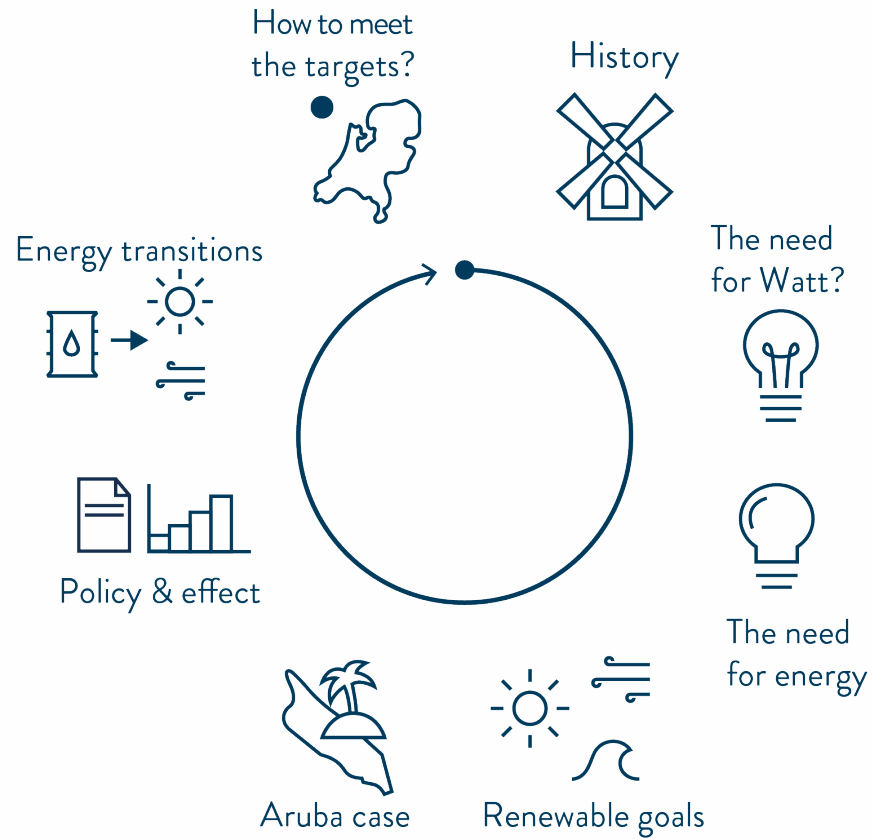




DE OUDE
BIBLIOTHEEK
ACADEMY

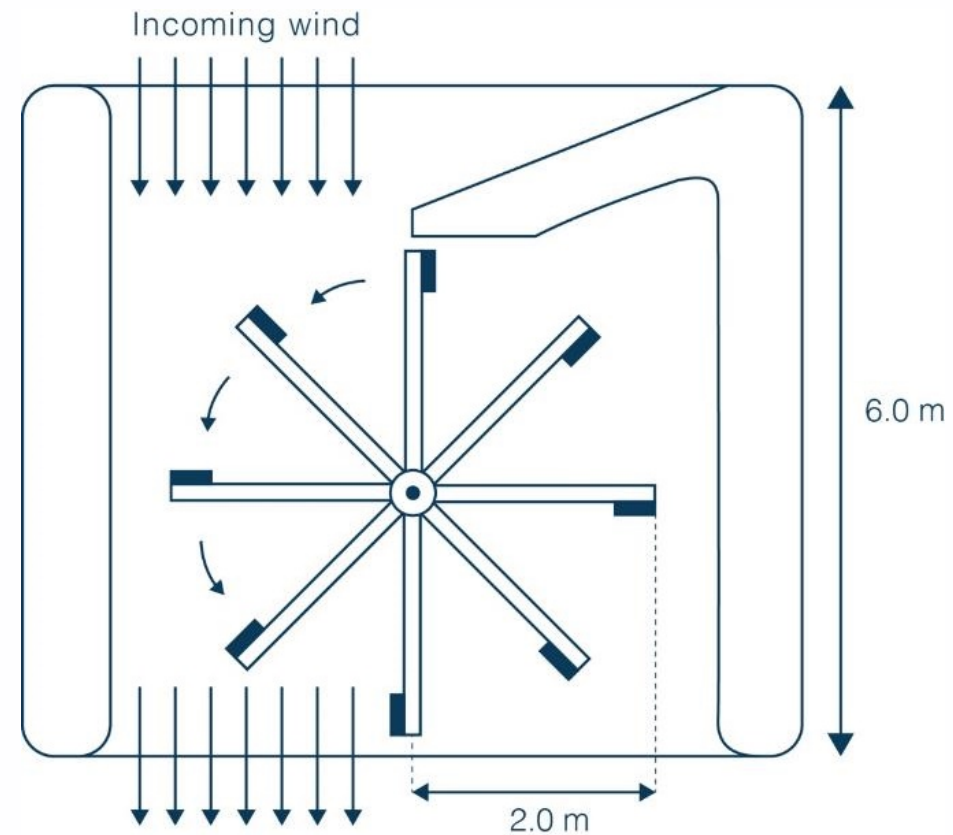
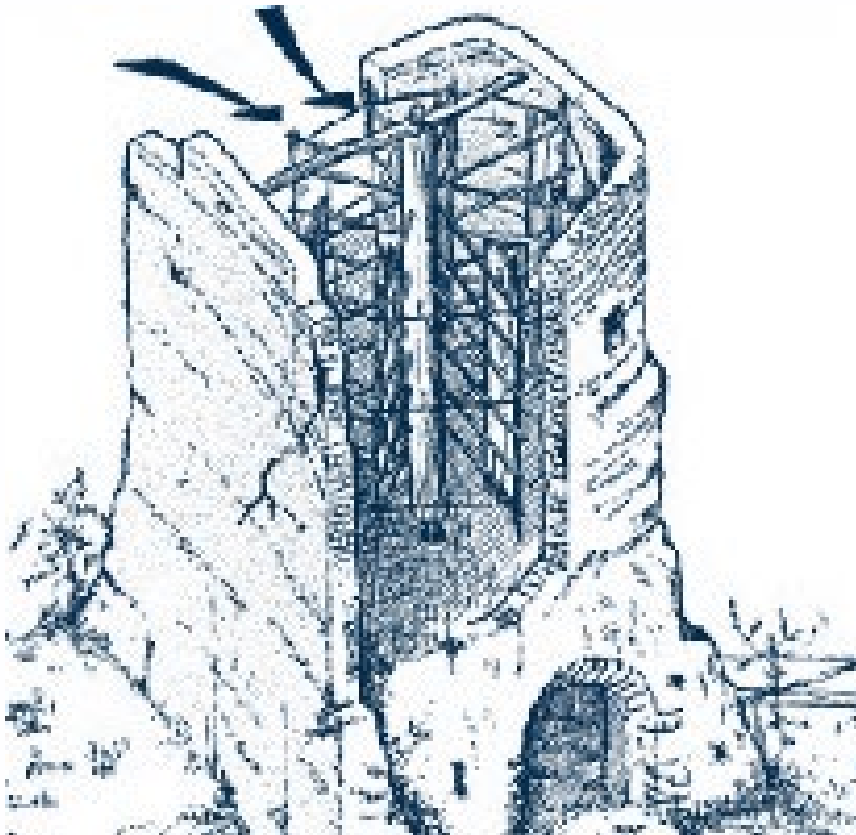


