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Transforming the Energy Enterprise Through Innovation

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Re-Energizing the Americas Conference
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www.energy.sandia.gov

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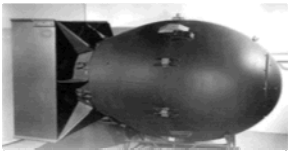
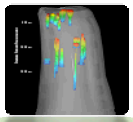
History of Sandia Energy Programs



Sandia was born as a nuclear weapons engineering laboratory with deep science and engineering competencies

Energy crisis of the 1970s spawned the beginning of significant energy work

Strategic Petroleum Reserve – geological characterization of salt domes to host oil storage caverns

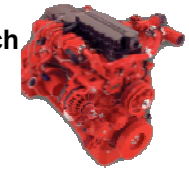


DOE's Tech Transfer Initiative was established by Congress in 1991

Advent Solar

Energy Policy Act of 2005

Combustions Research Facility (CRF) & Cummins partner on their newest diesel engine



Joint BioEnergy Institute

1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2007 | 2010

Our core NW competencies enabled us to take on additional large national security challenges

Vertical axis wind turbine

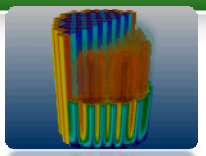
NRC cask certification studies & core melt studies

Solar Tower opens

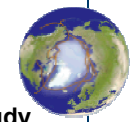
CRF opens to researchers

Power grid reliability study

Sunshine to Petrol Pilot Test



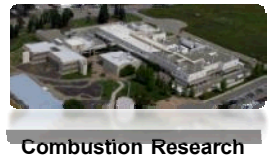
Consortium for Advanced Simulation of Light Water Reactors (CASL)



Climate study uncertainties to economies

SunCatcher™ partnership with Stirling Energy Systems

Large-scale pool fire tests of liquefied natural gas (LNG) on water



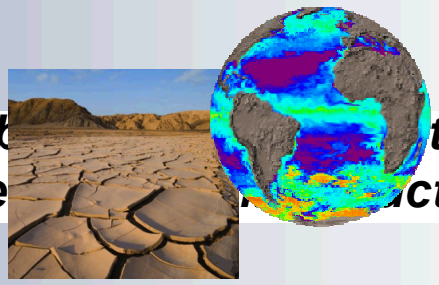
Combustion Research Computation and Visualization (CRCV) opens

Distributed Energy Technology Laboratory (DETL) to integrate emerging energy technologies into new and existing electricity infrastructures

Ties Between Energy Security and National Security

- *Global energy trade is creating international tensions*

- *We are consuming energy and fresh water supplies at unsustainable rates*



- *The energy infrastructure is vulnerab ter and terrorist attack and our defense posture is tie cture*

- *We are sending $1B each day outside of the United States for petroleum*

Example Innovations for a Safer, More Secure, More Reliable, More Sustainable, Cost-Effective Energy Future

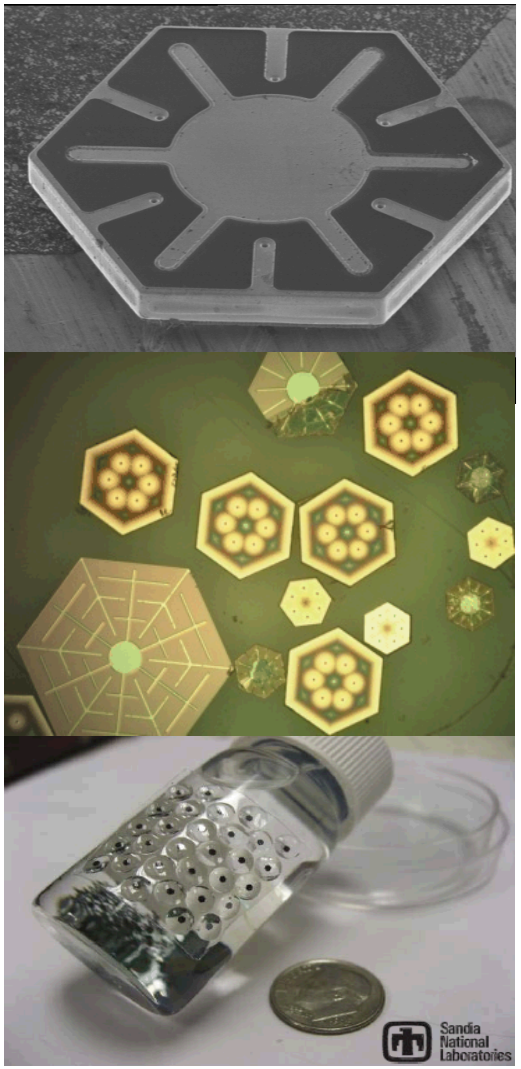
- **Solar Glitter**
- **Sunshine to Petrol**
- **Energy Water Simulation Tools**

