

13:30-18:00 June 29th,  
2016

China National  
Convention Center,  
Beijing, P. R. China

# 2016 The Future Energy (FE) Forum

Affordable, Reliable and Sustainable  
Energy for the Future

The Future Energy Forum 2016 (FEF2016) aims to promote effective ways to achieve a sustainable energy future. The UN announced the 17 Sustainable Development Goals (SDG 17) in 2015. The world should "Ensure access to affordable, reliable, sustainable and modern energy for all" (Goal No. 7). This forum is to provide a platform for the leaders and experts from different regions around the world to share their views and solutions on energy issues.

China is the largest developing country, with the highest share of global energy consumption. It is a great challenge to meet the target of emission reduction by 2030. The open talks and discussions in the Forum will provide a good chance for the advance of sustainable technologies and cooperation strategies in China.

The FE Forum is organized as  
a session of [CIGEE 2016](#)  
and [CDEE 2016](#).

Organized by WFEO  
Committee on  
Energy (WFEO-CE)

Co-organized by  
Tsinghua University, Energy  
Internet Research Institute (EIRI),  
Chinese Society for Hydro Power  
Generation (CSHPG)  
Chinese Society for Electrical  
Engineering (CSEE)

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World Federation of Engineering Organizations  
Fédération Mondiale des Organisations d'Ingénieurs



## **Germany's Energy Transition Swarmenergy – An Approach for (digitally) Distributed Electricity**

Carsten Ahrens

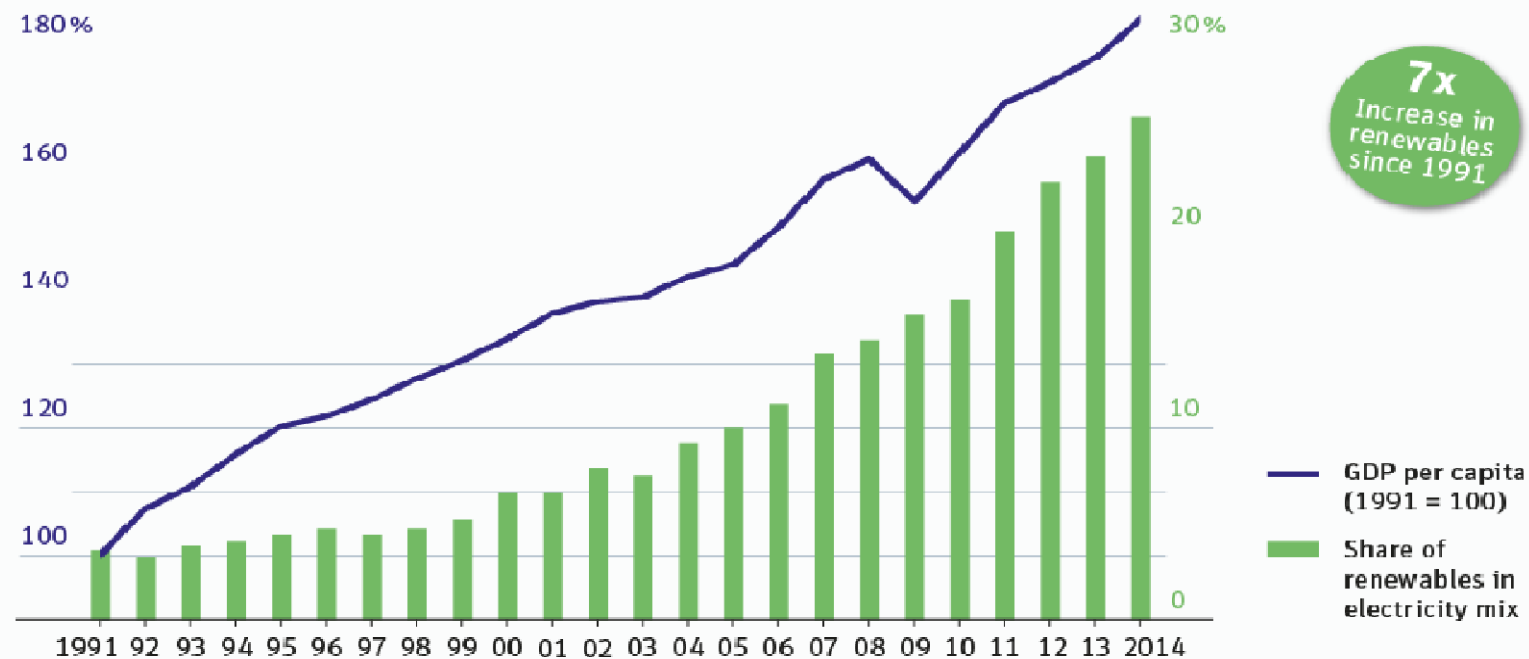
Jadehochschule, ZDI, Germany  
ECCE, WCCE, WFEO (Solar Group)

# RENEWABLES VERSUS ECONOMY

## Renewables do not hurt Germany's economy

Gross Domestic Product and share of renewables in power generation from 1991-2014, Germany

Source: BMWI, AG Energiebilanzen, Destatis



German Energy Transition

energytransition.de

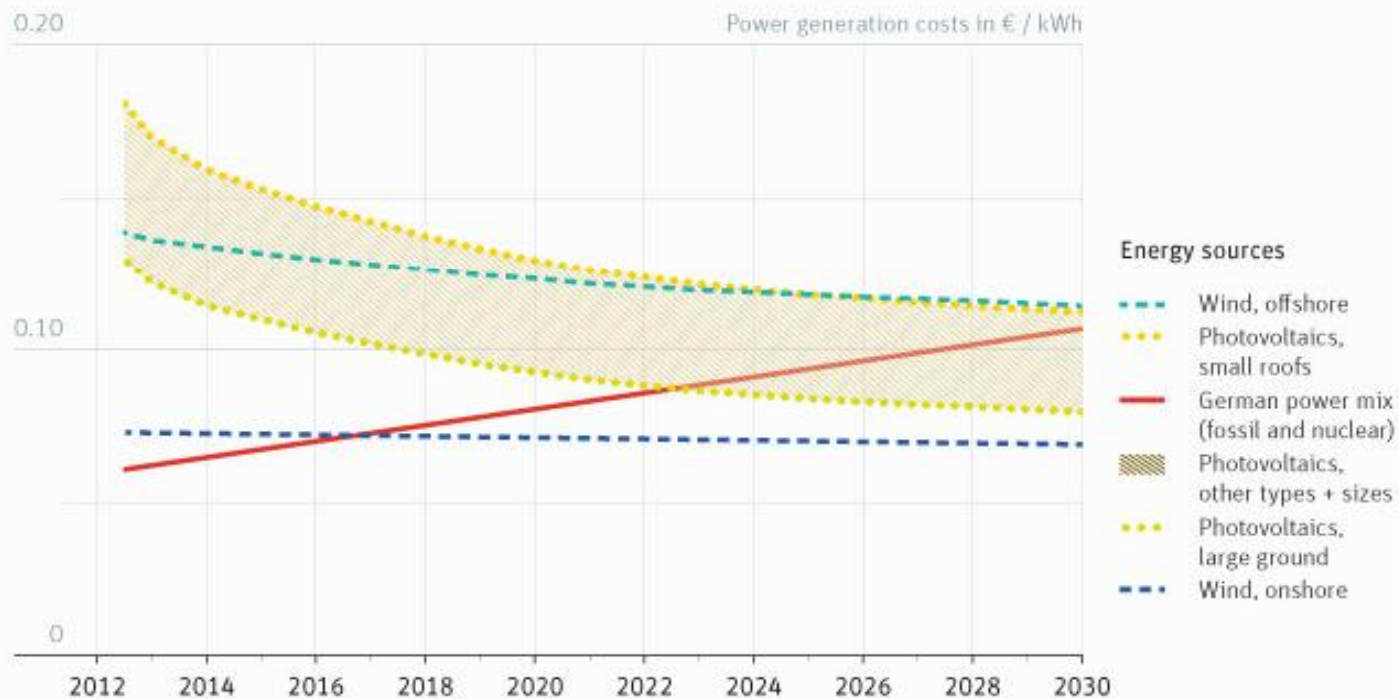
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# RENEWABLES ARE COMPETITIVE

