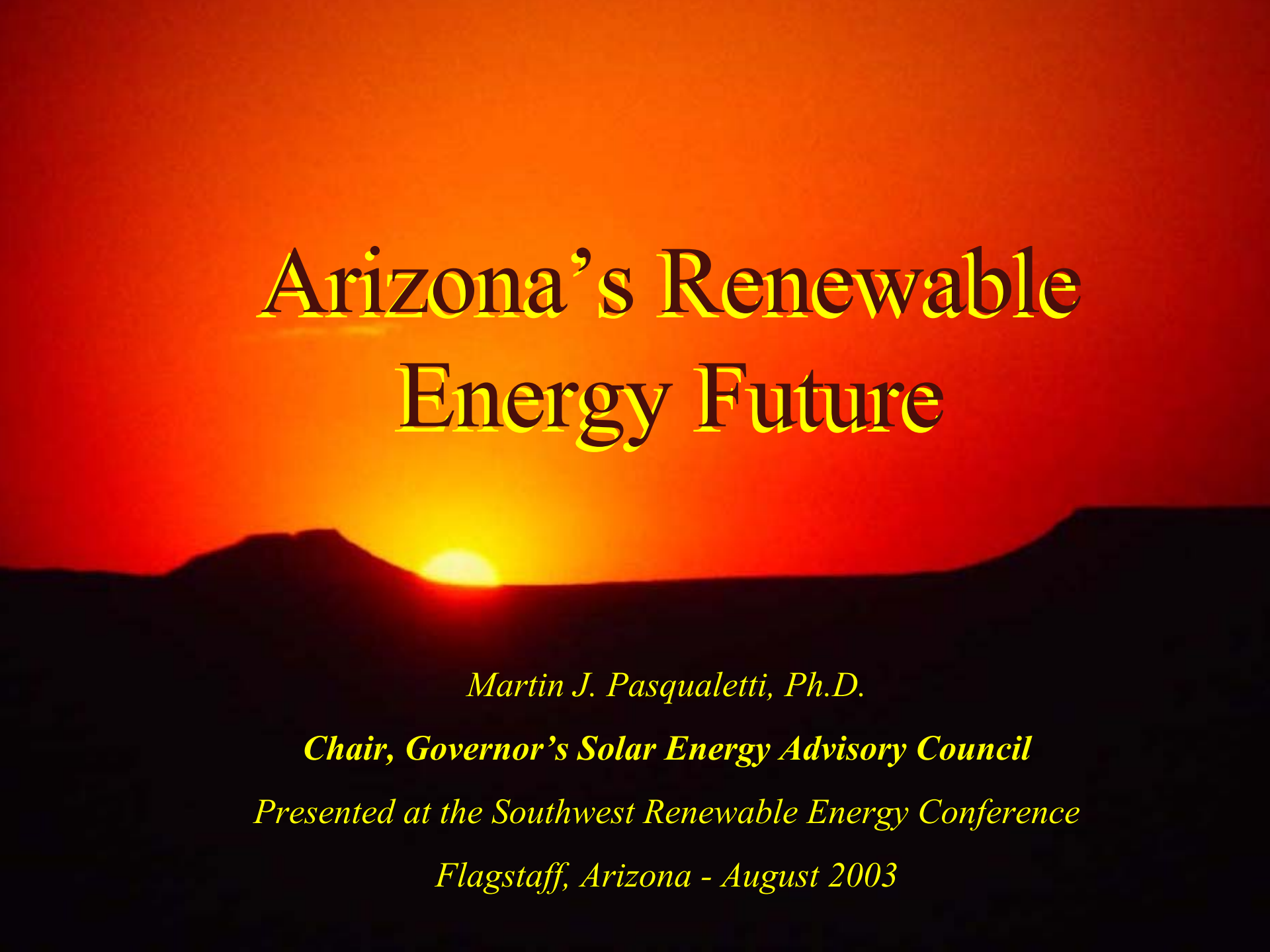


Arizona's Renewable Energy Future

Martin J. Pasqualetti, Ph.D.

Chair, Governor's Solar Energy Advisory Council

Presented at the Southwest Renewable Energy Conference

Flagstaff, Arizona - August 2003

Arizona's Alternative Energy Options

Overview

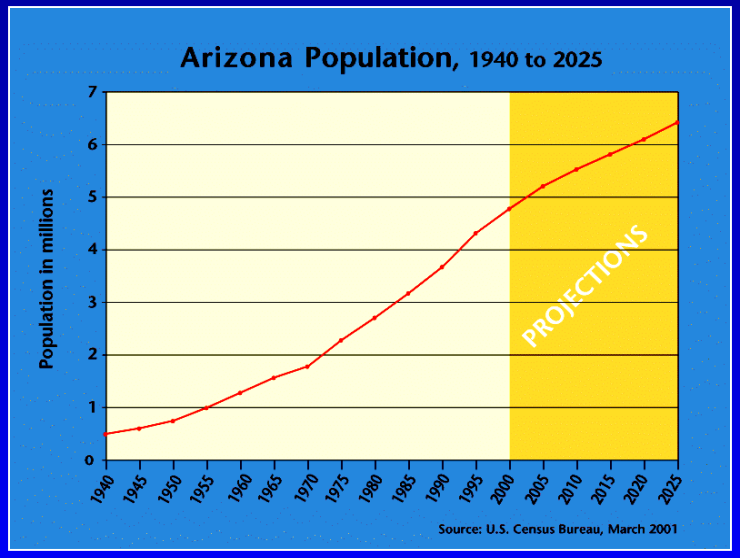
1. Arizona Conditions
2. Arizona Resources
3. Research and Development
4. Opportunities and Potential

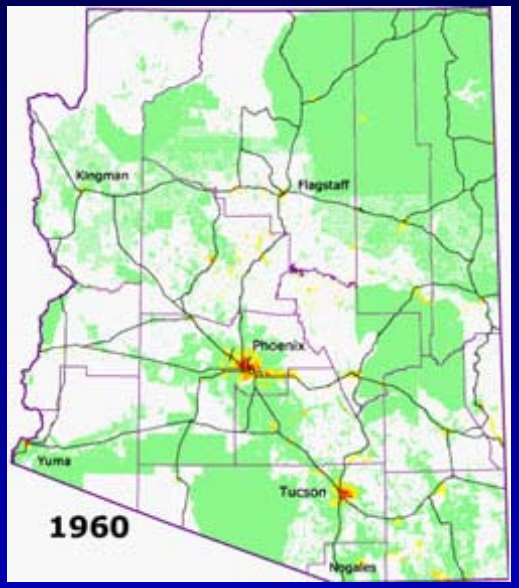
1. Conditions

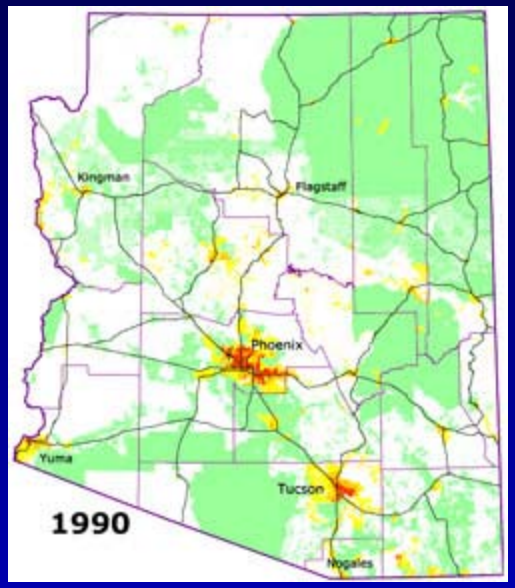
Open Space

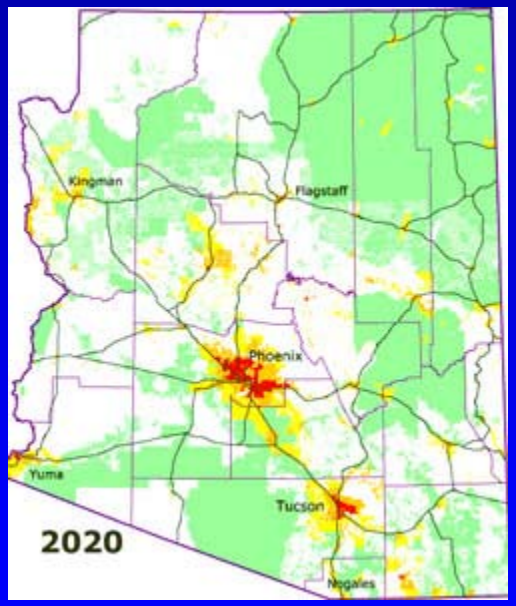
Aridity

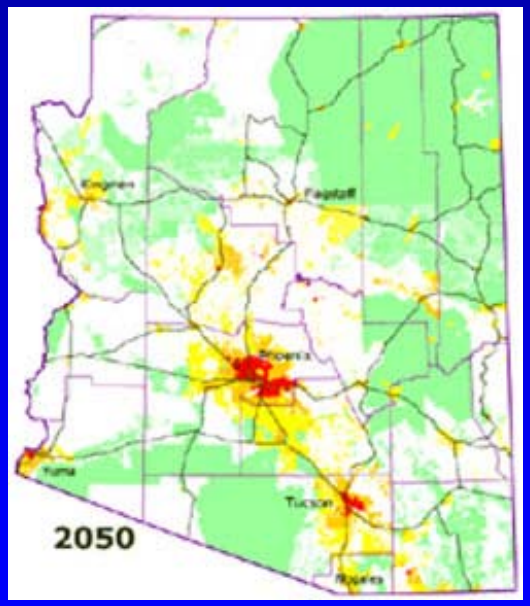
Growth


Arizona Population, 1940 to 2025
Population in millions
0
1
2
3
4
5
6
7
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
PROJECTIONS
Source: U.S. Census Bureau, March 2001


