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*Energy for the Future...*



Biomass

## Wind Power and CHP for Energy efficiency and balancing of fluctuating power

**Preben Maegaard,**

Director, Nordic Folkecenter for Renewable Energy  
President Emeritus, World Wind Energy Association  
Chairman, WCRE, World Council for Renewable Energy,



***Asian Institute of Technology, Feb. 2., 2013***

Folkecenter since 1974

had a crucial role:

- To inform
- To inspire
- To involve
- To demonstrate
- To test
- To transfer new technology





# PV at the Folkecenter





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Pan Stanford Series on Renewable Energy – Volume 2



Preben Maegaard  
Anna Krenz  
Wolfgang Palz

The Emergence of Wind Energy

# POWER for the World





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# • New Book



Distributed Renewable Energies for Off-Grid Communities. ISBN 978-0-12-397178-4, Trim 229mmx152mm

Spine 26.96

Energy/Engineering

## DISTRIBUTED RENEWABLE ENERGIES FOR OFF-GRID COMMUNITIES

Strategies and Technologies toward Achieving  
Sustainability in Energy Generation and Supply

Nasir El Bassam  
Preben Maegaard  
Marcia Lawton Schlichting

- Helps you to choose the optimal decentralized energy solutions to address your specific off-grid power supply challenges
- Includes coverage of wind, solar and biomass applications for both rural and urban communities
- Over 200 charts and diagrams, together with case studies and equations, provided as tools for concrete analysis

It is estimated that more than two billion people worldwide lack access to modern energy resources. Renewable energy has the potential to bring power to these many communities and individuals who function off the grid. *Distributed Renewable Energies for Off-Grid Communities* describes the latest advances in distributed and off-grid renewable energy technologies and offers strategies and guidelines for planning and implementation of sustainable, decentralized energy supply. Coverage includes wind, solar, geothermal, and biomass systems planning and integration, economic assessment models and the role of legislative structures.

### Related Titles

Sørensen, *Renewable Energy, Fourth Edition*, 978-0-12-375025-9  
Siwashani, *Smart Grid*, 978-0-12-388452-9  
Clark, *Sustainable Communities Design Handbook*, 978-1-85617-804-4



[www.elsevier.com](http://www.elsevier.com)

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El Bassam  
Maegaard  
Schlichting

DISTRIBUTED RENEWABLE ENERGIES  
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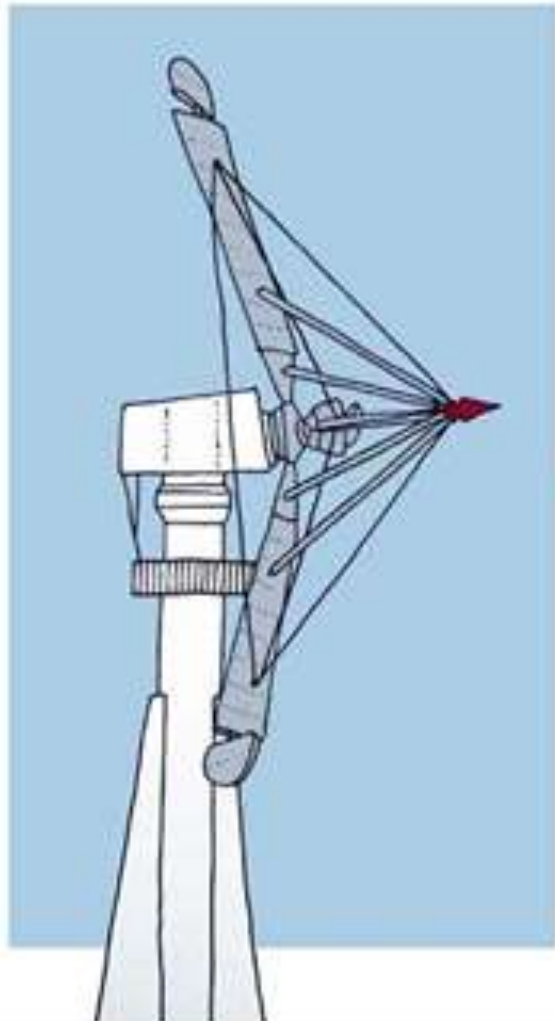
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New Book in 2013:

# The Emergence of Modern Wind Power



A hybrid of J. Juul's turbine with U. Hütter's blades is the **DANISH CONCEPT**



+



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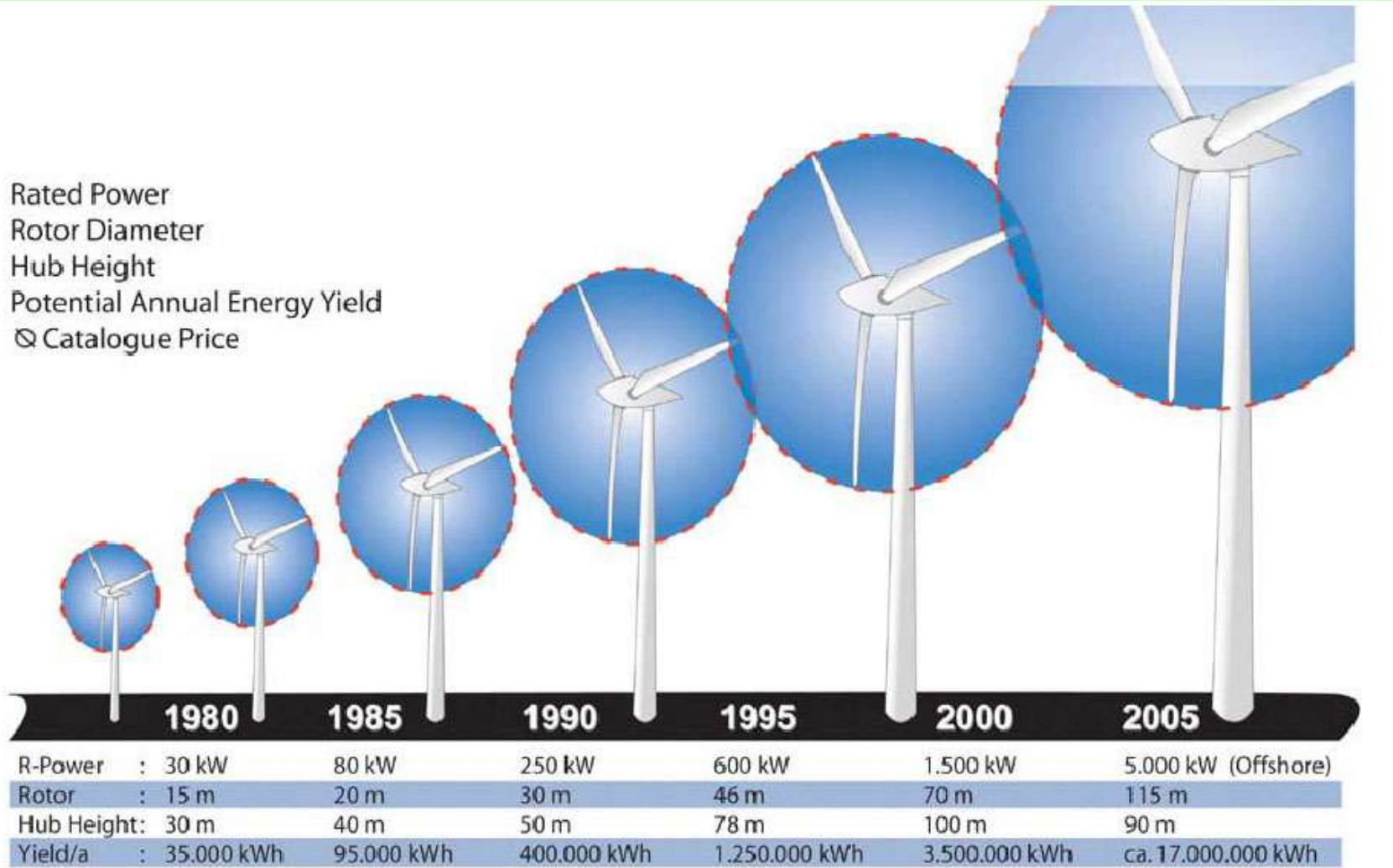


