

The new world of Power

Dynamics of renewable and non-renewable Energies

Dr. Rudolf Rechsteiner, lecturer on energy
Swiss MP 1995-2010, rechsteiner@re-solution.ch

I

Forecasts – can we trust them?

Part 1: Forecasts – can we trust them?

New renewable energy investments [excl. large hydro] / Bloomberg New Energy Finance, UNEP (2012) bn \$

Year	ASOC excl. (China & India)	China	Middle East & Africa	Europe	AMER (excl. US & Brazil)	Brazil	United States
2004	10	5	5	10	5	5	5
2005	15	10	5	15	5	5	5
2006	20	15	5	20	5	5	5
2007	25	20	5	25	5	5	5
2008	30	25	5	30	5	5	5
2009	35	30	5	35	5	5	5
2010	40	35	5	40	5	5	5
2011	45	40	5	45	5	5	5

Source UNEP/Bloomberg New Energy Finance 2012

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Figure 1 and 2

This paper tries to give a technology cross-cutting view regarding energy markets. New long term trends can be observed over the past ten years, changing the energy landscape. Investment in new renewable energies grew from 50 to 250 billion dollars since 2004 (figure).

Regarding market shares of renewable and non-renewable energies, the outcome is a result of perception of quality and quantity of resource, of

economics and of risks. Political frameworks need to be considered too. As we all know, there are externalities not reflected in the price of energy. Moreover the energy sector is highly subsidized by governments, including unpaid externalities. In this perspective, market shares tend to be a mirror of political programs, of industry lobbying and bribery too.

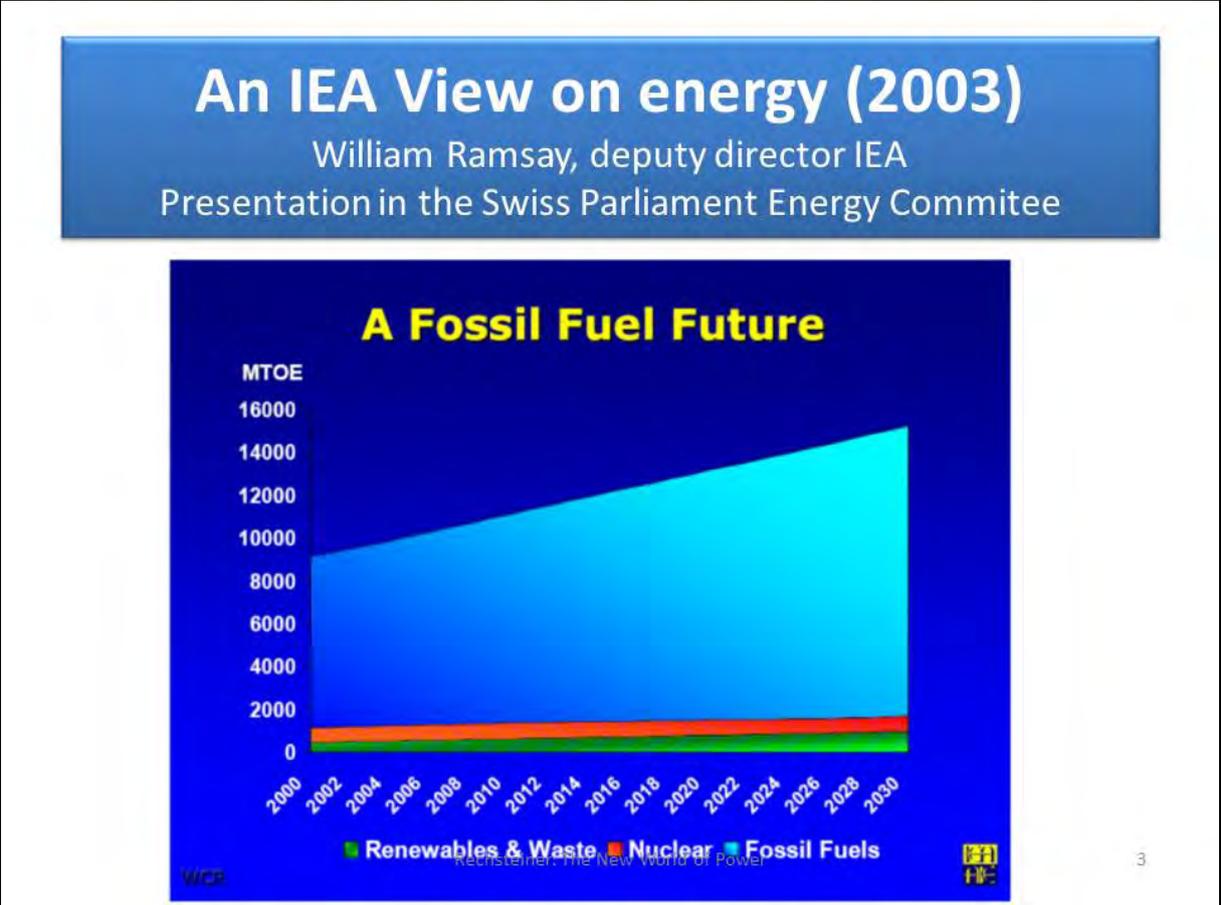
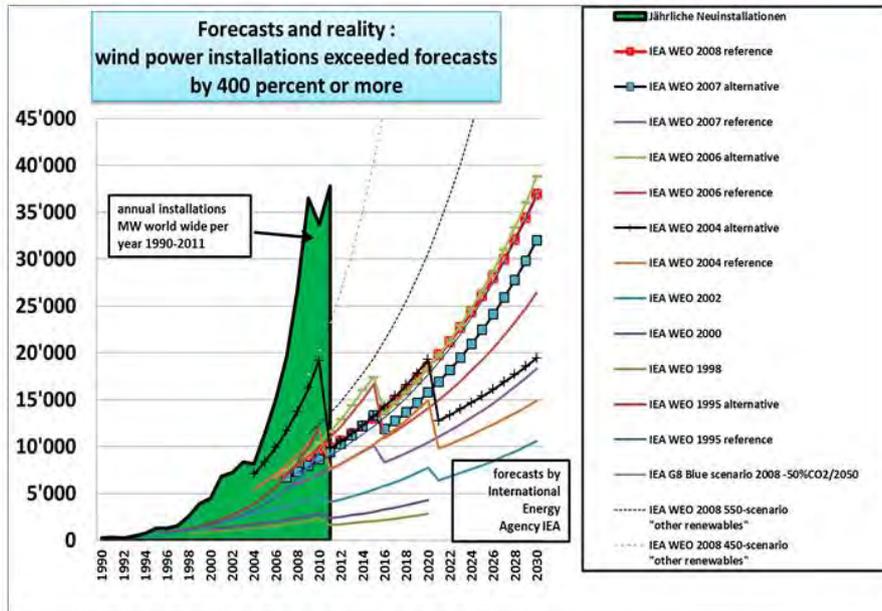


Figure 3
When I was active in the Swiss Parliament we enjoyed a visit of Mr. William Ramsay, the International Energy Agency (IEA) deputy director. As an American official he was in the fossil industry before joining the IEA, and fossil were his views. He predicted unprecedented growth of fossil fuels and stagnation for everything else. He criticized the Swiss government for its energy policy –which barely existed – and denounced wind and solar as subsidized, expensive and elusive energies.

Wind Power installations: reality (green area) and IEA projections



Sources: IEA/Wind power Monthly; Rechsteiner: The New World of Power

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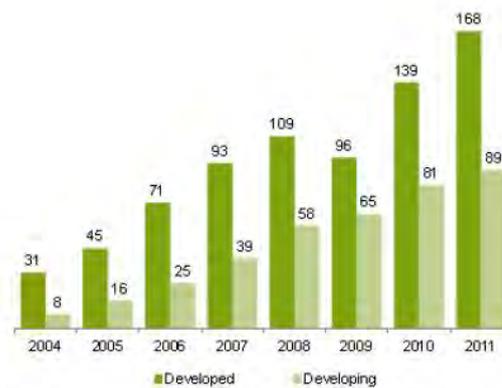
Figure 4

As we can see, the accuracy of IEA projections on renewable energy has been very poor. Wind power grew many times faster than predicted in the yearly World Energy Outlook by the IEA. The median fault was 400 percent.¹

¹ See: Rudolf Rechsteiner /Energy Watch Group: Wind Power in Context, 2008

Renewable energy investment growth

GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY:
DEVELOPED V DEVELOPING COUNTRIES, 2004-2011, BN \$



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

Source: BLOOMBERG
NEW ENERGY FINANCE:
Global Trends in
Renewable Energy
Investments 2012,
edited by UNEP

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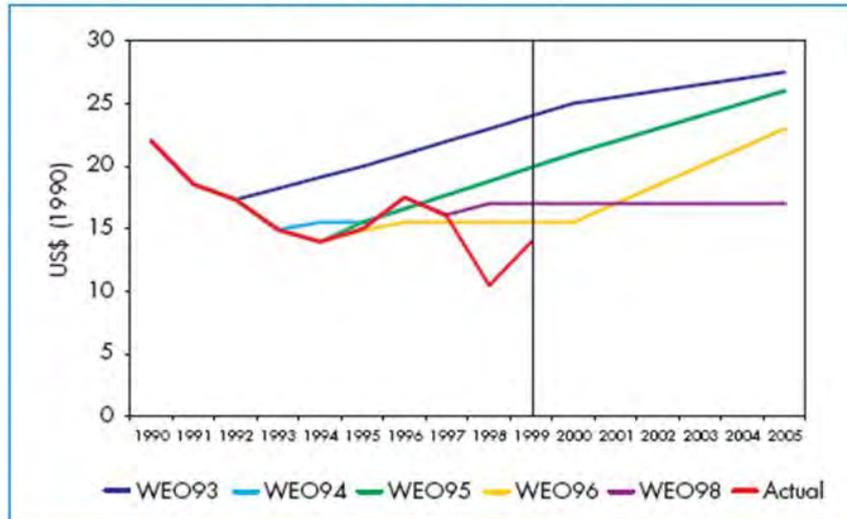
Figure 5

The 2012 UNEP Report on renewable energy² shows how successful the renewable sector emerged. The core of this industry grew up in Europe after the Chernobyl nuclear disaster. It was China, an industrial heavyweight, who adopted these technologies after 2005 successfully to become a world leader in wind power installations and solar module production. And it is in the developing countries where growth of renewables shows the highest rates.

² BLOOMBERG NEW ENERGY FINANCE: Global Trends in Renewable Energy Investments 2012, edited by UNEP

The IEA forecasts worked in the 1990s

Figure 14.1: Oil-Price Assumptions



IEA World Energy Outlook 2000

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Figure 6

The IEA perception for fossil fuels worked well in the nineties. The message was that cheap oil and gas will persist for many years. And that we should not care about energy when investing in new infrastructure such as cars, highways or airports.

IEA Oil Price Forecast method in 2002

*"Crude oil prices are assumed to remain flat until **2010** at around **\$21 per barrel** (in year 2000 dollars) – their average level for the past 15 years. They will then rise steadily to **\$29 in 2030.**"*

*International Energy Agency:
World Energy Outlook **2002**, p. 37*

Figure 7

In 2002 the World Energy Outlook of the IEA said: "Crude oil prices are assumed to remain flat until **2010** at around **\$21 per barrel** (in year 2000 dollars) – their average level for the past 15 years. They will then rise steadily to **\$29 in 2030.**" As we all know today with oil at 100 US-\$ per barrel, the reality is different.

The IEA method of supply prediction:
predict demand!

*„The **oil supply projections** of this Outlook are **derived from aggregated projections of oil demand**.... Opec conventional oil production is assumed to fill the gap.“*

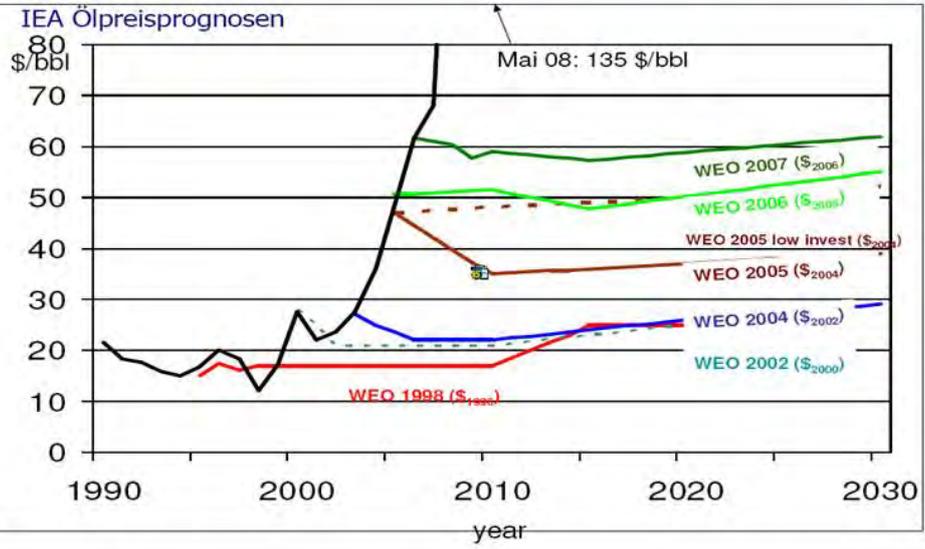
World Energy Outlook 2002 p. 95

Figure 8

These fault estimates did not evolve as a surprise, considering the IEA method of prediction. *The **oil supply projections** of this Outlook are **derived from aggregated projections of oil demand**.... Opec conventional oil production is assumed to fill the gap,*“ the IEA wrote in 2002.

