)* Platinum catalyst ORR activity decrease against applied potential for different ammonia concentrations. *(**C**)* Model of an ammonia molecule sitting on top of a platinum catalyst used in the theoretical calculations.

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MASTER THESIS
LAPTOP
ENERGY DISTRIBUTION, EFFICIENCY AND TECHNOLOGIES

CO2 Neutral Streetlights (low power & low cost data logger)

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DTU – IMM/Fotonik, Technical University of Denmark

INTRODUCTION

Risø National Laboratory is getting more and more requests from The Danish government on how to save energy. One of the main issue is saving money on power,special when it comes to streetlight. Before the end of the year 2012,1500 street lamps around Copenhagen will be changed for light sources with low power consumption. Technical and Environmental turn down the energy as a part of Copenhagen's goal of reducing the city's CO2 emissions by 20 percent by the end of year 2015. But how much power will the new lamps comsume? And can a street lamp produce sufficient power even in Denmark? Here will a low cost & lowpower[1] Datalogger come handy.

DESIGN

The data logger is an electronic device that records earthquakes(Sensor network), Wind ,daylight ,power used/produced on the street lamp over time. Data will then be uploaded via a wireless radio MESH[4] network(868 Mhz) to a database server for later analyze. The Prototype is developed on two microcontrollers(AVR and ARM Cortex-A8) with the low power and with fault tolerant in mind, equipped with extra storage for offline catching(like a uSD(16/32Gb)).The ARM CortexA8-board is running a full version of Ubuntu(OMAP), with Apache-webserver,PHP and MySQL-database for local catching of data, in case of the network is offline. Data will then be sync with the database server then there is connectivity. Controlling the Datalogger device can be done from the control center's webinterface or on the device it self(via Web or SSH). The device can even be used for other purposes like a (MESH) WIFI net, something like freifunk in Berlin & WNDW[3,2]. In a catastrophe area the “lamp-network” will still be running (because it is off-grid), even when the infrastructure is destroyed or very heavy loaded.

HOW LOW IS LOW?

How low cost? In a price range of around max.100 $ pr. main-unit and around 30$ for each 868 mhz-node(max.253). A data logger with the same functions can be something like the DT82E[3] datalogger(no nodes!) from DataTaker that have a price of £752 pr. Unit.(like 1190 $) please note that’s in 2012 exchange rate. *How low power ?* The main board is running on max.4 Watt-5volt with a 500(720) Mhz Cortex-A8 and the 868 mhz-nodes is running on max.1 watt-3.3volt. The goal is a very low/non power-footprints on the measurements ,in this case a street lamp.

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Smart demand voltage control in power networks

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INTRODUCTION

The goal of the project is to apply methods for storage energy, mitigate the instability of the power networks, decrease in power transmission loses, and protect the appliances against possible effect of power network instability or failure by using and upgrading the DFR-SmartBox devices. The DFR-SmartBox are a prototype devices for testing purpose algorithms and supervising the power networks at the end users. After testing the algorithms in these devices will be ready to be implemented in a mass production scale devices. These devices will manage the consumers appliances accordingly whit the real needs of the consumer, necessity of storage energy and flattening the demand of the modern power grid networks. Some of the consumer's devices have a good potential for storage energy by simple using them in a smart way. One of the problems with green energies (wind and solar) is that they are not available at all times. This leads to difficulties with integration onto the existing power network based on coals, and nuclear power plants.
Presently some technologies for power grid storage are available, but none of them have reached a high maturity in development due to reasons of conversion efficiency, life span and cost. For example the batteries are expensive, use environmentally harmful substances and have a very limited life span. Statistics shown that 60 to 80% total of energy in houses consumed in form of thermal energy for hitting or for cooling. Hitting usually is done by burning combustible substance like cool, methane gas, fossil oil products, wood etc. which create on the global scale enormous amount of CO2.In another hand are already available technologies as "ground source heat pumps" which usually have advertised efficiency between 250% and 400% this mean that can transfer for each KW electric energy consumed 2.5KW to 4KW thermal energy from the ground source. The electric batteries can have maximum theoretic efficiency of 100% usually 60 to 95%. Ground source heat pumps can provide also efficient hitting of homes and water in cold seasons and cooling in hot seasons. By simple using these devices in a smart way avoiding the highly electricity demanding time periods can save CO2, improve the power network stability, reliability, and minimize electricity loses caused by the heat dissipation in the conductors in the power network at all levels of power distribution network. The green generators usually can cover the low demand time periods but in the high demand periods only a small quantity of electricity is produced by the green generators and most of the electricity came from coal based power plants. The project aims an implementation a simple and viable method for a very large scale integration of smart demand response of consumers. Therefore has to be almost no extra price for implementation of it, also be able to deploy in all kind of networks around of world. Voltage network is considered to be used as an indicator of the local needs of energy in the power network. A proposed approach is to collect measurement data of power network voltage over a specific period of time and detect specific patterns of power network where runs based predominant on green energy or are in low demand time period.

Consideration of Human Health Impacts due to Indoor Exposure in the Sustainability Assessment of Buildings

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The aim of the project is to assess human health impacts originating from indoor exposure to chemicals released from building materials.

The topic of this master thesis is related to the Life Cycle Assessment of the Solar Decathlon House 2012, in order to support the sustainable report of this contest in a systematic and organized way. The assessment will be based on the previously conducted research on the material and chemical inventory of the Solar Decathlon House to obtain precise insights in the chemical emissions and exposures, based on the respective quantification and characterisation factors.

The project will start with quantification of the chemical emissions from building materials to the indoor environment. Building materials include the materials for construction of walls, floors, electric wiring, etc. The method used for quantification of emissions will be determined later. Options include literature review or modeling. This first step will result in calculation of indoor concentrations of chemicals.

The second step is the calculation of human exposure to the chemicals released from the building. Only a fraction of the chemicals present in the indoor air will end up in the human body. Human beings can be exposed via several pathways: respiratory, oral, or dermal. In this case, respiratory effects can be expected to result in the highest exposure. For that reason, the project will focus on respiratory effects.

Combination of the chemical's fate and exposure might be used in the development of characterisation factors for indoor toxicity for several chemicals.