## Renewables are becoming competitive

Forecast of power generation cost in Germany up to 2030

Source: Fraunhofer ISE



German Energy Transition

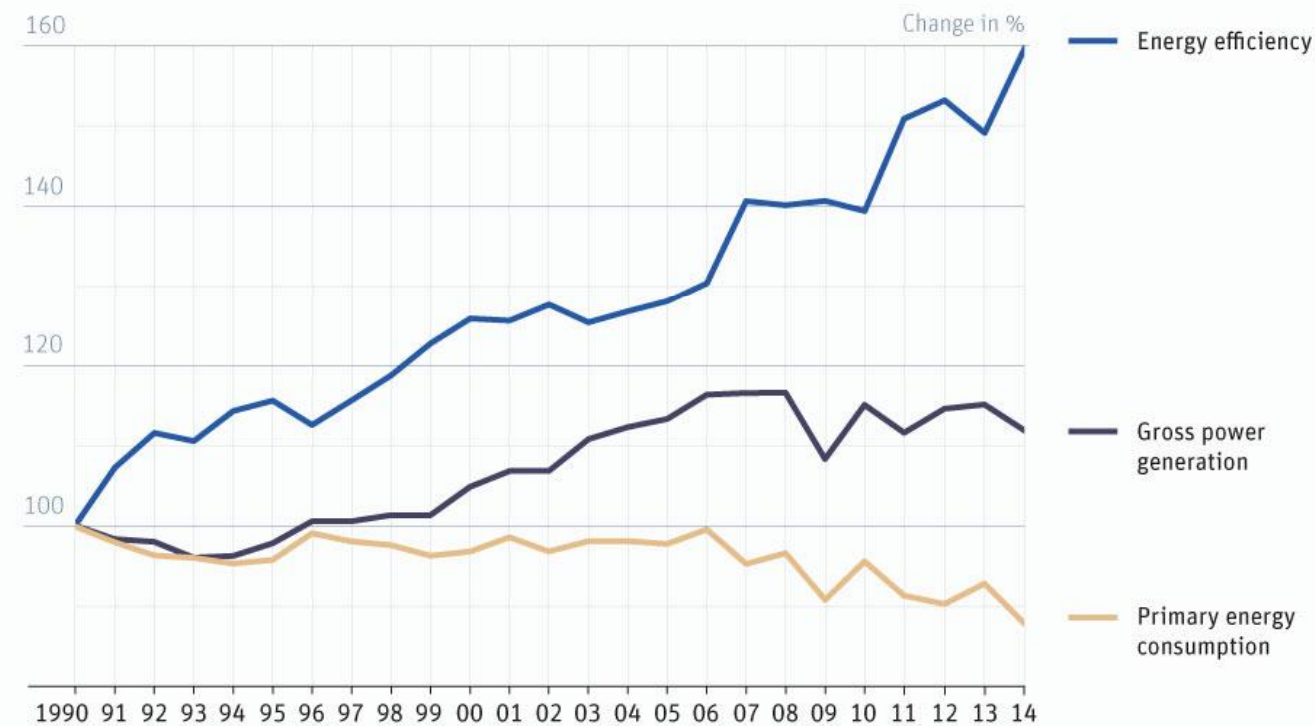
energytransition.de



## Germany is getting more value from less energy

Energy consumption is shrinking though power generation is up thanks to efficiency

Source: BMWI



German Energy Transition

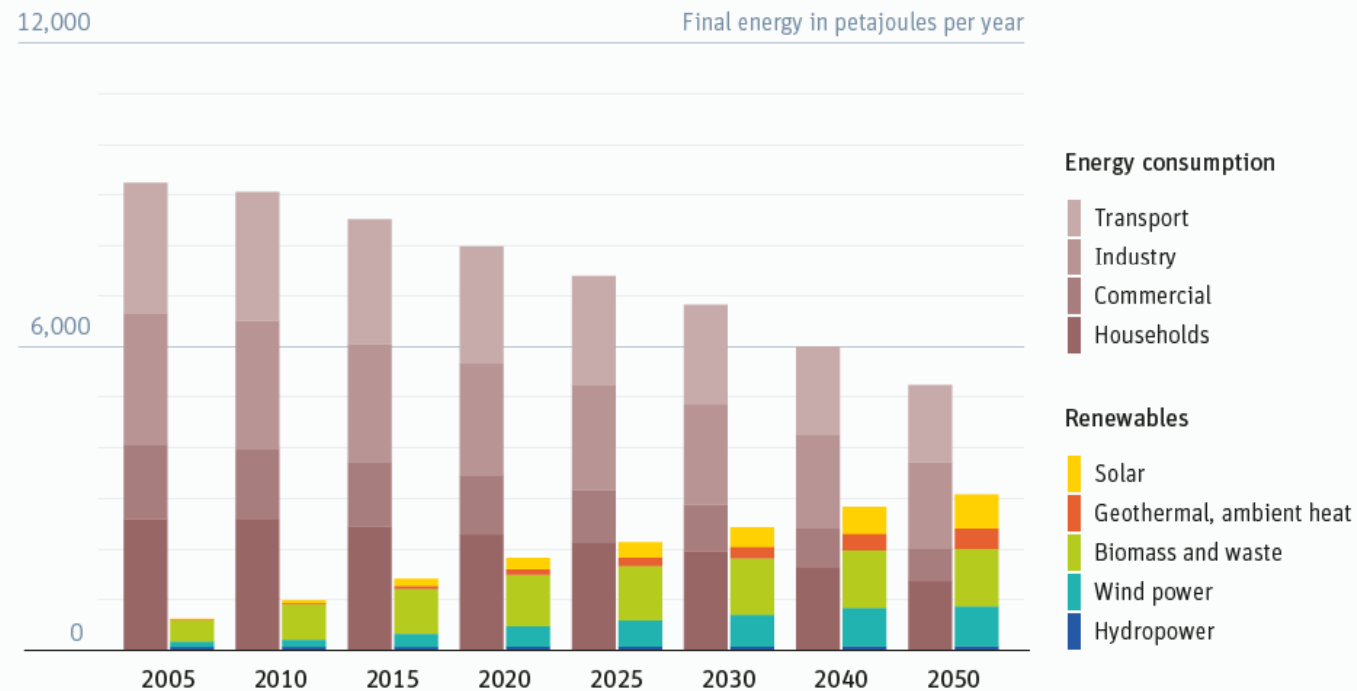
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## Germany's plan: ramp up renewables, drive down energy consumption

