Hydropower Impact Analyses
for Water Supply Reallocation Studies

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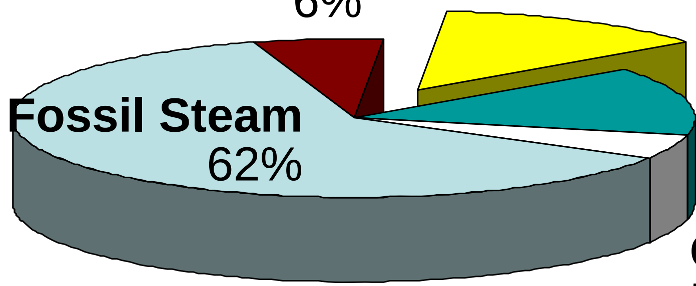
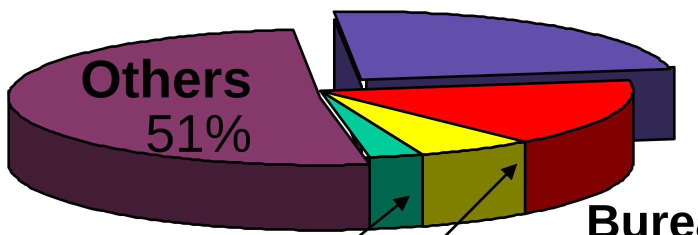
Water Supply Workshop
2 June 2009
Tulsa, OK

Electrical Power USACE Capacity



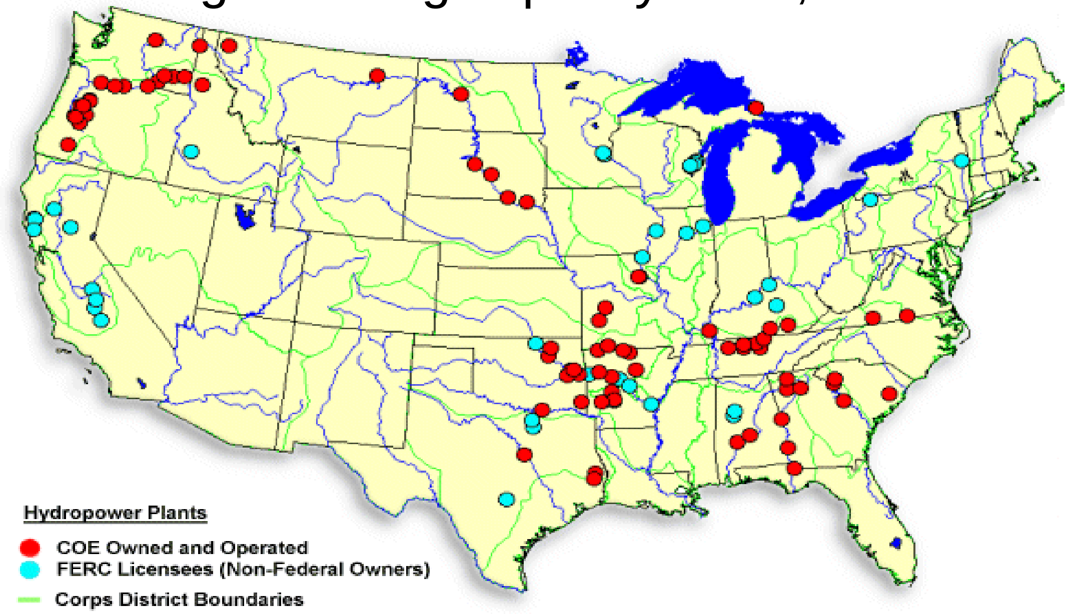
The USACE has an $18 billion investment in hydropower facilities. Approaching $1 billion in annual revenue. Big Business!!

