

Development of a CO₂neutral hybrid street lighting system for the Danish municipalities' illumination classes

Poulsen, Peter Behrendorff

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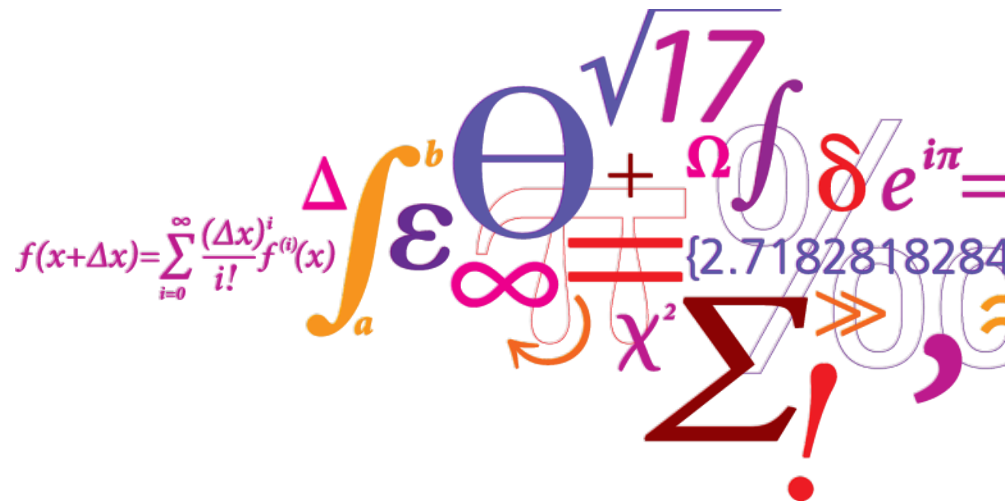
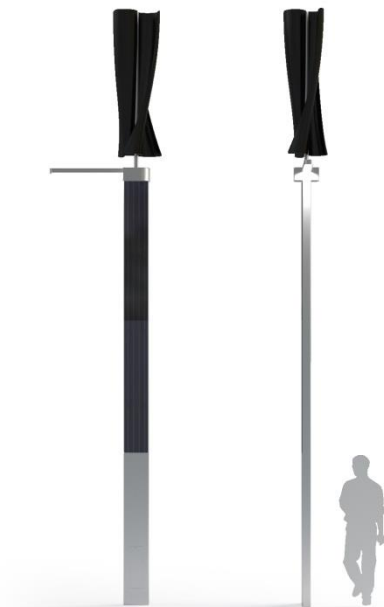
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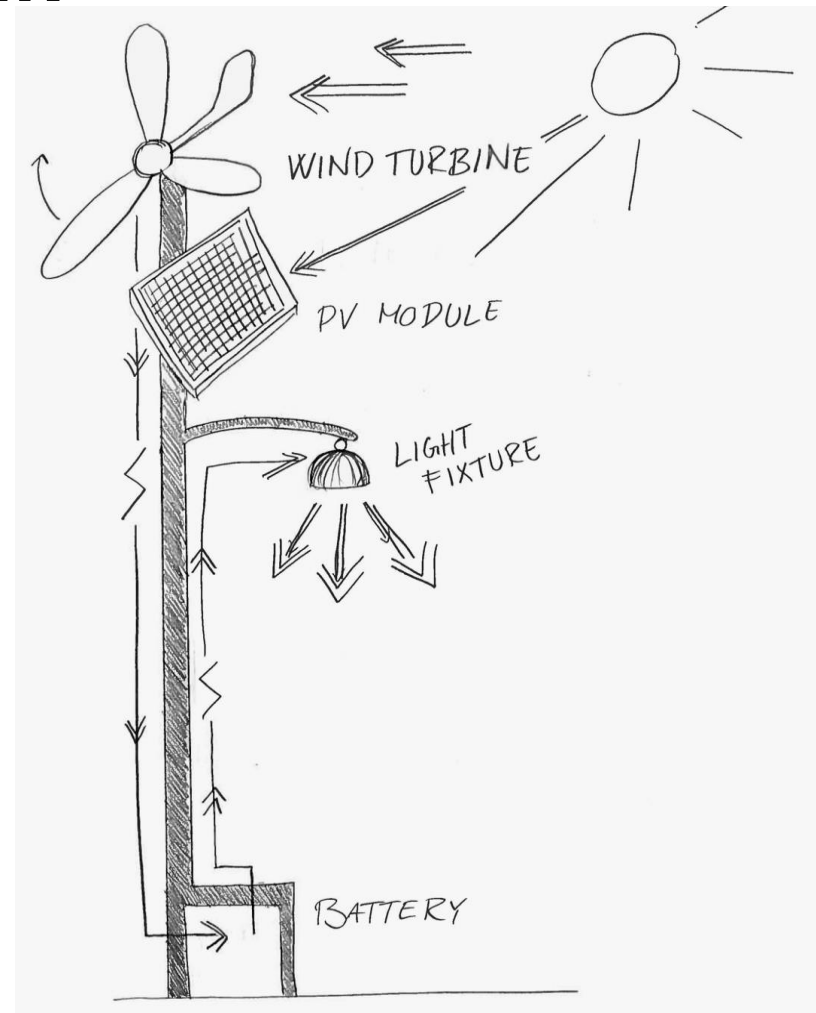
Development of a CO₂ neutral hybrid street lighting system for the Danish municipalities' illumination classes

