Transformation Dynamics in the Energy Sector

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Outline

- Lessons from the IRENA process
- Accelerating innovation in renewables
- Grid parity will change the game
- The next challenge: grid and storage
- Industry policy, new actors: China and USA
- Beyond electricity
- New priorities for public policies and infrastructure
- A vision for Europe: ERENE

LESSONS FROM THE IRENA PROCESS

IRENA – the most rapid foundation of a new IO in the last half century

- First Preparatory Conference, Berlin, April 2009
- Final Preparatory Conference, Madrid, October 2009
  - Breakthrough thanks to alliance DE/SP/DK
- Foundation conference in Bonn, January 2009:
  - 75 founding members
- Second PrepCom, Sharm el Sheikh, June 2009
  - 136 members (including US, GB, JAP, AUS)
  - Decision on headquarters: Abu Dhabi
  - Decision on Director General: Hélène Pelosse
  - Decision on work programme and budget

Lessons from the IRENA process

- During one year the scene has changed: renewable Energy is now being taken serious, has grown into larger political dimensions
- Renewable energy has become a top industry policy issue
- Rivalries and power games risk to hamper the chances for a rapid transformation of energy systems
- A paternalistic approach of industrialised countries inhibits the perception of the rapid rise of new powers
- Germany has underestimated the issues at stake, failed to forge appropriate alliances, was not sufficiently able to listen and to build consensus, lost its leading role in the process
- New alliances for a transformation are needed, with appropriate roles for all partners
- Europe needs a joint strategy for living up to its potential

THE UNDERESTIMATED INNOVATION SPEED OF DISRUPTIVE TECHNOLOGIES

Germany has triggered the take-off of the world PV market

PV Market Data 2008	
Newly installed power	1 500 MWp
Total installed power	5 334 MWp
No. of total systems installed	ca. 500 000
Turnover 2008	6 Bln € / 8.1 Bln $
Employees	45 000

Milestones

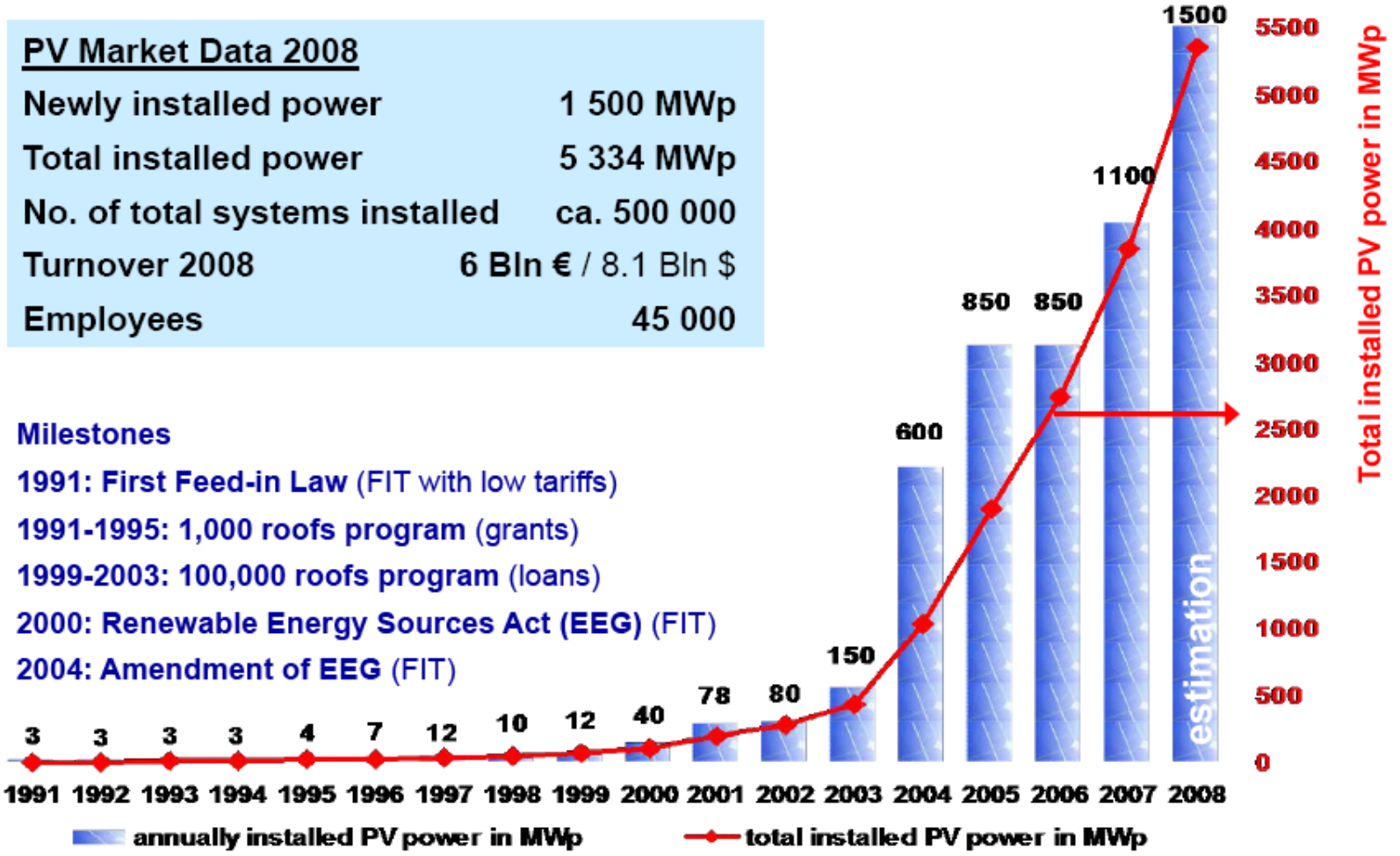
1991: First Feed-in Law (FIT with low tariffs)

1991-1995: 1,000 roofs program (grants)

