Renewable Energy as a Lever for Industrial Innovation and 100% Renewable Energy

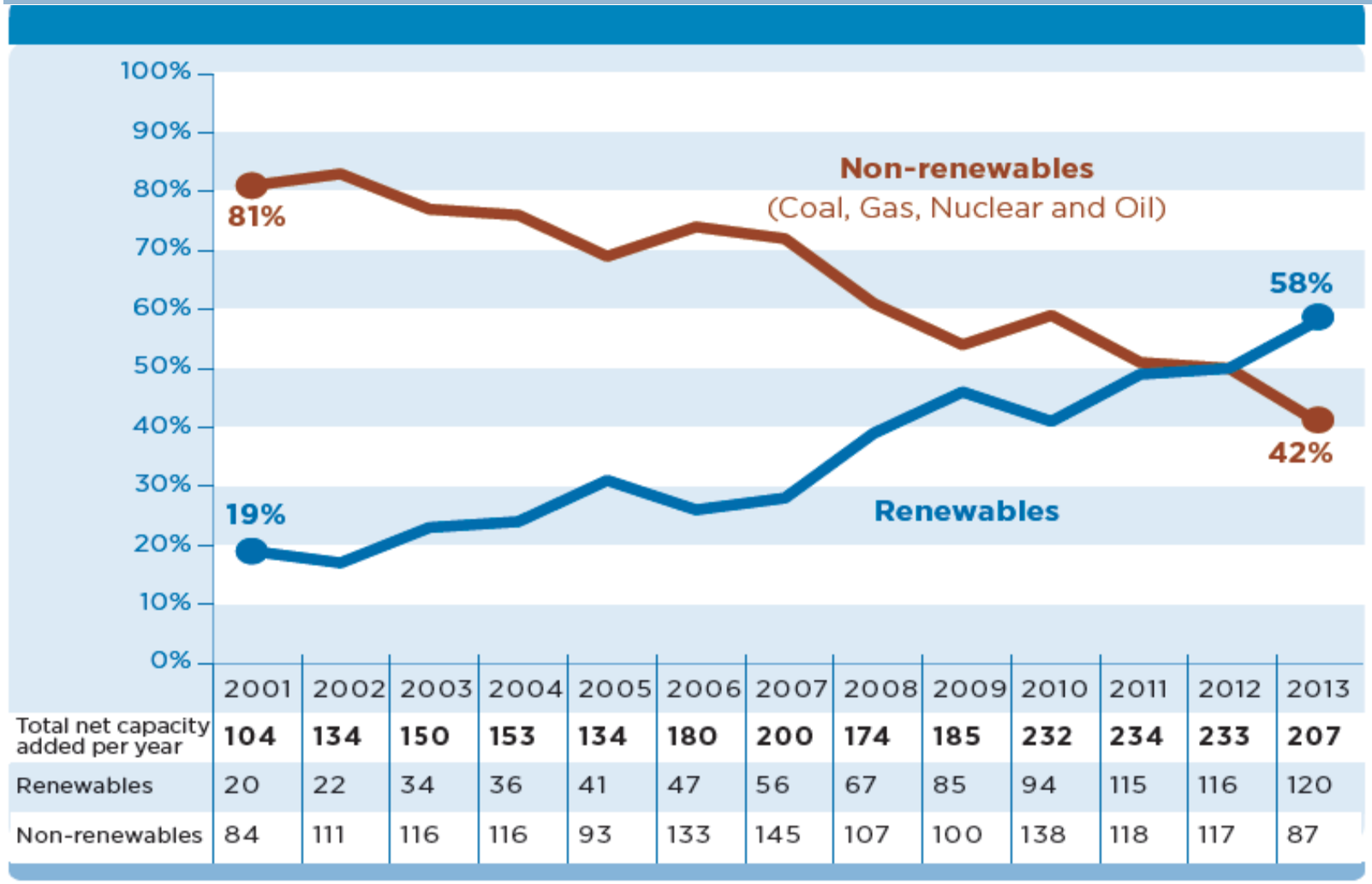
Experiences from Denmark

Preben Maegaard

Founding President, WWEA, World Wind Energy Association
Director (ret.) Nordic Folkecenter for Renewable Energy
Chairman, WCRE, World Council for Renewable Energy

Radical Technology, Bristol Sep 2, 2016

Since 2011 globally more new renewable energy capacity was installed than new capacity within fossil and nuclear power combined



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total net capacity added per year	**104**	**134**	**150**	**153**	**134**	**180**	**200**	**174**	**185**	**232**	**234**	**233**	**207**
Renewables	20	22	34	36	41	47	56	67	85	94	115	116	120
Non-renewables	84	111	116	116	93	133	145	107	100	138	118	117	87

Source: IRENA database

Wind Energy as a Lever for Rural Development

DENMARK'S ELECTRICITY SUPPLY SYSTEM:

- Till 1975 almost 100% dependency on oil
- Diversification of supply was decided
- Atomic energy first had main priority but the plans were cancelled in 1985
- Decentralization of supply got priority with CHP and renewable energy
- Strong AC and DC transmission cables to Sweden, Norway and Germany

Danish Energy Characteristics

- Since 1980 Permission not given to build conventional Power Stations:

The Consequences :

1. High Share of CHP, Combined Heat & Power: 60%
2. High Share of District Heating, 63%
3. High Share of Wind Energy: 42% in 2015
- 4. 70.000 employed within RE; 28.000 in Wind Industry

Future Challenges:

a. Replacing Coal with Renewable Energy
b. Organic Waste to be used for Biogas.
c. Transport Sector to change to Renewable Energy

Energy production in Denmark in 2015

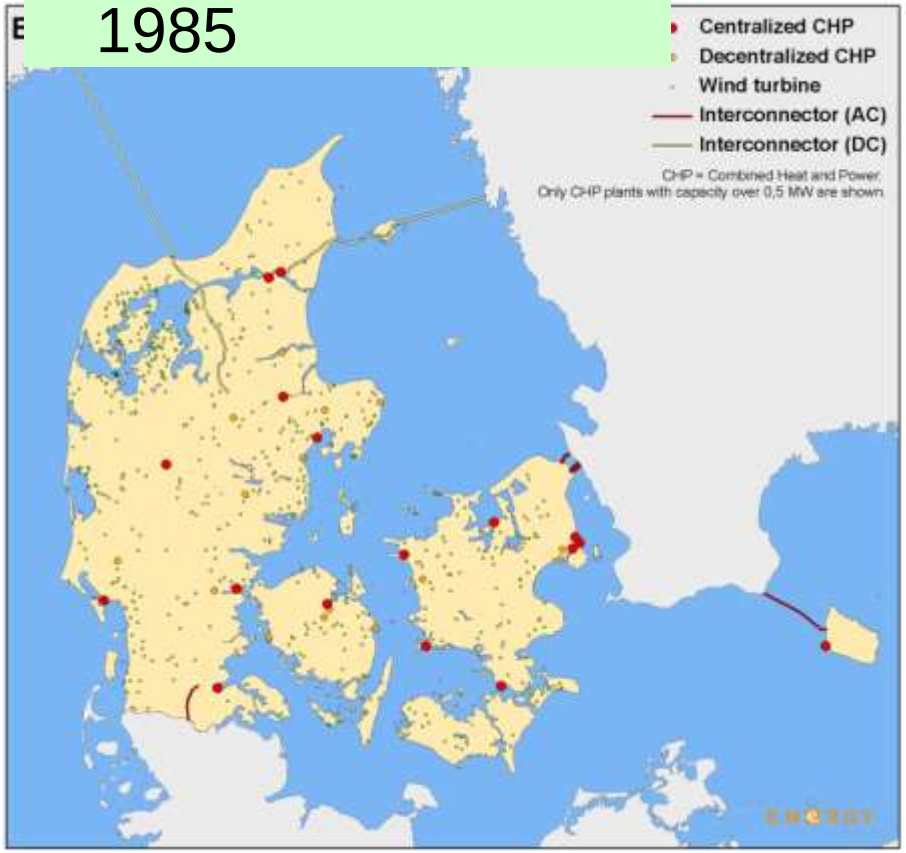
- District Heating: 105 TWh
- **Electricity: 35 TWh**
- Transportation: 40 TWh

180 TWh

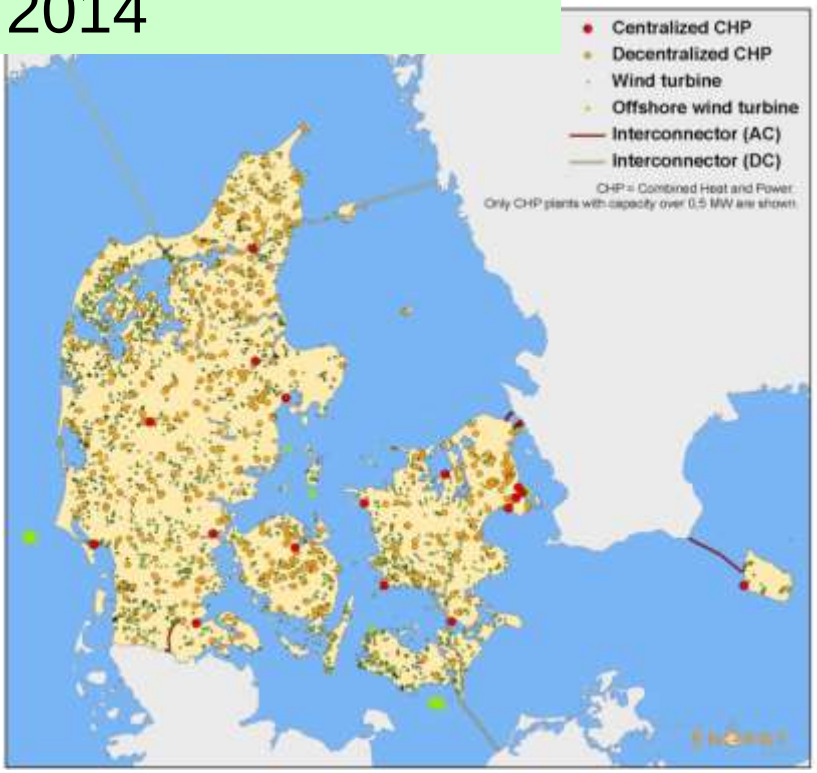
42% of the electricity are coming from the wind turbines