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# Development of Wind Energy Technology



Rated Power  
Rotor Diameter  
Hub Height  
Potential Annual Energy Yield  
☉ Catalogue Price





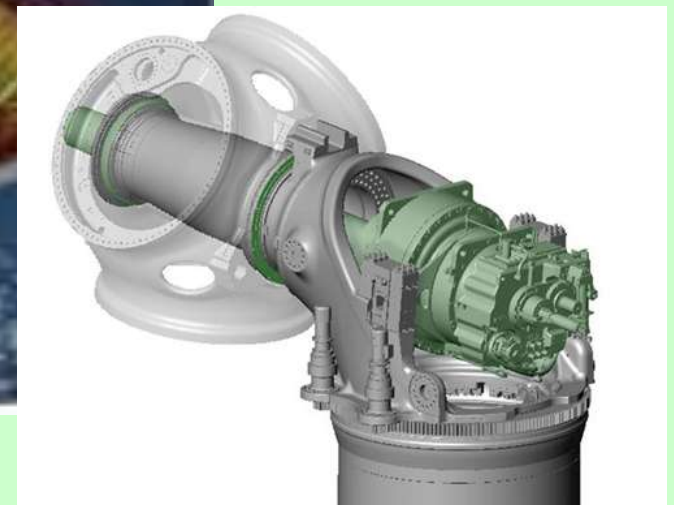
One 2 MW windmill:  
8 mio. kWh/y







# Alstom/Ecoténica 5 MW





# Local Production, Sri Lanka, 2013





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# Wind Power by Country, ultimo 2011



Country	Total Capacity end of 2011 [MW]	Added Capacity 2011 [MW]	Total Capacity end 2010 [MW]	Added Capacity 2010 [MW]	Total Capacity end 2009 [MW]
China *	62.733	18.000	44.733	18.928	25.810
USA	46.919	6.810	40.180	5.600	35.159
Germany	29.075	2.007	27.215	1.551	25.777
Spain	21.673	1.050	20.676	1.515	18.865
India *	15.800	2.700	13.065	1.258	11.807
Italy *	6.747	950	5.797	950	4.850
France	6.640	980	5.660	1.086	4.574
United Kingdom	6.018	730	5.203	962	4.245
Canada	5.265	1.267	4.008	690	3.319
Portugal *	4.290	588	3.702	345	3.357
Denmark	3.927	180	3.803	309	3.460
Sweden	2.816	746	2.052	603	1.450
Japan	2.501	167	2.334	251	2.083
Rest of the World*	24.200	6.000	18.201	3.191	15.010
<b>Total*</b>	<b>238.604</b>	<b>42.175</b>	<b>196.629</b>	<b>37.642</b>	<b>159.766</b>

\*- Preliminary Data

© WWEA 2012

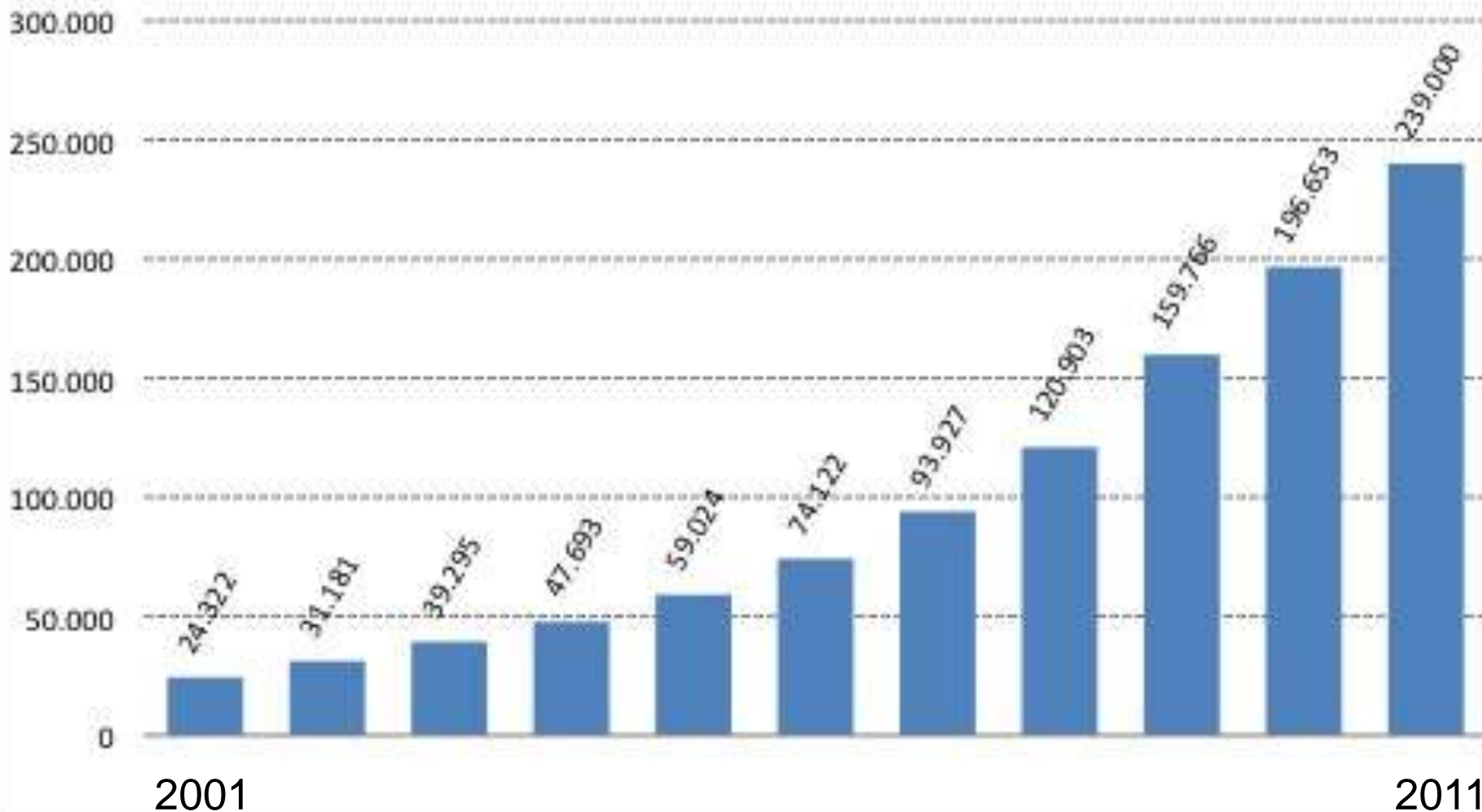


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# Wind Power, World Total 2001 til 2011



