The Appraisal of Renewable Energy Facilities and Solar Installations

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Events that shaped today’s thinking about technology mix for electric power

1970: Clean Air Act, marks major shift in government’s role in air pollution control

1973: OPEC oil embargo, sparks interest in solar energy

1979: Three Mile Island, PA nuclear accident

1986: Chernobyl nuclear accident in Ukraine

1989: Exxon Valdez oil spill in Alaska

1990: Congress passes act to stimulate development of hydrogen power

1993: Completion of 1st grid connected PV system in CA

1995: Acid Rain Program, Phase I begins

1997: Electric cars begin to be made by big car brands

1999: Acid Rain Program, Phase II begins

2000: Congress passes act to stimulate development of hydrogen fuel cells

2001: 9/11 terrorist attacks

2008: Crude oil prices reach record high of $134/bbl

2009: ARRA contains billions of dollars for renewable energy & energy efficiency developments

2010: BP oil spill in Gulf of Mexico

2011: Fukushima nuclear accident in Japan
U.S. crude oil prices over the last 50 years

Annual average prices, 1960 - 2011

Annual Average Price ($/bbl.)

Year

Future reliance on coal remains but will not increase

2009
- Coal: 44%
- Nuclear: 20%
- Natural Gas: 21%
- Petroleum: 1%
- Renewable Sources: 3%
- Hydro: 7%
- Other: 4%

2035
- Coal: 41%
- Nuclear: 17%
- Natural Gas: 20%
- Petroleum: 1%
- Renewable Sources: 5%
- Hydro: 6%
- Other: 10%

* Other: includes pumped storage, distributed generation, and combined heat and power

Source: EIA Annual Energy Outlook, 2011
Environmental regulations make coal more expensive

- The U.S. has a cap and trade policy, placing a mandatory cap on emissions such as SO\textsubscript{2} and NO\textsubscript{x} pollutants
- Polluters can choose to reduce emissions and sell allowances, bank for future use, or continue to emit at high levels and purchase allowances to cover the excess emissions
- CO\textsubscript{2} regulations put on back burner
- In January 2010, there were 22 coal projects either permitted, near construction or under construction, however by year-end, 10 projects had been cancelled

SO\textsubscript{2} and NO\textsubscript{x} Spot Prices

Source: FERC
New installations: renewable energy is projected to be a large piece

Capacity additions by fuel type, 2010-2015

Considerable growth in domestic renewable energy is expected

~420 billion kWh of renewable energy generation in the U.S., 2009

- Hydropower: 65.2%
- Geothermal: 16.9%
- Biomass: 13.5%
- Wind: 3.6%
- Solar: 0.8%

~724 billion kWh of renewable energy generation in the U.S., 2035

- Hydropower: 43.4%
- Geothermal: 22.6%
- Biomass: 24.4%
- Wind: 6.8%
- Solar: 2.8%

Source: EIA Annual Energy Outlook, 2011
Renewable Portfolio Standard (RPS)

- The 1999-2000 federal government mandate provides states with a mechanism to increase renewable energy generation.
- The intent is to stimulate market and technology development so that renewable energy becomes economically competitive with conventional technology.
- Goal is to generate about 25% of U.S. electric power from renewable sources by 2025.
- State’s RPS can require electric utilities and other retail electric providers to supply electricity from renewable energy sources.
29 states have Renewable Portfolio Standards (RPS) in place

Source: www.dsireusa.org, May 2011
Technology eligibility varies under Renewable Portfolio Standards (RPS)

- Under the various state requirements for RPS eligibility, all states include photovoltaics
- Solar thermal (hot water) is included in 30 states
- Biofuels, biomass, hydro, landfill gas, and wind are also all eligible in all states
Presentation overview

Technology Mix for U.S. Electric Generating Plants

U.S. Solar Energy - Overview and State Incentives

Appraisal of PV Solar Energy System
Components of a PV solar system
Layers of a typical solar module
Solar resources in the U.S. are plentiful, especially in the Southwest
Solar supply and demand is created by government

