

# Research and Innovation

Wind Energy Denmark 2018



Niels Langvad, Scientific Officer, Innovation Fund Denmark

# Ingeniøren - October 26, 2018

## Duraledge - 11.7 mn DKK invested



”Extending the current limits of wind energy development”

*Preventing the surface degradation and erosion of the wind turbine blades*

DTU Vindenergi, Vestas Wind Systems A/S, Siemens Gamesa Renewable Energy, LM Wind Power, Hempel A/S, Covestro Deutschland AG



# Ingeniøren - October 26, 2018

## FloatStep - 15.8 mn DKK invested

INGENIØREN · 1. SEKTION · 26. OKTOBER 2018 · 21

TEMA VINDMØLLER

HAVMØLLER NY BEREGNINGSMODEL SKAL KORTLÆGGE KOMPLICEREDE BELASTNINGER

### Søgang forvirrer flydende vindmøller

Forskere fra DTU og Siemens-Gamesa er gået sammen med vindmøllepioneren Henrik Stiesdal om et projekt, der skal udvikle beregningsmodeller for fremtidige flydende vindmøllefundamenter.

**Af Niels Møller Kjemtrup**  
nmk@ing.dk

Fremtidens danske vindmøller kan meget vel komme til at flyde på havet. Det er bl.a. ambitionen i projektet FloatStep, hvor DTU Vindenergi, Siemens Gamesa og Henrik Stiesdal samarbejder om at skabe regnemodellerne, der skal gøre det muligt at konstruere flydende havmøller på en rentabel måde. Innovationsfonden støtter projektet med 15,8 mio. kr.

Mange faktorer spiller nemlig ind, når havmøllerne ikke har fundamenteret solidt plantet i undergrunden, forklarer Henrik Bredmose,

**STIESDAL'S FLYDENDE VINDMØLLE-FUNDAMENT**

Flyder, køl og forankring er designet af Stiesdal Offshore Technologies, og møllen skal leveres af Siemens-Gamesa. Det hele er testet i DHI's bølgetank i 1:60 modelforsøg. Efter fuldskalaet vil data bruges til at validere DTU's beregningsmodeller.

**NACELLE**  
Et tilpasset kontrolsystem er nødvendigt, idet bølger får møllen til at vippe, og den dermed udsættes for andre vibrationer end en landmølle.

»Faktisk er udfordringerne lige nu med de lavfrekvente bølger – de lange, subharmoniske bølger, som hænger sammen med bølgegrupperne. De kan skabe svingninger i ankerkablerne. Det skal vi have beregnet mere på,« siger Henrik Bredmose.

Projektet har som delmål at udvikle en optimal flyder. De modeller, man får udviklet, vil kunne bruges til alle flydere. For projektet handler om at få forspring.

I udviklingsarbejdet er det særdeles nyttigt at få valideret regnemodellerne i fuldskala, for kun på den måde kan man blive sikker på, at de tager højde for alle elementerne i dynamikken mellem mølle, vind, flyder og hav. Efter planen skal Siemens-Gamesa levere en mølle på 3-6 MW, som man kan anvende i demonstrationsprojektet. Den udsendes til næste sommer og skal monteres på en TetraSpa-flyder.

**Et vigtigt forspring**  
Siemens-Gamesa har leveret en del data til FloatStep-projektet og vil ifølge Rune Rubæk, leder af selska-

## “Closing the existing gaps in the TRL and value chains”

- Enable cost reduction and more accurate design
- Reduce risk from extreme waves
- De-risk the installation and operation of floating wind turbine structures

DTU Vindenergi, Stiesdal Offshore Technologies, Siemens-Gamesa Renewable Energy A/S, STROMNING, University of Western Australia



# Knowledge-based growth

We invest in innovative ideas with significant potential to create knowledge, growth and employment in Denmark.



# Focus across the entire value chain



## Innovation Fund Denmark in numbers

8 bn DKK

Active portfolio

1800

Active projects

1.4 bn DKK

in 2018

2.5 bn DKK

Energy portfolio

150

Energy projects

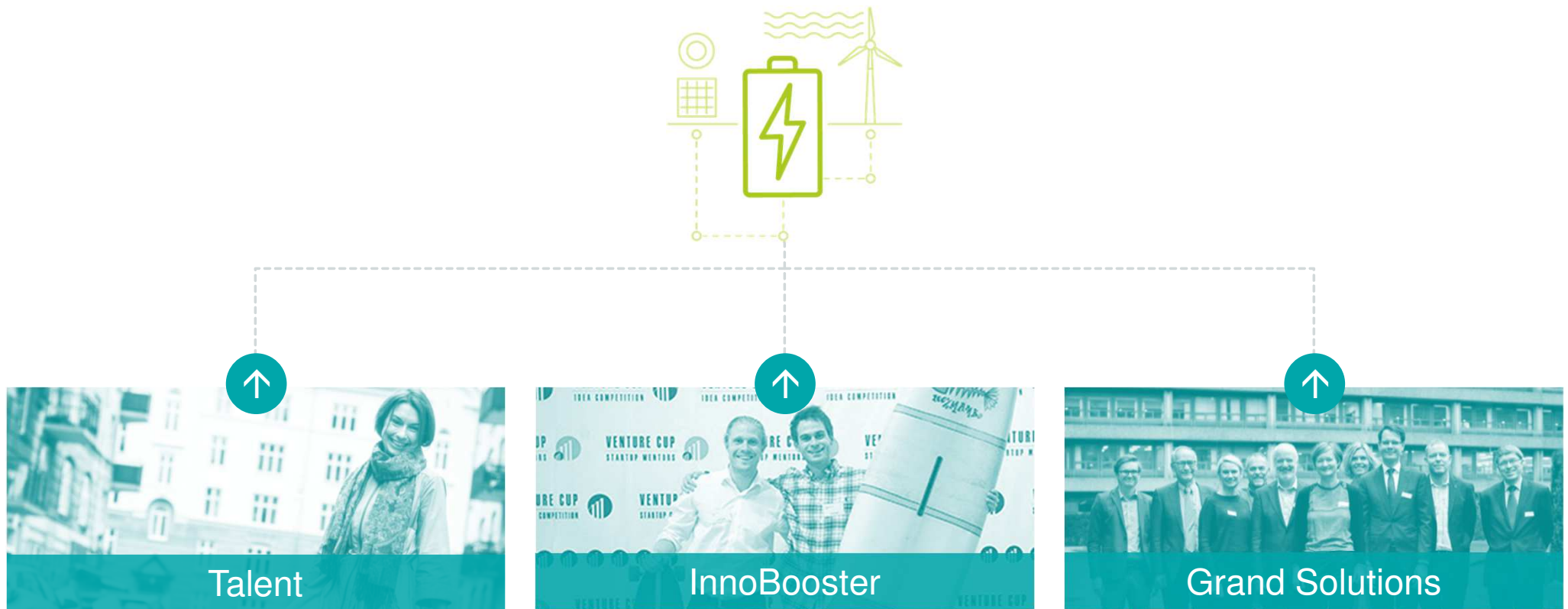
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Entries