Kingman
Flagstaff
Phoenix
Yuma
Tucson
Nogales
1960

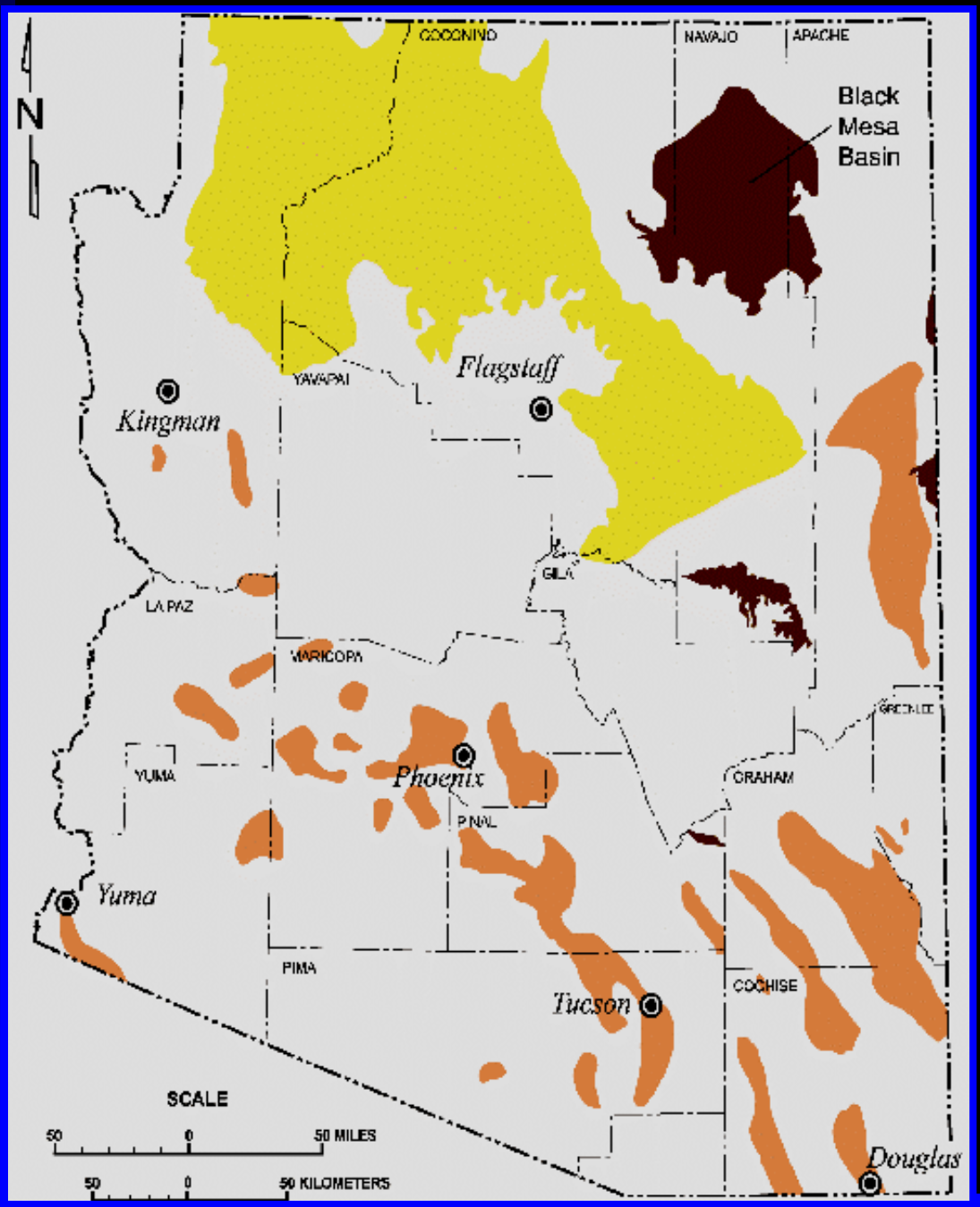

Kingman
Flagstaff
Phoenix
Yuma
Tucson
Nogales
1990


Kingman
Flagstaff
Phoenix
Yuma
Tucson
Nogales
2020


Flagstaff
Yuma
Tucson
2050

2. Energy Resources

A Rich Mix of Energy Resources



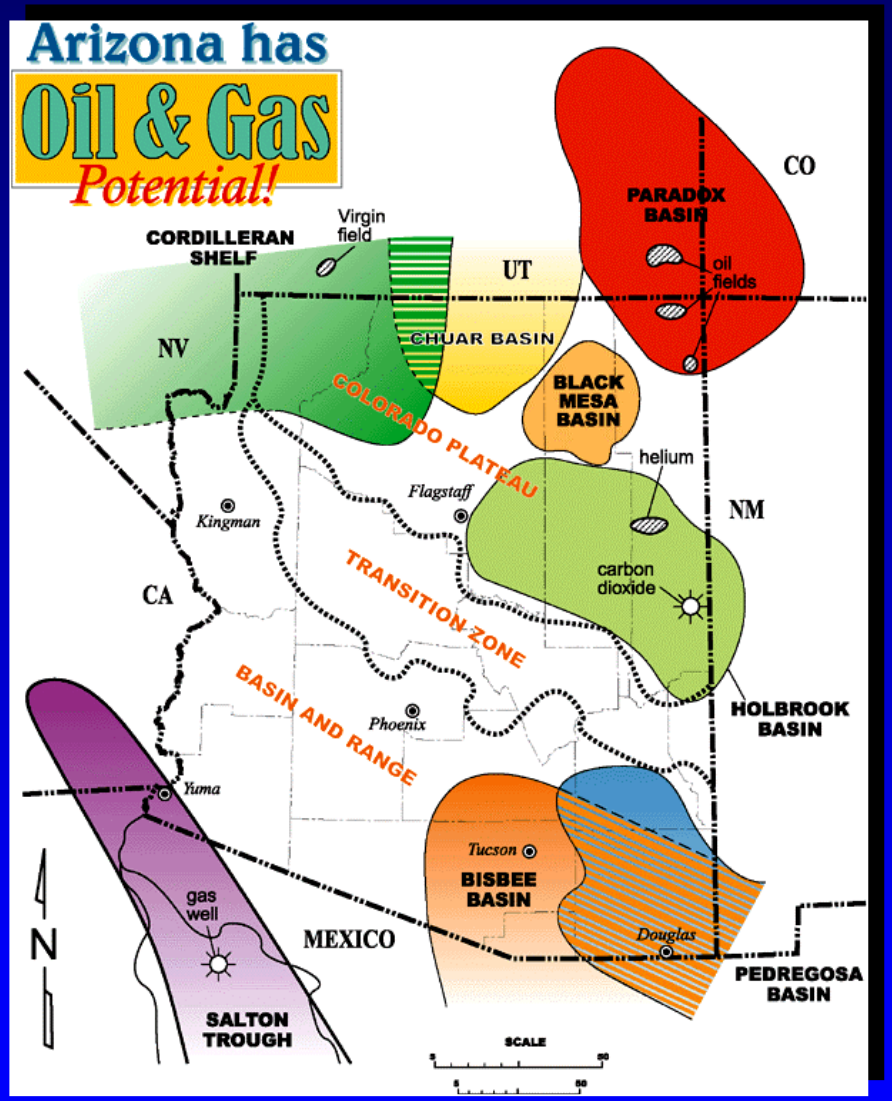
Coal

Uranium

Low to Moderate temperature ground water

Source: Arizona Geological Survey , 2001

