Today’s discussion

1. Modeled price-based transactive energy instabilities
2. Historic opportunity to enable broadband companies to provide grid management services that
   ● Raise the efficiency and lower the cost of electric power generation, distribution, and use
   ● Accelerate the safe adoption of renewable energy sources like wind and solar power
3. *Identify partners for pilot deployments*
Vision and Value Proposition

RCA provides ANSI/SCTE standard-compliant GRIDIoT® Optimum Load Shaping (OLS) signals, over multiple networks, to flexible distributed energy resources, such as electric vehicles, to voluntarily adjust their demand for electricity to ensure the maximum use of renewables, lowest generation costs and carbon emissions.

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Co-optimization of Load & Generation

Houses by region

Generic Loads

Model Predictive Controller

\[ f(\text{weather, }$/\text{kWh}) \]

\begin{align*}
\text{H} &\quad \text{V} &\quad \text{A} &\quad \text{C} &\quad \text{B} &\quad \text{T} &\quad \text{D} &\quad \text{W} \\
\text{Heat setpoints} &\quad \text{AC setpoints} &\quad \text{Capacity} &\quad \text{Ramp rate} &\quad \text{End of day SOC} &\quad \text{Setpoints} &\quad \text{Empirical usage} \\
\text{Heating} &\quad \text{cooling} &\quad \text{power} &\quad \text{storage} &\quad \text{renewable} &\quad \text{utility} &\quad \text{weather} \\
\end{align*}

Auto size

- HVAC
- Battery
- PV

\[ \sum_{\text{Houses} (t)} \text{FEEDER} \]

\[ \sum_{\text{Houses} (t)} \text{SCALE TO WEATHER ZONE} \]

Production Cost Model

- Per generator constraints
  - Startup cost
  - Min power
  - Max power
  - Ramp rate
  - Heat rate effic
  - Fuel burn $\$
  - CO2 emit
  - Min downtime

Generator counts

- Nuclear ST
- Coal ST
- Gas ST
- Gas CT
- Gas CC
- Gas IC
- LFG
- Utility solar
- Utility wind

Load \(_{(t)}\)

Optimum Shape \(_{t}\)

$/Wh \(_{(t)}\)

CO2/Wh \(_{(t)}\)

8:00 AM @ 5¢
9:00 AM @ 7¢
... 
11:00 AM @ 6¢

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1. Price-takers become price-makers

Load from Model Predictive Control control of air conditioning setpoints in 2,146 houses on PNNL Prototypical Feeder R-2500-1 in Houston, TX on 7/20/TMY
Iteration(s) result in Whac-a-Mole behavior

Load from Model Predictive Control control of air conditioning setpoints in 2,146 houses on PNNL Prototypical Feeder R-2500-1 in Houston, TX on 7/20/TMY
2. Optimum Load Shaping solution

Monetizing distributed storage and all flexible loads

1. RCA creates and sends forecast OLS that minimizes costs of electricity generation, purchasing, and distribution
2. Any network delivers OLS to connected devices
3. Devices modulate demand to meet OLS
4. Customers benefit from reduced electricity costs
5. States meet 100% renewable generation mandates
Problems OLS solves

- Storage charged with clean power
- Accelerate transition to EVs, low-cost 100% renewables
- Extend the life of the grid through non-wires solutions
- Lower the cost of power generation, distribution, and use
- Use existing metering & billing processes & infrastructure
- Provide transaction-less continuous demand response
OLS solves many problems

Global load shaping favors renewable energy and efficient generation

Local load shaping mitigates last-mile grid congestion identified by next-generation sensors
### Example savings: Electric vehicle charging

<table>
<thead>
<tr>
<th>Time</th>
<th>Forecast Load</th>
<th>Forecast Renewables</th>
<th>Net Generation</th>
<th>Flat Net Generation</th>
<th>Optimum Load Shape</th>
<th>EV Optimum Load Shape</th>
<th>Shaped EV Load</th>
<th>Unshaped EV Load</th>
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<td>c/h</td>
<td>c/h</td>
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<td>3.6%</td>
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<td>Totals</td>
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<td>100%</td>
<td>100%</td>
<td>10.00</td>
<td>10.00</td>
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</table>

The vehicle is in use and unavailable for charging from 0700 - 1800 hours.

