



EERC

EERC Technology... Putting Research into Practice

Water Extraction from Fossil Fuel-Fired Power Plant Flue Gas

ACC Users Group Workshop

Las Vegas, November 12th & 13th 2009



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University of North Dakota**

SIEMENS

What Does the EERC Do?



- The EERC is recognized as one of the world's leading developers of:
 - Cleaner, more efficient and innovative energy technologies to guarantee clean, reliable energy supplies for the United States and the world.
 - Environmental technologies to protect and clean our air, water, and soil.
- The EERC is a research, development, demonstration, and commercialization center.
- The EERC vigorously maintains a nonadvocacy position.
- The EERC enhances any guarantee.





EERC Facilities






Providing Strategic Solutions to Real-World Problems

The EERC provides practical, cost-effective solutions to today's most critical energy and environmental issues and challenges.

Our research portfolio includes:

- Clean coal technologies
- Coalbed methane
- Underground coal gasification
- Emission control
 - SO_x , NO_x , air toxics, fine particulate, and CO_2
- Mercury measurement and control
- CO_2 sequestration
- Global climate change
- Energy and water sustainability
- Energy-efficient technologies
- Distributed power generation – various fuels
- Hydrogen technologies
- Alternative fuels
 - Ethanol, biodiesel, biojet, and strategic fuels for the military
- Biomass
- Wind energy
- Water management
- Flood prevention
- Waste utilization
- Contaminant cleanup
- Advanced analytical technologies/extraction technologies
- Pesticides and neurological diseases



“Opportunity is missed by most people because it comes dressed in overalls and looks like work.”

–Thomas Edison

Water Permit Denied!
Power Project Cancelled

Water Is the Next Regulatory Frontier!

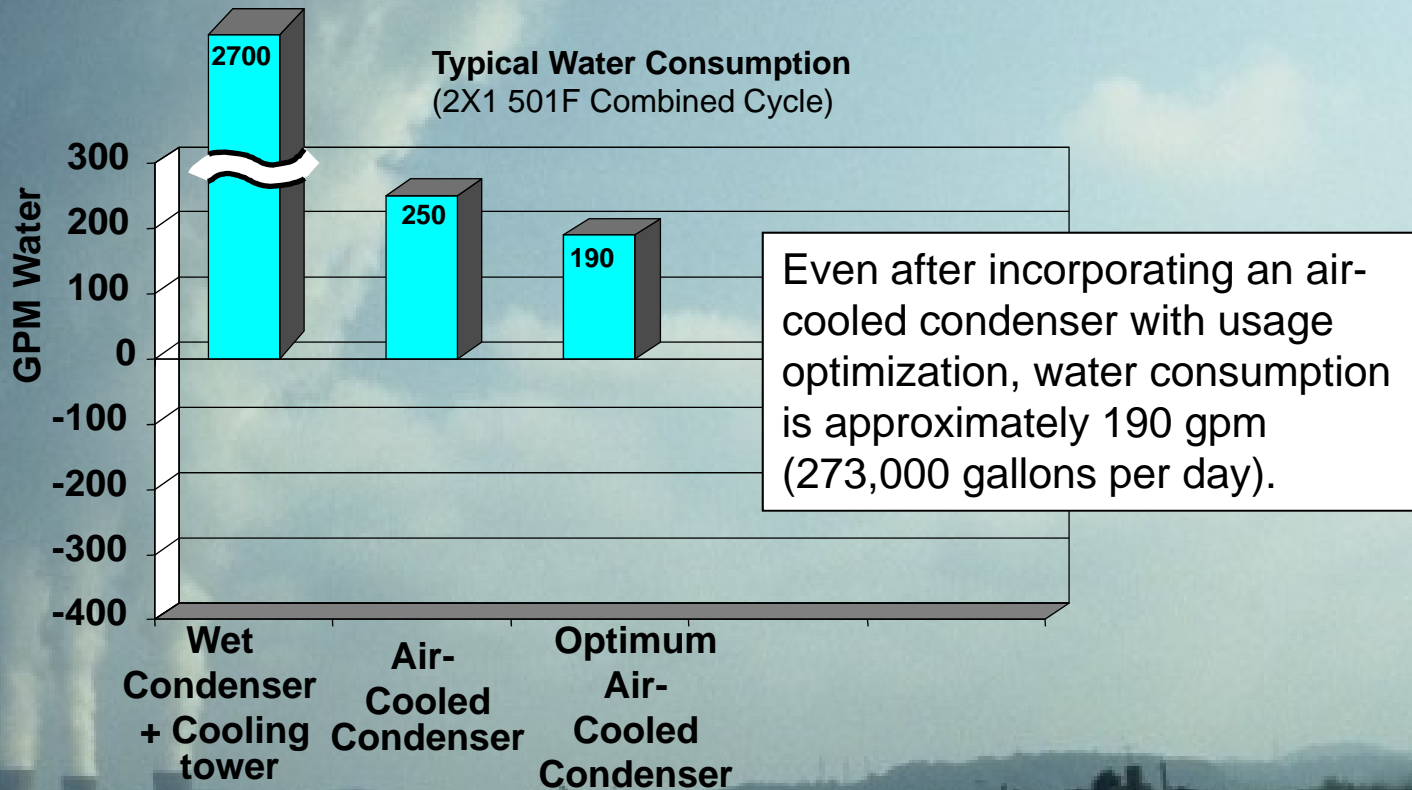
“The global water picture is bleak. Water use spiraled six-fold in the last century, more than twice the rate of population growth, and there is little prospect of a slow-down. Per capita supply is expected to drop by a third in the next two decades.”

