National Environmental Education Week

A National Environmental Education Foundation Program

Educator Webinar:
Teaching the Water-Energy Connection

presented by National Environmental Education Week
in partnership with River Network and Earth Day Network

Wednesday, March 31, 2010
6:30 p.m. Eastern time

Agenda

I. The Water-Energy Nexus

Presented by Bevan Griffiths-Sattenspiel, River Network

a. An overview
b. Q & A

II. Teaching the Water-Energy Connection

Presented by Sean Miller and Brenna Holzhauer, Earth Day Network

a. Success Stories
b. Q & A
c. Lesson Plans
d. Q & A

River Network
Connecting People, Saving Rivers

The Water-Energy Nexus

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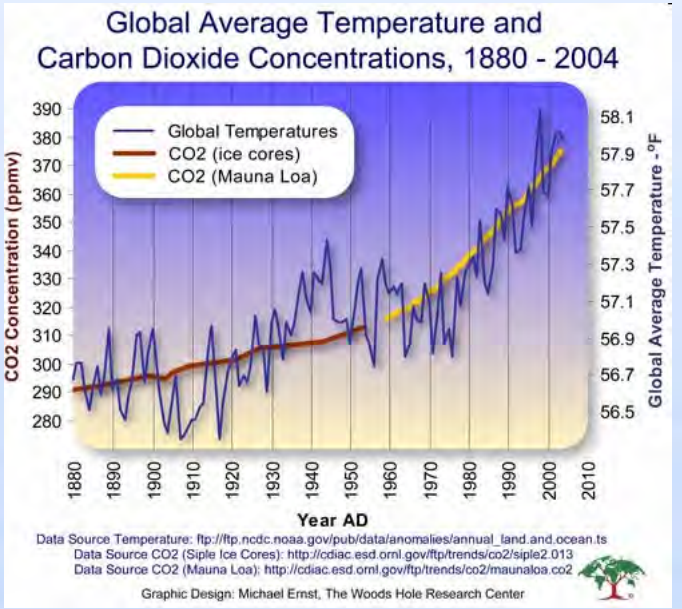
Water-Energy Nexus Outline

- Climate Change & Water
- Water for Energy
  - Water impacts/trends
  - Low-water alternatives
- Energy for Water
  - National overview
  - Saving Water Saves Energy

Human's Are Warming the Climate

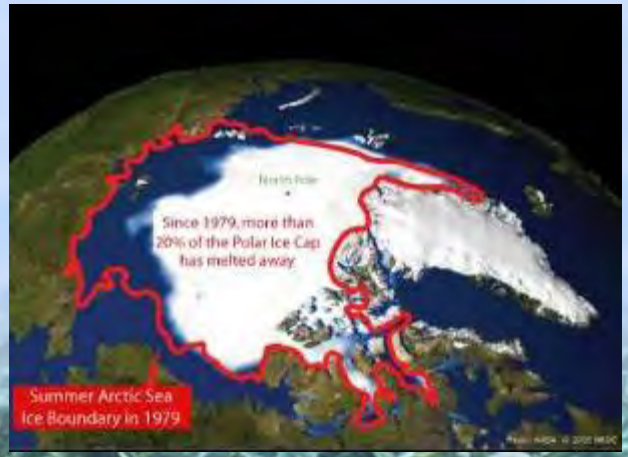
From the IPCC, 2007:

"Warming of the climate system is unequivocal…Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.



- **The first 10 years of this century have been the warmest decade on record.**
- **Carbon dioxide levels in the atmosphere are currently the highest they have been in at least 800,000 years.**
- **Sea ice in the Arctic melted to its third-lowest area ever measured last summer.**
- **Worldwide, ocean temperatures last summer were hotter than ever previously recorded.**

-Union of Concerned Scientists, email 2-25-10



Water Challenges

Flood Control

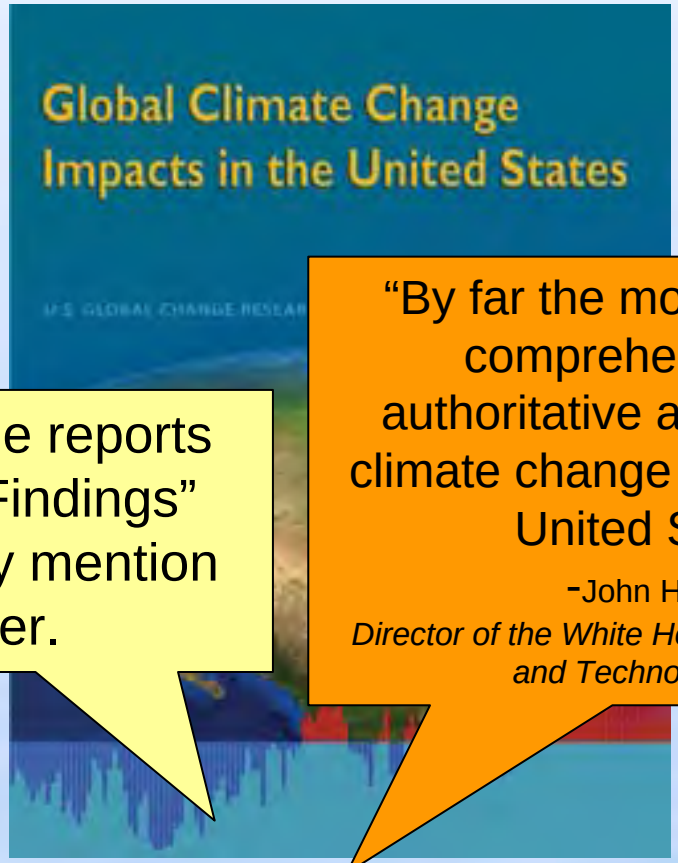
Water Pollution

Agricultural Water Demand

"Water and its availability and quality will be the main pressures on, and issues for, societies and the environment under climate change."

