Financing Concentrating Solar Power Plants: The CSP-Finance Project

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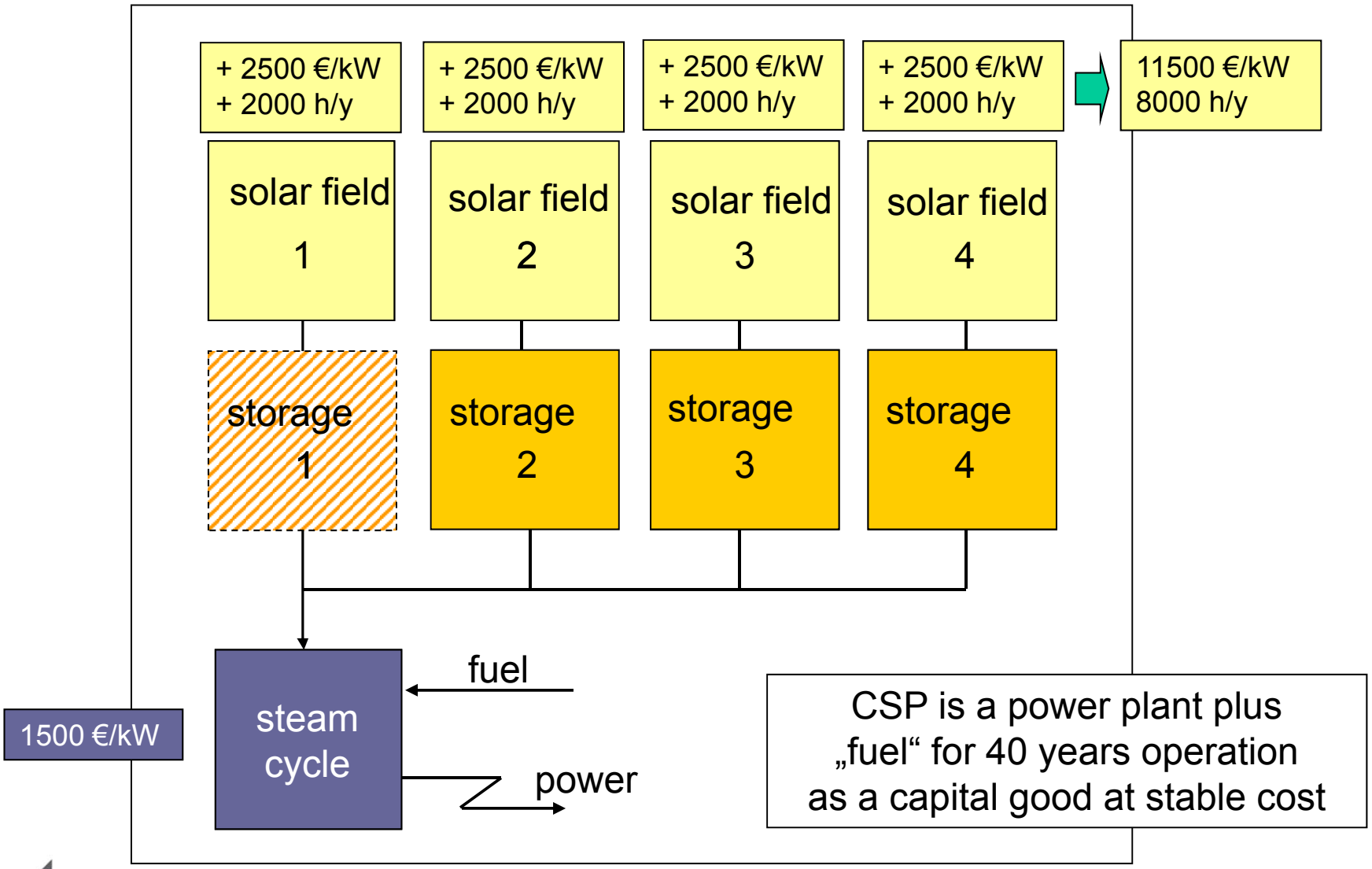
The World Bank, Washington D.C., January 25, 2012

CSP Investment

CSP Investment vs. CSP Performance



Investment Challenges for CSP

1. Long-term investment (20-40 years) not only for the power plants but also for their „fuels“.
2. Unknown future savings compared to volatile and unpredictable conventional fuel prices.
3. Known long-term cost but unknown long-term revenues if electricity output has to be sold at spot markets.
4. Additional cost of early plants cannot be recovered under conventional market conditions and less if competitors are subsidized.

➔ a solution to overcome these barriers is a long-term power purchase agreement (PPA) at a tariff that covers the life-cycle cost including a reasonable return of investment.

High capital cost of CSP is prohibitive for developing countries

1. limited national budgets cannot cope with high investments

2. low national credit ratings translate to high capital interest rates

3. high interest rates translate to a high capital cost

4. CSP can be introduced in a series of subsidized projects but markets will not develop

➔ real CSP markets could be initiated in developing countries by increasing the ratings of CSP projects towards AAA standard

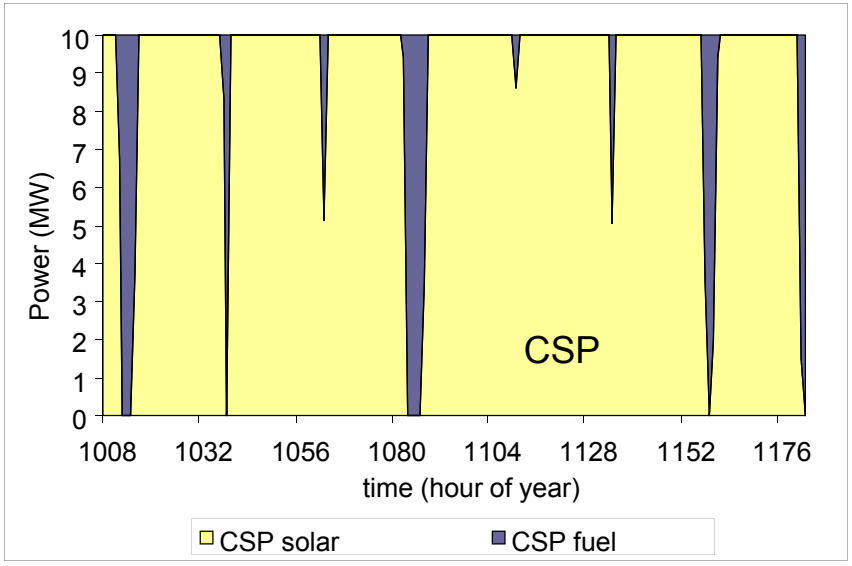
➔ high quality, low interest rates, low capital cost

