



# Initial Findings of Water Availability on RTEP Scenarios

State and Provincial Steering Committee Webinar

April 6, 2011

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**Colorado Department of Natural Resources  
Western States Water Council**



# Integrated Energy and Water Planning

## Project Goals

- Assessing how water availability intersects with planning for electric generation and its underlying transmission
- Formulating regional policies and analytical tools with respect to the Energy-Water Nexus – tie to above bullet

## Project Benefits

- Position the governors to be proactive on future issues regarding water availability and energy development
- Provide a model for more integrated planning in areas that have been traditionally stove-piped
- Improve regional data quality and consistency on water availability, overall water demand, and water requirements for energy

## Project Limitations

- Not intended to imply water as a deciding factor in siting of electric generation
- Current spatial resolution does not allow site-specific analysis
- Water availability data is being refined to include state data



# How Water Availability is Already Impacting Energy Policy and Siting Decisions

**Arizona – The Arizona Corporation Commission recently required the Hualapai Valley Solar Project to use 100% reclaimed water or operate as a dry cool only plant.**

**California – The California Energy Commission prohibits once-through cooling; the California Water Resources Board has also considered banning sea water for the cooling of power plants.**

**Colorado – In 2010, the Colorado Public Utilities Commission began requiring utilities to report water consumption and intensity at existing and proposed power plants**

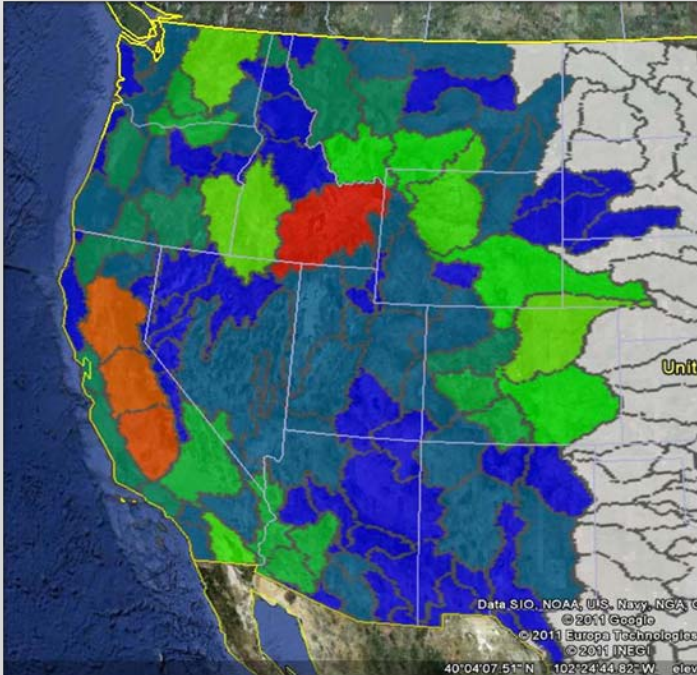
**Idaho – Passed 2006 bill placing 2-year moratorium on coal-fired power plants due to concerns of water availability**

**Nevada – Reid Gardner coal generating station retrofitted to save 280 million gallons of water a year**

**U.S. EPA – Revised Clean Water Act Section 316(b) would require best available technology at plant cooling intakes**



# Initial WECC Scenario Analysis



## 2010 WECC Transmission Scenarios

- WECC 2010 Reference Case
- High Load
- High DSM Scenario
- Carbon Reduction Scenario

Initial results produced by Sandia National Laboratories ; NREL assisted in developing metrics for water use/consumption by generation technologies

Caveat: All results are still preliminary and are being provided for illustrative purposes



# How This Analysis Can Inform Decisions

**Identify areas of risk due to potential water scarcity**

**Use drought analysis to consider power plant and electric system vulnerabilities**

**Identify and develop technological or management options for planners and policymakers to account for water availability when siting electric generation**

**Prepare governors, industry, and regulators to understand long-term challenges and trade-offs**



# Key Findings from Initial Analysis

**75% of water consumption from new electricity generation is located in basins prone to stress of surface water**

**Water withdrawal intensity declines, but water consumption intensity increases**

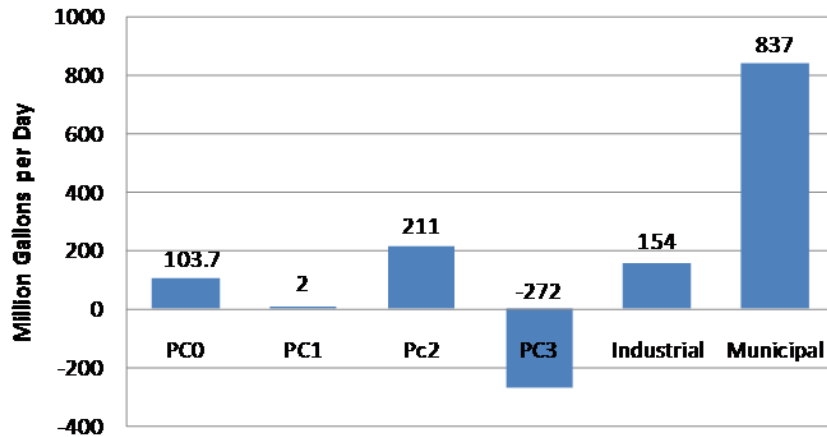
**Demands for water for electricity are relatively small in relation to agriculture, municipal and industrial uses, but the spatial and temporal distribution of electricity demands can be critical**

**The High-DSM scenario averts potential water conflicts in Southwest basins**

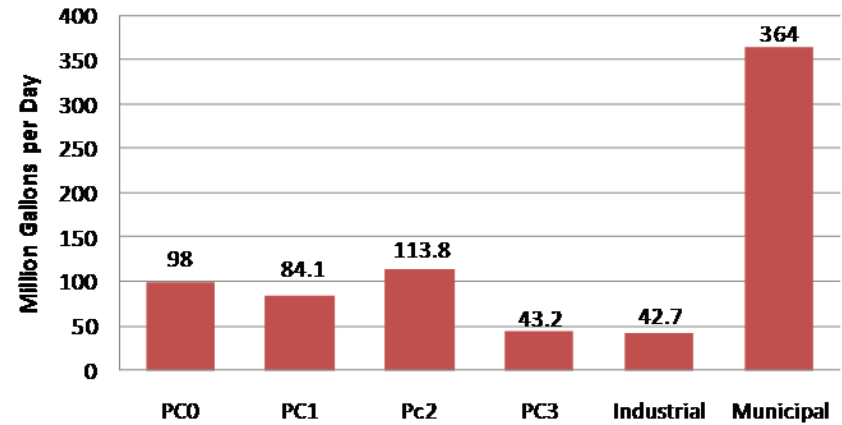


# Thermoelectric Withdrawal and Consumption by WECC Test Case

## New Withdrawal 2010-2020



## New Consumption 2010-2020





# Technical Analysis and Results of 2010 WECC Transmission Scenarios

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**Vince Tidwell**

**Sandia National Laboratories**



# Project Partners

- Sandia National Laboratories
  - Vincent Tidwell
  - Len Malczynski
  - Peter Kobos
- Argonne National Laboratory
  - John Gasper
  - John Veil
  - Tom Veselka
- Electric Power Research Institute
  - Robert Goldstein
- National Renewable Energy Laboratory
  - Jordan Macknick
  - Robin Newmark
  - Daniel Inman
  - Kathleen Hallett
- Idaho National Laboratory
  - Gerald Sehlke
  - Randy Lee
- Pacific Northwest National Laboratory
  - Mark Wigmosta
  - Richard Skaggs
  - Ruby Leung
- University of Texas
  - Michael Webber
  - Carey King



# Basic Modeling Assumptions

- Water withdrawal/consumption for existing fleet based on combination of available data from eGRID (2005) and USGS (1995 consumption and 2005 withdrawals)
- Withdrawals and consumption is only for fresh water
- Other water sector data based on USGS data (1995 consumption and 2005 withdrawals)
- Water availability data is based on USGS gauged stream flow data measured at the 6-digit HUC level (167 watersheds in the western US)
- Water sector data (except thermoelectric) is projected to 2020 using historical trends in per capita use, projected population trends (US Census) and projected changes in Gross State Product
- Water demand at future power plants is based on production values provided by WECC multiplied by the associated water withdrawal/consumption factor (based on NREL analysis). These factors vary by the type of plant and the associated cooling type.