-Intergovernmental Panel on Climate Change, 2007

U.S. Global Change Research Program



Eight of the reports "10 Key Findings" specifically mention water.

"By far the most up to date, comprehensive and authoritative assessment of climate change impacts on the United States."

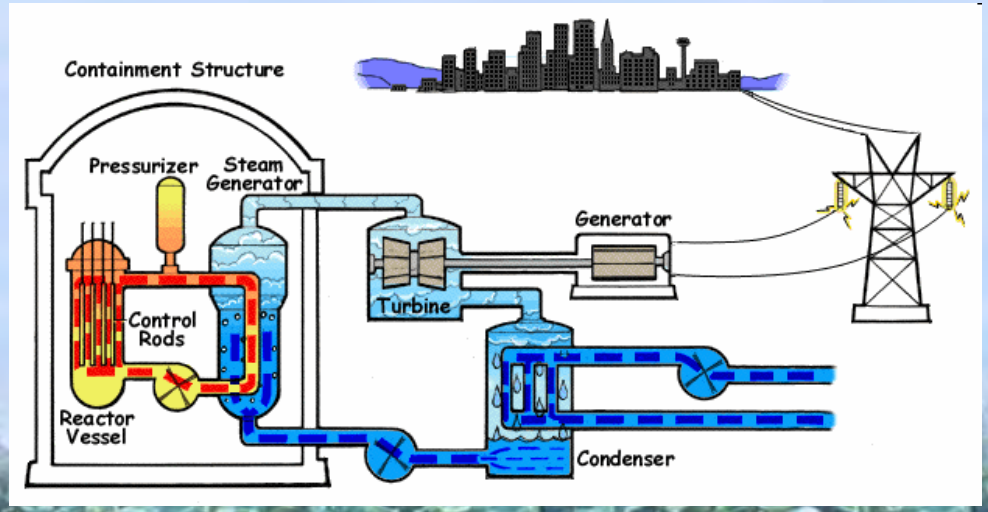
-John Holdren,
Director of the White House Office of Science and Technology Policy


THE
WATER-ENERGY NEXUS

U.S. Sources of Electricity

- Thermoelectric power accounts 90% of all electricity
  - Coal (49%)
  - Natural Gas (20%)
  - Nuclear (19%)
  - Petroleum (2%)

Thermoelectric Power: *Electrical power generated from a heat source, such as burning coal or nuclear fission, indirectly through devices like steam turbines.*



EIA <http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html>, diagram from <http://www.nrc.gov/images/reading-rm/basic-ref/students/student-pwr.gif>

Water for Energy: Once-Through & Withdrawals

- Power plants withdraw 49% of all water in U.S.
- A typical 500 MW power plant withdraws over 12 million gallons of water per hour, some as much as 20 million gallons per hour.
  - Equivalent to the volume of 440 to 730 Olympic sized swimming pools per day!

Water Withdrawal: *Water is removed from the ground or diverted from a surface source for use. This water is typically returned to the environment.*

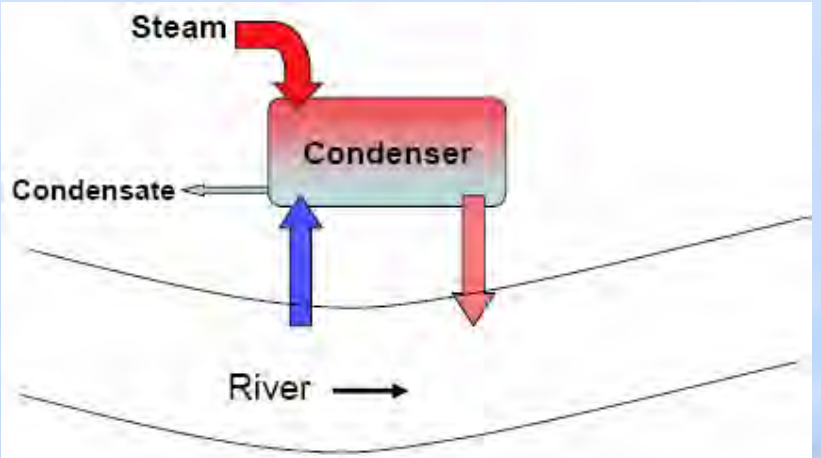


Figure II-2. Open-Loop Cooling System

Department of Energy/Office of Fossil Energy's Power Plant Water Management R&D Program. Summary July 2005. (Pg. 1) http://www.netl.doe.gov/technologies/coalpower/ewr/pubs/IEP_Power_Plant_Water_R&D_Final_1.pdf. And USGS <http://ga.water.usgs.gov/edu/wupt.html>

