NAIOP ReENERGYze Series:
Where Sun and Wind Hit the Bottom Line

June 16, 2010

ProLogis Fast Facts

- Founded in 1991 and quickly became a leading global provider of distribution facilities
- The world’s largest industrial REIT
- More than 475 million square feet of high-caliber distribution space owned, managed or under construction
- 2,400+ distribution facilities in 105 markets worldwide
- Over $34 billion in real estate assets
- Approximately 1,100 associates serve 4,400 customers
- Member of the S&P 500, traded on the NYSE (PLD)
- Headquartered in Denver, Colorado USA

All figures as of 31 March 2010
ProLogis Around the World

World's largest industrial REIT
More than 475 million square feet owned, managed or under construction
4,400 customers and 2,400 industrial properties across
North America, Europe and Asia

ASIA PLATFORM
12 million square feet
7 markets
2 countries

NORTH AMERICA PLATFORM
336 million square feet
54 markets
3 countries

EUROPE PLATFORM
127 million square feet
44 markets
13 countries

All figures as of 31 March 2010

ProLogis Park 70
intersection of I-70 and e-470

ProLogis Park 70
Distribution Center # 2
Solar Power
U.S. Demand

Core Demand
Ideal Electric Source

- Inexhaustible
- Cheap
- Clean

Legislative Mechanisms

Minimum solar or customer-sited requirement
* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources

29 states + DC have an RPS (6 states have goals)

Source: Database of State Incentives for Renewables & Efficiency (April 2010)
Engine of Change

- Inexhaustible
- Cheap
- Clean

U.S. Market Size

**Annual U.S. Solar Energy Capacity Growth (MWp dc)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity Growth (MWp dc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>22</td>
</tr>
<tr>
<td>2001</td>
<td>31</td>
</tr>
<tr>
<td>2002</td>
<td>49</td>
</tr>
<tr>
<td>2003</td>
<td>75</td>
</tr>
<tr>
<td>2004</td>
<td>91</td>
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<tr>
<td>2005</td>
<td>117</td>
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<tr>
<td>2006</td>
<td>146</td>
</tr>
<tr>
<td>2007</td>
<td>273</td>
</tr>
<tr>
<td>2008</td>
<td>351</td>
</tr>
<tr>
<td>2009</td>
<td>481</td>
</tr>
</tbody>
</table>

**Top 10 States for New Grid-Tied Solar Electric Installations in 2009**

<table>
<thead>
<tr>
<th>State</th>
<th>Capacity Installed in 2009 (MW)</th>
<th>Cumulative Capacity in 2009 (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calif.</td>
<td>220</td>
<td>1,102</td>
</tr>
<tr>
<td>N.J.</td>
<td>57</td>
<td>128</td>
</tr>
<tr>
<td>Fl.</td>
<td>36</td>
<td>100</td>
</tr>
<tr>
<td>Ariz.</td>
<td>23</td>
<td>59</td>
</tr>
<tr>
<td>Colo.</td>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>Hawaii</td>
<td>14</td>
<td>39</td>
</tr>
<tr>
<td>N.Y.</td>
<td>12</td>
<td>34</td>
</tr>
<tr>
<td>Mass.</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>Conn.</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>N.C.</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Others</td>
<td>29</td>
<td>78</td>
</tr>
<tr>
<td>Total</td>
<td>441 MW</td>
<td>1,653 MW</td>
</tr>
</tbody>
</table>

*Includes all grid-tied PV and CSP.

Source: Solar Electric Industry Association
Solar Power
Supply Chain

Supply chain gating item:

**Renewable Energy Demand**

Demand driven by:
Need for inexhaustible, cheap, clean power
Kyoto Protocol & other laws and mandates

Constraint status:
removed

Forward looking:
population growth and industrialization combined with evolving energy policies point towards increased demand
Solar Supply Chain

Supply chain gating item: **Incentive Mechanisms**

Demand driven by:
governments looking to comply with Kyoto Protocol and will of citizens

Constraint status: removed

Forward looking:
feed-in tariffs, rebates and policies will continue to emerge as deadlines for action draw near

