Financing Mechanisms for Solar Projects

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A view of the night time world

Source: NASA
World Solar Map
(Mean Annual Irradiance)
World Renewable Generation & Solar PV Growth

Source:
REN21, EPIA & PV News
Typical Project Finance Structure
Financing Challenges

- Capital Intensity
  - Demonstration of technology becomes very expensive proposition
- High levelized costs
- Lack of operational experience
- Intermittent nature of renewables
- Credit risk of consumer (prominent in case of rural electrification)
Factors affecting Economics of Solar Energy

- Capital Costs
  - Major components costs
  - Balance of the System
  - Cost of capital
- Efficiency & Capacity Factors
- Operation & Maintenance Costs
- Construction and Operation period
- Renewable Policies

Source: SolarBuzz
Estimated cost of new generation

Source: FERC 2008

[Bar chart showing estimated costs of various energy sources: Nuclear, Conventional Coal, IGCC Coal, Combined Cycle, Combustion Turbine, Wind, Geothermal, Concentrated Solar, Solar PV. Costs range from $0 to $8,000 per kW.]

Source: Compiled by FERC staff from various sources. Cost estimates exclude carbon capture and sequestration costs.
PV Roadmap

Assumptions: Interest rate 10%, technical lifetime 25 years (2008), 30 years (2020), 35 years (2030) and 40 years (2050); O&M costs 1%.

Source: IEA, PV Roadmap
Solar Thermal Roadmap

Levelized cost of electricity (€c/kWh)

- Hard coal
- Combined cycle gas turbine
- Solar-thermal: dispatchable

Source: A.T. Kearney, Solar Thermal Electricity 2025
19 - 22 September 2011, Johannesburg, SOUTH AFRICA
Improvements in Solar Cell Efficiencies

Best Research-Cell Efficiencies

- Multi-junction Concentrators
  - Three-junction (2-terminal, monolithic)
  - Two-junction (2-terminal, monolithic)
- Single-Junction GaAs
  - Single crystal
  - Concentrator
  - Thin film
- Crystalline Si Cells
  - Single crystal
  - Multicrystalline
  - Thin film
  - Silicon Heterostructures (HIT)
- Thin-Film Technologies
  - Cu(In,Ga)Se₂
  - CdTe
  - Amorphous Si:H (stabilized)
  - Nano-, micro-, poly-Si
  - Multijunction polycrystalline
- Emerging PV
  - Dye-sensitized cells
  - Organic cells
  - Various technologies
  - Inorganic cells

Efficiency (%)
Capacity Factor for Different Technologies

Source – NREL 2009
Electricity Cost Comparison

Electricity Cost Comparison, Large End Users: 2009

(Sources: Eskom, Pike Research)
Countries with strong policy framework & financial incentives account for 80% of global installed capacity.

Source: IEA, PV Roadmap
Policy evaluation and end goals

Criteria to judge renewables policy

- supply effectiveness (kW, kWh)
- cost effectiveness (kW/$)
- economic efficiency ($/ton CO₂)
- equity (fair distribution of costs and benefits)

Policy actions depend on end goals

- FIT and PTC supports industry development
- R&D promotes new applications
- Certified emissions reductions internalize environmental externalities
“Supply Push”: Government invests resources in technology R&D, diffusion of technical knowledge, and demonstration projects

“Demand Pull”: Government creates market incentives to encourage private firms to enter the market. These can include subsidies, tax breaks, or regulations

Direct Vs Indirect Funding

Emission trading / tax
Demand Pull Policies

- **Quota-based systems**
  - Government decides on quantity of renewable energy it wants and lets market set the price
  - Creates competition & uncertainty for project developers but can result in lower prices for consumers
  - India’s National Solar Mission with reverse bidding

- **Fixed price systems**
  - Government sets price (subsidy) and lets market decide on quantity
  - This has proven to be much more effective
  - FIT in Germany / Spain
## Policy actions for renewables promotion

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<tr>
<th>Production</th>
<th>Price</th>
<th>Quantity</th>
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<td>Feed-in tariff</td>
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<td>REC</td>
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<td>Green power marketing</td>
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Dominant Mechanisms for Renewable Development

- **Feed In Tariff**
  - Strength: Revenue Certainty
  - Weakness: Doesn’t adjust to Market

- **Favorable Taxation**
  - Strength: Easy to Implement
  - Weakness: Transaction Costs

- **Renewable Energy Credits**
  - Strength: Allows markets to drive prices
  - Weakness: Rules can be easily changed

- **Carbon Financing**
  - Strength: Large Markets
  - Weakness: Often viewed as “extra”
Feed-in Tariff ("FIT")