Denmark's Electricity Infrastructure 1985 and 2014

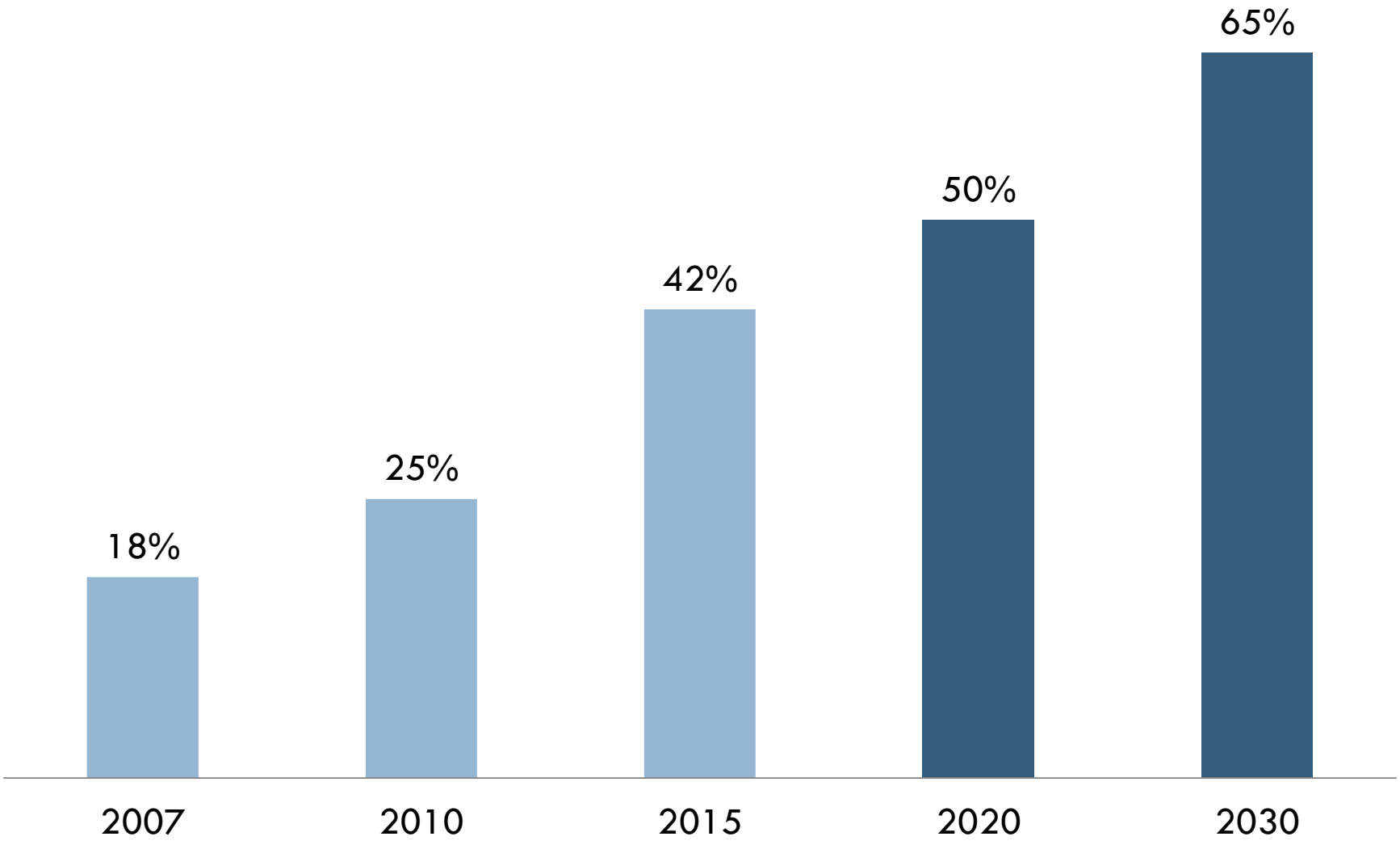
1985



2014



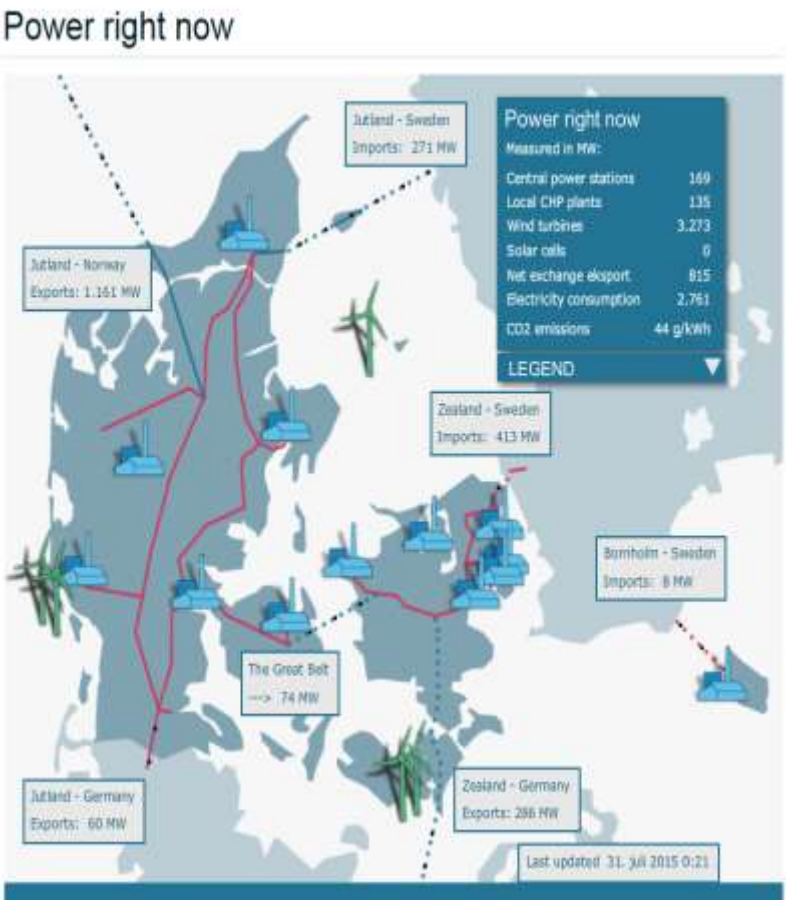
Share of wind power in Denmark (% rates)



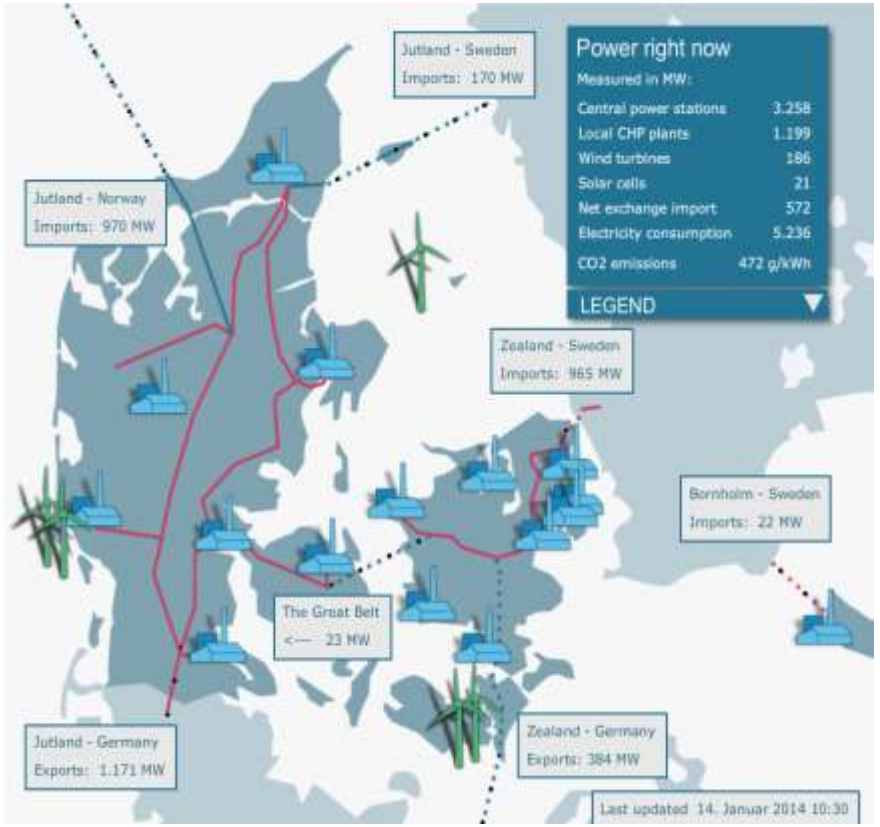
Fluctuations: From 2% Wind to 119%!