# Three entries

Talent, SME's and large public-private partnerships





# Innovation Fund Denmark

## Talent and SME's

2015-2018

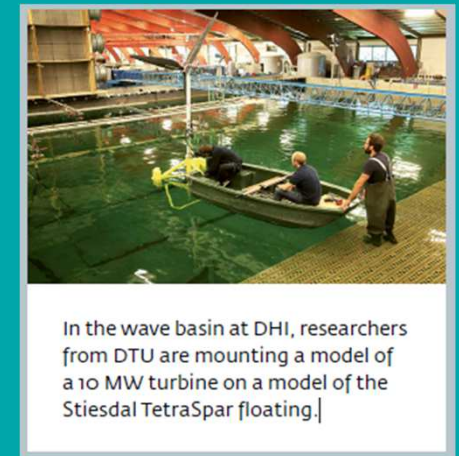
- 19 Industrial PhD's and industrial Post Docs related to the Danish wind energy sector.

2017

- 34 Innobooster - energy projects
- > 10 Innobooster projects- wind energy



Innobooster  
1 mn DKK invested



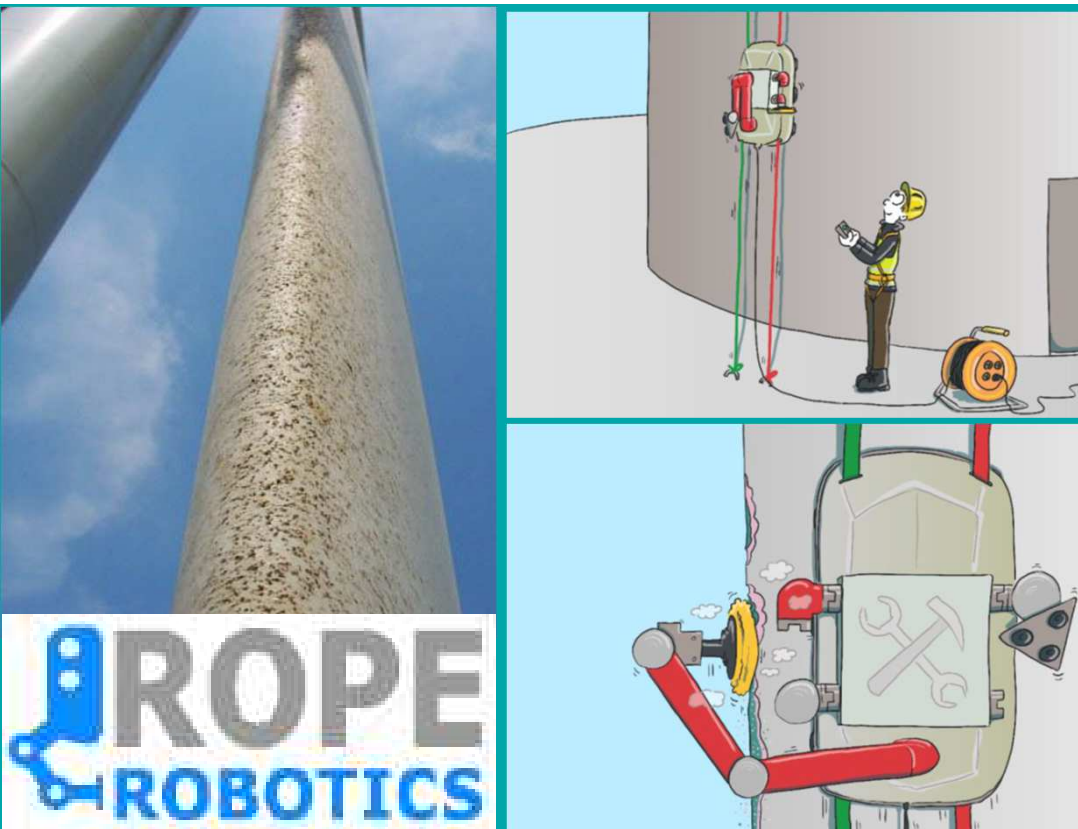
Innobooster  
400.000 DKK invested





# Innobooster project 2017

## Blade repair



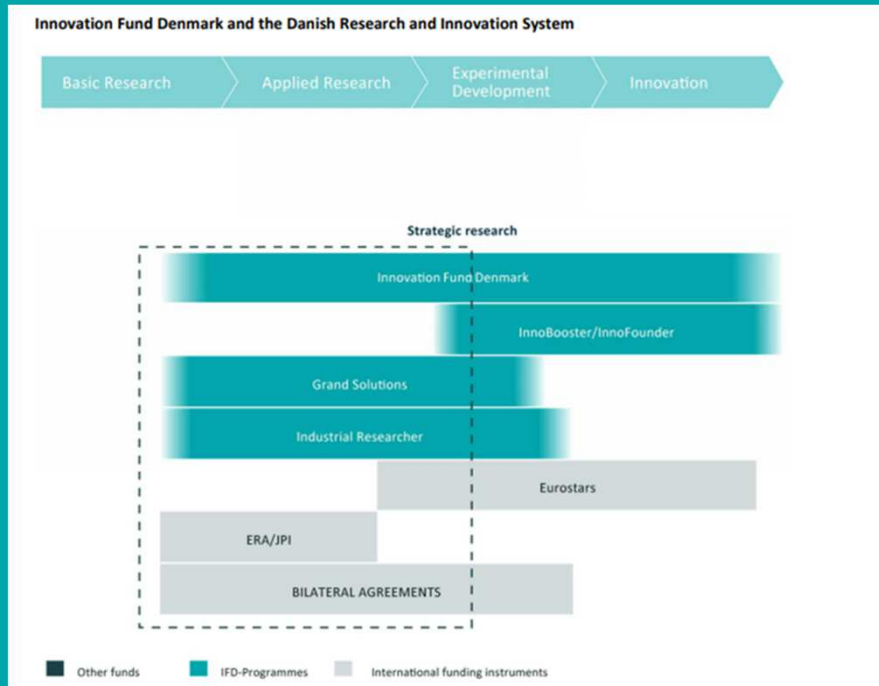
### Robotic solution for blade repair

*Development of 3 tools including CE-approval.  
Test of stability (lab) and repair of large scale  
wings.*

3.6 mn DKK invested



# How do we select projects?



**Strategic energy research  
TRL2-TRL4 (6)**



**Creates  
value**



**Benefit to  
society**



**Societal  
Readiness**

**"Implementation and beneficiary"**  
- no requirements to business plans as such



# Grand Solutions 2017 - Energy

## High quality wind projects

Project name	Acronym	Partners
WhiteWind: White Etching Crack bearing failures in wind turbines	WhiteWind	DTU Wind, DTU Mech, Vestas Wind Systems , Expanite , SKF GmbH, RWTH Aachen University, National Renewable Energy Laboratory, Argonne National Laboratory
Multi Storage Converter for Wind Energy	MultiCon	KK Wind Solutions , Design Flux Technologies , AAU
Novel Magnets for Flywheel Energy Storage	MagFly	AU Chem, AU iNano, AU Eng, WattsUp Power, Haldor Topsoe, SINTEX, DTI, Grundfos
Efficient and Economic Electrolytic Hydrogen production	EEEHy	DTU Energy, Danish Power Systems, Haldor Topsoe , FORCE Technology, AB Sandvik Materials Technology, GreenHydrogen.dk, Resolvent Denmark P/S, AAU, Sur-Tech