## World Total Installed Capacity [MW]

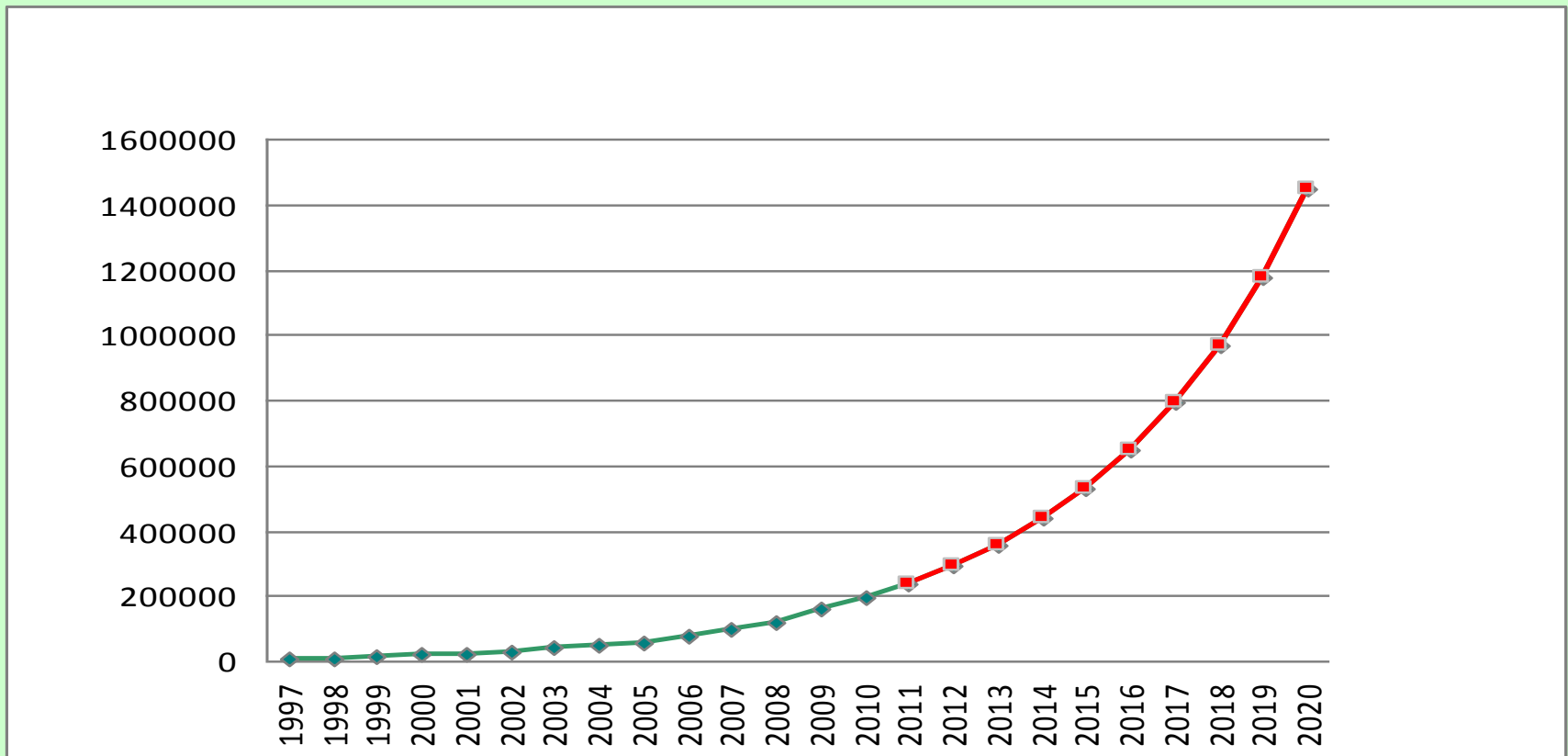




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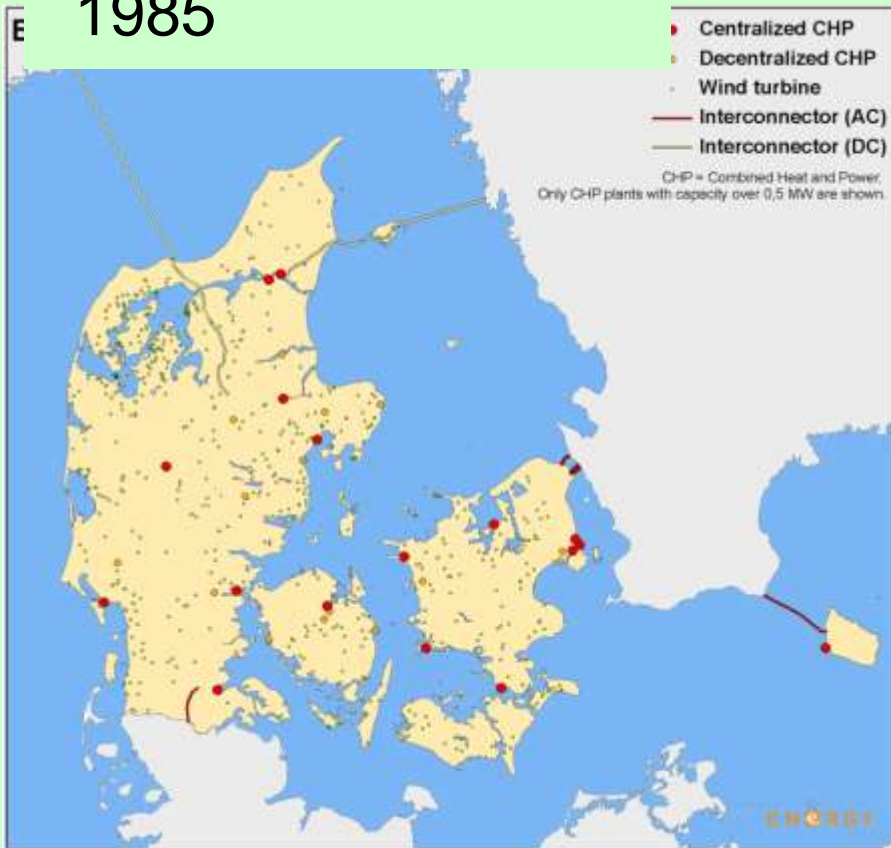
## Total Installed Wind Capacity 1997 – 2010 [MW] and Forecast of Wind Energy Installation Worldwide up to 2020



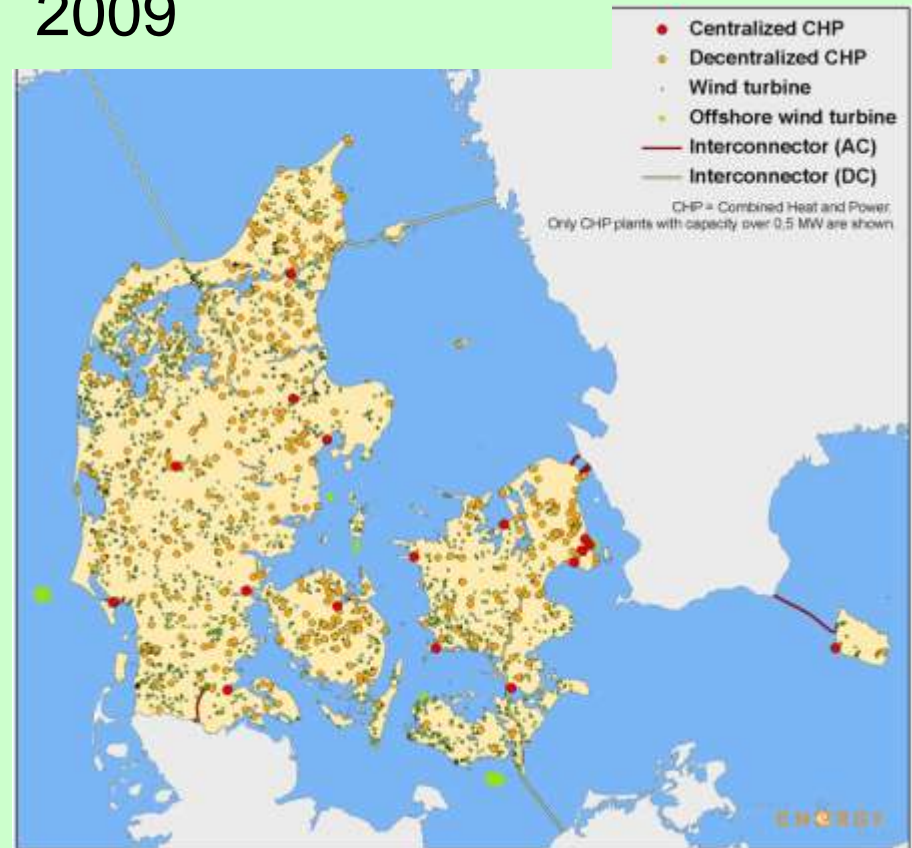
# Denmark's Energy Infrastructure 1985 and 2009



