This is a set of slides from a presentation given at

**Water & Energy In Maryland**

2010 Water Resources Symposium
hosted by the Maryland Water Resources Research Center
at the University of Maryland, College Park
on Thursday, Oct. 28, 2010

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Water and Electricity

Peter Dunbar
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### Terms, combinations, and permutations

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A multiuse site
Once through Gas/oil Closed Cycle

Simple Cycle (with combined cycle option)

Base Load

Peaking

Steam Cycle

Closed Cycle

Discharge canal

Once through

coal

Chalk Point – My favorite
It has everything
Combustion Technologies

Simple Cycle

- Low Capital costs
- Less Efficiency (High fuel costs per MW-hr)
- Peaking operation
- Low water consumption

Combined Cycle

- Higher Capital costs
- Better efficiency (lower fuel costs per MW-hr)
- Intermediate to base load operation
- Steam cycle implies high water consumption
Steam Cycle Power Plant
The Rankine Steam Cycle

\( Q \text{ dot} \) -- Heat flow rate to or from the system (energy per unit time)

\( W \text{ dot} \) -- mechanical power consumed by or provided to the system (energy per unit time)

This is the heat energy that needs to be removed from the cycle
Steam Cycle Cooling

Wet Cooling

Once through Systems
>400 Mgd

Closed Cycle Systems
Below 10 Mgd

Dry Cooling
Once Through Cooling – Quantity
Touching vs Consuming

Flow Through (MGD)

Evaporative Loss (MGD)
Once Through Cooling - Impacts
ΔT -- Dickerson Station D

Cooling flow
400 mgd (Potomac R) consumptive 1.5 mgd
ΔT 5 to 10 degrees

546 MW coal fired Steam unit

Discharge Canal

Diagram ofDickerson Station D's cooling flow system.
$\Delta T$ – Calvert Cliffs NS

**Cooling flow**
- 3,360 mgd
- $\Delta T$ 12 degrees F
- Consumptive 18 mgd

**River flows (mgd)**
- Susquehanna: 26,000
- Potomac: 7,500
- CCNS: 3,360
- Patuxent: 240
- City of Baltimore: 250

*Temperature Plumes*
Closed Cycle Cooling

Mechanical Draft Cooling Towers

- Mechanically operated fans to circulate air
- Low construction cost, higher operating cost

Natural Draft Cooling Towers

- Natural air circulation
- High construction cost, lower operating cost
Approaches to Cooling WaterAugmentation/Minimiziation

- River Augmentation
  - Reservoirs
  - OnSite Storage
  - Shut down Steam Cycle

- Unique Sources
  - Mine pools
  - Conjunctive use of resource (eg Waste Water)

- Conservation/infrastructure improvements

- Dry Cooling
  - Hybrid systems
Calvert Cliffs Unit 3

If constructed, CCU3 would be one of the largest single unit nuclear plants in the world.
Total intake 63 mgd

Desalination intake 4.4 mgd
Dry Cooling

Drawbacks

- Footprint
- Efficiency
- Noise

- $$$$
Dry Cooled Combined Cycle Plant

Linden Cogeneration Plant
Cogen Technologies, Inc.

285 MW
Combined Cycle
Mixed Wet/Dry Cooling
(Kelson’s Ridge)
Use of Water to Control Emissions
Brandon Shores SO2 Scrubber

- Average daily use of 1-2 mgd

- Options:
  - Ground Water
  - Treated Effluent
  - River/Bay
  - Reuse of internal wastewater
Hydroelectric
Generate electricity directly from water

A new set of terms

Run of river
Pumped storage
Peaking
Spinning reserve

Kaplan turbines
Bulb turbines
Aeration
Head

Water quality
Water quantity
Minimum flows
Fish passage

Recreation
Upstream and downstream
Flood storage
Impoundment levels
Susquehanna River Hydroelectric

Hydroelectric Dams on the Susquehanna river:

- Conowingo (MD)
- Holtwood (PA)
- Safe Harbor (PA)
- York Haven (PA)

Federal Licensing (FERC), negotiated settlements:

- Fish Passage facilities
- Operational Protocol to protect water quality
- Continuous minimum flows
Do fish need water?

20,000 cfs

5,000 cfs

0 cfs
Hurricane Agnus - 1972

730,000 mgd
(1,130,000 cfs)
Balancing the issues

The River
- Trout Fishery
- Water Quality
- Recreation (white water)

The Lake
- Flood control
- Lake Level
- Recreation (boating)

The Hydroelectric Facility
- Revenue
- Minimum Flows

Determine an optimum Operating Protocol for the Hydroelectric Facility
For more information....

http://www.dnr.state.md.us/bay/pprp

PPRP was established under the Power Plant Siting and Research Act of 1971. This enlightened legislation provided a model for addressing power plant licensing issues which several other states have adopted.

The enabling legislation established an Environmental Trust Fund to support the Power Plant Research Program. Funding is provided through an environmental surcharge that is assessed on all electricity used in the State. The surcharge adds between 10¢ and 20¢ per month to the average residential customer's electric bill.

The Power Plant Research Program (PPRP) functions to ensure that Maryland meets its electricity demands at reasonable costs while protecting the State's valuable natural resources. It provides a continuing program for evaluating electric generation issues and recommending responsible, long-term solutions.

The Maryland Department of Natural Resources (DNR) seeks to preserve, protect and enhance the living resources of the State. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how DNR strives to reach that goal through its many diverse programs.