www.energinet.dk/ *Power right now*

Wind power share 119%
July 31, 2015: 44 g CO2/kWh

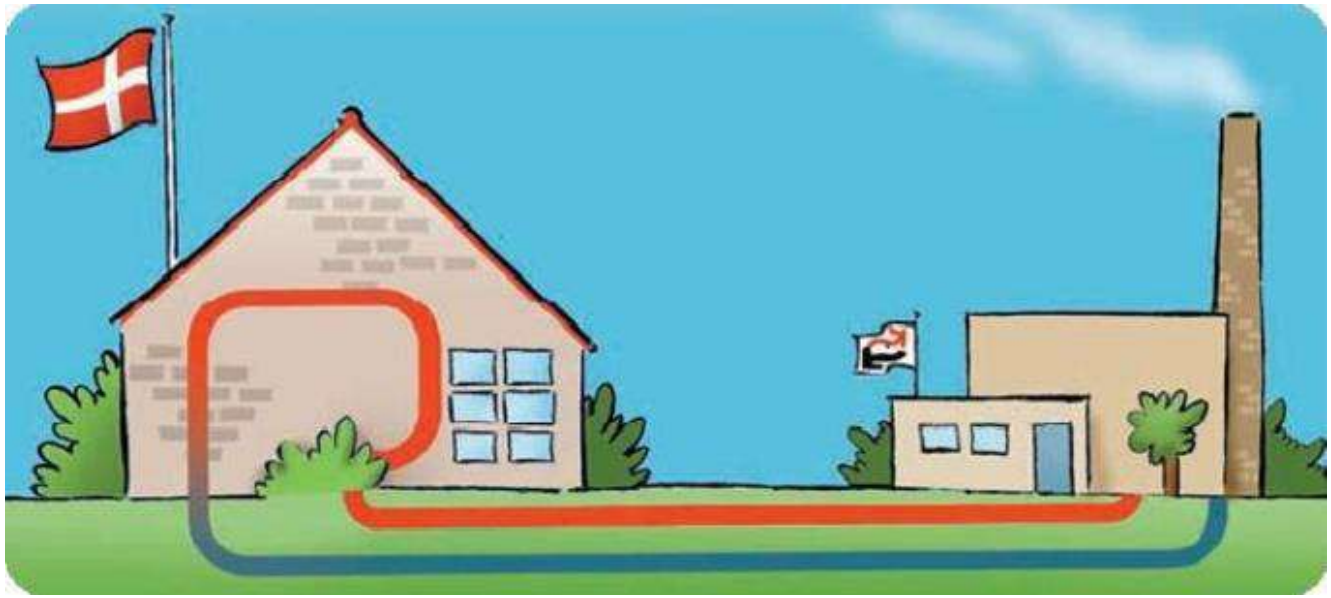


Wind power share 2%
Jan 14, 2014: 472 g CO2/kWh



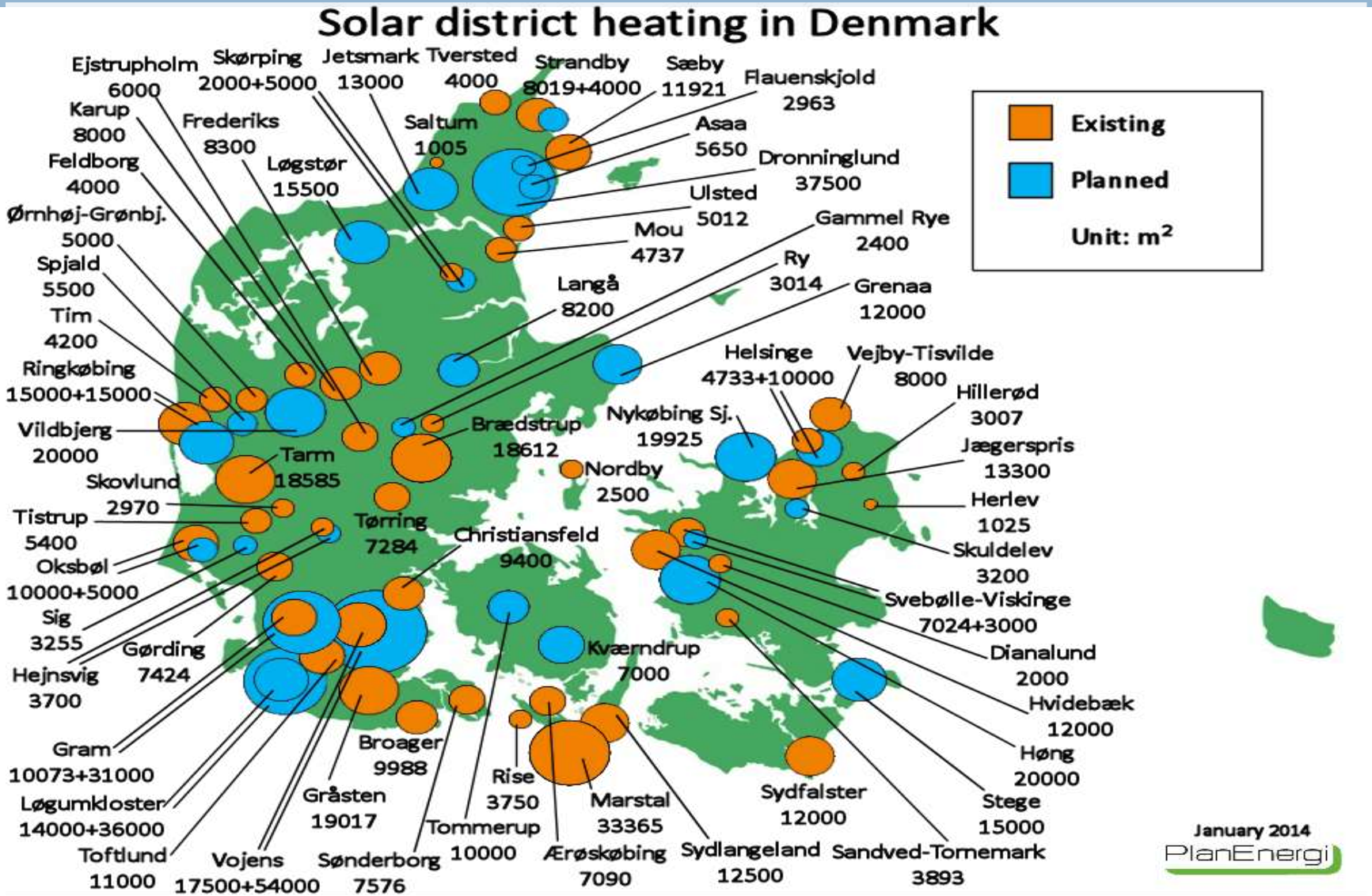
Danish District Heating

- Population 5.6 mio – District Heating 2.6 mio Homes
- 60,000 km District Heating pipes
- 64% of all homes heated – 98% in Copenhagen
- Ownership: Municipalities or Consumers Cooperatives



Source: ENS

Solar District Heating, Denmark 2014

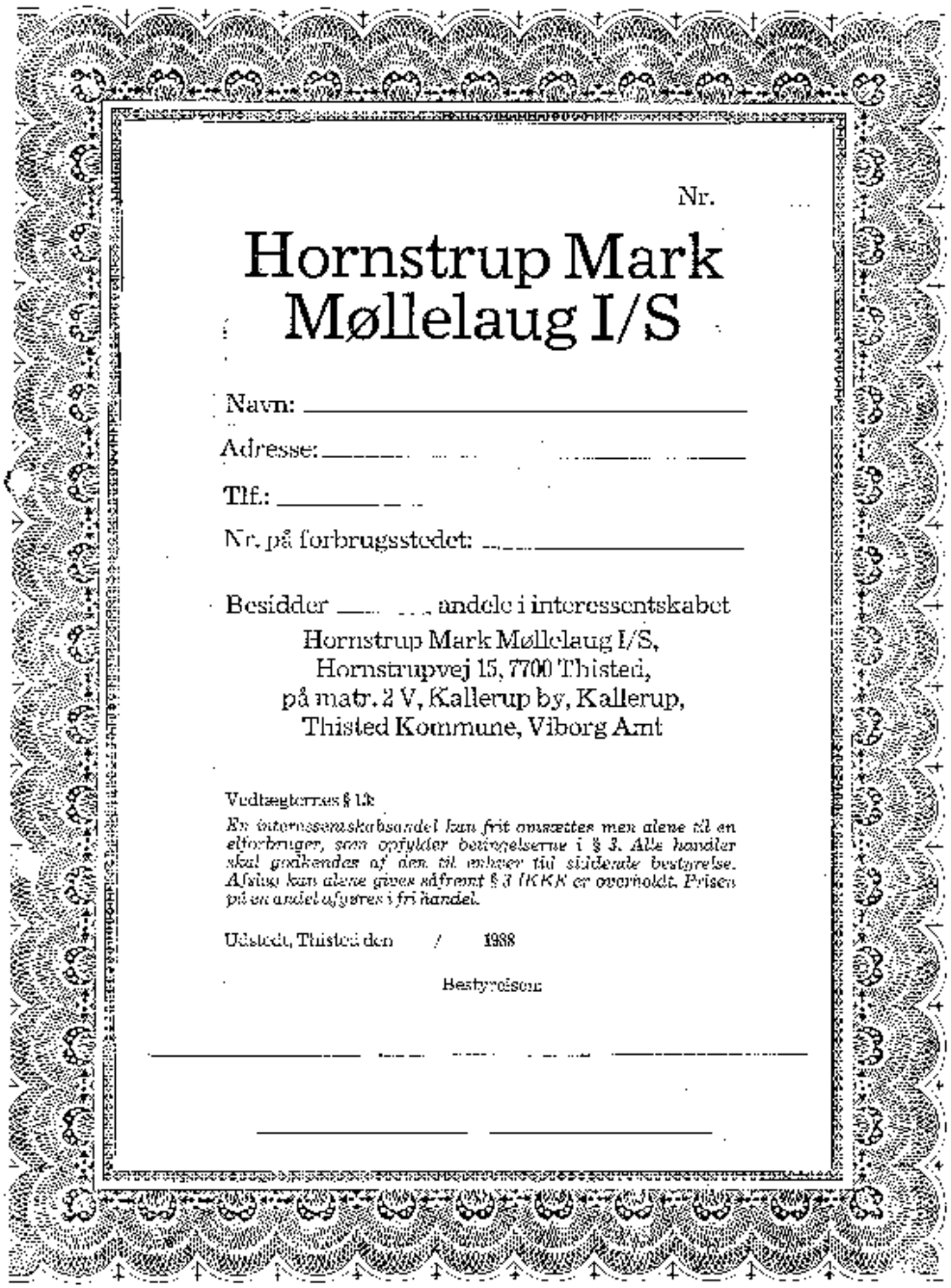


COMMUNITY POWER FOR THE COMMON GOOD

The Thy Region was pioneer within Community Power since 1981

- Community power is owned and operated by the community
- Wind power, solar thermal and power, biogas, biomass, and combined heat and power, CHP, and storage are basic community power technologies
- Financial benefits are returned to the community
- Community choose what infrastructure

  fits best to its needs and is economically efficient.



Nr. ...

Hornstrup Mark Møllelaug I/S

Navn: _____

Adresse: _____

Tlf.: _____

Nr. på forbrugsstedet: _____

Besidder ____ andele i interessentskabet
Hornstrup Mark Møllelaug I/S,
Hornstrupvej 15, 7700 Thisted,
på matr. 2 V, Kallerup by, Kallerup,
Thisted Kommune, Viborg Amt

Vedtægternes § 13:

En interessentskabsandel kan frit omsættes men alene til en elforbruger, som opfylder betingelserne i § 3. Alle handler skal godkendes af den til enhver tid siddende bestyrelse. Afslag kan alene gives såfremt § 3 IKKE er overholdt. Prisen på en andel afgøres i fri handel.

