Basic Characteristics of the Pumped-Storage Power Plant Vinodol

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• Pumped-storage power plant (PSPP) in the Croatian power system
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Introduction

• Construction planning of the 80ies
  • Facilitating the operation of big TPP and NPP – „flattening out of load duration curve”

• Construction planning nowadays
  • Facilitating the intermittent energy sources’ operation

• Ancillary services of the power system
**Pumped-Storage Power Plants in the Croatian Power System (1/3)**

**Already built:**
- **PSPP Fužine (1957)**
- **Reversible HPP Lepenica (1985)**
- **Reversible HPP Velebit (1984)**
Pumped-Storage Power Plant in the Croatian Power System (2/3)

PLANNED: *Projects from the 70ies and 80ies of the Past Century*
- PSPP Vinodol – there is a lower reservoir
- PSPP Borovik – there is a lower reservoir
- PSPP Mosor – trained Cetina river bed as a lower reservoir
- PSPP Senj – upgraded pool of Gusić Polje as a lower reservoir

*Newer Solutions*
- Reversible HPP Medvednica – lower reservoir is a pool of the HPP Prečko’s run-of-river plant
- Reversible HPP Korita – trained Cetina river bed as a lower reservoir
- Reversible HPP Vrdovo – lower reservoir is a HPP Peruća’s lake
Pumped-Storage Power Plants in the Croatian Power System (3/3)

- Pumped-Storage PP Borovik
- Pumped-Storage PP Velebit
- Pumped-Storage PP Fužine
- Pumped-Storage PP Lepenica
- Pumped-Storage PP Vinodol
- Pumped-Storage PP Senj
- Reversible HPP Medvednica
- Reversible HPP Vrdovo
- Reversible HPP Velebit
- Reversible HPP Korita

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Pumped-Storage Power Plants in the Vicinity

**Slovenia**

- Avče (2009)
- Kozjak (planned)

**BiH**

- Čapljina (1979)
- Vrilo (planned)
Pumped-Storage Power Plant Vinodol
Project Status

- Conceptual Design „Pumped-Storage Power Plant Vinodol“ 1980 - Elektroprojekt Zagreb
- Lower pool $1,0 \times 10^6$ m$^3$ built with a land ownership. 2m freeboard needed for the reservoir’s extension and purchasing of approximately 25% of the land.
- Ownership of the part of the land for the future power house, which is in the vicinity of the existing HPP Vinodol
- All objects entered into the Primorje-Gorski Kotar County’s Physical Plan and Vinodol Municipality’s Local Physical Plan
## Basic Data

### RESERVOIRS
- **upper pool**: $2.10 \times 10^6$ m$^3$
- **lower pool**: $2.45 \times 10^6$ m$^3$

### ENERGY DATA
- **Gross head**: 755 m
- **Installed flow**: 60/45 m$^3$/s
- **Installed capacity**: 390/366 MW
- **Average annual generation**: 950 GWh/700 GWh of the peak load
- **Turbine operation**: 9.7 hours
- **Possible pumped operation**: 12.9 hours
Project Advantages

• Vicinity of the existing HPP Vinodol (infrastructure)
• Suitable terrain configuration
  • Distance between the upper and lower pool is 2.5 km
  • High altitude difference of 755 m
• The first phase of the lower pool constructed
• Contained in the physical plans of the Municipality Vinodol and Primorje-Gorski Kotar County
• Local public support
• There is significant technical documentation and research data available
Location (1/2)

Basic Characteristics of the PSPP Vinodol
Vinodol System
Physical Planning Documentation

- Physical Plan of the Primorje-Gorski Kotar County

http://www.zavod.pgz.hr/docs/zzpuHR/docsplanovizupanija/5/karte/karta-2a.pdf

Basic Characteristics of the PSPP Vinodol

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Basic Characteristics of the PSPP Vinodol
Documentation (2/3)
EU Projects

• Work Programme LCE 9-09-2015 - Large Scale Energy Storage
• Application of the DEPHASES Project – Demonstration of Increased RE Grid Integration using Pumped Hydro energy storage with load balancing, Adaptive System Services and Environment and Societal Benefits
• Stakeholders are UCC, Enerco and Malachy Walsh & Partners from Ireland, Voith-Siemens from Germany, University in Zagreb (GF and FER) and HEP d.d. (share-holding company)
• To explore the possibility of increasing the installed capacity and storage volume (new gen set technology, increase of the upper and/or lower pool volume) of the existing pumped-storages
• To examine the possibility of construction with today’s spatial, ecological, legal and other requirements and explore the concept possibility through the application of new technology on the projects from the 80ies
Further Steps

- Collection of the existing documentation
- Preparation of project tasks (Conceptual Design, Prefeasibility Study)
- Decision on project’s continuation
Conclusion

- Pumped-storage power plant Vinodol and other reversible HPP capacities should be considered in terms of present conditions, which have significantly changed in comparison to the 70ies and 80ies (for example, the availability of the base load energy, price ratio between the peak and base load energy, development of the renewable energy sources (RES) – especially the wind energy and other) when most of the documents for the pumped-storage Vinodol was prepared.

- The advantage of the pumped-storage power plant Vinodol in relation to the other projects of reversible HPP and PSPP is that huge heads (approx. 750m) are achieved with proportionally short diversion, very high level of the project development (at the level of present documentation required for the Location Permit and the Building Permit for certain parts of the lower pool), very flexible and quick regulation of the Pelton turbine’s operation used for huge heads and smaller water flows, as well as good ratio of the pumping energy and turbine operation of 0.75.

- The Upper pool is outside of the Natura 2000 network area.

- The present ratio of the peak and base load energy is not sufficient to achieve the cost-effectiveness of the pumping plant, in the order of 1.2, therefore it is necessary to explore the value of ancillary services towards HOPS (Croatian Transmission System Operator Ltd), especially the secondary regulation, as well as the role of the PSPP in the compensatory energy of pumping into the system when it comes to the energy surplus from RES, wind in particular.
Thank you for your attention!

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