Rosatom Technical Academy

Current Status of Russian Nuclear Power Development and Cooperation with Europe: the Issue of Human Resource Development

March 1, 2018
Brussel

Prof. Vladimir ARTISIUK,

Vice-Rector for International Cooperation

Russian Nuclear Power Development in a Nut Shell

Russian Nuclear Power in a Nut Shell

Number of Power Units: 36

Total Installed Capacity: 28.9 GW

Russia's nuclear electricity share increased up to 18.9% in 2017



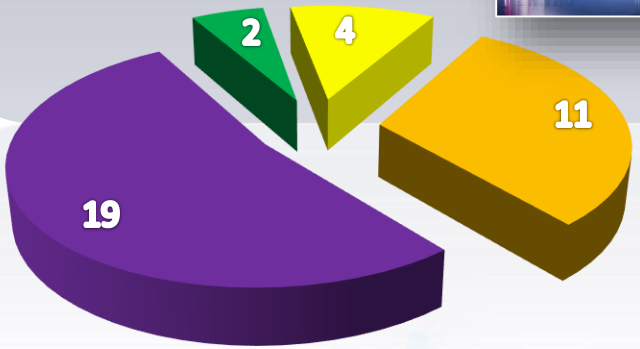







Kola
Leningrad
Smolensk
Kalinin
Kursk
Novovoronezh
Rostov
Balakovo
Beloyarsk
Bilibino

Reactor Types



- RBMK Units
- VVER Units
- BN (Fast Reactor) Units
- EPG-6 Units

- EGP-6 Unit
- BN Unit
- VVER-1000 Unit
- VVER-440 Unit
- RBMK Unit
- VVER-1200 Unit

http://www.rosenergoatom.ru/en/
https://www.iaea.org/pris/CountryStatistics/CountryDetails.aspx?current=RU

Achievements for Domestic Consumption: Generation III+ Reactors

http://www.world-nuclear-news.org/NN-First-VVER-1200-reactor-enters-commercial-operation-02031701.html

February, 2017

Unit 1 of the Novovoronezh II NPP has started commercial operation

http://www.world-nuclear-news.org/NN-Reactor-vessel-installed-at-Leningrad-II-2-01121701.html

November, 2017

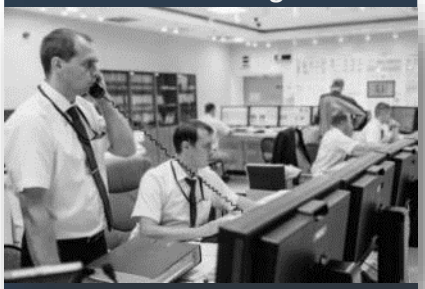
Reactor vessel has been installed at unit 2 of Leningrad II NPP

http://www.world-nuclear-news.org/NN-Leningrad-II-1-brought-to-minimum-power-06021801.html

February, 2018

Unit 1 of the Leningrad Phase II NPP is brought to the minimum controllable power level

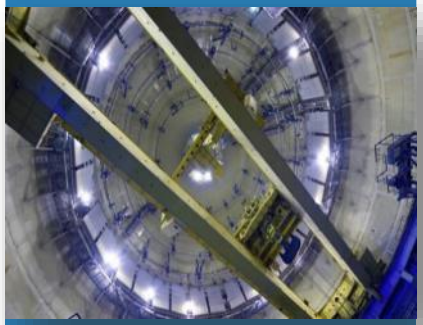
The first world reactor of the Generation III+ (Unit 1 of the Novovoronezh II NPP) has been connected to grid



August, 2016

http://www.world-nuclear-news.org/NN-Russia-connects-Novovoronezh-6-to-grid-05081601.html

Pre-commissioning has started at unit 1 of Leningrad II NPP



April, 2017

http://www.world-nuclear-news.org/NN-Russia-starts-pre-commissioning-Leningrad-II-unit-1-13041702.html

Kursk II began reinforcing the foundation slab for the reactor building of Unit 1

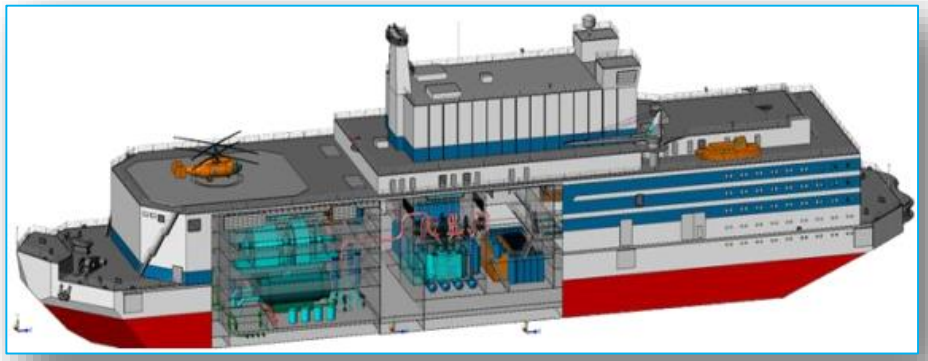
December, 2017

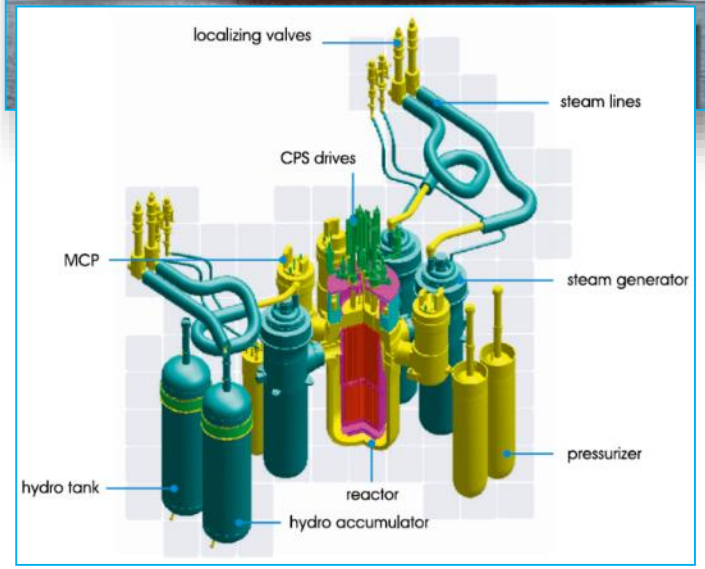
http://rosatomnewsletter.com/2017/12/28/kursk-ii-passed-construction-milestone/