Figure from DOE "Energy Demands on Water Resources"

Water for Energy: Closed-loop and Consumption

- Approximately 25% of all non-agricultural fresh water *consumption* in U.S. is used for thermoelectric power generation.
- On average, 2 gallons of water consumed per kilowatt hour

Water consumption: *Water is withdrawn from a source but not directly returned to the source because it is evaporated, transpired, incorporated into products and crops, or consumed by people or livestock.*

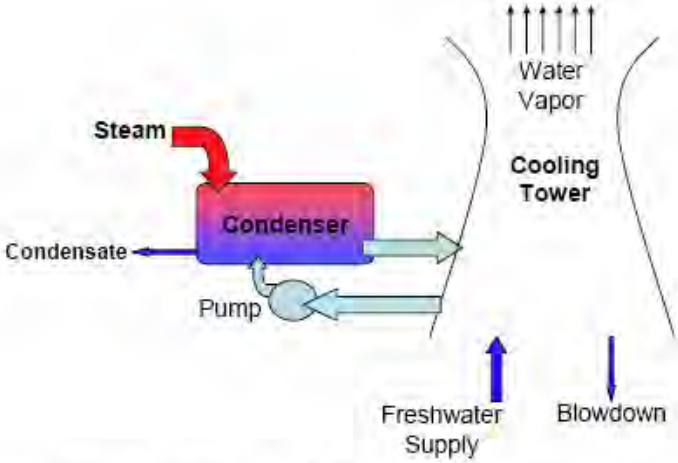


Figure II-3. Closed-Loop Cooling System

"Consumptive Water Use for U.S. Power Production" ,<http://www.nrel.gov/docs/fy04osti/33905.pdf>. Figure from DOE "Energy Demands on Water Resources"

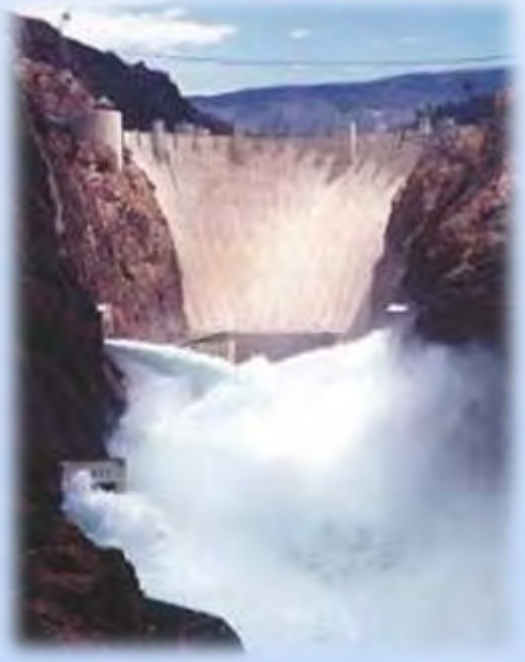
Water for Energy: Impacts of Thermoelectric Power

- Largest producer of toxic waste, surpassing plastic, paint and chemical manufacturing
  - **Heavy metals** such as selenium, cadmium, barium, mercury and lead
  - **Lake and streambed acidification** from sulfur dioxide and nitrogen oxides
  - **Toxic solid wastes** such as ash or slurry, nuclear waste
- Thermal pollution
- Wildlife, micro-organisms caught in intake structures
- GHG emissions from extracting, refining, transporting and burning fuels

NYT, “Cleansing the Air at the Expense of Waterways <http://www.nytimes.com/2009/10/13/us/13water.html>

Hydroelectricity: Water Evaporation

- Between 5% and 10% of U.S. electricity generation
- 3.8 billion gallons H2O/day
- U.S. average 18 gallons H2O *consumption* per kWh electricity



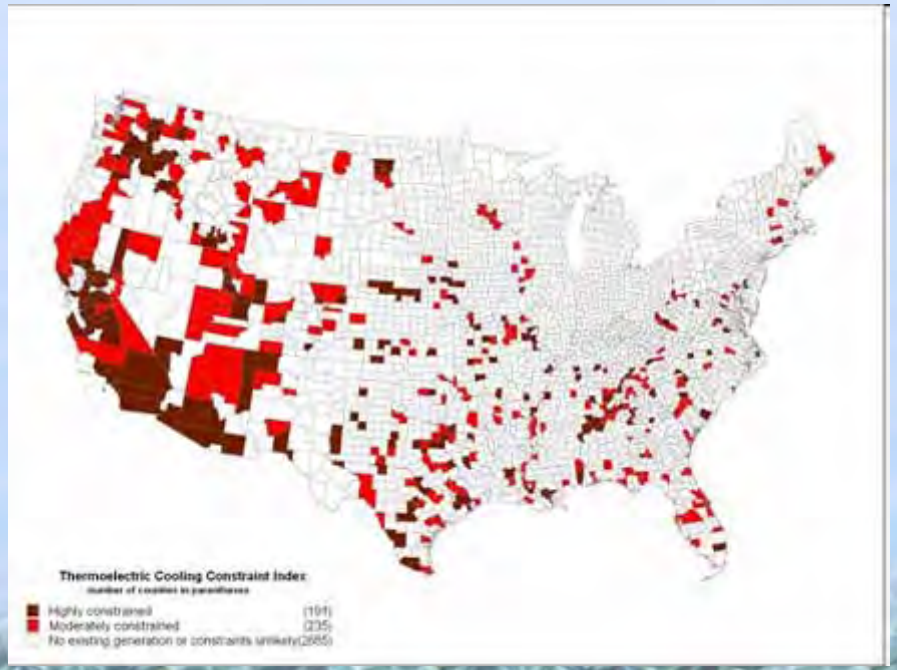
Hoover Dam:

1 billion gallons of water evaporates off surface per day.

