Considerations in Using Renewable Energy in Water Supply Development

2008 Multi-State Salinity Summit

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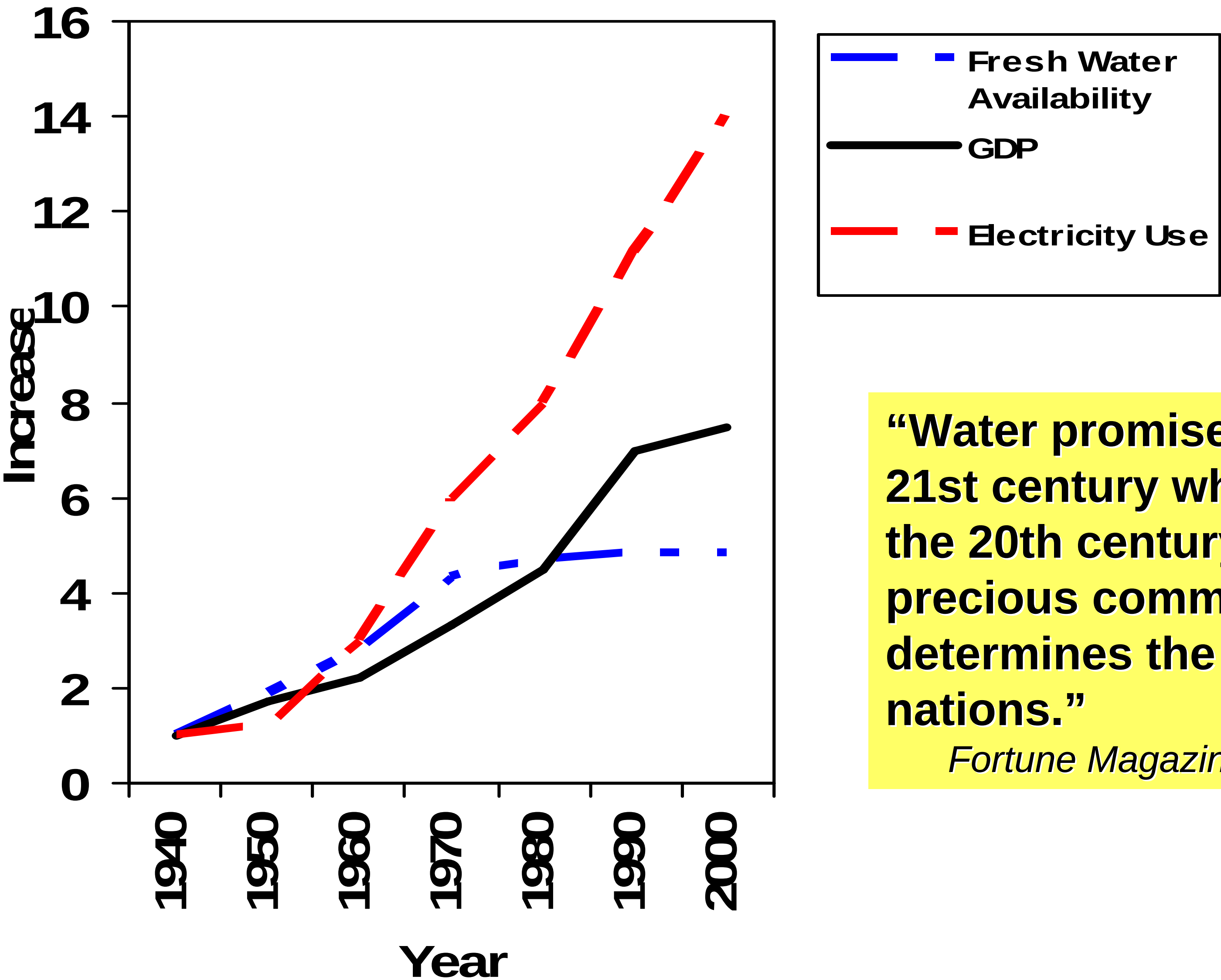
Water Is Now Being Discussed in Terms of Economic Growth and Productivity



"Water promises to be to the 21st century what oil was to the 20th century: the precious commodity that determines the wealth of nations."