Energy Performance of Sustainable Houses: LCA of the FOLD project house

Malte Peter Wiedemann

DTU Qualitative Sustainability Assessment, Technical University of Denmark

GOAL

The aim of this master project is to deliver a detailed LCA of the FOLD project house (DTU project for Solar Decathlon Europe 2012 Competition), components and technical installations, focusing especially on aspects of energy consumption. Besides generating general insights on the properties of processes involved in production this work furthermore has the goal to identify possible hot-spots and also offer suggestions for improvements regarding the environmental impacts of used materials and construction techniques. The LCA will therefore practically serve as orientation and decision-support tool during the development of the house and will also be part of the sustainability report (Sustainability in Energy Efficiency), as a final deliverable for the Solar Decathlon Europe 2012 Competition.

BACKGROUND

The modern definition of sustainability goes far beyond only considering the primary properties during the use phase of a product. Therefore, the main purpose of the FOLD project is to ensure the house's sustainability over its lifecycle. Since most of the parts of the house are completely new developed, it is important to not only look at how the application of these affects the environment but also what are the environmental impacts from extraction of raw materials, production and use.

METHOD

The work will be divided into two main parts, the special course that will aim at collecting the necessary basic data followed by the master thesis where the product system will be modeled and the energy balance calculated. The product system will be modeled using the GaBi LCA software and the aim is to use primary data, if available, to model the important processes. In order to gather as much primary data on the relevant processes as possible, the work will include research on the production of materials and their assembly. To establish access to these numbers a close cooperation with the sponsors and material and components' suppliers is crucial. Therefore one of the main project objectives is also considered to maintain a good communication and cooperation with the data providers. For the background processes generic data, available from various databases will be used.

Design and processing of structural components in biocomposites – Rotor blade for wind turbine cars

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INTRODUCTION

Composite materials are regarded as an outstanding class of materials for many advanced applications. The growing environmental concern has led to a search of substitutes for the inorganic fibre reinforcement. Biocomposites, using natural fibre reinforcement, offer many advantages such as lower environmental impact, the potentially lower cost and ease of disposal together with satisfying mechanical properties. Three small wind turbine blades have been designed and built using carbon, flax and carbon-flax blended fibres. The three concepts LCAs and aerodynamic properties have been compared using Abaqus FEM.

THEORY

Natural fibres due to their structure and chemical composition have a specific tensile modulus similar to glass fibres. Moreover the energy required for their production is considerably lower than the one of inorganic reinforcement. Among the most performing natural fibres is possible to find flax and hemp ones.

METHODS

Three wind turbine blades were realized through vacuum infusion process: one in carbon, one in flax, and one in a hybrid structure of carbon on the outer layers and flax in the inner layers. The resin used for the composite manufacturing is a 50% biobased epoxy resin. An optimization model was elaborated in order to optimize the composite layer structure and to validate the structural requirements needed for the blades: limits on tip's deflection is imposed and the optimization objective consists on minimizing the blade's torsion in order to keep constant the optimal angle of attack defined in the design stage and maximize aerodynamic efficiency. The MECO principle (Materials, Energy, Chemicals and Others) was used in order to find the energy required for the production of the different blades.

RESULTS

All the blades satisfied the mechanical requirements. In the table is possible to observe the result of the MECO analysis.

Blade Energy Consumption [MJ], angle of torsion [°] and weight [Kg]				
	Flax + Bio-Based Epoxy	Carbon + Bio-Based Epoxy	Carbon + Conventional Epoxy	Hybrid + Bio-Based Epoxy
Reinforcement	1,91	113,27	113,27	64,59
Resin	3,29	1,14	1.85	1,93
Total	5,20	114,41	115,12	67,52
Max Torsion angle	0.9	0.06	0.06	0.13
Weight	450	250	250	300

Table 1: Energy consumption, weight and angle of torsion for the different blades realized

CONCLUSION

The energy required for the construction of the flax blade is 23 times lower than the one in full carbon. The hybrid blade showed mechanical properties comparable with the blade of full carbon and allowed a reduction of 40% of the energy for the production.

Synthesis of Amides using Supported Gold Nanoparticles and Base as Catalysts

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ABSTRACT

Selective oxidation of alcohols is one of the most important reactions in organic chemistry and is used in the production of many bulk commodities, high-value fine chemicals, agrochemicals and pharmaceuticals. In the search for a more sustainable chemical industry, much effort has been devoted the development of efficient oxidation catalysts that uses molecular oxygen as oxidant. From the standpoint of green and sustainable chemistry, these oxidations are attractive because oxygen is a cheap and readily available oxidant that produces water as the only by-product.[1]

Here, I present the investigations of a novel reaction protocol for the synthesis of amides using a catalytic system consisting of supported gold nanoparticles and base in methanol,[2,3] see Figure 1.

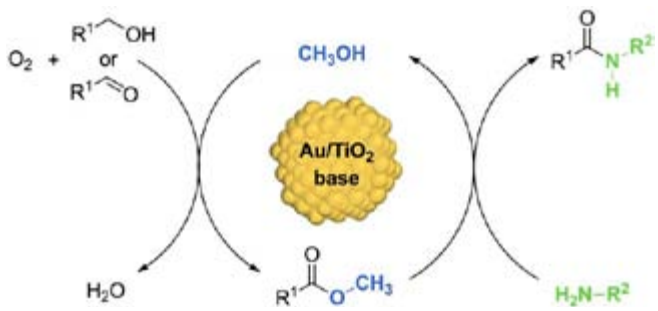

Figure 1. One-pot synthesis of amides using supported gold nanoparticles and base as catalysts.

In the first step of the reaction, the gold-catalyzed oxidation of an alcohol or aldehyde in methanol yields a methyl ester. In the second step, an amine is added and the methyl ester is converted into the desired amide by base-catalyzed aminolysis. As the same base is promoting both steps of the reaction, the synthesis can be performed in a convenient one-pot procedure without isolation or purification of the intermediate. The employed oxidant is pure molecular oxygen and the reaction can be performed under mild reaction conditions (25–65°C, atmospheric pressure). The reaction protocol was applied to a number of alcohols and amines, demonstrating the procedure to be versatile and applicable to a broad range of substrates. Furthermore, the involved reaction mechanism was discussed on the basis of kinetic data and theoretical density functional theory computations.

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MASTER THESIS
LAPTOP
OPTIMIZATION AND SUSTAINABLE MATERIALS

Catalytic decarbonylation in Ionic Liquids

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INTRODUCTION

With the repletion of the fossil resources and the increasing goblal demand for a more green chemistry industry, the devolopment of new and improved catalityc systems for the conversion of renewable feedstocks, as biomass, are needed. A possiblity of a greener chemical industry may be achieved by switching from enviromentally challenging solvents to more benign ones such as ionic liquids.