USACE 24% **(21,000 MW)**

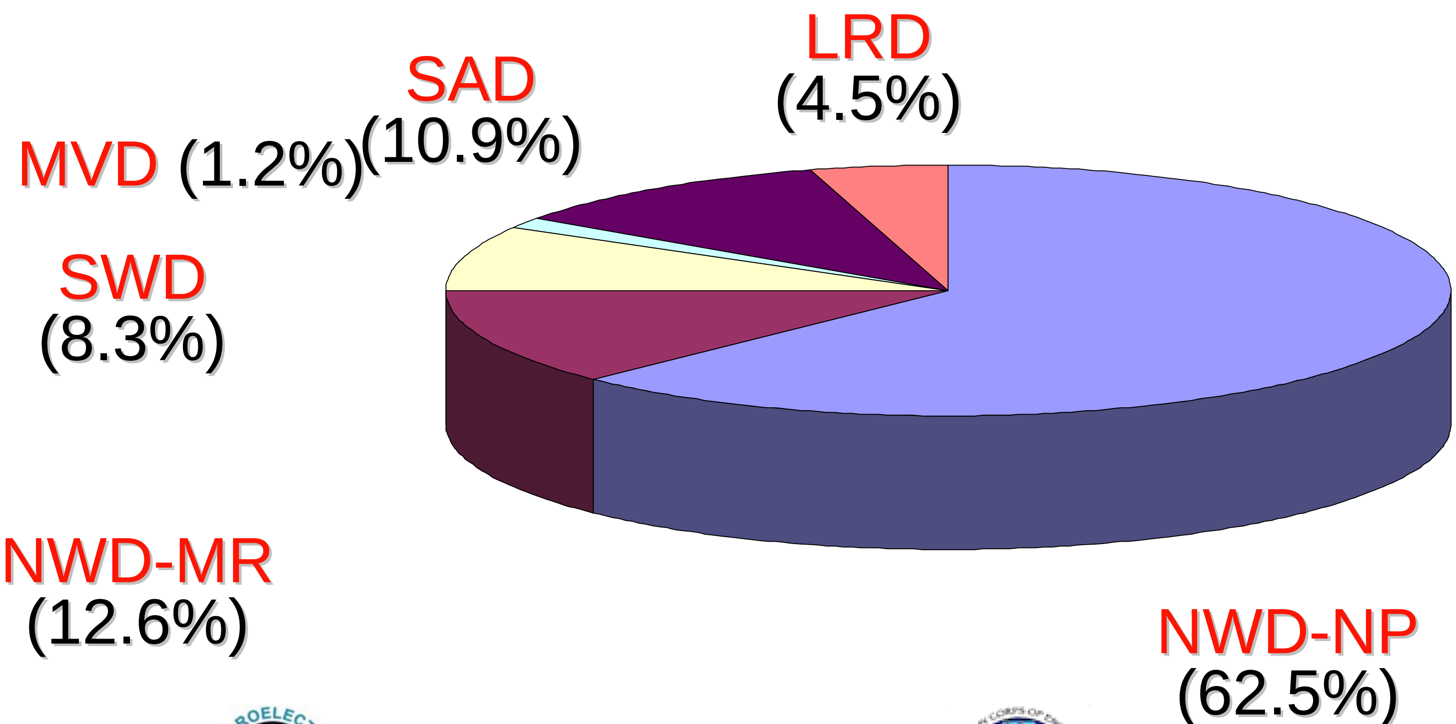


USACE Hydropower Capability

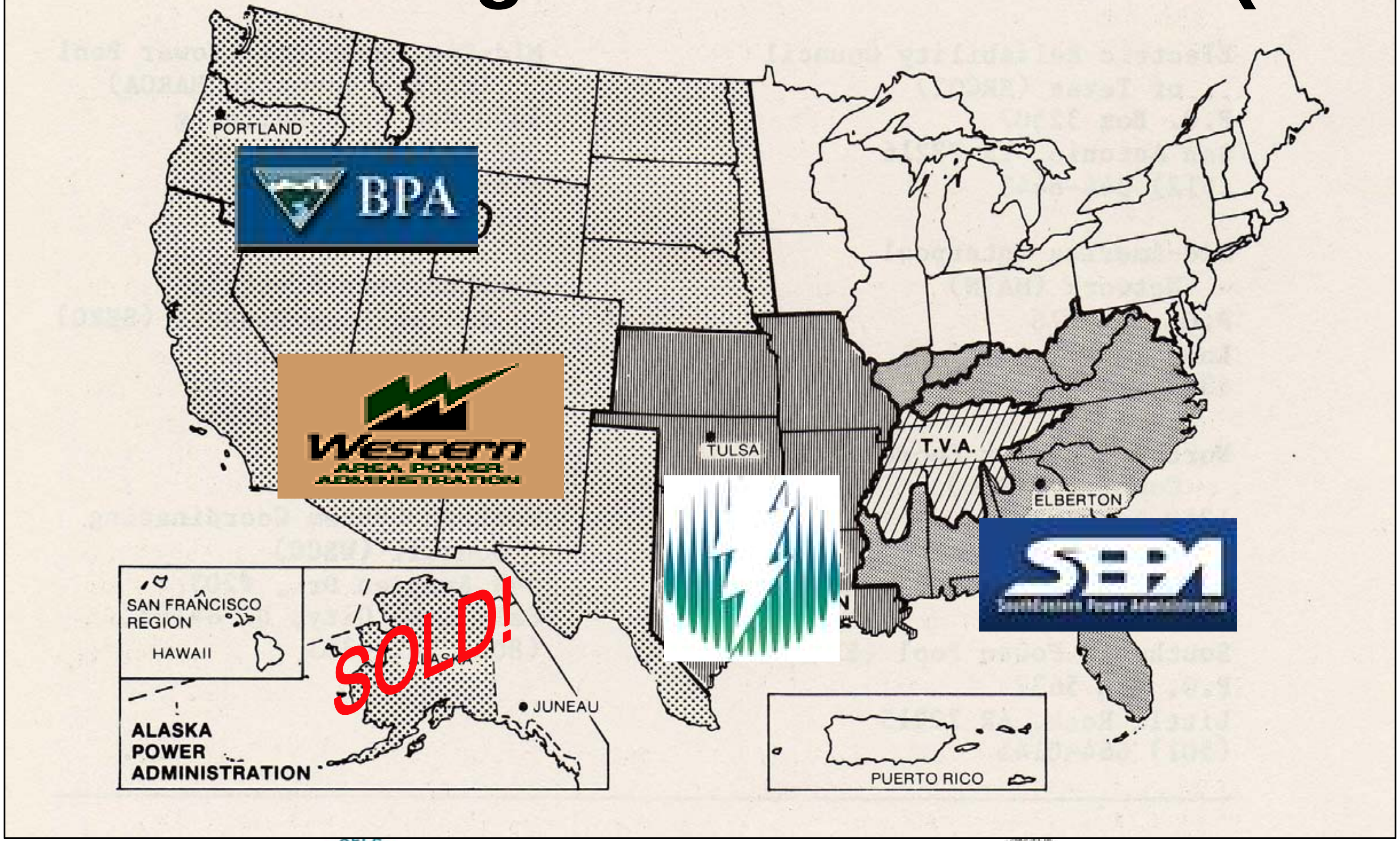
- 75 major hydropower plants in 16 Districts
- 376 generating units
- Generators ranging from <1 MW to 220 MW
- Total generating capacity of 21,060 MW



Hydropower Capacity Distribution by MSC