Organic Redox Flow Battery Systems	ORBATS	DTU Energy, Vestas Wind Systems , VisBlue, University of Aarhus, Lithium Balance, Harvard University
Reduced Assessment Time	RECAST	DTU, RES Group Ltd, EMD International, Vestas Wind System
Smart Tip	SmartTip	Siemens Windpower, DTU



# Grand Solution project 2017

## 18 mn DKK investment

### Organic Redox Flow Battery Systems (ORBATS)

Developing a **cost-efficient** and **sustainable** energy storage solution



November 27, 2017: Vestas arbejder sammen med en række partnere på at udvikle innovative løsninger, som vil nedbringe omkostningerne ved vindenergi. "Vi ser et stort potentiale i effektiv batteriteknologi, som et skridt på vejen til en fuldt bæredygtig energiforsyning", siger Anders Vedel, CTO og Executive Vice President, Vestas.

### Low cost large scale energy storage

ORBATS will develop a new, environmentally benign, and fully scalable aqueous redox flow battery technology replacing expensive vanadium with cheap water-soluble organic molecules as the charge storage medium.

DTU Energi, Vestas Wind Systems A/S, VisBlue, Aarhus Universitet, Lithium Balance



# Manufacturing value chain-Grand Solution investments

## SME's and larger enterprises

### MADE DIGITAL

*MADE Digital is a Danish version of Industry 4.0, where focus is on developing and implementing digital solutions tailor-made for the special needs of Danish manufacturing industry.*

IFD investment: DKK 79 mn

Total budget: DKK 196 mn

### AM-LINE 4.0

*AM-Line will pave the way for an industrial breakthrough of metal 3D print, combining development in technology, business model, design and digitalization. Focus is on accelerating transfer of knowledge to industry.*

IFD investment: DKK 35.2 mn

Total budget: DKK 88.3 mn



# Fast Track

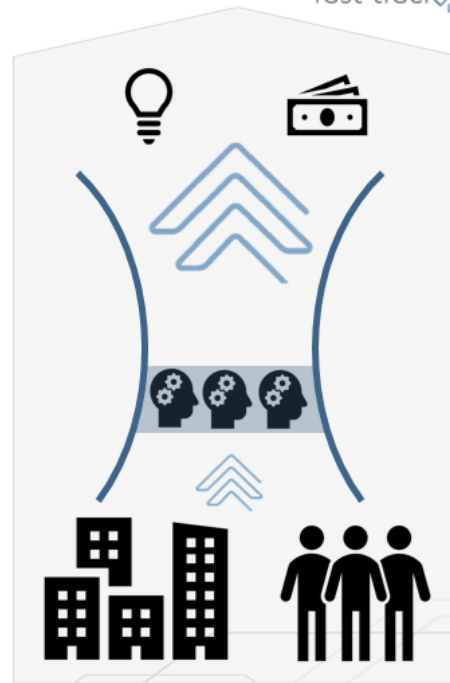
## Material science in action - SME oriented

