DANMARKS VINDMØLLEFORENING

S.P.O.K

Danish wind power

by

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Board member Danish Turbine Owners Association

CEO SPOK ApS

Background H C Soerensen

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Business and university background

- –PhD, 40 years with business development

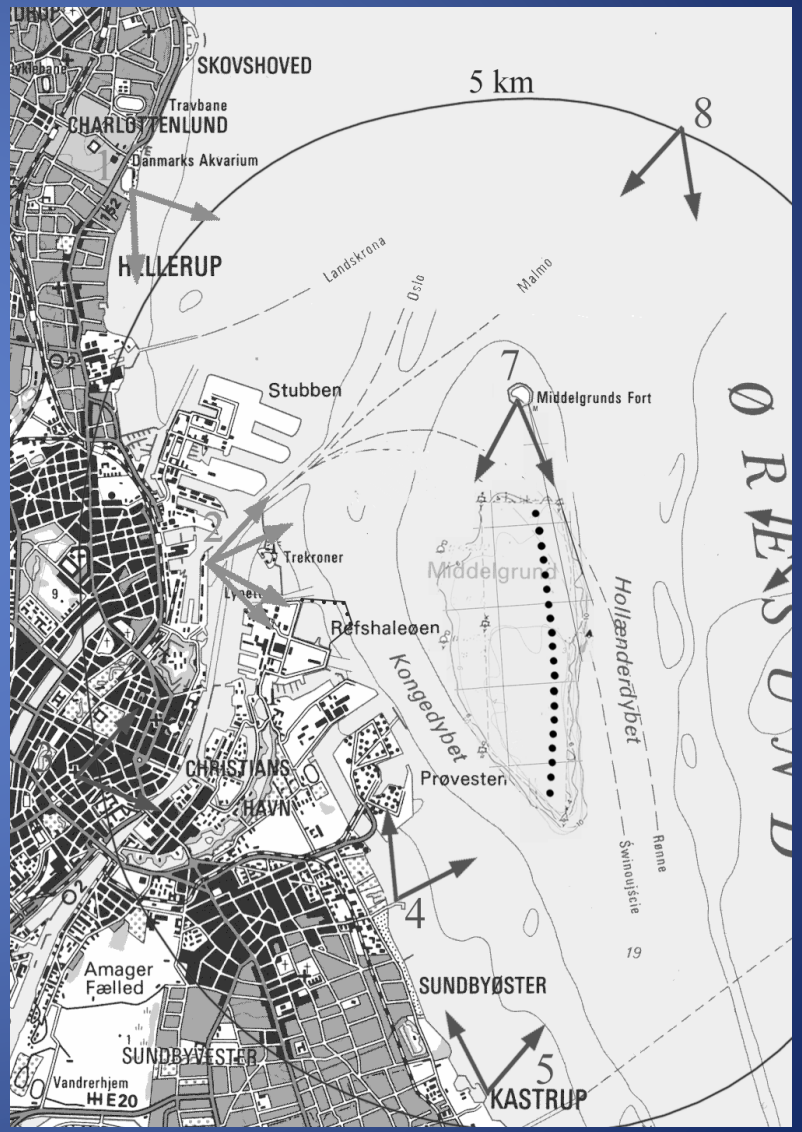
Project management large projects

- –Ocean wave energy (Wave Dragon), Tidal current (Tideng)
- –Offshore wind (Middelgrunden 40 MW, Samsø 23 MW, Hvidovre 7.2 MW)

Committees

- –Danish Wind Turbine Owners Association, board
- –European Ocean Energy Association, vice president to 2011

Middelgrunden 40 MW Wind Farm in 2000



Disposition

DANMARKS VINDMØLLEFORENING

- Danish energy plans 1976-2050
- Danish wind energy
- Danish cooperative model for wind
- Middelgrunden wind as case study
- What's next: ocean wave energy

Danish Energy Planning

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Key decisions

- 1976 RE plan based on energy security / special oil embargo 1973
- Fluctuating energy tax from 1982 keeping the energy price constant
  - Base for energy saving; investment in wind; feasibility of n-gas
- Energy plans in the 1990-ies based on global warming issues
  - Low CO_2 emission
- Energy plans in 2000-ies based on energy supply and global warming
  - Fossil free by 2050 / no coal after 2035

Constant energy consumption with increased GDP

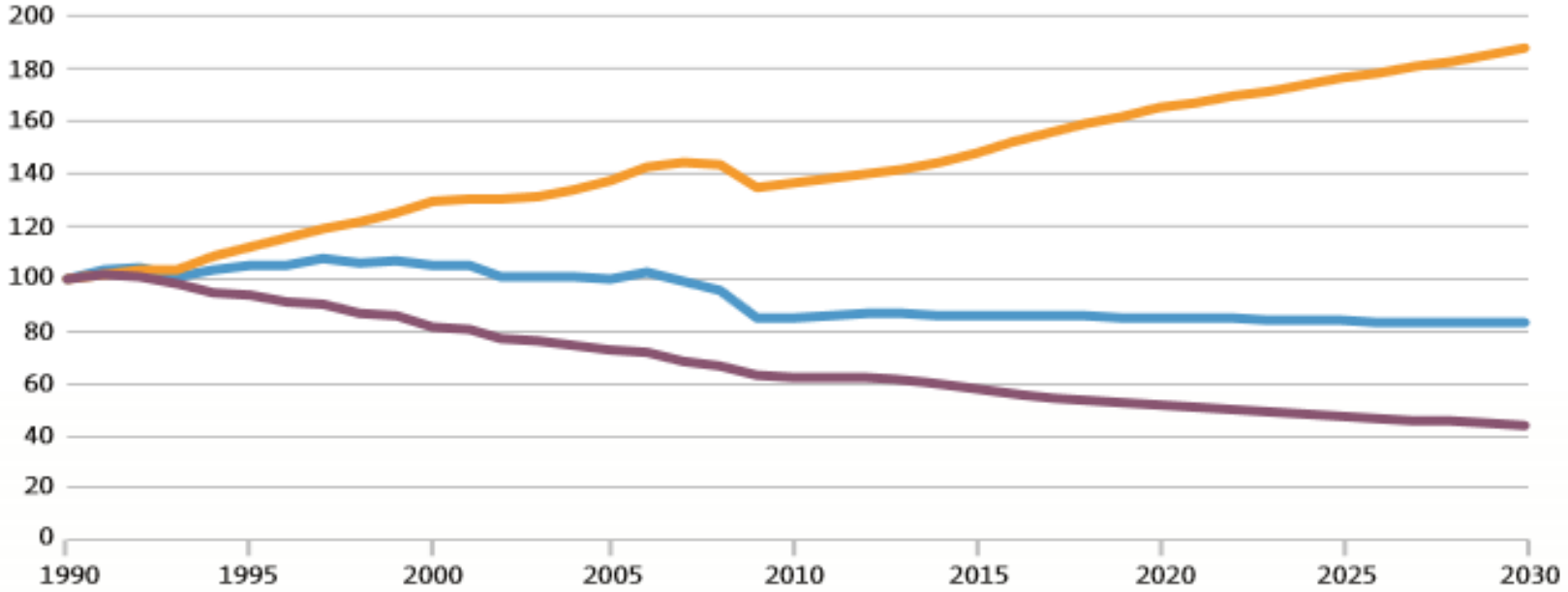

Figure 6: Development in GDP and in final energy consumption in industry (1990 = 100).

