- Thermal cooling needs
    - Use less water and maximize energy
        - X gal/MWh
        - Better quality assured data and metrics from EIA—QA/QC
        - Once-through—x gal/MWh; cut 50%
        - Recirculating—x gal/MWh
            - $/gal for reduction
            - where excessive use is
            - mechanism/incentive for transferring it
    - adoption
        - retrofit
        - new
    - For H2 economy same amount of water as used today
    - Characterize potential of same cooling technologies in buildings and industry to cut demand side
        - Industry, x%
        - Commercial buildings, 20-30% cut in water use
        - Lower energy demand
    - Define terms/technology
        - Use
        - Withdrawal
        - By technology
        - Conditions/seasonal/regional
    - Impact of 1 degree C temp by 2050 on cooling
    - Use lower quality water
        - What level/type—uniform definition
        - How many times does it recirculate
        - Acceptable disposal
            - Reduced volume by x%
            - Avoiding dilution
            - Tertiary uses—reuse applications
    - Avoiding/reducing by going to dispersed generation
        - Sizing of plants to grey water supplies
        - Characteristics of plant to location
    - Ground cooling/uses/use of waste heat
        - Co-location with uses like ag, district heat
        - Integrated with industry, buildings
        - What % increase is possible and at what cost? Need case studies.
- Hydropower needs
    - Build water allocation models to show uses among all users
        - Supply—over last 70 years—reservoir, how much has been paid for them/ownership—inflow/outflow
    - Demand
        - Defined by each use in basin—quantity and time—weekly for all 52 weeks
    - Price of energy by time

- Forecast to compare competing in-stream uses
    - Ability to look at how much used for new development, impact on other uses
    - Cost of development
    - "What if" scenarios—prepare
- Rehab—cost/quantity/potential
- Changes in model from climate change
    - Sedimentation
    - Flows
    - Flow variations into weekly data
    - Temp—demand/supply
    - Rainfall intensity—by basin, finer detail, as current and cheaply as possible
    - Impact of stream inflow requirements—technology
- Monitoring to adapt
    - Today, $10k/station/year – needs to be fraction of this cost
    - Data management
- Groundwater monitors
    - $5k each today, needs to be fraction of that
- Planning model based on historical
- Operational models
    - Built collaboratively
    - Build models to determine number of data points/system
    - 1 gauging station per sub-watershed
    - Budgets up to cover, or cheaper equipment
    - Building toward a real-time model for GPS
    - Groundwater different from surface water – ways to optimize groundwater
    - Buffering storage for energy and other uses

- Near—Population Growth
    - Substate level projections
        - That can be related to water, energy
        - Not driven by local politics—independent
    - Suitable for modeling
        - Historical data on trends
        - By river basin/water reservoirs
        - Septic system data
        - On public supply vs wells
        - Water use by home, industry, buildings
        - Focused on eastern US
        - Statistically sound
    - Models of building water use—like DOE2—all models need to be developed collectively with state and local agencies/stakeholders
    - Feed into models to optimize water uses—known but not communicated

        - WH
        - CHP
        - Building codes and water districts
        - Green buildings
        - Case studies/best practices
        - Where technologies work, and appeal to utilities/commissions
        - Where it feeds into community plans—like their safe water plans
        - Growth of water uses … irrigation, golf, pools
- Long-term needs—hydrogen
    - Assessment of water required
    - Energy/thermal cooling impacts
        - Goal of holding water requirements the same
        - Air pollutant emissions
    - Water for hydrogen—stable
        - What quality water? Salt? Where it is!
        - Transportation to hydrogen production—siting
        - Implications of production sites for distribution
        - How to put it in allocation models—value, cost, etc.
    - Water/vapor at end-use (fuel cells)
        - Impacts microclimate
        - Icing of roads
- Carbon sequestration needs
    - Ref interstate oil and gas assn report on CO2 storage
    - Increased energy demand
    - Water needs
        - Quantity?
        - Quality?
        - Locations
    - Holding water use and emission levels the sam
    - Water impact
        - Reinjection impact on groundwater
            - Where can it enhance/improve?
            - Negative impact?
            - By geology/hydrology
            - Secondary uses/benefits
        - Other impurities/metals
- Need: Aging infrastructure
    - Need quantification of cost implications
    - Quantify leakage/infiltration from old pipes
        - Infiltration from leaking pipes
        - Energy requirements of those
        - Check AWRA, others for data and info—what gaps?
        - Quality/cost of water/energy that could be recovered and where
    - Better geophysical/remote methods to understand
    - Better meters
        - AMR—more and better