- Nanowire Battery Electrodes
- Small Modular Nuclear Reactors
- Agent-based Controls for Microgrids
- Homogenous Charge Compression Ignition Engines

and many others…

Solar Glitter is a Microsystem-Enabled PV Concept

Thin PV Cells

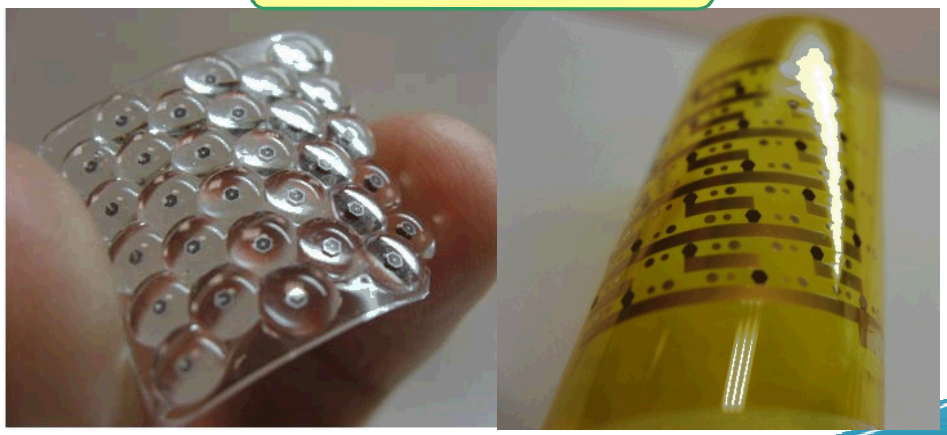


Goal: Develop advanced solar technologies and systems that will provide the US industry with a competitive advantage worldwide in delivering solar electricity at less than 10 cents per kWhr.

Motivation:

- **Double the efficiency and half the cost of conventional PV systems**
  - ➢ **high efficiency *(cell level >50%, system level >40%)***
  - ➢ **reduced cost (module cost of ~$0.5/Watt$_{peak}$, system cost of 2-3/Watt$_{peak}$).**

Flexible PV Modules



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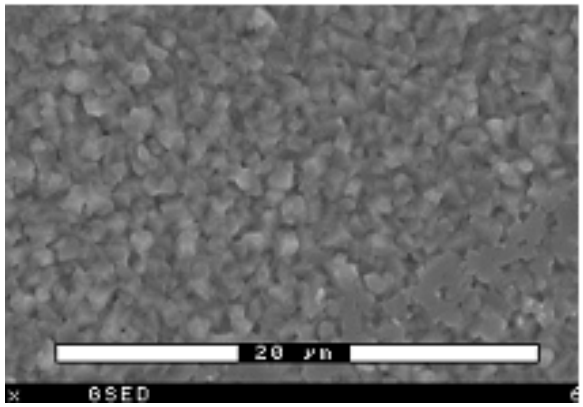
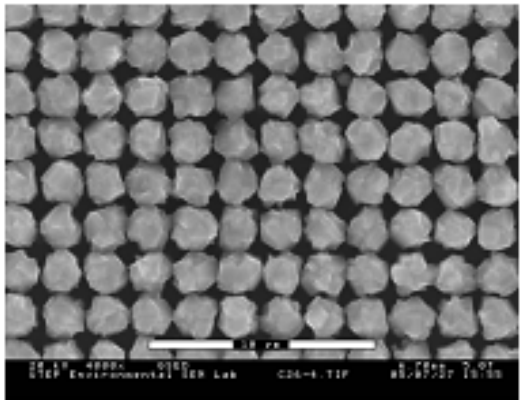
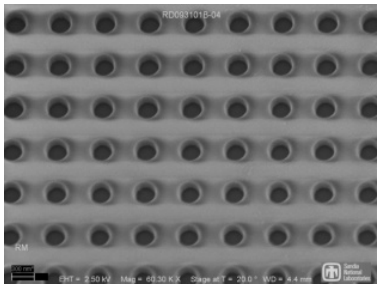
Enhanced CdTe PV Materials are Created by Reducing Defects Using Nanopatterned, Selective Epitaxy

