Renewable Energy and Combined Heat & Power - Opportunities and Challenges

Doug Smith,
Manager of Distributed Resources
Agenda

- National Grid & Distributed Resources Department
- Renewable Energy Systems
- Combined Heat and Power Cogeneration Systems
- Interconnection Procedures and Issues
- National Grid’s Renewable Energy Initiatives
Distributed Resources Department

- Manage Demand Response (DR) Programs and activities
- Help develop customer side resources (demand response, distributed generation, energy efficiency) to participate in wholesale energy and capacity markets
- Distributed Generation (DG) Collaborative process with states / other utilities / stakeholders to establish policy for interconnections
- Work with regulatory department and external parties to properly implement legislation on DG and net metering
- Smart Grid and Direct Load Control pilots
- Coordinate design/RFP process for National Grid owned Renewable Energy Installations
- Integrate Load Automation into our Energy Efficiency Programs
What is Distributed Generation?

- Distributed Generation (DG) is the production of electric power on-site at a customer facility or directly onto the electric distribution system.
- DG includes:
  - CHP (Cogeneration Plants)
  - Natural Gas-Engine Drive applications (Air Compressors, Blowers, Refrigeration)
  - Renewables: Wind, Solar, Biomass
- As more DG is added to distribution systems originally designed for power flow in only one direction, design changes are needed to ensure reliability and protection.
Transmission and Distribution System

An interconnected network of substations, wires and transformers that deliver electric service to customers in their homes and business.
Distribution System Protection - Why Does the Power Go Out?

- Motor vehicle accidents
- Animal contacts
- Tree contacts
- Equipment failure
- Weather related outages
  - Wind and rain storms
  - Snow and ice storms
- Distribution System Must be Protected From Distributed Generation and Vice-Versa
Renewable Energy - Solar

Two common types of solar energy:

- Solar Thermal
  - Use energy from sun to heat water or other medium
  - Relatively inexpensive – quicker payback

- Solar Photovoltaic (PV)
  - Sunlight is used to produce direct current (DC) power which is converted to alternating current (AC)
  - More expensive technology – need incentives to get a fast payback
  - Some new technologies are coming, like thin film and collector systems
  - Rapidly increasing number of installations
PV - What is it? How does it work?

Array (collectors) — Inverter

Behind the meter for net metering

Source: NYSERDA
PV – how much will it cost?

- About $7 - $10 per watt for easier installations
- Federal tax benefit up to 30% of expenditures
- NYS Income Tax Credit 25% up to $5,000
- Accelerated Depreciation, NYSERDA grants, etc.
- New Federal Stimulus Money?

For C-Corp installing 100 KW system valued at $900,000

- Out of pocket, $217,750, 24%
- Grant, $331,250, 37%
- Fed Tax, $270,000, 30%
- State Tax, $81,000, 9%
Solar Photovoltaic – Benefits

- **Value Streams**
  - Energy produced
    - Full retail value of kWH for all energy produced if net metering allowed
    - Can sell renewable energy certificates (RECs)
  - Capacity Market Revenues (larger systems)
  - Positive Public Relations Value
  - Hedge future energy prices

- **For 100 KW example**
  - Value of energy and RECs $0.13 + $0.03 = $0.16
  - PV produces 1,200 kWh/KW-year – energy production about 120,000 kWh/year valued at $19,200
  - Payback about 11 years.
Wind Turbines - sample

- **School to install a 600 KW wind turbine**
- Cost of $1,500,000
- Grant of $400,000 from State
- Production of 1,000,000 kWh / yr at $0.15 per kWh – roughly a 7 year payback.

- **Return on Investment**
- Highly dependent on wind conditions at site
Renewable Project Finances

- Federal Tax Credits can offset up to 30% of project cost
- State Tax Credit
- NYSERDA Incentives
- Net Metering Vs. Wholesale Market Revenues for exported energy
  - Net Metering is preferable if the project qualifies for it (up to facility peak load or 2 MW, whichever is lower)
- Renewable Energy Credits (REC’s)
- Federal Stimulus Package?
660 KW Vestas Wind Turbine at School
Small photovoltaic or wind turbine system
Other Renewable Energy Sources

- **Landfill Gas (Methane)**
  - Often flared off, better to capture energy with an engine-generator

- **Biomass**
- **Hydro**
- **Bio-Diesel**
- **Farm Waste**
- **Digester**
Barriers to Implementation – Sustainable

- **Technical**
  - Site adequacy for resource (e.g. wind, solar)
  - Interconnection onto transmission/distribution

- **Financial**
  - High first cost of equipment
  - Tax incentives often limited to C Corps, etc.
  - Uncertainty of future cash flow
  - Societal focus on first cost, NPV, and payback