Source: Energy Policy in Denmark, DEA, 2012

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The development up to 2008

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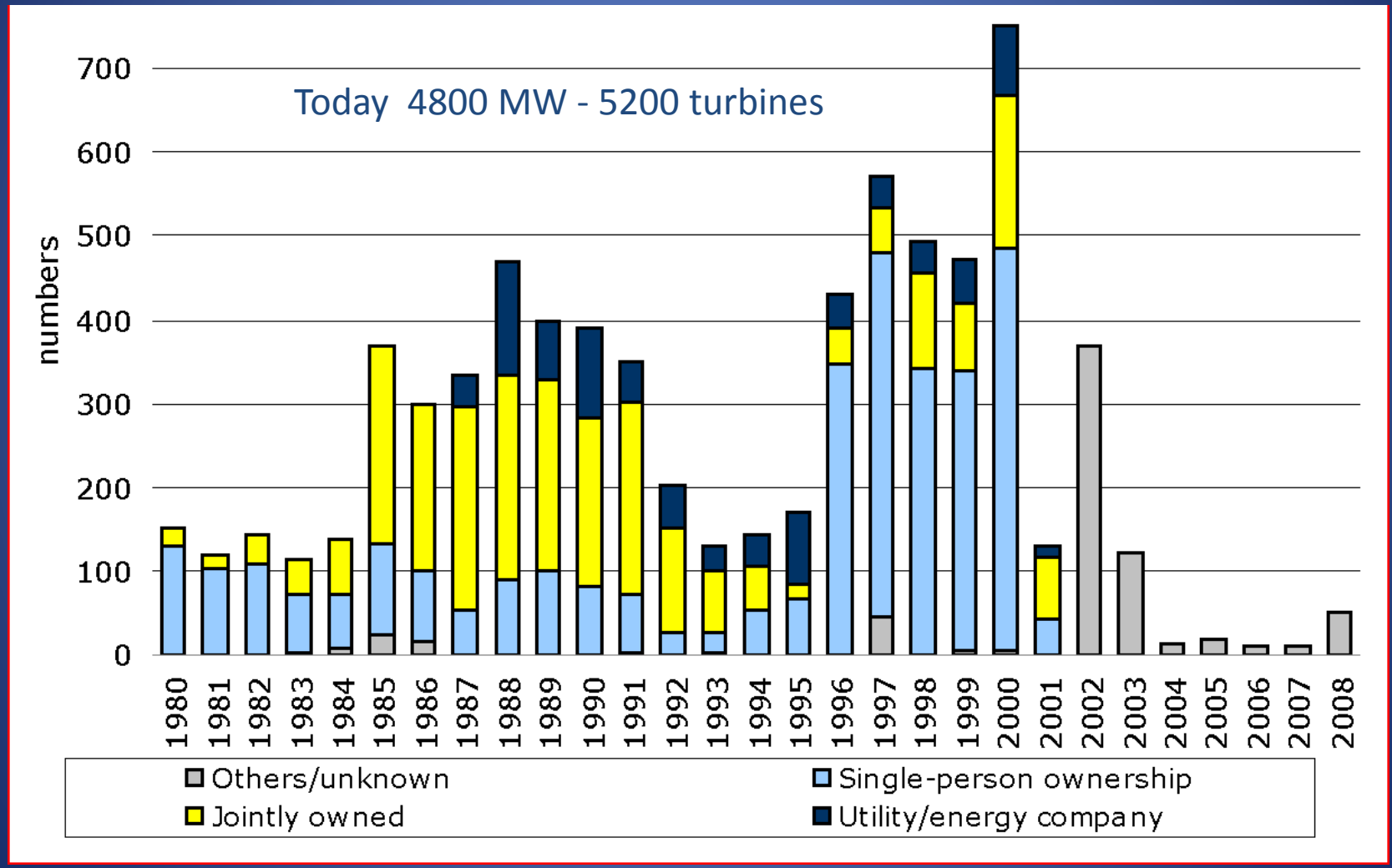

The development from 2008

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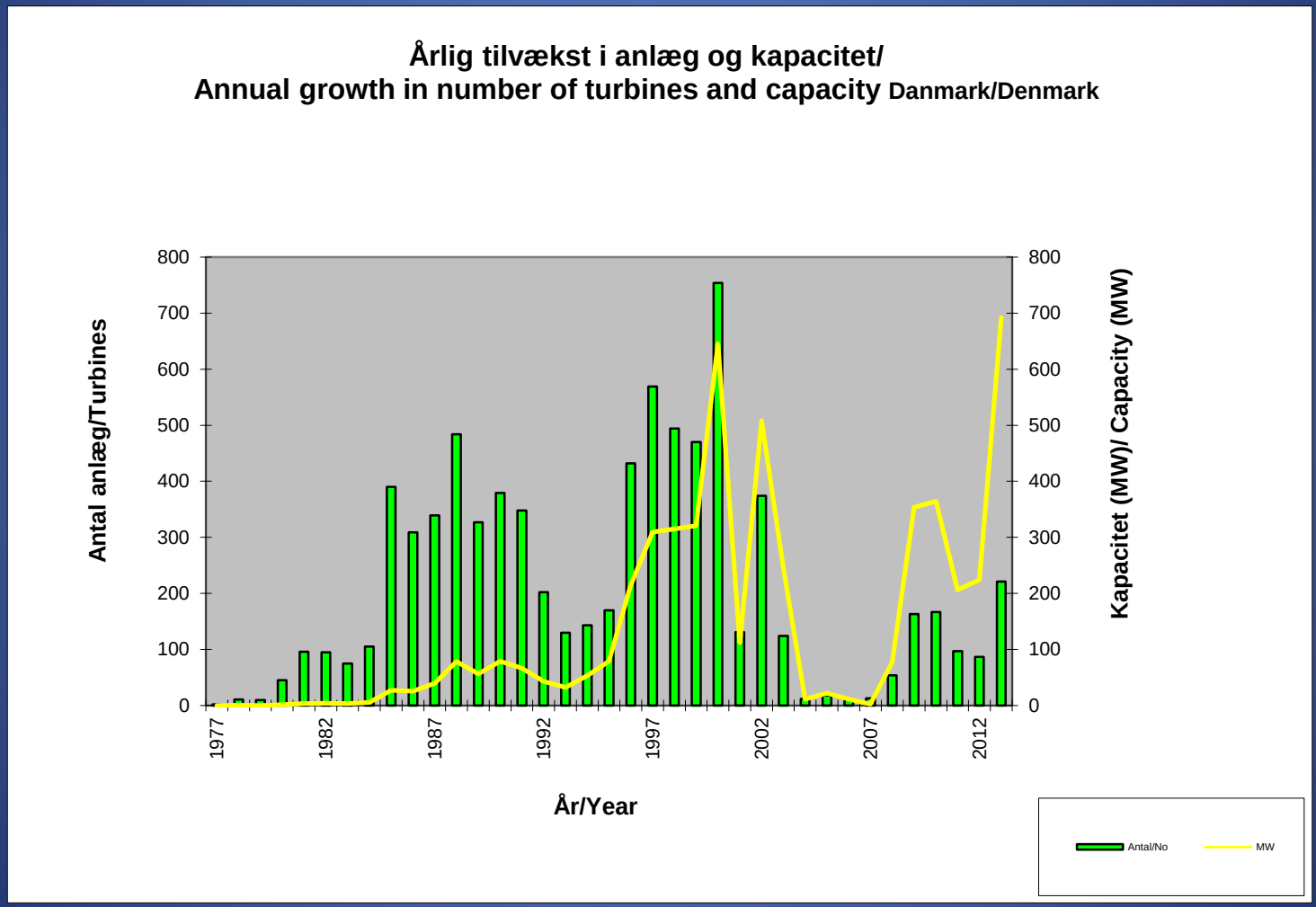
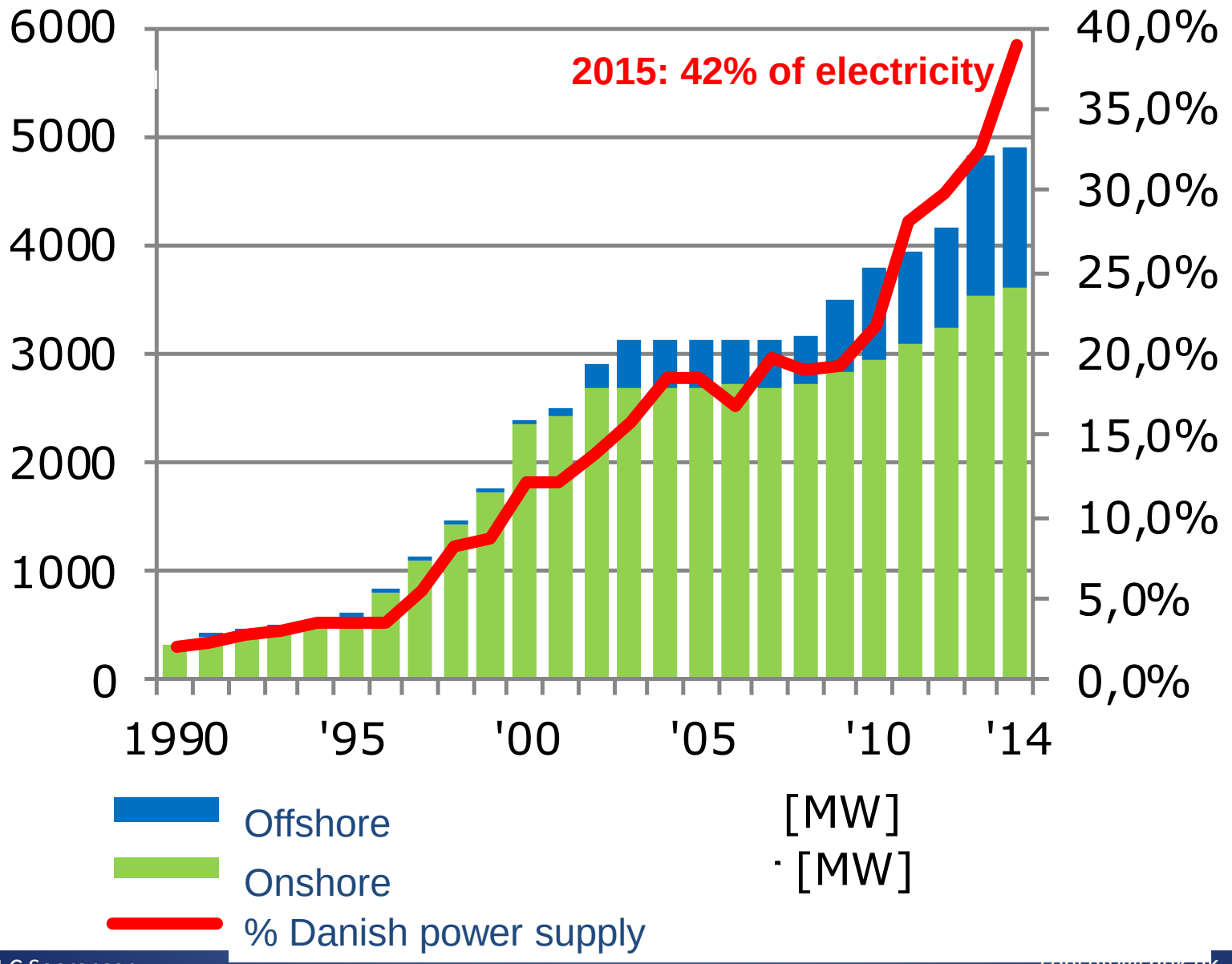