ELFORSK PSO 343-021



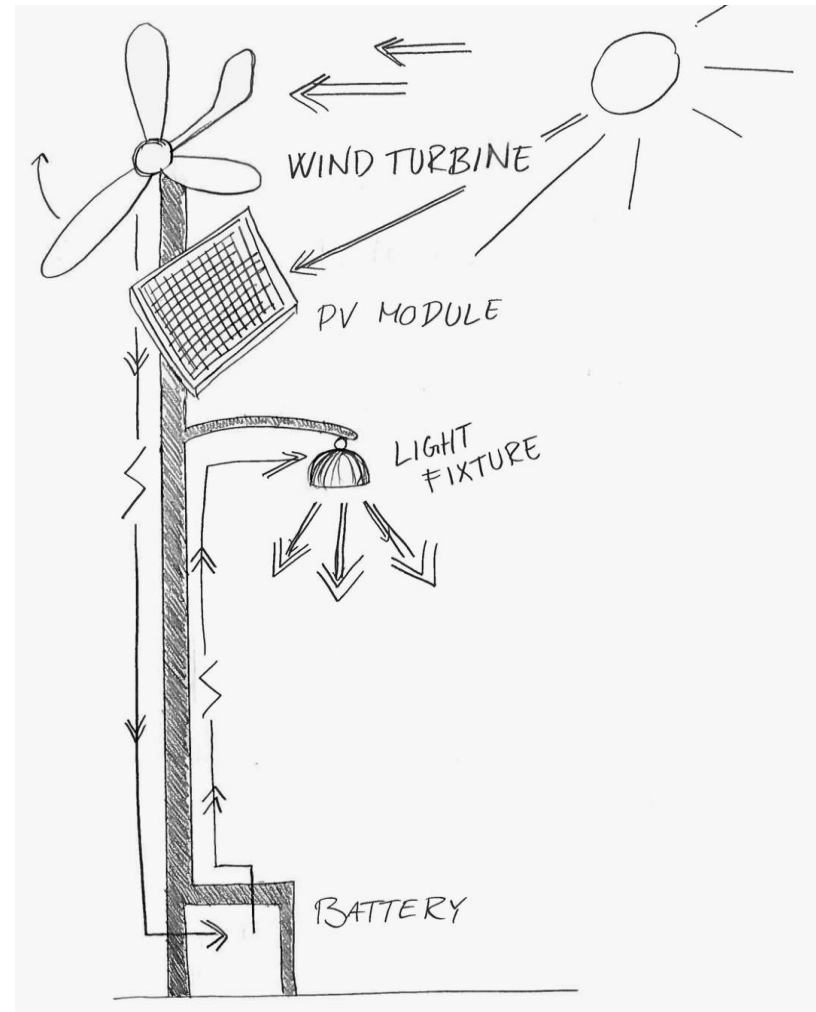
Peter Behrendorff Poulsen, Project Manager, DTU Fotonik

What is a hybrid system?



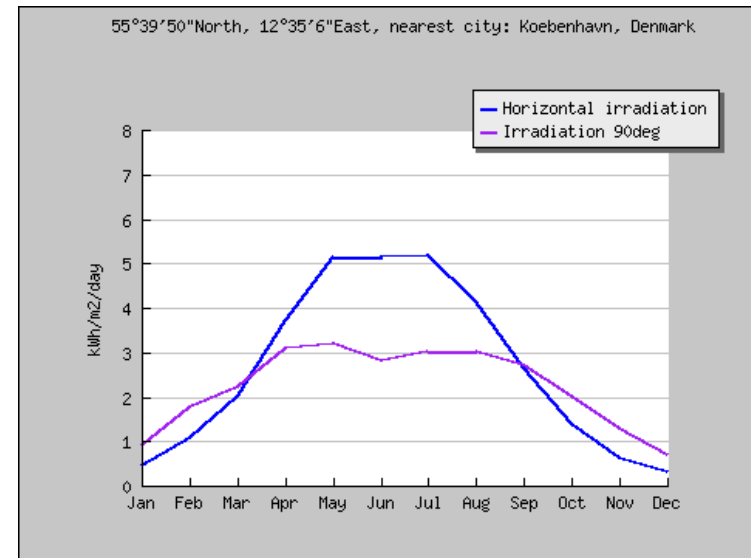
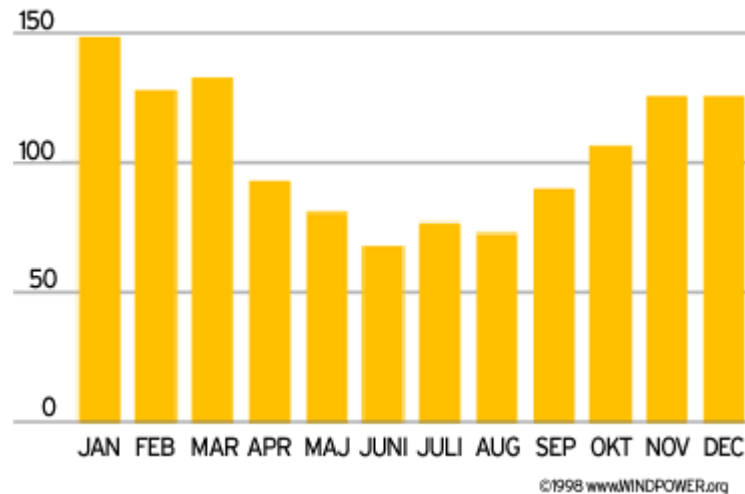
Vision

