



**Center for Geopolitics of Energy and Raw Materials
(CGEMP)**



In partnership with:



French Association of Energy Economists

Power in Germany: The turning point of 2011

One year later, lessons for neighbouring countries

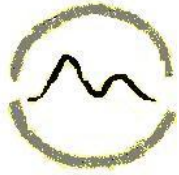
Innovation and new markets for the German industry

Prof. Dr. Georg ERDMANN, Technische Universität Berlin, President of the German Association for Energy Economics

Innovation and New Markets for the German Industry

*Prof. Dr. Georg Erdmann
Chair Energy Systems at TU Berlin*

*CGEMP-Conferennce „Power in Germany“
Paris, 22 June 2012*

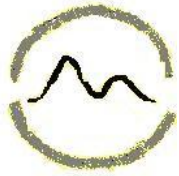


Outline

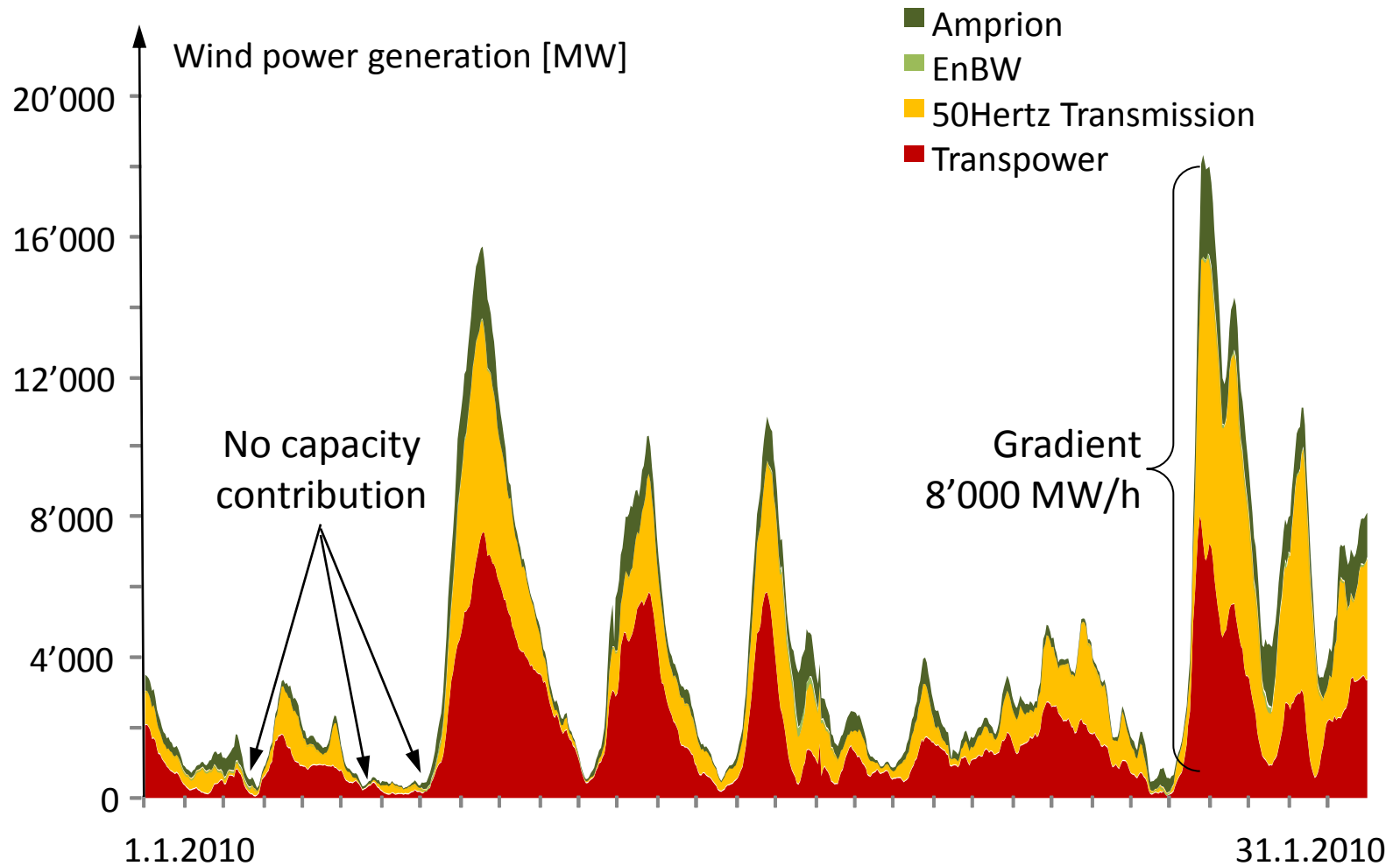
Innovation = Creative anger

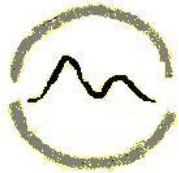
Why we should be angry about the German *Energiewende*?

- Concept remains somehow politically unclear:
 - Centralized vs. decentralized electricity supply
 - Renewable power marketing
 - Offshore wind (and new transmission lines)
 - Building insulation vs. more CHP
 - Manifold of distorting subsidies
- **Intermittency of Photovoltaic and wind power**
- **Reliability of power supply (power storage)**
- **Energy Costs – and who shall pay**