- **Other**
  - Permitting for towers or generators
  - Lack of expertise for feasibility studies or installation
  - License rights for use of land, space, right of way

- **These Barriers are becoming smaller!**
8 MW PV plant on brown field site
Questions on Renewable Examples
Combined Heat and Power (CHP)

- Good solution for a facility with process heat or large domestic hot water requirements
  - Public Housing
  - Universities
  - Hospitals/Nursing homes
  - Athletic clubs
  - Micro-CHP in houses (Climate Energy) is a promising technology
- NYSERDA Efficiency Programs can provide incentives for highly efficient installations
- Possible National Grid incentives coming as well
Integrated Energy Analyses for Customers

As part of National Grid energy efficiency filings in MA, NY, and RI, integrated energy audits are proposed to integrate the benefits of cost effective:

- Energy efficiency
- Automated load response
- Renewable energy
- Combined heat and power

What is the ‘optimal’ solution for each customer given capital, space, carbon reduction targets, and current energy usage?
# Developing Customer Carbon Reduction Plans

<table>
<thead>
<tr>
<th>Carbon Reduction Blueprint 2009-2011</th>
<th>Avg cost/kWh</th>
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<tbody>
<tr>
<td>Desired Reduction</td>
<td>$0.15</td>
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<tr>
<td>Total kWh used per year</td>
<td>12,000,000</td>
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<tr>
<td>Peak kWs</td>
<td>2,500</td>
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<tr>
<td>Annual Electric costs</td>
<td>$1,800,000</td>
</tr>
<tr>
<td>tons of CO2 per kWh</td>
<td>0.000455</td>
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<tr>
<td>Current CO2 emissions (tons)</td>
<td>5,460</td>
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<table>
<thead>
<tr>
<th>Measure</th>
<th>Chiller</th>
<th>Lighting</th>
<th>Load management controls</th>
<th>Photo-voltaic</th>
<th>Totals</th>
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<tbody>
<tr>
<td>Estimated Costs</td>
<td>$600,000</td>
<td>$100,000</td>
<td>$50,000</td>
<td>$1,000,000</td>
<td>$1,750,000</td>
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<tr>
<td>Estimated carbon reduction (tons)</td>
<td>55</td>
<td>11</td>
<td>0</td>
<td>501</td>
<td>567</td>
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<tr>
<td>Estimated energy (kWh) reduction</td>
<td>120,000</td>
<td>25,000</td>
<td>500</td>
<td>1,100,000</td>
<td>1,245,500</td>
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<tr>
<td>Peak load reduction (kWs)</td>
<td>50</td>
<td>20</td>
<td>50</td>
<td>140</td>
<td>260</td>
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<tr>
<td>Bill savings</td>
<td>$18,000</td>
<td>$3,750</td>
<td>$75</td>
<td>$165,000</td>
<td>$186,825</td>
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<tr>
<td>Utility or MTC rebate</td>
<td>$250,000</td>
<td>$35,000</td>
<td>$10,000</td>
<td>$300,000</td>
<td>$595,000</td>
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<tr>
<td>Various tax breaks</td>
<td></td>
<td></td>
<td></td>
<td>$300,000</td>
<td>$300,000</td>
</tr>
<tr>
<td>Customer contribution</td>
<td>$350,000</td>
<td>$65,000</td>
<td>$40,000</td>
<td>$400,000</td>
<td>$855,000</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Totals</th>
</tr>
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<tbody>
<tr>
<td>2009</td>
<td>1.0%</td>
<td>0.21%</td>
<td>0.004%</td>
<td>9.17%</td>
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<tr>
<td>2010</td>
<td>0.2%</td>
<td></td>
<td></td>
<td>9.2%</td>
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</table>

Note: these are simply representative values, not actual projects costs.
Interconnection of DG to Distribution System

- Depending on the project size and type, interconnection can be simple or it can be extremely complicated, expensive, and time consuming.
- Please contact your Account Executive (or other National Grid representative) early on to get the process started and understand potential timeframes and what may be required.
Some Initial Interconnection Issues

- **FERC jurisdiction vs. state jurisdiction?**
- **Can it be easily integrated with the EPS?**
  - Equipment capacity limits
  - Reverse Power flow onto transmission ?!?!
  - Spot networks – limited interconnection available
- **Modifications needed for distribution system?**
  - Ratings of lines, transformers, etc.
  - Is three-phase needed and available, poles,
  - Coordination of fuses, etc. on customer and utility side
- **Contracts: power purchase & interconnection**
<table>
<thead>
<tr>
<th>Activity</th>
<th>Start up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposal</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
</tr>
<tr>
<td>Permitting</td>
<td></td>
</tr>
<tr>
<td>Financing</td>
<td></td>
</tr>
<tr>
<td>Interconnection</td>
<td></td>
</tr>
<tr>
<td>Procurement</td>
<td></td>
</tr>
<tr>
<td>Installation</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td></td>
</tr>
<tr>
<td>Power Sales Contract</td>
<td></td>
</tr>
<tr>
<td>Maintain</td>
<td></td>
</tr>
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</table>
Distributed Generation issues for ISO and Utility

