Aug 12th, 9:10 AM - 10:10 AM

Overview of DRI’s renewable energy activities

Kent Hoekman
Desert Research Institute, Kent.Hoekman@dri.edu
Overview of DRI’s Renewable Energy Activities

2009 UNLV Renewable Energy Symposium
Las Vegas, Nevada
August 12, 2009
S. Kent Hoekman
Presentation Outline

1) Past RE activities at DRI
2) NSWEP Program
3) Development of DRI-REC
4) Other Recent DRI RE Projects
5) Initial Consortium Interest Areas
6) Future Growth Areas
Renewable Energy Activities at DRI: Past, Present, and Future

■ Early History

■ 1970s and 1980s:
  ■ Geothermal exploration using geochemical and hydrologic techniques
  ■ Solar research at Boulder City involving solar pond, PV systems, solar thermal
  ■ Outreach to community, utilities, installers, etc.

■ 1990s:
  ■ Development, demonstration, and assessment of off-grid renewable energy systems
More recent history – Outreach

**Green Power Program**

**Purpose:**
- Promote green sources of energy in Nevada, with an emphasis on educating Nevada’s K-12 population.

**Activities:**
- Install renewable energy systems at schools throughout Nevada
- Provide monitoring of energy production and use
- Support science curriculum
Northern Nevada Workforce Training

- Dept. of Labor funded collaboration between DRI and TMCC
- Objective: develop a system for training a local workforce in renewable energy
- Involved TMCC faculty externships with companies
- Explored other successful programs and local ventures
- Identified industry needs for trained personnel
- Developed course materials now in use
Nevada Southwest Energy Partnership (NSWEP)
- Federal initiative program in effect from FY02 to present
- 3 Nevada research institutions: DRI, UNR, UNLV
- DOE funding, managed by NREL

NSWEP Purposes:
- Promote RDD&D of Nevada’s renewable energy
- Partner with private sector
- Provide education and outreach regarding renewable energy
NSWEP-Funded Research Areas

Wind energy resource assessment

- Measurement and modeling to assess wind potential throughout the State
- Wind conditions at relevant locations and heights
- Detailed spatial and temporal scales
- Infrastructural considerations:
  - Accessibility
  - Proximity to power lines
  - Land use restrictions
NSWEP-Funded Research Areas

Hydrogen in Off-Grid Applications

- Produce $\text{H}_2$ by electrolysis as way of storing excess solar and/or wind energy
- When needed, use $\text{H}_2$ as fuel in gen-set to produce electrical power
Hydrogen in Transportation Applications

- Worked with Washoe County RTC to convert para-transit buses from CNG to HCNG
- Explored codes, requirements, and practical aspects of $\text{H}_2$ production, storage, and re-fueling in transportation applications.
- Assessed vehicle performance and emissions effects of conversions.
Other NSWEP-Funded Area: Development of DRI-REC

- Phase I: Planning (2007-2008)
  - Develop mission, goals, and strategies
  - Identify and prioritize areas of emphasis
  - Define structure and operating parameters

- Phase II: Doing (2009-2010)
  - Implement Phase I plan
  - Emphasize building of capabilities
  - No R&D focus

- UNR and UNLV are also developing RECs
Mission, Goals, and Strategies of DRI-REC

**Mission:** Grow DRI’s capabilities and expertise in the areas of RE research, development, demonstration, and deployment (RDD&D)

- Provide organizational umbrella under which all of DRI’s RE activities are conducted and coordinated.
- Provide recognizable “point of entry” for sponsors, collaborators, and other supporters to interact with DRI in RE areas.
- Provide a sound foundation of research expertise and capabilities from which DRI can build core strengths in RE RDD&D.
Mission, Goals, and Strategies of DRI-REC

**Goals:**

- Serve as a leader in Nevada for RE science and engineering.
- Establish active partnerships and collaborations as part of Nevada’s REC Network.
- Foster science and engineering talent within Nevada.
- Provide educational opportunities.
- Be competitive in responding to funding opportunities.
Mission, Goals, and Strategies of DRI-REC

Strategies:

