Demand Response - A Viable Alternative to Manage VRE

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1st International conference on Large Scale Grid Integration of Renewable Energy in India

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A Growing, Global Company, Since 1969

Global professional, technology + marketing services firm

Headquartered in Washington, DC, with:

- 55 Offices
- $1B in annual revenue

More than

- 5,000 People
- 80 Nationalities
- Speaking more than 70 Languages
What is demand response?

According to the United States of America’s Federal Energy Regulatory Commission, demand response (DR) is defined as:

“Changes in electric usage by demand side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.”

Contents

- Context of Demand response is changing…
- In addition to its traditional usage, DR is now being used for managing RE
- International experiences and state of DR
- India too has started experimenting…. ICF Pilot projects supported by Shakti Sustainable Energy Foundation
  - Jaipur DISCOM
  - BYPL
- Lessons learnt
Demand Response – Benefits to consumers and Utility

What’s in it for the DISCOM

1. Power Balancing: Can be used for peak demand management without getting into DSM penalty
2. Demand up response can help in integration of renewable energy: to avoid renewable curtailment
3. Can help in managing emergencies/contingencies like generation back-down or grid failure
4. Can be a source of reliable virtual generation in need at pre-determined prices, unlike exchanges or spot markets where prices vary significantly

What’s in it for the Consumer

1. Helps DISCOM provide un-interrupted supplies by managing peak demand - avoid blackouts
2. Helps consumers in installing more and more renewable energy (rooftop solar) and success of net-metering
3. Helps consumers understand their load pattern and manage it better: Supports load shifting under ToD tariffs
4. Helps avoid capacity addition in transmission and distribution infrastructure thereby keeping overall costs and tariffs down
What is demand response and how it can help

**DR Aggregator**

- On Line Monitoring of Demand Reduction thru data coming from GPRS enabled meter at DR Software.
- Confirmation of MWs reduction to Utility.
- DR Event-Trigger to act after X hrs of Intimation for Demand Response

**Utility**

- Analyze demand and supply; forecast the need for DR event

**DR Participants**

- Event Call-off from Utility to aggregator and hence to Participants
- DR Trigger from Utility to Aggregator to act after 4 hrs.

**DR Event**

- Hour 1
- Hour 2
- Hour 3
- Hour 4
- Hour 5
- Hour 6
- Hour 7
- Hour 8

**DR Event Trigger** from Utility to Aggregator to act after 4 hrs.

Load Shift from Participants/Industries

Information of DR thru e-mail and telephone to perform.
Demand response: a snapshot

The request to reduce demand is made for a specific time period on a specific day which is referred to as a demand response event or simply an event. Each event has three key measurement components:

**Baseline** – The amount of energy the customer would have consumed in absence of a request to reduce.

**Actual Use** – The amount of energy the customer actually consumed during the event.

**Load Reduction** - The mathematical difference between the baseline and the actual use.
International experiences
Demand Response- International Perspective

- DR took off in 2005. Since then DR has entered capacity markets in the USA in a big way.
- Present size of the DR program in USA is about 29 GW out of total size of all sorts of control programs is 66 GW.
- As per the estimates of the FERC, the average estimate of 8%-11% peak clipping is achievable through DR programs.

**US**

- The average estimate of 6%-13% peak clipping was achievable through DR program in Europe. These are really huge figures when considered at the system wide levels
- As of 2014, over 3.5 billion Euros were earned by the local economy annually through DR within 7 years after market opening.
Demand Response- International Perspective

- Various pilot have been implemented using smart grid technology to implement demand response programs in residential sector.

- Smart community pilot projects implemented in Japan (Kitakyushu, Yokohama and Kiehana Science City), demonstrates, how distributed generation can be used as demand response tool for grid management.

- Similar pilot projects have been implemented in Australia, Sweden, Indonesia and India, among others.
Demand Response pilots implemented in India
Demand Response Pilots in India

Pilot projects implemented in India:

- **TATA Power Company Limited, Mumbai Distribution:**
  - Auto DR with Smart meter
  - Scale: 21 Events conducted.
  - Malls, Hospitals, IT parks, Municipal sewage treatment plants, Airports participation.

