PHANES GROUP®

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How conditions in less stable markets affect cost - perspectives from a developer‘s standpoint

RG, March 2018

About Phanes Group

Phanes Group in Brief

- What we do
  - Development of solar energy projects
  - EPC / EPC management
  - Investor
  - Investment and operation management
- Application focus
  - Utility scale PV projects
  - Industrial roof top projects
  - Off grid solar applications / rural electrification
- Regional focus
  - Africa
  - MENA
- Development portfolio
  - Nigeria 235 MWp
  - Guinea 50 MWp
  - Mali 75 MWp
  - Zimbabwe 75 MWp
  - Under development: Ghana, Mozambique
- Rural electrification Niger, Nigeria

Selected References

- Largest utility scale PV project in the Caribbean
  Dominican Rep., 33.4 MWp, 2015 – 2016
  (Phase 2 2018)

- UK Housing Association Portfolio
  3,500 homes, 10.5 MWp, 2014 - 2016

- DP World Solar Power Programme
  Industrial roof tops, 23.2 MWp, 2016 – 2018

- Rural electrification Niger, Nigeria
  - Pilot village Niger, solar pumping Nigeria

Situation and Target

- Extremely low bids for electricity prices in Saudi Arabia, Chile, Mexico
  - Very large utility scale systems show electricity prices from recent auctions in some regions on extremely low levels
  - Saudi Arabia, Chile, Mexico are at approx. 0.02 $/kWh in 2017 auctions
  - Germany recently published an average bid value of 0.043 Euro/kWh (0.053 $/kWh)
- Cost factors for utility scale PV systems
- How can system prices develop over the next years
- Performance increase of PV systems
- What are the differences to regions such as Sub-Saharan countries

Basis for Extremely Low Auction Prices

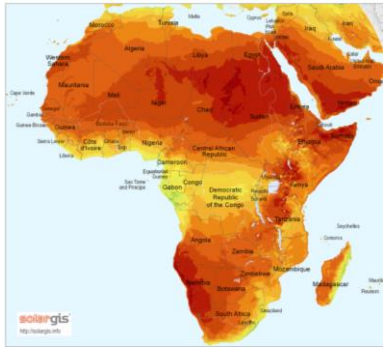
- Financial and “technical” environment
  - Countries with excellent credit rating and stable political situation
  - Access to very low capital cost and long financing terms
  - High solar irradiation levels
  - Time schedule – construction from Saudi Arabia mid 2019, Mexico 2020, Chile 2024

- PV system running cost requirements
  - Very low interest rates, long financing terms
  - Effective cost savings in operation and maintenance
  - No (UAE) or low (KSA) corporate taxes

- Are these tariffs real for today and other regions – no
  - Such low prices are a bid on future price development until 2020 and beyond
  - Faster decline expected than over the past years, lowest interest countries only

- Risk and returns
  - Very low single digit IRR’s
  - No room for any risk and deviation from cost expectations

BUT – What is the Situation in Less Stable and Developing Markets



- Problems e.g. African Countries
  - Lower credit rating, higher inflation cost
  - Currency risk for foreign investors, political risk
  - Longer project development times (cost)
  - Higher installation cost (transportation, safety, etc)
  - Utility scale systems - but not close to 500 – 800 MW blocks
  - Lower grid capacities

- Results for developing countries – outlook 2024
  - Ultra low tariffs are not in reach
  - Higher interest cost, shorter financing terms
  - Higher reserve accounts (DSRA)
  - Will we get low single digit interest rates — No
  - Will we get total system cost to levels as in the matured markets — No
  - Will we get to similar O&M cost — Possible

Cost Factors PV Systems – It is not just EPC cost

- Cost contributors – Total 100 %
  - EPC Cost 77 %
    - PV modules 39 %
    - Inverters 6 %
    - Mounting structure 16 %
    - EPC and other BOS 35 %
    - EPCM, grid, insurances 3 %
  - Financing cost 8 %
    - Fees, legal, due diligence , DSRA
  - Project development 12 %
    - External studies, legal, labour
  - Contingency 4 %

Major Cost Factors PV Systems – 87 % by Five Major Cost Blocks

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Major Cost Factors in Running Cost Without Taxes

- Cost contributors without depreciation
  (Example: 100 MWp, 1,100 $/kWp; 0.08 $/kWh; 2,000 kWh/kWp; no rent;
  financing 20 years at 7 % interest; 30 % equity; year 3; pre tax; 3 % inflation)

Operation & maintenance	15 %
Insurance	6 %
Reserves (inverter etc), admin.	2 %
Interest cost	40 %
Debt service	37 %

- Major Factors besides - most important - tariff
  - Interest
  - Debt service
  - O&M

Major Cost Factors Running Cost Without Taxes

- Cost contributors – Example
  - Debt service 40 %
  - Interest cost 37 %
  - Operation & maintenance 14 %
  - Insurance 6 %
  - Reserves (inverter etc), admin. 3 %

- What will be different in less developed countries
  - Debt service Higher
  - Interest cost Higher
  - Operation & maintenance Similar
  - Insurance Higher

- Consequences
  - Higher upfront financing and development cost
  - Higher running cost
  - High pressure on IRR

  => Higher tariff requirement

What can we do to reduce CAPEX

- PV module prices increased but will continue to decline in 2018 and the future
- System EPC cost decline until 2020 / 2021 by 30 % (ITRPV) including financing and development more likely 20 % (Bloomberg)
  - Example: tariff from 0.08 $/kWh -> 0.05 $/kWh — IRR down 80 %
  - Total system cost down 20 % at 0.05 $/kWh — IRR down 53 %
  - Operating cost down by 1/3 at same conditions — IRR down 40 %
- This all helps but not is enough
- Reduce module degradation to 0.02 / 0.01 %/y
- Increase system lifetime from 25 to 30 / 40 years
- Increase system performance to increase revenues

$$\text{LCOE} = \frac{\text{sum of costs over lifetime}}{\text{sum of electrical energy produced over lifetime}}$$

Performance Increase

- System cost and O&M reductions alone are not sufficient
  - Decreasing module and BOS cost
  - Module cost: efficiency, frameless glass/glass, bifacial
  - System design 1,500 V technologies, 70 % share by 2024
  - Reduction of financing cost
- Next steps in performance increase until 2024
  - Increase module efficiency (PERC and) Heterojunction modules 10 – 15 %
  - Single axis trackers 50 % share, approx. 15 %
  - Bifacial modules 20 % share, approx. 10 – 15 %
- LCOE (Levelized Cost of Electricity) from 0.08 $/kWh to 0.06 $/kWh is at the horizon
- LCOE of 0.04 $/kWh may come by 2027
- Tariffs in the 0.02 to 0.3 $/kWh range will not be achieved in less developed countries within a 2024 / 2027 timeframe

Summary

- Extremely low tariffs realistic only in developed countries with high credit rating and investor acceptance of low IRR's (plus excellent irradiation levels)
- PV module prices decline further (despite of current increases) but account to just 30 % of total system cost today
- Total system cost continue to decline, unlikely below 600 $/kWp in a 2024 time frame
- System performances will increase due to system design and module performances
- Less developed or less stable countries
  - Financing cost, interest rates significantly higher
  - Higher inflation rates
  - Installation cost
  - Project development risk and cost

  $\Rightarrow$ Tariffs in the range of 0.02 or 0.05 $/kWh are out of reach today, until 2024 and beyond

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