Offshore - onshore



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Danish Cooperative model for wind

- Shared ownership, one person one vote independent of shares
- Typically no loans – up front payment of total cost *
- One share equal to a production of 1,000 kWh/y
- Historically: ownership equal to own consumption of electricity
- Typically 3-5 shares => 3,000 – 5,000 kWh/y up to 2008
  * Typically 350€ to 670€ a share
  * A few banks are giving loans for individuals with security in revenue only

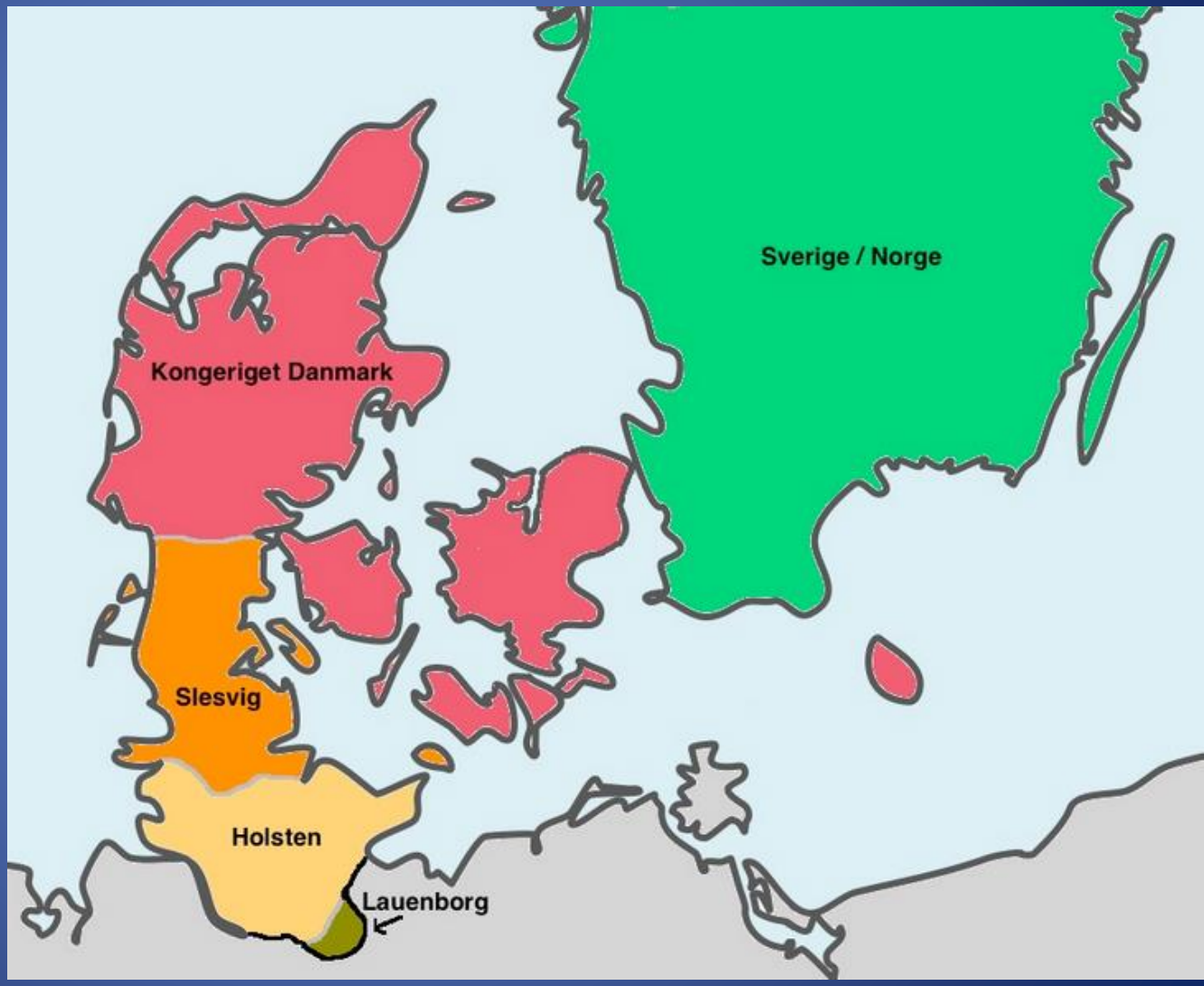
Simple tax rules possible – and needed:

- No tax when production revenue less than 940€/y
- Simple tax revenue form
- Only an advantage with less than about 10-20 shares**

** Else use standard for companies: profit less depreciation, but then remember auditor for the tax authorities

Danish Cooperation, history from 1866

- Demark lost the war with Preussen/Austria in 1864
- 40% of the agriculture area
- Political fight between family farmers and large farm owners



Danish Cooperation, history from 1866

- 1844: Rockdale UK
  In Denmark
- Shop in 1866
- Diary 1882
- 1882-1888 fast growth

Shop Rønne 1892

Danish Cooperation, history from 1866

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Diary 1892

Danish Cooperation, history from 1866

- 1844:
  Rockdale UK
  In Denmark
- Shop in 1866
- Diary 1882
- 1882-1888
  fast growth

Another diary
1992

Danish Cooperation, history from 1866

- 1844: Rockdale UK
  In Denmark
- Shop in 1866
- Diary 1882
- 1882-1888 fast growth

Loading bacon in Londo 1902

COOP's in Denmark today

- Agriculture: about 50% ; 15-20% of Danish industry
- Shops: 42% of turnover; 35.000 people
- Water supply: 2.600 (330/2.300 public/private)

Energy:

- Power distribution: most companies
- Power production – wind 18% / 850 MW
- District heating : 460 plants
- Biogas COOP's: 22 plants

The cooperative approach – how to start?

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In old days:

- Village got together; meeting called for; landowner also partner; discussion site;
- Planning process started then automatically;

Copenhagen (Middelgrunden):

- A small group from Lynetten wind farm started in 1996 called for interest to work and send application
- At the same time DONG Energy had started own search for setting up a wind farm at the reef
- We agreed to form a common group: *the NGO and DONG Energy to build and later split in two separate operational units each 20 MW and 10 turbines*

The cooperative approach- Benefits

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Advantages

- Local involvement
- Earlier involvement
- Profit stays locally

Disadvantages:

- Upfront payment even before consents
- Dependency of manufacturers when no grants

Today (from 2009 onshore):

- Minimum 20% local ownership to be offered within 4.5km, thereafter to local county
- Near shore farms: special incentives if local people is involved

The organisation

- Board of 5-7 people selected every 2 years
- No fee to board members
  - Administration office/book keeping /volunteers dependant of shares
  - One part time person paid to follow up on maintenance
  - Service company or manufacturer to do service
  - Audit company for account
- Home page for information; e-mail if possible
- Newsletter with call for General Assembly each year
- Open house for visiting if possible