METHOD

The thesis concerns with the decarbonylation of 2-Naphthaldehyde and *p*-Toluenaldehyde in various Ionic Liquids (IL's) and their effect as solvent compared to the previous reported diglyme reaction which is shown in the figure 2. The catalyst used for this experiment is the [Rh (dppp)2] Cl.

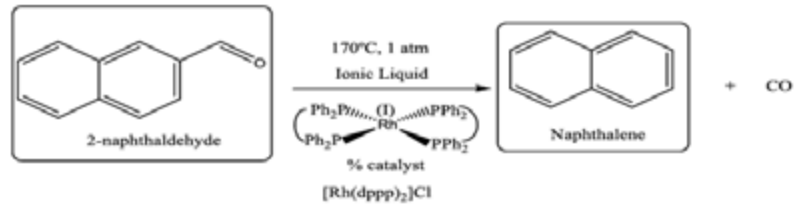

Figure 2: Global reaction

CONCLUSION

Here we demostrate the utilization of different ionic liquids as solvent for decarbonilation of aldehydes.

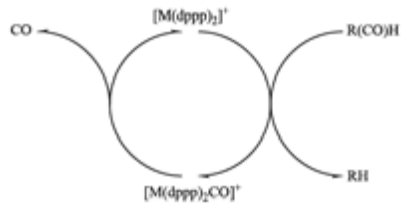

Figure 1: Pathway proposed for the catalityc decarbonilation reaction

The reaction presented in figure 1, provides a pathway for the conversion of aldehydes into decarbonylated molecules, which is a process that until now has shown low yields and poor selectivity. Recent studies have shown that the Group 9 metals are by far the most active metals for the catalityc decarbonytalion reactions, and that the rate determinating step is the decarbonylation of the metal complex. This knowledge presents an interesting opportunity for the selection of active catalyst-solvent combinations.

Turning the petrochemical market green - with RIBOSELECT

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A GLOBAL NEED FOR SUSTAINABLE PRODUCTION METHODS

Today most chemicals are manufactured by chemical, oil dependant processes. In the long run, this is neither environmentally nor economically sustainable. With the petrochemical industry being heavily dependent on fossil fuels and/or hazardous chemicals, production of chemicals will meet a future challenge, when oil resources become scarce and demand for sustainability and environmental impact becomes higher. Production of chemicals using enzymes and cell factories has the potential to displace petrochemical synthetic routes, and poses as a highly sustainable solution to these future challenges. Currently, the major limitation for bio-based chemicals is the long and expensive development process required to create efficient and cost-competitive biocatalysts.

RIBOSELECT – UNLOCKING NATURE'S BIOCATALYSTS

We have developed RIBOSELECT, a novel screening technology with ultra high-throughput capacity that accelerates the discovery and development rate of efficient biocatalysts by several orders of magnitude compared to existing technologies. The principle of the technology is positive selection. By a unique genetic system that couples growth of a cell (*E. coli* and yeast) to the presence of a chemical, we have enabled positive selection for chemical producing enzymes that are not normally essential for cell survival. The modular system can be tailored to respond to any compound of interest, and is thus currently being further developed as a platform technology for discovering biocatalysts for multiple compounds. The technology has been developed during Hans Genee's master thesis at the Novo Nordisk Foundation Center for Biosustainability.

The potential of this disruptive technology lies in its application to develop biocatalysts required for cost-competitive, bio-based production at a rate that far exceeds competing technologies. We have performed a preliminary analysis and identified vitamin B1, -B7 and -B12 as target chemicals that are currently produced by hazardous and unsustainable chemical methods, and we are currently working on applying RIBOSELECT in order to enable a bio-based production. Our analysis shows that manufacturers do not only gain a more sustainable production, but may also cut production costs with up to 80% by using our biocatalysts.

In conclusion, we believe that RIBOSELECT offers a solution that will be a major driver in the transformation of the chemical industry towards a green future and contribute importantly to revolutionizing, bio-based, chemical production.

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Proceedings in the Development of PCM Modules for Seasonal Heat Storage

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ABSTRACT

This thesis deals with thermal energy storage (TES) by the aid of supercooled phase change materials (PCM) based on sodium acetate trihydrate, and addressing certain issues encountered in on-going research, while elucidating the importance TES with PCM might hold in a future energy system. This technology seeks to counter the consequences of the fluctuating supply of renewable energy sources of energy and provide seasonally independent heat at a high security of supply, whilst aiding the introduction of higher shares of renewable power into the energy system.

Thermal energy storage have been researched and utilized for well over a century, while the supercooling property of several heat storage materials have been largely overlooked. Using this property actively, significant amounts of energy can be stored latently for extended periods of time - without any losses related to the length of storage. When combined with solar heating, this proves an interesting opportunity for dwellings to be self-sufficient with heat for all building technical services, like heating and hot water, etc. Simulations conducted by Schultz & Furbo (2007) demonstrates that a reasonably small amount of collector surface and storage volume respectively proves sufficient to supply a Danish household, without any auxiliary heating, if constructed in accordance with Energistyrelsens *Bygningsklasse 2020*-directive. Issues surfacing during the attempts do develop successful prototypes of such PCM-modules are being addressed during the course of this project, and among them follows:

- Small-scale experiments on the PCM composition (ratio of water to sodium acetate) for improved stability during supercooling, and;
- Determine latent heat of fusion for compositions exceeding 42 % water.
- Strength analysis to determine and improve problem areas in preceeding, deformed and failed module prototypes, incapable of cooping with high pressure.
- Socioeconomic perspectives on potential impacts on the existing energy system.
- Private economic analysis, simulating performance on the tested compositions and degree of solar fraction.

Recognizing the world as an entity with a finite amount of resources, mankind is quickly running out of our primary carriers of energy as fossil fuels are being depleted at an ever-increasing rate. While renewable sources of energy are being implemented worldwide as a response to the fossil depletion, one common denominator identifies and problematize them: With the exception of hydropower, they are all highly fluctuating and rather unpredictable - very much in contrast to mankind's demand for power and heat, thus emphasizing the importance thermal energy storage might hold in a future energy system.