Fortune Magazine, May 15, 2000

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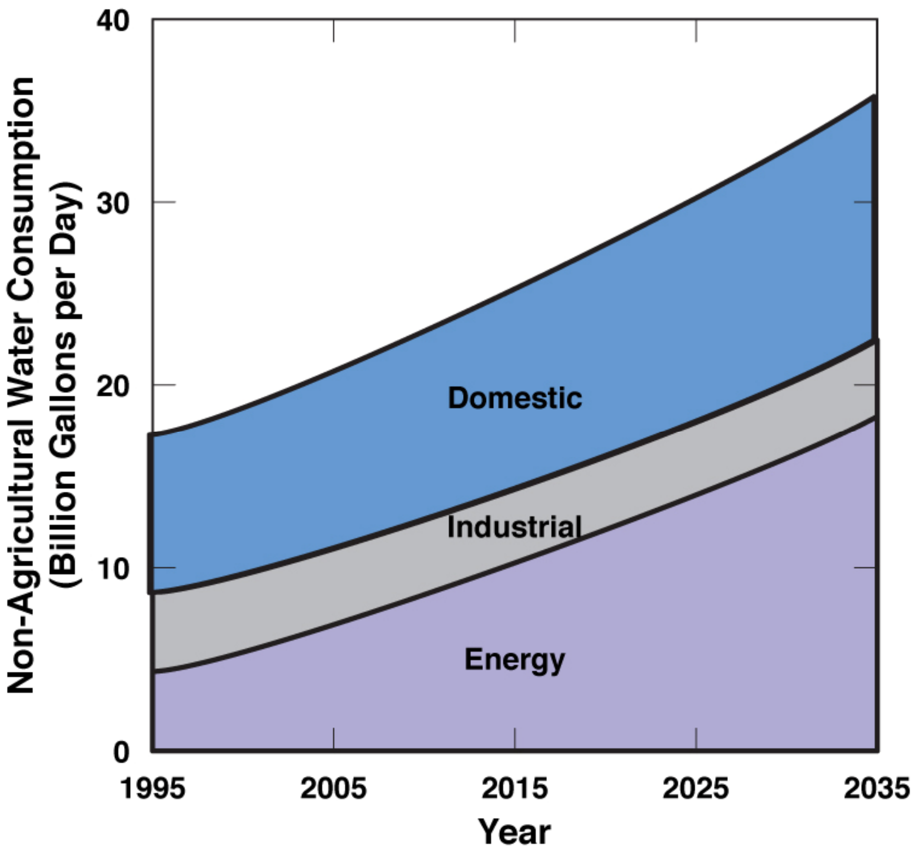
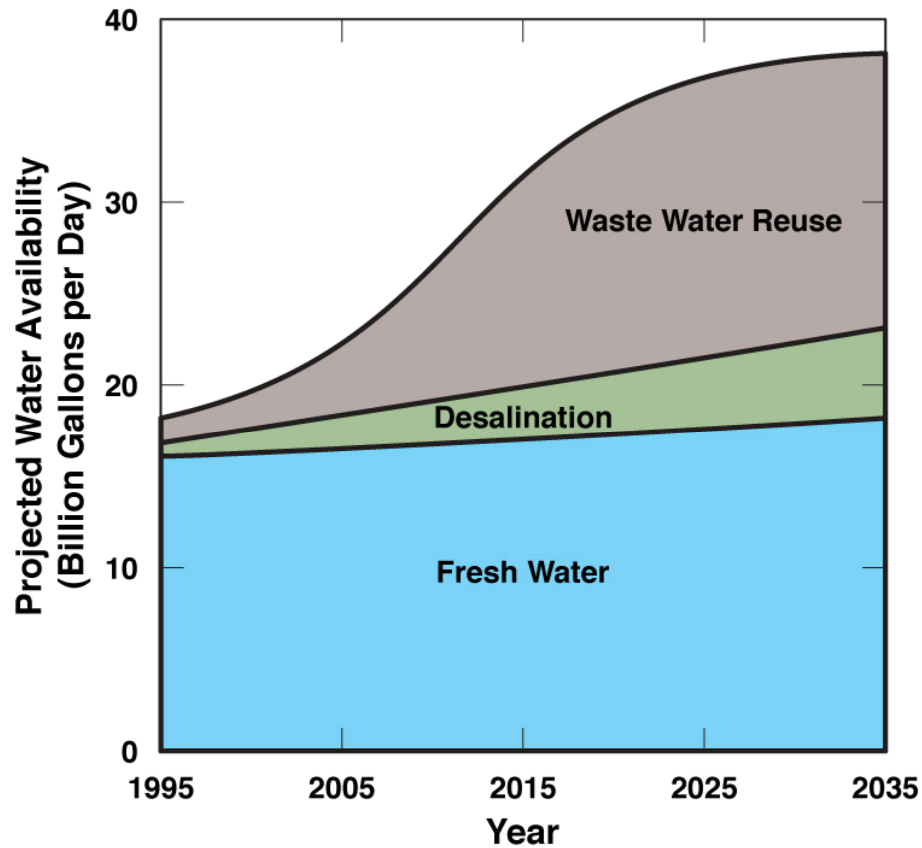
Projected Water Demands and Water Supplies





