Towards 100% Solar Energy for the SKA

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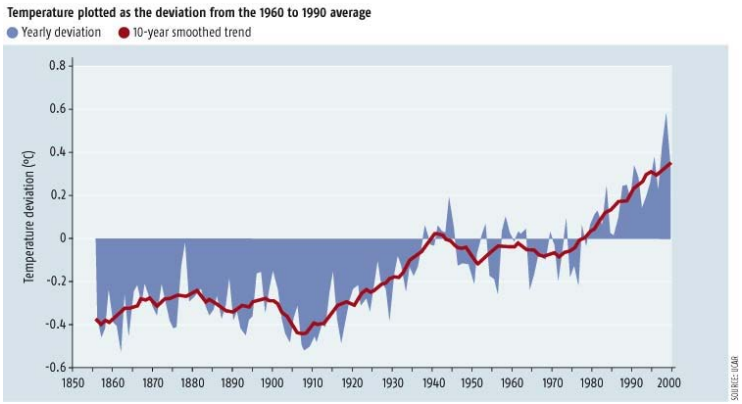
A radical transformation of our energy system is needed

- Limited availability of fossil fuels
- Climate change
- Risk of nuclear disasters
- Growing dependency on imports from a declining number of politically unstable regions

Important aspects to take into account:

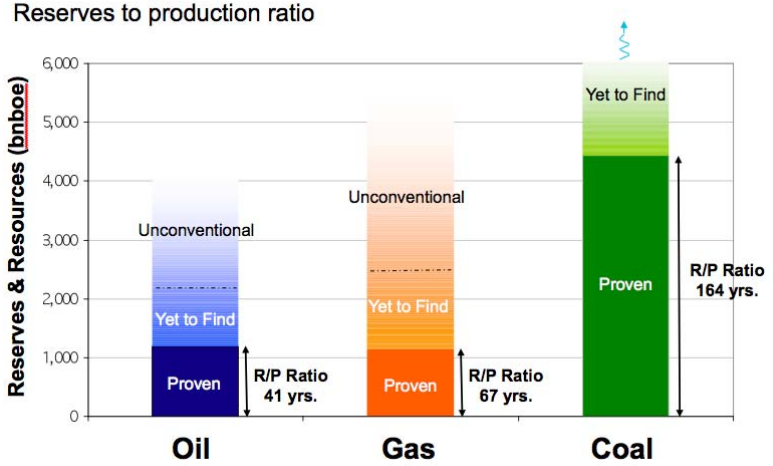
- The transformation needs time
  - Technological development
  - Capacity building
  - Investments in infrastructure
- Industrialized countries and countries with high consumption per capita must lead

The world is getting warmer



Availability of fossil resources

Reserves to production ratio



Source: World Energy Assessment 2001, HIS, WoodMackenzie, BP Stat Review 2005, BP estimates, Graph: Koonin, BP