European offshore wind drivers





Persian windmill – 700 AD





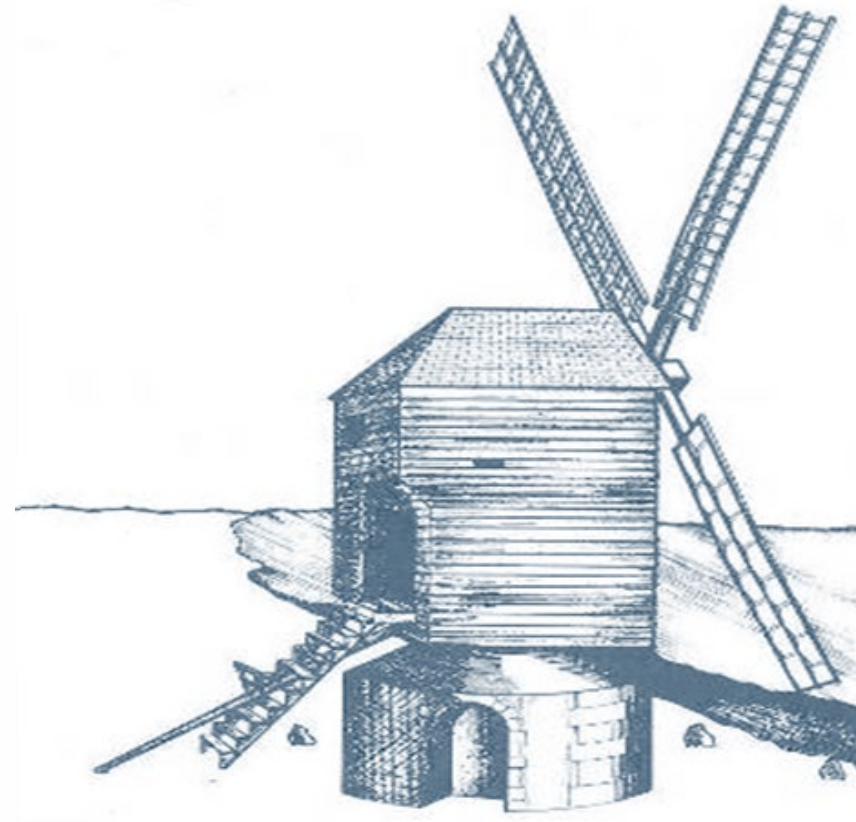
Persian deserts





Windmills -1650

3000 windmills in NL
33% of the workforce - 7.5 MW installed





Poul la Cour (DK) – 1891



- Tests
- Aerodynamics
- Electrification
- Making hydrogen



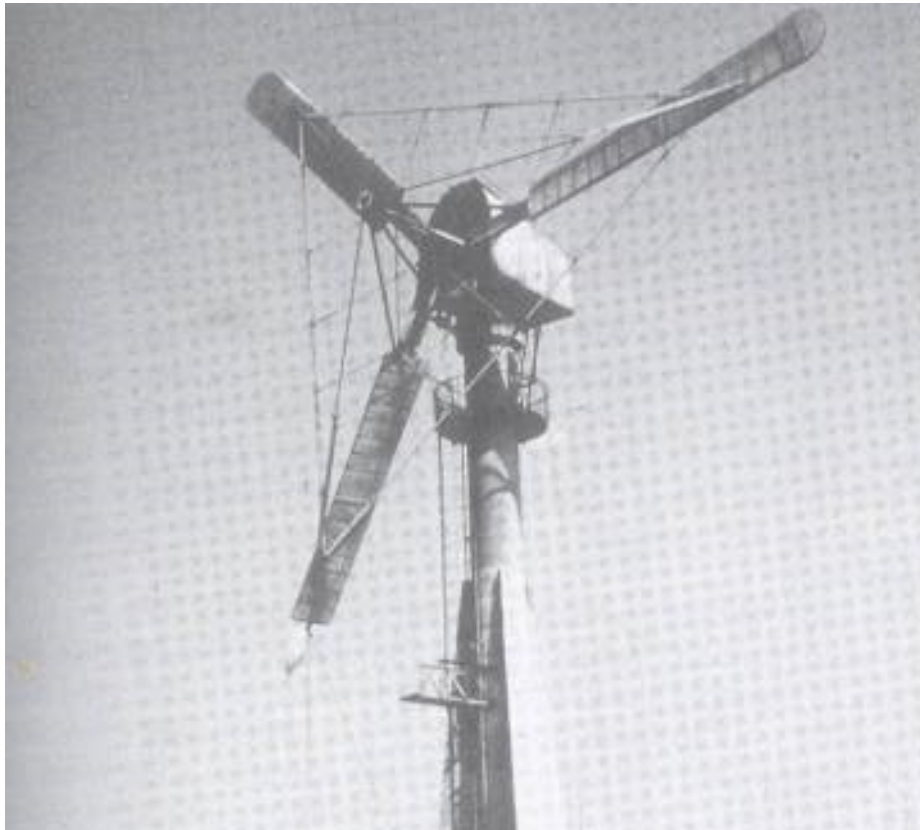
MW size – 1941



- 1.25 MW
- Steel blades
- Fatigue of blade



Gedser (DK) – 1958



- 1958
- 200 kW
- “The Danish Concept”