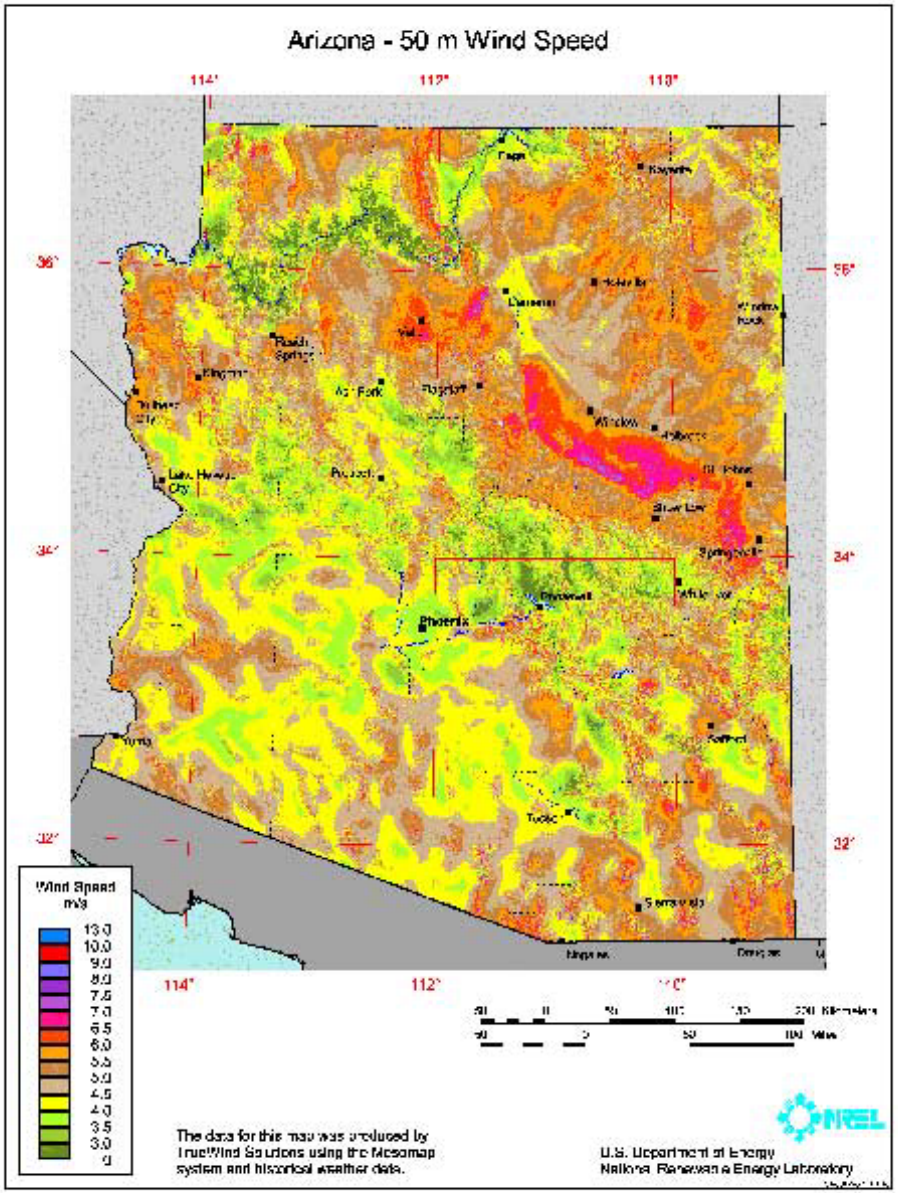
Oil and Gas



Arizona has produced 20 million barrels of oil and 28 BCF of natural gas, although coal is the principal developed fossil fuel.

Source: Arizona Geological Survey , 2001

Wind Power

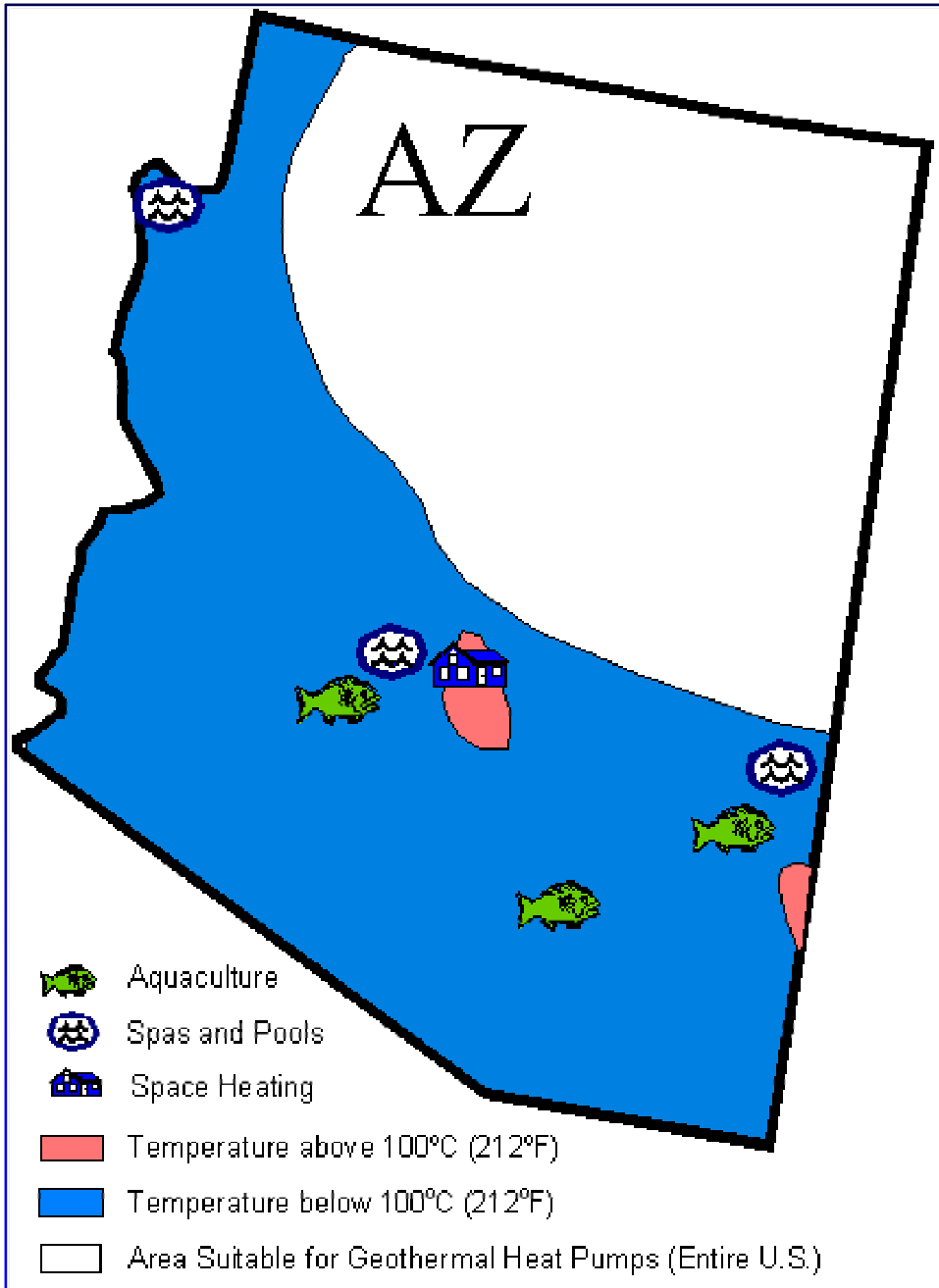


WIND POWERING AMERICA

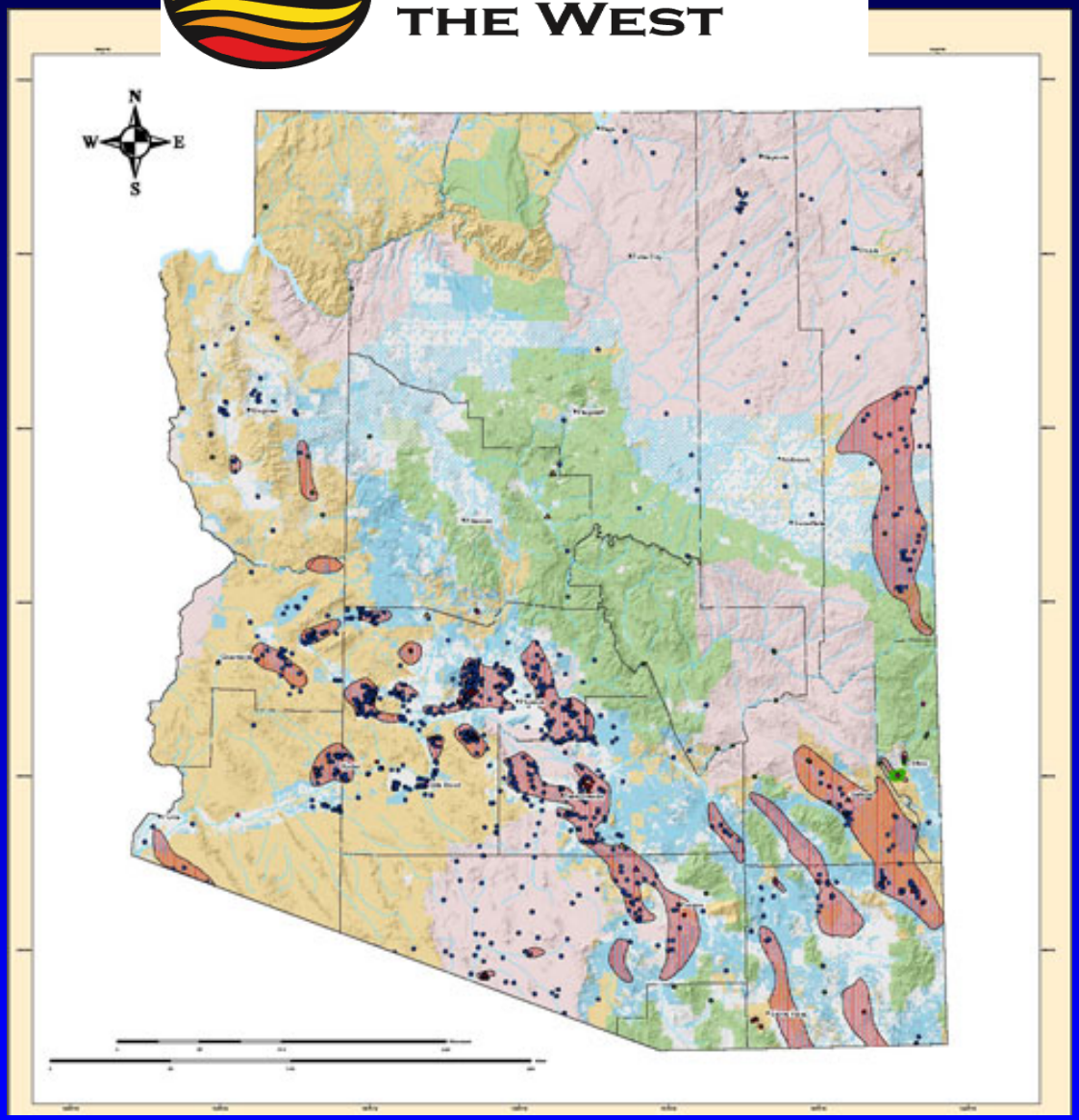
Arizona has several promising areas located primarily from St. Johns northwest to Cameron on the Navajo Reservation