Vision

Visionen for Fast Track



fast track



## Fast Track

Hempel, Terma, Siemens  
Gamesa, AU, DTU, DTI,  
Force Technology, Elplatek

Investment: 35 mn DKK  
Total budget: 60 mn DKK



# Other enabling projects



Drones



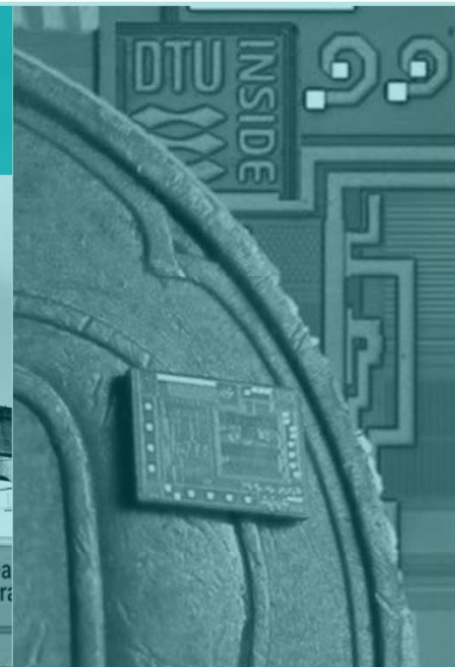
Wind turbine blades



Material science



Transportation



Tiny Power Converters



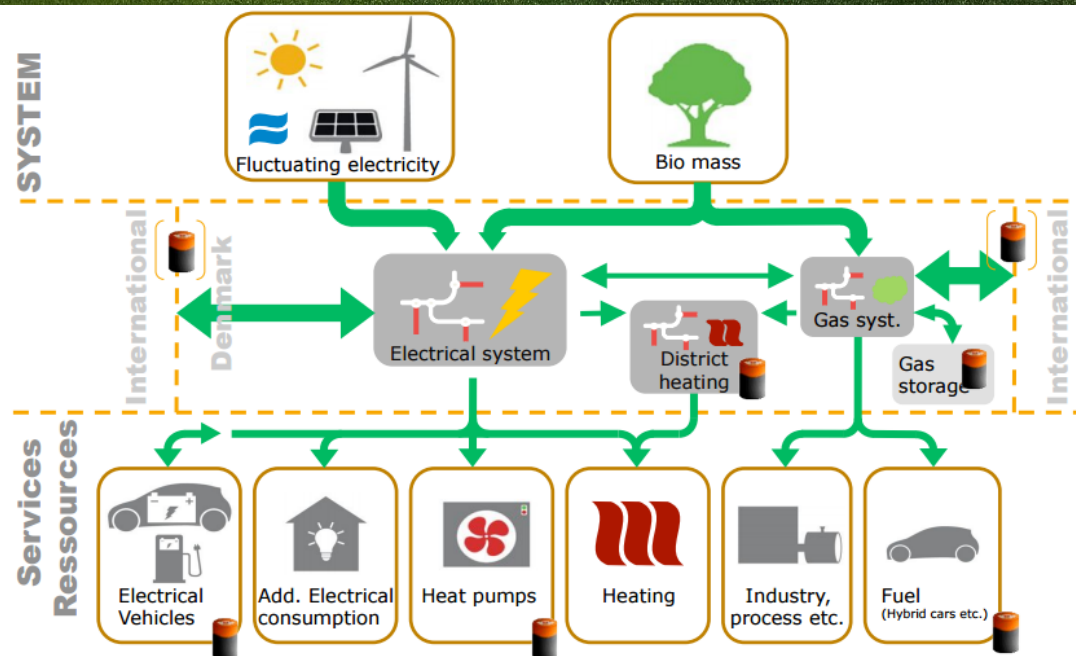




# Epimes

## Future integrated energy system

*Increased share of renewable energy*



DTU Vindenergi, DTU Mekanik, DTU Compute, DHI,  
DONG, Statkraft AS, University of Oxford og  
Stavanger Universitet