Energy Demands on Water Resources. U.S. Department of Energy. (Pg. 20) 2006 http://www.rivernetwork.org/rn/climate/energydemands
AND "Consumptive Water Use for U.S. Power Production". <http://www.nrel.gov/docs/fy04osti/33905.pdf>

Water for Electricity: Trends

- Water demands for energy are growing faster than any other sector
- Low carbon technologies may require more water
  - Carbon Capture and Sequestration, 30% more water
  - Concentrating Solar Thermal, 2x water compared to Coal
- By 2030:
  - Electricity demand expected to increase by 50%
  - *Consumption* of water for electricity production could more than double.
  - Equal to all non-agricultural H_2O consumption from1995



Energy Demands on Water Resources. U.S. Department of Energy. (Pg. 10-11) 2006 <http://www.rivernetwork.org/rn/climate/energydemands>

Transporation

Fuel type	Water Consumed (gallons per mile)	Water Withdrawn (gallons per mile)
Gasoline, Diesel, and Electricity from Renewable Source	Less than 0.15	Less than 1
Electricity derived from U.S. Grid	0.30 – 0.75	5 – 20
Corn-ethanol	28	36
Soy-based biodiesel	8	10

Biofuels *consume* between 2 and 200 times more water than gasoline

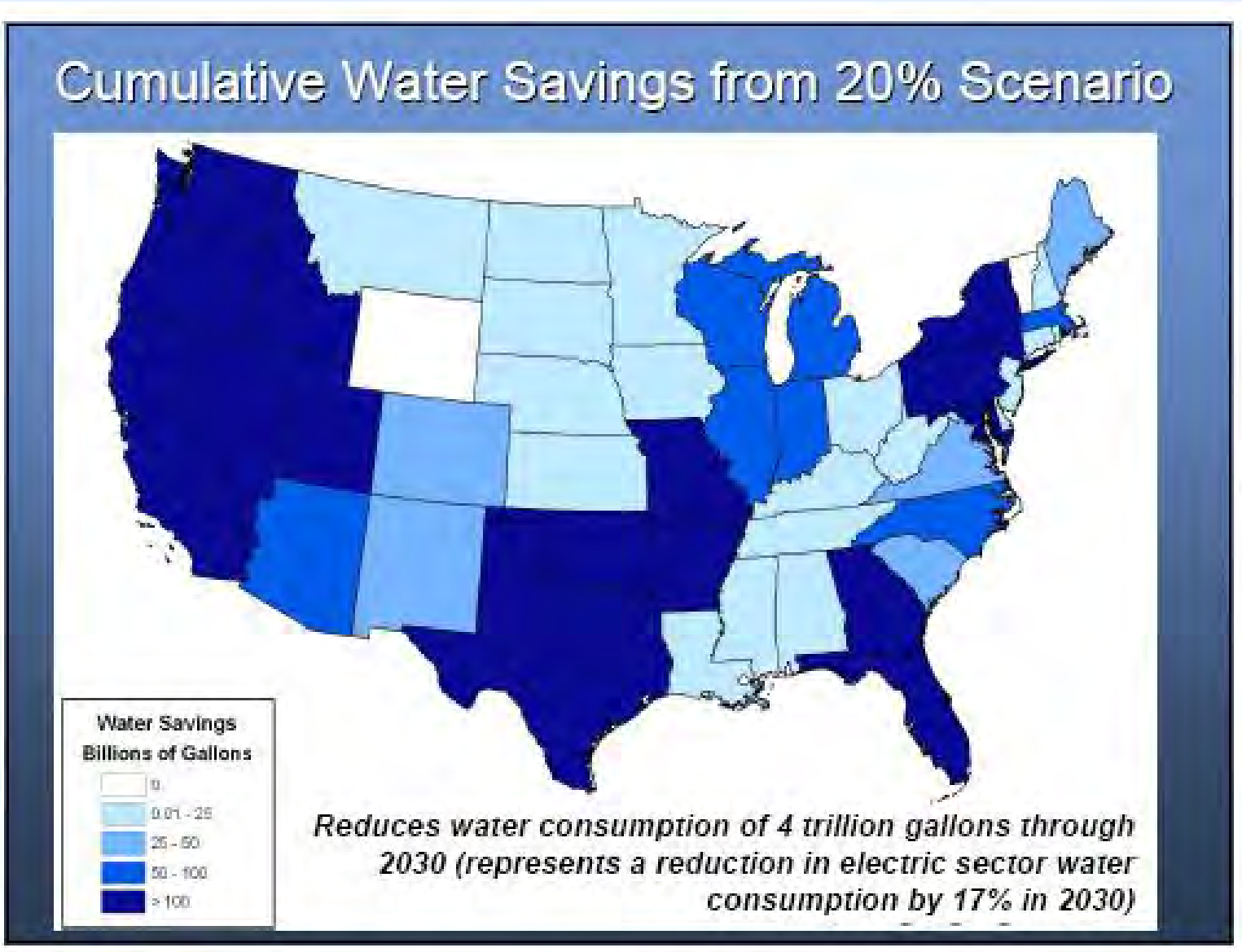
King, C. and Webber, M. “Water Intensity of Transportation.” Journal of ENVIRONMENTAL SCIENCE & TECHNOLOGY / VOL. 42, NO. 21, 2008 <http://pubs.acs.org/doi/pdf/10.1021/es800367m?isMac=289642>