Udstedt, Thisted den / 1988

Bestyrelsen

_____ _____

- What happened in 1992?
- And in 1998?
- In 2002 repowering program

- Community ownwership comes to an end

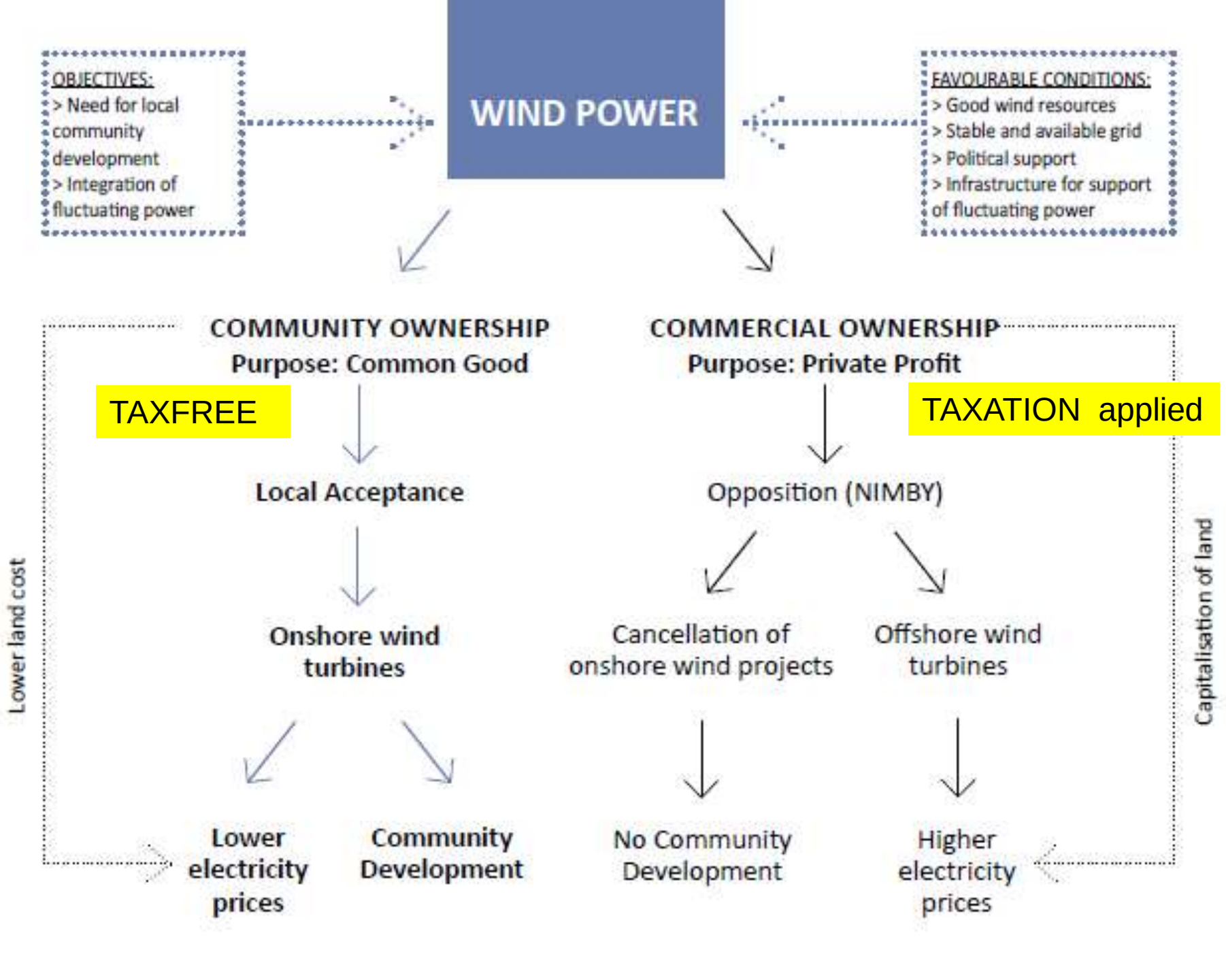
- 165.000 families in Denmark were co-owner

- In 2002 in Thisted Municipality 4000 households owned most of the wind turbines

- In 2015 Commercial investors had purchased nearly all

THE FUTURE?

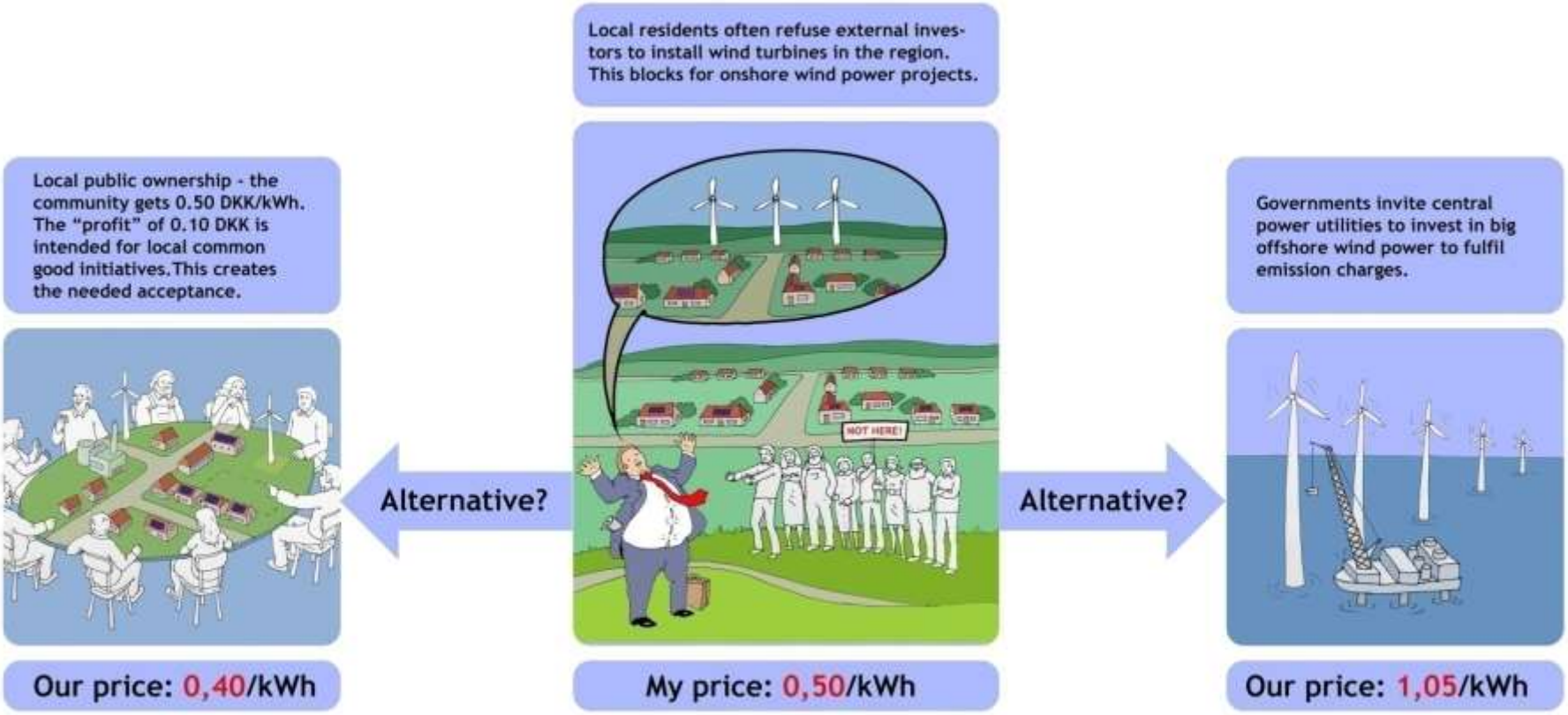
- More than 200 protest groups in Denmark
- Since 1998 very few new community power The population is FOR wind power; they protest against investor wind projects


OBJECTIVES:
> Need for local community development
> Integration of fluctuating power
WIND POWER
FAVOURABLE CONDITIONS:
> Good wind resources
> Stable and available grid
> Political support
> Infrastructure for support of fluctuating power
COMMUNITY OWNERSHIP
Purpose: Common Good
COMMERCIAL OWNERSHIP
Purpose: Private Profit
TAXFREE
TAXATION applied
Local Acceptance
Opposition (NIMBY)
Onshore wind turbines
Cancellation of onshore wind projects
Offshore wind turbines
Lower electricity prices
Community Development
No Community Development
Higher electricity prices
Lower land cost
Capitalisation of land

COMMUNITY WIND POWER for the World

Energy Democracy
Local Acceptance
Community Development
Lower Electricity Prices

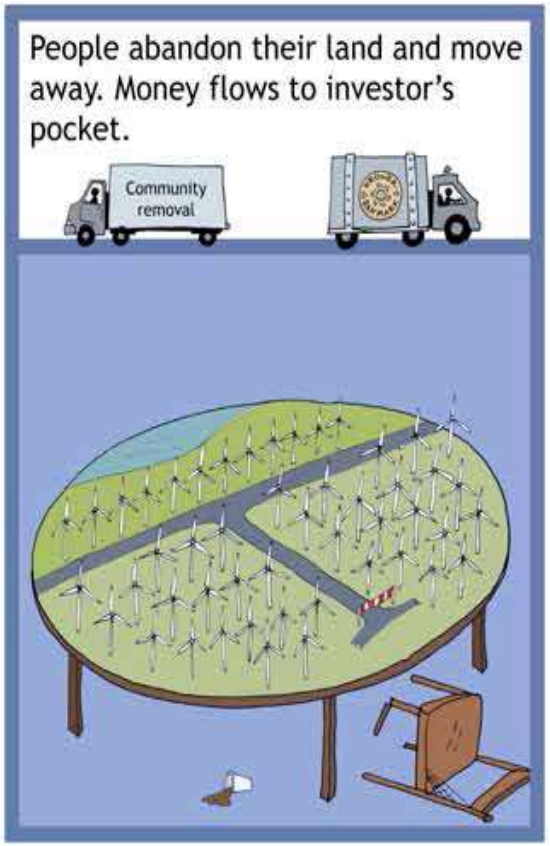
Welcome to Community Wind Power. It is cheaper as well!



