

# RECLAMATION

*Managing Water in the West*

## Hydropower Knowledge Assessment



U.S. Department of the Interior  
Bureau of Reclamation

hydro\_know\_assess.ppt  
05/19/2005

# Electricity Units

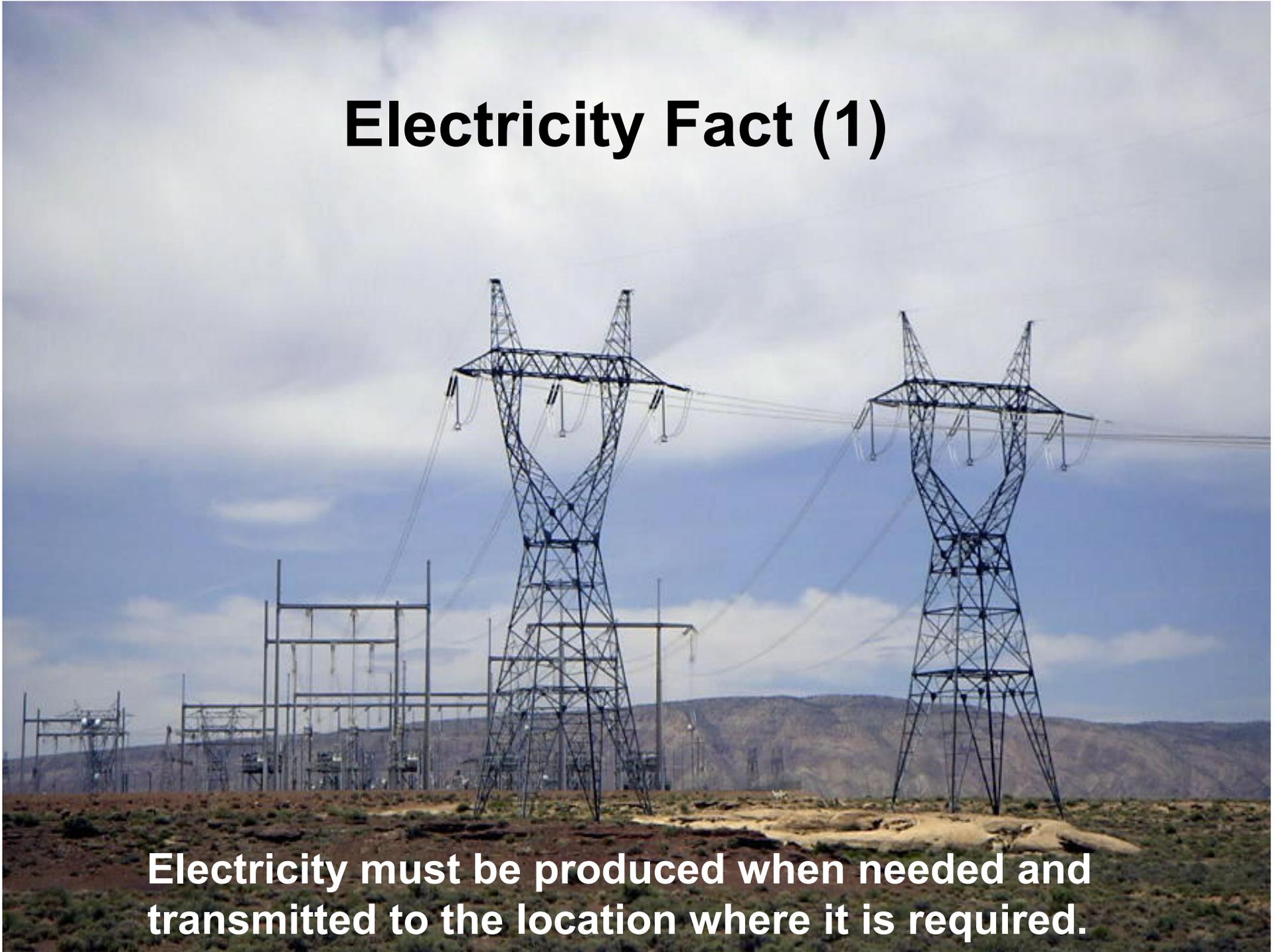
- 1 watt (W) = fundamental unit of measure
- 1 kilowatt (Kw) = 1000 watts
- 1 megawatt (Mw) = 1000 kilowatts
  