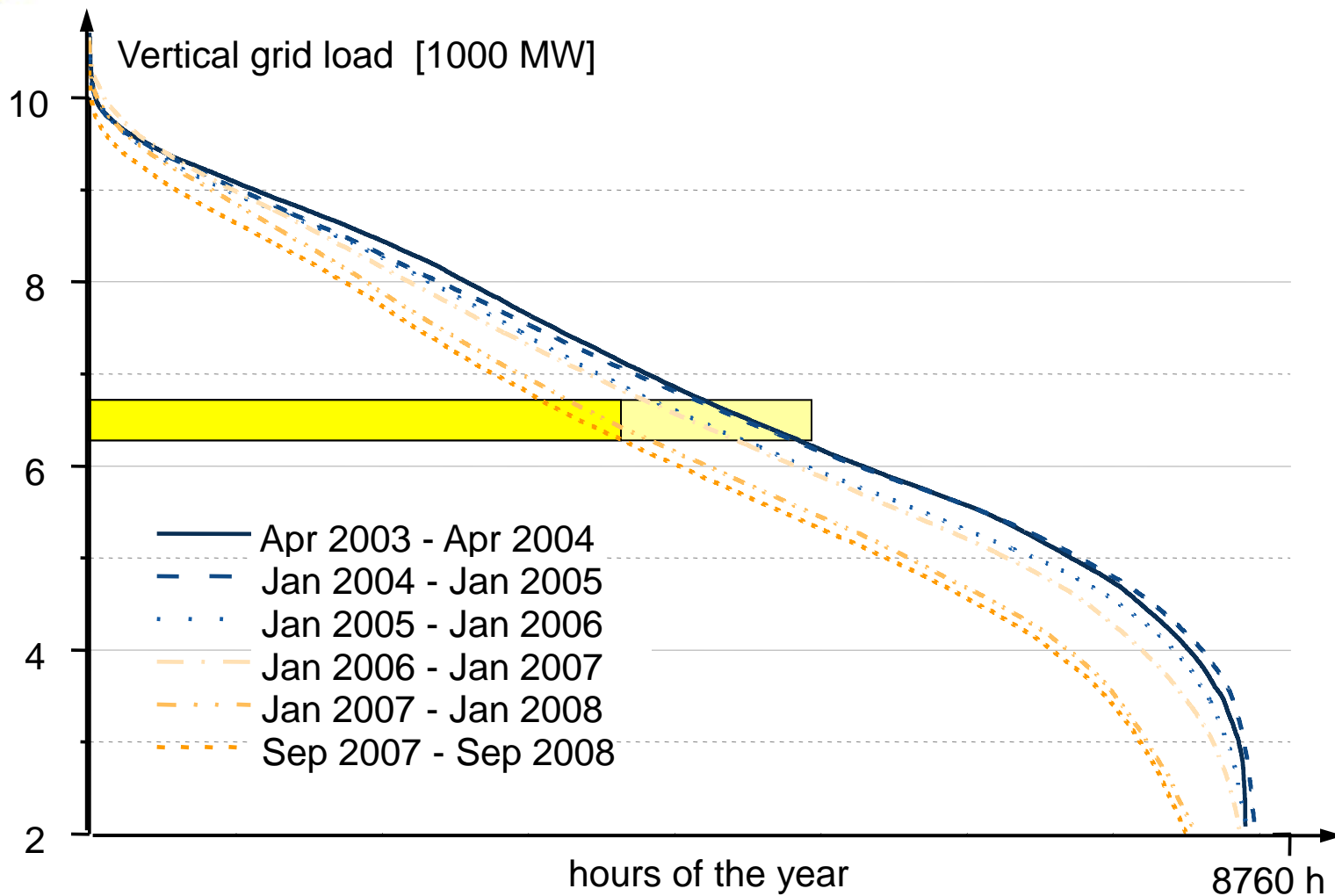
Volatility of Wind Power [Source: Ehlers 2011, S. 100]

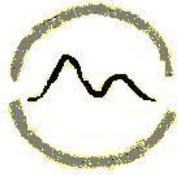




Ordered Duration Curves of Residual Load

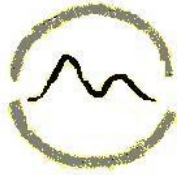
[Source VE-T GmbH 2009]





Implications: Intermittency

- Conventional thermal power plants need to develop new operation modes characterized by steeper gradients (in both directions)
- Traditional base load power plants have to reduce operation hours and will become, from an economic point of view, mid-load and even peak-load plants (with < 2000 full load operation hours)
- Reduced number of annual operation hours → Missing money challenging backup power plant investments
- Subsidizing 20 % of the market leads sooner or later to the situation to subsidize the whole market

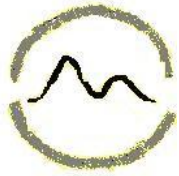


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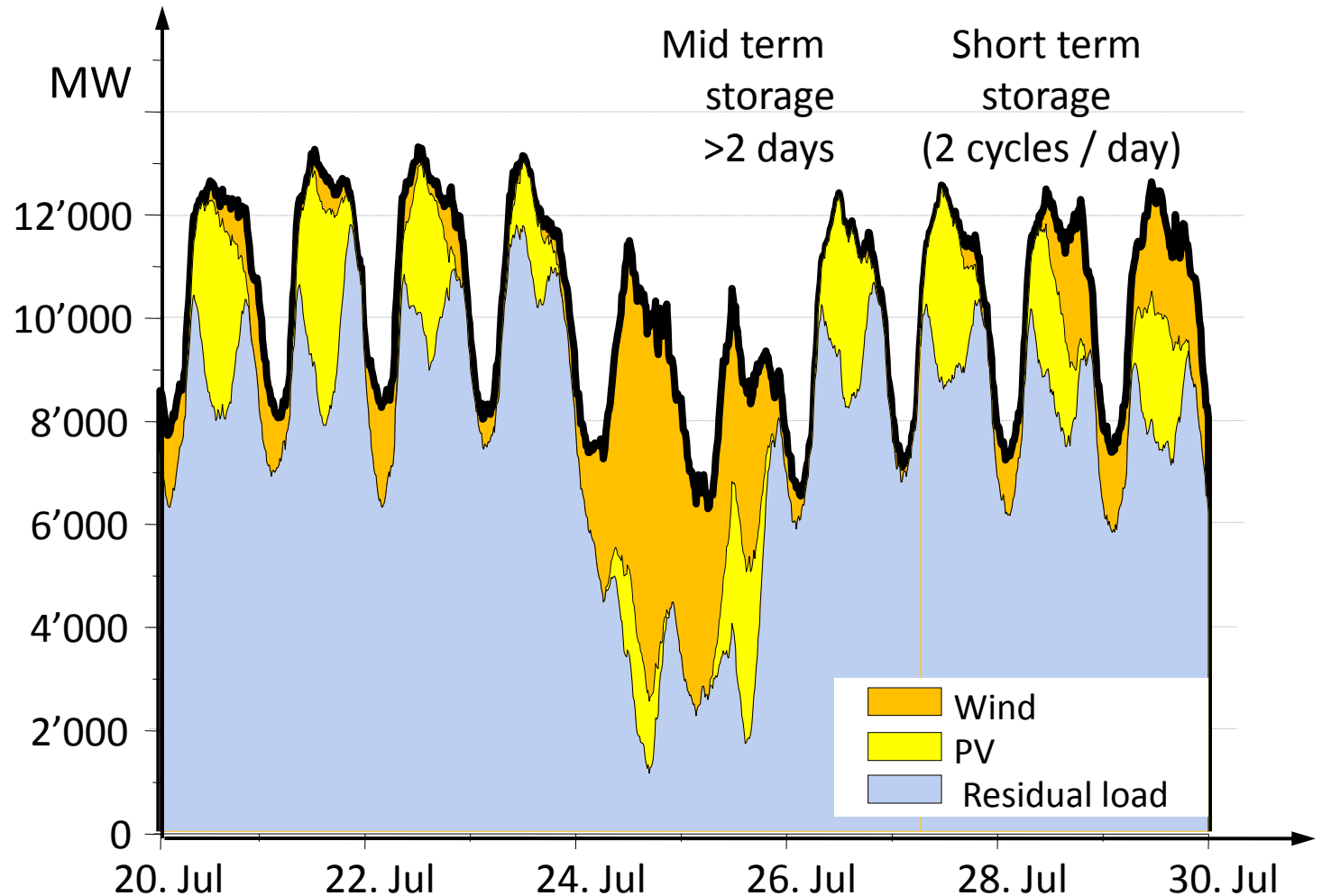
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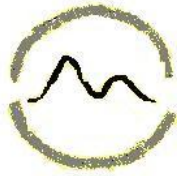
Why we should be angry about the German Energy Turn?

