



Doing our Part to Help Conserve Arizona's Water Resources and Reduce Global Warming by Saving Energy at Home

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Introduction

News reports about events related to global and local environmental issues have become common. Everyone has heard of, and many have experienced the impact of climate change due to global warming as average temperatures rise in many parts of the world. We grasp that the decade-old drought, and dwindling water resources might affect future growth and economic vitality in the region. We are also keenly aware that our contemporary lifestyle in

the arid climate of Arizona would not be possible without electrical energy (electricity) to keep us cool and pump water. We are becoming aware of the impact of the greenhouse gases (particularly carbon dioxide CO₂) released into the air (atmosphere) by the burning of fossil fuels like coal for energy production. At the same time

we are just beginning to account for the large amounts of water required to generate electricity.

As our awareness of our energy use and the associated demands we place on our local resources grows, we are beginning to better understand the impact each one of us has on the natural environment. At the same time we are beginning to realize that through our individual actions we can reduce this impact, our "footprint" for our common benefit today, and for the benefit of future generations.

This bulletin presents background on these issues and offers tips on how to save energy.

Electrical Energy production, water resources depletion and global warming are interconnected.

Global Warming and its Local Impact

Climate science has made dramatic leaps forward over these past decades. We now have a clearer picture of how the Earth's climate system works and how it is changing in response to our activities on the planet. A recent report by the Intergovernmental Panel on Climate Change (IPCC 2013)¹ stated that it has "very high confidence" in the fact that increasing levels of greenhouse gases, associated with

In the past, the idea that human activities could alter the composition of the Earth's massive atmosphere was far-fetched. Today, these activities have been shown to affect global-scale patterns in temperature and precipitation.

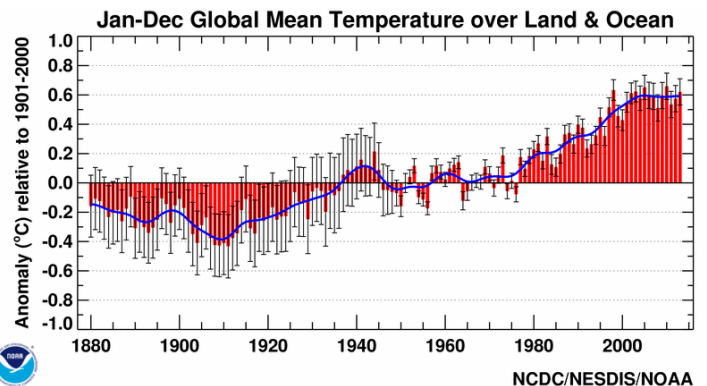


Figure 1. Instrumental record of global mean temperatures (blue line) 2014. Source: NOAA

¹ The IPCC is a program headed by the World Meteorological Organization and the United Nations Environment Program with representation from over 130 countries. It consists of a panel of over 600 scientists who author reports and over 2,500 additional scientists and government officials who reviewed the recent report.

the combustion of fossil fuels and changes in land use since the mid 1800's, have produced a net warming in the Earth's atmosphere. The IPCC statement is indicative of a strong consensus that exists about this effect within the global scientific community.

The high confidence in this connection is due to our better understanding of how the Earth's radiation balance changes when greenhouse gases like carbon dioxide (CO₂) increase (the Greenhouse Effect). Increasing amounts of incoming solar radiation are 'trapped' in the lower atmosphere as greenhouse gas concentrations increase. More precise measurements available with new instrumentation and technology show that the amount of energy leaving the top of the Earth's atmosphere is less than incoming solar energy. This imbalance is evidence of the enhanced greenhouse effect; shown by a recent increase in average global temperature variations, see Figure 1. The planet will continue to warm as long as the imbalance is present.