➔ low required PPA tariffs, reduced load for consumers and governments

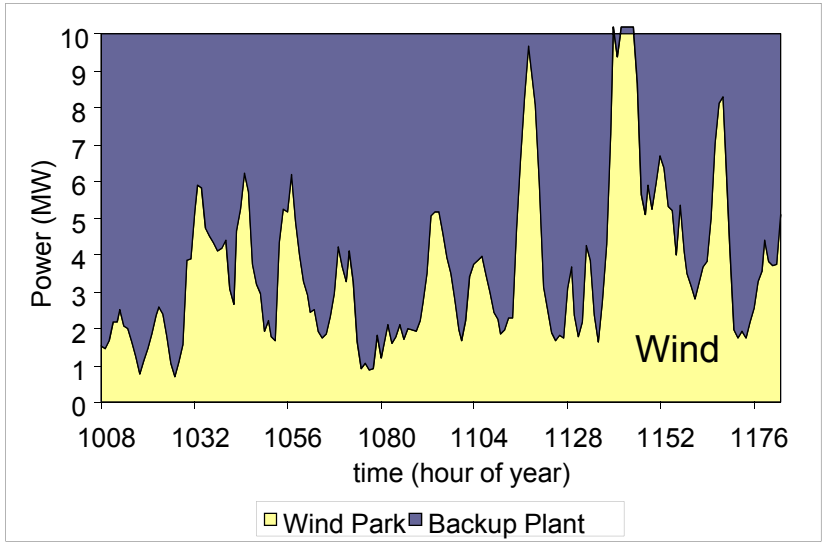
The role of CSP:
High quality supply

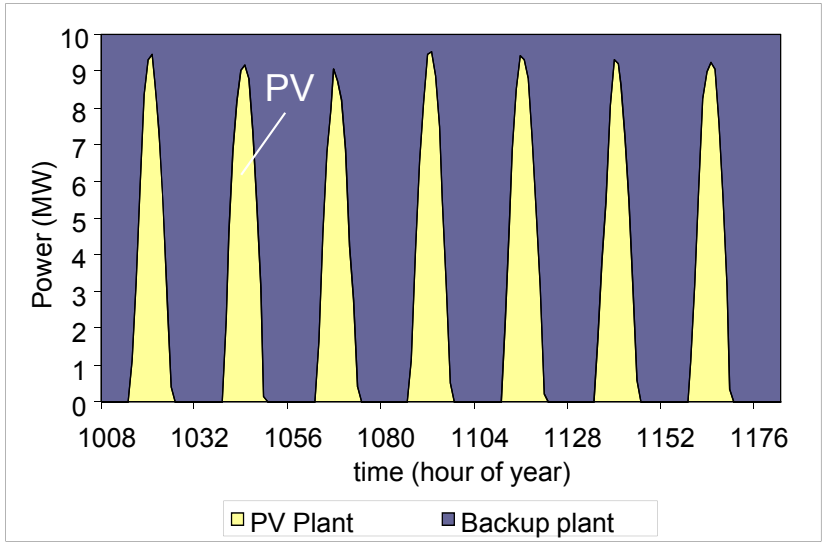
The RE quality challenge:
How to cover a defined load with RE?

10 MW CSP (incl. thermal storage & 10% gas)
10 MW PV + 10 MW backup from grid (75% gas)
10 MW Wind + 10 MW backup from grid (60% gas)