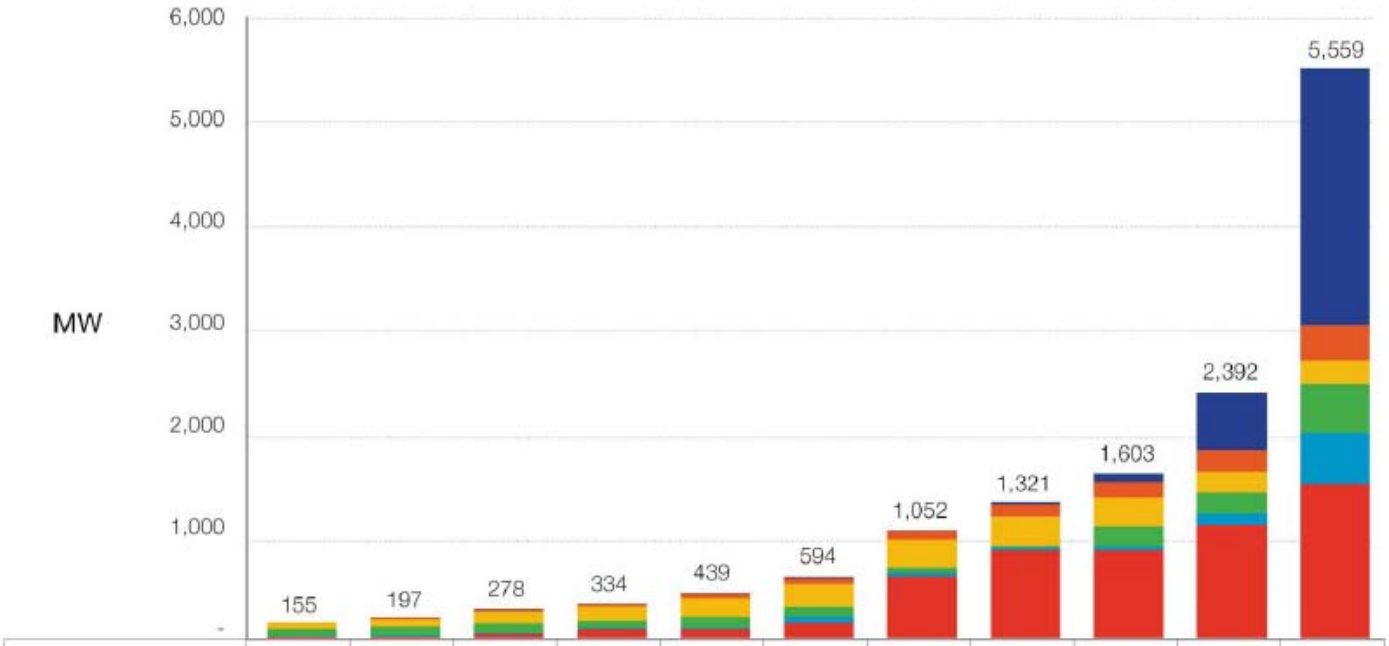
1999-2003: 100,000 roofs program (loans)

2000: Renewable Energy Sources Act (EEG) (FIT)

2004: Amendment of EEG (FIT)



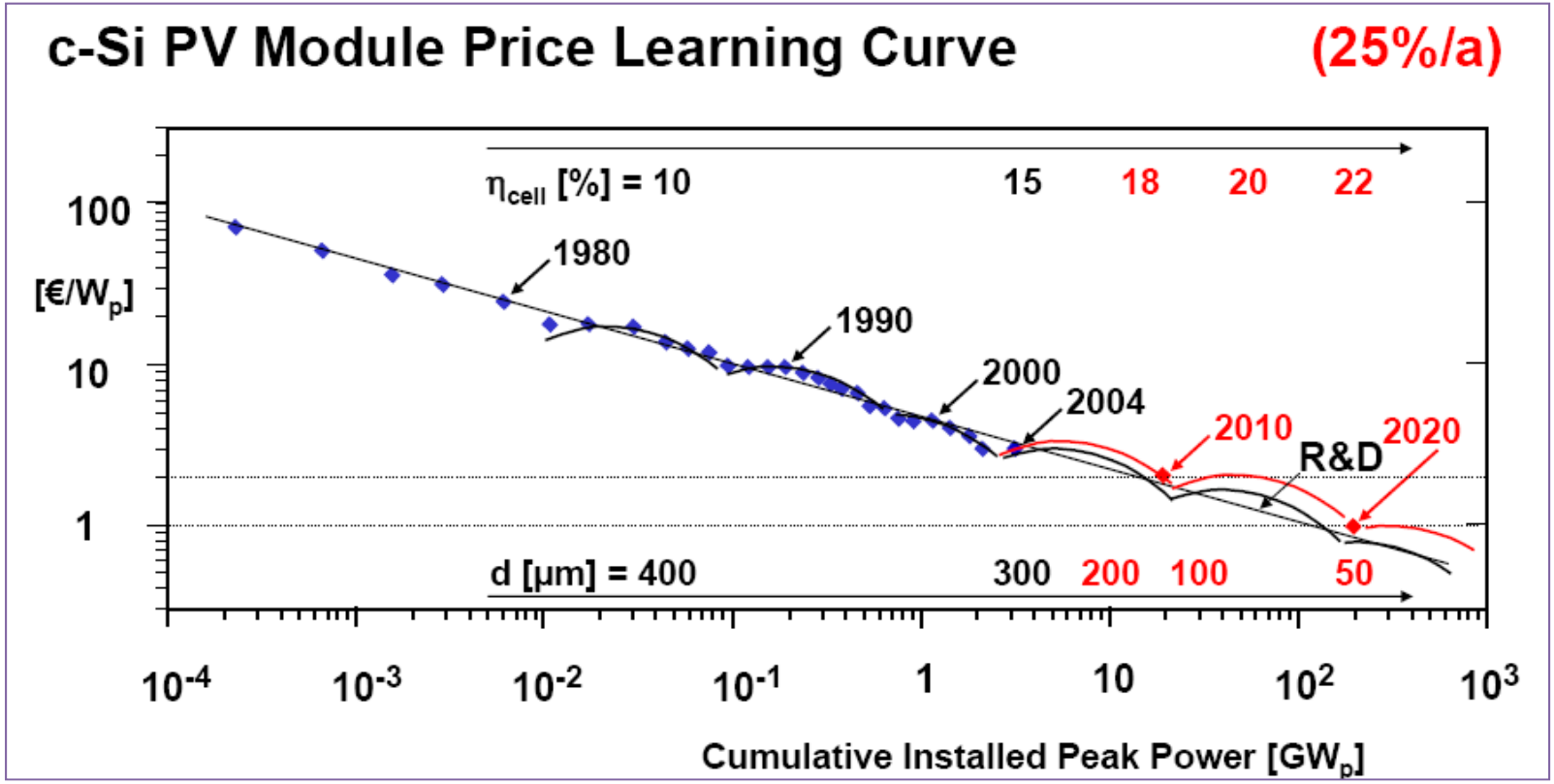
Global PV market development



MW	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Spain	0	1	-	2	9	10	6	26	88	560	2,511
USA	-	17	22	29	44	63	90	114	145	207	342
Japan	69	72	112	135	185	223	272	290	287	210	230
Rest of the world	68	84	94	75	104	98	53	12	196	207	485
Rest of Europe	8	11	10	16	16	50	30	30	37	108	492
Germany	10	12	40	78	80	150	600	850	850	1,100	1,500
TOTAL	155	197	278	334	439	594	1,052	1,321	1,603	2,392	5,559

