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EMPower

# EMPower Program – Large Scale Solar Power in Developing and Emerging Countries: Lessons Learned

*ECREEE Regional Workshop on the ECOWAS Solar Energy Initiative (ESEI)*
*18 - 21 October 2010, Dakar, Senegal*

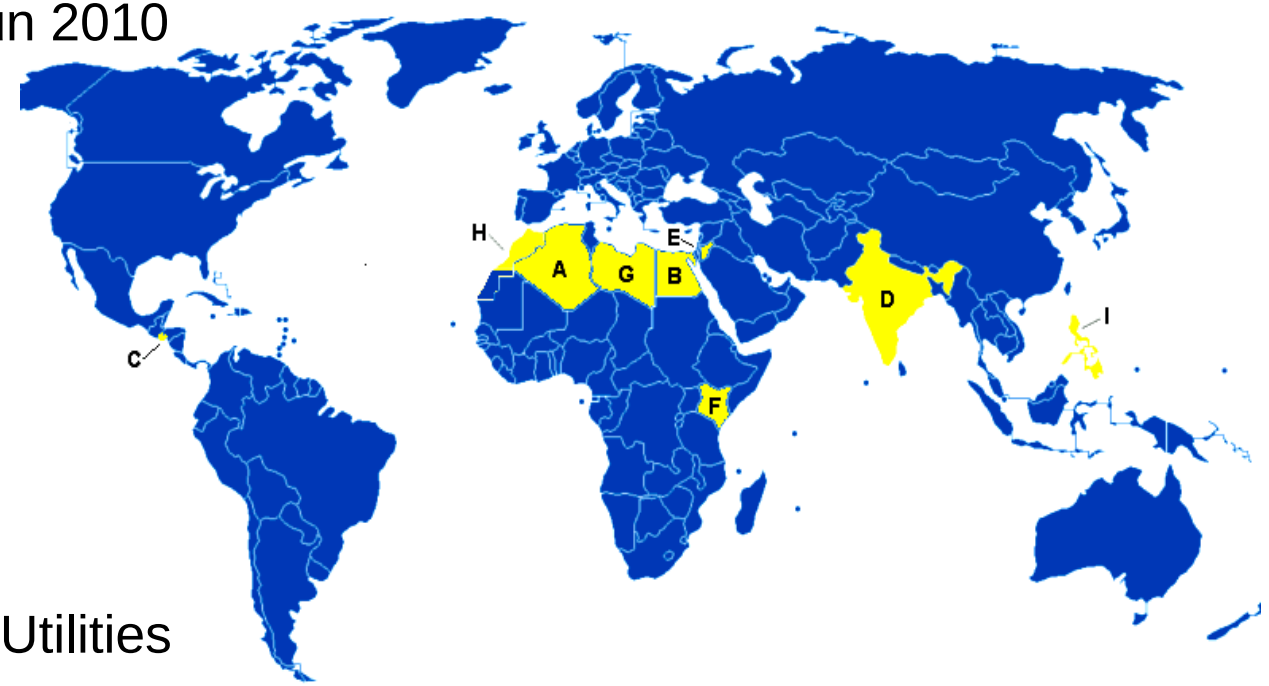
*Werner Klaus, Lahmeyer International GmbH*

# EMPower Program – Development of Large Scale Solar Power in Emerging and Developing Countries

- Objectives
  - Support Solar Power Market Development in sunbelt countries
  - Accelerate global demand for PV & CSP and cost reduction
  - Raise Awareness for the Cost and Value of Solar Power
- Outputs
  - **Pre-feasibility Studies** – Assist Utilities in development of large scale solar power projects
  - **Project Information Memorandae (PIM) -** Present key project data to stakeholders and investors
  - **Industry Advisory Board** – Link-up with solar industry
  - **Workshops** - get governments and stakeholders involved and share information

