Bulgarian nuclear energy – necessity and possible ways for development

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I. Status of the nuclear projects in Bulgaria.

II. The demand for the construction of new generating capacities for the electric power system in Bulgaria, including for the construction of nuclear capacities.

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I. STATUS OF THE NUCLEAR PROJECTS IN BULGARIA

I.1 Status of the Belene Project

I.1.1 Background

- **1981: DECISION FOR THE CONSTRUCTION OF BELENE NPP.**
- **1987:** Finalization of the Technical Design.
- 1990: Decision to freeze the Project due to a lack of financing.

- **2002: GOVERNMENT DECISION TO RESTART THE BELENE NPP PROJECT.**
- **2003-04:** Elaboration of Environmental Impact Assessment Report and of Feasibility Study.
- **2004:** Decision by the Ministry of Environment and Waters to approve the investment proposal for the construction of Belene NPP; Announcement of a procedure for the selection of Architect/ Engineer.

- **08 APRIL 2005 - GOVERNMENT DECISION FOR THE CONSTRUCTION OF A NUCLEAR POWER PLANT WITH 2,000 MW MAXIMUM INSTALLED CAPACITY AT THE BELENE SITE.**
- **2005:** A tender procedure for the selection of EPC Contractor (under a contract for Engineering, Procurement and Construction) was announced.
- **2006:** The Russian company "Atomstroyexport" won the tender and a contract for the construction of two power units was signed.
- **2007:** The European Commission Directorate General for Energy and Transport issued a positive statement on the Project and a certificate for compliance with the European Utility Requirements (EUR) technical requirements for third generation light water reactors was obtained.
- **2008 – 2012**: Long lead equipment, such as the Reactor Vessel (RV) and the Steam Generators (SG), was procured and, respectively, manufactured.

- **28 MARCH 2012: THE BULGARIAN GOVERNMENT DECIDED TO STOP THE PROJECT.**

I.1.2 Status

- The Belene NPP site has been selected and approved;
- The site is ready for construction - the preparatory activities are accomplished;
- The Technical Design, the Intermediate Safety Analysis Report (ISAR) and the Probabilistic Safety Analysis (PSA) have been elaborated and filed for approval at the NRA;
- The construction of Units 1 & 2 will take 6.5 years. The construction activities will be started one year after signing the EPC Contract;
- The main equipment for Units 1 & 2 has already been manufactured;
- The design has been approved by the European Commission;
- NEK has already invested about 1 billion EURO in the Project;
- The claims of Atomstroyexport against HEK are in progress – the decision of the Geneva court is expected to be announced in the beginning of 2016

I.1.3 How much will it cost?

- **EPC:** This cost represents inseparable part of ASE's tender proposal for EPC Contractor. It amounts at approximately € 3 997 260 000.

- **OWNER'S COSTS:** These costs are related to the construction of infrastructure necessary for the Belene NPP operation (mainly this refers to the electrical network, however, it includes also the roads, Water Supply and Sewerage, etc.). The cost is estimated to be €1.371 billion.

- **ESCALATION:** Such projects involve significant inflation risk, which is due to the long period necessary for the NPP's construction and also to the increase of the prices of goods and labor. ASE proposes to fix the EPC contract price at € 6.3 billion, i.e. to eliminate the inflation risk by agreeing on an escalation of € 2.3 billion.

- **FINANCIAL COSTS:** These are the costs for accrued interests. This figure of course is unclear and depends largely on the conditions of the financial agreement.

- **The TOTAL PROJECT COST (TPC) without the financing costs amounts at € 7 797 260 000.**

I.1.3 How much will it cost?

(continuation)

- **OPERATION AND MAINTENANCE COSTS:** These costs are much lower for Nuclear Power Plants as compared to the costs for other power generation sources, which is a great advantage of the former over the latter. It is assumed that such costs will amount at € 110 million yearly.