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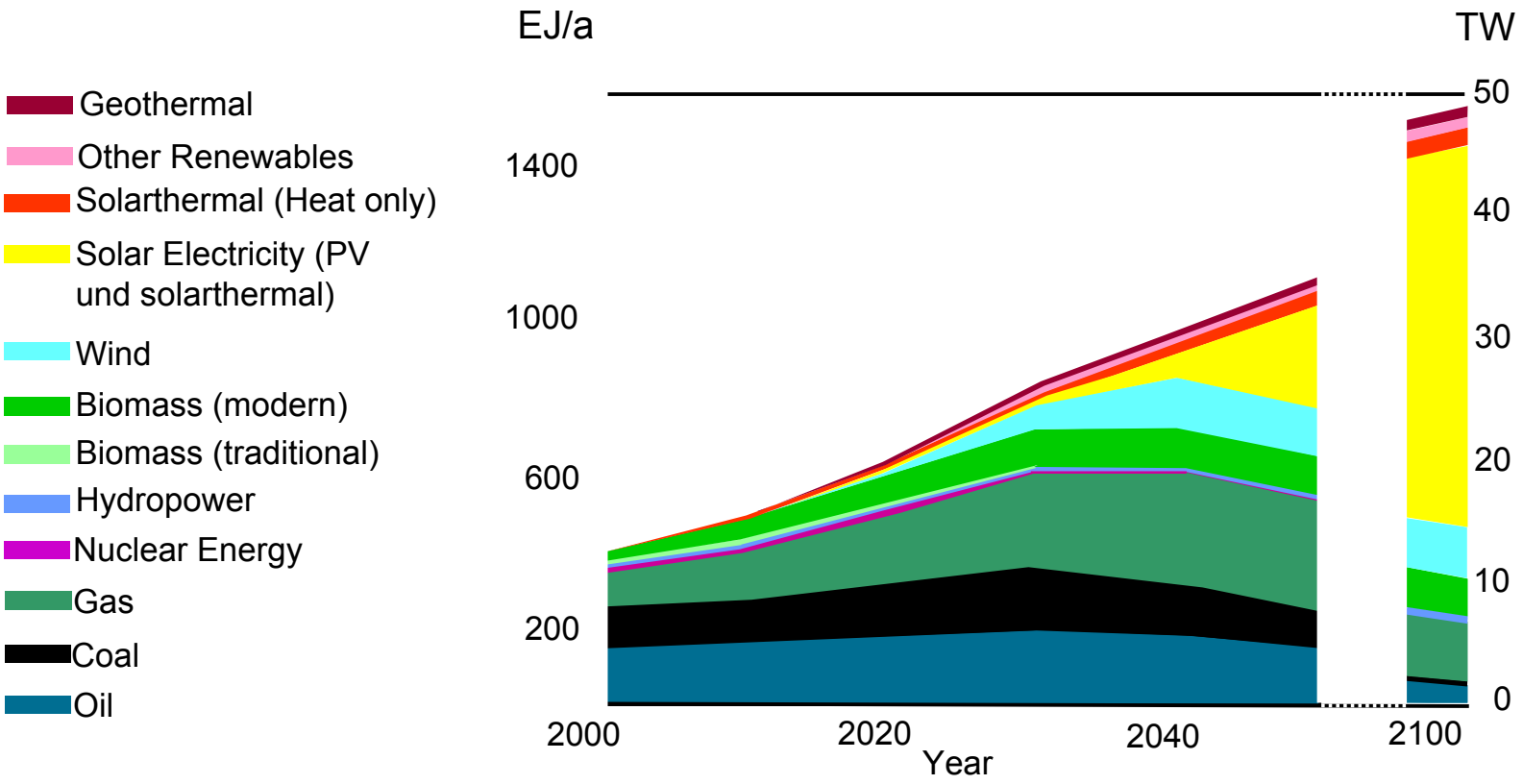
Exemplary Path, Global Primary Energy Consumption

Solar Energy will provide a large fraction of the Global Energy Need!



