Renewable Energy Research and Sustainability in Arizona

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AzRISE
Electricity Generation in Arizona (2006)

- Solar = 0.01%
- But solar is the most abundant renewable

- Coal 42.1%
- Nuclear 25.4%
- Natural gas 25.6%
- Hydro 6.8%
The Arizona Research Institute for Solar Energy

- Goal is to stimulate and guide the development and deployment of solar energy in Arizona.
- Combine science, engineering, economics, policy, education, workforce training, outreach, student programs.
- Approach is to form multi-disciplinary teams of faculty, natl. labs, industry, utilities to solve strategic problems.
- Partners at ASU, NAU, CSM, UCo, NMSU, UNLV, Sandia, NREL, PNL, Argonne, NIST.
- Current programs: 30 projects, 60+ students, 15 departments, 5 colleges 15 sponsors.
Solar Energy R&D

- Electricity generation:
  - Solar trough technology
    - Heat exchange fluids
    - Thermal storage fluids (MSE)
    - Thermal storage systems (AME)
  - Solar tower technology
    - Thermodynamics (AME)
    - Heliostats
    - Heat exchange fluids (MSE)
    - Heat engines
Solar Energy R&D

- Electricity generation:
  - Photovoltaics (MSE, Chemistry, ECE, OSC)
    - Efficiency
    - Cost
    - New materials, quantum dots, porous silicon, optical resonators
    - Transparent conductors
    - Sealants and reliability
  - Multi-junction cells (MSE, OSC)
    - Triple junctions – cost and processing
    - Going to more junctions – new materials, buffer layers
  - Cost, cost, cost (Eller, MSE)
Solar Energy R&D

Electricity generation:

- Concentrators:
  - CPV – Roger Angel (Astronomy)
  - Concentrated Solar Thermal – Stirling engines
  - Concentrated Solar Thermal – Brayton Engines (Southwest Solar Technologies) (MSE)
Solar Energy R&D

- **Measurements and testing**
  - TEP Solar Test Yard (Physics, ECE)
  - Solar irradiance, effects of long term exposure on module behavior and life time expectancy (MSE, Physics, Atmospheric Sciences)
  - Weather forecasting (Atmospheric sciences)

Alexander Cronin: TEP solar test yard (45 arrays)
Renewable energy: Variation in Production – NEEDS ENERGY STORAGE

- Good days produce predictable amount of energy
- Not so good days are more or less unpredictable
- Variation in production and demand

TEP test yard data in December 2008 (blue = DC power, red = AC power)
Professor Alexander Cronin (UA)
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<th>Duration</th>
<th>Hydrogen</th>
<th>CAES</th>
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<th>Flow cell</th>
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**Long term**  **Intermediate**  **Fast**
AzRISE Storage Research Areas

- **Supercapacitors**: New materials, membranes (MSE, ECE)
  - Partnership with NanoTune
- **Batteries**: New electrodes, electrolytes, controls (MSE, OSC)
  - Partnership with Lux Aviation (Solar Car), Sion
- **Compressed Air Energy Storage**: (MSE, MGE, CEEM)
  - Improved efficiency, new compression methods
  - Partnership with Southwest Solar Tech., AZ utilities
- **Pumped Hydroelectric**: (CEEM, Astronomy, Biosphere)
  - Survey of potential sites in Arizona
- **Hydrogen**: New materials, storage (MSE, OSC)
  - Partnership with Sandia National Labs, EMC
- **Biomass**: (Ag and ABE)
  - Future partnership with research at UA Biofuels Institute
Solar Energy Economics & Policy

- Economics of Compressed Air Energy Storage (CAES) and PV for energy arbitrage and power plant system optimization for utility-scale applications in AZ
- Evaluation of the value of potential battery technology
- Environmental benefits of investment in solar energy technology
- Arizona and SW region solar energy and economic outlook
- Market/risk analysis, best practices
- Land use analysis
- Policy incentives
- Climate change mitigation potential
- Options for integration of solar energy and storage into the energy supply system
- City, county and municipal planning for solar energy implementation

![Graph showing economic value of efficiency improvement](image-url)
Build strategies that can strengthen Arizona’s national and global solar presence

- Economic Research Report for deploying Solar in Arizona:
  - Costs, benefits, risks and opportunities
    - Estimated levelized cost of energy by technology
    - Impacts: jobs, environmental, water use, land use, societal
    - Policy recommendations
    - State-wide implementation action plan

- Policy Recommendations:
  - Integrated resource planning
  - Land designation for solar development
  - Utility sector incentives
  - Quality jobs through renewables
  - R & D policy and incentives
  - Storage and transmission
Educational Objectives

• Public awareness:
  – Lectures and seminars, expos and demonstrations
  – Public education

• Workforce training/retraining:
  – Technical training
  – Certificates for solar cell installers, maintenance, etc.

• Degree programs:
  – Undergraduate specialties in solar, renewable energy, sustainability
  – Graduate research and advanced degrees
  – Post graduate training

• New solar cells on campus:
  – Monitoring of solar flux, cloud effect and cell output on the web
  – Partnership with Arizona utilities
Student Projects

- Solar Decathlon – Arizona Solar House
- Solar Racing Car
- Solar Concept Car