Richard Collins on the 3rd World Water Forum in Kyoto, 2003

USGS identifies power industry as one of the largest users and consumers of water resources.

Estimated Use of Water in the United States, USGS 1990

Current State-of-the-Art Technology



Can Water Consumption Be Reduced to Zero?

Are There Alternative Sources of Water?



What Can Be Done?

Liquid Desiccant Dehumidification System

Flue gas water recovery system

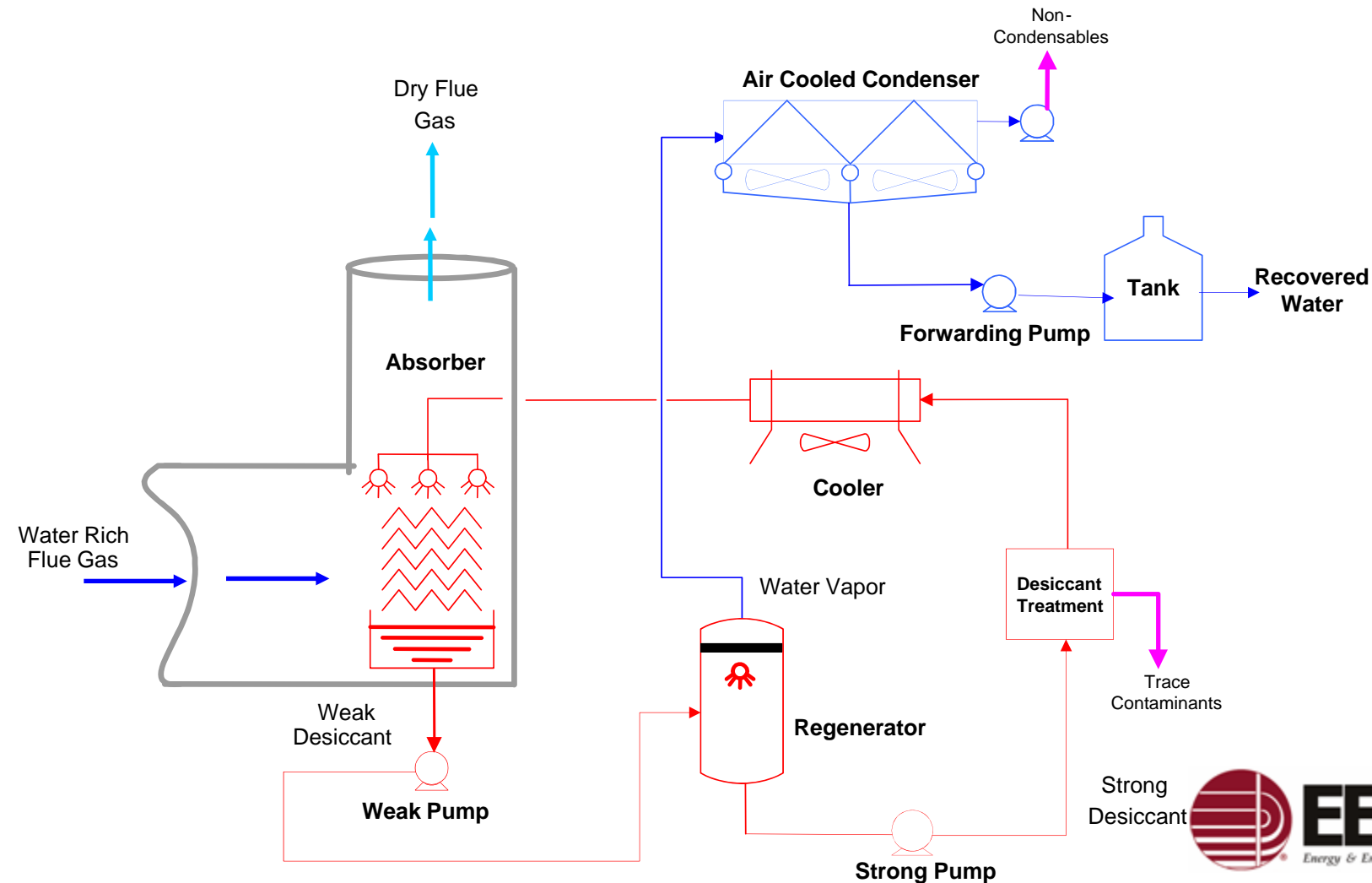