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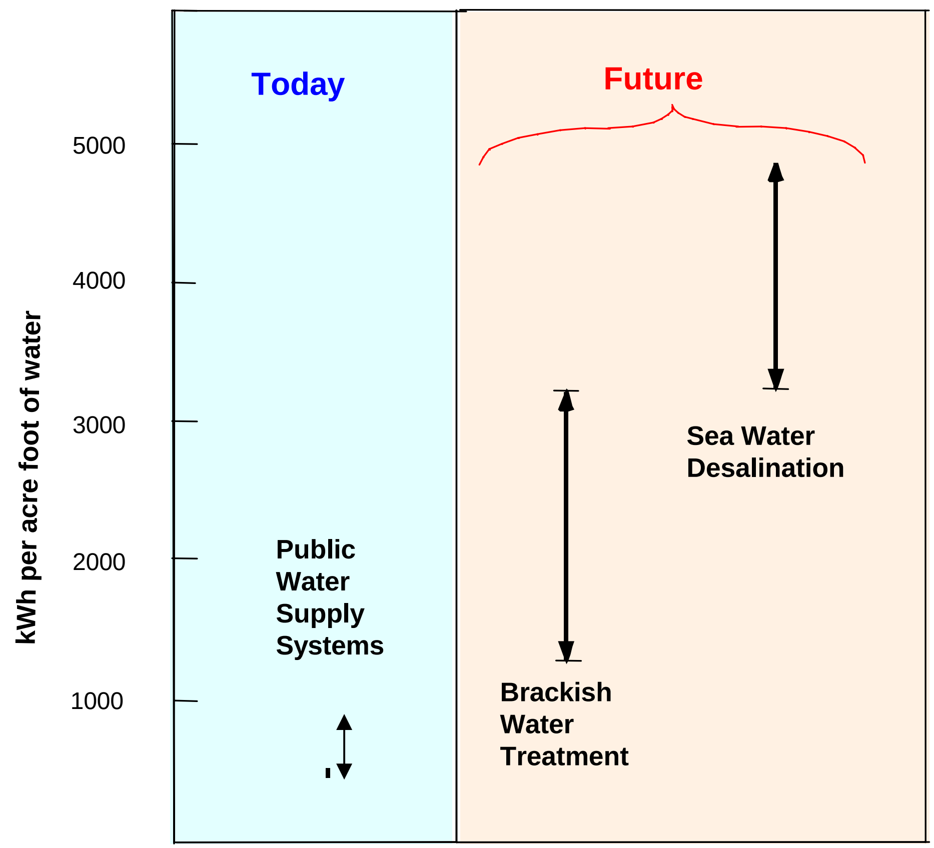
Non-traditional Water Supplies will be more Energy Intensive

- **Readily accessible fresh water supplies are limited**
  - **Increased energy for pumping at deeper depths and longer conveyance**
- **New technologies to access and/or treat non-traditional water resources will require more energy per gallon of water**
- **Energy is 80% of municipal water production, treatment, and distribution costs**
- **Water and waste water sector currently is 3-4% energy demand**

Power requirements for current and future water supply



Source: EPRI (2000), Water Desalination Task Force (2003)

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Brackish Groundwater National Desalination Research Facility

- **Grand Opening August 2007**
- **User facility coordinated by BOR**
- **Indoor test bays and evaporation ponds and five acres for for concentrate reuse research,**
- **Three large outdoor research pads for large-scale desalination testing at up to 60 gpm each, and**
- **Five acres for evaluation of renewable energy (wind, solar, and geothermal) and desalination system integration testing.**
- **Shake-down and some operational testing underway**

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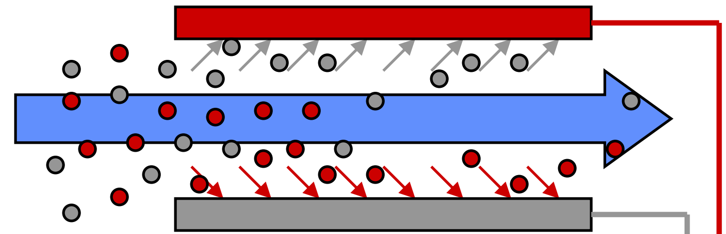
Texas Tech Wind Science and Engineering Research Center

- **Bench-Scale Wind-Water Development Research**
  - **5 kW Wind Turbine**
  - **Four-Element RO System**
  - **Reese AFB Wind ScienceTest Site**
- **Pilot-Scale Wind-Water Development Research**
  - **50 kW Entegrity Wind Turbine**
  - **Plains, Texas (Sandy Land UWCD)**
  - **Operational mid-2008**
- **Extensive cooperation in research on wind applications for desalination with NREL, Sandia, industry, and TWDB**
- **POC – Andy Swift 806-742-3476**

Capacitive Desalination/ PV Integration Research

- Analyze, correlate lab-scale Capacitive Deionization (CDI) results
  - Energy use (W-hr/gal)
  - Yield (gal treated/gal fed)
  - Selectivity for specific ions
- Couple Capacitive Deionization with photovoltaic power
  - Solar cell, battery size and cost
  - % utilization of CDI (fraction of time CDI runs)
- Estimate pilot-scale system cost
  - Power recovery from CDI plates
  - CDI material cost



