Summary of the Working Group on AI for Nuclear Power

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Technical Meeting on Artificial Intelligence for Nuclear Technology and Applications
#AI4Atoms Virtual Event
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Thank all WG members (22 people, 17 presentations)

State of the Art

- Benefits AI can bring to the nuclear power industry:
  - O&M cost reduction, to help maintain financial viability
  - Increased reliability and safety in operations
- Current technologies in different stages of development:
  - No example of established, wide adoption
  - Some applications are in initial stages of deployment at NPPs
  - Some are ready for initial field tests
  - Most are under research and development
- Regulators are also trying to proactively determine how to handle the technology

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Initial stage of deployment: CAP automation
Ready for field tests: NDE applications
NRC is looking into it; we heard from European regulator (UK)
May also mention that tech is being developed at research organizations, vendors, utilities.

Main Application Areas

- *Insights,* to extract lessons from operating experience
- *Prediction/prognostics*, to better inform maintenance activities
- *Automation*, to increase reliability and reduce time of common operations
- *Optimization*, to increase efficiency and design of complex processes
- *Analytics*, to increase the quality of current models
- Addressing deployment challenges
- Applications to new plants and new reactor designs

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Insights: analysis of maintenance records to assess maintenance practices
Prognostics: better prediction of FAC wear rates to inform inspection scheduling
Automation: NDT, CAP
Optimization: reactor control, outage scheduling, control room interface
Analytics: AI to model critical flow that happens at safety relief valves or LOCA
Deployment: ENIQ's recommended practice, German standartization roadmap
New plants: materials research

Challenges

- Data availability
- Distance between AI community and Nuclear power industry
- Understanding AI
- Industry acceptance
- Regulatory acceptance

The main challenged raised is data availability. Often data is sensitivite (for different reasons) which limits its sharing. AI being data-centric, this is a big impediment to further development. Alternative solutions are used (synthesized data) but not available for all cases.

The industry has issues, the AI community potential solutions. However these two groups are often far apart and communication between them is difficult given the lack of mutual understanding.

Understanding AI can be for leadership, but also for those who will be using the system. There is a cost to address all these challenges; in order to get industry acceptance, we need to show the value in overcoming them.

For many potential applications in the nuclear industry, nothing can be realized without regulatory acceptance. Help them understand so they can make informed decisions.

Next Steps

- ## Technology development
  - Increasing maturity levels
- ## Technology deployment
  - Taking ready technologies to the field
- ## Technology enabling
  - Developing needed technical building blocks
  - Addressing deployment challenges

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Technology development: Further development to speech and gesture control software system; Development of anomaly detection from plant monitoring data
Technology deployment: NDT
Technology enabling:
   Technical: NLP dictionary
   Deployment: UK's regulators route map

Accelerating Progress—IAEA's Role

- Main challenge is data
  - Higher data availability
  - Synthesized or anonymized curated datasets

✓ *IAEA data and information management systems gather, validate and manage data while facilitating access to users in the Member States.*

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Data sensitivity limits data availability.
increased data sharing and finding ways to make data more accessible would accelerate the development and adoption of ML methodologies
The method must conceal the identity of the data source while providing full access to all mathematical features employed by AI algorithms

Accelerating Progress—IAEA's Role

- Siloed development
- Distance between AI community and industry

✓ *IAEA Networks are an existing mechanism to foster longer-term collaboration around a specific topic*

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identifying common solutions and successful application areas across the industry would help leverage working solutions
Networks can include industry, regulators, AI experts from other fields

Accelerating Progress—IAEA's Role

- Understanding AI:
  - People who interface with the system
  - People who oversee the applications

✓ *IAEA Training workshops could be implemented to facilitate improved understanding of ML possibilities and limitations*

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Model transparency and making the ML systems understandable for both the people that interface with them and for the people that oversee them is required. While the users may not need full understanding on the machine learning techniques applied, they need to build a working understanding to facilitate effective interaction with the system

Accelerating Progress—IAEA's Role

- Faciliate industry acceptance

✓ *Coordinated Research Projects (CRPs) may be initiated on various aspects of AI.*

✓ *CRPs bring together research institutes in Member States to collaborate on research topics of common interest. Results of the CRPs are disseminated to all Member States through scientific and technical publications, and other communications media.*

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For the regulated nuclear environment, field trials and gaining acceptance of the utilities is crucial. For some of the use cases this is easier and they may help introduce AI/ML to the industry. For some use cases, more evidence is required to gain acceptance. Lack of consideration of potential blockers to deployment at the concept stage could prevent timely and effective deployment. Facilitating this process and experience sharing would accelerate and facilitate adoption of AI and ML.

CRPs could be implemented to facilitate this with **IAEA mediated field testing, round-robin exercises and peer review of ML/AI solutions** as they become available

Accelerating Progress—IAEA's Role

- Regulatory acceptance

✓ *Safety Standard/s or other publications elaborating safety or security requirements for AI, for example, establishing standards for Data Trustworthiness / Recoverability.*

✓ *IAEA Participation on relevant international standards committees, via events implemented in Cooperation*

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present lack of a clear route to the licensing of AI applications, where this may affect safety or security, has the potential to prevent deployment on active plant, and for the benefits of AI to be lost
Common but flexible principles and guidelines addressing the most common challenges met with gaining regulatory acceptance for AI/ML would help development and adoption

Accelerating Progress—IAEA's Role

- Guidance and recommended practices

✓ *IAEA publications: NE Series, Technical Reports, TECDOCS and/or non-serial publications*

IAEA topical reports on AI technology and or the practical use of AI in a nuclear power context would be beneficial. Examples include:
- core design/core monitoring and diagnostics/load optimization;
- PM and outage optimization;
- improving NDT/ISI results evaluation/interpretation/analysis;
- material ageing management;
- condition monitoring;
- autonomous monitoring;
- anomaly detection;
- elaboration / improvement of models;
- automating operations and work processes;
- streamlining work management process;
- reliability analysis and risk assessment;
- as well as data modeling and simulation

Expected Outcomes

- Increased data availability for AI application to achieve their potential and to facilitate and accelerate the application of AI technology.
- Improved modelling and simulation capabilities relevant to AI applications.
- Bridging the gap between the AI community and the industry for identified specific generic applications of interest.
- Capacity building to develop workforce competencies (students and practitioners) highlighting the value, mechanics and limitations of AI techniques

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Expected Outcomes

- Increased confidence in the adoption of AI in existing and future plants by providing guidance on the deployment of the technology.

- Streamlined licensing processes of designs comprising AI solutions (through the increased confidence).

- The availability of specific recommendations to NPP utilities, regulatory bodies, research and design organizations, as well as vendors with respect to the application of AI technologies.

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Thank you!