About Tierra Resource Consultants, LLC

- Founded in 2013; based in Walnut Creek, California
- Multidisciplinary energy and sustainability consulting engineering firm serving clients across North America
- Tierra’s consultants each leverage over three decades of energy industry experience
- Expertise includes engineering, economics, finance, strategy, resource planning and regulatory compliance
- Clients include:
  - Electric and gas utilities
  - Regulatory and governmental agencies
  - Industry research and advocacy groups
  - Energy service companies
  - Private sector companies
  - Design and construction firms
Integrating Utility and Consumer Goals for Synergistic Benefits

LEARNING OBJECTIVES:

1. Expand scope from one ZNE/ZNC building to portfolio and grid to address multiple goals
   a. Decarbonization
   b. Electric system reliability and resource management
   c. Energy system resilience
   d. Cost reduction goals for consumers and utilities
2. Impacts of energy use + carbon reduction efforts on load shapes + demand management
3. Understand importance of utility avoided costs in ZNE/ZNC program planning
4. Assess optimal mix of the following strategies to achieve goals
   a. Efficiency
   b. On-site renewable generation
   c. Demand management and battery storage
   d. Building/transportation electrification
   e. Integration with the electric grid
1. Reach climate neutrality by 2025 (buildings) and 2035 (w/ transportation)

2. Attract students, professors, funding, and research

3. Create a new model to demonstrate how to reach climate neutrality

4. Achieve goals with transparency, best value assurance, and partnership
Over 10 years – EPCs and PPAs were leveraged to reduce ASU capital requirements by 75%

ARIZONA STATE UNIVERSITY: PROJECTS COMPLETED BY AMERESCO (2004-2013)

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Cost (USD)</th>
<th>EPC (3rd Party Funds)</th>
<th>Institutional Capital (ASU Funds)</th>
<th>PPA (3rd Party Funds)</th>
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</thead>
<tbody>
<tr>
<td>2004</td>
<td>$39,942,154</td>
<td>$39,942,154</td>
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<tr>
<td>Boiler &amp; Burner Replacement</td>
<td>$2,600,000</td>
<td>$2,600,000</td>
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<tr>
<td>Combined Heat and Power Plant</td>
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<td>Cooling Tower Replacement</td>
<td>$1,500,000</td>
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<tr>
<td>2007</td>
<td>$40,600,000</td>
<td>$40,600,000</td>
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<tr>
<td>Central Plant and Utility Distribution System</td>
<td>$15,800,000</td>
<td>$15,800,000</td>
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<tr>
<td>Solar PV Phase II / 6.24 MW</td>
<td>$52,427,939</td>
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<td>$52,427,939</td>
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<tr>
<td>Solar PV Phases III &amp; IV / 3.66 MW</td>
<td>$22,179,159</td>
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<tr>
<td>Solar PV Phases VI and VII / 2.83 MW</td>
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<td>$15,959,810</td>
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<tr>
<td>Solar Thermal Phase V / 2 MW</td>
<td>$10,800,000</td>
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<tr>
<td>Solar PV Phase V / 901 kW</td>
<td>$7,171,188</td>
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<td>Solar PV Phase VIII / 1.3 MW</td>
<td>$7,594,749</td>
<td>$7,594,749</td>
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<tr>
<td>HVAC Upgrades</td>
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<td>$824,363</td>
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<tr>
<td>Total Dollars Invested (USD)</td>
<td>$262,095,362</td>
<td>$80,542,154</td>
<td>$65,420,363</td>
<td>$116,132,845</td>
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</tbody>
</table>

Percentage of Total Dollars Invested
- EPC = 31%
- PPA = 25%
- Institutional Capital = 44%

Resulting energy and GHG emissions savings:
- 98.5 GWh/year
- 1.4 million therms/year
- 77,247 tonnes CO₂e/year

Achieving aggressive GHG reduction goals requires financial creativity and “capital stacking”:
- EPCs
- PPAs
- Maintenance funds
- Grants
- Incentives
- Partnerships
- Cap and Trade Programs
- Etc….
BAU forecast of ASU energy costs - $555M from 2014-2025
Over 60% of backlog is related to energy-using electrical & mechanical equipment.

Replacement could yield energy savings that could then be leveraged to fund other investments, which could further reduce GHG emissions.
Take a comprehensive, integrated approach to transition ASU’s building portfolio to greater energy efficiency

- Portfolio strategy at ASU
  - Leveraged existing knowledge, audits, interviews
  - Assessed assets, technical potential
  - Proposed NZE / near-NZE for all new buildings
    - Visited NREL to tour ESIF and to identify process changes for performance-based building delivery
  - Strategies:
    - Continuous commissioning (CCx)
    - Cross-cutting measures (CC)
    - Deep energy retrofits (DEEP)
    - Deep energy retrofits over time (DOT)
    - On-site renewables (REN)
  - Calculated potential energy efficiency improvements
  - Targeted level of efficiency improvement:
    - 28% better than baseline
    - 37% better than baseline
Leverage microgrids to achieve utility and customer goals