- **Safety (people and equipment) - proper fault isolation**
- **Reliability (service quality and value)**
  - Voltage level
  - SAIDI and SAIFI (frequency and duration of outages)
  - Transients
  - Harmonics
- **Planning – long view of capacity issues**
  - ~3 years to site and install new substation
  - ~5 years to site and install new fossil power plant
  - Need reliable source of power for planning purposes
- **Costs**
What does the Distributed Generation Owner want to do?

- Quickly install generator and maximize value of energy which is produced – must deal with:
  - Technical challenges
  - Financial challenges
  - Other challenges
- Limit cost of equipment, engineering, installation
- Sell any excess power at highest rate and keep options open on sale of power and operation of equipment
- Utility is one of many challenges the IPP must deal with – but interconnection process is a necessary challenge
Interconnection – Potential Costs

- Application fee
- Additional engineering studies as needed
- Distribution facilities upgrades (examples)
  - Cost to install mile of three phase $100-200K
  - Gang operated disconnect and riser pole $5K
  - Meter work <$3K
  - Reverse Power Relay at 115 KV Substation
    ~$100K
Interconnection Process

- **Contact Utility Account Executive for Guidance**
- **Apply for interconnection**
  - Application fee and form
  - Engineered site plan
  - Electric one-line – stamped by registered PE
  - Equipment specifications
- **Site meetings**
- **Exchange of relay and protection information**
- **Drafting of contracts, Insurance**
- **Proposed relay test plan and witness test**
- **Authorization to interconnect**
Questions on Interconnection Issues?
# National Grid ownership of Renewables/Distributed Resources Potential by State

<table>
<thead>
<tr>
<th>State</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts</td>
<td>• Up to 50 MW of solar</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>• Legislation permits up to 15 MW of solar or wind generation</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>• Legislation passed that allows up to 6 MW of distributed resources to be rate based</td>
</tr>
<tr>
<td></td>
<td>• Could be direct load control, renewable generation, CHP, etc.</td>
</tr>
<tr>
<td>New York</td>
<td>• New York’s Public Service Commission has solicited our renewable energy policy recommendations</td>
</tr>
</tbody>
</table>

All require pre-approval filings before construction can begin
National Grid is working to implement the renewable provisions of the Green Communities Act

National Grid Solar Program consists of:

- Solar on Company sites
- Solar on state, municipal, school, commercial and low-income multifamily property
- Solar residential financial assistance and industry education

Targeting a filing for first quarter of 2009
MA Project Highlights

- 5 National Grid owned sites
- 4 of the sites were historically manufactured gas plants
- 1 site is an active materials distribution center
- Once approved - construction expected to begin Summer 2009
- Estimated at $38 million for first 5 MW at the five National Grid sites
- 30% tax credit will reduce this cost to an approximated $27 million

<table>
<thead>
<tr>
<th>Site (Ownership)</th>
<th>Capacity (MW)</th>
<th>PV Panels (approx)</th>
<th>Estimated Annual Output (MWh)</th>
<th>Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorchester (BGC)</td>
<td>1.3</td>
<td>6,300</td>
<td>1.6</td>
<td>6</td>
</tr>
<tr>
<td>Everett (BGC)</td>
<td>0.6</td>
<td>3,200</td>
<td>0.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Haverhill (BGC)</td>
<td>1.0</td>
<td>5,200</td>
<td>1.4</td>
<td>5</td>
</tr>
<tr>
<td>Revere (BGC &amp; NG)</td>
<td>0.8</td>
<td>3,600</td>
<td>0.9</td>
<td>3</td>
</tr>
<tr>
<td>Sutton (NG)</td>
<td>1.2</td>
<td>6,700</td>
<td>1.2</td>
<td>3</td>
</tr>
</tbody>
</table>
Conceptual Designs

Dorchester, MA
1,300 kWs

Everett, MA
600 kWs
Conceptual Designs

Haverhill, MA
1,000 kWs

Revere, MA
800 kWs

Sutton, MA
1,200 kWs
Impact of 1 MW (dc) solar array on feeder

Average Feeder Load
August 2008 - Haverhill, MA

Peak solar output is 632 kVA at 11:30 am. Between inverter, transformer, and module efficiency losses due to hot, humid weather, losses are 37% of the DC rating of the system.
Questions and Comments

♦ Thank You!

♦ Contact Information:

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