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Dynamic routing of busses

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INTRODUCTION

With environmental as well as financial incentives for its use, public transportation plays an ever important role in society. In the EU 60 billion passenger journeys were made in 2008 alone, according to the International Association of Public Transport (UITP, n.d.). Increased efficiency in the use of busses is therefore a important step in reducing oil consumption. This project investigates whether a bus fleet can be used more efficiently by using a demand responsive system. Instead of having static routes and time tables that busses follow, a customer would use an app or the web to order a bus to take her from her origin to her desired destination at a certain time. The operator then calculates which bus can serve the customer best and make sure that customer's request is incorporated in the ever-changing route of that bus. This dynamic solution to public transportation is used by Danish operator Movia with great success in the transportation of the elderly and handicapped, but has so far been deemed inappropriate for use in heavy traffic due to the fact that the quality achievable by current routing methods deteriorate when more people use the service.

THE PROJECT

In this project, a dynamic transportation system is simulated and the quality of the service with respect to travel time and oil consumption is compared with that of a static network. By introducing a completely new routing method that allows for people to transfer between busses, this project aims to greatly increase the quality of dynamic solutions in scenarios with a lot of demand on the service. Since this has earlier been the weakness of demand responsive transit systems, a solution to this problem could cause dynamic routing to outperform static bus systems in far more cases, fundamentally changing the way we will take the bus in the future.

ENVIRONMENTAL IMPACT

All modern bus fleets already have the equipment necessary to transform them into demand responsive transits. Furthermore, since the change is primarily software-based, research on this can immediately be applied world-wide. Even a small increase in efficiency can therefore get great consequences on the global scale, and great savings in oil consumption and CO_2 emissions can be obtained. This constitutes a crucial step on the path to a sustainable world.

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Influence of environmental factors on toxicity of ionizing compounds towards microalgae

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INTRODUCTION

Antibiotics have been largely applied nowadays in water environment and they can affect the metabolism and growth behaviors of the aquatic organisms. The toxicity values of the compounds are always studied with the standardized tests, such as ISO, NOEC or USEPA. These standard tests have a wide tolerance on the conducting environments. However in the real cases, the environmental conditions can largely affect the toxicity behaviors of antibiotics, particularly most of them are ionizing, which probably present larger variances in toxicity values.

Thus in the current study, the influence of environmental factors on the toxicity of two ionizing compounds, salicylanilide (CAS no. 87-17-2) and trimethoprim (CAS no. 738-70-5), was studied. The test aquatic organism is microalgae. Three environmental factors are in focus: pH, temperature and algae cultivation system (open/ closed).

METHOD

The standardized toxicity test method ISO 8692 (2004) was applied. A method development was implemented before the algae toxicity experiments in order to identify stable pH levels, 7, 8 and 9. The pH drift was required not to exceed 1, therefore all the results were checked and only the valid data were taken into further analysis.

RESULTS

pH condition can affect toxicity of ionizing compounds. For the acid salicylanilide, the toxicity decreased when pH increased and the opposite trend illustrated for the base trimethoprim. The correlation between pH and toxicity is mainly caused by the dissociation of the compounds. Temperature and growth rate of microalgae are in the positive correlation in the algae test. It is because most metabolism processes of algae are controlled by enzymes and enzymes are highly temperature-dependent. However, the temperature did not significantly affect the toxicity results. The algae cultivation system can also affect the toxicity results as well as growth rate of microalgae in toxicity test. The closed system indicated higher toxicity of both test compounds towards microalgae and higher growth rate of algae species, compared to open system. The reason may be the higher carbonate concentration in the aqueous phase. However more study needs to be conducted to clarify the question.

CONCLUSION

Three environmental factors in focus can affect the results of algae toxicity test. Influence of pH correlates with the dissociation behavior of the compounds and temperature alter the growth rate of algae species. For different algae cultivation systems, closed system shows higher toxicity of the compounds and higher growth rate of algae, when compared to open one.

Engineering of a lagoon for energy and water management for Copenhagen

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INTRODUCTION

This project originates from a desire to find an alternative to groundwater to sustain then Copenhagen drinking water demand. A driving factor is the EU Water Framework Directive that restricts the amount of groundwater allowed to be abstracted. One alternative to groundwater could be to construct and implementation of an alternative water supply including a lagoon. Such a lagoon is investigated in this project with regard to energy and water storage.

ENERGY STORAGE – GREEN POWER ISLAND

The energy storage potential of the lagoon was analyzed according to the Green Power Island principle and based on yearly, monthly and daily variation in wind power production. This resulted in lagoon surface of 280 km^2, 70 km^2 and 10 km^2 respectively. Beside the very large sizes of the lagoon a conflict between energy and water storage was identified. It is therefore not recommendable to stored energy and water in the lagoon at the same time. Regarding the energy aspect of the lagoon the location at Avedøre Holme was geological unsuitable as deep clay layer was missing to minimize infiltration into the lagoon, which would result in uncontrolled loss of energy.

WATER STORAGE – FRESHWATER LAGOON

If the lagoon only is to be used for water storage, the location at Avedøre Holme is suitable. The water supply lagoon was dimensioned based on extreme rain events, which resulted in a lagoon surface area of 1 km^2. Three different abstraction methods were simulated in the groundwater modeling program GMS MODFLOW. A relative large uncertainty is related to the model results. From sensitivity analyze and calibration it was found that boundary condition in the limestone and conductivities of the limestone was key model parameters that should be improved to reduce uncertainty. It was concluded that the lagoon could supply large amounts of water (16.5million m3/yr) depending on the abstraction method. The most promising method for extraction the lagoon water was by horizontal abstraction wells (Case C1) which had low effect on the surrounding groundwater level, a low risk of saltwater intrusions and easy clogging maintenances.
The water quality aspect in this project was estimated based on retention times. The retention time in the lagoon was estimated to approximately 3 month. The long retention time could give problems with algae growth. The retention times in the ground were estimate from 4 hour for the horizontal abstraction (Case C1) and to 40 days for the direct injection (Case B). The best water quality is likely to be achieved by direct injection method (Case B) due to the longest retention time the ground.
Abstracting water from the lagoon was estimated to be an energy efficient way (0.02 to 0.08 kWh/m^3) to get an alternative water sources, compared with other alternatives such as desalination (1.6 to 4 kWh/m^3).
Based on the investigation preformed in this project it was concluded that combining a lagoon with horizontal abstraction well (Case C1) is energy effective and a promising approach for alternative water supply for Copenhagen.

Design of the Root of a 61.5 m Wind Turbine Blade

Rohan Khubchandani

DTU Wind Energy, Technical University of Denmark

INTRODUCTION

The root of a modern day wind turbine blade can be considered a primary structure. The bending moment is the greatest at the root and hence it would make intuitive sense that the root is the thickest part of the blade. For larger blades, there is a significant build up in this region, and special quality, low exotherm laminates must be used in this area. The root must be circular to accommodate pitch bearings and to prevent high stresses in this region.