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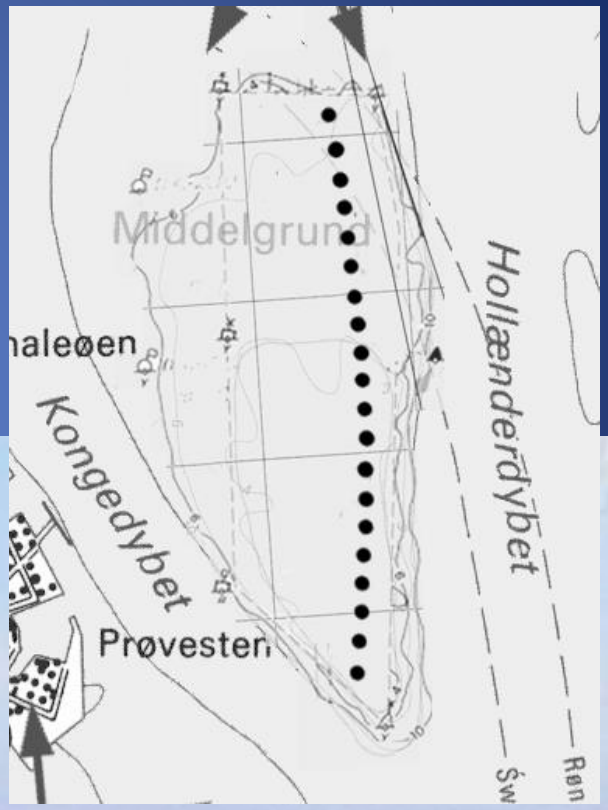
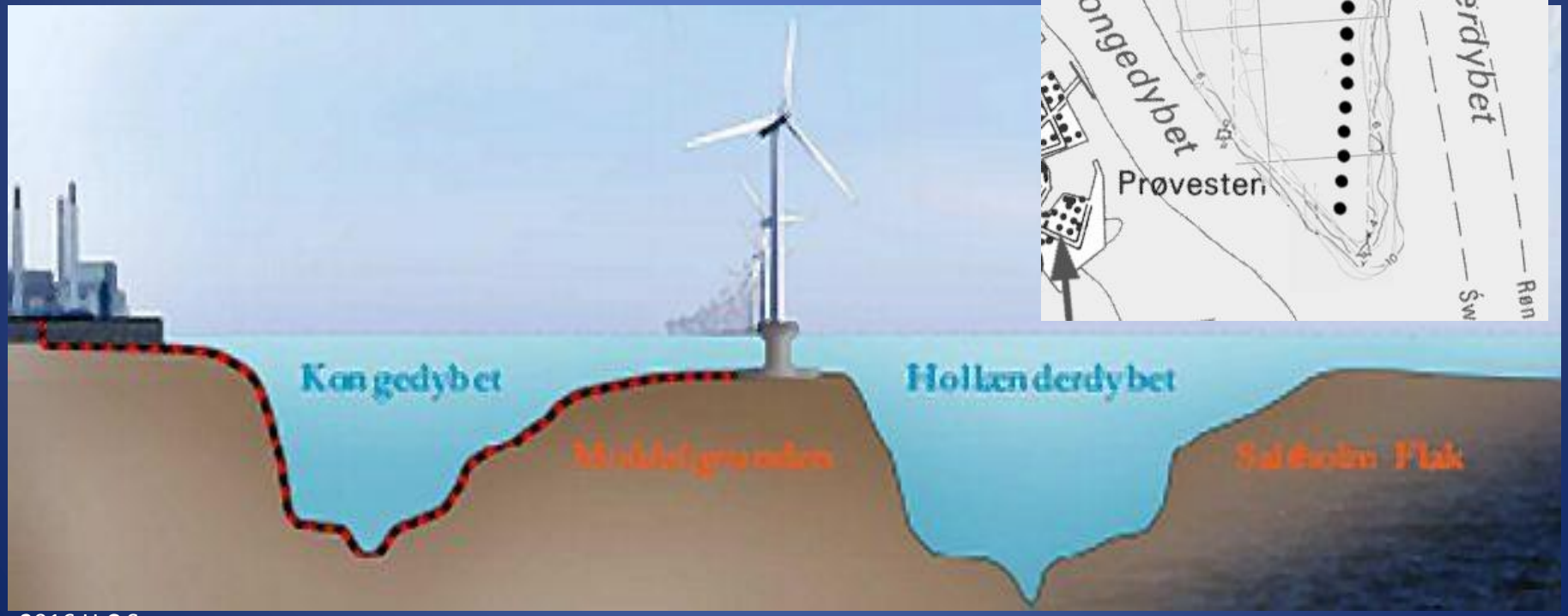
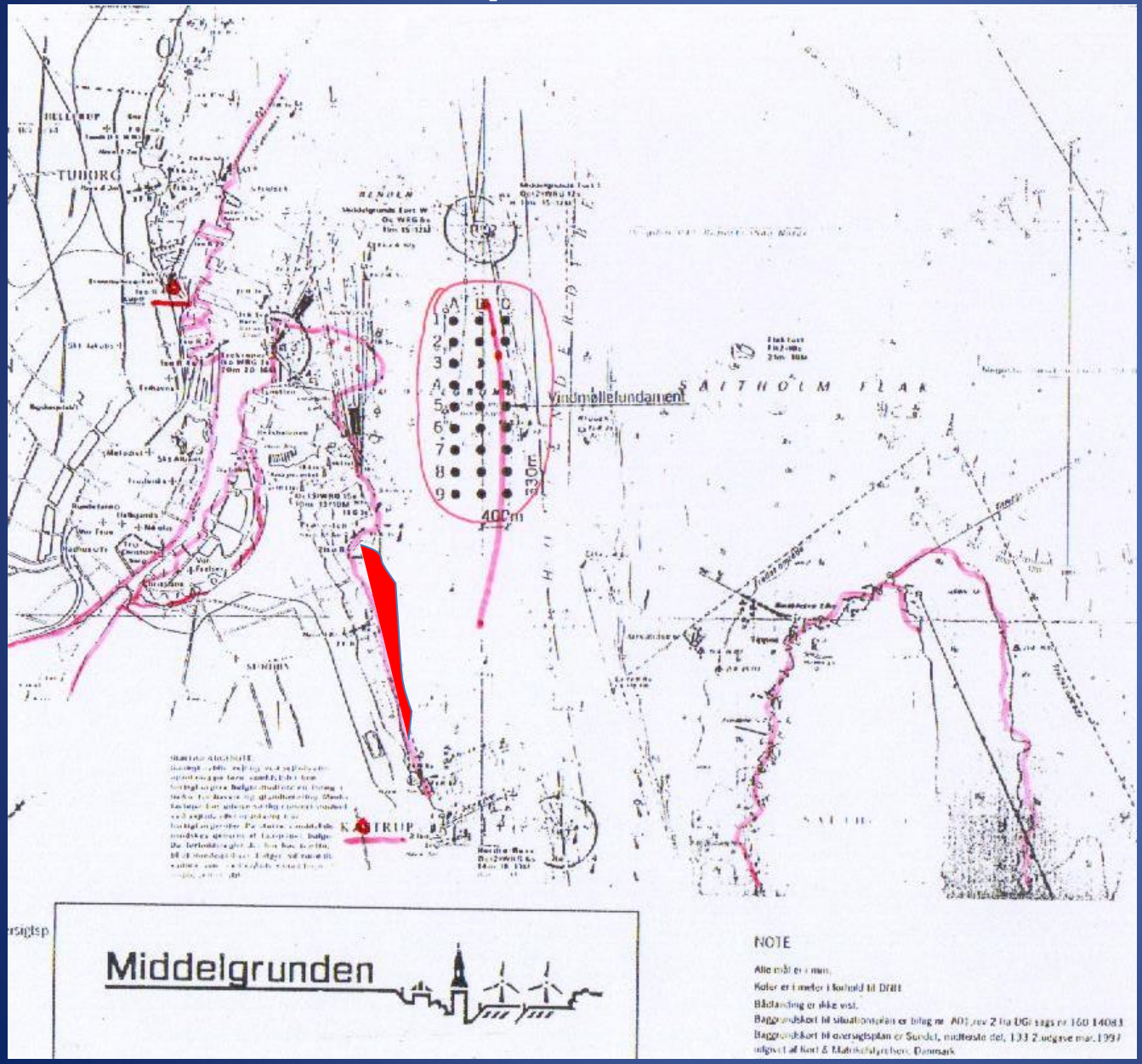
Middelgrunden 40 MW Wind Farm

The farm is constructed on a reef called Middelgrunden with a water depth of 1-6 m deep





