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MONTENEGRIN ELECTRIC ENTERPRISE - NIKŠIĆ

ENERGY SECTOR OF MONTENEGRO
STRATEGIC GOALS

Workshop on
WATER-FOOD-ENERGY-ECOSYSTEMS NEXUS
ASSESSMENT IN THE SAVA RIVER BASIN
ZAGREB
March 4-6, 2014
Situated in the south-west part of the Balkan Peninsula, on the south coast of the Adriatic Sea

- Surface: 13,812 sq.km
- Population: 662,000
- Length of borders: 614 km
- Length of sea coast: 93 km
- The highest mountain: Durmitor (2,525 m)
- The deepest canyon: Tara (1,300 m)
- Largest town: Podgorica
- The Capital: Cetinje
THE HISTORY OF MONTENEGRIN POWER SYSTEM

- Electrification of Montenegro began with the first decade of the 20th century
- First power plant was put into operation on August 19th, 1910 (Cetinje, 2x110 kW, diesel)
- First phase of development of the Montenegrin power system: HPP Podgor (1937), HPP Rijeka Mušovića (1950), HPP Slap Zete (1952), HPP Rijeka Crnojevića (1952), HPP Glava Zete (1955)
- Second phase of development of the Montenegrin power system (HPP Peručica, HPP Piva, TPP Pljevlja)
- Parallel construction of transmission and distribution networks
ENERGY DEVELOPMENT STRATEGY BY 2030

Gross domestic consumption of energy, 1990-2010 (PJ)

1 PJ (Petajoul) = 10^{15} jouls
Final energy consumption by sector, 1990-2010 (%)
ENERGY DEVELOPMENT STRATEGY BY 2030

Gross domestic consumption of energy and fuel, 1990-2010 (PJ)
ENERGY DEVELOPMENT STRATEGY BY 2030

Gross electricity supply, 1990-2010 (PJ)
Gross electricity supply, 1990-2010 (%)
ENERGY DEVELOPMENT STRATEGY BY 2030

Key scenarios of final energy consumption - realisation (2000-2010) and forecast by 2030, PJ

Realised (2000-2010) and forecasted total final energy consumption by energy form by 2030 - Reference scenario (PJ)
Energy balance of Montenegro in the period 2011-2030 (GWh)
MAIN PRIORITIES OF ENERGY POLICY BY 2030

1. Security in the energy supply
2. Development of the competitive energy market
3. Sustainable energy development

KEY STRATEGIC COMMITMENTS BY 2030

Maintenance, rehabilitation and modernization of existing and construction of new infrastructure for production, transmission and distribution of energy on the principles of fulfilment of international technical standards, energy efficiency, reduction of losses and its negative impact on environment;

Gradual reduction of energy import dependence by (i) reducing the specific consumption of final energy, (ii) increasing the energy production (primary and secondary) by use of own resources and (iii) reducing the energy losses from production to end consumption. From the current net energy importer, Montenegro plans to become the net exporter of electrical energy after 2020;
KEY STRATEGIC COMMITMENTS BY 2030

Reviewing the existing barriers for activation of all long-term energy development options;

Energy efficiency represents a priority in Montenegrin energy policy:

a. Provision of institutional conditions and financial incentives with the purpose to improve EE and reduce energy intensity in all sectors, from production to end consumption of energy;

b. Montenegro shall reach the indicative target of EE increase, which represents saving in the amount of 9% of the average final energy consumption in the country (without Aluminium Plant Podgorica) until 2018. Interim indicative goal until the end of 2012 amounts to 2%. Remaining average annual saving after 2018 shall be in compliance with the goals set out at the level of Energy Community or EU;

c. Rational use of energy in transport and promotion of EE measures (improved public transportation including the railway transport, promotion of energy efficient and low-emission vehicles, and integration of EE criteria in the transport infrastructure projects);
KEY STRATEGIC COMMITMENTS BY 2030

Exploration of oil and gas in the Montenegrin undersea and in continental area, as well as of coal in Pljevlja and Berane basin;