1. Can a hybrid system be developed full filling the needs of the Danish Municipalities?
 2. Is there a business model?
- Stand alone solution
 - Installation, pole, luminaire = free
 - No cabling
 - Free energy
 - Wind turbine, solar panel, battery



Wind and solar energy in Denmark

Vindenergi-index, Danmark (medel=100)





Albertslund Kommune

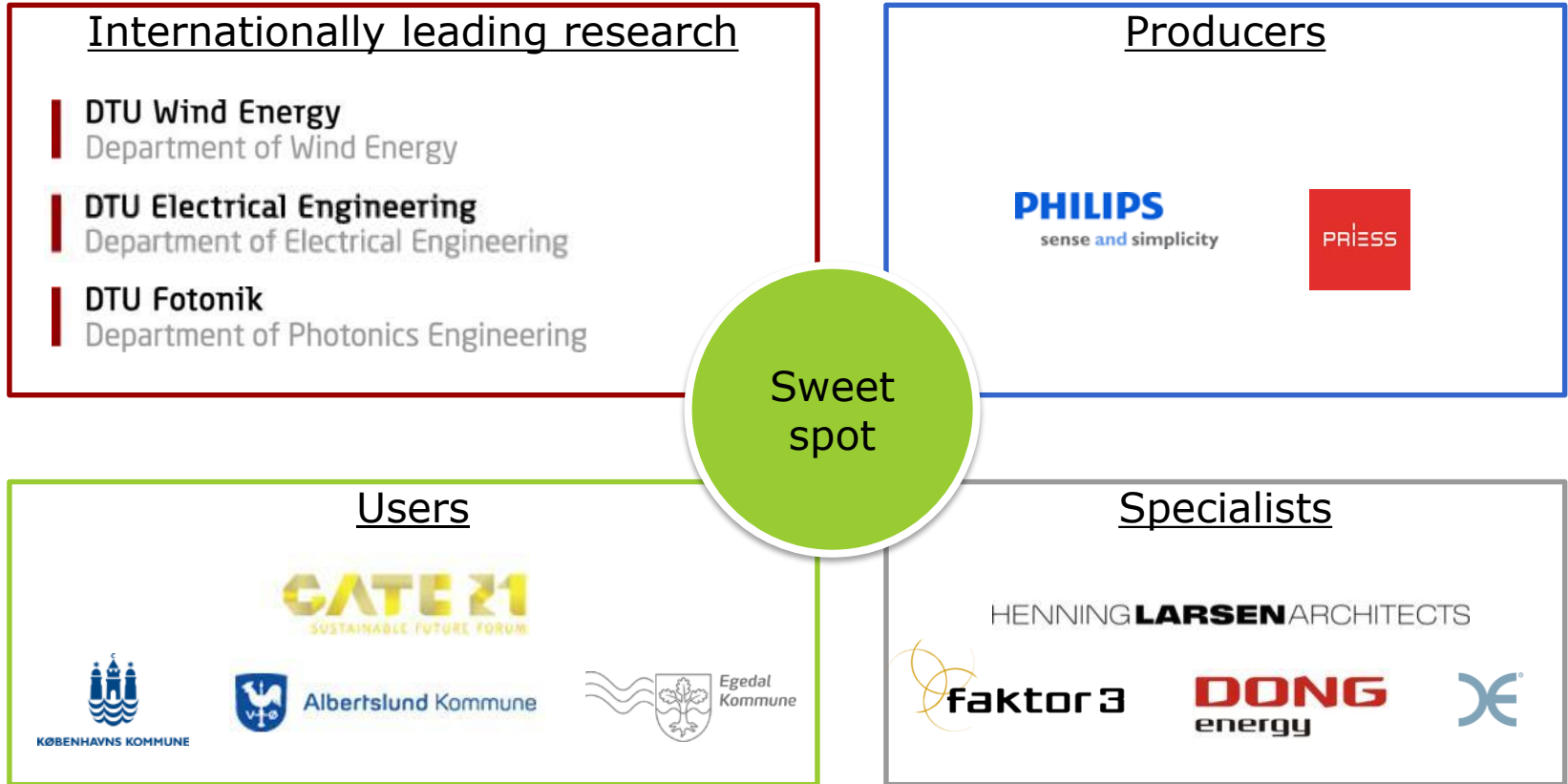


HENNING LARSEN ARCHITECTS



October 3rd 2013

Society driven innovation



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Department of Wind Energy

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Project contents

✓ Market Screening

- ✓ Which solutions exists
- ✓ Test and characterize a selection

✓ Develop Mathematical model

- ✓ Dimensioning of the system
- ✓ Validation using measurements on commercial systems

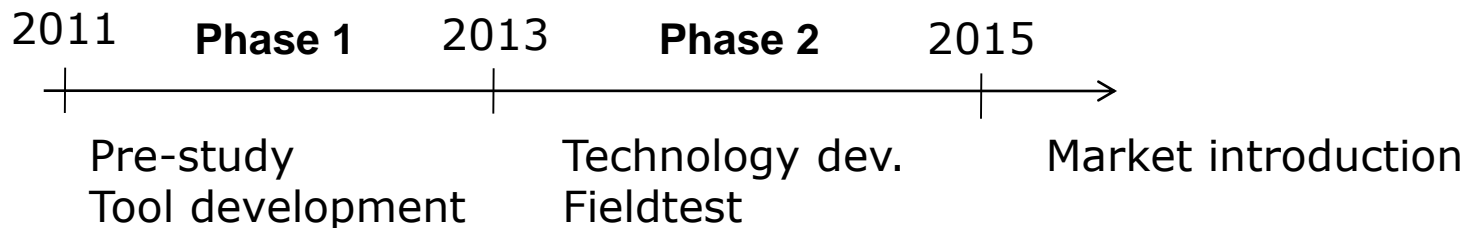
✓ Mapping the potential energy as a function of street lighting class