- 1 kilowatt-hour (Kwhr) = 1 Kw for 1 hour
- 1 megawatt-hour (Mwhr) = 1 Mw for 1 hour

# A Few Definitions

- **Load**- the demand for electricity at a specific time
- **Energy** - the ability to do work. Generally measured in Mwhrs.
- **Capacity**- the maximum power output level for which a generator is designed. Typically measured in Mw. Sometimes used to refer to the maximum demand or load
- **Ramprate**- the change in release over a one hour period. Often measured in cubic feet per second (cfs)

# Electricity Fact (1)

**Electricity must be produced when needed and transmitted to the location where it is required.**

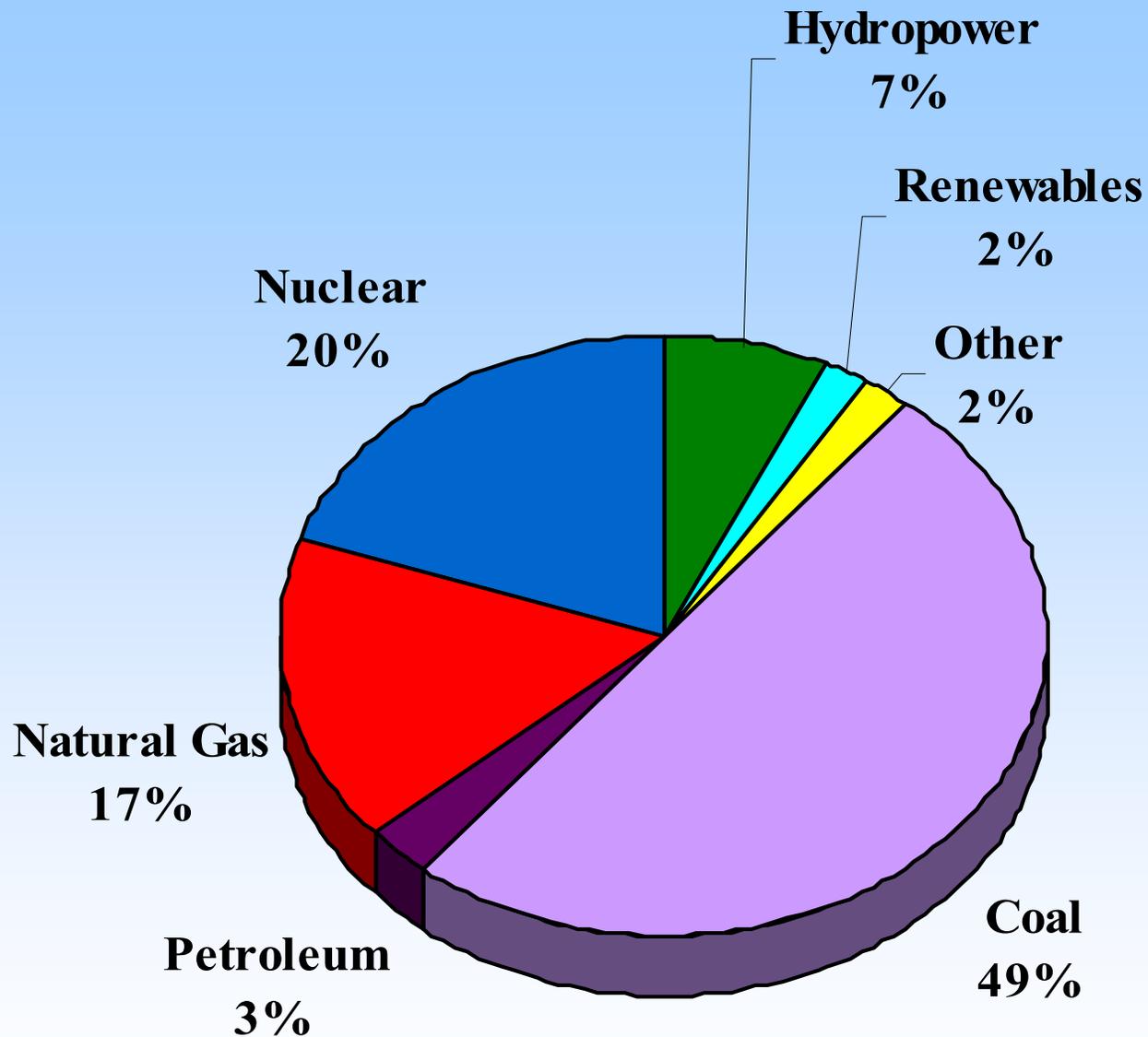


