The APIS project

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R2CA Summer school

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Co-funded by the European Union

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Key APIS objectives

Contribute to the following outcomes:

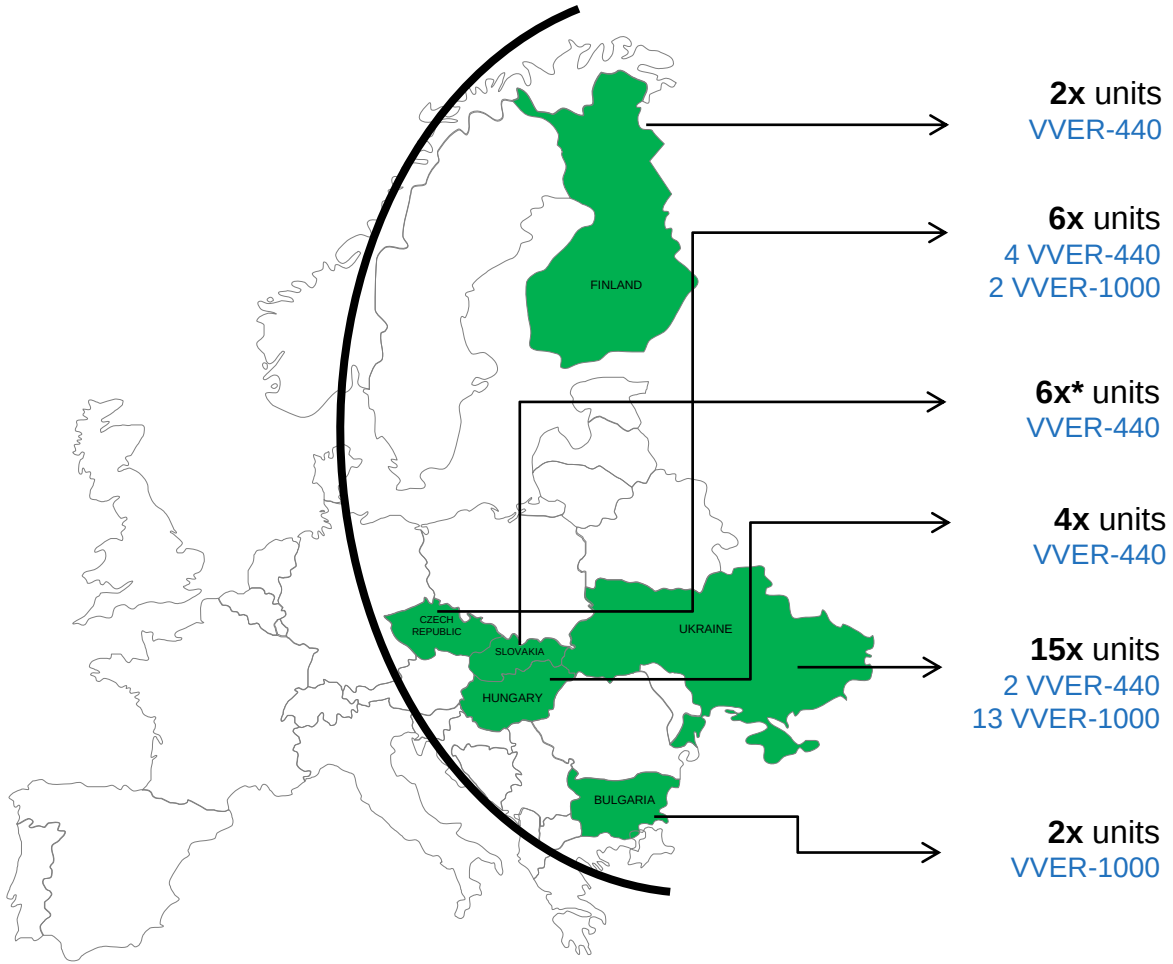
- Increased security of supply of nuclear fuel for VVER reactors
- Remove obstacles for European vendors to ensure the supply of highly reliable fuel for the uninterrupted, safe operation of VVER-440 and VVER-1000 reactors
- A coordinated approach to the licensing of alternative fuel for VVER reactors.