1985



2009

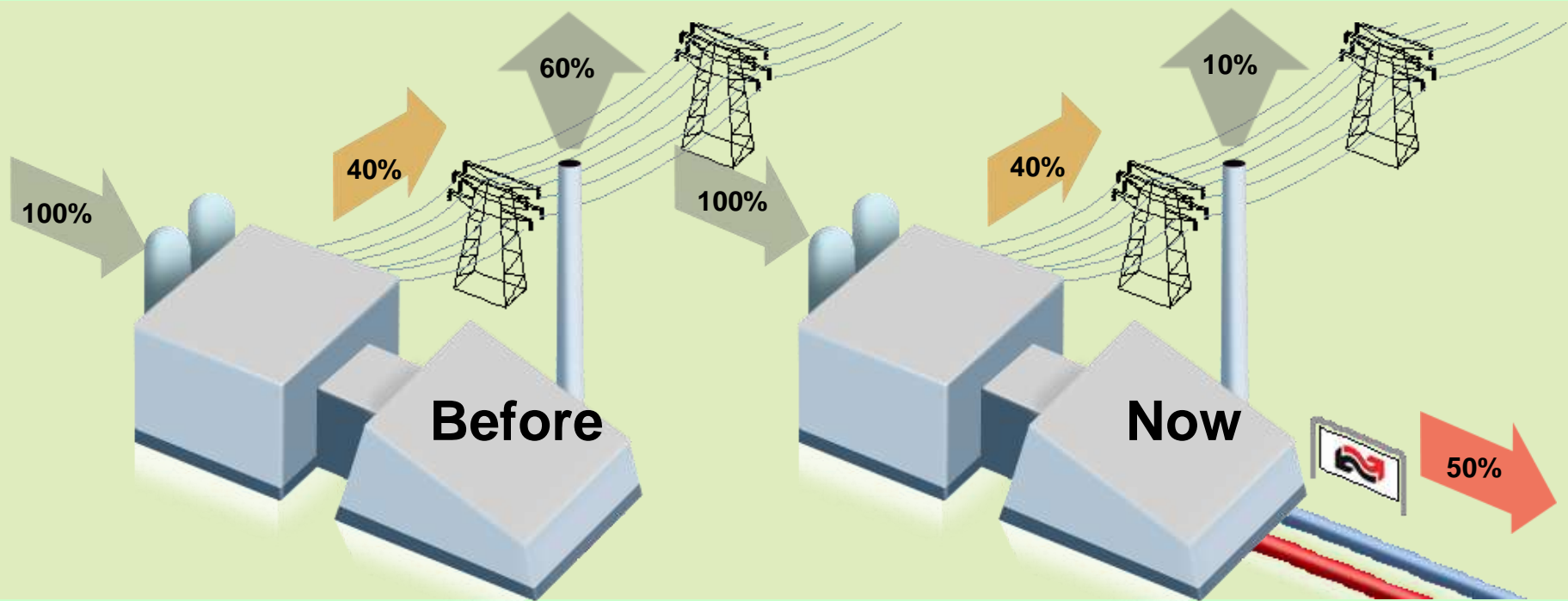




# CHP: Two Times more efficient!



**District Heating and CHP is the single most important improvement of energy efficiency**



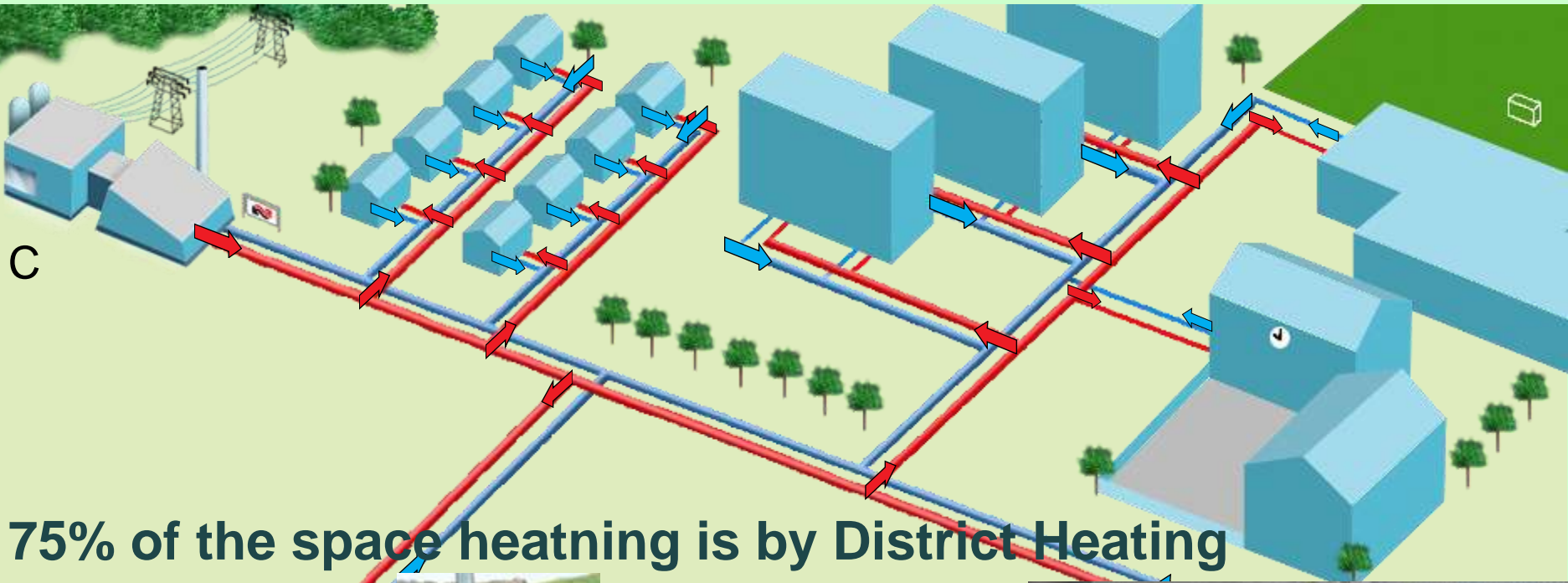
Conventional Power Plant

Combined Heating/Cooling & Power

# When the Cooling Towers are the Radiators in People,s Houses



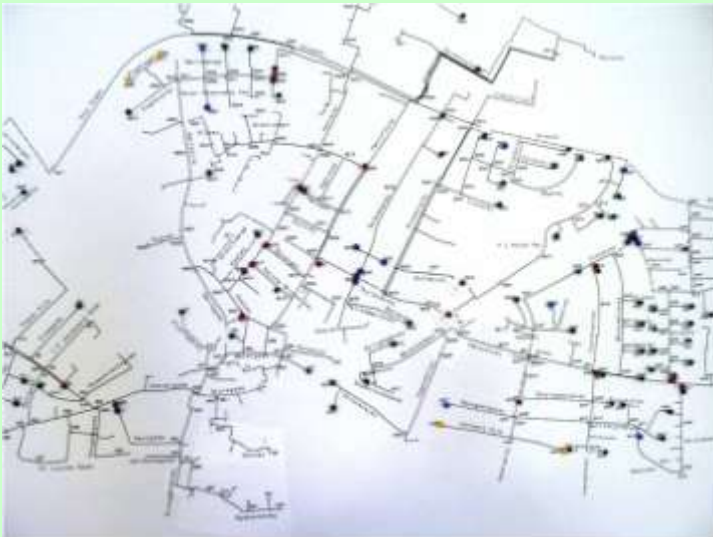
60.000 km pipelines for heating and cooling in Denmark