Steep learning curves

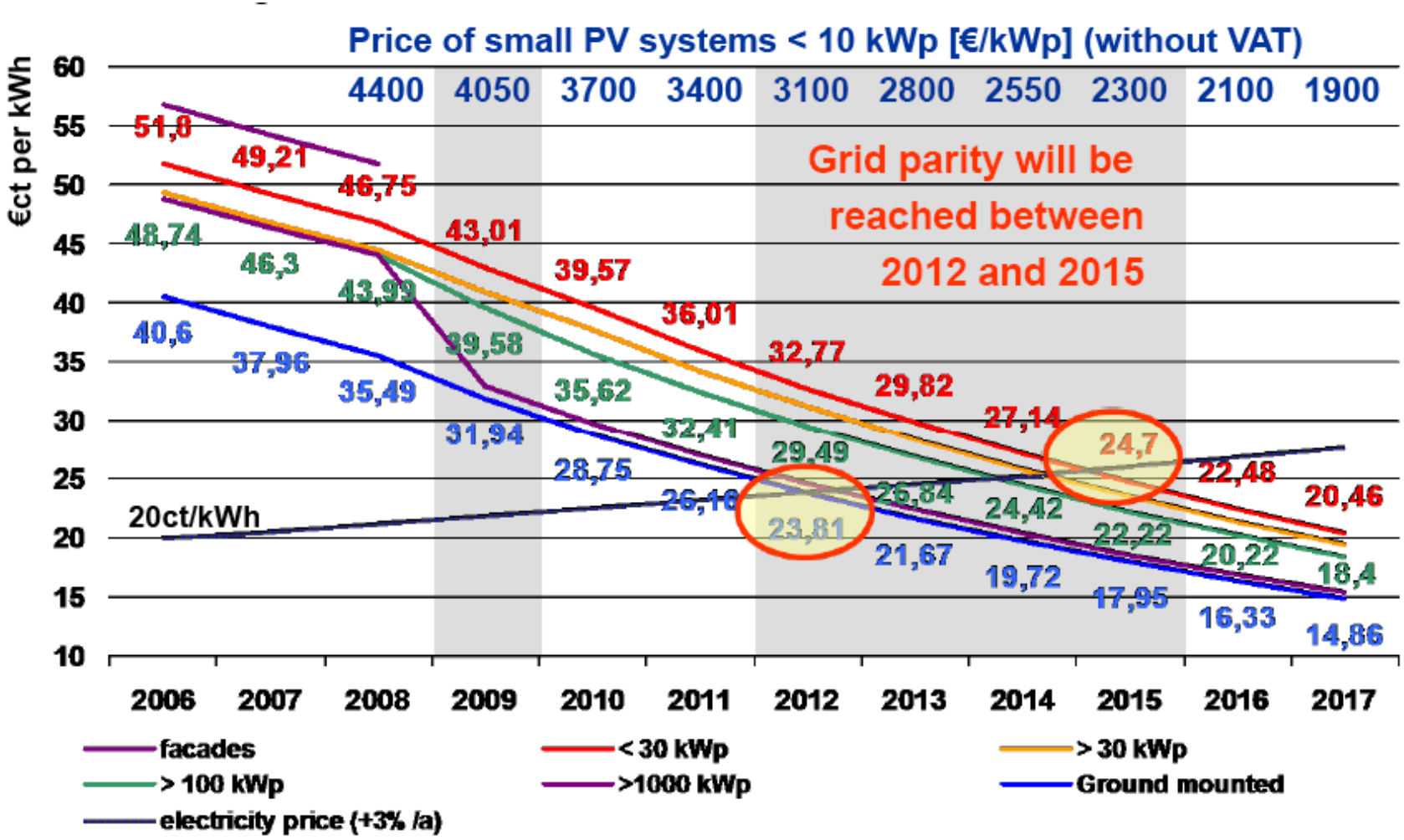
- PV: steepest learning curve of all energy sources
- Capacity growth more rapid than expected



Underestimated scope and multitude of innovations

- Massive R&D efforts since some years, to a large extent not yet on the markets, aiming at
  - Higher efficiency
  - Lower production costs
  - New application fields
- New promising approaches on many tracks
  - Improvement of existing PV cell types
  - New PV cell materials & principles (organic, dye sensitised, new multi-junction combinations)
  - New concentrator technologies (with and without tracking)
  - New production technologies
  - New packaging and integration technologies

German feed-in-tariff already anticipates grid-parity in five years

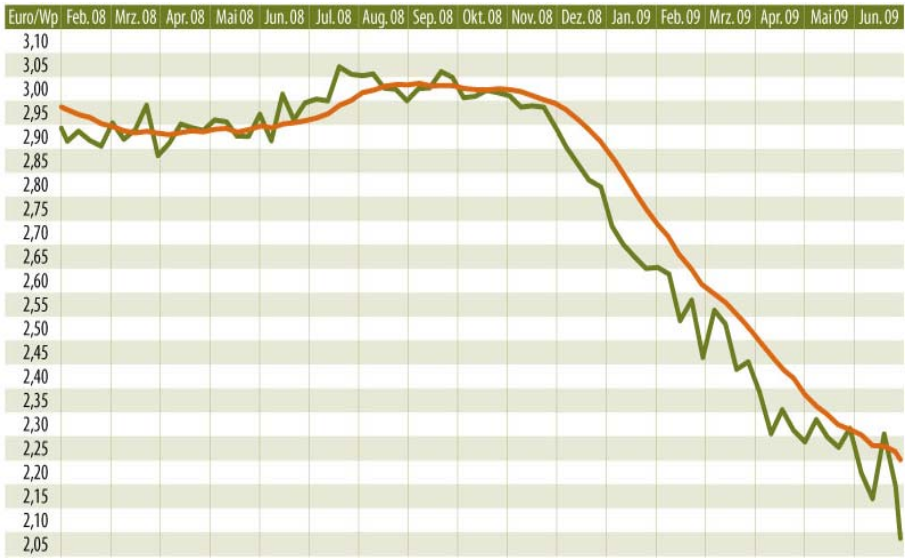


Costs and now also prices fall more rapidly

- Prices fell 30% Jan-Aug 2009:
  - Sufficient Si supply after completion of new facilities
  - Massive capacity build-up mainly in China, key-turn factories
  - Breakdown of the Spanish market, credit crunch
- Prices do not correspond to lowest available production costs
- Lowest module production costs today: around 1€/Wp
- Announced module production costs end 2010: <0,60 €/Wp