- **Supply** of solar power driven by significant government incentives for both construction and production

- **Demand** for solar power driven by government regulations *requiring* utilities to supply a portion of their electricity from renewable sources

- As a result, solar generated electricity expected to grow 8-fold from 2.3 billion kWh in 2009 to 16.8 billion kWh in 2035

- 10 MW standalone plant is equivalent to about 5,000 residential roof-top installations
Government incentives have led to new technology and U.S. jobs

- Cost effectiveness of thin-film cells are attractive to solar developers building large scale power plants
- GE plans to build a new plant making 400 MW of thin-film photovoltaic solar panels per year
- The solar industry currently has employees in all 50 states
- New commercial solar facilities in Oregon, South Carolina, and Mississippi will create 2,500 jobs with total domestic growth of 24,000 jobs expected in 2011
California and New Jersey lead the country in PV solar installations

- Both states have aggressive policies and incentives in place to encourage renewable energy

| 2011 Total PV System Installations
<table>
<thead>
<tr>
<th>Total Systems Installed</th>
<th>Total MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>87,222</td>
</tr>
<tr>
<td>New Jersey</td>
<td>9,566</td>
</tr>
</tbody>
</table>

- In 2010, PV installations nearly doubled (in terms of MW installed) compared to 2009 across the country

| 2010 PV System Installations
<table>
<thead>
<tr>
<th>Top States</th>
<th>MW Installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>258.9</td>
</tr>
<tr>
<td>NJ</td>
<td>137.1</td>
</tr>
<tr>
<td>NV</td>
<td>61.4</td>
</tr>
<tr>
<td>AZ</td>
<td>54.0</td>
</tr>
<tr>
<td>CO</td>
<td>53.6</td>
</tr>
<tr>
<td>PA</td>
<td>46.8</td>
</tr>
<tr>
<td>NM</td>
<td>42.8</td>
</tr>
<tr>
<td>FL</td>
<td>35.2</td>
</tr>
<tr>
<td>NC</td>
<td>30.7</td>
</tr>
<tr>
<td>TX</td>
<td>22.6</td>
</tr>
<tr>
<td>Rest of US</td>
<td>135.2</td>
</tr>
<tr>
<td>Total</td>
<td>878.3</td>
</tr>
</tbody>
</table>

Source: US Solar Market Insight, 2010 Year in Review
Incentives vary by state and are evolving

- Performance Based Incentives
- Net Metering
- Reduced or No Property Tax
- No Sales Tax on Equipment
- Income Tax Credits
- No Permitting Cost
- Public Benefits Fund and Government sponsored Loan Programs

Incentives encourage solar installations by reducing initial equipment costs and also provide a revenue stream to secure financing.
Over 40 states have implemented net metering policies

- Net metering allows electric customers who generate solar energy to “bank” excess electricity on the grid, typically in the form of kWh credits.
- These credits offset electricity consumed when the customer’s solar energy system is not generating enough electricity to meet its needs.
- Usually customers can receive retail rates for electricity sold to the grid, but in some states electricity that flows back to the grid will obtain a rate lower than retail prices.

Source: www.dsireusa.org, April 2011
Net metering policies vary, with NJ, TX, PA, & CO being the most favorable

For Example: Net metering in NJ (established in 1999)

- Allows metering for **systems up to 2 MW for all customer types**
- **No company limit** on aggregate net metering capacity
- Any **net excess generation** during a billing period is **carried forward** to the customer’s next bill as a full kWh credit **(at the utility’s retail rate)**
- At the end of a **12-month period**, the utility purchases remaining excess **electricity** at the utility’s avoided cost rate
- **Customers own SRECs** (solar renewable energy credits) associated with the electricity they generate
- Go to [www.DsireUSA.org](http://www.DsireUSA.org) for detail on each states current incentive programs
NJ is credited with resetting the bar for solar installation incentives

- Utilities must either produce or purchase a minimum of 2.12% of states demand from solar
- Net metering at retail prices
- For every 1MWH production an SREC is created, valued at about $400
- Rebate program expired