Power Marketing Administrations (PMA's)



HYDROPOWER ANALYSIS CENTER

CENTER OF EXPERTISE (MCX)

Hydropower System Analysis
ER 1110-1-8158

HDC Support

- Major Rehab
- Rewind

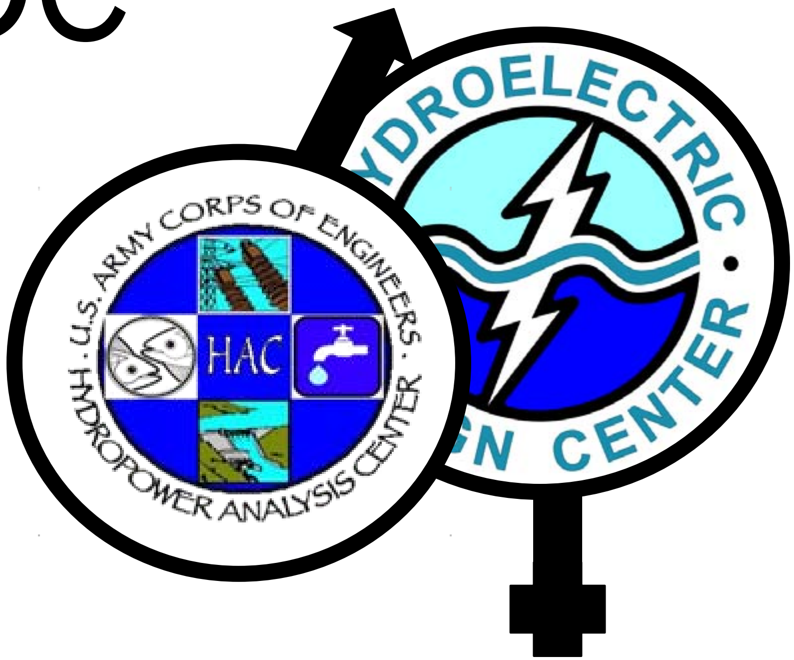
Work for Others

- Power Values
- Cost Allocation/ Reallocation
- River System Studies
- Miscellaneous Studies