✓ Select street lighting class for the design process

✓ Lab model

✓ Mock up

✓ Renderings



Screening of hybrid system market

- 29 hybrid systems identified (January 1st 2012)
- Official document
 - Director Center for Traffic CPH
 - Price
 - Delivery time
 - Data sheets
- Suppliers
 - Primarily in China (some with EU sales office)
 - 2 USA
 - 2 Canada
 - 2 Korea
 - 1 France

Primarily wind turbine suppliers



4 commercial systems was chosen

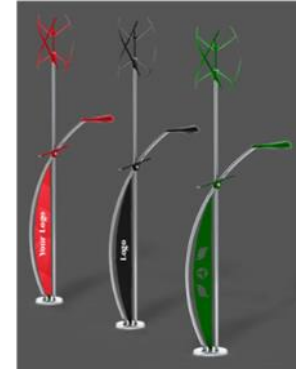
- Delivery time
- Rotor types
- Specifications
- Different distributors
- Different parts of the world



China Green Power



United Electricity



Sanya



Nheolis

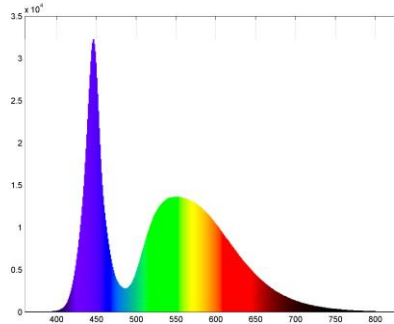


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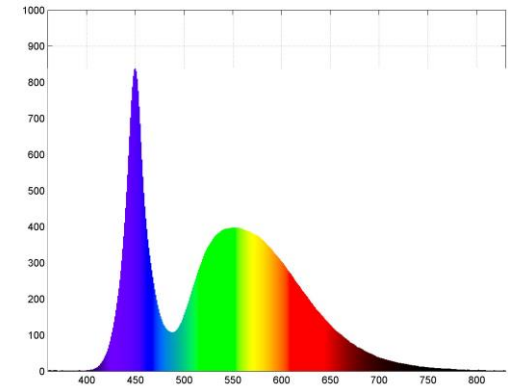
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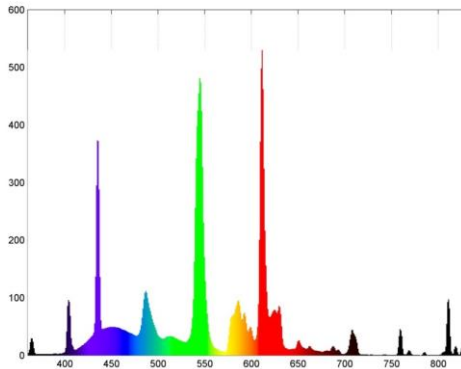
Nheolis



China Green Power

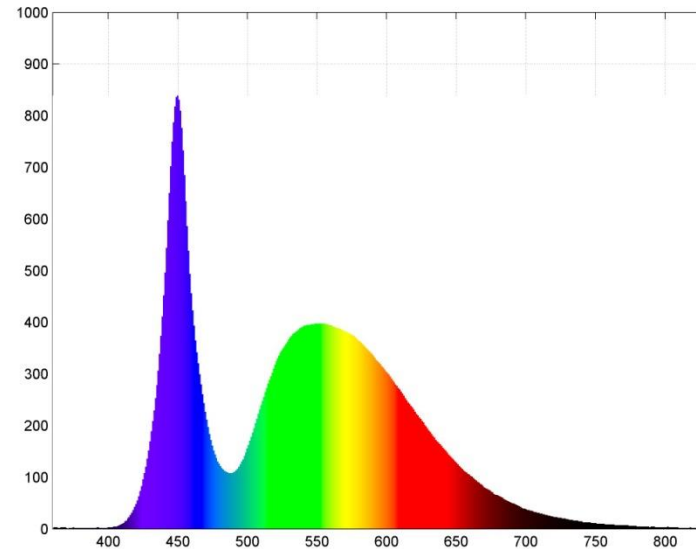


United Electricity



Lamp	Effekt forbrug	Color Rendering	Correlated Color Temperature	Duv
Neohybrid	60 W	73.0	7202	0.0073 (false)
China Green power	61.5 W	74.4	6663	0.0010 (true)
United Electricity		83.2	4693	0.0041 (true)