# EMPower Program – Key Data

- Sponsors: KfW and UNEP/GEF
- Duration:
  - Jul 2008 – Jun 2010
- Countries:



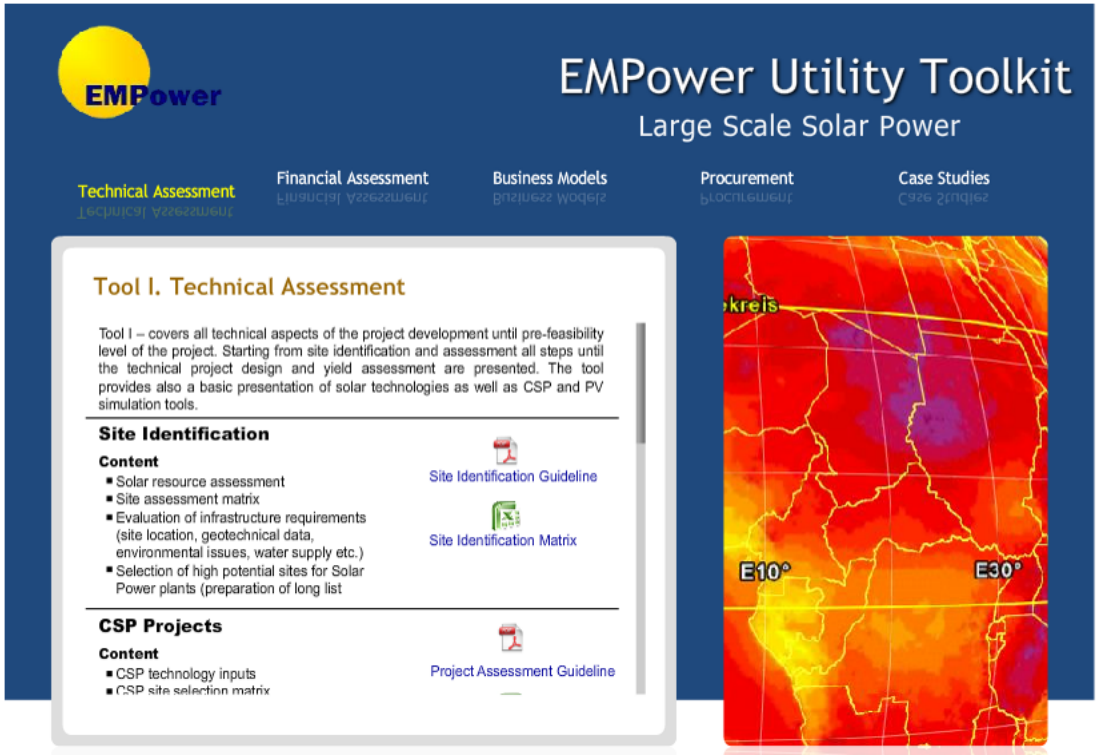

- Participants:
  - Private and State owned Utilities
  - Renewable Energy Agencies
  - Power / Energy Ministries

# EMPower Program – Project Pipeline

| Country | Partner | Technology | |
|---|---|---|---|
| • Algeria | NEAL | CSP | 100 MW |
| • Egypt | NREA | CSP | 100 MW |
| | NREA | PV | 100 MW + 2 MW off-grid |
| • El Salvador | CEL | PV | 5 MW |
| • India | RELIANCE | CSP | 50/100 MW |
| • India | SPICE | PV | 25 MW |
| • Jordan | MEMR | CSP | 50 MW |
| • Kenya | REV/KenGen | PV | 5 MW |
| • Libya | REAOL | CSP | 100 MW |
| | | PV | 15 MW |
| • Morocco | ONE | CSP | 50 MW |
| • Philippines | CEPALCO | PV | 1 MW |

# EMPower Utility Toolkit Large Scale Solar Power

- Technical, Financial and Economic Assessment
- Business Models & Lenders Package
- Tendering and Procurement
- Case Studies