## Electricity Fact (2)

- When you turn on a switch- somewhere in the interconnected electricity system, a generator must increase its output.
- When you turn off a switch- somewhere in the interconnected electricity system, a generator must decrease its output.



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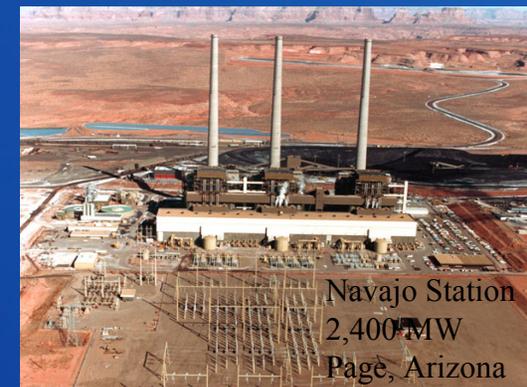


**U.S. Generation by Fuel Source 2003**

# Some Thermal Generation Resources



- Coal
- Natural gas CCCT
- Oil-fired steam
- Nuclear



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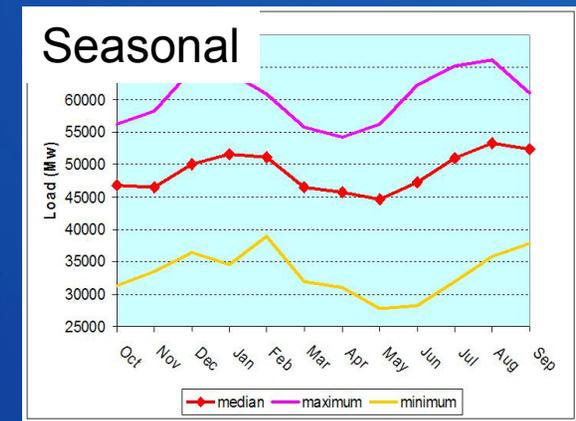
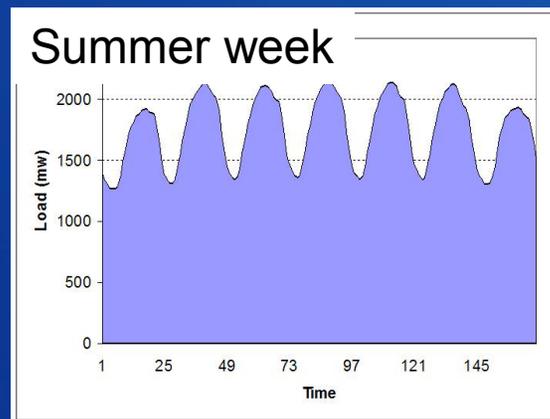
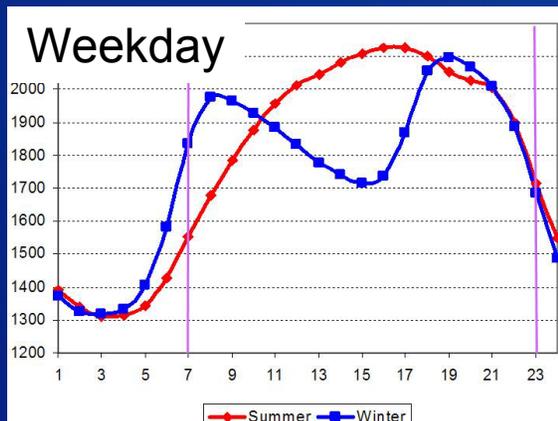
**WESTERN ELECTRICITY COORDINATING COUNCIL  
MAP OF PRINCIPAL TRANSMISSION LINES  
JANUARY 1, 2004**