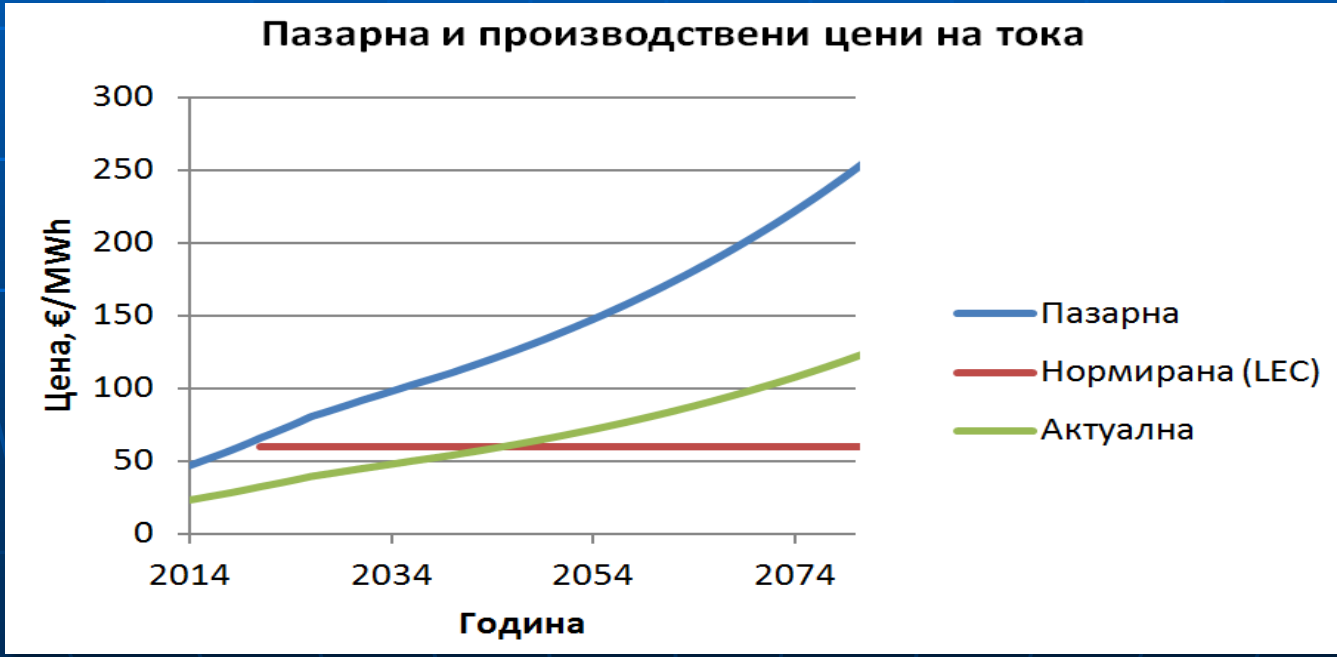
- **RADIOACTIVE WASTE STORAGE AND DECOMMISSIONING COSTS:** The estimated cost is €2 per MWh.

- **ELECTRICITY PRODUCTION COST:** It includes all the above stated components of the price of electricity generated by the plant, i.e. this is the price at which the generated electricity shall be sold, so as to cover all costs related to the plant's construction, operation and decommissioning, not including the escalation. This price, in the case of Belene NPP, will range between € 23-25/ MWh, provided that the cost for both power units is € 5 368 260 000. This price is relevant, if the electricity is to be sold today. In the future both the production cost and the market price will be incremented by one and the same escalation coefficient.

I.1.3 How much will it cost?

(continuation)

- **LEVELIZED ELECTRICITY COST :** The so called **Levelized electricity cost (LEC)** is used quite often in the practice. Although theoretical, LEC is suitable for the comparison of different technologies and designs, since it does not change (annuity cost) throughout the whole plant operation lifetime. It covers all costs related to the plant's construction, operation and decommissioning.
- **The estimated Levelized electricity cost from Belene NPP is about € 60 /MWh.**



**The prediction for the market price values has been elaborated based on analyses and estimates for Bulgaria and the region, as well as on the grounds of IAEA's predictions.*

I.2 Status of the Project for Unit 7 of Kozloduy NPP

I.2.1 Background

- 1. On April 11th, 2012, the Council of Ministers gave its consent in principle, under Article 45, paragraph 1 of the Safe Use of Nuclear Energy Act (SUNEA), for undertaking activities necessary for the construction of new nuclear capacity at the Kozloduy NPP site.

- 2. On May 9th, 2012, the project company Kozloduy NPP – New Build PLC was established, with Kozloduy NPP PLC as a sole owner of the capital. The company's goal is to perform study, design, construction, commissioning and licensing of a new nuclear capacity of the latest generation.

