Expert Group on Application of Remote and Robotic Systems in Nuclear Back-End (EGRRS)

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EGRRS Chair

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EGRRS Overview

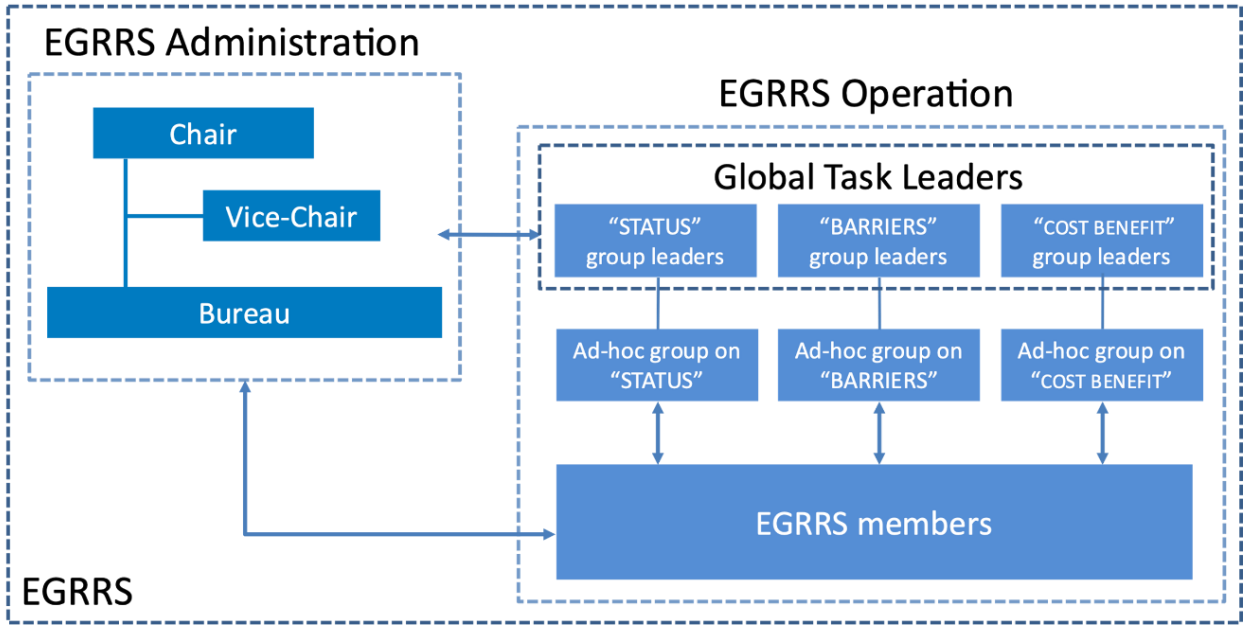
- Mandate: 15 November 2019 – 14 November 2021
- Deliverable: Draft Report expected by the end of 2021 (publication in 2022)
- Members: 57 nominations from 13 countries and the EC

  IAEA as observer
- myNEA link: https://mynea.oecd-nea.org/cms/jcms/t1_2004923/en/egrrs

EGRRS Development (end of mandate report) (i)

Management

- EGRRS Kick-off Meeting **09-10.12.2019:**
  - Development of EGRRS structure
- Regular bureau meetings (including Ad Hoc Leaders)
- Organization of virtual EGRRS Keynote sessions;
- EGRRS-1 Plenary Meeting **07.12.2020:**
  - Presentation of first results;
  - Approval of PoW 2020-2021;
  - Draft EGRRS Report discussed and development initiated;
  - Planning of last EGRRS mandate year with proposals for extension



EGRRS Development (end of mandate report) (ii)

EGRRS Keynotes:

- 1st keynote speech by Michael GUSTMANN “Emergency Response Robots at KHG - existing systems and current projects” (https://mynea.oecd-nea.org/cms/jcms/t1_2005314/en/egrrs-keynote-by-dr-gustmann-khg-germany-tbc?IGNORE_EXTERNAL_CALENDAR=false&usage=full&eventStartDate=1596110400000) (30.07.2020)

- 2nd keynote speech by Shinji KAWATSUMA “Robots and Remote Systems for Decommissioning Accident damaged reactors” (https://mynea.oecd-nea.org/cms/jcms/t1_2009413/en/2nd-egrrs-keynote?IGNORE_EXTERNAL_CALENDAR=false&usage=full&eventStartDate=1603364400000) (22.10.2020)

Four leg robot with baby robot


http://photo.tepco.co.jp/date/2012/201212-j/121211-01j.html

Four leg robot with baby robot was deployed for the survey of lower part of Bent tubes of unit 2 on December 11th and 12th. The first day's operation was completed.

