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About juwi

Company structure
- Founded in 1996
- juwi AG
- 63% MVV Energie AG
  37% Frema GmbH & Co. KG

Employees
~ 1,000 employees (worldwide)

Revenues
~ 700 Million Euro in 2016

Total capacity
> 4,000 megawatt (approx. 2,750 systems)

Annual energy output
- around 6 billion kilowatt-hours
- Supplies power for ~ 1.7 million households

Investment volume (since 1996)
more than 8 billion Euro
India team has executed 180 MWp since 2011 and another 300 MWp in pipeline

51 MWp, village Charanka, solar park, Gujarat, India

- Project implemented under: Bilateral PPA (under RPO)
- Type of PV modules: Poly-crystalline (300/305 Wp)
- Inverters: SMA, CP-900 XT
- Evacuation voltage: 11 kV (66 kV switchyard in developer’s scope)
India Roof top Target 40 GW

Current capacity; 210 MW in Industrial application, 143 MW commercial applications, 2016 data
Space availability

Figure 2.2: Rooftop solar potential by space availability in 2015 and 2022

Potential in 2015: 102 GW
- Industrial: 64 GW
- Commercial: 8 GW
- Residential: 30 GW

Potential in 2022: 128 GW
- Industrial: 71 GW
- Commercial: 12 GW
- Residential: 45 GW
State wise grid parity for commercial consumers

Figure 2.3: Grid parity status for commercial consumers in India (October 2015)
State wise grid parity for Industrial consumers

Figure 2.4: Grid parity status for industrial consumers in India
IRR for the roof top systems

Figure 4.4: Projected rates of return for new net metered systems

Rates of Return
Projected IRRs for typical new net metered rooftop solar systems compared to grid tariff by year in Andhra Pradesh

- Commercial
- Industrial
- Residential
- 15% IRR
PV hybrid project Australia
Hybrid Systems Industrial application with scale-able approach
Hybrid Systems: Comparison of Solar Penetration

Low Penetration Applications:
- Solar Penetration: 60%
- Solar Fraction: <25%
- Fuel Savings: <25%
- CAPEX: low
- Grid support: low
  - Generator leading system
  - Simple control mechanism
  - No BESS necessary
  - Brownfield

High Penetration Applications:
- Solar Penetration: Up to 200%
- Solar Fraction: Up to 100%
- Fuel Savings: >50%
- CAPEX: high
- Grid support: high
  - Battery or generator leading system
  - Complex control mechanism
  - BESS necessary
  - Diesel off-mode possible

© Power ratio $P_{PV}/P_{Gen}$
Why Hybrid Power is successful?

Benefits
- Cost: PV cheaper than diesel generation
- Diesel exposure: reduce impact of diesel price rises
- Carbon emissions: significant reduction
- Public image: enhanced profile
- Technology: simplifying solar/diesel integration

Renewable Energy Trend
- PV and Battery prices decreased > 50% in the last years
- PV and Battery prices keep decreasing

Fossil Fuel Trend
- Diesel & Gas: increasing with higher volatility
Australia

Degrussa Mine:
- **Mining:** Gold and copper
- **Location:** Doolgunna Region, North-Western Australia
- **Customer:** Sandfire Resources NL
- **Distance:** ~1000 km to Perth

Power Supply:
- **Diesel Power Station:** ~ 20MW
- **Operator:** 3rd party power station owner
- **Average load:** ~ 11MW
- **Average consumption:** ~ 100GWh p.a.
System Design

Hybrid Power Plant:
- PV-Modules: 10,565 MWp
- Tracking: East-West tracking
- PV-Inverter: 10 MW
- Storage: 4 MW / 1,8 MWh (6 MW peak)
- Operator: juwi Australia

Storage tasks:
- Provide spinning reserve to switch of gen-sets
- Control ramp rate → PV smoothing
- Additional spinning reserve at night
- Provide frequency support and power factor >0.8
- Grid forming if diesel-off mode (during low load days)
Summary and Outlook

Hybrid Power Plant

- Worldwide biggest combination of an off-grid, high capacity PV system integrated with a diesel power station
- 10.6 MWp PV + 6 MW Storage
- Reducing running Diesel capacity to minimum
- Diesel-off mode during low-load days
- Timeline: project start in mid 2015, commissioning in early 2016

Benefits:

- Reduced operation costs (~25% diesel savings)
- Increased lifetime of the mine
PV DG Hybrid project
1. Solar Fuel Saver (SFS) system
‘Perfect customer’ for SFS

- Diesel generator is the main source of power
- Scheduled power outage during day time
## Solar fuel saver: Payback calculation

<table>
<thead>
<tr>
<th>Solar PV capacity</th>
<th>100kWp for a load of 150kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure diesel system fuel consumption</td>
<td>189 kL</td>
</tr>
<tr>
<td>Solar-DG hybrid system, fuel consumption</td>
<td>150 kL</td>
</tr>
<tr>
<td>Fuel saved</td>
<td>39 kL</td>
</tr>
<tr>
<td>Yearly savings on electricity purchases (based on 5 hr Diesel generation operation/day)</td>
<td>INR 1.6 million</td>
</tr>
<tr>
<td>Cost of Solar fuel saver system</td>
<td>INR 5 million</td>
</tr>
<tr>
<td>Payback period</td>
<td>2.5 years</td>
</tr>
</tbody>
</table>
LV DC applications
Current usage AC in IT buildings
Changing to LVDC reduces it by 15%

LV DC in Buildings
DC Distribution

- 415V AC
- 380-400V DC
- 12V DC

Efficiency calculation in DC Distribution
1. PV generator
2. Switchboards on DC side
3. Load regulator

97% x 99% x 95% x 85% = 77%
Diesel consumption India

- 8% used for Power Generation contributing 2% of GDP
- 40000 MW of Diesel equipment's installed
- Cost Rising every year which is heavily subsidized by Government
LVDC Benefits

THE ENERNET: DC power instead of AC Power

• LV DC IN Buildings (ICT application): Can reduce consumption by 15%
• DC Micro Grids for Rural Villages; 300,000 Villages need!
• DC in Homes: High use during day and night (4 hrs in the morning and 4 hrs in the night)
• Industrial Establishments consumes 38% of Total Energy of 1200 Billion units generated.
• Since the generations are centralized, Transmission loss are 10-20% and AC to DC conversion losses are 10-15% which can be reduced.
• We Reduce Energy Loss by 10%, we will relieve the grid of 30,000 Mw, a saving of 200,000 Crs.
ESCO Model

Before Program Term
- Operating Budget
  - Operating Funds
  - Utility Budget
    - Lights
    - Air Conditioning
    - Heating

During Program Term
- Operating Budget
  - Operating Funds
  - Savings
  - Utility Budget
    - Lights
    - Air Conditioning
    - Heating
  - Investment
    - Modernization
    - Energy Retrofits

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Recommendations

• To make rooftop solar installations Exciting for residential societies,
• Reduce use of generator sets, as they are expensive and not pollution proof.
• Urging DISCOMS to support rooftop installation.
• Create a regulation on ownership for investors
• Support towards usage of mini-grid, and off-grid solar installations for houses and communities.
• Work on LV DC and Micro Grids
Thank You

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