1998-2007

IEA Forecasts never hit reality



Source: LBST – Werner Zittel

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Figure 9

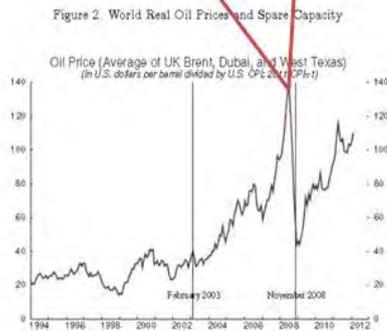
After 2003 the IEA had to adapt its oil price forecasts to reality. The IEA behaved like a weather forecaster, hoping to be 60 percent right by saying the weather tomorrow will be the same as today, which did not work well for oil prices, however.

II

Fossil fuels and decline rates

Part 2: Fossil fuels: decline rates and price cycles

2008 Oil at 147 \$ per barrel



1. Forecasts – can we trust them?
2. Fossil fuels: decline rates and price cycles
3. Renewable energies: growth and costs
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Figure 10

So let us go to the roots of errors in our next part.

In 2008 the oil price had surged to 147 \$ per barrel. The trust in cheap oil and into IEA predictions had waned. The time was mature to talk about oil decline rates.

IEA Oil Production Forecasts 2006 to 2008

a shift in perception

(source: IEA/Energy Watch Group)

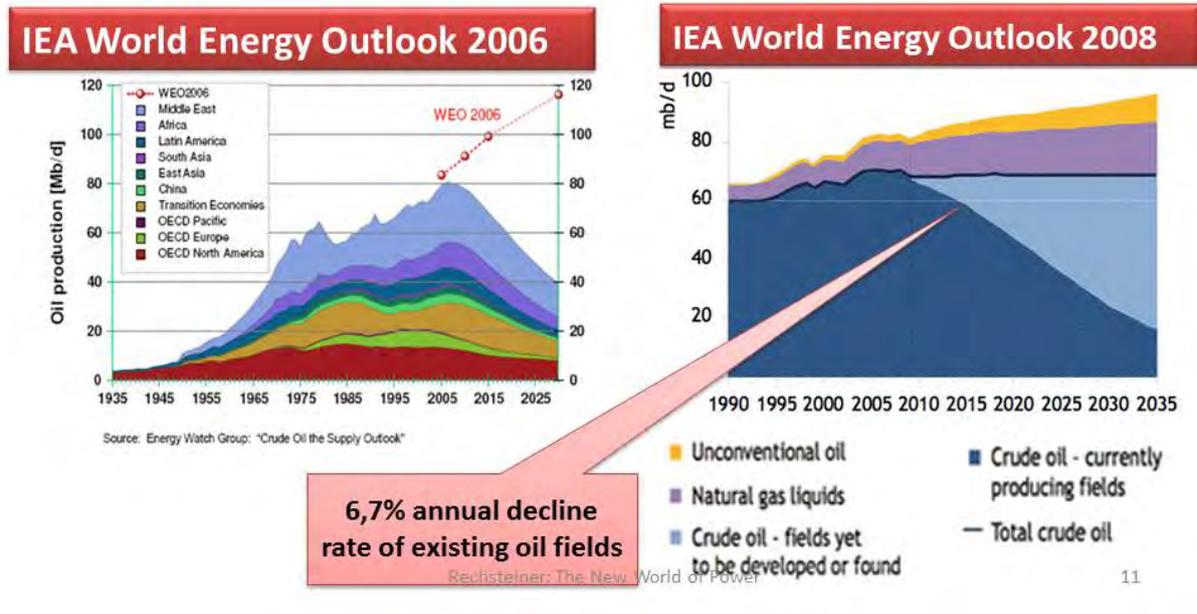


Figure 11

The peak oil discussion, initiated by Colin Campbell and Jean Laherrère in their famous Scientific American contribution³ and of Aspo – the association for Study of Peak Oil and Gas – gained widespread influence. The IEA World Energy Outlook in November 2008 reported intensely on decline rates. It applied well-established petroleum engineering principles to 800 post-peak fields that make up the majority of global oil supplies.

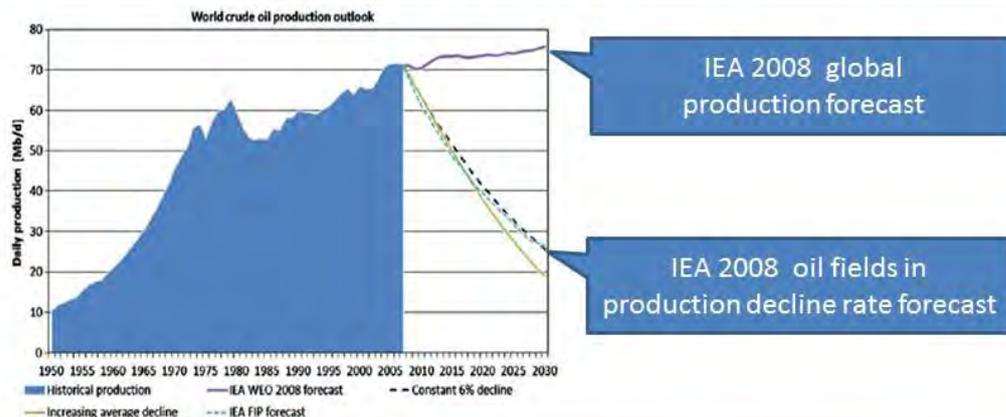
The natural decline rates of these fields were reported to average 3.4% for 54 supergiant fields, 6.5% for scores of giant fields and 10.4% decline rate for hundreds of large fields. At the IEA's 6.7% level of capacity declines, the current 74 million b/d of conventional oil supplies⁴ would require 5 million b/d of supplemental new capacity annually just to maintain a flat level of supply.

The IEA 2006 prediction of 120 mbd of oil by 2030 was abandoned.

³ The end of cheap oil, Sci.Am. 1999

⁴ excluding NGLs, biofuels, non-conventional oil and various other liquids)

After a decade of denial the IEA admits: decline rates of global oil fields at 6.7%



Post-peak oil fields show a decline rate of 5,5% per year (Höök, 2009)

Table 1
Characteristic parameters for all 261 post peak giant fields covered by this study.

	Mean	Median	Prod. Weight
Decline rate	-6.5%	-5.3%	-5.5%

Fields that had not reached the decline phase as of the end of 2005 were excluded.

Table 2
Characteristic decline rates of land and offshore fields.

# Fields	Field type	Mean (%)	Median (%)	Prod weight (%)
170	Land fields	-4.9	-4.4	-3.9
91	Offshore fields	-9.4	-9.0	-9.7

Fields that had not ended their plateau phase or were in build up phase as of the end of 2005 were excluded.

Source: Höök, M. et al: Giant oil field decline rates and their influence on world oil production .Energy Policy (2009),

Figure 12

In saying so the IEA exactly adopted the Aspo view on oil decline – their decline rates were identical – identified at 5.5% for giant fields bei Höök and Aleklett. We should be aware what that means. 5 mbd of new production each year, that is one new Saudi Arabia in terms of new oil every two years.

World Oil Price (real) and spare capacity (IMF 2012)

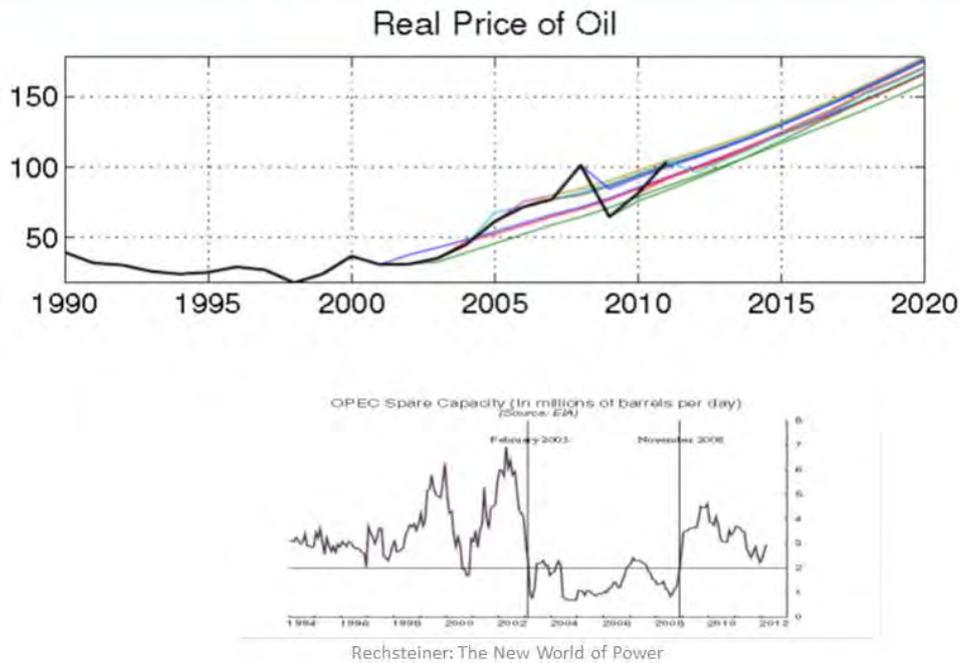


Figure 13

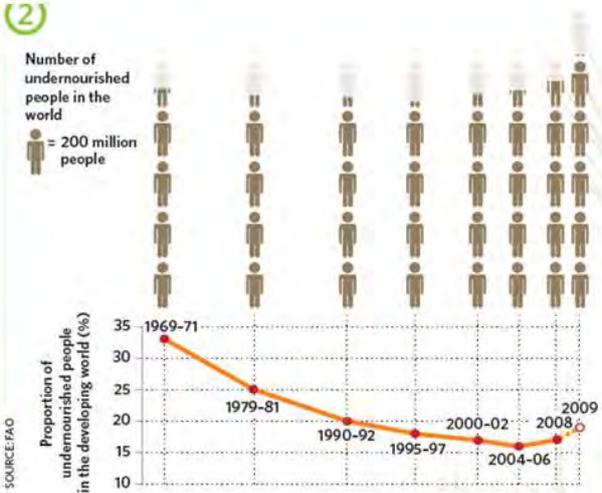
There is much hope to find this amount of new oil in the long run, but no evidence. Following an elaborated model of the IMF, oil prices persist at 100 \$ per barrel or more and will rise toward 150 Dollar by 2020.⁵ There is no spare capacity in the market that is not consumed within few years.

⁵ Jaromir Benes et al. The Future of Oil: Geology versus Technology,

Biofuels and global warming doubling food prices



Food Price Index (FAO)

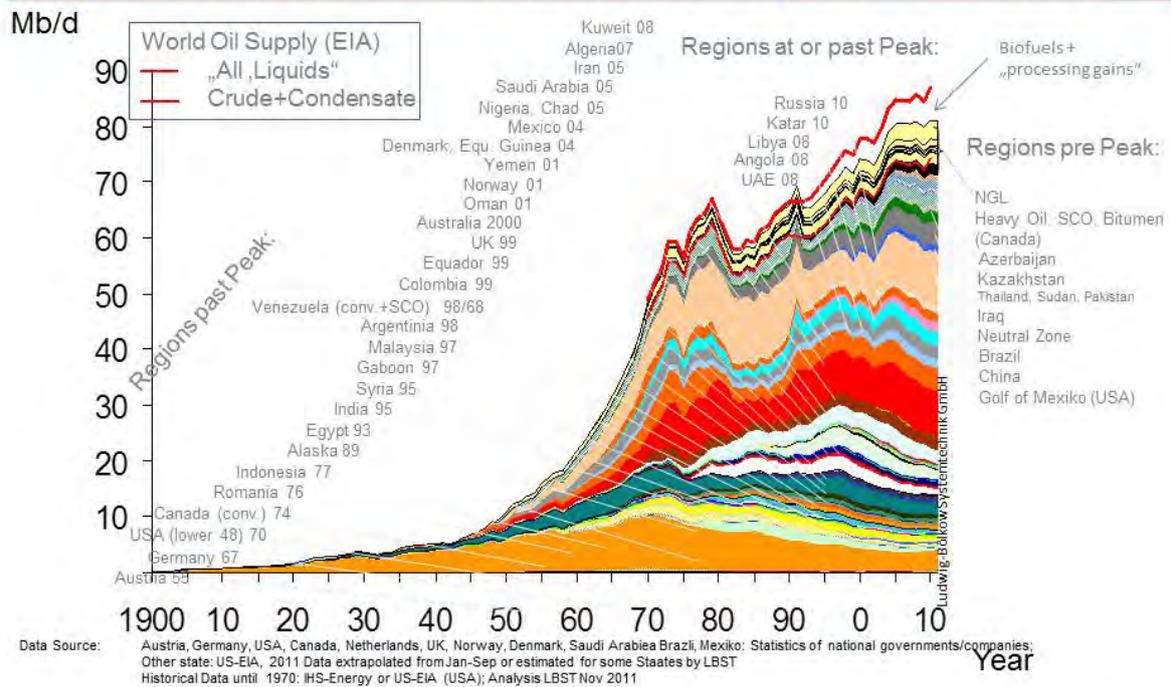


Nature 466/2010

Figure 14

Many nations started to develop unconventional resources such as oil sands, shale gas and biofuels from food crops. Biofuels and global warming drive up the price for foods with more people in poor countries starving. In this way, non-renewable energy starts to create new problems and conflicts. It causes food crisis and serious climate damage around the globe.