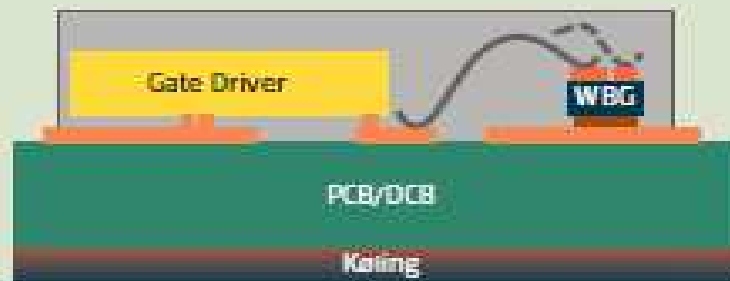
Investment: 6.2 mn DKK

## 2021: INTEGREREDE KOMPONENTER

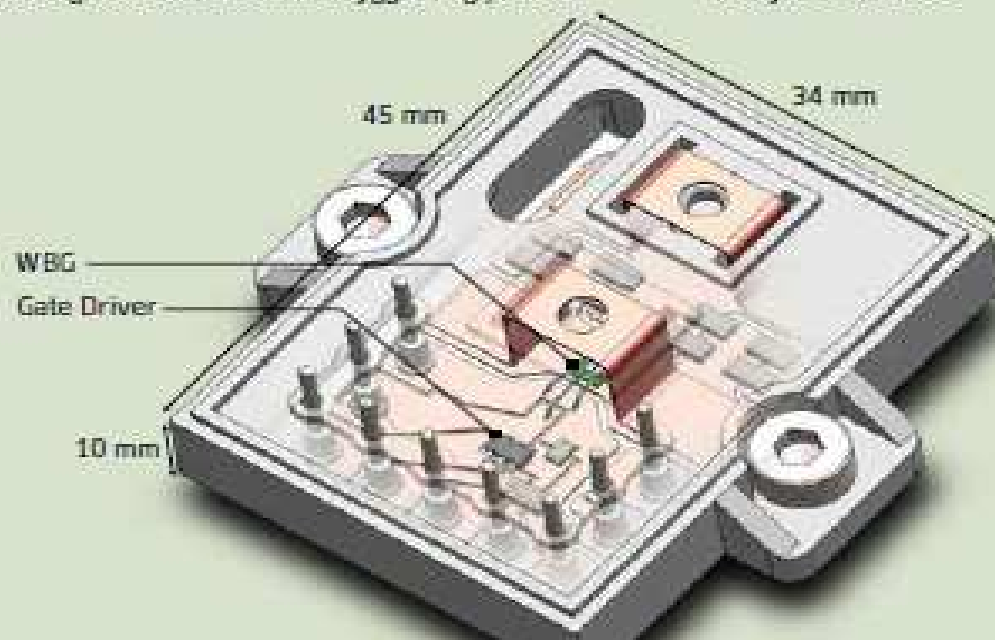
**INTEGRATION:** For WBG-halvledere er kortere afstande afgørende for, hvor høj en frekvens der kan opnås. Ved markant øget frekvens bliver filterspoiler og andre komponenter så små, at de i fremtiden kan bygges sammen i en integreret enhed. Fordelen er mange: et mere effektivt, kompakt og driftsikkert design samt simplere og hurtigere fremstillingsproces.



**LØSNING 1:** Filterspoiler, WBG-halvledere, kondensatorer og Gate Driver sammenbygges i og på PCB.



**LØSNING 2:** Komponenterne samles i ét modul med korte indbyrdes afstande.



◀ **EN PROTOTYPE AF LØSNING 2** er under udvikling på Aalborg Universitet. Her er både Gate Driver, WBG og kondensatorer indkapslet i selve modulet. Herved minimeres afstanden mellem Gate Driver og WBG-halvleder betragteligt. Frekvensen er på 2,5 MHz og effektniveau på 1 kW.

**GRAFIK:** Lasse Gorm Jensen  
**KILDE:** Stig Munk-Nielsen, AAU

## Apett

### Key technologies for the renewable energy system

*Smaller, cheaper and more energy efficient.*

*Digital twin*

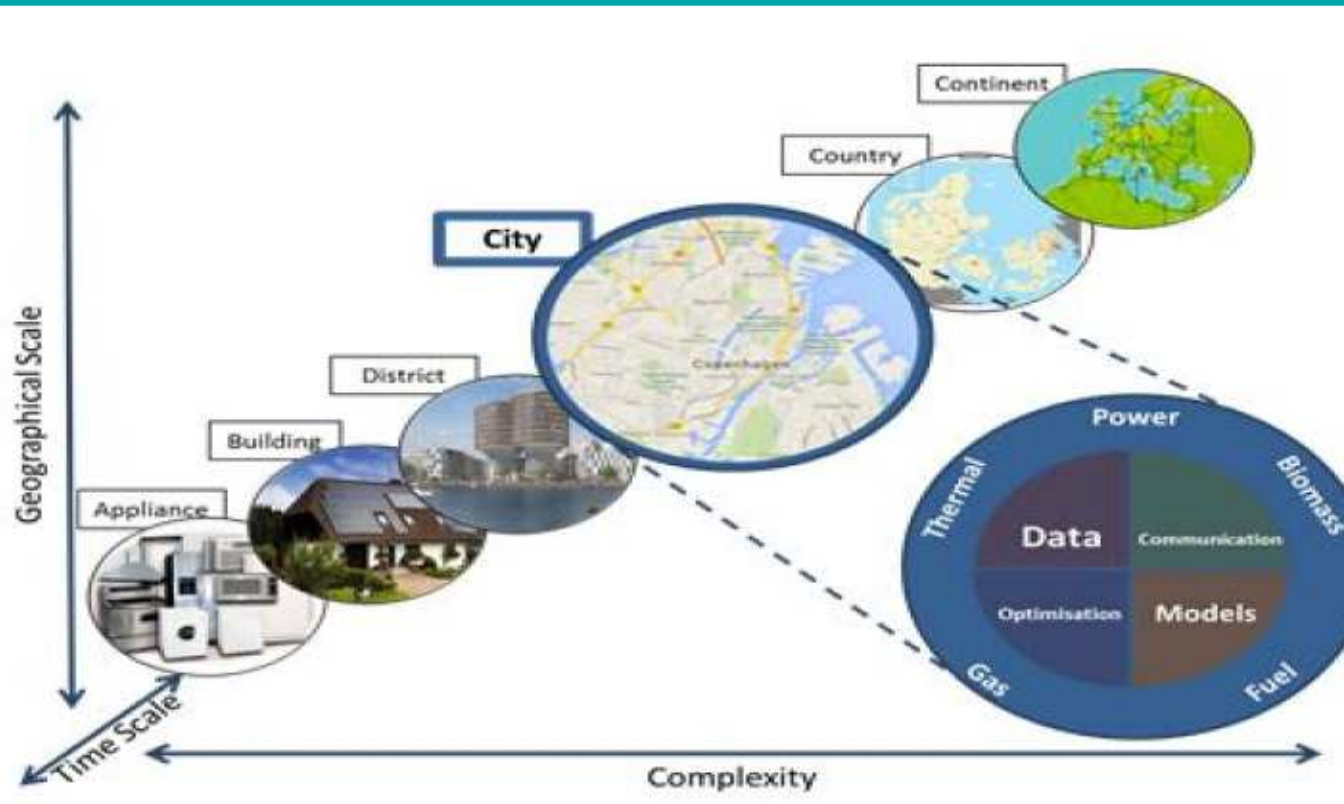
Aalborg University,  
Syddansk University, Grundfos Holding  
A/S, Danfoss Drives A/S,  
Vestas Wind Systems A/S, KK Wind  
Solutions, Danfysik A/S, Horsodan  
Elektronik A/S