maximum fuel efficiency in full load
maximum amortisation in full load





reduced fuel efficiency in part load
reduced amortisation in part load

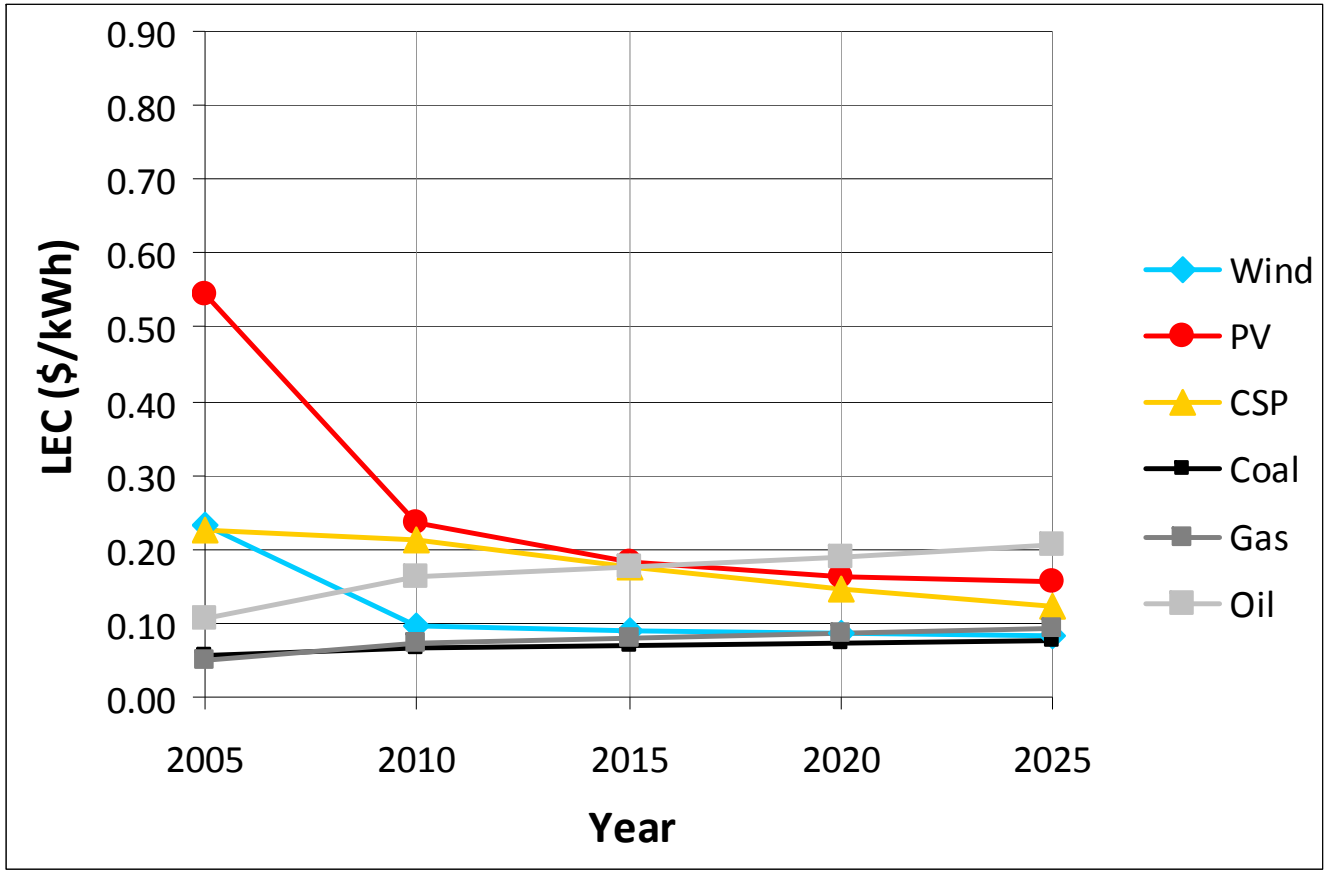
Comparing Wind, PV and CSP

- In most cost comparisons, PV and wind are assumed to have access to a cost-free, loss-free and unlimited storage device: the electricity grid. This seems wonderful, but is a rather expensive illusion!

- In contrast to that, CSP has a real, limited storage with cost and losses. Therefore CSP will always loose when compared to PV and wind in a way that does not compare equal quality of supply.

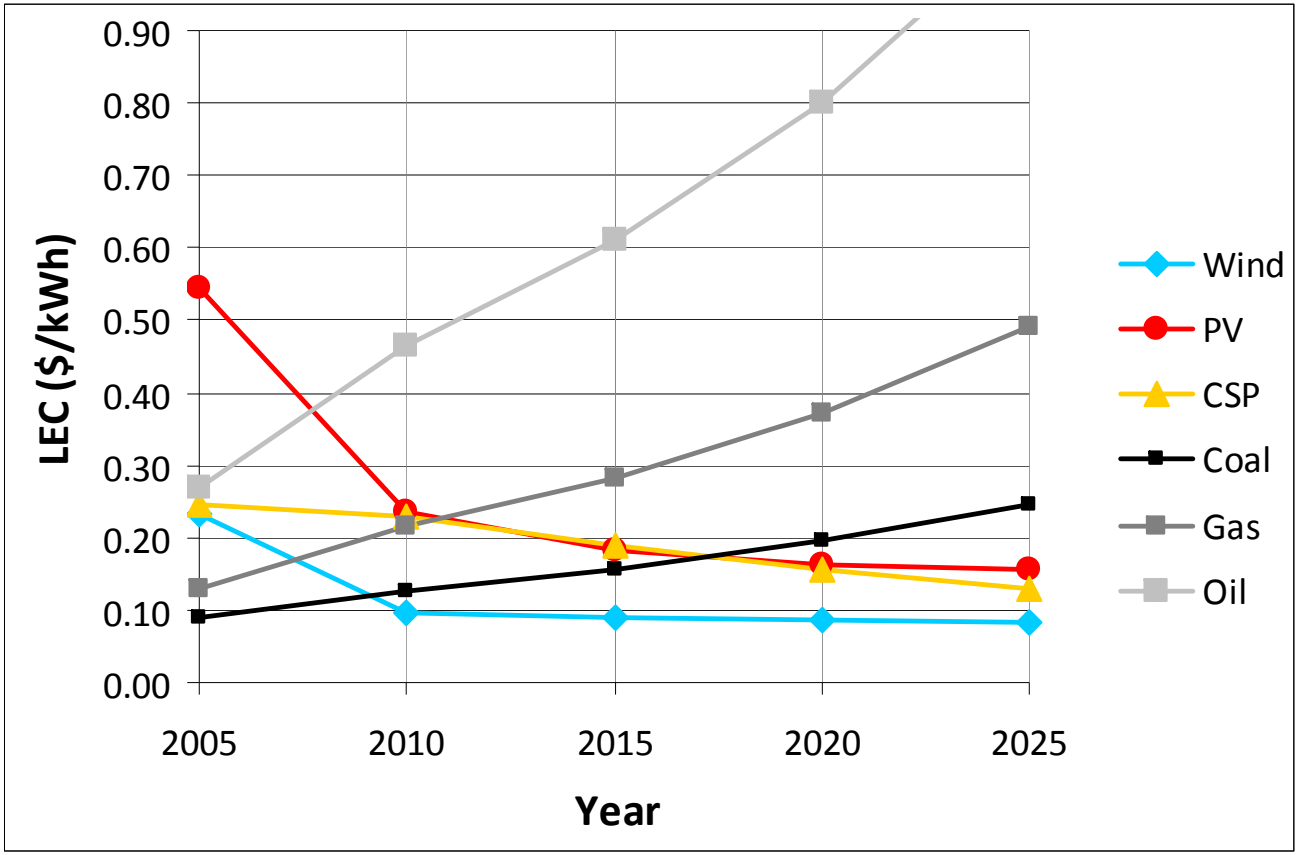
- There are 1 GW CSP, 40 GW PV and 200 GW wind power installed today. This means that the remaining potential for cost reduction of CSP is much higher than that for wind and PV, especially when storage and backup are included. This cost reduction potential must be tapped by decidedly developing CSP world wide (just like PV and wind has been developed in the past)

How compares the cost of electricity from different sources with 2%/a fuel cost escalation?



Wind = wind park
PV = PV plant

How compares the cost of electricity from different sources with 6%/a fuel cost escalation?

