Financing Concentrating Solar Power Plants: The CSP-Finance Project

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CSP Investment
CSP Investment vs. CSP Performance

CSP is a power plant plus „fuel“ for 40 years operation as a capital good at stable cost

11500 €/kW
8000 h/y

+ 2500 €/kW + 2000 h/y
+ 2500 €/kW + 2000 h/y
+ 2500 €/kW + 2000 h/y
+ 2500 €/kW + 2000 h/y

1500 €/kW
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 CSP 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

discount rate 7.5%/a, fuel cost escalation 2%/a
How compares the cost of electricity from different sources with 6%/a fuel cost escalation?

Wind = wind park
PV = PV plant
CSP = Concentrated Solar Power
Coal
Gas
Oil

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

the past decade suffered a 15%/a escalation!
How compares the cost of electricity for a guaranteed stable price contract for 40 years for firm 100 MW, 4000 h/a?

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

fuel for 40 a as initial investment!
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 scenario for the year 2050 for Germany.

Installed Capacities:

- Photovoltaics: 55 GW
- Wind Onshore: 40 GW
- Wind Offshore: 30 GW
- DESERTEC: 16 GW
- Import Norway: 4 GW
- Geothermal: 4 GW
- Biomass: 9 GW
- Biomass/Waste: 4 GW
- Hydropower: 6 GW
- Natural Gas: 63 GW

var. RE

flex. RE

flex. Fuel
Case study Jordan 2015: role of CSP and PV

Pipeline from Egypt

Jordan Case Study, DLR 2012
Case study Jordan 2030: role of CSP and PV

![Graph showing load in MW over time with different energy sources like Hydro, Industrial Units, Combined-Cycle / natural gas, CSP / base-medium, CSP / peak - medium, PV, Gas Turbine / natural gas / LFO, and Import. The graph highlights the role of CSP and PV in the Jordan energy mix.](image)
Niche markets for CSP
Break Even with different load segments

- Cost of CSP at DNI 2400 kWh/m²/a
- Peak Load Cost
- Medium Load Cost
- Base Load Cost
- Average Cost without CSP

Electricity Cost ($2010/kWh)

Year

2010 2020 2030 2040 2050
When to start?
When will it be reasonable to start investing in RE?

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?

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
When will it be reasonable to start investing in RE?

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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.