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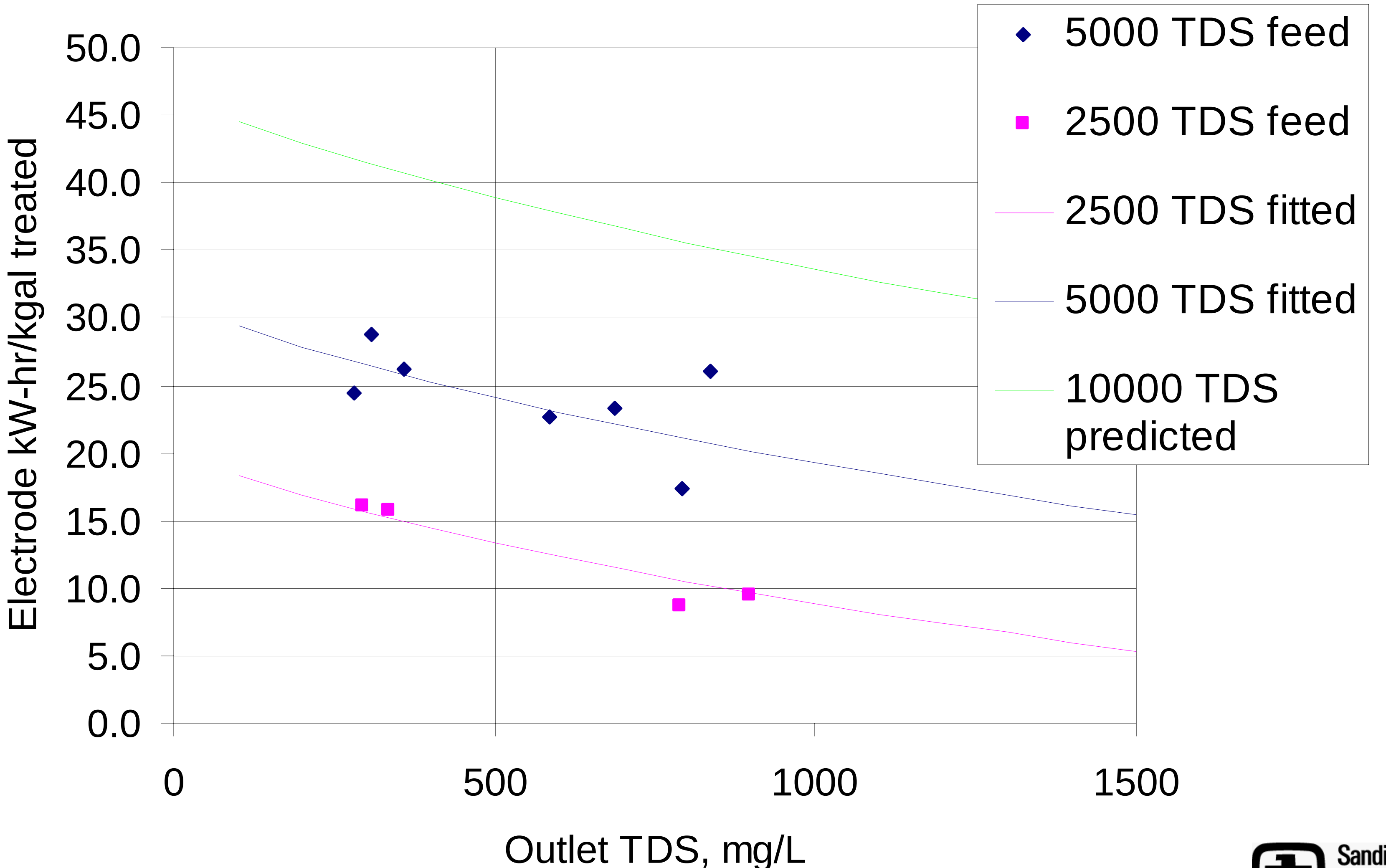
Results – Energy Usage