Traditional / disordered



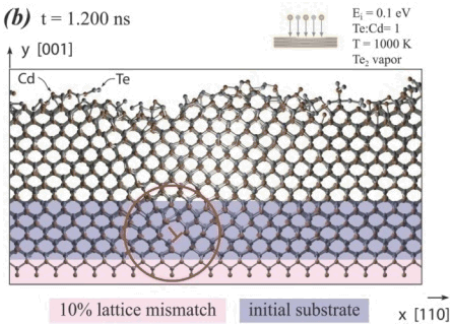
Patterned / ordered





Nanopatterned substrate fabricated at Sandia for UTEP

SEM picture of micro logos



Molecular simulation of CdTe defect formation

Zubia, D.; Romo, JL.; Cruz-Campa, J.; Aguirre, B.; McClure, J.; , "Photovoltaics of ordered CdTe/CdS nanoarrays," *Photovoltaic Specialists Conference (PVSC), 2009 34th IEEE* , vol., no., pp.001842-001845, 7-12 June 2009

Javier Terrazas, Aaron Rodriguez, Cesar Lopez, Arev Escobedo, Franz J. Kuhlmann, John McClure, David Zubia, Ordered polycrystalline thin films for high performance CdTe/CdS solar cells, Thin Solid Films, Volume 490, Issue 2, IMRC 2004, 1 November 2005, Pages 146-153

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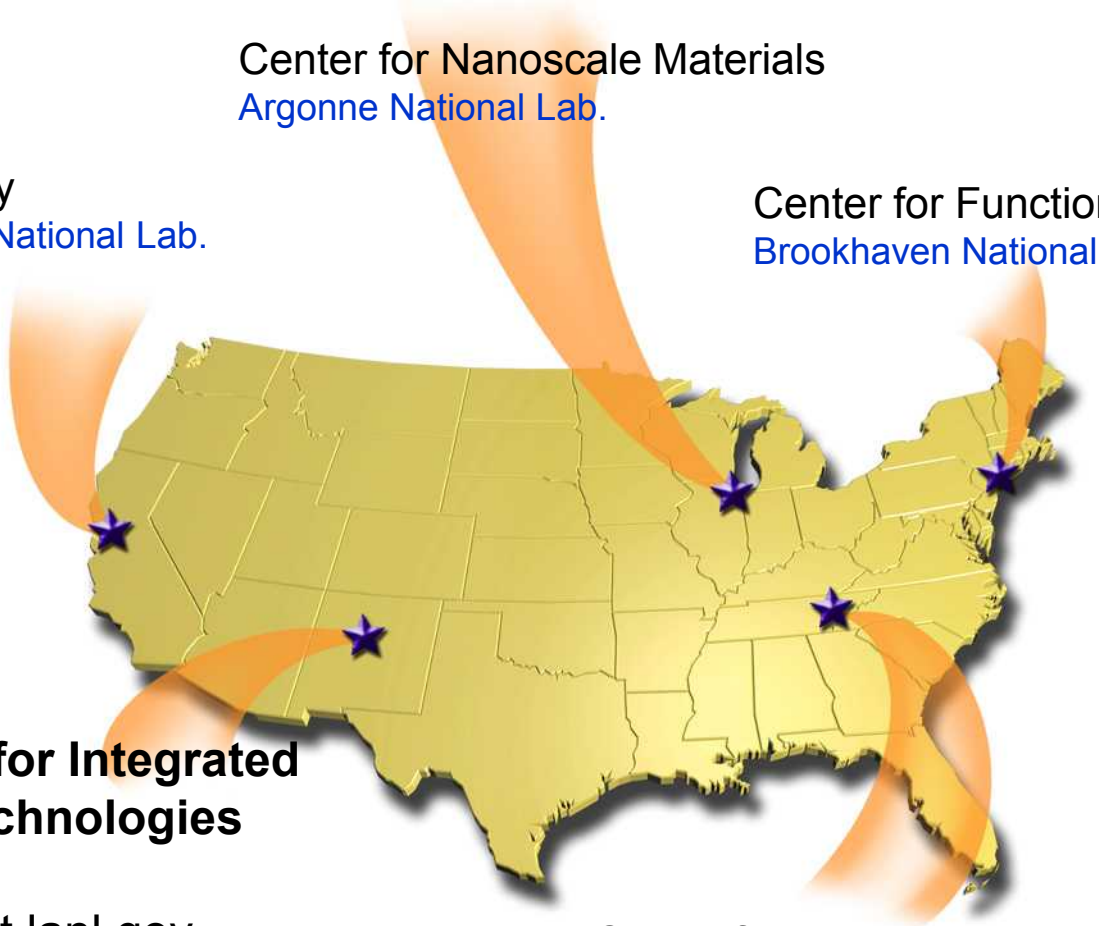
One Mechanism for Collaboration
U.S. Dept. of Energy Nanoscience Centers

Center for Nanoscale Materials
Argonne National Lab.

