Spanish dams: overview and recent developments

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• There are around 1.350 large dams in Spain.

• The development of such number is primarily linked to the need of regulation.

• The romans constructed 72 dams and weirs (catalogued). Two of them still under operation, near the city of Mérida (Emerita Augusta).

• Hydropower and flood protection also pushed the dam construction in Spain.
Mean annual rainfall: 685 mm
Surface: 505,000 km²
Bulk resources ≈ 300,000 hm³
Net resources ≈ 100,000 hm³
Mean annual flow (hm³)

Coefficient of variation
## Water Resources: Total & Per Capita Values

<table>
<thead>
<tr>
<th>Basin</th>
<th>Total Resources (hm³/yr)</th>
<th>Resources Per Capita (m³/person/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norte</td>
<td>42.100</td>
<td>6.240</td>
</tr>
<tr>
<td>Ebro</td>
<td>18.200</td>
<td>6.600</td>
</tr>
<tr>
<td>Duero</td>
<td>15.200</td>
<td>6.750</td>
</tr>
<tr>
<td>Tajo</td>
<td>12.860</td>
<td>2.030</td>
</tr>
<tr>
<td>Guadalquivir</td>
<td>7.780</td>
<td>1.590</td>
</tr>
<tr>
<td>Guadiana</td>
<td>6.170</td>
<td>3.710</td>
</tr>
<tr>
<td>Júcar</td>
<td>4.140</td>
<td>990</td>
</tr>
<tr>
<td>Cuencas Cataluña</td>
<td>2.780</td>
<td>450</td>
</tr>
<tr>
<td>Sur</td>
<td>2.420</td>
<td>1.170</td>
</tr>
<tr>
<td>Segura</td>
<td>1.000</td>
<td>730</td>
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</tbody>
</table>
TOTAL DEMAND
37,000 hm³/yr

Domestic supply
6,000 hm³/yr
16%

Irrigation
28,000 hm³/yr
78%

Industry
3,000 hm³/yr
6%
RESOURCES & AVAILABILITY

Natural flow
97,292 hm$^3$/yr

Availability with reservoirs

Demand ≈ 40%

Natural availability
8,905 hm$^3$/yr

Local 10%
Coord. 35%
Global 44%
Reserves 49%
DEVELOPMENT OF DAMS IN SPAIN

Graph showing the development of dams in Spain from 1900 to 2010.

- The x-axis represents the year, ranging from 1900 to 2010.
- The y-axis represents storage volume in hm³, ranging from 0 to 70,000.
- The graph displays two curves, one for storage and one for dams.

Legend:
- Red line: Storage (hm³)
- Blue line: Dams
• Storage volume of the hydroelectric reservoir: 24,000 hm$^3$ (40% of the total storage)

• Installed capacity: 18,000 MW

• Mean annual production: 36,000 GWh

• Maximum historical production: 47,500 GWh

• Maximum hydropower potential: 68,000 GWh

• Largest HPP in Spain:
  • Cortes-La Muela: 1,750 MW
  • Aldeadávila: 1,120 MW
  • Alcántara: 915 MW
Alcántara (buttress, 130 m)
Aldeadávila (arch-gravity, 139 m)
Cortes-La Muela (pumped-storage)

Lower reservoir

Head = 513 m

Upper reservoir

Head = 513 m
FLOODS IN SPAIN
GEOLOGY OF THE IBERIAN PENINSULA

Granites
Gneiss
Quartzites
Volcanic rocks
Siliceous rocks
Limestones
Clays
Marls
<table>
<thead>
<tr>
<th>TYPE (ICOLD notation)</th>
<th>WORLD (%)</th>
<th>SPAIN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAVITY (PG)</td>
<td>17</td>
<td>60</td>
</tr>
<tr>
<td>EARTHFILL (TE)</td>
<td>62</td>
<td>17</td>
</tr>
<tr>
<td>ROCKFILL (ER)</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>ARCH (VA)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>BUTTRESS (CB)</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>OTHERS</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

BARRAGE – DAM
Poids – Gravity
Terre – Earthfill
Enrochement – Rockfill
Voûte – Arch
Contreforts – Buttress
<table>
<thead>
<tr>
<th>DAM (river)</th>
<th>HEIGHT (m)</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALMENDRA (TORMES)</td>
<td>202</td>
<td>ARCH</td>
</tr>
<tr>
<td>CANALES (GENIL)</td>
<td>157</td>
<td>ROCKFILL</td>
</tr>
<tr>
<td>CANELLES (NOGUERA RIBAGORZANA)</td>
<td>151</td>
<td>ARCH</td>
</tr>
<tr>
<td>LAS PORTAS (CAMBA)</td>
<td>141</td>
<td>ARCH</td>
</tr>
<tr>
<td>ALDEADÁVILA (DUERO)</td>
<td>139</td>
<td>ARCH-GRAVITY</td>
</tr>
<tr>
<td>TOUS (JÚCAR)</td>
<td>135</td>
<td>ROCKFILL</td>
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<tr>
<td>SUSQUEDA (TER)</td>
<td>135</td>
<td>ARCH</td>
</tr>
<tr>
<td>EL ATAZAR (LOZOYA)</td>
<td>134</td>
<td>ARCH</td>
</tr>
<tr>
<td>BEZNAR (IZBOR)</td>
<td>134</td>
<td>ARCH</td>
</tr>
</tbody>
</table>
Almendra (arch, 202 m)
## LARGEST SPANISH RESERVOIRS

<table>
<thead>
<tr>
<th>RESERVOIR (river)</th>
<th>STORAGE (hm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA SERENA (ZÚJAR)</td>
<td>3.230</td>
</tr>
<tr>
<td>ALCÁNTARA (TAJO)</td>
<td>3.160</td>
</tr>
<tr>
<td>ALMENDRA (TORMES)</td>
<td>2.050</td>
</tr>
<tr>
<td>BUENDÍA (GUADIELA)</td>
<td>1.640</td>
</tr>
<tr>
<td>MEQUINENZA (EBRO)</td>
<td>1.530</td>
</tr>
<tr>
<td>CIJARA (GUADIANA)</td>
<td>1.505</td>
</tr>
<tr>
<td>VALDECAÑAS (TAJO)</td>
<td>1.450</td>
</tr>
<tr>
<td>RICOBAYO (ESLA)</td>
<td>1.200</td>
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<tr>
<td>ALARCÓN (JÚCAR)</td>
<td>1.110</td>
</tr>
</tbody>
</table>
La Serena (gravity, 91 m)
RECENT & CURRENT DEVELOPMENTS

- 10 RECENTLY FINISHED
- 5 UNDER CONSTRUCTION
- 2 RECENTLY BID
Yesa heightening

CFRD

\[ \Delta H = 30 \text{ m} \]

\[ \Delta V = 600 \text{ hm}^3 \]

\[ H = 115 \text{ m} \]

\[ V = 1.079 \text{ hm}^3 \]
Yesa heightening

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N.M.N. 511.00

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ALVADERO, CUENCO

CHIN DE MADERA

DESAJO DE FONDO

PRESA ALVADERO (C.C. 80608)

ALVADERO, EMBOCADURA
Yesa heightening
Merci de votre attention

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