Ocean Measurements in the Energy Sector
Case Studies

Small Sea Changes: Big California Impacts
Scripps Institution of Oceanography
May 25, 2010
Agenda

- Introduction to Sempra Energy

- Use of ocean research and measurements in the energy sector: case studies from Sempra’s operations
  - LNG regasification terminal design
  - Regulation ocean water use in cooling power plants
  - Prediction of summer temperature trends

- Concluding thoughts
Introduction to Sempra Energy

Utilities
- Largest U.S. gas utility
- Serve 24 million Californians

Infrastructure
- Import, transport and store natural gas
- Clean generation

Trading
- Decision made to exit Commodities JV
- Exit expected in 2010

Southern California Gas Company
San Diego Gas & Electric
Sempra LNG
Sempra Pipelines & Storage
Sempra Generation
RBS Sempra Commodities
Sempra LNG: Energía Costa Azul LNG regasification terminal

**First LNG receipt facility along North America’s West Coast**

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity</th>
<th>Investment</th>
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<tbody>
<tr>
<td>~15 miles north of Ensenada, Baja California, Mexico</td>
<td>1 berth, Q-Max* size ship</td>
<td>$1.2 B investment (incl. pipelines)</td>
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<td>320,000 m³ LNG storage**</td>
<td>Designed for low-cost expansion</td>
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<tr>
<td></td>
<td>1.0 Bcf/d firm, 1.5 Bcf/d mas send-out</td>
<td>Commercial operation May 2008</td>
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* Q-Max is the largest LNG ship in the world at 263,000-266,000 m³ of LNG, or approximately 5.6 Bcf to 5.7 Bcf of gas
** Equivalent to approximately 6.9 Bcf of gas storage
## Use of ocean measurements at ECA

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Project phase</th>
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<tbody>
<tr>
<td></td>
<td>Site selection</td>
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<tr>
<td>Tides</td>
<td></td>
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<tr>
<td>One year of continuous measurements</td>
<td></td>
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<tr>
<td>Tidal range of 1.6 m (MHHW to MLLW)</td>
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<tr>
<td>Sea level rise 2.2 mm/year</td>
<td></td>
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<tr>
<td>Seasonal water level variation of +/-0.1 m</td>
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<tr>
<td>Current</td>
<td>One year of measurements</td>
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<tr>
<td>One year of measurements</td>
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<tr>
<td>Direction is along shore</td>
<td></td>
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<tr>
<td>Velocities typically less than 0.3 m/s</td>
<td></td>
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<tr>
<td>Max. recorded speed of 0.6 m/s</td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>23-year record of wind speed and direction derived from two offshore buoys in Southern California</td>
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<tr>
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<tr>
<td>NW winds dominate</td>
<td></td>
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<tr>
<td>Fastest winds occur in April and May</td>
<td></td>
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<tr>
<td>Waves</td>
<td>Over 2 years of data at project site</td>
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<tr>
<td>23-year wave hindcast</td>
<td></td>
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<tr>
<td>Visibility</td>
<td>Data from San Diego (1987 to 2004)</td>
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<tr>
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<tr>
<td>Greatest visibility during summer months</td>
<td></td>
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<tr>
<td>Provides greatest restriction to operations in October (visibility &lt;2 nm ~5% of time)</td>
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Once-through cooling

Background

- Once-through cooling (OTC) refers to the use of river, lake or ocean water to cool exhaust steam in a power plant and discharging the water, now slightly warmer, back to its original source.
- OTC plants are the largest water dischargers in California; nationally, water use by power plants accounts for half of U.S. water use.
- While large volumes of water are used to minimize the intake-outlet temperature differential, OTC raises other environmental concerns:
  - Impingement: trapping of fish or shellfish against intake screens (~44 metric tons/year for CA OTC plants¹)
  - Entrainment: drawing-in of smaller aquatic organisms into the cooling system (79 billion biological specimens, e.g., fish larvae, invertebrates, aquatic life eggs)

Recent regulatory developments

- Power plant cooling water intake is subject to federal regulation under the Clean Water Act. In 2007 EPA suspended the rules governing its implementation due to preparation of new rules, but in the meantime, EPA has authorized states to implement their own regulations.
- On May 4, 2010, SWRCB issued regulations requiring a 93% reduction in water intake, effectively requiring generators to replace their OTC systems with "closed loop" systems that continuously re-circulate cooling water through the plant.

¹ Data source: California Department of Fish and Game.
Implications of OTC compliance

OTC plants in California’s electricity supply

- California’s OTC power plants include both fossil and nuclear plants.
- The fossil plants are generally older and less efficient so, although they account for 27% of capacity, they supply only 7% of electricity.

Impacts

- San Diego has only three OTC power plants:
  - Encina (Carlsbad)
  - South Bay (Chula Vista)
  - San Onofre Nuclear Generating Station

- SDG&E, in concert with the CPUC and CAISO, have been developing alternatives to the two fossil plants so that they can be shut down:
  - South Bay: YE2012 (Units 3 & 4 already retired, 1 & 2 to be replaced by Sunrise Powerlink)
  - Encina: YE2017 (to be replaced with other in-basin generation)

- Because it is not clear that nuclear plants can be retrofitted with air-cooling, the compliance schedule for California’s nuclear plants is still in development, pending further study.

California’s electricity supply in 2008

Source: Energy Commission Electricity Analysis Office
Using ocean measurements in forecasting natural gas demand

- Natural gas utilities develop short- and long-term forecasts of demand to facilitate system planning, construction and operations
  - In the early 2000s, SDG&E attempted to use oceanographic data to help forecast natural demand
  - The forecast was intended to predict whether an upcoming summer (June – September) would be warmer or cooler than average

- SDG&E worked with Scripps Institute of Oceanography to:
  - Collect surface water temperature data off the coast of San Diego from February through April of each year
  - Use these data as inputs into a model predicting summer weather

- Forecasting results were inconclusive
  - After five years, look-back analysis showed that model’s predictions were correct 52% of the time
  - Sempra discontinued the project in 2005

- Possible conclusions
  - Surface water temperature has limited impact on summer weather patterns
  - Model may not have captured the relationship
  - Potential distortions due to ocean current patterns
Concluding thoughts

- Sempra, like other energy companies, uses ocean measurements in our forecasting, planning, development and construction activities

- Ocean measurements are likely to become increasingly important to energy companies on the West Coast, due to:
  - Heightened environmental regulation
  - Climate change