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Regional Cooperation for the Energy Transition: The Role of Nuclear Power under
Environmental and Technological Constraints

Engineering Limitations for Implementing the Energy Transition

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BASIC ELEMENTS FOR THE ENERGY TRANSITION ENGINEERING

- **Coping with greenhouse gases concentration increase in the atmosphere;**
- **Drastically reducing fossil fuels combustion as the most utilized process to generate energy;**
- **Replacing combustion processes by electrical power;**
- **Following up the UN sustainable development goals;**
- **Assuring the existence of firm baseload energy;**
- **Considering additional losses of efficiency and transmission.**

RENEWABLES AND SUSTAINABILITY

- **Solar photovoltaic and wind energy require a large number of units per installed kW, leading to an early depletion of minerals like copper, lithium, nickel, cobalt and rare-earth elements, nickel and zirconium and platinum-group metals;**
- **Off-shore wind energy plants use ~15,500 kg/MW, on-shore plants ~10,000, solar energy ~7,000, nuclear ~5,000;**
- **UN sustainable development goals require among others the protection of biodiversity and the preservation of indigenous populations' dwelling places;**
- **Hydroelectric dams with reservoirs may be incompatible with these goals, requiring "run-of-river" type solutions subject to climatic intermittence.**

BASE LOAD

- **Assure the stability of the transmission lines by keeping the electric frequency constant;**
- **The existence of firm baseload energy guarantees a constant electrical frequency;**
- **Fossil fuel thermal plants, hydropower plants with important reservoirs and nuclear plants are used to generate baseload energy;**
- **The future trend will lead to the use of hydropower with reservoirs, biofuels and nuclear energy and to the increase of interconnection of electrical transmission systems across countries' borders.**

SYSTEMS EFFICIENCY AND TRANSMISSION LOSSES

- **Maximum electricity usage will diminish the efficiency of thermal energy consumption (home heating, cooking processes, electric cars usage);**
- **Entropy will be higher in future human-life systems;**
- **Efficiency of steam powered systems will also decrease due to higher condensing temperatures as a result of climate change phenomena;**
- **Power transmission from distant sites of solar and wind power sources will also generate important efficiency losses;**
- **The amount of power to be supplied will be much higher.**

NUCLEAR AS ONE OF THE CLEAN ENERGIES

- **The drastic reduction of carbon emissions will lead to the use of technologies that limit the combustion of fossil fuels;**
- **A more pronounced use of so-called clean energies (renewables, run-of-river hydro, biofuels and nuclear);**
- **Baseload will be supplied by hydropower plants with reservoirs and by nuclear power plants;**
- **The nuclear industry is the only one that contains, processes and controls its solid, liquid and gaseous wastes;**
- **Built near consumption centers, without long transmission lines, nuclear units require little space for installation.**

BRAZILIAN NUCLEAR COMMERCIAL ADVANTAGES

- **Brazil has been internationally recognized as an exporter of enriched uranium for nuclear power plants based on its process of centrifuge enrichment;**
- **Brazil has large amounts of natural uranium mineral resources and the expertise of fuel element manufacture, as well as the knowhow for LWR nuclear power engineering;**
- **Brazil is one of the few countries in the world to be able to provide enriched fuel elements under regional and international safeguards treaties;**
- **Brazil is now the only Latin American country with such rights.**

CONCLUSIONS

- **Due to global warming electrical energy will be used more intensively, replacing fossil fuels with sources that do not emit greenhouse gases;**
- **Electric power will be used in large scale;**
- **Pursuant to policies based on the UNSDGs the installation of fossil fueled plants, as well as of hydropower plants with large reservoirs, will be largely reduced;**
- **Combustion of fossil fuels will be replaced by clean energy sources, like renewables and nuclear;**
- **It will be necessary to ensure a generation of baseload power that accompanies generation by intermittent energy sources;**
- **Brazil is one of the few countries in the world to be able to manufacture and furnish enriched fuel elements under regional and international safeguards treaties;**
- **To provide clean baseload power in sufficient scale, near the consumption centers, the proven and available technology that exists is nuclear power.**