Vagaries of the river
Delivering reliable hydropower amid uncertain circumstances

Mark A. Gabriel
Western Area Power Administration Administrator & CEO

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Los Angeles, California
Mission and vision

• Market and deliver reliable, renewable, cost-based hydroelectric power and related services within a 15-state region of the central and western U.S.

• Continue to provide premier power marketing and transmission services to our customers, as well as contribute to enhancing America’s energy security and sustaining our nation’s economic vitality
Three lines of business

- **Federal Hydropower**
  - Market 10,503 MW of power from 56 dams
  - Buy and sell power to provide firm electric service

- **Transmission System & Service**
  - 17,000+ miles of transmission lines
  - Operate 3 balancing areas
  - 15-state operating region

- **Transmission Infrastructure Program**
  - Separate $3.25 B borrowing authority
  - Projects must facilitate renewables
  - Projects must have a terminus in WAPA’s footprint
Our power comes from
Water interface: hydropower

75,000 dams in the U.S.
2,200 hydroelectric powerplants

Photo by J. Carl Ganter / Circle of Blue
Conditions across footprint - flooding

2013 flooding eastern Colorado
Conditions across footprint - drought

Folsom Lake

Left:
Oct. 26, 2015

Right:
Jan. 14, 2017

(Vendor by Planet Labs)
Conditions across footprint – fire & ice

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Last Chance fire, 2012

SD ice storms, 2016
Oroville Dam, February 2017

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(Photos by Mercury News)
Oroville Dam, February 2017

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Colorado River at Lees Ferry, AZ

Annual Flow (MAF)

Water Year

Provisional data, subject to change

Estimated values for 2013-2015

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Colorado-Big Thompson

Annual storage averages

Information and graphic provided by Bureau of Reclamation
Missouri River Basin Snowpack

February 6, 2017

Total above Fort Peck

Total Fort Peck to Garrison

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Chart provided by Army Corps of Engineers
Hydro life in increasingly renewable world

Yellowtail Dam

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Pumped storage, another solution

WAPA markets energy from the Mount Elbert reversible pump-back unit in Colorado at Twin Lakes.
Regulatory environment

Acre Feet Bypassed from All GCD Experiments

<table>
<thead>
<tr>
<th>Number of Acre Feet Bypassed:</th>
<th>735,667 AF</th>
</tr>
</thead>
</table>

Emissions if utilities use gas plants to make up for lost energy from Glen Canyon Dam:

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Emissions</td>
<td>375,741,920 lbs</td>
</tr>
<tr>
<td>SOX Emissions</td>
<td>33,105 lbs</td>
</tr>
<tr>
<td>NOX Emissions</td>
<td>562,785 lbs</td>
</tr>
</tbody>
</table>

Emissions if utilities use coal plants to make up for lost energy from Glen Canyon Dam:

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Emissions</td>
<td>744,531,787 lbs</td>
</tr>
<tr>
<td>SOX Emissions</td>
<td>4,303,652 lbs</td>
</tr>
<tr>
<td>NOX Emissions</td>
<td>1,986,301 lbs</td>
</tr>
</tbody>
</table>

What Do These Numbers Mean?

CO2 output equals the annual air emissions from this many cars:

<table>
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<tr>
<th>Emissions</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Gas plant emissions</td>
<td>33,199 cars driven for a year</td>
</tr>
<tr>
<td>Coal plants emissions</td>
<td>65,783 cars driven for a year</td>
</tr>
</tbody>
</table>

Chart courtesy of Salt River Project
Hydro’s role in market environment
Balancing investment

Maintenance and Innovation

Vagaries of the river
Key takeaways

Though inextricably linked, the relationship between water and power continues to change. Partnership and innovation are key to maximizing the hydro resource.
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Photo by Bureau of Reclamation