Desiccant based

Power plants can reduce or eliminate water from outside sources

Fitted on any power plant that burns carbonaceous or hydrogeneous fuels

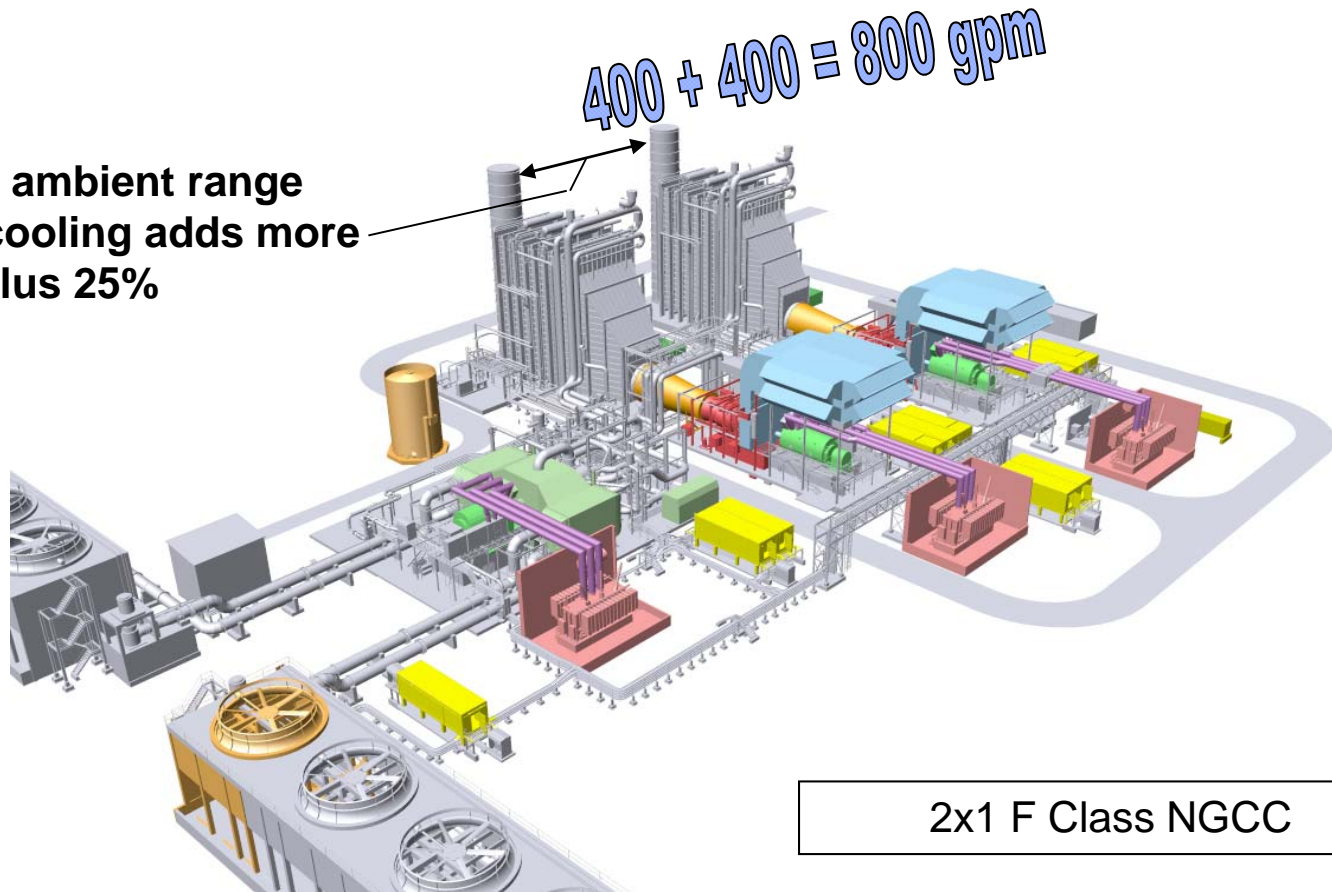
Retrofit and greenfield applicable

The Liquid Desiccant Dehumidification (LDDDS) Process



Alternative Water Source – Gas-Fired Plants

- Across ambient range
- Evap. cooling adds more
- IGCC plus 25%



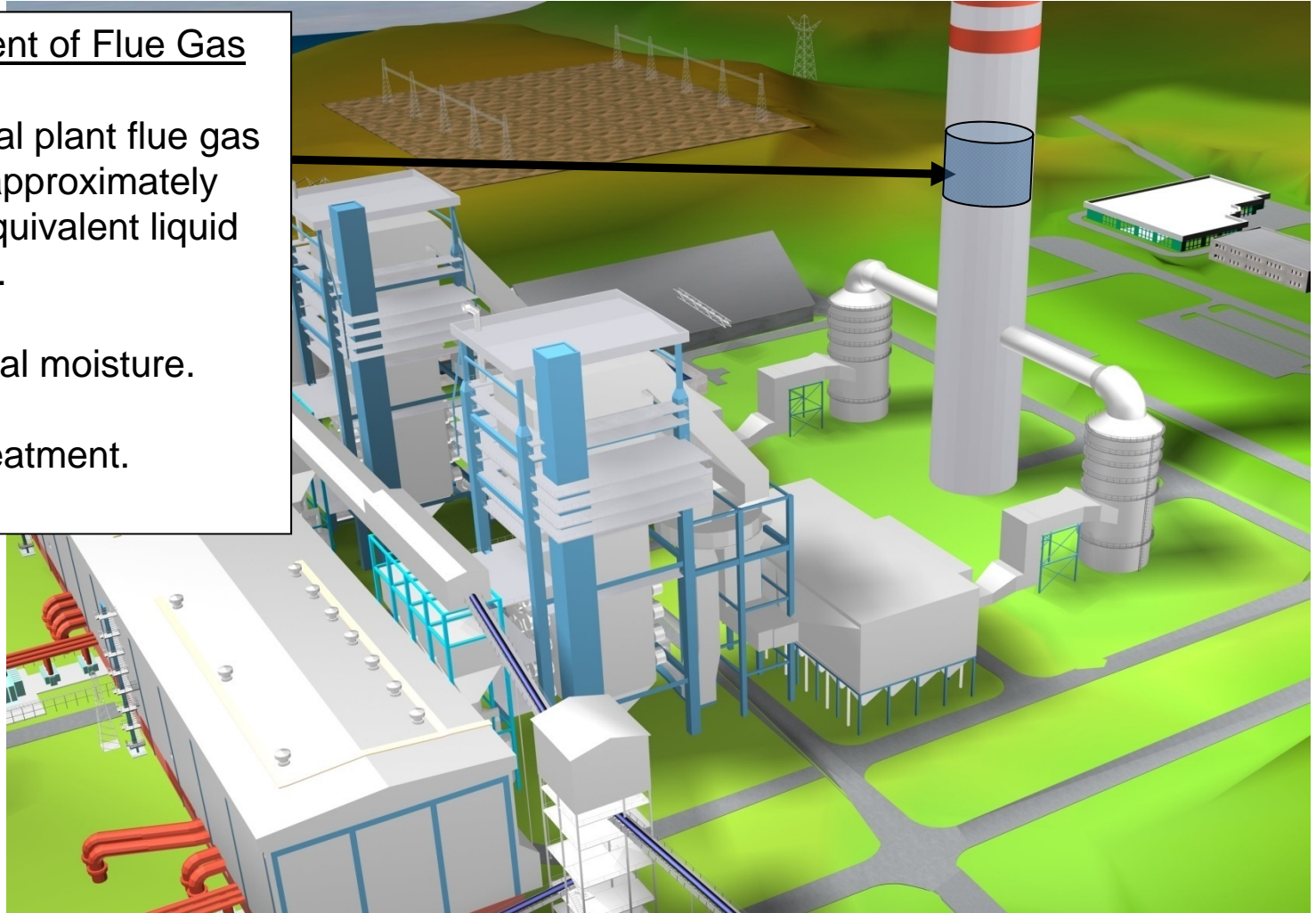
Potential Water Available (coal)