Monsters of the 70s-80s

- NASA
- Boeing
- No go



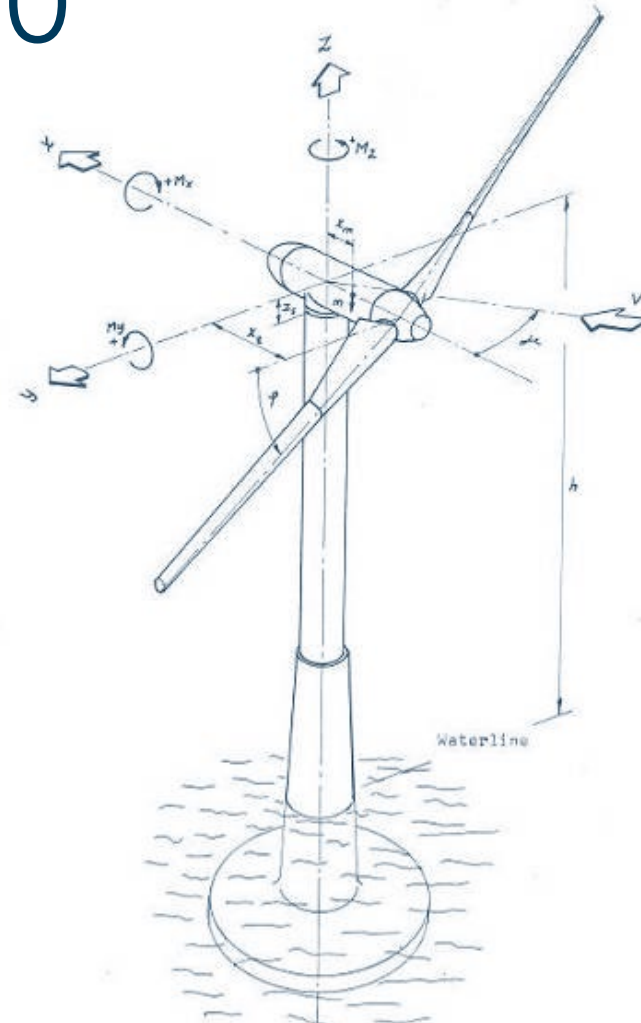


Offshore ideas 1970 - 1980

Oil crises

- Heerema
- RSV
- Boskalis
- Fugro

Inspired by offshore oil and gas industry





Vindeby (DK) – 1991

- 4.95 MW
- 11 x 450 kW
- GBS
- Tryout





OWEZ – 2006

- 108 MW
- 36 x 3 MW
- First offshore wind farm in NL





Gemini – 2015

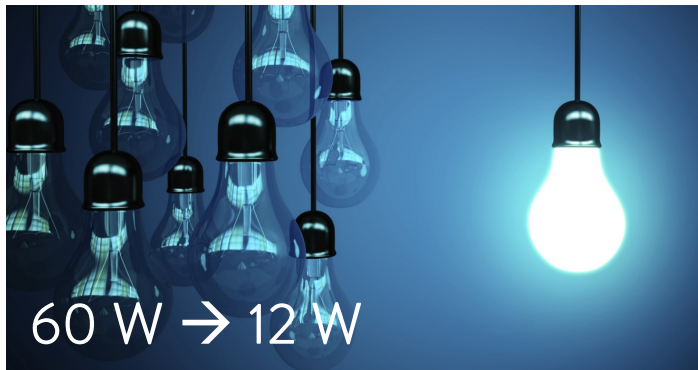
- 600 MW
- 150 x 4 MW
- Largest OWF in NL



Van Oord



The need for electricity



TV
3 hours per day
 $3\text{h} \times 100\text{W} = 300\text{ Wh}$
0.3 kWh



Train
10 hours per day
 $10\text{h} \times 2.5\text{MW} =$
25MWh 25 000 kWh



What is a Watt?





What is a Watt?





How much do we need?

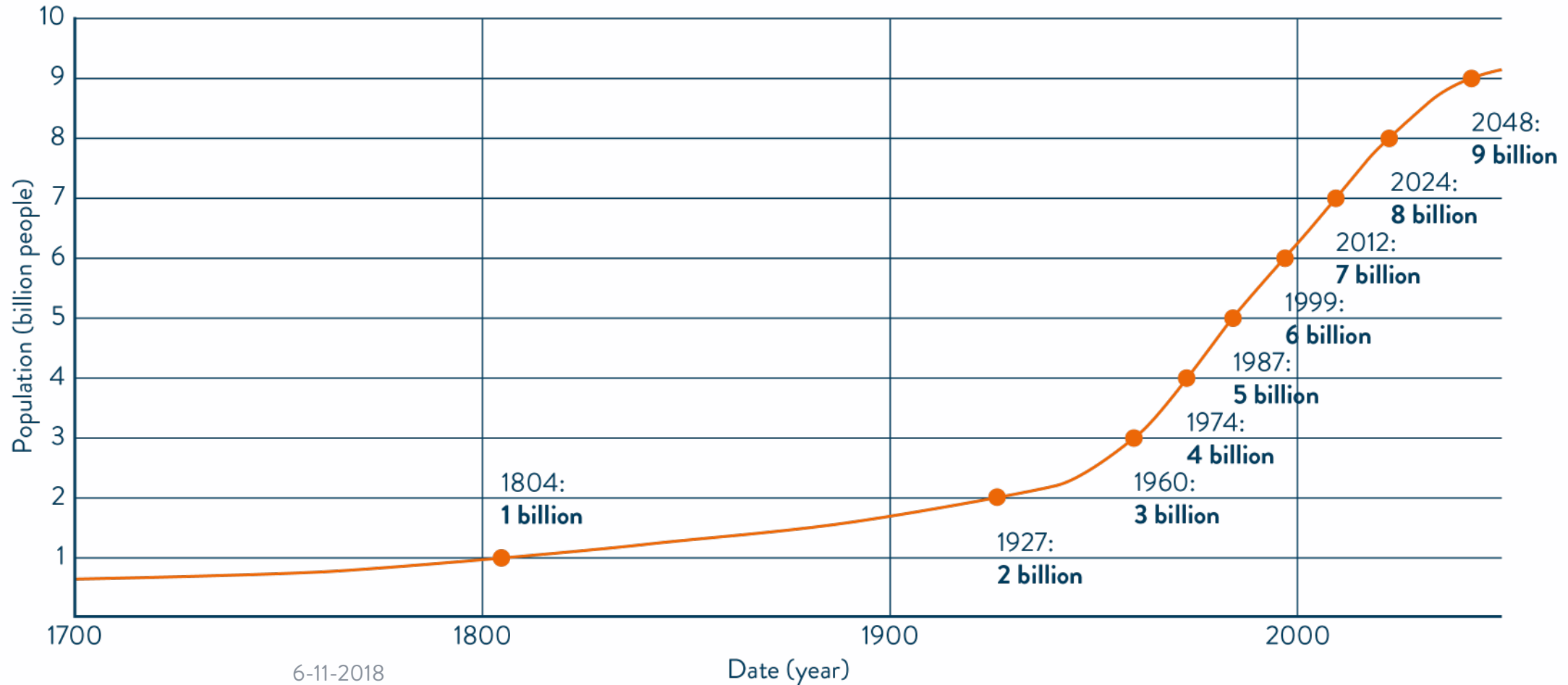
7,617,941,587 Current World Population

199,160,105 Energy used today (MWh), of which:

161,318,808 - from non-renewable sources (MWh)



Population growth





Urbanisation





Urbanisation



European offshore wind drivers



The need for energy

Electrification



6-11-2018



Why renewable policy?



**YOU'RE
ALL A
BUNCH OF
TREE-
HUGGING
HIPPIES!**



National anxiety





We talk!





Targets are set and then?