Proactive role of the policy of the State of Montenegro in the endeavors to provide access to the systems of natural gas through the international projects (Ionian-Adriatic gas pipeline and others), development of natural gas system (including the construction of regional gas pipelines and plants for utilization of natural gas);

Increased operational efficiency of energy companies by reducing the operational costs, technical and commercial energy losses, with justified return on investments;

Continued restructuring of EPCG AD and CGES AD in accordance with the principles of relevant EU energy legislation and duly issuing of plans for further development;

Sustainable development of energy sector in relation to the environment protection and international cooperation in this field, especially regarding the reduction of gas emission with greenhouse effect;

Pursuant to the verification of Kyoto protocol, being the country outside the annex of developed countries at least until 2012, provision on support to investors and provision of conditions for implementation of projects of so called Clean Development Mechanism (CDM);
KEY STRATEGIC COMMITMENTS BY 2030

Incentives for researches, development, transfer and application of ecologically sustainable new technologies in the energy sector; increased investments in education and scientific-research projects and incentives for the international cooperation in the field of ecologically sustainable new technologies in the energy sector, as well as introduction of lectures on energy in the educational system;

Harmonization of legislative-regulatory framework in accordance with the EU requirements and ensuring support for development and accelerated implementation of programs and projects on RES usage and implementation of EE measures, substitution of energy-generating products and development of local energy industry (combined generation of electricity and heat);

Creating appropriate legislative, regulatory, institutional and financial framework to encourage private sector involvement and investments in energy;

Securing social protection for endangered (vulnerable) energy consumers, as well as for labor surplus within the process of changes in the energy sector that might have impact to their social position;
KEY STRATEGIC COMMITMENTS BY 2030

Reaching the agreement with neighboring countries in relation to the optimal utilization of joint hydro-potential and water management, as well as planning and construction of new electric power interconnecting lines for connection between these countries;

Improvement of the regulatory process and professional independence of the Regulatory Energy Agency, aimed at continuous development of predictable and clear regulatory framework and favorable environment for investments into Montenegrin energy sector;

Active international cooperation in the energy sector.

Energy policy must ensure that the energy sector in Montenegro is developing as an open system in accordance with the EU and Energy Community energy system, open to private, domestic and foreign investments.
COAL SECTOR – MAIN RECOMMENDATIONS

Continue with rehabilitation of coal mines in Pljevlja for the needs of existing thermal TPP Pljevlja I and research in order to provide better basis for investment decisions so the Government and the concessionaires could make a decision on investing in second thermo-block in Pljevlja, i.e. TPP Pljevlja II,

Continue with mine exploration and study works in Maoce for the needs of new planned TPP Maoce and possible later use for the needs of TPP Pljevlja II in order to prepare the best possible basis for investment decisions,

Continue with explorations of coal reserves in Berane and start producing coal for the market and possibly mixing with lignite for the needs of thermal power plants in Pljevlja,

Gradually reduce consumption of coal in domestic consumption due to the known negative effects on the environment,

Merge Coal Mine company and TPP Pljevlja I (and later TPP Pljevlja II) into unique legal entity,

Study the feasibility of building power plants on imported coal.
OIL AND GAS SECTOR – MAIN RECOMMENDATIONS

Maintain a high level of competition in the market of oil products with continuous monitoring of product quality control and level of service of the company in accordance with the laws and regulations of the state.

Explore the possibility of structural changes in the sector of transport in order to reduce the specific consumption fuel to unit of service (tkm and pkm) and the possibility of introducing renewable energy sources (biofuels and electricity from RES).

Establish a central authority for management of reserves (CSE) and control of correct provision of oil reserves and coordination of implementation;

Prepare and adopt the relevant bylaws;

Establish 90-day stocks of petroleum products according to law and regulations in accordance with the timetable and obligations of Montenegro to the Energy Community and the European Union;

Maximum use of existing storage capacities with the construction of additional storage capacities.

Continue with and intensify exploration of potential oil and gas reserves in the Adriatic undersea.
OIL AND GAS SECTOR – MAIN RECOMMENDATIONS

Develop a feasibility studies of possible gasification of major cities of Montenegro with aim of determining the distribution gas pipelines development strategy.