Even with high confidence in greenhouse gas induced warming, our ability to predict the future is limited. Global climate models have to contend with the same complexity in weather patterns that limit short term forecasts. Confidence in projections that the planet will continue to warm *on average* remains high. How this plays out in any given location is still uncertain. Some recent studies project a shift towards drier winters for Arizona with little certainty in how summer precipitation might change. Even without knowing how precipitation might change, planning for increasing temperatures looks like a safe bet.

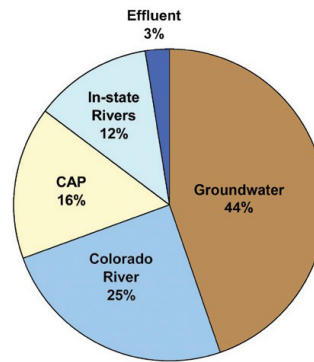
There is relatively high confidence in model projections that the Southwest will continue to warm, but precipitation projections are inconsistent.

Arizona Water Resources

According to the Arizona Department of Water Resources (AZDWR 2010), the State's annual water supply is about 7.5 million acre-feet see Figure 2. About 41% of this water comes from the Colorado River and Central Arizona Project (CAP). Groundwater accounts for nearly 44% of the water budget and the remainder is provided by in-state rivers (12%) and reclaimed water (3%). And while water demand continues to increase, Arizona is well into the second decade of statewide drought. In response to present and future concerns about water resources, the Governor of Arizona in 2007 signed a Drought Declaration for the State, asking everyone to "increase water conservation efforts" (ADWR website).

As the climate in the Southwest including Arizona becomes hotter and perhaps even drier, local and imported surface water sources are likely to diminish. These surface water sources account for more than half of the state's annual water

Water Supply



Water Demand

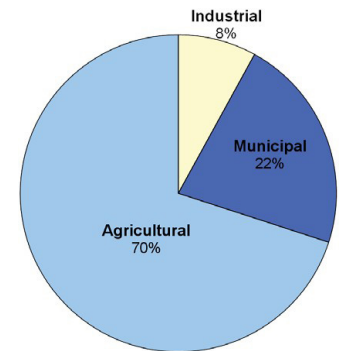


Figure 2. Arizona Water Supplies and Demands. Graph from Schwartz, K. and K. Uhlman. 2009..

budget. Lower rainfall and snowpack (in Colorado) and higher average temperatures will reduce runoff and increase evaporation losses from river streams and reservoirs. This will in turn place increasing demands on our other major non-renewable source of water, ground water.

In Arizona, most of electricity (~65%) is produced by burning fossil fuels, including natural gas and coal that generate greenhouse gases.

Water Use for Electricity Production in Arizona

In the US, fully 25 percent of all daily non agricultural fresh water is consumed for electrical power generation (Hightower, 2007). Arizona is a large producer of electricity exporting about 30% of its production in 2010 (SWEET, 2014). These exports benefit the State economically, but the extra production also uses valuable natural resources, particularly water. According to a National Renewable Energy Laboratory report (Torcelli et. al. 2003), hydroelectric power accounts for about 5-7% of the electricity generated. The reservoirs that produce this energy evaporate about 65 gallons of water per kWh of electricity produced. However, fossil fuel burning power plants produce most of the electric energy used in Arizona, see Figure 3. These power plants use about 0.32 gallons of water/kWh. Thus, on average each kW-hour of electricity generated from reservoirs and fossil burning plants uses nearly 8 gallons of water in Arizona.

The burning of fossil fuels, to produce electricity especially coal, releases large amounts of CO₂ gas into the atmosphere. For example, one kWh of electricity produced from natural gas will produce about 1 pound of CO₂. And the same amount of electricity generated from coal, will produce about 2 pounds of this greenhouse gas and other toxic chemicals².

² In the US scrubbers are required to reduce emissions of sulfur dioxide gas (produces acid rain) and the very toxic metal mercury from coal burning flue gases.