Geothermal Energy

Traditional Assessment



GeoPowering the West



Geothermal Categories

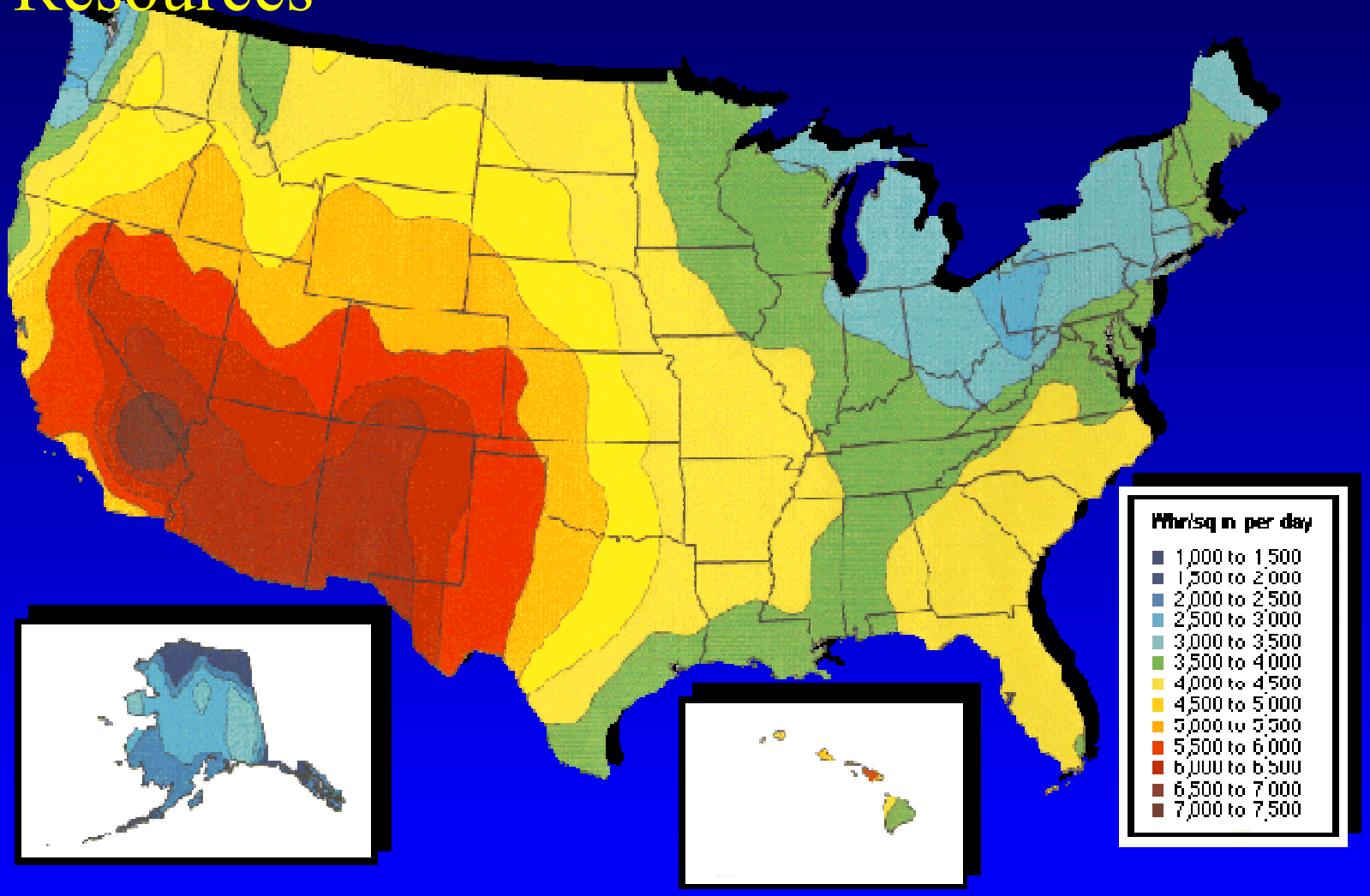
- Space Heating
- Aquaculture
- Spas/Resorts/Recreation Sites
- Areas with Potential for Direct Use Applications
- Areas with Potential for Electrical Generation

Land Ownership

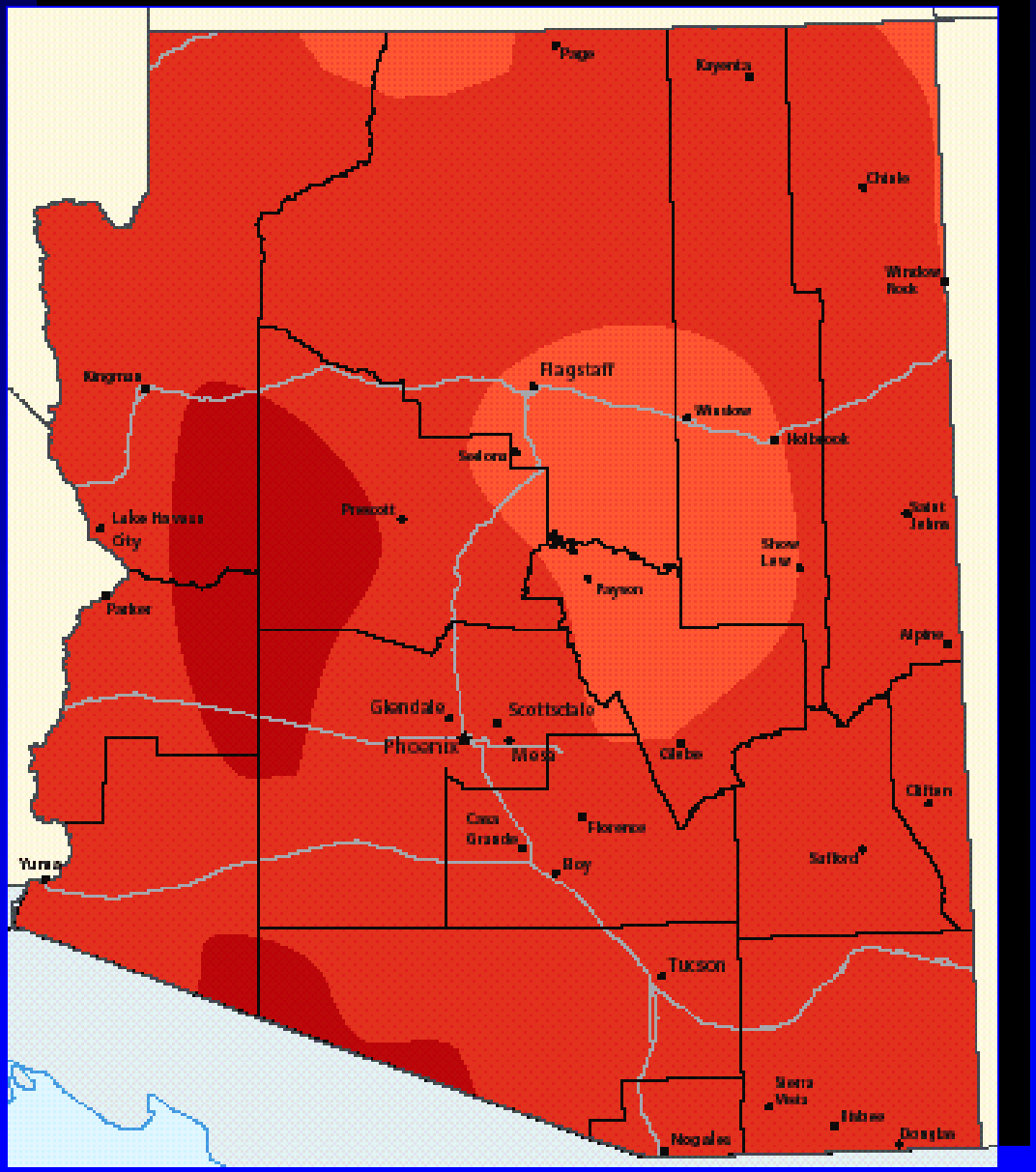
- Private Lands
- Bureau of Land Management and other Federal Lands
- State Lands
- Native American Lands
- U.S. Forest Service Lands

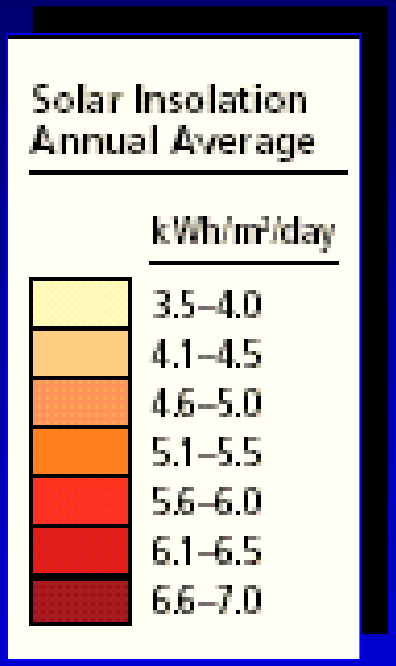
Map prepared by Patrick Laney and Julie Brizzee, INEEL for US DoE, based on data from Geo-Heat Center Geothermal Database, 2002 & NOAA, 1982.