World Oil Production 1900 – 2011 (Crude Oil+Condensate, NGL, Heavy Oil, Tarsands)



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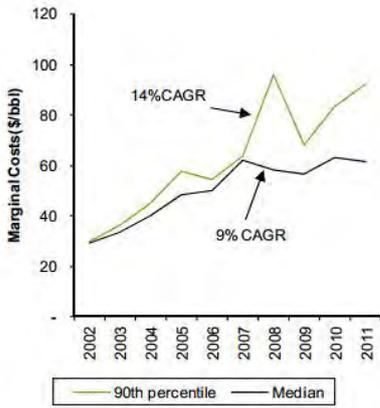
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Figure 15

There is strong evidence in many important oil territories that after peak oil, lost production cannot be replaced by conventional or unconventional resources, nor by natural gas.

Drilling Companies consuming more and more national income

Exhibit 10
Non-OPEC ex FSU marginal costs (90th percentile of production) and median marginal costs, 2002-2011



Source: Corporate Reports, Bernstein analysis

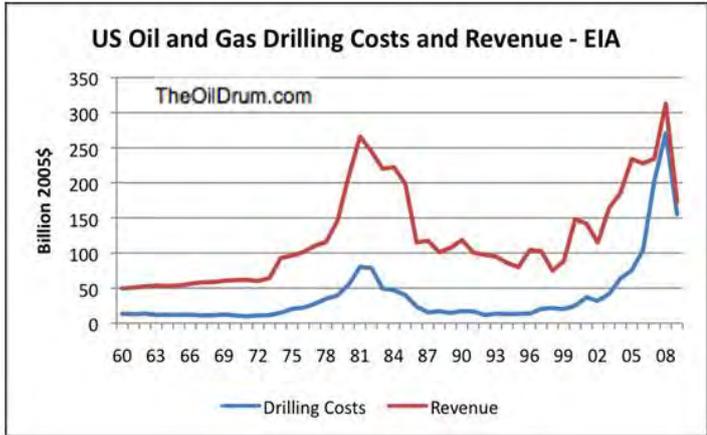


Figure 16

The marginal cost of oil production is reported to have increased by 9% year-over-year since 2002. Drilling companies are consuming more and more of the national revenue, a treadmill burden that creates no real new wealth.⁶

⁶ <http://ftalphaville.ft.com/blog/2012/05/02/983171/marginal-oil-production-costs-are-heading-towards-100barrel/>

Oil and natural gas price in energy equivalents (US)

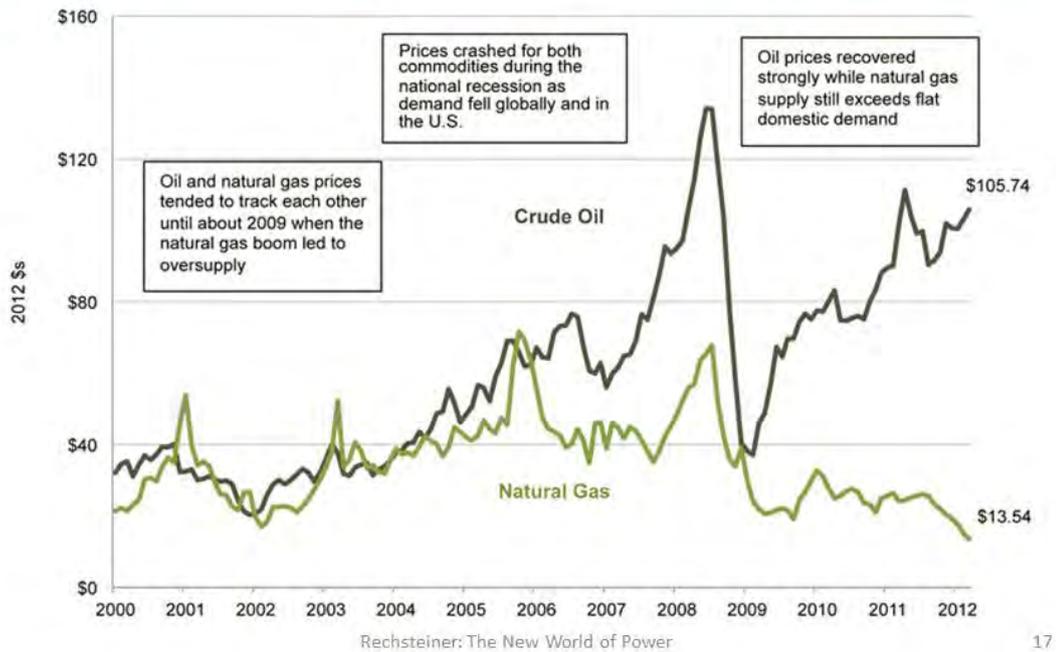
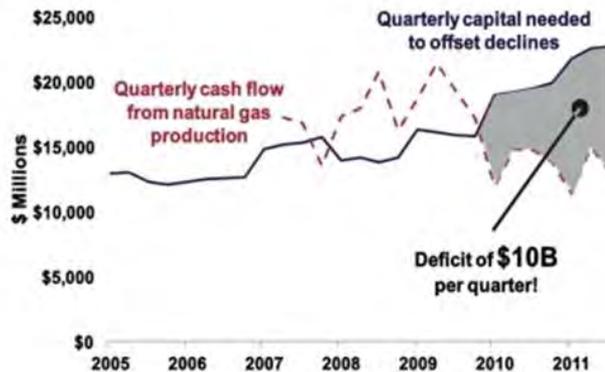


Figure 17

There are some short term winners in the non-renewable sector out of this. Unconventional energies such as unconventional oil and shale gas have emerged. It is a boom – sponsored by high future prices – that led to a natural gas glut with natural gas prices significantly cheaper than oil in the US.

Shale gas not profitable after gas glut

Fig 2: Total US Natural Gas Production Maintenance Capital and Cash Flow Generation



Sources: HPDI, Company Reports, ARC Financial Research

Exhibit 3. Total U.S. Natural Gas Production Maintenance Capital and Cash Flow Generation
Source: Arc Financial Research. Rechsteiner: The New World of Power

"We are all losing our shirts today." Mr. Tillerson said in a talk before the Council on Foreign Relations in New York.
"We're making no money. It's all in the red."

The Wall Street Journal
July 4, 2012
Citing Exxon Boss
Rex Tillerson

Figure 18

However, how sustainable are these new resources? Oil and gas companies complain about the high cost of drilling – Exxons Rex Tillerson telling us that “all is in the red”.⁷ investors are “locked in” – suffering high expenses due to the need for continuous drilling to compensate for high decline rates. It means that the cost of these products is on the rise soon.

⁷ Exxon: 'Losing Our Shirts' on Natural Gas - WSJ.com

<http://online.wsj.com/article/SB10001424052702303561504577492501026260464.html?mod=wsjde_finanzen_wsj_barro_n_tickers>

Natural gas decline rates (US)

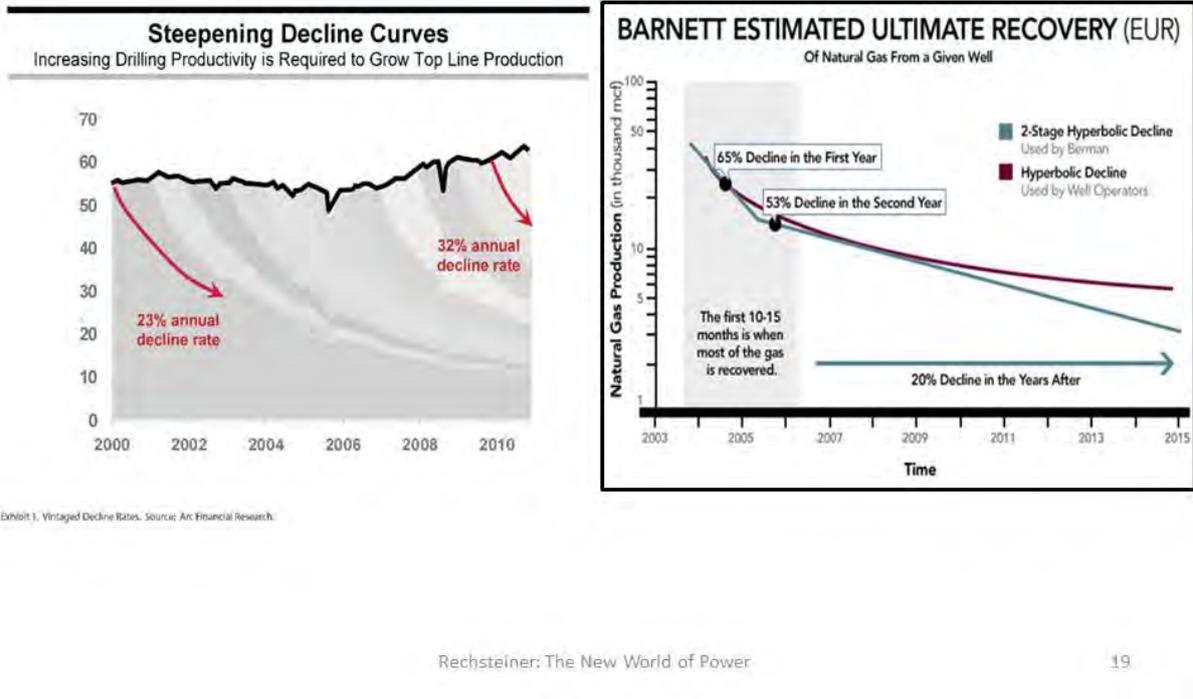


Figure 19

We should remember that unconventional resources are called unconventional because the effort to bring this energy to the market is higher than for conventional sources. The decline rates for natural gas shales and unconventional oil in the US are 20 to 30 percent a year, or more.

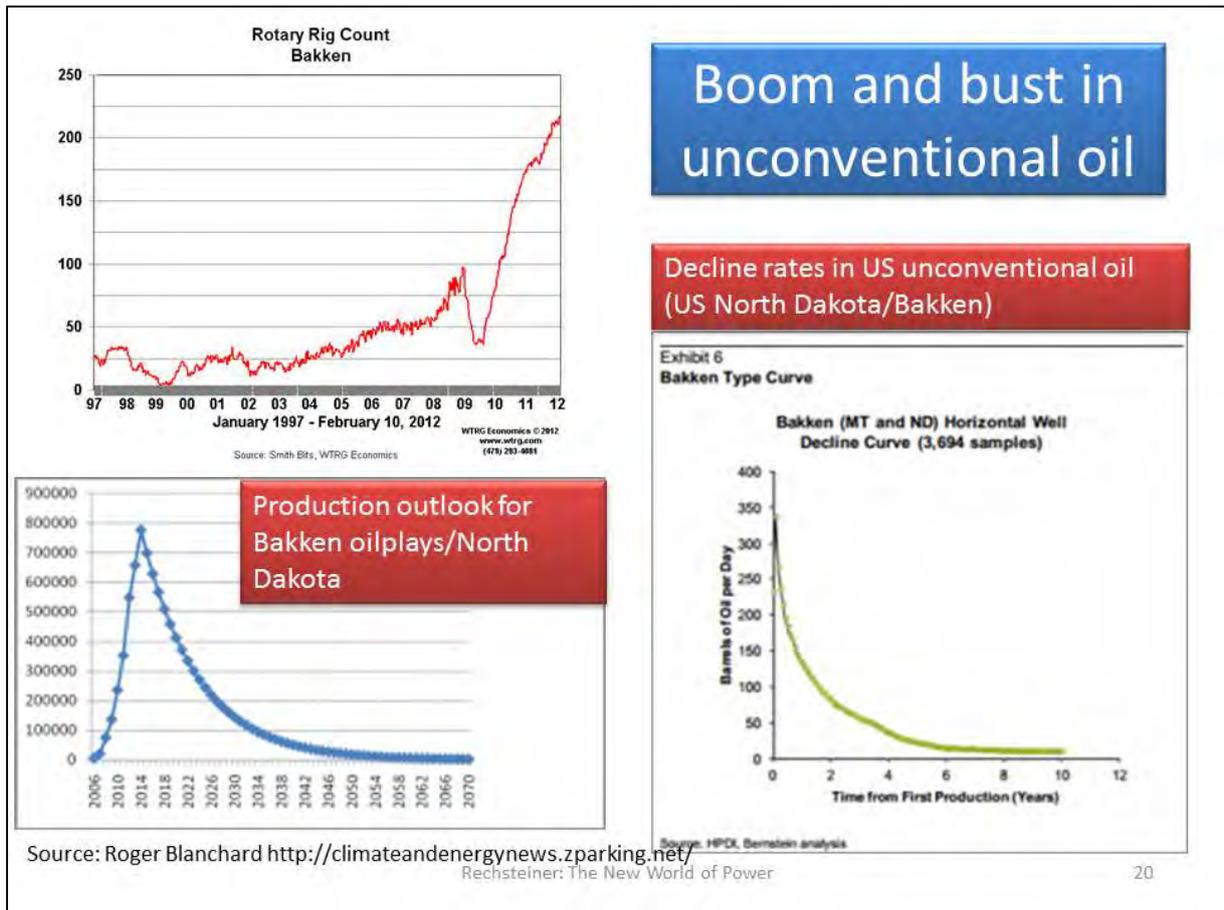


Figure 20

Therefore this boom might not persist for a very long time. The unconventional plays show characteristics of a gold rush boom and bust. After a while decline rates will dominate the overall expansion, costs will rise and the interest in such plays might disappear.