# Thyra supplies 10.000 households with heat and some power





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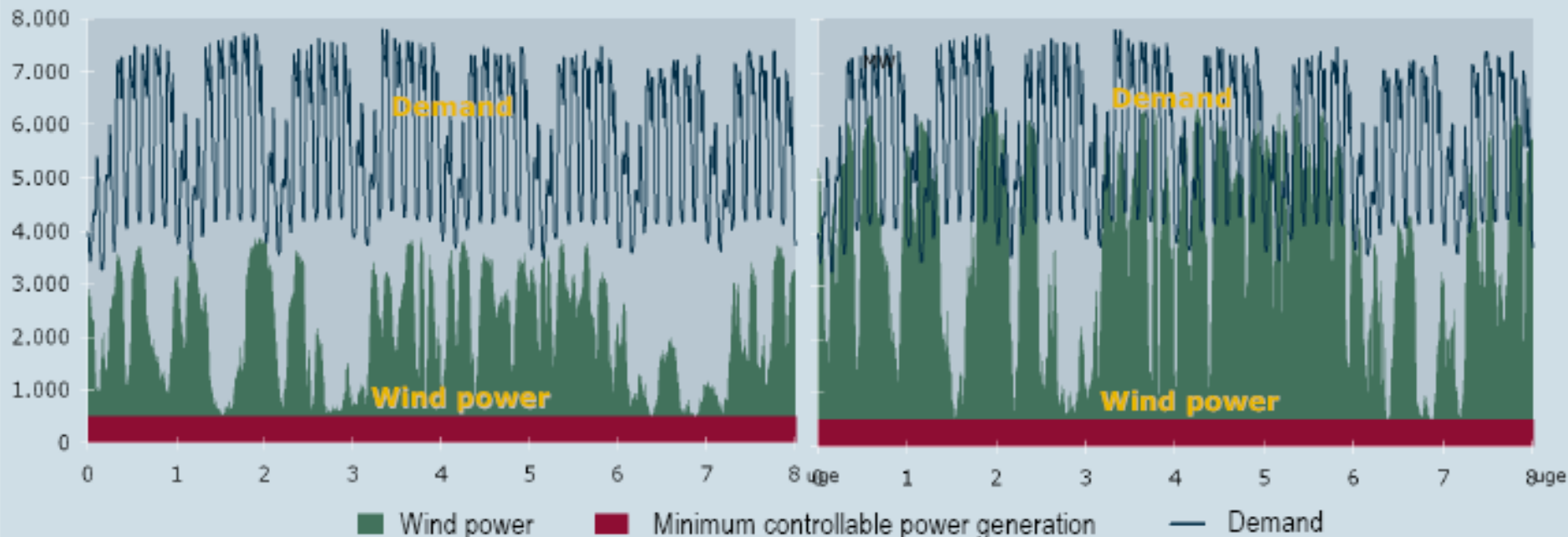
**Consumption of power is  
predictable –**

**Wind- and solar power  
fluctuates**

## Integration of additional 3,000 MW Wind power?

First 8 weeks of 2007

To day + 3.000 MW



Denmark must utilize **domestic resources** and **trade with neighbors**.

Security of supply must be maintained and the value of Wind power should be maximized ecological and economical



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# Denmark, Sep 7, 15.00, 2011



Målt i MW:	
Centrale kraftværker	948
Decentrale kraftværker	522
Vindmøller	3.266
Nettoudveksling import	92
Elforbrug	4.829
CO2 udledning	166 g/kWh



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# New Government: 50% from the Wind by 2020

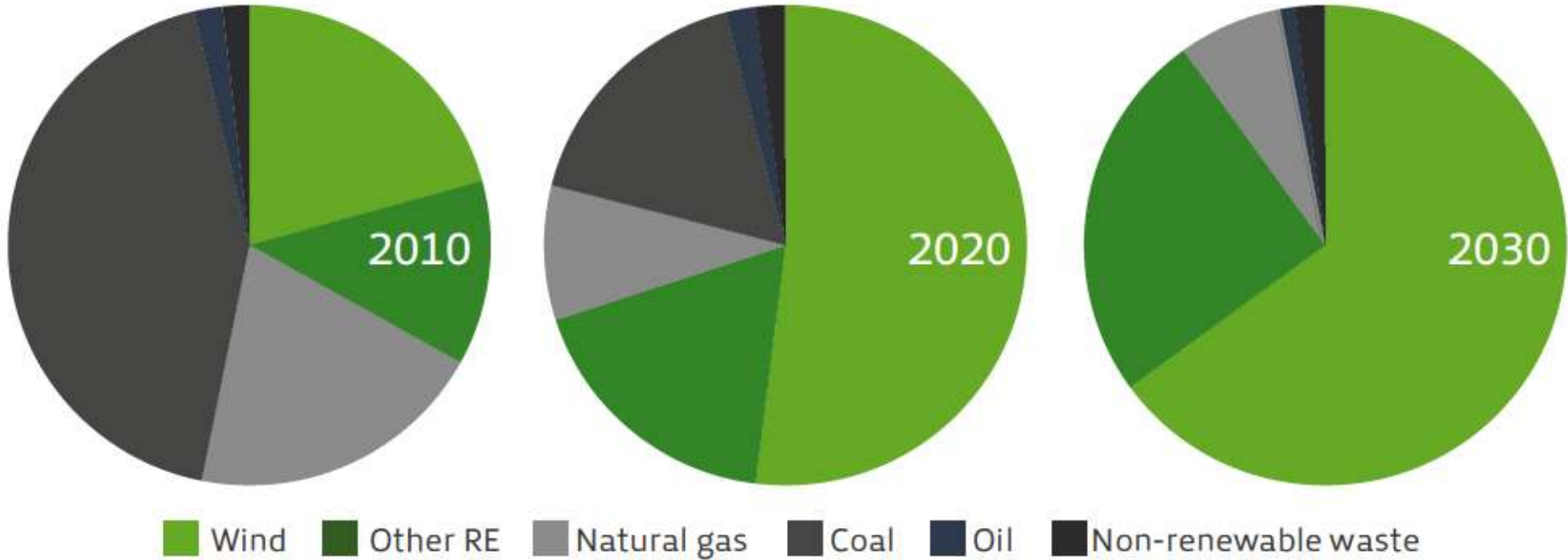
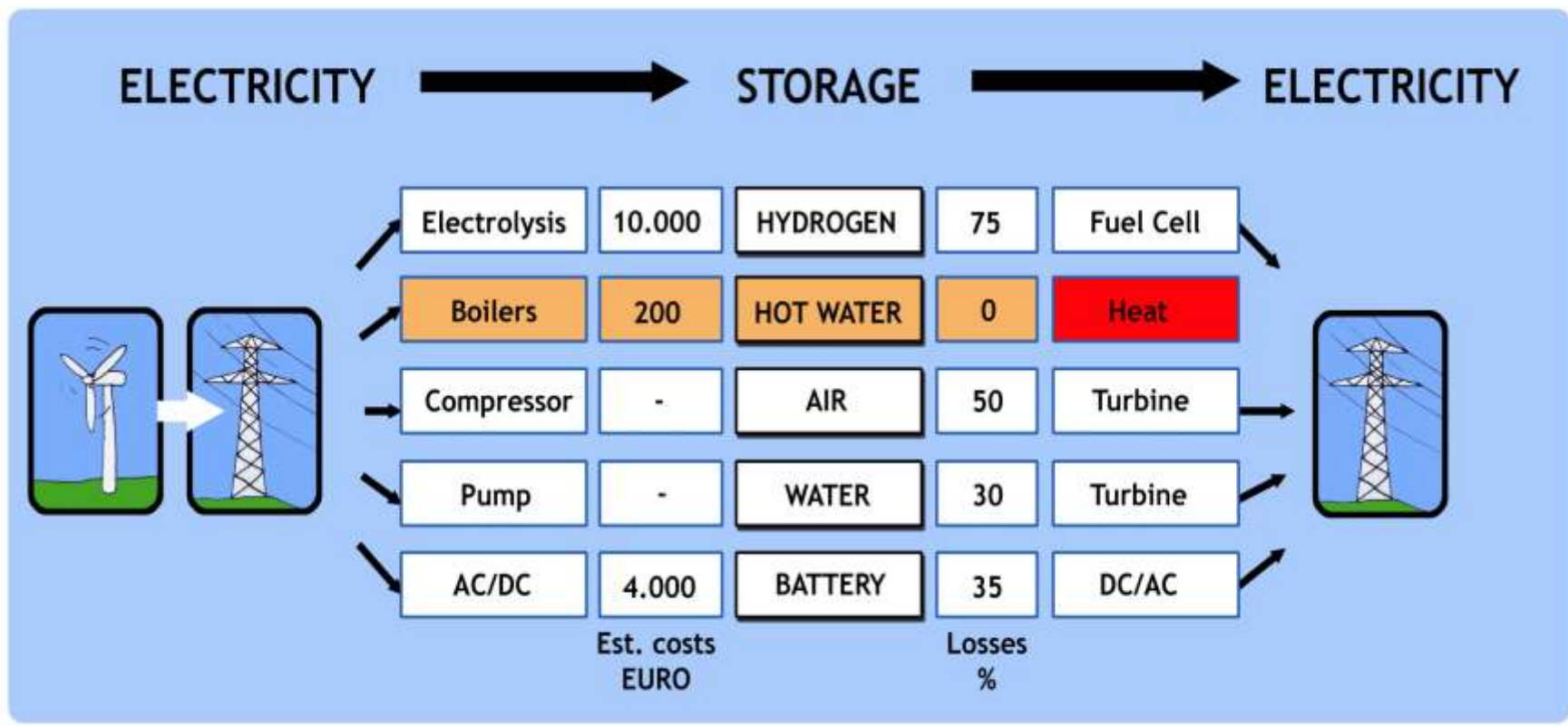