        - Replacement/diagnostics program
    - Pipe rehab technology/less disruptive
    - Models/tools for accounting/assessment
    - No-dig technology
    - Funding mechanisms
    - Asset management approach
        - Costs
        - Priorities
        - Planning
        - Funding approaches
        - Lifecycle v first cost
        - Business models—distribution of costs
        - Publicly acceptable
    - Water loss audit standard
- Upgrades
    - Efficiency to reduce strain on infrastructure
        - Green roofs
        - Cost effective
        - Impact on water, energy, cost
        - Facilitating reuse
    - Better information on application, impacts on UHI—tie into models
- Solutions—Instream uses
    - How to model/quantify demands with hard science analysis
        - Quantity
        - Timing
        - Temp
        - Turbulence
        - Variability
        - Depth at worst point in nav. Path
    - Upgrade/coordination with POTWS to supply flow
        - Needs real-time monitoring
        - Hydropower
        - Thermal cooling
        - Commercial development
        - Env
        - Aquatic
        - Aesthetics
        - Valuation of recreation/navigation
- Needs-instream uses
    - Comparable metrics
        - $ valuation
        - ranges min and max
        - vary by time and conditions
        - baselines
    - legal dimensions of this
        - rights

        - requirements
        - interstate
        - authorization—original purpose vs new purposes
    - technology to deal with extremes—quantified costs and locations in basins of …
        - produced water
        - pumped storage volumes
        - hydropower reservoir
        - aquifer storage and recovery
    - how does it all change with climate?
- Needs—water laws
    - Regional level instead of state
        - Water basins
        - Characterization – conflicts, needed deltas
        - Adaptive management
    - Other regional planning
    - National water commission to work on means to form/facilitate regional
        - ICWP as an approach?
    - Need unified forum/group to work with feds
        - No dam left behind
        - Opportunities for national actions

Solutions
- Data baseline
    - State water resource plans
    - Canvass states (GA)
    - Characterize
        - Quality, type
    - Water usage by user
        - Industry, power, ag, commercial, homeowner
    - Data on water utilities
        - Financial/economic
    - Hydrologic data, models
    - QA—has use
    - Need infrastructure to handle all this data
        - GIS capable
    - Data sharing, cooperation
- Universities—linkage of water resource institutes
    - Land grant universities
    - UGA
- State geological surveys
- USGS state reps
- Lots of holes and assumptions to fix
- Political issue of reporting
    - Like ag use in GA
    - States don't have funds to do some of it

- State by state assessment
- NRC study and recommendations
- Coordinating council—bring back water resources council
    - Find a mechanism
- Coordination across data, modeling, response
- Making data and info available—web sites and links, clearinghouses, something
- Mechanism for standardization of data and info—for measuring, reporting, what is appropriate and needed
- Water data that is as good as and comparable to energy data
    - Something to value it
    - A water information administration (long term)

Analysis needs

- National assessment
- Water/energy data that would let private sector exploit for energy/water savings/performance
- Technology characterization—interactions of systems
    - Economic value

Solutions

- TAG—for water technologies existing or emerging
- Technology adoption
    - Petroleum tech transfer institute approach—for water tech/operators
        - Water planning groups
        - City managers
        - Industrial water users
        - Ag water users
        - State water users
        - Water/equip suppliers
    - Technology demonstration effort on some of these
        - Env tech verification model
    - Bringing together separate energy and water infrastructures in countries
        - Mayoral/municipal
        - Electric utilities
        - Private water companies (15%)
        - PSDs
        - Water/energy conservation
- Pricing mechanisms/signals
    - Mechanisms for low-income
    - Feedback/response to price signal—with AMR
    - TOU pricing—seasonal
        - Reducing peak
        - Value of reducing peak
- Leak assessment audit standard should be widely adopted (water loss audit standard)
    - Benchmarking tools/usage analysis

- Assessment of impacts of climate change on baseline
    - 1 degree C temp rise by 2050, erratic
    - how does it change advantages of different technology and other solutions
    - risk reduction strategy by states
    - adaptation approach
    - sensitivity analysis
    - insurance industry connection
    - NOAA reference
- Hydroclimatology at NOAA as a resource
    - Relate water to climate change
- Can't afford solutions that are not holistic
- Population growth
    - Increase of SE to size of FL … what does that imply for infrastructure
        - Assessment of impact on water…demand, hydrology, all the groups involved
    - Better, decentralized/small water systems
    - Smart growth approaches—have lowered impacts
    - Make areas with infrastructure attractive
    - Modeling/control of pumping systems
        - SCADA system for water supply
    - Rigorous zoning and control related to energy and water
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