Solar Supply Chain

Supply chain gating item: **Raw Material Supply**

Demand driven by:
surge in demand for solar panels due to incentive mechanisms

Constraint status: removed

Forward looking:
silicon is the second most abundant element on earth (after oxygen)
Solar Supply Chain

Supply chain gating item:

**Module Supply**

Demand driven by:
surge in demand for solar panels due to incentive mechanisms

Constraint status:
removed

Forward looking:
technology and production advancements will continue to push prices lower

Solar Supply Chain

Supply chain gating item:

**Financing**

Demand driven by:
appetite to purchase power from larger projects by energy off-takers

Constraint status:
easing

Forward looking:
solar projects will begin to be seen as gov’t backed annuities and hence low risk worthy of large pension fund investment
Solar Supply Chain

Supply chain gating item:
**Host Sites**

Demand driven by:
see previous

Constraint status:
not yet satisfied

Forward looking:
Gov’t’s and regulators will give preference to rooftops due in part to existing infrastructure and location

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Solar Supply Chain

- Renewable Energy Demand
- Incentive Mechanisms
- Raw Material Supply
- Module Supply
- Financing
- Host Sites

*real estate is emerging as the predominant bottleneck in the solar supply chain*
High Coincidence with Electrical Demand:

United States

Land Constrained Market Example:

Inland Empire West
Solar Power
approaching the opportunity

ProLogis Solar Fact Pattern

Facts and Conclusions
+ 450+ million sqft of roofspace
+ $2+ billion of land held
+ Construction management expertise
+ Fund management expertise
+ Global commitment to sustainability
- No significant tax appetite
- Low/variable on-site energy consumption
- Short term floor leases (3 – 5 years on avg.)

\[ \therefore \] Net metering would be cumbersome and difficult to implement
\[ \therefore \] Net metering would not allow for full use of roof space
\[ \therefore \] Investment partners are needed to make efficient use of tax incentives
\[ \therefore \] Need to adapt our core skill set to this opportunity

Strategy: apply existing expertise to a new industry

- Site Host
  - Large global portfolio
  - On-site management
  - Local expertise
- Development Services
  - In-house expertise
  - Local labor relationships
  - Local permitting relationships
  - Strong track record

ProLogis Success to date:
- 25 MWp completed or under construction
- Repeat programs with 2 utilities (SCE, PGE)
- Active project pursuits in markets throughout Europe and North America
Roles Defined:
Site Host & Development Services Provider

**Site Host**
- **Supply:**
  - Host site
- **Terms**
  - 20 – 25 years
  - rent
- **Issues**
  - insurance
  - taxes
  - floor customers
  - access
  - risk allocation

**Development Services Provider**
- **Supply:**
  - project identification
  - due diligence
  - contract negotiation
  - vendor selection
  - technology selection
  - system design
  - construction management
- **Terms**
  - initial involvement only
  - paid during construction
- **Issues**
  - expertise
  - local manpower

Typical Project Structure:
Independent Power Producer

- **Building Owner (Landlord)**
- **ProLogis Management Team**
- **Utility / Investor**
- **Project SPV (one per installation)**
- **EPC Contractor** (designs/builds system)
- **O&M Contractor** (operations/maintenance)
- **Utility / Power Buyer** "Off-taker"
- **Debt Provider(s)"Project Lender"**
- **Rent**
- **Roof Lease**
- **O&M**
- **KWh**
- **Revenue**
- **Capital**
- **Equity**
- **OpEx**
- **CapEx**
Typical Project Structure:
Utility Owned

Building Owner “Landlord”

ProLogis Management Team

Utility

EPC Contractor (design/builds system)

O&M Contractor (operations/maintenance)

Rate Payers

Electrical Infrastructure

Project Oversight

Roof Lease

Rent

Payment

CapEx

OpEx

Solar Power

notable projects
Example Solar Projects

- Jennifer DC – Oregon
- PP Malsch – Germany
- Kaiser 7 – California
- PP Sant Boi – Spain
- PDX Corp Ctr East 1 & 2 – Oregon
- Kaiser 7 – California
- PP Zama – Japan
- PP Chanteloup – France

Solar Power

Case study: Southern California Edison – utility owned generation
Southern California Edison