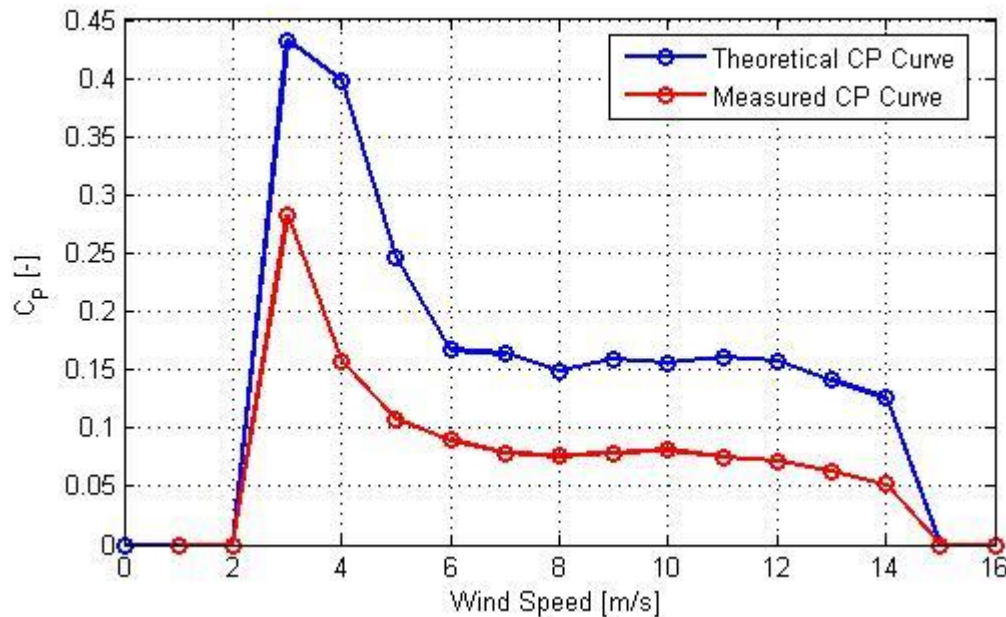
Sanya



About 6600 K

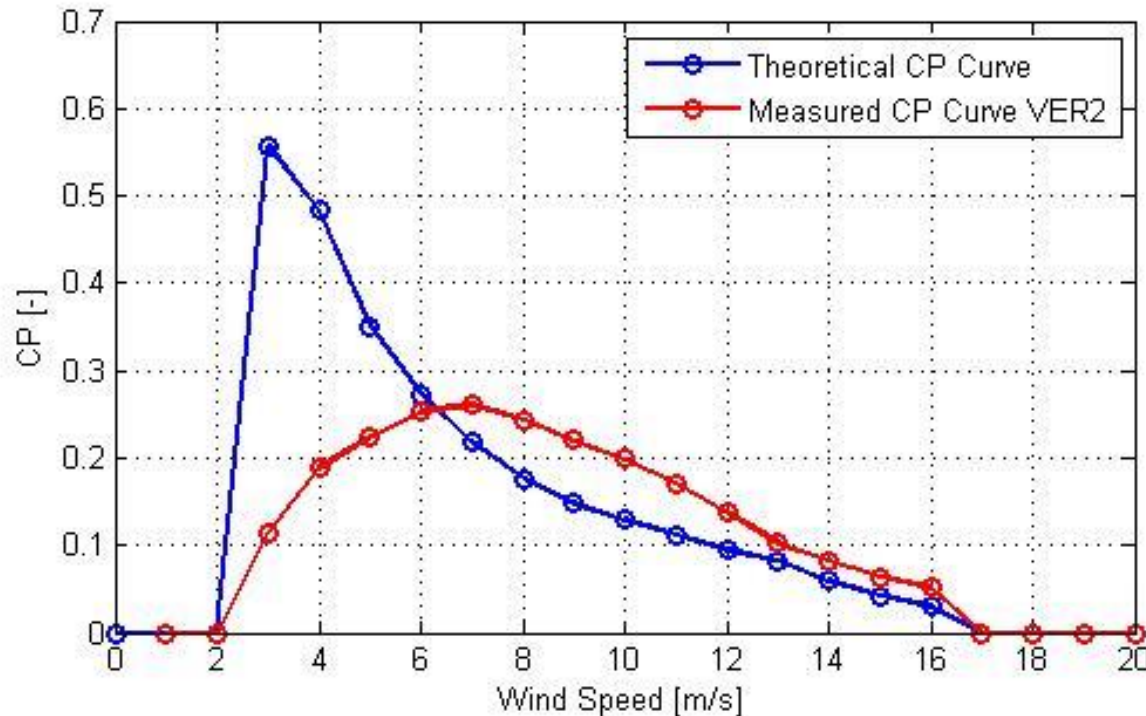
Wind turbine power curves

- Average wind speed in the urban environment: 1,5 m/s
- Challenges in turbine design and generator design