3 Source: German Advisory Council on Global Change, 2003, www.wbgu.de

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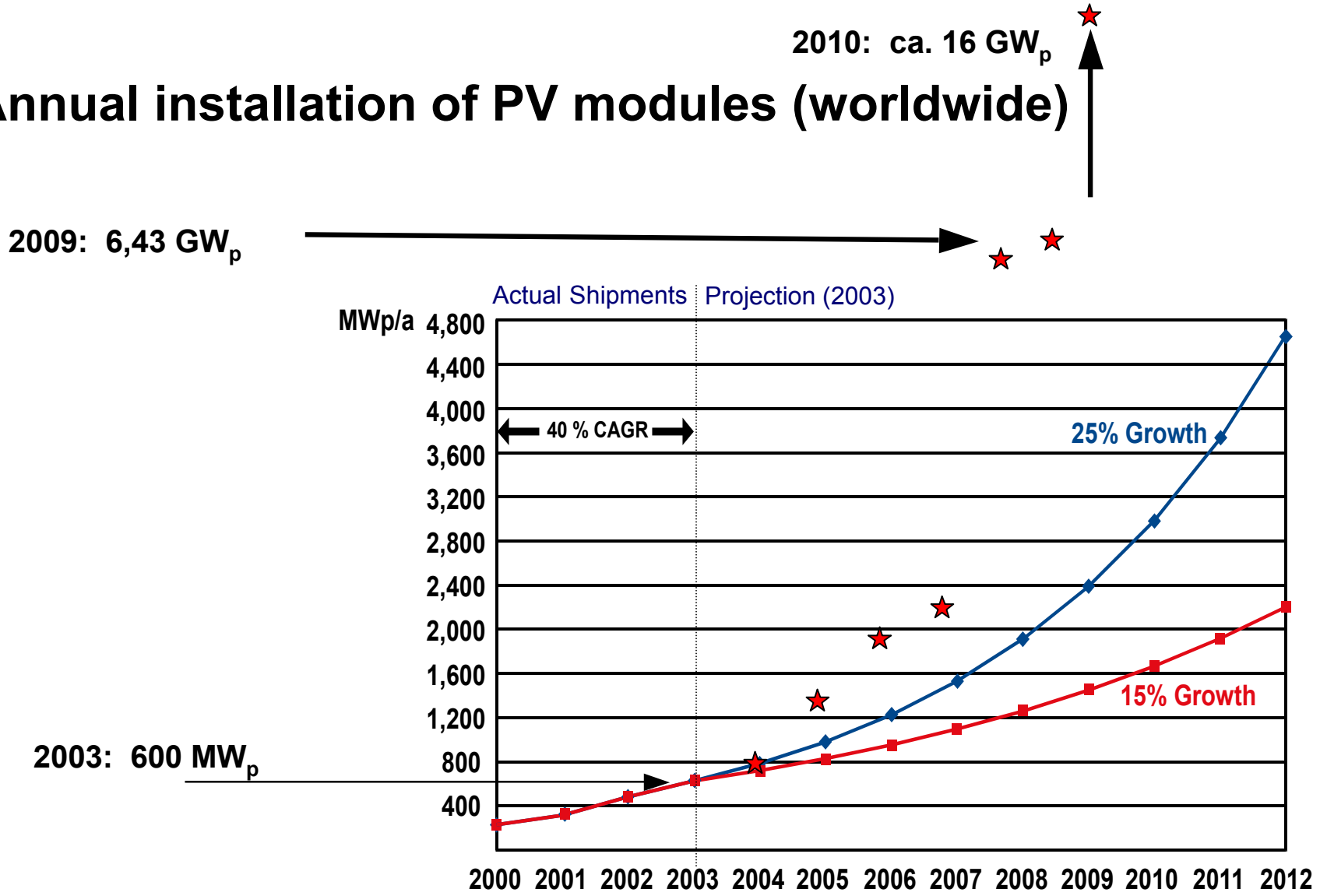
Annual installation of PV modules (worldwide)



Sources: 2000-2003 Strategies Unlimited, 2006 EPIA “solar generation”, 2007 LBBW Report, 2010 SolarBuzz or SKA et al., Berlin, April 7, 2011