EGRRS Development (end of mandate report) (iii)

Ad-hoc groups development

STATUS OF CURRENT TECHNOLOGIES AND USES / DEFINE TERMINOLOGY

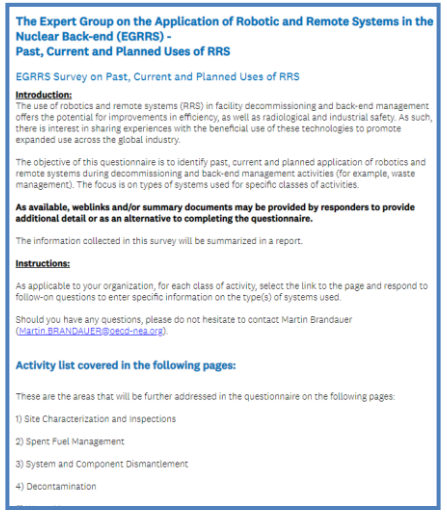
- Draft survey created to assess the current status of activities and main actors; https://www.surveymonkey.com/r/EGRRS-STATUS (Password: OeCD-NeA_202*)

BARRIERS / IMPEDIMENTS

- Survey created to identify barriers and impediments of RRS systems; https://ec.europa.eu/eusurvey/runner/EGRRSBarriers (Password: Oecd202*)
- 1st group meeting (04.06.2020), 2nd group meeting (02.07.2020)

COST BENEFIT ANALYSIS

- To access and quantify the cost benefits of RRS systems, strategy of doing the analysis has been discussed in their group meetings (07.07.2020 and 14.01.2021)


The Expert Group on the Application of Robotic and Remote Systems in the Nuclear Back-end (EGRRS) -
Past, Current and Planned Uses of RRS

EGRRS Survey on Past, Current and Planned Uses of RRS

Introduction:
The use of robotics and remote systems (RRS) in facility decommissioning and back-end management offers the potential for improvements in efficiency, as well as radiological and industrial safety. As such, there is interest in sharing experiences with the beneficial use of these technologies to promote expanded use across the global industry.

The objective of this questionnaire is to identify past, current and planned application of robotics and remote systems during decommissioning and back-end management activities (for example, waste management). The focus is on types of systems used for specific classes of activities.

As available, weblinks and/or summary documents may be provided by responders to provide additional detail or as an alternative to completing the questionnaire.

The information collected in this survey will be summarized in a report.

Instructions:

As applicable to your organization, for each class of activity, select the link to the page and respond to follow-on questions to enter specific information on the type(s) of systems used.

Should you have any questions, please do not hesitate to contact Martin Brandauer (Martin.BRANDAUER@oecd-nea.org).

Activity list covered in the following pages:

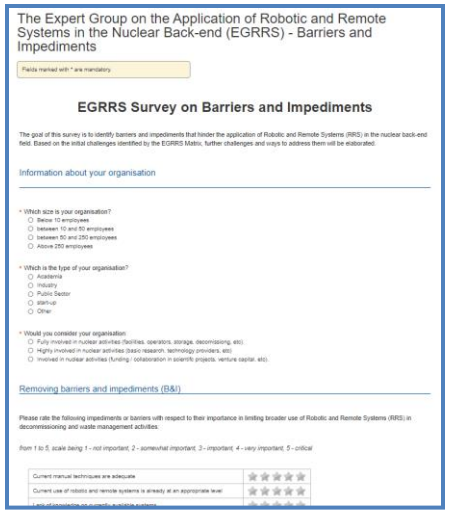
These are the areas that will be further addressed in the questionnaire on the following pages:

1) Site Characterization and Inspections

2) Spent Fuel Management

3) System and Component Dismantlement

4) Decontamination


The Expert Group on the Application of Robotic and Remote Systems in the Nuclear Back-end (EGRRS) - Barriers and Impediments

Fields marked with * are mandatory.

