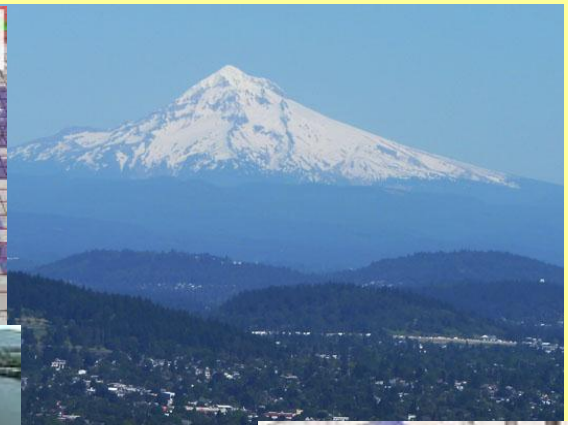
Portland State UNIVERSITY

Urban sustainability and energy research at PSU: An opportunity for differentiation



Intel Symposium on Urban Sustainability and Personal Energy Management

January 18, 2011

Portland State UNIVERSITY

What's the problem? What's the opportunity?

1) Large numbers of people are moving to cities
2) Equitable, efficient cities help achieve global sustainability goals
3) Every city is now experimenting with new policies
4) Companies, NGOs, universities also trying to improve cities
5) How can cities learn from each other more effectively?
6) How can embedded technologies make cities work better?
7) Can Portland make urban sustainability a major export?
8) Can PSU help expand the definition of urban sustainability?

What's the PSU situation?

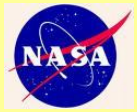
1) Only comprehensive research university in Portland
2) Motto: "Let Knowledge Serve the City"
3) Pockets of academic excellence, many in non-traditional areas
4) Engineering, natural, social sciences aim at urban/energy problems
5) Some Computer Science and System Science expertise from OGI
6) Research connectivity throughout the region
7) Student internships build bridges to organizations

Questions for today's discussion

1) What urban/energy partnering opportunities for Intel and PSU?
2) What grant proposals can forge stronger research ties?
3) Can we build urban bridges to higher-ranked universities?
4) Can PSU serve as a convener for different sectors?
5) Can Portland become the partner-of-choice for urban solutions?
6) Is there value in PSU having an over-arching research theme?