- **Customer Objectives**
  - Improve grid reliability, redundancy, resiliency, and flexibility
  - Gain experience designing and operating a microgrid
  - Discover associated capital and O&M requirements
  - Learn how microgrids can be used to reduce carbon emissions
  - Reduce energy costs, if appropriate
  - Learn about smart grids, DR, DER, renewable energy use and storage
  - Offer unique demonstration projects to benefit research and education goals
Leverage mix of tools and technologies to find the least-cost, grid-integrated approach to NZE/NZC.
## Roadmap components and strategies

<table>
<thead>
<tr>
<th>Built Environment</th>
<th>Supply &amp; Infrastructure</th>
<th>Transportation</th>
<th>Institutional Initiatives</th>
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</thead>
<tbody>
<tr>
<td>• Highly-efficient new construction and renovations</td>
<td>• Increase efficiency</td>
<td>• Optimize to reduce vehicle miles traveled (VMT)</td>
<td>• GHG Emissions Management System (GEMS)</td>
</tr>
<tr>
<td>• Reduce dependence upon natural gas</td>
<td>• On-site PV &amp; solar thermal</td>
<td>• Move to efficient vehicles</td>
<td>• Enhance sustainable building guidelines</td>
</tr>
<tr>
<td>• Implement large, integrated energy upgrade programs</td>
<td>• Energy storage</td>
<td>• Integrate alternatively-fueled vehicles &amp; microgrid</td>
<td>• Engagement / behavioral programs</td>
</tr>
<tr>
<td></td>
<td>• Develop flexible microgrids</td>
<td>• Offsets for air travel</td>
<td>• New financing &amp; project delivery mechanisms</td>
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</tbody>
</table>
Climate neutrality roadmap: integrated approach drives results

**Energy efficiency drives the economics of achieving climate neutrality**

**Best Case Mix – Results**

**Economic Benefits:**
- Reduce energy costs
- Reduce deferred maintenance
- Attract students, investment, research
- Improve asset utilization
- Reduce GHG with positive Net Present Value

**Social Benefits:**
- Position University as a Climate Leader
- Attract other Climate Leader partners
- Lead transition to Low-Carbon Society
- Integrate & drive higher-education mission

**Environmental Benefits:**
- Achieve significant GHG emissions reductions
- Demonstrate path to low-carbon operations
- Engage other leaders and multiply impact
NZE and Utility Planning Objectives

Core principles:
1. Ensuring Affordability
2. Achieving Decarbonization
3. Guaranteeing Grid Reliability

California Customer Choice; An Evaluation of Regulatory Framework Options for an Evolving Electricity Market (The “Green Book”), the California Public Utilities Commission.
Program Design Criteria – A Recent Project Example

The three-legged stool...

PLUS
• Economic and workforce development
PLUS
• Serving low income and disadvantaged communities
PLUS
• Emergency preparedness
The Utility Challenge (Arizona Example)

Value of energy is not the same for all hours of the year

• Significant reduction in net load during the daytime, non-summer seasons from solar DG

• Low or negatively priced energy during mid-day with more expensive prices ramping to late afternoon/evening

Evolving Load Shape
Non-Summer Illustration
A Balanced Approach to Utility Program Design is Required

- To meet goals, customer-facing utility programs require a balance mix of intervention strategies including EE, DERs, DR, and electrification.
- Locational and time dependent benefits come into sharper focus.
- Consideration of individual and aggregate load shape impacts is required.
Analyze Hourly DSM/DER Savings Load Shapes

- 8,760 hourly breakdown of average DSM/DER savings impacts by:
  - End use and DSM measure
  - Segment/building type (i.e. dual fuel)
- Mapped to current and potential new DSM/DER programs
- Build savings loads shapes for each measure based on their 8760 hourly load shapes and use cases
Resource Value - Marginal Cost Heat Map

Darkest shade represents the highest value hours for resource planning and the lightest shade represents the lowest value hours throughout the year.
Grid interactive HPWH dispatched by a utility program to help reduce early morning (6-9am) and late afternoon (6-9pm) peak demand while shifting energy use into midday hours to “fill the belly of the duck”
Measures with the Most Beneficial Load Shapes

From a utility resource planning perspective:

• Darkest shade shows percent of the most desirable savings, lightest shade shows least valuable

• Dotted lines show measures that provide <10% of desirable times, or >20% during least valuable.
An Evolving Utility Sector Paradigm

Current Planning Trend
- A focus on time and locational value of savings
- Time valued EE and DER at targeted hours
- Emphasis on demand management
- What about solar? + storage?
- Planning for electrification

Carbon Free Future
- Continued focus on time and locational value of savings
- EE all the time and lots of it
- As much solar as we can get + storage
- Continued emphasis on smart demand management
- Strategic electrification...how to integrate transportation?
Cost-effectiveness Testing

Which tests to use when?

The California Standard Practice Manual lays out test methods that have been the standard for analyzing the cost-effectiveness of utility programs for decades.

The Total Resource Cost (TRC) Test has been the benchmark standard in CA for energy efficiency programs...but was not designed to be used with electrification/DER/decarbonization programs.

The Resource Value Test (RVT) developed by the National Efficiency Screening Project provides a structured but flexible alternative approach to assessing the cost-effectiveness of NZE programs grounded in the utility’s policy priorities.
Thank you!

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