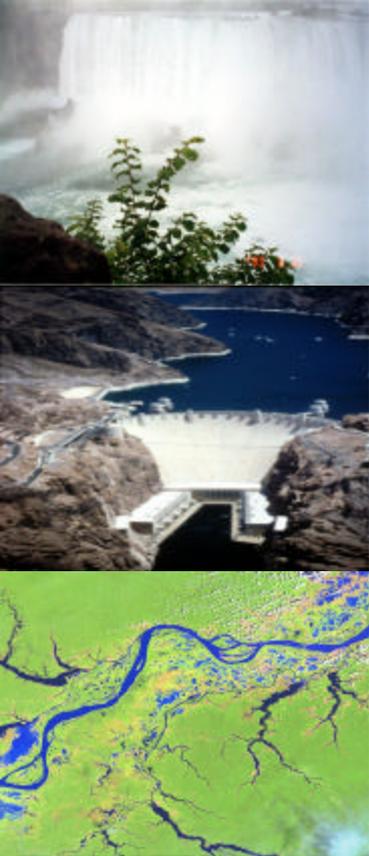


WATER ISSUE IN APEC ENERGY OUTLOOK

James Eastcott

**APEREC Planning Workshop at EWG-30
22nd August 2005, Ulsan Korea**

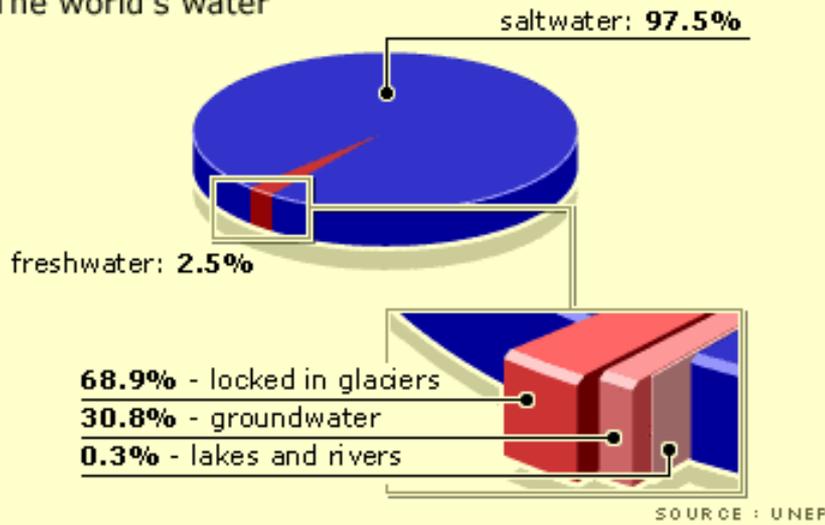


Introduction



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

The world's water



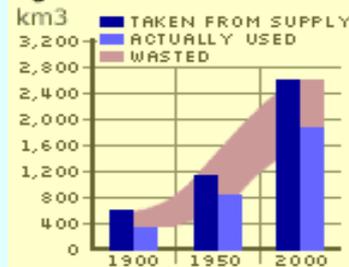
If condensed to 1 L fresh water equal to only 1 teaspoon

Much water is wasted

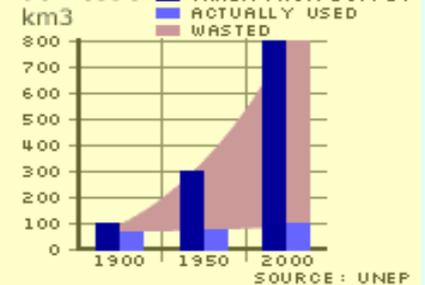
Global water use



Global use and waste – agriculture



Global use and waste – domestic



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)