EGRRS Survey on Barriers and Impediments

The goal of this survey is to identify barriers and impediments that hinder the application of Robotic and Remote Systems (RRS) in the nuclear back-end field. Based on the initial challenges identified by the EGRRS Matrix, further challenges and ways to address them will be elaborated.

Information about your organisation

* Which size is your organisation?
- Below 10 employees
- between 10 and 50 employees
- between 50 and 250 employees
- Above 250 employees

* Which is the type of your organisation?
- Academia
- Industry
- Public Sector
- start-up
- Other

* Would you consider your organisation
- Fully involved in nuclear activities (facilities, operators, storage, decomissioning, etc)
- Highly involved in nuclear activities (basic research, technology providers, etc)
- Involved in nuclear activities (funding / collaboration in scientific projects, venture capital, etc).

Removing barriers and impediments (B&I)

Please rate the following impediments or barriers with respect to their importance in limiting broader use of Robotic and Remote Systems (RRS) in decommissioning and waste management activities.

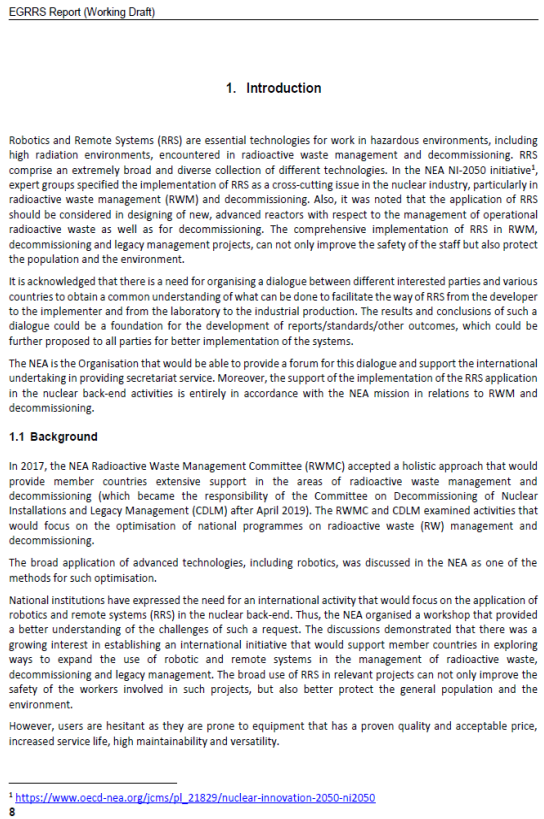
from 1 to 5, scale being 1 - not important, 2 - somewhat important, 3 - important, 4 - very important, 5 - critical

Current manual techniques are adequate	☆☆☆☆☆
Current use of robotic and remote systems is already at an appropriate level	☆☆☆☆☆
Lack of knowledge on currently available systems	☆☆☆☆☆

EGRRS Report

Draft structure of the report

1. Introduction
2. Programme of Work Summary
3. Ad-hoc Group Activities
   - 3.1 Status of the Use and Development of Robotics and Remote Systems in Back-End Applications
   - 3.2 Barriers / Impediments
   - 3.3 Cost Benefit Analysis
4. Lessons Learned/Discussion/Good practice
5. Future Work
6. Summary and conclusions


EGRRS Report (Working Draft)

1. Introduction

Robotics and Remote Systems (RRS) are essential technologies for work in hazardous environments, including high radiation environments, encountered in radioactive waste management and decommissioning. RRS comprise an extremely broad and diverse collection of different technologies. In the NEA NI-2050 initiative[1], expert groups specified the implementation of RRS as a cross-cutting issue in the nuclear industry, particularly in radioactive waste management (RWM) and decommissioning. Also, it was noted that the application of RRS should be considered in designing of new, advanced reactors with respect to the management of operational radioactive waste as well as for decommissioning. The comprehensive implementation of RRS in RWM, decommissioning and legacy management projects, can not only improve the safety of the staff but also protect the population and the environment.

