

Deutsche Bank Securities



Solar Photovoltaic Industry

Solar PV Economics and Industry Outlook – November 2008



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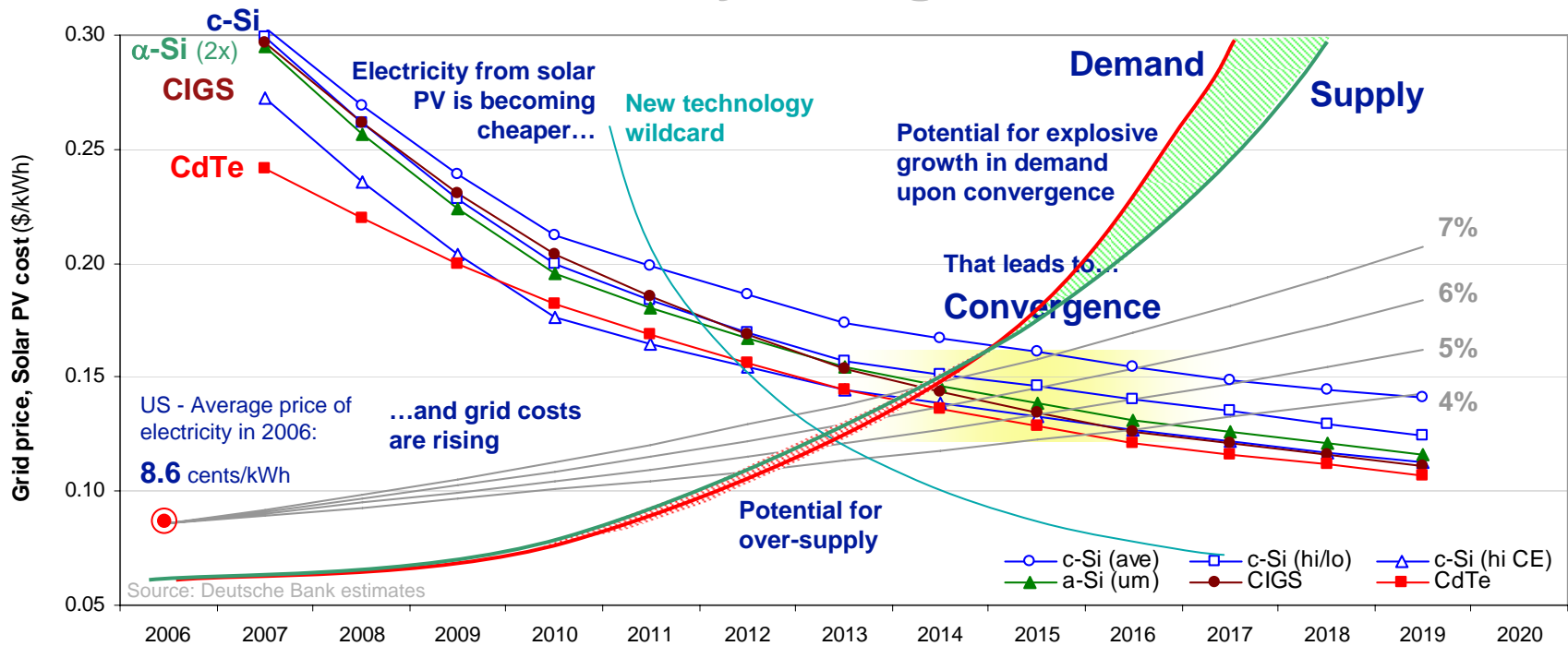
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Stephen O'Rourke (212) 250-8670

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Solar PV industry – long-term outlook



- ❑ No technical breakthroughs are required to achieve solar PV cost reduction curve
- ❑ Grid supplied electricity CAGR (in the US) will likely climb faster than since 2000 (i.e. >4.5%)
- ❑ Near term undersupply will likely revert to oversupply before returning to an acute undersupply
- ❑ New technology could accelerate solar PV cost reduction

Cost convergence and potentially explosive growth within 6 to 8 years

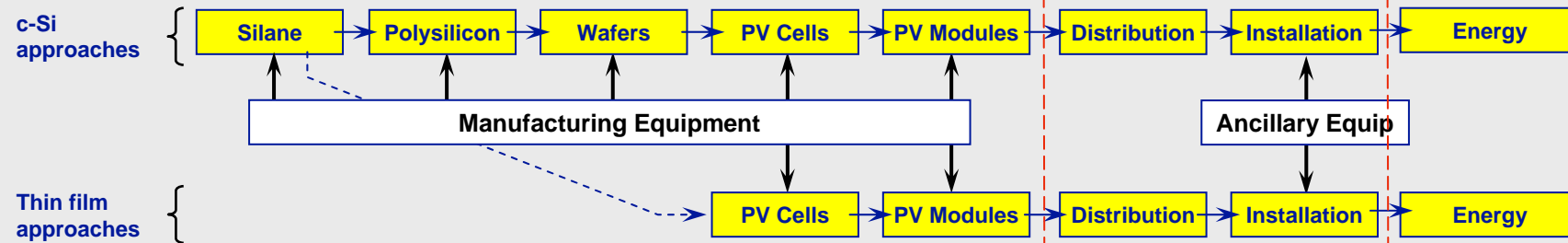


Economics by technology (what companies can do...)