Four sectors help conduct urban experiments

Government



Fund
Protect
Regulate
Negotiate

Universities

Educate
Discover
Convene
Integrate

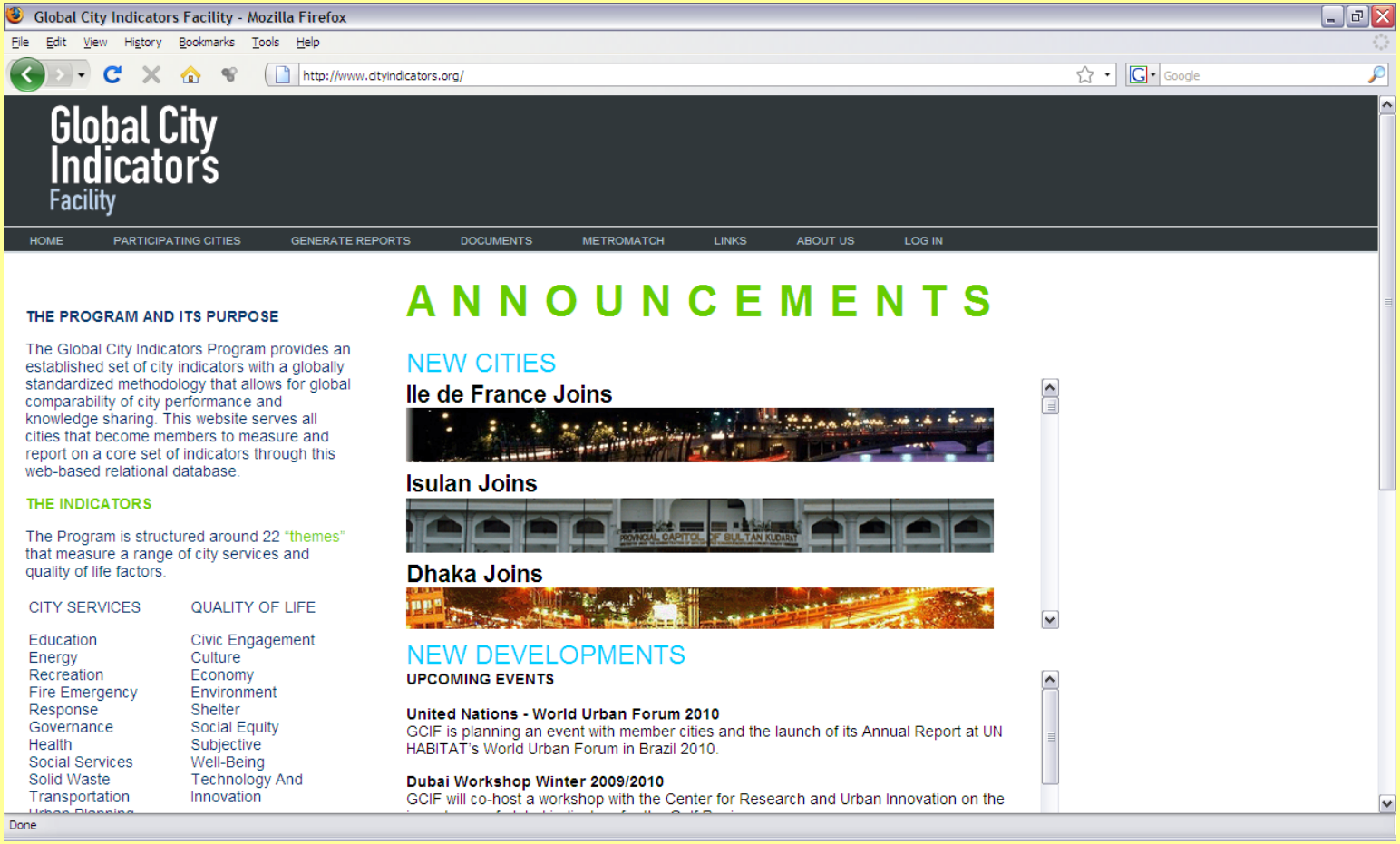
Advocate
Defend
Inform
Solicit

NGOs

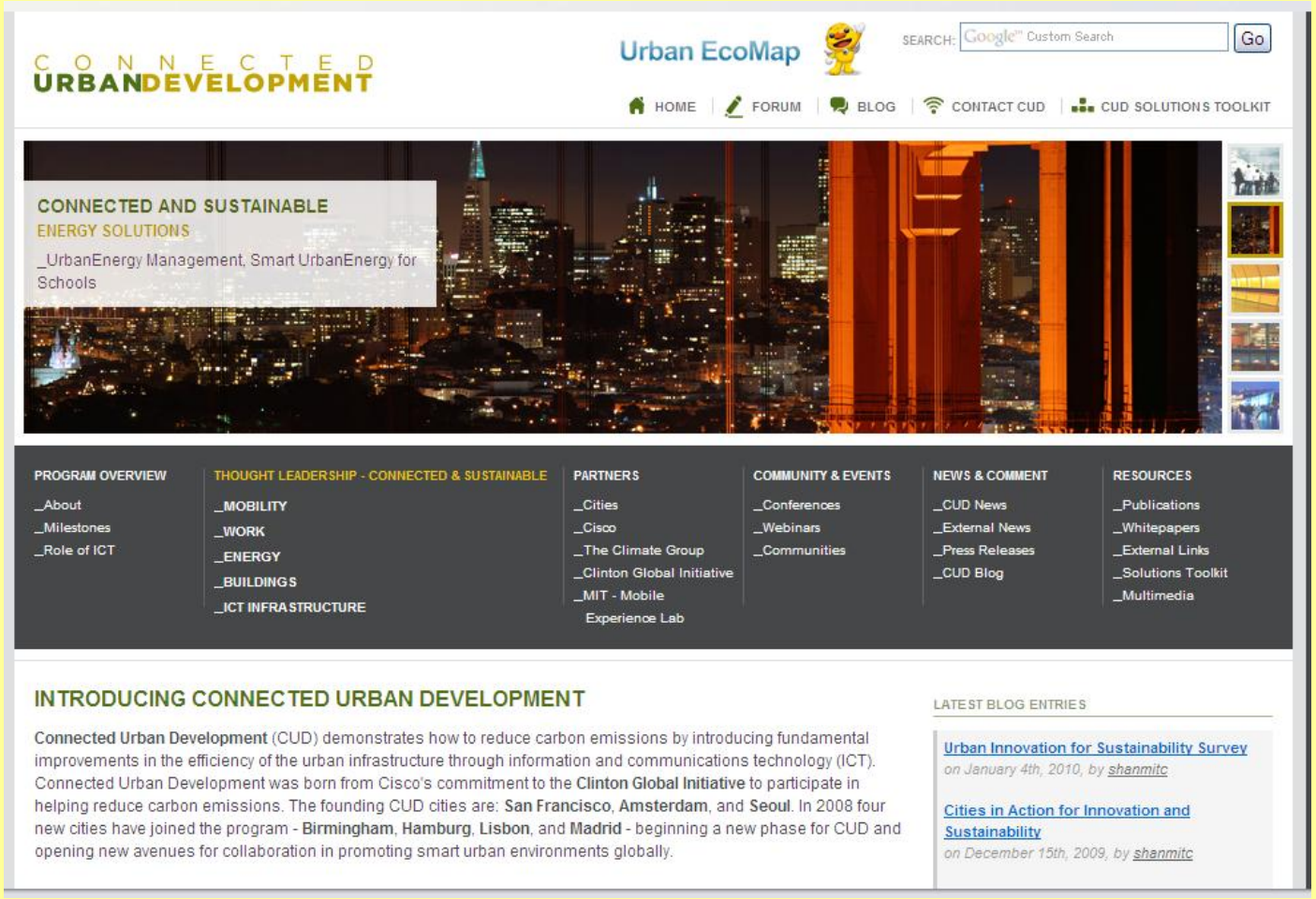
Contribute
Innovate
Employ
Invest

Corporations

World Bank's Global City Indicators Facility

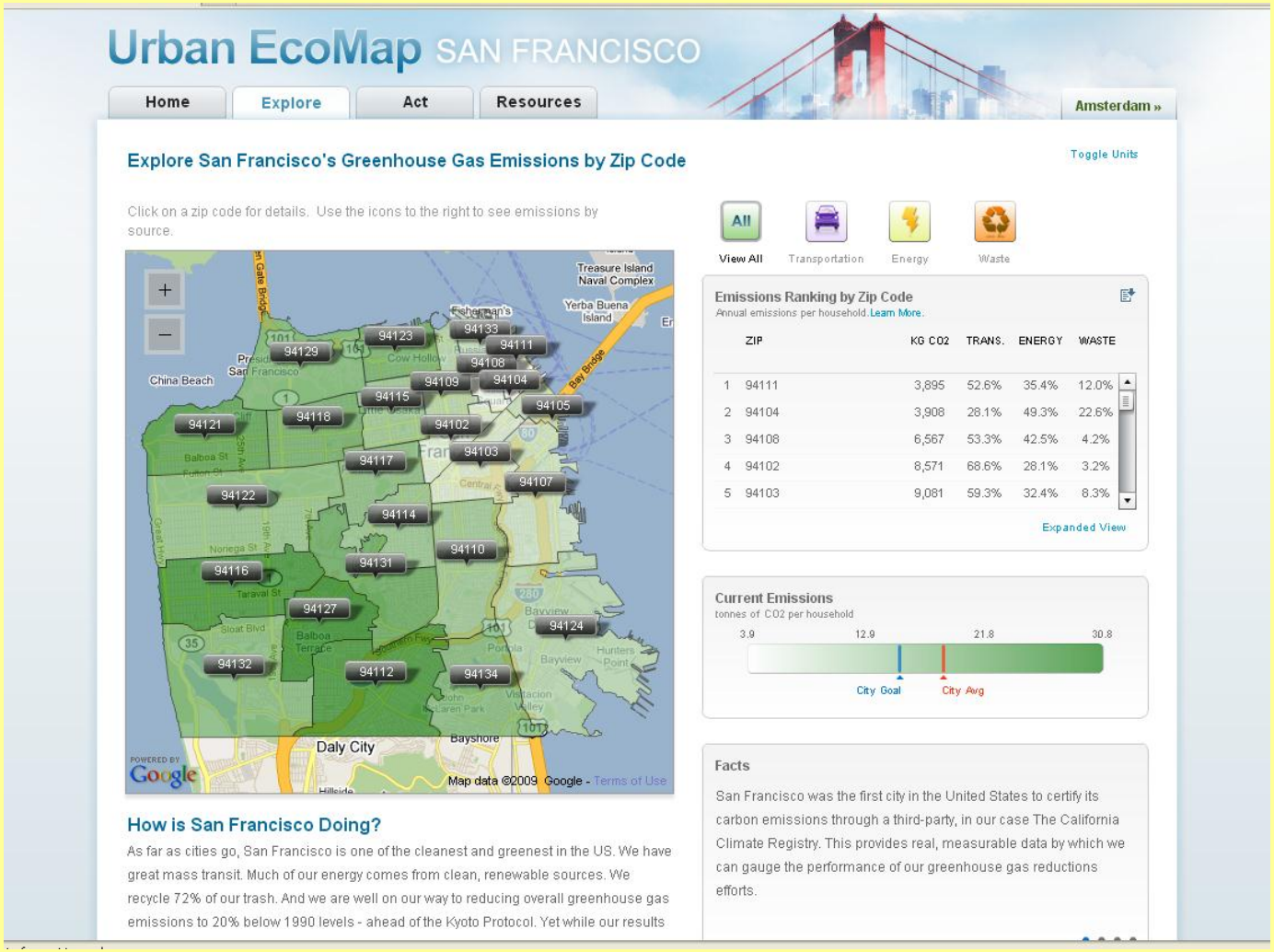


Cisco Systems' Connected Urban Development

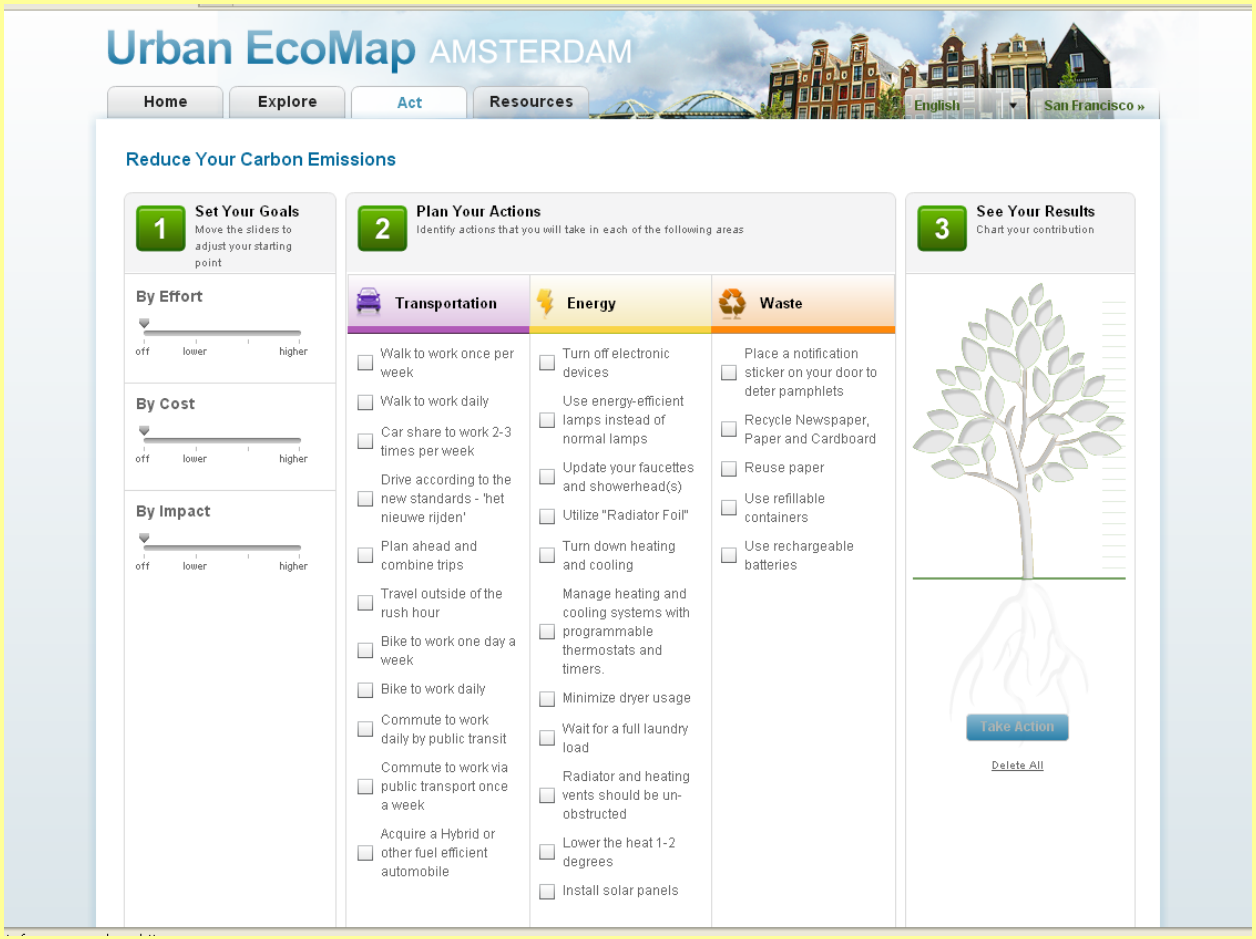


CUD's Urban EcoMap for Amsterdam, San Francisco and Seoul

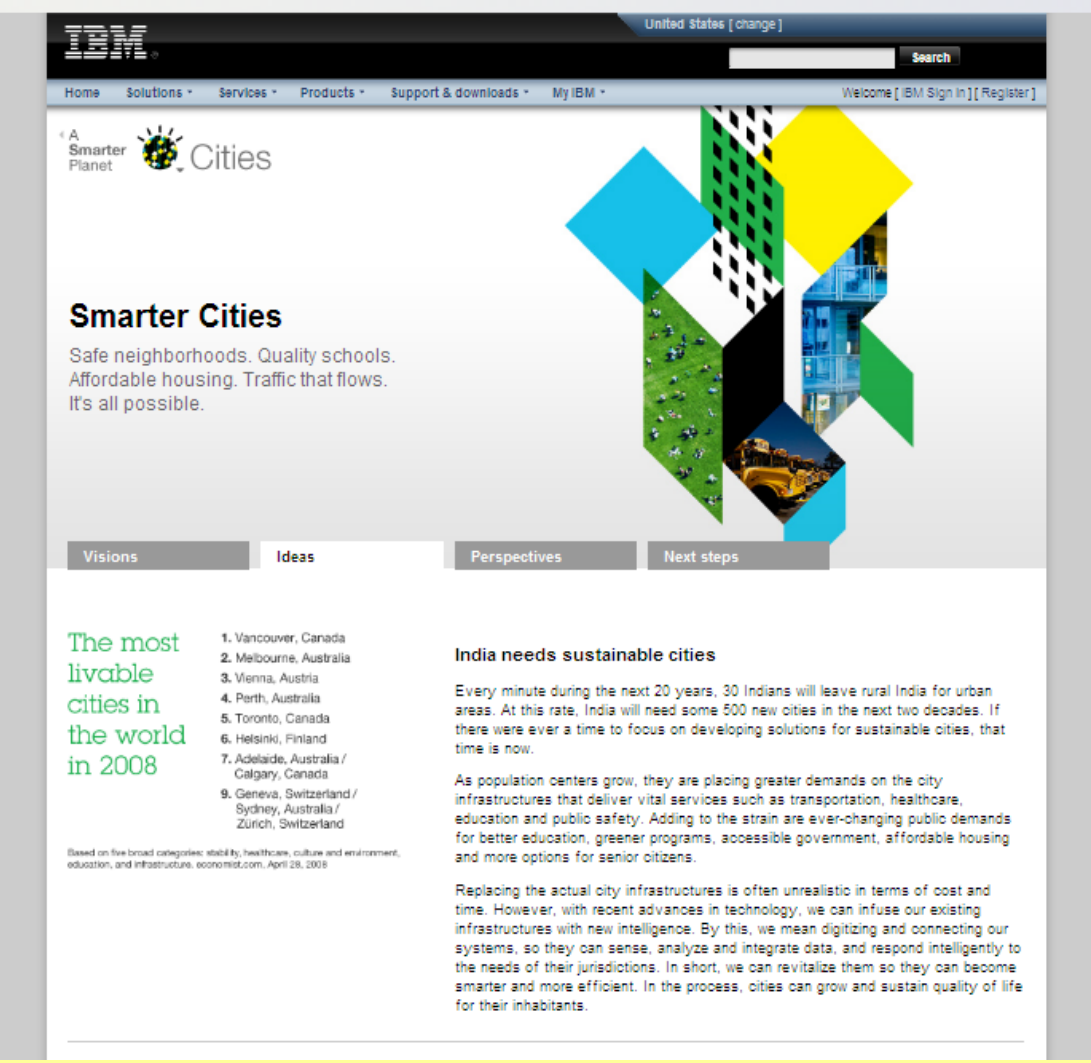
EcoMap shows environmental impact by zip code



EcoMap shows individuals how to reduce their footprint



IBM's Smarter Cities Program



