Dialogue Forum 11

INPRO Dialogue Forum on Roadmaps for a Transition to Globally Sustainable Nuclear Energy Systems

Welcome!

20-23 October 2015
Roadmaps for a Transition to Globally Sustainable Nuclear Energy Systems

Some introductory thoughts

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Major challenge towards sustainability
Reducing the GHG-emissions per TWh used
The evolving role for nuclear energy (1/2)

- Nuclear energy is the most visible though also most contested application of nuclear science & technology since it’s early application in the 1950’s
  - Nuclear energy was and became only available to those energy markets which were able to ‘afford’ it, i.e. initially benefiting of government support and later-on in those energy markets where long-term energy price stability and resource/energy-independency were valued.
  - Contested mainly for three reasons:
    - Safety with Three Mile Island, Chernobyl and Fukushima-Daichi, despite all different in nature, being the prime exemplifications;
    - Radioactive waste arising and the pending (final) management of it;
    - Proliferation risk and security of nuclear technology and materials increasingly debated in a changing geo-political context;
  - Challenged by:
    - Bankability of the nuclear option;
    - Skills (re)development worldwide;
The evolving role for nuclear energy (2/2)

- The energy market as a whole has changed and keeps changing as well:
  - After a liberalisation and deregulation wave since the end of last century challenging the nuclear energy competitiveness, a decarbonisation wave is requested from the energy conversion chain
    - While many energy technologies can be sustainable, they’ll only become in the context of a sustained energy policy towards a sustainable energy future based on lowest CO₂-eq/TWh technologies
    - Nuclear distinguishes from the other low CO₂-eq/TWh technologies, hydro and renewable energy, in providing large scale technology-mature capacity unlimited deployment while also, contrary to most renewable energies, providing high and stable energy return on energy invested (EROEI);
    - Though the bankability of nuclear energy remains a concern.
  - With the increasing socio-political awareness about the necessity to lower CO₂-eq/TWh ‘urgently’, nuclear energy is projected on a significant growth path conditional to
    - Guaranteed safety and security: promised by nuclear industry as no off-site emergency evacuation zone needs for new NPP-designs
    - Socio-politically accepted path forward to manage long-lived radioactive waste
    - Ensured absence and internationally guaranteed zero proliferation risk
Trend of world primary energy demand by fuel

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<th>1998</th>
<th>2008</th>
<th>2050</th>
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<td>TPES</td>
<td>7 228 Mtoe</td>
<td>12 272 Mtoe</td>
<td>22 078 Mtoe</td>
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TPES: Total Primary Energy Supply
Based on 2015-data, projected evolution of existing, under-construction and planned NPPs worldwide

Evolution of nuclear reactor park according reactor generations (reference: nuclInfo v1 2015)
A NPP-park becoming mostly LWR-based
Today’s and medium-term projected Nuclear Energy System
U Resources (RAR and IR)  (Red Book 2013)
Front-End Inventories ... Depleted Uranium
Amount (tHM) of used fuel in 2015

In total some 180 000 tHM used fuel stored in 2015

With varying degrees of maturity for final disposal option
RAR+IR Resources for main producing countries (Red Book 2013)

\[ \Sigma \text{RAR} = 4.6 \text{ M tU} \]

Today’s NPP-Park consumes = 60 ktU/yr

‘Today’s Park use’ = 75 years

\[ \Sigma \text{IR} = 3 \text{ M tU} \]

+ 50 years

SR = 8 MtU

+ 133 years
Impact of mono-Pu recycle in reachable BAU-scenario
“Interim-Storage Limited” and “Voluntary Reprocessing”-scenario used fuel arising
Thoughts on our DF11
Our contribution to major objectives for nuclear energy

- Nuclear energy’s share in primary energy = xx %
  - The “nuclear voice” should be heard more in world energy and sustainability debates
  - The nuclear community has to bring a credible trustworthy story on today’s and tomorrow’s nuclear energy options
    - Provide an internationally up-to-date technology roadmap on nuclear energy credible and trustworthy to all stakeholders

- While nuclear energy is already among the most sustainable energy technologies, nuclear energy can become increasingly sustainable at a limited LCOE-cost
  - Local socio-political-economic conditions will dictate the options and timing to transition to more sustainable nuclear energy systems
  - Despite limited in terms of LCOE, the absolute investments towards more sustainable nuclear energy may go beyond one government or surely company
  - Synergies, through bilateral and multilateral agreements, can facilitate both the introduction and growth of nuclear energy as well as its transition towards more sustainable options
    - Provide informative expertise allowing stakeholders and especially governments and investors to assess their options through synergistic international collaborations