Final energy supply and demand in Germany 2005-2050, scenario

Source: DLR Lead Study, scenario A



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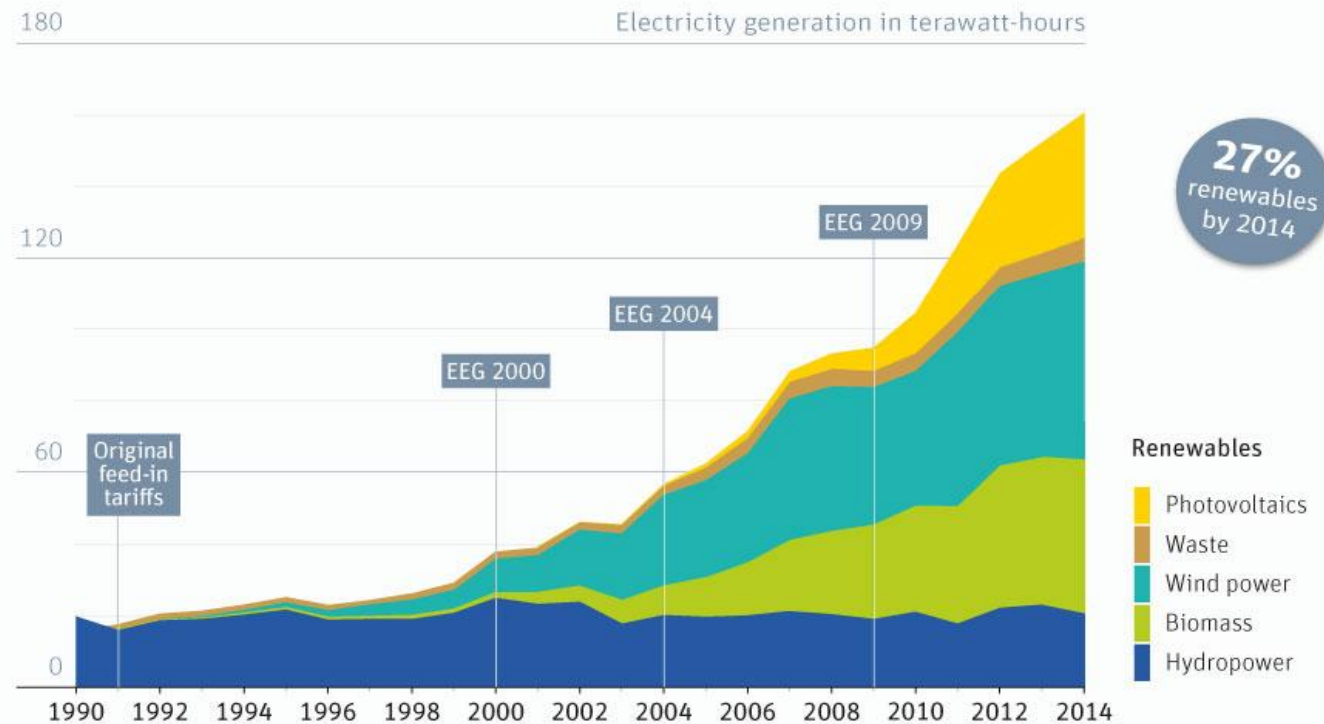


# FEED-IN TARIFFS FEED RENEWABLES

## Feed-in tariffs grow renewables

Renewable electricity generation in Germany, 1990-2014

Source: BMU



German Energy Transition

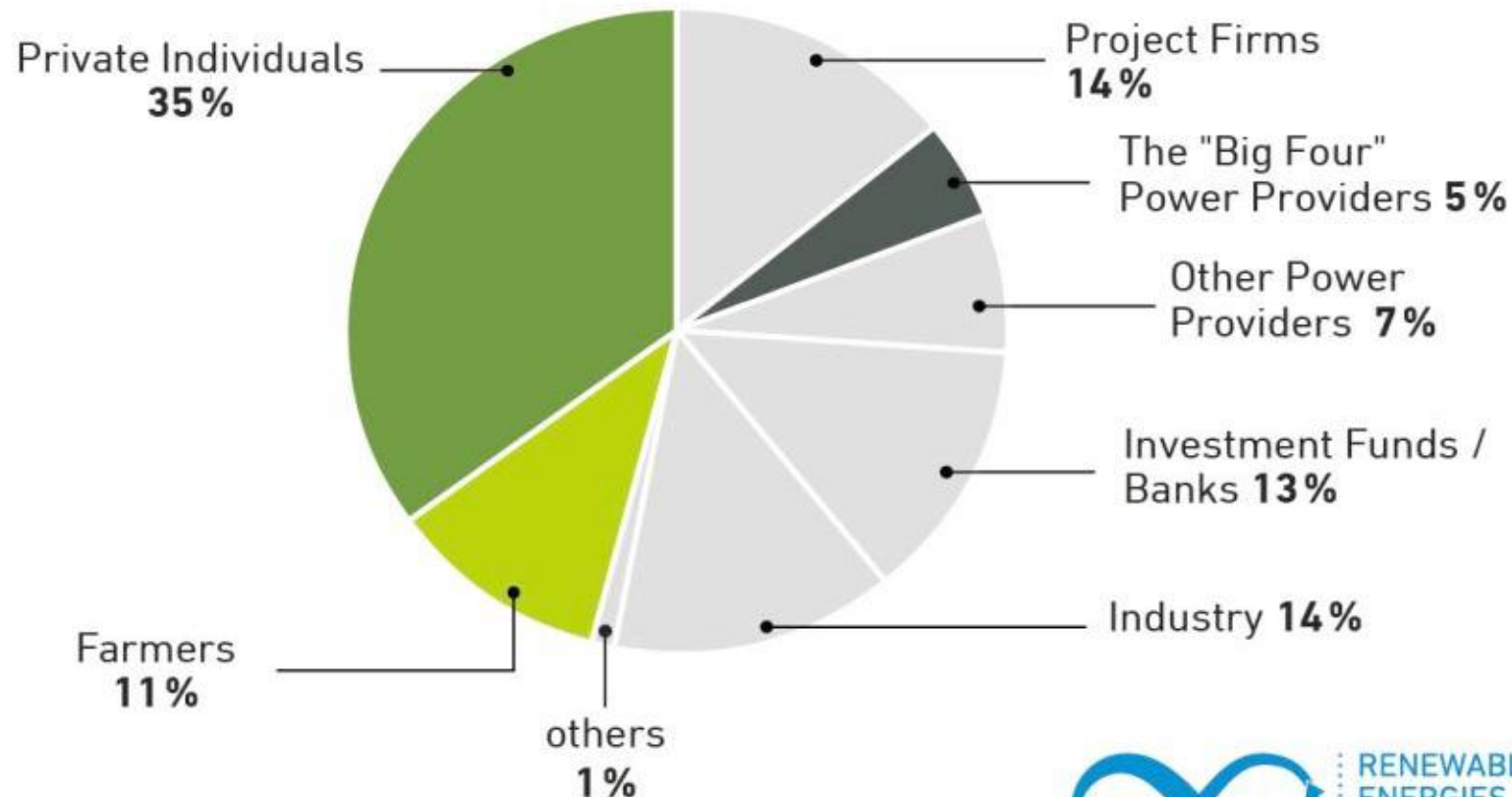
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## Renewable energy in the hands of the people

Ownership distribution of installed RE capacity for power production throughout Germany