- Politically undetermined concept of the energy turn:
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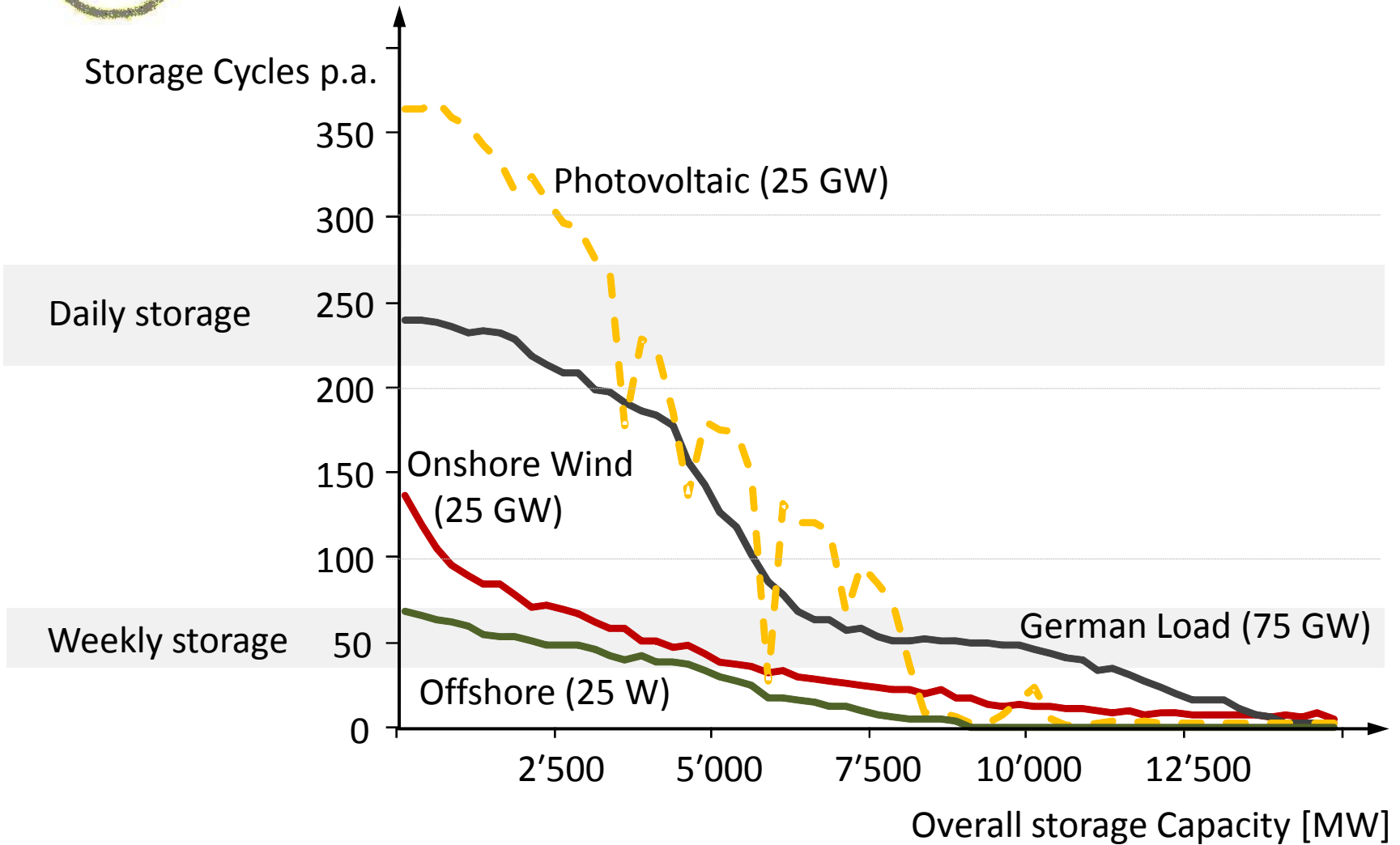


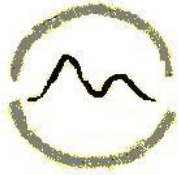
... Leading to Fluctuating Residual Load





Storage Cycles per Year [Source: Ehlers 2011]



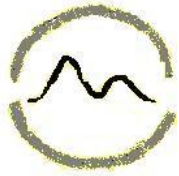


Cost of Electricity Withdrawn from a Storage

$$\text{Costs} \left[\frac{\text{Euro}}{\text{MWh}} \right] = \frac{1}{\eta} \cdot \left[\frac{cc \left[\frac{\text{Euro}}{\text{MW} \cdot \text{a}} \right]}{flh \left[\frac{\text{h}}{\text{a}} \right]} + oc \left[\frac{\text{Euro}}{\text{MWh}} \right] \right]$$