Water for Energy: Develop Renewables

Source	Gallons Per kWh
Wind	**0.001**
PV Solar	**0.030**
Nuclear	0.62
Coal	0.49
Oil	0.43
Nat. Gas	0.18
Hydro	18.27

Gipe, Paul. “Wind Energy Comes of Age,” 1995 http://www.awea.org/faq/water.html and “Consumptive Water Use for U.S. Power Production” ,<http://www.nrel.gov/docs/fy04osti/33905.pdf>

Wind Power



Source: Larry Flowers, Energy/Water Nexus, NREL

Water & Wastewater System Energy Use

- U.S. annual total = 75 billion kilowatt hours per year
- 3-4% of total U.S. consumption of electricity
- More than entire energy-intensive pulp/paper and petroleum sectors *combined*
- Comparable to the combined electricity consumption of all the microwaves, color TV's, and computers found in our homes

Sources: Pacific Institute & NRDC, "Energy Down the Drain"
EIA: http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html

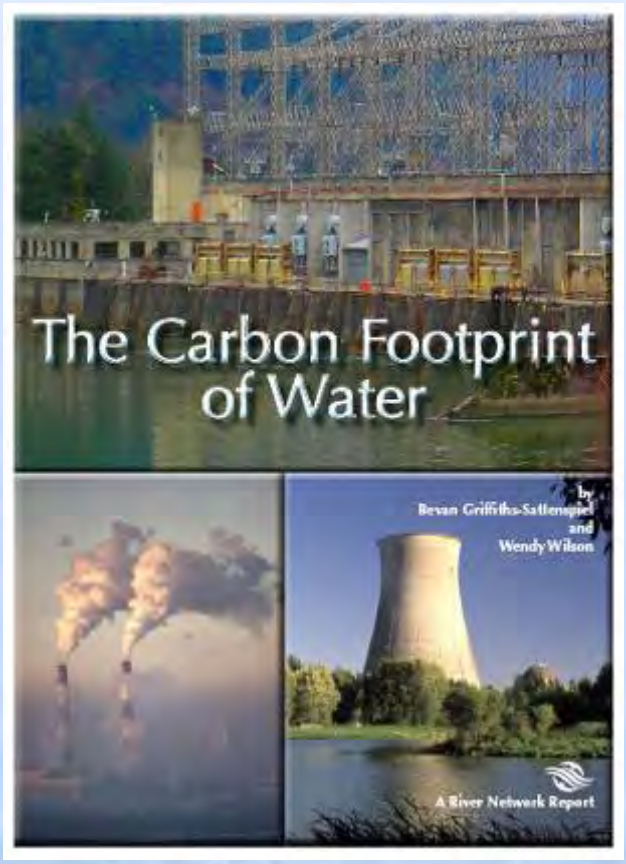
Inefficient Infrastructure

- The USGS estimates water losses in the water systems of the U.S. to be about 6 billion gallons per day
  - This represents more than enough water to supply the 10 largest cities in the US
  - Based on national averages, this water loss likely results in:
    - About 1.5 billion kWh of wasted electricity
      - Enough to supply 130,000 homes
    - 1.1 million metric tons CO_2 emissions

-George Kunkel Jr P.E.From “Water Efficiency and Accountability” pg. 65 of the March 2008 issue of Water Efficiency; Assumes 1,500 kWh/MG and 1.34 lbs. CO_2 per kWh

The Carbon Footprint of Water

- Water-related energy use is equivalent to *at least* 520 billion kWh (water heating only)
  - Electricity output of 150 thermoelectric or coal-fired power plants
- Resulting in 290 million metric tons of CO2 emissions
  - Annual greenhouse gas emissions of over 50 million cars



Consider:

- After space heating and cooling, water heating is typically the largest energy user in the home.
- Heating two gallons of water consumes more energy than lighting an entire home for an hour (400 watts vs. 250 watts).
- In five minutes, a hot water faucet uses as much energy as a 60-watt bulb uses in 14 hours.

