Nuclear energy: the solution for a clean energy transition?

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Abstract - For years, public opinion has been divided on the question of nuclear power as an energy of the future. Nevertheless, the media influence public opinion to "de-demonize" nuclear power. The media contribute to the popularization of nuclear power by blocking out fake news, and thus mitigate the fear that surrounds this resource. Now that the public is **better informed about this previously sensitive subject**, its perception has totally evolved (Figure 1: The evolution of nuclear perception). Indeed, nuclear power is seen as green energy (HO, Shirley S. and KRISTIANSEN, S.). **Therefore, it prompts us to question to what extent the transition to clean energy is conceivable, ensuring the fulfillment of needs while also considering the sustainability of nuclear energy.** Technical advances have been made to enhance nuclear safety and improve radioactive waste management. Yet nuclear power causes the **fewest deaths** per gigawatt per year, in other words 0.4% per gigawatt produced, compared with 36% with oil. Nowadays, people know nuclear power is a key part of the world's energy mix. Unlike fossil fuels, it does not emit greenhouse gases, which helps mitigate climate change. Nuclear power delivers reliable, stable energy output that meets electricity needs in developing and developed countries. It's a workable solution in the event of major economic crises. Nuclear energy can also be an asset for a sustainable and responsible ecological transition according to Alonso, Brook and Manelay in 2014 (BROOK, Barry W., ALONSO Agustin, MENELEY, Daniel A., and al). Indeed, nuclear energy can complement renewable sources as a sustainable solution for clean energy production. Nuclear energy provides a constant baseload supply, while renewable sources can be intermittent due to weather conditions. To address this variability, energy storage systems (ESS) are promising but not an ideal solution because currently verry expensive. Thermal energy storage is a viable alternative, allowing excess energy to be stored and converted back to electricity when needed. Alternatively, surplus energy can be directly utilized in industrial, commercial, or residential sectors, such as water desalination or powering electric vehicles. Coordination and flexibility are essential, facilitated by emerging technologies like Artificial Intelligence (AI), Internet of Things (IoT), big data analytics, machine learning, and wireless 5G. These technologies enable real-time monitoring and optimization of the energy grid, minimizing waste and maximizing efficiency. (KIM, Jong H. and ALAMERI, Saeed A.). However, insofar as nuclear power is highly dependent on water resources, **its sustainability must be questioned**. For instance, climate change and especially the increasing number of extreme events (such as drought), have an impact on the French nuclear power supply sector. Indeed, current climate scenarios project **a decline in summer and spring precipitation, leading to reduced river runoff and increased water temperatures**. This could result in partial shutdowns of nuclear power production during periods of extreme drought with a possible reduction in electricity production, and this is exacerbated by heat waves. Given the huge role of nuclear power in the French energy supply, any reduction in nuclear power production during extreme weather events could have deep economic implications. Changes in energy availability can influence production in other sectors, which can affect overall GDP (HANSKI, J., ROSQVIST, T. and CRAWFORD-BROWN, D.).

Keywords: nuclear energy, renewable energy, clean energy, new technologies, climate change, drought