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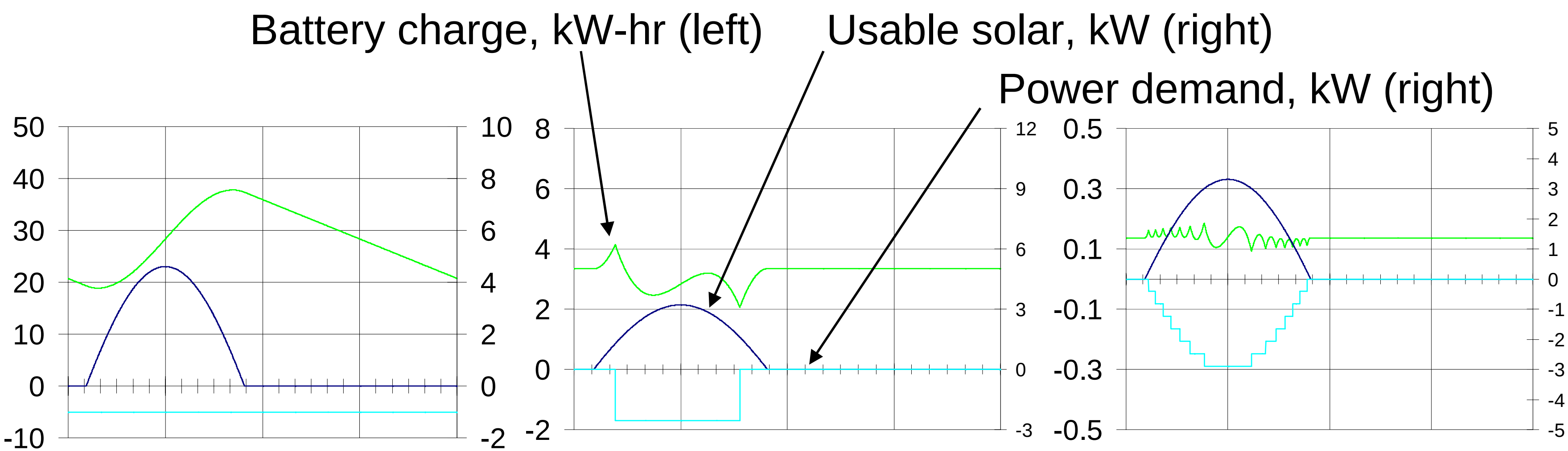
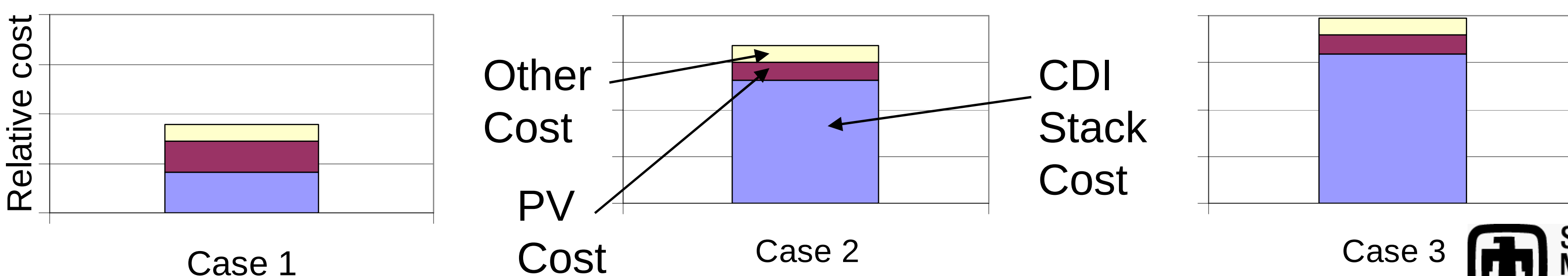
Pilot Scale System– PV System Evaluations and Considerations