Water Content of Flue Gas

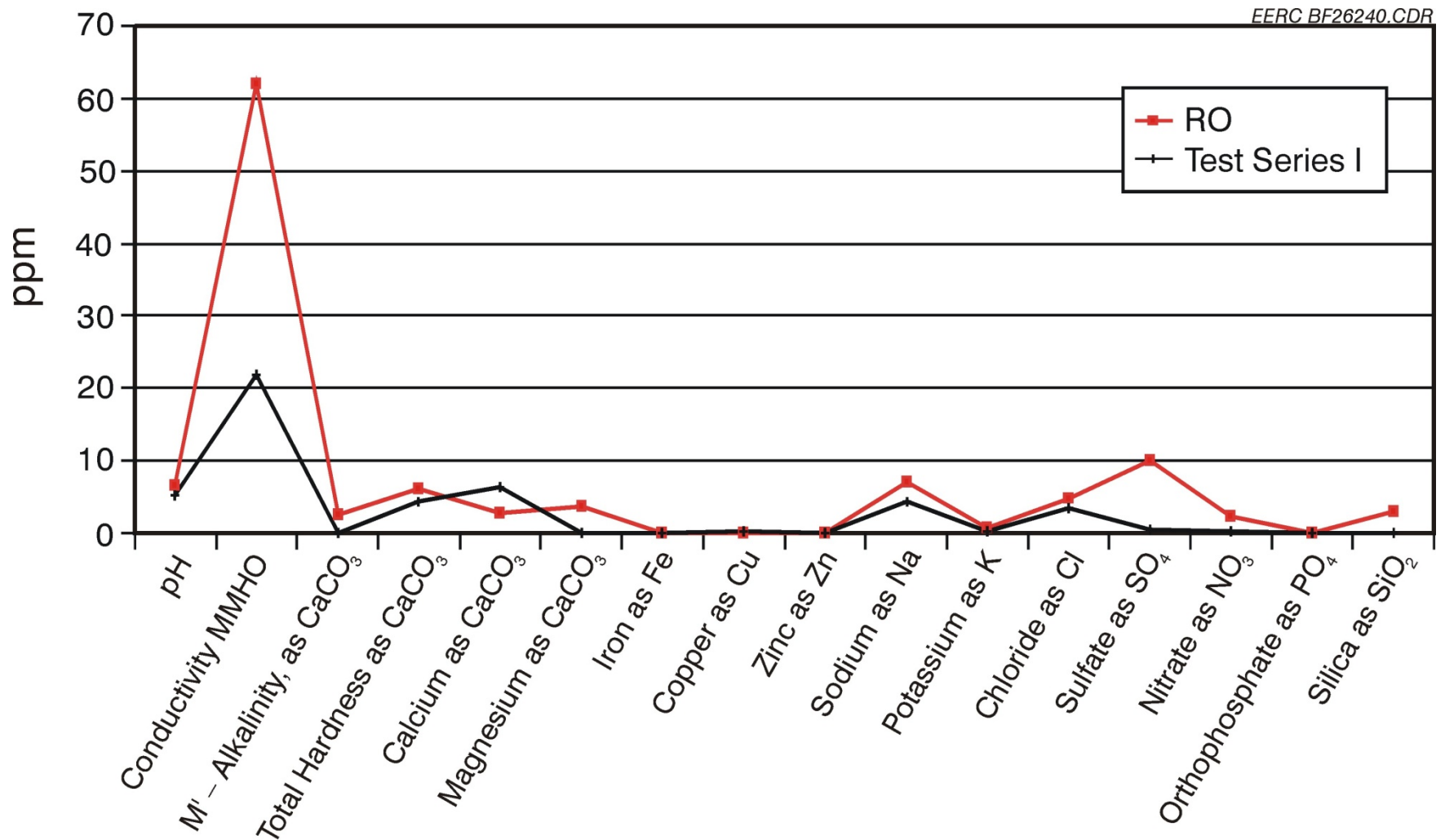
A 700-MW coal plant flue gas may contain approximately 1000–2400 equivalent liquid GPM of water.

Varies with coal moisture.

Varies with treatment.