Chinese crystalline modules

3,00 → 2,10 €/Ws



EPIA's ambitious growth path: Towards PV competitivity in Europe

European Photovoltaic Industry Association EPIA:

- Realistic learning curve:
  100% increase of installed PV → 20% cost reduction

→ Step by step grid parity will be reached in all important markets in the coming years

	2008	2012	2016	2020
Share of EU electricity markets where grid parity is reached	0%	10%	50%	90%

EPIA proposes as target for EU policies :

- Cumulative PV installed in Europe 2020 : 350 GWp
- PV share of EU electricity generation : 12%
- Annual growth rate of installed PV base : 40%

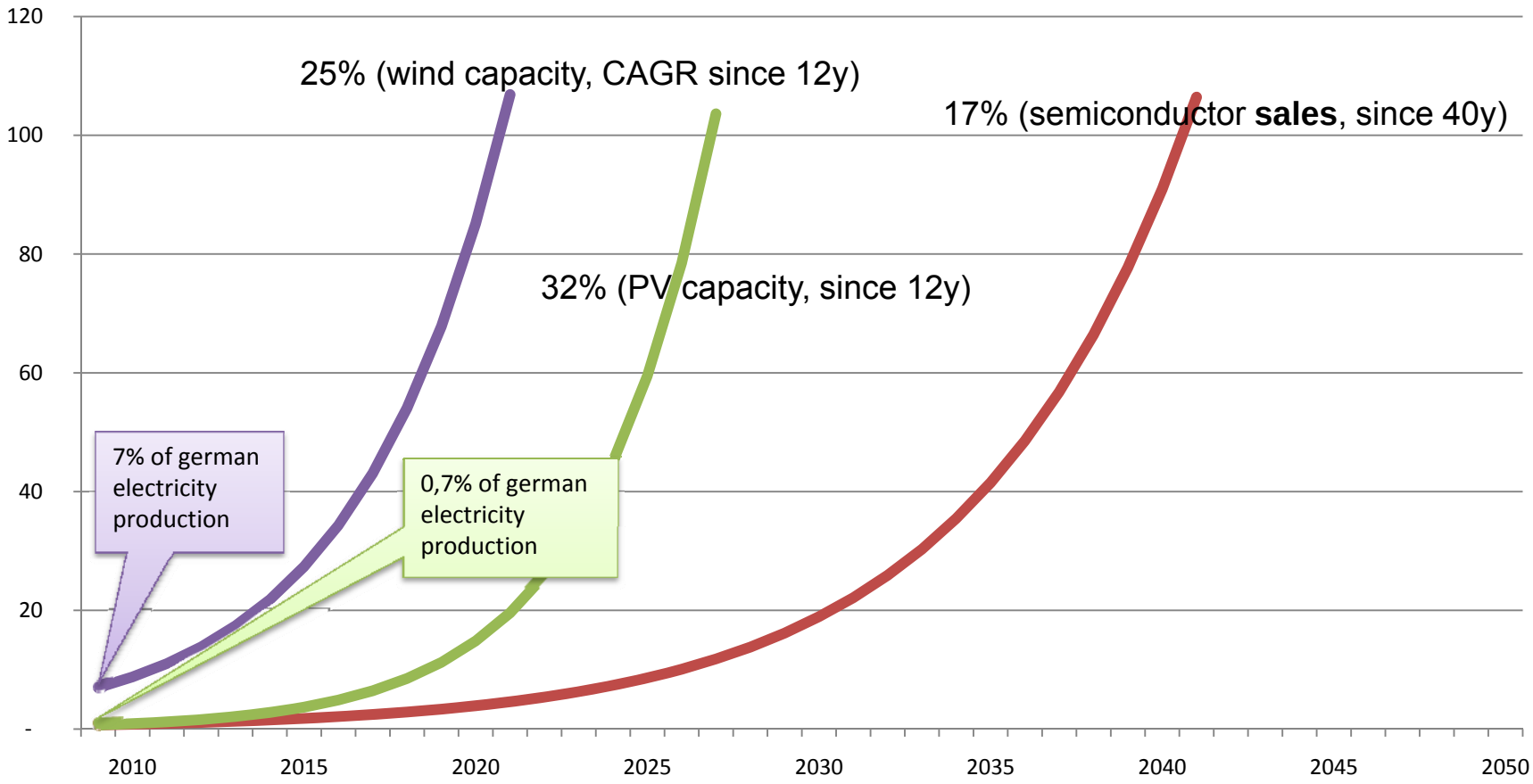
Renewable power growth

- **Wind** power: installed capacity World
  - Total installed in 2008: 120 GW
  - CAGR 1996 – 2008: 25,5% →
- **PV** power: installed capacity World
  - Total installed in 2008: 16 GW
  - CAGR 1996 – 2008: 32 % ↑
  - CAGR Germany 2000-2008: 68%

Nuclear Power Growth

- Nuclear electricity production World
  - CAGR 1973 – 1990: 14,3%
- Nuclear electricity production France
  - CAGR 1973 – 1990: 11%
  - CAGR 1979 – 1990: 22%
  - Power plant construction time 6-9 y

Extrapolating exponential growth



Time horizons

- Photovoltaics
  - factories: 15-40 months, increasingly turnkey, operation time <5y
  - Installation: weeks, months, planning increasingly standard, operation time 20-30y, decommissioning: weeks, nearly full recycling
- Wind
  - factories: 20-40 months,
  - Installation: weeks, planning > PV
  - operation time 20-30y, decommissioning: weeks, recycling covers costs
- Nuclear
  - building 80-100 months, little standardisation, long planning, high local impact.
  - operation time 30-50y, decommissioning >20 years + nuclear waste

Innovation cycles

- Short innovation cycles enable high innovation speeds
  - e.g. transportation: trucks will outdo railways in CO2 performance because innovation cycles are shorter
  - PV, wind are standardised at several levels (installation, factory), have shorter cycles at all levels: will rapidly outperform traditional systems
- Innovation in PV and wind brings
  - lower cost
  - less environmental (surface, landscape) impact
  - A larger range of applications
- Especially PV is a disruptive technology
  - steepest learning curve among renewable technologies
  - allows and facilitates electricity production at all scales
  - relies on unlimited resources everywhere
  - brings new actors into the game