=

Source: US EPA & ACEEE and Metropolitan Energy Center of Kansas City

Showerheads

- A family of four switching from a standard 2.5 gpm to an efficient 1.5 gpm showerhead can save:
  - 8,320 gallons of water
  - 1,240 kWh of electricity
    - more than a clothes washer
  - 1,660 lbs of CO_2
  - **About $175 off utility bills**

Assumes 5 showers per person week at 8 minutes each. Electric water heater, $0.102 per kWh, .2036 kWh/gallon hot water, 73.1% hot water.

Toilets

- If just 1% of American homes replaced an older toilet with a WaterSense labeled toilet:
  - 20% more efficient than the current federal standard
  - Save more than 38 million kWh of electricity annually
  - Enough electricity to supply more than 43,000 households for one month
  - Toilets only save cold water

Outdoor Water Use

"Of the 7 billion gallons of water used outdoors on the average day, as much as 50% is wasted due to wind, evaporation, improper system design, installation or maintenance."

– US EPA

This 7 billion gallons of water accounts for:

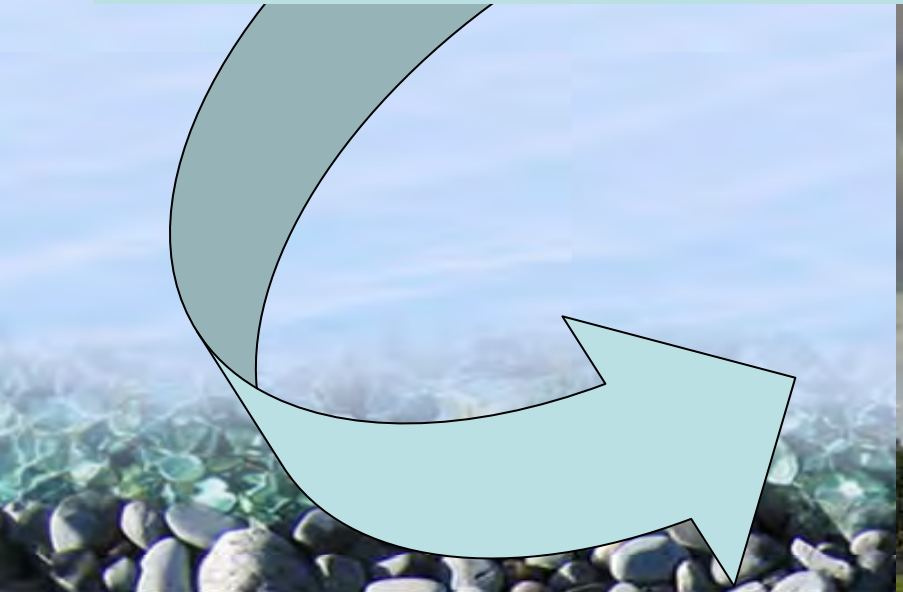
- Over 3.8 billion kWh per year
- About 2.7 million metric tons CO_2
  - Emissions of 520,000 cars
- Outdoor demand often drives need for energy-intensive marginal sources

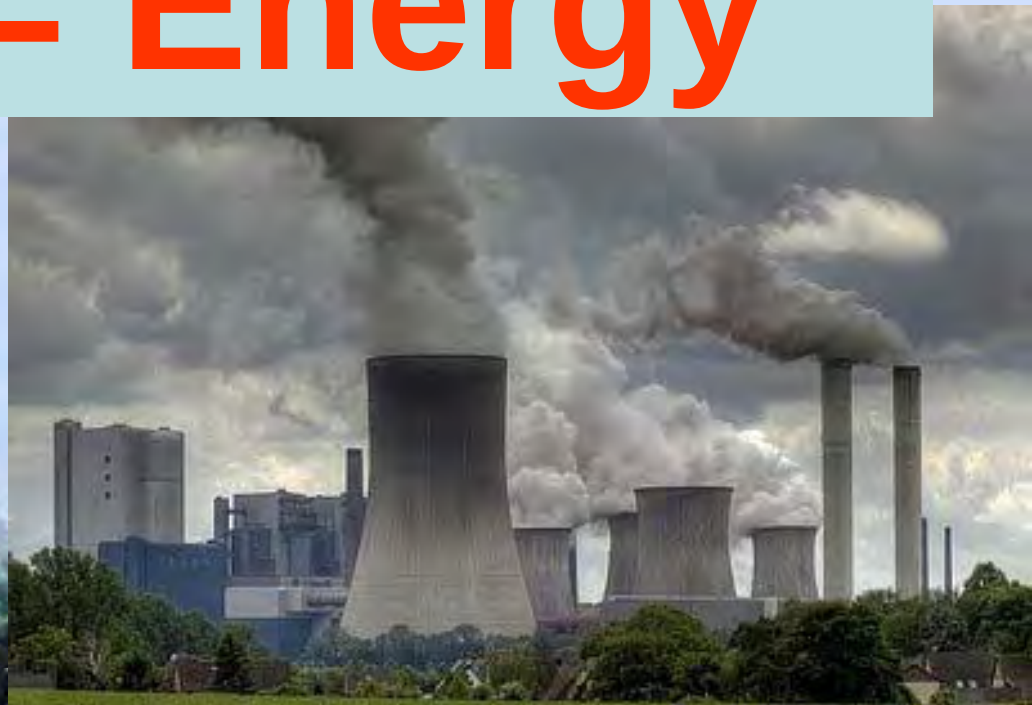
Assumes 1,500 kWh/MG and 1.34 lbs. CO_2 per kWh

Green Infrastructure and Low Impact Development (LID)

- Includes a variety of approaches
  - Green roofs
  - Permeable pavement
  - Bioretention areas or rain gardens
  - Downspout disconnection
  - Rainwater harvesting
  - Tree planting
  - Bioswales
  - Soil Amendments

Water = Energy





River Network
Connecting People, Saving Rivers

The End

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Questions?