Conventional Energy prices on the rise

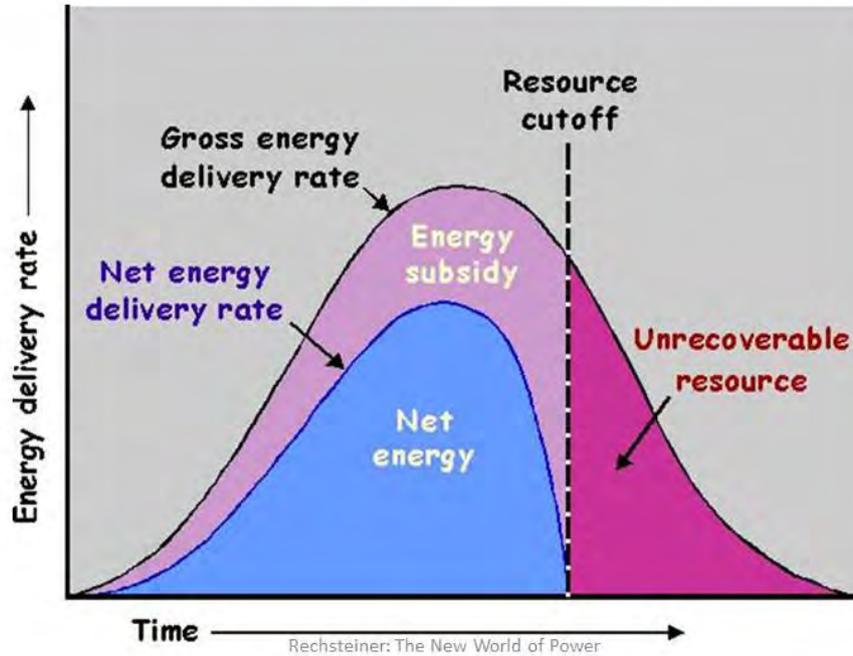


<http://www.indexmundi.com/commodities/> Rechsteiner: The New World of Commodities

Figure 21

An overall price rise worldwide for fossil products is visible, hurting consumers worldwide. Rising prices for coal, natural gas and oil are an indicator that former cheap resources get scarce due to overall decline rates, higher costs, longer transports, more pollution and clean-up cost, despite industry pretending the opposite.

Decline of net energy energy source to become uneconomic



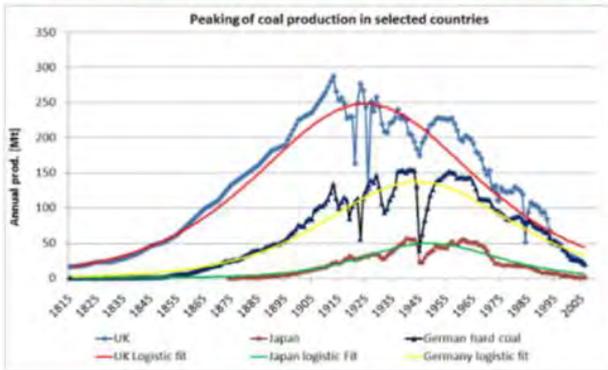
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Figure 22

More and more energy is needed to produce energy, and this comes at a cost. At a certain point an energy resource starts to be uninteresting. At one point net energy starts to get negative because investment cost turns out higher than energy return and alternatives turn out to be cheaper.

Coal production in post-peak coal nations

Coal production UK, Germany, Japan



China coal price

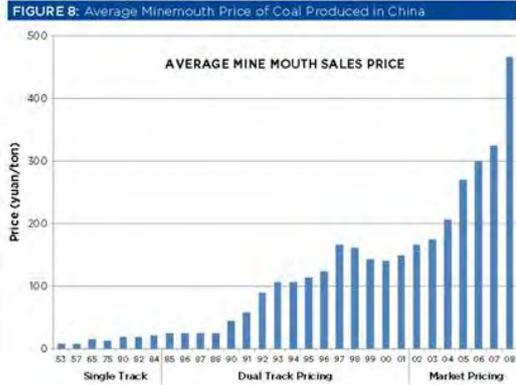


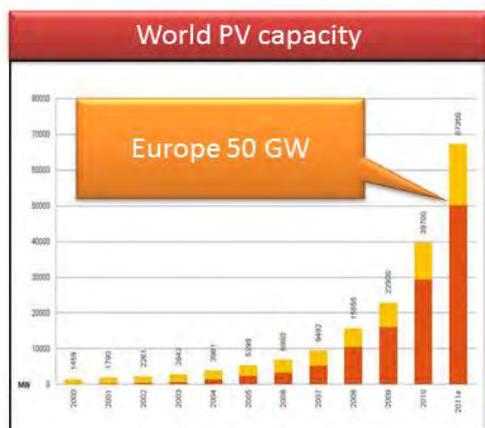
Figure 23

This situation has arrived in the past in some countries. The Stone Age did not end because of a scarcity of stones. And industrialized nations reduced coal production not because of a scarcity of coal, but because something different and more valuable had emerged.

III

Renewable energy growth

Part 3: Renewable energy growth



1. Forecasts – can we trust them?
2. Fossil fuels: decline rates and price cycles
3. Renewable energy growth
4. Dynamics within the power sector
5. Challenges ahead

Figure 24

The new player in the game is renewable energy of many kind. The figure shows the emergence of solar PV. It grew by more than a 50% compound annual growth rate (CAGR) over the last decade.

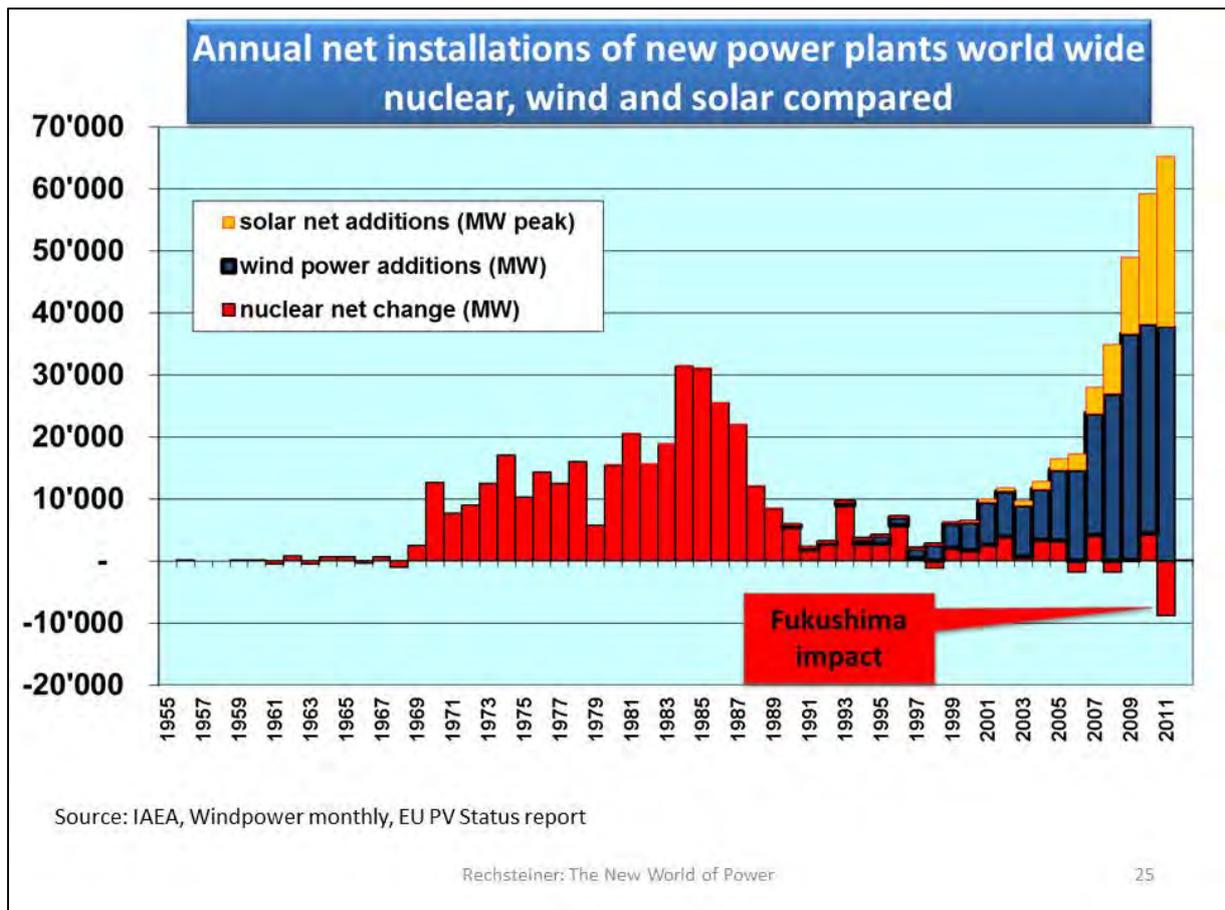
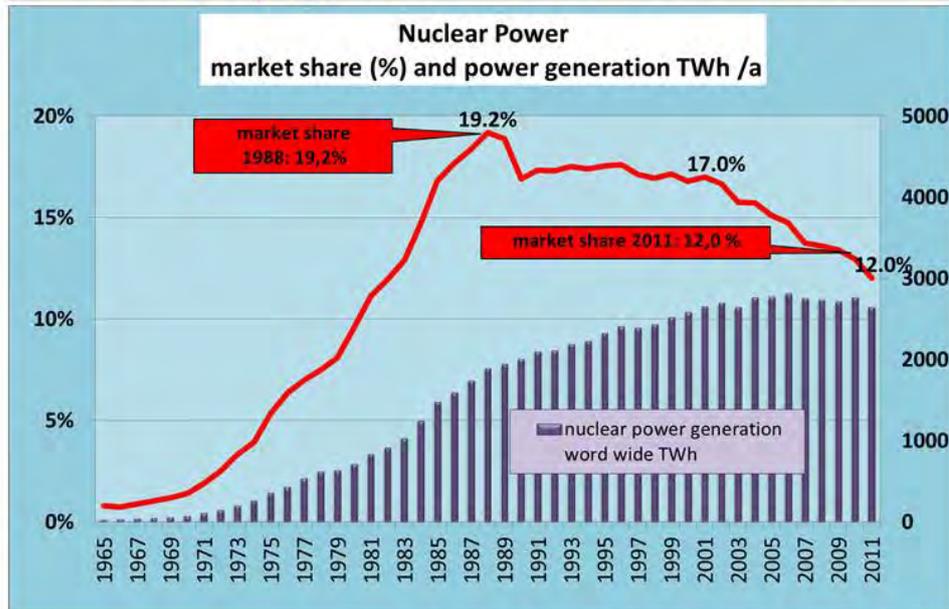


Figure 25

As we can see in this graph, this came along with a decline of new installations of nuclear plants which started to decline around 1986, after Chernobyl. Wind and solar installations grew at record growth rates since 1990 due to innovation and new market structures.

