Key objectives and results of the Gospostrateg-HTR project

Agnieszka Boettcher

NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

Seminarium Zakładu Energetyki Jądrowej i Analiz Środowiska (UZ3), 1.03.2022

GOSPOSTRATEG-HTR (GoHTR)

GOSPOSTRATEG - strategic Polish program of scientific research and development (R&D) work "Social and economic development of Poland in the conditions of globalizing markets"

Title: Preparation of legal, organizational and technical instruments for the HTR implementation
(Gospostrateg1/385872/22/NCBR/2019)

Consortium:

Ministry of Climate and Environment

NCBJ

ichtj

www.gohtr.pl

Phase A: Research work. Preparation of testing procedures and instrumentation necessary for their implementation(1-18M).

Phase B: Implementation procedures into approvals, especially in terms of Polish Atomic Law(19-36M).

GOSPOSTRATEG-HTR

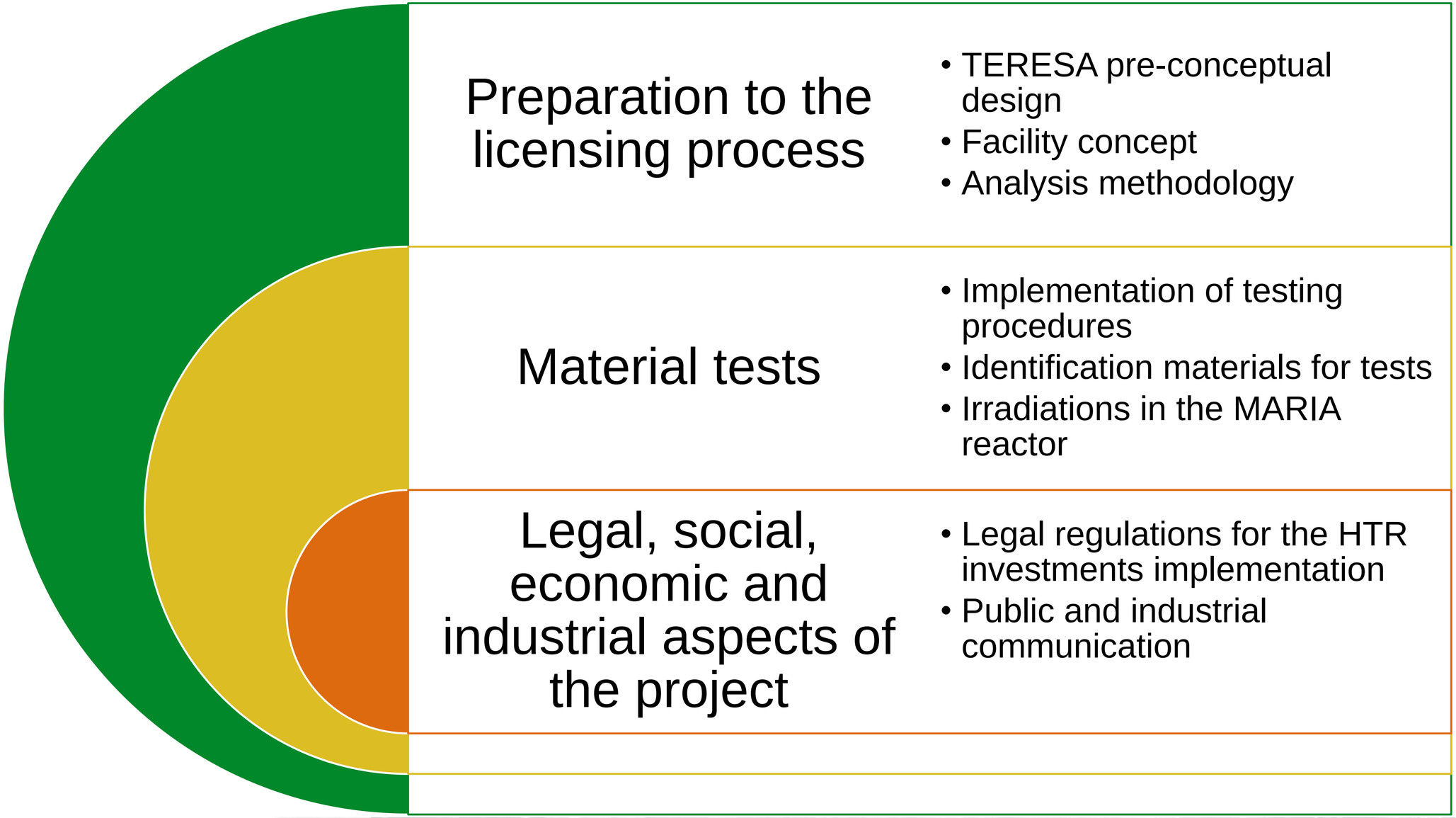
- Phase A
- (2019.02.01 – 2020.07.30)

1. Development of methods for diagnostics of structural materials in the HTR construction (NCBJ);
2. Development of methods for testing of structural materials in a nuclear reactor, and equipment for the execution of tests in the core(NCBJ);
3. Research and analysis of selected chemical aspects of the production and use of TRISO fuel in the HTR nuclear reactor(ICHTJ);
4. Comprehensive analysis of the necessary changes to the legal environment and the potential benefits of social, economic and industrial units for the Polish economy(ME, NCBJ).