Type your questions into the "chat" box in the right side of your WebEx screen.

EE Week 2010 – Be Water and Energy Wise

Earth Day Network

Success Story 1 – Conserving Energy

Power Down Fridays

B. Reed Henderson High School – West Chester, PA

- District report showed more energy used at Henderson than any other facility in the district.
- Student Environmental Club wanted to correlate with District's new Energy Management Policy and reduce school emissions.
- Students began by asking faculty to turn off lights, computers, and monitors not in use.
- This was successful but they wanted to do more.
- Students initiated Power Down Fridays - teachers and students avoid turning on lights or electronics all day on various Fridays.

Power Down Fridays
How

- Principal approached Environmental Club for ideas and assistance.
- Environmental Club was already knowledgeable - prior partnerships, activities and campaigns.
- Students and teachers worked together to create and promote.
- Students made commercial for school news broadcast, hung posters, silk-screened T-shirts, and installed Power Down light switch plates.
- Gave handmade bookmarks made from recycled materials as rewards.

Power Down Fridays
Results

- Environmental Club collected data from faculty - Henderson reduced its carbon footprint > 20 percent in the first month. Success has continued since.
- Environmental Club students are now helping other high schools in the area to promote Power Down Friday.
- Henderson alum Gerry Waldron, senior advisor for Rep. Markey (D-MA) added Henderson's Power Down campaign to one of Markey speeches on efficiency and "green schools."

Power Down Fridays
Resources

- See Henderson's initiatives with Earth Day Network: http://www.earthday.net/node/13399.
- See the article on the West Chester District website: http://www.wcasd.net/news/news040609.htm.
- "Power Down Friday" Student Toolkit: http://www.acespace.org/act-now/toolkit/facilities/power-down-day.
- Earth Day Network Education Grant Program: http://www.earthday.net/node/13458.
- Information, lesson plans and student action plans on daylighting and energy efficiency: http://www.earthday.net/greenschoolsfacilities.

Success Story 2 – Conserving Water

Rainwater Collection

Woodridge Elementary – San Antonio, TX

- For 5 years, several teachers have instituted raised garden beds and integrated them into the curriculum.
- Recent droughts in South Texas have resulted in stringent water rationing guidelines.
- Teachers began to brainstorm how to continue garden projects while practicing water conservation habits.

Rainwater Collection
How

- Teachers came up with idea to purchase and install 1,000-gallon rainwater collection system.
- Approached Earth Day Network and others for grant money to purchase cistern. Grant pending from city's water provider SAWS (San Antonio Water System).
- Teacher became certified as Junior Master Gardener.
- Working with Bexar County Master Gardeners Association to identify best location and technique for rainwater collection.

Rainwater Collection
Results

- Will be first rainwater collection tank installed in district.
- Increased watering capacity will allow future development of butterfly and hummingbird habitat.
- Students will be involved in planning.
- Master Gardeners Association will provide experts to teach appropriate techniques and provide support.

Rainwater Collection
Resources

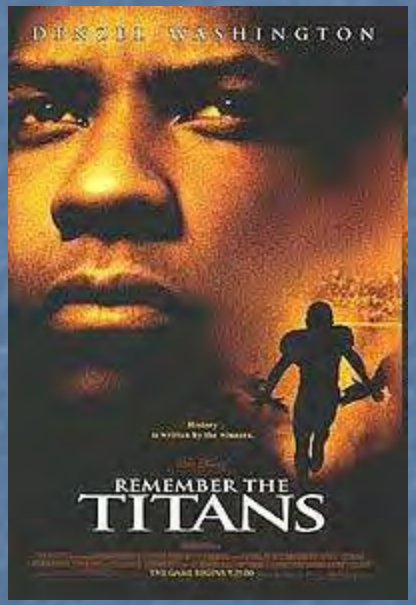
- Water Conservation background information: http://www.earthday.net/backgroundpdf/Water%20Conservation%20Background.pdf.
- Rain Garden Lesson Plan: http://www.earthday.net/lessonplanspdf/Let%20It%20Rain_%20Lesson%20Plan.pdf.
- Other resources on gardening and outdoor classrooms: http://www.earthday.net/greenschoolsrecreation.

Success Story 3 – Conserving Energy

Water Conversation

T.C. Williams High School – Alexandria, VA

- Remember the Titans (2000)
- 1st LEED GOLD K-12 VA School
- Main Green Feature: Water Conservation via Cistern



T.C. Williams Cont.

- 450,000 gallon cistern
- Saves 5 million gallons of potable water/yr
- Equals $30-40,000/yr; biggest green saver

T.C. Williams Cont.

