Oct 05, 2017

Can Nuclear Energy Thrive in a Carbon-Constrained World? Findings from a new MIT study

Jacopo Buongiorno

Professor
Department of Nuclear Science and Engineering, Massachusetts Institute of Technology, Cambridge, MA

ABSTRACT:

With 60 new reactors under construction worldwide, the nuclear industry is currently experiencing moderate growth, mostly concentrated in Asia. However, a much greater expansion is needed if nuclear is to play a significant role in combating climate change. The challenges hindering further growth of nuclear energy utilization include: (i) the high capital cost (3-5 billion dollars per 1000 MWe of installed capacity) and long lead time (5-7 years) required to build new plants; (ii) the negative perception about safety of nuclear plants in the public and governments of some countries; (iii) the economic and regulatory challenges of developing advanced nuclear technologies; (iv) a scarcity of sites suitable for new nuclear plants (NIMBY syndrome); (v) an inherent inability of nuclear plants to adapt to changes in market conditions (merchant vs. regulated) and/or mode of operation (load follow vs. baseload); and (vi) the concerns about disposal of nuclear spent fuel. If these challenges are properly addressed, there are major opportunities for nuclear to reduce carbon emissions worldwide and conquer new markets. For example, replacement of all coal-fired power plants in the U.S. would require about 200 GWe of baseload nuclear electricity. Moreover, the Electric Power Research Institute (EPRI) has estimated that 150-200 GWe would be needed to generate enough electricity to enable conversion of the whole fleet of passenger cars and light trucks in the U.S. to plug-in hybrids, thus effectively ridding the U.S. of its dependence on oil, and drastically reducing the emissions of greenhouse gases into the atmosphere. Similar figures (properly scaled) apply to most other major industrial and developing countries worldwide. MIT has launched a multi-disciplinary study, to assess the prospects for new nuclear technologies, policies, business models, and regulatory governance to accelerate the transition to a lower-carbon global energy system in the U.S. and around the world. Here we present a set of preliminary findings from the MIT study that are focused on (a) cost competitiveness of nuclear in various markets with and without carbon constraints, (b) technology innovations that could substantially reduce the capital cost of new nuclear plants, and (c) regulatory pathways to accelerate the deployment of advanced reactors.

BIOGRAPHY:

Jacopo Buongiorno is the TEPCO Professor and Associate Department Head of Nuclear Science and Engineering at the Massachusetts Institute of Technology (MIT), where he teaches a variety of undergraduate and graduate courses in thermo-fluids engineering and nuclear reactor engineering. Jacopo has published over 70 journal articles in the areas of reactor safety and design, two-phase flow and heat transfer, and nanofluid technology. For his research work and his teaching at MIT he won several awards, including, recently, the Ruth and Joel Spira Award (MIT, 2015), and the Landis Young Member Engineering Achievement Award (American Nuclear Society, 2011). He is the Director of the Center for Advanced Energy Systems (CANES), which is one of eight Low-Carbon-Energy Centers (LCEC) of the MIT Energy initiative (MITEI), as well as the Director of the MIT study on the Future of Nuclear Energy in a Carbon-Constrained World. Jacopo is a consultant for the nuclear industry in the area of reactor thermal-hydraulics, and a member of the Accrediting Board of the National Academy of Nuclear Training. He is also a member of the Naval Studies Board (National Academies of Sciences, Engineering, and Medicine), a Fellow of the American Nuclear Society (including service on its Special Committee on Fukushima in 2011-2012), a member of the American Society of Mechanical Engineers, and a participant in the Defense Science Study Group (2014-2015).