

**Questions and Answers**  
**IFNEC Webinar #5**  
***Energy Synergy (nuclear and renewable) and Hybrid System***

*To be updated upon receipt of other answers*

Question	Asker Name	Answer(s)/[Answered by]
1. For Slovenia, what are the plans and status of the Krsko NPP life extension? And is there future plans for new nuclear plant development and especially SMR's?	Farid Berry	<b>[Answered during session]</b> NPP Krško has started the process of life+A2:D23 time extension. The extension will enable us to operate for additional 20 years until 2043. As presented GEN is developing a new nuclear power plant (project JEK2). We see SMRs as an interesting option. That is the reason why we will continue to follow the development of new SMRs."
2. What is your schedule for proceeding with a Krsko 2 newbuild? When do you envision making a decision to go forward with this, and when would you hope to commission a new reactor at Krsko?	Philip Chaffee	<b>[Answered during session]</b> The newbuild project NPP Krško 2 is ongoing. GEN as the investor has prepared the necessary studies to support the stakeholder's strategic decisions. We have already applied for the Energy Permit and are ready to apply for the Spatial Plannig procedure. We believe that the Building Permit could be attained in five years period and in paralel also the decision on investment."
3. In order to promote further deployment of nuclear power, how can EU Member States with nuclear power programs (or ambitions to have nuclear power programs) ban together to get the EU to change its clean energy taxonomy that currently excludes nuclear power?	Paul Murphy	<b>[Answered during session &amp; live answered]</b> This is an extremely important point. Inclusion of nuclear in taxonomy and access to these funds will be crucial for the future of nuclear in the EU. In order to ensure positive outcome we should support and stimulate nuclear organizations and our governments to support the inclusion of nuclear in the taxonomy."
4. What stage is the Krsko unit 2 NPP development?	Farid Berry	<b>[Answered during session]</b> The newbuild project NPP Krško 2 is ongoing. GEN as the investor has prepared the necessary studies to support the stakeholder's strategic decisions. We have already applied for the Energy Permit and are ready to apply for the Spatial Plannig procedure.

5. To Daniel Levicar: Could You tell about total electricity consumption in Slovenia and electricity flows between neighbouring countries? Forecast for heat consumption in Slovenia?	Valentyn Kyrianchuk	<b>[Answered during session]</b> Slovenia consumes around 15 TWh of electricity per year. 20% of it is imported. Nearly all countries in the neighbourhood are import dependant. Gas demand for heat and industry in Slovenia has declined in the recent years. Households are shifting from oil, wood and gas to electricity (heat pumps). This shift is being subsidized."
6. To Mr. Pablo Ordoñez, to what extent does the current Argentine government hope to see new nuclear generation built at Atucha? What is the status of your talks with CNNC over Atucha-3?	Philip Chaffee	<b>[Answered during session]</b> Atucha III is a project endorsed by the new administration. Conversations with China and ongoing. Very few issues remaining to be agreed. The project will most probably be launched next year.
7. Question to Argentina: Say few word about construction of CAREM reactor. How the construction is in progres? Will it be operational by 2022?	ANDRZEJ MIKULSKI	<b>[Answered during session]</b> No, present plans call for CAREM reactor to be operative in 2024. It is showing good progress, although works are presently suspended due to the pandemia.
8. Many thanks to Juan for your presentation. I am confused with one figure. Why are the shares of "oil shale" included in the "coal" instead of the "oil"?	Jinfeng Li	<b>[Answered during session]</b> I don't know! It should not be so, as you say. It doesn't change the "border" though.
9. CAREM25 will be the FOAK SMR, how is the project develop in the commercial aspect? Are you in any talks to start selling it? Thank you very much.	Guido Zanelli	<b>[Answered during session]</b> CAREM 25 will not be a commercial unit. It may be of interest for some countries as the first (though not commercial) NPP. The commercial module is the next step in the development of the CAREM technology.
10. To Mr. Pablo Ordoñez, how will the commercialization program of CAREM 25 work? When and where will the next CAREM 25 plant be built?	Philip Chaffee	<b>[Answered during session]</b> No plans for another CAREM 25. The next CAREM will be a prototype of higher power.
11. Did you seek feedback from current hydrogen users? How interested are they in nuclear generated hydrogen? Any constraints, conditions?	Aliki van Heek	<b>[Answered during session]</b> Yes. In some cases ultimate hydrogen users have been a part of the analyses conducted that have led to the demonstration projects. In many cases we see a desire for hydrogen produced by non-emitting processes (versus steam methane reforming), which opens

