Renewable and Sustainable Energy Reviews 32 (2014) 16–28

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Assessment of the actual sustainability of nuclear fission power

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ARTICLE INFO

Article history:
Received 22 August 2013
Received in revised form
16 December 2013
Accepted 4 January 2014
Available online 23 January 2014

Keywords:
Economics of nuclear power
Nuclear and CO_2 emissions
Nuclear risk acceptance
Loss of human habitats
Independent nuclear agency

ABSTRACT

This paper uses 19 criteria to assess whether nuclear fission power can be a part of sustainable development. This yes or no qualitative evaluation is due prior to ongoing marketability assessment and promotion of nuclear power by, for example, the IAEA, the IEA and the UK government. The criteria are classified into five groups. 'Planet' results demonstrate that the incompatibility of nuclear expansion with electricity efficiency and full renewable power deployment largely overshadows the carbon-free steam generation of nuclear fission. 'Prosperity' analyses show that including rolled-off costs and risks would raise bills to heights difficult to quantify due to doubts, long-term invisibility and irreversibility. 'Risks' may be catastrophic and are not insurable, while weaponry proliferation adds a further dimension. 'People' analyses reveal that some nuclear power is affordable for present generations when many costs remain unpaid; however, developing countries cannot afford the capital costs and technology intensity, and catastrophes wreak havoc on national economies, singling out exposed communities losing their habitats. 'Politics' assessments demonstrate that nuclear technocracy dominates the scene in many countries; the technocrats heavily influence policy-makers, the media, and celebrities speaking out in favor of nuclear. We identify the need for an independent global agency and for independent national nuclear regulatory institutions to safeguard the public interest.

Contents

Abbreviations: 2DS, IEA's 2 °C Scenario; CCS, Carbon Capture and Storage; UK DECC, UK Department of Energy and Climate Change; EPR, European Pressurized Reactor; GDP, gross domestic product; Gen IV, fourth generation nuclear technology; GHG, greenhouse gases; IAEA, International Atomic Energy Agency; IEA, International Energy Agency; INPRO, International Project on Innovative Nuclear Reactors and Fuel Cycles (by IAEA); IPCC, Intergovernmental Panel on Climate Change; NAIIC, Nuclear Accident Independent Investigation Commission; NPT, Non-Proliferation Treaty; NRC, Nuclear Regulatory Commission, USA; PWR, pressurized water reactor; SD, sustainable development

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http://dx.doi.org/10.1016/j.rser.2014.01.008

1. Introduction

Addressing climate change implies decarbonizing electricity generation as the most important energy system-wide change, with a critical role for energy efficiency [1]. Renewables and nuclear power are substitutes for fossil fuel-based electricity generation. Leading institutions such as the International Energy Agency [1], the International Atomic Energy Agency [2] and the UK Department of Energy and Climate Change (DECC) [3] apply their sustainability assessment frameworks to the nuclear power option and conclude that nuclear power can form a legitimate part of a sustainable energy mix, providing certain challenges are met. This paper aims to answer the research question of whether the renewed 'policy push' for nuclear power is indeed warranted from a sustainable development point of view.

According to the IAEA [2], the concept of sustainable development encompasses three interdependent and mutually reinforcing pillars: social development, economic development and environmental protection, all linked by effective government institutions. This fourth dimension, 'Institutions and Policies', is assigned the limited task of managing the complicated industrial activities involved in nuclear systems. Linking certain principles, criteria and requirements to each of these four dimensions, the IAEA has developed an extensive framework for assessment. However, in accordance with the IAEA's mandate, this framework also serves to effect the 'responsible promotion' of nuclear power. In the IAEA framework, 'responsible' denotes accordance with the status quo in energy supply thinking and practice. This is exemplified by several 'acceptance limits' placed on the assessment criteria, such as: 'Meet regulatory standards of a specific Member State' [3, p. 84]; 'Lower consequences compared to existing facilities' [3, p. 106]; 'the generation of waste shall be kept by design to the minimum *practicable*' [3, p. 18]; 'waste shall be managed in such a way that *undue burdens* are not imposed on future generations' [3, p. 18] (our emphasis). Identifying and applying 'best current practices' is no guarantee that these practices meet the standards of sustainable development, however. The IAEA is failing to address the fundamental question of nuclear power's role in a sustainable energy future.

The IEA [1], on the other hand, situates the sustainability challenges facing nuclear power within a narrow techno-economic framing of climate change mitigation. Based on techno-economic optimization modeling, nuclear power is positioned as a vital contributor to the IEA's 2 °C Scenario (2DS). According to the IEA, however, nuclear power remains hampered by four types of impediments or 'challenges', which correspond to the usual sustainability dimensions. The technical and market challenges are considered, respectively, to be 'technological developments to improve safety, performance, lifetime management, radioactive waste handling' [1, p. 127] and 'very large capital cost to build nuclear power plants' [1, p. 127]. Meanwhile, 'supply chain capabilities, human resource availability, lack of regulatory framework' [1, p. 127] are the challenges identified at the institutional and political level. Social and environmental challenges are grouped within one category and comprise 'final disposition of waste and public concern about safety risks' [1, p. 127]. Remarkable is the blindness of IEA for the actual risks associated with nuclear power. The IEA is not addressing the risks, but the public not willing to accept the risks: 'to reach nuclear goals, countries need to make significant efforts to convince an increasingly skeptical public that nuclear power should continue to be part of the future energy mix' [1, p. 73]. Thus, the IEA approach is limited to the marketability of nuclear power, and does not extend to a consideration of its sustainability.

Finally, the UK DECC's sustainability appraisal of the national nuclear policy statement [4] emphasizes mainly environmental and health sustainability criteria, while social criteria are limited to the impact that building new nuclear power plants may have on employment opportunities and the welfare of local communities. This limited scope obviously falls short of a full sustainability appraisal of the nuclear option.

This brief review of assessment frameworks in use reveals that an extended framework for proper prior assessment of nuclear fission power's suitability for advancing sustainable development (SD) is lacking. We propose nineteen criteria for the effective assessment of nuclear fission power in terms of sustainability, which are summarized in Table 1 and discussed briefly in Section 2. The nineteen criteria are classified into five groups. Four of these groups align with the four dimensions of sustainability (planet, prosperity, people and politics), while one additional group addresses the nuclear risks pervading the other four dimensions. Following a brief discussion of the nineteen criteria (Section 2), the remainder of the paper is structured to correspond to the five groups: planet (Section 3), prosperity (Section 4), risks (Section 5), people (Section 6) and politics (Section 7). The risk group is placed in the middle of the five, because nuclear risks affect nuclear fission power's performance on the criteria of the four other groups.

2. Framework for assessing whether nuclear power can be part of sustainable development

At the Rio summit in 1992, SD was universally approved as preferred paradigm for structuring our common future [5]. Since