Combining new sensor technologies with computer models for better management decisions

Portland is IBM's chosen test bed

Non-IT companies can be partners for urban sustainability research

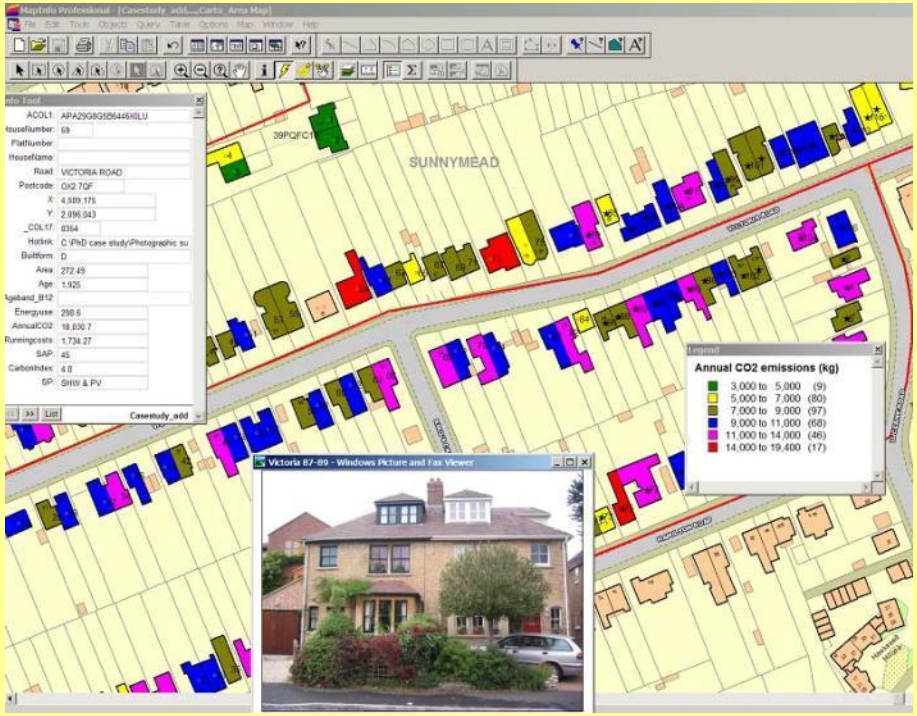
- Wal-Mart: (retail supply chain)
- Waste Management Inc: (material flows)
- KB Home: (residential construction)
- CEMEX: (construction materials)
- Veolia: (urban environmental monitoring)
- BP Solar: (urban renewable energy)
- U Haul: (social mobility)
- Henkel/Dial: (home products)
- Arizona Public Service: (electricity generation)
- Salt River Project: (urban water and power delivery)

MIT SENSEable Cities Lab "Copenhagen Wheel"

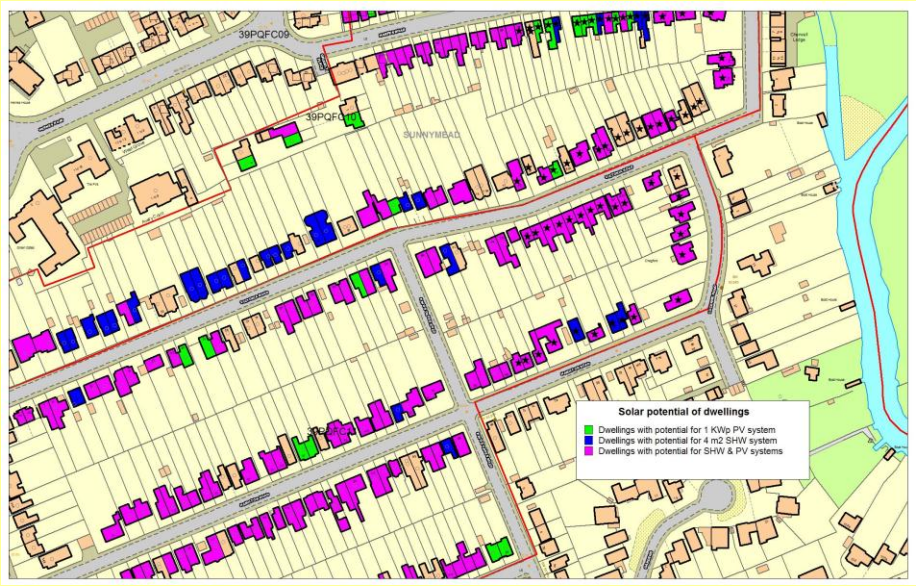
What can we learn from other cities?