Decline of nuclear power electricity generation and market share



Source: BP Statistical Review of World Energy June 2012

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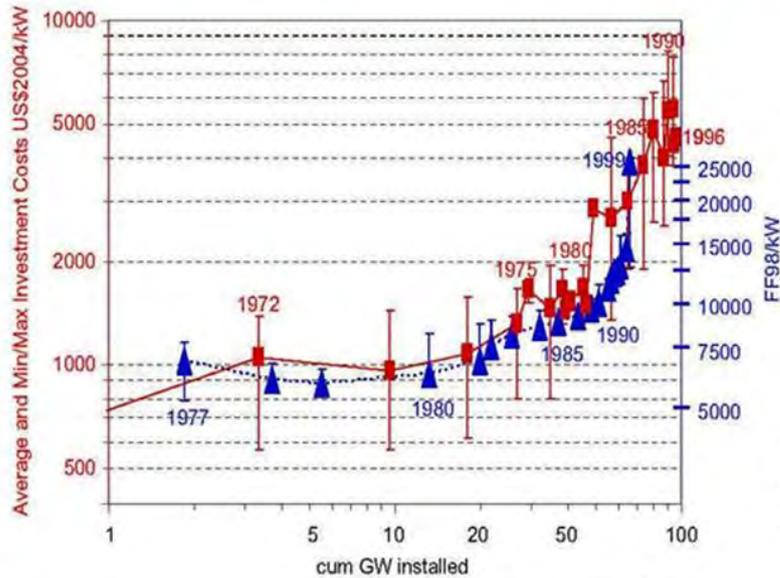
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Figure 26

Market share of nuclear energy fell from 19 percent to 12 percent of global electricity consumption and nuclear power generation had its historical peak in 2006. The nuclear industry is confronted with cost overruns, additional security costs, unresolved radioactive waste issues and protests.

Negative learning curve of nuclear power

Cost over time of French and US new nuclear reactors



Source
Grubler, Energy
Policy, Sept 2010

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Figure 27

For nuclear energy a negative learning curve has been observed by various analysts – and the trend continues with the much hailed European Pressurized Reactor EPR of Areva who showed cost overruns of some 100 percent, covered by the French tax payers.⁸

⁸ Le Monde 31.August 2011

Learning curves of renewable energies

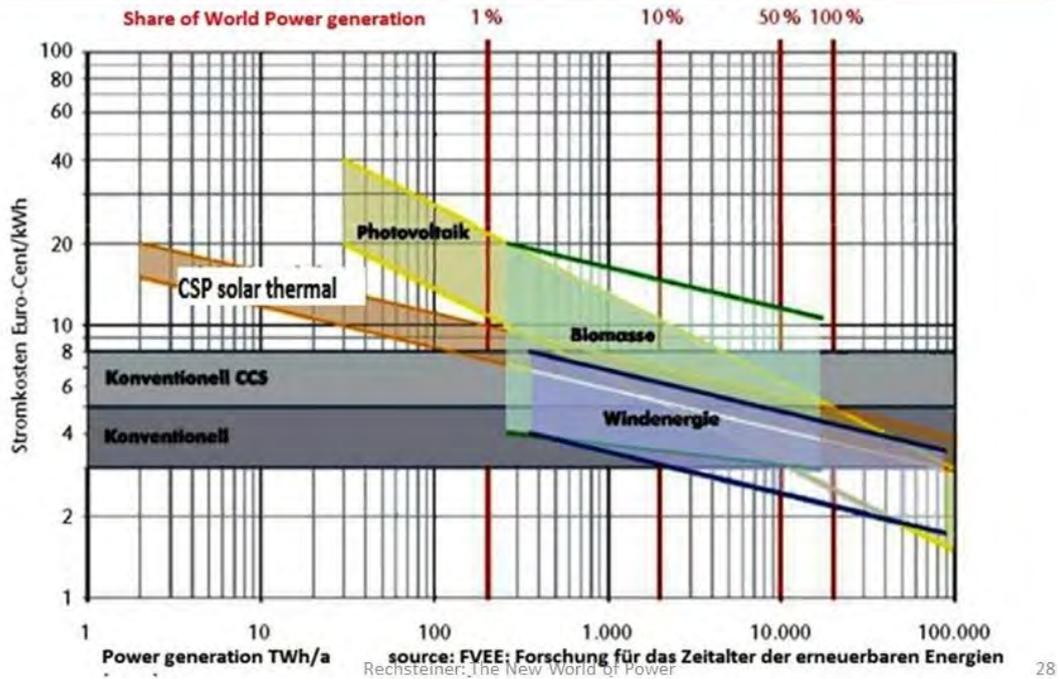
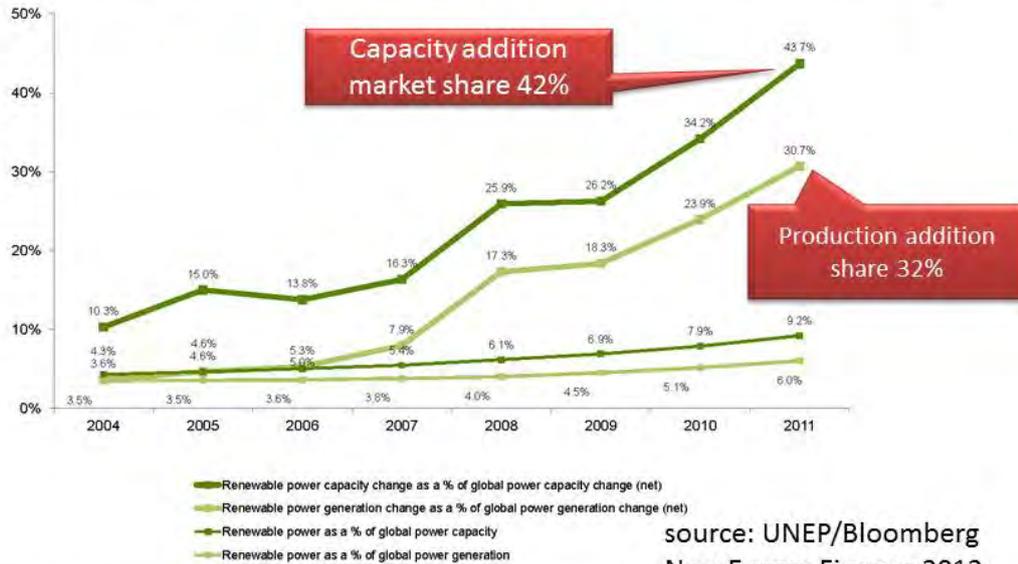


Figure 28

The learning curve of renewable energy goes definitely the other way round and shows a virtuous circle. Photovoltaics, wind power and other renewable energies offer a cost reduction over time rather than an increase. Each of the latter can fulfill all power needs worldwide.

The rise of renewable market share (large hydro excluded)

FIGURE 25: RENEWABLE POWER GENERATION AND CAPACITY AS A PROPORTION OF GLOBAL POWER, 2004-2011 %



Sources: EIA, IEA, Bloomberg New Energy Finance, International Energy Agency, The New World of Power

Figure 29

In 2011 renewables covered 43.6 percent of all new capacity additions. Adjusted for reduced full load hours, the additional energy was 31percent of all electric power additions, says UNEP. The overall contribution of renewables still is rather low, however, due to the huge old capacity built over past decades.

16 reasons of wind power's success

1. The primary energy is cost-free ;
2. The primary energy never runs out;
3. There is an abundant resource creating power independence in many regions of the world;
4. Stable life-cycle-cost can be guaranteed;
5. Wind power is competitive with other new power sources;
6. wind turbines cause no carbon, air emissions nor hazardous waste;
7. No water for cooling is needed;
8. Wind has an energy payback of less than 1 year;
9. There is global, easy access to wind technology;
10. Time to market is very short;
11. Fast innovation cycles prevail;
12. Wind is a young technology, allowing progress on the learning curve and cost reductions;
13. Wind is decentralized power with a non-exclusive structure;
14. Distance to consumers is moderate (1-1000 miles);
15. Wind has positive side benefits such as taxes, income for farmers, and remote areas;
16. Wind energy creates know-how and human labor;

Source: Rechsteiner,
Wind power in Context (2008)

Figure 30

It would be wrong to reduce the success of renewables to the factor of cost only. Behind this success story there is a trend for energy security and energy independence, new jobs, localized generation, short construction periods, local income and continuous technical innovation. For wind power, 16 different factors can be identified:

1. The primary energy is cost-free ;
2. The primary energy never runs out;
3. There is an abundant resource creating power independence in many regions of the world;
4. Stable life-cycle-cost can be guaranteed;
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9. There is global, easy access to wind technology;
10. Time to market is very short;
11. Fast innovation cycles prevail;
12. Wind is a young technology, allowing progress on the learning curve and cost reductions;
13. Wind is decentralized power with a non-exclusive structure; it allows small organizations or groups in various places to become a part of the power generation business and to sell it for a profit –

very different from the exclusive structure of the oil, gas or nuclear business

14. Distance to consumers is moderate (1-1000 miles);
15. Wind has positive side benefits such as taxes, income for farmers, and remote areas;
16. Wind energy creates know-how and human labor.

Many of these apply to solar as well. An additional advantage of solar is the relief of decentralized generation in times of congested grids.

IV

Dynamics within the power sector

Part 4: Dynamics within the power sector

From 15% to 25% market share of renewable power 2012-2018

Figure 1 Global renewable electricity production, by region (TWh)

Year	OECD Americas	OECD Asia-Oceania	OECD Europe	China	Brazil	India	Rest of non-OECD
2005	1000	500	500	200	100	100	100
2006	1100	550	550	250	150	150	150
2007	1200	600	600	300	200	200	200
2008	1300	650	650	350	250	250	250
2009	1400	700	700	400	300	300	300
2010	1500	750	750	450	350	350	350
2011	1600	800	800	500	400	400	400
2012	1700	850	850	550	450	450	450
2013	1800	900	900	600	500	500	500
2014	1900	950	950	650	550	550	550
2015	2000	1000	1000	700	600	600	600
2016	2100	1050	1050	750	650	650	650
2017	2200	1100	1100	800	700	700	700

Source: IEA Mid Term Renewable Energy Market Report 2012

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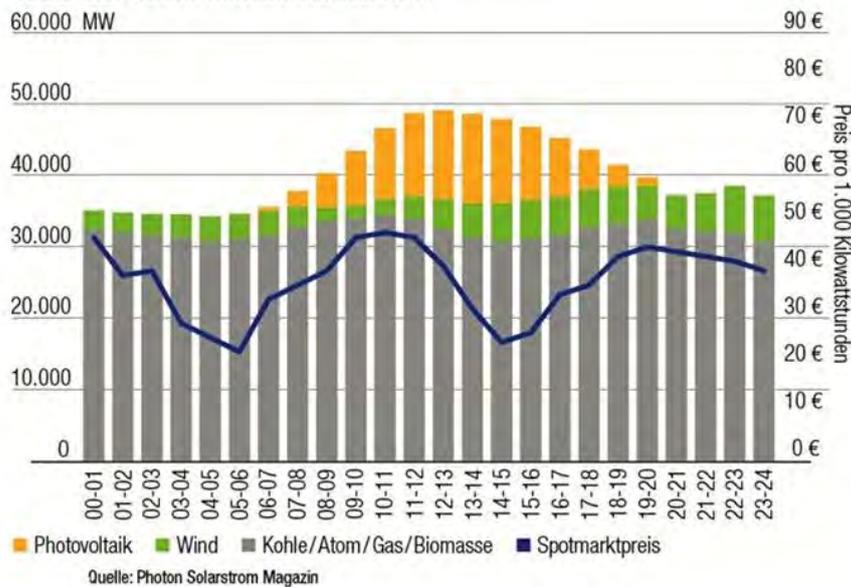
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Figure 31

Now the renewables market share starts to bite the conventional sector. The overall market share of renewables – including large hydro – will rise from 15 percent today to 25 percent in 2018, says the Mid-Term Renewable Energy Market Report of the International Energy Agency.

German Power Spotmarket 16 Juli 2011

Deutscher Strom-Mix am 16. Juli 2011



Source:
EEX/Photon

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Figure 32

The falling cost of renewable energies has tough implications for conventional energies. Due to its low variable cost and fuel cost of zero, wind and solar are the preferred power sources on the merit order of power plants.

Wind and solar start to influence gross market prices. When the sun is shining, more expensive technologies are pushed out of the market and the latter have to reduce their capacity. This leads to higher costs in the conventional sector – running in shorter cycles and less full load hours. As can be seen on the German spot market: During day time with highest demand, spot prices begin to fall.