Figure 3.2 Electricity production by energy source (adjusted for electricity trading)

## Energy key figures for 2011

Denmark	
Wind share of net generation in area	29.4 %
Wind share of consumption in area	28.3 %
RE-share of net generation in area	41.1 %
<b>Electricity accounts for the grid</b>	<b>GWh</b>
Electricity generation ex facility (Gross including own consumption)	35,040
Electricity generation ex facility (net including own consumption)	33,210
Imports, gross	11,728
Exports, gross	10,410
Grid loss in transmission grid	934
Sale to distribution	33,594
<b>Specification of electricity generation</b>	<b>GWh</b>
Electricity from wind turbines	9,765
Electricity from hydropower and photovoltaics	18
Electricity from thermal production on RE-fuels	3,851
Electricity from thermal production on non-RE-fuels	19,577

# Wind Heat and Power, WHP





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# NEXT STEP

Integrating wind and CHP



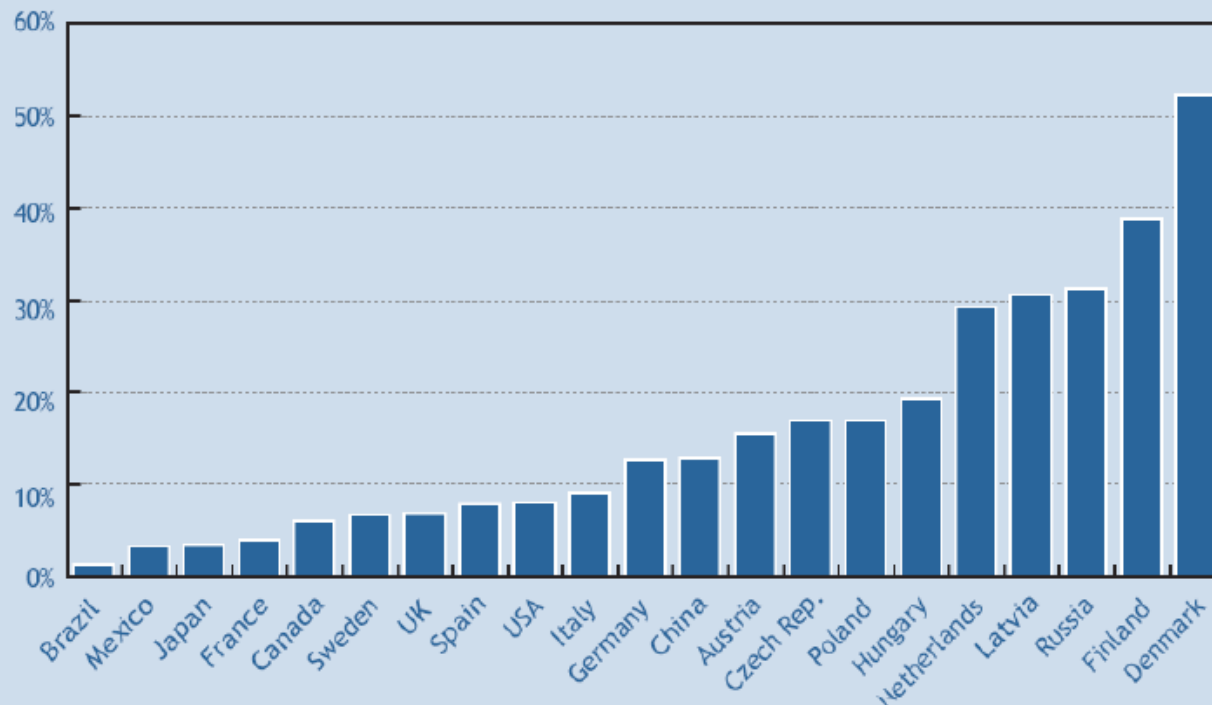


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# CHP in Selected Countries



## CHP as a Share of Total National Power Generation



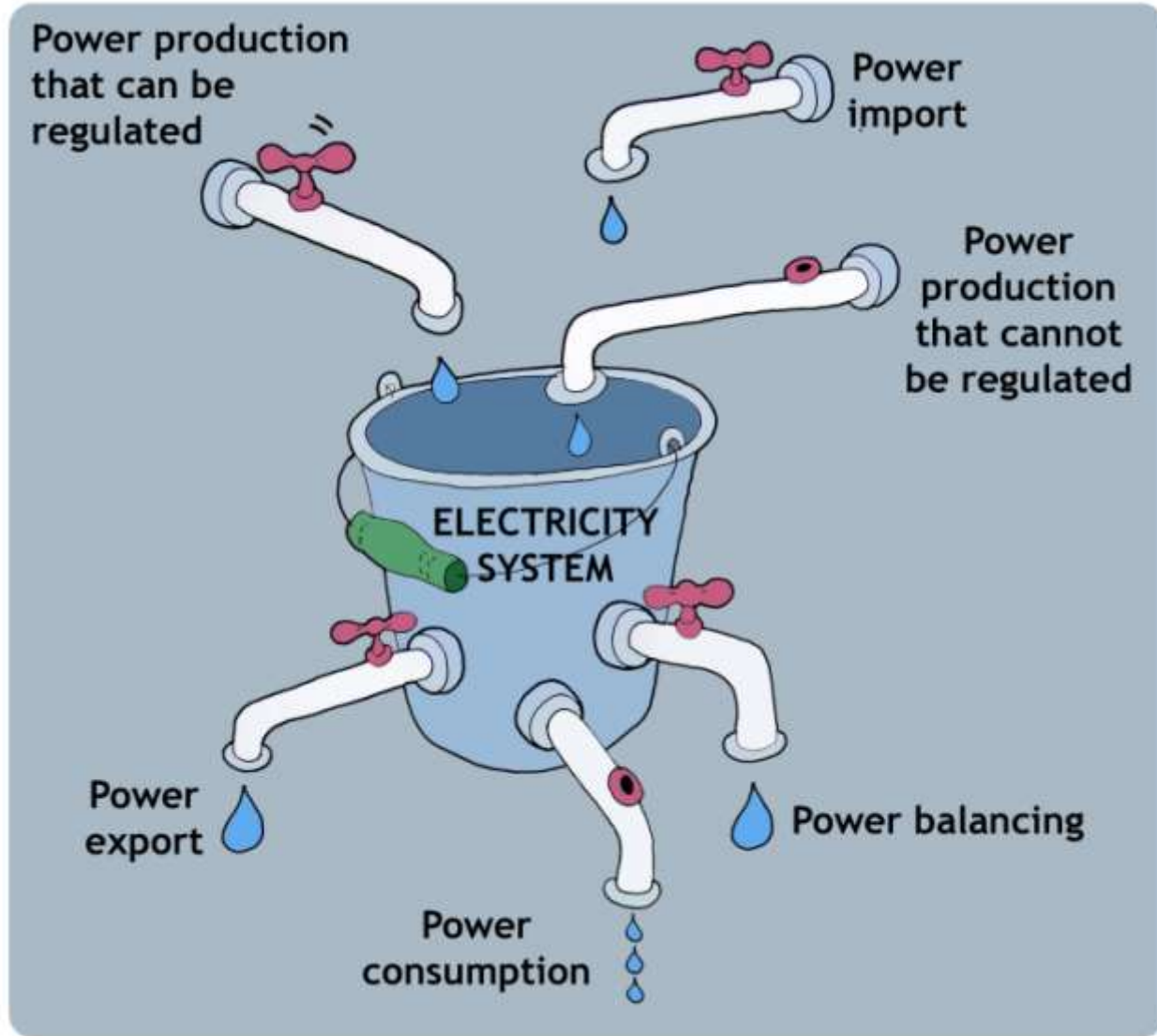
Source: IEA, *CHP: Evaluating the Benefits of Greater Global Investment* (2008).