Source: trend:research  
As of: 4/2013

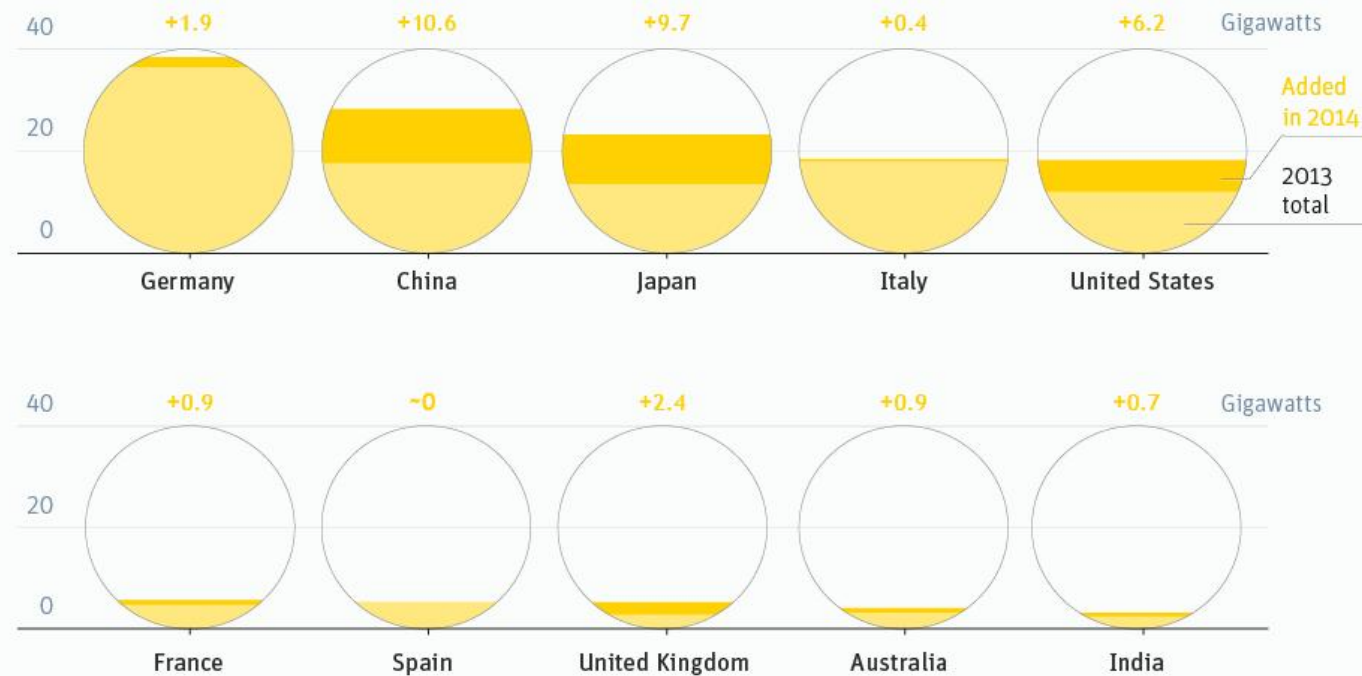


# SOLAR COUNTRIES

## Germany is a leader in solar

Top 10 countries for solar power in terms of total installed capacity, 2014

Source: REN 21



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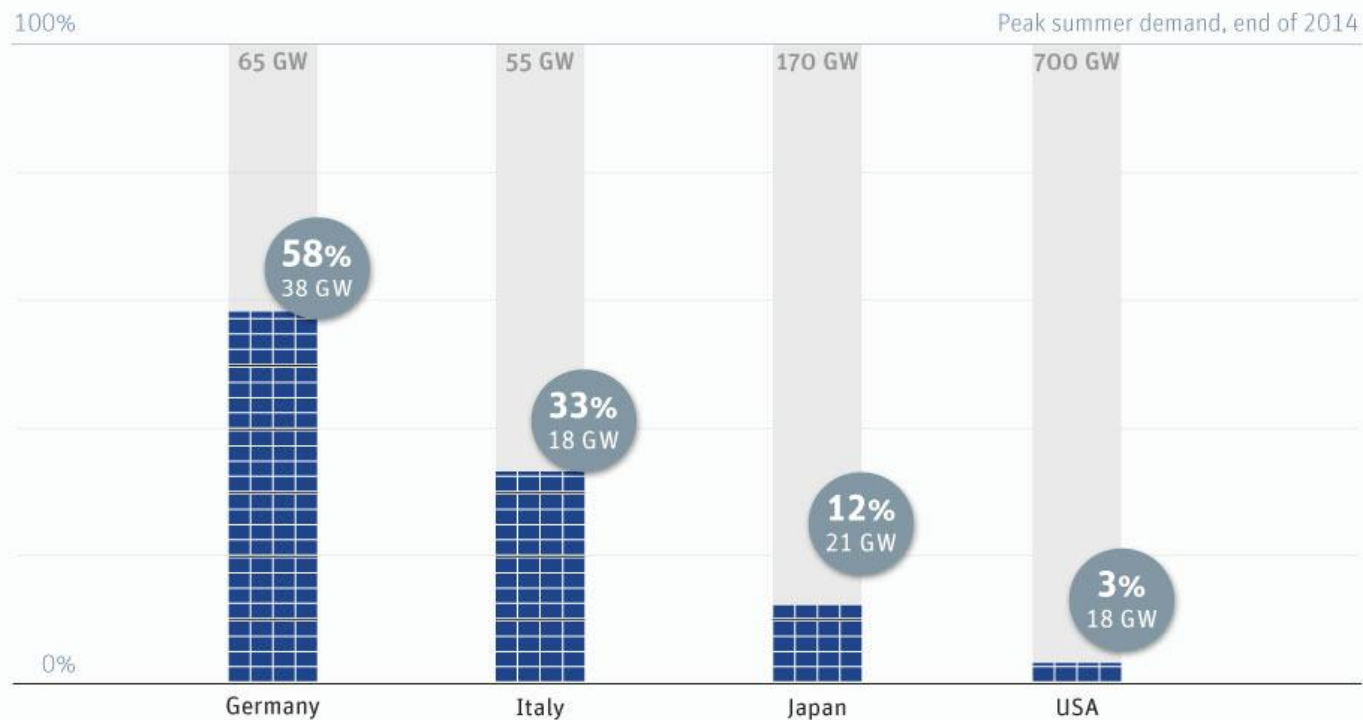


# INSTALLED SOLAR CAPACITY

## Germany's installed solar PV capacity is already half of power demand

Germany has most solar PV installed in absolute (38GW) and relative terms (58% of peak demand)