2,440 kWp dc
607,320 sqft

Case Study:
Southern California Edison – utility owned generation

- **2007**
  - 03.2007: Pilot project announcement
  - 05.2007: ProLogis submits response to SCE request for proposal
  - 06.2007: ProLogis response not shortlisted
- **2008**
  - 05.2008: SCE files with CPUC
  - 09.2008: Construction of pilot project begins
  - 12.2008: Interconnection of pilot project begins
- **2009**
  - 06.2009: CPUC approves SCE UOG program
- **2010**
  - 05.2010: Tranche I and 100 MW MOU announcement
  - 06.2010: Construction of tranche I begins
Case Study:
Southern California Edison – utility owned generation

Building Owner
“Landlord”

ProLogis Management Team

Southern California Edison

SCE Rate Payers

EPC Contractor
(design/builds system)

O&M Contractor
(operations/maintenance)

Rent

Roof Lease

Project
Oversee

CapEx

OpEx

Electrical Infrastructure

Payment

Solar Power
case study: Spanish projects – private investor partner
Case Study:
Recurrent Energy – private investor partner

Spanish project – 4.8 MWp
Barcelona (5 buildings) + Madrid (3 buildings)
Solar Power
technology basics

Photovoltaics – not a new technology

- 1839: Photovoltaic (PV) effect discovered by French physicist Edmund Becquerel
- 1883: First solar cell (1% efficient) created by American inventor Charles Fritts
- 1905: PV concept explained and endorsed by Albert Einstein
- 1950’s: Bell Labs developed 6% efficient silicon cells for remote communications stations and NASA deployed PV on the United States’ first satellite (Vanguard I)

Evolution of the technology has been slow – active R&D since mid-1970s has resulted in continual efficiency improvement. Experimental products now at 40% + conversion efficiency, but mainstream products much lower.
The photovoltaic reaction – how does it work?

- Sunlight is composed of photons – "packets" of energy
- Some photons are reflected, some are absorbed and some pass through
- The absorbed photons knock electrons into a higher state of energy
- Typical PV cells comprised of a thin layer (wafer) of silicon (semiconductor) with a distinct element (doping) applied to each side – for example:
  - Phosphorous = negatively charged
  - Boron = positively charged
- This three material structure creates a "P-N junction" (positive-negative junction)
- Electrons excited by the sun’s radiation flow across the junction to create electricity
- This "photovoltaic effect" is a natural reaction based on material properties (no moving parts, no fuel)

Photovoltaic effect animation

Source: www.sunnywineenergy.com
Module basics – crystalline

- Modules consist of cells, some type of glazing and electrical connections
- Efficiencies vary by product and manufacturer – figures provided are only indicative
- Technologies have different price points along with production differences
- Technologies have different physical (weight, flexibility, etc.) and operating (light type, temperature, etc.) characteristics
- There are two basic categories of PV technology in the mainstream market
  - Crystalline silicon – rigid, framed panels (mature, trusted technology)
  - Thin-film – takes various forms (newer technologies, but becoming more common)
- Crystalline silicon (c-Si) – silicon layer with doping applied
  - Monocrystalline → 14 to 17% efficient
  - Polycrystalline → 11 to 14% efficient

Module Efficiency Source: www.speedace.info/speedace_images/pv_solar_module_efficiency_chart.jpg

Module basics – thin-films

- Thin-film – one or more thin layers of film deposited on a substrate
  - Amorphous silicon (a-Si) → 6 to 10% efficient
  - Cadmium telluride (CdTe) → 8 to 11% efficient
  - Copper indium gallium selenide (CIGS) → 9 to 11% efficient
- Thin-films are available in several forms
  - Enclosed in glass – “glass-on-glass” (CdTe, CIGS, a-Si)
  - Flexible laminates – “BIPV” (CIGS, a-Si)
  - Cylindrical tubes – Solyndra® (CIGS)
PV terminology