This part accounts for nearly 20% of the cost of the blade and there has been recent trend for global blade manufacturers to sub contract these root segments to reduce cycle time.

PROJECT

In this project, current bushing concepts (i.e. the T bolt and the embedded carrot) and literature relating to materials and structures of the root of wind turbine blades will be reviewed. A coarse model (using SOLID 186 elements) of the root of a 61.5 m blade will be designed using the finite element program ANSYS.

The next stage of the project will comprise, multi scale modeling, where an alternative 3D concept for the root bushing (sub model) will be combined with the coarse model. The results from the coarse model will be mapped to the sub model.

Global cross sectional loads will obtained from the Horizontal Axis Wind Turbine Code (HAWC) develop by the DTU department of Wind energy. These will be applied at one end of the cross section and the effects of these global loads, on the bushings, will be carefully studied.

Once the vital loading conditions have been identified there will be the design of an experimental test setup.

SUSTAINABILITY

Most countries are trying to move towards renewable sources of energy, to gain energy independence and reduce their reliance on fossil fuels. Wind energy is a crucial part of the clean energy solution.

In recent times the trend in the wind industry has been towards designing blades with a larger swept area. As blades grow larger, they are going to comprise of several sub components with the root being an extremely critical region. The project involves optimization and analysis of a sub component of a wind turbine blade. It is mandatory to have a great deal of structural integrity in this region, to transfer the loads from the blade to the hub, else there could be catastrophic failure of the blade.

Simulation and Optimization of a Steam Co-generation Plant with Integrated Bio-ethanol Production

C. Lythcke-Jørgensen

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Second generation bioethanol production is often favored over first-generation as it decouples food and energy production. It is as well considered a more sustainable way of using biomass for energy purposes than combustion as it sustains and recycles the potassium contents. The aim of this project was to implement second-generation bioethanol production in existing thermal power plants to reduce the costs of producing sustainable biofuel for the transportation sector while at the same time increasing the flexibility of the plants' electric power production, allowing for higher levels of renewable power penetration in the grid.

The project focused on a thermodynamic optimization of integrating second generation bioethanol production based on straw in the combined heat and power production at existing power plants. The basis is the combined heat and power plant Avedøreværket 1 (AVV1) and a biorefinery based on the IBUS (Integrated Biomass Utilization System) process with wheat straw as feedstock.
Models of both AVV1 and the IBUS plant were developed in the simulation program Dynamic Network Analysis. The AVV1 model deviations were in the range of up to 4% on all parameters, with a special electricity production deviation at Benson minimum load of +10%. The bioethanol production, CO2 generation and the water consumption at the IBUS plant are all within the ranges presented in literature.
The IBUS plant feedstock upland was determined by an economy of scale estimation, stating a maximum feedstock transport distance of 50km. Based on the feedstock upland size and numbers on agricultural practices from Danmarks Statistik, the process capacity of the IBUS plant was dimensioned to be 22.4ton/h, equaling a heat consumption of 48.4 MJ/s.
An exergy analysis is used to determine the thermo-energy optimal extraction point of steam from AVV1. For indirect use of the extracted steam, the Intermediate Pressure 2 (IP2) turbine inlet is best suited, while for direct use of the extracted steam, the first extraction point at the Intermediate Pressure 1 (IP1) turbine is best suited. The electricity production of AVV1 is given an extra flexibility of 6.2-6.9MW for the first option depending on the operation mode, and 6.0-6.6MW for the second option.
An economic analysis of using extracted steam for an IBUS plant rather than using a gas fired boiler is yet to be finished, but present results suggests a reduction in operation cost of 10-45% for an integrated plant compared to the 'stand alone' scenario.

Many studies have pointed out the increased sustainability in processing straw in an IBUS facility prior to combustion rather than using it for direct combustion in thermal power plants. This study shows that an integration of an IBUS plant at a thermal power plant can reduce the operation cost of the IBUS production markedly, while at the same time increasing the electric power flexibility of the power plant. The latter ability will become increasingly important in the nearest future as the newly set governmental target of 50% wind power penetration in the grid will challenge the power production at thermal power plants even further.

Estimation of Sea Ice Concentration from SAR Images

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ABSTRACT

Recently, the effect of climate change has been that new ship routes through the Arctic ocean has opened, routes that are shorter and faster, and thereby fuel saving which is of great interest. This suggests a significant increase in sea traffic in the formerly ice covered areas. This expected increase in traffic poses a greater demand for accurate mapping of the remaining sea ice, mapping that is today done manually by the various ice services around the world. Moreover, there is a significant interest in the evolution of sea ice coverage and its interaction with the atmosphere from a climatological point of view.
The primary tool for estimation of sea ice is today synthetic aperture radar (SAR) images from various satellite systems. These images allow ice service operators to detect and monitor ice regardless of weather conditions and time of day. The sea ice mapping is done by skilled experts within the field, who based on a combination of texture, intensity and shape are able to produce fairly precise ice charts. The task of such ice mappings is, however, a time and man-power consuming operation, leading to the fact that the increasing demand for sea ice concentration estimates cannot be fulfilled by manual operators in a cost-effective way. Alternatively, automatic or semi-automatic systems for ice estimation could be used.
In this project methods are studied and developed for (semi-)automatic estimation of sea ice type and concentration. This is done, using the recently developed texture-segmentation approach "Learning Dictionaries of Discriminative Image Patches" (Dahl and Larsen, 2011) on scale-space representations of SAR imagery.

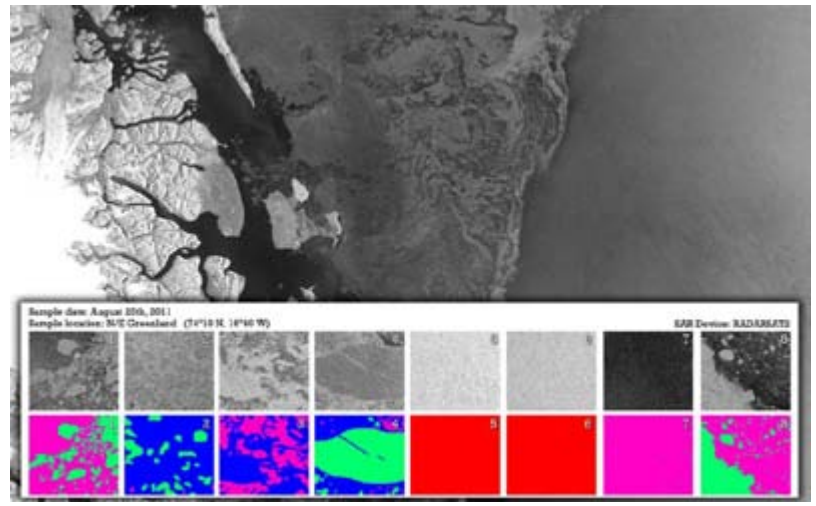

Figure 1: Typical SAR sea-ice image, with segmentation samples overlain.