**LEGEND**

- 1 500 KV
- 2 345 KV - 500 KV
- 3 230 KV - 345 KV
- 4 115 KV - 230 KV
- 5 60 KV - 115 KV
- 6 30 KV - 60 KV
- 7 15 KV - 30 KV
- 8 7.5 KV - 15 KV
- 9 3.75 KV - 7.5 KV
- 10 1.875 KV - 3.75 KV
- 11 0.9375 KV - 1.875 KV
- 12 0.46875 KV - 0.9375 KV
- 13 0.234375 KV - 0.46875 KV
- 14 0.1171875 KV - 0.234375 KV
- 15 0.05859375 KV - 0.1171875 KV
- 16 0.029296875 KV - 0.05859375 KV
- 17 0.0146484375 KV - 0.029296875 KV
- 18 0.00732421875 KV - 0.0146484375 KV
- 19 0.003662109375 KV - 0.00732421875 KV
- 20 0.0018310546875 KV - 0.003662109375 KV
- 21 0.00091552734375 KV - 0.0018310546875 KV
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# Demand for Electricity

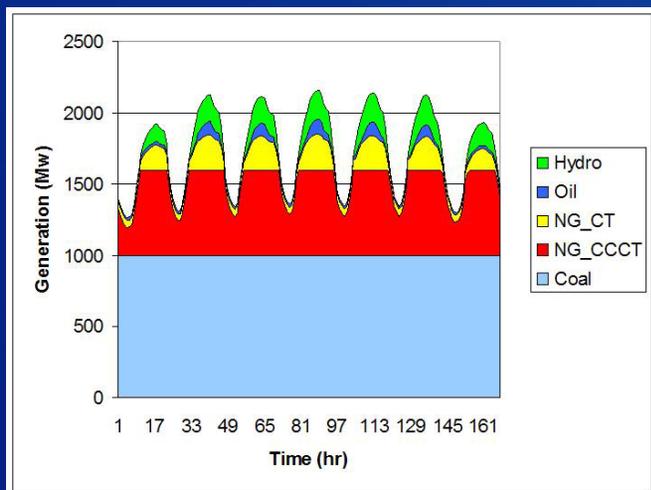
- Varies instant by instant
- Has characteristic daily, weekly and seasonal patterns



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# Load and Production Cost

- It costs more to produce electricity during periods of high demand
  - Only certain types of powerplants can change output rapidly and follow load during high demand periods
  - Least cost plants are dispatched (used) first, followed by increasingly expensive generation sources



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# Representative Plant Costs (2003\$)

Plant Type	Overnight cost (\$/kw)	Fixed O&M cost (\$/kw)	Variable O&M (\$/Mwhr)	Fuel Cost (\$/Mwhr)
Coal	1,213	24.36	4.09	10.59
NG CT	374	9.31	2.80	49.04
NG CCCT	558	10.35	1.77	40.25
Oil-Steam	na	8.80	3.64	65.93
Hydro	1,415	12.35	4.80	None
Nuclear	1,957	60.06	0.44	4.53

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# Aspects of Management Regimes That Impact Hydropower Production

- Spills
- Limitations on release, ramp rates
- Altered monthly release pattern
- Effects on reservoir elevations

