

Row 1, Extraction

- Produced water management (increasing problem, high certainty) (12 votes)
 - Geothermal produced water
 - Mine flooding—source of water
 - Water quality—impacts on—produced water TDS
 - Increasing problem in Powder River basin
 - Conventional produced water (oil production)—TDS, HC contaminants, brackish—less potential reuse
 - CBM produced water—exponential increase
 - Mostly sodium bicarbonate. May be useable if treated for irrigation. CBM may be useable immediately—1,000-2000 TDS vs 10000-20000 TDS
 - CBM conflicts with ag and other uses because of impact on shallow aquifers
- CBM—right now focus is getting rid of it
- Perception—water utilities don't know about produced water, “yuck” factor—not risk takers
- Supply reliability issues—urban uses it to build houses—don't want to build on something impermanent—but that may also apply to groundwater—time variability, not static
- Grey water uses of produced water
- Water is available, is there money—prefer to buy what they know
- What is a resource today may not be tomorrow
- Water for dust abatement in oil fields, steam flooding requires it, oil shale
- Oil shale—order of magnitude ranges—low to high depending
 - Depends on duration of oil price levels, and high price levels, uncertainty
- Water for frac operations, drilling that makes it very contaminated, flooding requires water, has to be free of sulfate reducing bacteria
 - Problem of collocation
 - Can use irrigation water, clean
 - In some fields using more water than producing
 - CBM water could be –depending on transport--\$11B
- Depletion issues related to fish and wildlife
- Nowhere to dispose of produced water in some cases—CA (2 votes)
- Salinity problems in Central Valley changing practices—disposal
- Treated and discharged
- Use of produced water for irrigation—is being used

Row 2, Fuel Production

- Coal slurry—peabody at window rock—decreasing problem—mojave just shut down
- Refinery wastewater streams (1 vote)
 - That need to be treated, could contain selenium

- Use of recycled (increasing)
- All in coastal and urban areas, so have to treat
- Biofuels—irrigation for crops (2 votes)
 - Processing—aqueous catalytic process
 - In NW, looking at waste products
 - Energy balance—lots of variability
- Biofuels—water will limit at some point, compete with food production (2 votes)
 - Ethanol
 - Biodiesel
 - Anaerobic digestion
 - Dairies
 - Feedlots, hog farms
 - Partly water treatment
 - POTW
- Biohydrogen—10+ years out
 - Problem with tradeoff with methane v hydrogen
 - Benefit of C neutral
 - H2 infrastructure issues
 - Does need water to start

Row 3, Electricity Production

- Water consumption for fossil fuel thermal plants (7 votes)
 - Are the cooling alternatives cheaper than RE?
 - Fossil prices—gas, coal, nuc
 - RE prices
 - Lots of variations and assumptions
 - What about 10 years out?
 - Water quality and cooling
 - Blowdown and makeup
 - Corrosion and scaling, if
 - Could use less if they could use for more cycles
 - Better Q in produced water
- Most plants are going to zero liquid discharge
 - ~\$7+ million for ZLD system on 500 MW combined cycle (SMUD)
- There are water treatment technologies available
- Dry v wet cooling
- Rising value of recycled water
- Big capital costs
- Evaporative cooling inland even more expensive
 - Water quality limits operation
- Air emissions—SO2 reduction techs—wet scrubbing better for high S coal, ties into permitting (1 vote)
 - Tradeoff in removal efficiency v water
 - Powder River basin favors the lower water use techs
- Retrofit feasibility—very facility specific going wet to dry