2012 Electricity Generation Breakdown

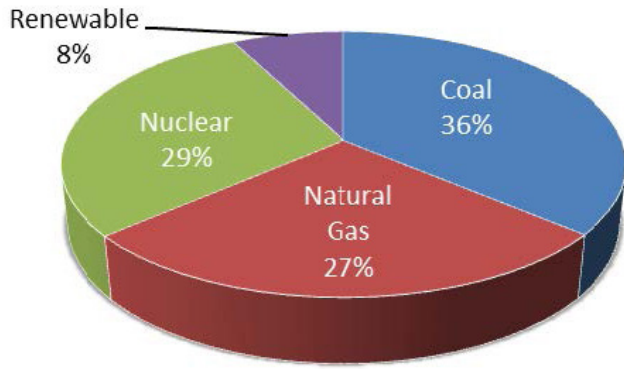


Figure 3. Arizona Electricity Generation. Source: SWEET (2014).

The US and many other countries around the world have very large coal deposits (reserves) that are easily accessible. The rising demand for electricity has climate and environmental scientists concerned due to the increasing emissions of greenhouse (particularly CO₂) and toxic gases associated with the rapidly growing number of coal fired power plants.

Putting it All Together—Our Actions are Inter-connected

In the preceding sections we have shown how electricity production is linked to the major environmental challenges of greenhouse gases and water consumption, see Figure 4. As we search for better, more efficient and environmentally friendly technologies to produce electricity, which is critical in addressing this issue globally, each of us can conserve some electricity and help reduce the growing demand. We will see in the next sections that saving

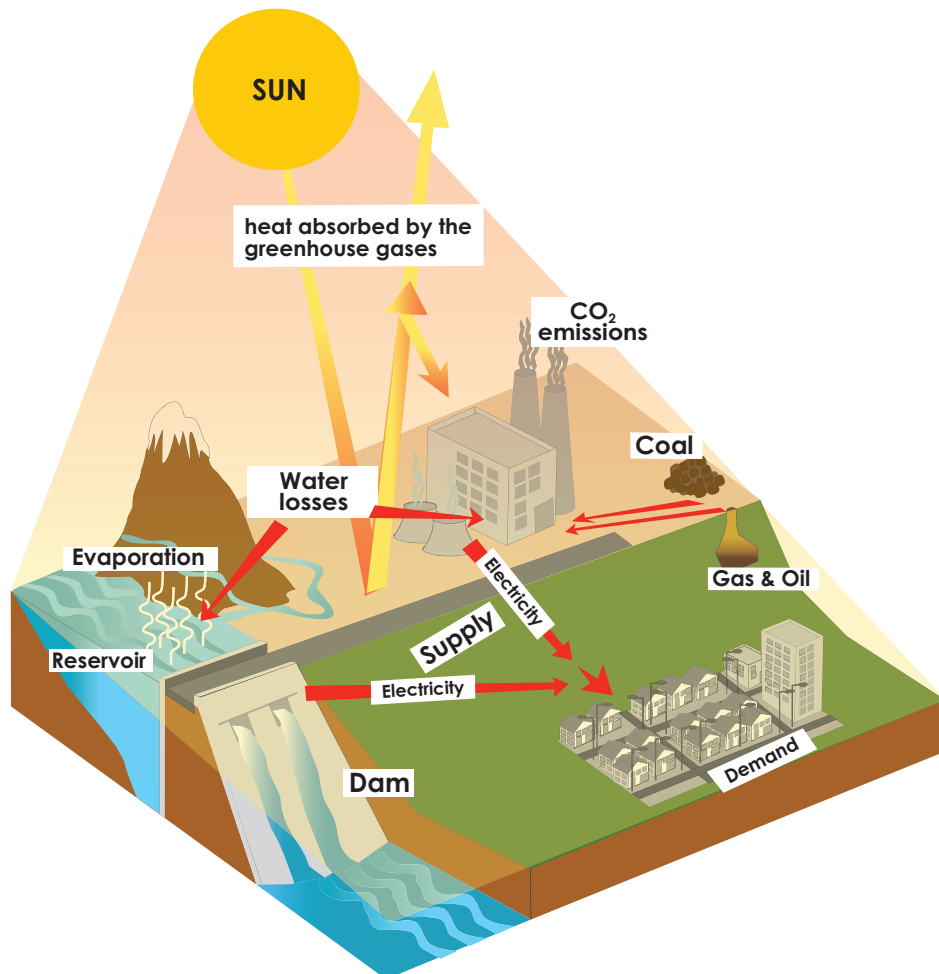


Figure 4. Switching off a light causes less demand for electricity and this in turn reduces carbon dioxide emissions and water use.