EEX electricity spot market 7. März 2012: Spot price at day cheaper than at night

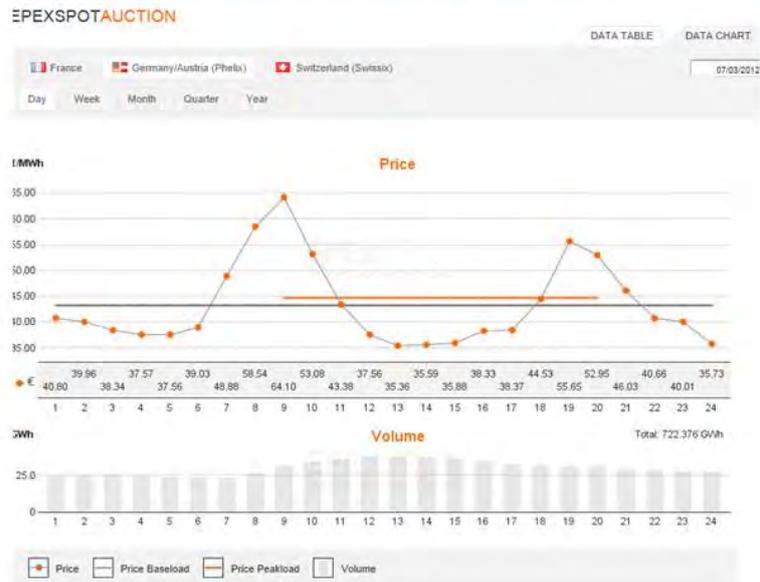


Figure 33

Even in winter time solar and wind power combined lead to low prices during high demand. This price curve of March 7, 2012 shows day rates lower than night rates – something quite new in the world of power.

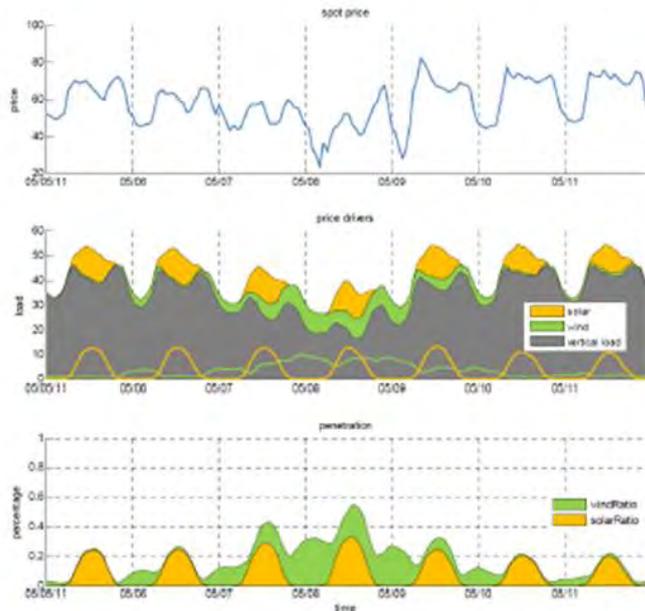
Market Clearing Price Germany Sunday August 8, 2012



Figure 34

On a sunny Sunday, gross market prices often stay below 3 Euro Cents all over during daytime. This is a benefit for all consumers, not just for consumers of wind and solar power.

Effect of Solar: May 5th-11th 2011



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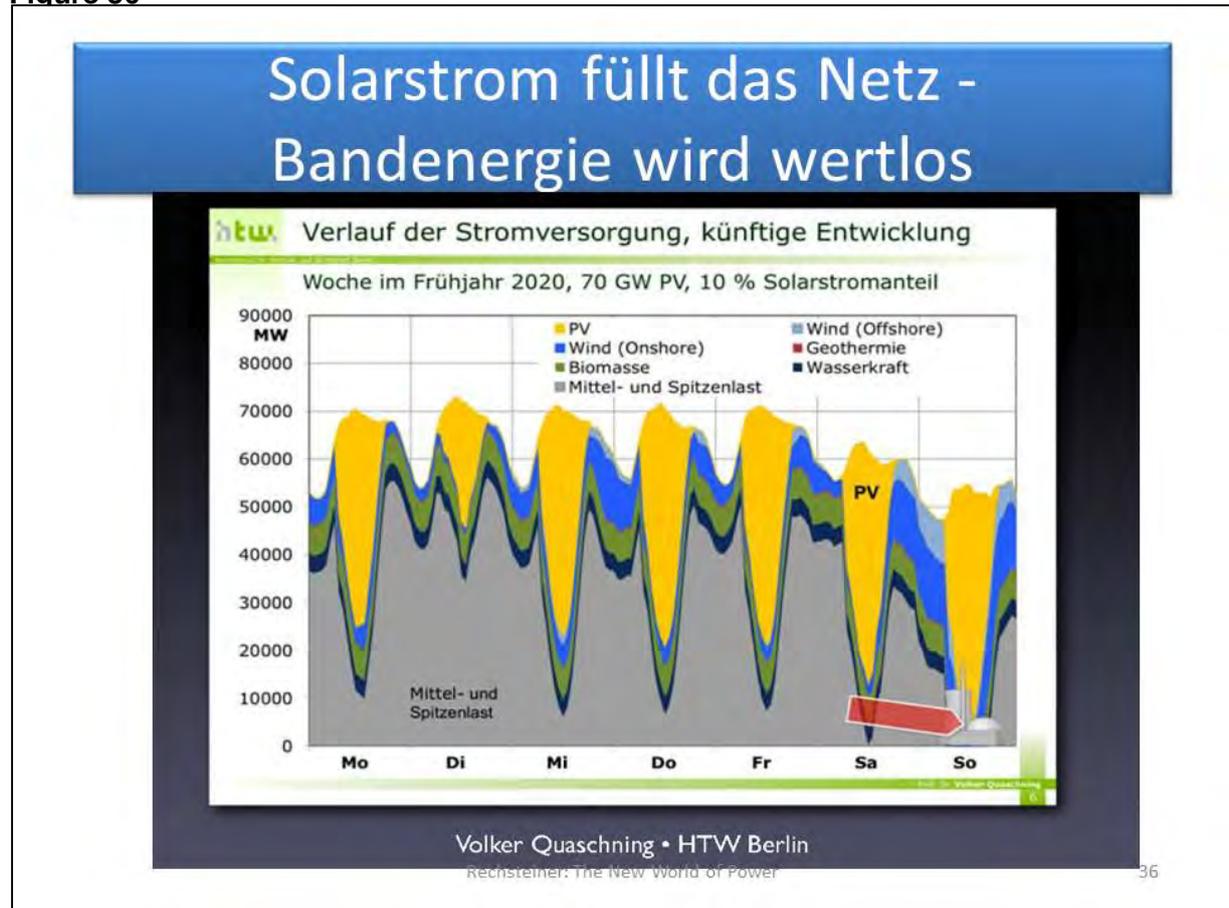
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Wind and solar
reduce market
prices due to zero
marginal cost

Figure 35

This figure displays the role of wind and solar in the German market over a typical week in May 2012. Some of the excess power is exported to neighboring countries and influencing their price structure too.

Figure 36



Extrapolating this trend to 2020 it is expected that wind power and solar bite more and more into market shares of conventional energies.

One conclusion of this is that traditional base load power from coal and nuclear does not fit into a world based on renewable energies. Flexible natural gas plants are doing better.

V

Challenges ahead

Part 5: Challenges ahead

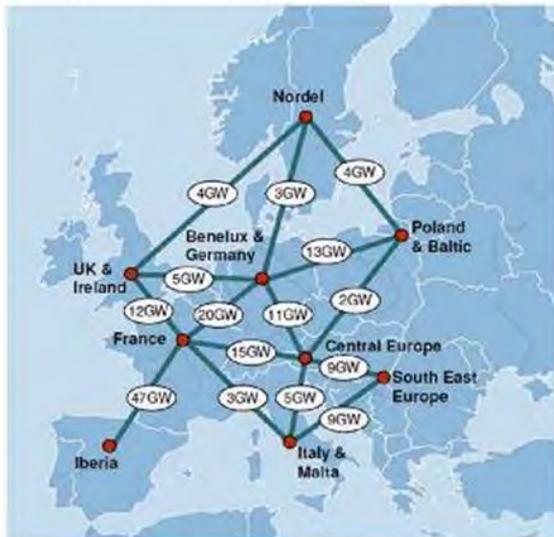
1. Forecasts – can we trust them?
2. Fossil fuels: decline rates and price cycles
3. Renewable energies: growth and costs
4. Dynamics within the power sector
5. Challenges ahead

Figure 37

Of course this secular change comprises some challenges; renewables need a different market structure and infrastructure.

Grid capacity extensions throughout the European Union

Nötige Transfer-Kapazitäten eines Super-grids aus Sicht der EU-Kommission



The benefits of grids

- Balancing power by deliveries to other markets
- Access to new resources
- Access to existing storages (pump storage)
- Access to excess power in other areas

Quelle: Tom Howes, EU-Kommission

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Figure 38

There are various possibilities for integration of renewable energies. Grid extensions and a change toward HVDC grids are promoted by the European Union. New grids and grid extensions have many benefits: balancing power generation with different technologies over different regions, access to new markets and access to power storage facilities such as pumped hydro in Scandinavia or in the Swiss mountains.

Einspeisevergütungen in Deutschland 1990-2010: von 3% auf 25% sauberen Strom (50% bis 2020?)

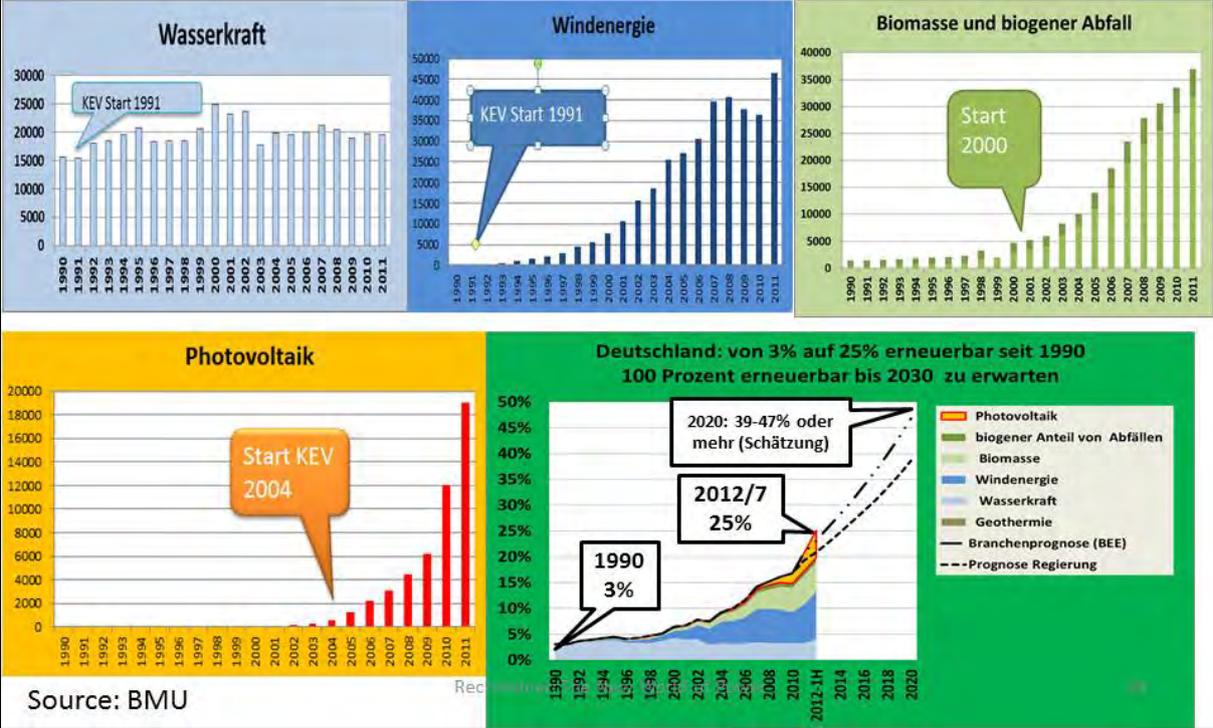


Figure 39

There is a controversy on the question of cost of renewable energies. The German feed in tariffs (FITs) have been adopted by some 60 nations. They successfully led to a fast expansion and cost reduction. There is no doubt that Germany will come close to a 100% renewable energy in the power system by 2030 up from 3 percent in 1990 and 25 percent now.