High number of cycles
or high storage volume

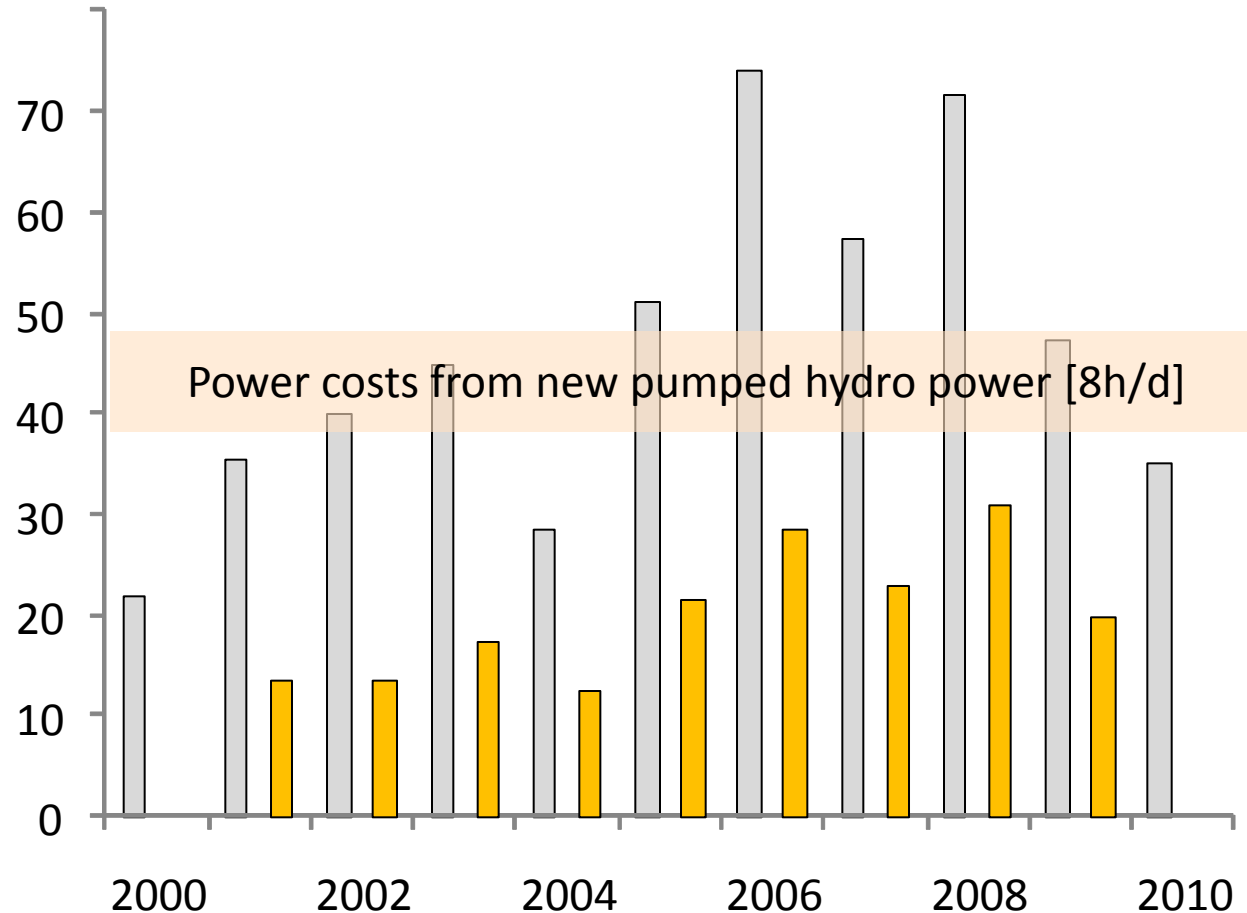
| | |
|--------|----------------------------------|
| cc | Annualized capital costs |
| oc | Energy and operation costs |
| flh | Full load hors |
| η | Energy efficiency of the storage |



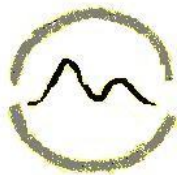
EPEX Price Spreads

Average
spread/day
[Euro/MWh]

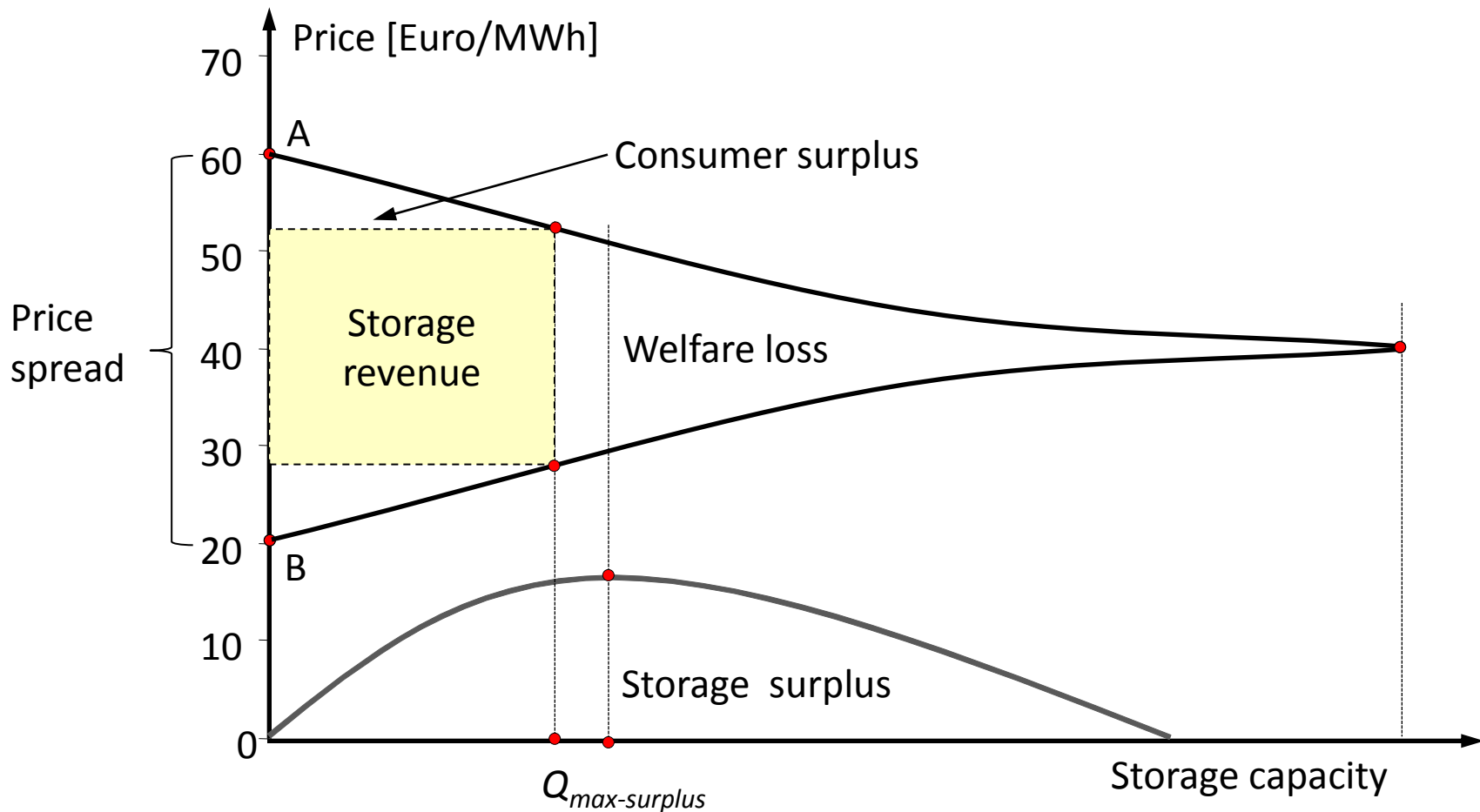
■ 1 hour
■ 8 hours
(optimal)