- **Jaipur Vidyut Vitran Nigam Limited (JVVNL):**
  - Manual DR funded by Shakti Foundation
  - Scale: 17 consumers overall participation. 4 Events conducted.
  - Manufacturing/Processing Industries participated

- **TATA Power Delhi Distribution Limited:**
  - Auto DR with Smart meter funded by USTDA.
  - Scale: 162 consumers overall participation. 17 Events conducted.
  - Plans to Scale up to 40 MW in the Future

- **BSES Yamuna Private Limited (BYPL):**
  - Manual DR funded by Shakti Foundation
  - Scale: 25 consumers overall participation. 8 Events conducted.
  - Malls, Hospitals, Offices, Hotels, Manufacturing Plant participation

Conducted by ICF, supported by - Shakti Sustainable Energy Foundation
Overview of the planned approach for both Jaipur and Delhi

Planning
- Customer Selection and enrollment
- Metering and data collection Infrastructure
- Baseline calculation
- Settlement Mechanism
- Communication protocol between stakeholders
- Training to stakeholders

Pre-DR event
- Forecasting the need for DR event
- Scheduling of DR participants
- Reliability testing
- Communication protocol between stakeholders

During DR Event
- Event Monitoring
- Managing communication between stakeholders
- Resolving any operational issues

Post DR Event
- Settlement calculation
- Billing and settlement
- Conflict resolve
- Auditing and monitoring
- Verification and reporting
Demand Response pilots implemented in India

Rajasthan
Pilot Project Results of Jaipur: Trial event

Date: 13\textsuperscript{th} March 2014

Time: 7:00 pm to 8:00 pm

ICF analyzed the state’s load data and especially the patterns in \textit{wind generation} and formulated a strategy on how to identify the next events.
Pilot Project Results of Jaipur: Event 1

Date: 29th April 2014

Time: 7:15 pm to 8:15 pm

- RDPPC identified the event
- Overdrawing power of national grid
- The grid frequency also fell below 49.8 Hz for two blocks
- It caused higher rates of penalty due to additional charges
- Frequency Range - 49.76-49.93
Pilot Project Results of Jaipur: Event 2

Date: 21\textsuperscript{st} May 2014

Time: 5:00 pm to 6:00 pm

- RDPPC identified the event
- Overdrawing of power from the national grid
- The grid frequency was above the 50.05 mark for 3 out of the 4 time blocks
- The charge for overdrawl was nil in these blocs.
- Frequency Range: 50.02-50.13

![Graph showing power consumption and grid frequency during Event 2]
Pilot Project Results of Jaipur: Event 3

Date: 23rd May 2014
Time: 10:00 pm to 11:00 pm

- RDPPC identified the event.
- The Discom was in under drawl for 3 blocks out of 4 and in over drawl in 1 block.
- It happened due to unforeseen weather conditions.
- Frequency range 49.75 – 49.92.
### Pilot Program: Summary

<table>
<thead>
<tr>
<th>Event no.</th>
<th>Date</th>
<th>Time (hrs)</th>
<th>No. of participants</th>
<th>MW of DR proposed</th>
<th>MW of DR provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13-03-2014</td>
<td>1900-2000</td>
<td>10</td>
<td>26.00</td>
<td>21.99</td>
</tr>
<tr>
<td>3</td>
<td>21-05-2014</td>
<td>1700-1800</td>
<td>10</td>
<td>28.40</td>
<td>22.07</td>
</tr>
<tr>
<td>4</td>
<td>23-05-2014</td>
<td>2200-2300</td>
<td>10</td>
<td>29.00</td>
<td>21.70</td>
</tr>
</tbody>
</table>
Demand Response pilots implemented in India

Delhi
Rationale for implementing DR program in Delhi

Key observations:

- Over drawl in Apr to Oct 2016 was in the range of 0-150 MW
- High deviation charges paid in 7 months (Apr-Oct, 16)
Results of DR pilot in Delhi

BYPL conducted 8 DR events as pilot events in month of May-June (being peak summers period)

Parameters for choosing DR events were:
- Expected frequency prior to DR events was not above 50 Hz
- Over-drawal was expected during the event due to high temperature forecasts
- To test consumers ability to reduce the demand at different hours