- Cities taking the lead in discovering sustainable solutions
- Each city has unique challenges and opportunities
- Competition to be “green” is helping cities find new ideas
- Regional cooperation is essential

Carbon mapping on an urban scale (DECoRuM)



Distribution of CO_2 emissions on a house-by-house level in Oxford



Estimating the solar potential of dwellings in Oxford

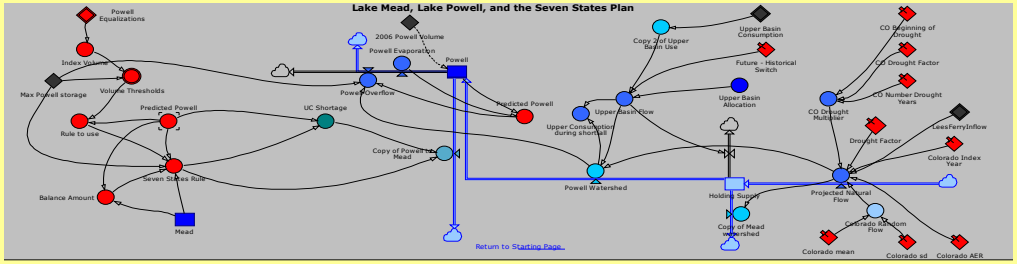
- **GIS-based, domestic carbon-counting and carbon-reduction model**
- **Bottom-up toolkit helps planners measure, model, map, & reduce energy use and carbon emissions on a house-by-house level**

Domestic Energy, Carbon Counting and Reduction Model (DECoRuM)

- Led by Professor Rajat Gupta of Oxford Brookes University
- Provides urban- and dwelling-level, GIS-based carbon mapping
- Does not require access to property
- Links to thermal infrared remote sensing measurements
- Cost-benefit analysis enables comparisons of different options
- Helps estimate value of citywide solar energy installation
- Being applied in Oxford (UK), ASU-Tempe, Phoenix, London
- Helps persuade homeowners to install energy-saving options
- www.decorum-model.org.uk

Decision Center for a Desert City

- Addresses urban water decision-making under uncertainty
- Regional stakeholders engaged from start to finish
- Decision Theater helps them assess alternative futures
- Could also apply to air pollution, energy, traffic, food



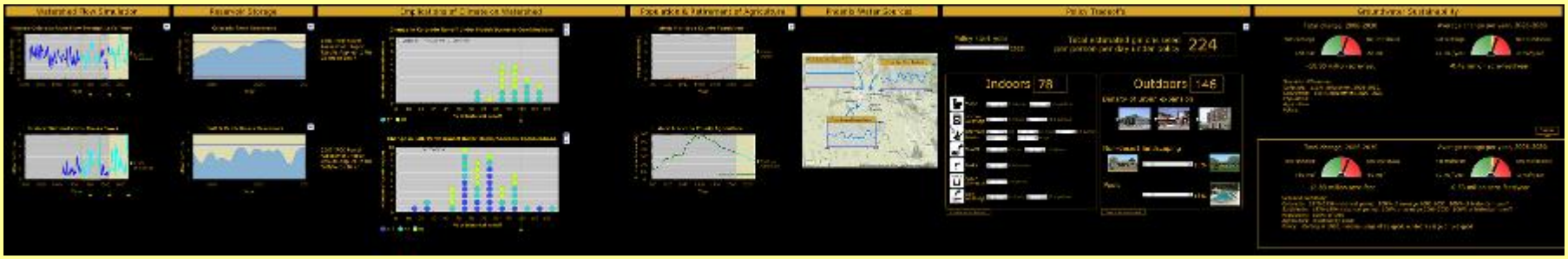
"WaterSim" forecasting tool in Decision Theater

***WaterSim has* many user-adjustable variables**

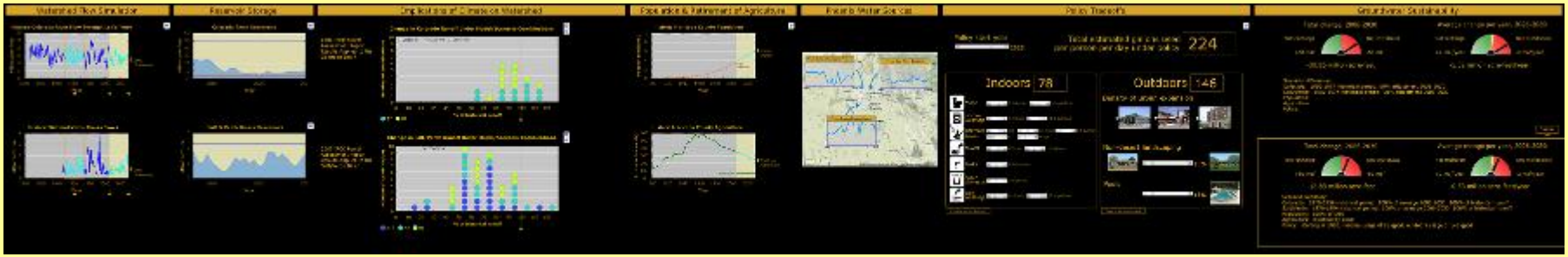
Research and Strategic Partnerships

Portland State UNIVERSITY

WET



DRY



Watershed Simulation	Climate Change	Land Use & Population	Policy Tradeoffs	Groundwater Sustainability