Aruba





The Aruba case



- Caribbean island
- 110 000 inhabitants



50% Cooling

12% Water desalination

38% Other



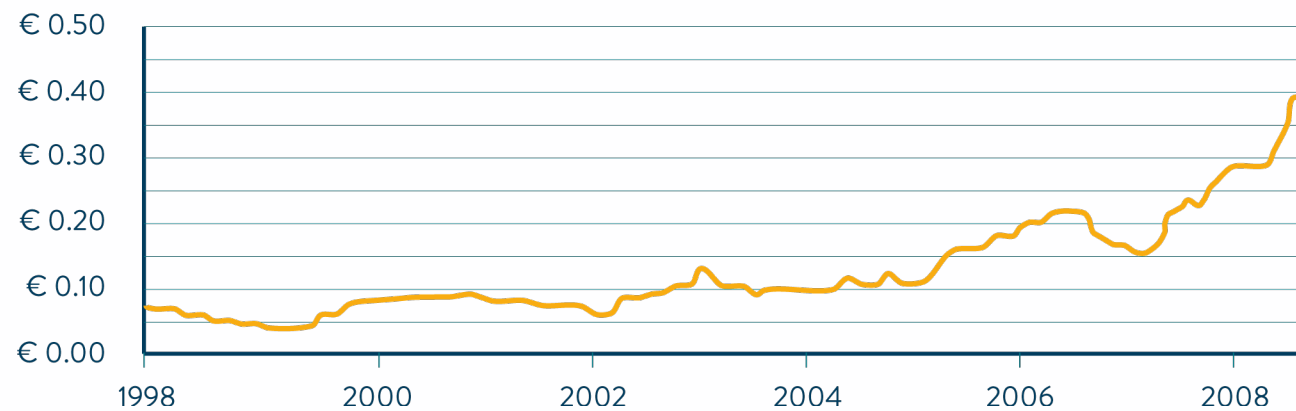
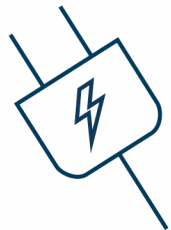
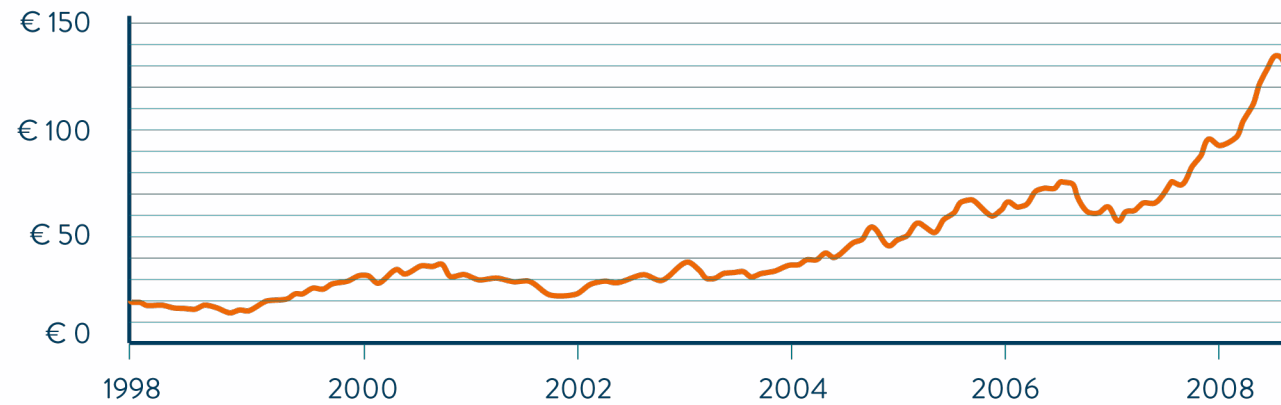
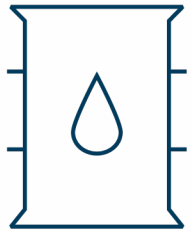
Generation



- Heavy fuel oil
- Cheap energy
- Life is good



Sextupling oil price





The situation in 2008

Aruba

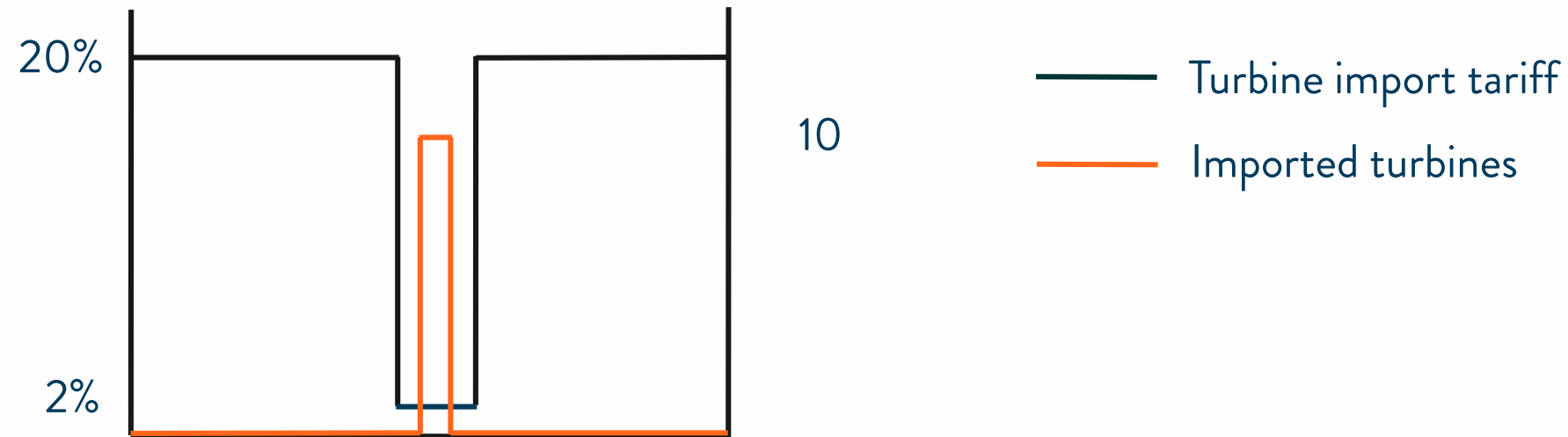


The Netherlands





Government response





Vader Piet farm



10 Turbines

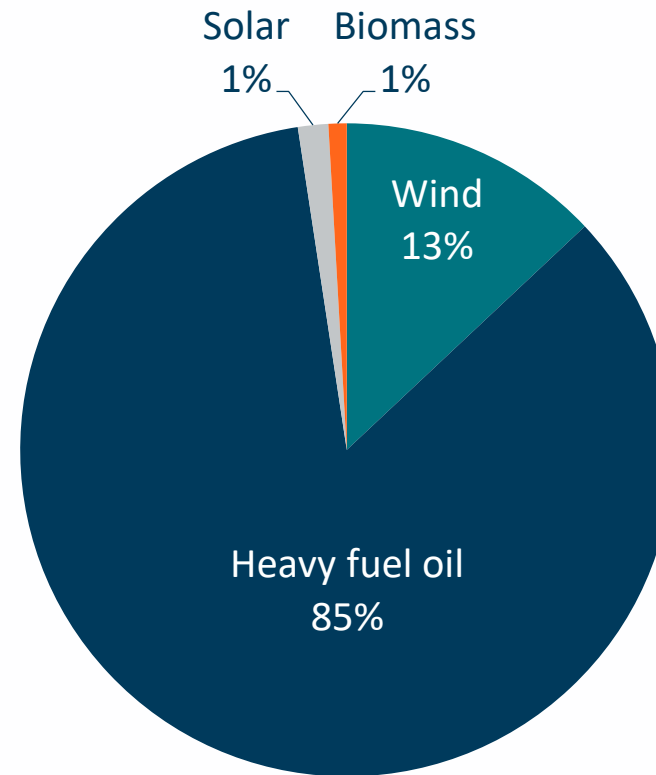
3 MW / Turbine



Two years after initial move

Energy price down by 20%

Globally fourth in wind energy!