Solar Energy – Arizona Leads the Nation in Resources



Distribution of Arizona's Solar Resource





Data source: NREL, 2002

3. Research and Development

A Sample of Research & Testing Facilities

ASU Photovoltaic Testing Laboratory

NAU Renewable Energy Laboratory;
Center for Sustainable Environments

APS STAR center – Solar Testing and Research

UofA Environmental Research Laboratory

Maricopa County - Photovoltaics

Yuma Proving Ground – Photovoltaics

Yuma Proving Grounds – Covered Parking

Sedona Pump – drawing water from 860 feet

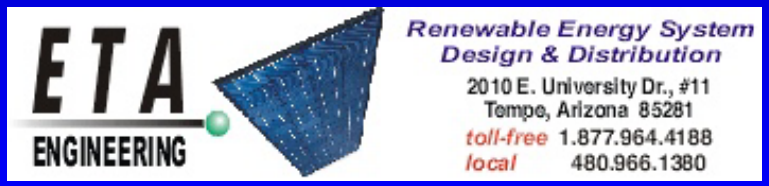
Correctional Facility saves $6,000 per month

Off-grid use – Ranching Country

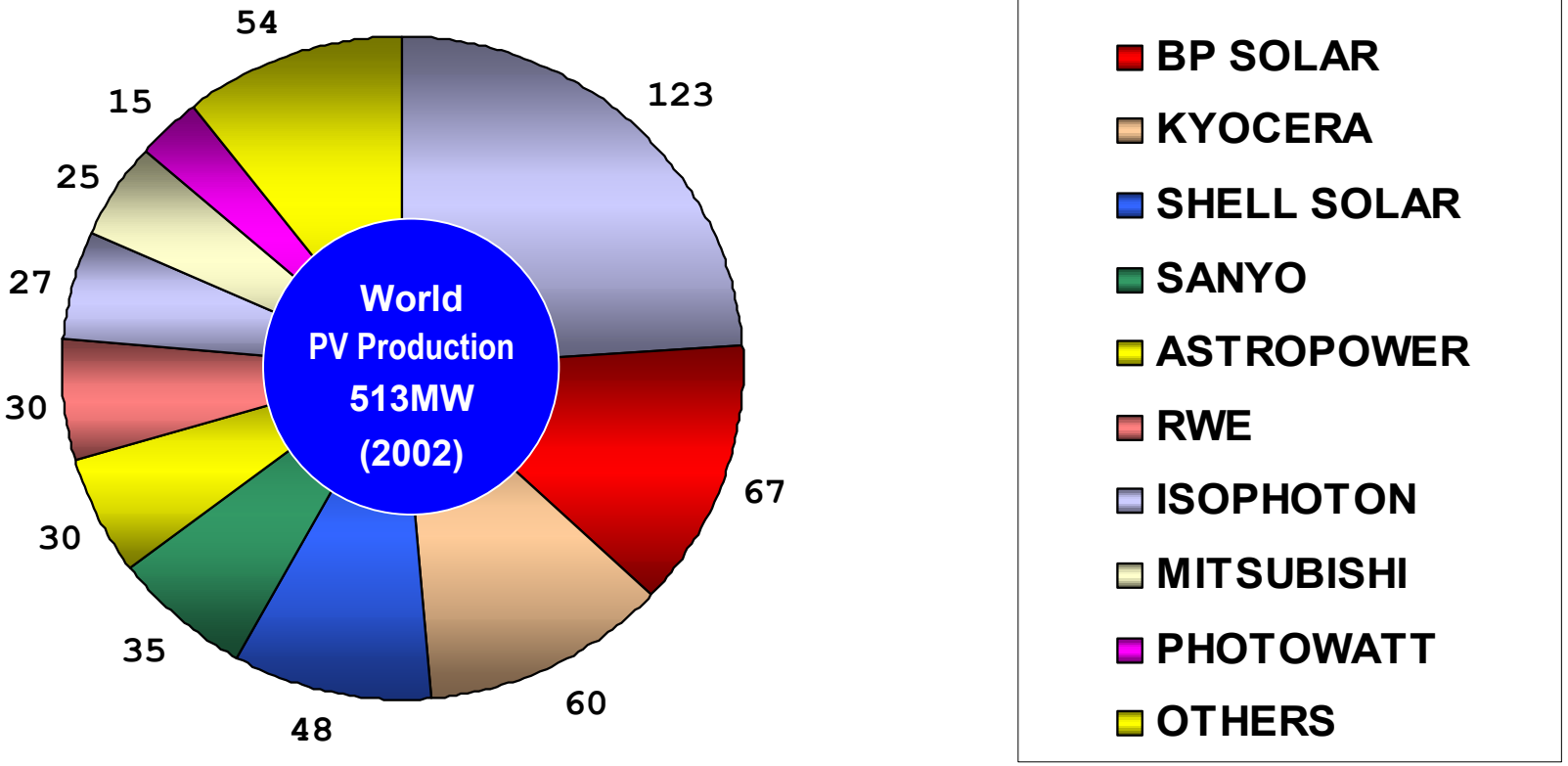
Million Solar Roofs

A Sample of Solar & Wind Firms in Arizona

As of 2002, there were ~70 solar and wind companies in Arizona, with more than 650 employees.