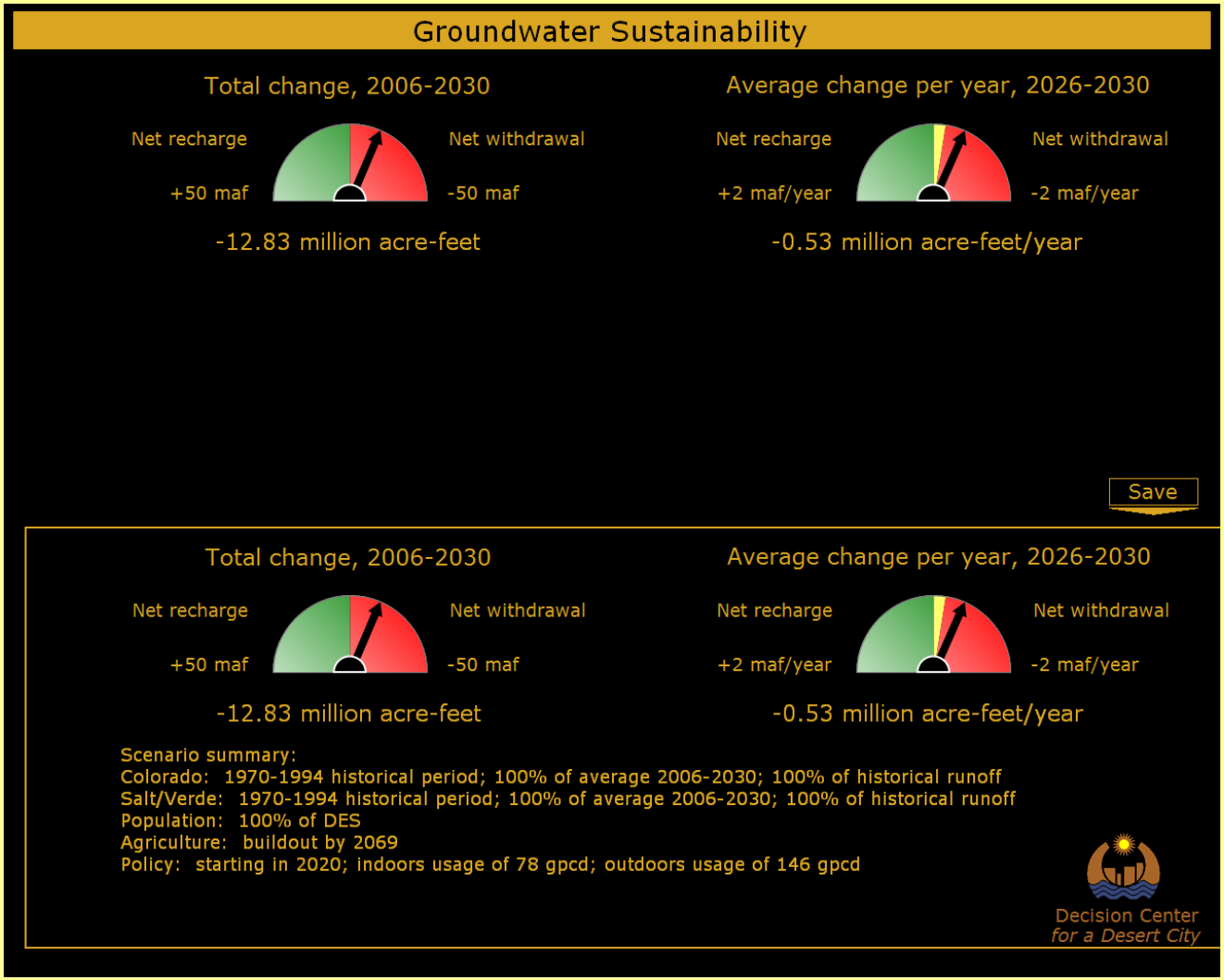
More technical ⟷ **Less Technical**

Slider bars on graphs allow alternate futures to be assessed in real time

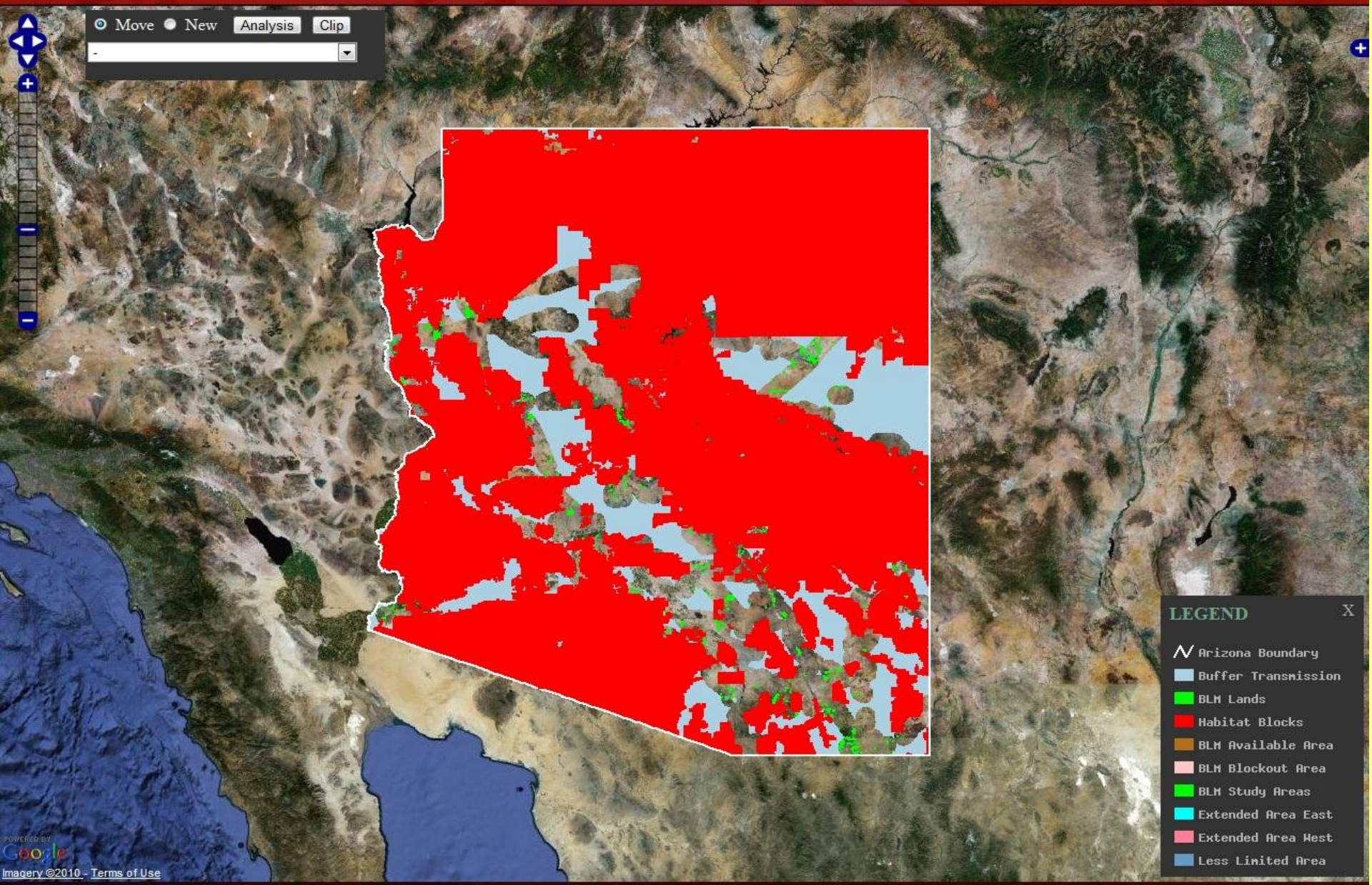
WaterSim also available online at http://watersim.asu.edu

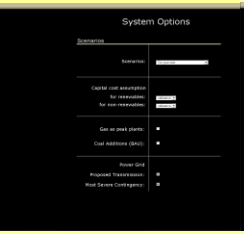
Policy Tradeoffs

Groundwater Sustainability

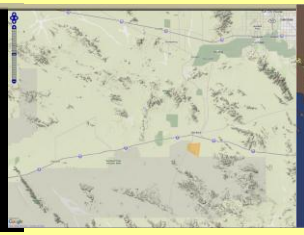


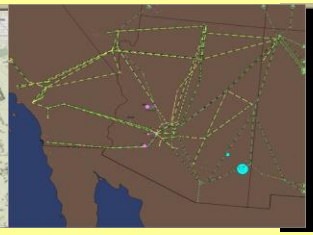
Az SMART
Arizona's Solar Market Analysis and Research Tool

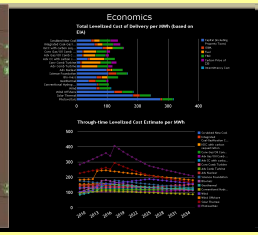

Move
New
Analysis
Clip
-
LEGEND
X
Arizona Boundary
Buffer Transmission
BLM Lands
Habitat Blocks
BLM Available Area
BLM Blockout Area
BLM Study Areas
Extended Area East
Extended Area West
Less Limited Area
Google
Imagery ©2010 - Terms of Use

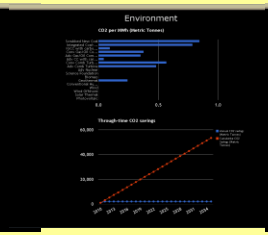

System Options
Scenarios
Scenarios:
Capital cost assumption
for renewables:
for non-renewables:
Gas or peak plants:
Coal Additions (GW2):
Power Grid
Proposed Transmission:
Most Severe Contingency:

Policy & Technology Options
Policy
Real Carbon Price (2010$ per metric ton)
Alternative Solar Investment Tax Credit (%)
Technology
Power plant type
Cooling
Custom Solar Technology
Name of Technology
Nominal Capital Cost ($ per kW)
Annual Real Rate of Decline in Capital Cost (%)
Nominal O&M ($ per kW)
Capacity Factor (%)
Economic Life (years)
Water use per MW (gallons)
Area use per MW (acres)