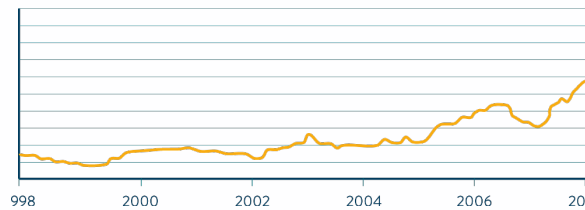
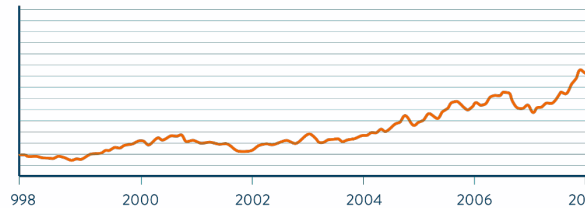




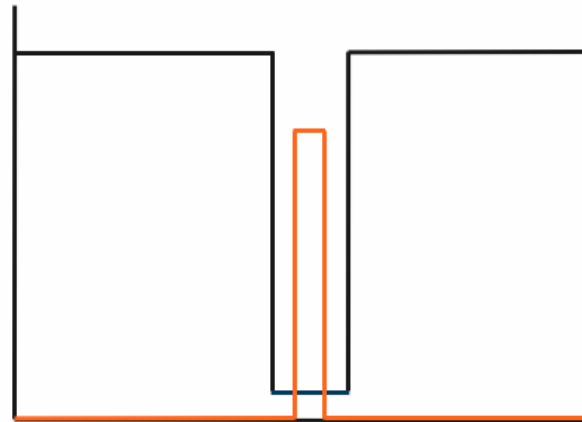
Aruba

Start: 2008

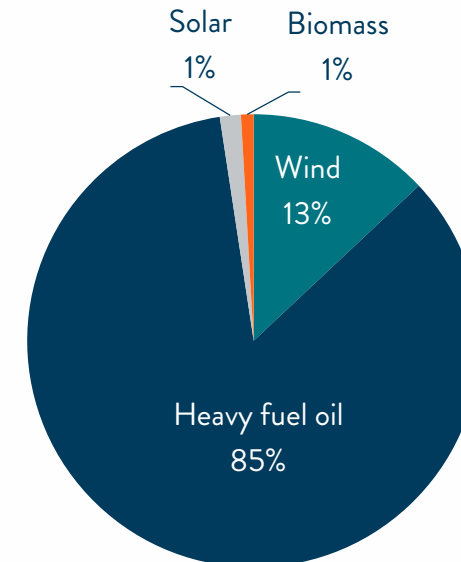
Total time: 2 years



1. urge



2. response



3. effect



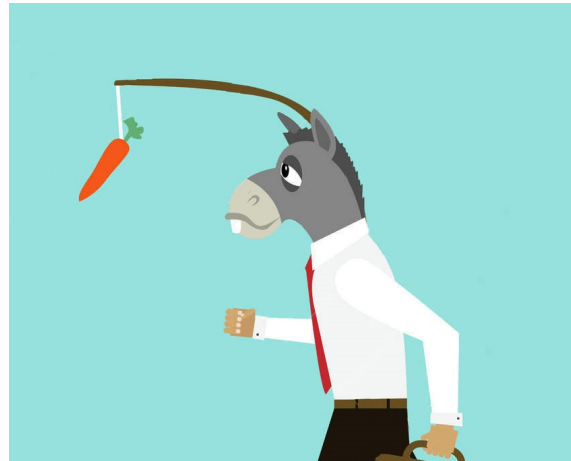
Denmark

Start: 1985

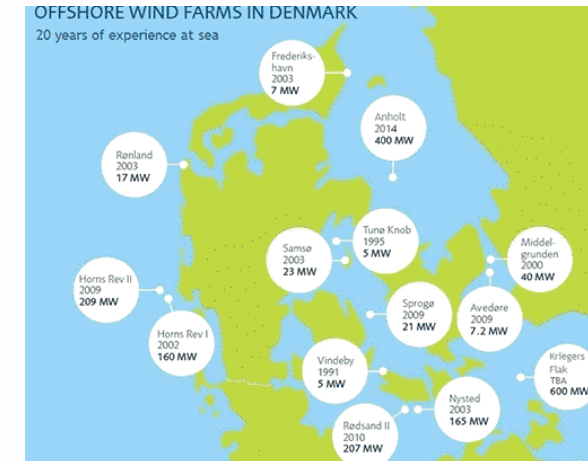
Total time: 30 years



oil crisis



feed-in-tariff



40% wind & 1st in the world



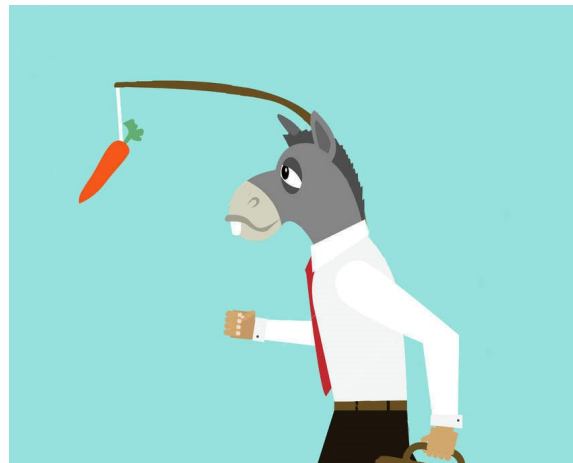
Germany