Technical optimisation – visual impact

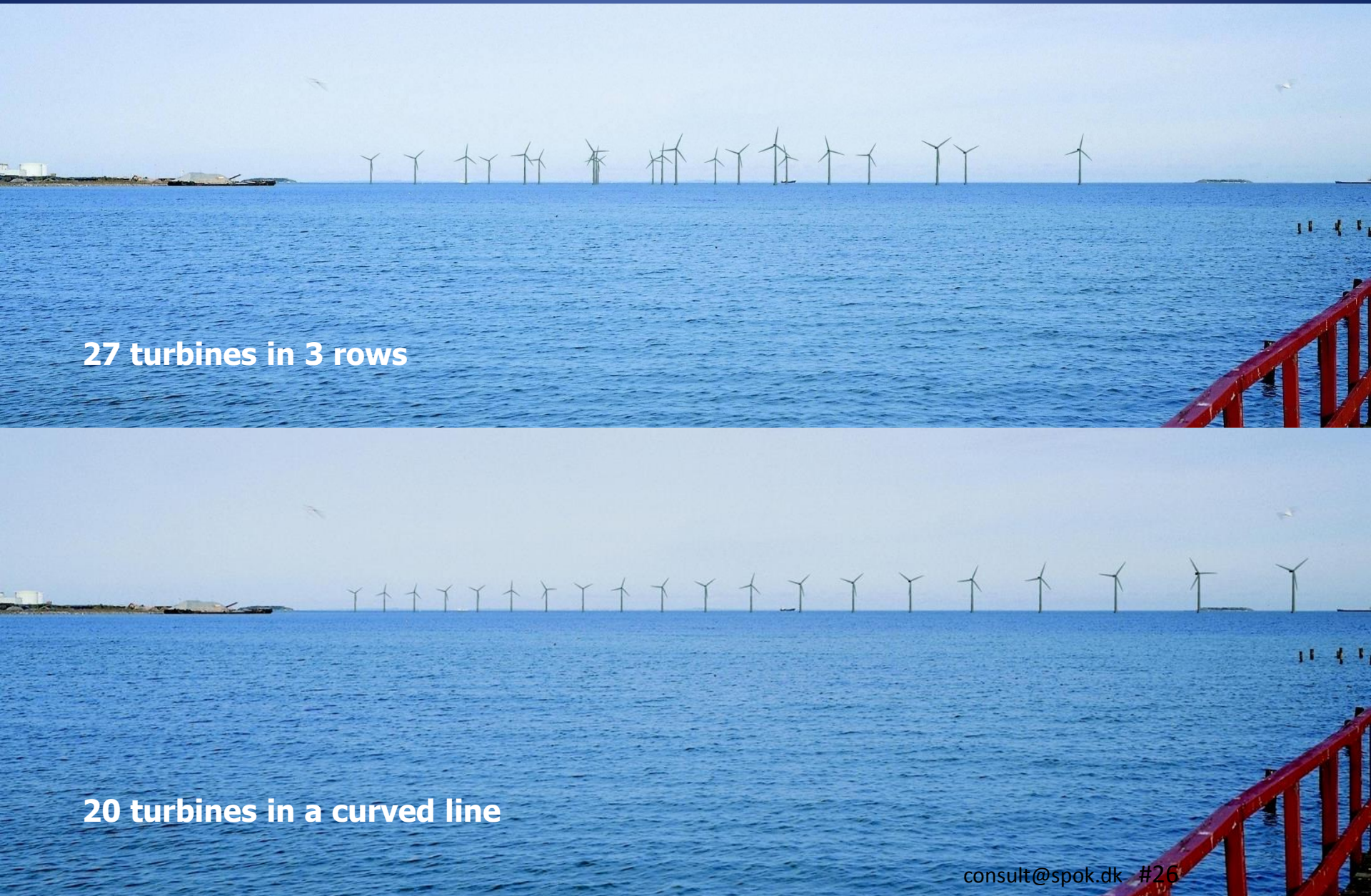


3 rows in the north part, 27 turbines –

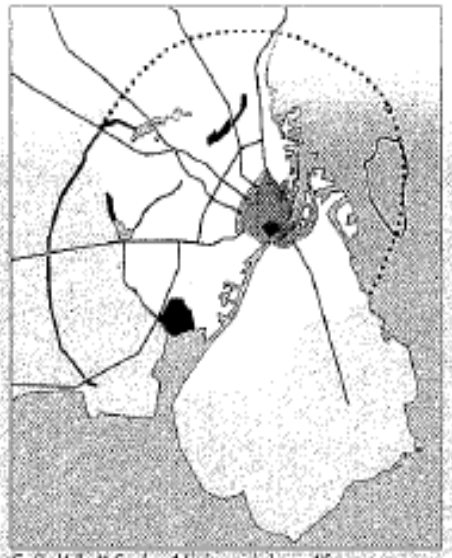
changed to one line over the whole length

Our closest 1997 – potential neighbor

Visual Impact – two alternatives



Visual impact – the defence circles



ØRESUND

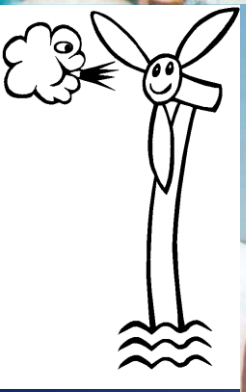
MIDDELGRUNDEN

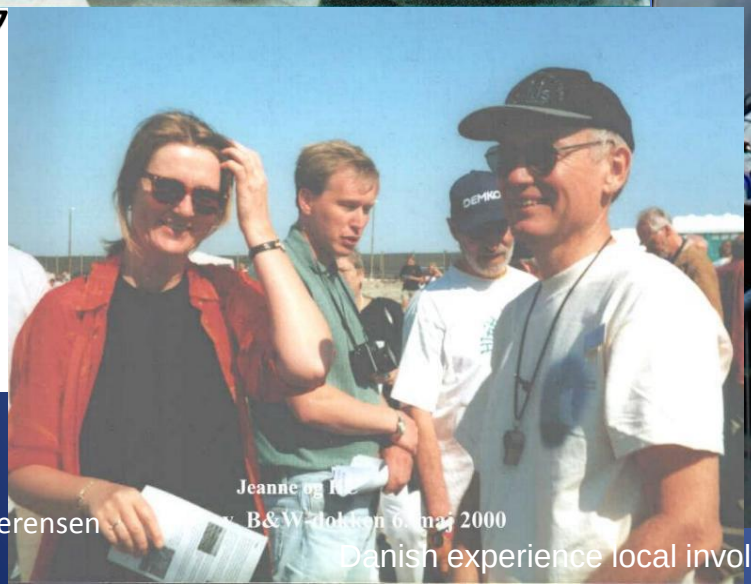
KØBENHAVN

Parkens layout følger Københavns gamle forsvarsanlæg.

The Farm layout is following the defense system of Copenhagen dating back to the Middle Age.