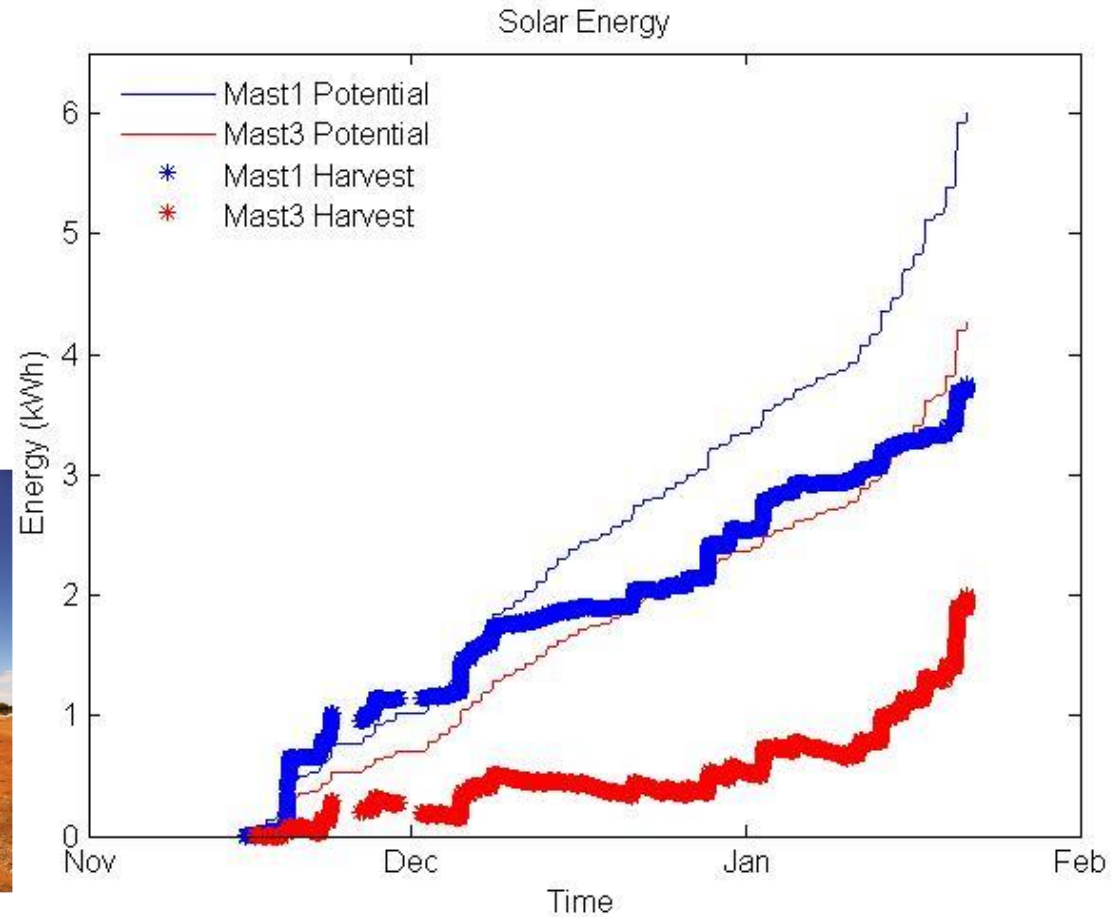


Wind turbine power curves

- Average wind speed in the urban environment: 1,5 m/s
- Challenges in turbine design and generator design



Solar panels



Batteries

- Very cheap lead acid batteries
- 1 VRLA battery
- Short life time



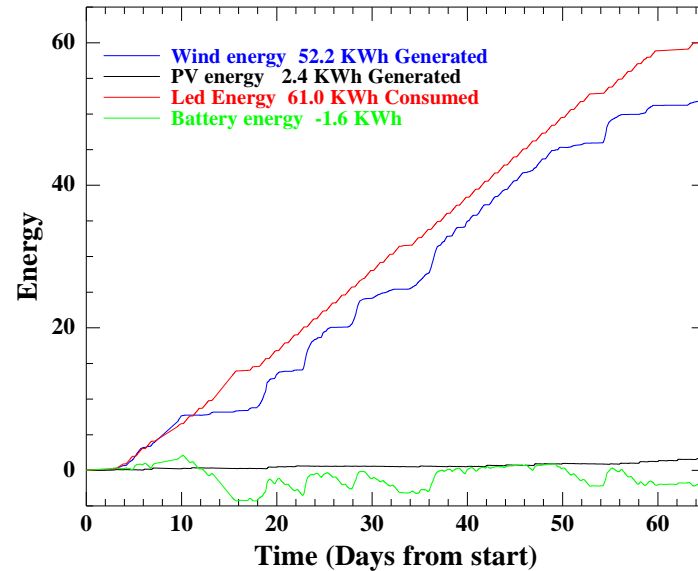
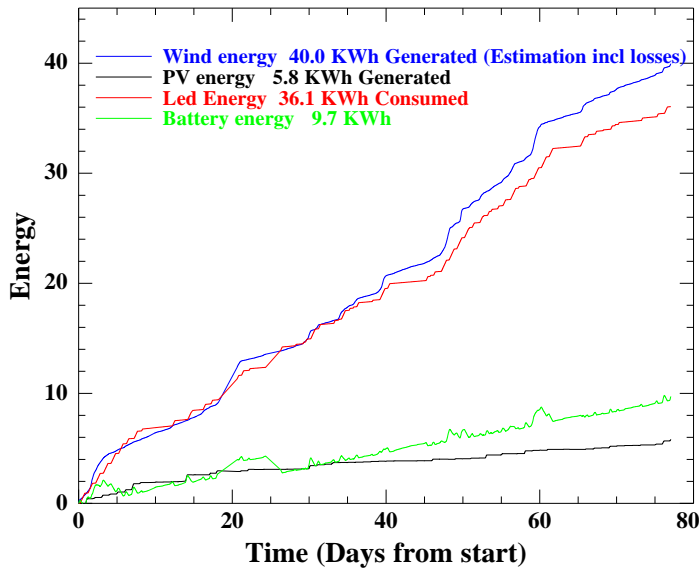
Energy balance