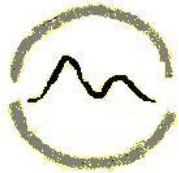


Additional revenues through system services and financial speculation



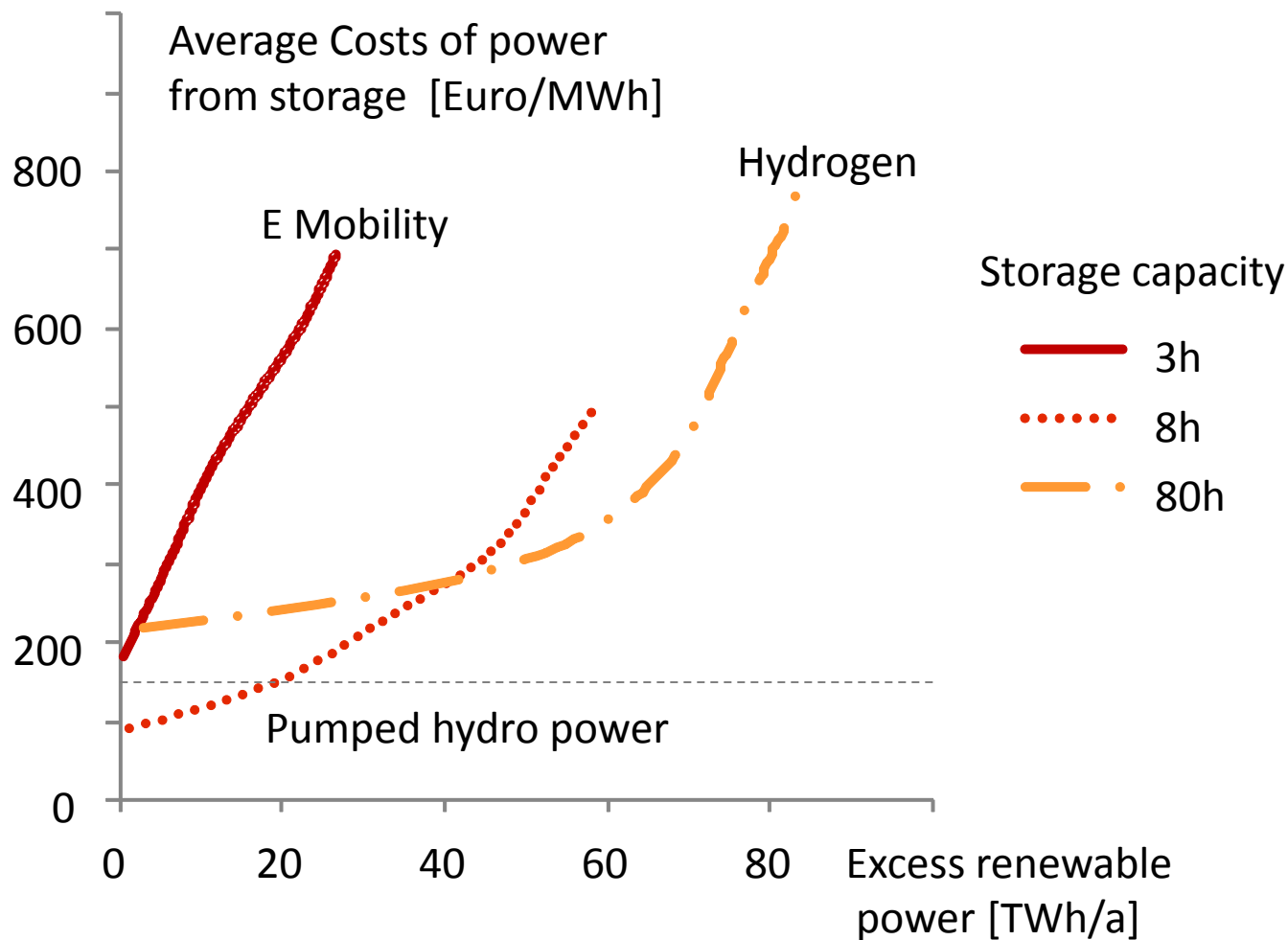
Canibalization of Storage Revenues

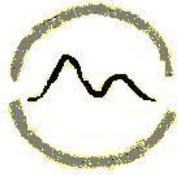




Modelled Costs of Power from Storage

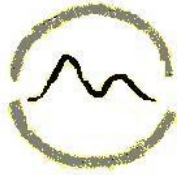
[under optimistic assumptions]





Implications: Reliability of Power Supply

- High shares of renewable power require backup systems
 - Interruptible load (functional storage)
 - Backup power stations (emergency load, CHP, distributed generation)
 - Transmission grid extensions (as far as renewable sources across Europe are statistically uncorrelated)
 - Different types of storage devices
- The economics of capital intensive systems suffers
 - from small annual number of operation hours
 - Cannibalization of revenues
- Is the energy only EPEX market able to solve the missing money problem? (I would say yes, if the feed-in regulation for renewables is modified)