# Thermoelectric Water Withdrawal and Consumption Factors

Table 1. Water consumption factors for renewable technologies <sup>1</sup> (Gal/MWh)									
Plant Type	Cooling	Technology	Primary factor	Low	High	Min	Max	n	Sources
PV	N/A	Utility Scale PV	16	0	32	0	33	3	11,18,20
Wind	N/A	Wind Turbine	0	0	1	0	1	2	1,12
CSP	Tower	Trough	896	796	995	725	1109	17	5,11,14,16,18,27,28,30-35
		Power Tower	793	738	847	751	912	4	18,27,28,31
	Dry	Trough	73	61	84	43	79	10	14,32-34
		Power Tower	26	26	26	26	26	1	3
	Hybrid	Trough	263	126	399	117	397	3	6,32
		Power Tower	170	57	283	102	302	2	6
	N/A	Stirling	5	4	5	4	6	2	4,18
		Fresnel	1000	1000	1000	1000	1000	1	6
Biopower	Tower	Steam	638	412	863	480	965	4	4,8,9
		Biogas	235	235	235	235	235	1	19
		Steam	300	300	300	300	300	1	8
	Pond	Steam	390	390	390	390	390	1	8
	Dry	Biogas	35	35	35	35	35	1	9
Geothermal	Tower	Dry Steam-(freshwater)	0	0	0	0	0	1	11
		Dry Steam-(geothermal fluid)	1796	1796	1796	1796	1796	1	11
		Flash-(freshwater)	12	2	22	5	19	2	4,17
		Flash-(geothermal fluid)	2583	1853	3314	2067	3100	2	17
		Binary	3088	1872	4303	1700	3963	3	11,15
		EGS	4272	3057	5488	2885	5147	4	9,11,15
	Dry	Flash	0	0	0	0	0	1	9
		Binary	0	0	0	0	0	1	9
		EGS	1185	1185	1185	1185	1185	1	9
	Hybrid	Binary	221	221	221	221	221	1	15
EGS		1406	1406	1406	1406	1406	2	9,15	



# Thermoelectric Water Withdrawal and Consumption Factors

**Table 2. Water consumption factors for conventional technologies<sup>1</sup> (Gal/MWh)**

Plant Type	Cooling	Technology	Primary Factor	Low	High	Min	Max	n	Sources
Nuclear	Tower	Generic	684	542	825	581	845	5	8,11,26,29
	Once-through	Generic	212	49	376	100	400	3	8,21,26
	Pond	Generic	560	560	560	560	560	1	8
Natural Gas	Tower	Combined Cycle	227	159	296	130	300	5	8,18,24-26
		Steam	853	639	1068	662	1170	4	4,11,22,29
		Combined Cycle with CCS	487	487	487	487	487	1	23
	Once-through	Combined Cycle	73	27	120	20	100	3	8,22,26
		Steam	240	169	311	95	291	2	4,11
	Pond	Combined Cycle	240	240	240	240	240	1	26
	Dry	Combined Cycle	2	0	5	0	4	2	8,26
Inlet	Steam	340	340	340	340	340	1	4	
Coal	Tower	Generic	702	423	981	480	1100	5	7,8,20,21,36
		Subcritical	519	398	640	394	678	6	23,24,26
		Supercritical	525	468	582	458	594	6	23,24,26
		IGCC	383	356	411	358	439	7	23,24
		Subcritical with CCS	1329	1329	1329	1329	1329	1	23
		Supercritical with CCS	1148	1148	1148	1148	1148	1	23
		IGCC with CCS	501	475	527	479	530	3	23
	Once-through	Generic	239	118	360	100	317	3	8,11,21
		Subcritical	107	73	141	71	138	3	26
		Supercritical	97	67	127	64	124	3	26
	Pond	Generic	390	390	390	390	390	1	8
		Subcritical	773	739	807	737	804	3	26
		Supercritical	37	6	67	4	64	3	26



# Thermoelectric Water Withdrawal and Consumption Factors

## **WECC Designator**

Biomass  
Cogeneration  
Combined Cycle  
Combustion Turbine  
Geothermal  
Internal Combustion  
Nuclear  
Solar-CSP  
Steam-Coal  
Steam-Other

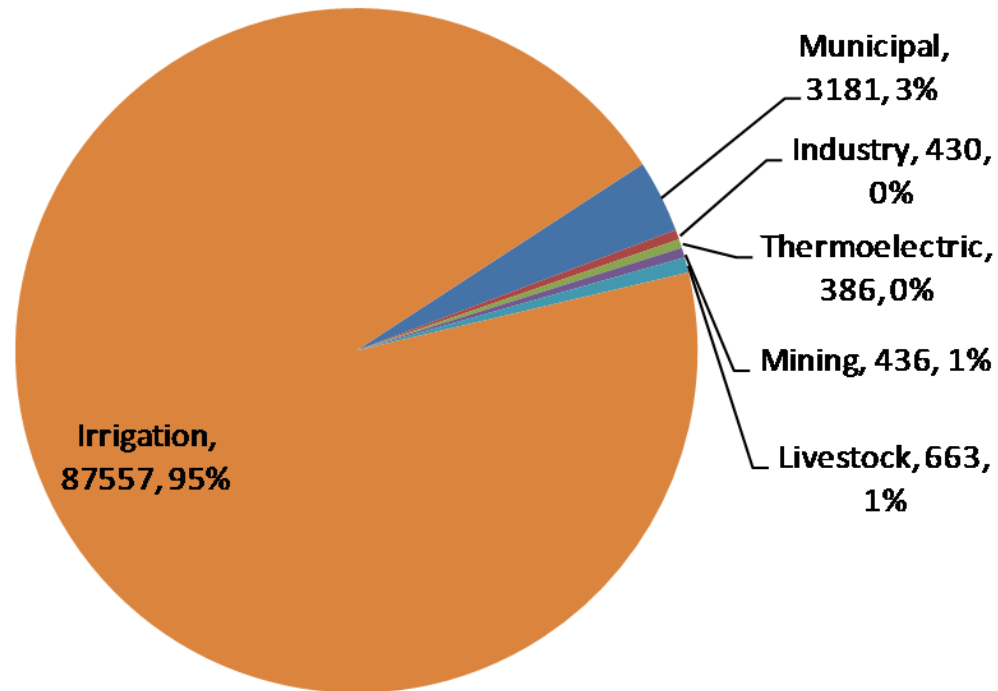
## **Water Use Factor**

Steam  
No Water Use  
Natural Gas Combined Cycle  
No Water Use  
Average of All Technologies  
No Water Use  
Generic  
Average of Trough and Power Tower  
Generic  
Natural Gas Steam