APIS vision:
To create security of supply of nuclear fuel for Russian designed pressurized water reactors (VVER) operating in the EU and Ukraine

European Commission

VVER Fuel Market in Europe

16* VVER-440 and 17 VVER-1000 units



2x units
VVER-440

6x units
4 VVER-440
2 VVER-1000

6x* units
VVER-440

4x units
VVER-440

15x units
2 VVER-440
13 VVER-1000

2x units
VVER-1000

* Mochovce unit 3 starting-up, unit 4 close to completion

APIS OBJECTIVE

Secure nuclear fuel supply to European VVER nuclear power plants

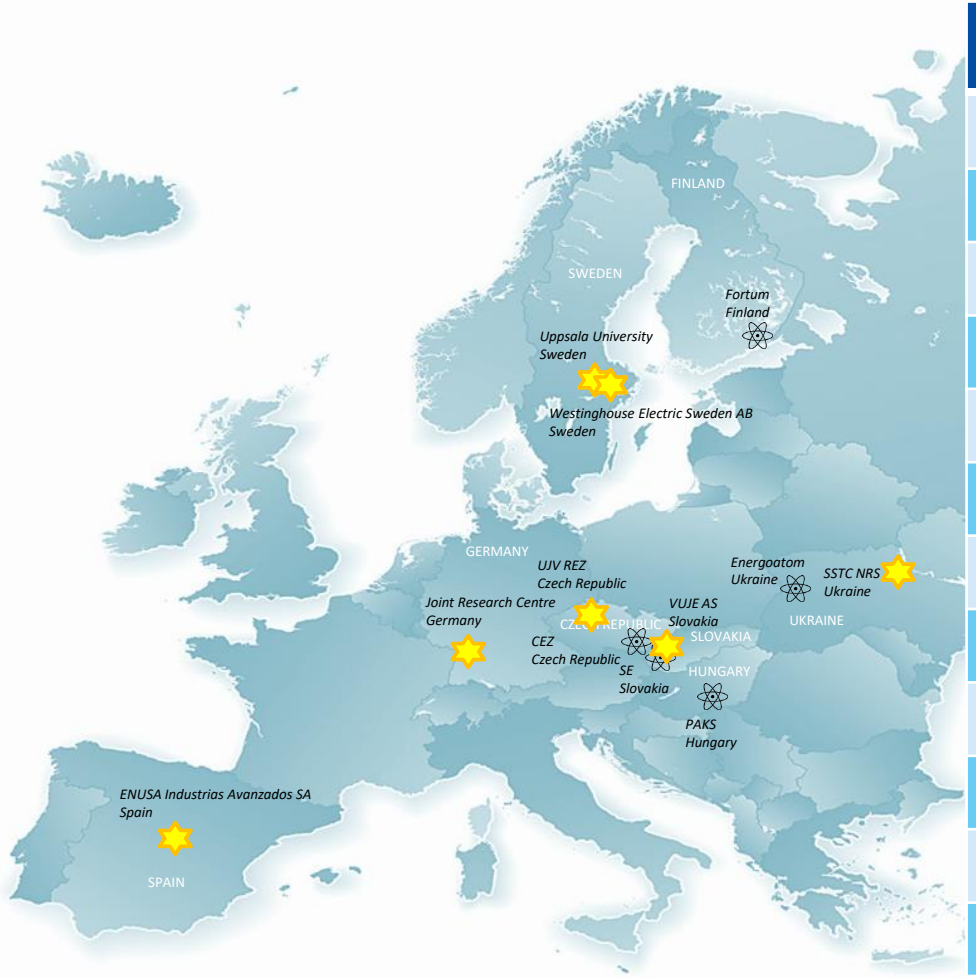
	VVER-440	VVER-1000
		**Bulgaria** Kozloduy 5-6
	**Czech Republic** Dukovany 1-4	**Czech Republic** Temelín 1-2
	**Finland** Loviisa 1-2	
	**Hungary** Paks 1-4	
	**Slovakia** Bohunice 1-2, Mochovce 1-2, Mochovce 3 (starting-up) Mochovce 4 (under construction)	
	**Ukraine** Rivne 1-2	**Ukraine** Rivne 3-4, Khmelnitski 1-2, South Ukraine 1-3, Zaporizhzhia 1-6

Accelerated Program for Implementation of secure VVER fuel Supply

APIS – bee in Latin

APIS	Accelerated Program for Implementation of secure VVER fuel Supply
Contract period & Commencement date	2023-2025 (36 months duration as of Jan 1, 2023)
Project setup	Westinghouse and 11 consortium partners
Budget	Total max grant amount: 10 MEUR (Grant agreement expected to be signed shortly)
EU Funding	50 % of the eligible costs for for-profit entities and 75% for non-profit entities.