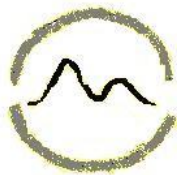


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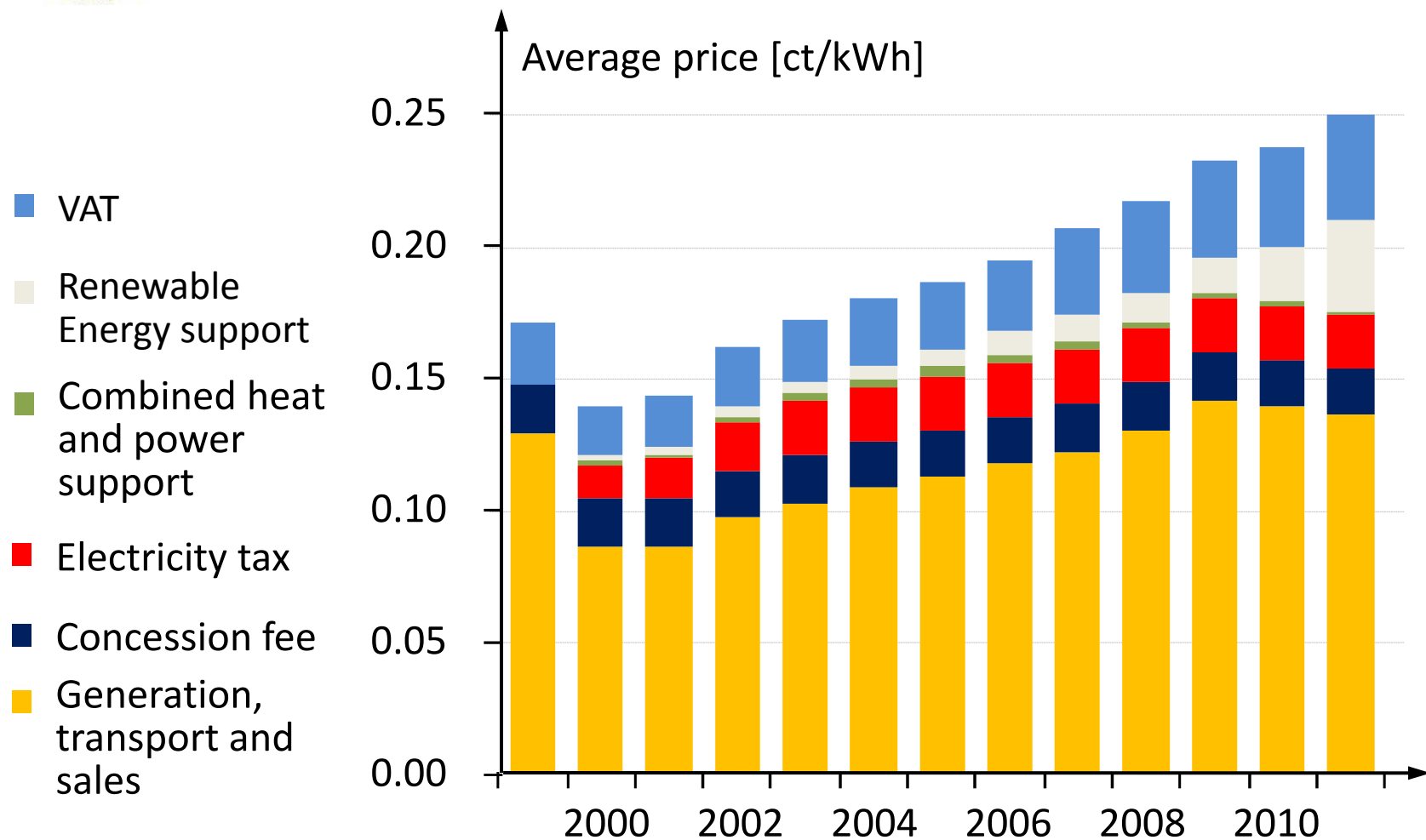
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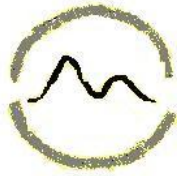
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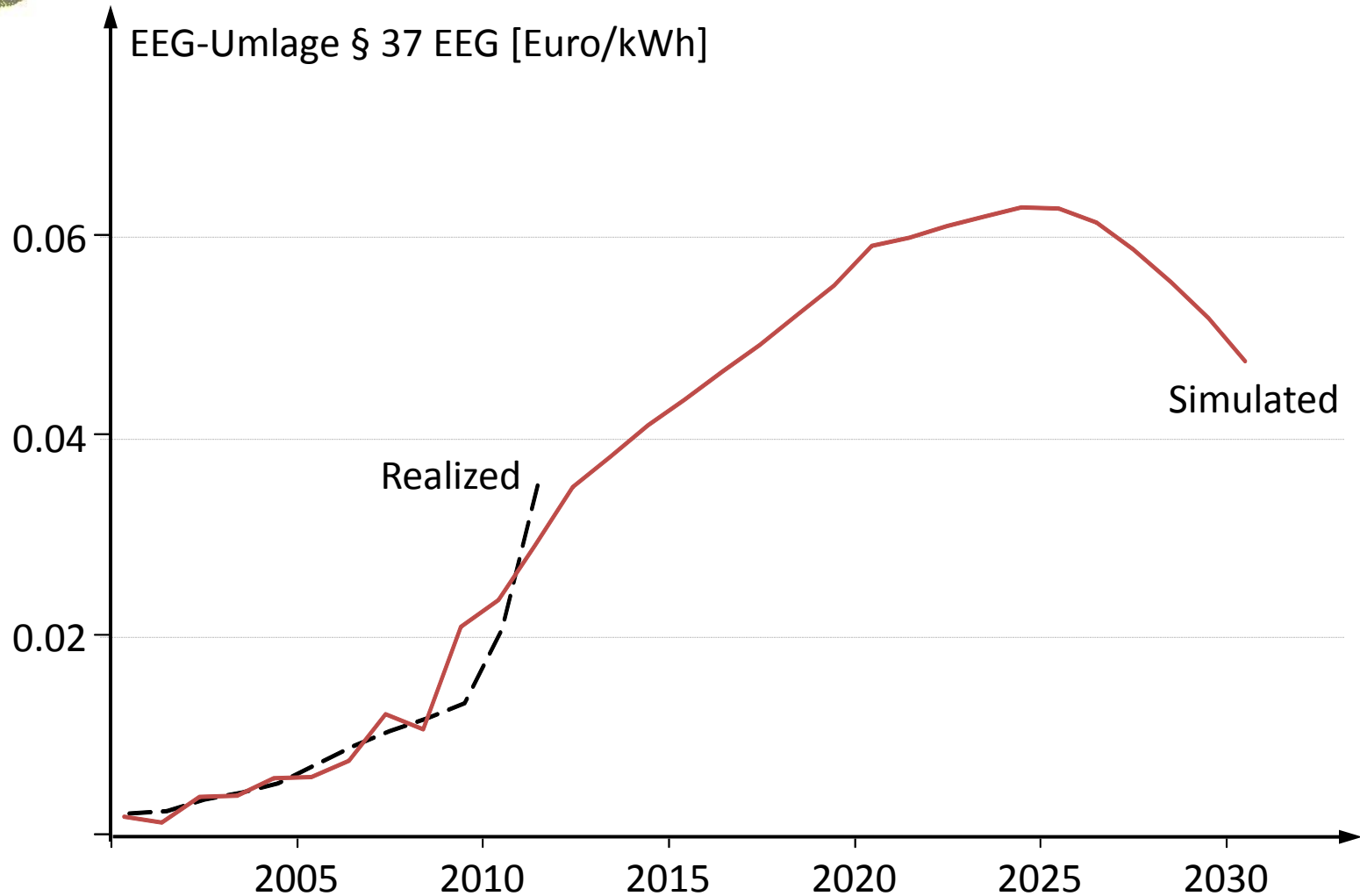


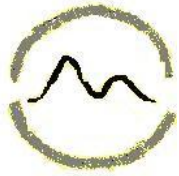
Household Electricity Prices [Data source: BDEW]