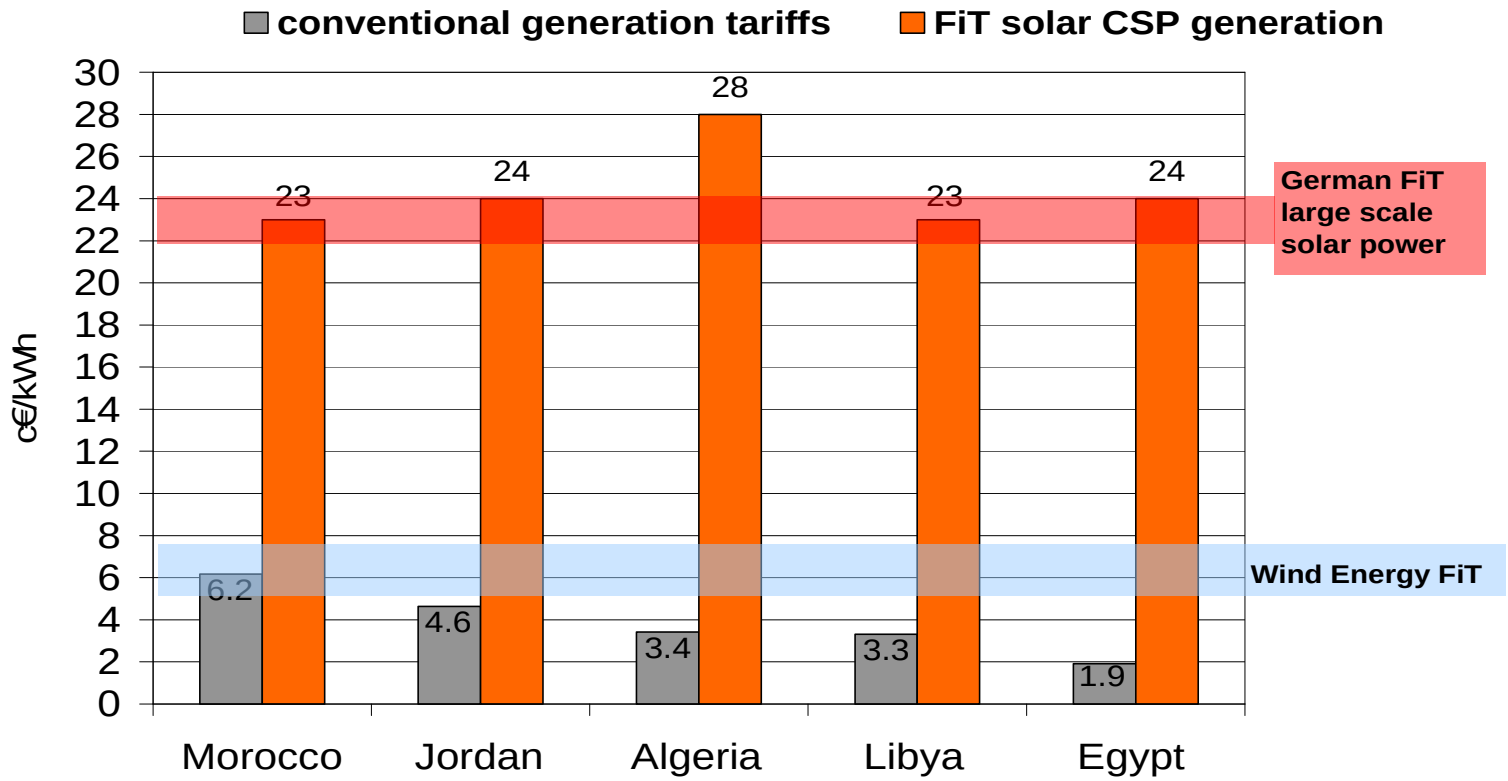



→ online access
**http://empower-ph2.com/EMPowerToolkit/**

# EMPower Workshops – Selected Findings

- Solar Power Markets are developing at high pace (volume↑ prices ↓) → Solar will play central role;
- Solar Power requires currently 18 to 30 c€/kWh;
  → gap of 200 – 400% to conventional power
  → exception: off-grid diesel systems, PV feasible!
- Tariff requirement in Africa (e.g. Kenya 27 c€/kWh) higher than tariffs paid in Germany (24 c€/kWh)!
  - Cost of equity and loans
  - Project and country risk
- Consumer Grid Parity (household & industrial) is close
- Strong support is required to introduce solar power
  - Framework: grid access, priority dispatch, “cost plus” tariffs