- 3. Up to the present moment, the project company Kozloduy NPP – New Build PLC has performed the following main survey activities:

  - A feasibility (technical & economical) study for technology selection has been conducted and approved;

  - A geological survey of possible locations for the construction of new nuclear capacity at the Kozloduy NPP site has been conducted and approved;

  - A survey for determining the location of the future site for a new nuclear capacity has been conducted and approved;

  - An Environmental Impact Assessment (EIA) for the construction of new nuclear capacity at the Kozloduy NPP site has been developed and approved.

I.2.1 Background

(Continued)

- 4. By Decision No. 772 dated December 11th, 2013, the Council of Ministers took the following decisions:

- It approved the Minister Stoynev's Report on undertaking activities necessary for the construction of a new nuclear capacity at the Kozloduy NPP;

- The Ministry of Economy and Energy (MEE) shall authorize the Bulgarian Energy Holding (BEH) to conclude a Strategic Investment Agreement with Toshiba Corporation (Japan) for the implementation of the project – "Construction of a new nuclear power capacity at Kozloduy NPP", with the technology of Pressurized Water Reactor (PWR) – using Westinghouse Electric Company's (USA) AP III 1000 + pressurized water reactor;

- The MEE shall supervise the negotiations.

- 5. Subsequently, by Decision No. 378 dated June 6th, 2014, the Council of Ministers approved Minister Stoynev's Report on changing the investor from Toshiba Corporation (Japan) to Westinghouse Electric Company (USA).

- 6. After intensive negotiations, on August 8th, 2014, a Shareholders' Agreement was signed between Kozloduy NPP – New Build PLC, Kozloduy NPP PLC and Westinghouse Electric Company (USA) for the construction of new nuclear capacity at the Kozloduy NPP site.

I.2.2 Status

- Under the terms and conditions of the Agreement, it will enter into force after its approval by the next government of the Republic of Bulgaria.
- It is supposed that currently the Government of Bulgaria fulfills this decision.

I.2.3 General information

FOR A III+ E GENERATION NUCLEAR UNIT OF AP- 1000 TYPE, IT IS KNOWN THAT:

- It's a Unit with priority of the passive safety systems;
- This type of reactor is not yet licensed for construction in any country of the European Community;
- According to its other technical characteristics, it can be said that it is equivalent to the project for NPP – 92 (B 466), designed for BNPP construction.

I.2.4 How much will it cost?

- **ACCORDING TO DATA PROVIDED BY WESTINGHOUSE TO THE MEDIA, IT IS EXPECTED:**

- That KNPP Unit 7 will cost $ 7.7 billion, whereas the nuclear Unit AP 1000 alone will be about $ 5.3 billion. This estimate does not include the costs for connection, for supporting infrastructure construction, for RAW storage facility and SF storage facility. This sum does not include also the costs for decommissioning of the future Unit 7;

- That the price of electricity will be $ 75 for MWh;

- That Unit 7 will be commissioned not earlier than 2025.

I.3 Conclusions

- **Conclusions**

- The idea to have a new NPP in Bulgaria is not dead !!!

- For both projects there are available preconditions which giving us a hope that they will be started according to their readiness and necessity for new electricity production capacity in Bulgaria.

I.4 Other projects

- I.4.1 Units 5 and 6 in NPP Kozloduy Live Time extension
- - the project is under development
- - it will take about 10-15 years for both units
- - the estimated cost is about 400 millions EURO
- - for the moment active work is going on unit 5 – new license is expected to be issued by ANR at 2017
- I.4.2 Decommissioning of units 1-4
- - project is in force since 2002. Expectation is to be finished in 2030
- - financing is provided by EBRD – European Commission – until this moment are used about 500 millions
- - the main projects which are in force now are : construction of Radiana storage for low and meddle level RAW, construction of the workshop for reprocessing of the materials form decommissioning; preparation of project for decommissioning of the primary circuits of units 1-4 and others