		opportunities for renewable and nuclear energy produced hydrogen.
12. Question for Dr. Ordonez. What is the percent completion of CAREM25 SMR currently under construction? Has a budget been secured to complete the project? When is the target completion date? Thank you.	Akira Fitzsimmons	<b>[Answered during session]</b> Target date, 2024. Percent completion around 60%. Funds allocated year by year.
13. To Ms Bragg-Sitton, Is it possible to incorporate the hydrogen production system into the existing nuclear power plants? Thank you very much.	Jinfeng Li	<b>[Answered during session]</b> Yes. The two projects I highlighted will incorporate hydrogen production at two currently operating plants in the U.S. They both use low temperature electrolysis, which only requires electrical integration, but they are looking to subsequent project phases that will consider thermal interconnection for higher efficiency hydrogen production.
14. Question for Dr. Bragg-Sitton. For the nuclear-hydrogen demonstration, will there be developments in use of machine learning/AI in operational control that may be implemented?	Akira Fitzsimmons	<b>[Answered during session]</b> We are currently conducting research on use of ML/AI for system control. The industry partners lead the operational aspects of the current fleet demonstrations, but we are also working on R&D at the laboratories to implement the next phase of these integrated systems that could be thermally interconnected and thus introduce additional control strategies.
15. To Kamil : Can you kindly explain how Europe will be able to increase until 65% of Renewable and have a stable grid ?	STEPHANE CATHALAU	<b>[Answered during session &amp; live answered]</b> The strategy is based on further investments in grid infrastructure upgrades, increased integration of different energy vectors, further deployment of energy storage systems (considered options include hydrogen & hydrocarbons), and enhanced ancillary services, including improved scheduling and dispatch, frequency and voltage control, and operating power / spinning reserves

16. Mr. Tucek, what would be 500C steam MWh cost from HTGR? In Fermi Energia we calculated based on 800GWh consumption of 200C steam cost below 20€/MWh	Kalev Kallemets	<b>[Kamil Tucek]</b> Based on a preliminary analysis conducted in 2017 (to be further refined in the frame of the currently ongoing GEMINI+ Euratom H2020 collaboration project), the levelised cost of steam is estimated to be 8.3 €/GJ (3 €cts/kWh) at 4% discount rate, and 12.7 €/GJ (4.6 €cts/kWh) at 8% discount rate.
17. Question to Juan : When does CAREM-25 operate ?	Keung Koo KIM	<b>[Answered during session]</b> Present date is start of commissioning by 2024.
18. What are the requirements for grid robustness for transforming the energy system from supplying the energy demand to optimizing the total system utilization including generation and storage?	Görkem Güngör	<b>[Answered during session &amp; live answered]</b> When developing models to determine stability/security of grid it is important that constraints around production, consumption and nominal frequency requirements are met. Furthermore, it is important to simulate faults and model post-fault behaviour with demand side management (e.g. EV charging profiles), frequency response and calling upon storage mechanisms such as batteries to assess the constraints above are met.
19. For Hossam, does the micro modular reactor have enough capacity to substitute for the NPP during outages? Very interesting presentation.	Farid Berry	<b>[Live answered]</b>
20. To M. Gabbar, which would be the range of the optimised capacities of the batteries associated to the grid you presented in the last slide?	Alessandro Pantano	<b>[Live answered]</b>
21. Did you ever try simulate this grid ? Without a sufficient nuclear basic production, the target will be impossible to reach even if as discussed currently the nuclear is progressively eliminated from the grid. Example Fessenheim today in France.	STEPHANE CATHALAU	<b>[Aiden Peakman]</b> From UK scenarios modelled we have observe that with around electricity mixes in 2050 with large deployment of electric vehicles (around 10 million undergoing Demand Side Management [DSM]), large battery storage and energy mixes of around one-third VRES, one-third nuclear and one-third biomass/CCS, the system does meet key stability/security constraints. As VRES penetration becomes higher this becomes more challenging