Total installed renewable energy projects from 2001 to May 31, 2011

<table>
<thead>
<tr>
<th>Technology</th>
<th># of Projects</th>
<th>Total kW</th>
<th>Total Rebates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>9,566</td>
<td>339,613</td>
<td>$355,380,787</td>
</tr>
<tr>
<td>Biomass</td>
<td>18</td>
<td>30,910</td>
<td>14,207,886</td>
</tr>
<tr>
<td>Fuel Cell</td>
<td>8</td>
<td>1,505</td>
<td>4,707,312</td>
</tr>
<tr>
<td>Wind</td>
<td>39</td>
<td>8,039</td>
<td>5,074,117</td>
</tr>
<tr>
<td>Total</td>
<td>9,631</td>
<td>380,067</td>
<td>$379,370,102</td>
</tr>
</tbody>
</table>

Source: www.njcleanenergy.com
Solar Renewable Energy Certificates (SRECs) are a crucial component of NJ’s solar incentives

- SREC model provides renewable energy credits that acts as a production subsidy
- SRECs are traded in a competitive market, with prices determined by market forces within each state
- Energy associated with SREC is sold separately and is used by another party
- **Electricity suppliers are the primary purchasers of SRECs** (only receive a certificate, not the electricity generated from the system, to meet state RPS solar requirement)

**How do SRECs work?**
- Each time a system generates 1,000 kWh of electricity, an SREC is earned and placed in the customer's electronic account
- SRECs are sold on the electronic SREC tracking system, providing revenue for the first 15 years of the system's life
SREC prices are driven by market forces, while SACP prices are fixed by state

- The **Solar Alternative Compliance Payment (SACP)** is the penalty that utilities must pay if they are unable to generate or buy SRECs at mandated yearly amounts.
- 2011 **SACP** price is $658/MWH which is above 2011 SREC of $600/MWH.
To receive SRECs, NJ owners must participate in the SREC Registration Program (SRP)

- Registration of project
- Start of construction
- Registration accepted
- Construction completion
- Final paperwork submitted and deemed complete
- Project is issued a New Jersey Certification Number which enables it to generate New Jersey SRECs

- All solar projects in NJ must register at NJCleanEnergy.com
- Registration provides market participants with information about the pipeline of anticipated new solar capacity and insight into future SREC pricing
The NJ SREC tracking system enables account holders to track solar energy system production

- Through the tracking system, SRECs are issued to account holders based on recorded or estimated production of the solar energy system
- After solar system has been installed an SREC tracking system account is established
- SRECs will then be deposited monthly into the owners account based on either estimated or actual reported energy production
- The SREC tracking system also records the sale of SRECs from generators to purchasers
Presentation overview

Technology Mix for U.S. Electric Generating Plants

U.S. Solar Energy - Overview and State Incentives

Appraisal of PV Solar Energy System
Appraisals are often required for project financing

- Typical leasing scenario is the sale-leaseback: lease length usually equivalent to PPA (PPA between lessee and the Host)
- Bank (Lessor) takes tax credit or cash grant and can claim tax depreciation
- Lessee has option to purchase at the end of the lease term
- The system off-taker receives benefits of reducing reliance on local power grid and use “green” marketing
- Appraisal determines FMV at lease commencement, purchase option date, and residual value at end of lease
### Income Approach requires an analysis of the solar system’s cash flows throughout its EUL

#### Approach to value
- Use of a discounted cash flow analysis is recommended
- Direct Cap problematic for new system:
  - Timing of rebates, typically over first few years
  - Other incentives, such as PBIs, are for a specified number of years (usually 5 to 15)
  - PPA may expire prior to end of EUL
  - System efficiency changes over time
  - Accelerated depreciation not uniform

#### Cash flow considerations
- Estimated yearly generation (kWh)
- PPA terms
- Current and forecasted electricity rates
- Rebates (if applicable)
- SRECs / PBIs
- O&M costs
- Insurance costs
- Inverter replacement costs
A typical solar system will produce cash flows for over 35 years

