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THE ROLE OF NUCLEAR POWER IN SUSTAINABLE LOW-CARBON ELECTRICITY SYSTEMS

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Overview

Nuclear technology is considered by most international institutes as one of the four major low-carbon energy options, coming in line after demand-side management including enhanced energy efficiency and renewable energy supplies, but before carbon capture & storage. Today, nuclear GenII or GenIII (+) fission reactors deliver medium-pressure steam for power generation, with other technologies (the so-called GenIV options - breeders, high-temperature reactors - or GenV option - fusion) in demo phase. This demo research aims to develop the 'sustainable' nuclear power of the future – i.e. safer, more resistant to proliferation, less resource intensive, and producing lower quantities of high-level waste.
Most analysts and modelers juxtapose nuclear and other low-carbon supplies. This practice is investigated from a theoretical perspective, supported by empirical evidence about the composition and functioning of integrated power supply systems.
For the future several authorities foster much hope for the GEN IV and GEN V nuclear technologies. Technology assessment is cumbersome and requires well-established frameworks, in particular when sustainability assessment is pursued. Because no common, globally accepted methodology is approved, there exists a large discrepancy across the assessments. It is explored how sustainability assessments of nuclear power are performed by public authorities and their authorized institutes. Recommendations about proper frameworks may be derived.

Methods:

The paper will be the result of desk study of mainly two streams of publications. First, the reports by established institutes like: IEA (International Energy Agency), IAEA (International Atomic Energy Agency), IPCC (Intergovernmental Panel on Climate Change): 5th Assessment Report by Working Group III (April 2014). The focus will be on the latest IPCC report, because IPCC has a mandate and mission to be globally comprehensive and balanced, without being policy prescriptive.
Second, reports about the actual functioning of various types of low-carbon power plants in integrated power systems. Because various countries have developed different compositions in power generation, a panel of a few representative cases will be selected.

Results:

The future of nuclear power in the electricity supply systems depends on the proper analysis and modeling of the interaction between nuclear power and the twin efficiency-RE as leading low-carbon options. A simple juxtaposition of the options fails to reveal important interactions in practice. The significance of the juxtaposition failure still has to be assessed.
The comparative analysis of assessments carried out by international institutes, in particular by the 2014 working group III report of IPCC, will deliver suggestions and propositions for an improved sustainability assessment framework to evaluate the role of nuclear fission reactors in low-carbon electricity supply systems.

Conclusions:

More informed conclusions about the expectations with respect to nuclear power as a low-carbon energy supplier may be derived from the research proposed above, and from the results that will be presented at the conference. Because nuclear power is a contentious issue, the findings will be discussed from a variety of perspectives (discourses).

References:

IAEA, International Atomic Energy Agency (2009) "IAEA tools and methodologies for energy system planning and nuclear energy system assessments", Vienna.

IPCC, Intergovernmental Panel on Climate Change (2012). “Renewable energy sources and climate change mitigation, Chapter 8: Integration of Renewable Energy into Present and Future Energy Systems”, pp. 609-705, Cambridge University Press.
IPCC, Intergovernmental Panel on Climate Change (2014). “Fourth Assessment Report. Working Group III: Mitigation, Chapter 7: Energy Systems”, www.ipcc.ch
Joskow,P.L. and Parsons, J.E. (2012) The Future of Nuclear Power After Fukushima, Economics of Energy & Environmental Policy, 1(2): 99-113
Manfren, M., Caputo, P., Costa, G. (2011). Paradigm shift in urban energy systems through distributed generation: Methods and models”, Applied Energy 88: 1032-1048
Stoft, S. (2002) “Power System Economics. Designing Markets for Electricity”, IEEE Press, Wiley-Interscience, 468p.
Verbruggen, A., Laes, E., Lemmens, S. (2014) “Assessment of the actual sustainability of nuclear fission power”, Renewable and Sustainable Energy Reviews 32: 16-28