It is acknowledged that there is a need for organising a dialogue between different interested parties and various countries to obtain a common understanding of what can be done to facilitate the way of RRS from the developer to the implementer and from the laboratory to the industrial production. The results and conclusions of such a dialogue could be a foundation for the development of reports/standards/other outcomes, which could be further proposed to all parties for better implementation of the systems.

The NEA is the Organisation that would be able to provide a forum for this dialogue and support the international undertaking in providing secretariat service. Moreover, the support of the implementation of the RRS application in the nuclear back-end activities is entirely in accordance with the NEA mission in relations to RWM and decommissioning.

1.1 Background

In 2017, the NEA Radioactive Waste Management Committee (RWMC) accepted a holistic approach that would provide member countries extensive support in the areas of radioactive waste management and decommissioning (which became the responsibility of the Committee on Decommissioning of Nuclear Installations and Legacy Management (CDLM) after April 2019). The RWMC and CDLM examined activities that would focus on the optimisation of national programmes on radioactive waste (RW) management and decommissioning.

The broad application of advanced technologies, including robotics, was discussed in the NEA as one of the methods for such optimisation.

National institutions have expressed the need for an international activity that would focus on the application of robotics and remote systems (RRS) in the nuclear back-end. Thus, the NEA organised a workshop that provided a better understanding of the challenges of such a request. The discussions demonstrated that there was a growing interest in establishing an international initiative that would support member countries in exploring ways to expand the use of robotic and remote systems in the management of radioactive waste, decommissioning and legacy management. The broad use of RRS in relevant projects can not only improve the safety of the workers involved in such projects, but also better protect the general population and the environment.

However, users are hesitant as they are prone to equipment that has a proven quality and acceptable price, increased service life, high maintainability and versatility.

[1] https://www.oecd-nea.org/jcms/pl_21829/nuclear-innovation-2050-ni2050

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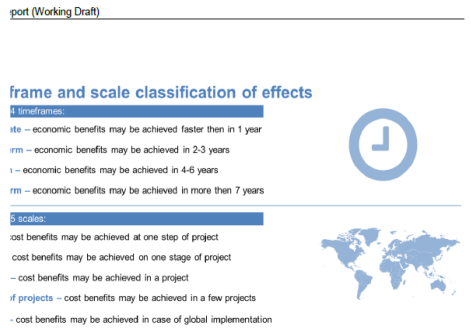
port (Working Draft)

frame and scale classification of effects

timeframes:

te – economic benefits may be achieved faster then in 1 year

rm – economic benefits may be achieved in 2-3 years

– economic benefits may be achieved in 4-6 years

rm – economic benefits may be achieved in more then 7 years

scales:

ost benefits may be achieved at one step of project

cost benefits may be achieved on one stage of project

– cost benefits may be achieved in a project

f projects – cost benefits may be achieved in a few projects

– cost benefits may be achieved in case of global implementation

5. Future Work

ared)

late of the EGRRS is extended to Stage 2, the following work is proposed for consideration:

tablish an Ad-Hoc Group for standardization of R&D, production and licensing approaches, interfaces d implementation of robotics in back-end;

termine the most prospective and required directions for the development of robotics and remote stems;

epare recommendations and proposals for international R&D cooperation and coordination to cilitate development and implementation of robotic solutions; and

alyse impact of robotics on the nuclear energy sustainability across the globe and compliance with e UN Sustainable Development Goals

al example in an emerging field, the use of RRS in the construction and operation of deep geological repositories (DGRs) for used nuclear fuel and high-level wastes can be further studied in conjunction with the RWMC.

Conventional mining technology for constructing a DGR (e.g. drill and blast) is complex, labour intensive and prone to creating excavation damage zones in the host rock which could be detrimental to the long-term performance of the repository. Alternate construction technologies, such as robotic tunnel boring machines, show promise as a safer, more efficient method for DGR construction. In addition, operation of a DGR will also require robotics and remote systems due to the inherently high radiation environment.