Case 1: CDI runs 24 hr/day, PV has storage for night/day operation (86% CDI utilization)

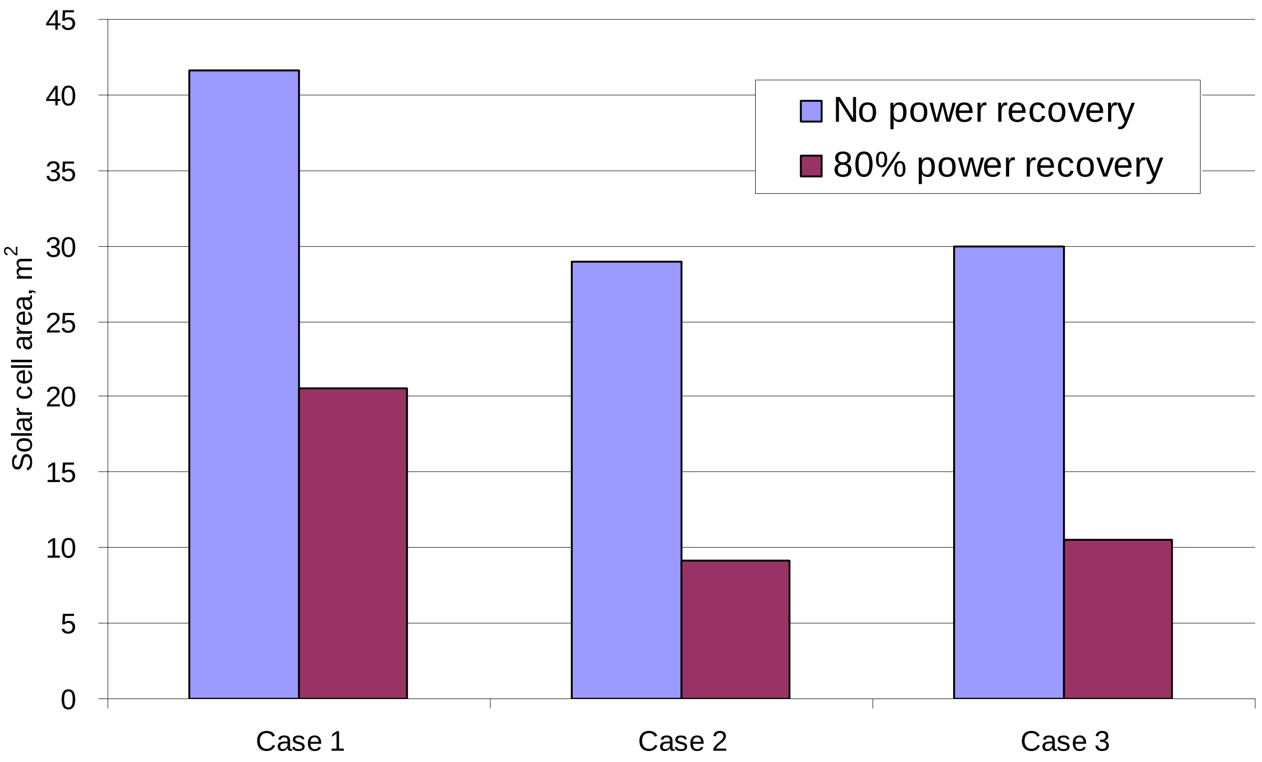
Case 2: CDI runs 7 hr/day, PV has storage for day operation only (25% CDI utilization)