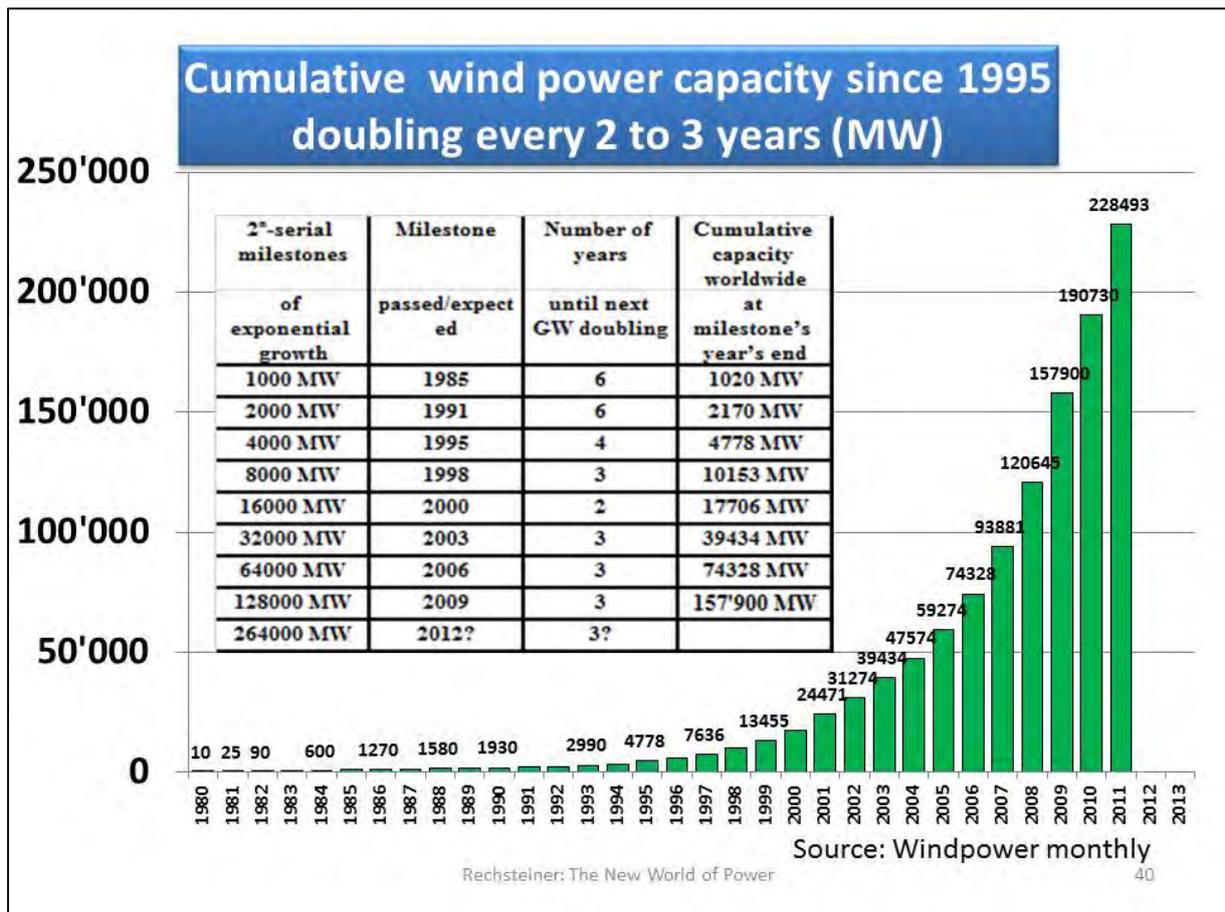


Figure 40

Wind power doubled its capacity every two to three years since 1995. This has reduced the cost of wind power significantly. Wind is on a par with new coal and natural gas, and minor price disruptions in the coal and gas market will accelerate its use.

Feed-in-Tariffs achievements: 65% lower cost for solar PV within 5 years

Solar Module costs since 1976 (BNEF)

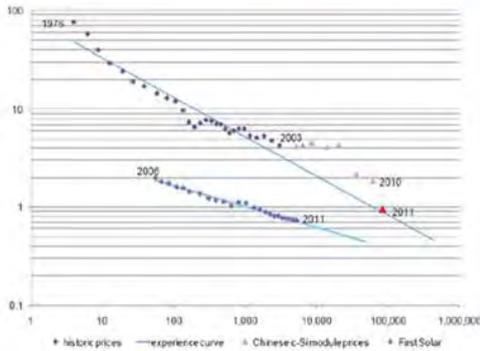


Figure 1: PV module experience curve 1976-2011 (BNEF, 2012a).

Solar system costs per kW (BSW)



Source: BSW

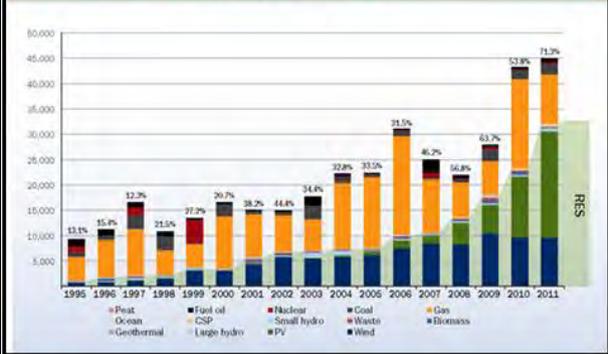
Morgan Bazilian et al: Re-considering the Economics of Photovoltaic Power BNEF 2012

Figure 41

For solar the trend for cost reductions was even steeper. System cost fell by two third over the last five years. This opens many new markets in the future.

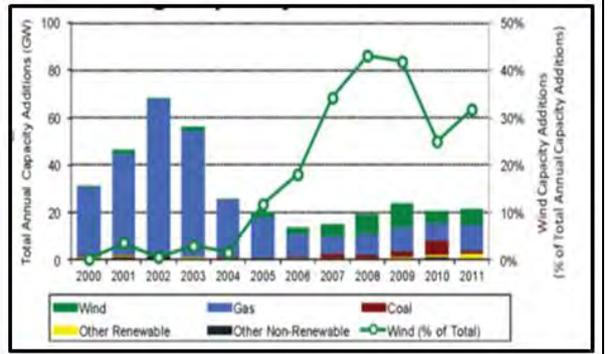
Market share of renewable power plant installations in Europe and the US

71 Percent capacity market share of renewables in Europe (2011)



Source: EWEA 2012

33 Percent Market Share of Renewables in US



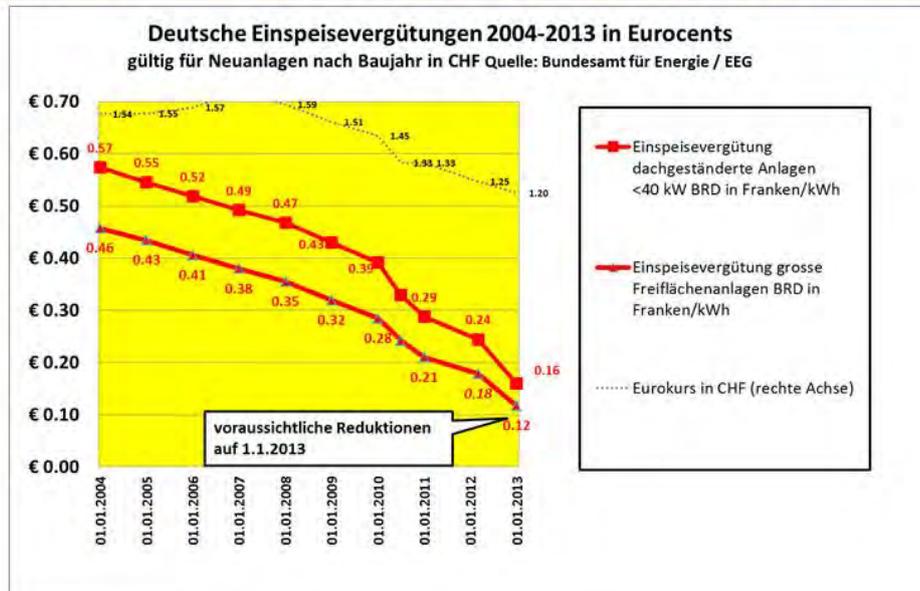
Source NREL/Ryan Wiser 2012

Figure 42

In Europe and the US market shares of renewables have grown substantially over the last decade. Renewables start to have a decisive impact on electricity supply and the need for residual power plants is shrinking.

The decline of solar cost

German Feed-in-Tariffs as an indicator



Source EEG/BMU

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Figure 43

Feed-in-Tariffs have reduced the costs of all kind of renewable installations, especially of solar photovoltaics. The German feed-in-tariffs for solar have been pushed down as low as 12 Eurocents by 2013, down from close to 60 Eurocents per kWh. The reduction of generation cost was possible due to a stable market framework.

Solar cost reductions after introduction of Feed-in-Tariffs (FiT)

Reductions of solar cost in Switzerland (Swiss Cents per kWh)



Why Feed-in-Tariffs are good

- FiTs are no subsidy, paid by consumers/polluters
- initial up front payment gives investment security and delivers energy at a fixed price
- Initial public cost is paid back due to owed to the Golden End and merit order impact
- Renewable energies give protection against price rises of natural gas, coal, nuclear disasters
- Local renewable power increases security of supply
- FiTs compensate for the cleanliness of the new energy.

Figure 44

Here you can see the evolvement of the Swiss feed in tariffs for residential and open land solar power. A new competitive situation is emerging from this, with a lot of bashing against the new competitors.

Feed in tariffs often are criticized as a subsidy. But considered over a life cycle it is not.

- The price guaranteed is rate based, financed by consumers, not by taxes, the finance is self-reliant and polluter-oriented.
- In an open market, all renewable energies and nuclear start at a cost that is higher than market price, but due to the long life of renewable appliances, there is a return for the initial expense in the Golden End.
- In the open power market, no single power plant is cost effective against a market power price of some 5 to 7 €/kWh, except maybe natural gas. But for natural gas a 60 percent cost share comes for the fuel and it would be unwise to bet on cheap gas only that may rise in price over time.

- For security of supply it is better to have a portfolio of different sources. Therefore we need a market structure that pays for these benefits and for the cleanliness of energy.

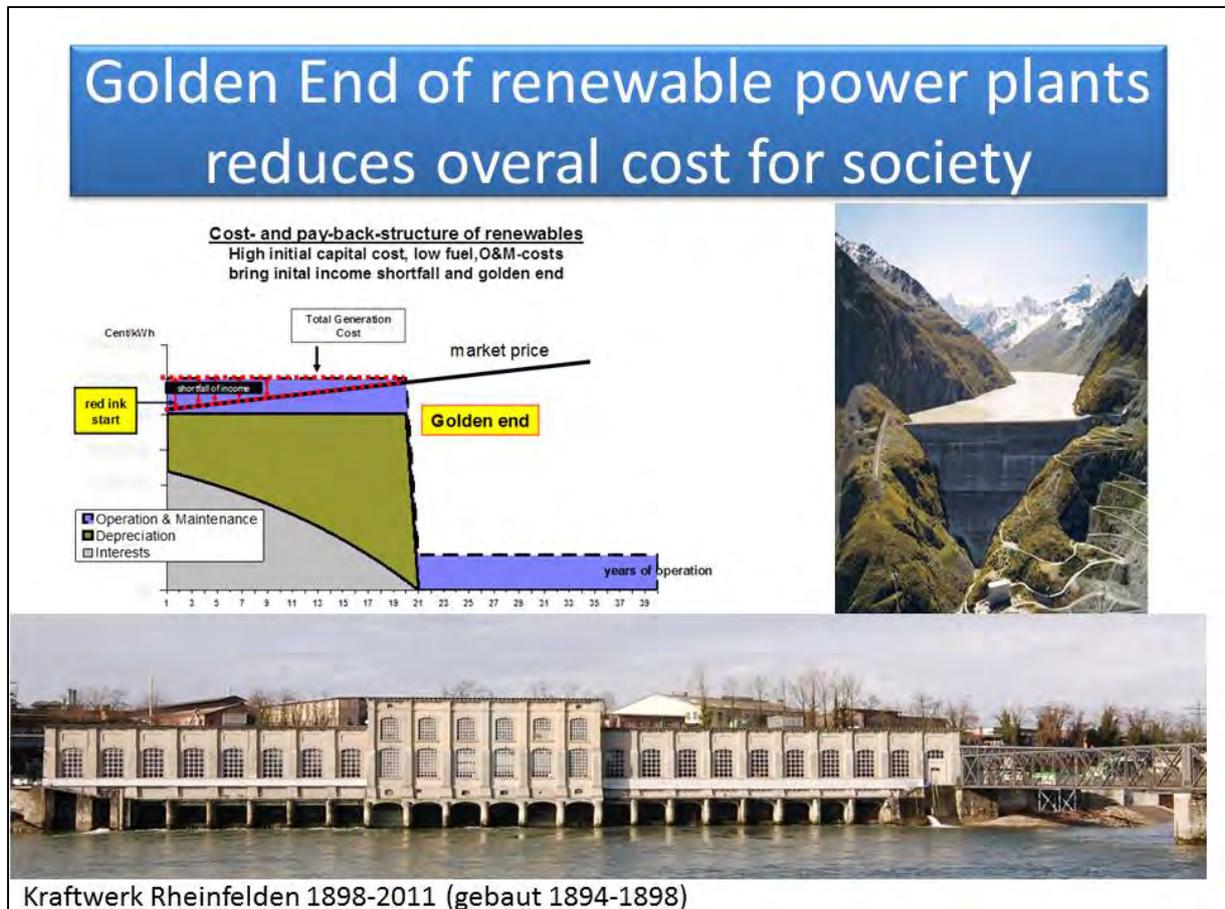


Figure 45

With a life cycle cost approach, most renewable energies are cost effective today even at a higher initial price. Many Swiss hydro facilities produce at just 2 Cents per kWh, once depreciation of investment is paid for. The use of this infrastructure assets extend from 30 to 100 years beyond the pay-back-horizon of company finance, with cross-generational benefits.