- Hydropower (10 votes)
 - Relicensing
 - Some undeveloped potential
 - Pressure to remove dams
 - Large v small hydro, new techs
 - Diversions for other uses reduces output—salmon streamflow req. out of synch with ideal elec. Prod
 - Drought
 - How to share shortages between states
 - Loss of 20% of capacity at Glenn Canyon from env.
 - Highly important for peaking and flexibility
 - Restricted upramp, ops, can't easily firm others
 - Large share of NW
 - NW is energy constrained, not capacity constrained
 - Exacerbated by climate change (seen now)
 - Regulatory issues (ESA, NEPA)
 - Ag comp.
 - Reduce flexibility to firm wind—influences other elect. Sources
- NOx control—low NOx comb, SLR, anhydrous ammonia—but fear of leaks constrains, a signif amount combine water user
- Other emission controls? Future regulation—metals
- Nuclear—could be near-term for deciding, but 15 years to power
 - Reprocessing—mixed oxide fuels to extend supply—breeder—water?
 - Biggest issues is in cooling
 - No Yucca mountain every 7 years
 - Siting and cooling issues
 - Large plants?
 - Different size thermal plants—distributed or central
- Siting—central v distributed (1 vote)
 - Far more flexibility in smaller plants
 - Small scale nuc in urban areas
 - Same with hydro—smaller, alt techs
 - Elec, water, or fuel can be transported—what is most efficient to move?
 - Non-consumptive cooling in front of consumptive uses like irrigation
- How will utilities acquire the water needed for future load growth—from ag and irrigation in past—can't rely on that forever (increasing near-term problem) (11 votes)
- Data monitoring and measuring of water supplies right now—to make most efficient use of it now—storage and diversion
- Impact of Katrina disasters on equipment availability, including dealing with CBM, water-constrained system that is very tight
- Climate change (5 votes)
 - Impacts pattern of demand
 - Impacts capacity/capability
 - Shift but also the variability is important

Row 4, Renewables

- For PV and wind, water use not an issue as we import panels—ind or small scale
- Should be able to do it in the US
- Energy a value-added commodity
 - \$40B/day market as population grows—at
 - Not seeing that opportunity
 - Could miss out on large opportunity
 - Cleaning PV cells could be done upstream and used for irrigation or other uses
- No contingent markets for water—needed to help hydropower low-flow gaps
- Pinon pine and juniper harvesting—immediate impact on water quality—whole tree
- Tradeoffs between renewables
- Biomass—location—irrigating to generate electricity doesn't make sense
- Growing biomass—irrigation
 - Residues/waste are a different issue—ag residues, byproducts—impacts soil quality
 - Others pure waste
 - Harvest impact on water quality and reserves
- Urban uses/growth to reduce water.energy—water harvesting
- Work with industrial users/developers to reduce fertilizer and inputs—right now practices
- Increase in geothermal—water quality, reinjection, cooling (1 vote)
 - Home uses could drive growth
 - At what rate
 - Some grants in NW
 - Could go into home use—direct use
- Industrial vs home markets—different water req
- Geothermal needs to be reinjected—a produced water issue—expensive
- Possibility of treatment—desal roadmap

Row 5, Energy, Other

Row 6, Urban Uses

- Energy intensive treatment processes—ozone, uv, membrane, ocean desal (6 votes)
 - Driven by regulation and new water supply
 - Inland desal—arsenic
 - Tremendous growth
 - Cuts across groundwater and surface water
 - Water treatment, econ dev problem
 - New contaminants—energy intensive
 - Perchlorate
 - Dioxane
 - MTBE
 - Salts, concentrate disposal—big env problem
- Regressive water rates—tend to fall heavily on fixed and low income
- Produced water treatment/sewage water treatment
- Bottled water growth—amount of money/resources is very high—marketing water out of the tap as well—perception issues
 - Adds to gap between rich and poor
 - Public v private diffs
- Could treat POTW water to potable—public resistance/acceptance
- Urban vs Ag vs Energy—in drought years the strains grow—sharing shortages—all in context of water
- Inefficiency—lack of incentive to conserve (11 votes)
 - Treated water
 - Legal issues—
 - Embedded infrastructure
- Diff between water conservation and efficiency
 - Conservation is programs to limit use
 - Efficiency is getting same goal with less water (focus should be here)
- IRP—looking at sources of supply the same as efficient
 - Demandside and supplyside treated equally
- Financing and adoption/implementation (6 votes)
 - Large gap in adoption in tech by builders/consumers—10 years from intro to use—collecting rainwater and thermal storage—slow adoption—need to narrow gap
- Efficiency tech and products
 - New ideas and tech lack capital to develop the good ideas and techs
 - In const industry great opportunity in res and commercial adoption held back by codes and standards and regs
- Stormwater runoff—paving and runoff—contamination
- Landscaping in arid areas
 - Staying about same problem
 - Covenants and codes that require “Kentucky bluegrass”
- Capital formation in public agencies to implement—no longer self-sufficient
 - Political will—that fades with rain, grows with drought—varies with rainfall