  - Long term political commitment

# EMPower – Lessons Learned (1)




- CSP tariff requirements
  - high compared to conventional tariffs an other renewables
  - In same range as large scale PV in Germany

→ **Integration of Solar Power needs strong support**

# EMPower – Lessons Learned (2)

- LEC vs FiT – definition of the different concepts

Levelized Electricity Cost (LEC)

$$LEC =: \frac{\text{Present Value of OPEX+CAPEX (at market prices)}}{\text{Discounted Energy Production}}$$

*"pure unit cost of power generation"*

Fed-in Tariff requirement (FiT):

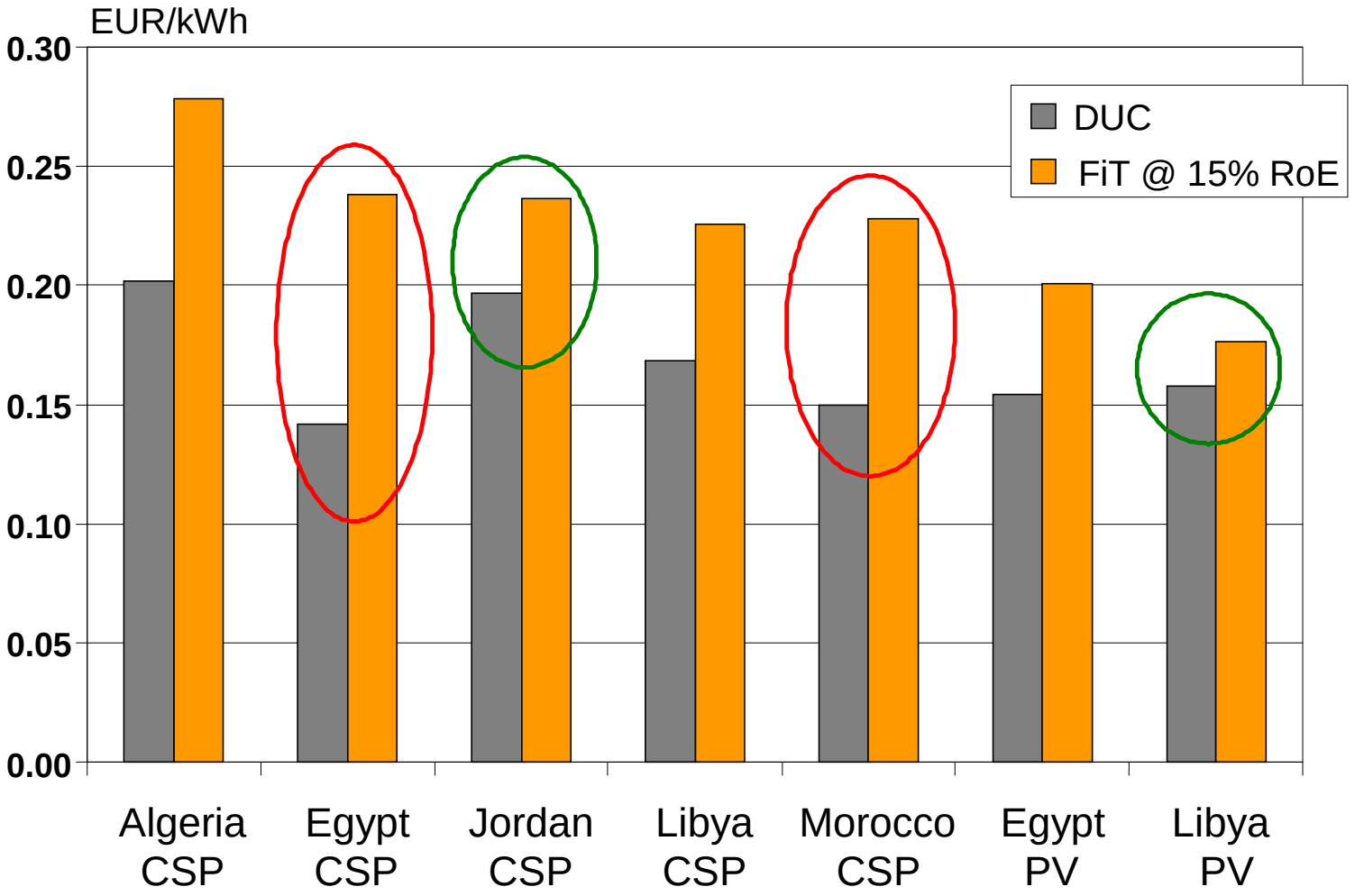
$$FiT =: \frac{\text{PV of (OPEX+Debt Service+Dividends+Cash Reserve)}}{\text{Discounted Energy Production}}$$