Wind power prices in Denmark

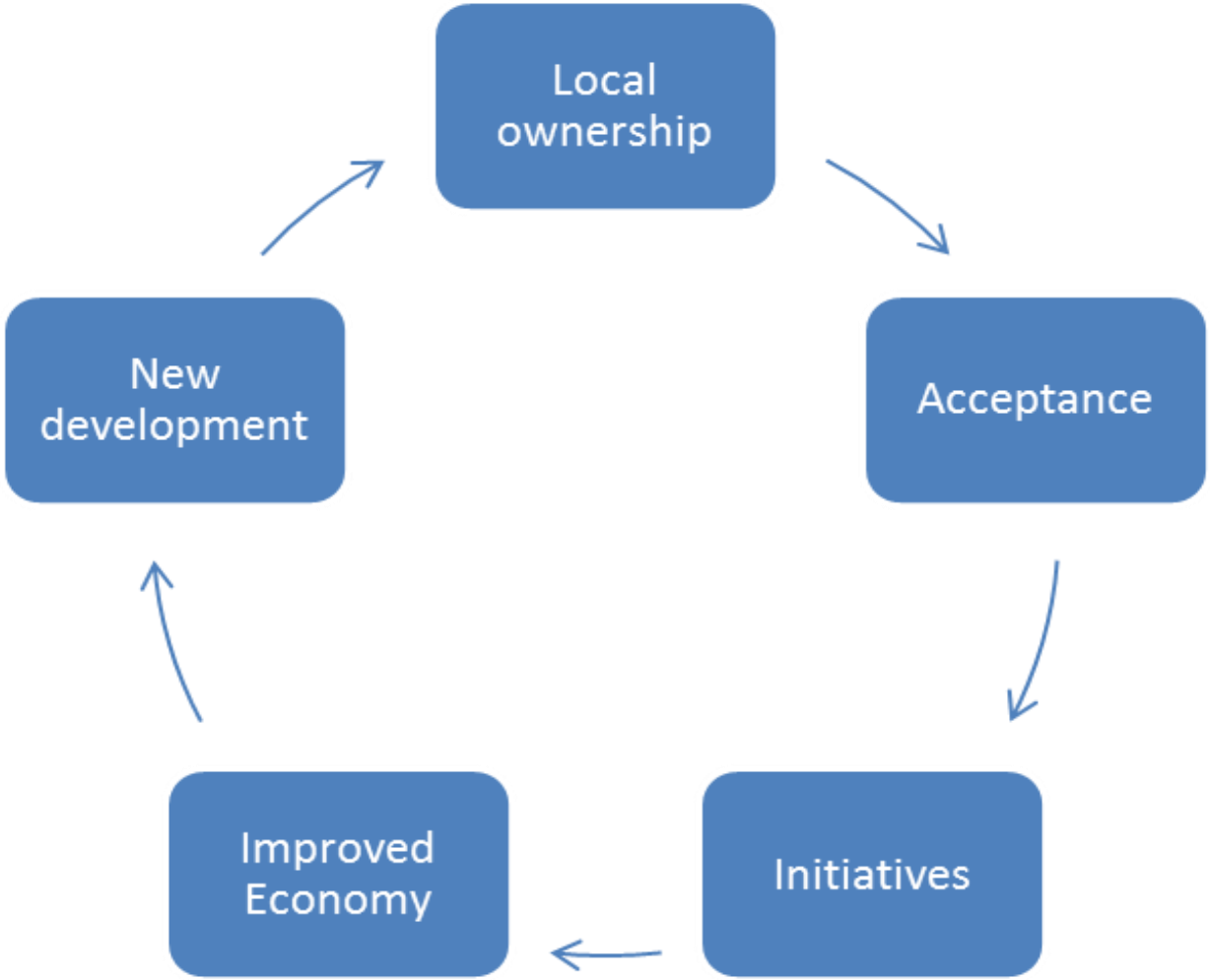
Not 20% - but 100% local ownership as the alternative to external investors.

OPTION 1.



OPTION 2.

Acceptance and new economy with community power



In 2012 the local municipality declared:

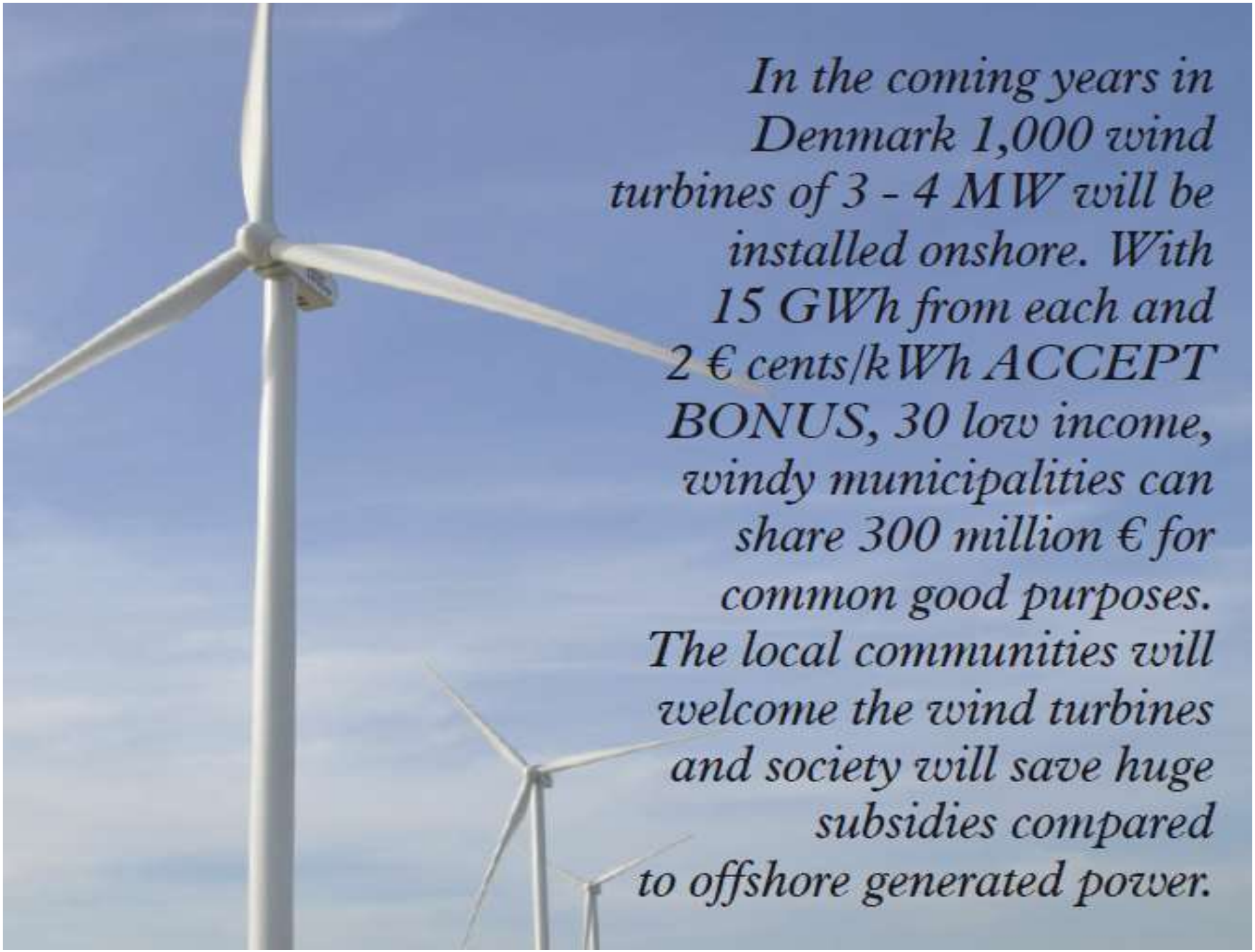
Future wind projects must have the acceptance of the local residents.

But is Energy Democracy possible?

ECONOMY OF ONSHORE AND OFFSHORE WIND POWER

ACCEPT BONUS FOR THE LOCAL COMMUNITY

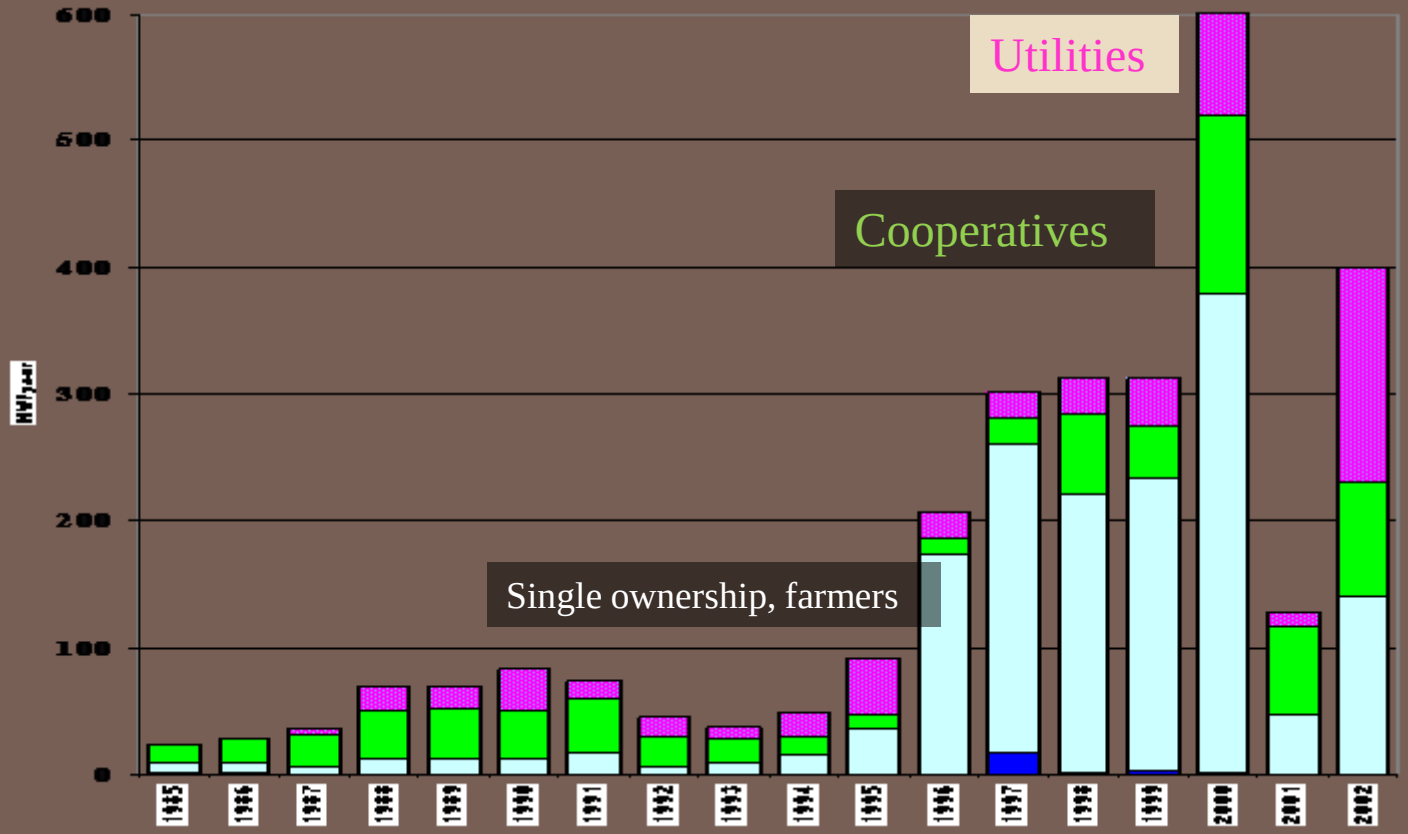
- The ACCEPT BONUS **from renewable energy projects will benefit the residents of local communities,** i.e. the main objective is achieving the **common good**.
- In contrast, the main objective of commercial ownership models is **to generate private profit.**