- Lack pricing mechanism, go be seat of pants
- Shorten gap in adoption
- Incentives work better than regs
- Archaic state laws (4 votes)
 - Domestic policy that every NM is entitled to drinking water (ie they can have a well—groundwater issues—developer driven—impacting aquifers)
- Individual RO systems, UV and filters—impacts on
 - Expensive—willingness to pay
 - Real benefits?
 - Private vs public solution
 - Voluntary vs involuntary—public/everybody has to pay
 - View a tax or expense, vs a direct product
 - Public viewed as inefficient
 - Bottled introduces much more waste
 - Conditioning/RO salt goes into the public system
 - FDA regulates water, other is a utility

Row 7, Agricultural Uses

- True costs are not reflected in ag uses—cost of head of lettuce is nowhere near real costs, skew economics (12 votes)
- Owns most of the water, based in 1850 tech, laws don't recognize technology creep—rights for diversion were geared to crops of that period—more efficiencies in use, but still own the same water
 - Better definition of water duty, reducing
- Use it or lose it water rights laws—SW
- Difficult to transfer, depends on nature of right—ownership—attached to place and purpose of use—not clear—shares vs physical
- Crop selection—are crops grown really appropriate for water situation—subsidies to corn, rice, wheat—has econ consequences—back to true costs (1 vote)
 - Side effects of pesticide and fertilizer use
 - Availability of labor—optimize
 - Selenium
 - Salination of land
 - Drainage ditches
 - Surface wastes
 - Groundwater contamination
 - Some farming creates habitat that may _____ changes
- How do you assign true costs to groundwater—now based in electricity needed to pump it alone—how do you assign it?
 - NRC has a paper and other methodologies
- Irrigation and selenium, saline, other side effects of irrigation—have to drain and dispose (2 votes)
 - Have to drain off, reuse potential varies by location, how to optimize
 - Have lost cleaning function of ponds and wetlands
 - Disposal of residuals, brine

- Flood irrigation, impact on quality
- Impacts on hydrologic system caused by changes in water use—from ag to power impacts gw recharge, sw (1 vote)
 - Also vegetation, wildlife
- Potential climate change on agric and its water demand

Rows 8 and 9, Electricity and Energy Production Uses

- Energy production uses tend to impact water quality and availability for other users—CBM as an example
- Withdrawal vs consumption vs availability for other uses
 - EPA and once through cooling regs—first set struck down—uncertainty
- Hydropower and increased instream uses, and competing ag other usrs (1 vote)
- Competition with tribal/cultural uses, impacts (2 votes)

Row 10, Environment and Recreational

- Increasing bans on rec. use or reservoirs—because of biological and MTBE from 2-stroke engines
- ESA, NEPA, CWA, SDWA and regulation of quality (9 votes)
 - As a result of applications there is less water avail for energy uses
 - CWA impacts disposal and discharge—set bounds
 - CWA also benefits—can be positive on water treatment
 - CWA may curtail interbasin water transfers by requiring NPDES permits
- Temperature impacts—impacts of discharges
- Lake/reservoir levels needed for boating/other uses constrain withdrawals (2 votes)
 - Lake Havasu
 - Minimal flows/water level linkages to permits for withdrawals
 - Other downstream—kayaks, trout, environmentalists

Row 11, Other

- Produced water from mines increase sw flows, when closed the pits retain water that would have flowed—hydrology—also contaminants from mining—copper
- Economic impacts—on other users

Priority Problem Area 1

- Extraction—produced water management issues
 - Conventional
 - CBM
- How will utilities acquire the water for future demand? Past patterns/approaches won't work.
- Hydropower

Priority Problem Area 2

- True costs/valuation in ag uses
- Urban—inefficient and lack of incentives to conserve
 - Treated water
 - Embedded infrastructure and custom
- Environmental/rec uses
 - CWA, SDWA, NEPA and ESA constraints and influences