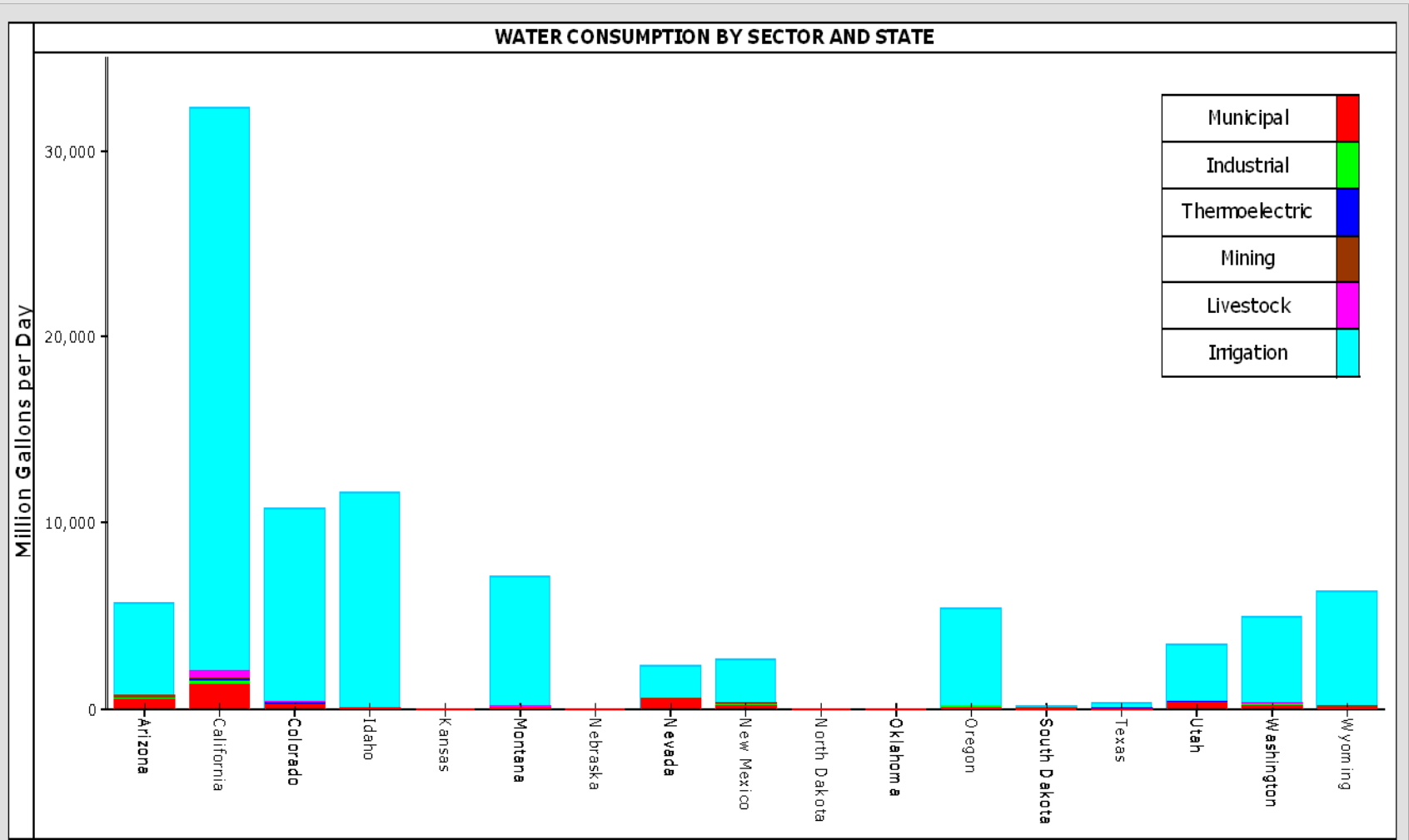


# 2010 Water Consumption by Sector

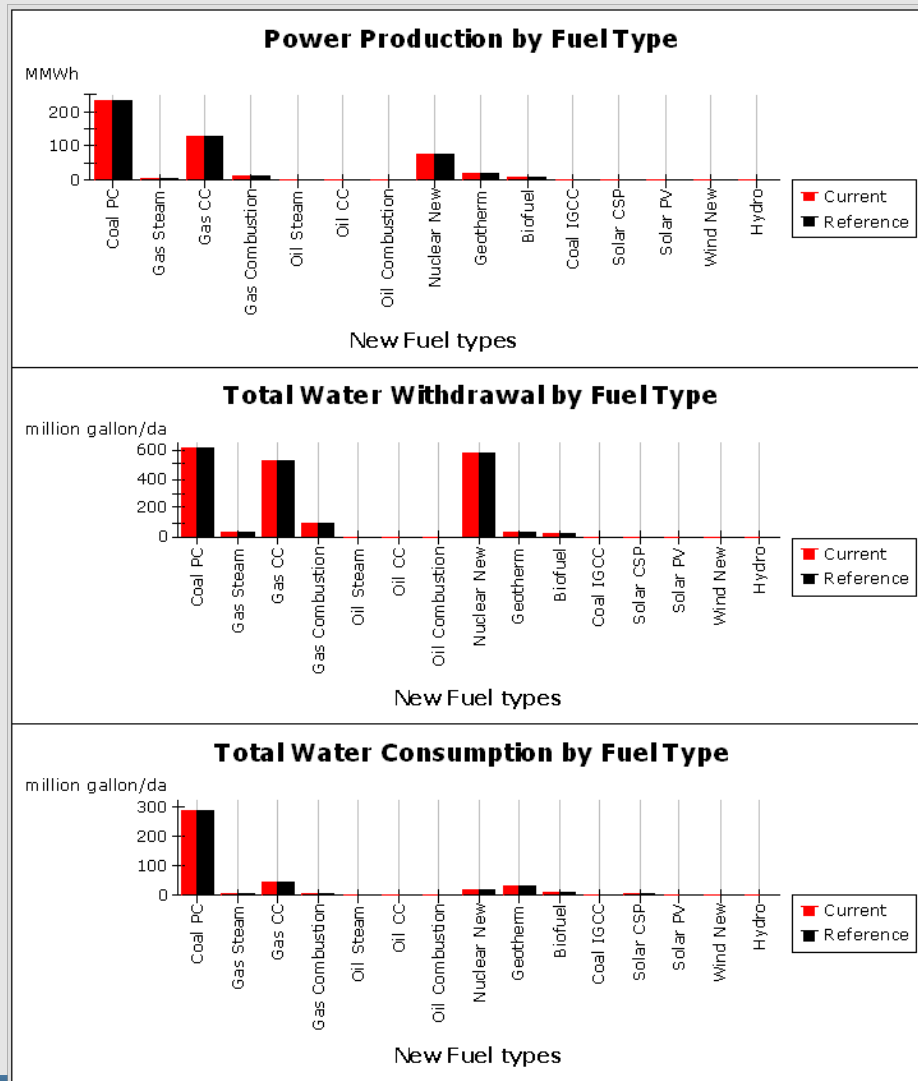
## 2010 Water Consumption (MGD)