Scaling-up times

- From an industry point of view, scaling up PV and wind power capacity with annual growth rates over 30% is feasible
- Ensuring smooth growth at high rates is a challenge for market regulation, especially in the subsidy phase
- Scaling-up speed is not limited by production
- The main challenge is to rapidly integrate a high share of fluctuating electricity production

  (→demand side management, interregional exchange, storage)

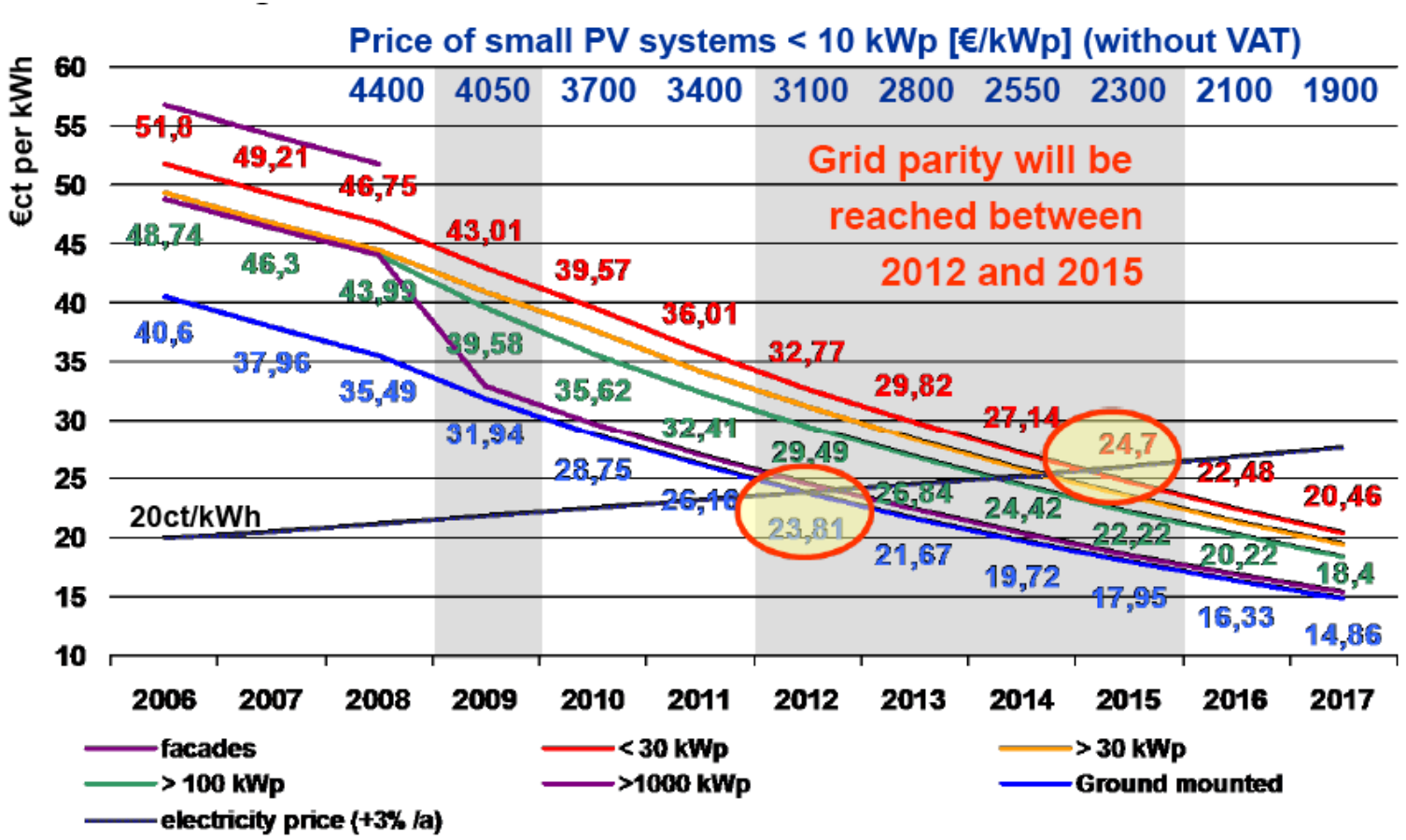
Transition technologies

- The necessity of a transition to a carbon-free energy system is not questioned anymore
- Nuclear energy and CCS are often promoted as transition technologies before reaching a fully renewable supply
- The development of an optimal supply with pervasive, inconspicuous PV make take several decades
- In the meantime, even aesthetically disturbing wind and PV installations are an ideal transition technology
  - their impact is completely reversible
  - they have extremely short build-up and decommissioning times
  - building additional grid and storage capacities with existing technologies has less impact than conventional power plants
  - NIMBY is no solution, we need a large discussion about trade-offs

GRID PARITY WILL CHANGE THE GAME

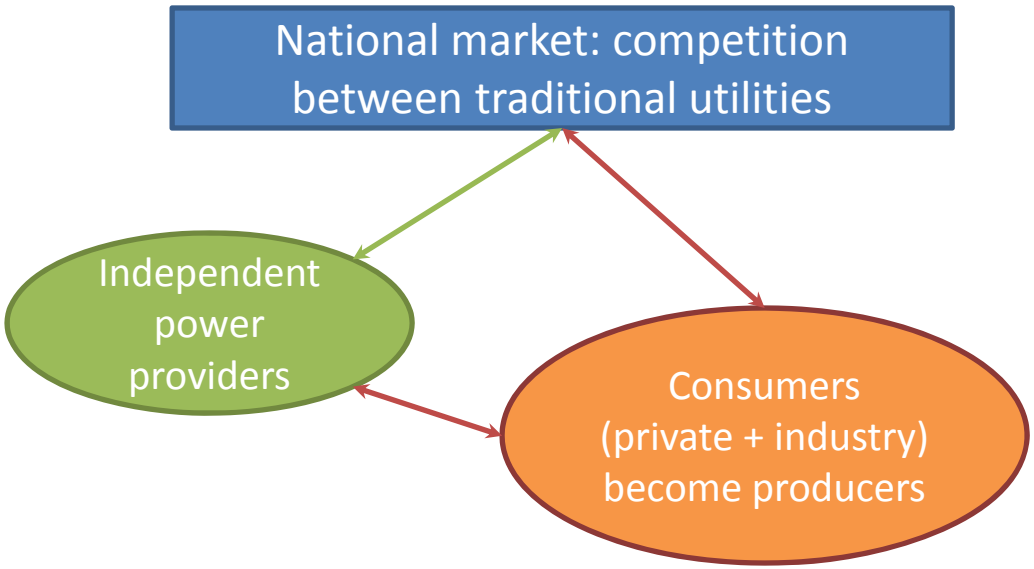
Grid parity comes very soon

even quicker than German legislators have anticipated in 2008:



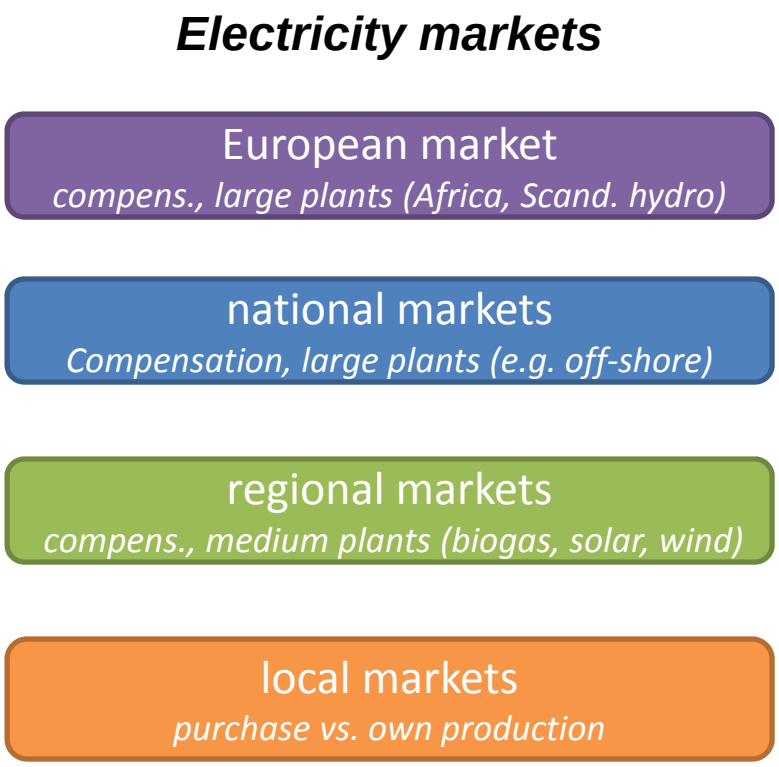
Grid parity for consumers will change the game

- New technologies provide an alternative at the level of the wall outlet
- A new market at this level will affect traditional utilities and regulation
- Captive power production will increase, the amount of utility provided electricity will decrease

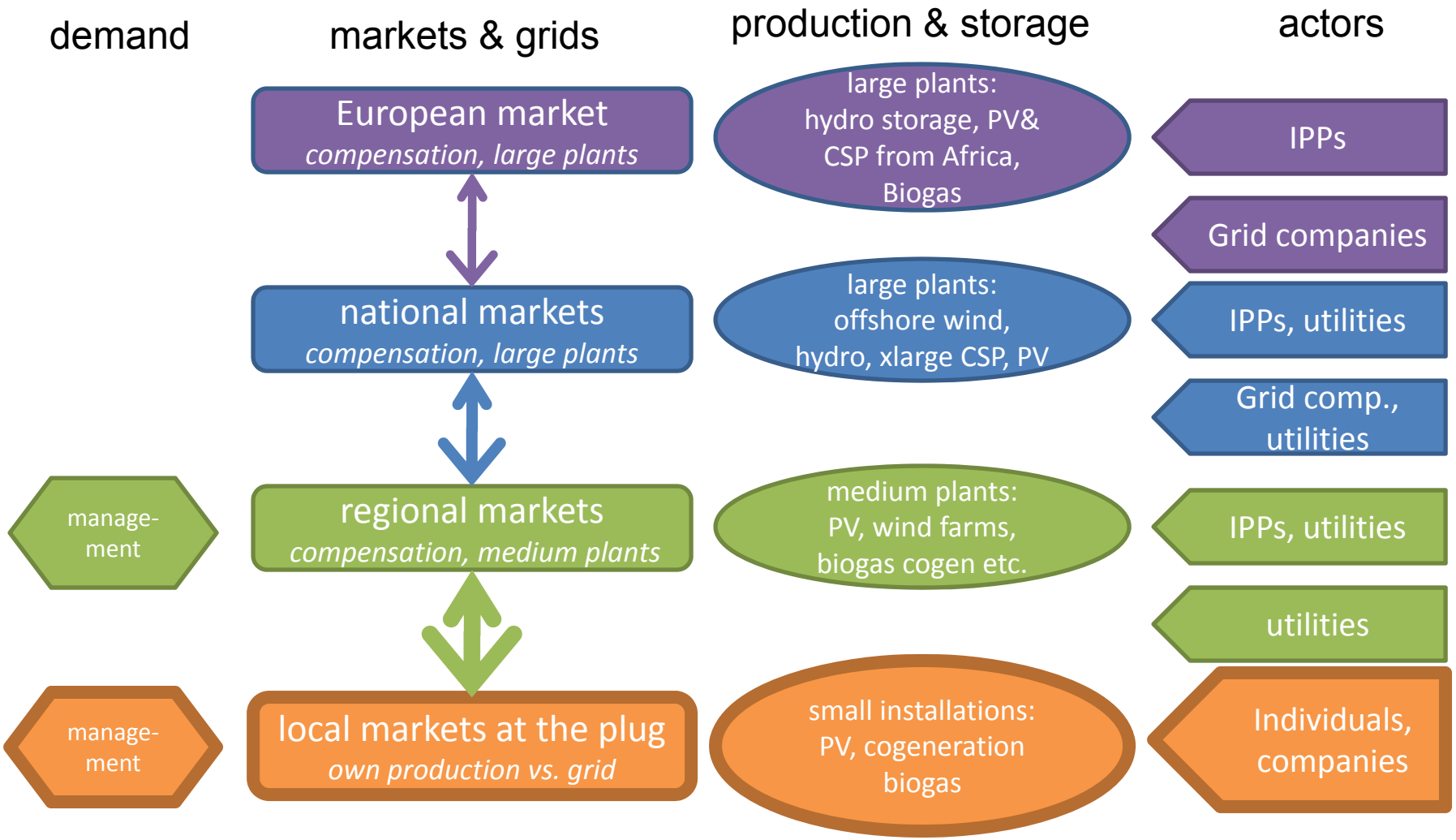


Towards a multi-level system

- Increasingly the business of utilities will be to buffer fluctuations at various levels of the system
- The hierarchical system is over – smart grids will have to manage complex systems with many actors
- Probably, there will be a need for markets at different levels: European, national, regional, local – taking into account the cost of system functions