Solar roof power cheaper than residential power tariffs

FIGURE 39: ESTIMATED RESIDENTIAL PV PRICE PARITY IN 2012 AND 2015, \$ PER KWH

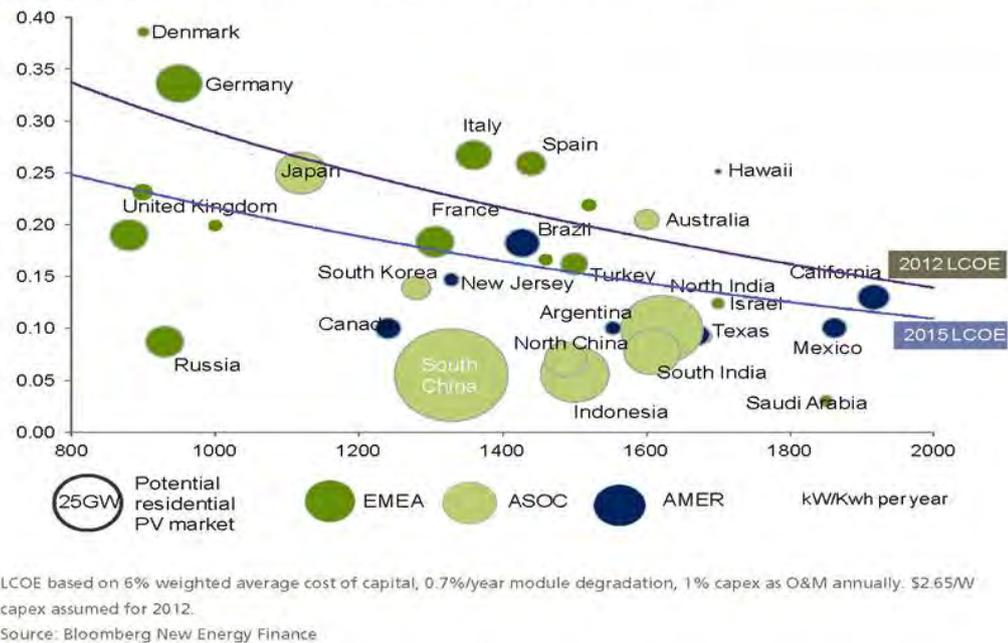


Figure 46

Due to the reduction of cost, new markets are evolving without the FIT structure. Renewable distributed energy generation represents a growing part of the electric power industry, specially where electricity costs are high and large percentages of the population are without access to power. Peak shaving and decentralized load management are a seductive motive for utilities, too. Beyond feed-in-tariffs, PV will result as a least cost option.

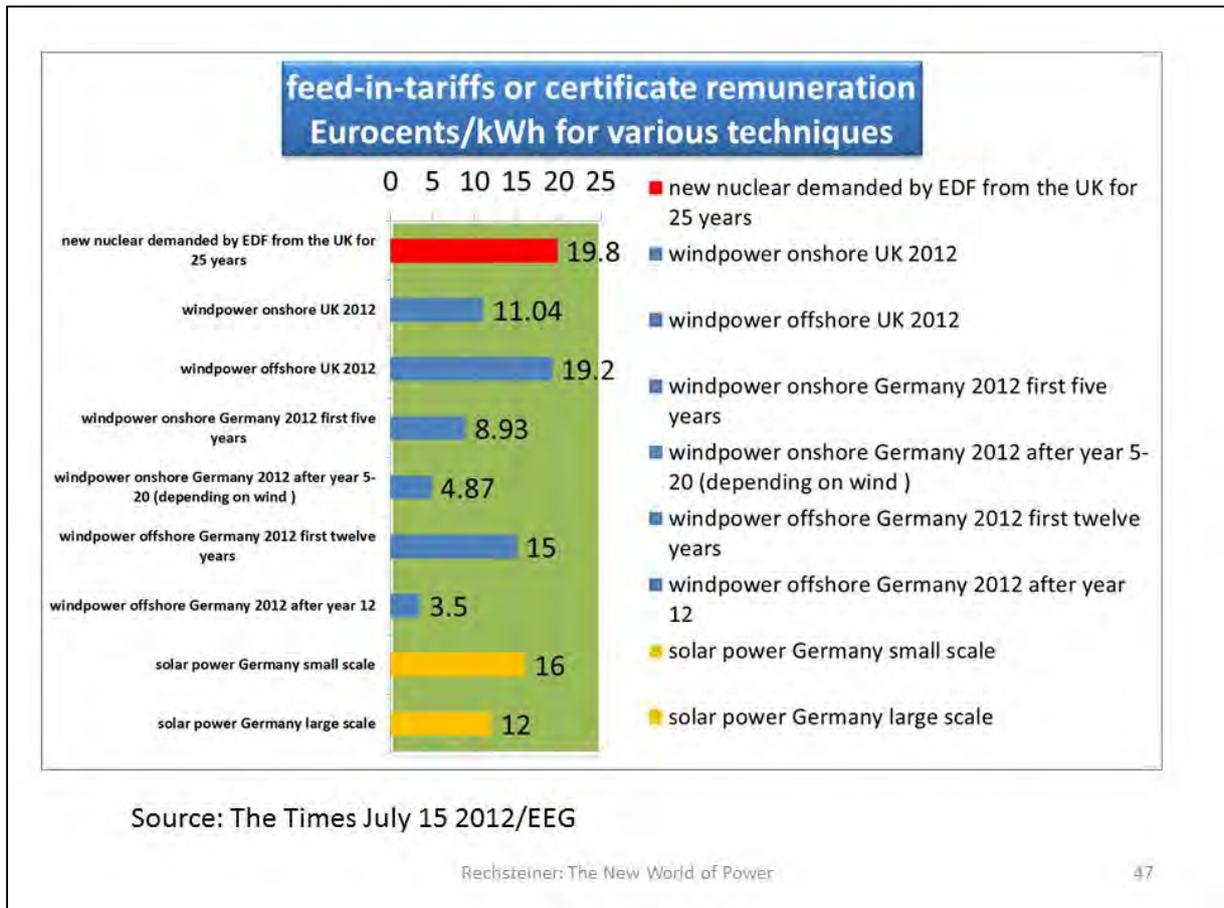


Figure 47

Nuclear power will eventually drop out of market due to high cost and unresolved risks. The compilation of feed in tariffs shows that the cost of new nuclear is higher than the cost of renewables. The nuclear industry asked David Cameron for a feed in tariff of more than 16 Pence per kWh. This is what The Times of London reported on July 15, 2012. Electricité de France (EDF) wants to be paid £165 per MWh (19.8 euros per MWh) for its proposed 3.2 GWe reactor and Hinkley C in Somerset, UK. The Times complained that the British consumers would be locked in for 25 years at a cost that goes much higher wind power onshore, wind power offshore and even solar.⁹

⁹ <http://www.thetimes.co.uk/tto/business/industries/utilities/article3476326.ece>

Cheaper renewables are the real game changer

Accelerate focus on **demand side innovation** to bring more renewables into use

– **Traffic sector**

- Electric traction as a low cost option with better efficiency than internal combustion engine
- **Power to Gas** as an alternative to electric traction
- Power to gas as a source for aviation

– **Heat pumps** and decentral heat storage

– **Solar thermal and storage as a source in the housing sector**

Figure 48

We need new market frameworks including regulatory rules for sites with less prolific productivity, storage opportunities, rules for grid extensions as well as back-up power and a proper merit order management. The overall management might look as a complex affair. But once basic rules are defined it will work easily.

A special focus should be put now on demand side innovation to bring renewables into more use. Cheaper renewables are a game changer. In the traffic sector, electric propulsion will emerge as a low cost option with cheaper batteries, thanks to much better efficiency of electric engines than internal combustion engines.

Power to Gas can be used as an alternative for automotive use and it can contribute to excess power management, and of course a valuable source for aviation.

In the residential sector, heat pumps and heat storage can accommodate better self-supply. Solar thermal is a valuable source of energy for the housing sector, too

100 percent renewable Switzerland solar or wind power instead of nuclear

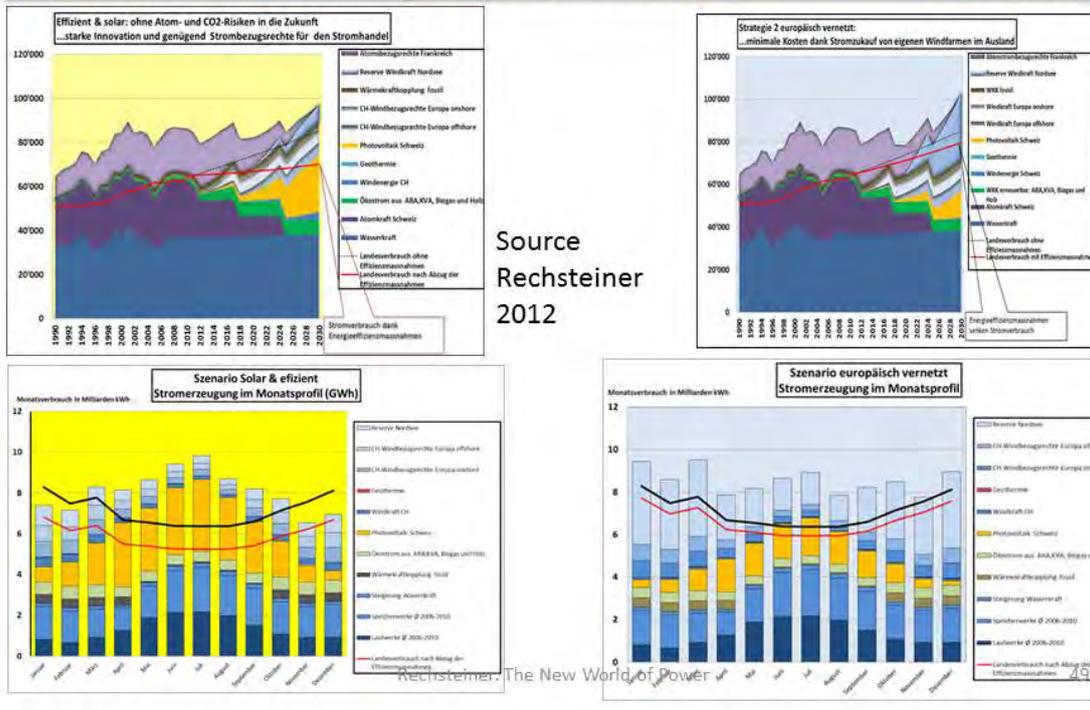


Figure 49

Renewable energies use local resources which fluctuate along weather conditions. Their specific use and combination therefore has a regional face as you can see in these two options for Switzerland - pointing to a wind based or solar based 100% renewable delivery.¹⁰

¹⁰ Rudolf Rechsteiner: 100 Prozent erneuerbar, so gelingt der Umstieg auf saubere, erschwingliche Energien, Orell Füssli Verlag 2012

Challenges ahead for renewables

- A fair price for non-polluting power
 - Coverage of investment costs and risks over a facility's life time
 - Integration of sites with high, medium and lower productivity, avoiding windfall profits
 - Long term stability of regulatory frameworks for cost reduction
- Access to the grids at non-discriminating prices
 - Preferential access to grids
 - Interconnection of different weather zones and technologies
 - Transparent grid codes
- Security of supply and backup management
 - Forecasting of demand and supply
 - combining storages such as biomass, hydro, batteries in a low cost way
 - Creation of intra-day and intra-hour markets for power exchange
 - Fair compensation of idle backup capacities
 - storing fossil fuels as "lenders of last resort"
- Environmental care
 - minimizing environmental impacts while mobilizing natural resources by incentives and regional planning obligations
 - Fair and sensitive planning of renewable energies and grids with a 100% approach in mind
 - Protection for rare species, natural rivers, exceptional landscapes

Figure 50

The challenges for a switch to renewables include

- A fair price for non-polluting power
 - Coverage of investment costs and risks over a facility's life time
 - Integration of sites with high, medium and lower productivity, avoiding windfall profits
 - Long term stability of regulatory frameworks for cost reduction
- Access to the grids at non-discriminating prices
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- Fair and sensitive planning of renewable energies and grids with a 100% approach in mind
- Protection for rare species, natural rivers, exceptional landscapes

Why renewables succeed: the benefits

- Reliable, inexhaustible and virtually free (but weather dependent) primary energy (wind, solar, hydro, geothermal)
- Resilient due to decentralized, interconnected generation
- Affordable, on the way to become a least cost-solution, chance for a Golden End
- needing a favorable market structure
 - balancing high up-front cost with later benefits
 - Diversity of sources and interconnection

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Figure 51

Renewable energies are a reliable, inexhaustible and virtually free primary energy, predictable but weather dependent.

They can create a resilient system by decentralized, interconnected generation.

They are becoming the backbone of an affordable energy system, in many places becoming a least cost-solution. Renewables need a supportive market structure, open grids and large geographical interconnections with open access. Higher up-front costs are paid back by all kind of benefits including cheaper costs in the Golden End and virtually no pollution.