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Design and Simulation of a CO_2 capture process using activated potassium carbonate

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ABSTRACT

In this project a simulation of a CO2 capture process using Aspen Plus 7.2 will be investigated. The CO2 in the flue gas emitted from a typical power plant will be investigated using a solvent composed of potassium carbonate activated with piperazine. The thermodynamic model used for the simulation is extended UNIQUAC which will be validated in Aspen from experimental data from the literature. A process simulation of the full set-up of the capture process will be validated from pilot plant data from the literature. Finally an optimal process design will be made focused mainly on energy reductions. atabases will be used.

Diabatic Distillation

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INTRODUCTION

My Project is on Diabatic distillation, also called Heat Integrated Distillation. Distillation processes worldwide consume around 3% of the total energy consumed, due to the large number of distillation processes. Therefore it is an area, where a lot of energy can be saved. The conventional distillation process has a very low efficiency and therefore there is room for improvement. By using Diabatic distillation, the efficiency of the process can be increased and thereby large amounts of energy can potentially be saved. In this project, a new and simple design method based on the conventional McCabe-Thiele method will be developed

THEORY

For a Heat Integrated Distillation Column(HIDiC), the rectifying section are operating at a higher pressure than the stripping section. Thereby there is a temperature difference between the section, which can be used to transfer heat internally in the column between the sections.
For setting up the model for the system, simple mass and energy balances are used.

METHODS

For making the design, the McCabe-Thiele method is used. First it is applied on a conventional distillation column. This results in a number of stages with corresponding compositions used to determine the heat transfer. This is used to calculate liquid and vapour flows from the mass and energy balances and thereby, new operation lines can be drawn for the McCabe-Thiele diagram. This iterates until the same number of stages is repeated and this is then the number of stages needed in the HIDiC, with the specified pressure difference. All operation conditions also needs to be specified

RESULTS

The design and simulation calculations are carried out in MatLab. All have a feed flow of 100 kmole/hour with a feed composition of benzene of 0.5 and feed thermal conditions q = 0.5.

Cases	P_r	Design x_w	Design x_D	N	Sim x_w	*Sim* x_D	X_S
1	1.95	0.05	0.95	24	0.949	0.051	58.2%
2	2.02	0.025	0.975	30	0.974	0.026	59.4%
3	1.70	0.1	0.9	24	0.902	0.098	56.9%

Table 1 Design vs. simulation results for the benzene-toluene system

CONCLUSION

This method is very simple method based on the well-known design method McCabe Thiele. Providing the desired operation conditions and purities of the compound, together with the thermodynamical data, the design template can give the number of equilibrium stages needed. Afterwards the simulation can be carried out and the energy savings can be calculated. This results in energy savings of 57-59% for the cases evaluated. This is a huge potential for saving large amounts of energy in the industry. Further study, especially experimental studies are vital for improving this distillation method.

Significance of design parameters for very low energy use and good indoor climate: Simulations and measurements of Danish single family passive houses

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The largest project so far in Denmark testing the performance of passive houses was the “Komforthusene”- project near Vejle. The monitored indoor climate and energy use was published in January 2012 (Larsen et al, 2012) and the results showed poor thermal comfort in many houses. The missing or external solar shading of the windows together with poor possibilities for natural ventilation and therefore also night cooling were seen as the most significant factors. Furthermore, the missing focus in the evaluation and documentation of the expected indoor climate in the design phase was seen as a problem, too.

This actual study takes up the results from “Komforthusene” – project together with new measurements on yet another passive single family house, located north of Copenhagen, which is very representative for typical Danish single family house design, consisting of brick walls and saddle roof. The façade facing south, however, is characterized by large windows that are provided with manually controlled external shading devices. In addition to the mechanical ventilation with heat recovery there is potential for good natural ventilation with roof windows.

The measured indoor temperatures, CO_2 - and relative humidity –levels and energy are compared with dynamic building simulations and simple methods like PHPP and Danish standard energy calculation tool Be10. The focus is on finding the significance of the design parameters – including solar shading and ventilation strategy – on the indoor climate and energy use. In addition, the ability of the different tools to predict the performance of a very low energy house is studied.

The study is a part of a master thesis carried out in spring 2012 at the Technical University of Denmark, DTU.

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Life Cycle Assessment of Micro Manufacturing

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In order to verify the assumptions and stereotypes concerning the environmental friendliness of the micro products, the application of Life Cycle Assessment (LCA) tools is getting widespread. According to the regular belief, the environmental impacts of the micro components seem to be less than their macro counterparts due to the small amount of material usage, less production energy and less quantity of waste. On the other hand, the design and manufacture of so-called micro parts plays an increasing role. Micro parts are usually defined by having critical dimensions in at least two dimensions below 1 mm or having functional features below 1 mm [**1**]. The small size is often seen as an indication of a smaller environmental footprint, but the manufacturing efforts are usually quite significant both in terms of machine sizes and energy consumption per weight unit of product [**2**]. Furthermore from a technological perspective, efforts associated with the creation of the necessary precision usually comprise use of auxiliary equipment and special materials as well as temperature and humidity control [**1**]. Finally, both in MEMS and other micro products the use of rare materials is often seen due to the small amount in use.

In the current research, a LCA approach is carried out for two micro products. The investigated micro parts are representative for two different sockets for signal carriage of hearing aid instruments. The LCA described in this study uses IMPACT 2002+ as the assessment methodology and the software SimaPro 7.3 as the LCA tool. In addition, by scaling a socket up to 25 times a macro component is assumed in order to compare the environmental impacts of a micro and a corresponding macro product. In each of the LCAs, gold and the process of coating are identified as the most hazardous material and process.