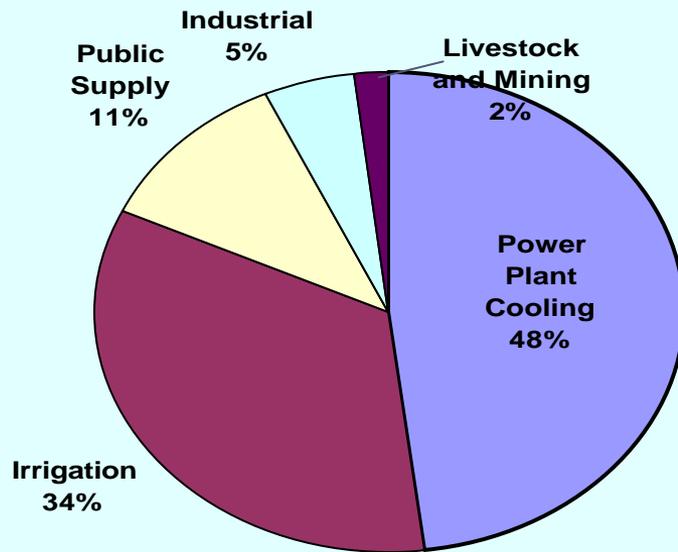


Electricity generation

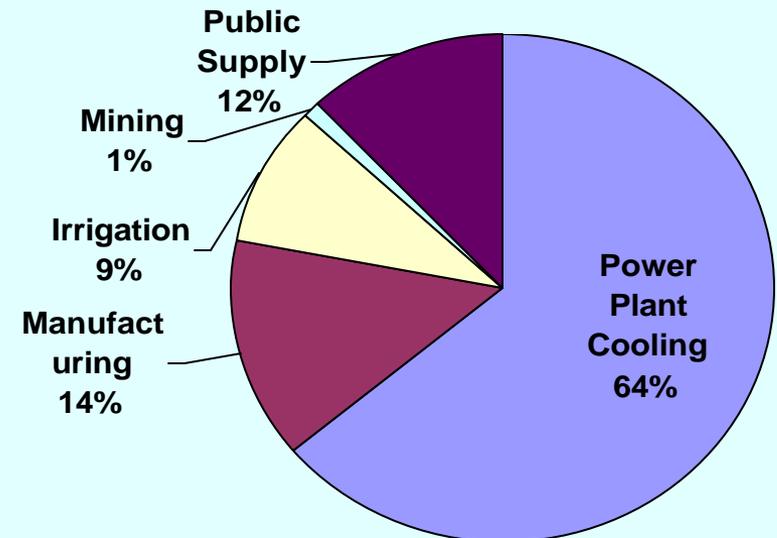


How much water is used?

Power Generation is one of the largest types of water withdrawal



USA



CANADA

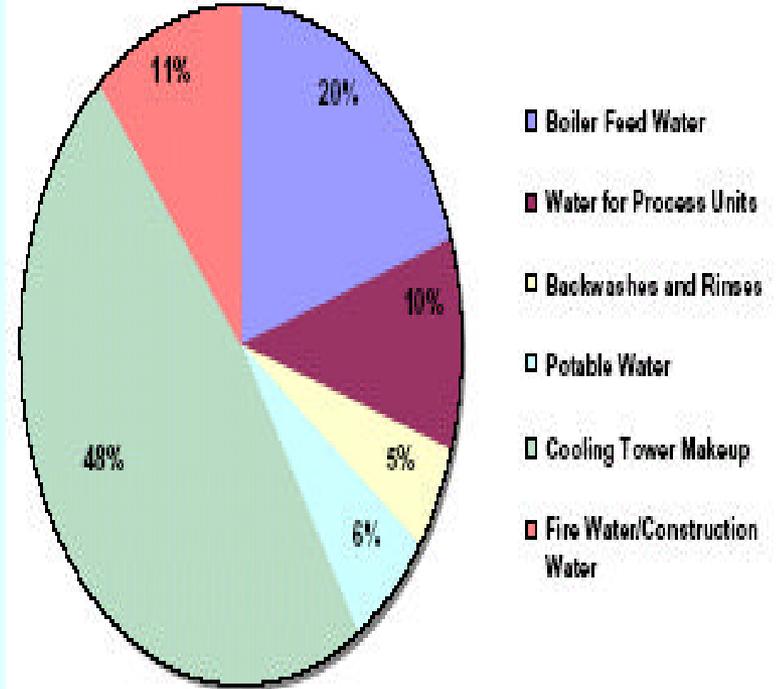
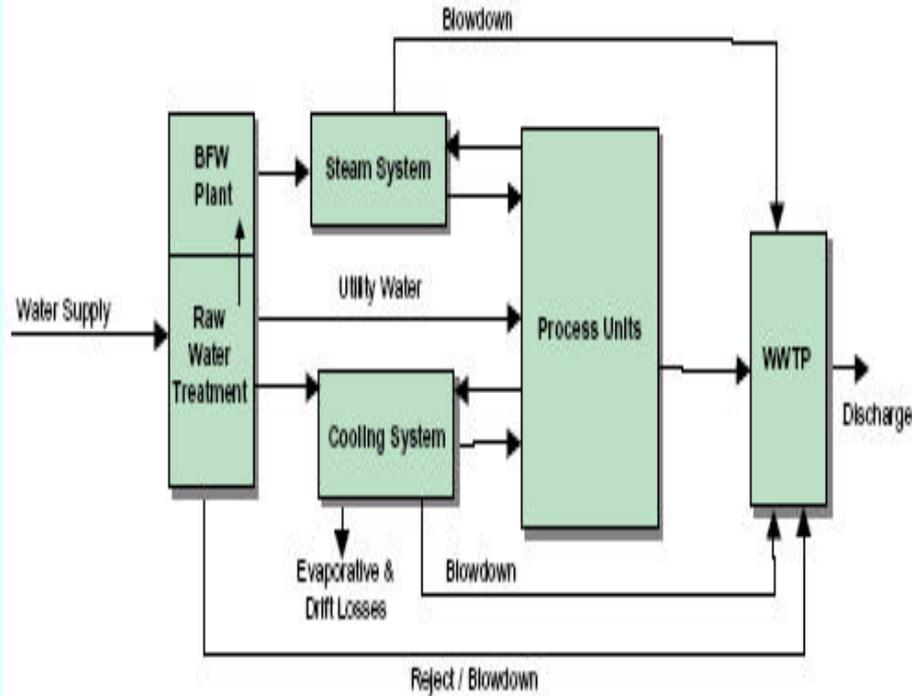