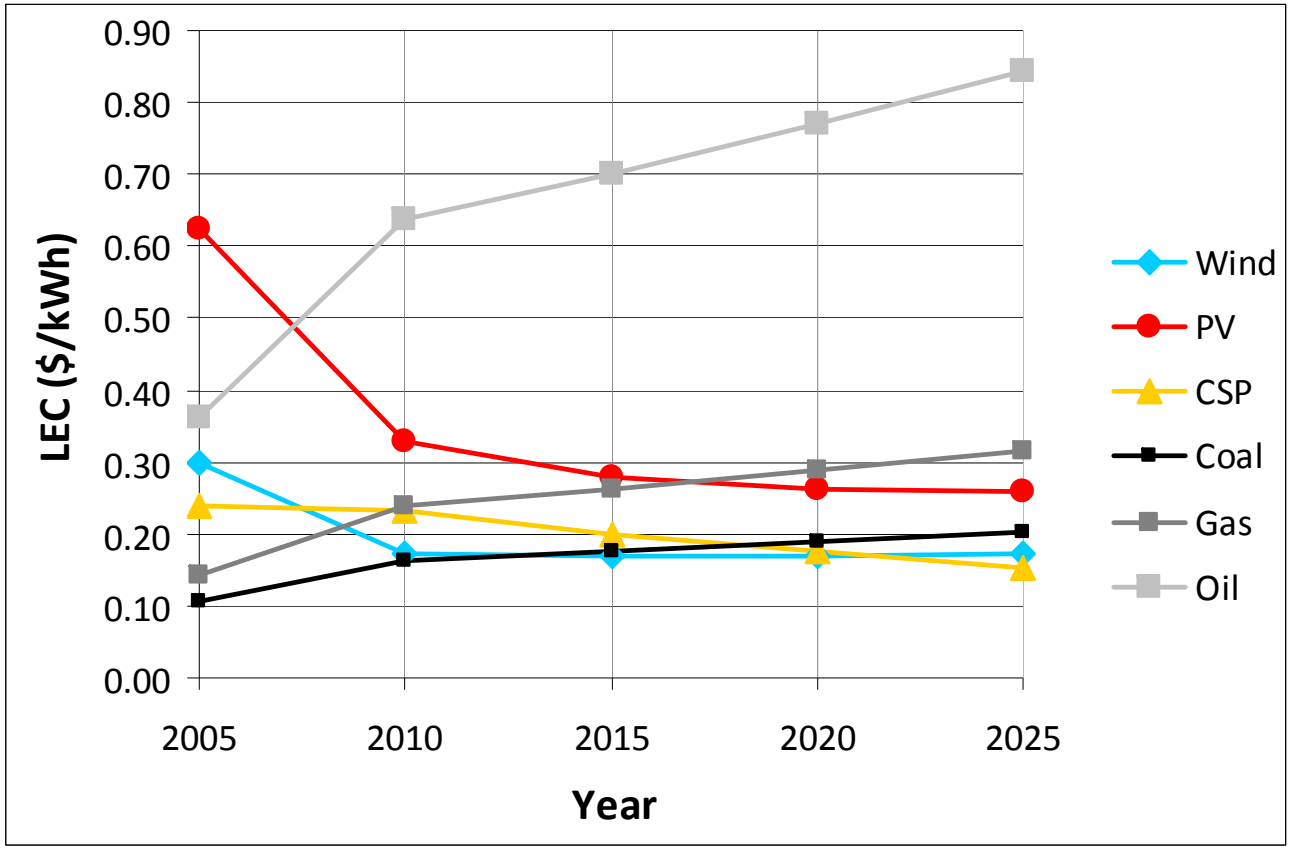


Wind = wind park
PV = PV plant

the past decade suffered a 15%/a escalation!

discount rate 7.5%/a, fuel cost escalation 6%/a

How compares the cost of electricity for a guaranteed stable price contract for 40 years for firm 100 MW, 4000 h/a?



fuel for 40 a as initial investment!

CSP = 100 MW CSP incl. thermal storage incl. 10% hybrid operation with gas
Wind = 200 MW wind park + pump storage + 10% backup from gas power plant
PV = 250 MW PV plant + pump storage + 10% backup from gas power plant

discount rate 7.5%/a, fuel cost escalation 2%/a

Comparing Fuels, Wind, PV and CSP

Lesson learned:

➔ **Compare systems with equal technical quality of supply including production, storage and backup!**

➔ **Compare systems with equal economic quality of supply including long-term price stability!**

The Role of Wind, PV and CSP in Emerging RE Markets

- PV and Wind do not deliver firm capacity, but can produce a lot of electricity at a relatively low cost.

- Strong, well developed power markets in industrial countries can integrate large amounts of PV and wind power, as the existing capacity can balance fluctuations.

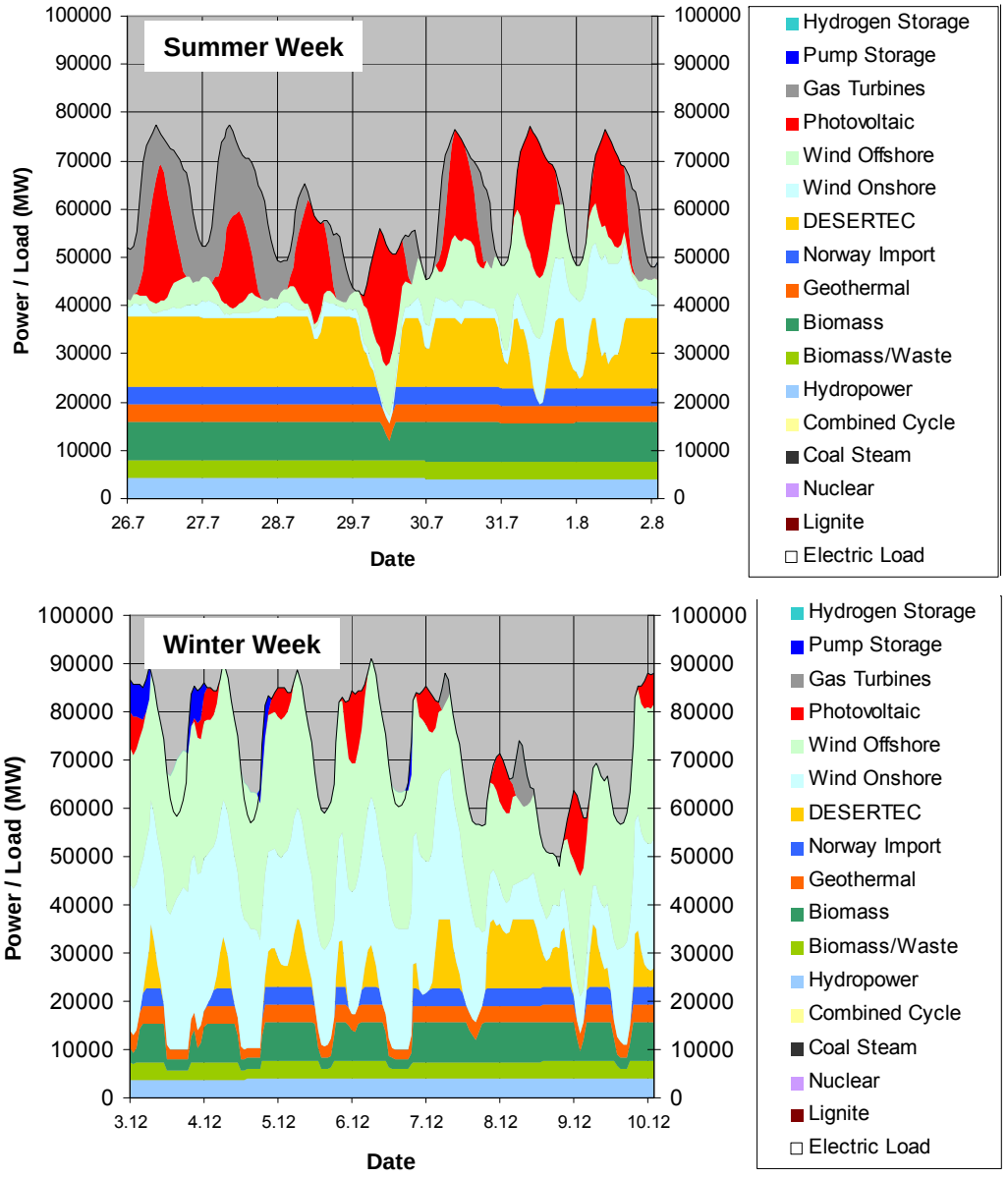
- Growing power markets in developing countries need addition of firm capacity, preferably by CSP, biomass or hydropower.