Priority Problem Area 1, Detail

- Conventional produced water uses
 - 10 bbl water for every bbl of oil – 50 million bbl/day
 - Very limited reuse potential because of cost of treatment and opportunities that can use that quality
 - Not a factor because not part of water cycle—not a lot of water
 - Very dispersed
- CBM
 - Similar access problems—in remote areas
 - Quality is much better—minimal treatment to livestock, irrigation, streamflow augmentation
 - Disposal is key
 - Rapid water pumping at start, then declining—a surge individually, but less over whole industry—500 gal/min for how much gas—1-2 tcf/yr
 - Powder River, CO River basins
 - Growing. How fast?
- Use of wastewater for reservoir support in geothermal
- Overlaps with areas with critical water resource issues—good match—overlaps deep water depletion areas
- Hydrological impacts of mining and other extraction
 - GW v SW, shallow/deep
- How will utilities acquire water for demand?
 - Different time perception
 - Communication/perception
 - Money
 - Gas—different perception of time
 - Utility will go to water and fuel, in relation to transmission—they don't match
 - Uranium not a minemouth issue

- Coal is a transport issue
- Water and demand
- Gas is alive and well, but depends on infrastructure
- Conservation/efficient potential
- CO2 sequestration options influence
 - Pace to inject
- Ag relationships
- Side-effects—like odor from farmers to fuel production

Priority Problem Area 2 Detail

- True costs/valuation
 - Subsidies/policies based on past conditions
 - Have definite benefits
 - Benefits/costs changed?
 - If we could create markets it could help determine value, improves efficiency
 - Influences tech. adoption/possibility
 - Problem has changed from allocating what was seen as unused, to allocating scarcity

Priority Problem: Extraction—Produced water; impacts on transportation and other infrastructure

- NEED: Quantify the volume/characteristics (7 votes)
- NEED: Location/relation to other infrastructure—fuel/water
 - Where water and fuel for power production are
- NEED: Water amount over time—individual and as a group—now and in future
- NEED: Processing in energy efficient way/cost-effective
 - Sodium/pH/CO2/lime treatment
 - RO expensive
 - Ion exchange
 - Dialysis
 - Higgins loop
 - Above three underdeveloped—go from bench to reality
 - 1.5 million gallons of CBM on other projects—could do a 125 MW plant with this kind of water
 - 10 cents/bbl to 50 cents/bbl of water in CBM
- NEED: A process of engagement, expertise to study and resolve
- NEED: Soil/plant/soil information research that do well with CBM—for ag (6 votes)
 - Plants
 - Solids
 - Management
 - Users
 - Salinity is challenge—have to get to 800 TDS, from 1000-2000 levels

- NEED: Public involvement/engagement—tribes, local communities
- NEED: Series of case studies of successful management that people can learn from experience (2 votes)
- NEED: Ability to use gas directly
- NEED: Solutions now—permits are going in and developed. Already interstate water quality issues—water is already being produced (1 votes)
- NEED: Other solutions—reinjection is not whole answer
- NEED: Alternative methods for gathering and distributing water—very dispersed wells, short-term storage tanks
- NEED: Clarity on water rights/property—varies state by state
- NEED: Regulatory roadmap—need buy-in from regulators to be meaningful
- NEED: Who...
 - States, DWQ, locals, tribes
 - Municipalities
 - Mineral agencies
 - Landowners/water owners
 - BLM, BoRec, USFS, DoD, USACE
 - Tribal
 - DOI on conveyance
 - Coastal commissions
 - Environmental groups
 - Potential water users
- NEED: Technology that prod. CBM with less prod. Water
 - Water to biologically produce more CBM?
 - Improved fracturing?
 - Tech to increase pressure
 - Enhanced recovery?
 - Better seam characterization drilling to avoid highest water extraction
- NEED: Accelerated schedule—now, because the problem is now—immediate political will, 1800 permits issued by this summer
- NEED: A way to characterize how it could work with other water resource
 - Use less gw/sw for irrigation
 - Watershed management
- NEED: A coherent, federal approach that brings all the agencies together--coordination
- NEED: Permitting issues
 - TDS discharge on a gross tonnage basis, vs. concentration, volume, etc.

