EUROPEAN
COMMISSION

Brussels, 9.1.2023
COM(2023) 1 final

**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS**

**JRC technical report on "Assessment of the potential for energy efficiency in electricity generation, transmission and storage"**

{SWD(2023) 1 final}

**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS**

**JRC technical report on "Assessment of the potential for energy efficiency in electricity generation, transmission and storage"**

## Summary of JRC technical report on "Assessment of the potential for energy efficiency in electricity generation, transmission and storage"

The report presents, with a non-technical approach, the results of an assessment carried out to evaluate the potential for energy efficiency in conversion, transformation, transmission and storage of electric energy.

The report follows the guideline that is outlined in Article 24.13 to the Energy Efficiency Directive 2012/27, as amended by the Directive 2018/2002; examining the three main pillars of possible energy efficiency development, namely conventional fuels, storage and High Voltage Direct Current (HVDC) transmission. Therefore, the document describes those three main technological solutions focusing on energy efficiency, to explore possible savings potentially obtainable. The report contains a review of current efficiency levels, of known margins for improvements, and a rough estimate of possible primary energy savings at European level; first it investigates the single technological solutions separately; then presents conclusions and ranking in the last Chapter.

**Chapter 2** presents the results on the technology adopted and efficiency assessment in thermal power plants, with particular reference to conventional fossil fuels (coal, gas, oil) power stations, complemented by selected statistical data about efficiencies, consumptions, capacities, etc. The report describes current and prospective efficiency levels including estimates of potential primary energy savings under some assumptions related to the decarbonisation policy currently adopted.

The reason why efficiency in renewable electricity generation is not researched is essentially economic. The cost structure of the most common generation facilities is strongly lopsided towards investment costs (CapEx), while operation cost (OpEx) are limited to maintenance, as the operators do not have to pay for fuel cost. Consequently, the conversion efficiency of renewable electricity generation, although technically interesting, has not been actively researched, and scientific literature is quite limited. Not very different considerations apply to the nuclear electricity generation: in most operating nuclear reactors only 30-35% of the thermal energy produced by the fission is converted into electricity, while the remaining is dissipated in the environment as waste heat. This share has only marginally improved in the last few decades. The cost structure of the nuclear electricity generation is quite similar, even if not identical to the renewable one; the bulk of the costs are represented by the CapEx (building and dismantling the plants), while the cost of fuel (usually enriched Uranium) only represents a small share of the total generation cost; also in this case the issue is poorly researched, as the priority is improving safety and reducing downtime for refuelling and maintenance. Some projects of the upcoming ‘Generation IV’ reactors are designed for an higher efficiency, but to date only prototypes exist.

**Chapter 3** describes several different types of storage available for electric systems explaining the maturity of technologies, while providing more details for those technologies that show current and future better perspectives (hydro pumped power stations, batteries, compressed air, flywheels). Although the report supplies roundtrip efficiency assessments, one should also consider that a direct comparison in terms of efficiency among storage alternatives that might be addressed to the solution of very different technical issues, is difficult. The report explains for example that one cannot use (yet) supercapacitors to deal with large amount of energy; each technical problem should be addressed by the proper class of storage systems; within that class, of course, the most efficient technology should be adopted. The key message is that storage technologies are interesting not because they allow a direct saving of primary energy, but because they make it possible to integrate energy coming from Renewable Energy Sources (RES) into power systems, thus improving the efficiency of the system as a whole.

**Chapter 4**, dealing with HVDC transmission comes to similar conclusions: improving the efficiency of transmission systems, which is already very high (about 98%) and approaching the physical limits it is not suitable. HVDC transmission is interesting because it makes it possible to transfer energy in conditions where HVAC systems would neither be technically nor economically affordable, and this is true in particular for subsea cables that allow the integration of wind power from large off-shore wind farms, thus resulting in an indirect saving of primary energy. The chapter therefore describes the main characteristics of HVDC systems and presents the operating conditions leading to best efficiency and highlights possible future uses in the European context. In fact, the real efficiency improvement is indirect, i.e. improving the integration of renewable energy sources and minimizing curtailment; however these issues, as well as system integration, demand response and energy demand in general are outside the scope of the study.

**Chapter 5** reports the conclusions of the assessment carried out on the potentials of each technology for what the energy efficiency is concerned. Wherever possible, a quantification of realistic saving has been performed, under simplifying assumption, showing the potential for improvements in terms of primary energy saving.