Case study Germany 2050

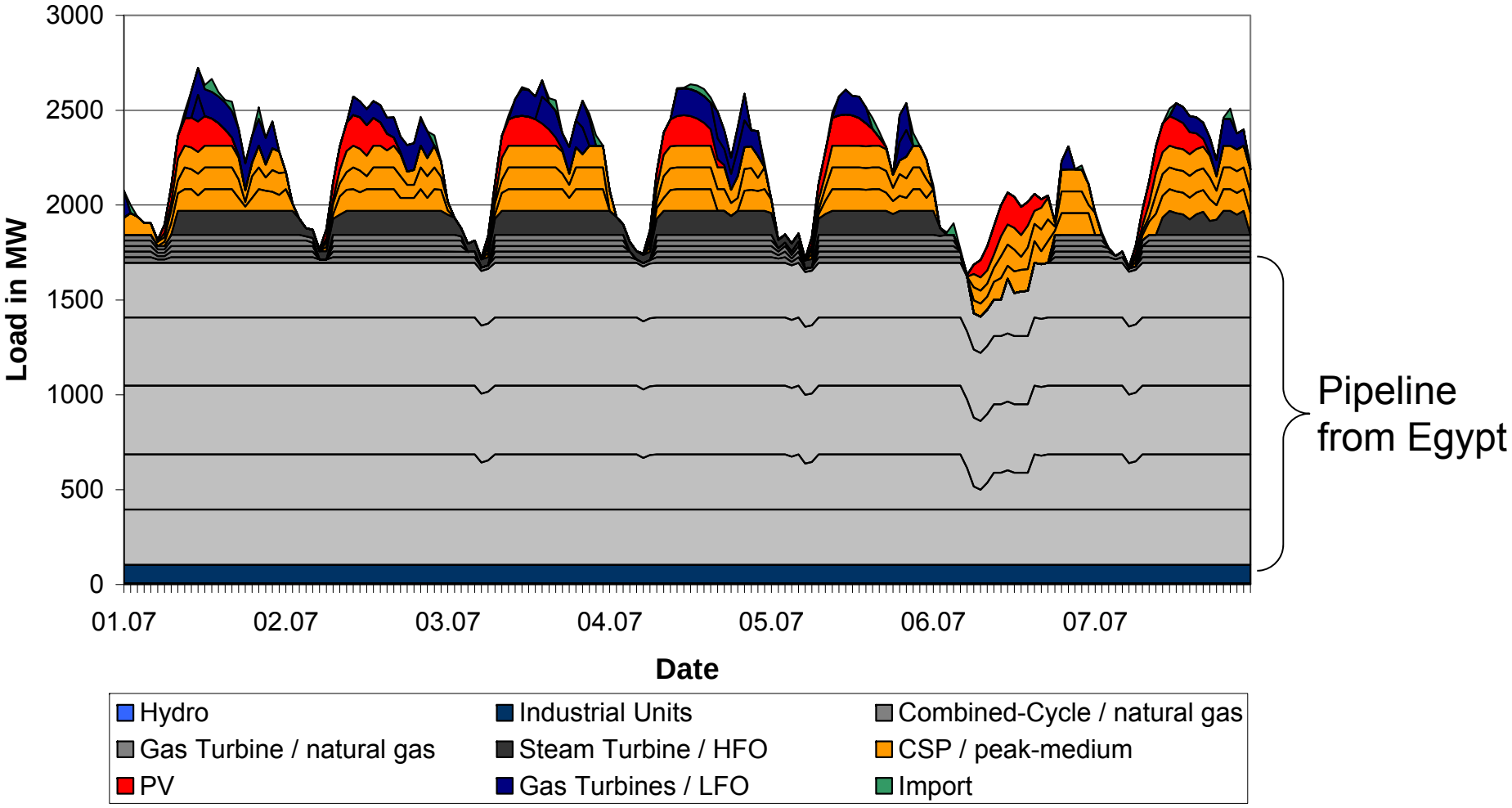
The role of variable and flexible renewable power sources in a 90% renewable electricity scenerio for the year 2050 for Germany.

Installed Capacities:

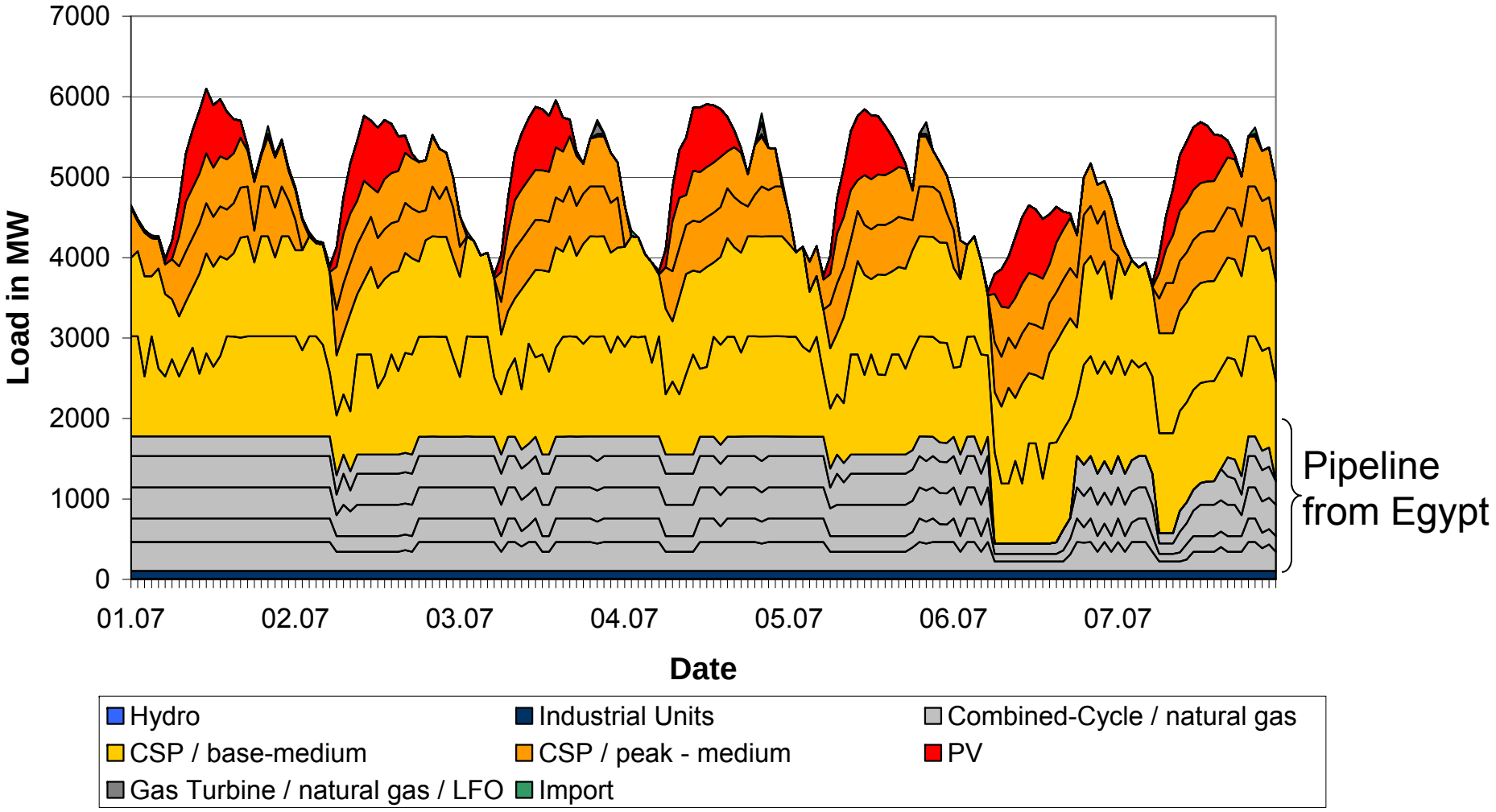
Photovoltaics:	55 GW	var. RE
Wind Onshore:	40 GW	var. RE
Wind Offshore:	30 GW	var. RE
DESERTEC:	16 GW	flex. RE
Import Norway	4 GW	flex. RE
Geothermal:	4 GW	flex. RE
Biomass:	9 GW	flex. RE
Biomass Waste:	4 GW	flex. RE
Hydropower:	6 GW	flex. RE
Natural Gas:	63 GW	flex. Fuel



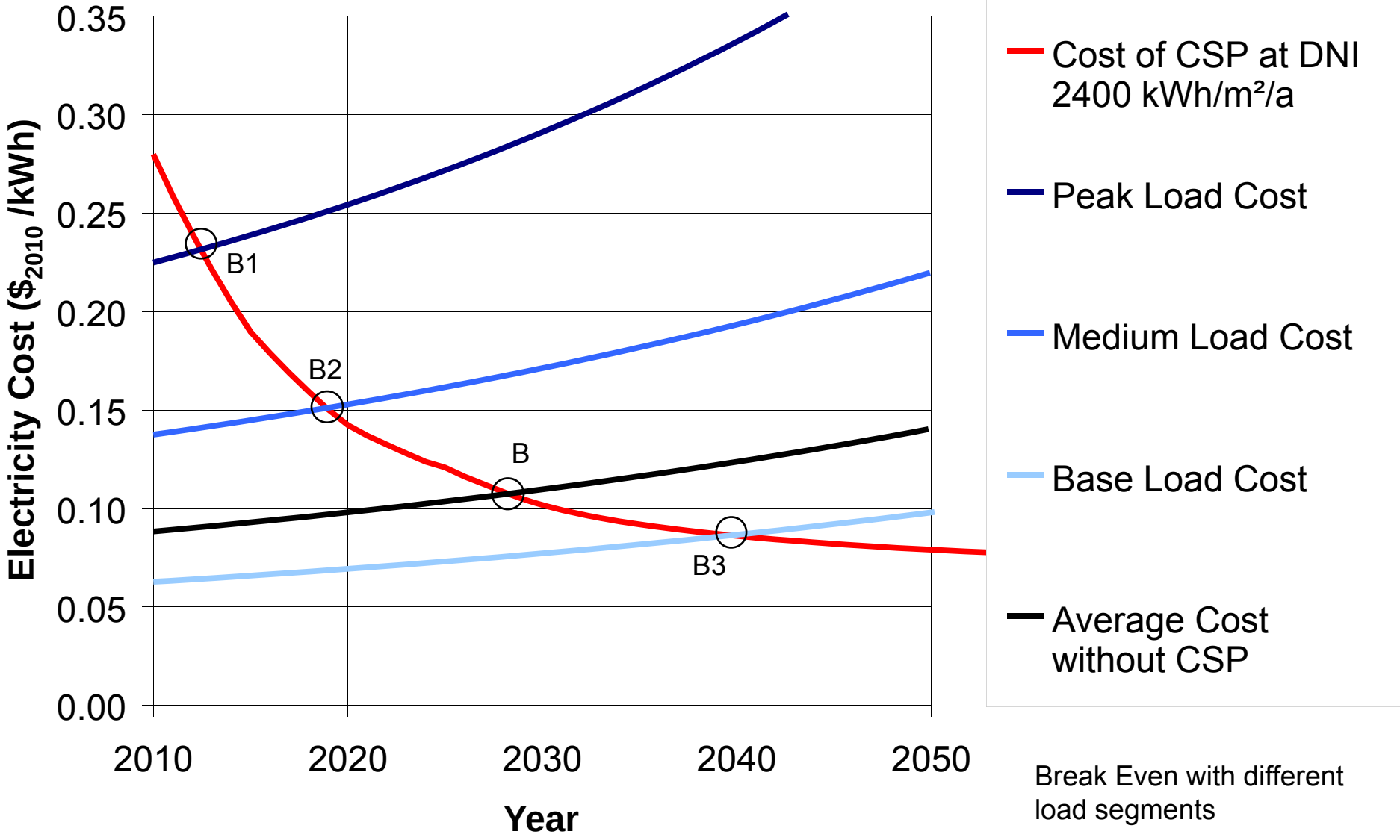
Case study Jordan 2015: role of CSP and PV