energy at home is not difficult and can be achieved with few changes to our way of life while bringing significant benefits. Energy efficiency can be more economical than building new power plants. (Amory Lovins, 1990).

Conservation

A 10% electricity savings could meet the water needs of more than 42,000 Arizonans annually.

As the state's population grows and the decade-old drought continue to stress our limited water resources, any permanent water savings will be welcomed by state water use planners and our fragile desert environment. The average Arizona residential water use

is about 130 gallons per person per day which is higher than the national average. Just a 10 % reduction in electricity use, generated by fossil fuel burning power plants, could save the state at least two billion gallons of fresh water (~6,100 acre-feet) every year. A Arizona Fact Sheet on Energy efficiency and consumption SWEET (2014), calculated that an aggressive plan to conserve energy in Arizona could save up to 4.1 billion gallons per year by the year 2020.

Climate scientists believe that slowing the rate of CO₂ releases into the atmosphere will slow down global warming and may prevent sudden local climate changes. Just A 10% percent reduction in our total electricity use, generated from fossil fuel burning (coal and gas), would prevent the release of about 3.0 million metric tons of CO₂ gas into the atmosphere. This may seem insignificant compared to the total global CO₂ emissions of over 25 billion tons/year, but it is a positive step.

Buildings (residential and commercial) account for about 74% of the electricity consumption in the US. Reducing the energy use at home and at work has the greatest potential for reducing carbon dioxide emissions and for saving water (C2ES 2014). Therefore, conserving just ONE kWh of electricity at home has three important benefits (but there are many others, SWEET 2014):

- 1) **It earns the homeowner about 9 pennies.** Benjamin Franklin said "a penny saved is a penny earned".
- 2) **Saves up to 8 gallons of valuable fresh water³**
- 3) **Prevents the release of 1-2 lbs of the greenhouse gas CO₂ and other toxic gases into the atmosphere.**

Aquifer overdraft has caused the disappearance of 90% of all riparian habitats in Arizona.

What's a Watt?

A Watt-hour is a unit of energy (power spent per unit time). Your electricity bill is provided in kWh (1000 Watts per hour). To calculate the rated (maximum) energy that an appliance can use, locate the appliance rating sticker, multiply the amperage (Amperes or Amps.) by the recommended voltage (Volts or V). Then divide the result by 1000 to obtain kWh.

To summarize: (Amperes x Volts) / 1000 = kWh ("Watt" is often abbreviated "W").

Do your own home appliances energy use audit: If you want an exact energy consumption of an appliance, use the Kill A Watt load Meter and Monitor (P3 International®) or a similar device⁴, available at local hardware-electronic stores. You will be amazed to see the amount of energy leakage of many common home appliances have. Home energy audits to help conserve air conditioning and heating energy costs should be performed by qualified professionals. Energy providers often have energy savings programs and may offer free home energy audits.

How quickly can we spend ONE kWh of energy at home? Here are some common examples:

- Leave a 100 Wh desktop computer ON for 10 hours.
- Leave a 35 Wh flat (LCD) monitor ON for 1 day.
- Leave a 60 Wh incandescent light ON for 17 hours.
- Leave a 7 Wh an LED (light emitting diode) on for about 6 days.
- Use a 1300 Wh toaster or hair blow dryer 3-5 minutes every day for a week.
- Leave a 3 Wh VCR or TV or DVD or LCD... on standby mode 24 hours/day for two weeks.
- Leave a 1 Wh direct current (DC) power supply plugged into the wall socket for about 6 weeks, even when not connected directly to any electrical appliance. Yes, these pesky DC power supplies that have crept up into our modern life are now populating many of our wall electric outlets. See next section.