### Key assumptions
- **System Size (kW)**: 1,127.5
- **Total Cost of Equipment ($/kW)**: 5,000
- **System Cost ($)**: 5,637,500
- **Initial kWh Production**: 1,720,000
- **Degradation per year**: 0.5%

### Year 1 rebate

| Years | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 ...
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<tbody>
<tr>
<td><strong>Electricity generation (kWh)</strong></td>
<td>1,720,000</td>
<td>1,711,400</td>
<td>1,702,843</td>
<td>1,694,329</td>
<td>1,685,857</td>
<td>1,677,428</td>
<td>1,669,041</td>
<td>1,660,696</td>
<td>1,652,392</td>
<td>1,644,130</td>
<td>1,635,909</td>
</tr>
<tr>
<td><strong>PPA rate ($/kWh)</strong></td>
<td>0.120</td>
<td>0.124</td>
<td>0.127</td>
<td>0.131</td>
<td>0.135</td>
<td>0.139</td>
<td>0.143</td>
<td>0.148</td>
<td>0.152</td>
<td>0.157</td>
<td>0.200</td>
</tr>
<tr>
<td><strong>PBIs ($/kWh)</strong></td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
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<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>SRECs ($/kWh)</strong></td>
<td>0.63</td>
<td>0.58</td>
<td>0.53</td>
<td>0.487</td>
<td>0.469</td>
<td>0.457</td>
<td>0.446</td>
<td>0.432</td>
<td>0.415</td>
<td>0.387</td>
<td>0.36</td>
</tr>
</tbody>
</table>

### Revenues
- **Electricity revenues**: 206,400, 211,529, 216,786, 222,173, 227,694, 233,352, 239,151, 245,094, 251,184, 257,426, 327,182
- **PBI revenues**: 86,000, 85,570, 85,142, 84,716, 84,293
- **SREC revenues**: 1,083,600, 992,612, 902,507, 825,138, 790,667, 766,585, 744,392, 717,420, 685,743, 636,278, 588,927
- **Total rebate (cash grant)**: 1,691,250
- **Total revenue**: 3,067,250, 1,289,711, 1,204,434, 1,132,027, 1,102,654, 999,936, 983,543, 962,514, 936,927, 893,704, 916,109

### Expenses
- **Inverter Replacement (around year 15)**: 16,913, 17,335, 17,769, 18,213, 18,668, 19,135, 19,613, 20,104, 20,606, 21,121, 21,649
- **Insurance**: 39,463, 39,885, 40,319, 40,763, 41,218, 41,685, 42,163, 42,654, 43,156, 43,671, 44,199
- **Total expenses**: 3,027,788, 1,249,826, 1,164,116, 1,091,264, 1,061,435, 958,251, 941,379, 919,860, 893,771, 850,033, 871,910
- **EBITDA**: 3,027,788, 1,249,826, 1,164,116, 1,091,264, 1,061,435, 958,251, 941,379, 919,860, 893,771, 850,033, 871,910
Cost Approach - Total solar system installation costs are forecasted to decrease

- Improved manufacturing techniques and technology
- Current average price to install PV system in the U.S. $4,000 per kW
- Average cost in the U.S. is projected to decline to $3,150 per kW by 2015


Source: GlobalData, February 2010
PV modules are the greatest cost component of the overall system

<table>
<thead>
<tr>
<th>Cost Components</th>
<th>Average Cost Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Module</td>
<td>60%</td>
</tr>
<tr>
<td>Inverter</td>
<td>10%</td>
</tr>
<tr>
<td>Other equipment (mounting structure, wiring, meter, switches)</td>
<td>15%</td>
</tr>
<tr>
<td>Installation</td>
<td>15%</td>
</tr>
</tbody>
</table>
Obsolescence factors for solar installations

**Physical:**
- Unless PV system has solar tracking capability, there are no moving parts
- EUL could be life of roof
- Inverters have limited life

**Functional:**
- Degradation 0.5% annually
- Today, state-of-art efficiency about 20% compared with 15% 10 years ago
- New technology in future could be 30% efficient