World PV Production (MW) / 2002



Courtesy: Bob Hammond, Prescott, AZ

Data : Photovoltaic-News Mar/2003

A Sample of Organizations and Programs

AriSEIA

The Arizona Solar Energy Industries Association

Tucson Coalition for Solar

Arizona Solar Energy Association

Project Sol

Exploring the science and technology of solar energy

Scottsdale's Green Building Program

American Hydrogen Association

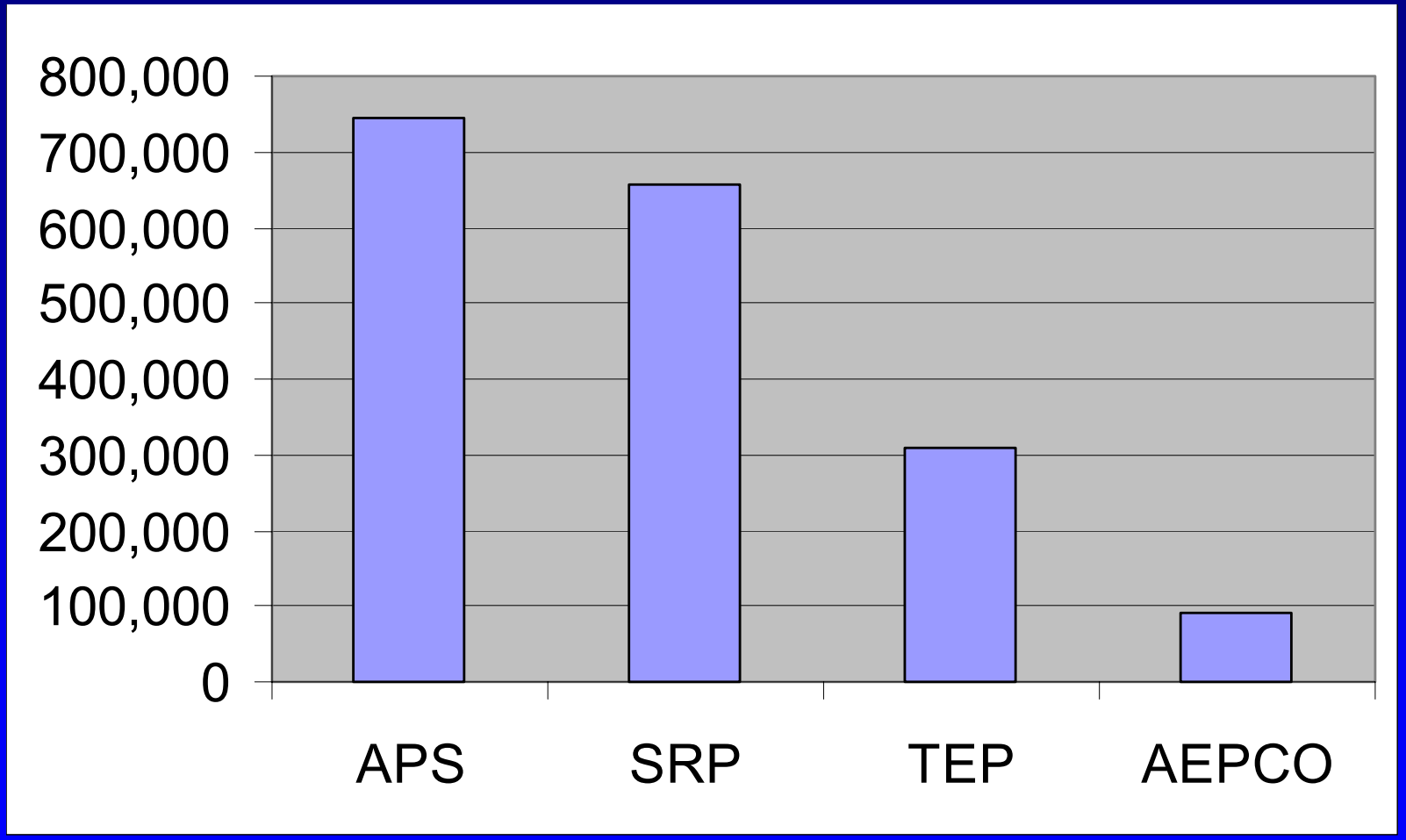
Arizona Solar Center

www.AzSolarCenter.org

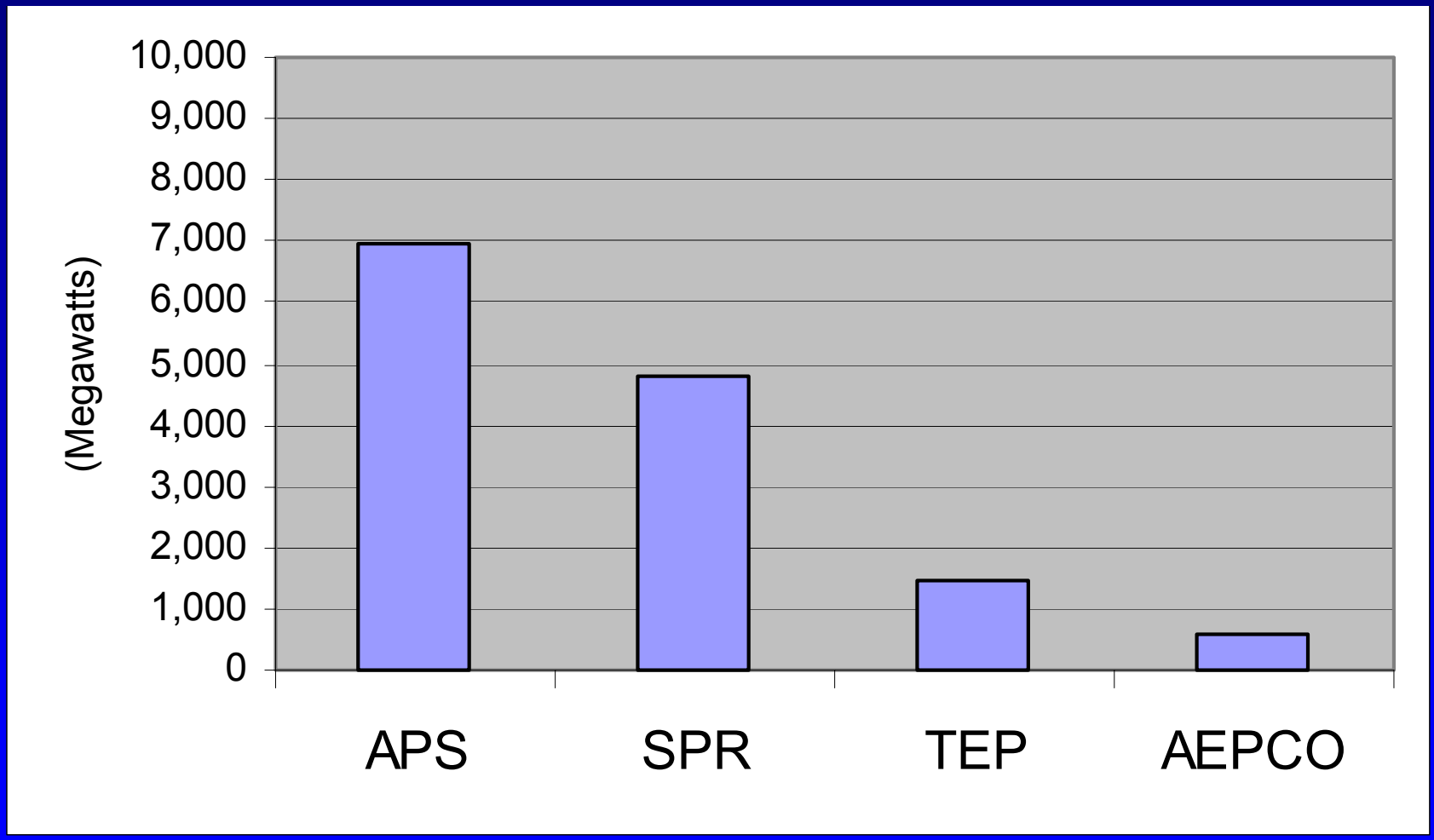
Arizona Electrical Utility Companies

- Arizona Public Service
- Salt River Project
- Tucson Electric Power
- AEPCO

Customers per Utility 2000



Generating Capacity per Utility 2000



Environmental Portfolio Standard R14-2-1618

- March 2001, ACC establishes EPS, requiring retail sellers of electricity to provide a percentage of retail electricity sales from certain specific renewable energy resources
- Must derive at least .2% (to increase to 1.1% by 2007-12) of the total retail energy sold from new solar resources or environmentally-friendly renewable electricity technologies
- The EPS requires that at least 50% (60% by 2004) must be solar electric
- *Source: ACC website*

Arizona's Environmental Portfolio Standard Results (in kWh) 2001-2002

	2001	*2002*
APS	34,786,461	56,273,572
TEP	9,874,606	25,419,075

EPS Results (in kWh) for 2001-2002 (APS)

	2001	2002
Solar Electricity	17,237,202	9,126,664
Solar Hot Water	6,241,328	2,208,334
Solar Air Conditioning	--	--
Landfill Gas	11,307,931	44,938,574
Biomass	--	--
Wind	--	--
Total	**34,786,461**	**56,273,572**
	(99.1% of requirement)	(59.68% of requirement)

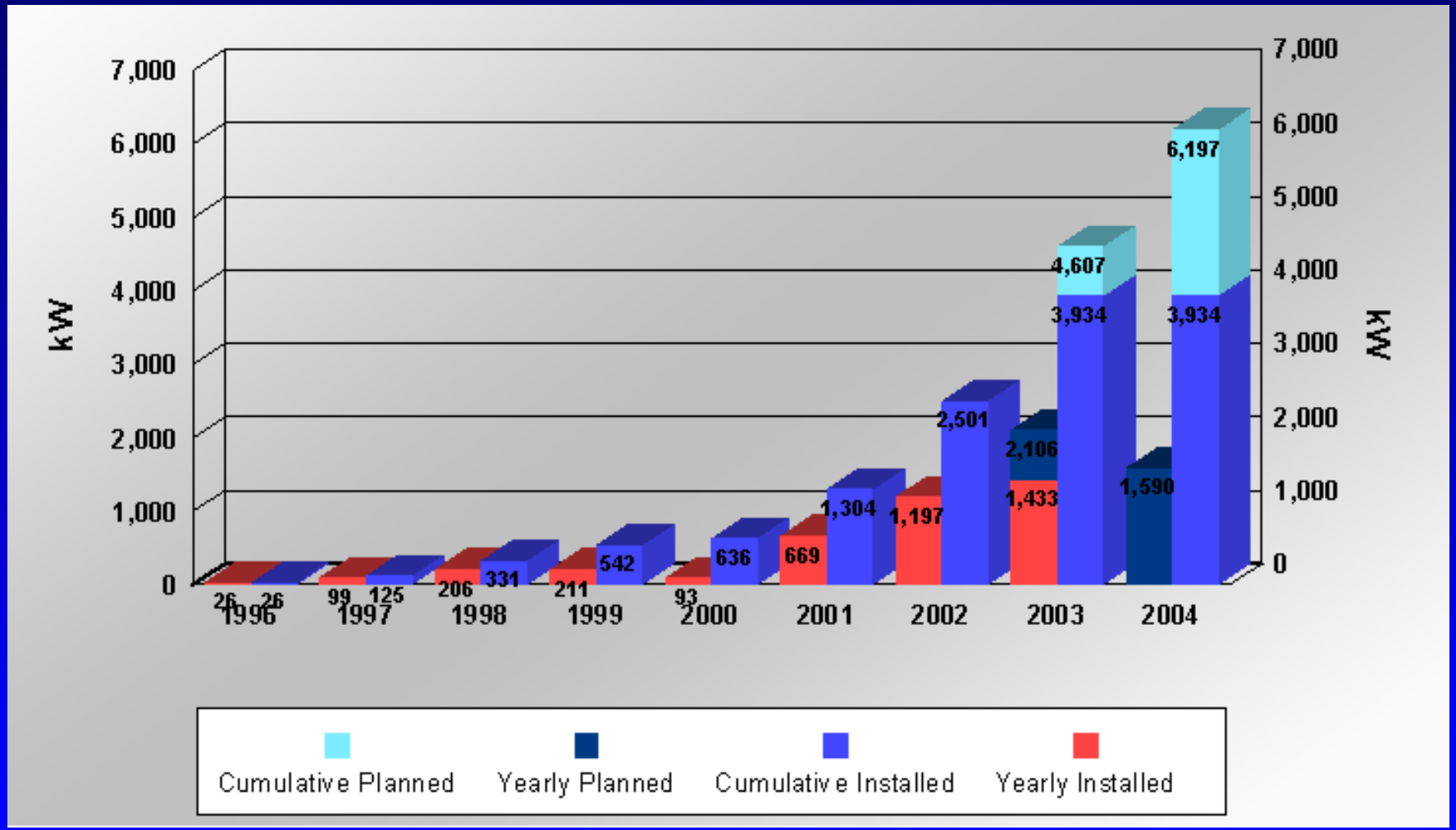
Source: THE FIRST TWO YEARS OF RESULTS FOR ARIZONA'S ENVIRONMENTAL PORTFOLIO STANDARD, presented by Ray T. Williamson at the 2003 ASES Conference

EPS Results (in kWh) for 2001-2002 (TEP)

