The business case of PV-hybrid Mini-grids: actors, contracts, drivers for profitability

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The German Solar Industry Association

**TASK**  To represent the German solar industry in the solar thermal and photovoltaic sector

**VISION**  A global sustainable energy supply provided by solar (renewable) energy

**ACTIVITIES**  Lobbying, political advice, public relations, market observation, standardization

**EXPERIENCE**  Active in the solar energy sector for over 30 years

**MEMBERS**  More than 850 solar producers, suppliers, wholesalers, installers and other companies active in the solar business

**HEADQUARTERS**  Berlin

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New business models for PV: Investor guideline for international markets

BSW-Solar in cooperation with Intersolar Europe

- Overview of business models in international PV markets
- Information on market potentials, project structures, cash flow models, stakeholders,
- Practical guideline to develop markets with Power Purchase Agreements, net-metering, self-consumption, mini-grids, etc.
- Description of barriers and success factors for the different business models
- Or at BSW-Solar booth in hall B1.580 at special Intersolar Europe discount!
PV- hybrid Mini-grid

Technical Characteristics

• distributed grid-integrated or off-grid energy system consisting
• distributed generation with PV and other sources
• multiple energy loads of different customers
• may include energy storage technology
• usually based on a monitoring and control system which manages generation, distribution, consumption and storage
• if grid connected, a parallel or “islanded” mode of operation is usually selectable
The case of PV-hybrid Mini-grid

Brownfield: Hybridisation of existing Mini-grids

Microgrid Capacity by Market Segment, World Markets: Q4 2012 (Source: Pike Research)

- Remote Systems: 691 MW (22%)
- Commercial/Industrial: 327 MW (10%)
- Community/Utility: 669 MW (21%)
- Military: 578 MW (18%)
- Institutional/Campus: 915 MW (29%)

Electricity Cost ($/kWh)

Today

Time
The case of PV-hybrid Mini-grid

Greenfield: New PV Hybrid Mini-grids

Source: Electricity Access Database (IEA)
The case of PV-hybrid Mini-grid

Customer segmentation by different value propositions

Source: Lilienthal HOMER Energy
The case of PV-hybrid Mini-grid
Private sector investment

Delivery models for PV-hybrid Mini-grids in remote areas in developing countries – selection

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Public</td>
<td>BOO by public entity (government / state utility / agency)</td>
</tr>
<tr>
<td>Community based / cooperative model</td>
<td>BOO by community / cooperative / municipal utility</td>
</tr>
<tr>
<td>PPP Model 1</td>
<td>Public entity builds and owns, Private sector: operation under concession or management fee</td>
</tr>
<tr>
<td>PPP Model 2</td>
<td>Private sector builds and owns generation asset and sells power (eg. PPA) Public entity operates distribution element</td>
</tr>
<tr>
<td>Fully Private</td>
<td>BOO of generation and distribution asset of mini-grid by private sector under concession. Sells power</td>
</tr>
</tbody>
</table>
PV-hybrid Mini-grid
Possible business models for private sector

**Construction**
- EPC

**Generation**
- Technology Performance, Generation asset maintenance
  - Integrated (Micro-utility) ESCO
  - Generator + Daily Plant Operations and Management

**Distribution**
- Demand Engagement and Revenue Collection
  - Micro-utility (Distributor)

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Typical Capacity</th>
<th>Expected Equity IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated (micro-utility) ESCO</td>
<td>Generation, Transmission, Distribution Sites are owned and managed by the ESCO</td>
<td>15 ~ 40 KW</td>
<td>Low to medium</td>
</tr>
<tr>
<td>Asset Light ESCO</td>
<td>Variant: the asset is not owned by the operating ESCO itself but a third party owner (TPO). ESCO operates the asset and pays a monthly fee.</td>
<td>15 ~ 40 KW</td>
<td>high</td>
</tr>
<tr>
<td>GENCO</td>
<td>Focussed on primarily generation</td>
<td>15 ~ 50 KW; or fewer plants of 100~ 200 KW</td>
<td>medium</td>
</tr>
<tr>
<td>Micro-Utility Distributor</td>
<td>Invests in the mini-grid (distribution systems) and focuses on shaping demand in the area of operation</td>
<td>Variable</td>
<td>Not viable without subsidies</td>
</tr>
</tbody>
</table>

Source: cKinetics
PV-hybrid Mini-grid
Private sector investment

Framework conditions

Requirements to be met for private sector investments in fully integrated ESCO (generation and transmission)