*"unit remuneration required to make project profitable"*

*Note: WACC assumed as discount rate;*
*Interest rates below market rates assumed*

# EMPower – Lessons Learned (2)

- The Gap between LEC and FiT



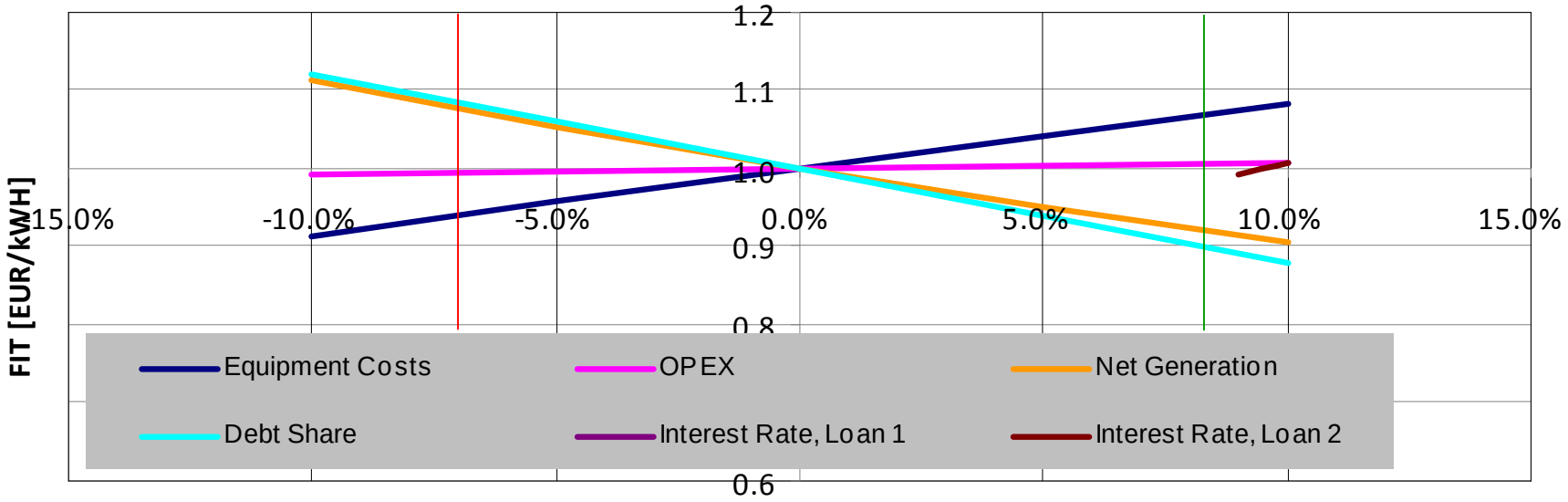
# EMPower – Lessons Learned (2)

