Teaching the Duck to Fly
Ten Strategies To Help Us Reach 100% Clean Energy

South Sound Climate Action Convention
Olympia, Washington
What’s a “Duck Curve?”
Why is this an issue?

Solar helps meet daytime load.

Loads still rise in the early evening.

Compounded by wind coming and going.
How Do Utilities Manage This Now?
Guess What: Ducks Can Fly

A duck in water has very much the shape of the CAISO graphic. The “fat body” floats, and the tall neck breathes.

A duck in flight stretches out its body and straightens its neck in order to reduce wind resistance.
Ten Strategies To Align Loads to Resources (and Resources to Loads) with Illustrative Values for Each

1. Targeted energy efficiency
2. Peak-oriented renewables
3. Manage water pumping
4. Grid-integrated water heating
5. Storage air-conditioning
6. Rate design
7. Electricity storage in key locations
8. Demand response
9. Inter-regional exchanges
10. Retire inflexible older generating units

Not every strategy will be applicable to every utility.
Strategy 1: Targeted Energy Efficiency
Strategy 2: Peak-Oriented Renewables

- Late-afternoon wind
- Hydro re-dispatch
- Solar/thermal
- West-facing solar

![Graph showing annual 80-m diurnal wind energy patterns.](image)
Strategy 3: Manage Water Loads

- 7% of national electricity usage.
- Water and wastewater systems have storage.
- It may be cost-effective to augment the tanks and reservoirs.
Strategy 4: Water Heating

• 14% of residential usage.
• Every water heater is a thermal battery.
• Heat the water when power is cheap; use the hot water as needed.

Above, Sequentrie’s patented variable-capacity grid-interactive water heater.
45 Million Electric Water Heaters

Hawaii: 60%
West: 26%
Midwest: 30%
Northeast: 22%
South: 60%

Census Housing Survey Table 2.5 (2010)
Rule #1: No Cold Showers
No, You Don’t Run Out of Hot Water
Potential: Double Existing Wind and Solar
Strategy 5: Air Conditioning Storage
A/C is ~30% of Peak Demand

- Commercial load doubles;
- Residential load up 4X
- Option:
  - Appliance standards
  - Service standards
  - Retrofit incentives
We Can Store “Cool” as Ice (in fact, most of us already do)
Small Buildings: Unitary Storage Air Conditioning
Large Buildings: Ice or Chilled Water Storage

Calmac

Photo: © Gunther Intelmann for Cook+Fox Architects
Austin Energy: District Cooling System

Source: Austin Energy
Strategy 6: Rate Design

Interim Time-of-Use Rates

- **Off-Peak**: 23.7 ¢
- **Mid-Day**: 14.9 ¢
- **On-Peak**: 37.3 ¢

*Illustration reflects October 2016 Interim Time-of-Use rates.*
SMUD: Customers Actually Do Things

Behavioral Actions Taken to Reduce Load Between 4 and 7 pm

<table>
<thead>
<tr>
<th>Action</th>
<th>Default CPP</th>
<th>Default TOU-CPP</th>
<th>Default TOU</th>
<th>Opt-in CPP</th>
<th>Opt-in TOU</th>
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</thead>
<tbody>
<tr>
<td>Did Laundry Off Peak</td>
<td>73.5</td>
<td>76.3</td>
<td>86.1</td>
<td>88.7</td>
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<tr>
<td>Turned Off Lights</td>
<td>73.5</td>
<td>71.6</td>
<td>73.2</td>
<td>80.5</td>
<td>81.4</td>
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<tr>
<td>Did Dishes Off Peak</td>
<td>62.1</td>
<td>63.6</td>
<td>68.9</td>
<td>70.5</td>
<td>72.7</td>
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<tr>
<td>Turned Off Air Conditioner</td>
<td>45.8</td>
<td>52.9</td>
<td>45.1</td>
<td>70</td>
<td>61.8</td>
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<tr>
<td>Increased Temperature on Thermostat</td>
<td>43.4</td>
<td>35.8</td>
<td>37.5</td>
<td>40.9</td>
<td>47.4</td>
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</tbody>
</table>
Strategy 7: Electricity Storage
Strategy 8: Demand Response

How Demand Response Works
BPA Residential Auto Direct Load Control Pilot

Utility issues a demand response event
Event is transmitted via power line carrier or radio signal to home
Most Customers Will Consider DR

- Not interested at all: 21%
- Already use these services: 9%
- Extremely/very interested: 29%
- Moderately/a little interested: 42%

Strategy 9: Inter-regional Power Exchange

- Transmission lines mostly used for baseload connections and economy energy.
- Also useful for peak diversity exchanges.
Diversity Between Regional Peaks

West Coast Electricity Consumption by Month

Source: http://www.eia.gov/electricity/data.cfm#sales.
Strategy 10: Retire Inflexible Older Generation

• Minimum load restrictions on older power plants force utilities to run them at hours when the generation is not needed.

• In some places, this forces prices to zero or negative; in others it forces curtailment of renewables.
Northwest Coal Retirements
Northwest Coal Retirements
Teaching the Duck to Fly

Requesting Permission for Take-Off
About RAP

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