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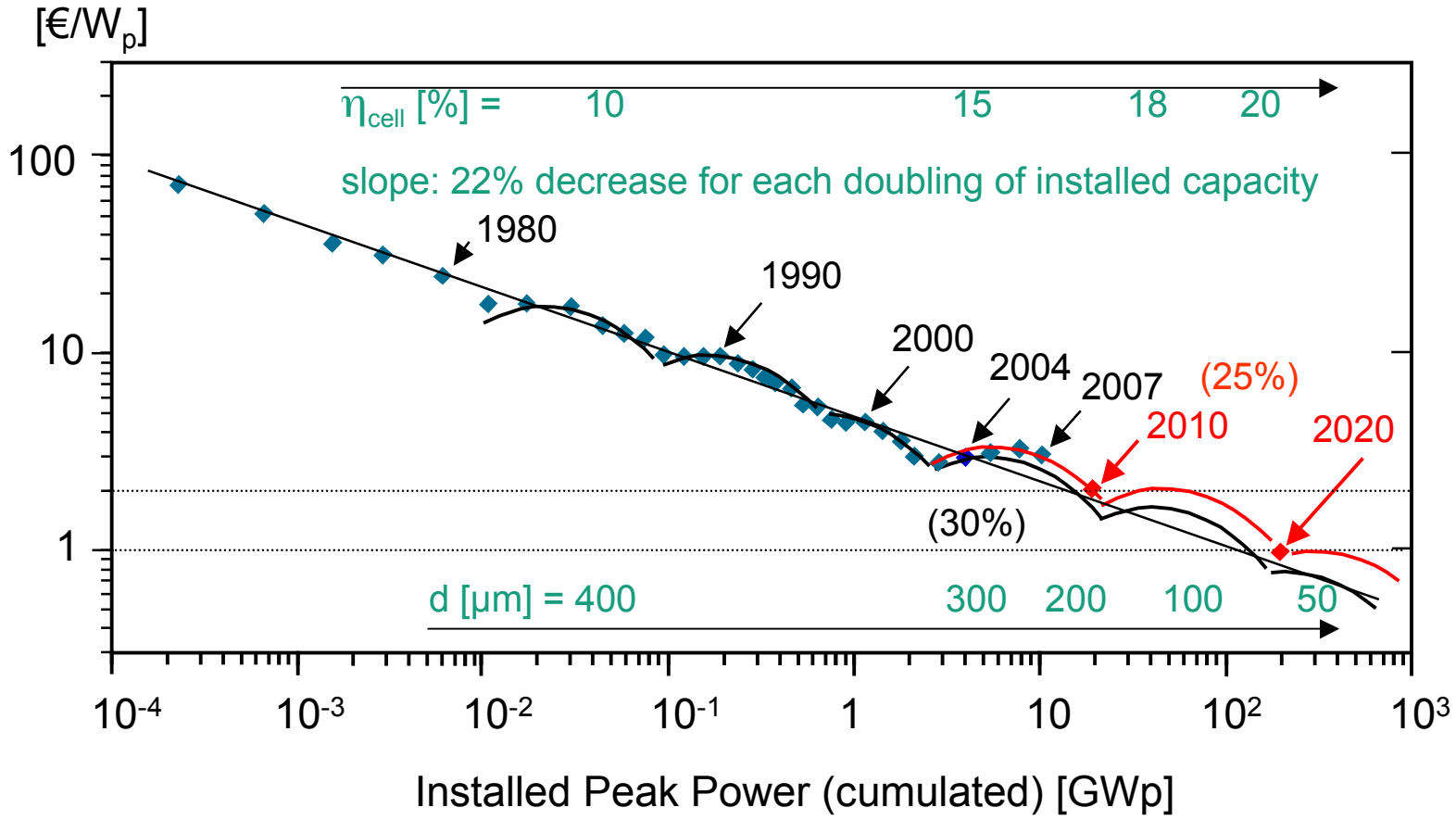
Learning Curve of Crystalline Si PV Module Prices



5Slide courtesy of G. Willeke

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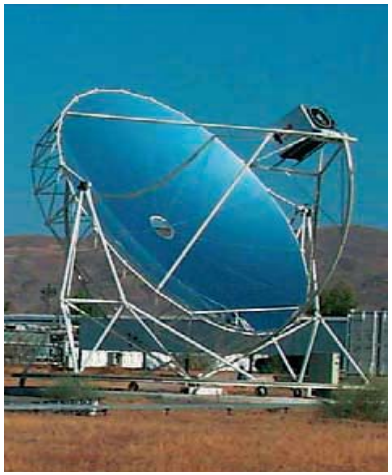
Segmentation of the Efficiencies in the Solar Cell Market

- 1 - 5 %: Organic, Dye, Nanostructure Cells
- 6 - 11%: Thin film cells (a-Si, microcryst.-Si, CIS, CIGS, CdTe)
- 14 - 18%: mc-Si, umg-Si, simple c-Si cells
- 20 - 24%: High efficiency, mainly c-Si cells
- 36 - 41.1%: High-efficiency III/V tandem cells for concentrators with 25 - 30% module efficiency

Concentrated Solar Thermal Technologies: CST

			
C ~ 70-90 commercial η_a ~ 12%-14% LEC_{2020} ~ 5ct/kWh	C ~ 60-120 demo η_a ~10%-12% LEC_{2020} ~ 5ct/kWh	C ~ 300-4000 demo η_a ~ 14%-18% LEC_{2020} ~ ?	C ~ 500-1000 comm. demo η_a ~ 10%-15% LEC_{2020} ~ 5ct/kWh

Desertec - Vision of an Electricity Super Grid
SKA - Vision of a mini - Desertec!