Consider the feasibility of building power plant on natural gas that would provide economic justification for the development of gasification of the country in regions that are in the immediate vicinity of IAP corridor.

Update LoE to harmonize with the third package in the field of gas and adopt the necessary by-laws in the field of gas within the deadlines set by the Energy Community.

Establish Transmission System Operator for Gas in accordance with LoE as company 100% owned by the state, which will play an important role in the planning and development of the project of connecting Montenegro to the regional pipelines and which will also provide further support to state in gasification of Montenegro.

Gas sector needs to be strengthen with human resource capacity in all relevant institutions responsible for policy and regulation of the gas sector.

Support introduction of LPG as a substitute for oil products and coal and electricity in services (tourism) and households.
ELECTRICITY SECTOR – MAIN RECOMMENDATIONS

Complete the reconstruction and revitalisation of existing power generating plants (TPP Pljevlja I, HPP Piva, HPP Perućica, sHPPs) in order to achieve environmental stabilization, increase generation efficiency and improve performance of existing plants according to the Strategy.

Based on previous research on possibilities of construction of new power plants, the construction is recommended according to the Strategy.

Timely prepare and adopt spatial planning documents (detailed spatial plans, strategic assessment of environmental impact, etc.) for all proposed power plants in the Strategy in order not to jeopardize the project implementation schedule,

Construct new power plant in accordance with the best international standards and practices with respect to legal and regulatory requirements and environmental protection,

Prepare study on using hydro potential for all rivers in Montenegro (in the mainstream and tributaries), for selected objects prepare preliminary feasibility studies,

Reaching agreement with neighbouring countries regarding the optimal utilization of joint hydro potential and water management.
ELECTRICITY SECTOR – MAIN RECOMMENDATIONS

TPP MAOČE AND TPP PLJEVLJA 2

Intensify preparatory research and promotion of projects aimed at better preparing tender documentation and securing investors and construct TPP Maoče together with the opening of mine Maoče,

Complete the feasibility study for construction of TPP Pljevlja II and intensify research activities with an aim to ensure sufficient quality data for making investment decisions for the construction of power plant and expansion of capacities of coal mine for the need of TPP Pljevlja I and TPP Pljevlja II,

Build TPP Maoče with a capacity of 350 MW with power lines for its connection to the transmission network,

Construct TPP Pljevlja II (with possible subtraction of heat for heating the town of Pljevlja).
ELECTRICITY SECTOR – MAIN RECOMMENDATIONS

HPP ON MORAČA RIVER

Decide on a model for awarding concession for HPP on Morača River and intensify the process of selection of the concessionaire,

After the selection of the concessionaire, carry out research work for technical solution adopted by the Government within the framework of issuance of concession,

Construct HPPs on Moraca River based on adopted technical solution with power lines for its connection to the transmission network.

HPP KOMARNICA

Decide on a model for awarding concession for HPP Komarnica and intensify the process of selection of the concessionaire,

Build HPP Komarnica based on adopted technical solutions with power lines for its connection to the transmission network.
ELECTRICITY SECTOR – MAIN RECOMMENDATIONS

HPP BOKA, HPP KRUŠEVO, HPP ĆEHOTINA

Intensify analysis and investigation work, carry out feasibility study in order to ensure sufficient quality data for making investment decisions for possible construction of HPP Boka and/or HPP Kruševo after 2030,

Continue and intensify negotiations to reach an agreement with BiH and Croatia on division and use of joint hydro potential.