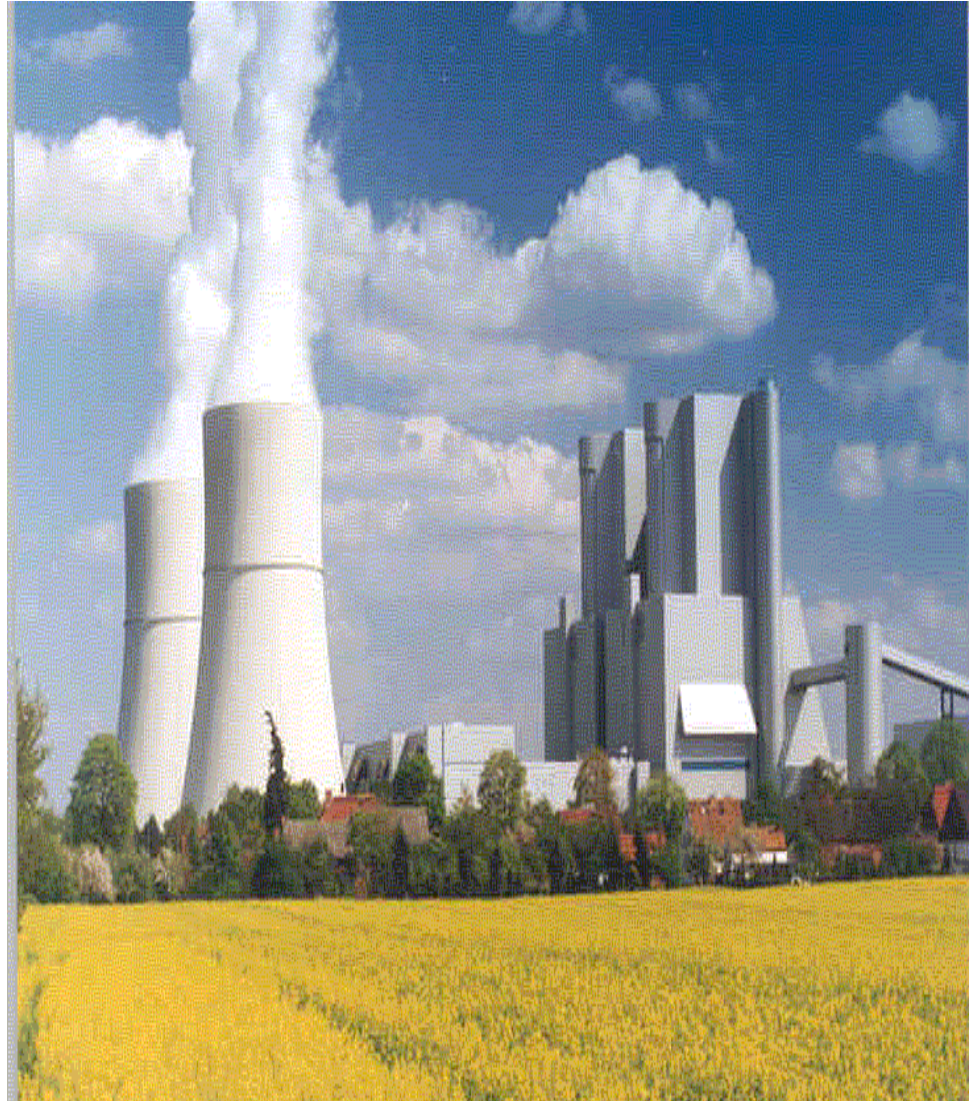
Pilot NG Test Results



Proof of Concept Pilot Test Results

Summary Pilot Test Results

- ✓ Complete system with regeneration – demonstrated
- ✓ Natural gas and coal – demonstrated
- ✓ System stability – automatic operation demonstrated
- ✓ Desiccant carryover – undetectable