**Economic:**
- Potentially a big issue as sale of an existing facility will not receive most of the front-loaded government incentives
- Lower demand for electricity from conservation
### Cost Approach Calculation

**Subject plant:**
- **Install date:** 2003
- **Capacity:** 1,500 kW
- **Efficiency:** 15.0%
- **UEL:** 35 years

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<table>
<thead>
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<tbody>
<tr>
<td><strong>Replacement Cost New</strong></td>
<td></td>
</tr>
<tr>
<td>$5,000/kW x 1,500 kW</td>
<td>$7,500,000</td>
</tr>
<tr>
<td><strong>Physical Depreciation</strong></td>
<td></td>
</tr>
<tr>
<td>8 years old / 35 years EUL</td>
<td>22.9 %</td>
</tr>
<tr>
<td><strong>RCNLD</strong></td>
<td></td>
</tr>
<tr>
<td>RCN x (1-Phys. Dep.)</td>
<td>$5,782,500</td>
</tr>
<tr>
<td><strong>Functional Obsolescence</strong></td>
<td></td>
</tr>
<tr>
<td>(20% eff. - 15% eff.) / 20%</td>
<td>25 %</td>
</tr>
<tr>
<td><strong>Fair Market Value</strong></td>
<td></td>
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<tr>
<td></td>
<td>$4,337,000</td>
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</tbody>
</table>
Thin film technologies and costs improving

- Market share is expanding rapidly
- Advantages: relatively low consumption of raw materials, high automation and production efficiency, ease of building integration and improved appearance
- Disadvantages: lower efficiency, limited experience with lifetime performances
- Manufacturing costs per kW <$1,000
Crystalline silicon PV panel technology is proven and reliable

- 85 to 90% of the market share
- Single and multi-crystalline modules
  - Multi-crystalline are less expensive, but less efficient
- Long lifetime, most manufacturers’ warranties are for 25 years
- Technology challenges: reduce materials, improve cell concepts, automate manufacturing
- Efficiency levels are currently 16-20%
- Degradation between 0.25% to 0.5% per year
- Single crystalline cell prices $1.14 per watt compared to $1.09 per watt for multi-crystalline

Source: IEA, Venture Beat
Crystalline silicon PV panel efficiency is to reach 25% by 2020 –2030

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Single crystalline: 21%</td>
<td>Single crystalline: 23%</td>
<td>Single crystalline: 25%</td>
<td></td>
</tr>
<tr>
<td>Multi crystalline: 17%</td>
<td>Multi crystalline: 19%</td>
<td>Multi crystalline: 21%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry manufacturing aspects</th>
<th>Si consumption &lt; 5 grams/Watt (g/W)</th>
<th>Si consumption &lt; 3 (g/W)</th>
<th>Si consumption &lt; 2 (g/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New silicon materials and processing</td>
<td>Improved device structures</td>
<td>Wafer equivalent technologies</td>
<td></td>
</tr>
<tr>
<td>Cell contacts, emitters, and passivation</td>
<td>Productivity and cost optimization in production</td>
<td>New device structures with novel concepts</td>
<td></td>
</tr>
</tbody>
</table>

Source: IEA PV Roadmap
Thin film efficiencies are also expected to improve in the near future

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Thin film Si: 10%</td>
<td>Thin film Si: 12%</td>
<td>Thin film Si: 15%</td>
<td></td>
</tr>
<tr>
<td>CIGS: 14%</td>
<td>CIGS: 16%</td>
<td>CIGS: 18%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry manufacturing aspects</th>
<th>Roll to roll manufacturing, packaging</th>
<th>Simplified production process, low cost packaging, management of toxic materials</th>
<th>Large high efficiency production units, recycling of modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected R&amp;D areas</td>
<td>Improved substrates and transparent conductive oxides</td>
<td>Improved cell structures</td>
<td>Advanced materials and concepts</td>
</tr>
</tbody>
</table>
QUESTIONS?

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