<table>
<thead>
<tr>
<th>Event no.</th>
<th>Date</th>
<th>Time (hrs)</th>
<th>No. of participants</th>
<th>MW of DR expected as per survey</th>
<th>MW of DR provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24-04-2017</td>
<td>1530-1630</td>
<td>14</td>
<td>3.8</td>
<td>2.36</td>
</tr>
<tr>
<td>2</td>
<td>05-05-2017</td>
<td>1530-1630</td>
<td>11</td>
<td>3.8</td>
<td>1.14</td>
</tr>
<tr>
<td>3</td>
<td>15-05-2017</td>
<td>2200-2300</td>
<td>13</td>
<td>1.24</td>
<td>2.15</td>
</tr>
<tr>
<td>4</td>
<td>19-05-2017</td>
<td>1900-2000</td>
<td>15</td>
<td>1.48</td>
<td>3.33</td>
</tr>
<tr>
<td>5</td>
<td>24-05-2017</td>
<td>1530-1630</td>
<td>15</td>
<td>3.8</td>
<td>3.45</td>
</tr>
<tr>
<td>6</td>
<td>26-05-2017</td>
<td>2200-2300</td>
<td>13</td>
<td>1.24</td>
<td>2.15</td>
</tr>
<tr>
<td>7</td>
<td>05-06-2017</td>
<td>1530-1630</td>
<td>12</td>
<td>3.8</td>
<td>1.89</td>
</tr>
<tr>
<td>8</td>
<td>06-06-2017</td>
<td>1530-1630</td>
<td>9</td>
<td>3.8</td>
<td>0.89</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>23 MW</strong></td>
<td><strong>17.4 MW</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Participation of consumers across DR Events

Industry-wise break up of total DR Attained (KW)

- Railway: 294
- Mall: 1868
- Manufacturing: 5178
- Hotel: 4503
- Office: 2060
- Hospital: 1835
- Mall: 1868
- Hotel: 4503
- Office: 2060
- Hospital: 1835

Response of Consumers across 8 DR Events (KW)

<table>
<thead>
<tr>
<th>DR 1</th>
<th>DR 2</th>
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<th>DR 4</th>
<th>DR 5</th>
<th>DR 6</th>
<th>DR 7</th>
<th>DR 8</th>
</tr>
</thead>
</table>
## Industry-wise participation of consumers in DR

### Industry-wise scale and number of participation of consumers across 8 Pilot DR Events

<table>
<thead>
<tr>
<th>Date</th>
<th>DR 1</th>
<th>DR 2</th>
<th>DR 3</th>
<th>DR 4</th>
<th>DR 5</th>
<th>DR 6</th>
<th>DR 7</th>
<th>DR 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR provided (MW)</td>
<td>2.36</td>
<td>1.14</td>
<td>2.15</td>
<td>3.33</td>
<td>3.45</td>
<td>2.15</td>
<td>1.89</td>
<td>0.89</td>
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Some media reports on BYPL DR programme

BSE plans to scale up incentive scheme for power savers

BSES Yamuna and BSES Rajdhani Power are planning to offer financial incentives to large power consumers in Delhi who cut down electricity consumption when requested.

BSES consumers save 17 MW power via Demand Response

Large consumers of BSES, one of Delhi’s two electricity distribution companies (discoms), saved 17,000 KW of power over a recent six-week period through a demand side management (DSM) project, the discom said on Thursday.

Bijli ki khalat 17,000 kilowatts kam ki upbhootakao ne

Bijli khalat samarpit karan koi upbhootakao ne

Peeak awars men upbhootakao ne koi bijli khalat men 17 hajjar

Kilowatts ko karmi

Beeesayee hasar samarpit ke liye eek maunul dimand reshaam proujekat shru kaida tha, jiskar tahat upbhootakao ne peeak awars ke duraan apna bijli khalat men 17 hajjar kilowatts ko karmi thi...
Lessons learnt
### Lessons learnt

<table>
<thead>
<tr>
<th><strong>Consumers picked up DR concept very quickly</strong></th>
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<tbody>
<tr>
<td>- Consumers eager to participate in the pilots and indicated willingness for long term programmes.</td>
</tr>
</tbody>
</table>

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<tr>
<th><strong>DISCOMs realized the usefulness of DR as a tool</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- To manage its demand – supply position.</td>
</tr>
<tr>
<td>- To manage vRE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Wider participation of different consumer categories enables better DR</strong></th>
</tr>
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<tr>
<td>- Due to different working cycles and conditions, impact can be larger</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th><strong>Better understanding of the consumer load pattern</strong></th>
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<td>- With more awareness on type of load shifted/curtailed by consumers, utility can get better understanding of timings for demand shifting/curtailment.</td>
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</table>

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<tr>
<th><strong>DR can to be developed as market based instrument</strong></th>
</tr>
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<td>- Which can be used for managing VRE along with other options like energy storage, balancing plants like gas based plants and hydro resources.</td>
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