Energy Systems for the 21\textsuperscript{st} Century

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy’s National Nuclear Security Administration under contract DE-AC04-94AL85000.
The Energy Supply Challenge

- Rising Worldwide Energy Demand / Energy Costs
- Growing Impact of Climate Change
- Oil-Producing Regions Instabilities
Sandia’s Vision

Provide systems perspective and technological solutions for fuel and electricity that help assure:

- Secure and sustainable supply
- Safe and resilient delivery infrastructure
- Clean, efficient use of resources

Technology Innovation—In a Systems Context
## Key Attributes of Future Energy Systems

### Energy Surety Requirements

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>Safely supplies energy services to end user</td>
</tr>
<tr>
<td>Secure</td>
<td>Resists natural and manmade disruptions</td>
</tr>
<tr>
<td>Reliable</td>
<td>Maintains delivery when &amp; where needed</td>
</tr>
<tr>
<td>Sustainable</td>
<td>Matches resources with needs</td>
</tr>
<tr>
<td>Cost Effective</td>
<td>Energy at lowest predictable cost</td>
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</table>
The Current Energy System

- Over 50% of energy resources are lost in conversion and transport
- Diversity of sources difficult for grid to accommodate
- Reliance on nature to close the cycle on waste by-products
An Integrated Strategy for a Sustainable Future

Persistent Energy Sources and Conversion Processes

Fossil Fuel Sources and Conversion Processes
An Integrated Strategy for a Sustainable Future
An Integrated Strategy for a Sustainable Future

Persistent Energy Sources and Conversion Processes

used nuclear fuel

END USE
Electric
Transportation
Residential
Agriculture
Industrial

Recycled Resources

Fossil Fuel Sources and Conversion Processes

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An Integrated Strategy for a Sustainable Future

Persistent Energy Sources and Conversion Processes

Hydrocarbon Intermediary (Production & Storage)

Fossil Fuel Sources and Conversion Processes

CO₂ capture and reuse

END USE
Electric Transportation
Residential Agriculture
Industrial

Recycled Resources

Hydrogen & Carbon Sources
A Transition Strategy for Fuels

• Hydrogen as an energy carrier is decades away

• Conversion to liquid hydrocarbons speeds use
  – relatively safe - toxicity, flammability
  – high mass and volumetric energy density
  – existing infrastructure distribution
    system adaptable

• The transition strategy provides fuel and
  reduces GHG emissions while
  using existing energy infrastructures
  – requires a systems view
  – requires improved system efficiency
  – extends life of petroleum resources
  – is carbon neutral
Sandia’s Energy Surety Focus Areas

- Energy systems with reduced carbon emissions
- Energy surety microgrids
- Persistent energy technologies
- Hydrogen and combustion science
- Alternative transportation fuels: solar/nuclear-based and bio-based

Success = Technology Brought to Market
Sandia’s Commercialization through Industry Partners

<table>
<thead>
<tr>
<th>Discovery Research</th>
<th>Use-Inspired Research</th>
<th>Applied R&amp;D</th>
<th>Demo</th>
<th>Market Entry</th>
<th>Market Penetration</th>
<th>Market Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock/bit innovation</td>
<td></td>
<td></td>
<td></td>
<td>Cummins</td>
<td>TPI and Knight &amp; Carver</td>
<td>Many Companies</td>
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<tr>
<td>Combustion modeling and testing</td>
<td></td>
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<td></td>
<td>GM</td>
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<tr>
<td>Hydrogen: storage, systems design, codes and standards</td>
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<tr>
<td>Wind turbine blade innovation</td>
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<td></td>
<td>Advent Solar</td>
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<tr>
<td>Semiconductor materials, systems, and manufacturing innovation</td>
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<tr>
<td>Compound semiconductor materials</td>
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Thank You

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