Case 3: CDI sections engaged in morning, disengaged in afternoon (23% CDI utilization)



PV Area with CDI Energy Recovery

- **FTC energy recovery lowers PV system cost dramatically (6000 TDS lab prototype costs shown) by lowering required solar cell area**



Case 1: 24 hr/day
Case 2: 7 hr/day
Case 3: Phase in/out

Evaluation of Wind Energy for Water Pumping and Desalination at Seminole, TX

- TTU with NREL, Sandia, and TWDB
- 3 MGD system
- Detailed matching of wind energy, water demand, and water storage by hour
- Used 1.5 MW wind turbines
- $0.08 kWh energy costs, $0.03 kWh power sell back

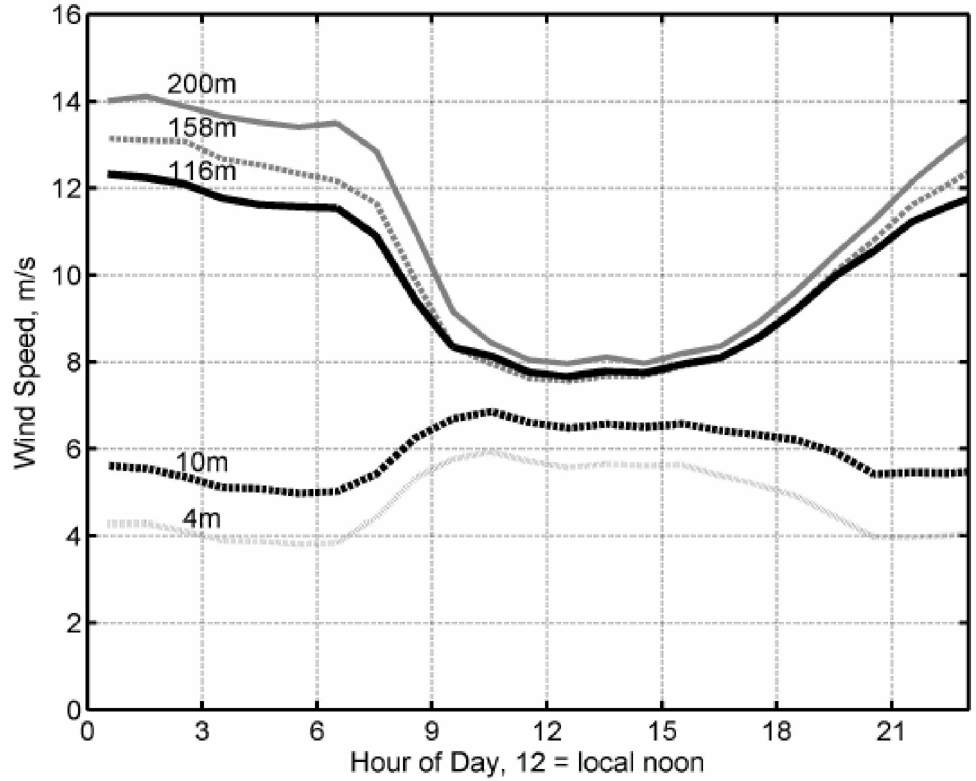
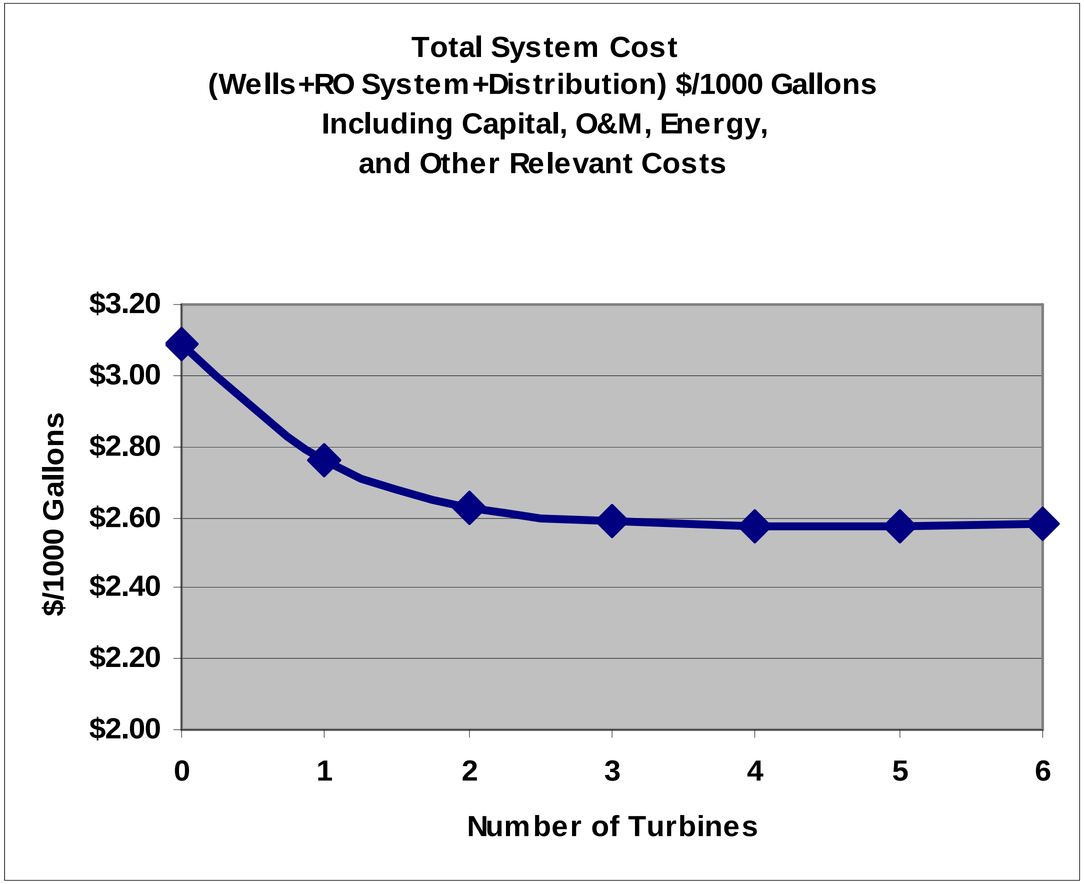


Fig. 78. Average diurnal evolution of the observed wind speed at each height level at Lubbock, Texas.

Integrated Wind-RO System Costs
3 MGD – Seminole, TX

- 2000 ppm TDS feed water
- Santa Rosa formation, ~1200 feet deep
- Traditional energy use for water treatment with RO - $3.10/1000 gal