Achievements for Domestic Consumption: Marine Reactor Plants – Floating NPP

Russian State Expert Examination Board has approved the operation of floating nuclear power plant Akademik Lomonosov

http://www.world-nuclear-news.org/NN-Russias-floating-power-plant-clear-for-operation-11011801.html





Flushing of the primary circuit systems of both reactor units has been completed

http://www.rosenergoatom.ru/en/for-journalists/highlights/24908/

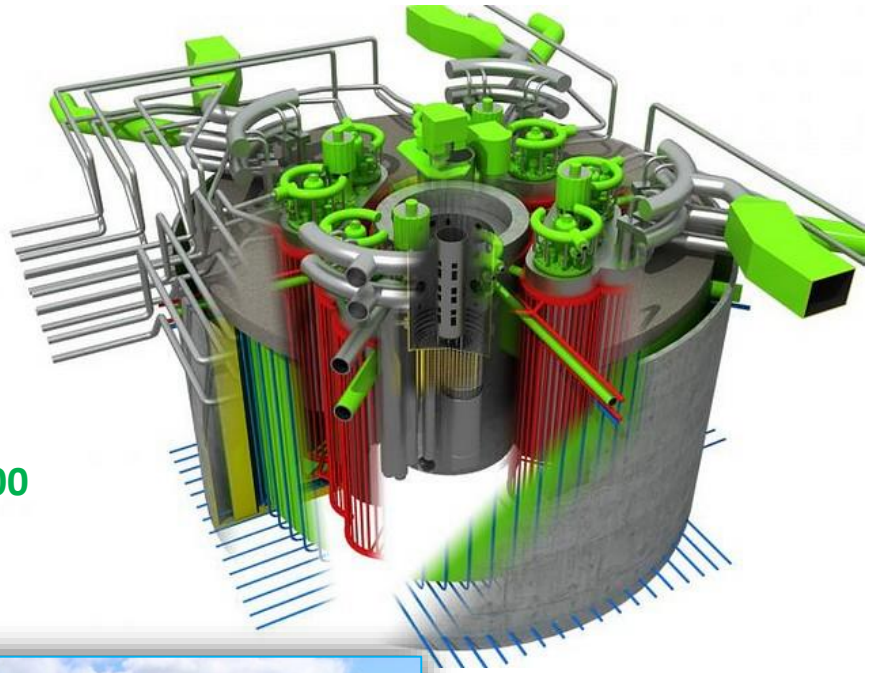
- **Russian floating plant cargo arrives at Pevek**
- **Commissioning is scheduled for 2019**

http://www.world-nuclear-news.org/NN-Russian-floating-plant-cargo-arrives-at-Pevek-30101701.html

Achievements for Domestic Consumption: Fast Reactors with Heavy Liquid Metal Coolant – BREST-OD-300

- **BREST-OD-300 is a lead-cooled natural-safety reactor facility for the NPP Pilot & Demonstration Energy Complex with an on-site fuel cycle**
- **The project of BREST-OD-300 incorporates the best technological solutions of the studied fast reactor concepts**
- **Construction of fuel fabrication plant for BREST-OD-300 begins in 2018**

http://www.world-nuclear-news.org/NN-Russia-to-build-fast-reactor-fuel-plant-in-2018-29121701.html



The cost of the BREST project can be reduced by 10-12 billion rubles due to optimization

https://www.riatomsk.ru/article/20170114/rosatom-brest-300-project-in-scp-is-optimized-but-not-frozen/

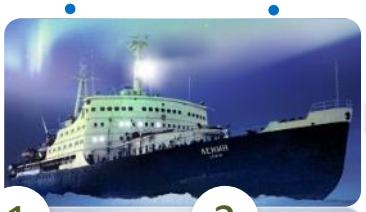
https://www.riatomsk.ru/article/20171013/reaktor-brest-300-na-shk-stoimostj/

Achievements for Domestic Consumption: Marine Reactor Plants – Nuclear Icebreakers (1/2)

Development of the nuclear-powered icebreakers in Russia

Commissioning

1959 – "Lenin"



1 OK-150

1970* – "Lenin"

2 OK-900

* OK-150 is replaced by OK-900

1975 – "Arktika"

2 OK-900A

1977 – "Sibir"

2 OK-900A

1985 – "Rossiya" (in commission)

2 OK-900A

1988 – "Sevmorput" (in commission)

2 OK-900A

1989 – "Sovetskiy Soyuz"

2 OK-900A

1989 – "Taymyr" (in commission)

3 KLT-40M

1990 – "Vaygach" (in commission)

3 KLT-40M

1992 – "Yamal" (in commission)

2 OK-900A

2007 – "50 Let Pobedy" (in commission)

2 OK-900A

3 nuclear icebreakers of the Project 22220 are currently under construction

4 RITM-200

Achievements for Domestic Consumption: Marine Reactor Plants – Nuclear Icebreakers (2/2)

Sibir icebreaker (anticipated commissioning – 2020)

Russia launches “world’s biggest and most powerful” nuclear icebreaker ship Sibir

http://www.independent.co.uk/news/world/europe/russia-nuclear-icebreaker-ship-sibir-world-biggest-most-powerful-northern-sea-route-baltic-shipyard-a7965596.html