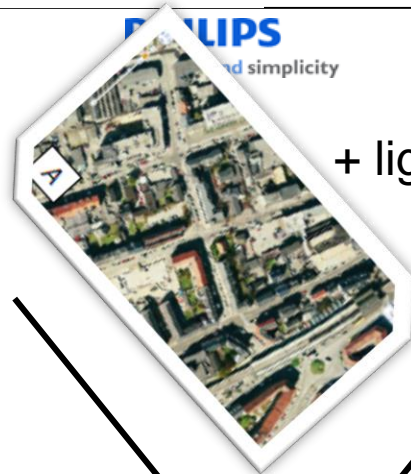
Mast 1



Mast 3



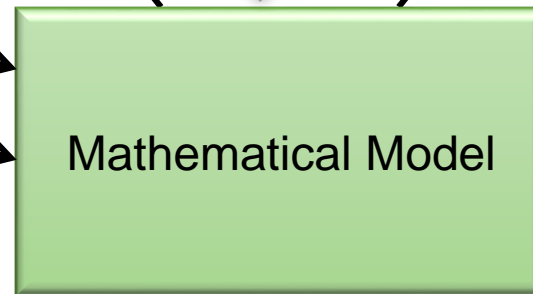
Mathematical model



+ lighting requirement+ GPS coordinates

Solar data

Wind data



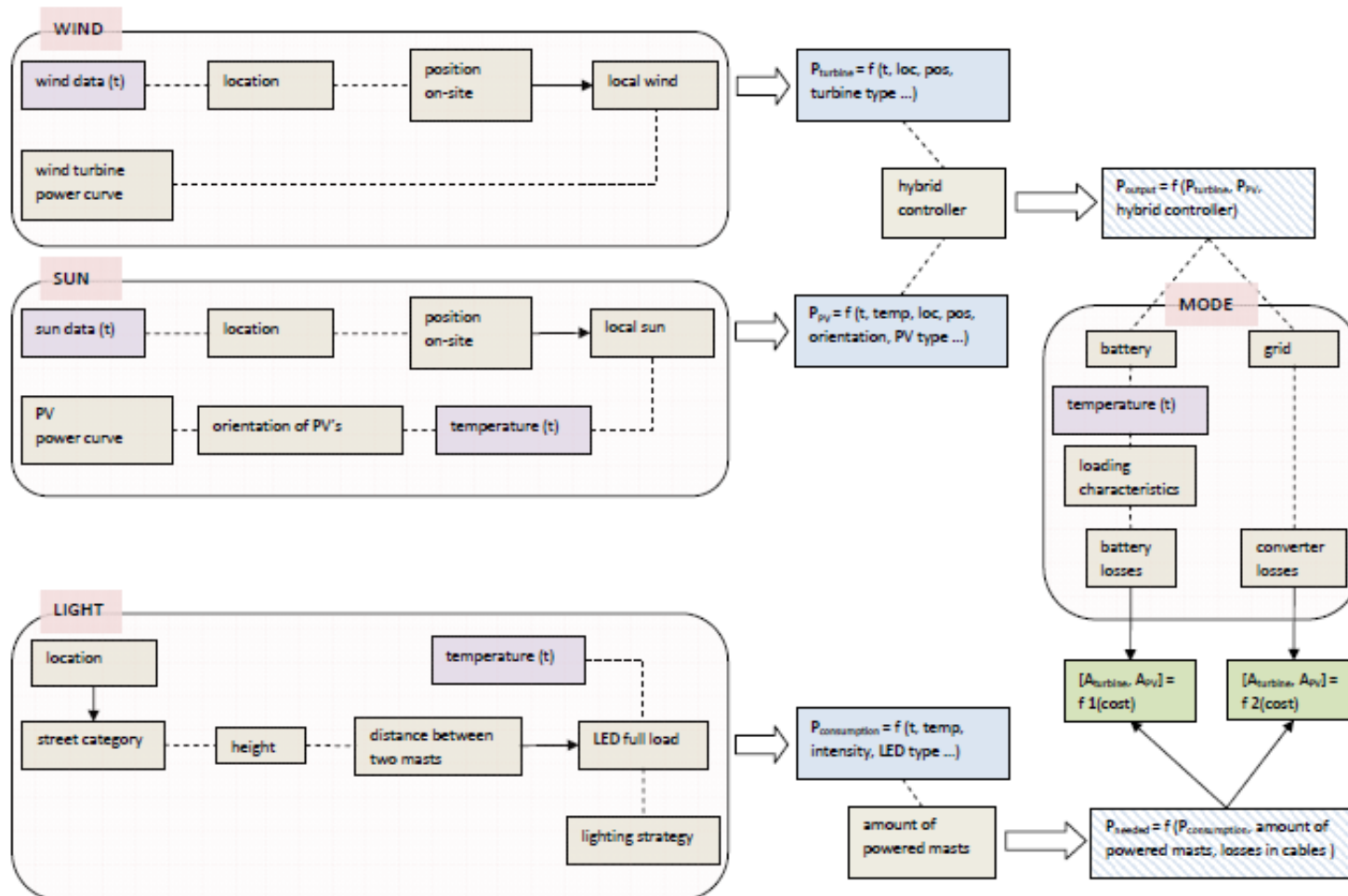
LED energy use

Battery tech.