Considering the value chain

Solar PV value chain for c-Si and thin film technologies

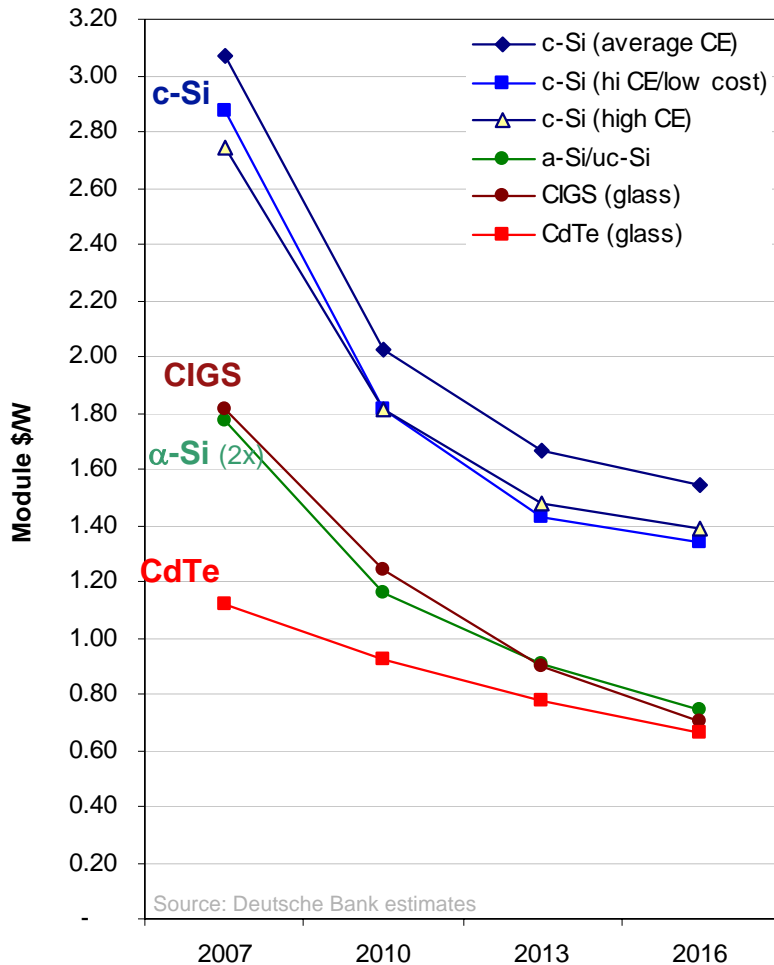
Source: Deutsche Bank



<input type="checkbox"/> Three points in the value chain warrant the most careful consideration	1. Manufacturing \$/Wp at the module level	2. System level (price) \$/Wp	3. LCOE (\$/kWh)
<input type="checkbox"/> Data variability (i.e. input costs/prices confidence levels)	Good	Frustrating	Pwr: good Sys: variable
<input type="checkbox"/> Variance error trend (due to technology consolidation and data)	Very positive	Positive	Positive

A company's cost structure at key points in the value chain has enormous business model implications

Module manufacturing cost per watt (\$/Wp)



- ❑ c-Si will remain the high cost module manufacturer
 - We consider three variations:
 - 1) average conversion efficiency (CE)
 - 2) higher than ave CE / lower than ave cost
 - 3) high conversion efficiency

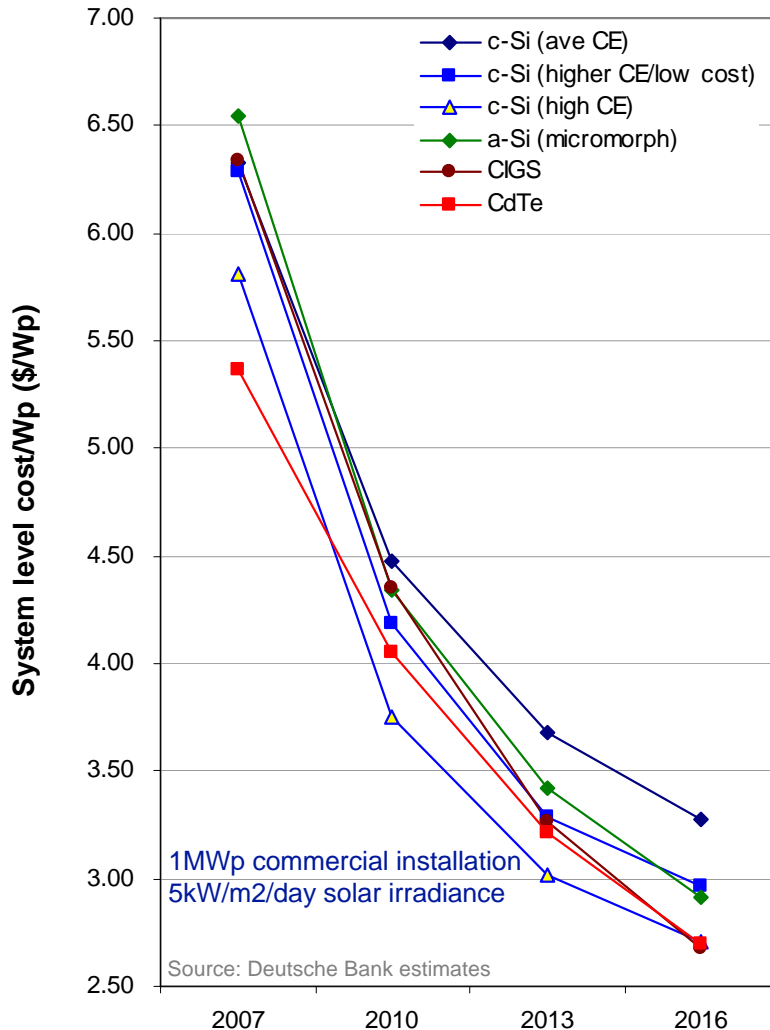
- ❑ a-Si (micromorph) is yet to enter production
 - This should become the “standard” a-Si offering
 - Learning curve yet to be surmounted

- ❑ CIGS is yet to enter production
 - Promises highest CE of thin film approaches
 - Stubbornly difficult process