Priority Problem: Utility acquisition for future demand

- NEED: Efficiency on plant side—decrease slope on withdrawals
 - ? magnitude
 - Gain on utilities has big impact on downside
- NEED: Efficiency by other users—flood irrigation to more efficient (3 votes)
- NEED: Demand—alt. technologies demand curve to compare to supply side

- Location specific conditions
 - Remember it is not an efficient market
- Could combine information for plant location/siting
- Turn into R&D and cost goals
- NEED: Inform buyers of institutional/time framework of water transfers—advance planning
 - Reduced time to transfer
 - More realistic time frame planning
- NEED: Incentives for end users to reduce amount of water—it ripples back into energy for transport, treatment, etc. (11 votes)
- NEED: Water brokerage services—to anticipate needs, smooth transactions—buying rights for future use
 - Contingent markets capability
- NEED: Integrated analysis of siting, fuel, water use—integrated across all uses
 - Treatment
 - Potential users
 - Produced water
 - Lifetime of sources—like CBM, “fossil” sources

Priority Problem: Hydropower

- NEED: Analysis of climate change
 - Availability
 - Fluctuations/magnitude
 - Tied to more sophisticated modeling/management
 - Water quality impacts, like sedimentation, watershed integration
 - Seasonal timing/magnitude in regular _____ (datter?)
- NEED: Ecosystem information (7 votes)
 - Info on biological needs
 - Impacts of mitigation measures
 - Which are effective, how effective, why... science to backup mitigation measures
 - Costs of mitigation measures
 - Applied research benchmarks
 - Morphology agreement, stream _____
- NEED: Research/information on non-streamflow solutions
 - Driven partly by institutional beliefs
 - Acceptance of “non-natural” solutions—salmon, chubb, paddle sturgeon—specific to river systems
- NEED: What invasive species are out there? What are their impacts?
- NEED: Agreement on goals/definition
 - Recover (not cause jeopardy)
 - What is the level to restore to
- NEED: Assessment of changing water uses—hydropower, ag to urban, others
 - Regulatory roadmap

Priority Problem: True costs/Valuation

- NEED: Integrated analysis
 - Cost to process water, disposal, transport
 - Differences between market costs/intrinsic value
- NEED: Facilitated trading, markets that can help determine value—emission allowances?
- NEED: Market barriers—
 - Water utilities can't discriminate among customers
 - Willingness to pay/water quality service like utilities
 - Interruptible service
- NEED: Has a whole spectrum of values that need to be determined
- NEED: Uses outside pricing/markets—habitat, wildlife, etc.
- NEED: Value of environmental benefits of alternative users—outside markets (1 vote)
- NEED: Cross subsidies of federal users to ag uses
- NEED: Measure of what are the distortions, what could be fixed?
 - Cotton in US
 - Research on subsidies/incentives for overconsumption/waste
 - Inconsistencies in policies on water/ag supports
- NEED: Tradeoffs/values of management—water that could be moved from food to other uses with low impacts—not a single value-compensation
- NEED: Region/location specific data and analysis—varies within season as well
- NEED: Energy security/food supply issues, loss of farms, sprawl—taking water from ag is not simple solution

Priority Problem: Urban

- NEED: Incentives for solar, wind, other non-water-using RE
- NEED: Layered structure of charges to charge higher users more—on a broader scale (3 votes)
 - Promulgate successes
 - Also applies to electricity
 - That doesn't punish the poor
 - Incorporate into construction and building
 - EnergyStar
 - Codes
- NEED: 90% of homes are not architect designed—better spec homes
 - Incentives
 - Penalties
- NEED: Incentives beyond fixtures
 - Recycling/grey water
 - Solutions to code issues
 - Education
 - Builders
 - Retrofitters
 - Consumers
 - Address homebuilding on a national scale

- NEED: WaterStar
- NEED: Regulations/impediments in resid.
 - Custom
 - Mandatory measures
- NEED: Impacts of micro measures on public systems
- NEED: Land-use planning that takes account of water use (1 vote)
- NEED: Plan review for water use/design features like there is for energy
- NEED: Incentives for sustainable/low-impact communities
- NEED: DSM type impacts on water utility revenues
- NEED: Xeriscaping/landscaping
 - LV turf removal example
- NEED: Pavement and runoff
- NEED: How to deal with, make available to low-income—community-based approaches
- NEED: Solution to reinvestment in city infrastructure—capital