The charger takes unavailability into consideration and autonomously adjusts the Optimum Load Shape that it received from the supply-side.

### Deliver OLS over any network

<table>
<thead>
<tr>
<th>Cost $</th>
<th>Savings %</th>
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<tr>
<td>1.70</td>
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SCTE STANDARD

SCTE 267 2021

Optimum Load Shaping for Electric Vehicle and Battery Charging

Network Operations Subcommittee

Preliminary - Draft - Not Yet Adopted

NOS 207

Requirements for Power Sensing in Cable and Utility Networks
Summary of New SCTE standards

Reduce ops costs, create revenues

- **OLS:** Creates and monetizes virtual power plants of electric vehicles, hubs, data centers -- while improving resiliency

- **Sensing:** Detects and forecasts HFC and grid power quality issues and congestion. Reduces outage disasters. Improves outage coordination. Lowers electricity bills.
Summary of Optimum Load Shaping

ANSI/SCTE 267 standard issued in April 2021 for charging EVs and batteries

- Jointly optimizes supply and flexible loads w/o two-way comms, PII or opt-in
- Continuous transaction-less demand response use voluntary predictive control
- Day-ahead forecast specifies percent of energy use per interval
- Supports hierarchical control of multiple objectives: Costs, Carbon, Congestion

Benefits

- Favors renewables, minimizes generation cost/carbon, distribution congestion
- Leverages SCTE Power Sensing standard to identify & forecast congestion
- Overcomes non-deterministic price-maker vs. price-taker instabilities and prevents cliffs, rebounds, and oscillatory load responses

Ready for pilot deployments
Grid Modernization

Aging infrastructure; fire-prone areas

www.gridmetrics.io outage alerts

Carbon-free generation by 2030-2050

Climate change warnings and concerns

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3. Questions and Pilot Opportunities

Contact us to

● Sign up
● Further discussion

Thank you!
Supplemental Slides
Global outlook: O&M Expense

$500B annual generation fuel cost

$100B annual savings potential

$10B annual savings based on 10% market share

The value of Optimum Load Shaping increases with renewable penetration

Results from daily simulation of Texas hot summer day

50% of homes with Solar PV

100% of homes with Solar PV

29% of load shaped

59% of load shaped

RES Curtailment avoided
Grid + IoT + Storage = Savings + Maximum Renewable Penetration

- Business & savings grow with Internet-connected devices
  - Same Optimum Load Shape sent to most devices
  - No Opt-in. Much simpler than Transactive Energy
  - Support widespread electrification with T&D “non-wire” upgrades
- Consumer-inclusive business model
  - Brings community together
  - Key to socio-economic success
OLS deployment strategy

Phase 1: Enable utility
- Forecast Load & Renewables
- Forecast Market Pricing
- Forecast Distribution Congestion
- Forecast Optimum Load Shape

Phase 2: Enable devices

Internet

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Core Team

Robert Cruickshank, CEO/CTO: PhD in Architectural Engineering
• 37 years in telecom, led design of world standard cable modem aka DOCSIS
• 40 years in network ops and researching orchestration of supply and demand

Laurie Asperas Valayer, CSO: MBA Energy Management
• 35 years innovating energy, ecodesign, educative and sports industries

Marc Asperas, Chief Legal Counsel: CS in Electrical Engineering, JD in Patent Law
• 29 years developing and managing network and CPE Intellectual Property portfolios

Frank Sandoval, Head of Development: BA in English and Computer Science
• 35 years designing and managing development of software, APIs, and protocols

Advisory Board: ISO, IOU, Muni, Co-op, NREL, CableLabs, Univ of Colo, Univ of Denver, connected device manufacturers
Distribution feeder daily response to control of A/C, Battery, Water heater for 50% PV, 8 MW Peak

Unshaped in Red
Shaped in Blue