SMALL HPPs

Undertake further activities to encourage construction of small HPPs under the principle of assigning concessions for watercourses, research, and technical and economic use of water and energy potential for generation of electricity in small hydro power plants,

Build small HPPs in line with the Strategy with power lines for its connection to the transmission or distribution network.
ELECTRICITY SECTOR – MAIN RECOMMENDATIONS

WIND, SOLAR, BIOMASS POWER PLANTS

Work towards the harmonization of legislation in order to simplify and speed up the procedures for obtaining the necessary permits for construction of facilities that use renewable energy sources,

Continue research work and study for the possible realization of offshore wind farms and more rapid dynamics of realization of on-shore wind farms, photovoltaic power plants and biomass projects (for electricity generation and/or heat),

Carry out all required analysis and study for preparation of the project for incineration of municipal solid waste in Montenegro (waste potential, location of the facility and other.),

Build wind farms, photovoltaic power plants and biomass power plants according to the Strategy with power lines for their connection to the transmission and distribution network.
DISTRICT HEATING SECTOR – MAIN RECOMMENDATIONS

Develop a study introducing district heating system in local communities in the municipalities of northern Montenegro (Kolasin, Berane, Zabljak and Plužine), and other cities of Montenegro (Niksic, Bijelo Polje, Cetinje, Podgorica) for use of biomass or waste heat from industrial processes and implement projects if studies show their justification,

Implement district heating system based on biomass for the town of in Pljevlja (supplied about 20% of the population),

Develop a study on heating of Pljevlja (supplied about 70% of the population) and implement the heating system of Pljevlja in case of construction of TPP Pljevlja II using cogeneration of this block.

Preparation of additional assessments of availability of resources for introducing industrial and small cogeneration and high-efficient cogeneration plants in Montenegro and feasibility studies in local conditions is recommended in order to determine economic potential of using co-generation in concrete projects,
DISTRICT HEATING SECTOR – MAIN RECOMMENDATIONS

Develop and adopt program of development and use of high-efficient cogeneration,
Monitor the development of legislative and regulatory framework in the EU and timely transpose obligations of Montenegro according to the Energy Community into legislation and regulations concerning cogeneration and high-efficiency cogeneration.

Strengthen capacity at the local level to strengthen the promotion of district heating sector and strengthen the institutional framework necessary to implement the Strategy in this sector, and also prepare municipal energy development concepts in accordance with LoE.

ENERGY EFFICIENCY – MAIN RECOMMENDATIONS

Develop and adopt program of development and use of high-efficient cogeneration, Montenegro will follow closely the developments in EU and worldwide regarding EE in the supply side,
Assessment of the scope for the establishment of an EE obligations scheme for energy suppliers or distributors,
Assessment of the scope for the establishment of obligations for new and significantly refurbished thermal power plants to allow for recovery of heat by means of CHP;
Gradual introduction of smart grid and smart meters technologies
Montenegro will follow closely the developments in EU and worldwide regarding EE in the supply side,

Assessment of the scope for the establishment of an EE obligations scheme for energy suppliers or distributors,

Assessment of the scope for the establishment of obligations for new and significantly refurbished thermal power plants to allow for recovery of heat by means of CHP;

Gradual introduction of smart grid and smart meters technologies

Promotion of ESCO services, public private partnership schemes for EE, energy auditing and EE consulting services and the like,

Establishment of incentive schemes to support EE investments.

Establishment of a permanent inter-ministerial committee to support, promote and monitor implementation of the regulatory framework for energy performance of buildings,

Training and capacity building of auditors and of staff responsible for licensing of buildings and inception,

Definition of the nearly-zero energy building.
ENERGY EFFICIENCY – MAIN RECOMMENDATIONS

Technical assistance for the establishment of energy management and energy information systems,

Investment programmes for EE in street lighting, water supply systems, sewage systems and other utilities,

Provision of support for enabling alternative financial mechanisms in public sector (energy performance contracting, third party financing, and the like),

Measures for a more conscious use of energy and proper maintenance for energy systems, especially air-conditioning units, shift to more efficient lighting, household appliances and air conditioners, drastically reduce direct electricity use for heating and production of hot water and incorporation of RES, mainly solar thermal systems and modern biomass systems,

Special programmes targeting promotion of specific EE and/or RES technologies (e.g. introduction of integrated Buildings Energy Management Systems – BEMS, improved boilers’ efficiency, CHP, waste heat recovery, large scale solar thermal systems, use of biomass, etc.),