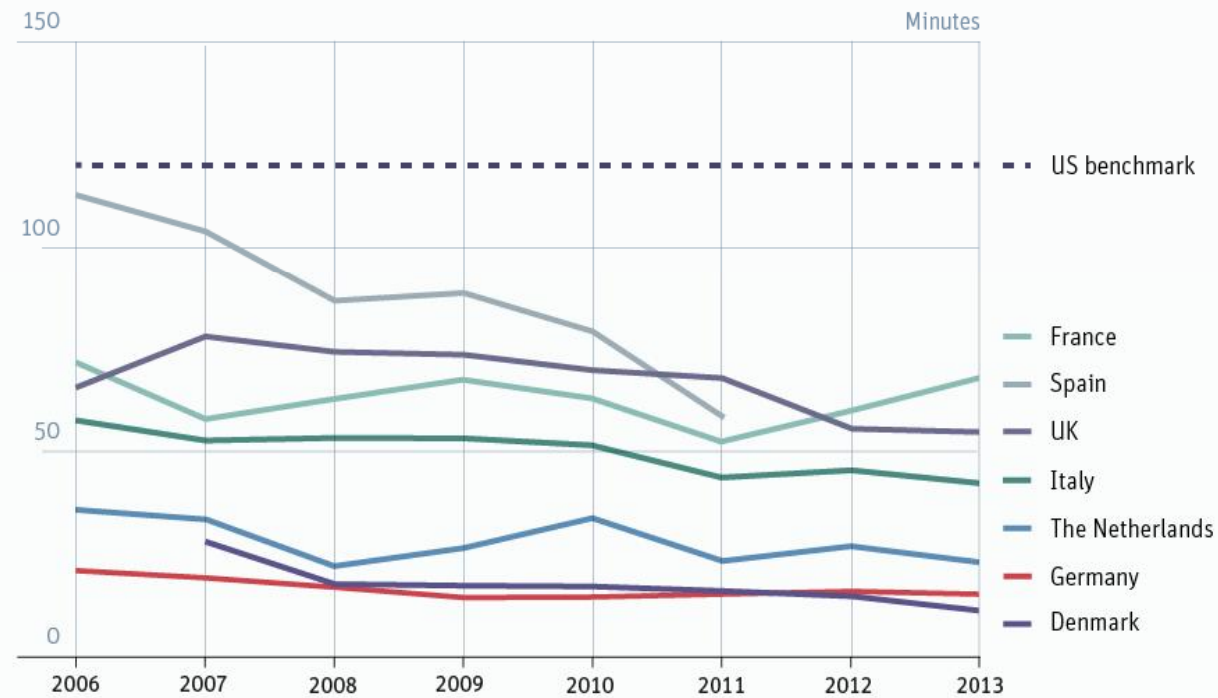
Source: REN 21, own calculations



## Grid reliability and renewable growth seem to go hand in hand

Minutes of power outages per year (excl. exceptional events), based on Saidi

Source: CEER and own calculations

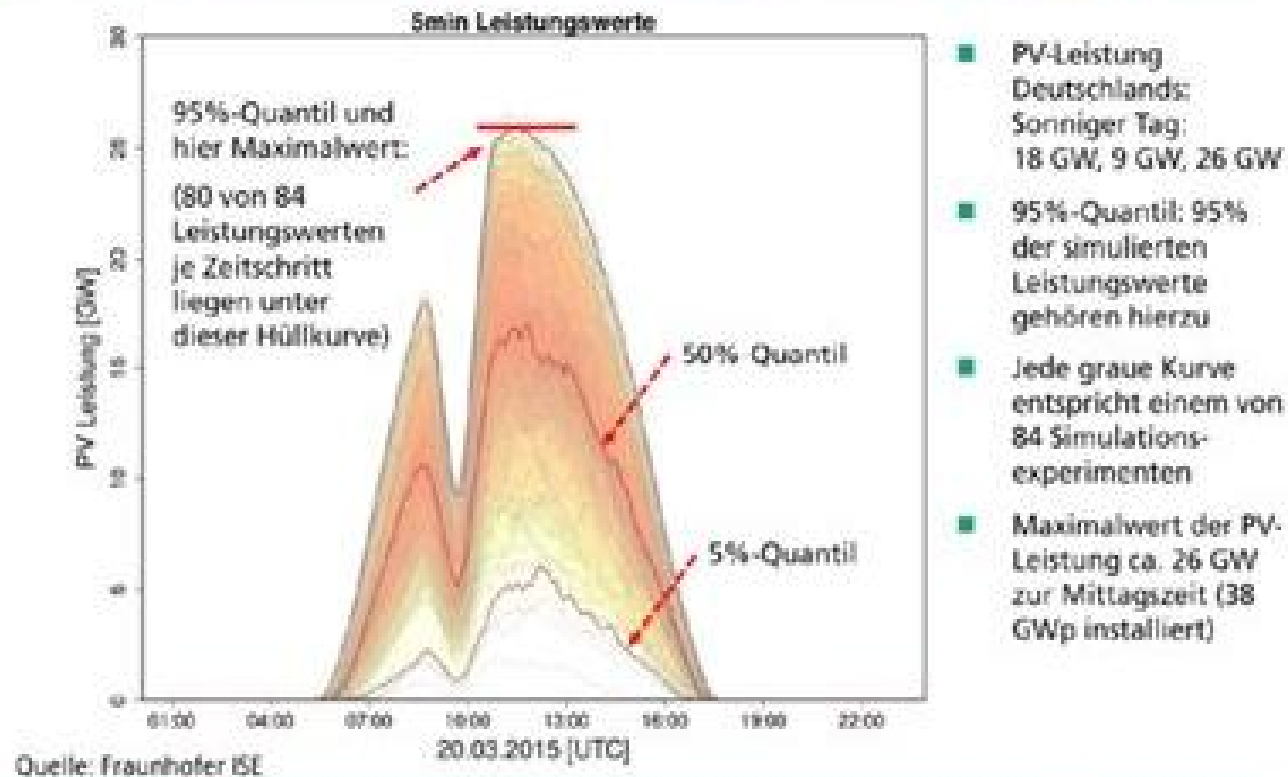


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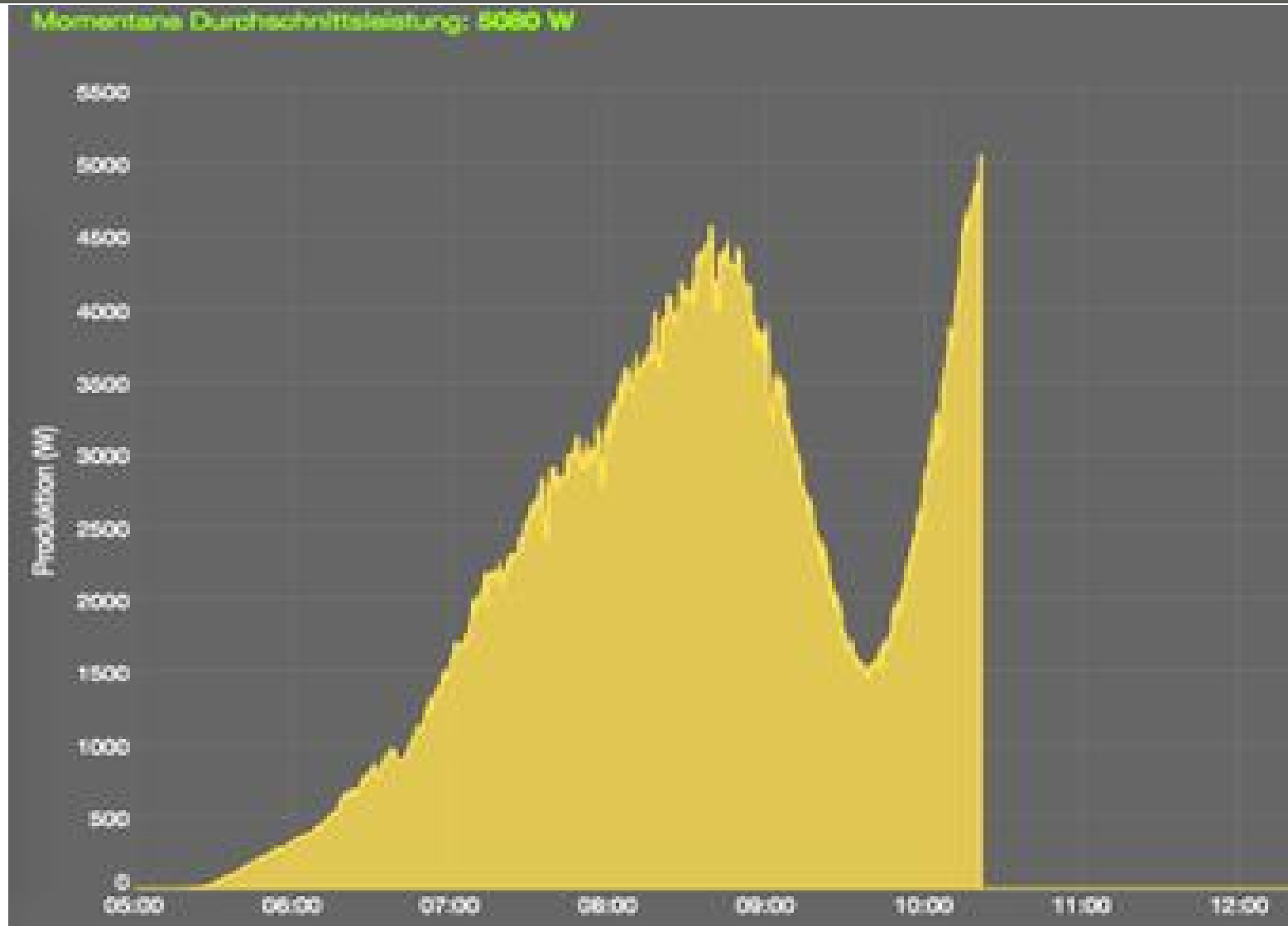
## PV-Erzeugungsleistung am 20. März 2015 Simulation auf Basis von realen Messdaten (2011-2014)