Start: 1995

Total time: 20 years



climate change & Fukushima



feed-in-tariff



35 GW installed

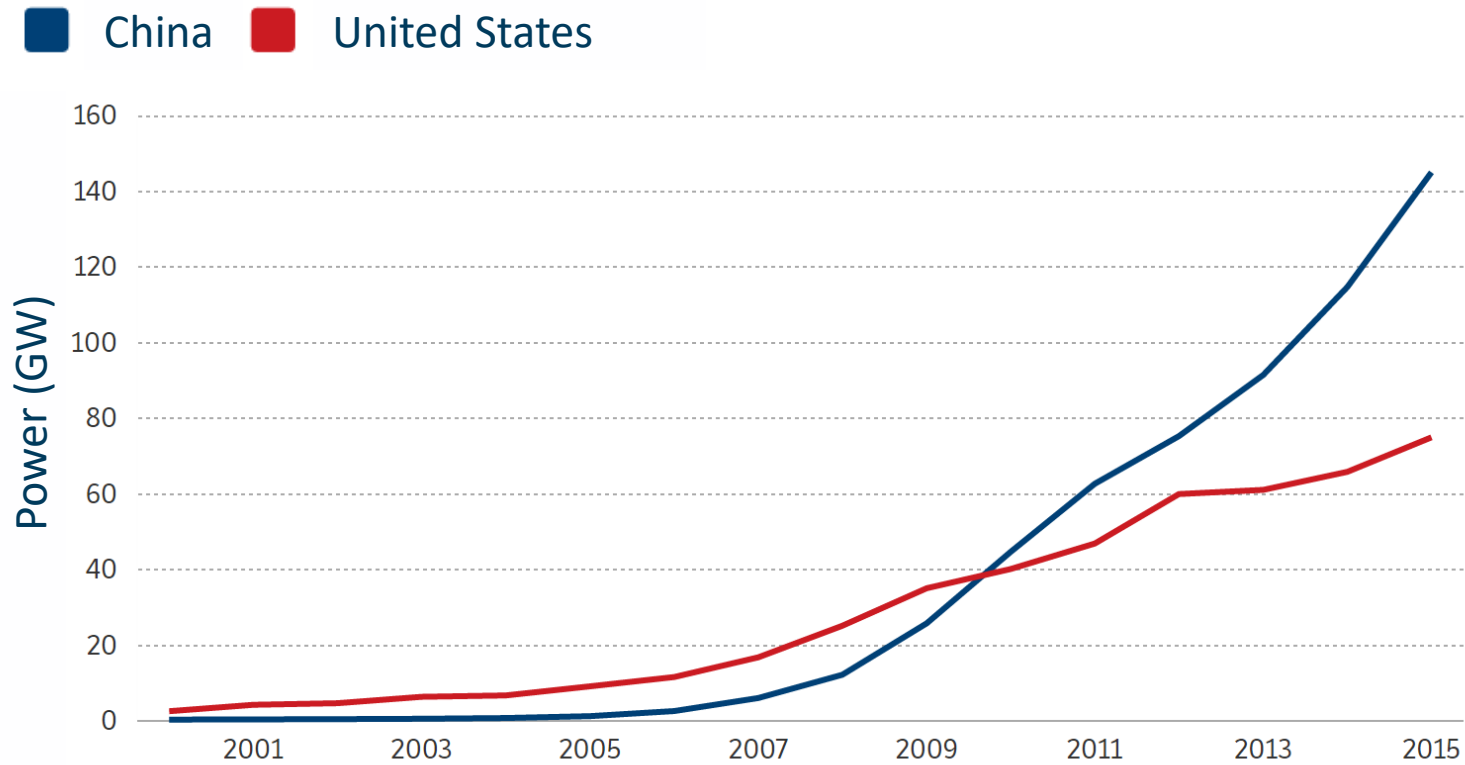


China





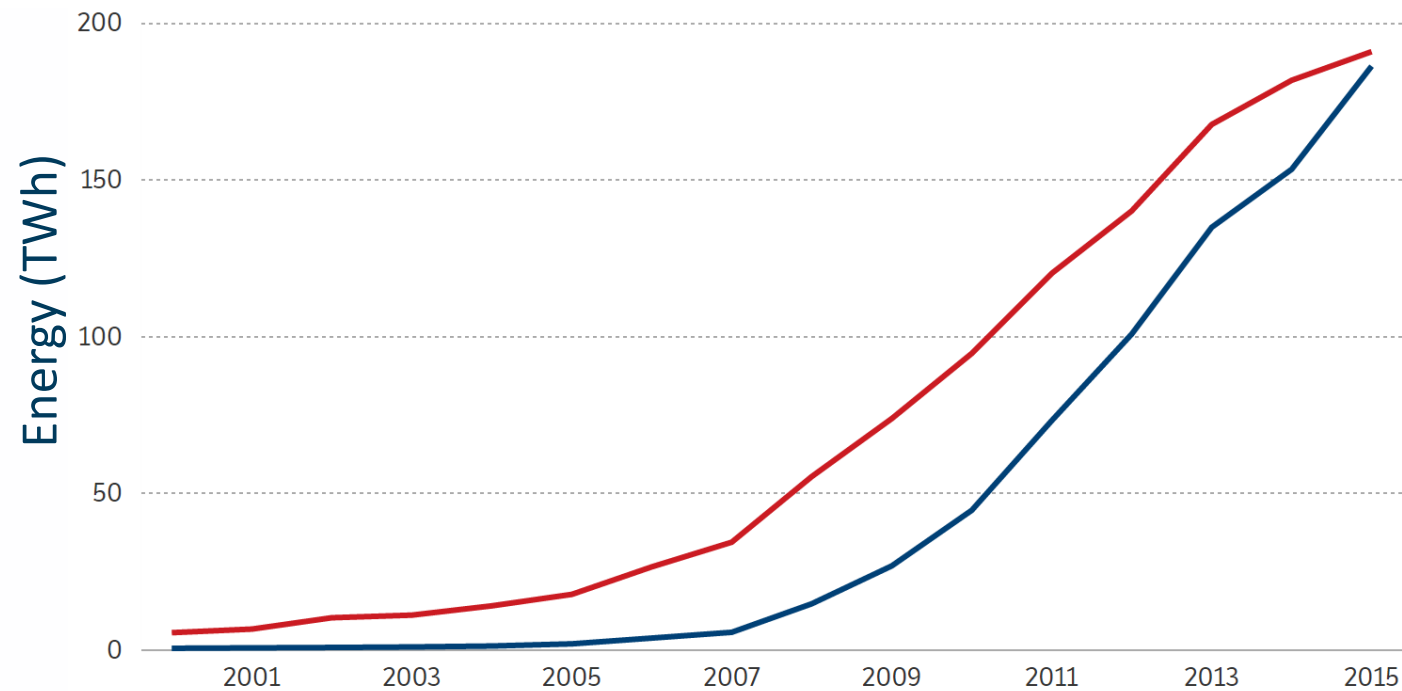
Total wind power





Total wind energy

■ China ■ United States





The Netherlands

Start: 1995

Total time: 20 years



climate change & oil crisis



changing policies



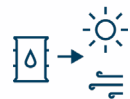
(only) 6,6 % wind energy



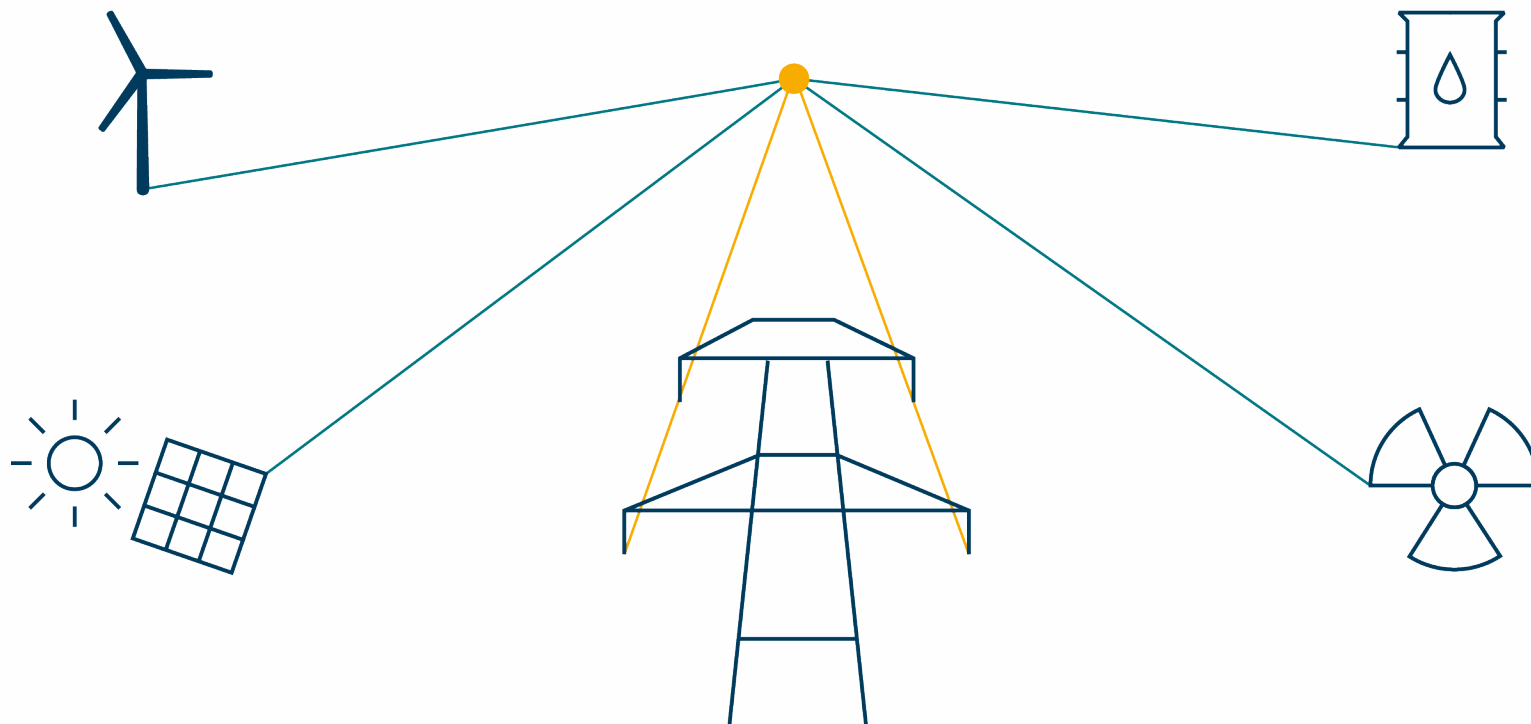
Dutch policy (2018)