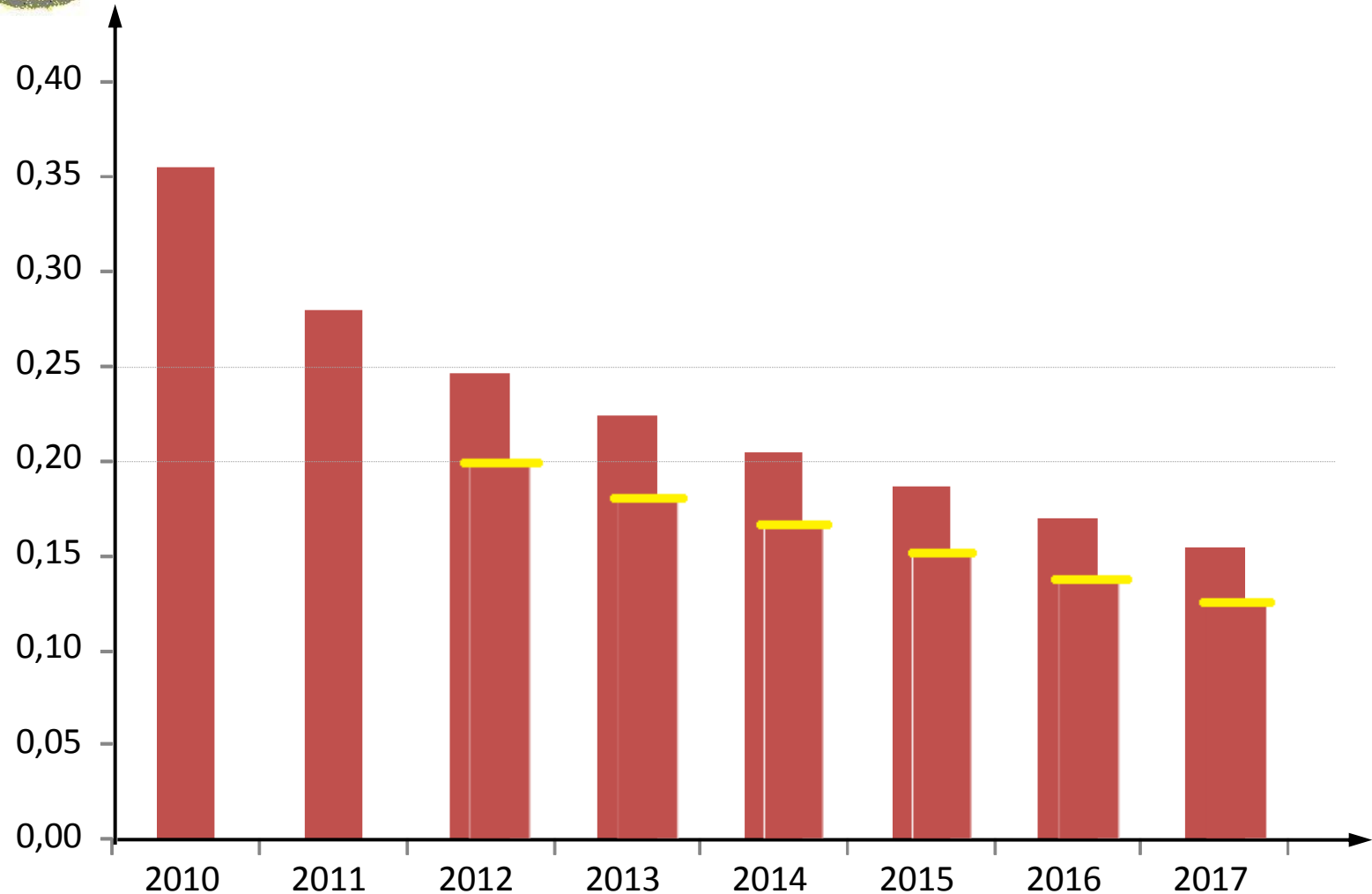


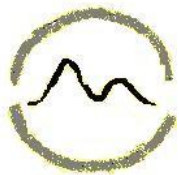
Evolution of the Renewable Energy Surcharge





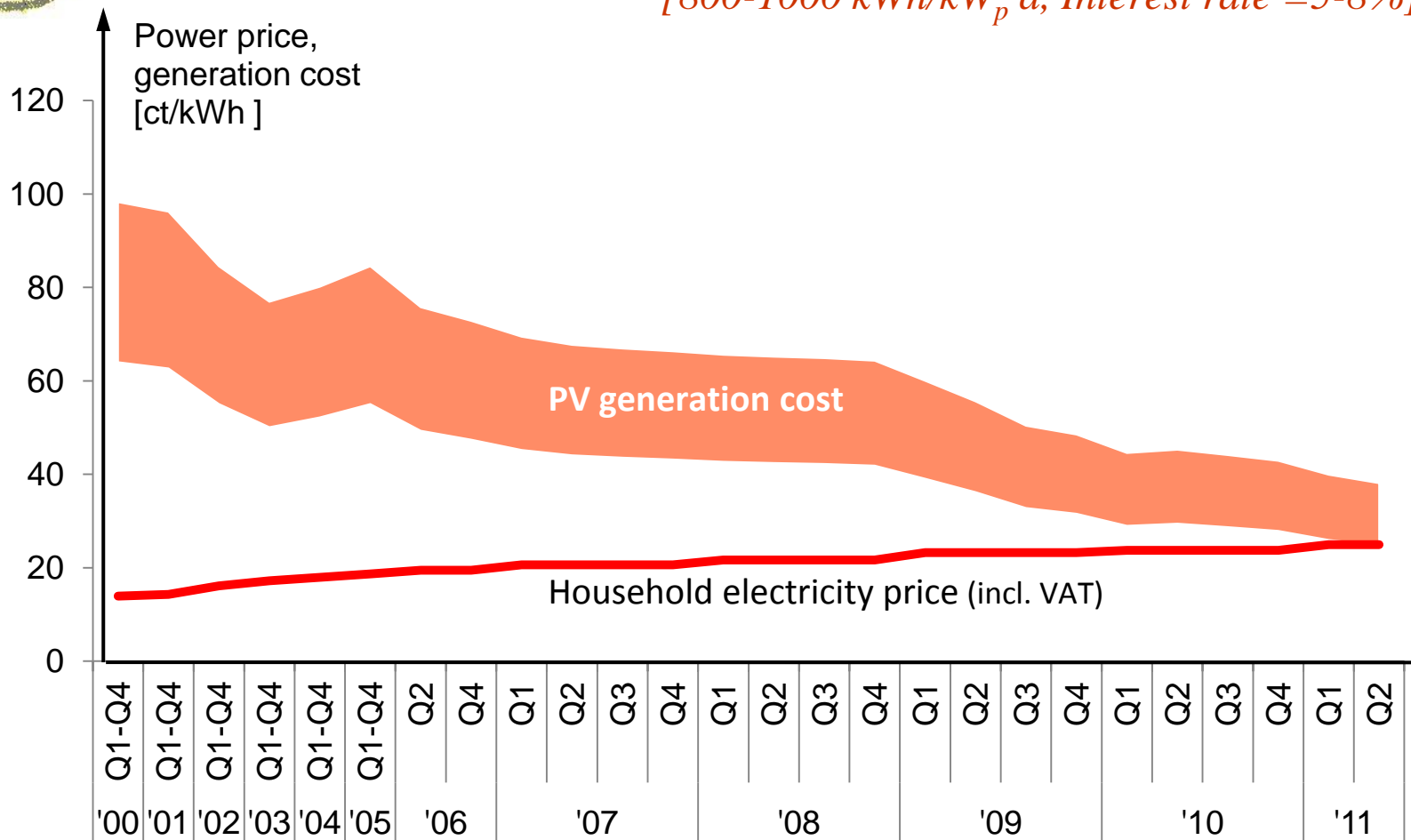
Fed-in Tariff of PV < 30 kW_{el} [§ 20a EEG]