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# PV PRODUCTION DURING SUN ECLIPSE

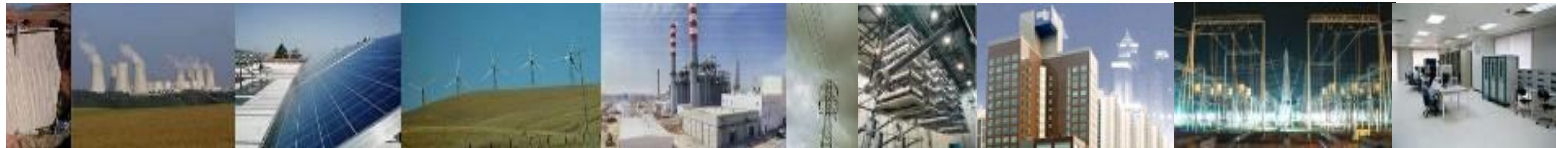


# ISLAND SOLUTION BY TENNET



## Energy Internet, an Effective Way Toward Sustainable Future

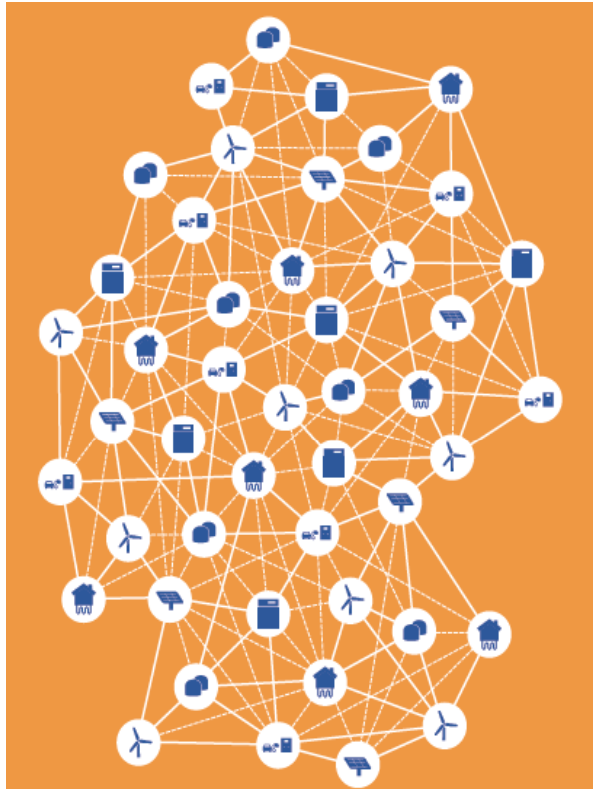
Prof. Ruomei LI  
Nov 29<sup>th</sup>, 2015



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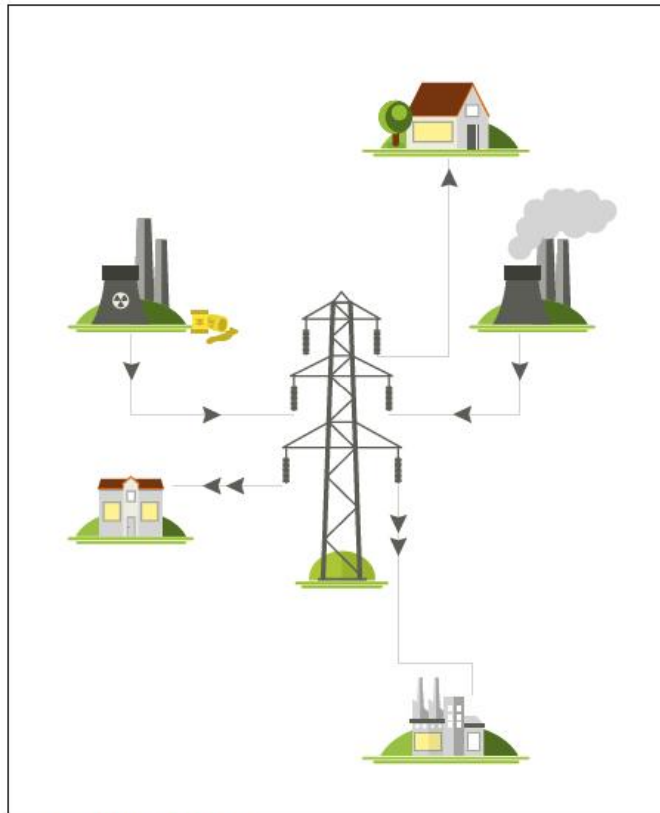


„Germany has strong renewable energy research and development capabilities and China’s manufacturing ability can provide cost-effective renewable power facilities. Sino-German cooperation could decrease tremendously the cost of renewable energy in the future, making renewables fully competitive with fossil fuels, ensuring a secure and affordable price, and facilitating economic growth.“