Project organization – Consortium



Participant #	Participant organisation name	Country
1 (Coordinator)	WESTINGHOUSE ELECTRIC SWEDEN AB	SE
2	ENUSA INDUSTRIAS AVANZADA SA	ES
3	JRC - JOINT RESEARCH CENTRE	BE
4	VUJE AS	SK
5	SSTC NRS	UA
6	NRI / ÚJV Řež	CZ
7	PAKSI ATOM	HU
8	SLOVENSKE ELEKTRARNE AS	SK
9	CEZ AS	CZ
10	UPPSALA UNIVERSITY	SE
11	FORTUM POWER AND HEAT OY	FI
12	SE «NNEGC «Energoatom»	UA

APIS OBJECTIVE

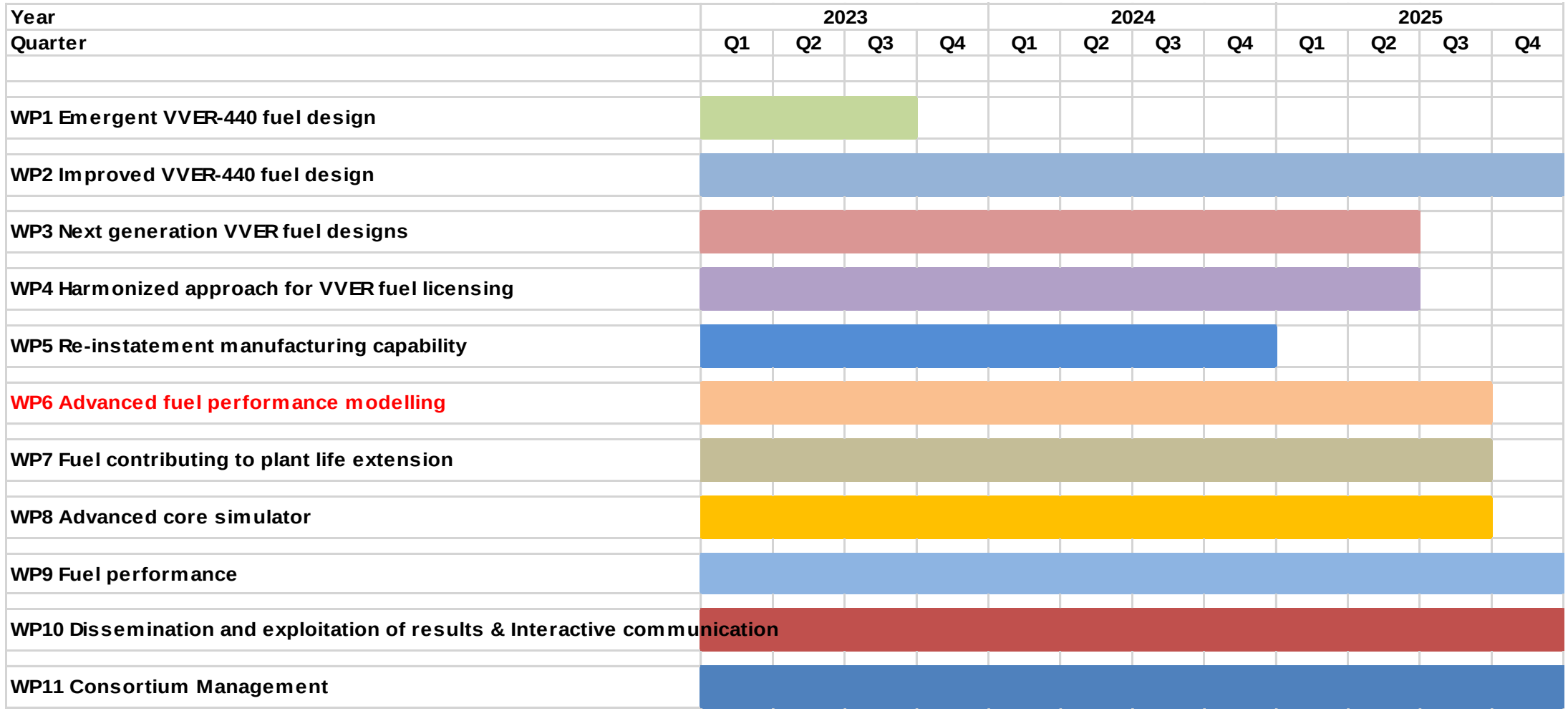
Secure nuclear fuel supply to European VVER nuclear power plants