Asia Pacific Energy Research Centre
(APERC)

Asia-Pacific
Economic Cooperation

Source: USGS and Env. Canada

Cooling in Refinery



Closed Circuit Cooling

65 – 90 gallons of water per barrel of crude oil

Distribution Water Use



Cleaning Media

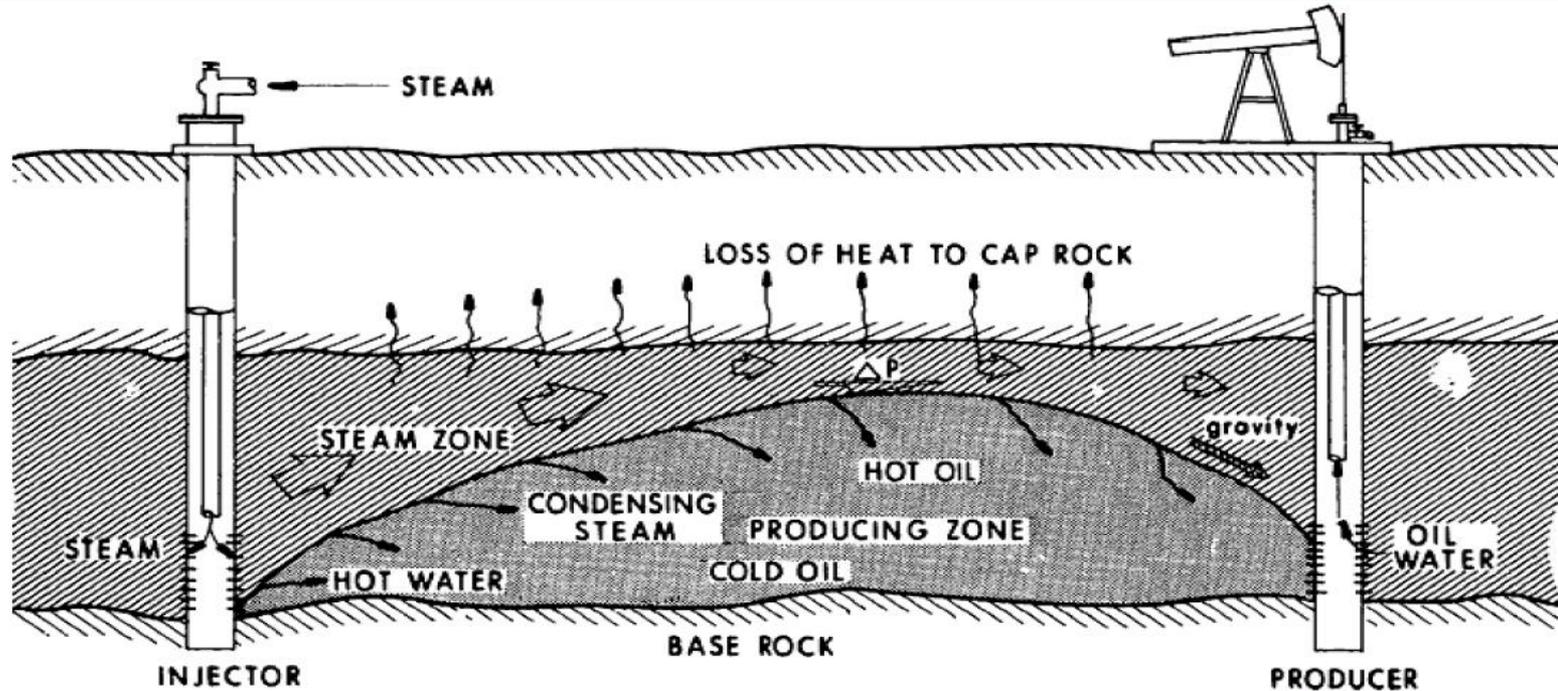


Coal Production

- Dust control consumes about 5.2 gallons per ton of coal produced
- magnesium chloride (0.003 gallons solution per ton of coal)



