

## Good Work Under the Sun

### Solar Growth in Arizona: Economic Development, Jobs and the Environment

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## Agenda

- Introduction
- The Opportunity
- Solar Energy Basics
- Economic Development & Job Creation
- Next Steps
  
- Other
  - Reducing Risk & Exposure to Fossil Fuels
  - Industry Development

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## Venture Catalyst Inc.

- 30 years experience in business/ project design and development
- 11 years experience in renewable energy commercialization & financing
- 20 year presence in Arizona

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## Opportunity

- Solar energy supplies over 35% of electricity and 69% of our energy needs by 2050 (3,500 GW), dominated by solar electric photovoltaic ("PV") technologies. *The Grand Solar Plan, Scientific American January 2008*
- Solar energy development brings 12 jobs per MW (35 million +).
- Solar energy development increases energy security.
- Arizona is a key nexus for solar energy deployment and solar energy innovation and manufacturing.

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## Solar is a Better Energy Product

Solar is a zero-emission energy source

- Solar is scalable and growing
  - Solar is growing globally at 41% per annum, 60% in U.S.
  - Solar combined with other smart grid technologies can meet 100% peak load growth
- Solar is competitive
  - Nuclear, coal, natural gas power plant costs have increased significantly
  - Transmission infrastructure has increased in costs and takes significantly longer
  - Distributed technologies can be built quickly, averting power crises more effectively
- Solar is predictable
  - Combined with demand response, solar is as predictable as a fossil fuel peaking plant
  - Solar is well correlated to air conditioning and lighting loads
- Solar space is available
  - Each year over 2 billion square feet of new roofs are installed – supporting far more than 40 GW solar needed to meet 100% of incremental load growth in the US
  - Brownfields, airports, wastewater treatment facilities, public lands are excellent sites

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## Solar Generation – Going to Scale

- 60% growth per annum in U.S. solar industry since 2001
- The solar industry exceeds \$16B per year – equal to the global wind industry.
  - Accelerated investments in solar estimated at \$232 billion by 2016 with new extension of ITC\*
- Solar enjoys more uniform support from the general public than any other technology
- As a distributed resource, solar generates more jobs than any other renewable energy technology - **7 permanent jobs per installed MWh**
- Solar could meet all new growth in US electricity capacity over next 20 years



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## Capturing the sun's heat or light



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## Deployment

- Technology Type
  - Solar Thermal
  - Solar Photovoltaic ("PV")
- Development Format
  - Central Station
    - Large scale (20MW+), remote locations, connected to transmission infrastructure (*higher voltage, longer distance*)
  - Distributed Generation ("DG")
    - Large (up to 20MW) to small scale connected to distribution network near customer load (*lower voltage, shorter distances*)

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## Solar Thermal Options for Utility-Scale Power



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## Power Delivery



Transmission

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Distribution

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## Large Scale Distributed Generation

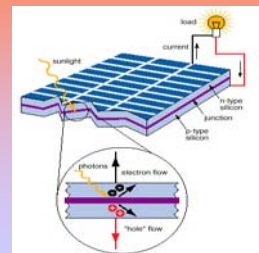


Alamosa, Colorado 8.2 MW SunEdison for Xcel Energy Distributed Generation

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## Photovoltaics ("PV" Solar Electric)

- Light knocks loose electrons from atoms
- Freed electrons have extra energy, or "voltage"
- Internal electric field pushes electrons to front of cell
- Electric current flows on to other cells or to the load
- Cells never "run out" of electrons



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## Kinds of Technology

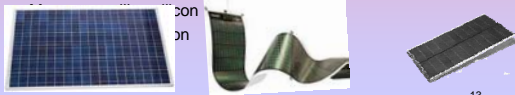
### • Crystalline

- More energy produced / sq. ft.
- More \$\$\$ per kW
- More prevalent
- Time-tested

### Thin film

- Less energy produced / sq ft.
  - Less \$\$\$ per kW
  - Better performance in shading & heat
  - Flexible and laminate forms
- Types:
- Amorphous silicon (a-Si)
  - Cadmium telluride (CdTe)
  - Copper indium gallium diselenide (CIGS)

### • Types:



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## Where are the jobs?