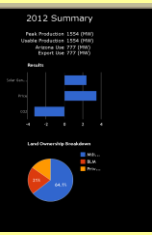




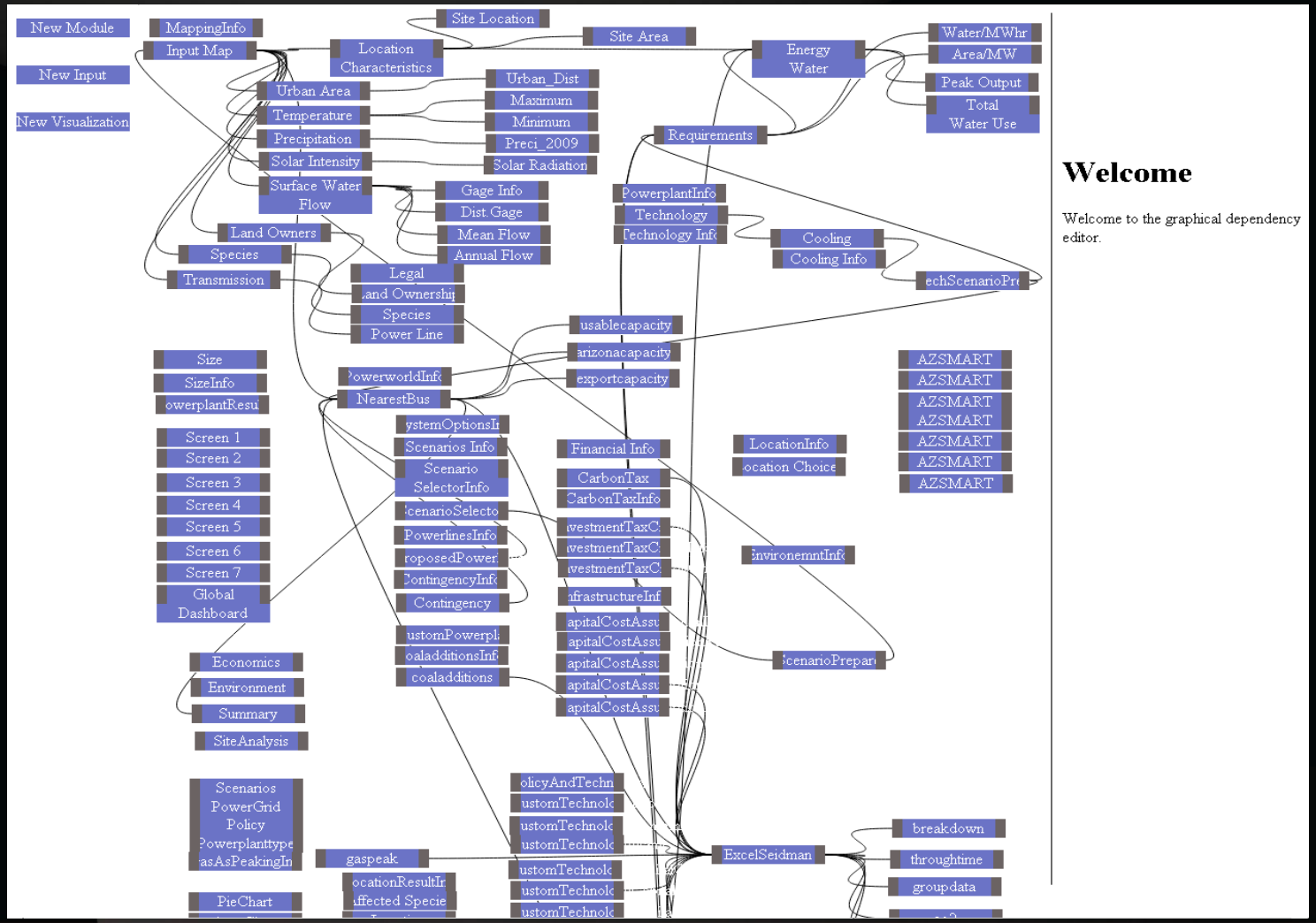

Economics
Total Levelized Cost of Delivery per MWh (based on CAC)
Through-time Levelized Cost Estimate per MWh


Environment
CO2 per MWh (Metric Tonnes)
Through-time CO2 savings

Site Analysis
Location Information
Location
Area
Closest Urban Area
Distance to closest transmission line
Solar Radiation
Max Temp
Min. Temp
Total Water Use
Precipitation (2009)
Closest Stream Gage
Current Discharge (aFt/year, 2009)
Top 5 Affected Species


2012 Summary
Peak Production 1554 (MW)
Usable Production 1554 (MW)
Arizona Use 777 (MW)
Export Use 777 (MW)
Results
Land Ownership Breakdown

TECHNOLOGY PLATFORM



ASU DECISION THEATER
ARIZONA STATE UNIVERSITY

System Options

Scenarios

Scenarios:	Do your own
Capital cost assumption	
for renewables:	reference
for non-renewables:	reference
Gas as peak plants:	☐
Coal Additions (BAU):	☐
Power Grid	
Proposed Transmission:	☑
Most Severe Contingency:	☑

Policy & Technology Options

Policy

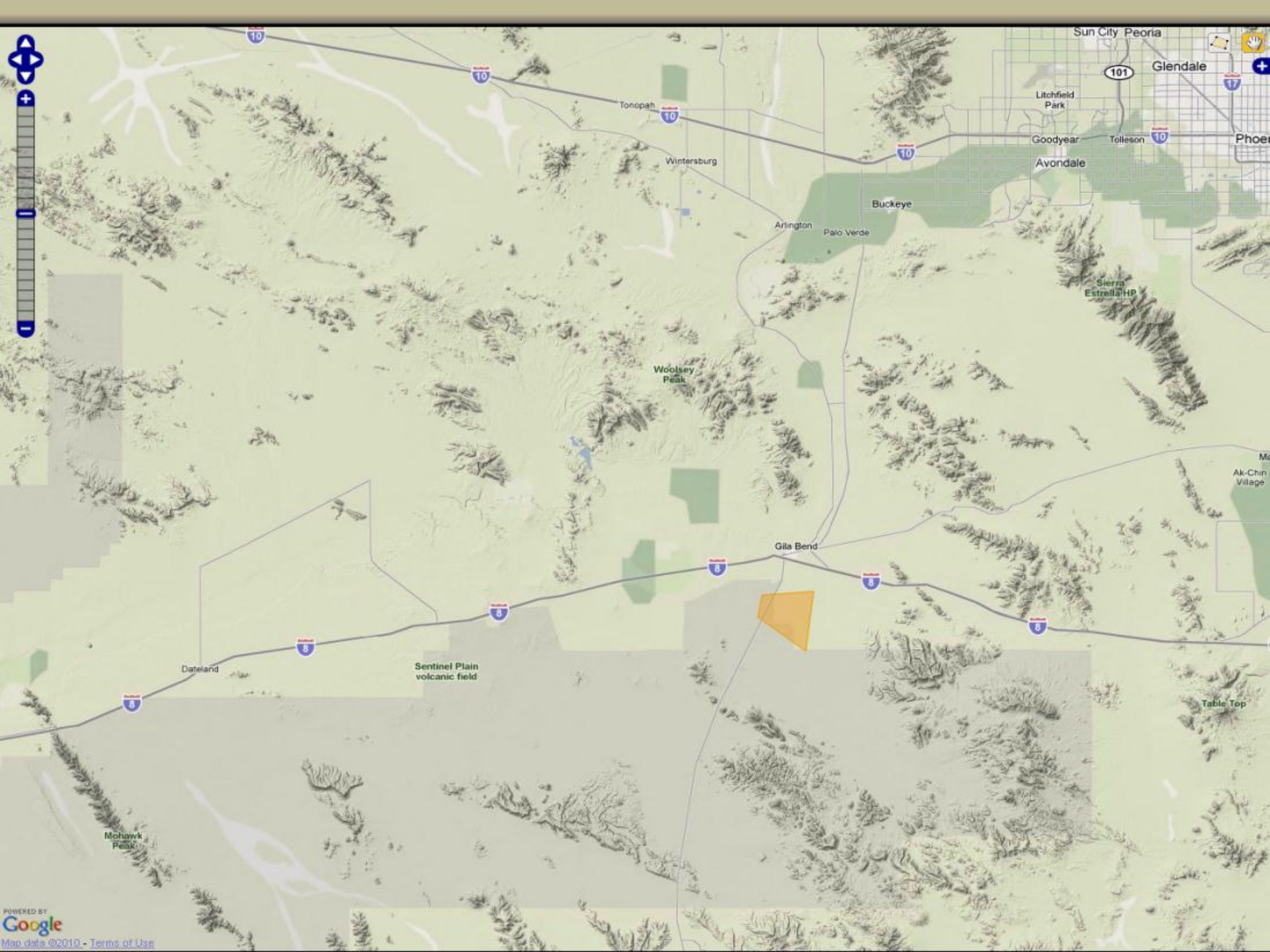
Real Carbon Price (2010$ per metric ton)	30
Alternative Solar Investment Tax Credit (%)	☐ 30