In the coming years in Denmark 1,000 wind turbines of 3 - 4 MW will be installed onshore. With 15 GWh from each and 2 € cents/kWh ACCEPT BONUS, 30 low income, windy municipalities can share 300 million € for common good purposes. The local communities will welcome the wind turbines and society will save huge subsidies compared to offshore generated power.

Real World Example:
Hvide Sande, fishery harbour Denmark:
100% local acceptance

Sdr. Vium August 2016, Wind and Social Housing

Annual installation of wind turbines in Denmark 1985 - 2002



Main types of windpower ownership in Denmark, 1985 - 2003

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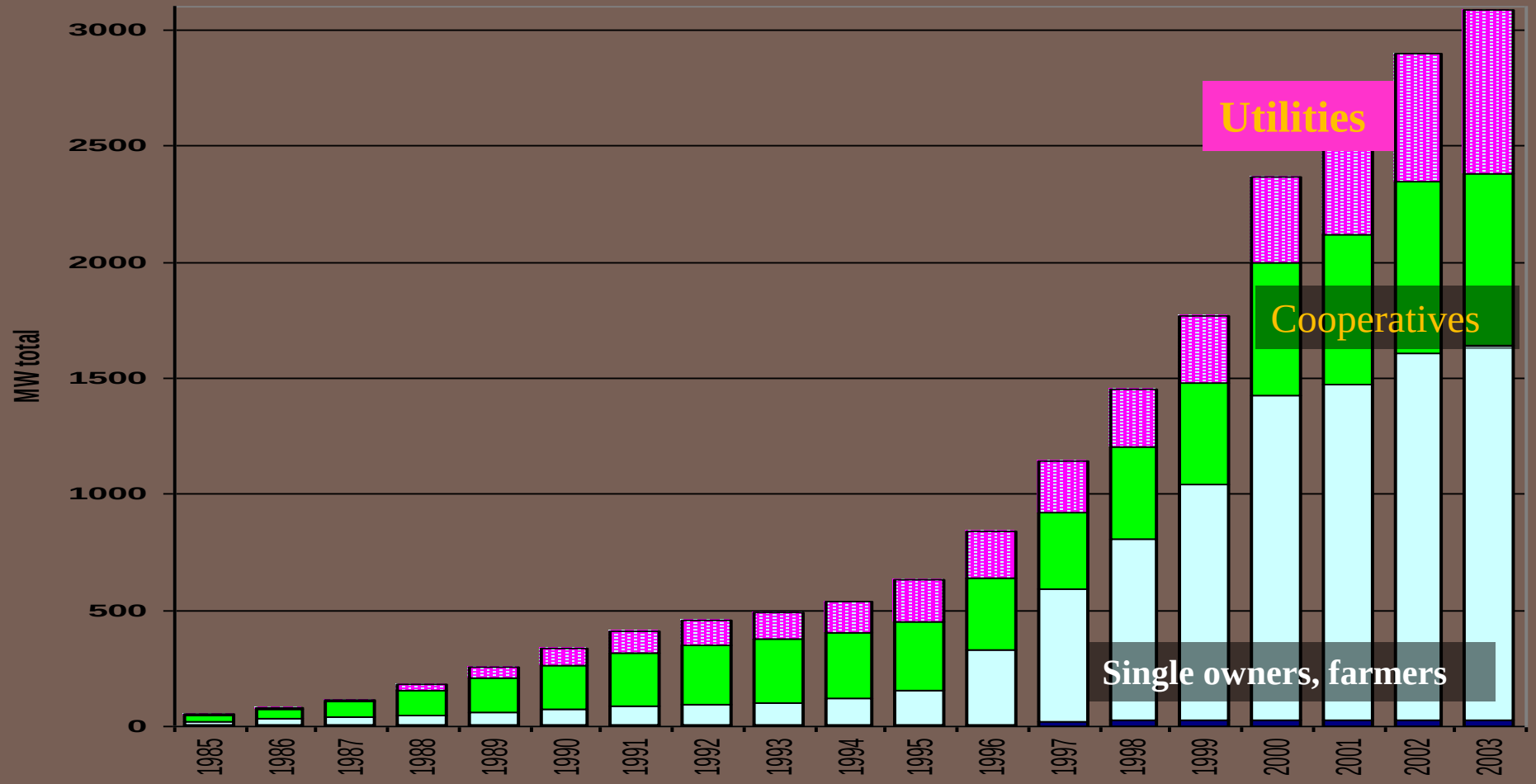
Since 2003 no registration of ownership.



Consequenses of 5 forms of ownership

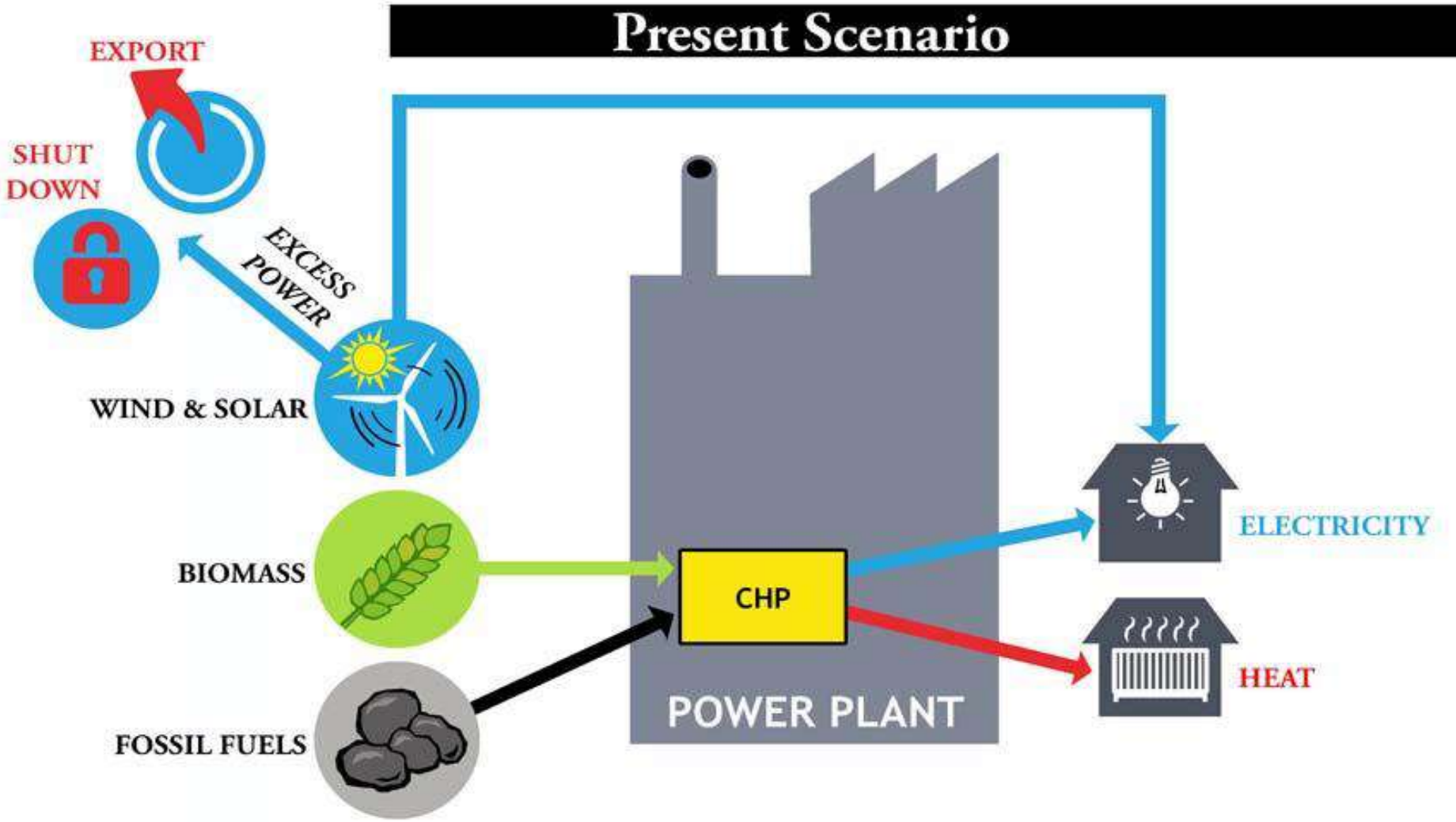
Who to own?	Local acceptance	Local development
Common good fonds, 20% Coops	Yes	Yes
20% Coops, 80% for investor	?	No
60% for utility, 40% for Coop	Yes	No
Vattenfall model, local buy-out	No	No
Municipal ownership	May be	May be

