WATER ISSUE IN APEC
ENERGY OUTLOOK

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Earth – the “Blue Planet”, the “Water World”

If condensed to 1 L fresh water equal to only 1 teaspoon

Much water is wasted
Outline

- Water Role in Energy Extraction and Production
- Development Methodology to assess water issues in Energy E&P
- Some initial finding
Role of water in energy processes

Where is water used?

- Media of work (steam in a turbine, hydroelectricity)
- Cooling Media
- Cleaning Media
- Enhanced production: (steam flooding, water flooding)
Electricity generation

How much water is used?

Power Generation is one of the largest types of water withdrawal

Source: USGS and Env. Canada
Cooling in Refinery

Closed Circuit Cooling

65 – 90 gallons of water per barrel of crude oil

Distribution Water Use

Source: CH2M

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Cleaning Media

Coal Production

- Dust control consumes about 5.2 gallons per ton of coal produced
- magnesium chloride (0.003 gallons solution per ton of coal)
In some fields, the water-to-oil ratio can be as high as 10 or 20 to 1.

Source: Dilgren (82) and E2M
Methodology

Scope: Cooling System in Power Sector and Refinery

Criteria/framework for assessment:
- Scarcity (constrain index)
- Alternative/new technology and Cost
Future Water Scarcity
Historical Water Demand Calculated based actual generation by fuel type and applying the water use factor for the generating units at that plant for each fuel type (Water withdrawal = Actual Electricity Generated [A kWh] x water use factor [B per kWh])

Scenario: fuel mix, new technology or technology improvement, new regulation, etc.
Water Use and Pre-Treatment

Primarily used in cooling

Nuclear, coal and gas-fired power plants each have their own unique water treatment requirements for boiler make up water

- Deoxygenation
- Ion Exchange
- Softening
- Dealkalization
- Demineralization

\{ \begin{align*}
\text{Low pressure steam} \\
\text{Medium pressure steam} \\
\text{High pressure steam}
\end{align*} \}
Treatment of wastewater streams

- Main effluent waste streams from
  - Boiler blow-down
  - Cooling tower blow-down

- With increasingly stringent environmental standards significant capital expenditures
  - Heavy metal contamination - coal
  - Thermal limits on effluent discharge
1. Water withdrawal for power generation in APEC in 2020 is projected to reach 74 billion m³ (74.3 km³).

2. Of this 1.3% or 950 Million m³ is consumed.

3. About 15% or 142 Million m³ projected to be fresh water.

4. Some economies may be constrained in supplying water for power generation, but are yet to be identified.

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Water Use Projection

Australia

Vietnam

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Alternative Water Sources

Primarily for inland generation facilities
- Cooling water from municipal wastewater treatment plants
- Industrial wastewater streams
- Marginal water sources not applicable for other uses
  - Brackish water resources
  - Wastewater from coal mines

But all of these new sources incur increased costs
Alternative Cooling Systems

- **Dry Cooling - closed loop**
  - Reduced water needs but high capital and operational costs
  - Low thermal efficiency

- **Wet Cooling - closed loop**
  - Less capital intensive but requires more water

- **Hybrid Cooling - mix of Wet/ Dry**
  - High capital and operational costs but lower water requirements

- **Once Through Cooling**
  - Lowest capital and operational costs
  - Only cost effective where seawater used
Emerging Technologies

Clean Coal Technologies
- Fairly water intensive
  - Cleaning of coal
  - Water based fuels (depends on technology)
  - Effluent discharge problems

Hydrogen (?)

Biofuels – possible water conflict
Implications

- Difficulties in siting new power plants
- Possible refinement of government policy required
- Increased cost (increased use of lower quality water sources, saline water...)
- Increased risk of conflict (between users/ economic sectors, or economies)
- Need some methodology through which to deal with these issues
Concluding statement

Screening study of the water budget for the US conducted in 2002...

- “the cost of insufficient water over the next 50 years can be huge,” and that “…water availability can severely constrain electricity growth”