Work package #	Work Package Title	Lead Participant Short Name	Person-Months	Start Month	End month
1	Emergent VVER-440 fuel design	Westinghouse	104	1	9
2	Improved VVER-440 fuel design	Westinghouse	93	1	36
3	Next generation VVER fuel designs	Westinghouse	136	1	30
4	Harmonized approach for VVER fuel licensing	Westinghouse	36	1	28
5	Re-instatement manufacturing capability	ENUSA	499	1	24
6	Advanced fuel performance modelling	JRC	62	1	34
7	Fuel contributing to plant life extension	SSTC NRS	25	1	34
8	Advanced core simulator	Westinghouse	66	1	35
9	Fuel performance	Westinghouse	78	1	35
10	Dissemination and exploitation of results & Interactive communication	Uppsala University	31	1	36
11	Consortium Management	Westinghouse	15	1	36

100 person-years over 3 years

APIS TIME SCHEDULE

Secure nuclear fuel supply to European nuclear power plants

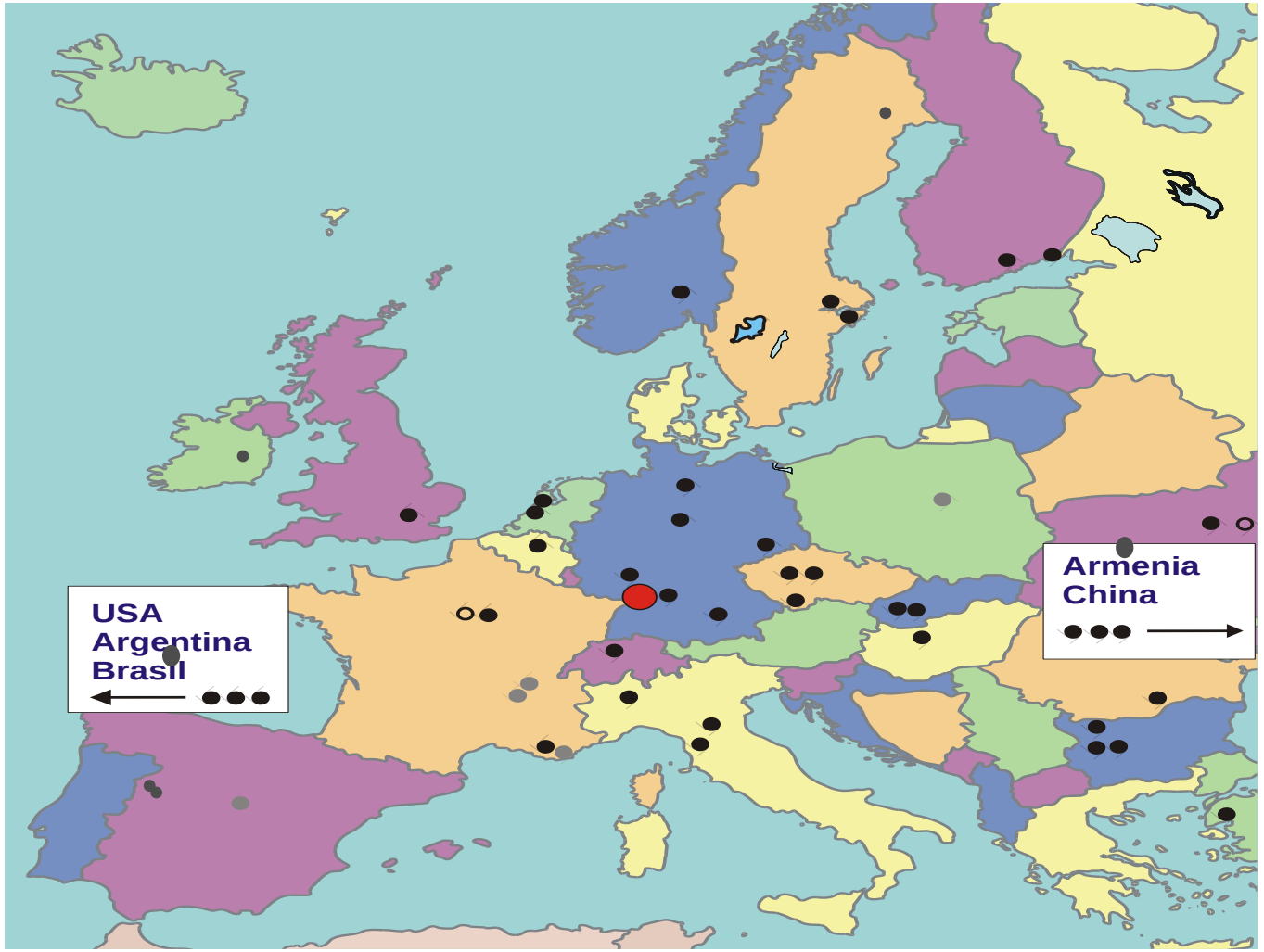


WP6: Advanced Fuel Performance Modelling

Objectives

1. Implement new material properties (ADOPT fuel and EnCore cladding) in latest version of TRANSURANUS code
2. Update coupling interfaces for upgraded TRANSURANUS code with DYN3D, ATHLET and RELAP for multi-physics analysis (e.g DBA or DEC-A analysis)
3. Develop modern methodologies for model development and code calibration in frame of BEPU analysis

TRANSURANUS user group



54 organisations:

- ETSON members
- Research organisations
- Fuel designers
- NPP operators
- Universities (ENEN)

Background (1/2)

- Development of TRANSURANUS-VVER version at WWER-2019 conf.
- EXTRA project (AEKI): extend TRANSURANUS (TU) to VVER fuel
- ESSANUF project (WSE): VVER-440 fuel
  - WP3 (Fault analysis): DBA analysis with TU coupled with RELAP, ATHLET, DYN3D