Prosumers drive electricity markets at different levels



Subsidiarity in the electricity system

- The controversy ‘totally centralised’ / ‘totally decentralised’ is senseless and essentially over
- A rapid transition towards 100% renewables requires contributions on all levels
- The big money and the grid management functions of the large utilities are essential
- However, they have to completely revise their business model. Learning complex interaction in a multi-level system and going back to a support role is essential for their survival
- **The principle of subsidiarity – a function on a higher level is only justified if the lower level cannot perform it – is essential for efficiency, flexibility and sustainability**

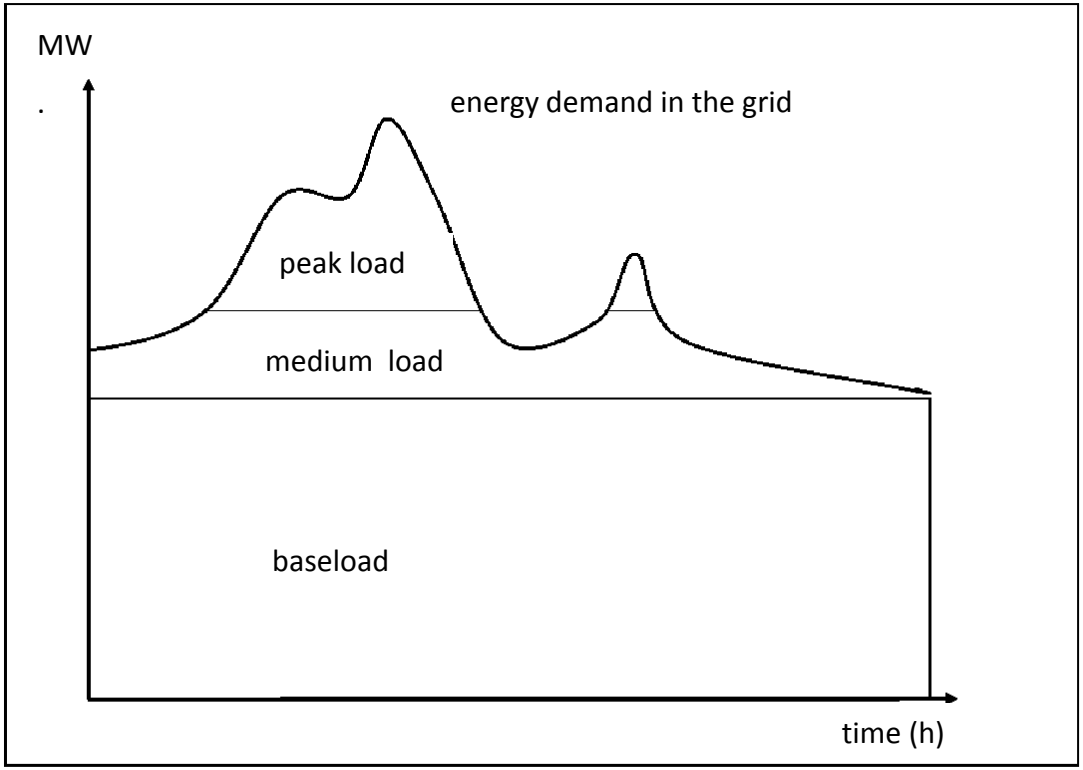
The end of an era

- Energy production devices are becoming standardised consumer goods
  - no serious environmental impact, no long-term risks
  - unlimited resources
  - rapid innovation cycles
  - individual investment decisions
- Renewable energies can free us from the restrictions and risks of the fossil-nuclear era
  - From heavy environmental impacts and long-term risks
  - From safety concerns requiring control and intense regulation
  - From energy security problems leading to international conflicts
  - From monopolies determining policies, slightly tamed by regulators
- After having passed the threshold of credibility, disruptive advantages will accelerate adoption

THE NEXT CHALLENGE
GRID AND STORAGE

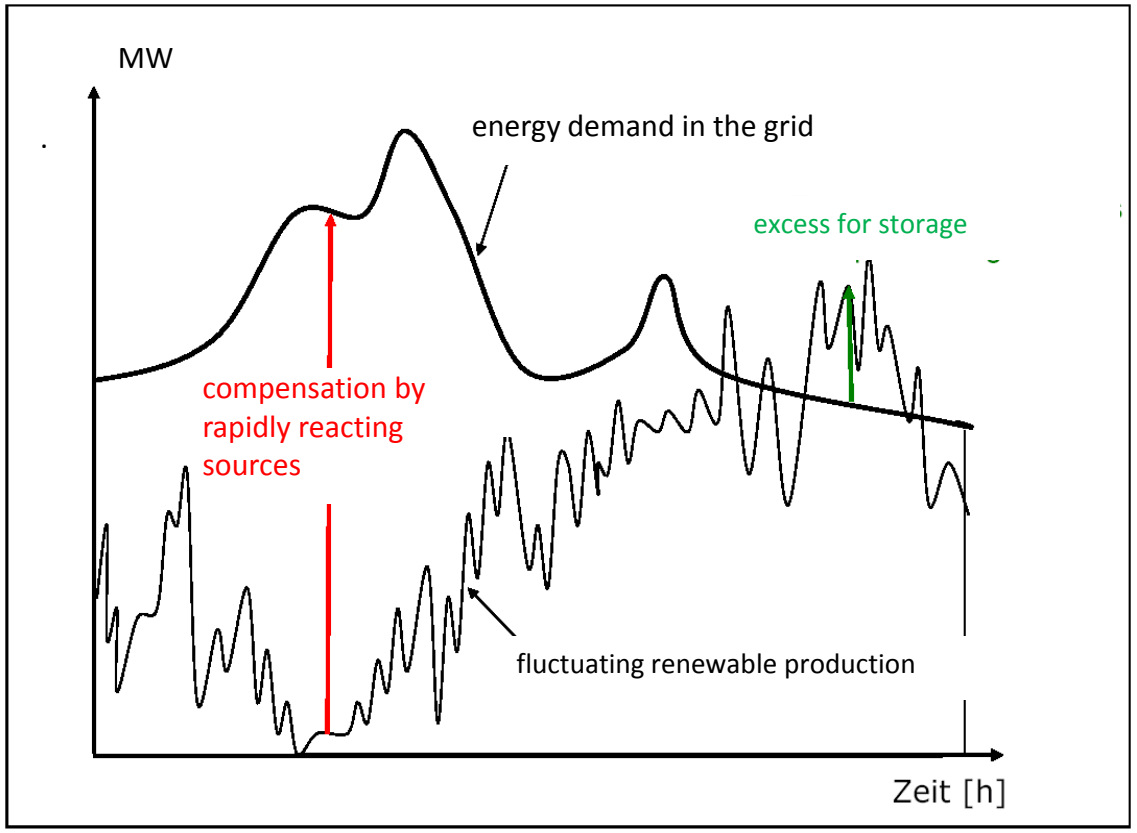
The old baseload concept

- cheap baseload electricity from large plants
- expensive peakload from more variable sources
- central steering of production in a small number of units
- Very little demand side management