# 2010 Water Withdrawal and Consumption by State and Sector

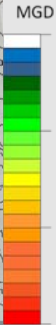
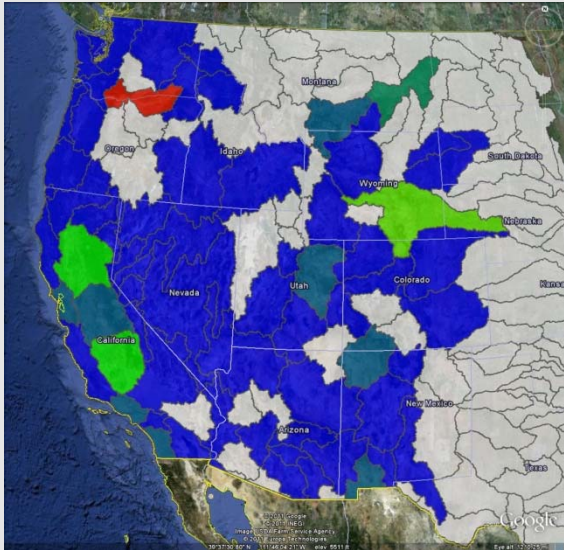


# 2010 Thermoelectric Power Production, and Water Withdrawal/Consumption

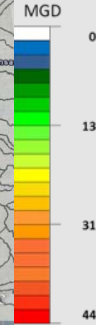
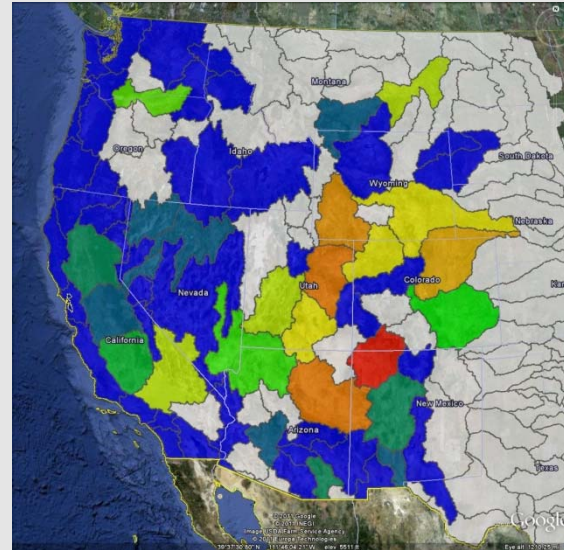


# 2010 Water Withdrawal and Consumption by 6-Digit Watersheds

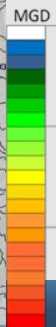
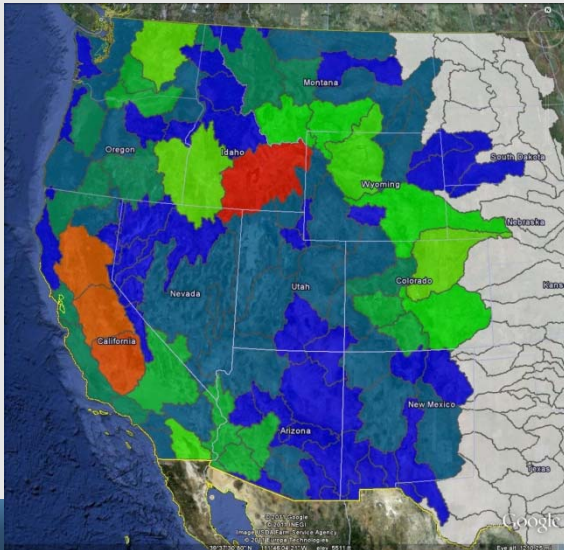
## Thermoelectric Withdrawal



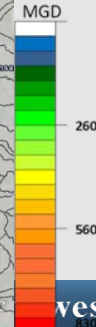
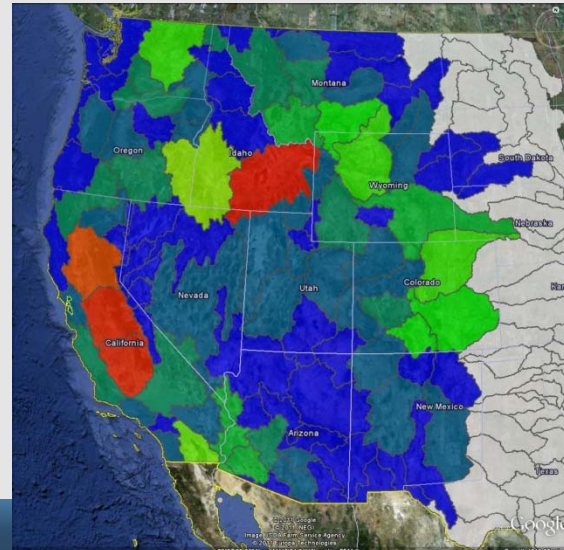
## Thermoelectric Consumption



## Non-Thermoelectric Withdrawal



## Non-Thermoelectric Consumption



# TEPPC Base Case: PC0



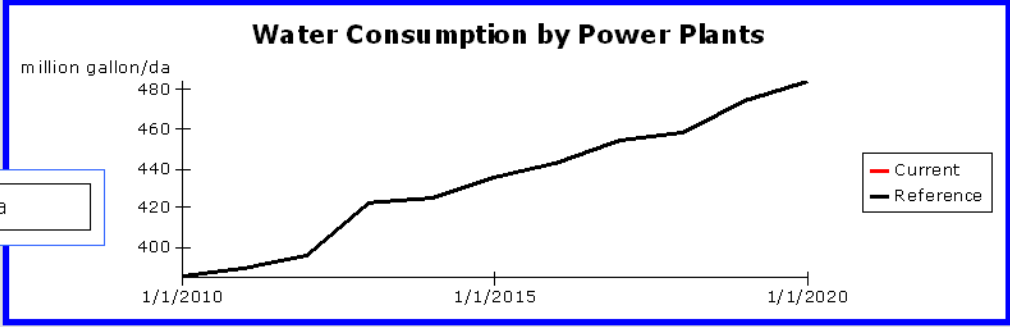
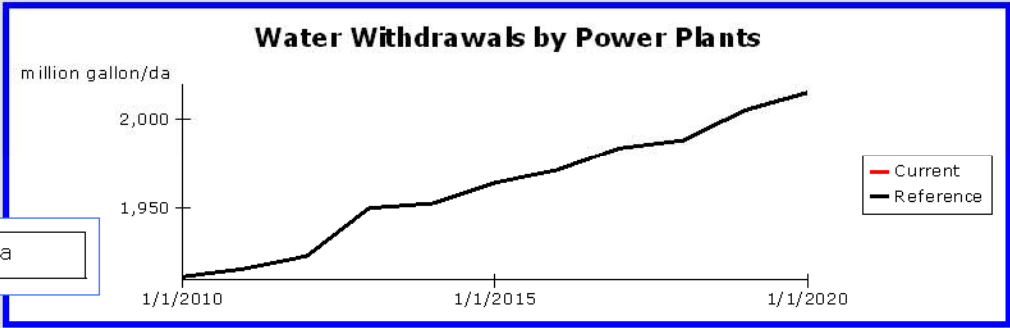
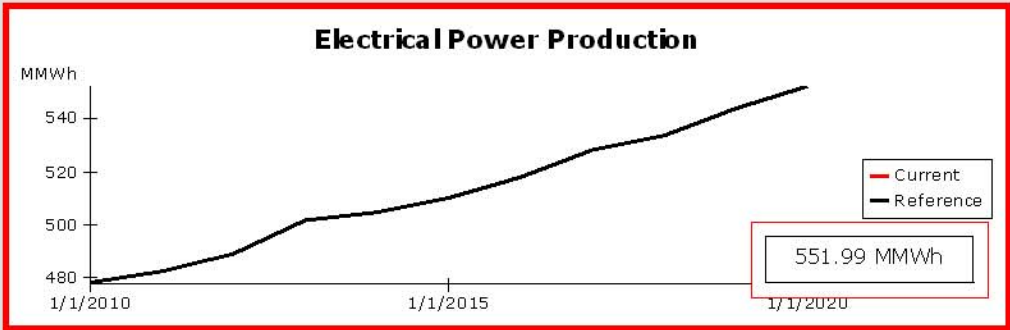
Home