Investment 35 mn DKK

Total budget 48 mn DKK



# The intelligent and integrated energy system

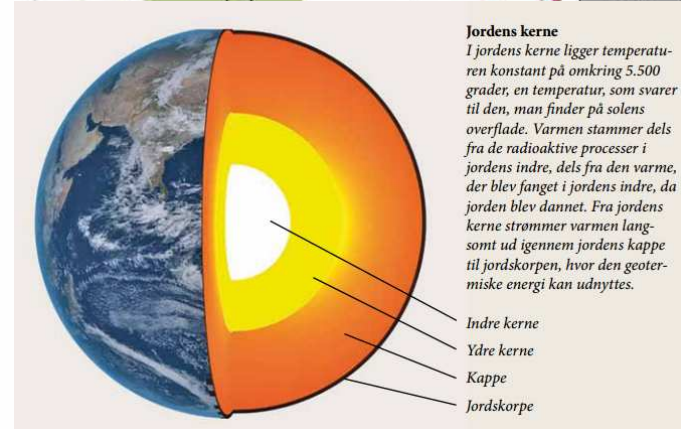
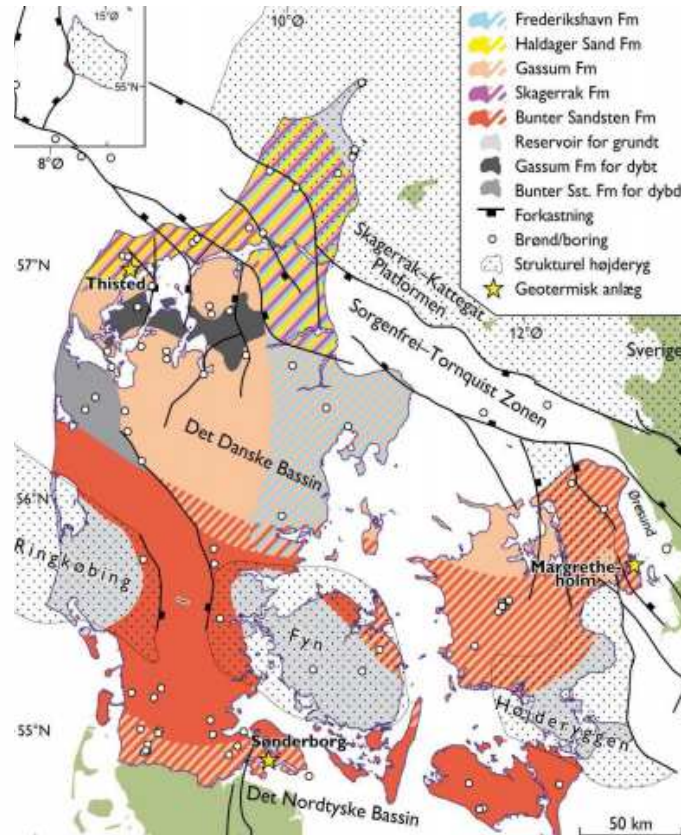
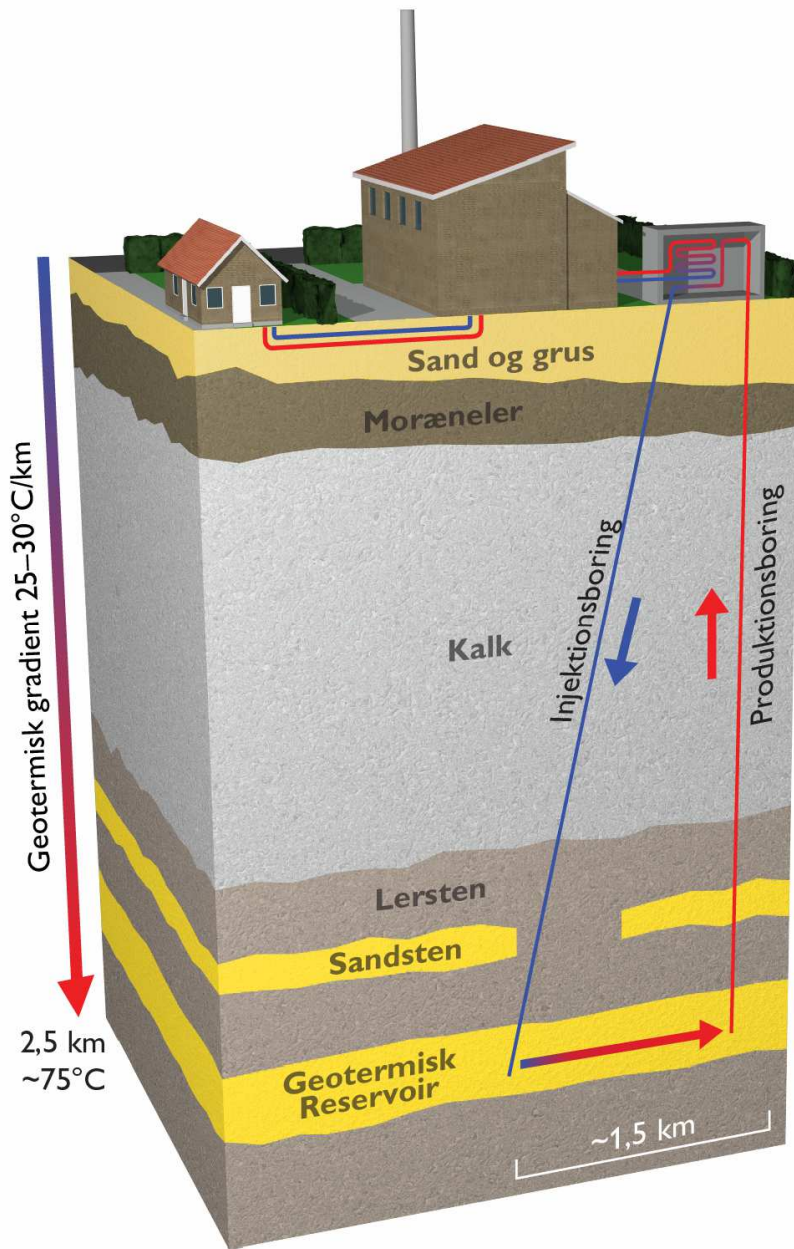