Involvement of local people in the project

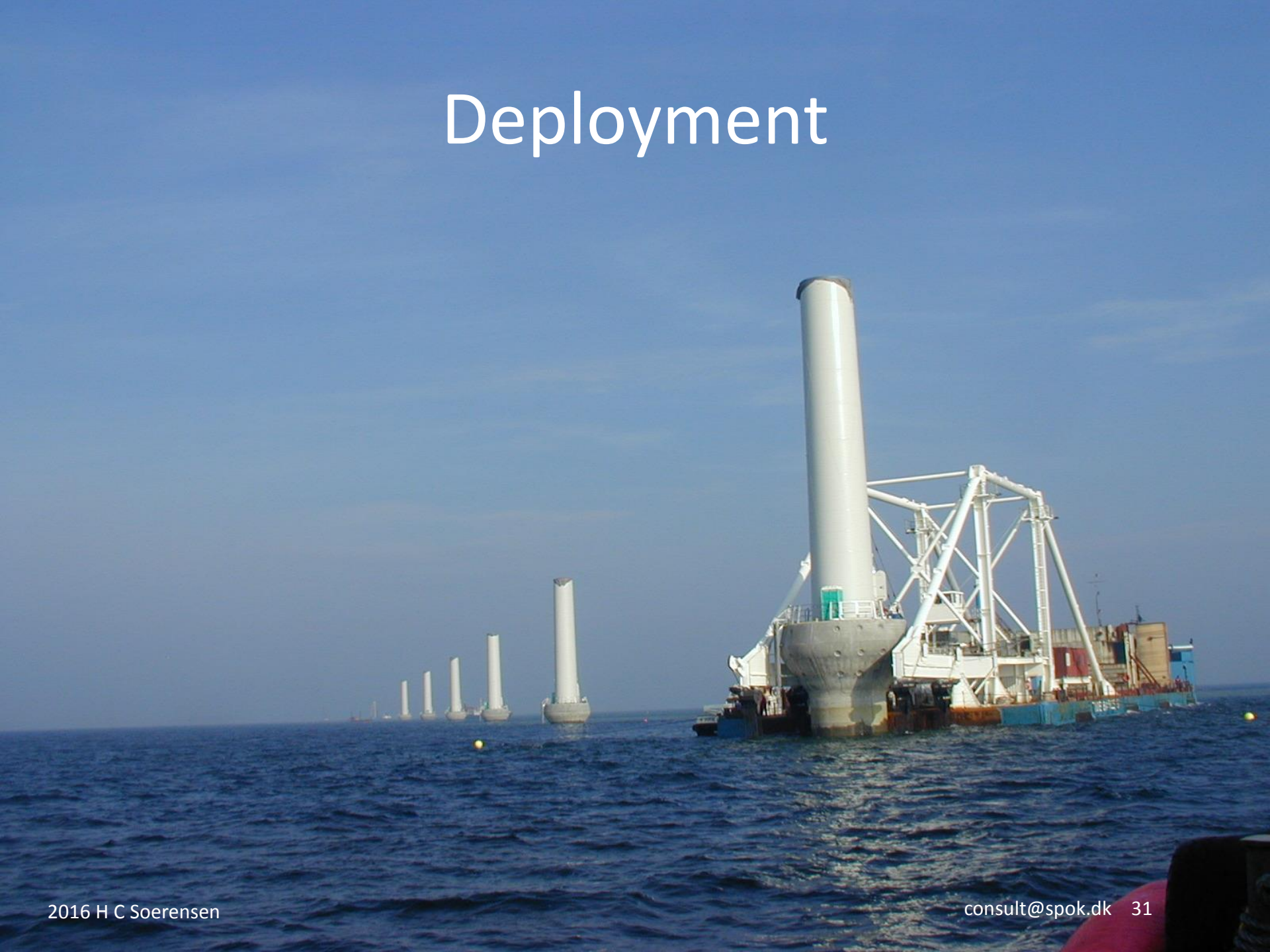


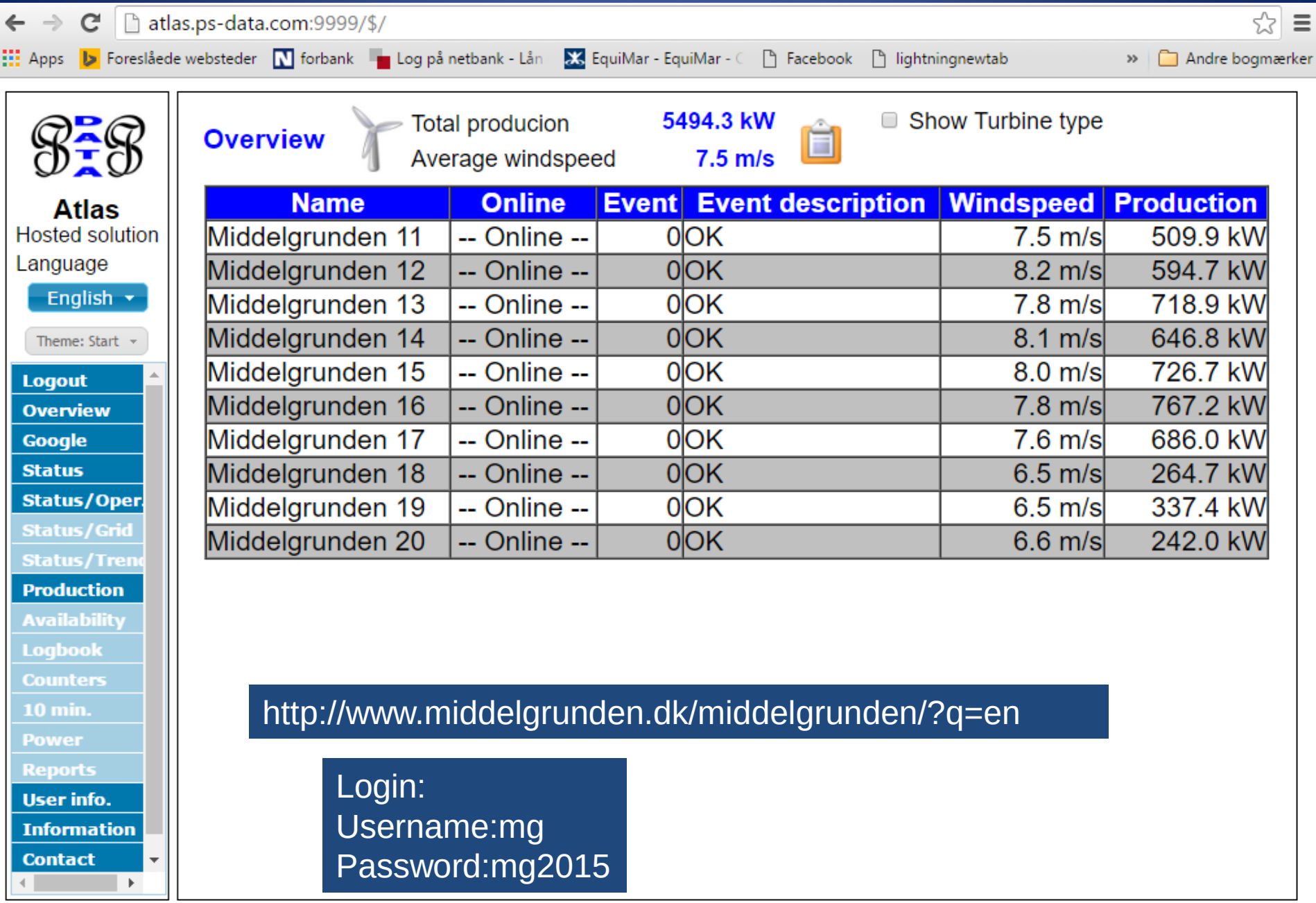


Casting concrete

The dry dock

Deployment

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Apps
Foreslåede websteder
forbank
Log på netbank - Lån
EquiMar - EquiMar -
Facebook
lightningnewtab
Andre bogmærker
Atlas
Hosted solution
Language
English
Theme: Start
Logout
Overview
Google
Status
Status/Oper
Status/Grid
Status/Trend
Production
Availability
Logbook
Counters
10 min.
Power
Reports
User info.
Information
Contact
Overview
Total producion 5494.3 kW
Average windspeed 7.5 m/s
Show Turbine type
Name | Online | Event | Event description | Windspeed | Production
Middelgrunden 11 | -- Online -- | 0 | OK | 7.5 m/s | 509.9 kW
Middelgrunden 12 | -- Online -- | 0 | OK | 8.2 m/s | 594.7 kW
Middelgrunden 13 | -- Online -- | 0 | OK | 7.8 m/s | 718.9 kW
Middelgrunden 14 | -- Online -- | 0 | OK | 8.1 m/s | 646.8 kW
Middelgrunden 15 | -- Online -- | 0 | OK | 8.0 m/s | 726.7 kW
Middelgrunden 16 | -- Online -- | 0 | OK | 7.8 m/s | 767.2 kW
Middelgrunden 17 | -- Online -- | 0 | OK | 7.6 m/s | 686.0 kW
Middelgrunden 18 | -- Online -- | 0 | OK | 6.5 m/s | 264.7 kW
Middelgrunden 19 | -- Online -- | 0 | OK | 6.5 m/s | 337.4 kW
Middelgrunden 20 | -- Online -- | 0 | OK | 6.6 m/s | 242.0 kW
http://www.middelgrunden.dk/middelgrunden/?q=en
Login:
Username:mg
Password:mg2015

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Ocean Energy to follow wind?

The theoretical global resource is estimated to be in the order of:

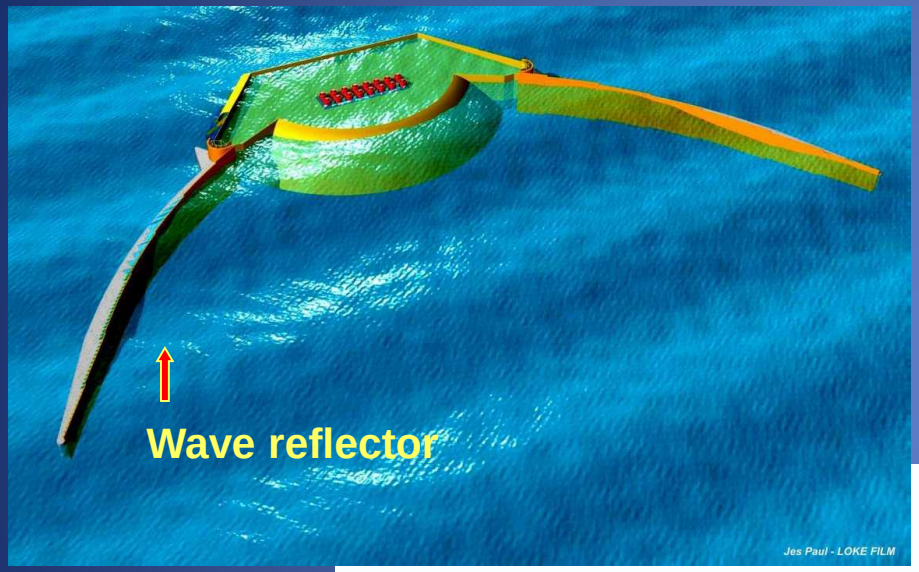
- 8,000 - 80,000 TWh/year for wave energy;
- 800 TWh/year for tidal current energy;
- 2,000 TWh/year for salinity gradient energy;
- 10,000 TWh/year for ocean thermal energy

Worlds electricity consumption 20,000 TWh/year

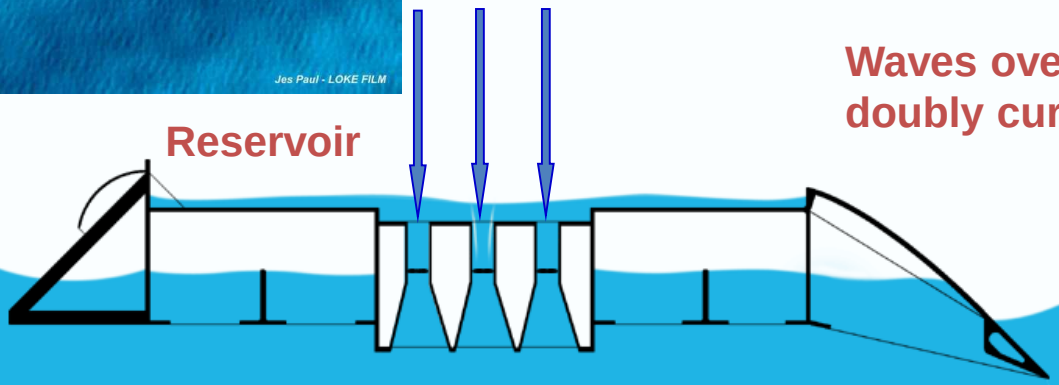
Source: EC SET plan, World Energy Council, IPCC

Wave Dragon principle

The *Wave Dragon* is a slack-moored wave energy converter that can be deployed alone or in parks wherever a sufficient wave climate and a water depth of more than15m is found.



Climate	Power	Yearly production
12 kW/m	1½ MW	4 GWh/y/unit
24 kW/m	4 MW	12 GWh/y/unit
36 kW/m	7 MW	20 GWh/y/unit
48 kW/m	12 MW	35 GWh/y/unit



20,000 hours production

- Real sea testing in scale 1:1 in a scale 1:5 sea state of the Atlantic
- Web cam 25 m/sec wind