- 2022
 - 50% less gas from Groningen
- 2030
 - CO2 reduction of 49% (aim)
 - No electricity from coal
 - No gas from Groningen
- 2050
 - CO2 reduction of 95% (target)



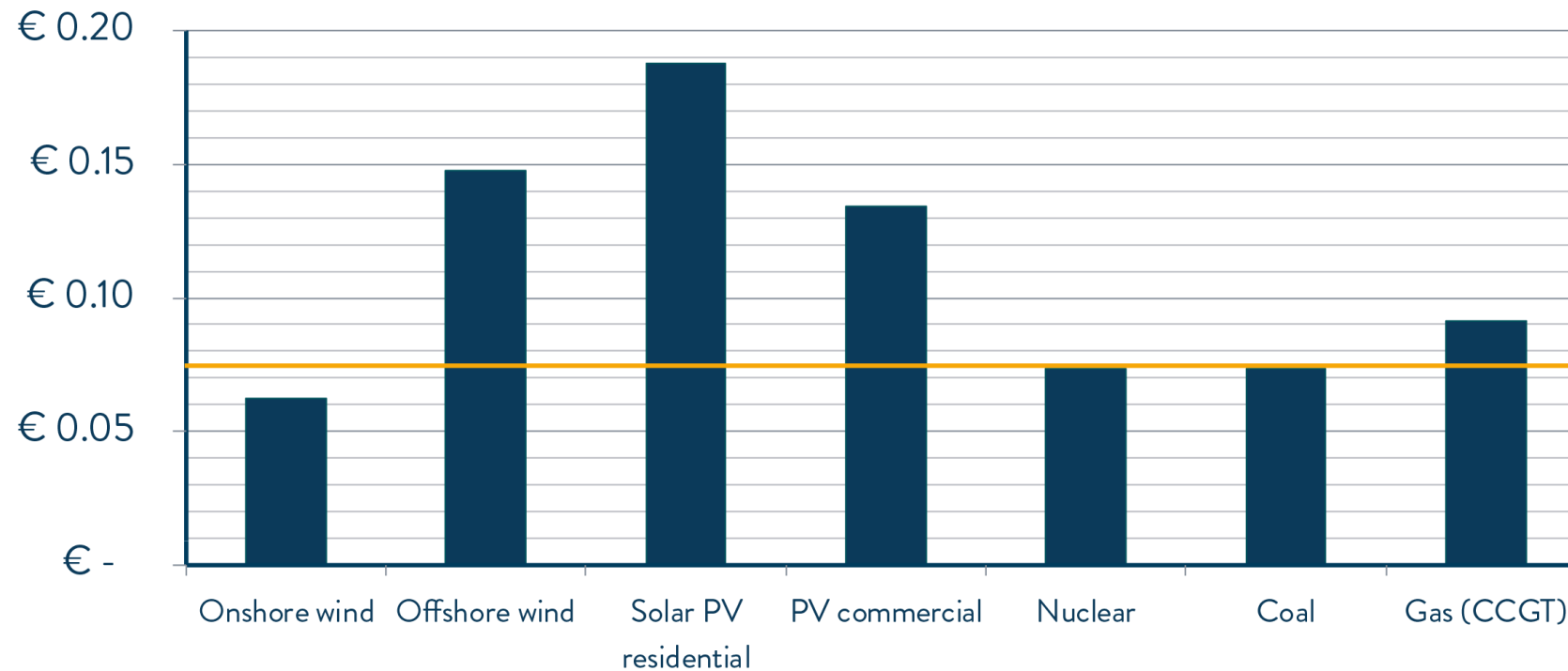


Energy mix





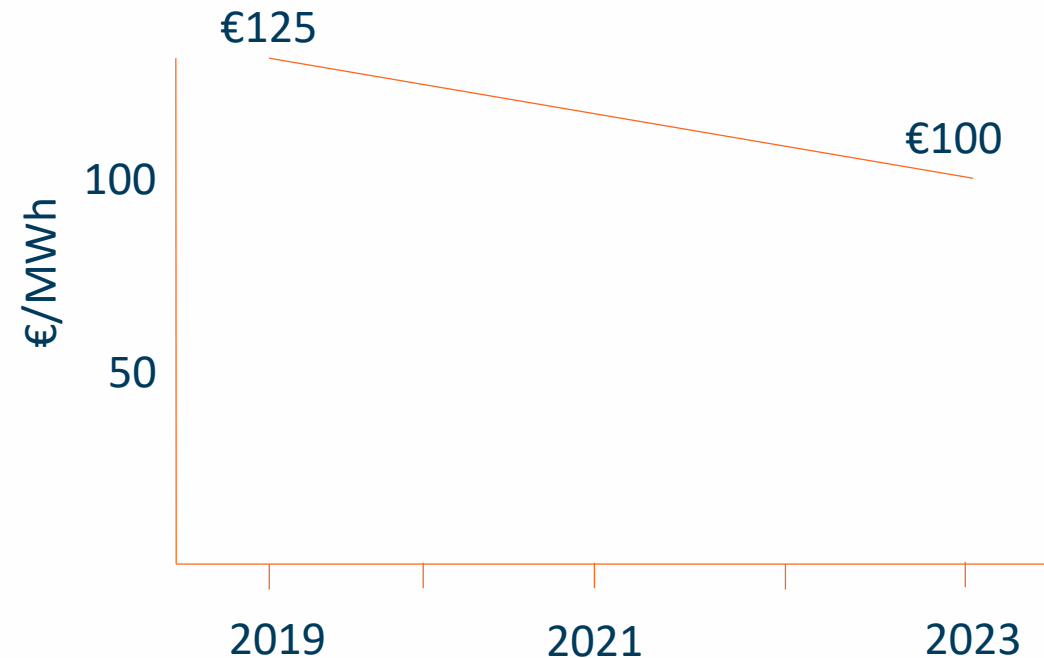
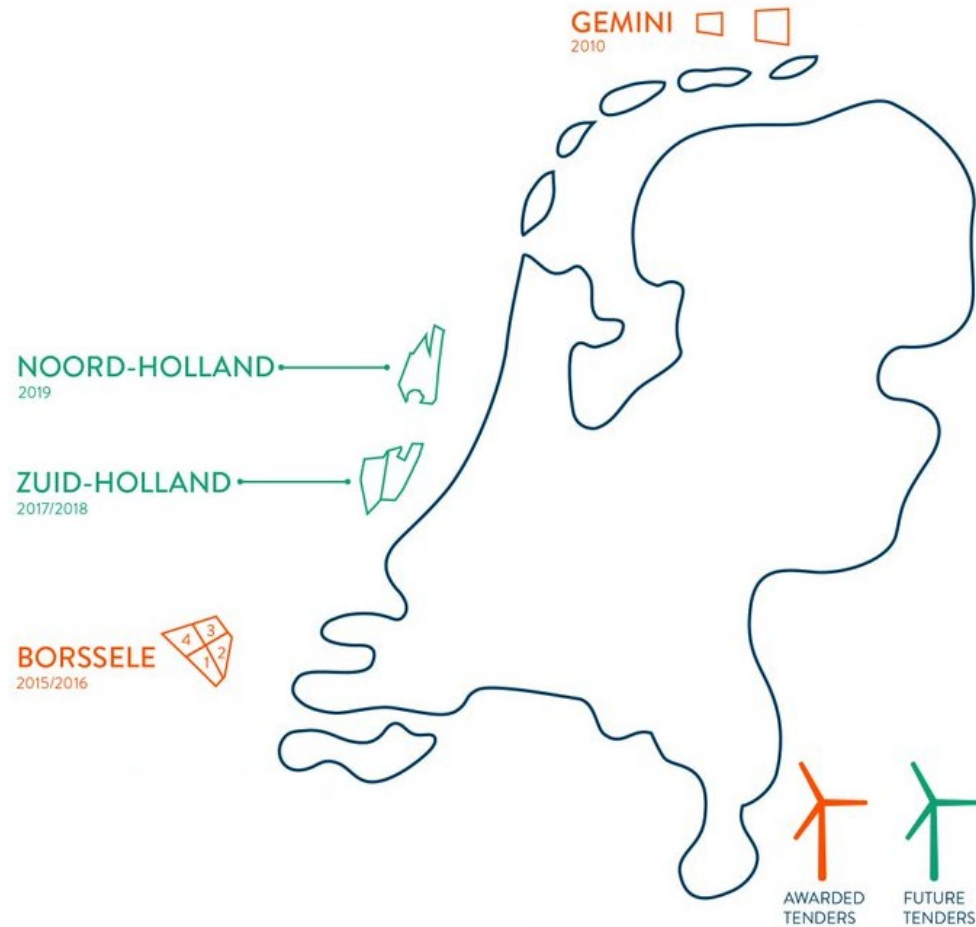
Current cost of energy (kWh)



50 % cost reduction!



Offshore wind - Tendering process





Offshore wind - Tendering process

5/2010: Gemini - Northland Power, Siemens, van Oord - 0,168 €/kWh