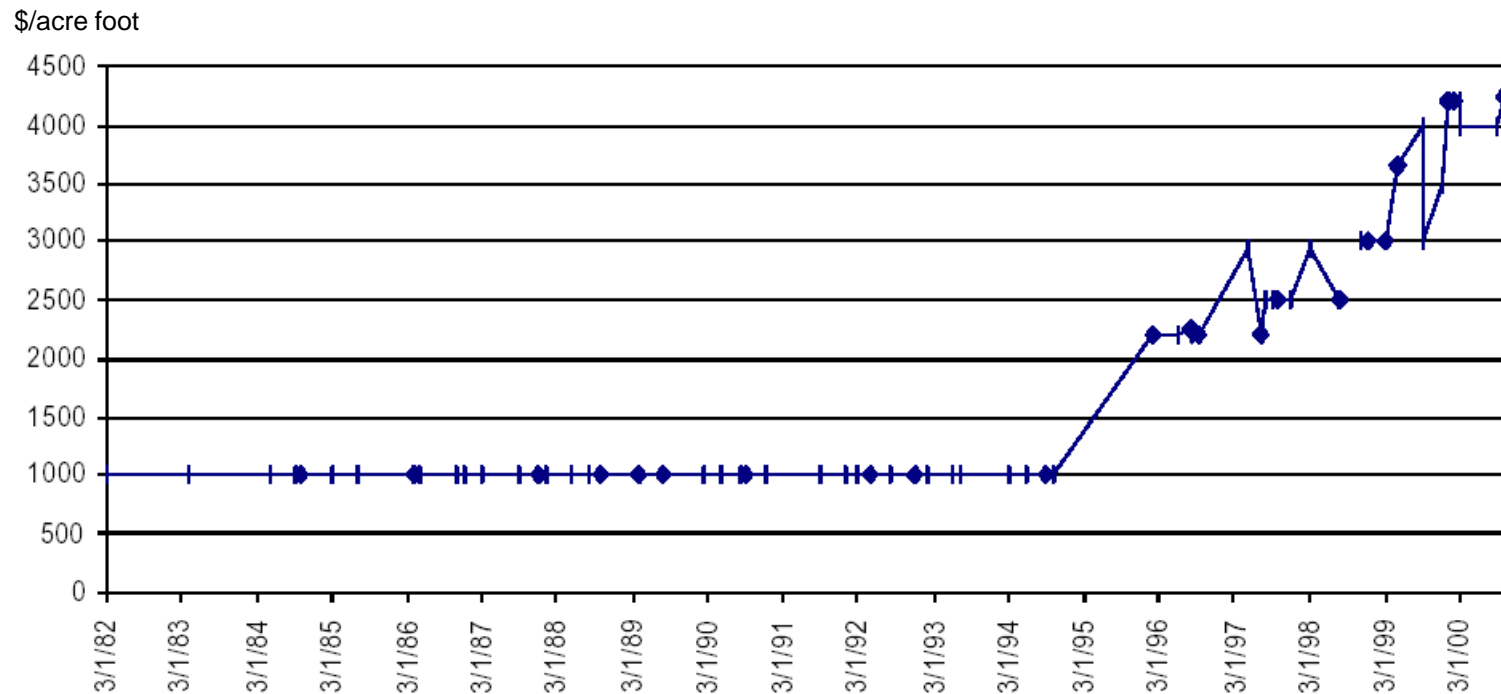


Water Prices Are Rising

Example: Rio Grande

Is WETEX™ Economically Viable?

Historical Price of Water Rights in the Middle Rio Grande, New Mexico



Source: University of New Mexico



Costs of Substitute Technologies Conservative Assumptions