1. Build upon DRI’s history and existing core competencies
   - Environmental science/environmental assessments
   - Atmospheric science: wind measurements and modeling
   - Laboratory capabilities
   - Understanding of geothermal systems
   - Knowledge of fuel composition, properties, and uses
   - Integration of small power systems
Mission, Goals, and Strategies of DRI-REC

**Strategies:**

2. Partner with others to expand range of competency

- Partner Groups: universities, government labs, research institutions, and the private sector
- Desirable Partner Disciplines:
  - Engineering and bioengineering
  - Power generation and transmission
  - Biomass conversion processes
  - Transportation systems
  - Agriculture
  - Economics
  - Policy development
  - Architecture
4 Main Areas of Emphasis within DRI-REC

1. Integrated Renewable Power Systems
   - Upgrade and combine DRI’s existing RE components into an integrated system
   - Relocate existing power monitoring and control modules
   - Expand renewable power generation capacity (additional PV units)

2. Wind Energy Research Capabilities
   - Develop instrumented tall research tower
   - Develop improved wind forecast capabilities using research tower
4 Main Areas of Emphasis within DRI-REC

3. Biomass/Biofuels Research Capabilities
   - Develop and utilize instrumented lysimeters for plant growth studies
   - Improve characterization of thermochemical products from biomass treatment

4. REC Administration, Coordination, and Outreach
   - Develop educational and outreach materials
   - Establish relationships with external stakeholders
Other Recent DRI RE Projects

**Literature Review of Biodistillate Fuels**

- Consider both biodiesel and renewable diesel fuels

**Topic areas:**
- Policy drivers
- Feedstocks and volumes
- Production technologies
- Fuel properties and specs
- Engine emissions
- In-use performance
- Life-cycle impacts
Other Recent DRI RE Projects

**CO₂ Recycling**
- **Sabatier Reaction:**
  - Highly exothermic ($\Delta H = -165$kJ/mol CO₂)
  - Utilize renewably-generated H₂
  - Application in natural gas power plant

- **Laboratory-scale reactor system built**
  - Demonstrated feasibility
  - Once-thru – no recycle
  - Used pure gas mixtures
  - Plan to continue with more realistic system
Other Recent DRI RE Projects

**Utility Accountant**

- Provide appliance-specific energy usage data
- Identify least efficient appliances
- Single point of measurement
- DRI patent pending

Usage Table

<table>
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<tr>
<th>ID</th>
<th>Name</th>
<th>Location</th>
<th>Category</th>
<th>Cost</th>
<th>Energy (kWh)</th>
<th>Ave Power (W)</th>
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Other Recent DRI RE Projects

- **Biomass-to-energy conversion**
  - Cooperative project with GTI, UNR, REII, and CWT
  - Optimize hydrothermal pre-treatment process for lignocellulosic biomass
  - Characterize physical and chemical properties of pre-treated feedstocks
  - Evaluate gasification of pre-treated feedstocks
  - Assess availability of biomass resources in Nevada
Other Recent DRI RE Projects

- **Algal-Based Fuels**
  - Nevada has excellent resources in:
    - Solar
    - Geothermal
    - Available land
  - But very little biomass
  - Concept: utilize existing resources to promote biomass growth in the form of algae.
Other Recent DRI RE Projects

- Algal-Based Fuels (cont.)
  - Algal growth is an exponential function of temperature
  - Utilize solar and geothermal energy to increase and stabilize algal temperatures
  - Initial areas of work:
    - Algal strain isolation
    - Selection of suitable geothermal resources
    - Optimization of algal culturing
1) Advancing Biofuels Research and Development
   - Pre-treatment of lignocellulosic biomass
   - Thermal treatment of biomass
   - Algal-based fuels

2) Solar
   - Solar power for renewable H₂ production
   - Integrate with CO₂ recycling system

3) Geothermal Prospecting
   - Hyperspectral remote sensing
   - Relationships between heat flow and isostatic rebound
Future RE Growth Areas for DRI

- Energy efficiency/buildings efficiency
- H₂ utilization in stationary and mobile applications
- Greenhouse gas life-cycle assessments (LCA)
- Assessments of RE system efficiency
- Chemical characterization of biomass-derived intermediates and products
- CO₂ recycling and sequestration
- Enhanced geothermal systems
- Climate impacts of RE
Visit DRI-REC at http://rec.dri.edu