Programmes addressed to specific sub-sectors such as hotels, commercial centres, industrial companies etc.
Finalise the institutionalization of the market (electricity market operator, distribution system operator);

Implementation of measures to secure more favourable environment for participation of new participants in the energy market and increase competitiveness of electricity market;

Ensure the development and implementation of information technology and measuring infrastructure as technical support to the energy market and its subsequent inclusion in the regional processes;

Continuously develop and adapt electricity market design and monitor the development of the regional market;

Further develop and improve the existing incentive scheme for electricity generation from RES;

Start with implementation of new market institutions (national or regional stock exchange, CAO, etc.) and regional integration, to provide adequate infrastructure for the operation of these institutions;

Gradually establish an institutional and regulatory framework and specify the bearer of the project of gasification of the country
ELECTRIC POWER SYSTEM OF MONTENEGRO

PRODUCTION
- HPP PERUCICA 307 MW, 930 GWh
- HPP PIVA 342 MW, 760 GWh
- TPP PLJEVLJA 210 MW, 1 150 GWh
- 7 SMALL HPPs 9 MW, 21 GWh

CONSUMPTION
- CONSUMERS AT 110 kV 2 200 GWh
- DISTRIBUTION CONSUMERS 2 000 GWh
- TRANSMISSION LOSSES 150 GWh
- DISTRIBUTION LOSSES 500 GWh

DEFICIT
1 700 – 2 000 GWh
## HYDRO POWER POTENTIAL

<table>
<thead>
<tr>
<th>River</th>
<th>Capacity MW</th>
<th>Exploitable GWh/a</th>
<th>Exploited GWh/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moraca</td>
<td>737</td>
<td>1 524</td>
<td>0.15</td>
</tr>
<tr>
<td>Zeta</td>
<td>330</td>
<td>1 058</td>
<td>985.35</td>
</tr>
<tr>
<td>Piva</td>
<td>702</td>
<td>1 613</td>
<td>870.5</td>
</tr>
<tr>
<td>Tara</td>
<td>541</td>
<td>1 603</td>
<td>3.5</td>
</tr>
<tr>
<td>Lim</td>
<td>280</td>
<td>936</td>
<td>-</td>
</tr>
<tr>
<td>Cehotina</td>
<td>56</td>
<td>161</td>
<td>-</td>
</tr>
<tr>
<td>Ibar</td>
<td>27</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>2</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2 675</strong></td>
<td><strong>6 952</strong></td>
<td><strong>1 861</strong></td>
</tr>
</tbody>
</table>
THERMAL POWER POTENTIAL

- DARK LIGNITE FROM PLJEVLJA BASIN:
  - BALANCE RESERVES: 205 MILLIONS OF TONS
  - EKSPLOATATION RESERVES: 175 MILLIONS OF TONS

- DARK LIGNITE FROM BERANE BASIN:
  - BALANCE RESERVES: 38 MILLIONS OF TONS
  - EKSPLOATATION RESERVES: 17 MILLIONS OF TONS

- POSSIBLE GAS EXPLOITATION IN THE COASTAL AREA

- POSSIBLE CONNECTING TO GAS INSTALLATIONS
ENERGY DEVELOPMENT STRATEGY

- Wind generators:
  - 50 MW (by 2015)
  - 50 MW (by 2020)
  - 20 MW (by 2025)

- Communal waste power plant:
  - 10 MW (by 2015)

- Power plants - heat generators on biomass:
  - 2 MW (by 2020)
  - 3 MW (by 2025)

- Solar energy exploitation
TRANSMISSION SYSTEM OF MONTENEGRO
(possible future projects)

400 KV Pljevlja - Visegrad

400 KV Pljevlja - Lastva Grbaljsa
220 KV Perućica-Lokrovnik

DC line Montenegro - Italy
**HPP KOMARNICA**

**CONCEPTUAL ELABORATION OF HPP KOMARNICA (1988)**

- **Dam height**: 176.0 m
- **Brutto storage capacity**: 260 Mio m³
- **Usable storage capacity**: 160 Mio m³
- **Normal operating level**: 816 (810) m als
- **Installed water flow**: 2 x 65 m³/s
- **Installed capacity**: 130.0 MW
  - **Turbine**: 2 x 84 MW, Frensis
  - **Generator**: 2 x 95 MVA
- **Connection net voltage**: 110 kV
- **Annual production**: 231,80 GWh
- **Construction period**: 7 years
- **Construction cost**: 160 Mio €
HYDRO POWER PLANT “PIVA”