- ❑ CdTe is and will remain the module cost per watt leader

CdTe is a disruptive technology
at the module level

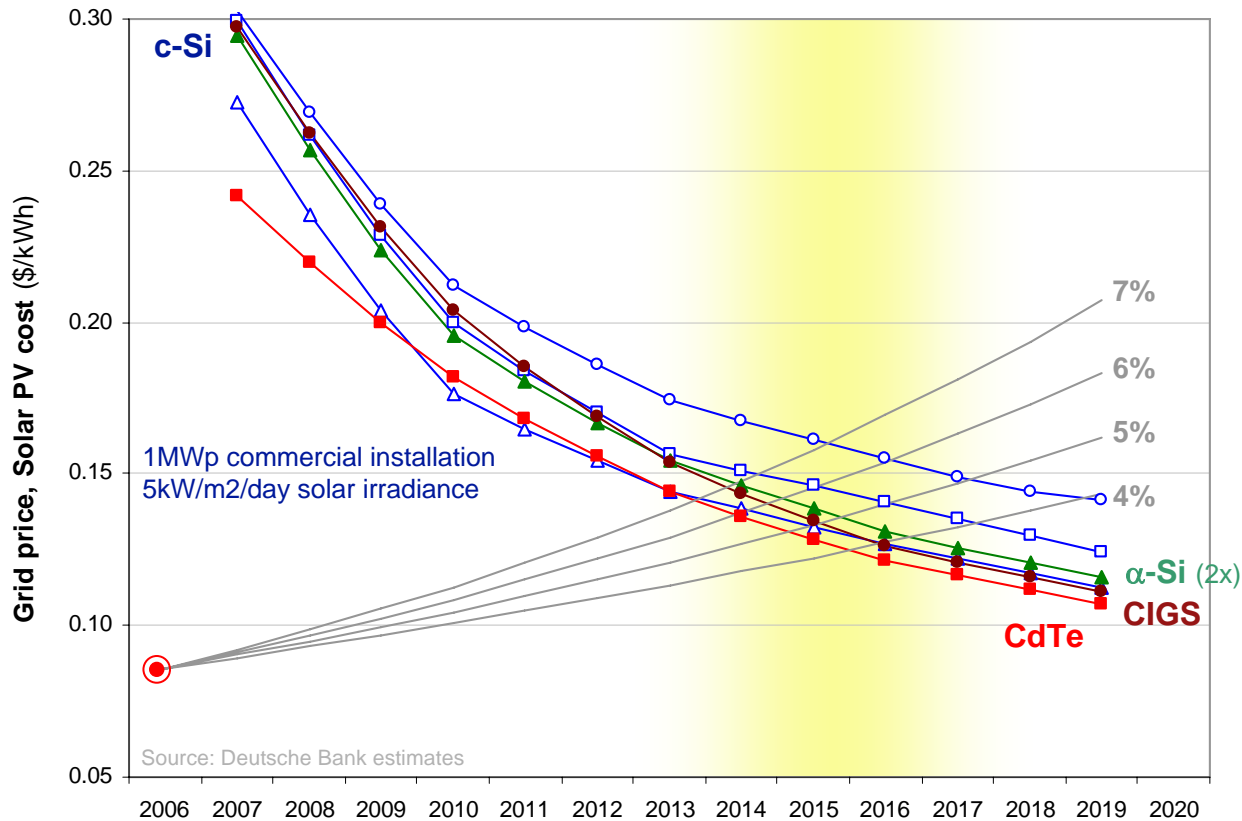
System price per watt (\$/Wp)



- Incentive programs distort data; this should normalize
- BOS data is very wide ranging (geographically/installer)...
 - ...driving the greatest variance error in any model
- Modules are typically >50% of system price
- Higher power density modules (higher CE) drive proportionally lower BOS costs (not quite linearly)
- Geography/integrator efficiency/margin variance is big
- c-Si and CdTe are supported with real data
 - CdTe has shown lowest system \$/Wp thus far
 - High CE c-Si can deliver lower system \$/Wp
- a-Si (micro-morph) and CIGS data is extrapolated

CdTe may lead (\$/Wp) at the system level, but it is not disruptive → c-Si competes effectively.

Levelized Cost of Electricity (LCOE)