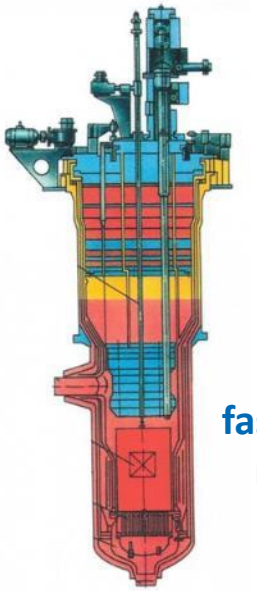
Baltic Shipyard in Saint Petersburg completed the installation of both RITM-200 reactors on the new generation Sibir nuclear icebreaker

http://www.tvel.ru/wps/wcm/connect/tvel/tvelsite/presscentre/news/e17b7d80423cdf6b8b039bb2cb3f9f43

ZiO-Podolsk manufactured and shipped tank equipment included in the RITM-200 reactor facility for the nuclear icebreaker Sibir

http://rosatomnewsletter.com/2017/12/28/ritm-200-installed-at-sibir-icebreaker/

Achievements for Domestic Consumption: Research Activities – MBIR

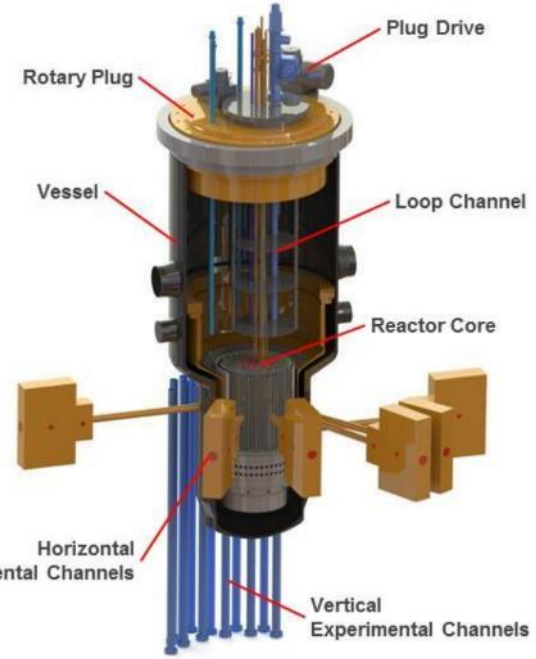


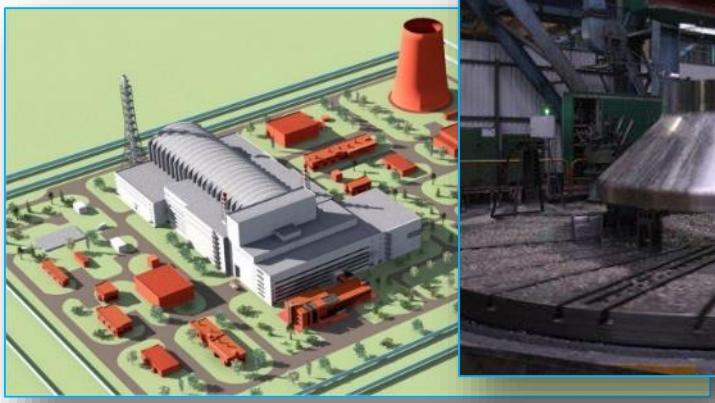
BOR-60 fast neutron research reactor (1969)

Construction of the 4th generation fast neutron research reactor

Creation of an International Research Center

MBIR (Planned for commissioning in 2020)





Russia starts to build MBIR vessel

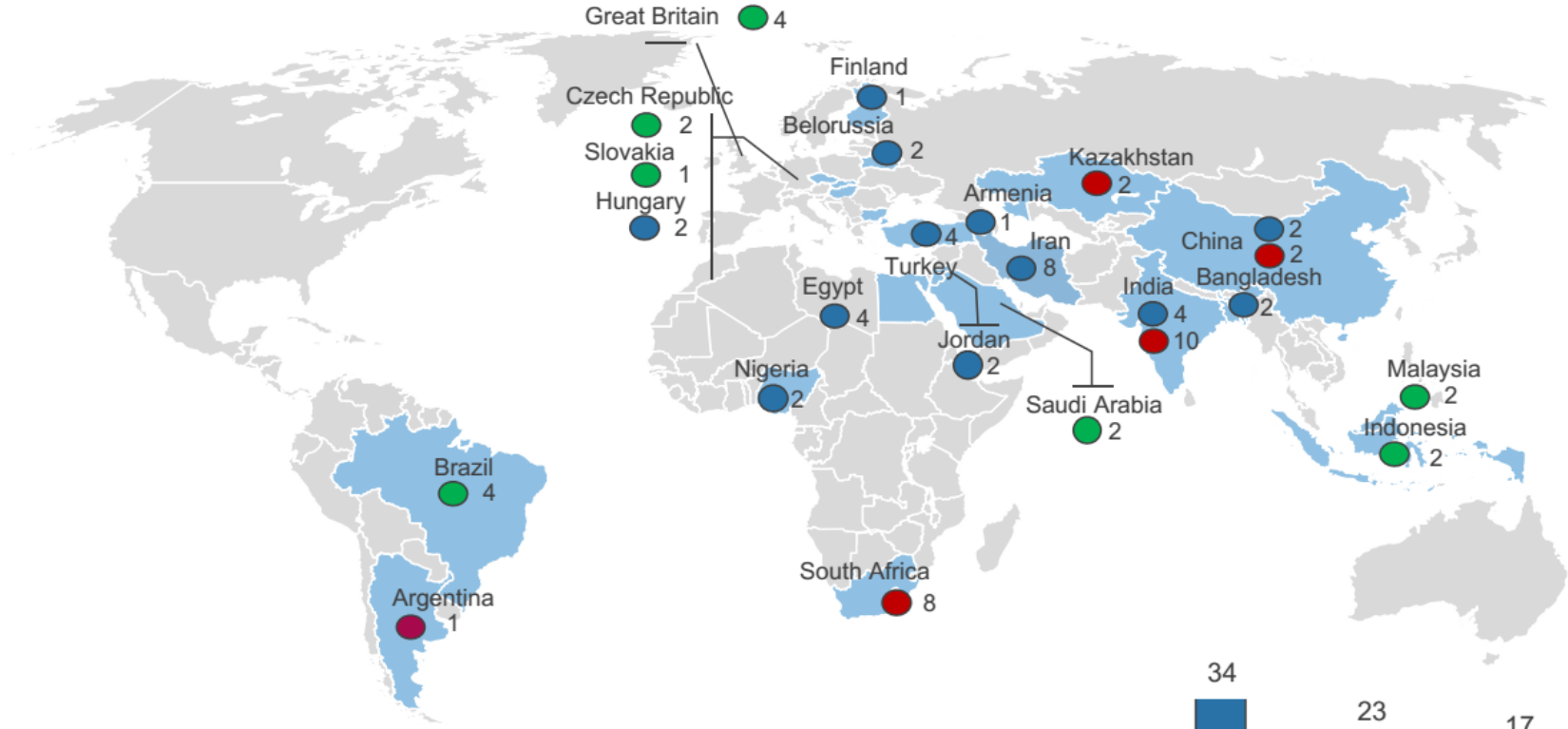
http://www.world-nuclear-news.org/NN-Russia-starts-to-build-MBIR-vessel-27031702.html