## CITIES

DTU, Aalborg Universitet, Energinet.dk, EMD International, HOFOR, University College Dublin, ENFOR A/S, Tecnia, AffaldVarme Aarhus, NREL, Fjernvarme Fyn A/S, Esbjerg Varme Østjysk Fjernvarme, Dansk Fjernvarme, DFF EDB, EA Energianalyse Lean Energy Cluster, Danfoss A/S, Topsoe Fuel Cell A/S, Dansk, Energi, EMT Nordic, Samsung, Eurisco, Seoul National University, DONG Energy A/S, Frederiksund Forsyning, Grundfos, SydEnergi, Konkuk, AI, Neas Energy A/S, Neogrid Technologies ApS, Project Zero A/S, Dansk Industri, Teknologisk Institut, Rambøll Danmark A/S, SE Blue

Investment: 44 mn DKK  
Total budget: 71 mn DKK





# Geotherm

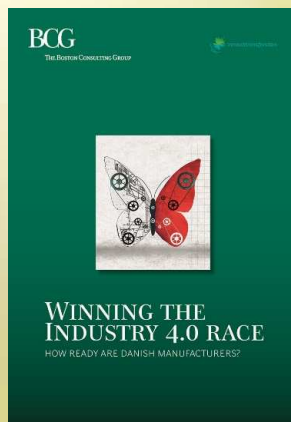
## Geothermal energy

*Research and development of best practice methodologies*

Qeye Labs, FORCE Technology, GEUS, HGS, Sønderborg Geotermiske Anlæg, Thisted Varmeforsyning Amba

Investment: 17 mn DKK  
Totalt budget: 24 mn DKK

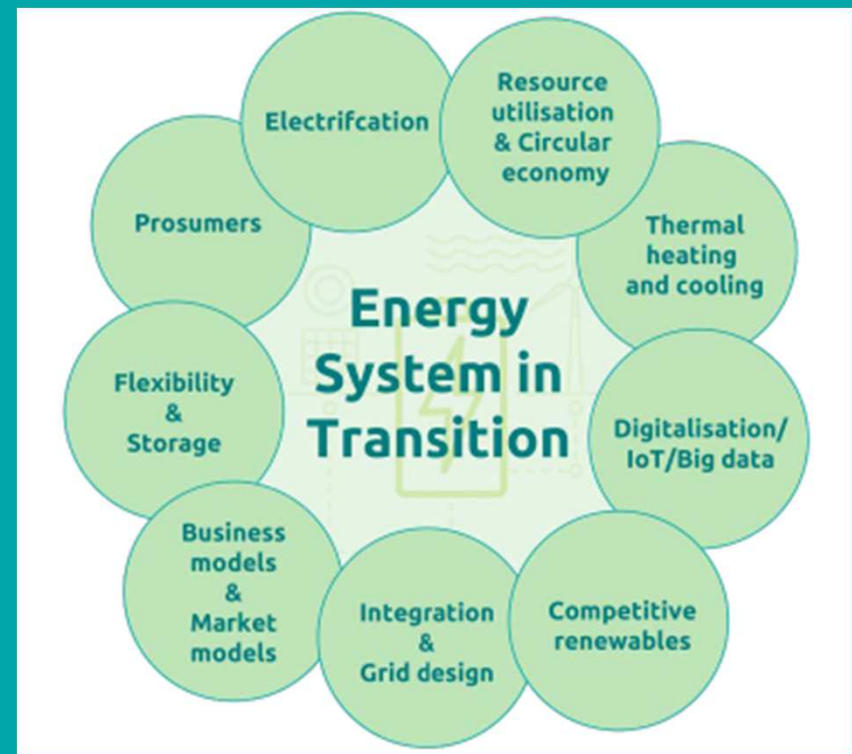
# Spotting trends



# Innovation Fund Denmark

## Trends and drivers

The deployment of sustainable energy solutions, novel smaller and decentralised systems, and an increased competition within the industry, put pressure on today's centralised management of production and supply chain within the Danish energy sector.

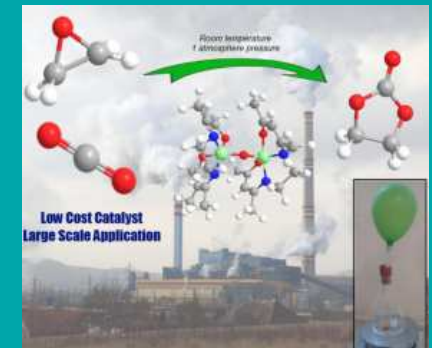
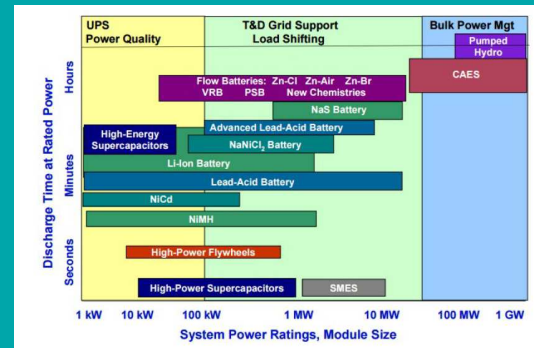