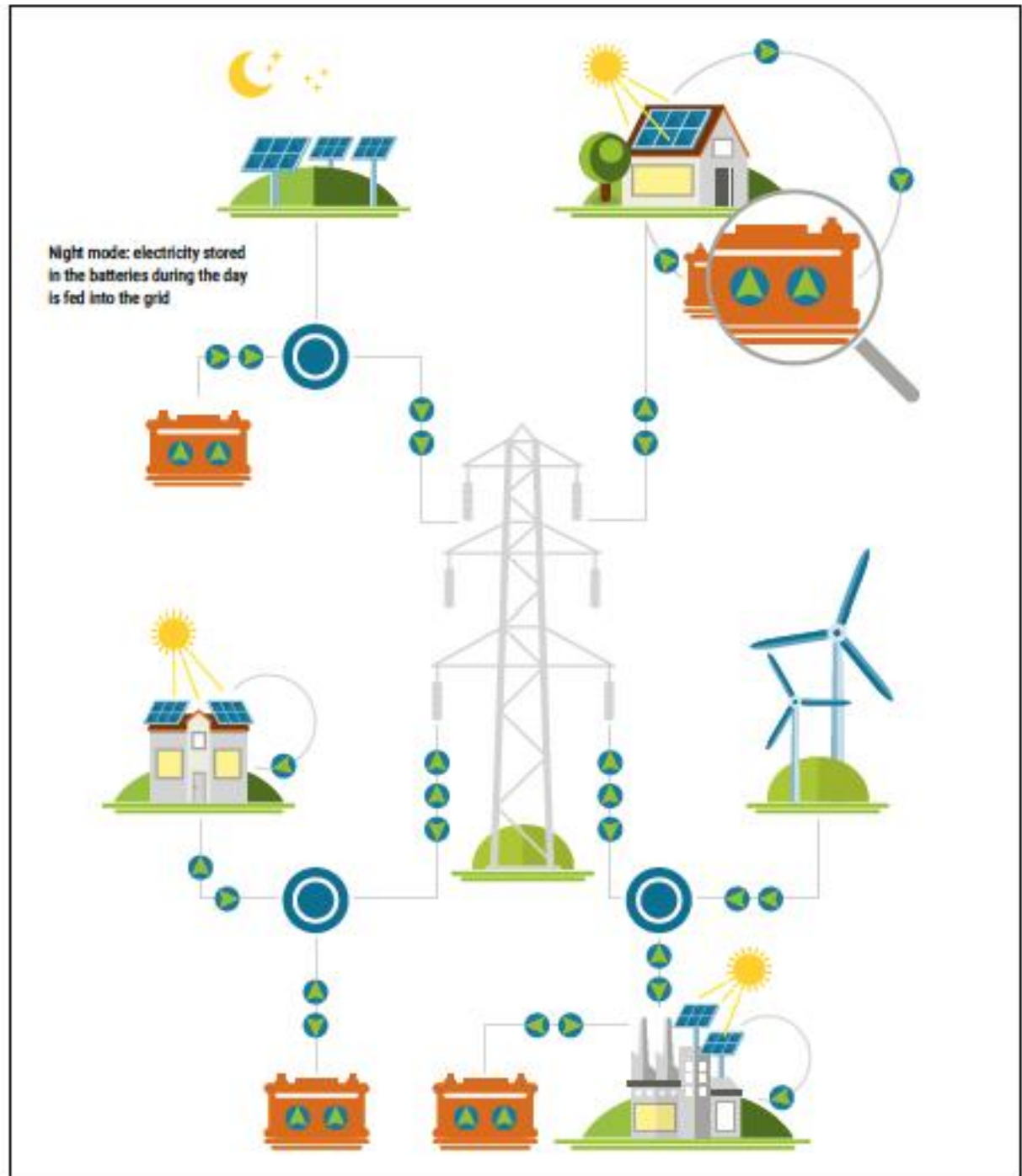
Fuqiang Yang, Senior Advisor of China Program,

[www.nrdc.org/](http://www.nrdc.org/)

# SMART GRID WITH IT - PLATFORMS



GRID - A CONVENTIONAL ELECTRICITY



GRID - IT-PLATFORM - STORAGE - RENEWABLE ELECTRICITY AND DIGITAL INFORMATION

03.07.2016

Ger  
Swarmenergy – An A

# COST DEGRESSION OF LI-BATTERIES

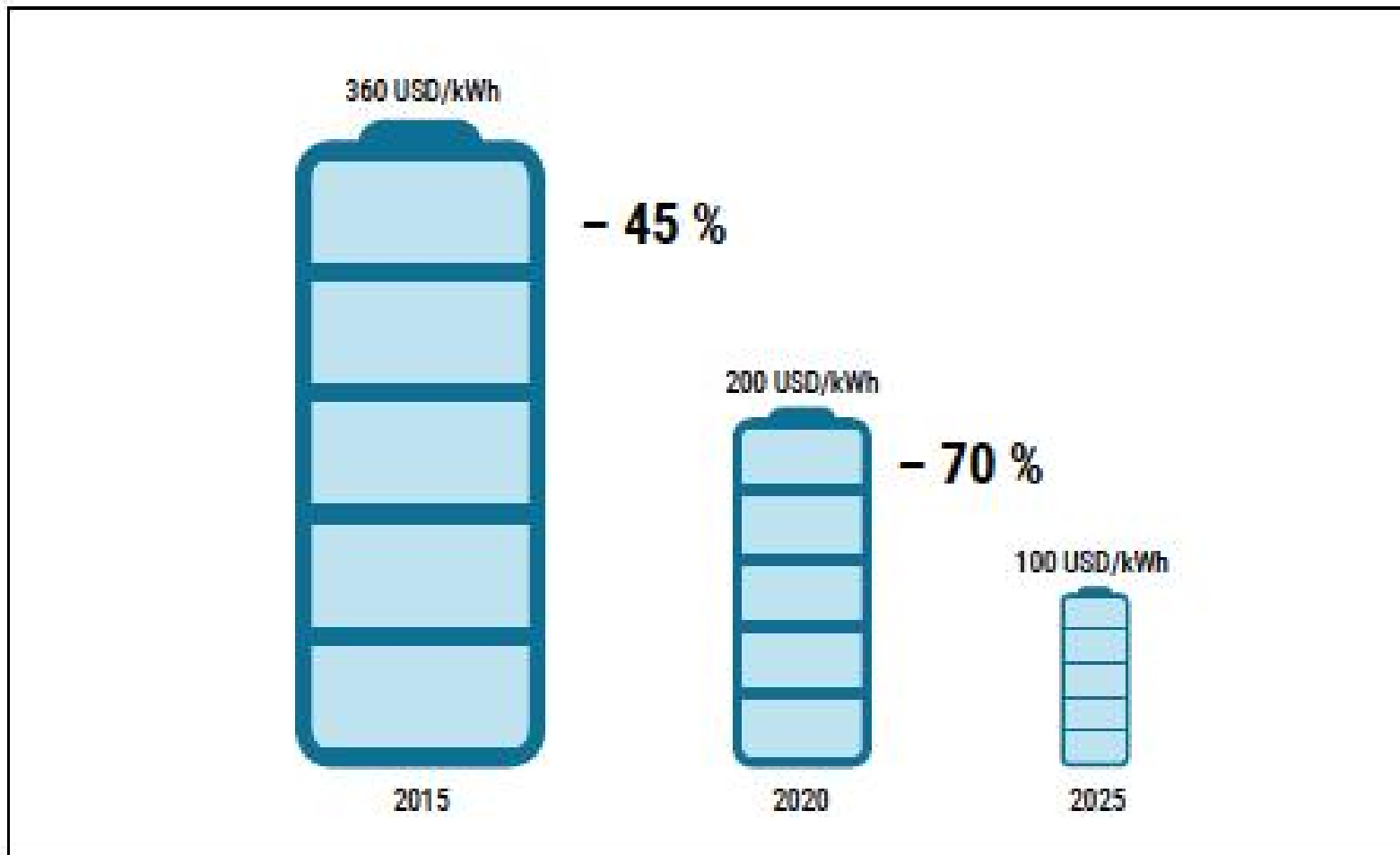
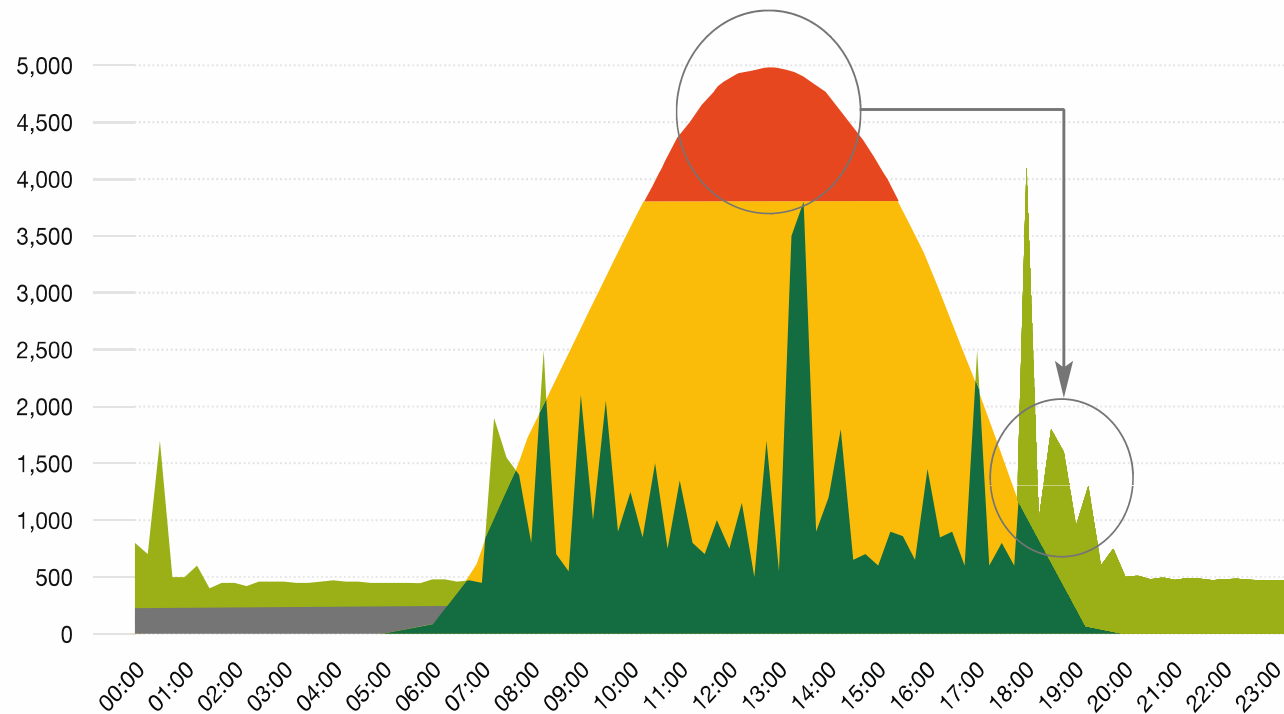