Community Power Conference in Copenhagen, Sep 9, 2016

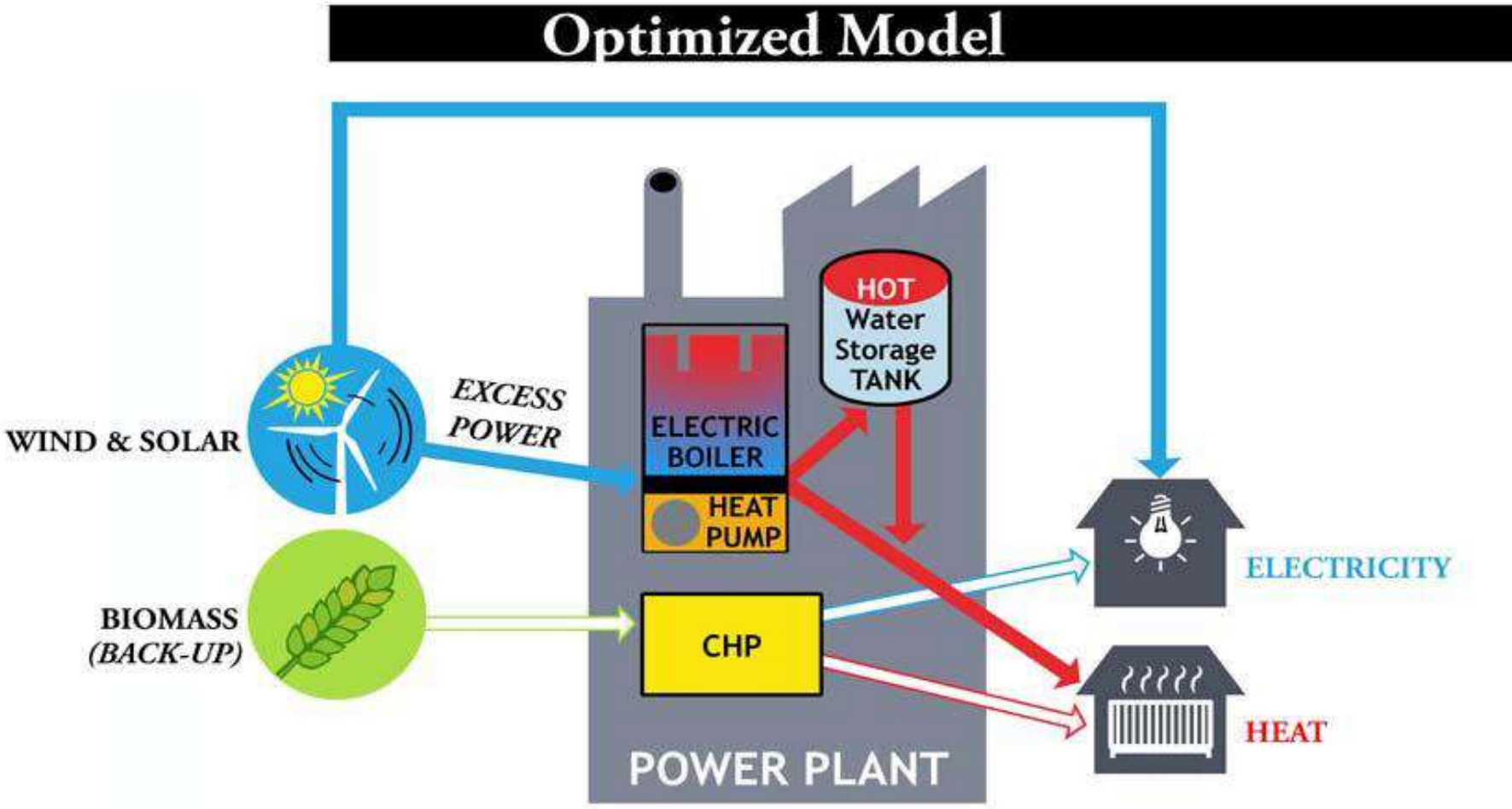
Purpose:

- **How to** develop and implement renewable energy solutions based on alternatives to tendering, certificates, and other commercial models as prepared by DG Competition, and promoted by the central power utilities.
- **How to** distribute the benefits of community-for-the-common-good projects to generate local development and to achieve the necessary local acceptance.
- **How to** *substitute the costly offshore* power with onshore power to reduce electricity prices and improve the overall economy.
- **How to** create democratic ownership by involving all local residents

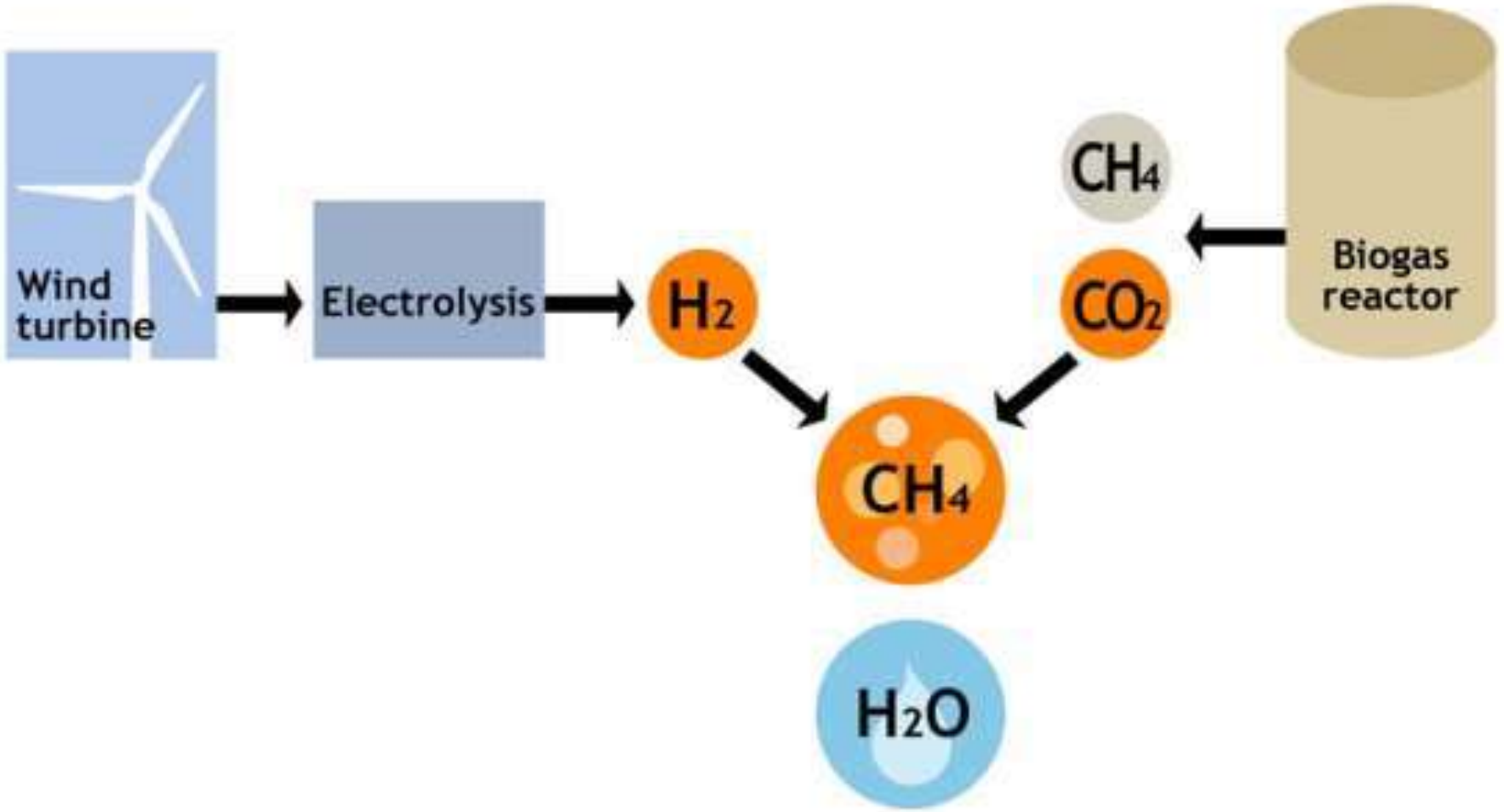
The challenge of the coming years: Best use of the excess power (1)



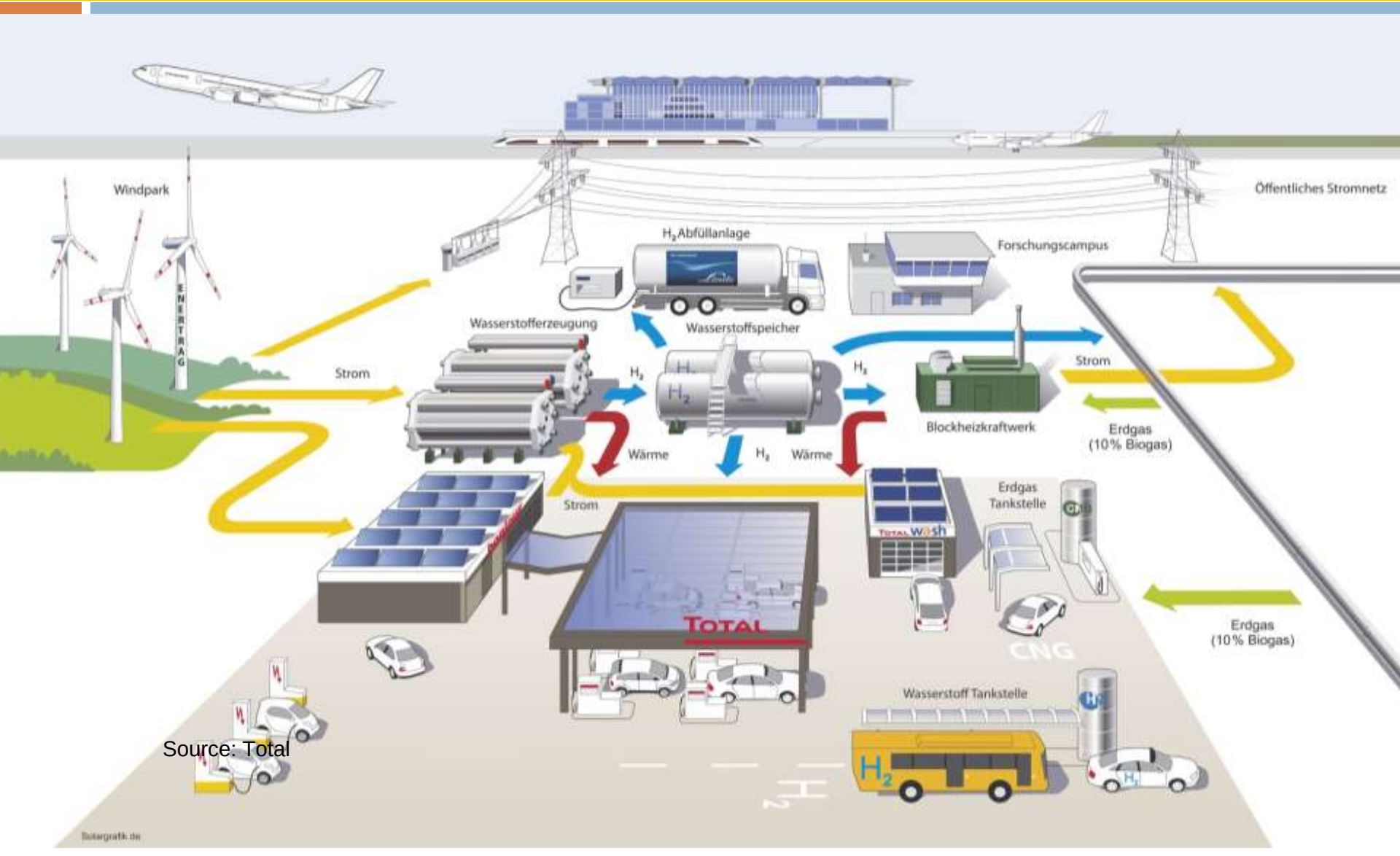
The challenge of the coming years: Best use of the excess power (2)