**Average use of CHP is just 9%**



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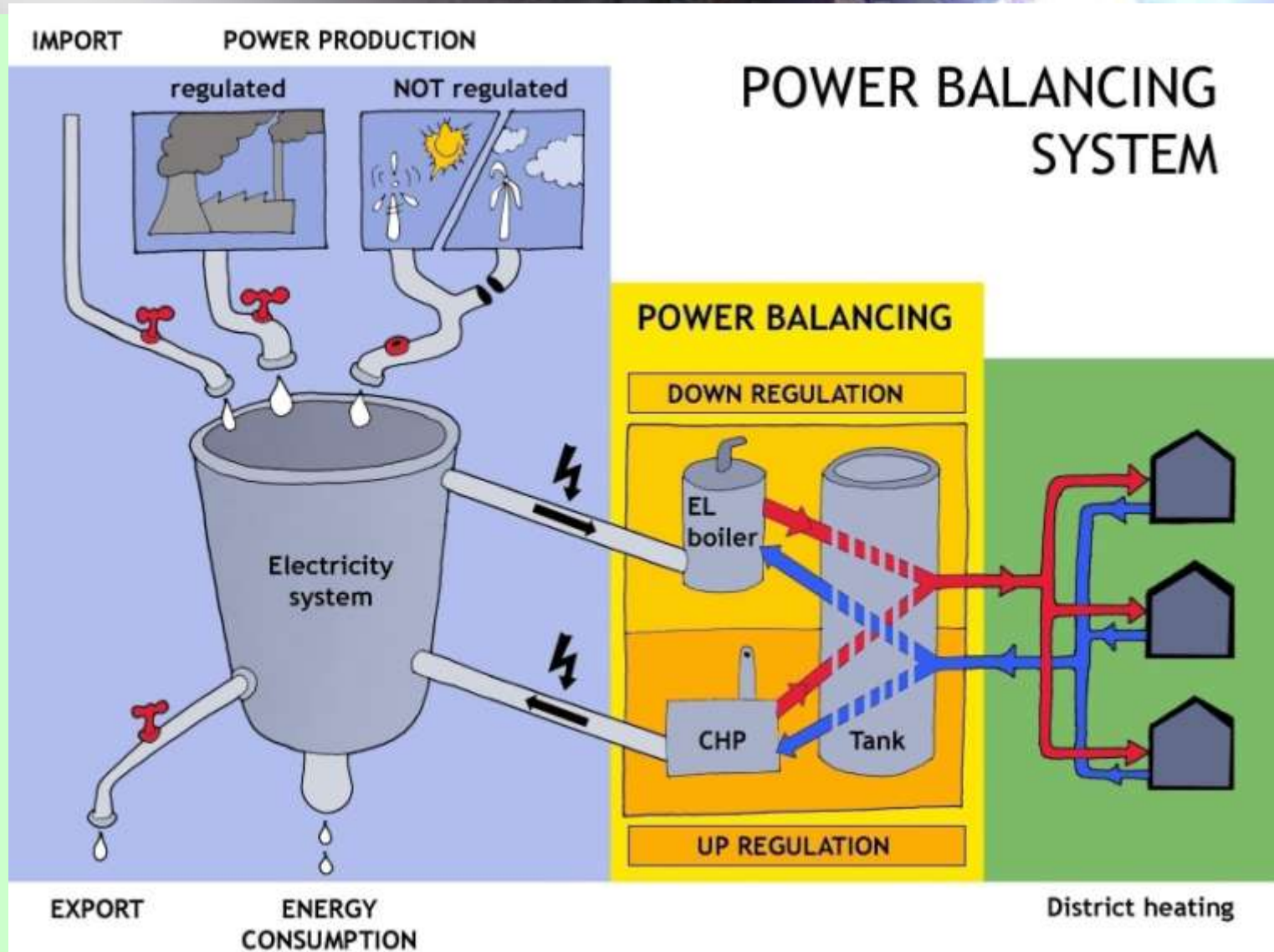
# The Need for Power Balancing





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# Power balancing must happen in the communities



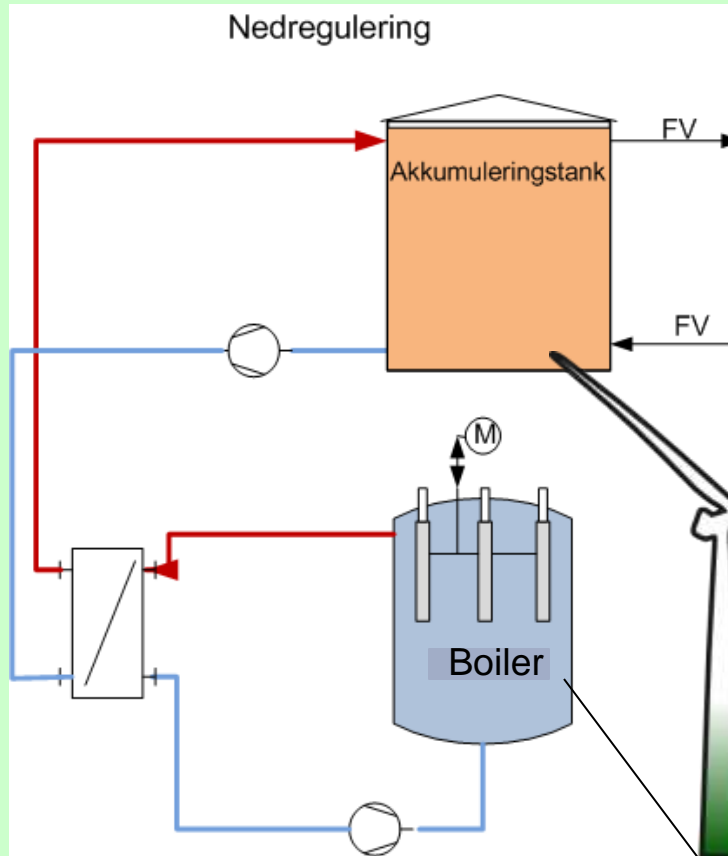


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# Basic down-regulating technologies



