Water and energy – a Norwegian perspective

Jørgen Bjørndalen
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DNV GL: a quality assurance and risk management company

OUR PURPOSE: TO SAFEGUARD LIFE, PROPERTY AND THE ENVIRONMENT

OUR VISION: GLOBAL IMPACT FOR A SAFE AND SUSTAINABLE FUTURE

150+ years

100+ countries

100,000 customers

12,500 employees

5% of revenue spent on R&D

MARITIME

OIL & GAS

ENERGY

BUSINESS ASSURANCE

DIGITAL SOLUTIONS
Hydropower in Norway – the land of plenty

Hydropower Status Report 2019

Europe installed capacity

COUNTRIES BY ADDED CAPACITY IN 2018 (MW*)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Turkey</td>
<td>1,050</td>
</tr>
<tr>
<td>2</td>
<td>Norway</td>
<td>410</td>
</tr>
<tr>
<td>3</td>
<td>Austria</td>
<td>308</td>
</tr>
<tr>
<td>4</td>
<td>Ireland</td>
<td>140</td>
</tr>
<tr>
<td>5</td>
<td>Italy</td>
<td>108</td>
</tr>
</tbody>
</table>

EUROPE CAPACITY BY COUNTRY*

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Total installed capacity (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Norway</td>
<td>32.756</td>
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<tr>
<td>2</td>
<td>Turkey</td>
<td>28.004</td>
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<td>3</td>
<td>France</td>
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<td>4</td>
<td>Spain</td>
<td>21.258</td>
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<td>5</td>
<td>Switzerland</td>
<td>16.948</td>
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<td>6</td>
<td>Sweden</td>
<td>16.488</td>
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<td>7</td>
<td>Austria</td>
<td>14.725</td>
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<tr>
<td>8</td>
<td>Germany</td>
<td>11.258</td>
</tr>
<tr>
<td>9</td>
<td>Portugal</td>
<td>7.347</td>
</tr>
</tbody>
</table>

* Including pumped storage

hydropower.org/statusreport
98% hydropower; 32 GW
- Decreasing share due to wind power increase

Theoretical potential >600 TWh annual production

Economic potential >200 TWh
- Protected: 50 – 55 TWh
- Current annual capacity: 136 TWh ± 30 %
- Remaining potential: 23 TWh

Reservoir capacity: 87 TWh
- 50% of European storage capacity

Photo: Statkraft
Climate change: Warmer, wetter and wilder

Photo: Riksantikvaren
Increased weather volatility & expected precipitation
Increased weather volatility & expected precipitation
Increased weather volatility & expected precipitation
Requirements to protect marine life

Photo: BKK
Utilities invest in spawning grounds and ensure there is sufficient flow during spawning periods

Photo: BKK
Management of hydropower – avoid erosion of river banks

Photo: bt.no
This is 8 TWh of stored energy

The energy sector can manage volatility

Photo: Statkraft
European and Norwegian regulatory approach to water resource management

- 1887: unlike other European countries, Norway institutionalised private property rights for rivers and river systems (watercourse)
- 1906 – the Panic act: realised that foreign capital took ownership to Norwegian watercourses
- 1917; revision of the Panic act
  - Empowered the government to set conditions for any private utilisation of water resources
  - Taxation
  - Public interests
  - River basin management
  - Reversion; after 60 years, private power plants must be handed over to the state
- Main principles continues: owners utilisation of watercourses is subject to public control

- Holistic river basin management plans, with regular revisions
Water resource management: conflicting interests

- Implementation lagging behind
  - Complicated processes
  - Major conflicts are not resolved
    - The directive does not solve the conflicts, it defines processes to create solutions
- Key conflict areas not so much related to energy as to pollution vs. wildlife and recreational use
Thank you!

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