Enhanced Recovery



In some fields, the water-to-oil ratio can be as high as 10 or 20 to 1



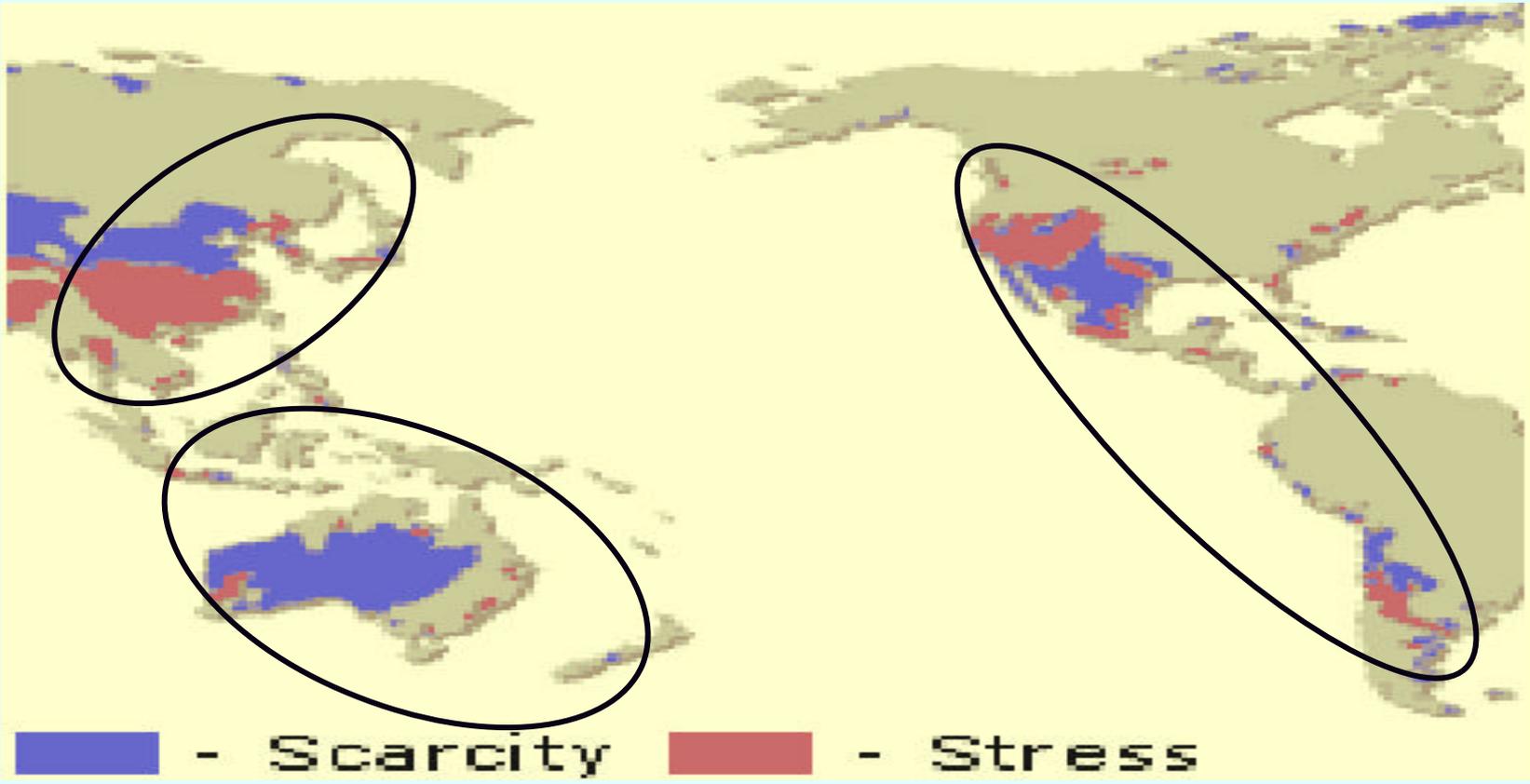
Methodology



- **Scope: Cooling System in Power Sector and Refinery**
- **Criteria/framework for assessment:**
 - Scarcity (constrain index)
 - Alternative/new technology and Cost



