ENERGY PLANNING AND THE TRANSITION TOWARDS RENEWABLE ENERGY SYSTEMS

POUL ALBERG ØSTERGAARD
PROFESSOR, ENERGY PLANNING
AALBORG UNIVERSITY - DENMARK

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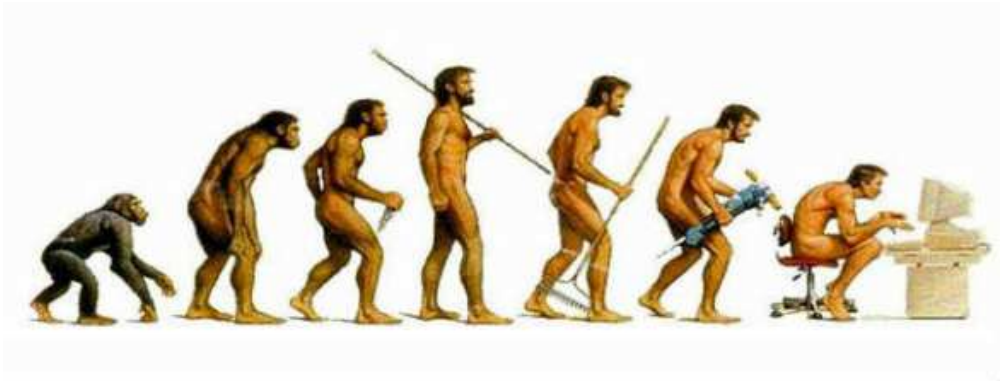
reINVEST

Agenda

- What was
- What is
- What might be

What was

Development through external energy contribution



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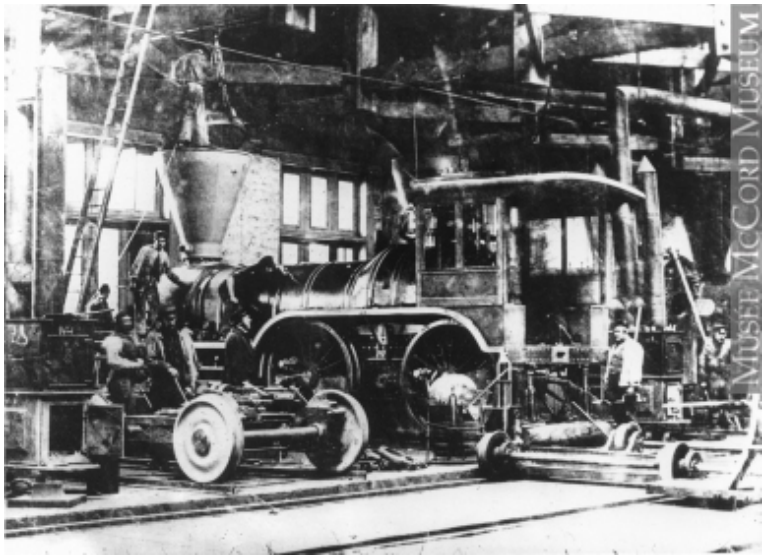
Development through external energy contribution



Sources: The Internet & La Première phase industrielle Au Canada (1850-1900)

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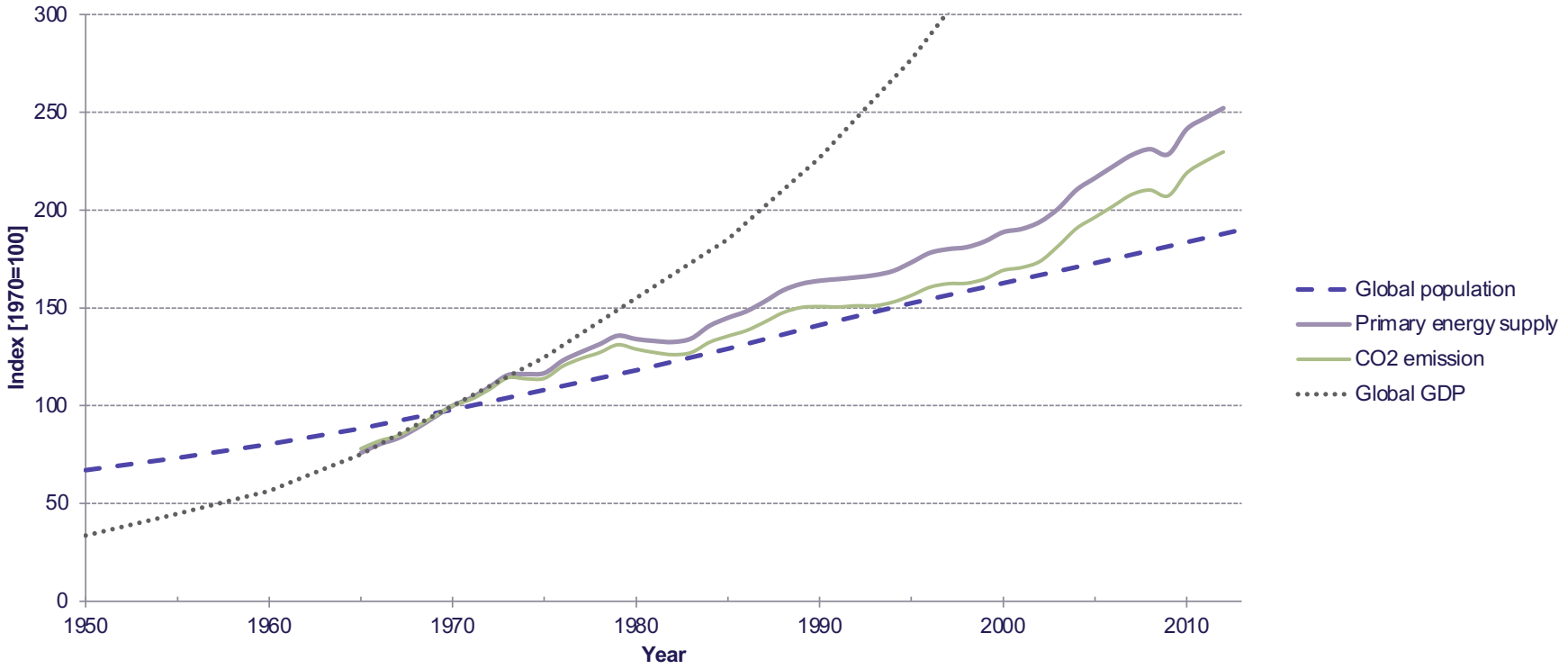
Development through external energy contribution