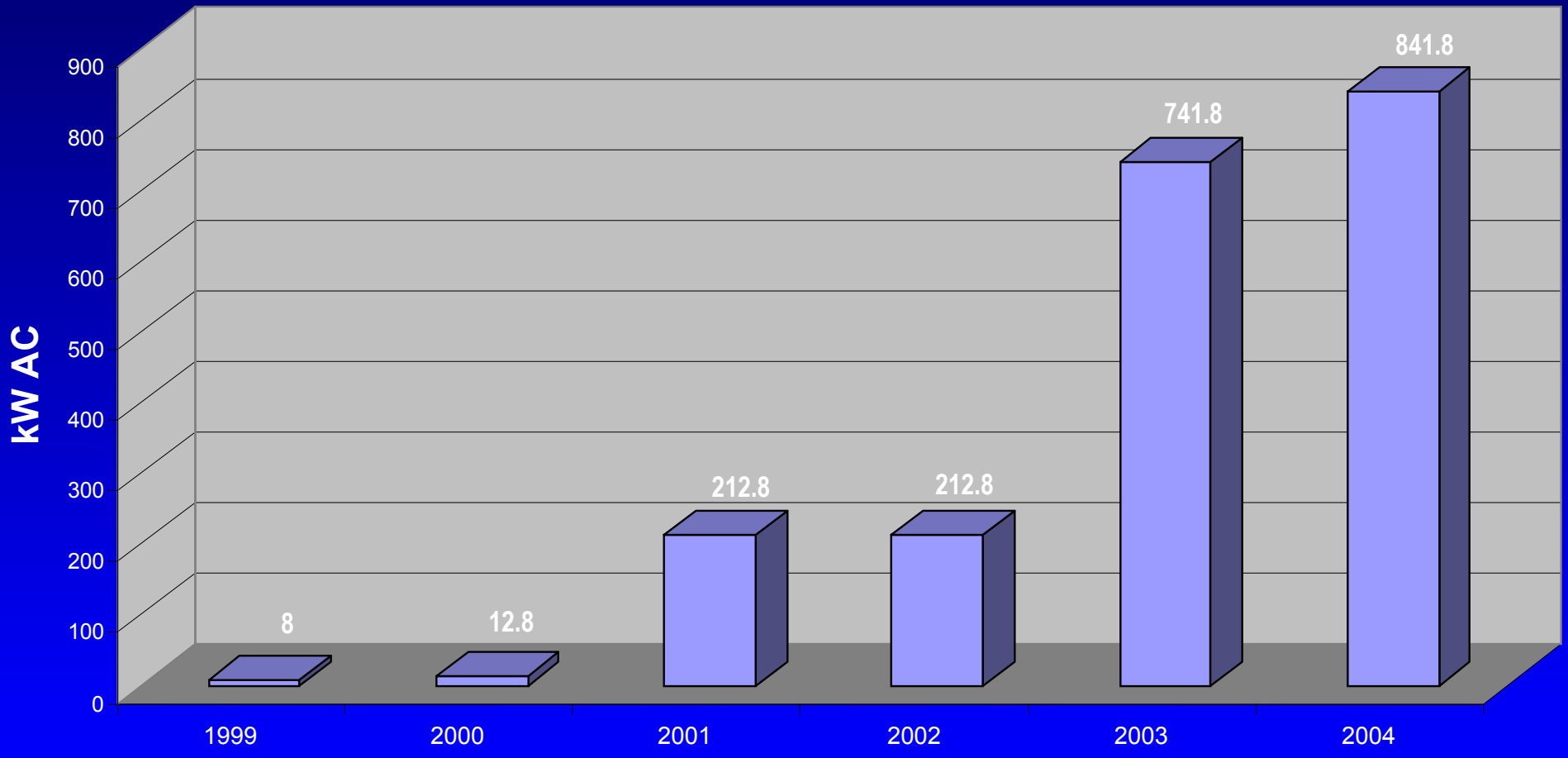
	2001	2002
Solar Electricity	2,990,538	9,006,169
Solar Hot Water	--	--
Solar Air Conditioning	--	--
Landfill Gas	6,884,068	16,024,836
Biomass	--	--
Wind	--	388,070
Total	**9,874,606** (71.7% of req)	**25,419,075** (79.31% of req)

Source: THE FIRST TWO YEARS OF RESULTS FOR ARIZONA'S ENVIRONMENTAL PORTFOLIO STANDARD, presented by Ray T. Williamson at the 2003 ASES Conference