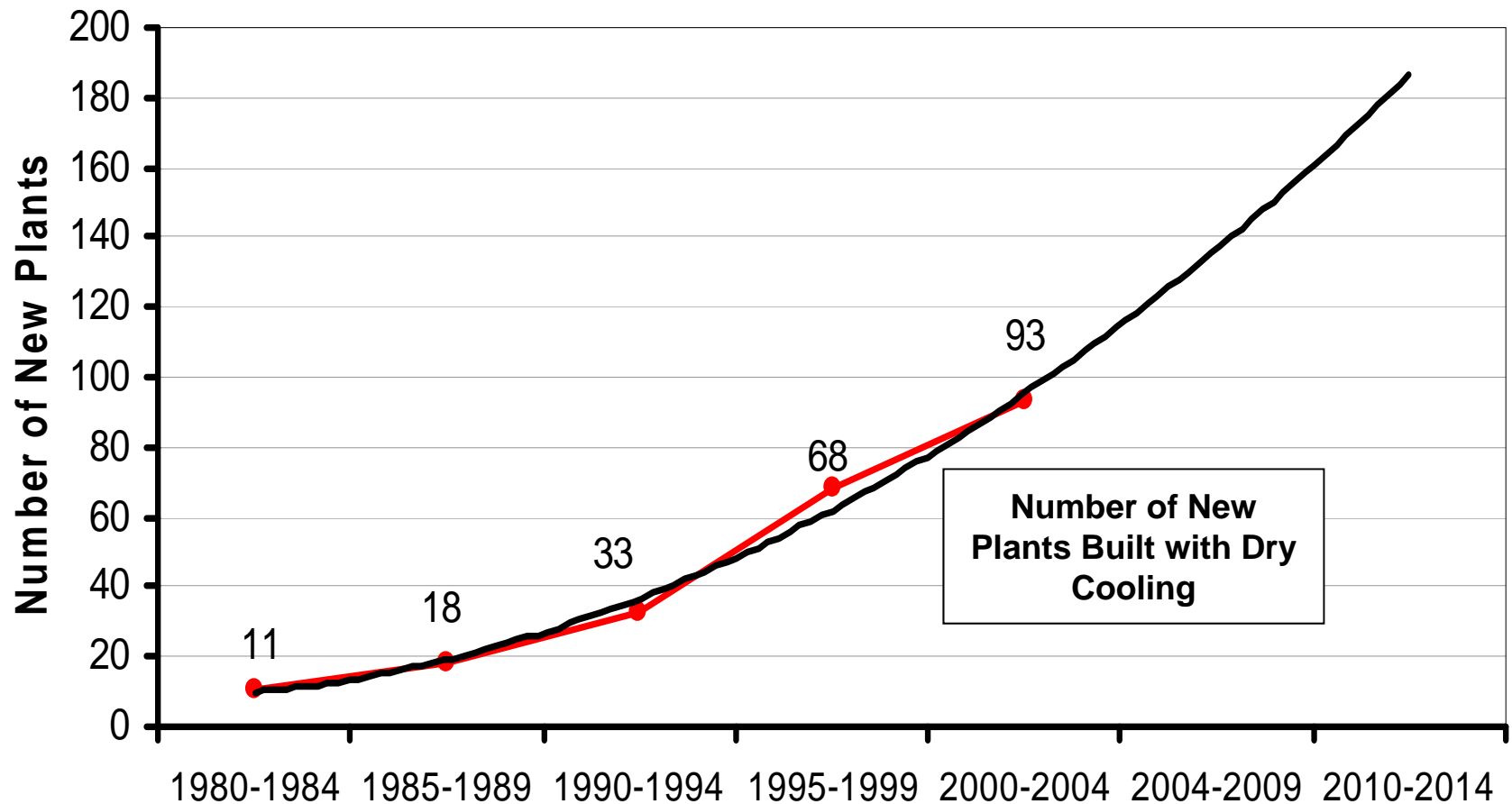
SYSTEM	Δ Capital Expense	Δ Water Cost	Total
Wet Cooling Tower	BASE	BASE	BASE
Dry Cooling Tower	\$26.6	-\$27	-\$0.4
Air-Cooled Condenser	\$14.3	-\$27	-\$12.7
WETEX with ACC	\$25.3	-\$46	-\$20.7