Water for Energy

Water by Sector

2,014.83 million gallon/da

483.89 million gallon/da



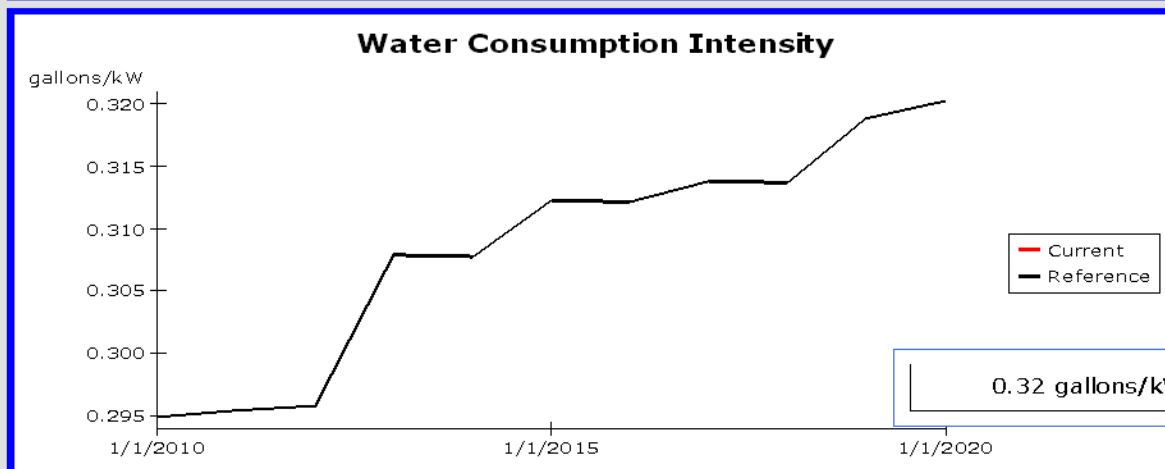
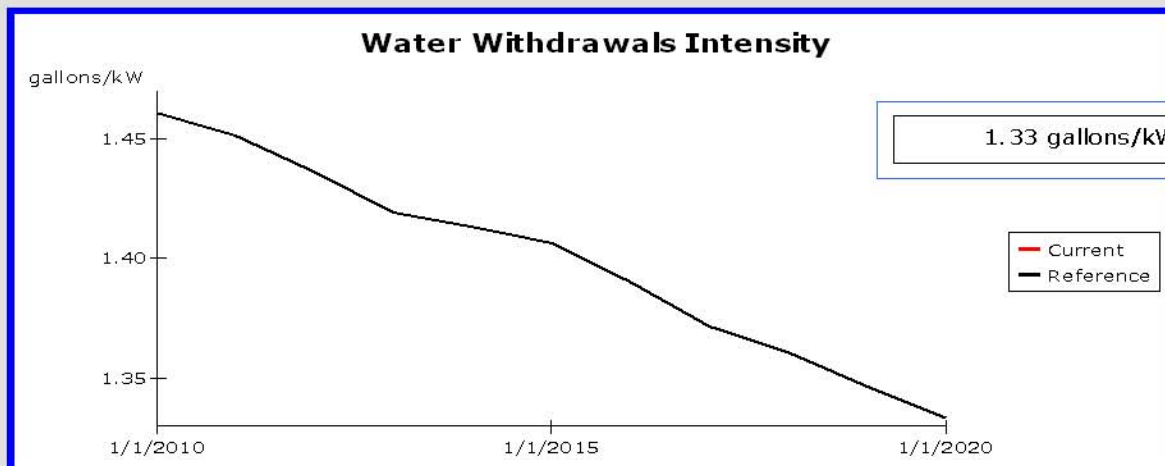
# TEPPC Base Case: PC0



Home

Water for Energy

Water by Sector



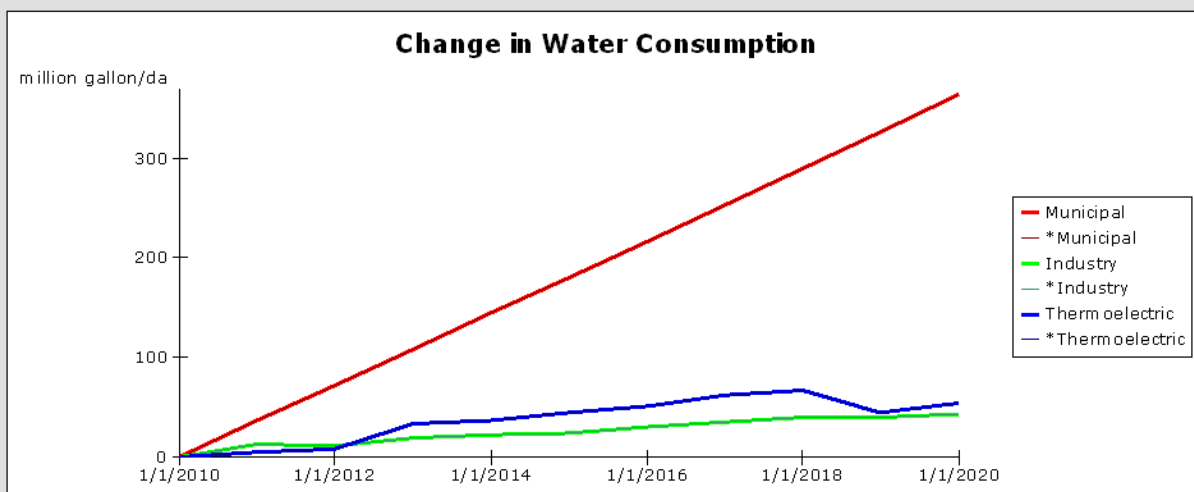
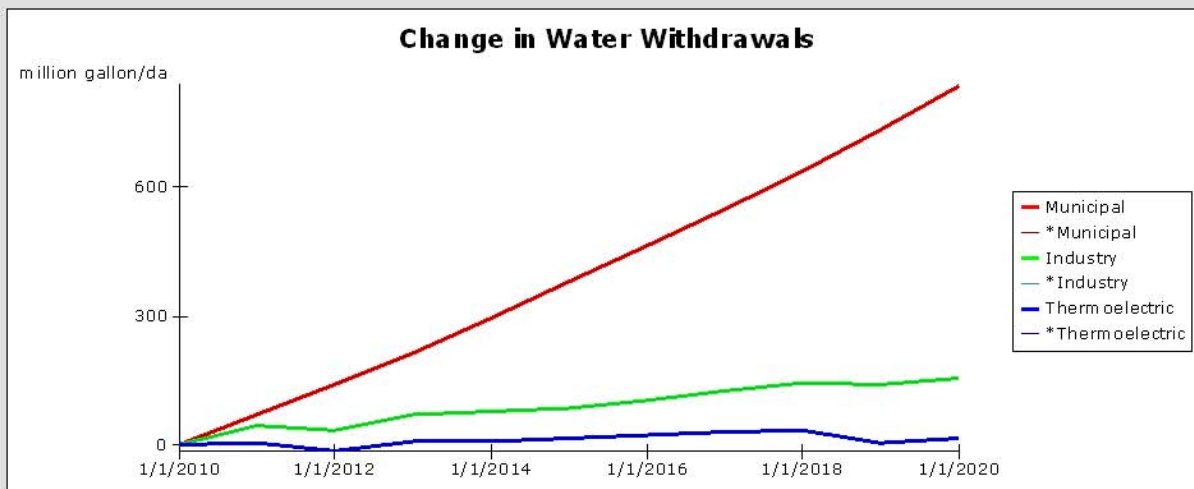
# TEPPC Base Case: PCO