- Energy is a prerequisite for human development
- Today the metabolic energy demand is about 1/20th of the fuel-based energy of an average Danish man and mankind has gone from a simple metabolic lifeform to a lifeform operating through a large external energy use – exometabolism

Global energy trends



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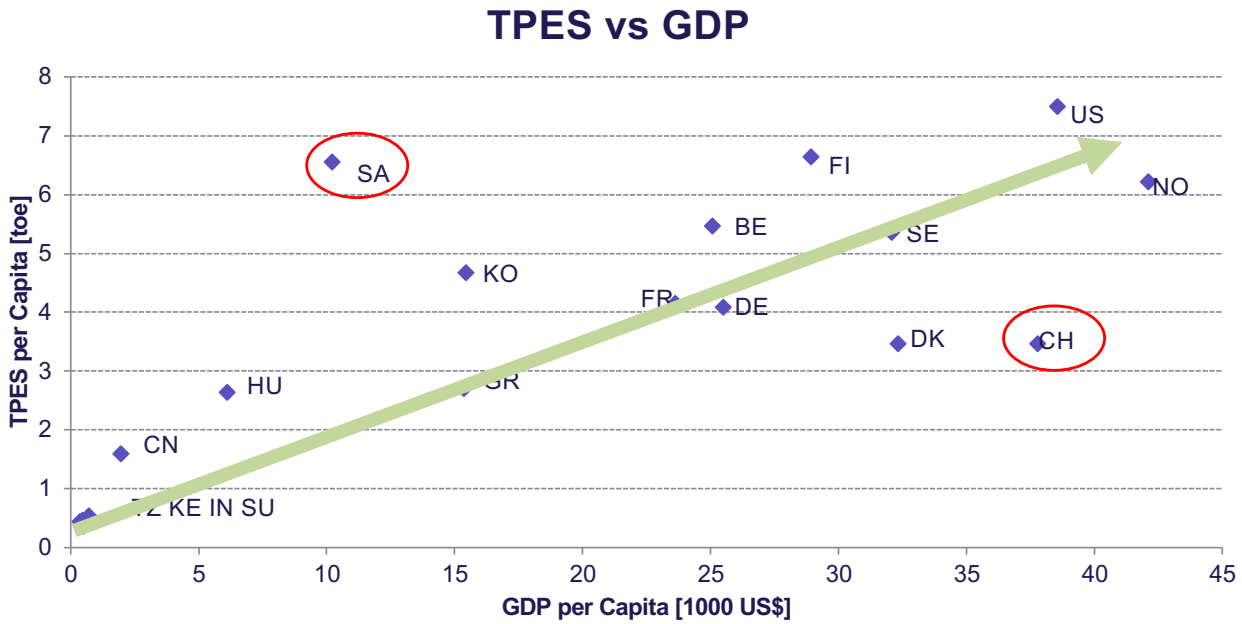
What is

Relative performance of selected countries



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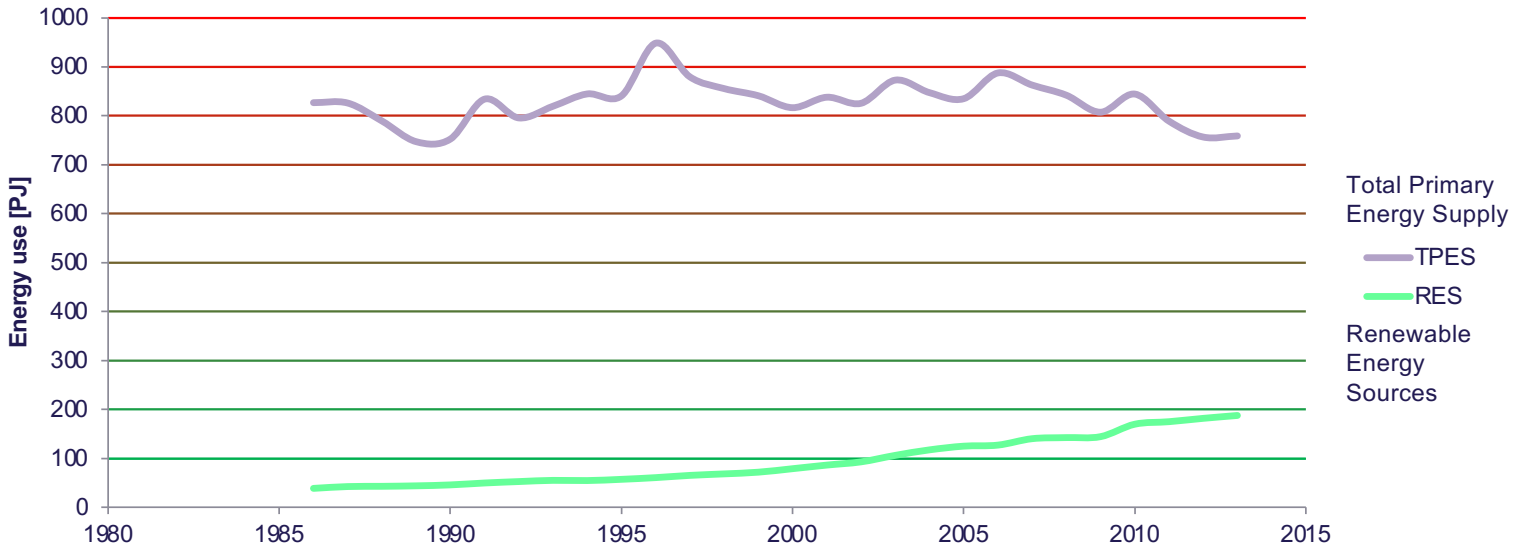
An example: Danish energy supply over the last 30 years