- AC vs. DC – alternating current versus direct current
  - Renewable energy installations normally produce direct current (like batteries)
  - The electrical grid operates with alternating current (like normal outlets)
  - Usually about a 15% power loss between DC and AC
- Capacity – the power generating capacity of a cell, module or system
  - Standard units are watts, normally expressed in kilowatts or megawatts
  - Figures typically quoted in nominal peak DC output (“nameplate”)
  - Example System Description:
    - System containing 15,000 modules nominally rated at 100 watts-peak (Wp)
    - 15,000 modules x 100 Wp / module = 1,500,000 Wp DC capacity
    - 1,500,000 Wp DC = 1,500 kilowatts-peak (kWp) DC = 1.5 megawatts-peak (MWp) DC
- Production – the energy produced by a cell, module or system
  - Standard units are kilowatt-hours (kWh)
  - For reference, a typical American home uses about 11,000 kWh per year (2008, DOE)
- Yield – the production relative to system size for a given module or system
  - Standard units are kWh / kWp (annual)
  - A 1.2 MWp DC system modeled to produce 1,200 kWh / kWp will yield 1,440,000 kWh / year
Insolation / irradiance

- Insolation is the solar radiation energy striking a given area in a given amount of time.
- Often expressed in W/m², kWh/m²/day, or kWh/kWp/year.
- US has relatively good solar resource.

There are public and private insolation databases:
- Public: NREL, NASA (free)
- Private: Meteonorm, 3Tier (paid)

Typical system configuration

- PV system components are modules, an inverter, a meter and a destination for the power.
- 100% of electricity generated by rooftop system is fed into grid (power not used on site).
- Shorter building lease terms make net metering challenging.
- Floor customer interests are not in conflict with power sales.
- Production from rooftops exceeds typical building demand.
Solar Power
installation practicalities

Attachment methods

- Modules can be installed on a roof in a variety of ways
- Can be directly adhered to roof membranes or supported on racking
- Racking can penetrate the roof and structurally attach, or be self-ballasted
- Ballasted systems generally weigh more than mechanically attached systems
- Total system weights range from about 2 lbs/SF to more than 10 lbs/SF
Attachment methods - examples

Some systems can be ballasted, mechanically attached, or both

Racked system with concrete paver ballast

Penetrating racked system

Accessory equipment

- Typically, large ground-mounted inverters are used on our projects
- Inverters are normally located near the existing transformer
- New disconnects, panels and transformers may also be required
- Wire management systems and combiner boxes collect circuits on the roof
- Cables are generally run down the exterior wall, enclosed in a decorative chase
Rooftop solar design considerations

- Structural capacity – must be validated/optimized with specific design
- Roof integrity – warranty and technical issues must be addressed in design
- Mounting – ballasted, adhered, attached; landscape, portrait, double-stack, etc.
- Orientation – modules aimed at true south (not magnetic south) in N. hemisphere
- Tilt angle – performance, wind loads, self-cleaning, row spacing
- Reserve areas – typically we reserve specific roof areas for future HVAC; may also have existing obstructions on roofs (skylights, fans, etc.) that cause shading
- Roof space optimization – maximize value to ProLogis, usually by maximizing kWh
- Equipment counts and locations – inverters, transformers, disconnects
- Losses – cable size, distance, DC to AC, soiling, snow, degradation over time
- Ladder – style, location, attachment
- Grid access – location, impacts

Indicative figures – large-scale projects

- System pricing: $3.00 to 5.00 / Wp DC – installed system cost
- Typical cost breakdown (generic example)

<table>
<thead>
<tr>
<th>Item</th>
<th>$/Wp</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modules</td>
<td>1.67</td>
<td>52%</td>
</tr>
<tr>
<td>Racking</td>
<td>0.55</td>
<td>17%</td>
</tr>
<tr>
<td>Inverters</td>
<td>0.29</td>
<td>9%</td>
</tr>
<tr>
<td>Labor</td>
<td>0.41</td>
<td>13%</td>
</tr>
<tr>
<td>Electrical</td>
<td>0.13</td>
<td>4%</td>
</tr>
<tr>
<td>Indirects</td>
<td>0.18</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3.23</td>
<td>100%</td>
</tr>
</tbody>
</table>

Balance of System (BOS) = $1.56/Wp

- Module pricing: $1.00 to 2.50 / Wp DC – raw module cost

- Rooftop power density rules of thumb
  - Crystalline: 200,000 SF per MWp DC
  - Rigid thin-film: 300,000 SF per MWp DC
  - Laminated thin-film: 400,000 SF per MWp DC
Solar Power
ProLogis test installation

ProLogis Rooftop PV Test Site
QUESTIONS?

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