GEMINI
2010

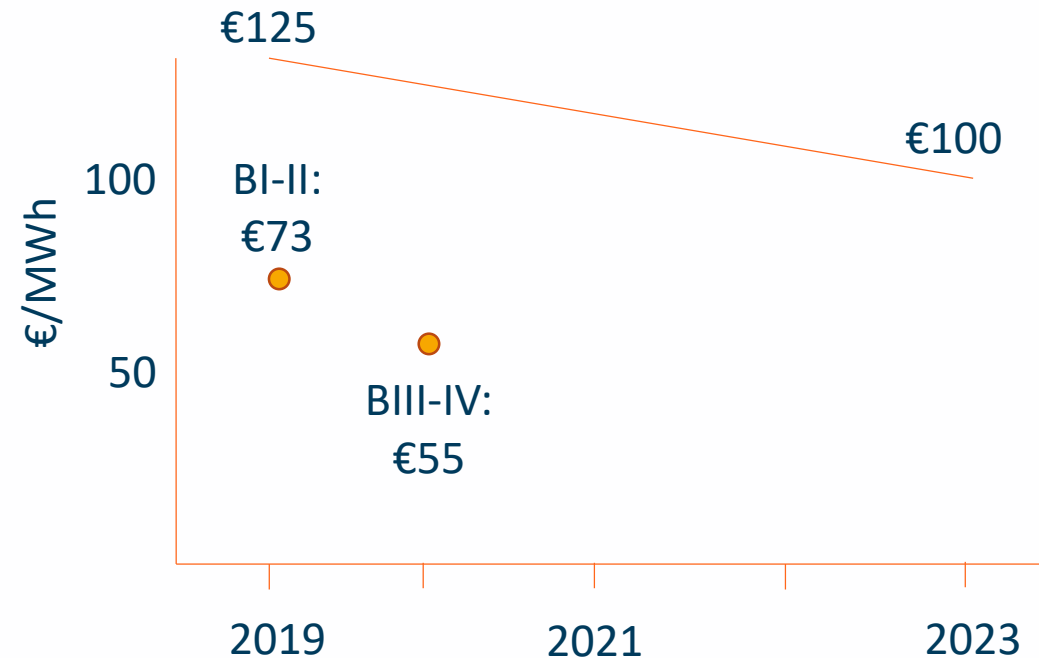
NOORD-HOLLAND
2019

ZUID-HOLLAND
2017/2018

BORSSELE
2015/2016

7/2016: Borssele 1&2 - Dong - 0,073 €/kWh

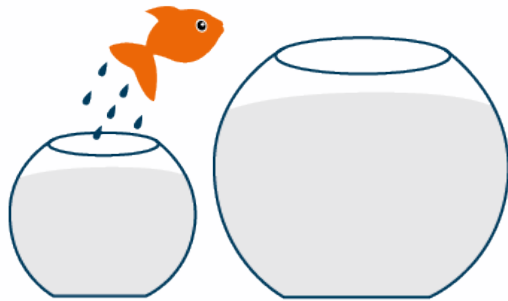
12/2016: Borssele 3&4 - Shell, van Oord, Eneco - 0,055 €/kWh





How can this be achieved?

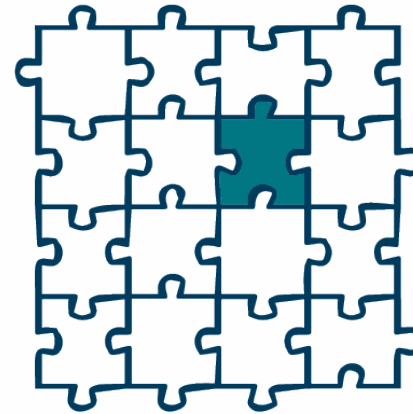
INNOVATION!



A bigger
market



Integrated
design



Standardized
solutions



Lower cost
of capital



DE OUDE
BIBLIOTHEEK
ACADEMY