Future Water Scarcity



Calculation and Projection



- 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



Low pressure steam



Medium pressure steam

High pressure steam



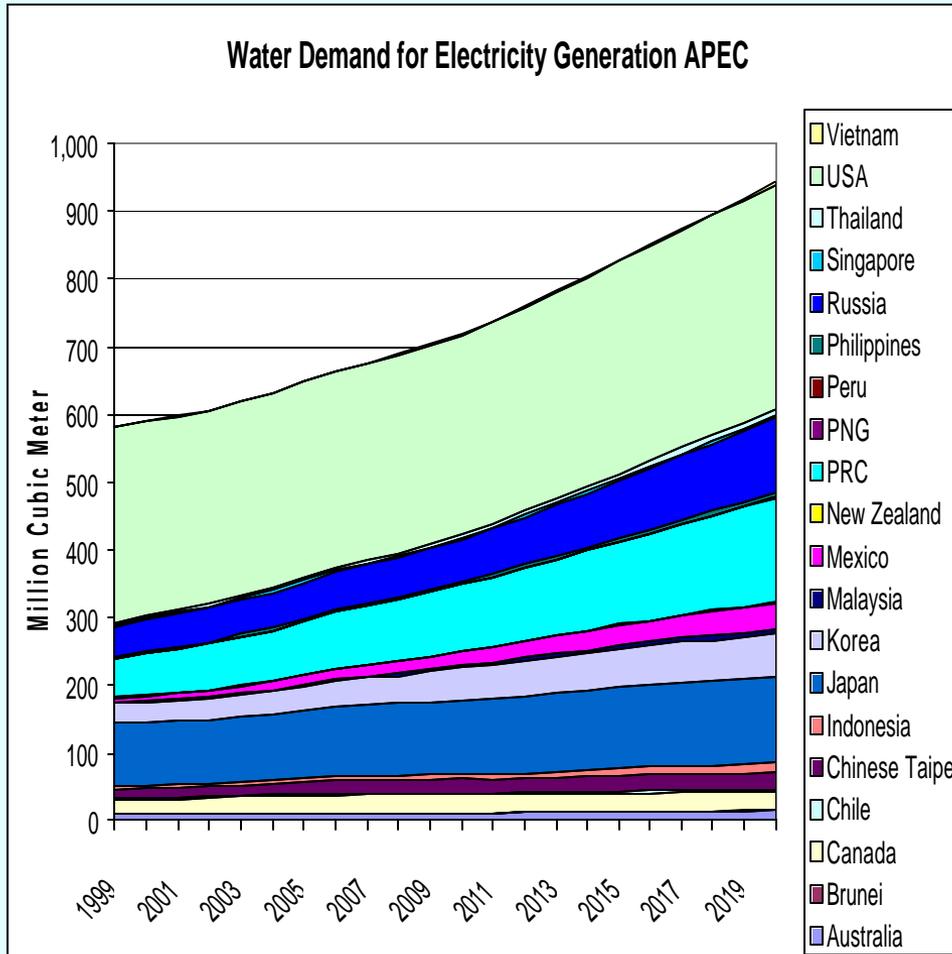
Treatment of wastewater streams



- ☞ 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