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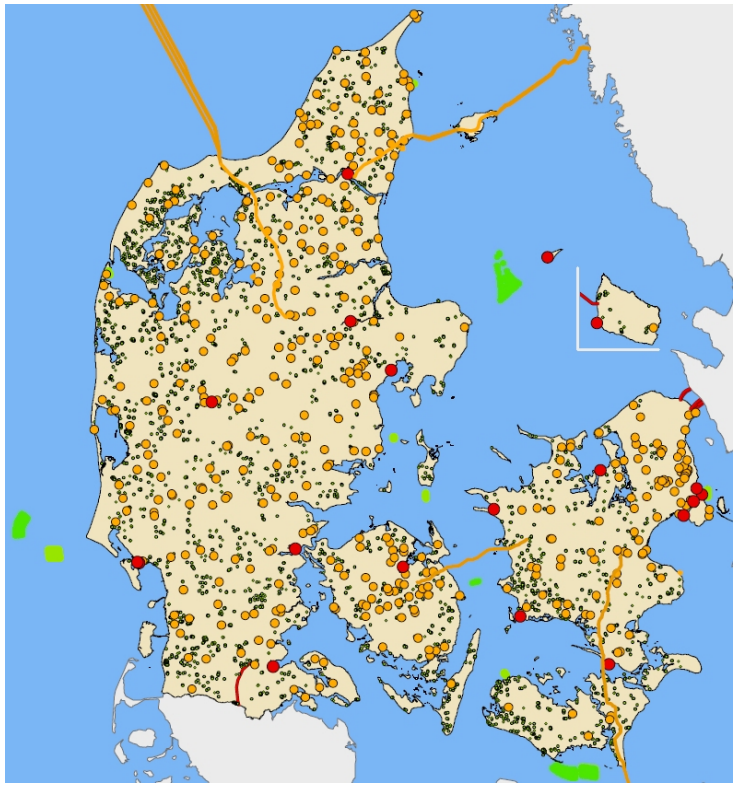
From a central to a distributed energy system



2013

Centralt kraftvarmeværk	Central CHP
Decentralt kraftvarmeværk	Local CHP
Vindmølle	Wind
Havvindmølle	Off-shore wind
Udlandsforbindelse (vekselstrøm)	AC Interconnection
Udlandsforbindelse (jævnstrøm)	DC interconnection

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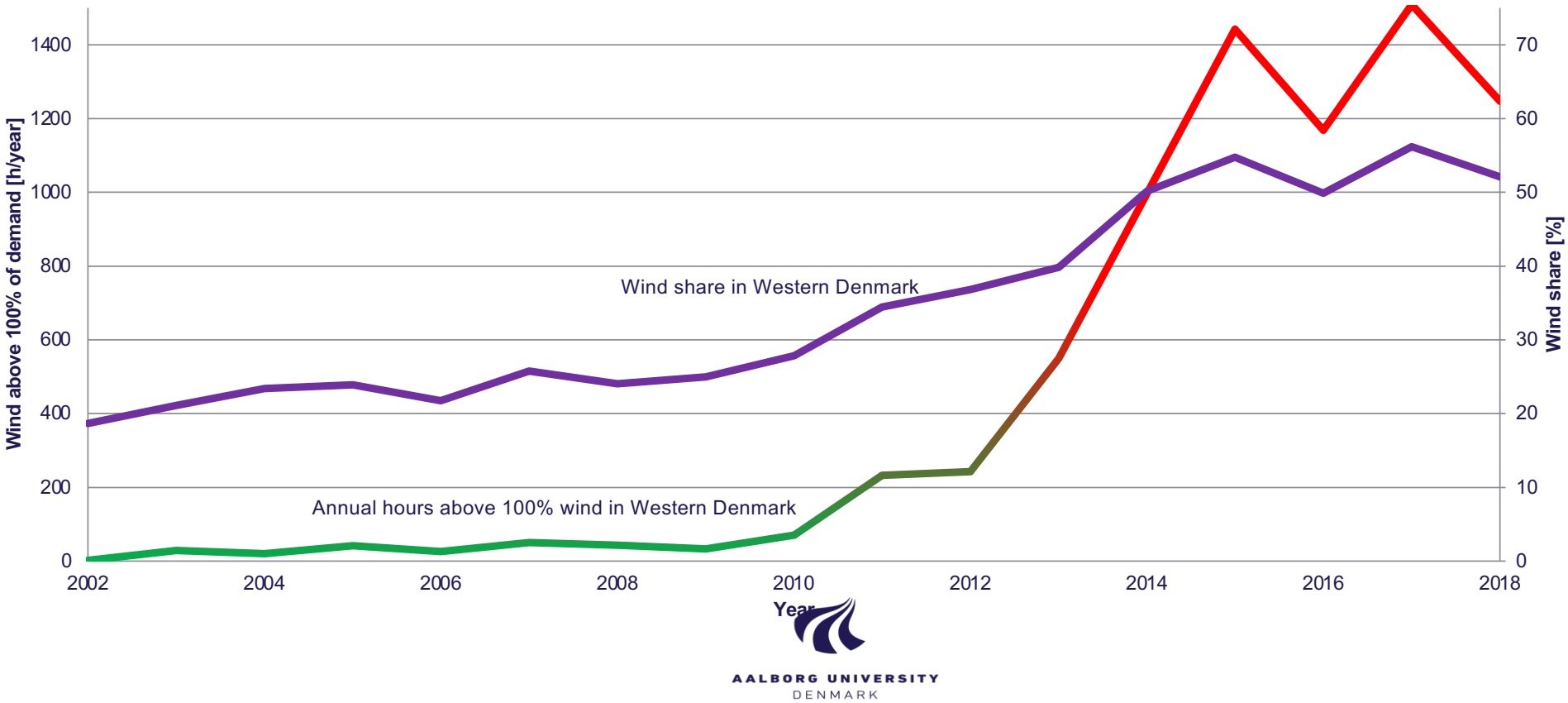
Maps: Danish Energy Agency