The new paradigm: no need for baseload plants

- Variable production from renewables wit zero marginal cost
- Compensation with rapidly reacting sources (e.g. gas turbines)
- Storage becomes important
- Load management becomes important (smart grid)
- No need for baseload plants



Bridging the gap between demand and production profiles

Requires a more sophisticated system approach:

- Adapting demand through demand management with smart grids
- Smoothing fluctuationg production through inter-regional exchange
- Developing storage
  - hydroelectricity, pump storage: Scandinavia, Alps
  - batteries, integrating electric cars
  - other storage technologies (compressed air, etc.)
- Intelligent coupling with the heat market
  - taking advantage of the easier storage of heat
  - Making use of heat pumps and hybrid systems

A new role for utilities

- Selling and distributing centrally produced electricity is not anymore the main task
- Selling compensation services becomes the main issue
  - bi-directional transfer at all levels: grids
  - compensation, storage, transformation between energy forms at all levels: steering, auxiliary storage & production
  - support for demand side management: smart grids
- New importance of infrastructure, redefinition of public and private roles is necessary

Challenges for regulation

- The new multi-level system with new actors and modified roles of the old ones will require new multi-level regulatory frameworks
- They must be in place within less than a decade
- A clear vision must soon provide orientation for the necessary learning process – it needs to be developed at a European level

BEYOND ELECTRICITY

Electricity is the easiest task

- Transition to renewables is easier in the electricity sector than in the heat sector or the transport sector
- Heat sector: high CO2 impact, linked to the huge capital stock of buildings with slow renewal times and other priorities – process heat easier
- Transport sector: important driver for CO2 emissions, conditioned by complex lifestyle issues, public infrastructure and territorial policies
- All sectors are increasingly interconnected

Interrelationships essential for transformation

- Cogeneration links electricity and heat production, infrastructures, time schedules, storage issues must be considered on both sides. Cogeneration from biomass will play an important role in buffering varying electricity supply from solar and wind power.
- The transport sector will increasingly rely on electricity but may also use biogas and biofuels. Batteries of electric cars may provide storage opportunities to the public grid
- With increasing energy efficiency in buildings and new thermal storage techniques, electric heat pumps may play an increasing role in the heat sector.

Energy efficiency

- Improved energy efficiency remains a decisive element of a rapid and cost-effective transformation path
- Improving energy efficiency is in many cases cheaper than producing energy
- Efficiency awareness will raise with increasing involvement of citizens, companies and municipalities in energy production

NEW PRIORITIES FOR PUBLIC POLICIES

No time to loose

- The point of no return for renewables has been passed
- Disruptive technologies start to change the markets
- Most actors involved have not yet understood the speed of change triggered by feed-in-tariffs for renewables
- Grid parity of distributed generation will reach most major markets within less than a decade
- Many utilities waste forces and money in defending outdated centralistic business models
- Policy makers and regulators need to speed up concepts and action for ensuring a most rapid but smooth transformation
- New business dimensions and new players require a revision of renewable energy industry strategies
- The climate change threat requires to accelerate transformation – delaying inevitable changes will cause clashes and environmental damage

Renewable energy industry policies

- Renewable energy technologies have become adult and have to compete on international markets
- National strategies are limited, a European approach is necessary
- Important new players, mainly China and USA are challenging the leading role of European renewable industries
- Mass production of standard goods is not a particular European strength
- Production technologies & equipment will be a European strength also in the future – they require complex technology integration
- The integration of REN technologies in other technologies – construction, transportation, infrastructure, appliances – can open opportunities
- System integration of REN technologies will be the key for a successful role of European industry in the global context
- International competition helps to accelerate change – smart transition strategies can help to avoid unnecessary capital destruction

Priorities for public policies in Europe

- Some more years determined support for renewable energy technologies until full competitiveness is reached
  - ensuring continuous strong growth allowing for falling prices
  - ensuring priority for renewables
  - slowly combining and integrating different European approaches
- Accelerated development of an appropriate multi-level system in Europe: concept, infrastructure, regulation
- Electricity: emphasis on grid and storage issues
- Heat: more ambitious policy mix
- Transport: systemic approach, electrification, biogas
- Integrate energy production and efficiency policies

Remaining risks

- Despite the strong dynamics of renewables, energy markets continue to remain strongly determined by regulation
- Strong forces in the incumbent energy industry try to delay a transition to renewables, to influence public regulation and to heavily invest in outdated infrastructure
- The transition from 30% to 70% renewables will be decisive for changing the structure of the energy system, ensuring priority for renewables is essential in this phase
- Delaying the inevitable transition results in higher costs for the society, for the environment and most probably also for the incumbent industries
- Timely policy changes should prevent costly disruptions

A VISION FOR EUROPE: ERENE

Why ERENE?

- After the agreement on the EU energy package and the 20-20 by 2020 goals, long-term orientation is needed for guiding structural decisions in EU, national and industry policies
- A fundamental transformation of the EU energy system towards renewable energies will require a new multi-level system and new competencies and activities at the EU level
- An alliance of those aiming at such a perspective could have success when joining in an initiative involving
  - a joint vision for the EU energy system and appropriate objectives
  - the development of appropriate institutional proposals
  - a broad campaign addressing policy makers throughout Europe

The ERENE Initiative

- The Böll-Foundation and the European Green Foundation are starting to build such a broad alliance involving
  - Personalities from different political denominations
  - Renewable Energy industry, Environmental NGOs
  - Labour unions, consumer organisations as far as interested
  - Researchers, Think Tanks, all other forces interested to contribute
- Starting point: a study of Lutz Mez and Michaele Schreyer for the HBS on the potentials of 100% renewable electricity supply in Europe and proposals for appropriate strong EU institutions (European Community for Renewable Energy: a new treaty, a framework for intensified cooperation…?)
- The present stage: exploration of the landscape of possible partners throughout Europe

THANK YOU

www.irena.org

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