Home

WECC Totals

Water for Energy



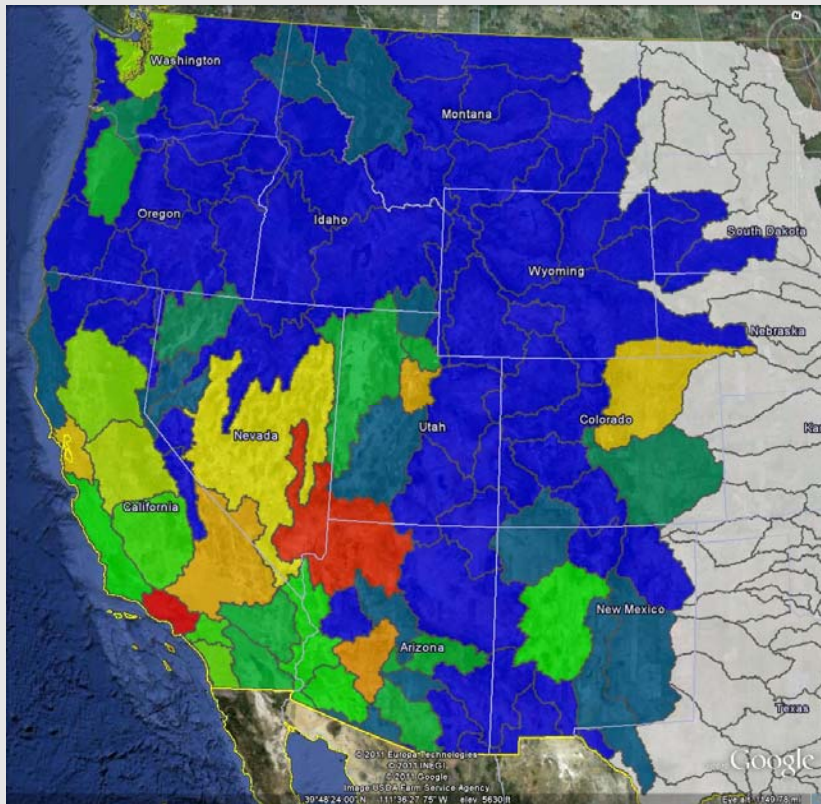
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[www.westgov.org](http://www.westgov.org)