- In millions of dollars
- NPV using today's prices, 3.5% inflation, 10% discount
- 25-year plant life
- Wet cooling tower cost is \$4 million
- Wet cooling tower water cost NPV 25 years \$46 million
- Water cost \$0.003/gal for raw water, \$0.05/gal for demin. water
- WETEX enables \$18 million. Savings on demin. water

Using Rio Grande prices, the savings from WETEX with ACC would be **\$127 million.**

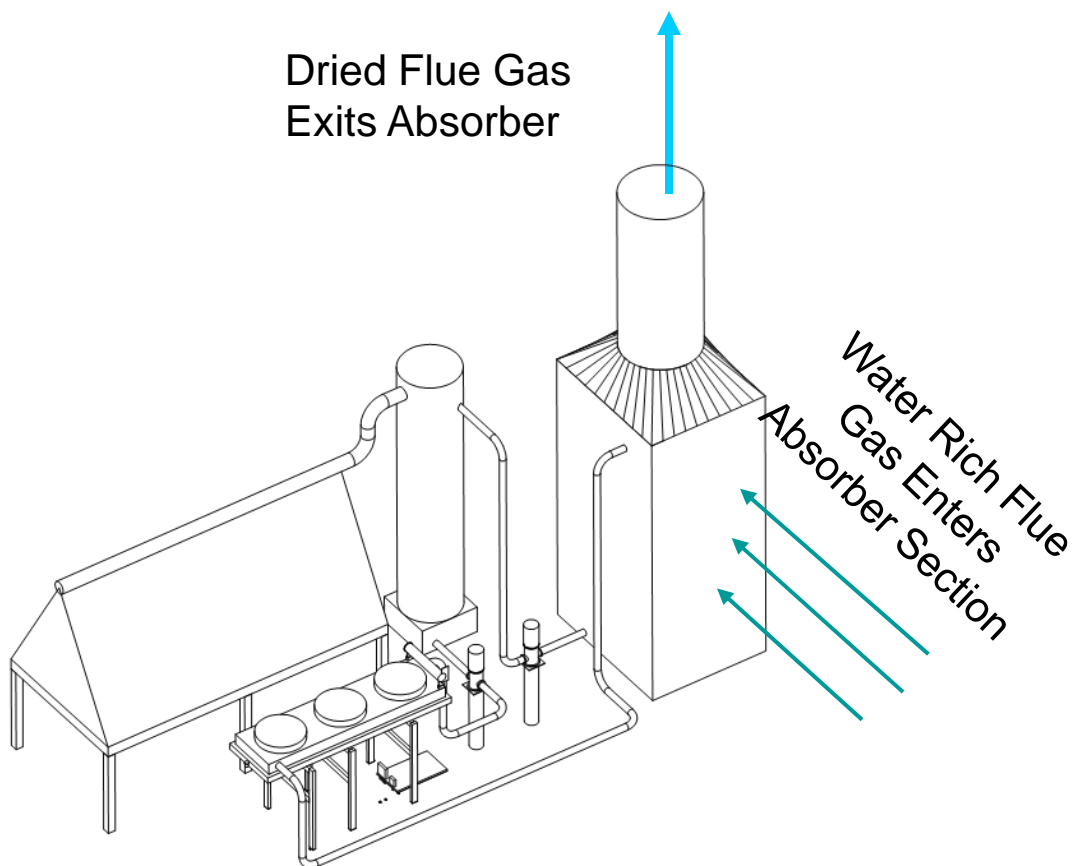
Commercial Market Vision

New Air-Cooled Power Plants Worldwide



Next Steps?

Subscale Demonstration at Power Plant





Conclusions

- 30% water recovery is achievable/50% is feasible.
- Potential for gas-, coal-, and syngas-fired plants.
- Equipment can be designed and operated to meet variable performance and cost targets.
- Water quality is exceptional, similar to R.O. outlet.



Thank You

***“Whiskey is for drinking,
water is for fighting”
-Mark Twain***



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