		<p>but is dependent on the level of DSM, storage and systems partaking in frequency response.</p> <p><b>[Kamil Tucek]</b> Details of the related assessments are given in “A Clean Planet for all, A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy, Communication from the European Commission, COM(2018) 773 final of 28 November 2018, and the accompanying In-Depth Analysis”.</p>
<p>22. What is the basis of EU 2050 plans for renewable power providing 65% of demand by 2050? How will this level of penetration be balanced by 24/7 carbon free base load during weather events and lack of sunlight ? Will 65% penetration be able to provide safe stable grid frequency control since there is no inertia in their power production process?</p>	<p>Steven Mirsky</p>	<p><b>[Kamil Tucek]</b> The EU future energy system will rely on much higher balancing capacities, including: (i) better interconnections on all grid levels, extending pan-European, national electricity grids and connection to extra EU areas with high renewable potential that would improve the match between supply and demand; (ii) more energy storage, helping to match demand and supply over multiple time frames; (iii) deeper demand response; and (iv) flexible generation units. Further details are provided in “A Clean Planet for all, A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy, Communication from the European Commission, COM(2018) 773 final of 28 November 2018, and the accompanying In-Depth Analysis”.</p>
<p>23. Thank you for interesting presentation. From viewpoint of hybrid nuclear energy and renewable energy or nuclear energy use for not electricity such as hydrogen generation or heating. However current SMR using natural circulation, Can SMR have advantage for future energy system?</p>	<p>MITSUMASA FUJITA</p>	
<p>24. To Mr. Pablo Ordoñez: what are the issues that remain to be agreed in your Atucha-3 talks with CNNC?</p>	<p>Philip Chaffee</p>	

<p>25. Is nuclear energy produced hydrogen competitive in price compared with the traditional way of produced hydrogen?</p>	<p>Oreo Lin</p>	<p><b>[Aiden Peakman]</b> See the slide that includes a snapshot of economic analysis of H2 production; the related report is linked on this slide. Th economics of H2 production depend on the electricity price, production scale, and H2 production efficiency for the selected technology. The regional price of natural gas also impacts the economics of traditional H2 production. So, in some regions/scenarios nuclear-produced hydrogen can be cost competitive.</p>
<p>26. What are the determining factors when one considers the pros and cons of centralised versus distributed control for nuclear-renewable hybrid systems? And what will be the 'interface' in terms of the regulatory safety compliance, for example for design basis (nuclear plant) accidents?</p>	<p>Akira Fitzsimmons</p>	<p><b>[Aiden Peakman]</b> There are number of contrl strategies, i can answer with more details later. Thanks</p>
<p>27. Have you an idea of the total amount of energy that we have to produce for having a sufficient quantity of H2 (produced by electrolysis High temp) for transportation (ship, trucks, cars, buses, taxis,...) It is incredibly high : Producing it with renewables and/or nuclear will be impossible.</p>	<p>STEPHANE CATHALAU</p>	<p><b>[Aiden Peakman]</b> Good question. Taking the UK as an example, it's reasonable to assume that for shipping in 2050 energy demand may be around 150 TWh of demand, perhaps around 50 TWh of road transport maybe difficult to decarbonise, which results in around 200 TWh of potential H2 demand – and this does not include other potential demand for H2 from industry wanting to decarbonise or decarbonising residential/commercial heating with H2. Some UK scenarios envisage H2 demand up to ~700 TWh/yr. For comparison, the UK currently produces around 27 TWh of H2 via steam methane reforming so H2 production would need to increase by around a factor of ten and be all low-carbon under these future scenarios. It is very challenging.</p>