Power output de-rate factors

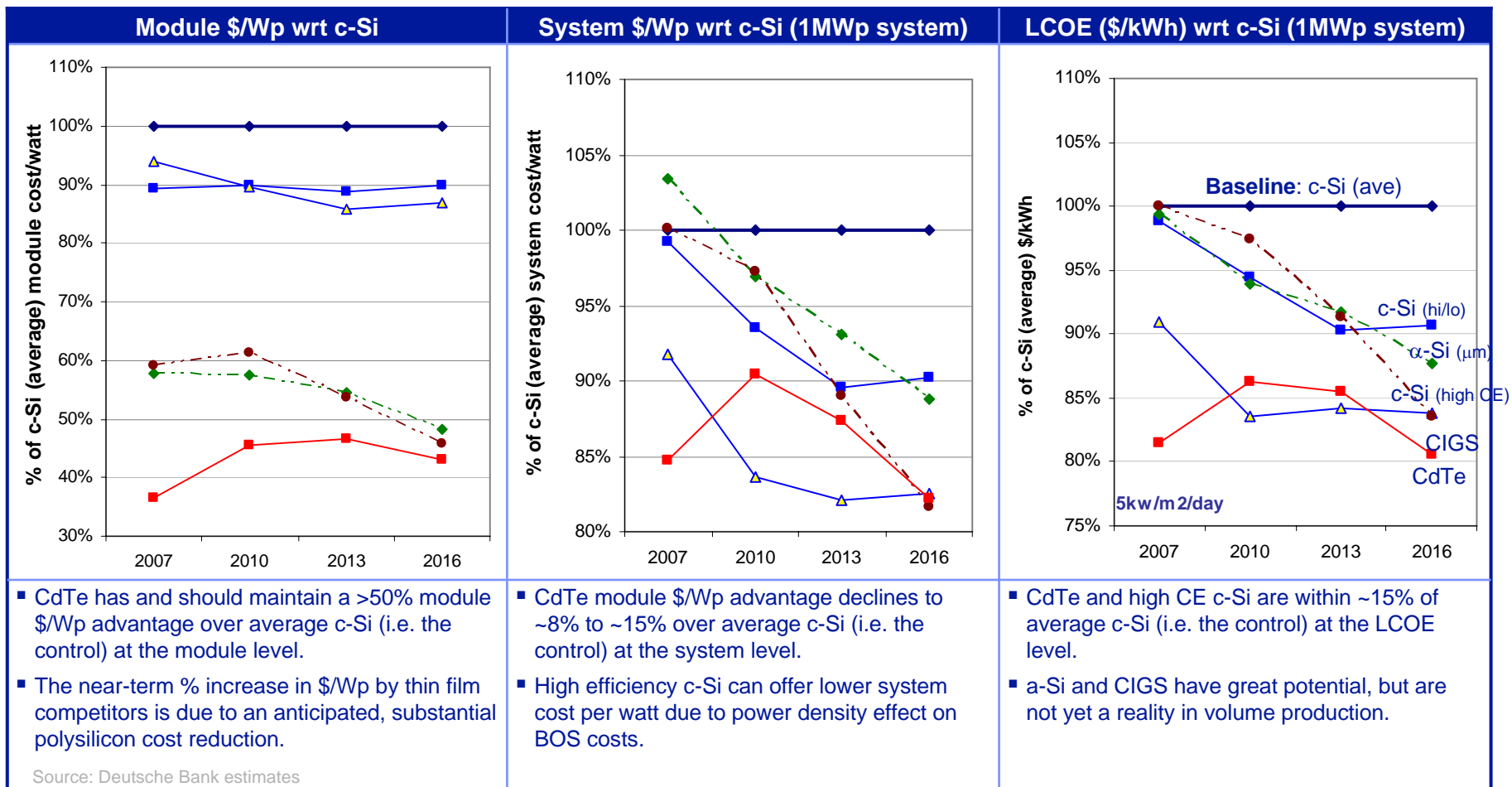
- Temp coefficients
- Annual degradation
- Occlusion
- Orientation
- Inverter losses
- Line losses
- Spectral response

Financing considerations

- Time period
- Discount rate
- Inflation rate
- Federal taxes
- Local taxes
- Land costs
- % financed
- Financing term
- Financing rate
- Maintenance costs

**There are leaders, but no clear cut winners.
Several technologies will prove competitive.**

Comparative advantages – LCOE (with respect to c-Si)

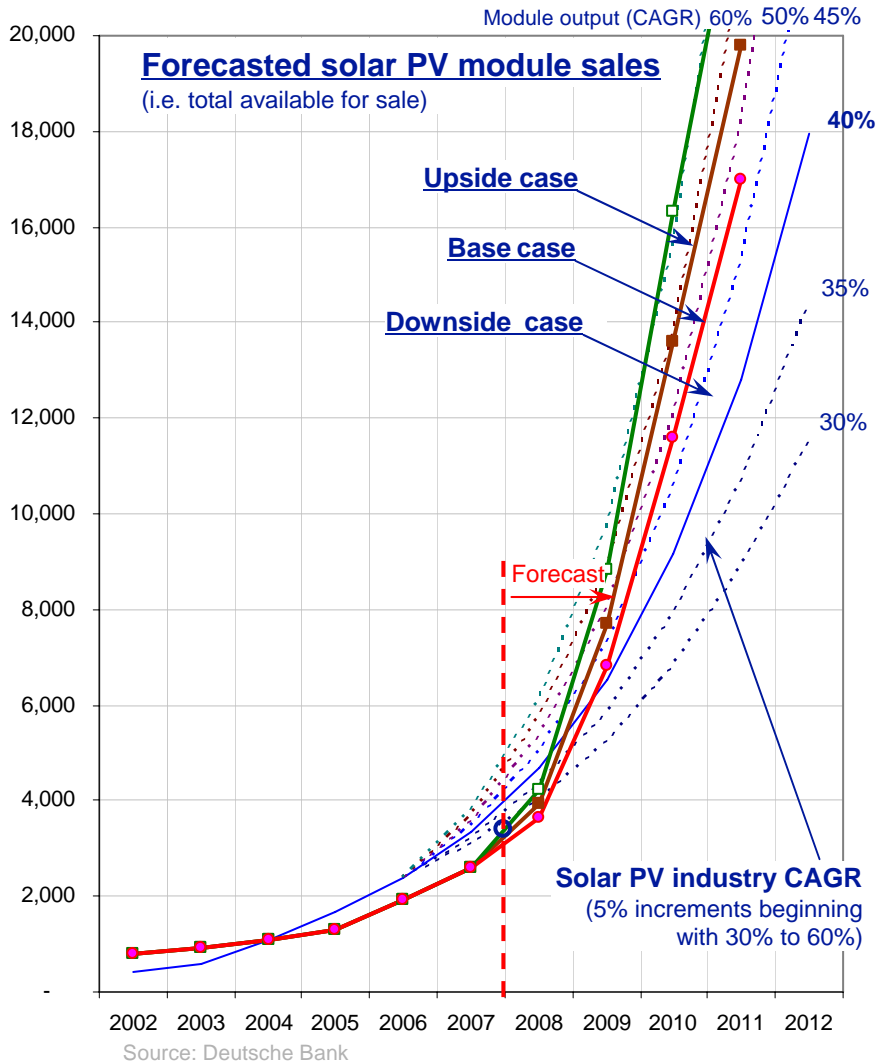


There are leaders, but no definitive winner at the LCOE level



Supply and Demand (what an industry does...)