- Deployment
- Manufacturing
- Re-positioned existing businesses
- Re-deployed intellectual property

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## Jobs – Coming to Arizona

### Solar Jobs

*440,000 estimated new permanent jobs in solar by 2016, nationally*

### Arizona –

16,000 jobs in photovoltaic electricity from solar

Greatest growth:  
New manufacturing  
Construction  
Engineering



### Trades:

Roofing  
Electrical  
Plumbing

## Potential Solar Jobs

State/Region	Total New Jobs – 2016	New Employment 2009-2016 (Job-Years)
California	214,000	676,000
New Mexico	19,000	44,000
<b>Arizona**</b>	<b>15,000</b>	<b>69,000</b>
Nevada	9,000	41,000
<b>Southwest Total</b>	<b>257,000</b>	<b>830,000</b>
<b>Great Lakes Total</b>	<b>40,200</b>	<b>58,200</b>
<b>All other states</b>	<b>53,800</b>	<b>99,800</b>
<b>US Total</b>	<b>440,000</b>	<b>1,200,000</b>

\*Economic Impacts of Extending Federal Solar Tax Credits, report prepared for the Solar Energy Research and Education Foundation, Navigant Consulting, September 15, 2008

\*\* PV and Solar Thermal job estimates, combined

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## What Kind of Jobs?

Industry	Revenues (billions)	Direct Jobs (thousands)	Total (direct plus indirect) Jobs Created (thousands)
Renewable Energy	\$39.2	194	446
Energy Efficiency	932.6	3,498	8,046
<b>TOTAL</b>	<b>\$971.8</b>	<b>3,692</b>	<b>8,492</b>

Source : Management Information Services, Inc. and American Solar Energy Society, 2007.

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## Job Categories, Typical Salaries

Occupation	10 year % Growth Forecast	Median Salary	% With Bachelor's Degree	Education
Materials Scientists	8	\$74,400	84	Bachelor's
Physicists	7	91,500	92	Doctoral
Microbiologists	17	63,400	96	Doctoral
Biological Technicians	17	36,500	60	Associate
Conservation Scientists	6	53,900	88	Bachelor's
Chemists	7	63,500	94	Bachelor's
Chemical Technicians	4	40,100	27	Associate
Geoscientists	6	73,200	94	Doctoral
Natural Science Managers	14	99,100	90	Bachelor's
Environmental Eng. Technicians	24	42,000	16	Associate
Soil and Plant Scientists	20	58,000	84	Bachelor's
Mechanical Eng. Technicians	12	49,500	18	Associate
Environmental Sci. Technicians	16	38,500	47	Associate
Biomedical Engineers	31	75,400	80	Bachelor's
Chemical Engineers	11	75,200	92	Bachelor's
Mechanical Engineers	10	77,000	88	Bachelor's
Electrical Engineers	12	75,000	83	Bachelor's
Environmental Engineers	14	74,500	92	Bachelor's
Computer Scientists	26	94,000	67	Doctoral
Life & Physical Sci. Technicians	20	45,200	50	Associate
Utility Plant Operators	4	53,000	10	OJT
HVAC Technicians	12	37,600	14	OJT
Energy Audit Specialists	18	39,500	18	OJT
Forest & Conservation Workers	6	27,000	8	OJT
Refuse & Recycling Workers	5	26,000	2	OJT
Insulation Workers	6	\$30,200	2	OJT

Source: Management Information Technology Inc, US Bureau of Labor Statistics

Energy Efficiency and Renewable Energy –

Occupation, Wage and Educational Forecasts

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## NABCEP – Baseline Certification

- PV Requirements/Education (must be 18 and pass exam)
- Prerequisites to Certification (in addition to passing exam)
  - a) Four (4) years of experience installing PV; OR
  - b) Two (2) years of experience installing PV systems in addition to completion of a board-recognized training program; OR
  - c) Be an existing licensed contractor in good standing in solar or electrical-construction related areas with one (1) year of experience installing PV systems; OR
  - d) Four (4) years of electrical-construction related experience working for a licensed contractor, including one (1) year of experience installing PV systems; OR
  - e) Three (3) years experience in a U.S. Dept. of Labor approved electrical-construction trade apprenticeship program, including one (1) year of experience installing PV systems; OR
  - f) Two-year electrical-construction related, or electrical engineering technology, or renewable energy technology/technician degree from an educational institution plus one (1) year of experience installing PV systems; OR
  - g) Four-year construction related or engineering degree from an educational institution, including one (1) year experience installing PV systems.

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## SunEdison Sample Job Description & Qualifications

### Solar Installer

#### SUMMARY OF FUNCTIONS:

Responsible for proper layout, assembly, installation, and securing of PhotoVoltaic mechanical racking systems. This person will offer feedback during and at completion of job. Key duty is installation, but will also assist in on-the-job training.

**ESSENTIAL DUTIES AND RESPONSIBILITIES** Uses plan sets to determine proper locations, sizes, and installation of all mechanical assembly. Measures, cuts, assembles, bolts, and screws and installs structural framing and solar modules. Constructs and installs temporary structures and supports, including scaffolds for workers to stand on, chutes for wet concrete, forms for concrete foundations and timber structures to support machinery. Cuts, assembles, and shapes building materials using hand and power tools...

