The Renewables Challenge: Matching Loads to Resources

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The California ISO “Duck Curve”: Increasing solar means steep afternoon ramping.
What Causes This Challenge?

Variable Loads

Wind

Solar
Teaching the "Duck" to Fly
Ten Strategies To Align Loads to Resources (and Resources to Loads) with Illustrative Values for Each

1. Targeted energy efficiency
2. Orient solar panels
3. Use solar thermal with storage.
4. Manage electric water heat
5. Require new large air conditioners to include storage
6. Retire older inflexible power plants
7. Concentrate rates into “ramping” hours
8. Deploy electricity storage in targeted locations
9. Implement aggressive demand response programs
10. Use inter-regional exchanges of power

Not every strategy will be applicable to every utility.
Some Things That Are NOT the Answer
Policies:
70% Clean Energy by 2030
Visionary Energy Code

Programs:
Hawaii Energy
Solar tax credit

Pricing:
Time-varying prices
Critical Peak pricing
Bits and Pieces of “The Answer”

- Concentrate conservation on key hours;
- Make loads more flexible;
- Use pricing design to shape loads;
- Install storage in key locations;
- Keep a shared grid viable;
- Resolve the “big wind” vs. “distributed energy” policy debate.
HECO Residential Peak Loads

Strategies:
Target key loads and key hours.

- Cooling: 32%
- Water: 12%
- Heat: 12%
- Lighting: 13%
HECO Commercial Peak Loads

Strategies:
Target key loads and key hours.

- Lighting: 45%
- Cooling: 17%
Strategy 4: Grid-Interactive Water Heating (GIWH)

• Acts as a low-cost “battery”
• Stores a full day’s supply
• Provides ancillary services to the grid
• **NOT:** simple timers.
Grid-Integrated Water Heating: Low-Cost Battery

16.14 kWh
Current Charge Level

8.86 kWh
Current Reserve Capacity

25.00 kWh
Total Storage Capacity
Technical Potential: Hawaii

- ~150,000 electric water heaters;
- ~600 MW of potentially controlled load;
- Enough for ~300 MW of variable renewables;
- Could end Maui wind curtailment.
Strategy 5: Require Storage On New AC

Require new AC units to include thermal (ice/water) storage, under grid control.
AC Storage Can Shift Load Into Target Hours

A/C chilled water or ice storage can move the entire cooling load into low-cost hours.
Thermal Storage Is Cheaper Than Electricity Storage

Capital cost per unit energy - $/kWh output

Capital cost per unit power - $/kW
Thermal Energy Storage Is More Efficient Than Electricity Storage
Water Pumping Uses ~5% of kWh

$0.20/kWh when power is "cheap"

$0.50/kWh when power is "expensive"
## Strategy 7: Pricing

<table>
<thead>
<tr>
<th>Current HECO Residential Rate</th>
<th>Future TOU/CPP Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$9.00/month</strong></td>
<td><strong>$9.00/month</strong></td>
</tr>
<tr>
<td>First 350 kWh: $0.34</td>
<td>Lower-voltage</td>
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<tr>
<td>Next 850 kWh: $0.35</td>
<td>Distribution: $0.10/kWh</td>
</tr>
<tr>
<td>Over 1,200 kWh: $0.37</td>
<td>Power Supply:</td>
</tr>
</tbody>
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|                        | Off-Peak: $0.10     |
|                        | On-Peak: $0.30       |
| Critical: $0.50        |
## Pricing

<table>
<thead>
<tr>
<th>Current HECO Schedule P (Large Users)</th>
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<tbody>
<tr>
<td><strong>Cost:</strong> $350.00/month</td>
</tr>
<tr>
<td><strong>Demand/kW:</strong> $24.34</td>
</tr>
<tr>
<td><strong>Energy/kWh:</strong> $.26</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Future TOU/CPP Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost:</strong> $350.00/month</td>
</tr>
<tr>
<td><strong>Demand/kW:</strong> $10.00</td>
</tr>
<tr>
<td><strong>Energy / kWh:</strong></td>
</tr>
<tr>
<td>Off-Peak: $0.17</td>
</tr>
<tr>
<td>On-Peak: $0.37</td>
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<tr>
<td>Critical: $0.57</td>
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Electricity Storage
How Do Electric Car Owners Use Power Differently?

Average Hourly Grid Electricity Use:
Electric Car Households vs. Typical Households

Average kWh of grid electricity use per household

Morning | Midday | Evening | Midnight/Wee Hours

Electric Car Households*

Typical Households

*Electric Car households defined as customers enrolled in night-time car charging rate plan.

http://www.renewableenergyworld.com
Preserving A Shared Distribution Grid
Resolve “Big Wind” “Big Geothermal” and “Decentralized Power” Issues

"Mi Energía Solar"
Big Wind

Geothermal

Biofuels

Decentralized

©dhayward
Lais Ogata
HECO’s Future?

City Wide Service by White Front Cars

Market Street Railway Co.
San Francisco
About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

Teaching The Duck to Fly available at:  http://www.raponline.org/document/download/id/6964

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Proposed Action Items

• Target conservation at high-cost hours
• Install controls on electric water heaters
• Require new AC units to have storage
• Implement time-varying pricing for all customers
• Phase down solar incentives as the industry matures
• Ensure rate design does not push solar customers off-grid.