Supply – total sales (GWp/year) scenario analysis



Total module sales (three cases) (GWp)

	2008	2009	2010
Sales base case	3.9	7.7	13.6
Sales downside case	3.6	6.8	11.6
Sales upside case	4.2	8.8	16.3

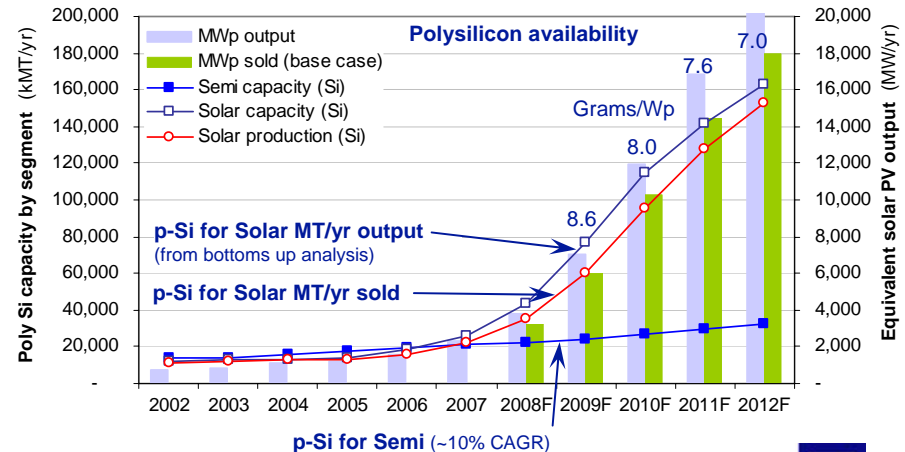
* "Sales" is adjusted for FGI, etc. at year-end

c-Si module supply (GWp)

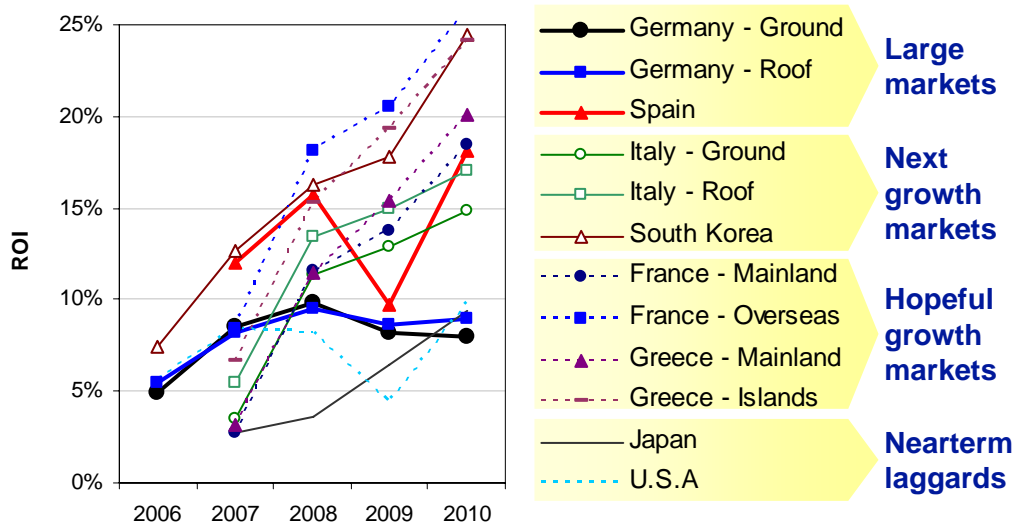
	2008	2009	2010
Production	3.8	7.0	12.0
Sales	3.3	6.0	10.3

Thin film module supply (GWp)

	2008	2009	2010
Production	0.8	1.9	3.8
Sales	0.7	1.7	3.3



Demand - (ROI) based demand growth by Region

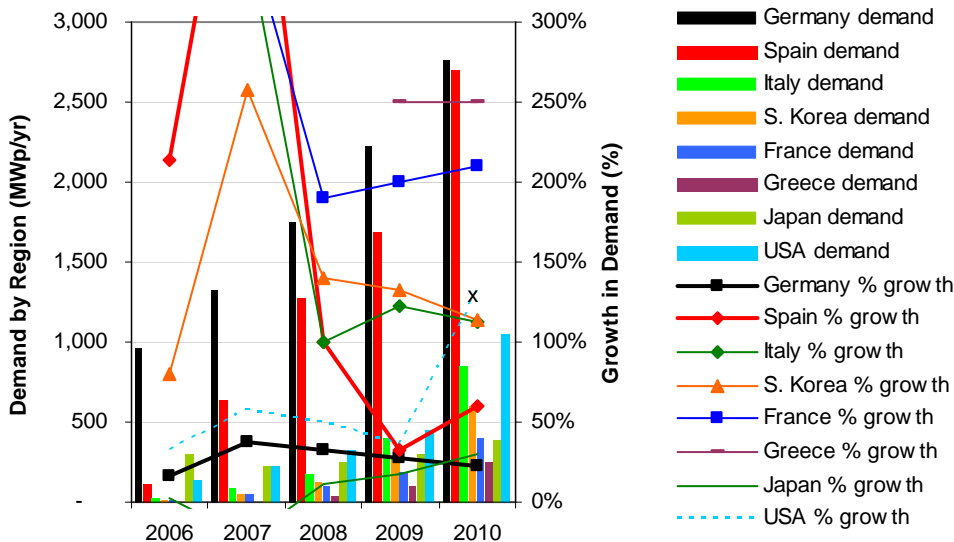


Toward a regional demand model

- We built a demand model with regional ROI's as primary demand growth determining metrics.
- The quantification of exogenous effects must be estimated when known.
- Incentives will continue to be key demand drivers over the next several years.