Case study Jordan 2030: role of CSP and PV



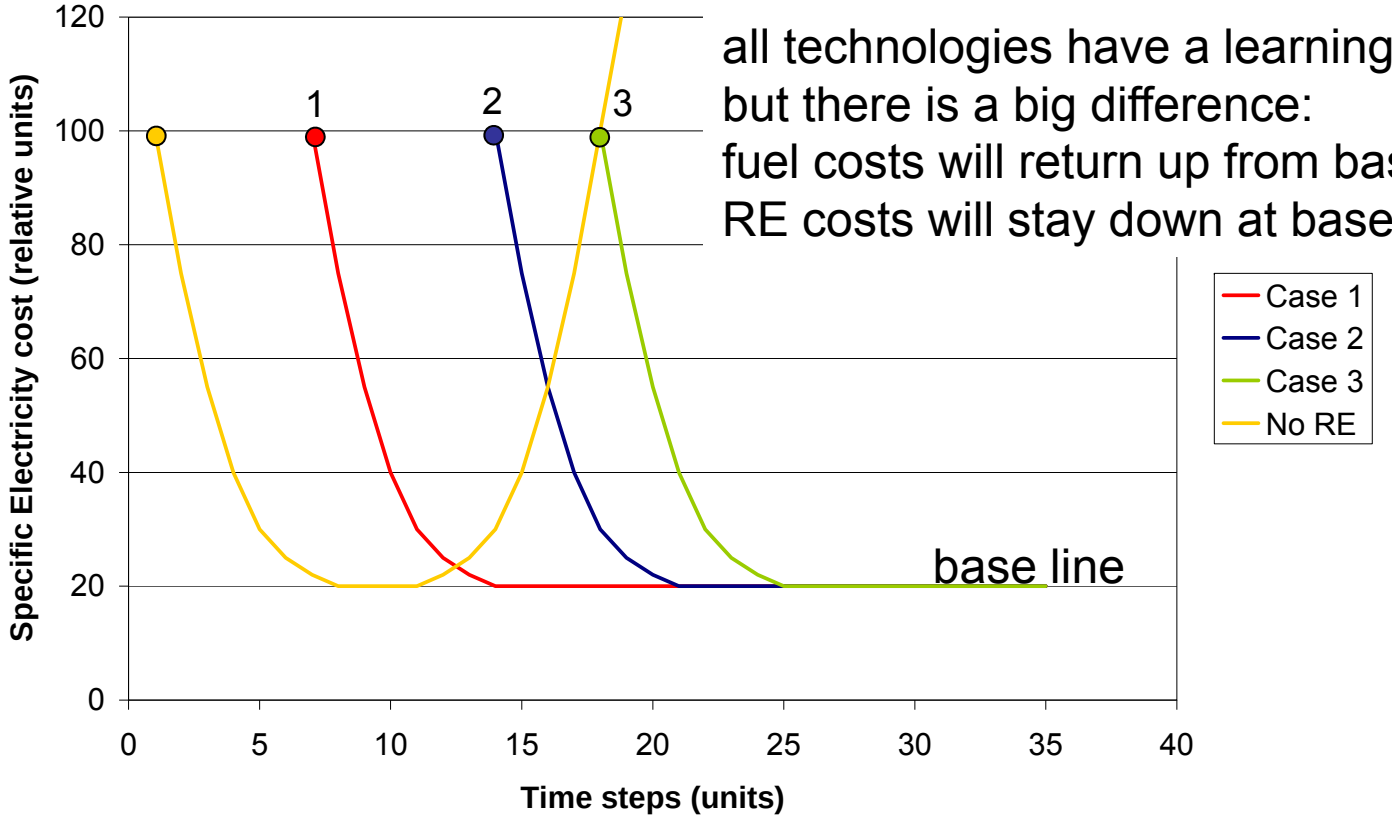
Niche markets for CSP



Break Even with different load segments

When to start?

When will it be reasonable to start investing in RE?



all technologies have a learning curve,
but there is a big difference:
fuel costs will return up from base line
RE costs will stay down at base line

1. as soon as the RE learning curve can be initiated?
2. when fuel prices exceed the base line renewable energy cost?
3. when fuel prices reach the initial renewable energy cost?