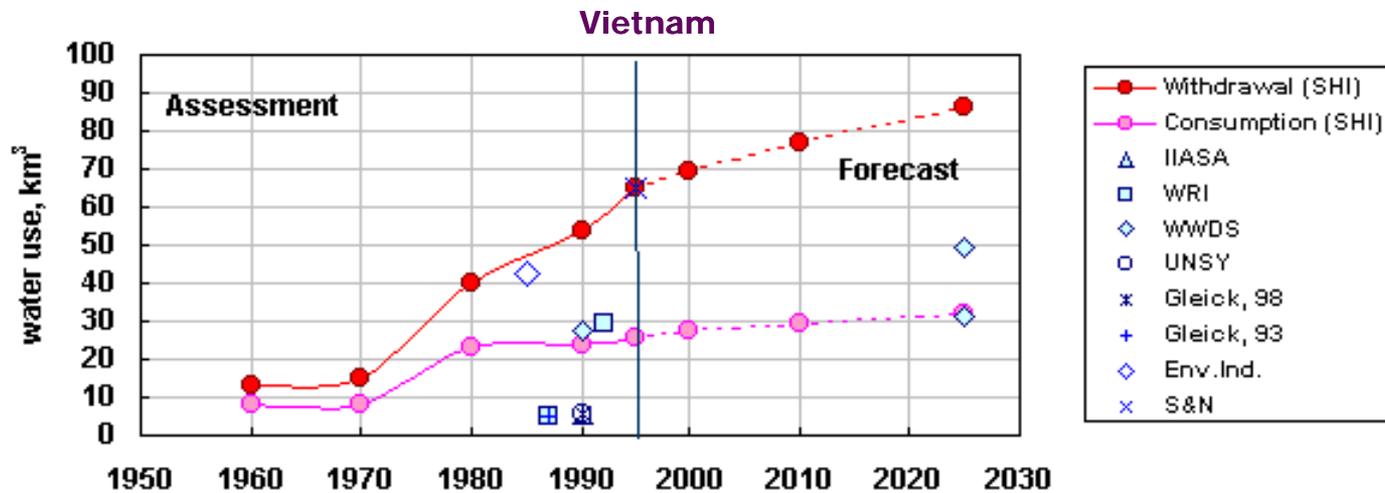
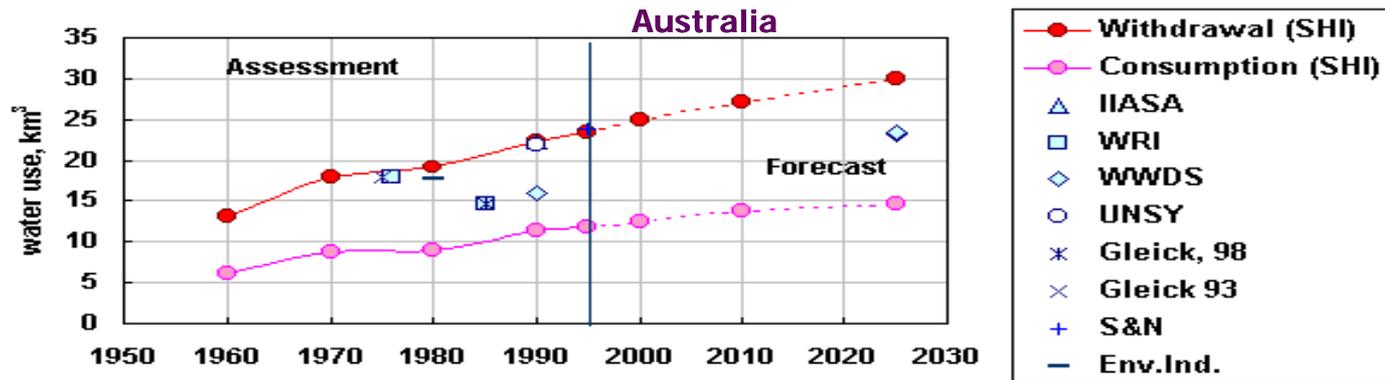
Water Consumption



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



Water Use Projection



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 intense 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”