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EGRRS Report (ii)

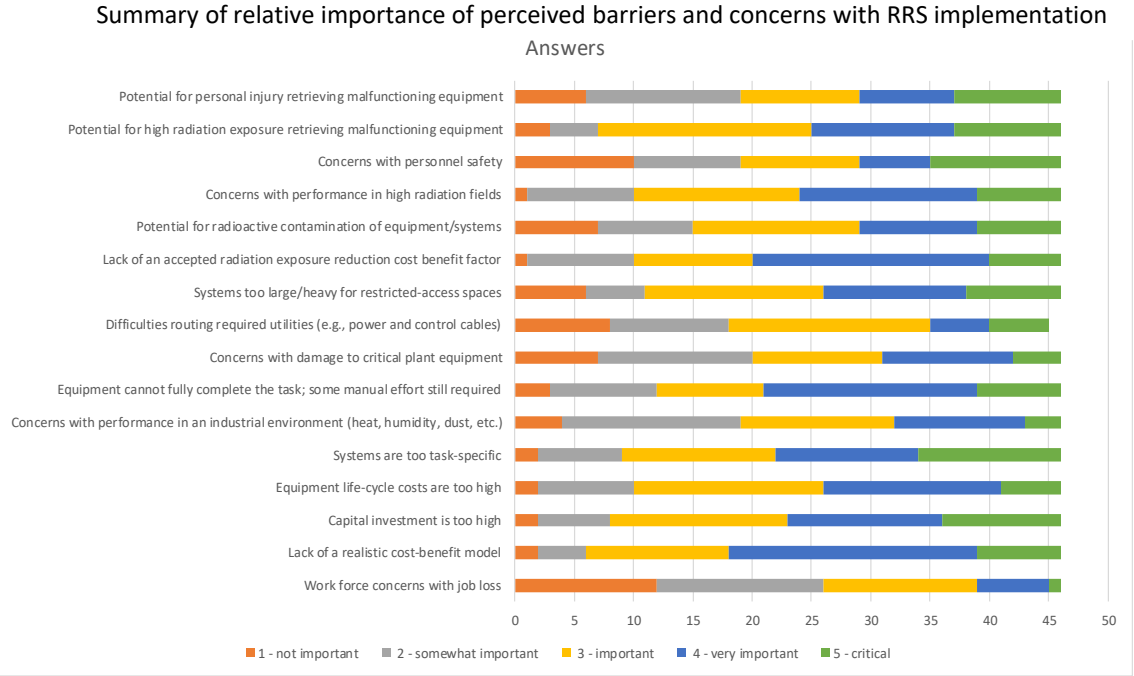
3.1 Status of the Use and Development of Robotics and Remote Systems in Back-End Applications

- Information was compiled from several sources, including a survey of practitioners, researchers, and nuclear safety regulators;
- Review of published literature; and the combined expertise of the EGRRS Status Group (review is not exhaustive), a sufficiently broad overview of the types and uses of robotics and remote systems is provided.
- The information may be used as the basis to establish an interactive data base of robotic and remote systems for practitioners, researchers and regulators engaged nuclear facility decommissioning and waste management.

EGRRS Report (iv)

3.2 Barriers / Impediments

- The questions in the survey addressed topics both general and focus activities on nuclear back-end.
- Difficult to establish trends using a small set of results, proper quantitative analysis may reveal some more patterns.
- To increase survey sample size, additional responses are required. The ad-hoc group is currently pursuing means to disseminate the survey to a larger group of experts including researchers, end-users and suppliers. These further responses will be included in the final report.



EGRRS Report (v)

3.3 Cost Benefit Analysis

- The Cost-Benefit Analysis (CBA) Group provides a global vision on economic effects of robotic technologies as well as to consider practical cases with a notably positive impact. Since a global view and hands-on assessment require different methodologies, the CBA Group has developed a hybrid approach to address the needs of different parties.

- To provide a global review, the Group has:
  - Developed a system of economic drivers and metrics for their qualitative assessment.
  - Considered of both direct and indirect effects to cover a wide range of factors may provide economic benefits of robotic solutions.

