PRACTICAL EXAMPLE OF SOLAR AND HYDRO ENERGY HYBRID SYSTEM - THE NEED FOR A REVERSIBLE POWER PLANT

Zoran NIKOLIĆ, Institute of the technical sciences of the SASA, Beograd
Dušan NIKOLIĆ, Entura Hydro Tasmania, Australia
Renewable electric energy sources

Advantages:
• No greenhouse gases emission
• No climate change
• Renewable

And problems
• Variable sources of electricity
• 5 Eurocent/kWh

Serbia - 27% from renewable energy sources by 2020. Total installed:
• photovoltaic power plants is about 9 MW
• wind power plants is 500 MW
• Biogas generation is only 16 MW
• co-gen plants sum up to only 11 MW
Net new generation capacity added in 2014 – 2016 by technology type
World wide energy storage – 160GW (2 GW in Australia)

- Lowest cost storage
Kidston Project
Quick Facts of Kidston Solar Project Phase One

• AC capacity: 50MW
• DC capacity: 63MW
• Annual output: 145GWh
• Project lifespan: 30 years
• Number of panels: 540,000
• Tracking system: Single-axis
• Connection: 132kV
• Project cost: $115M
The graphical display of commissioning of a solar power plant
Quick Facts of Kidston Pumped Storage Hydro Project:

• Nameplate capacity: 250MW
• Generation duration: 8 hours
• Storage capacity: 2,000MWh
• Upper reservoir: Wises Pit (52ha)
• Lower reservoir: Eldridge Pit (54ha)
• Project lifespan: 80 years
• Number of turbines: 2
• Turbine details: 125MW rev. turbines
• Start-up time: <30seconds
• Max gross water head: 218m
Quick Facts of Kidston Solar Project Phase Two

- AC capacity: 270MW
- DC capacity: 340MW
- Annual output: 783GWh
- Project lifespan: 30 years
- Number of panels: 3,000,000
- Tracking system: Single-axis
- Connection: 132kV
- Project cost: $600M
Quick Facts of Reversible hydroelectric power plant Djerdap 3

• four kilometers upstream of Lepenski Vir.
• level of the Djerdap Lake is 68m
• The first stage of construction - lake "Pesača", total area of 68 hectares, at an altitude of 450 m, which can accumulate 18,5 million m³ of water, with a drop of 400 m. The energy value of the accumulation is 15,1 GWh, with the necessary energy to fill the accumulation of 20,6 GWh.
• The second stage of construction involves upgrading the accumulation lake "Pesača" at an altitude of 470 m, which can accumulate 32,5 million m³. The total area of accumulation is 102 hectares.
• The third stage of construction - lake "Brodica" which can accumulate 542 million m³ of water
• The total quantity of water in the accumulation lakes “Pesača” and “Brodica” is 578 million m³. The energy equivalent of both accumulations would be around 484 GWh. The total power for all three stages is 2400 MW.
• The machine building is a cast-type type with an underground storage of a machine with zippers and drive equipment.
Reversible hydroelectric power plant Djerdap 3

**Generator characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent power</td>
<td>315 MVA</td>
</tr>
<tr>
<td>Generator power</td>
<td>300 MW</td>
</tr>
<tr>
<td>Power factor</td>
<td>0.95</td>
</tr>
<tr>
<td>Number of revolution</td>
<td>375 per minute</td>
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<tr>
<td>Cooling</td>
<td>air</td>
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<tr>
<td>Incentiv</td>
<td>Thyristor</td>
</tr>
<tr>
<td>Efficiency</td>
<td>94.8-98.8 %</td>
</tr>
<tr>
<td>Motor-generator weight</td>
<td>800-1000 t</td>
</tr>
</tbody>
</table>
Reversible hydroelectric power plant Djerdap 3

**Pump-turbine characteristics**

- Nominal power: 300 MW
- Number of revolution: 375 per minute
- Shaft diameter of the spade blades: 5250 mm
- Number of blades of the conducting device: 20
- Number of rotary wheel blades: 7
- Motor efficiency: 98.5-99%
Conclusion

Cost of:

• Current pooled price in the NEM is about $60/MWh

• Thermal (coal) power plant is about $80/MWh

• 100% renewable electricity grid is about $90/MWh (PV and wind generation 2/3 and reversible power plant 1/3)

• Reversible power plant Bajina Bašta
  1,34kWh – 1kWh