The issue of excess power generation



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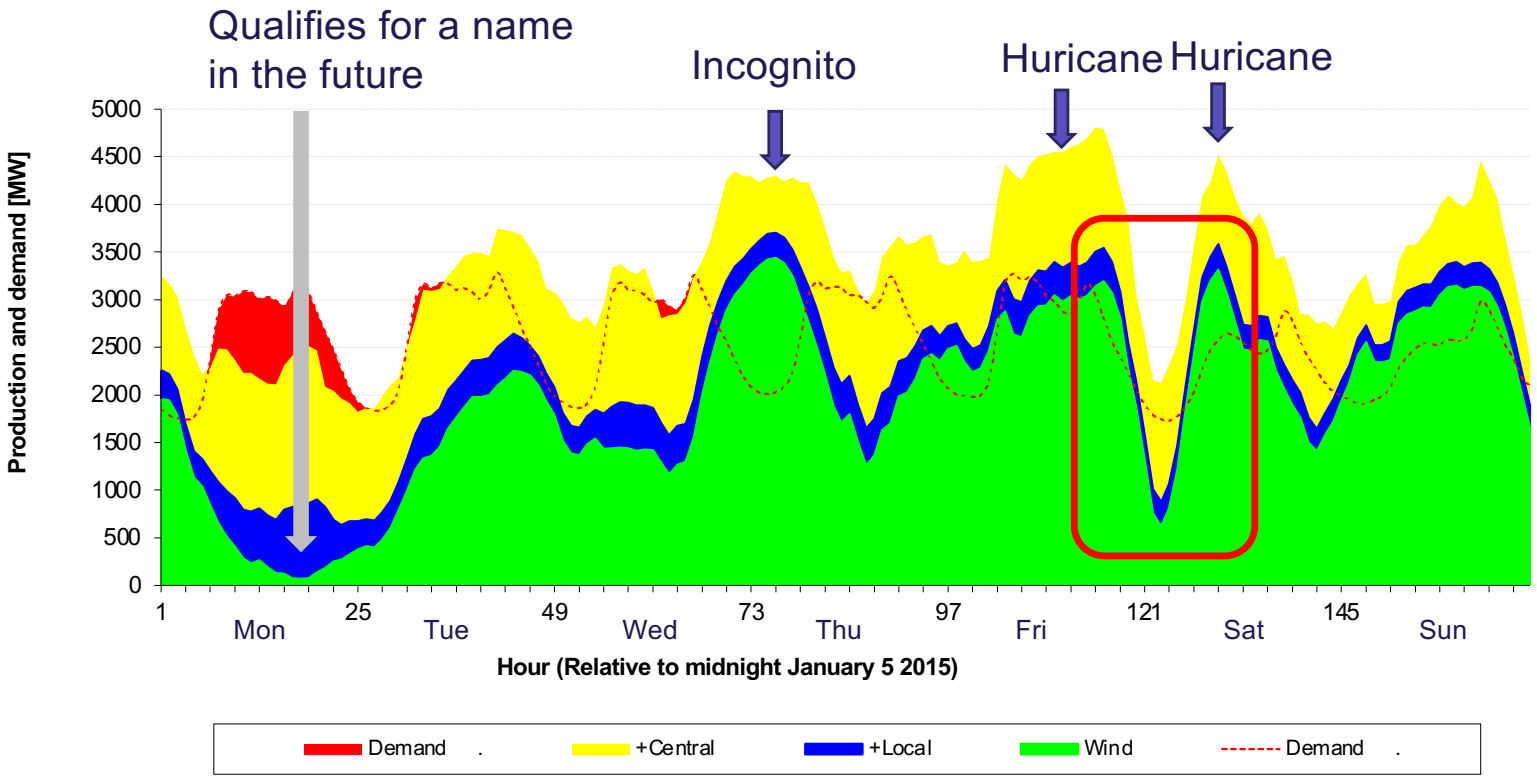
A week in Western Denmark



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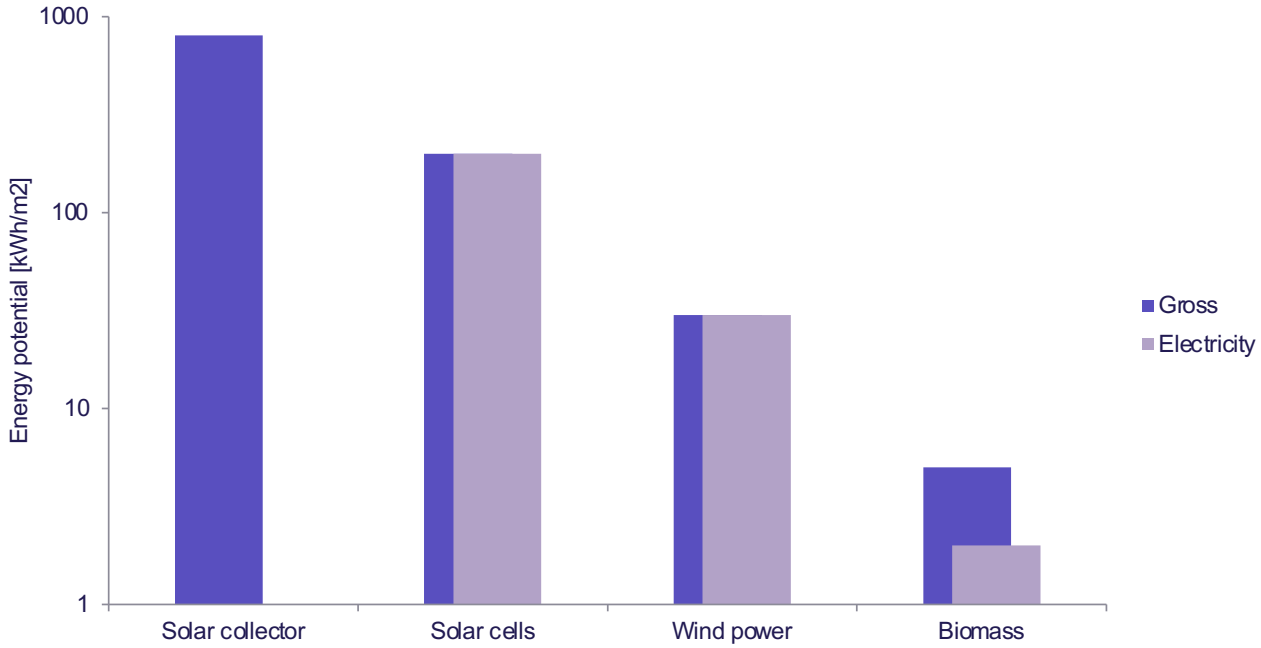
What might be