# Innovation Fund Denmark

## New competences and knowledge

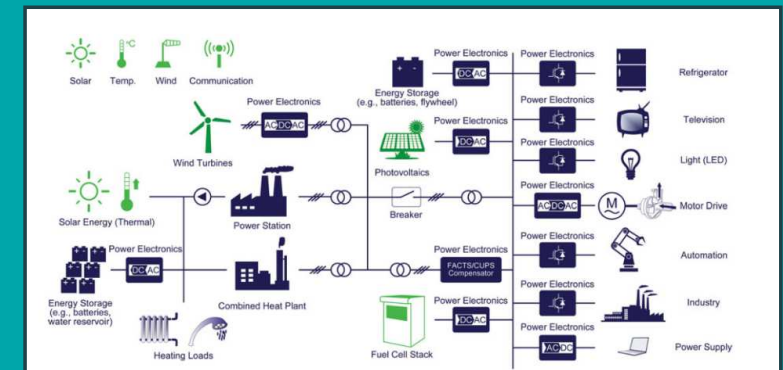
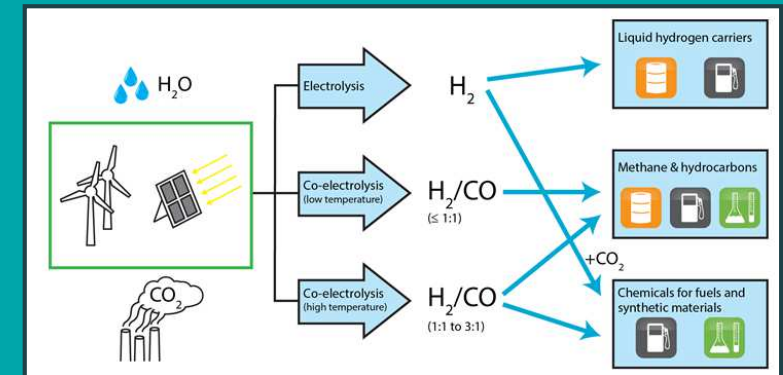
- New business models-new competences
- Cross sectorial and multi disciplinary
  - Data science, AI, machine learning
  - Big data, block chain
  - Material science
  - Aerodynamics
  - Manufacturing
  - Geology
  - Meteorology
  - Catalysis and electrolysis



# Innovation Fund Denmark

## Investment strategy - Energy

- System integration and new business models
- Electrification
- Digitalization, IoT, big data, AI and machine learning
- Carbon capture and utilization
- Batteries, P2X and energy storage
- Power electronics and energy efficiency
- Integration of large quantities of renewable energy



# Investment strategi 2018-2020

## Strategic research

The aim is to increase growth and employment in all parts of Denmark by strengthening the global market position and competitiveness of Danish industry:

- Strengthen the strategic research within the energy field
- Incremental and radical innovations

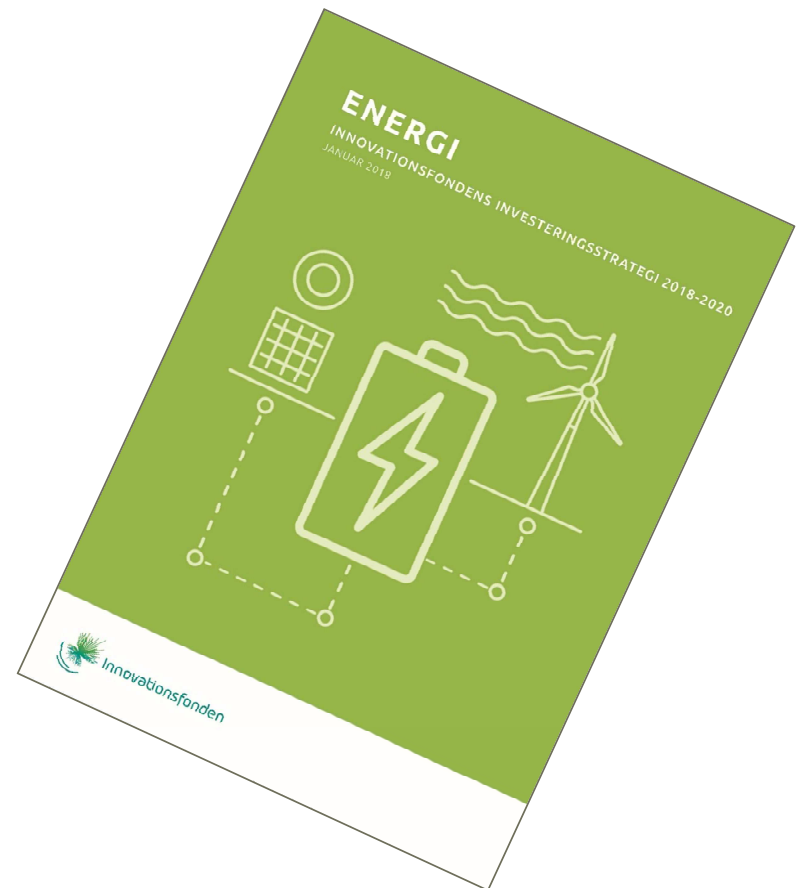
IFD investments will contribute to building new skills and new knowledge, increasing the power of innovation, and –not least – in generating new solutions, services, and products.



# Investment strategy 2018-2020

## Public-private partnerships

Strong publicly and privately funded research and knowledge based innovation are prerequisites for retaining and expanding existing Danish positions of strength as well as building new future Danish strongholds.



# Innovation Fund Denmark

## Research and innovation strategy - SUMMARY

Continued focus on the Danish wind energy sector:

- Strong public-private partnerships
- Large and small projects - long and short
- Strategic research - low TRL levels
- SME`s and Talent
- Cross sectorial and multidisciplinary including the manufacturing value chain

Agile and efficient governance of investments.

THANKS...





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