Wind-Power-to-H_2-to-Gas (CH_4)

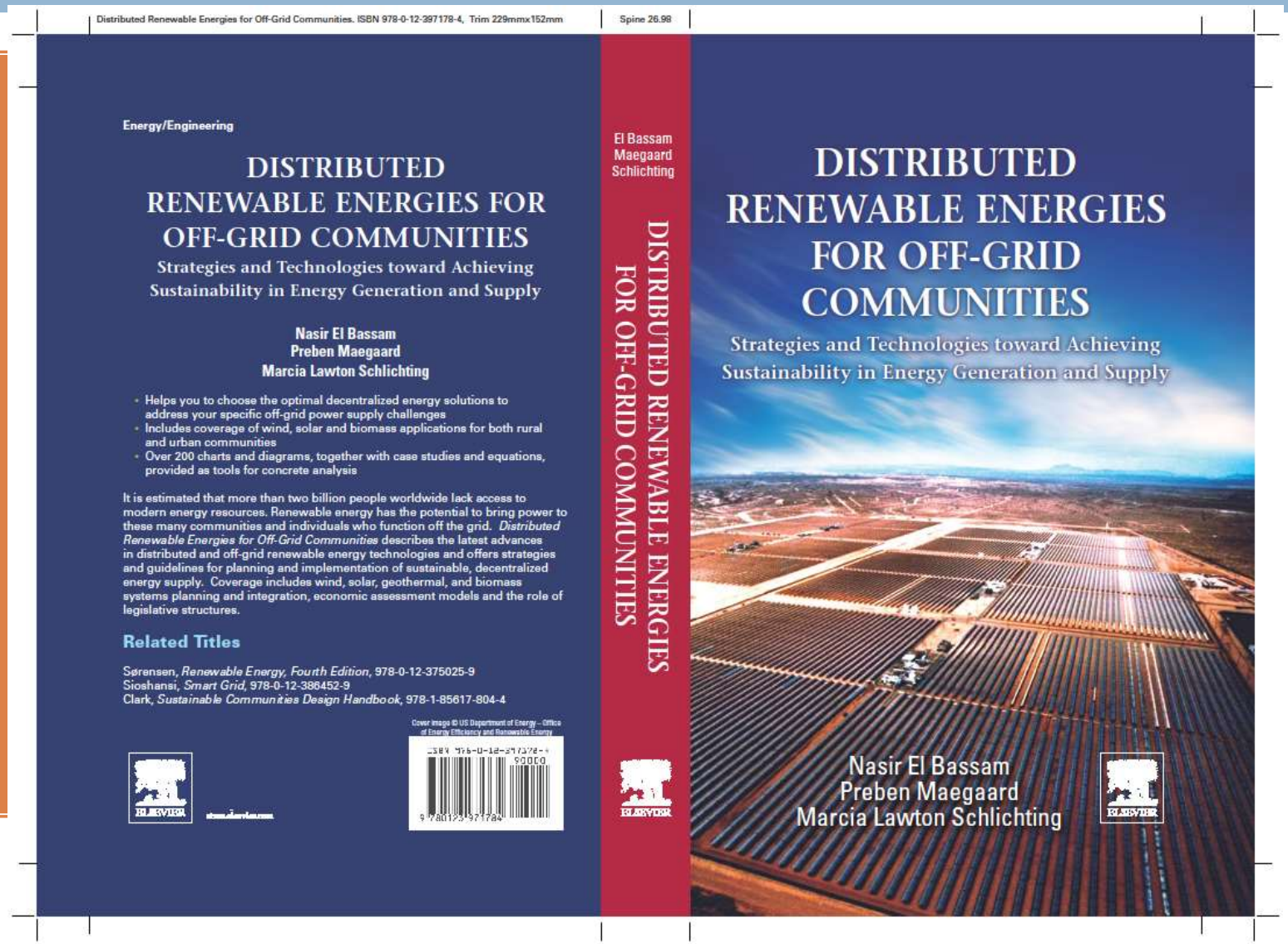


Integrated Hydrogen System



Source: Total

Book: Off-grid Renewable Energy



References

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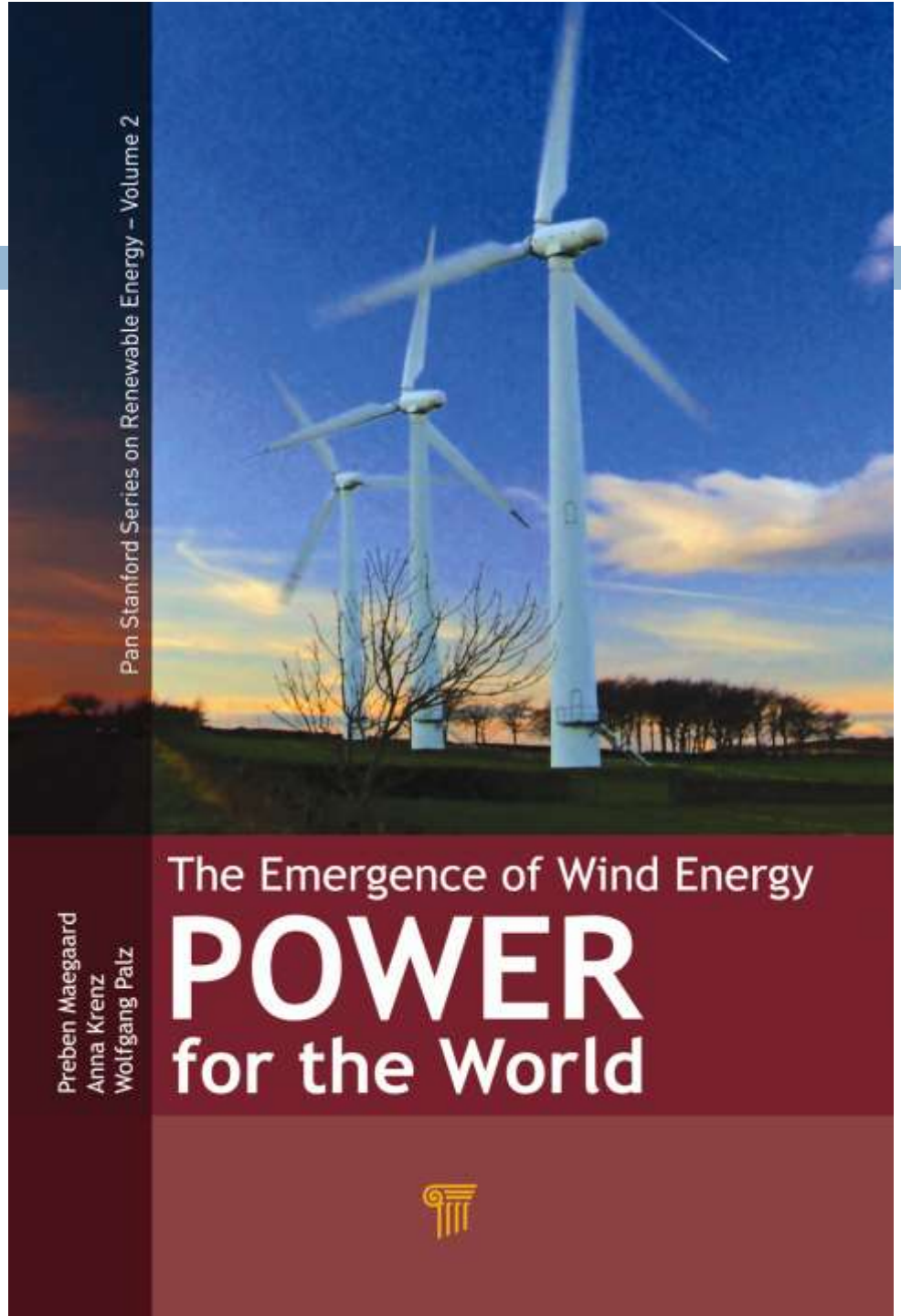
2. Maegaard, P.: "*Integrated Systems to Reduce Global Warming"* in "Handbook of Climate Mitigation", Springer Science, New York, 2012
3. El Bassam, N., Maegaard, P., Schlichting, M.L., "Distributed Renewable Energies for Off-Grid Communities," Elsevier Science, New York, 2012.
4. Maegaard, P., "*Wind Energy Development and Application Prospects, of Non-Grid-Connected Wind Power,"* in: Proceedings of 2009 World Non-Grid-Connected Wind Energy Conference. IEEE Press 2010.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