Options for energy production under Danish conditions



Multiple competing needs for biomass:

Food, fodder, fibre, fertilizer, feedstock, forests – and fuel

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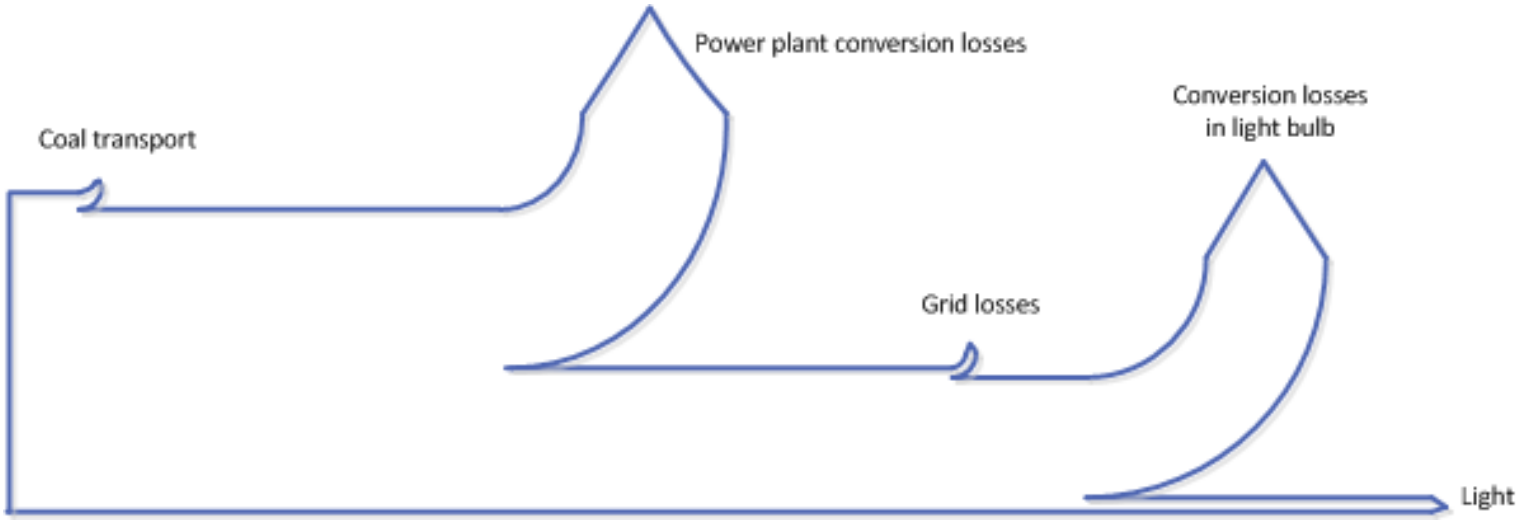
Trends, solutions and implications

- Small biomass availability which must be used wisely.
- Large fluctuating power availability
- Potentially large imbalances
- Electrification of the energy system



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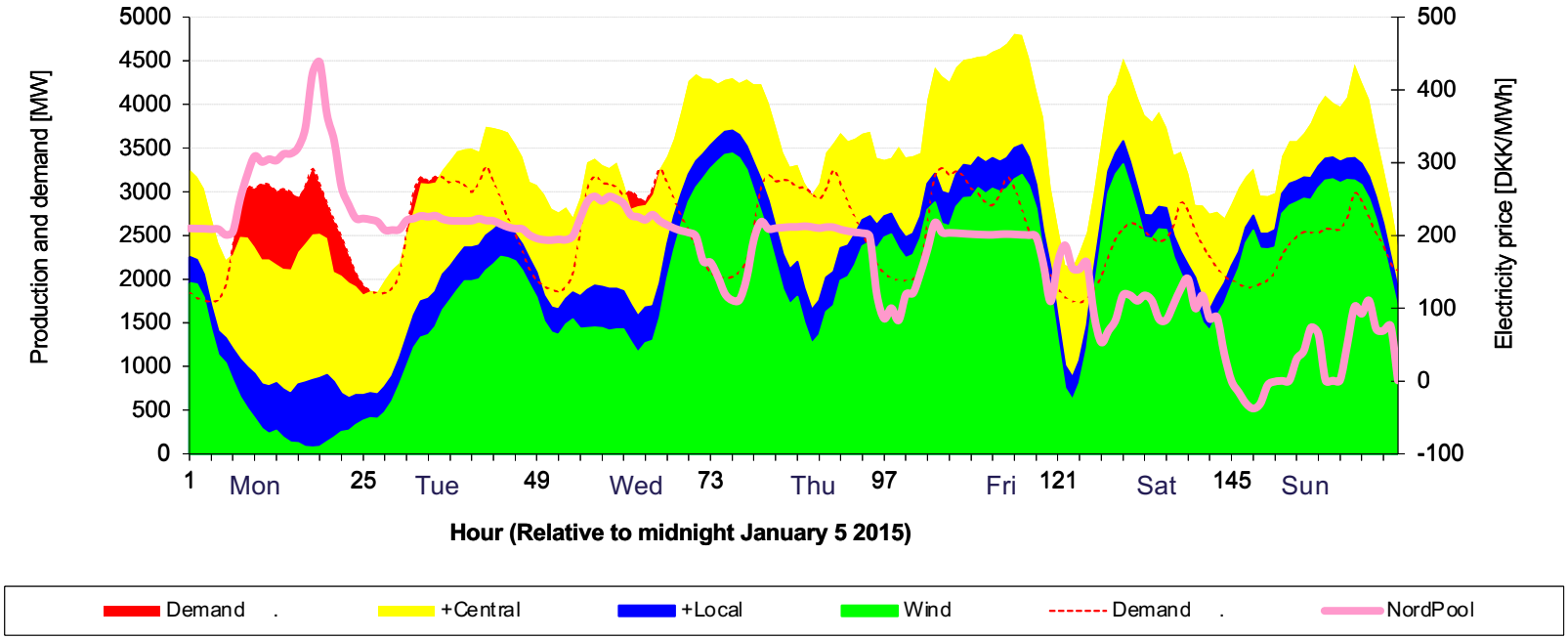
Electrification of the energy system