## Hot water storage



20 MW electric boiler





Vorupör, 1,8 MW<sub>el</sub>, 800 Inhabitants





# Faaborg, 7 Mw<sub>el</sub>, 7.000 Inhabitants



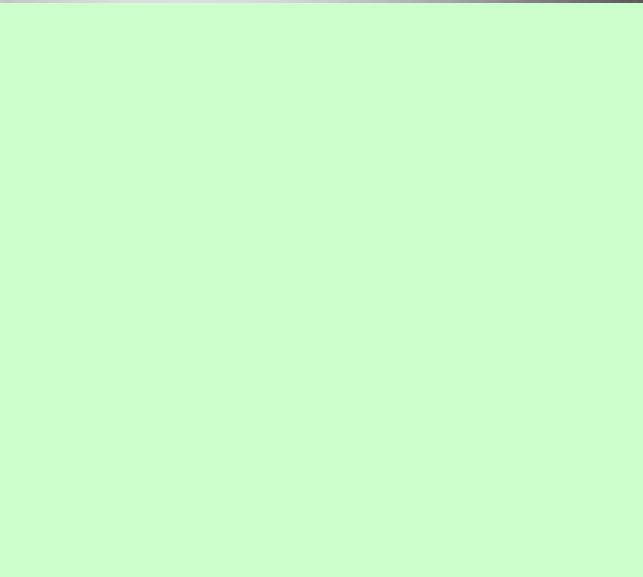


# Wind Power for Heating in Hanstholm





# 6 MW Electric Boiler in Snedsted

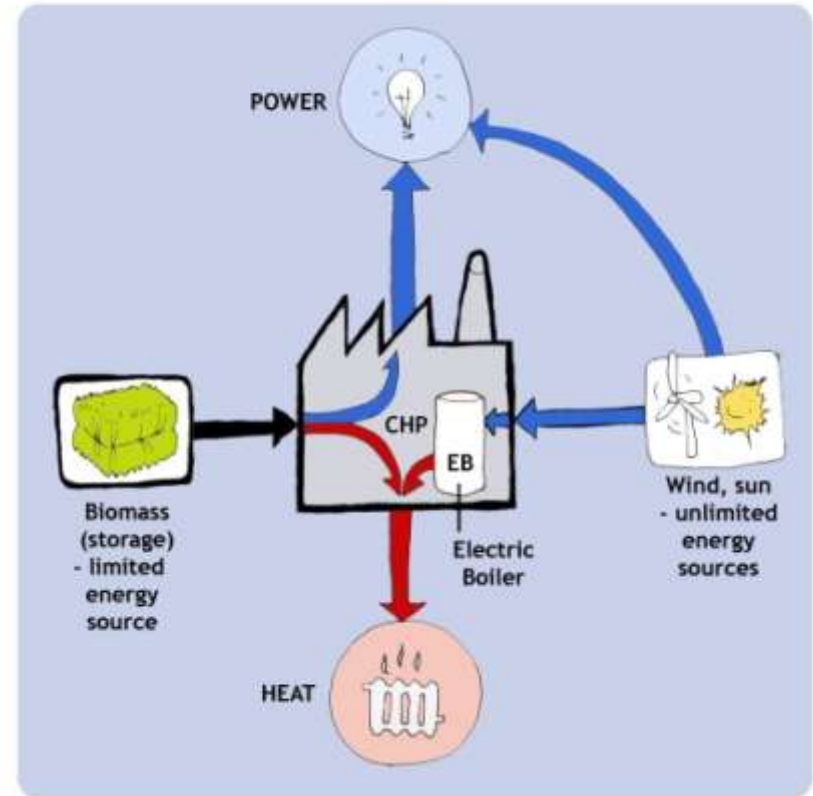
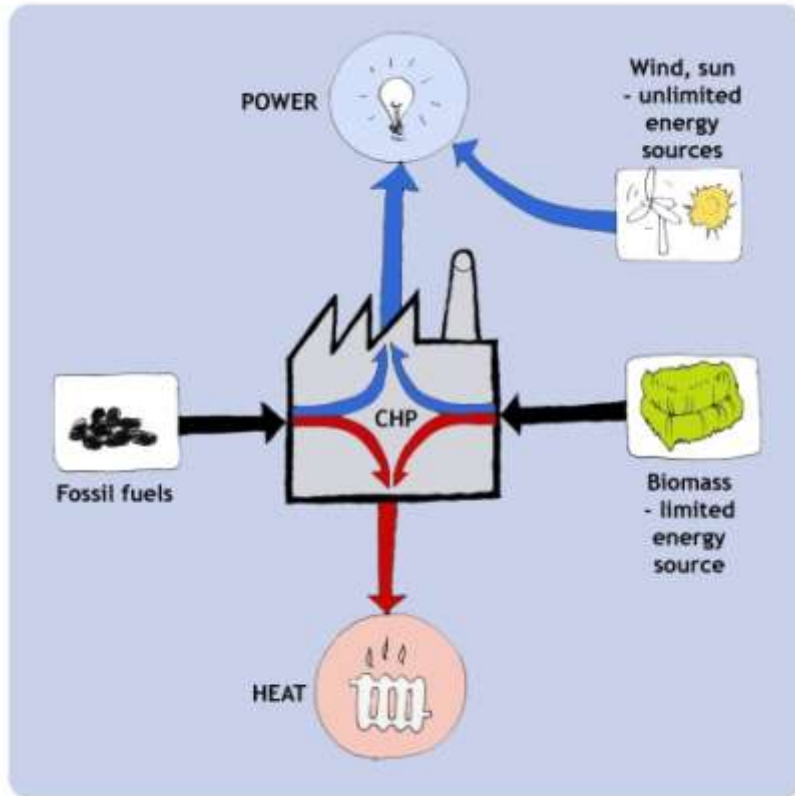






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# Replacement of Fossil Fuels by stored Biomass





# The Supply Doctrine



1. Further development can make wind & solar power the primary source for electricity and heating
2. Excess power will be used in local CHP plants and replace biomass and natural gas.
3. Biomass and natural gas will be back-up storage when wind- and solar energy is not sufficient.
4. Biomass and NG are limited resources and should not be used when sufficient solar and wind is available.



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### Energy consumers' democracy

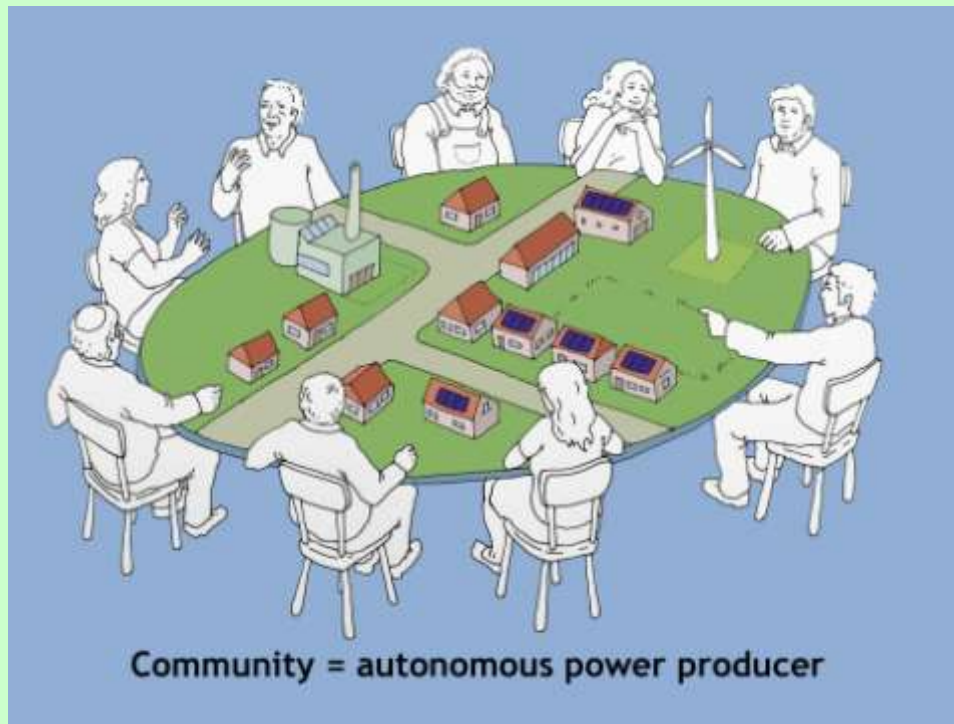


### Energy producers' democracy





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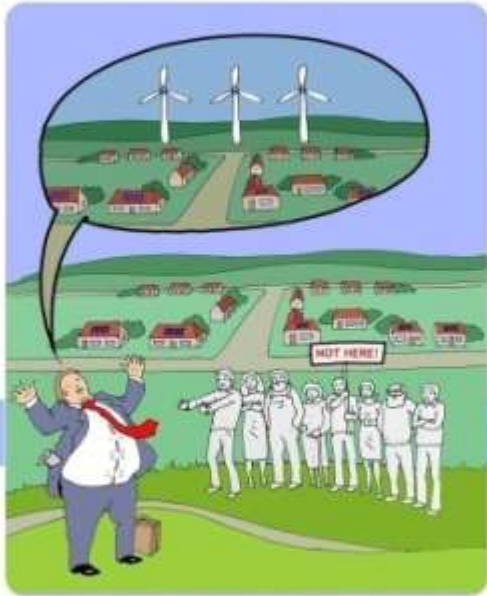


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# Welcome to Community Wind Power. It is cheaper as well!



Local residents often refuse external investors to install wind turbines in the region. This blocks for onshore wind power projects.



My price: **0,50/kWh**

= **CAD 0,10/kWh**

Governments invite central power utilities to invest in big offshore wind power to fulfil emission charges.



Our price: **1,05/kWh**

= **CAD 0,21/ kWh**

Local public ownership - the community gets 0.50 DKK/kWh. The "profit" of 0.10 DKK is intended for local common good initiatives. This creates the needed acceptance.



Our price: **0,40/kWh**

= **CAD 0.08/kWh**

Alternative?

Alternative?

## Wind power prices in Denmark



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# Wind is a natural resource!



*The answer. . . . .*







# End of the Presentation



**Thank you for listening!**

**Questions and comments are welcome.**

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