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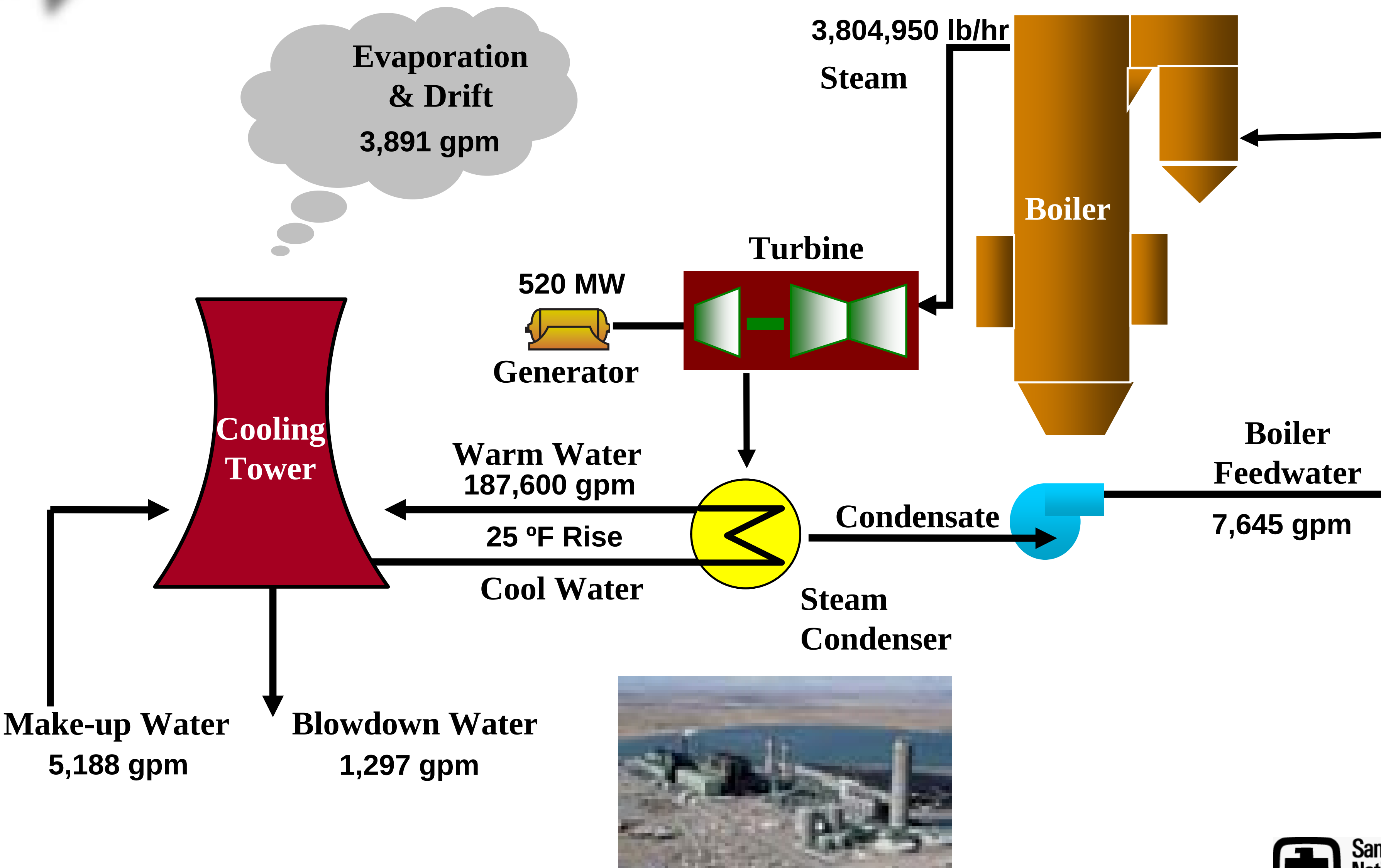
Water Balance for 500 MW Coal Power Plant and Water Productivity Considerations



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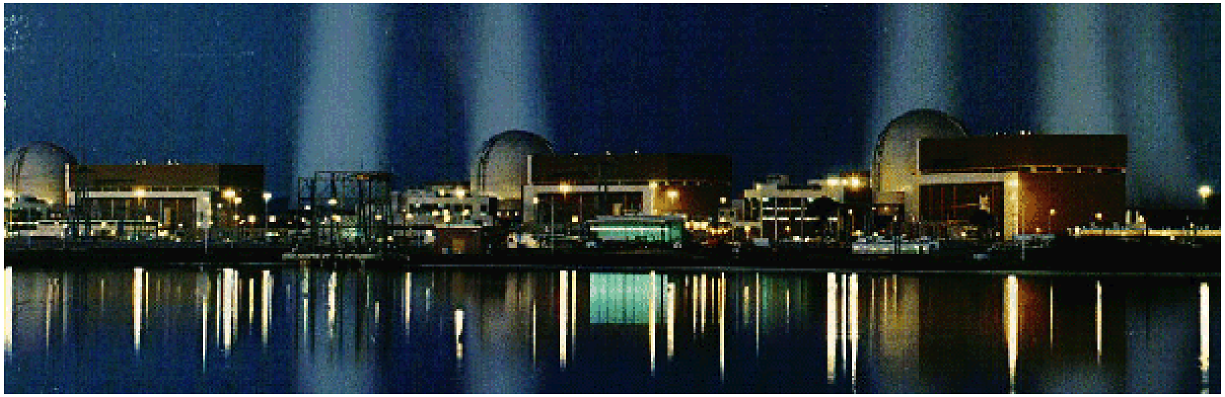
Emerging Use of Evaporation Ponds for Algal Biodiesel Production

- Electric power industry is looking at power plant blowdown for algae production
- Micro algae are adaptable to water quality levels exceeding 35,000 ppm TDS
- Might incorporate carbon capture to increase algae production
- DARPA has funded intense research program to assess commercial viability



Conclusions

- **Anything "wet" will become a resource**
- **Energy is an increasing cost concern in utilizing water resources efficiently**
- **Increasing water capital and water productivity (more crop per drop, more watt per drop) will be necessary to maintain economic growth**
- **Ubiquitous communications, computing, and control systems will improve the way we monitor and control energy and water use**
  - **Enabling innovative approaches to energy and water management and change energy and water infrastructure development and integration**