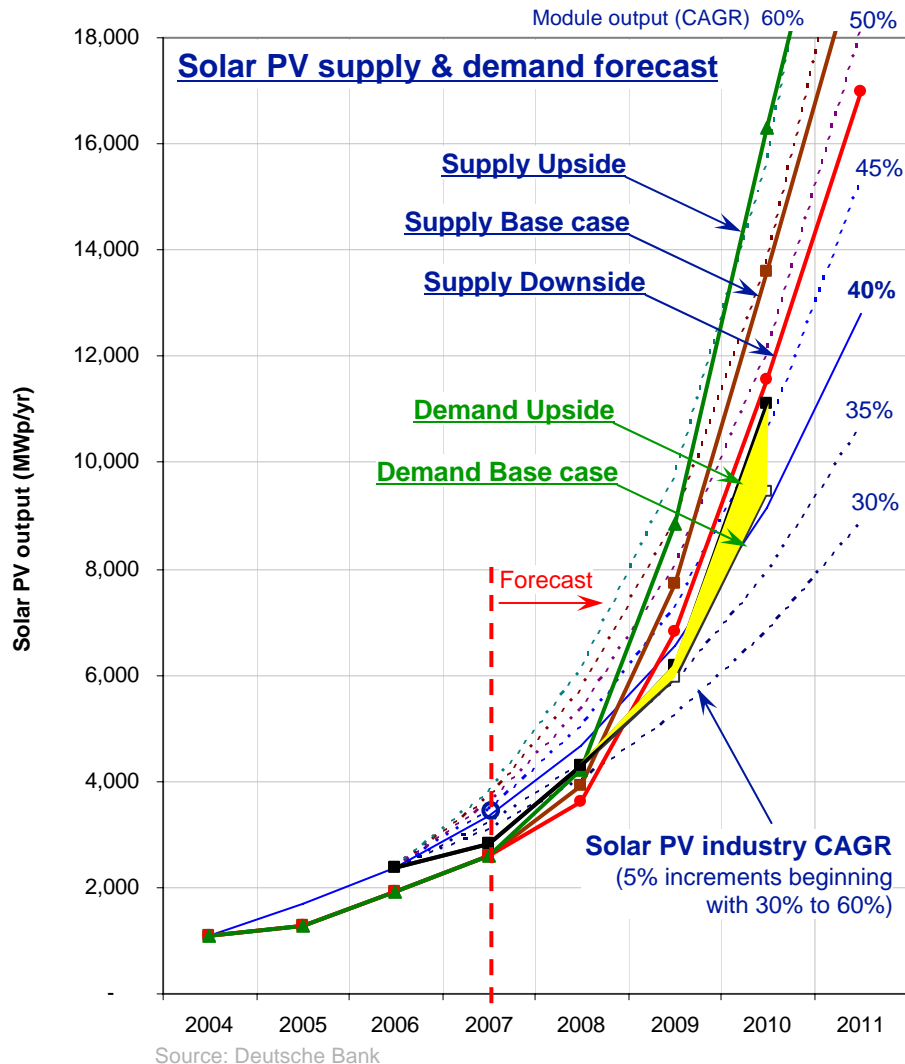
Regional demand outlook

- Germany will slow in 2009, and can be quantified based upon calculable ROI trends. Spain is defined.
- Italy and S. Korea should become the next growth leaders as ROI dictates.
- France and Greece have great ROI based potential, offset by exogenous effects.
- US will lag until 2010 when comprehensive climate legislation is enacted.
- Japan will lag, but remain a solid MWp contributor.



Source: Deutsche Bank

Supply vs Demand



- Supply should exceed demand under present assumptions in 2009
- Our best estimate of when an oversupply dynamic emerges is early-to-mid-2009
- An over-supply dynamic could be mitigated provided our downside supply scenario is married with our upside demand scenario.
- We are biased positively on supply and negatively demand scenarios.

Quantification of supply and demand in light of many, many variables leads us to believe that the probability is very high of an over-supply dynamic emerging, and an industry shakeout beginning later in 2009.

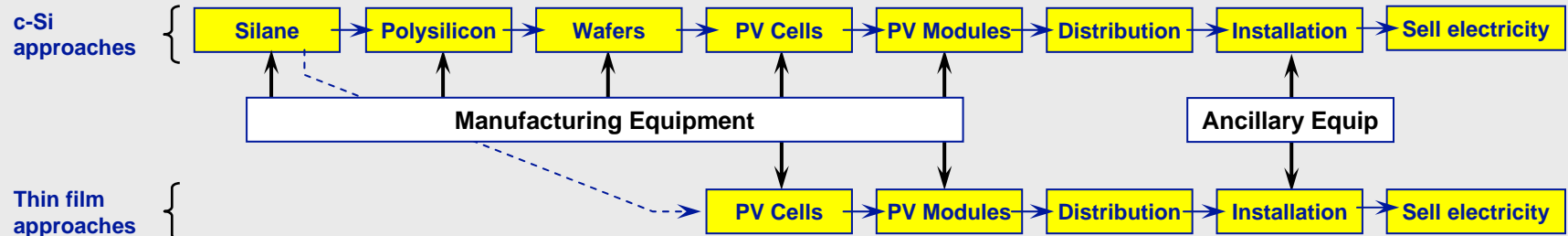


Business models and markets (measuring strategic acumen...)