- Gap between LEC and FiT
  - Jordan and Libya show the lowest gap: 4 and 5 c€/kWh
  - Gap is highest for Egyptian and Moroccan projects: 10 and 8 c€/kW.
- Reasons
  - Lower corporate tax rate (e.g. Jordan 5% vs. Egypt 40%);
  - Income tax holiday (e.g. in Libya 5 years)
  - Longer loan repayment period for Jordan and Libyan
  - Higher dividend payments in first years

**→ Combination of fiscal incentives and loan terms is effective mean to reduce tariff requirement by up to 10 cEUR/kWh**

# EMPower – Lessons Learned (3)

- Equity Share in Solar Projects
  - Equity share is most sensitive variable for CSP tariff requirement
  - +8% debt (75% to 81% share) change FiT by -10%
  - -7% debt (75% to 70% share) change FiT by +9%




→ **Build Lenders Confidence in CSP and PV Projects**

# EMPower – Lessons Learned (3)

- How to do Build Lender's Confidence?

**→ Recommended Measures to policy makers**

**(a) Simple and Consistent Framework Design**

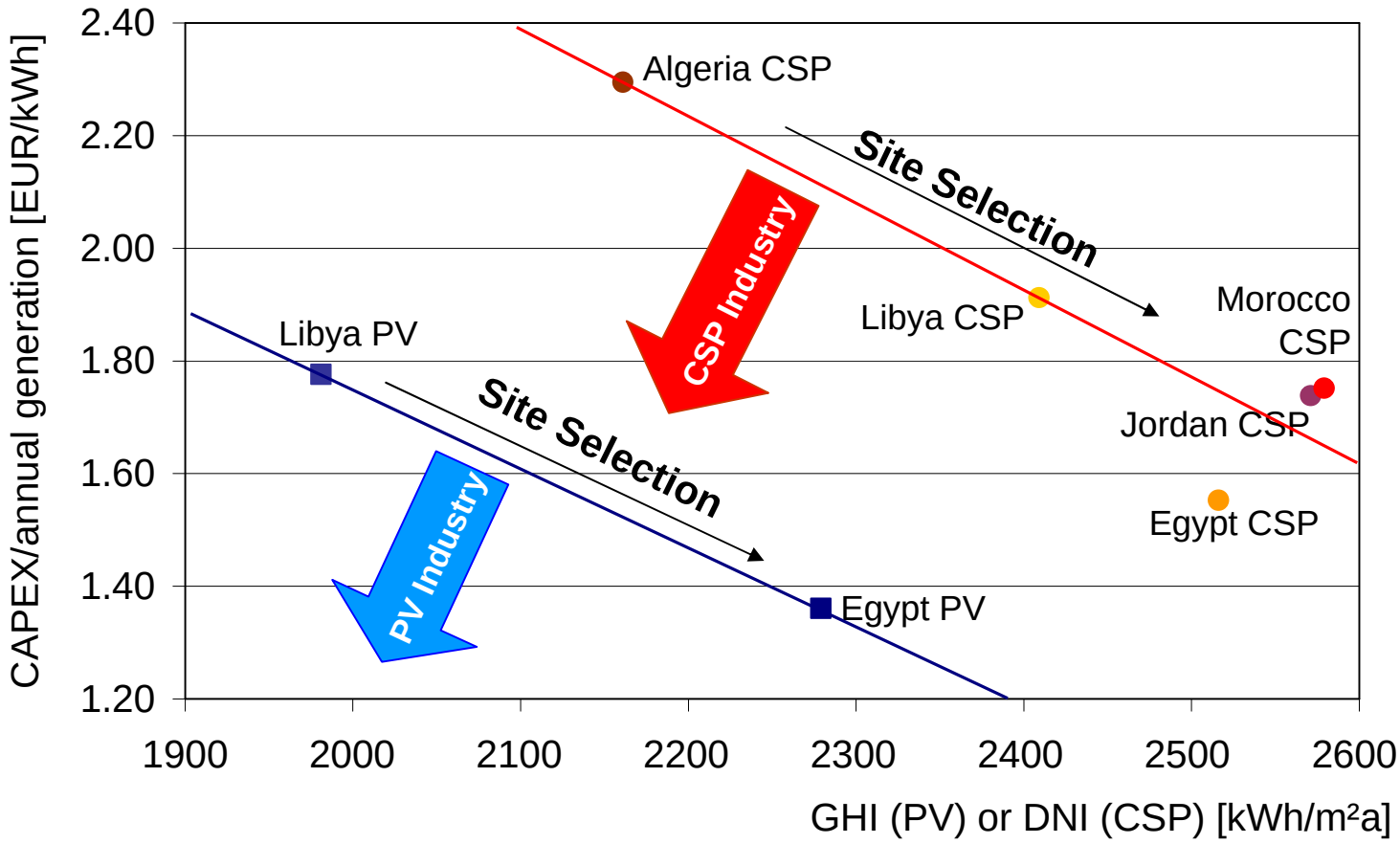
**(b) Assure strong long- term political commitment to Solar Power**