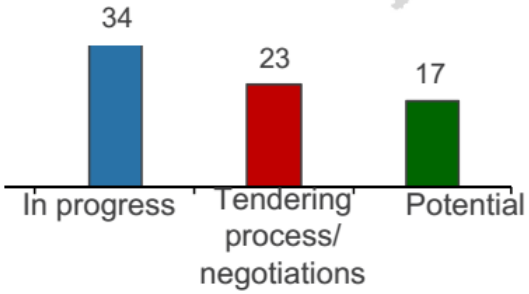
Achievements on the International Arena: VVER Technology Expansion

“Russia unrivaled in nuclear power plant exports”

the japan times

https://www.japantimes.co.jp/opinion/2017/07/27/commentary/world-commentary/russia-unrivaled-nuclear-power-plant-exports/#.Wlw5kKhl_IU





$133 billion

Rosatom foreign order portfolio for the next 10 years

http://www.bulatom-bg.org/files/conferences/Varna2017/pdf/Plennary/10-00_Titov_Varna_Jun07_rev5.pdf

Achievements on the International Arena: WWER/VVER Technology Expansion – Belarusian NPP (1/2)

Main parameters:

Power units: 2 x 1200 MW

Reactor type: VVER-12001

Implementation scheme: EPC (turnkey)

Key events and further steps

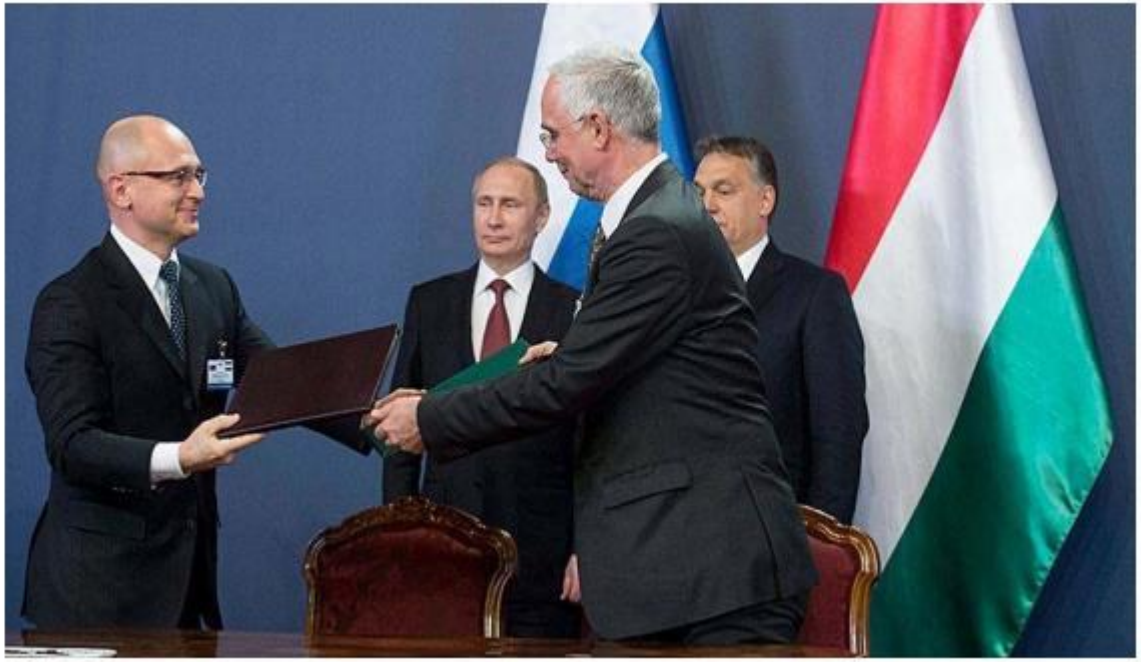
03/15/2011	01/31/2012	07/18/2012	11/02/2013	2016-2017	2018-2020
Signing of IGA on cooperation in NPP construction	Signing of Contract for development of design and top-priority detailed design documentation for Belarusian NPP	Signing of General Contract for construction of NPP	Signing of decree N499 on construction of the Belarusian NPP, which allowed JSC Atomstroyexport, the general contractor, to start construction of the Belarusian NPP	Signing • Contract for NPP service maintenance • Contract for SNF removal • Contract for nuclear fuel delivery	Commissioning of power units 1 and 2

Achievements on the International Arena: WWER/VVER Technology Expansion – Hungary, Paks 2 NPP

Main parameters:

Power units: 2 x 1200 MW

Reactor type: VVER-1200



Key events and further steps

03/28/2014

Signing
- FIGA, 80% of financing of the joint credit

12/09/2014

Conclusion of the contracts
- EPC
- Service maintenance
- Fuel

2017

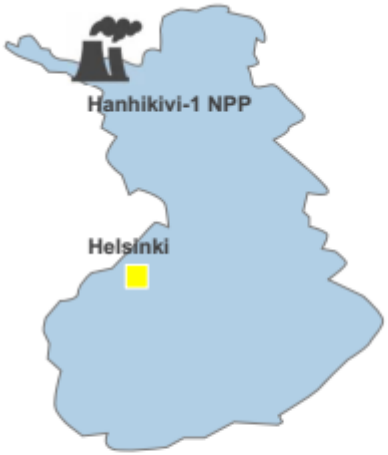
Signing
- March, project obtained site license from the Hungarian Atomic Energy Authority
- April, the Hungarian Environmental Authority of second instance issued its decision on the environmental license of Paks 2

http://www.bulatom-bg.org/files/conferences/Varna2017/pdf/Plennary/10-00_Titov_Varna_Jun07_rev5.pdf

http://www.world-nuclear-news.org/RS-Hungary-gets-site-licence-for-Paks-II-project-31031702.html

Achievements on the International Arena: WWER/VVER Technology Expansion – Hanhikivi-1 NPP, Finland

https://www.instagram.com/fennovoima/



Main parameters:

Power units: 1 x 1200 MW

Reactor type: VVER-1200

Commissioning: 2024 (Commercial startup)

Key events and further steps

07/01/2010	12/21/2013	02/25/2015	2017	2018-2024	2024
The approval has been received for NPP construction from the Parliament of Finland	Conclusion of • EPC-contract • Fuel delivery contract	Conclusion of • IGA on cooperation	Construction of roads, fences, lightning and electricity distribution systems, education building and main gate building has been completed	NPP construction	Start of commercial operation date for Hanhikivi PP

Achievements on the International Arena: Cooperation on Radioactive Waste Management

Rosatom and the French radioactive waste management agency Andra signed a cooperation agreement concerning the final isolation of RW

http://www.world-nuclear-news.org/WF-Rosatom-and-Andra-expand-cooperation-23111702.html

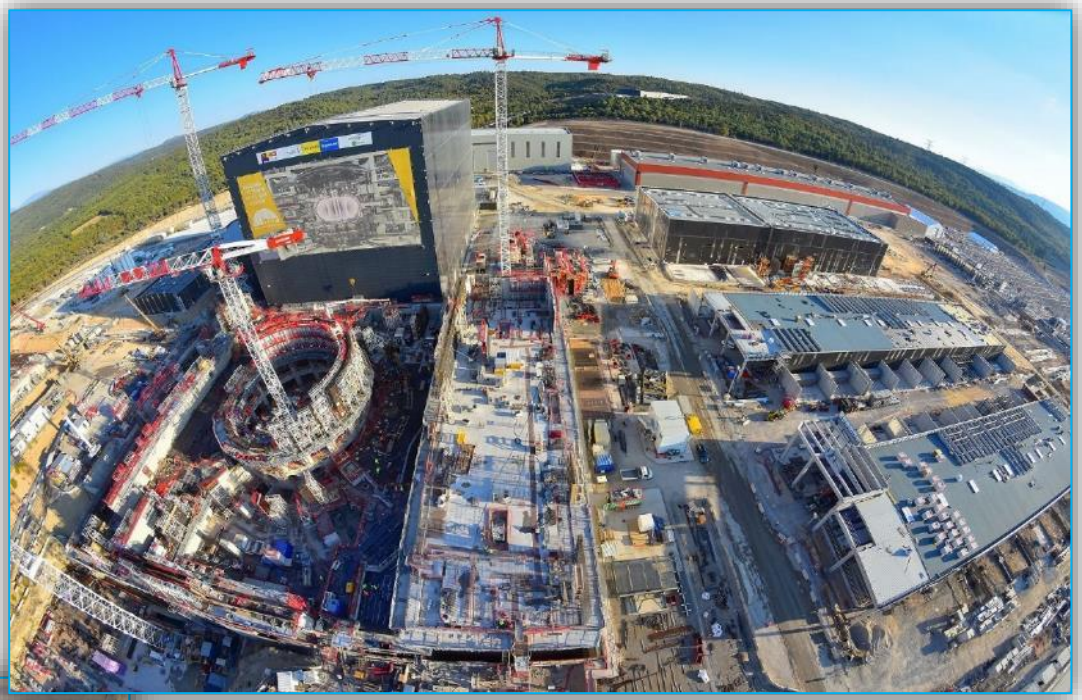
Japan and Russia have signed a memorandum on the exchange of information on reactor physics experiments for minor actinoid transmutation for radioactive waste processing and management

http://www.world-nuclear-news.org/WF-Rosatom-and-Andra-expand-cooperation-23111702.html

Achievements on the International Arena: Future Technologies – ITER Project

ITER fusion project passes construction milestone - 50% of the 'total construction work scope through First Plasma' is now complete

http://www.world-nuclear-news.org/NN-Iter-fusion-project-passes-construction-milestone-1112175.html



Russia sent six trailers with high-current busbars for the power supply systems of ITER's superconducting magnet

http://www.world-nuclear-news.org/NN-Rosatom-head-visits-Iter-latest-equipment-batch-sent-12091701.html

Cooperation with Europe in the Field of Nuclear Education and Training

ENEN-RU History – Milestones and Plans for Training (1/3)

2011 ENEN-RU I project 2013

Pilot training #1 – Engineering aspects of nuclear fuel fabrication – ROSATOM-CICE&T, Russia May 20th-26th, 2012

- Following the test the trainees were awarded **ECTS grades**

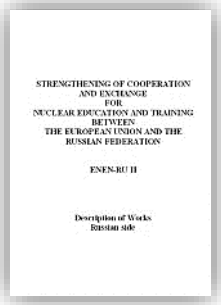
Pilot training #2 – Experimental reactor physics – CTU, Czech Republic October 1st-5th, 2012