The significance of environmental impacts for macro components compared to micro components is achieved by defining a parameter as “impact ratio”. This parameter shows that how much the environmental impacts of a micro product are changed when the product is scaled up. Moreover, the environmental impacts of every micro and macro socket per unit weight of them is calculated by applying another parameter named “net impact” and the results reveals that the net impact of micro sockets is considerably higher than the corresponding one for macro sockets. The “net impact” is computed again after removing gold as the material which causes the most significant environmental impacts. The outcomes show that yet again the environmental impacts of micro per unit of weight is significantly more than those of macros which in turn leads to doubt over the hypothesis of environmentally friendliness of micros compared with macros. Moreover, the uncertainty of the results is estimated for the different scenarios by performing a sensitivity analysis and no considerable difference is observed except for varying the amount of gold.

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Application of Fibre Reinforced Bio-Composites Intended for Cradle to Cradle Shell Structures.

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This abstract is based on a master thesis carried out in the fall of 2011 and works within the context of sustainability and structural design. Traditionally do concrete, steel and timber constitute the load-bearing elements of structures but with the emerging awareness of carbon footprint new possibilities have emerged.
The objective of the thesis was to design a mobile structure for a *Cradle to Cradle* (C2C) Pavilion – a project originally designed by 3XN and COWI – which communicates a new green, holistic approach to building design. The purpose of the pavilion is to demonstrate new building technologies within the framework of C2C worldwide, thus the pavilion can be disassembled, moved and reconstructed at another location.

Cradle to Cradle is an environmental paradigm that aims to design consumer goods and products with a positive influence on society by eliminating the concept of waste. Basically should all materials used in production be constituted in a cyclic metabolism (either a technological or biological) and function as *nutrition* for new production.

Through an integrated design process and material test results from the WOODY Project obtained by DTU Wind Energy (former Risø DTU) an *umbrella shell* structure consisting of four hyperbolic paraboloid shells is designed to constitute the C2C pavilion. The shells are made in flax fibre reinforced composites; a material which safely can be decomposed, thereby respecting the requirements of the biological C2C metabolism. Due to the high tensile strength (237MPa) and stiffness similar to concrete (20 GPa) is the material highly suitable for application in shell structures. These structures are known to be highly effective due to the in-plane force flow, which enables slender and elegant designs.

Besides from the ability to be recycled or decomposed the materials are evaluated upon hard and soft factors. Hard factors are environmental material data (CO_2 emission, water usage etc.), while soft factors primarily are related to the green experience/appearance generated. Both factors are fulfilled in a successful design.
In the process of material selection is it important to consider the context and thus the phrase *sustainable materials* is discussed in relation to a temporary mobile structure where weight and lifetime is of importance. As a result is it rephrase to *sustainable use of materials,* which means sustainability is related to the context instead of an ultimate expression.

The structure has been analyzed through a finite element model in Abaqus, where the principal in-plane force flow have been located in an equilibrium stress state in order to ensure an optimal placement of fibres to fully utilize the mechanical properties.
It results in a two cm thin and light (3.5 times lighter than concrete shells) structure combined with a visual green dimension, which relative easy can be transported around world to communicate sustainable solutions of Cradle to Cradle. All materials used in the project enter either the closed technological or biological metabolism after use.

Light-harvesting biomimetic membranes

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Over the past few years, considerable attention has been devoted to the development of low-cost photovoltaic device technologies. In this context, organic solar cells have the potential advantage of being cheaper and less energy consuming in fabrication, yet they still lack efficiency. Here we studied how wild type Bacteriorhodopsin (bR) a membrane protein found in the archae *Halobacterium salinarum* may be used as efficient light harvester in organic solar cells.

bR is a light-driven pump that uses the energy of a photon to translocate protons vectorially across the membrane. In order to make an efficient bR-based organic solar cell it is important that the membrane matrix in which the bR is embedded is optimal for protein function and storage of the photon-generated proton electrochemical gradient. Therefore we reconstituted bR in lipid/polymer based biomimetic membranes and investigated how the host matrix affected protein function and proton gradient storage. We demonstrate how the barrier properties of lipid membranes can be modulated by organic solvents and how mixed lipid-polymer systems can be used to control orientation and efficiency of the reconstituted bR. Take together our results points to how the bR host matrix may be optimized in order to create robust efficient organic solar cells.

Decision supporting tool based on LCIA's marine eutrophication damage model

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Life Cycle Assessment (LCA) is an environmental assessment tool used to address and evaluate the environmental exchanges (inputs/outputs) and the potential environmental impacts of a product or service from 'cradle to grave'. It consists of a standardized iterative process that includes a Life Cycle Impact Assessment (LCIA) phase.

LCIA quantifies the potential for environmental impacts by evaluating impact scores resulting from the emission inventories and specific characterization factors (CF). The evaluation takes place either at the midpoint (MP) or endpoint level (EP) in the cause-effect chain. The midpoint might be the increase in the nutrient concentration in the water and the end-point the degree of reduction in species diversity.

Marine eutrophication is one of the impact categories in LCIA and is caused by nutrients enrichment and organic loading to marine coastal waters. The present study of damage (effects) estimation relies on the sequential correlation between nitrogen (N) inputs, the biomass production, the organic matter (OM) degradation, the resulting oxygen depletion, and the potential effects on biota. The latter can be assessed by a Species Sensitivity Distribution (SSD) method, where a Potentially Affected Fraction (PAF) of species is expected as a result of that N input. The same rationale is shared by Risk Assessment (predicting an effect from a stressor), or in establishing Environmental Quality Criteria (where a 'safe' concentration is defined bearing a known acceptable effect). Compiling the fate and effect factors into CFs at ecosystem's MP and EP level compartments help assessing the resulting impacts and shaping a damage model for marine eutrophication.

This ecosystem-based approach can bridge between a scientific tool (LCA) and management/regulatory frameworks, and may act as a Decision-Support System (DSS) by quantifying the impacts of emitting nutrients and OM into marine coastal ecosystems. Its results may be used in supporting an informed decision by managers and legislators, in preparing, adapting, or revising legislation on fertilizers composition, wastewater treatment, deciding about practices of application of inorganic/organic fertilizers, land use, agriculture carrying capacity, etc. – in short, estimations of the effects of their management and operational decisions.