The Danish public acceptance of wind power

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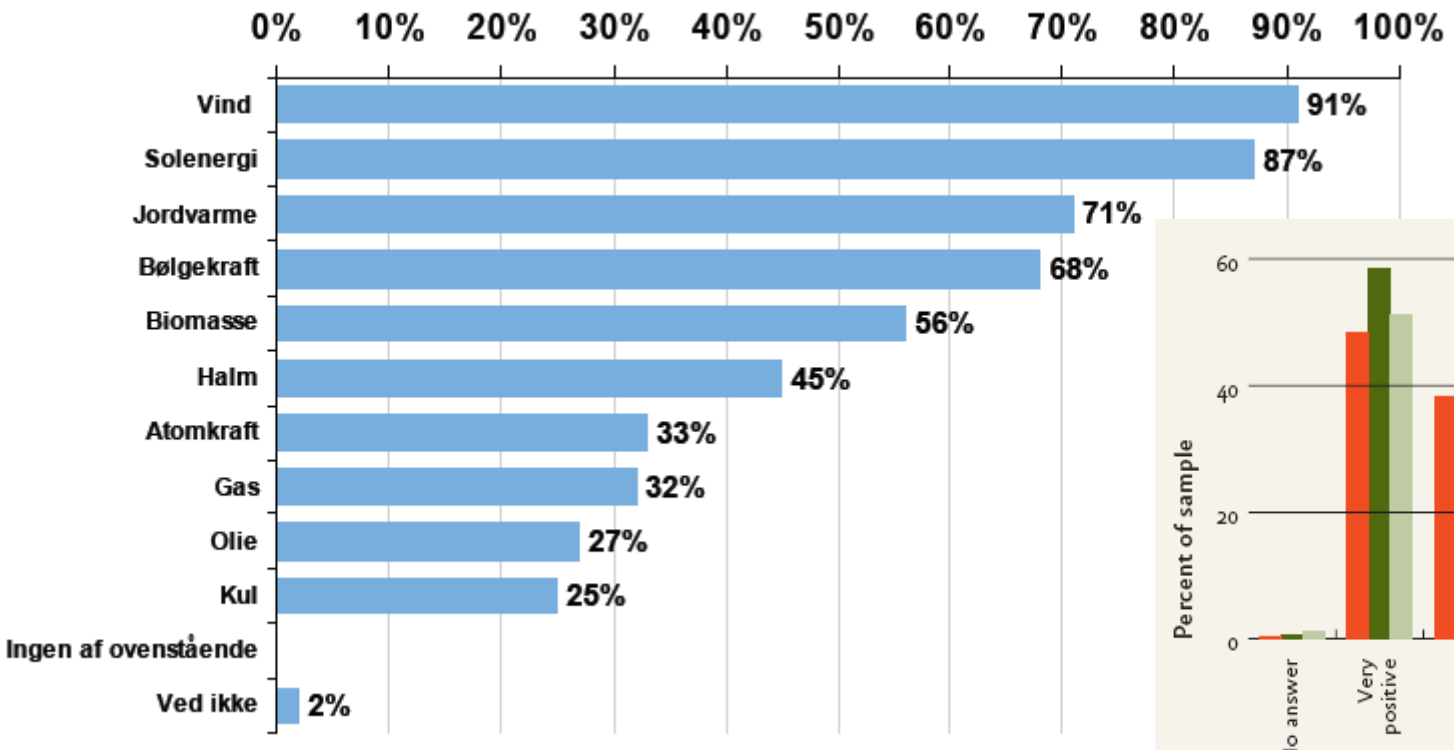

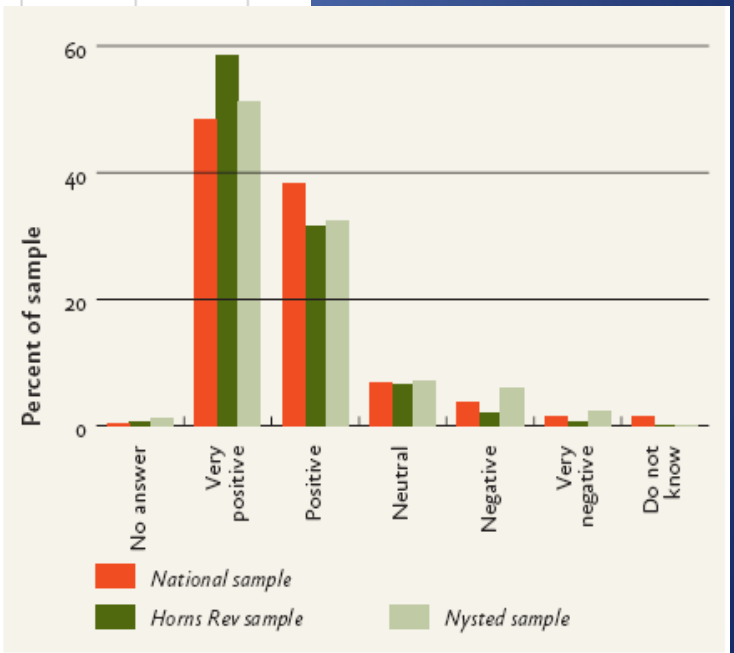

Figure 14: The attitude towards existing wind farms divided onto each of the three samples

More than 90% support:
more wind and has it as #1 source

References

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Data the Copenhagen coop projects

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	Lynetten	Middelgrunden	Hvidovre	Prøvestenen
Year	1995/96	1996/2000	2007/2009/ 2011	2013
Power	7 x 600kW	20 x 2MW	3 x 3.6MW	3x2MW
COOP/Utility	4/3	10/10	1/2	1/2
Shares/owners	3,600/902	40,500/8,553	10,700/2,268	4,055/1,800+
Price/share	604€	570€	670€	663€
Upfront work	Coop/Utility	Coop & Utility	Coop & Utility	Utility/Coop
Upfront payment	Coop/Utility	Grant/Utility	Utility	Utility
Cost	4.1mill€	49.5 mill€	22 mill€	8,07 mill€

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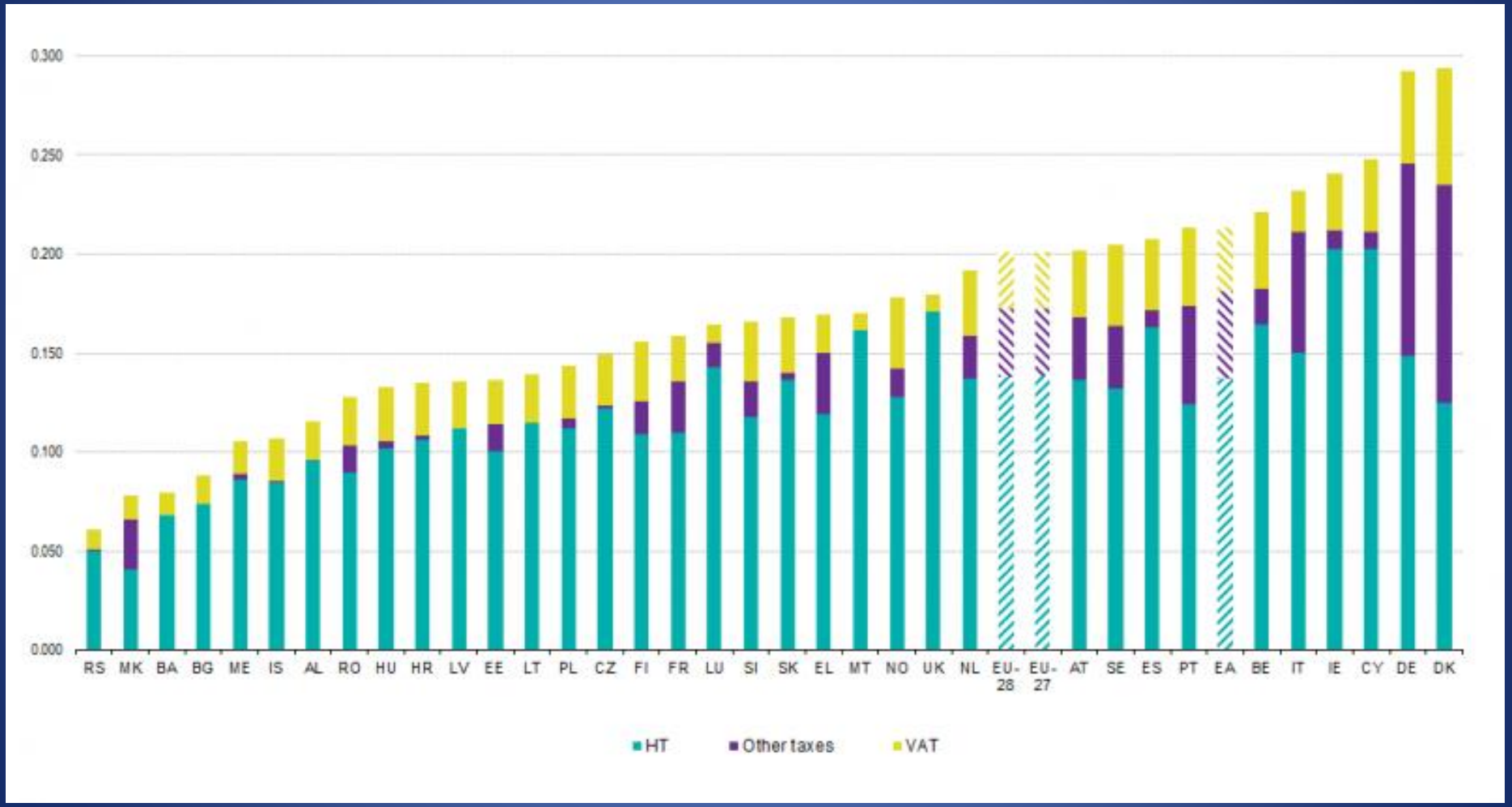
The RE-law of 2008

- Minimum 20% local ownership to be offered within 4.5km, thereafter to local municipality; at cost price; if not sufficient buyers you can as developer keep it by yourselves.
- Loan guaranty after basic work have been done of up to 67,200€ for each project
- Social Green Fund to Municipality 11,800€/MW
- Compensation for neighbours possible