Molecular Foundry
Lawrence Berkeley National Lab.

Center for Functional Nanomaterials
Brookhaven National Lab.



Center for Integrated Nanotechnologies (CINT)
www.cint.lanl.gov
Sandia National Labs.
Los Alamos National Lab.

Center for Nanophase Materials Sciences
Oak Ridge National Lab.

Los Alamos NATIONAL LABORATORY
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"Sunshine to Petrol" Technology Uses a Novel Conversion Device

CR5: "Counter-Rotating Ring Receiver Reactor Recuperator"

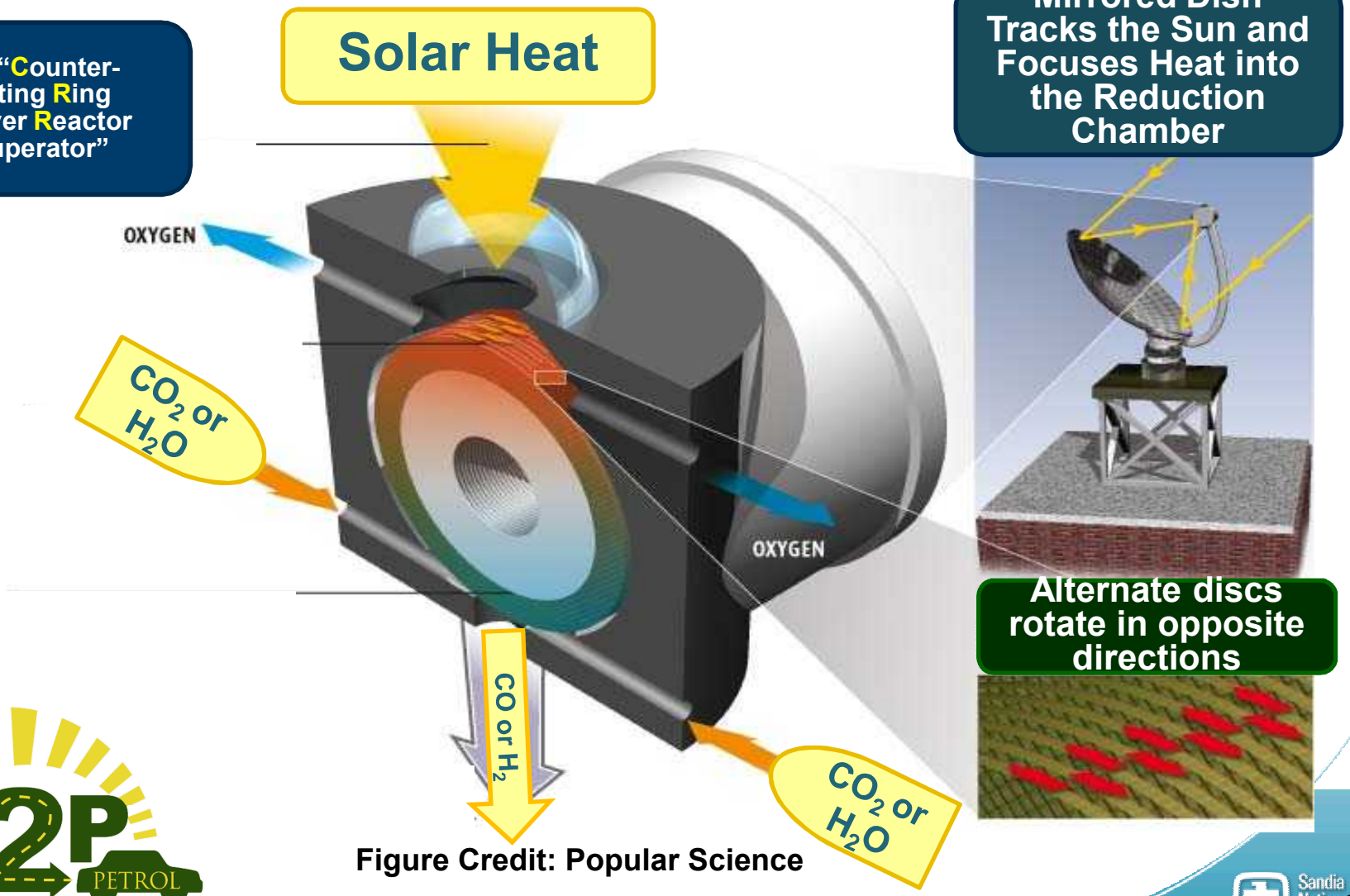

Figure Credit: Popular Science

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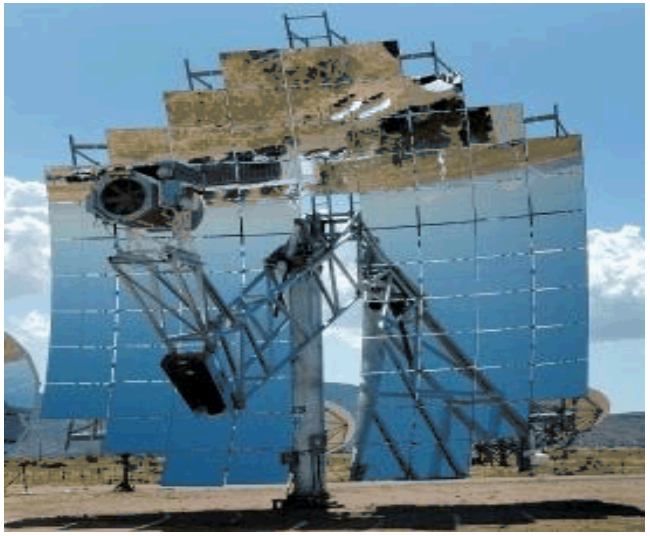
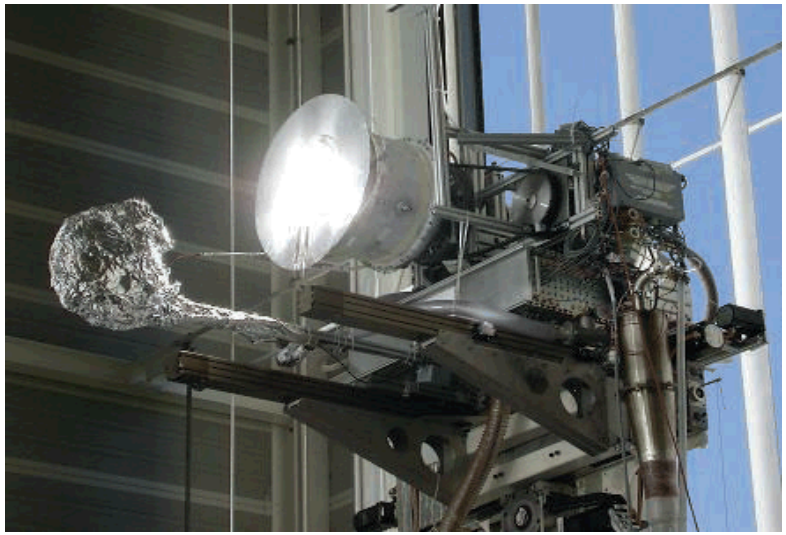
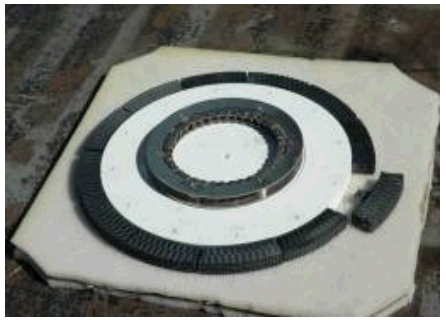
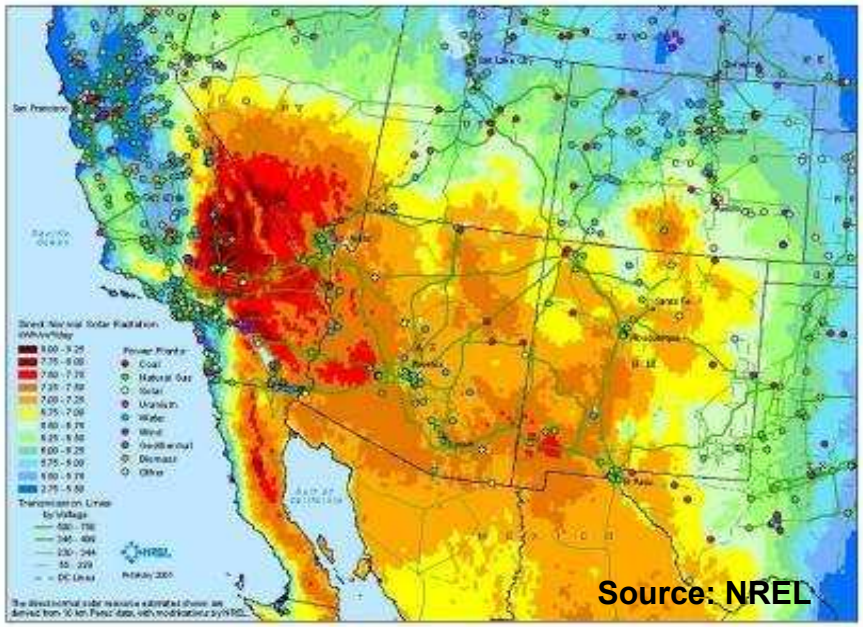
“Sunshine to Petrol” uses the Sun to Break Apart CO_2 and Store Energy in Hydrocarbons