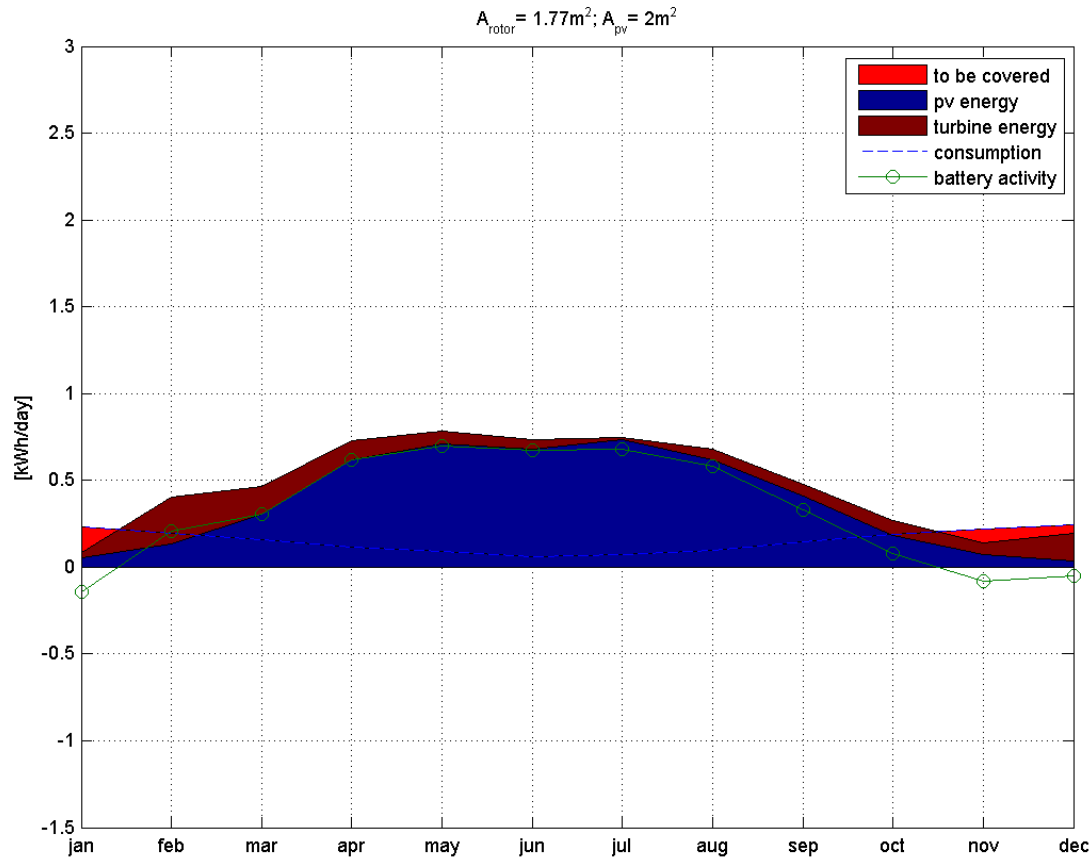


Solar panel area, angle, orientation
Rotor area, placement, rotor type
Battery capacity

Mathematical model



Energibalance - NHEOLIS

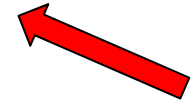


Street classes in Copenhagen

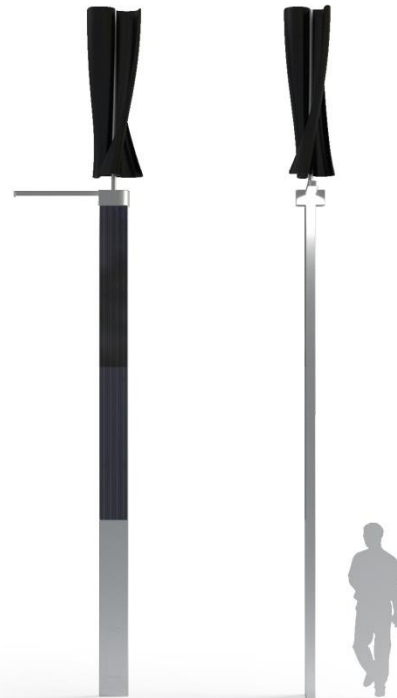


- Red:** "Regional roads"
- Dark blue:** "Distribution streets"
- Light blue:** "Larger city streets"
- Orange:** "Pedestrian streets"
- Dark gray:** "Local streets"

E2 Roads > 70%
2.5 lux



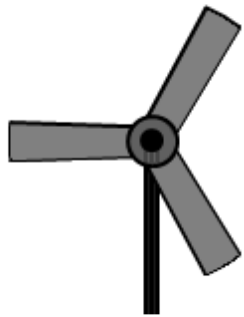
CopenHybrid vs internationalt state of the art



Test platform for hybrid systems

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Department of Energy Conversion and Storage

DTU Wind Energy
Department of Wind Energy

DTU Electrical Engineering
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Future work

- Wind energy optimization unit (generator starting at low torque, MPPT on electronics, gear)
- Optimization of solar cell unit (primarily electronics)
- Adjusting the LED unit and implementation of intelligent control
- Optimizing battery pack
- Optimizing the electronics
- Optimization of mathematical modeling system for the design of systems
- Optimization of mechanical engineering / design
 - Weatherability
 - Strength
 - Production

Conclusion

1. Can a hybrid system be developed full filling the needs of the Danish Municipalities?

WELL – it seems possible!

2. Is there a business model?

Maybe! 😊

Labor cost -> high

1000 \$/m in Copenhagen cabling cost

Solar panels cheaper than ever

Small wind turbine maturing

LEDs 2x efficiency in 2015

Battery prices going down on e.g. LiFePo4

Sensors/intelligence

3. International markets?

Some commercial systems are already installed

- Thanks to ELFORSK PSO 343-021, funding
- Thank you for your attention

Internationally leading research

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Producers

PHILIPS
sense and simplicity

PRIESS

Users



GATE 21
SUSTAINABLE FUTURE FORUM


KØBENHAVNS KOMMUNE



Albertslund Kommune

Egedal
Kommune

Specialists

HENNING LARSEN ARCHITECTS




DONG
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