Summary of Cost-Benefit Drivers and Assessment Approaches

DRIVER	DESCRIPTION	ASSESSMENT APROACH
Operation scheme	Use of robotics vs manual performance of tasks. Will influence CAPEX and OPEX.	Indirect
CAPEX (Capital Expenditures)	Total capital cost of facility/system	Direct impact. Calculation.
OPEX (Operational Expenditures)	Total operational costs	Direct impact. Calculation.
Risks	Change in nature and costs associated with risks and their management	Direct impact. Calculation.
Staff	Total number of staff required	Direct impact. Calculation.
Time of execution	Impact on project schedule. Related to OPEX and personnel adiation exposure	Direct impact. Calculation.
Licensing and Regulatory process		Indirect
Social acceptability		Indirect
Knowledge management	Skills availability, training requirements	Soft direct impact. Calculation.

EGRRS Report (vi)

3.3 Cost Benefit Analysis (cont'd)

- To perform the relevant calculations, practical cases have been identified based on experience of implementing robotic/automated solutions with the most evident economic effects.
- These cases consider two scenarios of a project—with and without robotic solutions.
- The cases clearly demonstrate effects of robotics harnessed to be used in nuclear back-end and their advantages over non-robotic options.
- The cases also demonstrate how the provided economic drivers may be applied in practice.

New Mandate Proposals presented at RWMC-54

The new mandate of the EGRRS (2022-2023, *to be drafted*) proposes the following topics (on a VC based approach):

- Developing a systematic approach for benchmarking of best practice of RRS applications (database implementation);
- Provide an iterative process of solution-finding towards the identified barriers in the regulatory framework (with regulators, operators, developers, TSO, etc.);
- Analyse the future implications of emerging AI developments, while monitoring and synergize new developments, and advise member states on the implications/opportunities;
- Develop Cost-benefit methodology/structure for RRS application in the Back-end field providing a decision-making tool on the “human” vs. “robotics” task;

EGRRS contribution to DigiDECOM 2021(i)

International workshop focusing on digital transformation, robotics and other game changing trends in nuclear decommissioning, dismantling and waste management.

Special contribution with an EGRRS session (3rd day): ***"Innovation needs, solutions and initiatives related to digitalisation as well as robotics and remote systems in decommissioning"***

Location: **Online workshop**
https://ife.no/en/event/digidecom2021/

Date: **23.-25.03.2021**

EGRRS contribution to DigiDECOM 2021(ii)

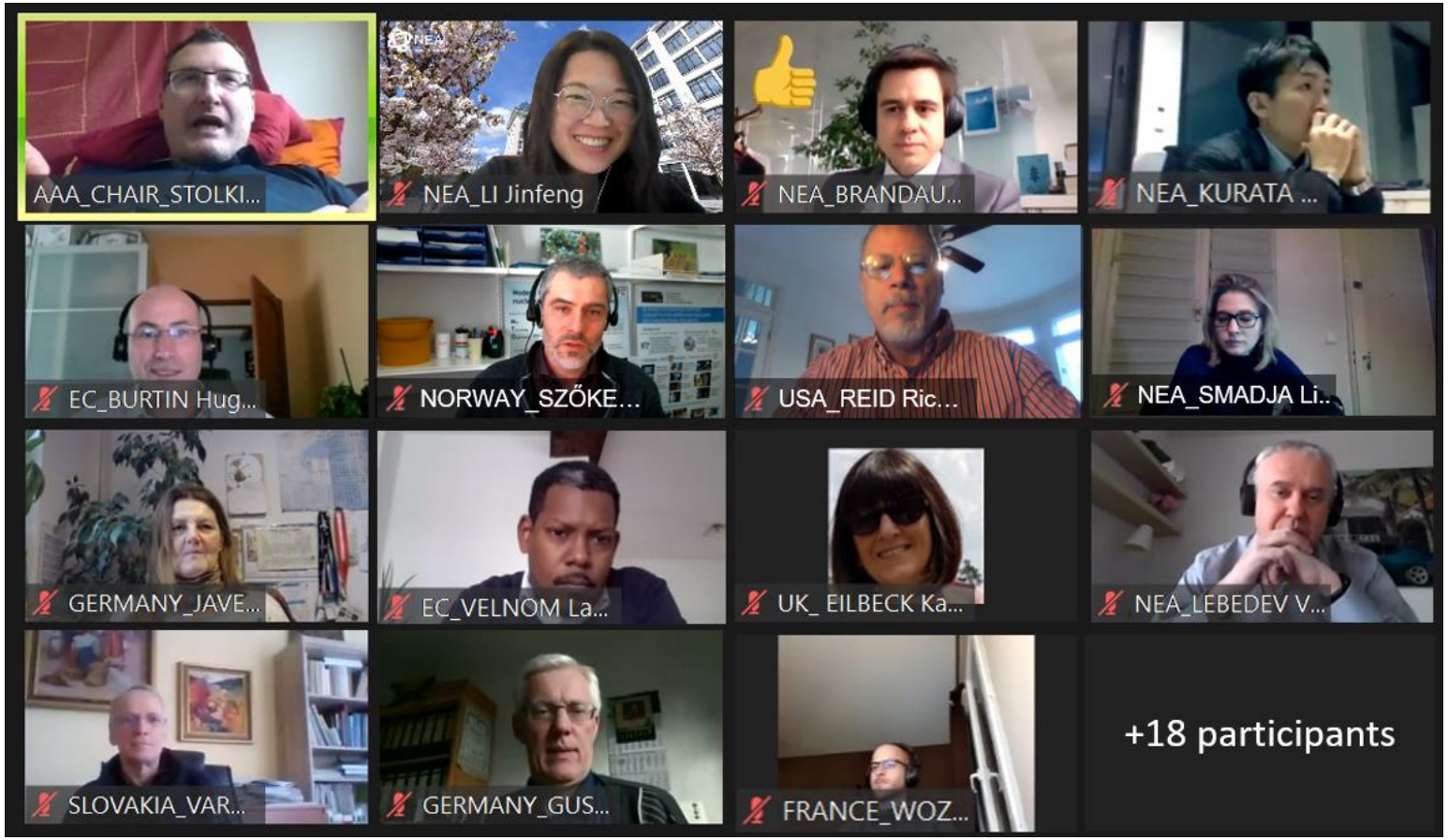
The webinar in 2021 aims;