- Guarantees the plant owner a fixed price paid for each kWh of electricity
  - Incrementally raises price of electricity
  - May have floor and cap on prices
- Policies are designed to be in effect for multiple years before renewal is necessary
- Mostly European countries opted for FITs.
  - Other countries like India, South Africa have introduced FITs recently
  - India has opted for “reverse bidding” along with FIT
- Provides revenue Certainty
- Not market based, hence doesn’t drive innovation
- FIT ends up saving consumer money by displaying fossil fuel and greenhouse gas emission.
Feed-in Tariff ("FIT")

- Eligible Technologies
  - Fluctuating & firm technologies
- Eligible Plants
  - Region specific
- Tariff Calculation Method
  - Guarantees “Fair & Sufficient” profitability
  - Germany: cost covering renumeration
  - France: profitability index method
  - South Africa: reasonable rate of return
Feed-in Tariff ("FIT")

- Technology & Size specific
  - Based on generation cost of RE power
- Duration of tariff payment
  - Related to level of tariff payment
- Financing Mechanism
  - Additional cost is distributed equally among all electricity consumers
- Purchase obligation
  - Important ingredient for successful execution
- Priority grid access
Tax Incentives

- Production Tax Credits: Income-tax credit per kWh of renewable energy
- Investment Tax Credits: Certain portion of capital cost is eligible for tax credits
- Accelerated Depreciation
- Stimulus packages provided by many governments worldwide contained these benefits
- Recent economic crisis has dried up tax equity investments
- Industries can use their capital effectively and also can benefit from sustainable energy
- Creates complex structures (partnership-flip, sale-leaseback)
Renewable Portfolio Standards

RPS Policies with Solar/DG Provisions

www.dsireusa.org / September 2011

WA: double credit for DG

OR: 20 MW solar PV x 2020; double credit for PV

NV: 1.5% solar x 2025; 2.4 - 2.45 multiplier for PV

CO: 3.0% DG x 2020; 1.5% customer-sited x 2020

MI: triple credit for solar-electric

OH: 0.5% solar-electric x 2025

IL: 1.5% PV x 2025

WV: various multipliers

MO: 0.3% solar-electric x 2021

NC: 0.2% solar x 2018

NH: 0.3% solar-electric x 2014

MA: 400 MW PV x 2020

NY: 0.4788% customer-sited x 2015

NJ: 5,316 GWh solar-electric x 2026

PA: 0.5% PV x 2021

DE: 3.5% PV x 2026; triple credit for PV

MD: 2% solar x 2022

DC: 2.5% solar x 2023

16 states + DC have an RPS with solar/DG provisions

19 – 22 September 2011, Johannesburg, SOUTH AFRICA

www.solarenergy-africa.com
Renewable Energy Certificates (REC) Mechanism

**REC Option**
- **Electricity Sell at Market Price**
- **Sell to Dis-Coms at Price ≤ Avg Price**
- **Sale of RECs at Power Exchange**

**Feed-in Tariff**
- [State Regulated Tariff]
- Sale of electricity to DISCOMs at State regulated tariff (Preferential Tariff)

**Green Attributes**
- REC (Solar & Non-Solar)

* - Weighted Average Pooled Price at which distribution licensee has purchased electricity (including cost of self generation, long-term and short term purchase) in the previous year, but excluding the cost of RE power purchase
Floor & Forbearance Price

➢ Why have a price floor?
   ✓ In young market fear that undue pressure by relatively few large buyers can force price down as well as provide for some revenue certainty for generation developers.

➢ Why have a price cap “forbearance price”?
   ✓ Since there are expected to be less resources then the overall requirement a limit on the amount that loads should have to pay was set.
Carbon Financing

- Kyoto Protocol adopted in 1997, entered into force in 2005
- Sets binding targets for 39 industrialised countries and the EU for reducing greenhouse gas emissions: 5.2% reduction against 1990 levels over 2008-2012 period
- Countries must meet targets through national measures or via three market-based mechanisms:
  - Emissions Trading: AAUs
  - Clean Development Mechanism: CERs
  - Joint Implementation: ERUs
- One allowance: 1 tonne of CO2
- No clarity on pricing due policy uncertainties

Source: Inter-continental Exchange
Emissions Volume and Prices

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Total Annual Volume (All Emissions Contracts)  EUA Front-Dec Settlement Price  CER Front-Dec Settlement Price
Financing solar energy currently faces challenge due high capital costs and lack of operational experience.

Government incentives exist to bring down some costs and to support innovation.

Despite all government incentive, proper due diligence and project specific structuring is required to get maximum value out of projects.