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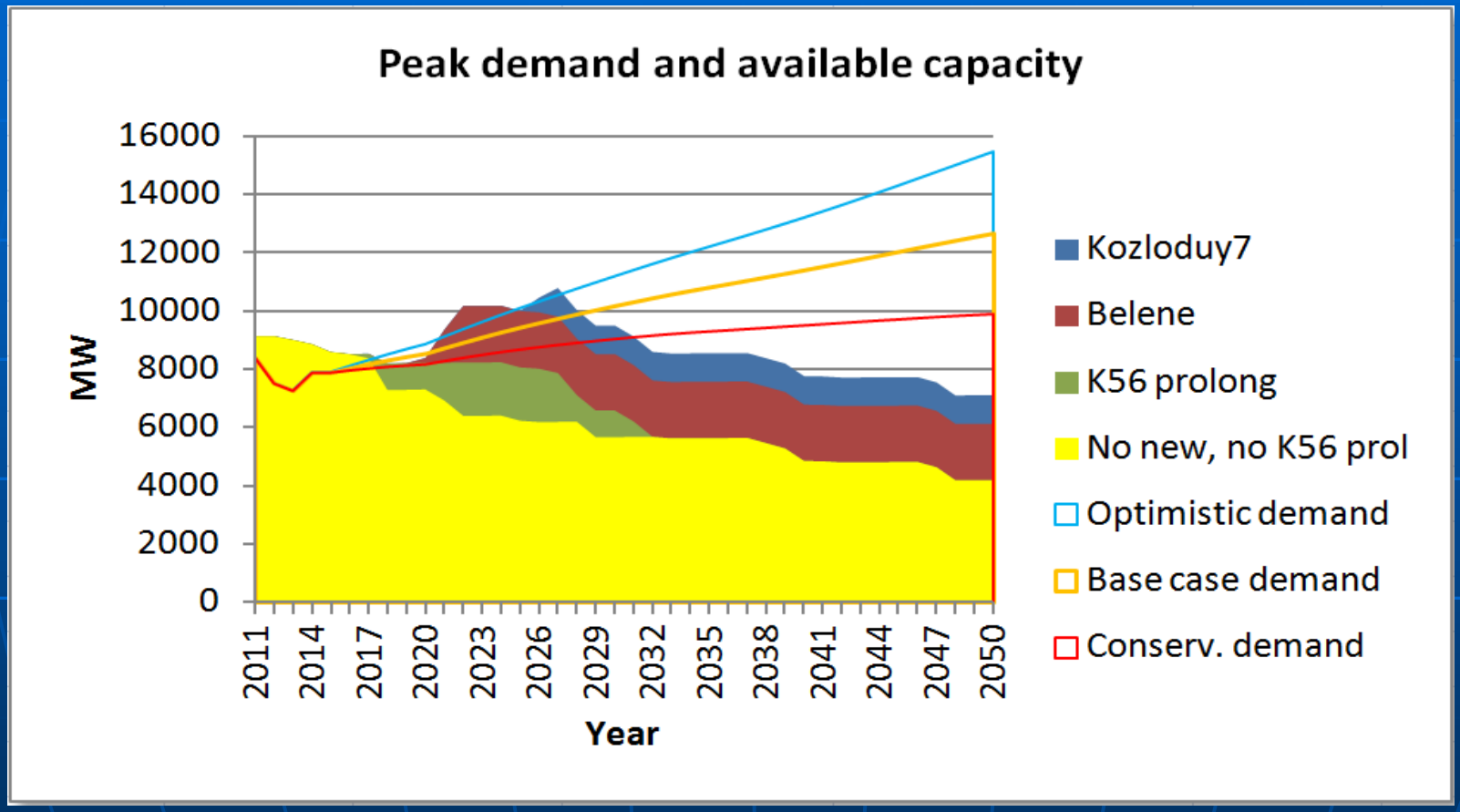
II. NECESSITY OF CONSTRUCTION OF NEW GENERATING CAPACITIES FOR THE ELECTRIC POWER SYSTEM IN BULGARIA, INCLUDING NUCLEAR CAPACITIES