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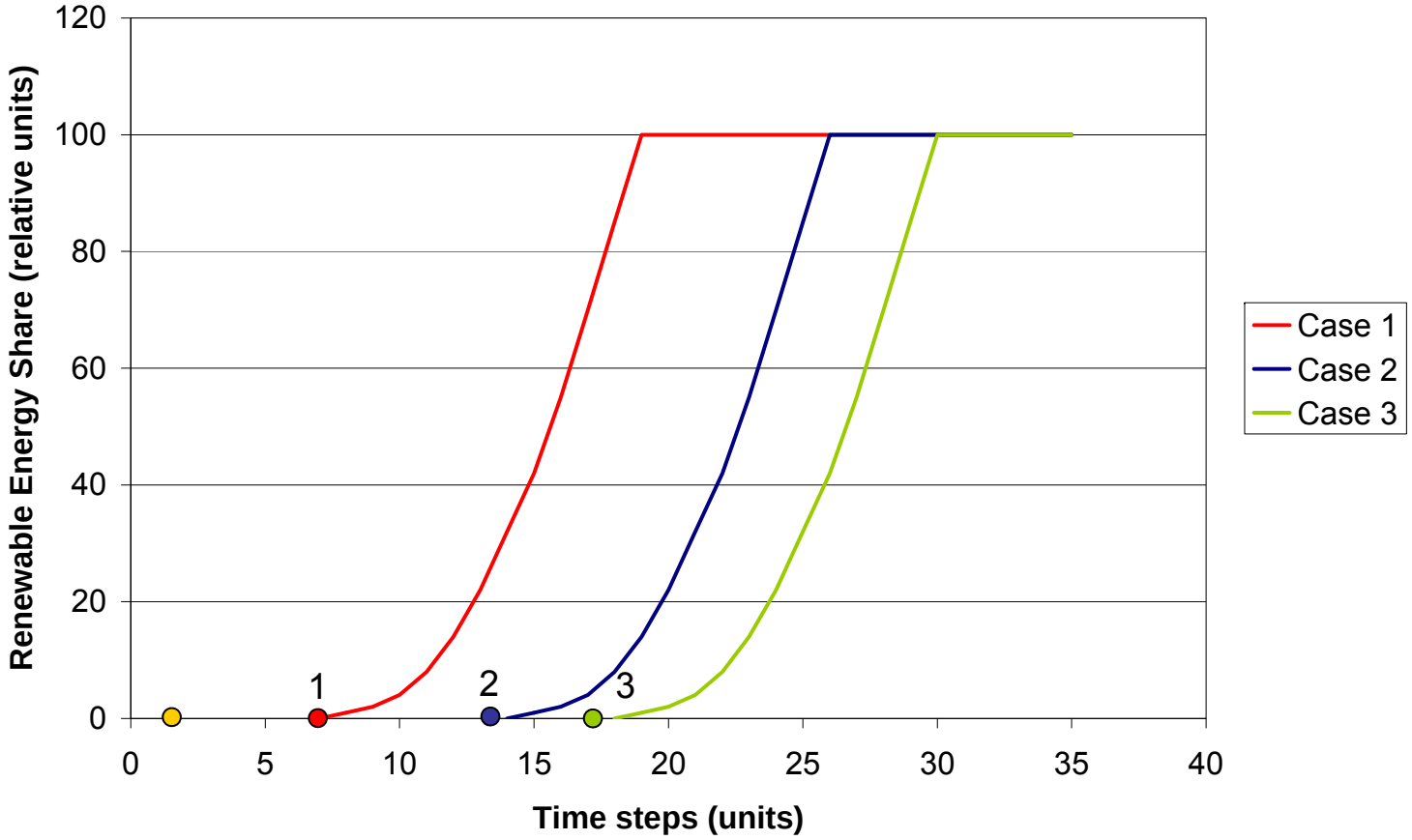

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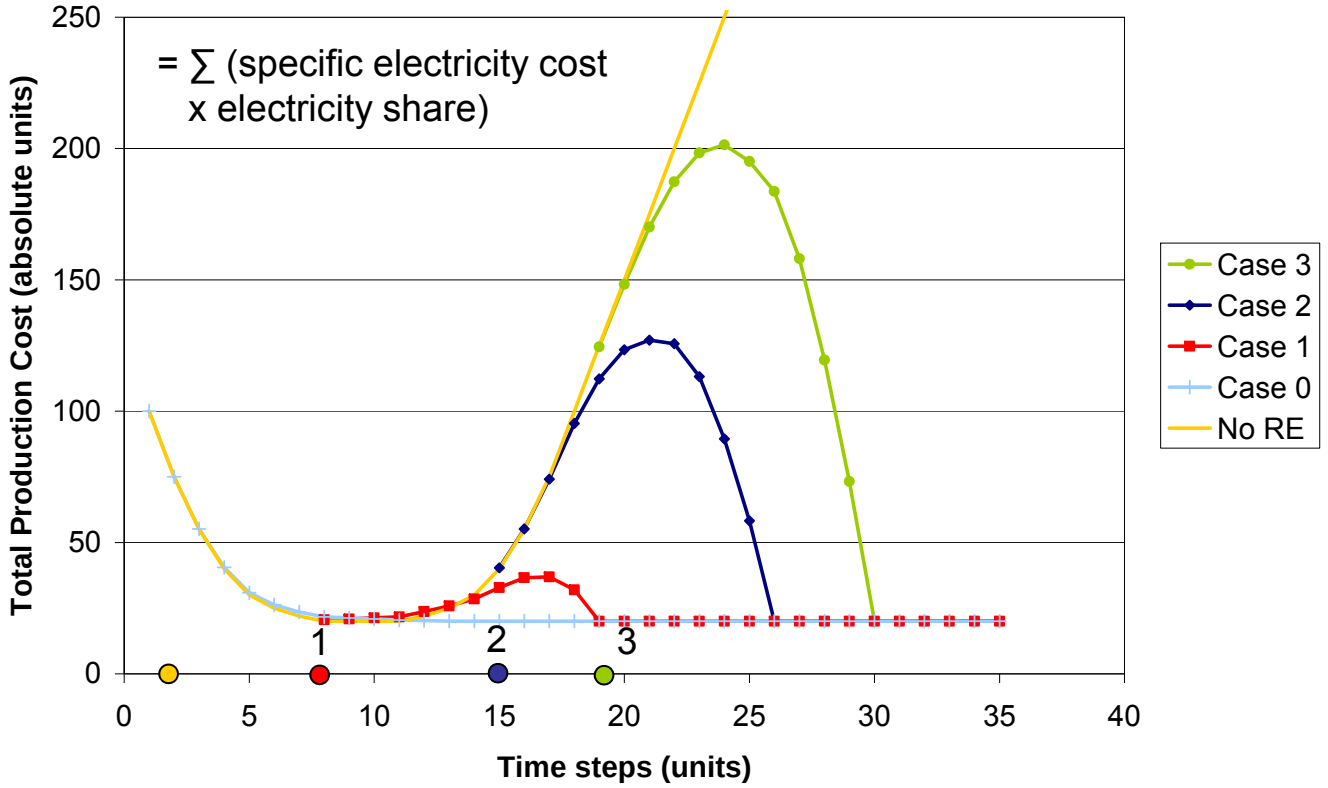

1. as soon as the RE learning curve can be initiated!
2. when fuel prices exceed the base line renewable energy cost?
3. when fuel prices reach the initial renewable energy cost?

How to start?

Setting an appropriate policy framework

- recognize the need for large RE investment
  (RE investment replaces fuel consumption for decades!)
- reduce capital cost by increasing RE project ratings towards AAA
  (re-insured PPA, guaranteed renewable electricity tariff)
- recompense the quality of flexible & renewable power
  (re-insured PPA, guaranteed renewable firm-capacity tariff)
- provide transparent, long-term stable regulatory and policy framework to trigger real RE markets
- start immediately!

If we always ask for least-cost solutions,
we may end up with a least-cost planet.

Thank You