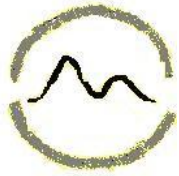


Generation Cost of PV Roof Installations

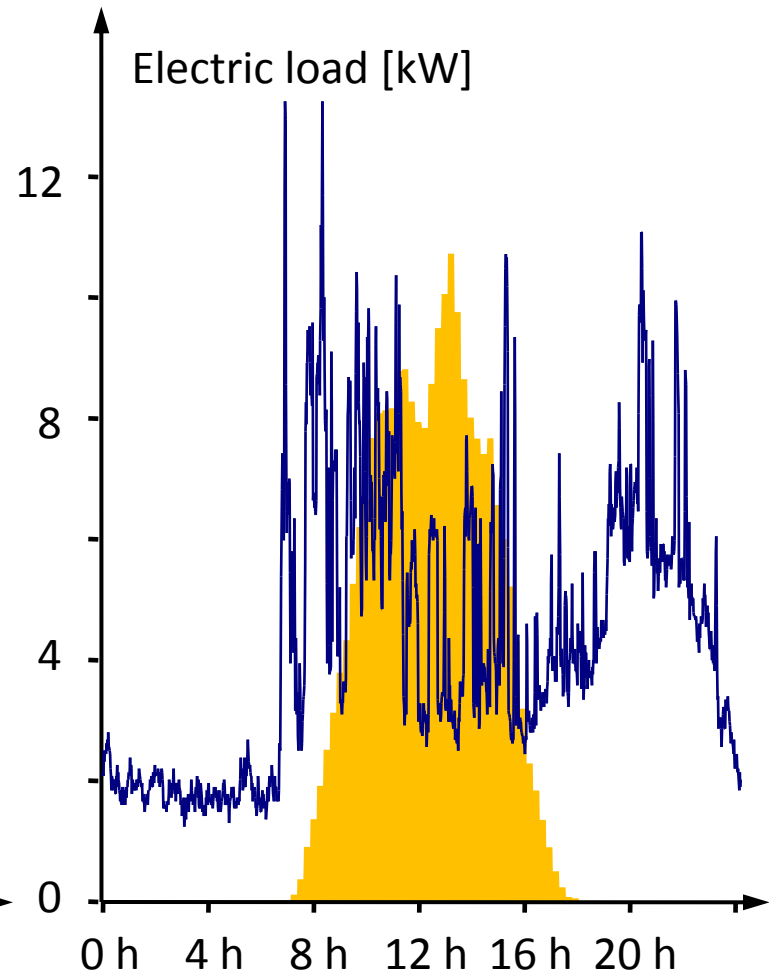
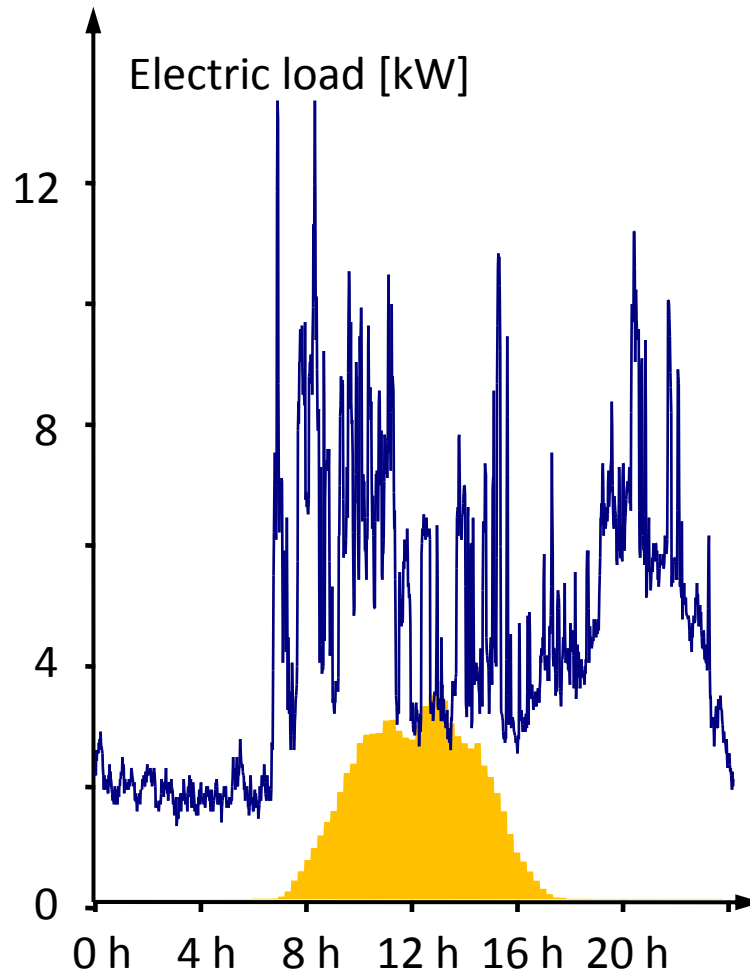
[800-1000 kWh/kW_p'a, Interest rate =5-8%]

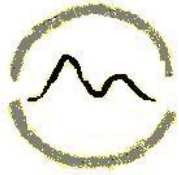


Source: Johannes Henkel and Lars Dittmar 2011



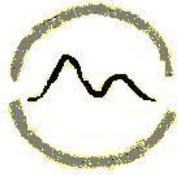
Load profile of 10 Three-Person-Households





Implications: Energy Costs

- Power will become more expensive through
 - Renewable capacity investments
 - Backup and storage capacity investments
 - transmission and distribution grid investments
- Energy intensive industries (and some customers) will be exempted from paying the additional costs (What happens at the limit?)
- Grid parity issue will be generate a self reinforcing pressure towards decentralized power generation
- Stranded system costs, social imbalance, regional imbalance
- And what about European single market



Conclusion: Portfolio of Innovations

- Renewable generation technologies: Forecasting of wind and PV; satisfaction of grid requirements (50.2 hz problem); direct marketing; further cost reductions and efficiency improvements, particularly for offshore wind and geothermal
- Thermal power: Flexible generation; market design that solves the missing money problem
- Storage: Battery costs, security and lifetime; power to gas; hydrogen and fuel cells; thermal storages; flexible electric demand such as heat pumps, battery vehicles etc.
- Transmission grid: Temperature management; HVDC cables; offshore connection; enhancement of the planning processes
- Distribution grids: DG preparation for system services, smart metering (information technology)