Figure 28: Expected cost degradation for lithium batteries; Source: UBS, 2014

# PEAK SHAVING STRATEGY (GRID + STORAGE)



- PV production stored
- PV production fed into the grid
- Self-consumed PV electricity
- Self-consumed PV electricity through storage
- Non RES electricity supply

source: Based on SMA figures, 2012

Bosch, Germany  
Storage and Manage-  
ment System  
BPT-S 5 Hybrid





# BUILDING INTEGRATED PV (BIPV) INDUSTR. WORLD



## CONNECTING THE SUN

SOLAR PHOTOVOLTAICS ON THE ROAD  
TO LARGE-SCALE GRID INTEGRATION

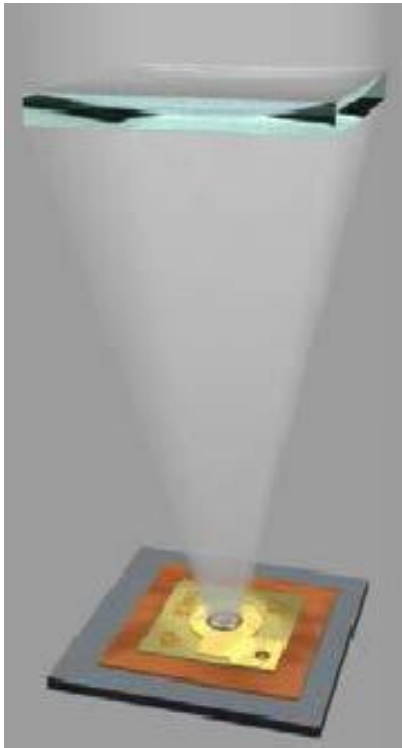
How will photovoltaics  
provide solutions for  
Europe's energy future?



**Solar Photovoltaics provides economic benefit and grid solutions  
generating electricity where and when you need it.**

Read the new study from the European Photovoltaic Industry Association  
[www.connectingthesun.eu](http://www.connectingthesun.eu)





Concentration of sun radiation HCPV rooftop-system on 2-axis sun tracker



# SMALL (RURAL) PV APPLICATIONS WORLDWIDE



## Small PV-Applications

Rural Electrification and  
Commercial Use

University of Applied Sciences Ulm,  
Ulm, Germany  
June 17<sup>th</sup>/18<sup>th</sup>, 2013



[www.otti.eu](http://www.otti.eu)





## 1. The end of the fossil era has begun

The successful global progress of renewable energies, the signal sent by the G7 states from Schloss Elmau in June 2015, the discussion started after the climate protection pledge in the USA and China on an effective global climate regime plus the decreasing use of coal in China and the USA and a spectacular drop in the price of oil since 2014 all lead to the question of whether the beginning of the end of the fossil age has already begun. Besides the reality of climate change, the drivers of this development are the increasingly volatile energy prices, particularly the above-mentioned drop in the price of oil, and a growing global awareness of the health effects of fossil energy generation, leading to growing regional protests.



## 2. The energy future has already begun

The energy transition is a global reality. Photovoltaics and wind energy in particular have developed within a few years into new key energies for the 21st century. In 2013 more renewable energy power plants in terms of power generation capacity were set up worldwide than coal, gas and nuclear power plants put together. In terms of investment, the renewables sector is now significantly ahead of traditional energy technologies.

## 3. The energy future is renewable

The global progress of renewable energies is primarily a result of the almost unbelievable success in reducing the costs. Wind energy plants on land are still the most cost-effective technology for renewable power generation. But in Germany the costs for solar power have dropped by 80 per cent since 2005. Increasing numbers of economy and financial experts are basing their analyses on photovoltaics now becoming the most cost-effective technology for electricity generation in ever more regions of the world. Electricity from the sun and wind will expand its triumphal progress beyond the power sector into the areas of mobility and heating.

## 4. The energy future is decentralised

Energy generation from wind and sun but also from other renewable energy sources is decentralised. Instead of a few large power plants, in the energy system of the future millions of small plants will generate energy. Many of the stakeholders involved are both producers and consumers of power (prosumers). However, this does not mean that only small power plants will be left. The large systems and plants based on wind and solar power will probably retain their position in the new energy system. But in many poorer regions of the world which have an abundant supply of sun and wind, members of the public as prosumers could benefit long-term from decentralised renewable energy systems.

## 5. The energy future is digital

energy system of the future characterised by volatile wind and solar renewable energies. The IT and energy sectors are growing together. Only a combination of both will be able to reliably match the energy supply and demand at all times. The rapid cost degression in the storage technology, particularly for small and large battery banks, opens up the possibility of reliable energy supply at any time, finally even with a 100 per cent transfer to renewable energies.

- The Renewable Energy Act devised in Germany is a global success which has enabled wind and solar power to compete with conventional power generation in ever more regions of the earth
- Between 2004 and 2014 the global photovoltaic capacity has increased by a factor of fifty and wind energy capacity by a factor of eight
- Since 2013 more renewable power capacity is installed annually around the world than fossil and nuclear together
- Between 2000 and 2012, 57 per cent of new investment in power generation plants went into the renewable energy sector, 40 per cent into fossil fuels and 3 per cent into nuclear power plants

# Thank you for your attention

Germany's Energy Transition  
Swarmenergy – An Approach for (digitally) Distributed Electricity

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