- Heating - heat pumps and improved climate screens
- Transportation - electricity where possible – otherwise power-to-x
- Industry - electricity where possible – otherwise power-to-x
- Others - electricity

Revisiting Week 2



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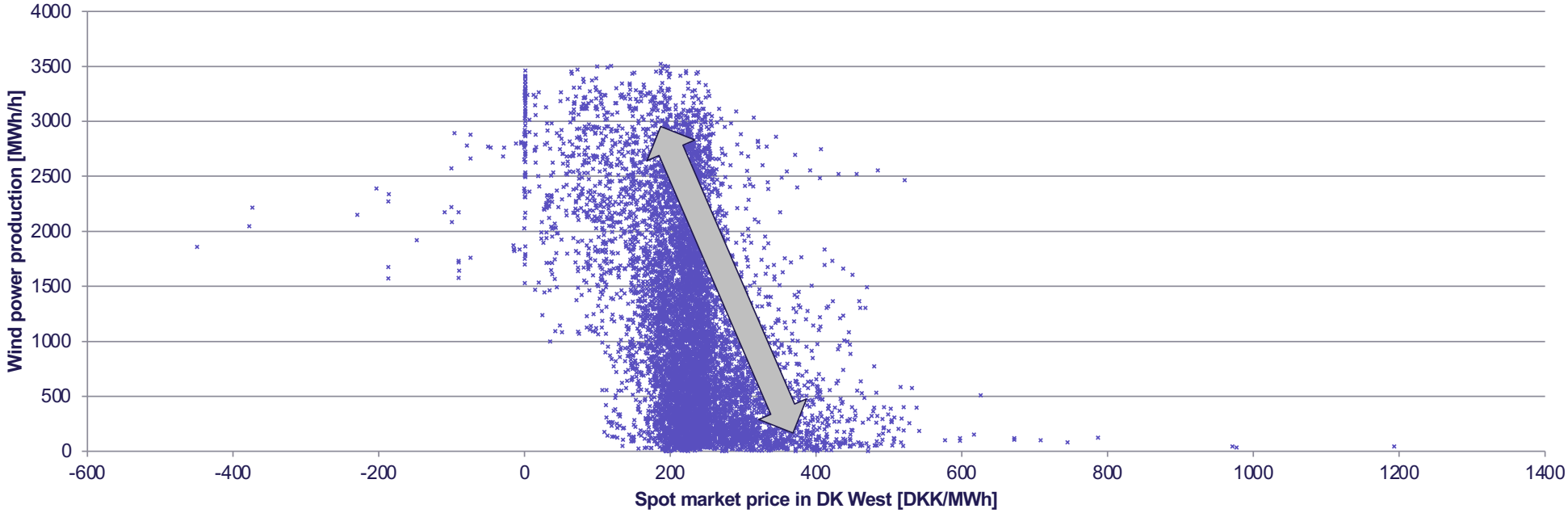
Issues in future renewable energy systems

- Integration – matching demand and supply
- Market issues
- Investment issues
- Barriers relating to
  - Acceptance
  - Ownership
  - Operation
  - ….

Electricity spot market prices in Western Denmark



200DKK= 27€

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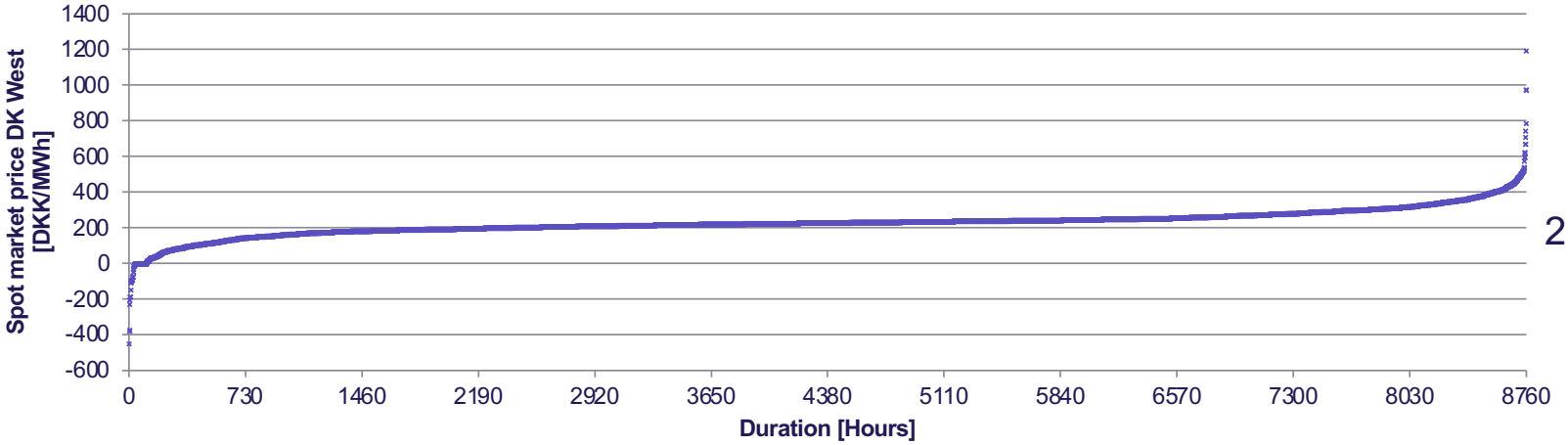
Electricity spot market prices in Western Denmark



200DKK= 27€

Is cheap electricity good?