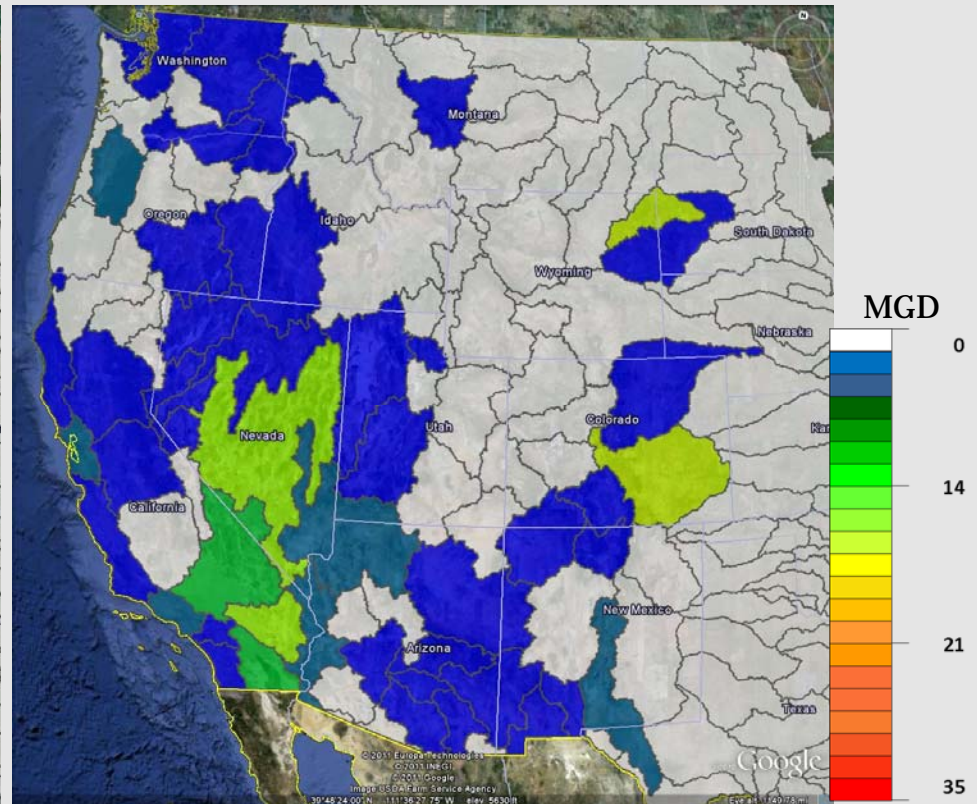


# Growth in Non-Thermoelectric and Thermoelectric Consumption 2010-2020

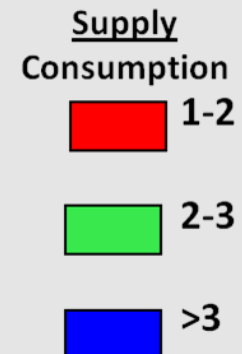
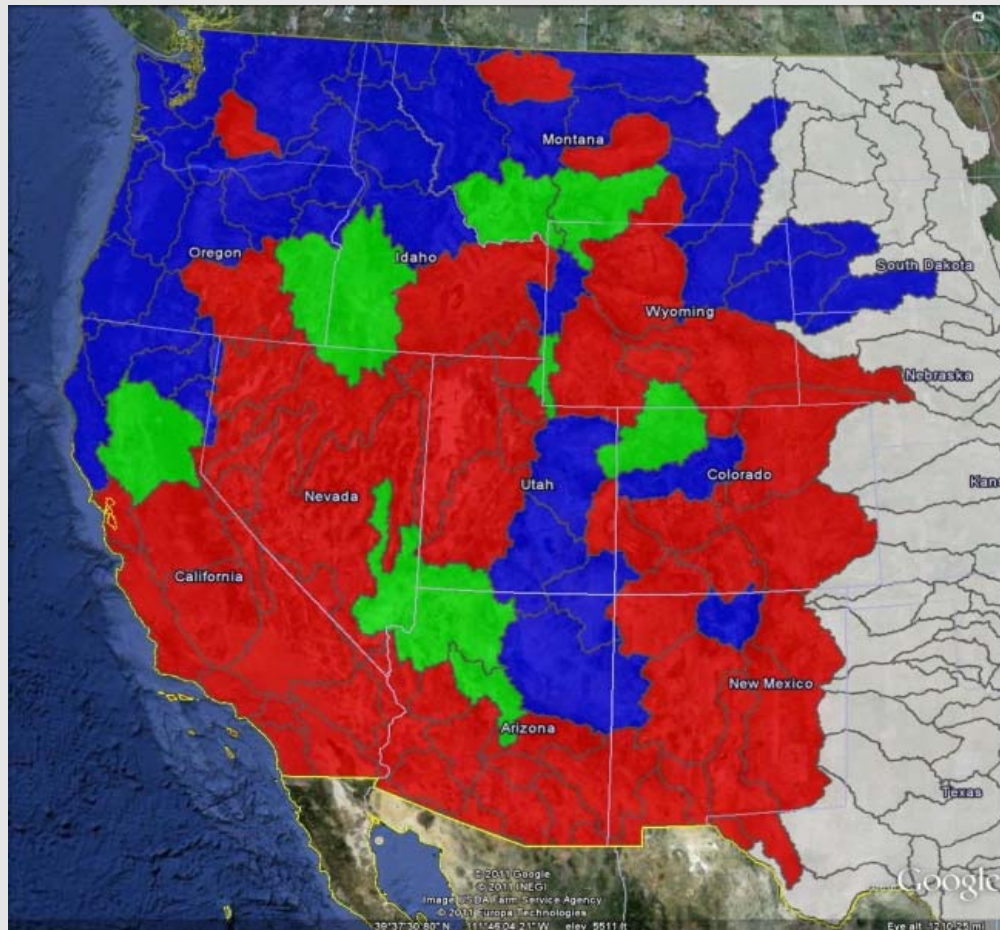
## Non-Thermoelectric Consumption