- 220 m arch concrete dam
- Installed discharge: 3 x 80 m³/s
- Reservoirs capacity: 880 Mio m³
- Nominal head: 160 m
HYDRO POWER PLANT “PIVA”

- Commissioned in 1976
- High head peak power plant
- Installed capacity 3 x 114 MW
- Francis turbines
- 220 kV switchyard

- Mean annual production 760 GWh
- Mean annual production (with valorisation) 1050 GWh
## HPP KRUŠEVO - Lower

### CONCEPTUAL ELABORATION OF HPP KRUŠEVO - Lower (1974)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual flow through HPP</td>
<td>75,80 m³/s</td>
</tr>
<tr>
<td>Dam height</td>
<td>64,0 m</td>
</tr>
<tr>
<td>Brutto storage capacity</td>
<td>25,4 Mio m³</td>
</tr>
<tr>
<td>Usable storage capacity</td>
<td>18,0 Mio m³</td>
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<tr>
<td>Normal operating level</td>
<td>495 m als</td>
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<tr>
<td>Installed water flow</td>
<td>240,00 m³/s</td>
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<tr>
<td>Installed capacity</td>
<td>120,0 MW</td>
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<tr>
<td>Turbine</td>
<td>2 x 60 MW, Frensis</td>
</tr>
<tr>
<td>Generator</td>
<td>2 x 65,5 MVA</td>
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<tr>
<td>Connection net voltage</td>
<td>220 kV</td>
</tr>
<tr>
<td>Annual production</td>
<td>321,90 GWh</td>
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<tr>
<td>Construction period</td>
<td>4 years</td>
</tr>
<tr>
<td>Investment cost</td>
<td>cca 150 Mio €</td>
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</table>
HPP KRUŠEVO (Upper) in the Tara Valley

Variant B

Dam KRUŠEVO (Upper)
## HPP KRUŠEVO - Upper

CONCEPTUAL ANALYSIS OF HPP KRUŠEVO - Upper (1974)

### Varijant A – Derivation Tunnel and Power House in the Piva Valey
- **Net head**: 51,35 m
- **Calculated net head**: 49,35 m
- **Installed capacity**: 107 MW
- **Annual production**: 288,00 GWh

### Varijant B – Derivation Tunnel and Power House in the Tara Valey
- **Net head**: 54,90 m
- **Calculated net head**: 52,90 m
- **Installed capacity**: 114 MW
- **Annual production**: 309,00 GWh

### Varijant C – Dam Power House
- **Net head**: 36,00 m
- **Calculated net head**: 34,00 m
- **Installed capacity**: 76 MW (62% HPP Lower)
- **Annual production**: 198,00 GWh
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual flow through HPP</td>
<td>23,83 m³/s</td>
</tr>
<tr>
<td>Installed flow</td>
<td>70,00 m³/s</td>
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<tr>
<td>Length of the inlet tunnel</td>
<td>29.86 km</td>
</tr>
<tr>
<td>Diameter of the inlet tunnel</td>
<td>6.6 m</td>
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<tr>
<td>Installed capacity</td>
<td>225.4 MW</td>
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<tr>
<td>Turbine</td>
<td>2 x 112.7 MW, Frensis</td>
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<tr>
<td>Generator</td>
<td>2 x 125.0 MW</td>
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<tr>
<td>Connection net voltage</td>
<td>220 kV</td>
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<tr>
<td>Annual production</td>
<td>661.0 GWh</td>
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<tr>
<td>Construction period</td>
<td>5 years</td>
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<tr>
<td>Investment cost</td>
<td>292 Mio €</td>
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</tbody>
</table>
THANK YOU
for
YOUR ATTENTION

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