  - WP4 (Fuel Rod Design): Select TU code, implement WSE models
- McSAFE(R) projects (KIT):
  - Advanced code coupling (Serpent-Subchanflow-TU): new TU code version with pointer based global variable domains for variable transfer between TU and supervisor module (Serpent/SCF) via ICoCo

Background (2/2)

- New materials (EATF)
  - Fuels: UN, U_3Si_2 fuel, Cr-doped fuel
  - Cladding: FeCrAl, Cr-coated cladding
- BEPU analysis
  - **UU** (Inverse UQ
  - EPFL, NINE, UNIPI, POLIMI

R2CA and McSAFER projects

OperaHPC project

Participants in WP6

Participant	Nr	Person-months
Westinghouse	1	6
JRC	3	9
VUJE	4	6
SSTC NRS	5	12
NRI/UJV REZ	6	15
SE-A.S.	8	0.1
CEZ	9	0.2
UU	10	14
FORTUM	11	0.5

Deliverables of WP6

1. Report about implementation of specific material properties and models in TRANSURANUS platform (JRC)
2. Report about the code and model calibration of the new TRANSURANUS version (UU)
3. Updated methodology for code coupling of TRANSURANUS-RELAP (VUJE)
4. Updated methodology for code coupling of TRANSURANUS-ATHLET (WSE)
5. Updated methodology for code coupling of TRANSURANUS-DYN3D (NRI-UJV)

Interactions with other WPs

- WP3: next generation VVER fuel design:
  - Input from WP3
    - D3.1 Report on ADOPT pre-study
    - D3.2 Report on oxide coating pre-study
  - Tool to evaluate impact of ADOPT characteristics on transient fuel rod behaviour
- WP4: Harmonized approach for VVER fuel licensing
- New coupling interfaces for WP4

Stay in Touch

- Project coordinator: Sabina Kristensson
- **Contact:** info@apis-project.eu
- Webpage: https://apis-project.enbomweb.se/

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