Structural Health Monitoring of Offshore Wind Turbines

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[+]Vattenfall

Observed settlements of the grout connections between the wind turbine and the monopile foundation have been experienced at over 60% of Europe's offshore wind farms including Vattenfall's offshore wind farm at Horns Reef. That gave rise to the idea of an improved condition monitoring of fatigue loads and to develop a Load Observer Tool in close cooperation with Vattenfall and the mayor objective of this project is **to develop a tool to estimate the remaining lifetime.**

Problem Statement and Method

In this project, well-known methods from system identification, state estimation and fatigue analysis are applied in an innovative approach for application in condition monitoring.
A Wind Turbine Generator (WTG) Load Observer model, representing the wind turbine response, is formulated to determine the loads. In this reduced t-order aero-elastic model, standard available SCADA signals are used to estimate rotor averaged wind speed and the rotor thrust force online. In 10-min blocks estimated wind and thrust force signals are post-processed into a mean wind speed and an equivalent fatigue force applying a standard rainflow counting method. Corresponding, prior calculated, mean wind speed dependent distributions of equivalent fatigue thrust force and probability of occurrence are updated for each 10-min sequence and applied for updating a lifetime fatigue load estimate.

Discussion

Only the low frequent response can be captured by the WTG Load Observer model based on the standard available SCADA signals. Therefore acceleration measurements are needed to capture the dynamic response of the wind turbine response caused by the rotor (1P effect), the blades passing the tower (3P effect for a 3-bladed wind turbine) and waves at offshore locations. The Kalman filter is needed and implemented to process this signal. Combining the information the right thrust force can be estimated.

Potential/Outlook

Having knowledge about the remaining lifetime loads the condition of the grouting can be predicted by the Load Observer Tool. By continuously monitoring the experienced loads and an extrapolation of these loads, valuable information about critical components can be obtained and damages avoided. Further, scheduling of inspections and maintenance can be optimised, turbine life time prolonged and structural optimisation performed. Also, bad performance due to not considered aero-elastic phenomena or unsuitable controller settings can be pointed out. All these benefits represent a huge value for a wind operator as Vattenfall.

Power output maximization of Wind-Turbines

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[2]Department of Informatics and Mathematical Modelling, Technical University of Denmark

INTRODUCTION

Choosing correct strategy to control Horizontal Axis Wind Turbine (HAWT) is crucial in order to produce maximum available power. However, before designing the controller, mathematical model of wind turbine must be formulated. The controller must deal with not only non-linearities in the model description, but also with stochastic influences of the wind, and shifting between control objectives. Stationary analysis of the differential equations together with the physical limitations of the turbine itself yields in four operational regions. The main project idea, is to formulate a universal optimization problem, which ensures maximum power production subject to constraints.

MODEL PREDICTIVE CONTROL

Model predictive control (MPC) has been chosen as a control strategy. MPC has several advantages. The main advantage is, that the algorithm calculates the optimal control action, but still obeys constraints. These constraints are mainly physical limitations of the system e.g. angular velocity of the turbine, or change in the pitch angle. Imposing constraints may also be motivated by safety of operation.

CONCLUSIONS

This project deals with new strategies of controlling the HAWT. Controllers currently implemented, has several drawbacks, mainly they don't account for the constraints. MPC together with Kalman estimator allows us to operate closely to upper physical limitations of the HAWT, without damaging the turbine. Therefore we can produce more power, with same wind turbines.

Modelling and control of an inverted pendulum turbine

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[4] Vestas Technology R&D

INTRODUCTION

The wind energy is one of the most important and developed sustainable energy sources. One of its drawbacks is the large initial investment in the wind turbine. A significant part of the total cost of a wind turbine accounts on the tower since it has to be very stiff to stand the forces induced by the wind. If the turbine is left free to lean forward, this forces can be dynamically compensated by the gravitational force of the tower itself resulting in a lighter structure. The modelling and control of these futuristic wind turbine is developed in this project.

MODELLING

Having a good model is crucial for studying the stability and the performance of the wind turbine as to get a proper control of it. Having as an initial reference a conventional model of a wind turbine, and then adding an extra degree of freedom, the inclination of the tower, we will make a similar effect to having a hinge in the bottom of the tower. A mathematical model of the inverted pendulum turbine has been obtained.

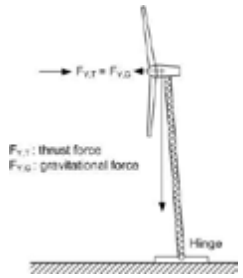

Figure 1 Inverted pendulum turbine

CONTROLLING

Without active control, the turbine would simply collapse. The control law has been designed in order to maximize the generated electrical power while keeping the turbine in an appropriate inclination that avoids the collapse of the tower. It is important to highlight that the implemented control uses the same control variables as the current wind turbines.

CONCLUSIONS

This project studies the feasibility of this uncommon wind turbine system design but also promotes sustainable energy and opens a wide range of new implementations in the world of wind turbines, like the offshore floating support structure wind turbines that would allow to place wind parks in zones with deep sea grounds.

CONQUER THE WORLD

A sustainable idea led to a third place in GRØN DYST 2010 for Rasmus Davidsen. This was the start of a domino effect which included an invitation to one of the world's largest conferences in green energy in Abu Dhabi - and made him 250,000 Danish crowns richer.

"Had it not been for my participation in the GRØN DYST contest I would barely have had these opportunities" to quote third prize winner Rasmus Davidsen. In brief, Rasmus Davidsen introduced the use of nanotechnology in surface treatment for solar cells in a new way. The solar cells demonstrate greater efficiency with a method that is both cheaper and faster than most commonly used methods in the industry today: "There's plenty of sun. However, in relation to the industry, on the other hand, it's a costly affair when energy has to be extracted the traditional way for commercial purposes. Our nanocoating is the solution that makes solar power competitive" says Rasmus Davidsen.

In addition to a spot on the podium at GRØN DYST for the entrepreneurial project "Black Silicon Solar", the invention also gave him the opportunity to attend the World Future Energy Summit in Abu Dhabi - one of the world's largest conferences on green energy.

And, as if that wasn't adventurous enough, Rasmus made his own way to win the main prize of 250,000 Danish crowns in the prestigious national entrepreneurial competition, Venture Cup, which was held in June 2011.
"Not in my wildest imagination had I thought that I should be standing as winner of the Venture Cup 2011, or that I should experience a conference in the United Arab Emirates as a speaker in front of participants from the global industry. But thanks to GRØN DYST I did!"

The list of Rasmus' further achievements is long. He has since founded his own company, won the Danish Championship in CleanTech, has been among the 6 chosen ideas presented at The Global Cleantech Open Ideas Competition in the United States, and finally, he participated in the Cairo Global Summit on Mew York Stock Exchange, selected as one of the 50 most innovative ventures started by undergraduate college entrepreneurs in 2012.

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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.

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