1. It must be legal to operate an micro-utility ESCOs; micro-utility ESCOS should be able to obtained licenses easily.

2. Micro-utility ESCOs must be allowed to charge tariffs resulting in risk equivalent margins.

PV-hybrid Mini-grid
Business environment

PV-Hybrid Mini-grid Stakeholders

- EPC
- Load & Supply Mgmt
- Operator
- Generation assets
- PV other Storage

Stakeholders:
- Bank
- Equity Investors
- Target Returns
- Micro-Finance Institution
- Power Consumer(s)
- Power

Cashflow
Powerflow
Contracts

Service Contract
Service Fee Opex

PPA contract
Power Supply
Power Price

Subsidies

Optional

Regulatory Authority

Electrification Authority

Donor Organisation

Optional

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PV-hybrid Micro Utility Customers

ABC Model

The A(nchor) – B(usiness) – C(ommunity) Model

Anchor + Business + Community
- Households have access to affordable energy

Anchor + Business
- Local businesses use power to increase operating hours

Anchor
- Large, reliable credit-worthy customer

Households: low electricity demand, mostly for lighting, mobile-phone charging and household appliances

Businesses: higher electricity demand for productive use

Anchor customer: financially sound, guarantees electricity purchase, secures commercial operation

Potential anchor customers
- Telecommunication towers
- Mining companies
- Agro-processing industry
- Tourism industry
- ...

Source: GIZ
PV-hybrid Mini-grid
Project development steps

Framework conditions

Identification  Planning  Financing / Procurement  Implementation Construction  Operation

Technical Planning

• Loads and generation capacity: Daily and over lifetime

• PV and other RE & dispatchable resources stability of the system

• Control System

Matching Supply and Demand

Project take-off
PV-hybrid Mini-grid
Project development steps

Framework conditions

Identification ➔ Planning ➔ Financing / Procurement ➔ Implementation / Construction ➔ Operation

- Pricing and tariffs
- Costs
- Operation / Management Model
- Revenue Streams
- Involvement of local community
- Ownership & Governance
- Growth Strategy
PV-hybrid Mini-grid Project development steps

Framework conditions

Identification → Planning → Financing / Procurement → Implementation Construction → Operation

First sight factors of profitability

Costs → Pricing and tariffs → Operation / Management Model → Revenue Streams → Involvement of local community → Ownership & Governance → Growth Strategy
Operation- Management Modell

Costs (Magnitude and Structure)

Costs can be difficult to predict

**Types of Costs**

- Transaction Costs
- Management Costs
- Operation and Maintenance Costs
- Replacement Costs
- System Extension Costs
- CRM costs (training)
- Tariff collection costs
- Monitoring costs
- Fraud / Theft
- Investment and Financing Costs

**Cost reduction methods**

- Efficient appliances and lights
- Incentives for electricity usage during times of abundant renewable energy generation (tariff / DSM)
- Load management system / Commercial load scheduling
- Integration of quality management and lean enterprise approaches into the electricity metering and billing approach
- Reduction of travel and HR-costs by hiring and training local personnel
- Restrict residential use
PV-hybrid Mini-grid
Revenues (kWh sold)

Stabilization methods

• Foster productive and diversified use of electricity, e.g. by cooperating with Micro-Finance Institution
• Incentivize and motivate customers to plan their consumption ahead
• Appropriate metering concepts, balancing flexibility and
Operation- Management Modell
Tariffs and Pricing Models

Tariff model as the binding element
• make Mini-grid financially viable and sustainable
• willingness and ability of customers to pay
• accepted by regulatory authority
• support economic development and improve living standard in the villages
• enable understanding of mini-grid operation and demand side management

Stepped **pricing model** that differs by levels of availability factors

<table>
<thead>
<tr>
<th>Client</th>
<th>Price</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key / Platinum</td>
<td>Premium</td>
<td>Highest</td>
</tr>
<tr>
<td>Gold</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Silver</td>
<td>Lowest</td>
<td>Regular</td>
</tr>
</tbody>
</table>
Financing along the micro-utility development timeline

<table>
<thead>
<tr>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of model</td>
<td>Select village</td>
<td>Political framework</td>
<td>Company foundation and financing</td>
<td>Model implementation and financing</td>
</tr>
</tbody>
</table>

- **Cashflow**
  - Business plan and development subsidy
  - PPP money or subsidies for pilot phase
  - PPP money or subsidies for scale-up

- **Breakeven point**
  - Equity from impact investors, loans from development banks, etc.

Source: IRENA adapted from INENSUS,
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Thank you for your attention…

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