- Collects rain water from roof
- Used for toilets, irrigation & AC
- City water used for drinking
- Community Support & Planning

T.C. Williams Cont.

- Additional Info:
  - Take a digital tour of school, including "cistern animator:" http://tcwilliams.alexandria.greentouchscreen.com/
  - Take a video tour at www.earthdaytv.net "In the Classroom" Channel

Success Story 4 – Conserving Energy

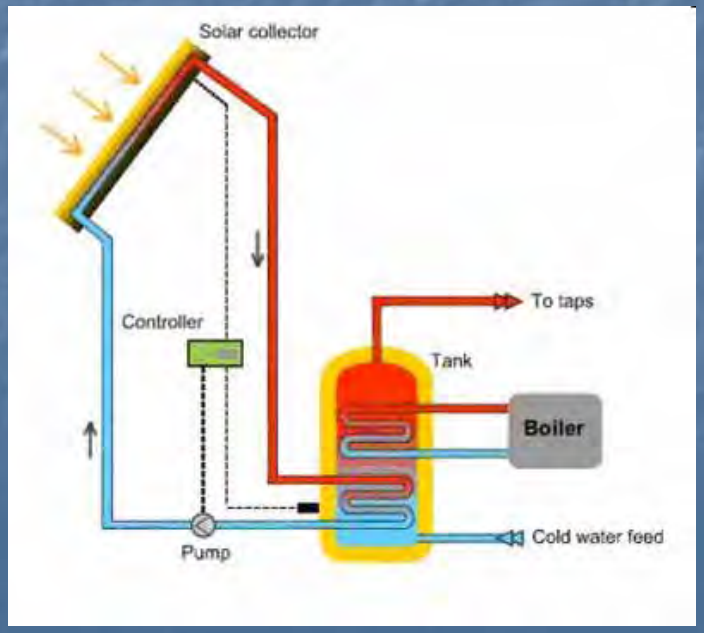
Photovoltaic Solar Installation

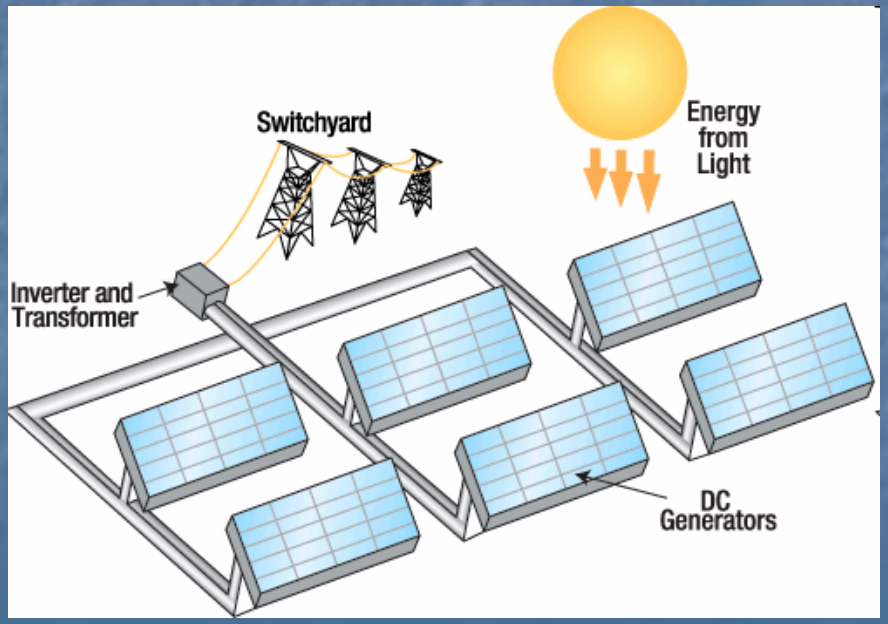
Bloom High School – Chicago Heights, IL

- Art Deco 1930s CCC School; Southside
- Awesome Teacher Support

Bloom High School Cont.

- Two kinds of Solar: PV & Thermal
- Best source of Renewable Energy
- Cutting Red Tape





Bloom High School Cont.

- **6.2 kW Photovoltaic System** installed on roof will power 15 – 20 classrooms and result in the following pollution reductions per year:
  - Greenhouse Gases (CO2): 38,600 Pounds (19.3 Tons)
  - Nitrogen Oxides (NOx): 54 Pounds
  - Sulfur Dioxide (SO2): 136 Pounds
  - Mercury (Hg): 700 Milligrams
  - $500,000 total savings over 25 years

Bloom High School Cont.

- Action Plan for Solar at Your School: www.earthday.net/greenyourschool (Click “Facilities”)
- Check out Bloom High School’s PV Monitoring Website: http://view2.fatspaniel.net/PV2Web/merge?&view=PV/standard/Simple&eid=215264
- Bloom High School Science Club: http://www.bloomhs.org/ Click “Clubs”

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Program Websites

http://rivernetwork.org/swse

http://earthday.net

http://eeweek.org

Thank you!

- Audio and video from this webinar, PowerPoint presentations, resource lists, and Q & A will be archived at www.eeweek.org
- A survey will be sent via email
- Information about future webinars will be shared via EE Week e-news and www.eeweek.org

Knowledge to live by

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