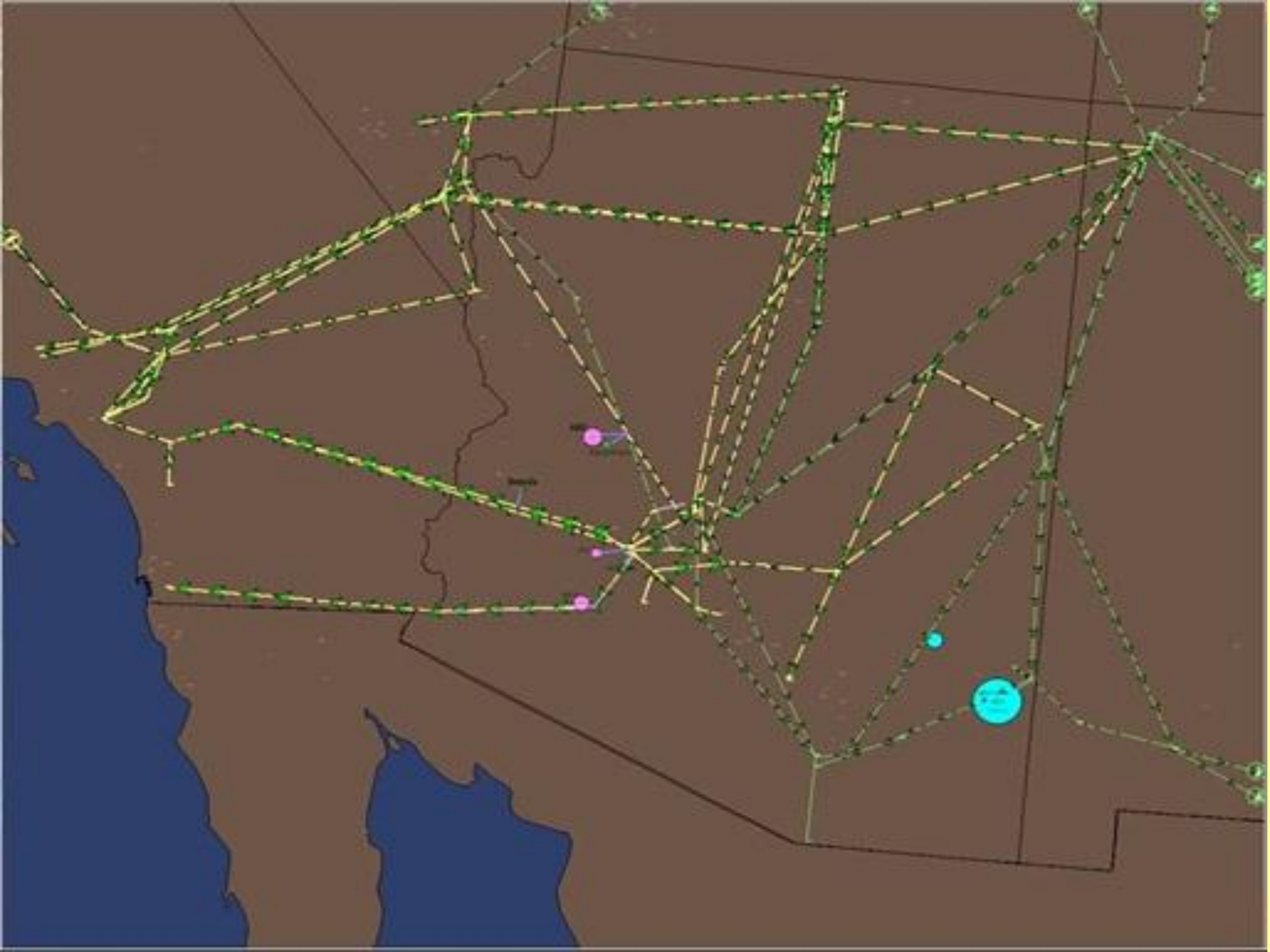
Technology

Power plant type	Photovoltaic
Cooling	Air Cooling

Custom Solar Technology

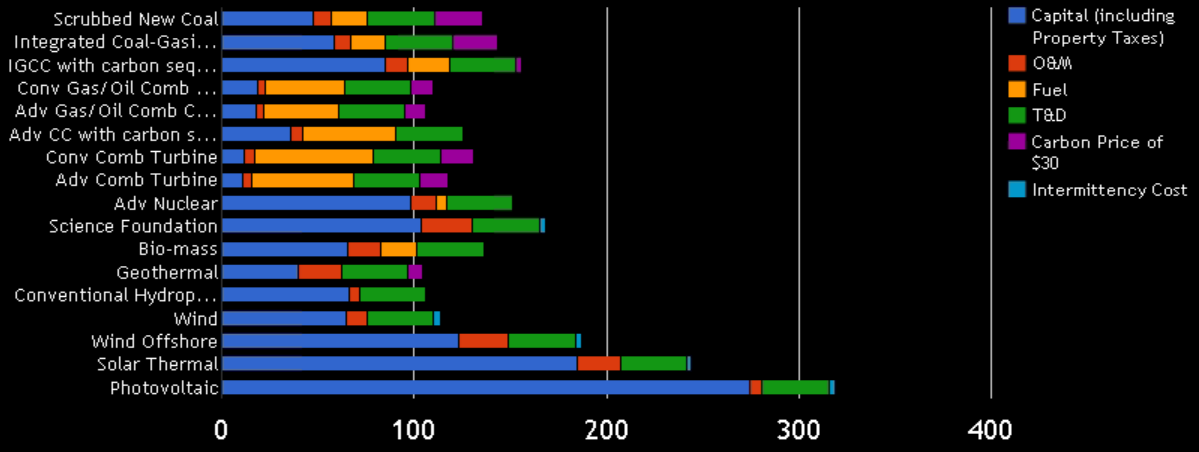
Name of Technology	Science Foundation
Nominal Capital Cost ($ per kW)	3000
Annual Real Rate of Decline in Capital Cost (%)	3
Nominal O&M ($ per kW)	54
Capacity Factor (%)	23
Economic Life (years)	30
Water use per MW (gallons)	2
Area use per MW (acres)	6


Sun City
Peoria
Glendale
101
Litchfield Park
Goodyear
Tolleson
Avondale
Tonopah
Wintersburg
Buckeye
Arlington
Palo Verde
Sierra Estrella HP
Woolsey Peak
Gila Bend
Ak-Chin Village
Dateland
Sentinel Plain volcanic field
Table Top
Mohawk Peak
Google
Map data ©2010 - Terms of Use

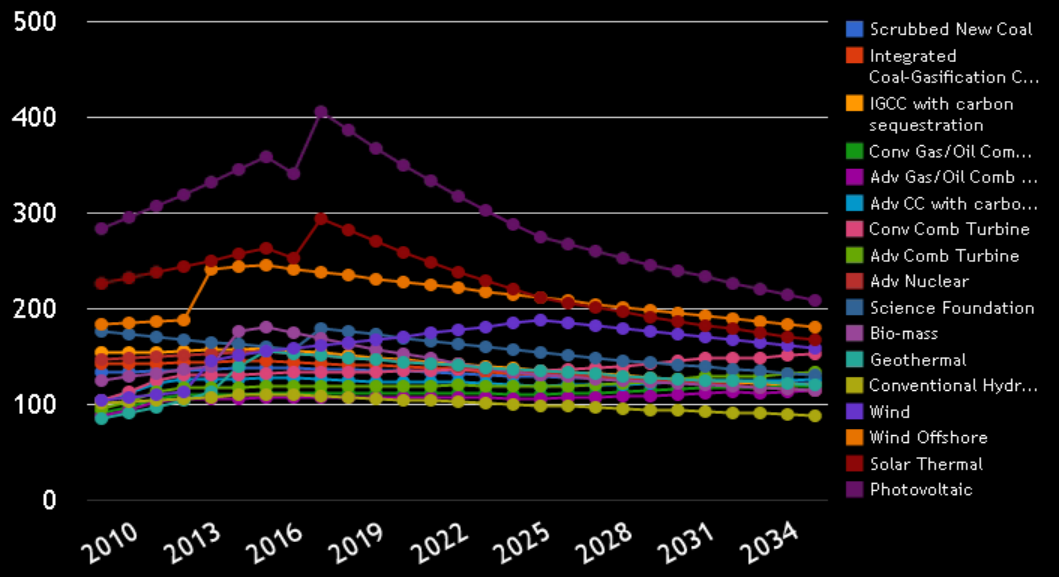


Economics

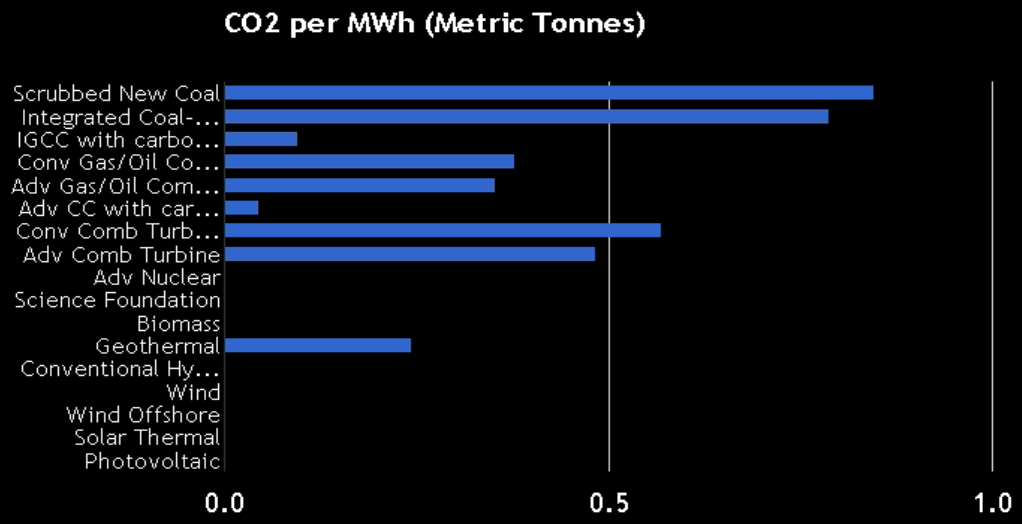
Total Levelized Cost of Delivery per MWh (based on EIA)