Figure 5. Home energy saving and monitoring devices: LED and CFL bulbs, power strip, timer, Watt meter.

³ This includes water evaporation from reservoirs in AZ. But it can be argued that most of these losses would occur on dammed rivers with or without hydroelectric power generation.

⁴ High voltage appliances (240V) cannot be tested using this type of consumer-oriented devices. To test high voltage appliances (dryer, AC, etc) seek the help of a professional electrician.

Energy Saving Tips

Ways to help conserve energy fall into two categories: the home hardware (number and types of electric appliances, lights and home construction); and lifestyle or behavior (how or how often we use the home appliances, lights). In the home hardware category there are several ways to conserve energy listed in order of increasing costs and difficulty.

- Replace old incandescent lights with new compact fluorescence light (CFL) bulbs or better yet the new LED bulbs that are U.S. EPA Energy Star qualified that use at least 4 times less energy than older incandescent bulbs, last at least 10 times longer, and do not contain mercury.
- Install programmable thermostat and set temperatures seasonally (winter, lower; summer higher) for period when house is unoccupied and at night. A change of just 1 degree can reduce energy use by 4% depending on the fuel used to heat the home. Close vent in unoccupied rooms.
- Replace old (>10-15 years) appliances such as refrigerators, washers and driers with new US EPA Energy Star rated models. Note that new front-loading washers use up to 60% less electricity and water per load than older top-loading models and newer model refrigerators and freezers use up to 50% less energy. Use cold water for washing clothes and keep coils on refrigerators clean and make sure air flow through coils is not obstructed.
- Replace inefficient windows, weather-strip doors. Add attic insulation and vent roofs to decrease heat and cold air losses, as recommended by a home energy audit.
- Change electric hot water heaters to natural gas if possible. Install low flow shower heads and reduce shower times.
- Consider a solar photovoltaic system, to generate your own electricity with the help of a professional installer. Do not forget to check with you local utilities,

and consults state and federal tax codes for any rebates and/or tax credits that are available related home energy savings/generation.

- **Identify insipient⁵ power users and find ways to turn them off or unplug them completely. This includes all of those chargers and low voltage invertors we now use like phone chargers, electric toothbrushes, printers and other home office appliances... and don't forget the TV (especially LCDs), TIVO, Cable box, etc in our media center, etc.**

To make this easy you can:

- **Connect several (low voltage) appliances to single accessible power strip.**
- **Add a programmable timer to appliances and/or power strips located in hard to access outlets or places.** Make sure that the rated Amperes or Watts of the outlet, power strip and timer are not exceeded by the (sum of) the load(s) of ALL appliance(s) connected.

Keep in Mind

Significant energy savings can be realized by following the above recommendations. But in recent years modern homes have been invaded by numerous electronics devices and appliances with “standby” modes and external low power supplies (invertors), see footnote⁵ above. **Note again that many of these devices and appliances consume electricity, even when not in use.**

Large home appliances have become much more energy efficient. But, older flat screen televisions (Plasma, and some liquid crystal display (LCD), may consume more electricity than older vacuum tube TV sets. Flat screen TVs (42-50+ inch) use ~200-350 Wh (about 2-4 times more energy than conventional TV sets). Upgrade to new energy efficient light-emitting diode (LED) TV sets when possible. Consider turning off TV sets when not watching and limit/share TV viewing time.

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**Changing our behavior can also increase energy conservation at home, and this can be simply summarized:
When not needed, switch off lights and turn off appliances and TVs completely or better yet disconnect them from the wall socket and unplug unused power supplies.**

⁵ These devices use energy constantly, even when not in use or not turned on.

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