II.1 System Information

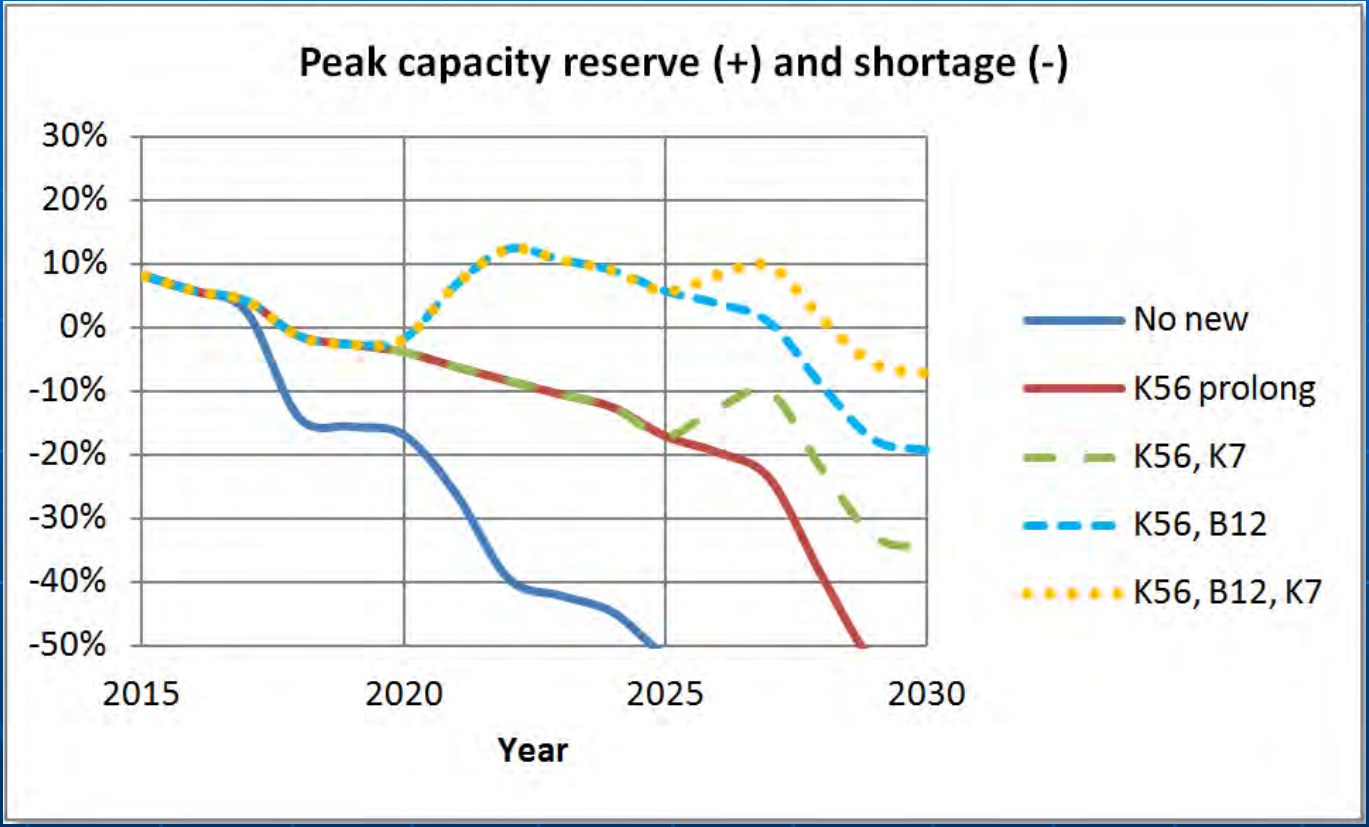
Installed Power Capacity Type	Installed power capacity MW	Commissioning Period	Percentage of the Total Installed Power Capacity %
NPP	2000	In operation since 1991-1993 (at operation life of 30 years)	18.3
TPP on lignite coals	3298	The last two units are in operation since 2011. (at operation life of about 25 years) and the older units are commissioned in the period of 1966-1985 .	30.1
TPP on black and brown coals	850	Commissioned in the period 1964-1985. (at operation life of about 25 years)	7.8
Factory and Heating Plants	794	Commissioned in the period of 1956-1988. (at operation life of about 25 years)	7.2
Generating capacities of Renewable Sources of Energy including: -Water -Wind -Sun -Biomass	4001 2223 694 1038 46	The last significant water power was commissioned in 2009. Commissioned after 2004 Commissioned after 2004 Commissioned after 2004	36.6
-Total installed power capacity	10943		100

II.2 Available Power Capacity and Peak Demand, MW



- **BNPP Commissioning in 2020-2021. Prior to BNPP startup there is a shortage of peak demand (in 2018- 2019).**
- **KNPP Unit 7 Commissioning in 2025. Nevertheless , there is again a shortage in 2027.**

II.2 Available Power Capacity and Peak Demand, MW



- **Despite the Belene NPP start up in 2020-2021 and the Kozloduy NPP Unit 7 start up in 2025, the cold reserve does not meet the requirements of the European Network of Transmission System Operators (ENTSO-E). Moreover, there is a shortage of power, which shall be compensated by power cuts or import of expensive peak electricity .**

II.3 Conclusions

- II.3.1 It can be seen from the data that the power capacities providing the base load electrical power generation required for the country are ageing and this leads to system instability.