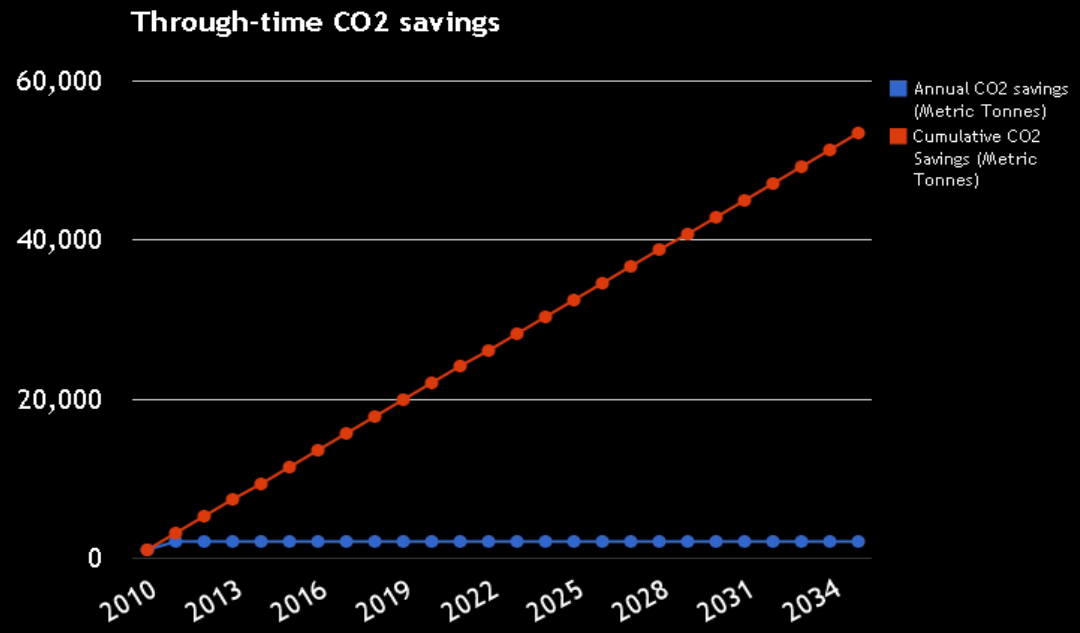


Through-time Levelized Cost Estimate per MWh



Environment





Site Analysis

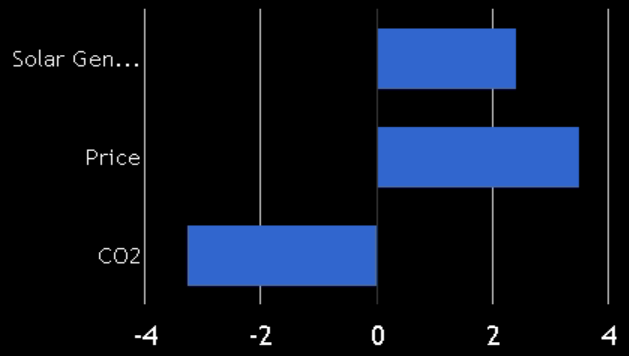
Location Information

Location	-112.73, 32.87 (lon, lat)
Area	9326.1 (acres)
Closest Urban Area	Ajo, AZ, 48.36 (km)
Distance to closest transmission line	11.31 km
Solar Radiation	278.68 (gW h/Day)
Max Temp	107 (Degrees F)
Min. Temp	38 (Degrees F)
Total Water Use	192 (af/year)
Precipitation (2009)	1796.89 (af/year)
Closest Stream Gage	GILA RIVER below Painted Rock Dam, AZ (30.92km)
Current Discharge (af/year, 2009)	72.4
Top 5 Affected Species	Sonoran Desert Tortoise [1b]

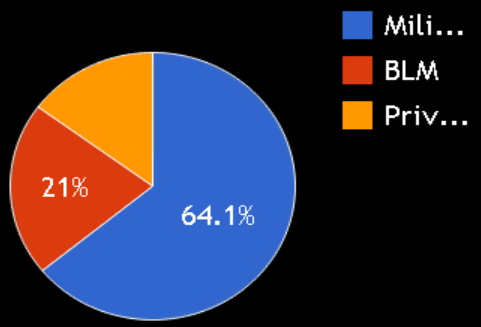
2012 Summary

Peak Production 1554 (MW)
Usable Production 1554 (MW)
Arizona Use 777 (MW)
Export Use 777 (MW)

Results



Land Ownership Breakdown



PSU Sustainable Energy Research

David Sailor

Professor
Mech & Materials Engineering

Performance testing of a retrofit window product

Indow Windows Inc.

Testing thermal, acoustic, noise abatement properties

Funding from Oregon BEST

Phase change materials in buildings

Testing materials that store heat in day and release it at night

Impact of roof technologies on energy consumption

Green roof energy simulation model

PSU Sustainable Energy Research

Huafen Hu

Development of building energy model database for PSU campus

First step toward model-based central energy control system

Asst Professor
Mech & Materials Engineering

PSU Sustainable Energy Research

Raul Cal

Asst Professor
Mech & Materials Engineering

Wind energy and turbulence

Just built a wind tunnel facility

PSU Sustainable Energy Research

Graig Spolek

Professor
Mech & Materials Engineering

Lab measurement of building cooling energy reduction due to green roof

Design and test green roofs with optimal performance

Test around Metro Portland

PSU Sustainable Energy Research

Nirupama Bulusu

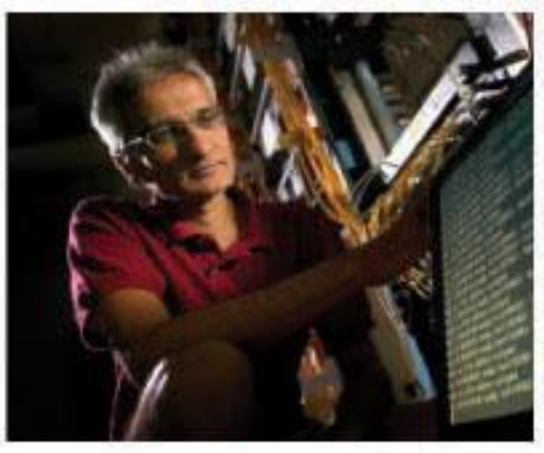
Assoc Professor
Computer Science

Sensor networks

Has PhD student, Thanh Dang, Intel intern on smart buildings

PSU Sustainable Energy Research

Suresh Singh



Power-Efficient Ad Hoc Mobile Networking

Low-power internet devices and protocols

Professor
Computer Science

PSU Sustainable Mobility Research

Dan Hammerstrom

Electric Vehicle two-course sequence

Intro to electric drives and drive control

Vehicles as systems

Professor
Electrical and
Computer Engineering

PSU Sustainable Energy Research

Loren Lutzenhiser

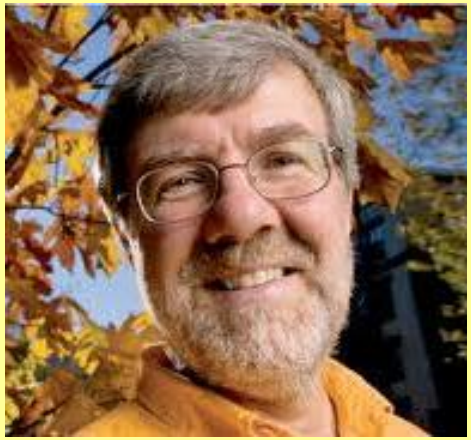
Links between urban energy use and global environmental change

Behavioral influences on conservation in households and businesses

Professor
College of Urban
and Public Affairs

PSU Sustainable Energy Research

Carl Womser



Professor
Chemistry

Solar energy

Artificial photosynthesis using novel organic materials

PSU Sustainable Mobility Research

Miguel Figliozzi

Assoc Professor
Civil & Environmental Engineering

Optimizing transit bus fleet management

Integrated multimodal transportation, air quality, livability corridor study

Commercial electric vehicle fleet analysis

Impact of weather on bicycle ridership

Climate change impact on transportation infrastructure

PSU Sustainable Mobility Research

Chris Monsere

Assistant Professor
Civil & Environmental Engineering

Intelligent Transportation Systems Laboratory

Analysis of freeway travel time reliability at the segment level for hotspot identification

PSU Sustainable Energy Research

Peter Dusicka

Assistant Professor
Civil & Environmental Engineering

Seismic evaluation of Green Building Structure

Combining seismic safety with green construction

PSU Sustainable Energy Research

Tugrul Daim

NW Regional efficiency roadmap

Associate Professor
Engineering & Tech. Management