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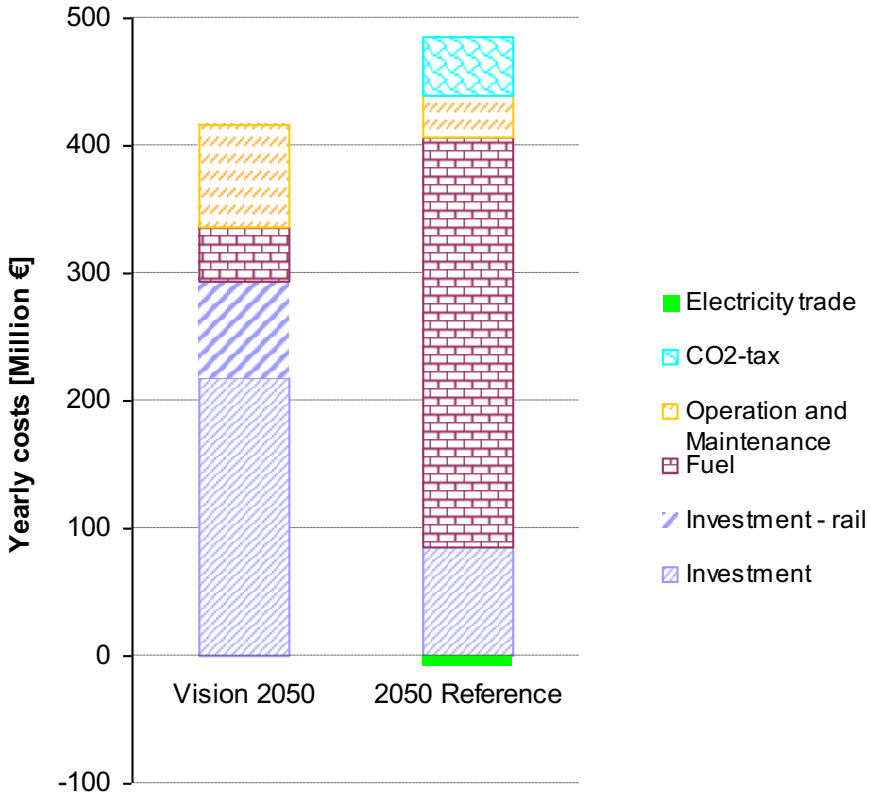
Needed: New energy market

- Where wind and PV do not lower the price level (too much..)
- Where bidding is not necessarily short-term marginal cost-based
- Where demand stabilises prices
- Where thermal facilities can afford not to operate – and to operate
- Where flexible technologies supply the required flexibility
- Where forecasting demands are limited as much as possible

Costs of renewable *vs* conventional energy systems



- Sunk costs
- A shift from modest investment costs and high running costs to high investment costs and modest running costs

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Energy costs – supply, demand and a touch of uncertainty

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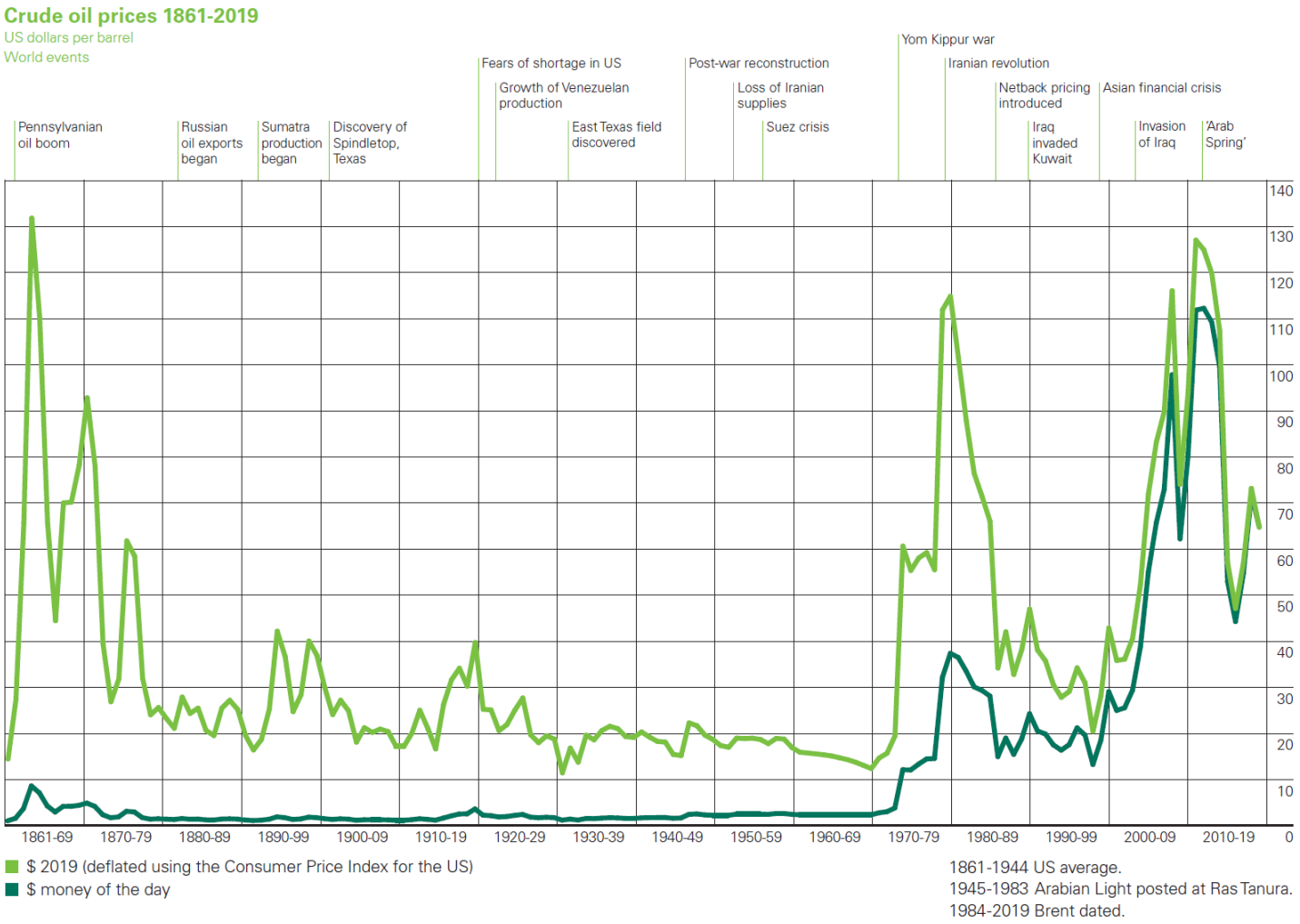