"bringing together a multidisciplinary international community for open and highly interactive exchanges about experience from earlier applications, as well as opportunities for future applications of innovative technologies and methods in nuclear decommissioning, dismantling and waste management."

(source: https://ife.no/en/event/digidecom2021/)

Thursday - 25 March: Innovation needs, solutions and initiatives related to digitalisation as well as robotics and remote systems in decommissioning	
Surveys of the NEA Expert Group on the Application of Robotics and Remote Systems in the Nuclear Back-end (EGRRS): ***1. STATUS OF CURRENT TECHNOLOGIES AND USES / DEFINE TERMINOLOGY:*** https://www.surveymonkey.com/r/EGRRS-STATUS (Password: OeCD-NeA_202*) ***1. BARRIERS / IMPEDIMENTS*** https://ec.europa.eu/eusurvey/runner/EGRRSBarriers (Password: Oecd202*) *A participation in advance of the meeting would be appreciated.*	
1	Robotics and Remote Systems applications in the Decommissioning and Radioactive Waste Management - The NEA EGRRS
2	Robotics and 3D gamma mapping technologies for supporting nuclear decommission
3	Digital innovation for robotics applications in decommissioning
4	Modular UGV and humanoid robot platform based technology – prospects for application in nuclear decommissioning
5	Robotics research and applications by FIU
6	Examples from Chernobyl NPP (TBC)
7	Economic drivers for robotic and remote systems in decommissioning (incl. FREMES example)
8	Increasing of Robot's Autonomy in Nuclear Application (TBC)
10	**Discussion of innovation needs and possible solutions related to robotics applications in decommissioning** **Breakout to groups:** Group 1 Status and trends for robotics applications for decommissioning Group 2 Barriers and impediments for robotics applications for decommissioning Group 3 Safety and security requirements for robotics applications for decommissioning Group 4 Digitalisation and robotics – how can they strengthen/enable each other? Group 5 Economic benefit drivers for robotics applications in the nuclear
11	Short summaries from the group discussions presented in Plenary

Thank You!



EGRRS-1 Plenary Meeting **07.12.2020**

If you have questions of this presentation, contact Martin BRANDAUER [Martin.BRANDAUER@oecd-nea.org]