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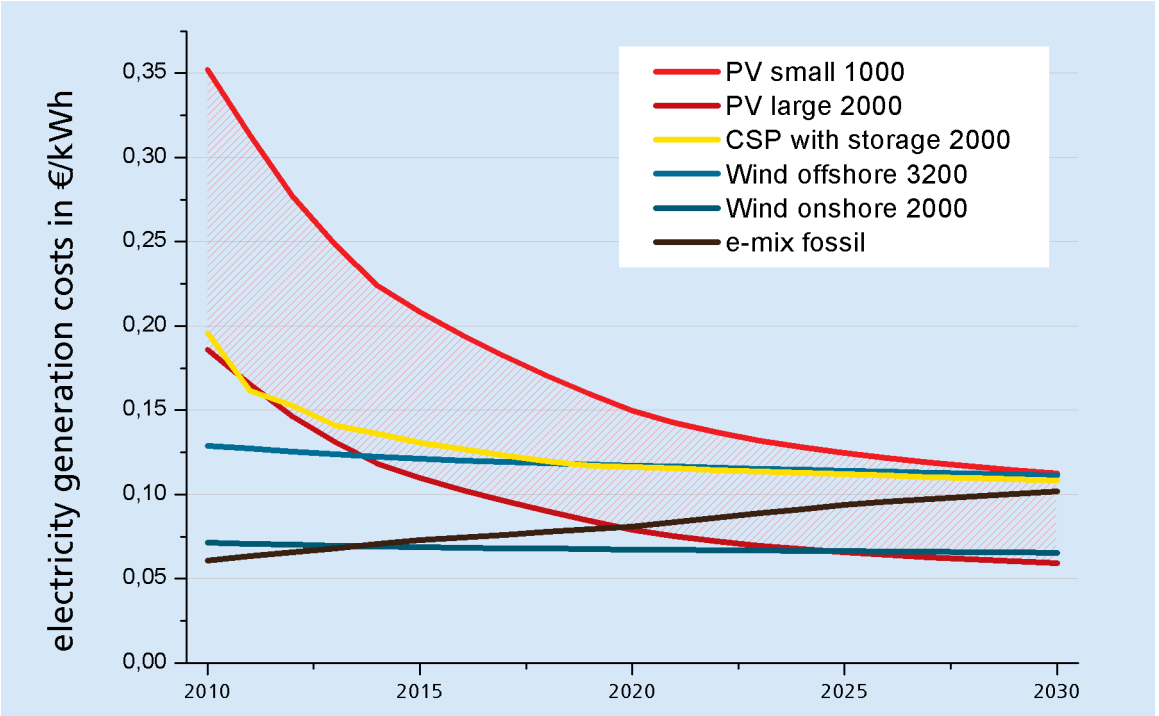
Electricity generation costs and learning curves

- Good progress ration for PV leads to competitive electricity generation costs
- Onshore wind power already today competitive
- Offshore wind power with significant higher costs, also on long term



Technology	Reference	2020	2030	Progress Ratio
PV	Sarasin 2009	656 GW	2221 GW	85%
CSP	Greenpeace 2009	68 GW	231 GW	92-96%
Wind (on/off)	GWEO 2009	709 GW	1420 GW	95/97%
Strommix fossil	Leitszenario 2009			