- Establishment of Internships in European universities for Russian students

2014 ENEN-RU II project

September 29-30, 2014 ROSATOM-CICE&T hold the ENEN-RU II project kick-off meeting

A successful kick-start to the ENEN-RU II project was given


STRENGTHENING OF COOPERATION AND EXCHANGE FOR NUCLEAR EDUCATION AND TRAINING BETWEEN THE EUROPEAN UNION AND THE RUSSIAN FEDERATION

ENEN-RU II

Description of Works Russian side

E&T:

- *ROSATOM-CICE&T*
- *NRNU MEPhI*

Experimental facilities and labs:

- *FSUE "SSC RF – IPPE"*
- *NIFKhI*
- *JSC "SSC RIAR"*

Management:

- *ROSATOM*

2015

June 1-2, 2015, Moscow ENEN-RU II 1st Progress Meeting

- **ENEN-RU II Progress meeting at Moscow office of ROSATOM-CICE&T**
- **Round Tables at ATOMEXPO-2015 :**
  - «Methods and mechanisms of international cooperation to support education&research for sustainable nuclear power development»
  - «Integrated solution for personnel training and development of nuclear infrastructure for national nuclear programmes»

ENEN-RU History – Milestones and Plans for Training (2/3)

2015

ENEN-RU II Training #1 – Engineering aspects of nuclear fuel fabrication – ROSATOM-CICE&T, Russia, November 23-27, 2015

The updated training course for nuclear fuel fabrication

Trainees:	Romania (5), Czech Republic (2), Italy (2), Germany (1), Slovakia (1), Spain (1), IAEA (1)
TOTAL	**13**

November 24, 2015, ROSATOM-CICE&T. ENEN-RU II 1st Forum Meeting

The meeting attendants participated in XIV International Conference "NPP Safety and Personnel Training" Plenary session

2016

ENEN-RU II Training #2 – The safety issues of VVER-type reactors with nuclear fuel based on reprocessed uranium – ROSATOM-CICE&T, Russia, June 27 – July 01, 2016

Trainees:	Slovakia (3), Italy (2), Armenia (1), Romania (1)
TOTAL	**7**

June 27-28, 2016, ROSATOM-CICE&T. ENEN-RU II 2nd Project Meeting

- Discussion of WPs' status and planning
- Possibilities and interests for ENEN RU III

2016

ENEN-RU II Training #3 – Joint course "Safety Culture Management: Methodology and Practice" – ROSATOM-CICE&T, Russia, October 3-7, 2016

School on SC participants:

By country:	Russia (86), Finland (3)
TOTAL	**89**

ENEN-RU II Training #4 – Systematic Approach to Training Methodology – TECNATOM, Spain, October 10-14, 2016

By country:	Russia (6), Spain (4)
TOTAL	**10**

ENEN-RU History – Milestones and Plans for Training (3/3)

2017

ENEN-RU II Training #5 – Simulation of different NPPs operation – CTU, Czech Republic, May 30 – June 2, 2017

A group of instructors from ROSATOM-CICE&T participated in the training.

As a technical tour the participants visited a VR-1 research reactor

Trainees:	Russia (6)
TOTAL	**6**

2017

ROSATOM-CICE&T and ENEN signed a Memorandum of Understanding – ATOMEXPO-2017, Moscow, June 20, 2017

Memorandum of Understanding to renew the successful cooperation between ROSATOM-CICE&T and ENEN, which began in 2010

Final Meeting of the ENEN-RU II Project – ATOMEXPO-2017, Moscow, June 21, 2017

- Discussion of results under WPs
- Proposals for the ENEN RU III

2018-2021

ENEN RU III Project

Scope of cooperation:

- Nuclear **Education**
- Nuclear **Training**
- Nuclear **Research**

Interests:

- Gen-IV reactros
- NFC based on REMIX and MOX

New members:

From RU side: Tomsk Politechnic Univ, Ural Federal Univ)

Fennovoima Case and Rosatom Tech

Training courses for Fennovoima Oy

2016 – 2017

(with particpation of Teknatom)

The main objective of this training course is to provide information about the basics of reactor physics of VVER-1200 and its relation to the provision of safe and reliable NPP operation, the basic concepts of the nuclear fuel cycle, technical solutions of Hanhikivi NPP project and to describe the key NPP systems. 321 certificates were issued.

Teknatom S.A. held the visit of the joint group of representatives Fennovoima Oy, RAOS Project, RUSATOM Service and Rosatom Tech. 2017

The main purpose was to assess the potential of the partners of Rosatom Tech in terms of participation in the training of personnel of the international customer.

Training of TUV SUD

(participation of STUK experts) Munich, Germany

2016

The course programme was implemented as 40-hour training, including the final examination.

The experts of Rosatom Tech, RASU and ZAES were the instructors

Fennovoima's audit of RosatomTech

2017

Within two days, the ROSATOM Tech's quality management system was evaluated by the Fennovoima's audit team in accordance with the pre-agreed audit plan. Particular attention was given to the role and responsibility of the organizations involved into the education and training of the Fennovoima personnel within the "Basic Plant Course. Part I and Part II".

Training for NPP operators and instructors

2019-2023

Training for 48 persons of operators and instructors

Training for NPP operator for maintenance and repair

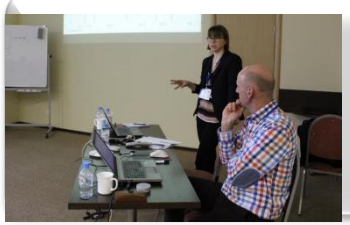
Collaboration between Hungary and Rosatom Tech

Training courses for MVM Erbe Ltd. 2017

Experts from Rosatom Tech. held the first training module for the personnel of company MVM Erbe Ltd. The training was aimed at receiving the information on particularities of AES-2006 design. The program of the first module is focused on receiving the knowledge regarding design development, design of different systems, structures and components of AES-2006 (VVER-1200 reactor) at the examples of Hanhikivi-1, Leningrad-2 and Paks-2.