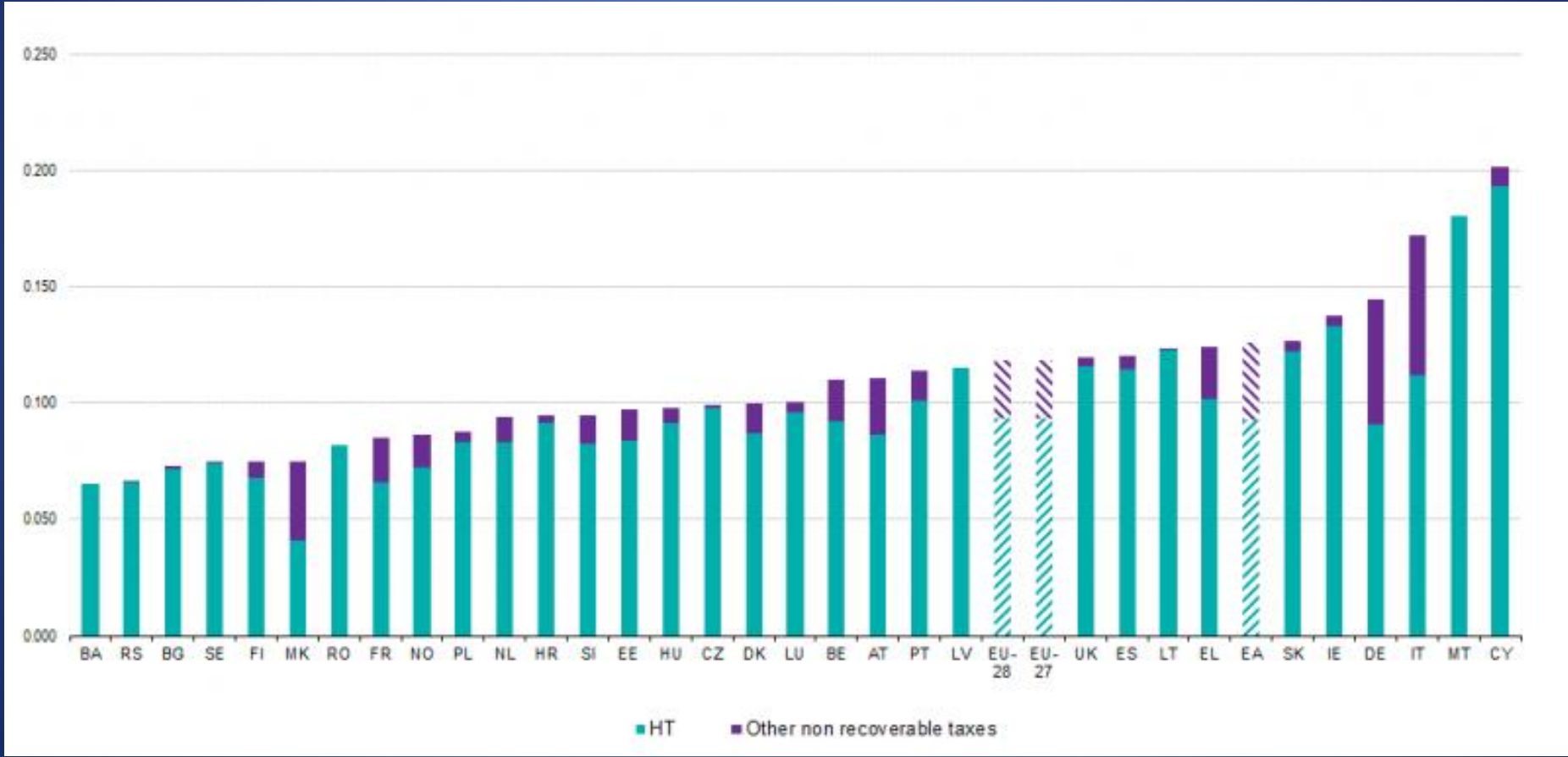
Projects typically 3-6 turbines which is the most accepted pattern by people in the Danish landscape

Price of electricity for households



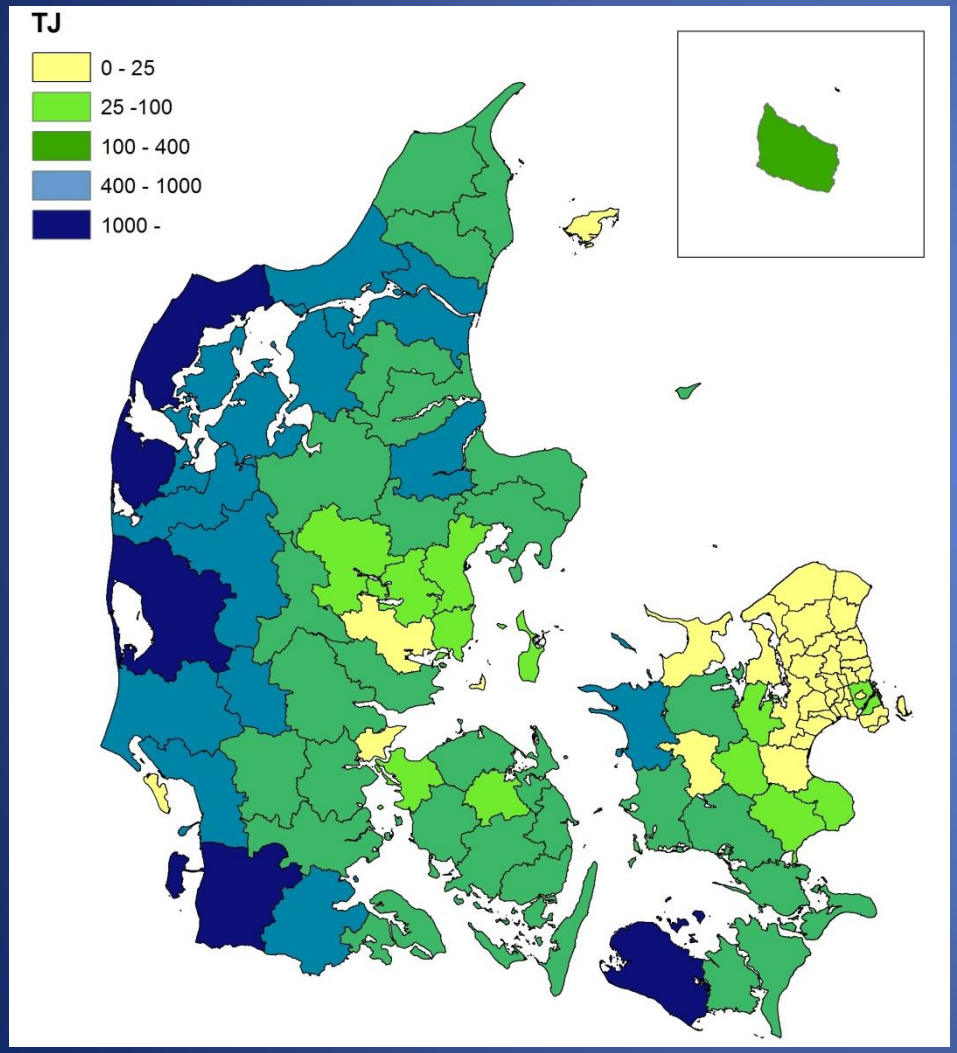
Source: Eurostat 2013

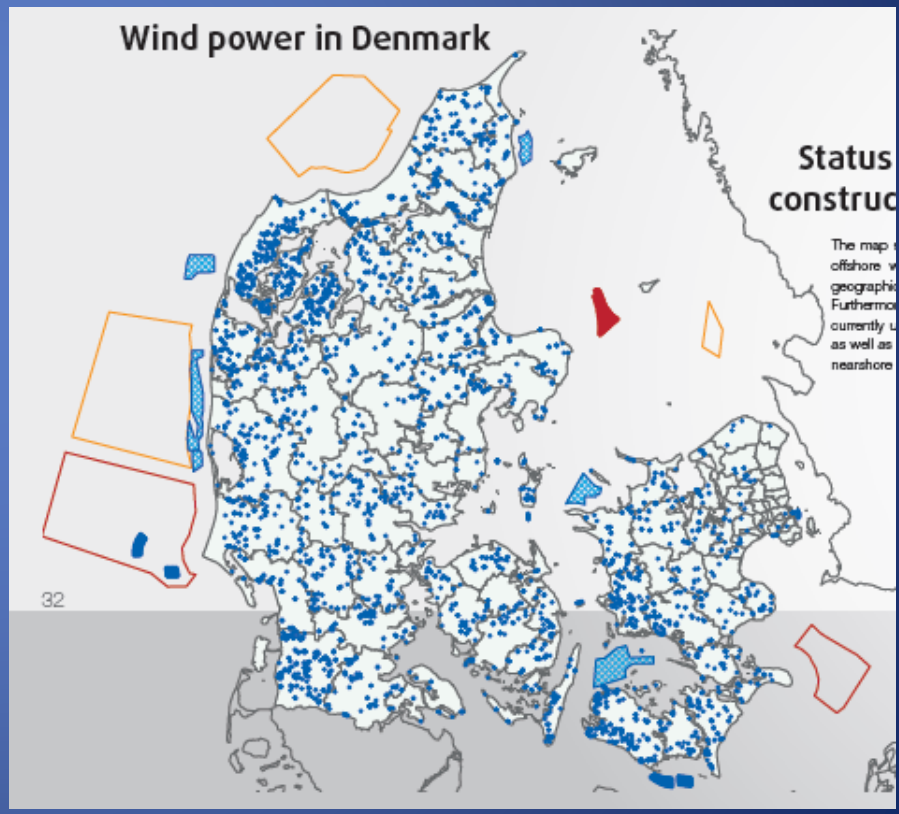
Price of electricity for industrial consumers



Source: Eurostat 2013

Wind power – Municipalities - offshore





Growth in wind energy Denmark

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