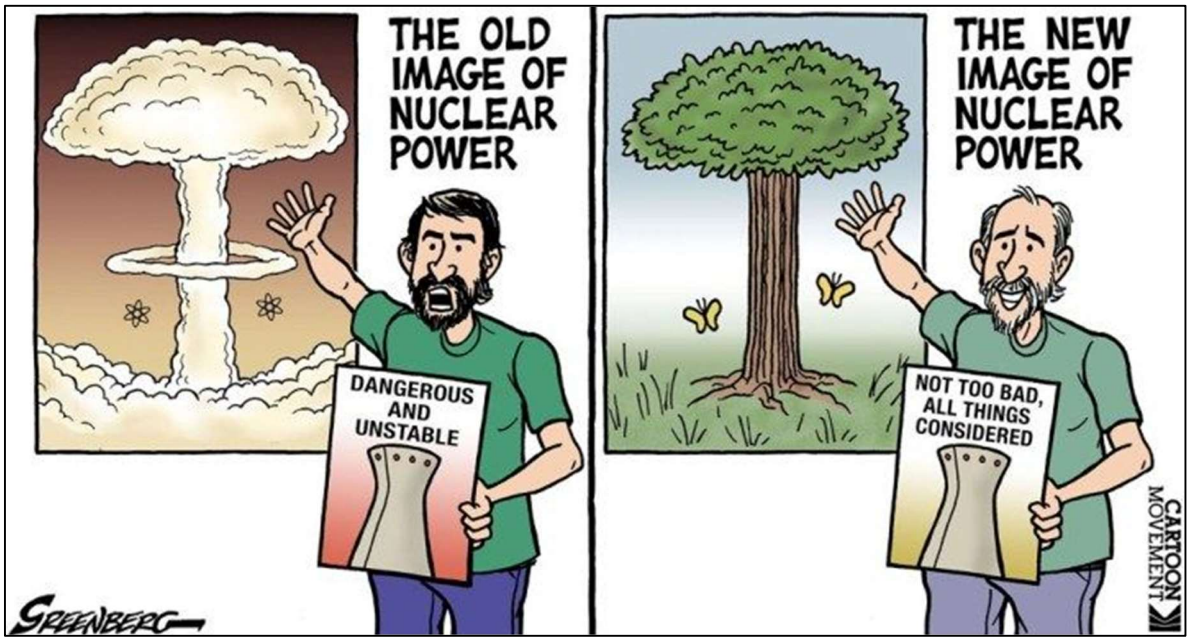

Figure 1: The evolution of nuclear perception

This cartoon entitled "Nuclear Power: Then and Now" was created by an American cartoonist, Steve Greenberg. It was published on the online platform *Cartoon Movement* on the 29th of March 2009. The cartoon deals with the topical question of nuclear power and highlights how climate change debate has changed the way people look at this source of energy. This cartoon represents two different perceptions of nuclear energy through the time.

Indeed, on the left-hand side, an old vision of nuclear energy is emphasized. In this initial portrayal, nuclear energy is represented as something dangerous that needs to be stopped, as evidenced by the man's expression of discontent towards nuclear energy. He also holds a sign that reads "dangerous and unstable" further underscoring the negative perception of nuclear power. Moreover, behind him (on the background) is a large poster depicting a mushroom-shaped cloud emitting atoms, reminiscent of a nuclear explosion. Indeed, it might reference various nuclear disasters, such as Three-Mile Island in 1975, Chernobyl in 1986 or Fukushima in 2011. The main colours in this first image are warm with a gradient from red to black. There is some red (from his sign) and some orange and brown (from the explosion). These colours evoke fire and danger. Furthermore, the green T-shirt worn by the man contrasts with the red of his sign as if he were spearheading the ecological cause.

Nevertheless, on the right-hand side, the same man has aged, and his perception of nuclear energy has shifted. His facial expression has changed as well, and he is now smiling. His sign once again references nuclear energy, but now qualifies it as "not too bad, all things considered". Moreover, the mushroom-shaped cloud has morphed to a tree where butterflies replace atoms. Colours are now colder, with blue, green and brown, reminiscent of nature. Indeed, nuclear energy has been considered as a green energy source since 2022. The man's clothes are duller, less vibrant than in the first image. This clearly signifies a change in opinion, where the man appears more at ease and knowledgeable about how nuclear power works. It suggests that the latter is the least polluting energy and the most suitable for our energy consumption.

To conclude, the cartoon offers a representation of the evolution of perceptions around nuclear energy. It illustrates two contrasting points of view of the same person. This transformation reflects broader societal changes influenced by the climate change debate and advances in the understanding of nuclear technology. Ultimately, the cartoon prompts reflection on how changing perceptions shape our attitudes toward energy sources and environmental sustainability.

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