Considering business models over the near term

Solar PV value chain for c-Si and thin film technologies

Source: Deutsche Bank



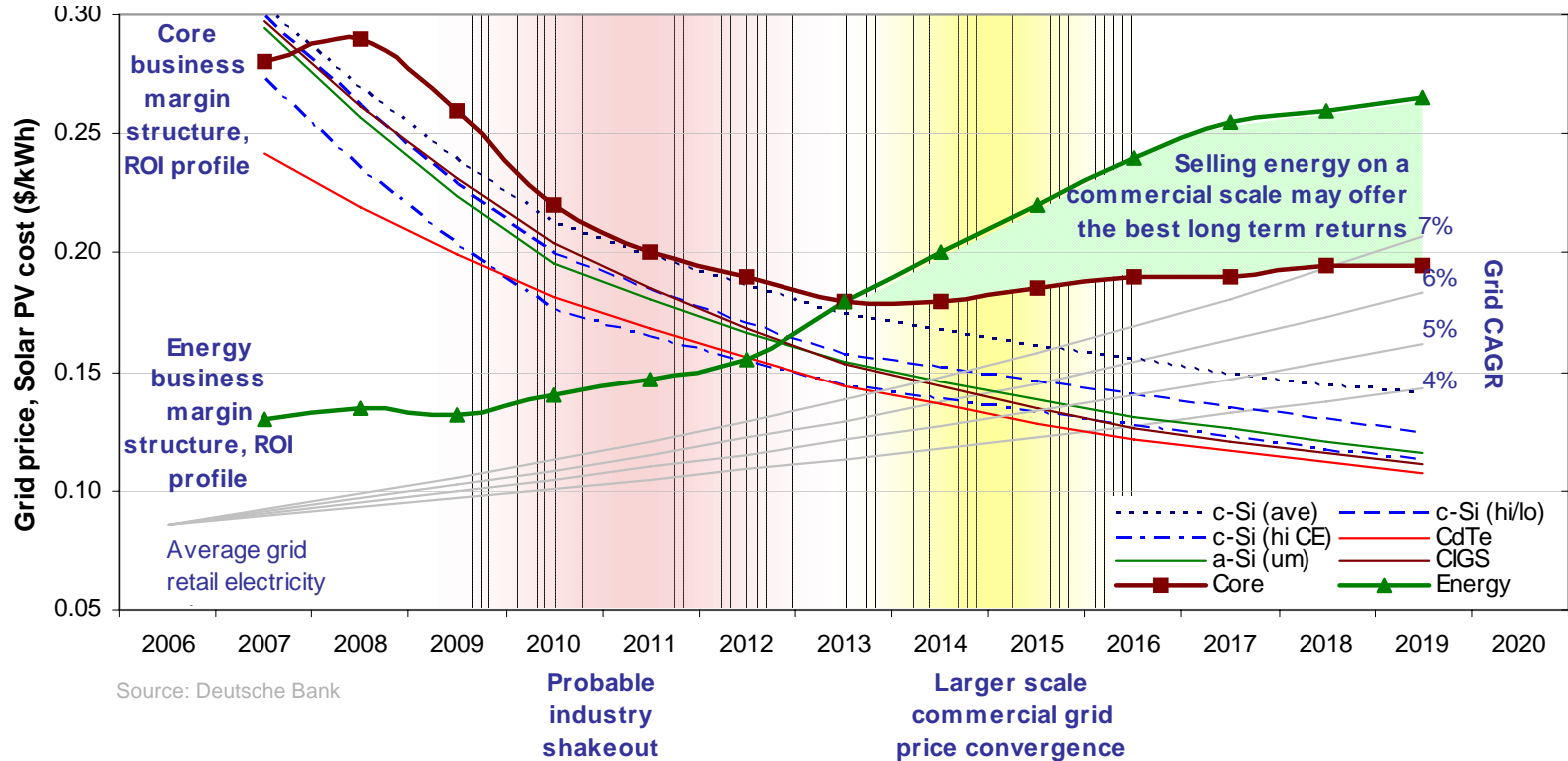
Source: Deutsche Bank

Vertical integration (i.e. beyond the module, not simply to include the module)

- ❑ **Low cost module manufacturer:** if a company makes only solar PV modules, then being the low cost module manufacturer is an imperative to compete over the long term. (i.e. thin films) ...And, it might even be enough.
 - **New materials/technology:** enormous opportunity for new technologies to lower cost per watt at module and system level.
- ❑ **High cost module manufacturer:** if a company controls the value chain to the end user, then it is not imperative to be the low cost module manufacturer provided the company's technology enables adequate cost to be extracted further down the value chain. (i.e. c-Si) → the advantage of high power density, and the necessity to integrate to the end user
- ❑ **Selling electricity as a distributed utility:** Power Purchase Agreements (PPA) offer 20 year annuity streams that solar PV system integrator/ installers can offer; it is unclear how non-integrator/installers will be able to effectively participate in PPAs.
 - **ROI becomes more attractive over time:** as grid supplied electricity costs climb and solar PV supplied electricity costs decline, the ROI improves over time
- ❑ **Silicon manufacturers:** silicon contract pricing will not collapse. In a worst case scenario silicon spot pricing could approach contract pricing, but leading producers' margin structures are unlikely to decline. Longer-term, a silicon shortage is likely to re-emerge.

Considering business models over the long term

1MWp commercial installation (5kW/m2/day solar irradiance)



The most profitable places – the ends of the value chain

- Selling energy on a commercial scale
- Manufacturing and selling silicon when the shortage returns
- Why continue to make cells/modules, an inevitable commodity?
 - If a company has a technology advantage that enables the lowest LCOE with which to compete for energy contracts

Solar PV - Technologies and End Markets

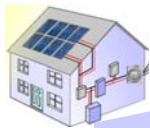
Residential

New home development and existing home retrofits

Crystalline-Si will dominate

- Limited roof area
- Aesthetics are important
- Cost sensitive
- Mounting technology key
- No tracking
- Case by case economics