**(c) Foresee strong guarantees for the investor's revenues**

**(d) Build track record of successful policy implementation**

# EMPower – Lessons Learned (4)

- Generation Specific Capital Cost



# EMPower – Lessons Learned (4)

- Generation Cost
  - Not plant cost (CAPEX) is decisive but
  - Capital per energy unit generated (CAPEX/annual generation)
- CAPEX – reduction potential: CSP & PV industry
- Annual Generation – Increase potential
  - Site selection: very best solar resource
- Limitation: Error and uncertainty in solar radiation data
  - 15 – 25% in DNI for CSP projects
  - 10 – 15% in GHI for PV projects

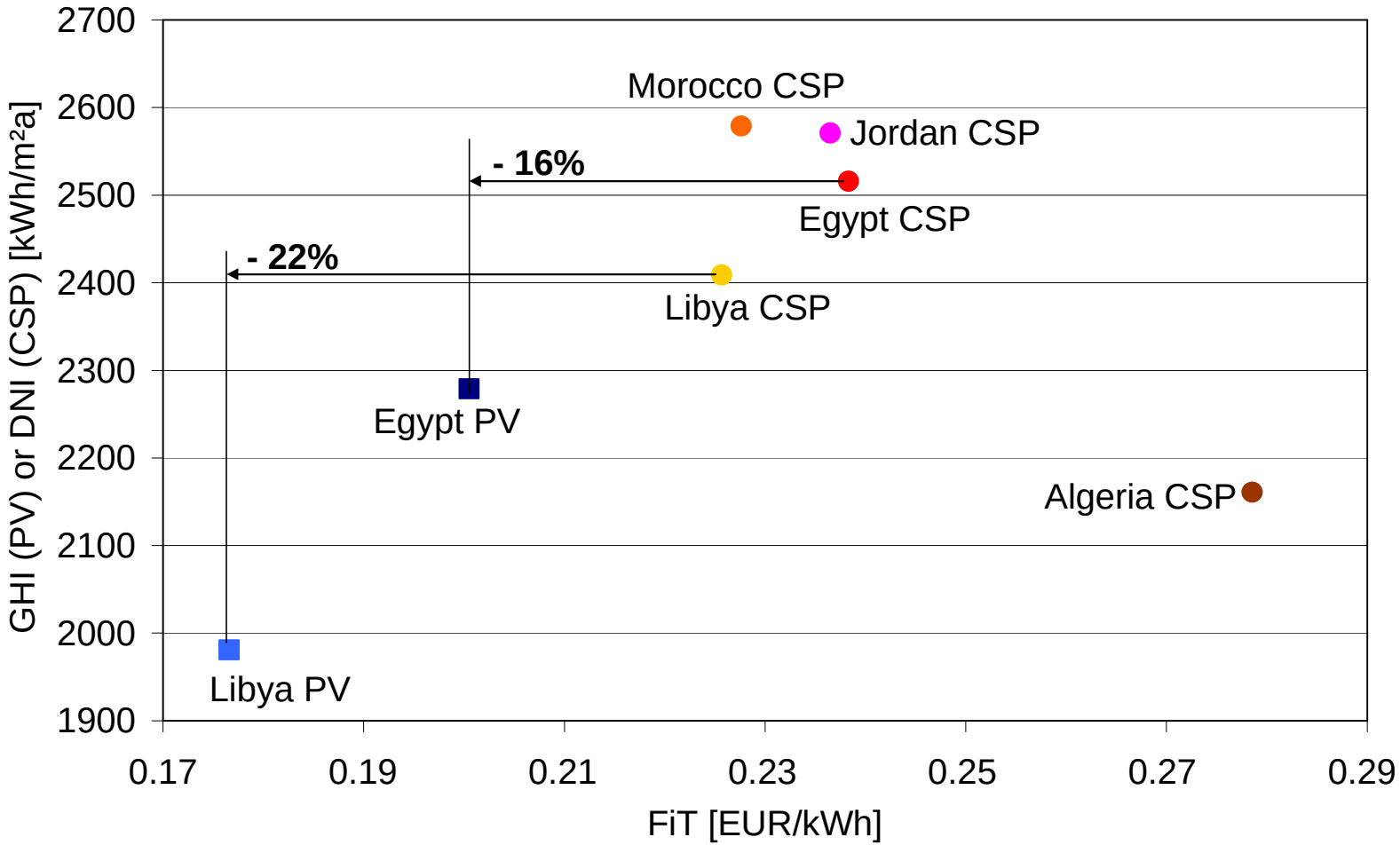
**→ Recommended Measures**

**(a) Reference measurement network for GHI / DNI**

**(b) high resolution & accuracy Radiation Database for DNI + GHI**

# EMPower – Lessons Learned (5)

- Cost comparison of CSP and PV



# EMPower – Lessons Learned (5)

- Comparison of CSP and PV

| PV | CSP |
|---|---|
| - Currently lower investment cost (absolute and generation specific) | - Optional thermal energy storage for dispatchable power (same cost but eventually higher value). |
| - PV has currently a lower FiT requirement | |
| - Industry mid term outlook: PV cost advantage will grow further | - CSP has strong mid-long term cost reduction potential |
| - Modular technology: small economy of scale effect on plant level | - Large economy of scale effect on the plant level |
| - Also suitable for smaller areas, complex terrain and roofs | - Requires large flat and horizontal terrain |
| - Simple and short planning | |
| - Fast construction, little complexity | |

# Conclusion for ECREEE

- EMPower showed strong and serious interest of countries in sunbelt to exploit solar power;
- First countries already established a solar policy, framework and support scheme;
- Cost of solar power still major barrier, however future fossil prices and volatility need to be considered;
- Concessional financing will be required. It is more effective when fiscal incentives and loan terms are combined;
- PV is short term more attractive (and feasible off-grid);
- CSP attractive for high DNI regions (> 2.500 kWh/m²a) and in combination with storage.

# Thanks for your attention!

Many thanks to the sponsors


And all partners of the project

CEL, Reliance Power, SPICE, Cepalco, NEAL, NREA, MEMR/JEPCO, ONE, REAOL, RE, CarbonAfrica, etc.

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