Special Activities

- Procedures for Evaluating Hydro Power Benefits
- Hydro Power Manual

H-AC/DC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HAC
HYDROPOWER ANALYSIS CENTER

Areas of Expertise

- Hydropower Planning
- Energy Studies
- Capacity Studies
- Economic Analysis
- Special Studies
- Turbine Performance Selection
- Pacific Northwest Issues
  - Regional Planning Activities
  - ESA Studies

HYDROPOWER ANALYSIS CENTER

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- MCX is responsible for USACE hydropower analyses
- ER 1110-1-8158 mandates use of MCX services
- MSCs monitor and certify use of MCX
- MCX maintains expertise

Hydropower Planning Policy and Guidance

- ER 1105-2-100
  - Economic & Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)
- EM 1110-2-1701
  - Hydropower Manual
- FERC's Hydroelectric Power Evaluation
- Evaluating Hydropower Benefits
  - US Water Resources Council Water and Energy Task Force

Marketing of Federal Hydropower

- Federal Power Customers
  - "Preference Customers" through Federal Power Marketing Administrations
  - Preference Customers can include Municipalities, Cooperatives, Public Utility Districts, Federal agencies, Irrigation Districts, Native American Tribes
  - In addition, some power is marketed to Investor Owned Utilities and Direct Service Industries
- Cost of Federal Hydropower
  - Sale to Power Customers generally "At Cost" Sale to Power Customers generally "At Cost"
  - Cost includes repayment of power related capital costs (generation and transmission) including interest, annual O&M Costs, purchase power and wheeling costs

Evaluation of NED Hydropower Benefits

"Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units."

P&G, p. 1, 1 March 1983

The Role of HAC: Benefits and Economics

- HAC Role:
  - Analysis of hydrologic, hydraulic, and outage data
  - Determination of hydropower energy and capacity
  - Development of hydropower benefits
- Benefits:
  - Hydropower benefits produced by HAC represent maximum potential benefits assuming no outages, and are used as input into risk analysis models
- Economics:
  - Economics are based on benefits, costs, and probability of outage, and are determined with risk analysis models

Power Value Determination

- Energy Value
  - System Production Cost model
    - $AURORA_{XMP}$
    - Contract with **platts'** ***M2M Power***
      - SPECIAL STUDIES
- Capacity Value
  - FERC Spreadsheet Model
    - HAC maintains price indexes
    - Indexes maintained
      - Handy/Whitman's electric utilities cost indexes
      - ENR skilled labor
      - EIA fuel costs
      - GDP deflator