- II.3.2 The future of the structure of our Electric Power System under the new climatic and political conditions, namely:

  – requirements for minimal environmental pollution;

  - requirements for % of installed power capacity from RES ;

  - restructuring of road transport and moving to electric cars;

  - EU plans for development of common Electric Power System are mainly oriented towards: **Electric Power System in which the base load electric power will be generated by the nuclear power industry and the remaining needs will be covered by the electric power energy generated by the RES**.

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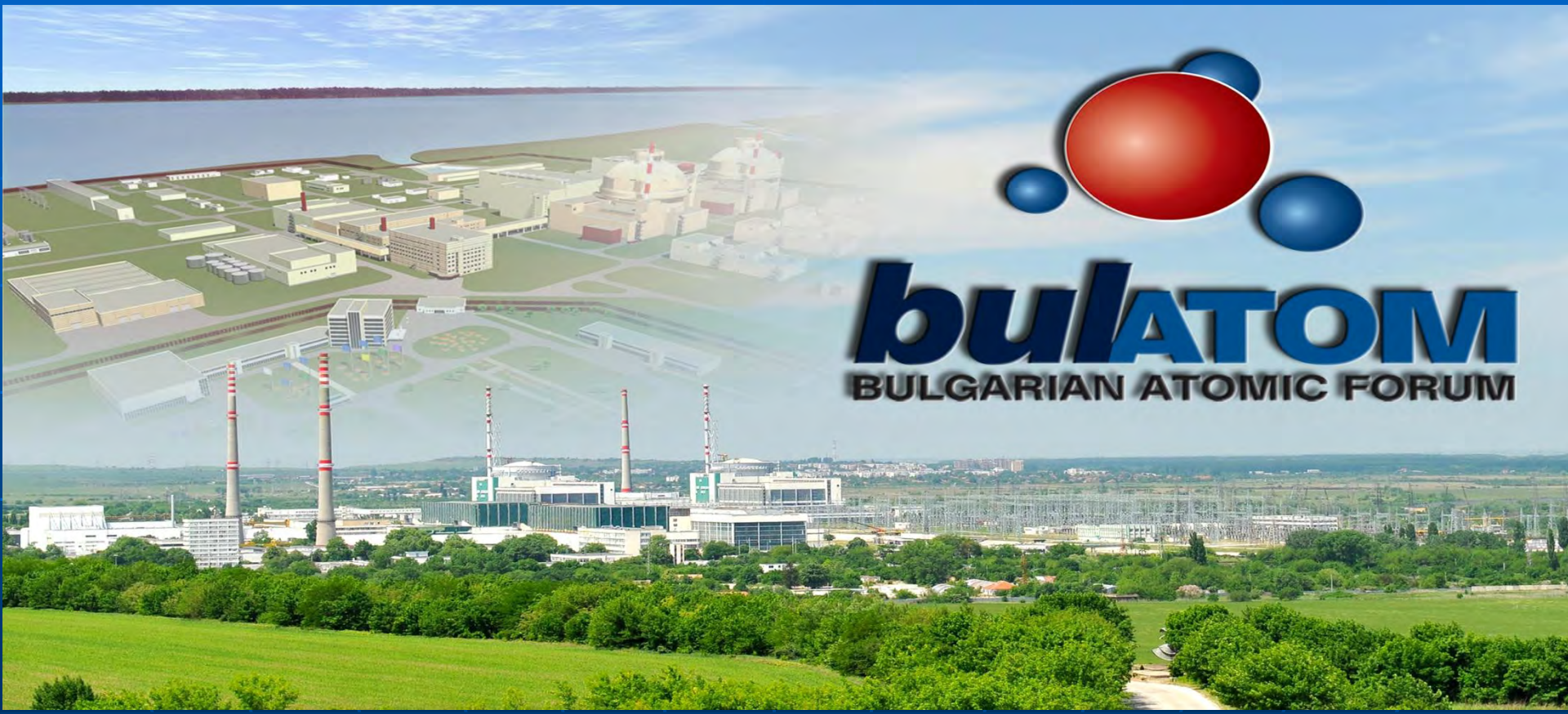

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