Solar Resources Analysis Shows the Promise of Scale with High Efficiency Target



- U.S. petroleum demand is 20.7 million barrels per day (mb/d, 2007)
- 12.5% lifecycle efficiency could produce 16.6 mb/d (80% of total U.S. demand)
- NM alone could produce 23% of U.S. demand

"Filtered" Land Area Analysis

State	Land Area (10^9 m^2)	Solar Capacity (TW)	Fuel Capacity (GW)	(mb/d)
AZ	49.9	3.37	421	5.9
CA	17.7	1.20	150	2.1
CO	5.5	0.37	46	0.7
NV	14.5	0.98	122	1.7
NM	39.3	2.65	331	4.7
TX	3.0	0.20	25	0.4
UT	9.2	0.62	78	1.1
Total	139.2	9.39	1,174	16.6

139 billion m^2 is 1.5% of total U.S. land

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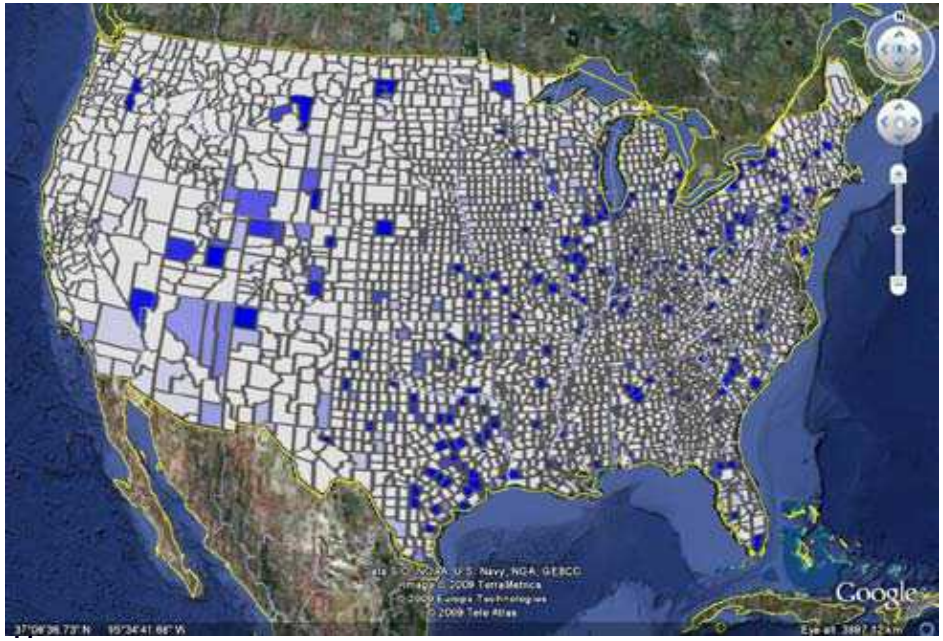
Decision Support Tools Assist in Understanding Energy and Water in the Western and Texas Interconnects

Example of Energy-Power-Water Simulation (EPWSim) model (Tidwell et al. 2009)



Sandia National Labs and partners:

- **Argonne National Laboratory**
- **Electric Power Research Institute**
- **Idaho National Laboratory**
- **National Renewable Energy Laboratory**
- **Pacific Northwest National Laboratory**
- **University of Texas**

Sponsored by the National Energy Technology Laboratory (DOE)

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Our Vision is to…

Enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy, climate, and infrastructure problems.

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