Priority Problem: Env./Rec and Laws

- NEED: Regulatory roadmap
 - State and local element of this
 - Oil and gas commission regulations
 - Inconsistencies between statutes and agencies
 - Scientific/analytical input into framework—understanding
 - Technological solutions/adoption
 - Information and decision support tools, to understand
- NEED: Antiquated laws—identify and characterize

Priority Problem: Bioenergy

- NEED: Total evaluation (9 votes)
 - Non-economic benefits
 - Economic
 - Resource uses/balances
 - Feedstocks
 - Slash/thinning
- NEED: Forestry/ag/synergies among organizations
- NEED: Produced water potential for energy crops
 - For remediation and energy (ie decontamination of water)
- NEED: Opportunities that don't compete with food production
- NEED: CBM opportunity in particular
- NEED: Research on aquaculture potential with produced water—a thermal cooling pond with generation
 - Research on collocation opportunities
 - Green uses?
 - Aquatic energy crops—briny water
 - Looking at biofuels from scratch—like algae
 - CO2 sequestration potential

- NEED: Potential regulatory hurdles/impediments
- NEED: Information—marketing and dissemination
- NEED: Research—genetic engineering of species that can use the water, fit climates—best crops (switchgrass)
- NEED: Bioenergy and watershed management--improvement
- NEED: Invasive species? What are unintended impacts?
- NEED: Harvesting heat from produced water—not just bioenergy—other energy uses?
 - Heat pumps?

- NEED: Comp. National Energy Policy—that includes water

- SOLN: Centralized collection
- SOLN: \$1B to collect (short dist.)
 - Treat then dispose
 - Solutions that can compete with dumping
 - \$1-7/bbl to move
- SOLN: Integrated solutions—not easy, hard to sell
- SOLN: Integrated roadmap to solutions

Hydropower--Ecosystems

- SOLN: Part of solution is habitat—what are ways to change how humans impact habitat, that are acceptable?
- SOLN: You protect the environment and compensate on power prod. side
- SOLN: ASTM Working on standard to evaluate env. Impact of diff. gen. technologies—
 - Even RE has impacts, just different—wind, site, visual, avian
 - Better information and analysis tools
- SOLN: Advanced power storage—that could mitigate conflicts between power and flow
- SOLN: Or on an energy production basis
- SOLN: Ownership—who wants it, who owns it
- SOLN: Watersheds and oil basins cut across the conflicting interests—get right people in the room
 - Has worked in NW
- SOLN: Has to be focused on implementation
 - Can't just be about research – has to solve problem

Bioenergy

- SOLN: More funding for plant genetic studies—some in corn, oil crops, soy, peanuts
- SOLN: Crops that would profitably replace high water consumption
- SOLN: Bioremediation and energy
 - That is energy
 - And irrigated land
 - Tolerate of salt/contam.
 - i.e. genetic map of alfalfa to take up saline
- SOLN: Biopower production and cooling water

Market/Incentives

- SOLN: WaterStar program similar to EnergyStar
- SOLN: Federal water efficiency standards for appliances
 - Effective
- SOLN: Tiered pricing from water consumption
 - Metering system that provides some feedback—how frequently
 - That also varies with seasonal peak
 - Low cost meter retrofits

- Easier to read meter
- \$1000/home
- Smart metering on electric side
- Could charge the user for meter
- SOLN: Involve government in transporting produced water to where it is needed
- SOLN: Get rankings/measures of cost/technology options—people know what they are working with
 - Capital cost
 - Operating cost
 - Lifetimes
 - Discount rates
 - EPRI tag for water tech

Ag side

- SOLN: Continued effort to remove the inefficiencies—still biggest withdrawal
 - Ag WaterStar
 - Collocating with old plants to use their water more efficiently
 - Using/bolstering T&D to use existing infrastructure
 - Connecting to combined
- SOLN: Rights in agriculture adjudicated to find out how much is there and could transfer—most have not been adjudicated
- SOLN: Jr right claims on senior rights—already 1st in line
- SOLN: Provide incentives (carrot) to reduce and stick in the “opportunity/true costs”

- SOLN: Regulatory roadmap—water/energy
- SOLN: Around NEPACT 2005
- SOLN: White House level summit
- SOLN: Intra-agency to implement
- SOLN: BLM, others have parts on issues like CBM
- SOLN: Statewide—regional—technical/topic
- SOLN: Build up on a watershed basis