Source: C. Kost, T. Schlegl, Fraunhofer ISE December 2010

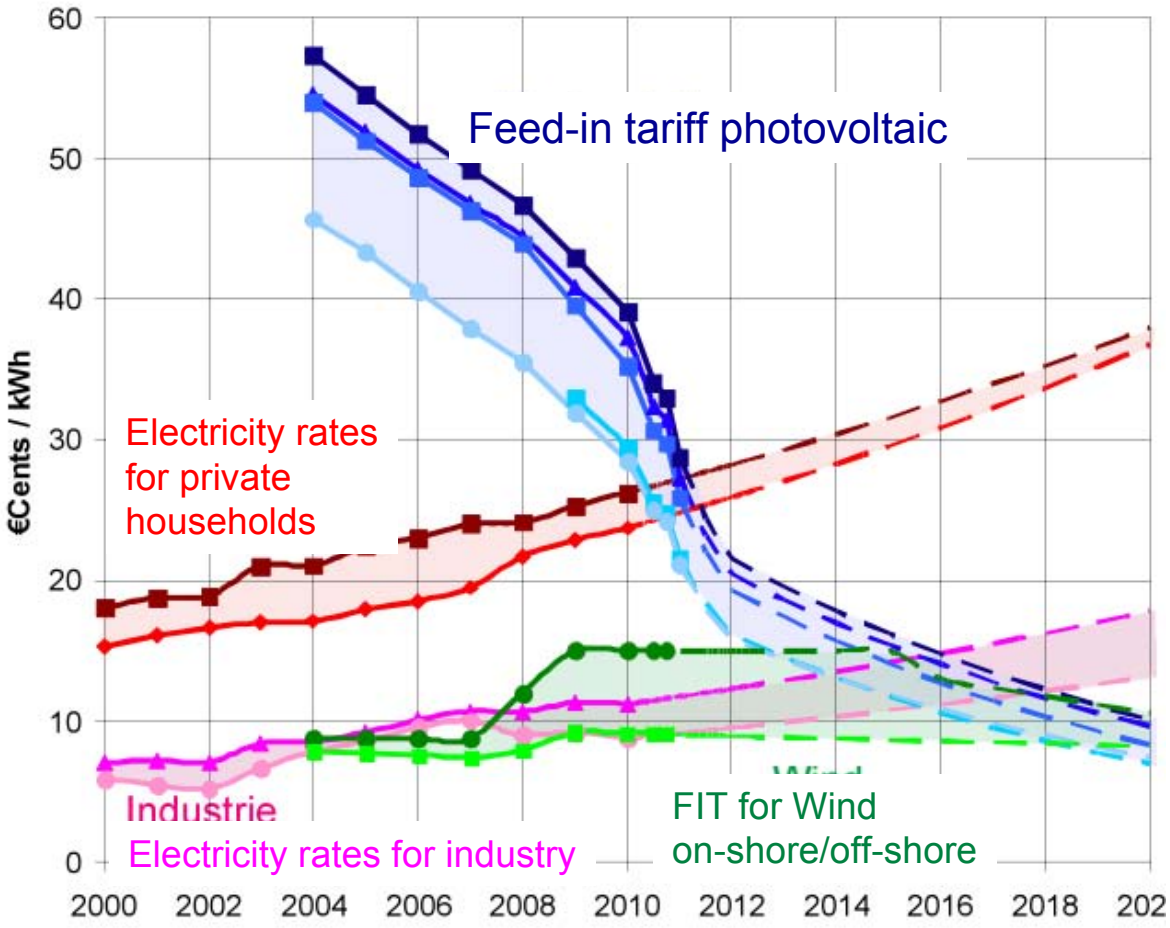
Strong reduction of feed-in tariffs (FITs) in Germany

- Due to the strong market growth the FIT on PV was reduced dramatically
- From July 2011 on, PV electricity will be cheaper than the rate payer price of private households
- Due to the FIT, Germany has the lowest PV system prices worldwide

  Residential PV system price:
  in Germany: $4 / Wp
  in California: $8.5 / Wp

⇒ **The feed-in tariff is proven the most powerful instrument to stimulate market growth**

Feed-in tariffs and electricity rates in Germany



Graph: B. Burger, 02.2011

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Conclusion: SKA and the World's Green Energy Future

- The world is moving fast towards a green energy future; the open question is, will it be fast enough to avoid catastrophic climate change, climate instability;
- The goal is 100% renewable energy generation at greatly increased energy use efficiency; PV will provide a 10-40% fraction of total energy;
- The large energy needs of scientific megaprojects like the SKA should not add greenhouse gas emissions
- The challenge to provide 24/7 reliable energy from renewable sources requires the development of mini-grid solutions with storage
- Key to the success of a 100% RE-SKA will be the development of innovative systems solutions: PV, CPV, CST solar power, wind if available, plus storage;
- Scientific megaprojects powered by 100% RE such as the SKA can help to blaze the trail to CO_2 - free power for major scientific instruments and for the world.