Instructors

Training for Paks II instructors



Training course on Nuclear PSA in cooperation with Lloyd's Register Nuclear Academy 2017

In Saint-Petersburg branch of Rosatom Tech., a 4-day course was held for personnel of the ATOMPROEKT. This course was delivered by the leading experts of the Lloyd's Register Nuclear Academy in cooperation with Rosatom Tech. experts . The training course combines theory with practical examples from industry, as well as interactive sessions and hands-on practice using RiskSpectrum PSA software. The purpose of this course is to give participants an introduction to specific PSA topics such as low power and shutdown PSA, internal hazards, external hazards including seismic, Level 2 and Level 3 PSA.

Green Frontiers Initiative (GFI) / Research Enhancing Nuclear through University Collaboration (RENUC)

Green Frontiers Initiative (GFI) –

IAEA initiative in fostering international university collaboration on nuclear research, technology development and innovation
(initiated in NKM Section in 2015)

In GFI format the IAEA formed a new type of activity - consolidation of research resources of universities for:

- promotion and awareness of innovative reactor technologies
- focusing small, economic and safe nuclear plant designs that minimize radioactive waste and that can support hybrid non-electric applications like energy conversion and desalination

Cooperation research projects proposed by GFI members:

- **Advanced High Temperature Reactor (AHTR)** (Witwatersrand/SAN NEST)
- **iMagine – two-component nuclear fuel cycle with (potentially) Molten Salt Reactor** (University of Liverpool/University of Edinburgh/University of Manchester)
- **Small and Medium size nuclear Reactors (SMRs)** (Rosatom Tech)
- **Foam-for-nuclear (OpenFOAM-based)** (Ecole Polytechnique Fédérale de Lausanne EPFL)
- **Validation and Uncertainty Quantification of Multi-Physics Analysis of Advanced Nuclear Reactors** (North Carolina State University)

- **Possibility to use ENEN-RU experience in collaboration and facility data base development**
- **Possibility to jointly (EU+RU) participate in GFI/RENUC projects**