**QUALIFICATIONS** Basic skills and knowledge of construction. Minimum 1-2 years experience in related field. Able to take and follow instructions and/or direction from plans and supervisors. Ability to read and interpret plans accurately a plus. Ability to transfer plans into actual construction. Strong organizational and problem solving skills a plus. Must be a self motivator and team participant.

**PHYSICAL DEMANDS** Ability to communicate orally with management and other co-workers is crucial. Able to work outside in hot and cool weather. Hearing and vision within normal ranges is helpful for normal conversations, to receive ordinary information and to read plans and documents. Heavy lifting 50-60 lbs required. Exertion of up to 75 lbs of force occasionally may be required. Good manual dexterity for the use of common mechanical tools...

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## Next Steps

- Focus on key skills
  - Construction skills
  - Solar installation (PV and Thermal-for residential) on the path to NAPCEP
  - Communication (written and spoken, multi-media), Decision Making, Critical Thinking, Collaborative/ Team Building
  - 2007 Federal Training Bill, to be funded
- Integrating with solar businesses
  - Apprenticeships
  - Making job creation & training work for the businesses as well as employees

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## Next Steps

- Managing Expectations
  - Timing & Volume of jobs a function of solar deployment projects

### Proactive Strategies

- Aggregating demand
- Focusing on "strategic partners"

More solar deployment projects means more solar jobs.

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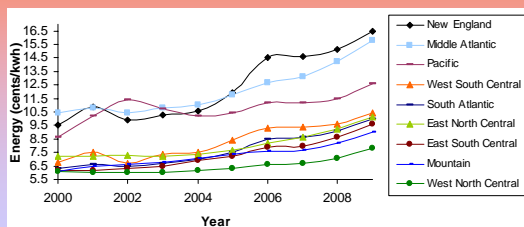
## Reducing Risk & Exposure to Fossil Fuels

- Electricity Price Drivers
- Solar Benefits

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## U.S. commercial electricity prices: by region

On average, prices have increased 4.76% each year for the last 8 years



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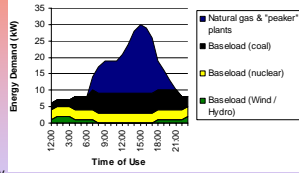
## Energy demand drives costs

Demand drives energy production

- Energy plants are dispatched by (lowest) variable costs

Utility rate breakdown

- Baseload rate
- Peak rates
  - driven by volatile variable costs
- Demand charges
  - determined by facility's highest energy use



To save energy \$\$\$...

- Reduce peak demand from utility

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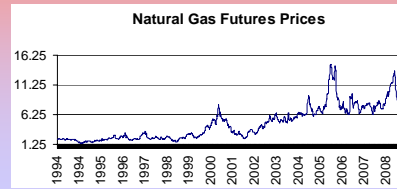
## Peak energy prices: volatile & increasing

Cause

- Lower natural gas (NG) production
- Less new NG drilling
- Oil prices increase
- Higher NG prices

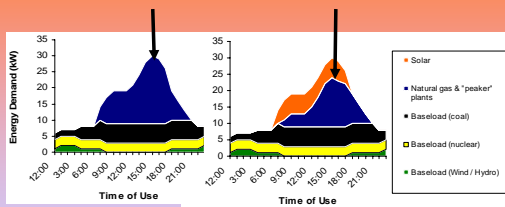
Effect

- Higher NG prices
- Higher NG prices
- Higher NG prices
- Utilities raise rates



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## Solar reduces your peak demand



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## Questions?



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## Manufacturing

- PV
  - Attract new business: component manufacturing and ancillary services (with scale of 100MW +)
    - Limited opportunity in existing market: global marketplace, dominance of Asia and low cost operating environments.
- Thermal
  - Large central projects need component supply: glass, steel, etc.
- Develop new products and services for the solar technology wave
  - Support services for construction and new manufacturing.
  - Advanced/ High Performance Materials (nano, CFRP)

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## Re-positioning existing businesses

- Construction
- Project Management
- Rack Fabrication
- Optics
- Advanced Materials

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## Re-deploying intellectual property

- Storage
- Reflector surfaces and films

## Storage for PV Technologies

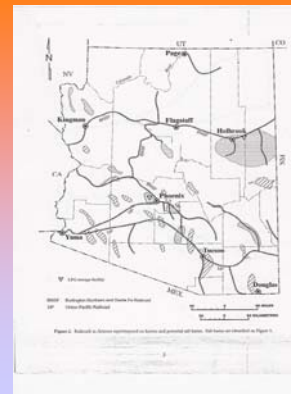
- Batteries
- Inverter based (short term)
- Flywheels
- Compressed Air Energy Storage

## Emerging Storage Opportunities

- Technology improvements across all forms
- Compressed Air Energy Storage in Arizona salt caverns

## Arizona Salt Deposits

Resource for  
Compressed Air  
Energy Storage



## Compressed Air Energy Storage