# Effect of Spills

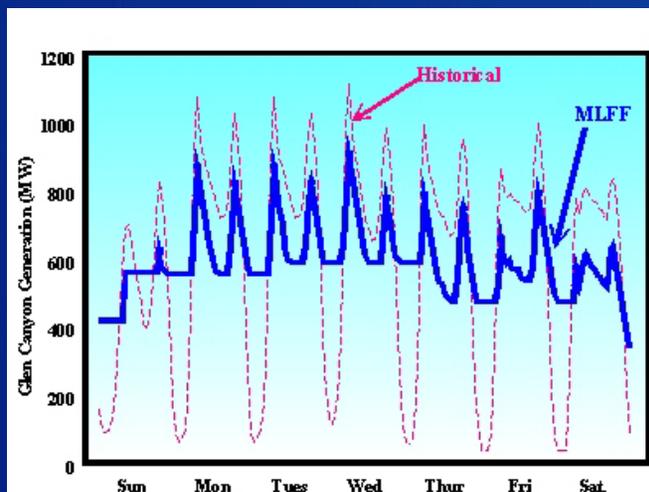
- Spills are releases which bypass the powerplant and don't generate electricity
- Avoidable spills represent a lost opportunity to generate electricity at a later date



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# Effects of Release Limits

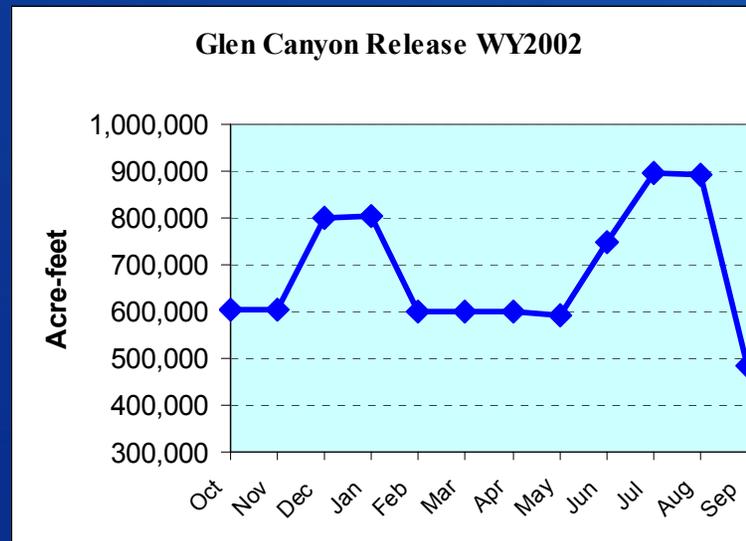
- Constraining minimum and maximum releases and the maximum daily change in release, reduces plant operation range and capacity
- Ramprate restrictions reduce responsiveness
- More generation occurs during hours with a lower value
- Capacity and value of generation are reduced



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# Effects of Alterations in Monthly Release Pattern

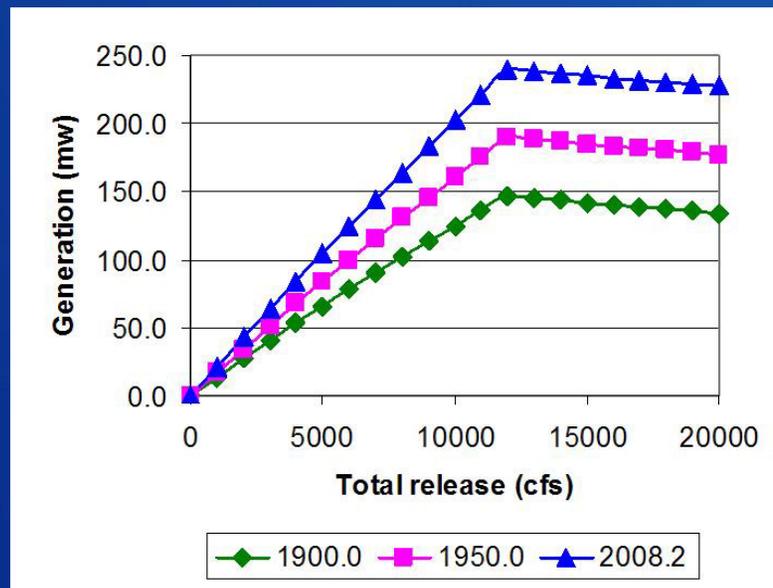
- Shifting of monthly release volumes and generation to lower demand months (shoulder months) reduces the capacity in peak months and the value of the hydropower generated.