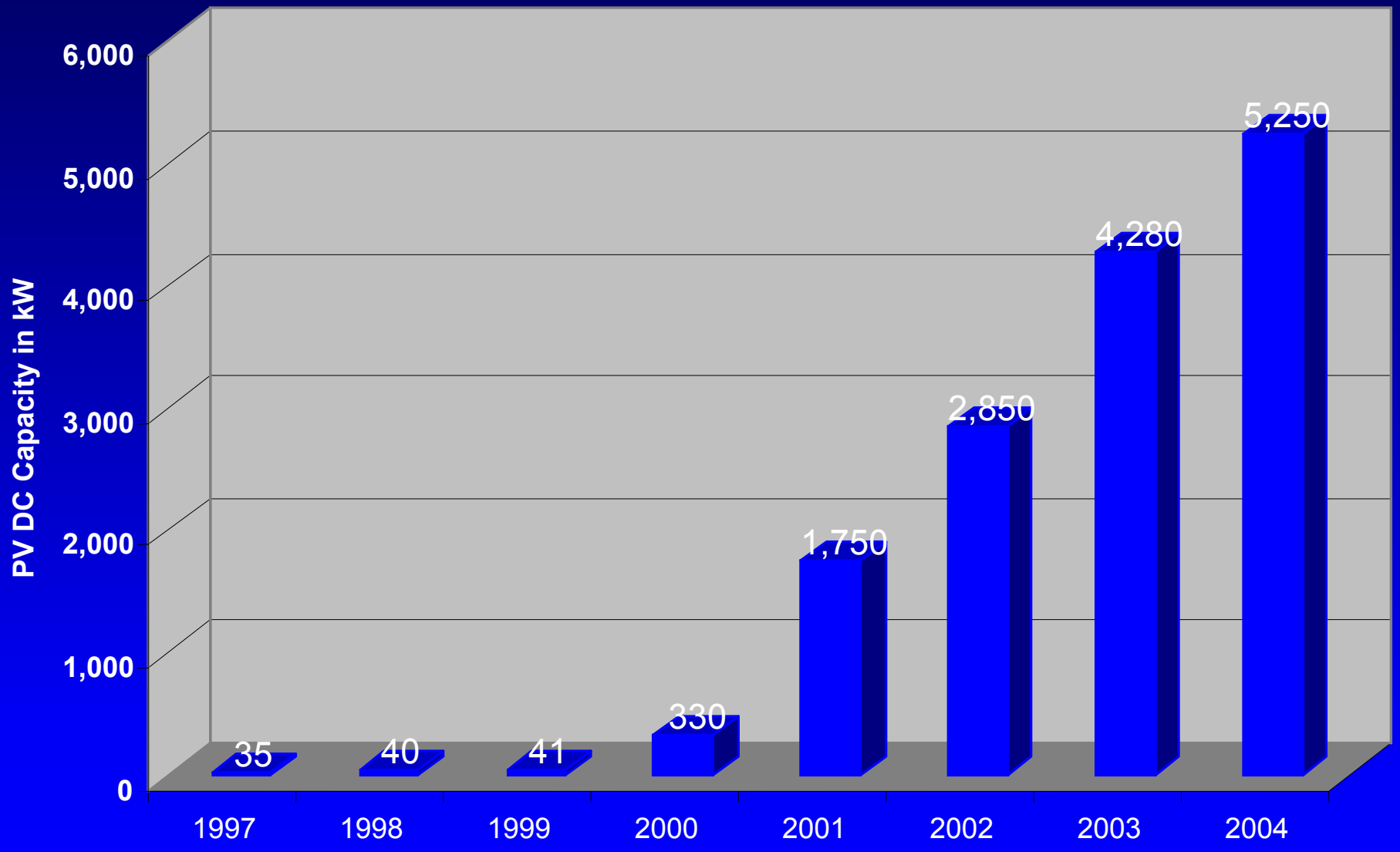
Arizona Public Service kW DC



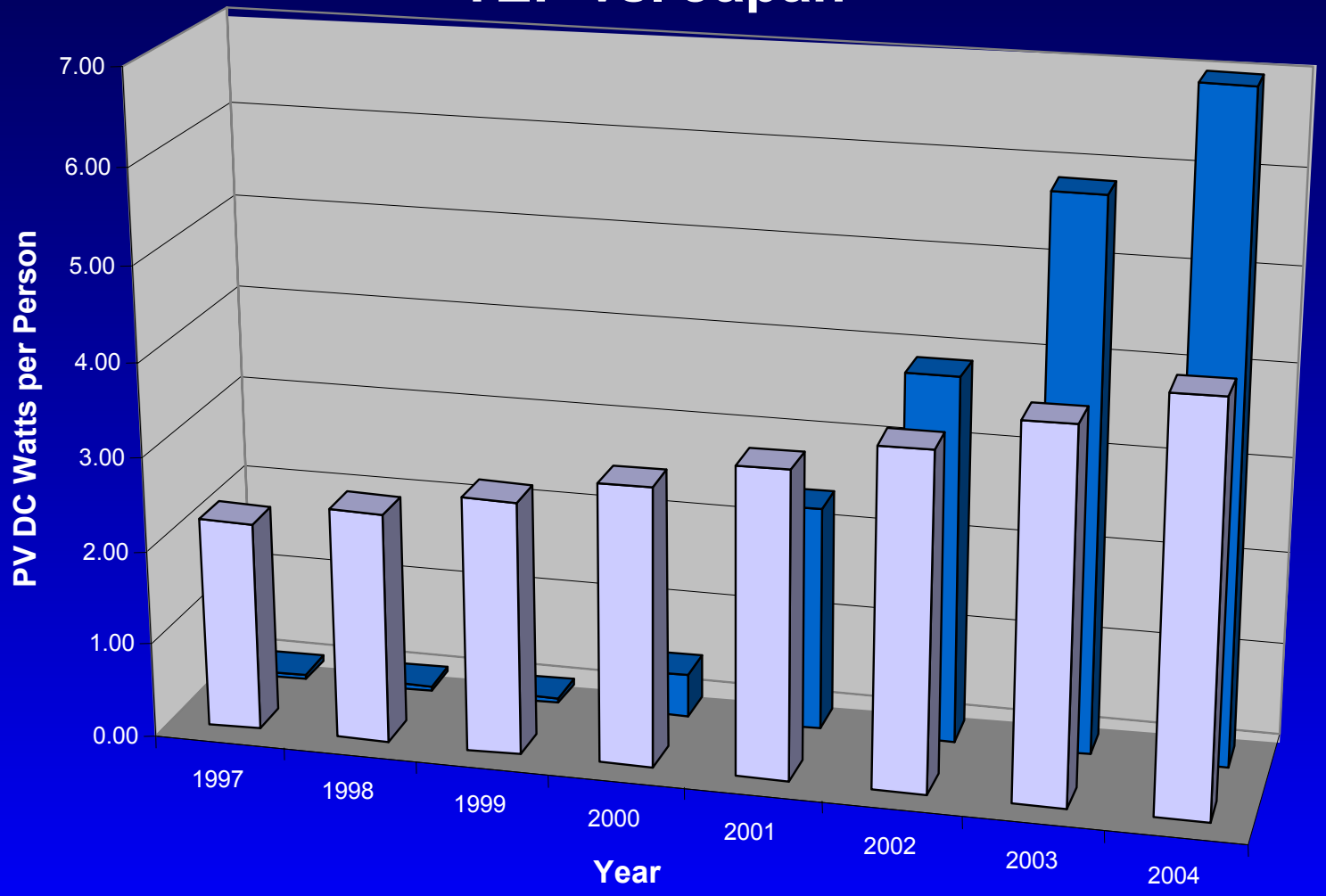
Salt River Project Solar kW AC



Tucson Electric Power Solar kW DC



PV DC Watts per Person Comparison
TEP vs. Japan



Japan 2002 Actual (other years estimated w/10% /Yr Growth)

TEP by Year

Summary of Renewable and Efficiency Programs

- Public Utility Companies (solar, wind, landfill gas)
- Private Firms (~ 70)
- Arizona Green Building Council (Scottsdale)
- Arizona Energy Office (> $5 million in federal programs)
- Universities and college (>$7 million in DoE funding), plus instruction programs and energy efficiency goals
- Tribal Energy Self-Sufficiency (Comprehensive Indian Energy Program)
- Hydrogen (Phoenix Project, American Hydrogen Association, APS refueling & research)

Given our Abundant Resources, a Record of R&D, Substantial Expertise and Experience, and Great Public Enthusiasm for Renewable Development, What is the Economic Impact on the State? What Could it Be?

2003 Sales by Solar & Wind Sectors With AZ Impact & Multipliers				
				Total
Segment	**$ Sales**	**AZ Impact**	**$ Multi.**	**$ (AZ Cash Flow)**
Utility-PV	20,400,000	5,860,000	1.8	30,948,000
RE Distributors	43,500,000	6,800,000	2.0	57,100,000
RE Dealers/Installers	12,450,000	9,270,000	2.2	32,844,000
Consultants	300,000	270,000	2.0	840,000
Manufacturing	20,200,000	8,200,000	2.0	36,600,000
RE Architects	1,200,000	1,000,000	2.1	3,300,000
	$98,050,000	$31,400,000	-	$161,632,000
The summary represents 36 separate inputs or consolidations of inputs				
Note that this is about .1% of the World Market				

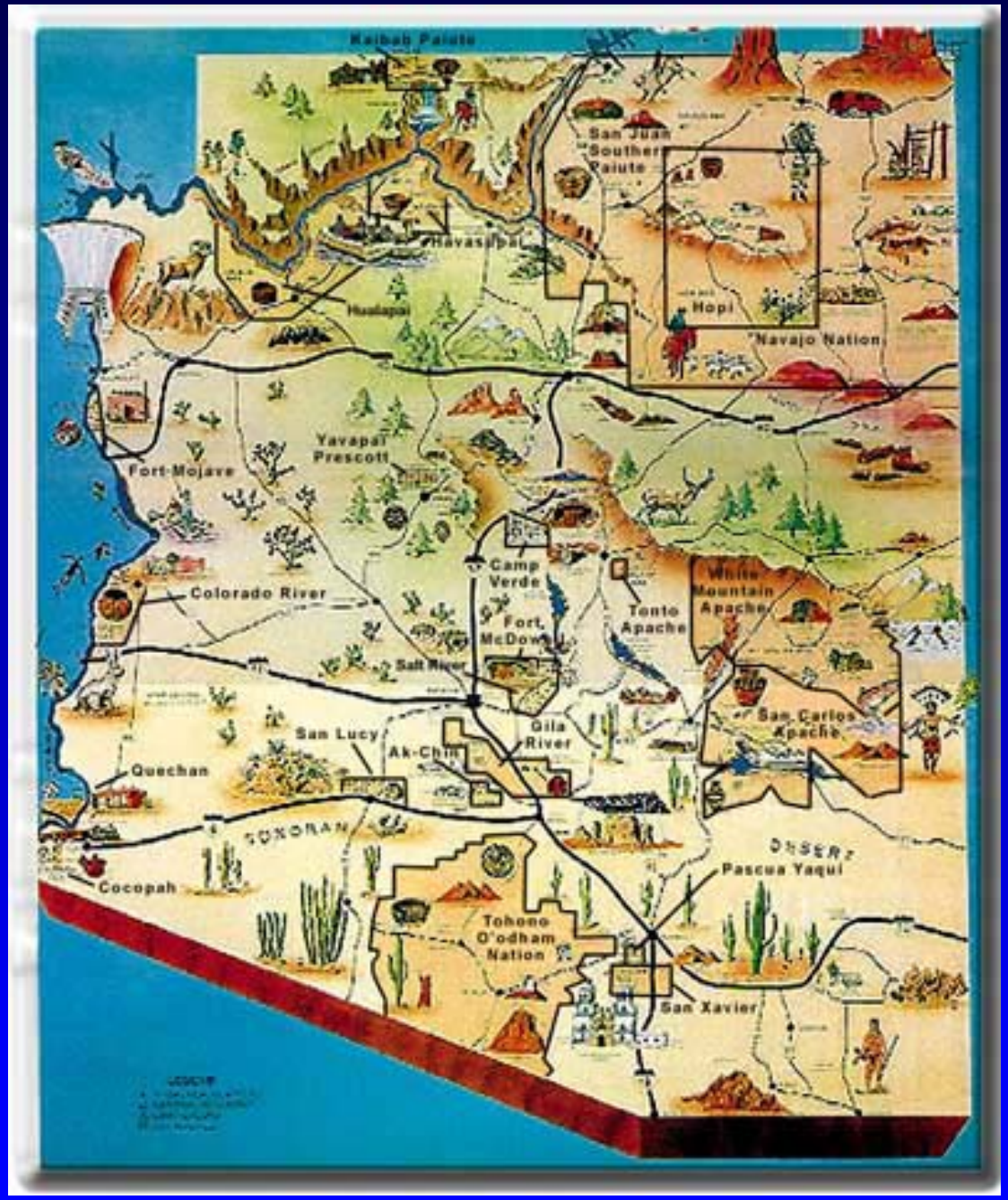
Compiled by Lane Garrett, ETA Engineering, Tempe, AZ

4. Opportunities and Potential

Opportunities for Renewables and Efficiency

- Rapid growth favors quick and substantial benefits from sustainable architecture and engineering
- World-class resource favors solar/PV, solar hot water, and solar/hydrogen
- Open space, isolated areas of demand, rapid growth, polluted air, and scarce water favor solar and wind
- Unusual co-located resources of wind, solar, and geothermal favor ‘renewable energy parks’ (e.g. Springerville)

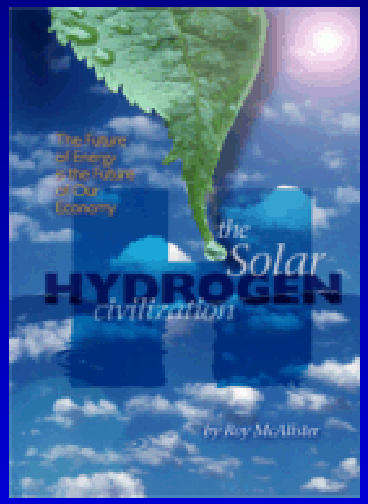
Renewables on Tribal Lands



Arizona Solar/Hydrogen Initiative

THE PHOENIX PROJECT

Shifting from Oil to Hydrogen with Wartime Speed, by Harry Braun, Phoenix, AZ



THE SOLAR HYDROGEN CIVILIZATION

by Roy McAlister, President Amer. Hydrogen Association, Tempe, AZ

"APS On the forefront of hydrogen fuel use" -- *The Business Journal of Phoenix* (4/28/03)

Arizona Renewables – 2020 megawatts

Wind	Geothermal	Solar	Biomass	Total
660	480	1,800	40	2930

Arizona exceeded all but one state in study area (Utah, Colorado, Arizona, New Mexico, Montana, Wyoming, Nevada).

Source: Western Resource Advocates

Snapshot of Arizona's Energy Situation

- Arizona's level of population growth and renewable energy development will outpace all other mountain states
- Arizona's benefits from energy efficiency will meet or exceed all other states
- Arizona's greatest opportunity to meet demands with local resources is with renewable energy
- Arizona's greatest need will continue to be to meet demands without further degrading environmental quality

Arizona Department of Commerce
Energy Office
Solar Energy Advisory Council

Goals

- Improve energy efficiency and use of passive design
- Increase development of all renewable energy resources
- Cut the $4.3B leaving the state every year in energy expenditures in half by the year 2010
- By year 2010 Arizona's leadership in solar helps the state sustain long term economic growth with a cleaner environment.
- Improve renewable development on Tribal lands
- Move toward a renewable/hydrogen economy
- Establish Arizona as the --

Renewable Energy State