Thin film technologies will not likely play in residential market



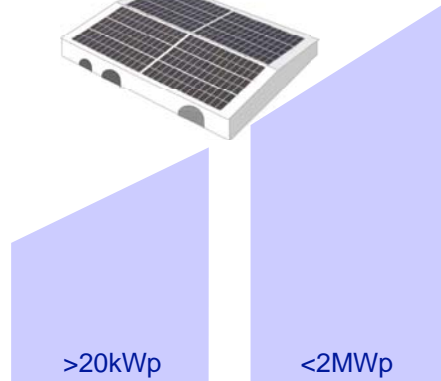
Residential

Commercial

Office buildings and "big box" stores

Crystalline-Si
 Thin film technologies

- Limited roof space (?)
- Weight considerations
- Building integrated (BIPV)
- Cost sensitive
- Tracking not practical
- Weather a factor



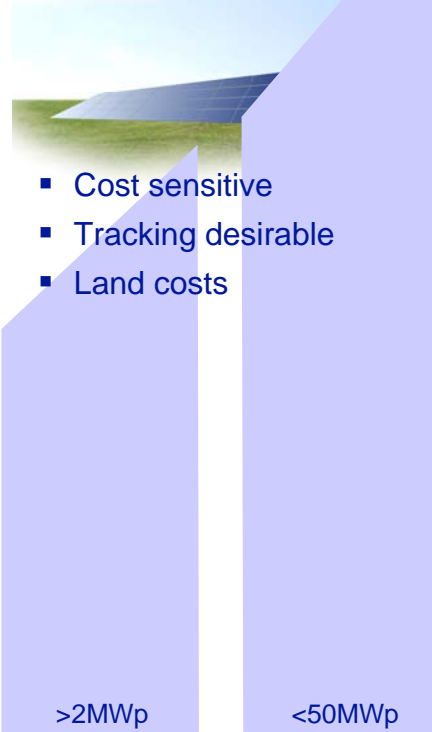
Commercial

Industrial

Large open field installations

Crystalline-Si
 Thin film technologies

- Cost sensitive
- Tracking desirable
- Land costs



Large commercial/industrial

Utility scale

Power plant installations

c-Si (High CE)
 CdTe
 Other TF (?)

Solar Thermal may be most competitive at this scale

- Storage
- Traditional secondary plant
- \$0.12/kWh to \$0.14/kWh today



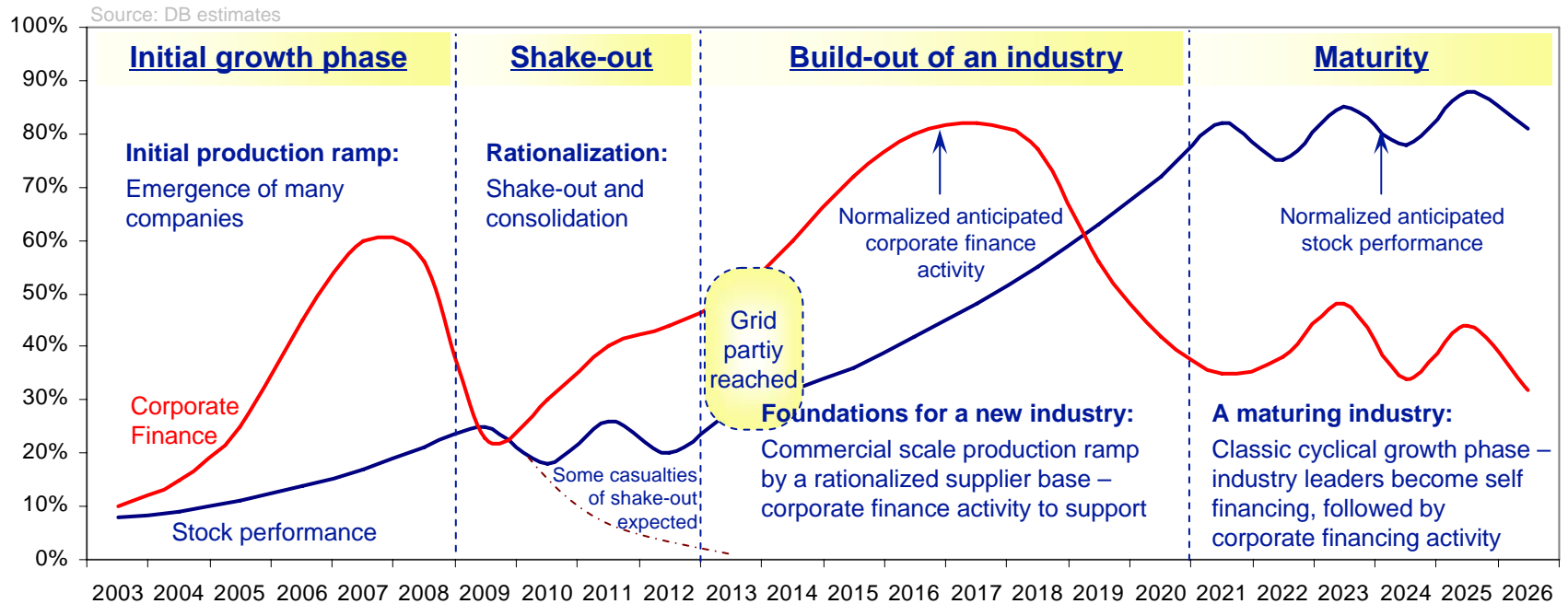
Utility scale

Size of systems (Wp)



Solar PV – a means of translation (measuring an industry’s health and maturity)

Solar PV industry outlook – Wall Street translation



☐ Initial financing boom on-going

- Public – silicon technology based financing → market capitalization and liquidity become adequate for many investors
- Private – transition from silicon to thin films and next generation materials (technology windows opening/closing)

☐ Oversupply will drive a shakeout: corporate finance activity will decline and shift to M&A

- Some companies will not survive; longer-term industry leaders will emerge

☐ Average grid parity reached → huge production ramp ensues → corporate finance to fund expansion

☐ Industry reaches cyclical growth phase → self-financing will drive larger portion of subsequent expansion



Thank you

Appendix 1

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