Legal Basis for Implementation of Work

2 Agreement between SAEC ROSATOM and IAEA on extrabudgetary contribution

IAEA ROSATOM

AGREEMENT

between

The International Atomic Energy Agency

and

The State Atomic Energy Corporation "Rosatom",

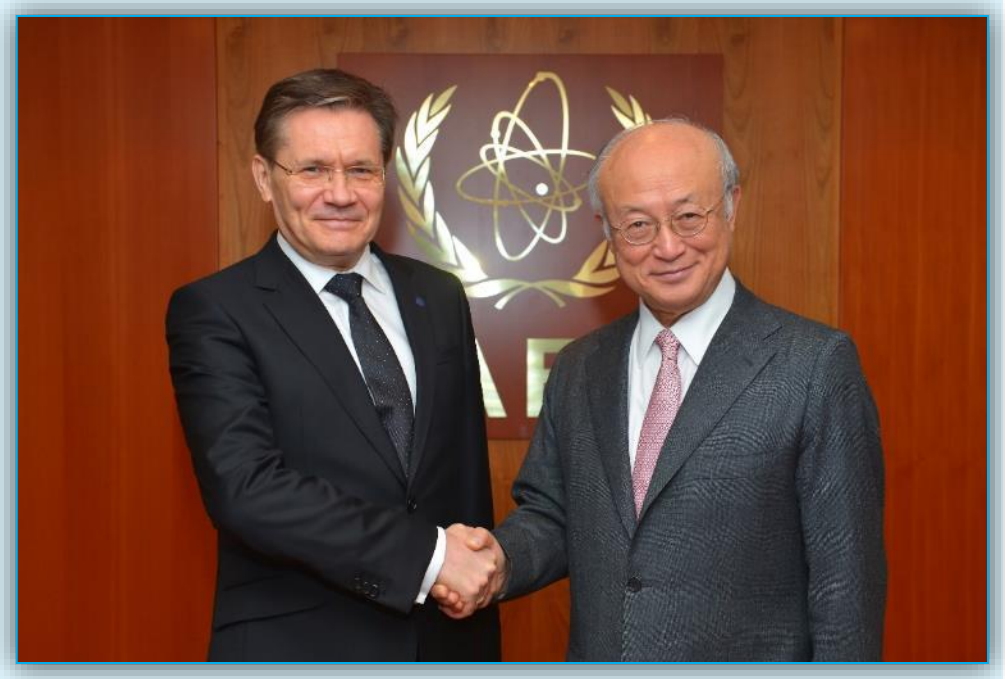
Concerning

Extra budgetary Contribution

to the Implementation of the IAEA Technical Cooperation Projects on

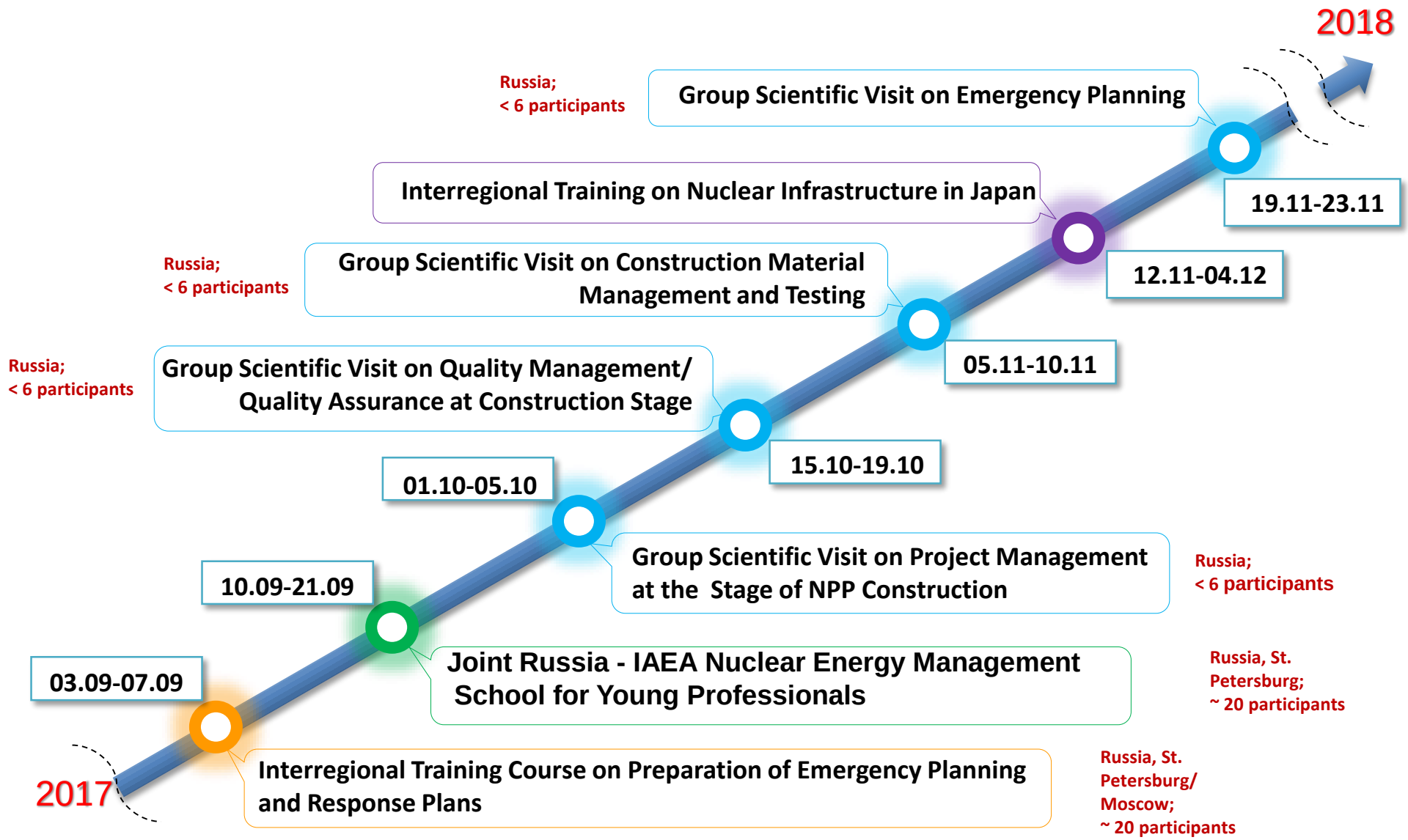
Nuclear Infrastructure Development

IAEA Technical Cooperation Department Project INT/2/018

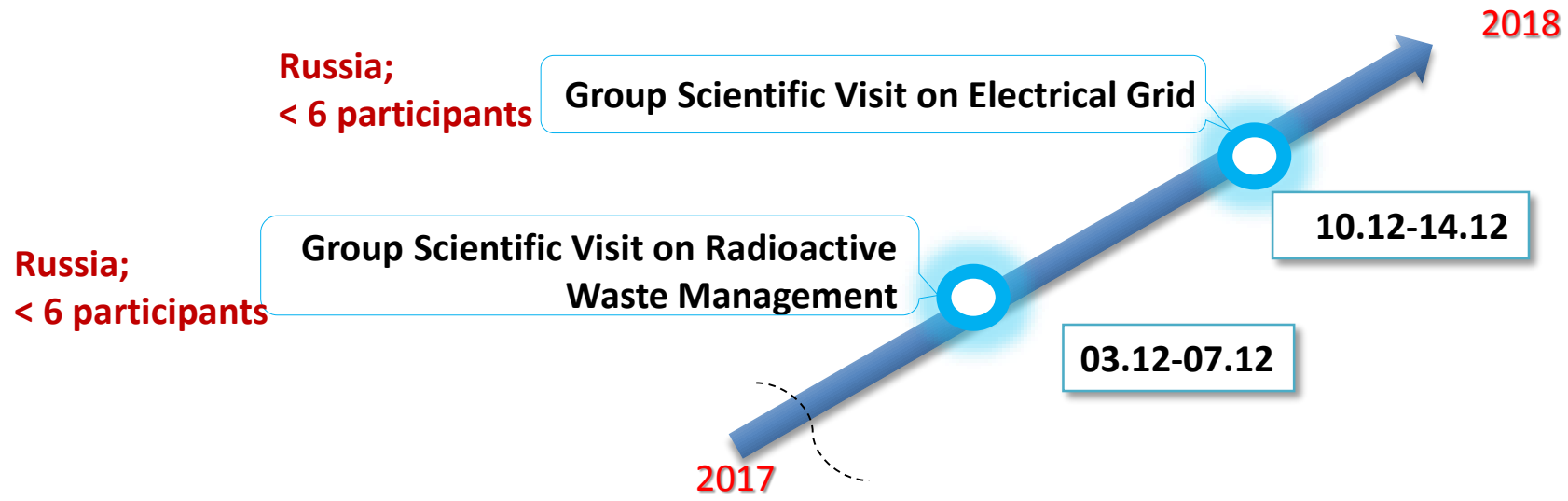


Training Within the Framework of the IAEA TC Project in 2018 (1/3)

Training Within the Framework of the IAEA TC Project in 2018 (2/3)



Training Within the Framework of the IAEA TC Project in 2018 (3/3)



TOTAL: 16 events; ~180 participants; 20 training weeks

Conclusions

1. **ENEN-Ru project has been proved to be a vital platform to continue cooperation between Europe and Russian Federation in nuclear field**
2. **Based upon ENEN-Ru accumulated experience it is possible to arrange ENEN participation in training activities in Russia for new-comer countries**

Thank You & Welcome to Obninsk

Technical Academy
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