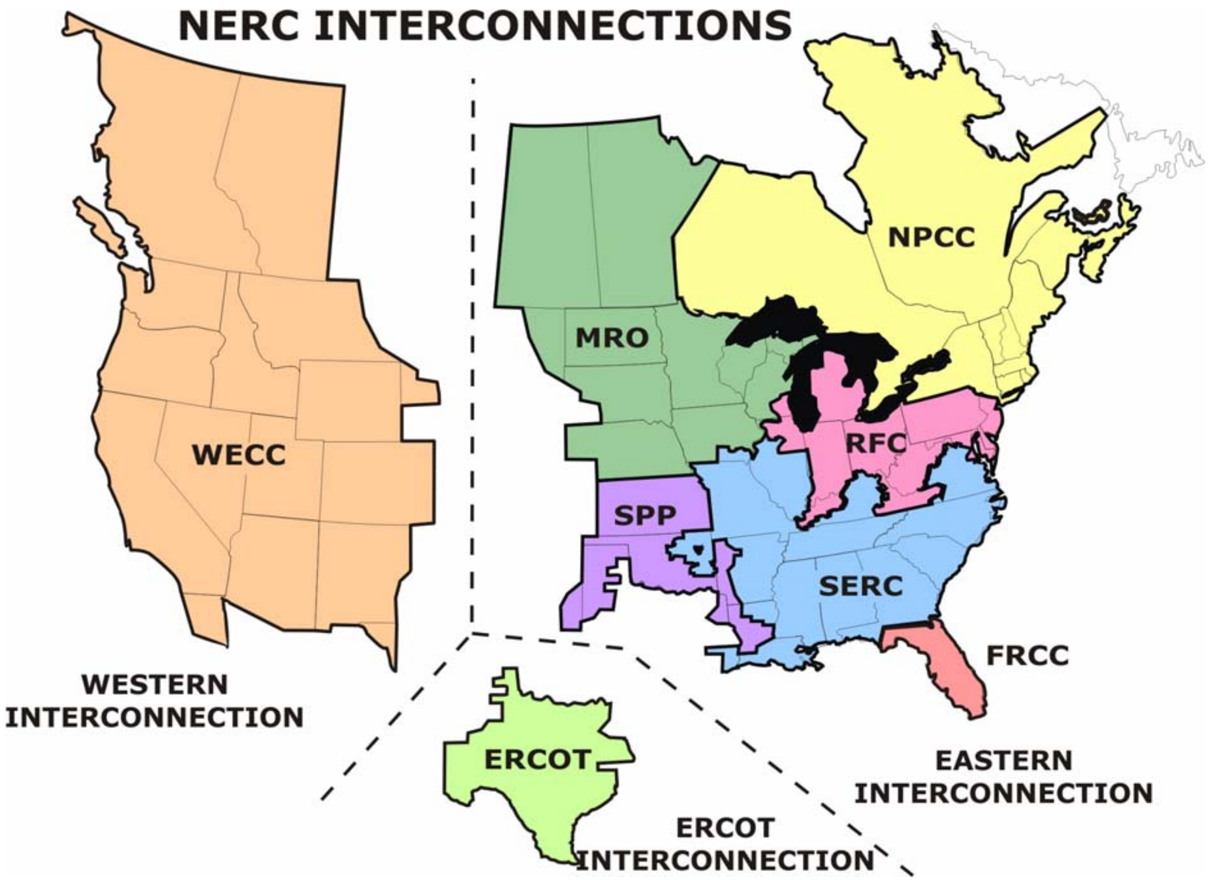
In Some ways the Value of Power is like Real Estate –

Location –

Location –

Location !

North American Reliability Council



Power Value: Energy

- Energy value represents cost of fuel and variable O&M for the displaced mix of thermal plants' generation.
- Energy value is developed by HAC using proprietary electric power price forecasts developed by a third party vendor – **platts**
  - Platts develops monthly 20-year forecasts for both Peak and Off-Peak energy, as well as capacity values for all NERC Regions
  - **platts** uses a system production cost (SPC) model called AURORA
    - simulates power system operation, dispatching generation projects into the regional load
    - meets the load in the most efficient and economic manner possible within constraints
- Energy value, in economical terms, is the marginal value

Power Value: Capacity

- Capacity value is developed by HAC using procedures developed by the Federal Energy Regulatory Commission (FERC)
  - Capital, fixed O&M, and fuel inventory are determined for alternative thermal plant types
  - Typical generation-duration curve is developed to determine the hydropower plant's role in the power system
  - A least costly, most likely combination of thermal plant types is determined
- Capacity value represents the least costly, most likely combination of thermal plant types displaced by the hydropower plant
- Energy value, in economical terms, is the marginal value

Determining Hydropower Production

- Energy and capacity data usually developed from sequential streamflow routing (SSR) models such as ResSim*(HEC-5)*, SUPER, and HYSSR
- $Power_{kW} = Q*h*e/11.81$
  - Q =>flow
  - H =>head
  - e =>efficiency
- Availability is the amount of time the generating units are available to produce power
- Power demand determines when and for how long the generating units are operated

Determining Hydropower Production

- Dependable capacity measures the amount of capacity a hydropower plant can carry with some degree of reliability
- Average Availability Method defines the average capacity that can be supported in the power system load during the peak demand period of the year
- This dependable capacity represents the amount of thermal capacity that would be equivalent to the hydropower plant, given the limitations imposed on the hydropower plant by streamflow and reservoir elevation that varies both on a daily, seasonal, and year-to-year basis

Other Possible Power System Benefits
Ancillary Services

- Reactive Supply from Generators
- Regulation and Frequency Response
- Operating Reserves Spinning
- Operating Reserves, Supplemental Reserves
- Black Start Capability

Power Benefits SUMMARY

- Replacement cost of alternative power
- Energy benefits = energy value x gain in annual energy
- Capacity benefits = capacity value x gain in equivalent capacity
- Potential power benefits = energy benefits + capacity benefits
- Project life-cycle economics are determined in a risk analysis model
  - based on power benefits, cost, and probability of outages

Questions ?

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