Peak Time Demand Management Using Distributed Solar Inverters

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Presentation Outline

- About Enzen
- Present Scenario – Indian Context
- Conservation Voltage Reduction
- Proposed Concept Implementation
- Simulation Results
- Conclusion
**Enzen**

Exclusively focussed on **Energy & Utility** sector

Industry specific **Expertise & Frameworks**

Knowledge & Innovation led

**Outcome based** models delivering customer **value**

**Smart Grid** technology integrators delivering **Operational Excellence**

<table>
<thead>
<tr>
<th>Revenue Growth</th>
<th>Employees</th>
<th>Industry orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound annual growth rate (CAGR) of 75% since inception</td>
<td>Globally: 3,000+</td>
<td>Focus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renewables</td>
</tr>
</tbody>
</table>

**Locations**

Globally: 20+

**Customers**

Globally: 155+

**Business Units**

1. Business Transformation
2. Business Operations
3. Energy and Water
4. Digital Enterprise
Present Scenario – Indian Context

Emerging Trends

- Indian economy growing at ~6-8%
- Target 175GW of renewables by 2022
- Significant electric vehicle load by 2030
- Emphasis on Demand Side Management
Some Implications

• Technical
  – Voltage balancing becomes a challenge
  – Reverse power flows from high volume of unplanned energy sources at distribution level
  – Changing Load Profiles – EV charging and increased demand
  – RE needs to take up responsibility to support grid operations and efficiency measures

• Regulatory
Conservation Voltage Reduction (CVR)

• What is CVR?
  – Voltage reduction (within +/- 5%) at the distribution level to reduce power consumption during peak times
  – For many devices, Power $\propto \text{Voltage}^2$ ....

• How is it presently done?
  – By tap change of substation transformer
  – Capacitor bank switching
  – Line regulators
Some Issues with This Method of Control

- Finer control.. Can only create a step change

- Response speed...typically takes tens of seconds

- Extent of control....Reduction only possible until the voltage in the lowest point of circuit is within limits
Proposed Concept – Dynamic Voltage Reduction Through Solar Inverter

Dynamic and Finer control of Voltage; Quick response

Another advantage

Without Solar Support

With Solar Support

Increased energy savings with reduced voltage profile
Implementation Architecture

During peak times, grid SCADA sends Q setpoints to solar and EV charging stations to reduce voltage.

After the event, the Q points are reset.

Finer, Quicker, Scalable Way of Voltage Control. Increased savings when augmented with traditional methods.
Simulation Analysis

Before CVR

After CVR

3MW of reduction in power by 0.01 pu reduction in voltage.
Multi-Bus System

- Bus 4 has EV charging stations, and aggregated rooftop of 80MWp
- Bus 7 has an aggregated solar and wind farm of 180MW
Simulation Results

### Table 2. Parameters – No CVR

<table>
<thead>
<tr>
<th>Bus</th>
<th>Load (MW, MVAR)</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>169, 19</td>
<td>1.02</td>
</tr>
<tr>
<td>5</td>
<td>138, 46</td>
<td>0.99</td>
</tr>
<tr>
<td>4</td>
<td>96, 10</td>
<td>1.01</td>
</tr>
</tbody>
</table>

### Table 2a. Parameters – With CVR

<table>
<thead>
<tr>
<th>Bus</th>
<th>Load (MW, MVAR)</th>
<th>Voltage</th>
<th>Q absorbed by Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>162, 18</td>
<td>0.96</td>
<td>-25 MVAR</td>
</tr>
<tr>
<td>5</td>
<td>134, 45</td>
<td>0.95</td>
<td>-25 MVAR</td>
</tr>
<tr>
<td>4</td>
<td>91, 9</td>
<td>0.96</td>
<td>-25 MVAR</td>
</tr>
</tbody>
</table>

Power saving obtained = 16 MW

### Table 3b. Parameters – With CVR

<table>
<thead>
<tr>
<th>Bus</th>
<th>Load (MW, MVAR)</th>
<th>Voltage</th>
<th>Q absorbed by Solar</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>159, 18</td>
<td>0.95</td>
<td>-28.3 MVAR</td>
</tr>
<tr>
<td>5</td>
<td>134, 45</td>
<td>0.95</td>
<td>-25 MVAR</td>
</tr>
<tr>
<td>4</td>
<td>89, 9</td>
<td>0.95</td>
<td>-25 MVAR</td>
</tr>
</tbody>
</table>

Power saving obtained = 20 MW

Optimization for maximum possible savings
Mapping of Some MW Solar Installations in Karnataka
Conclusion

✓ Solar Inverters have the capability to dynamically absorb/generate reactive power

✓ This concept can be used as a means of implementing Conservation Voltage Reduction (CVR)

✓ Advantages of this approach include: Granularity of control, flexibility, response speed, and increased reliability

✓ This way of control can be augmented with traditional method to increase the effectiveness
Thank You