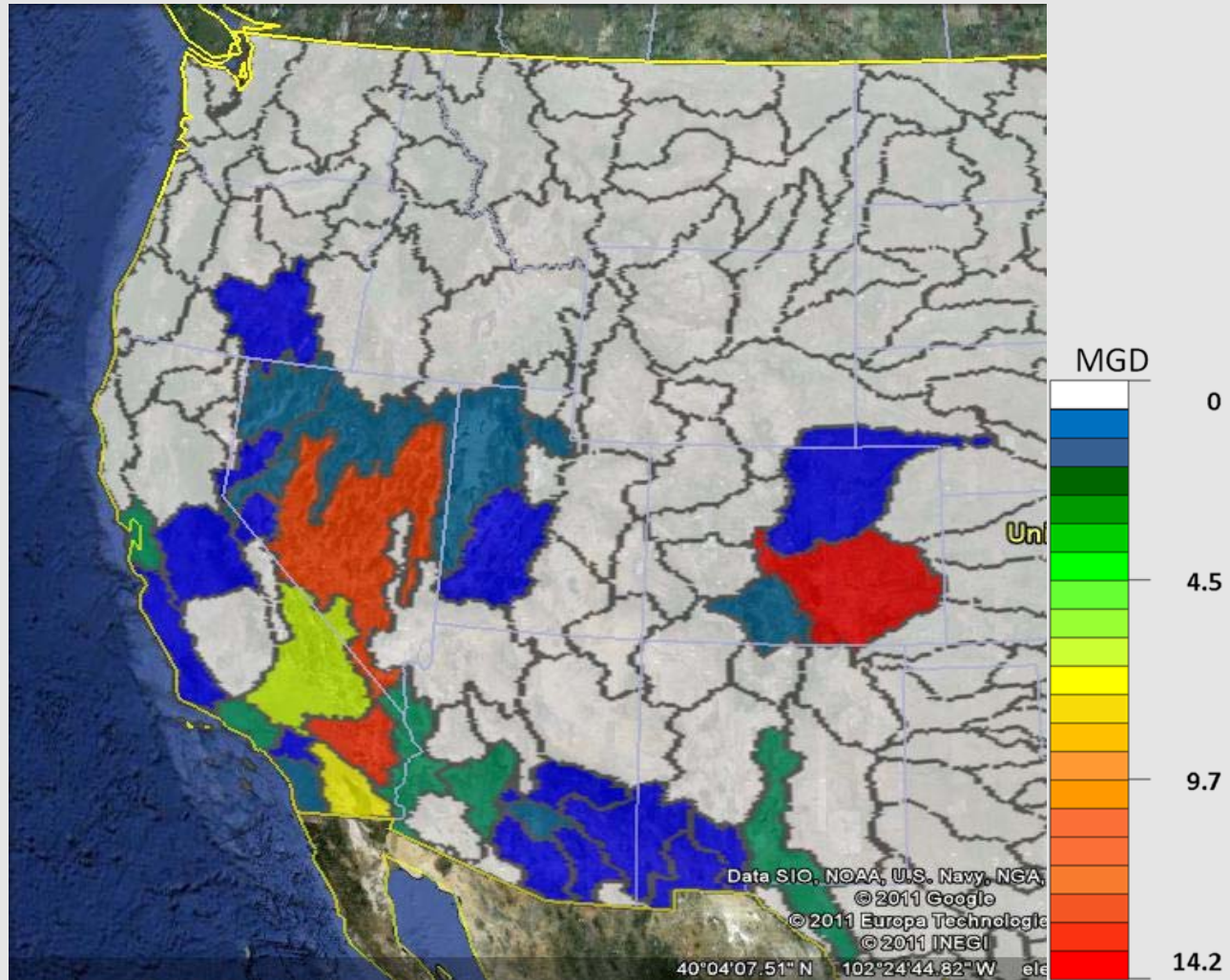
## Thermoelectric Consumption



# Regions Prone to Water Stress



# New Power Plant Water Consumption in Basins Prone to Surface Water Stress 2020





# Integration of Energy-Water Analysis into WECC Transmission Plans

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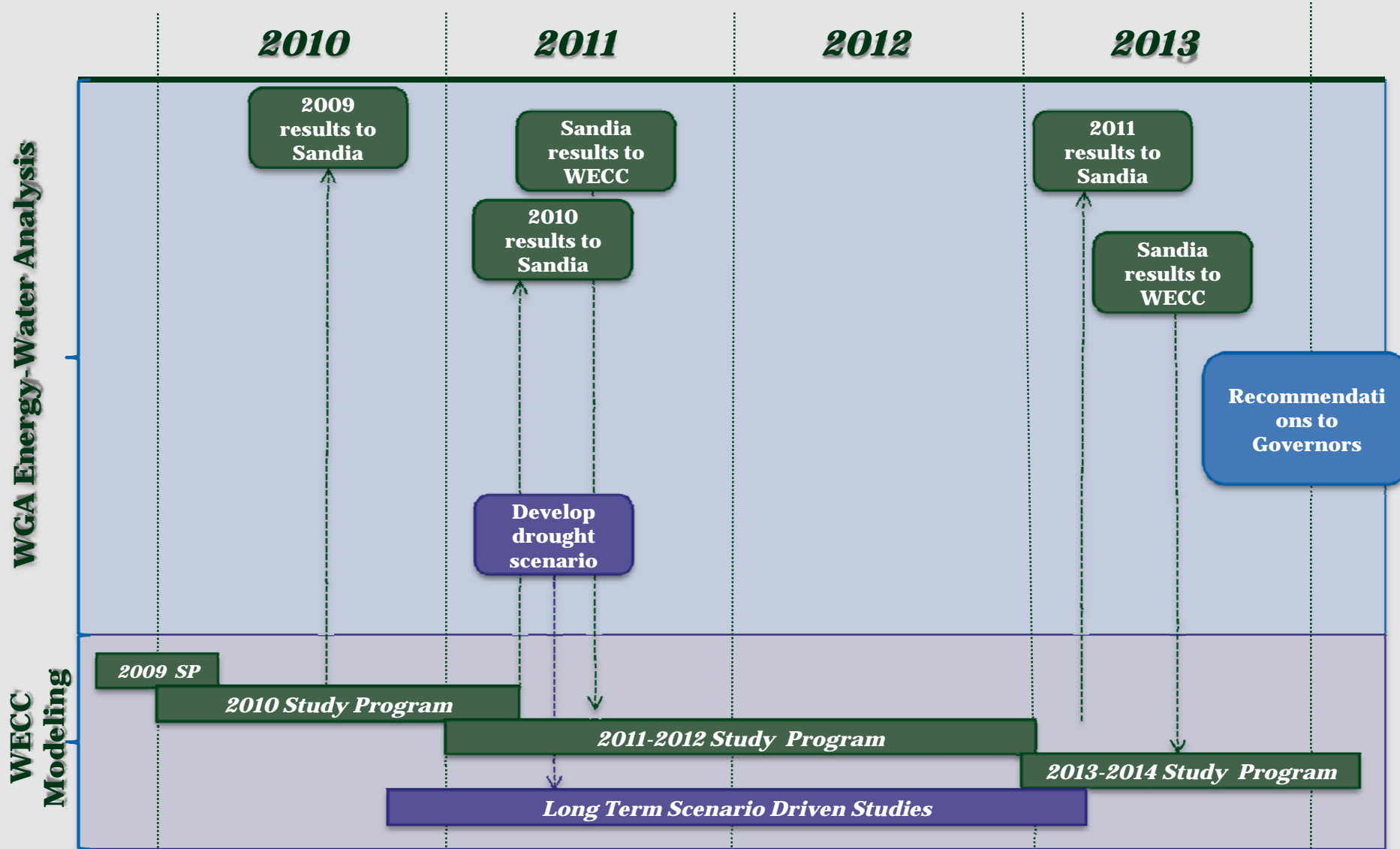
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**Byron Woertz**

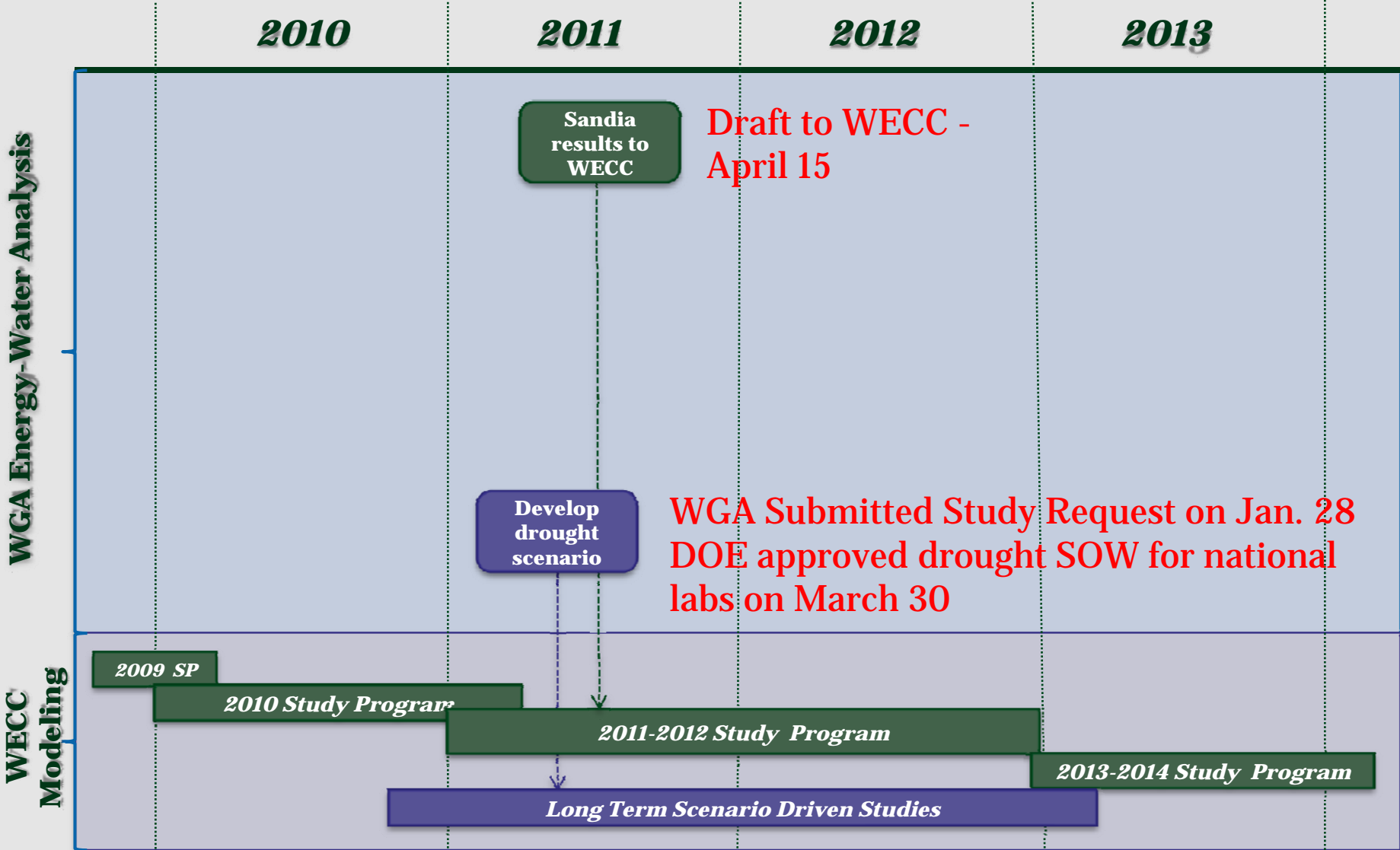
**Western Electricity Coordinating Council**



# Integration in the WECC Transmission Plans



# Integration into the 10-year WECC Transmission Plan





# Technical Analysis and Results of 2010 WECC Transmission Scenarios

State and Provincial Steering Committee Webinar

April 6, 2011

**Tom Iseman**  
Western Governors' Association

**Alex Schroeder**  
Western Governors' Association



# Future and Additional Work

## **Drought/Climate Study Request**

## **Incorporation of State Water Supply and Demand Information**

## **Energy-Water Case Studies**

- **Initial studies on regulatory and siting policies, regulations, etc. in AZ, CA, and NV**
- **Energy-Water survey to Western water managers**

## **Policy Recommendations to Western Governors**



# Coordination with SPSC, SPSG, and EDTF

## **Input from SPSC SPSG and the EDTF Sought on:**

- **Availability of drought contingency plans for utilities**
- **Consensus development of a likely drought scenario**
- **Future refinement of generation and cooling data**
- **Overall project feedback**