Source: BP

Example of a previous investment problem

- CHP Plants planned under an assumption of increasing electricity process and relatively stable fuel (natural gas) costs
- Instead, electricity prices fell, and natural gas prices increased thus eroding economic feasibility of these plants

Needed: Financial certainty and motivation

- Low discount rate for public investments
- Floor prices for fossil fuels
- (And market adaption as touched upon before)

Integrating renewable electricity

Matching supply and demand throughout the year

Photo: Wikipedia

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Solution 1: Interconnection

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Solution 2: Trading

- Trading is only relevant if there are differences
- Trading should be among “unequals”

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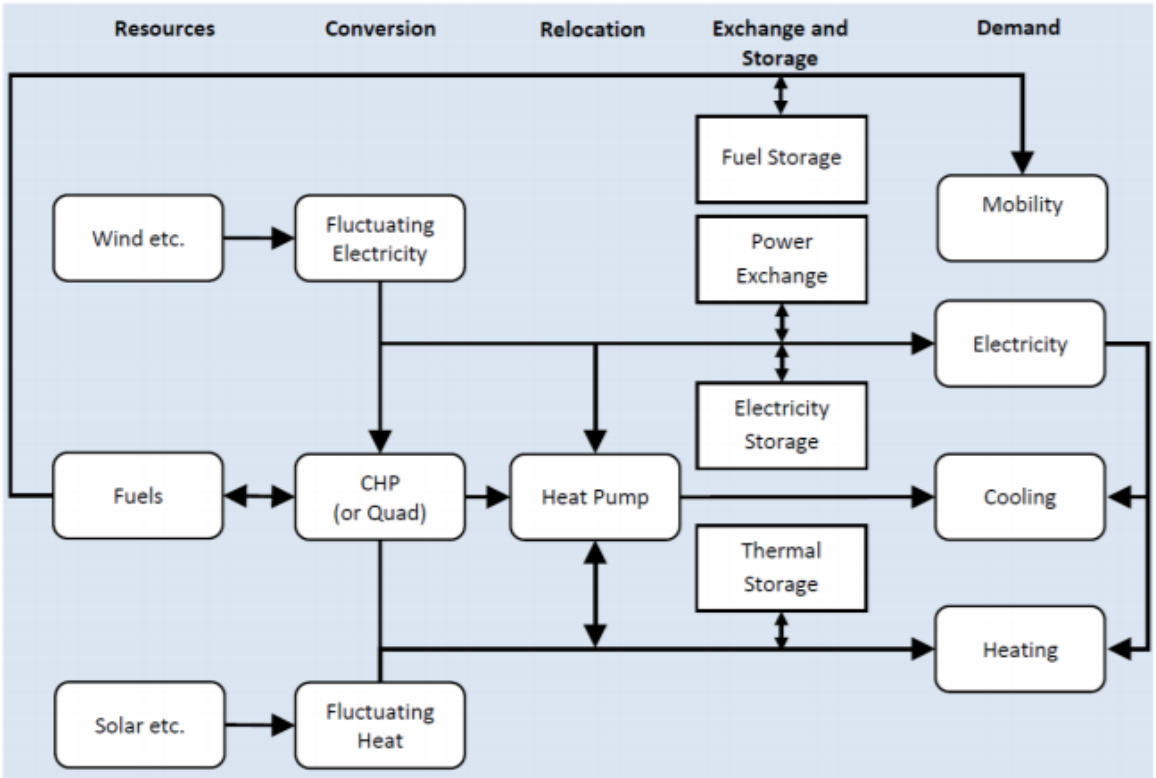
Solution 3: Flexible electricity demand

- A house uses 3-5 MWh per year for ordinary electricity demand
- A house uses 5-6 MWh per year for heating and domestic how water using heat pumps (obviously mainly in the winter)
- An electric vehicle uses 2-3 MWh per year

- Limited flexibility in load shifting within ordinary electricity load
- Integration across traditional demand sectors and utilisation of local flexibility; smart energy system
- Makes trading relevant once selling and buying becomes a conscious decision rather than a natural consequence of the weather



Summarising

- We are looking into a heavily electrified electricity system based to an even higher extent on fluctuating power production
- We cannot rely on trade with our neighbours to solve the issue of balancing the electricity system – particularly when factoring in similar developments in different places
- Geographic differences do not offer sufficient variability or flexibility
- We need to activate the inherent flexibility in house heating and transportation – while the flexibility in the traditional electricity system will not give much support to the general electricity system

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