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# Reservoir Elevation Effects

- Lower reservoir elevations reduce head
- At any given release, when the head is lower, generation is reduced



# Cause and Effect Summary

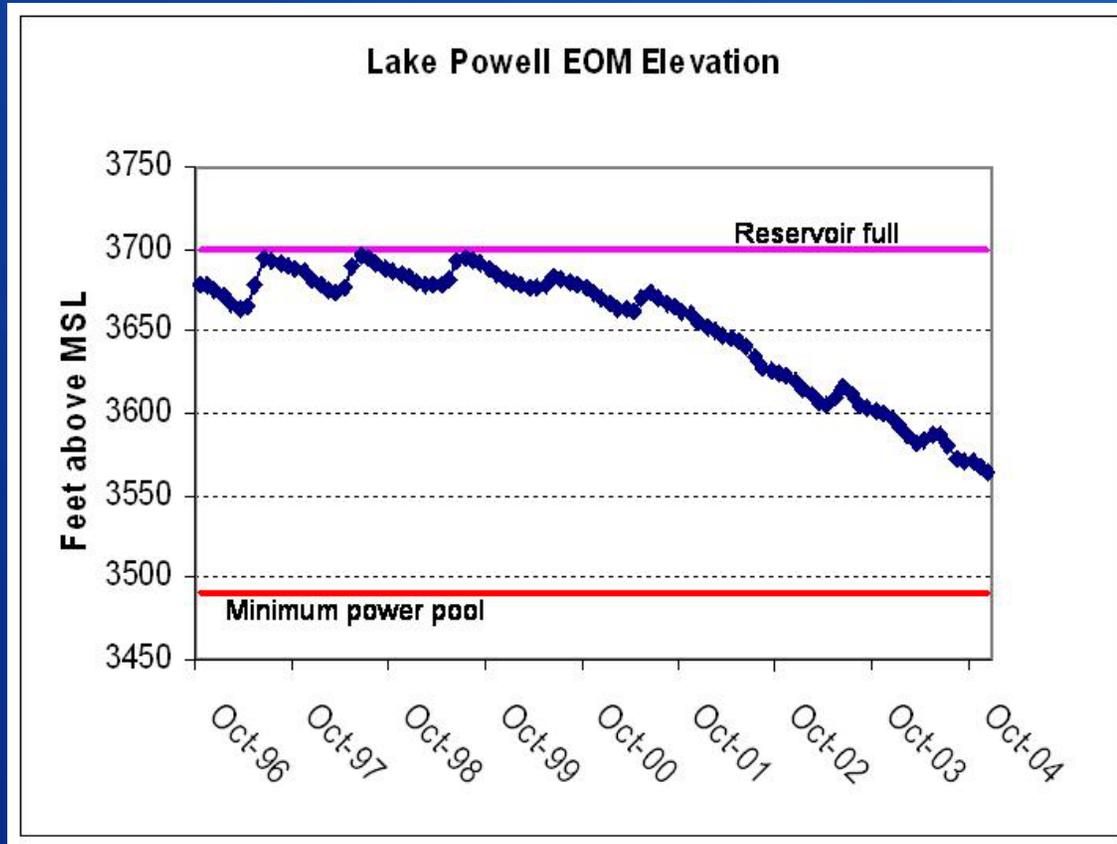
<b>Cause</b>	<b>Effect</b>
<b>Spill</b>	<b>Reduced generation at a later date</b>
<b>Limits on releases, ramp rates</b>	<b>Reduced operational range, capacity and value of generation</b>
<b>Adverse change in pattern of monthly release</b>	<b>Reduced capacity and value of generation</b>
<b>Lower reservoir elevation</b>	<b>Lower head and generation</b>

# Cost Ranking<sup>1</sup>

1. Spills
2. Adverse shifting of monthly releases
3. Release constraints

<sup>1</sup>highest cost (1) to lowest cost (3)

# An Additional Consideration...



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