- Phase B
- (2020.08.01 – 2022.03.31)

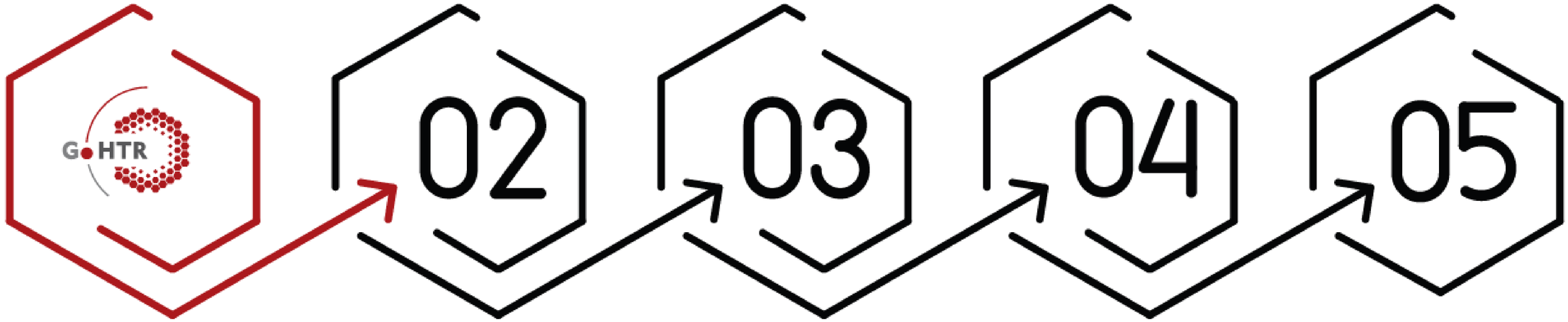
5. Preparation licensing process (certification) of HTGR reactors on the example of a research reactor(ME, NCBJ, ICHTJ);
6. Preparation draft of legal regulations for the HTR investments implementation; developing a strategy in the social, economic and industrial aspects of the project(ME, NCBJ, ICHTJ);
7. Piloting of test procedures for the use of construction materials for the HTR reactor design, including tests in the Maria reactor core (NCBJ);
8. Preparation of technical and economic assumptions for the construction of a fuel production unit for high-temperature reactors(ICHTJ).

GOSPOSTRATEG-HTR: Key objectives



Preparation to the licensing process	• TERESA pre-conceptual design • Facility concept • Analysis methodology
Material tests	• Implementation of testing procedures • Identification materials for tests • Irradiations in the MARIA reactor
Legal, social, economic and industrial aspects of the project	• Legal regulations for the HTR investments implementation • Public and industrial communication

GOSPOSTRATEG-HTR: TERESA pre-conceptual design



PRE-CONCEPTUAL DESIGN

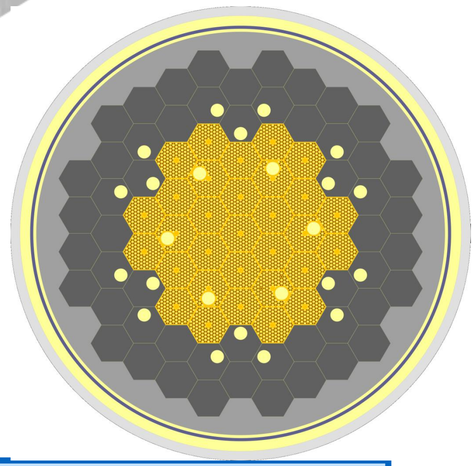
CONCEPTUAL DESIGN

PRELIMINARY DESIGN

BASIC DESIGN

EXECUTIVE TECHNICAL DESIGN

GOSPOSTRATEG-HTR



Pre-conceptual design of research HTR named TERESA

- Design based on GEMINI+ Project- down-size of HTR for Industrial application
- Safety analyses (T-H, neutronics, PSA, et. al.)
- Secondary circuit design
- System balance calculations

TERESA functions:

1. Research (e.g. passive heat removal tests, codes validation);
2. Experimental (technological appliances in micro scale - e.g. turbine);
3. Applicative (electricity and heat production for own NCBJ needs)

GOSPOSTRATEG-HTR: TERESA pre-conceptual design, main parameters

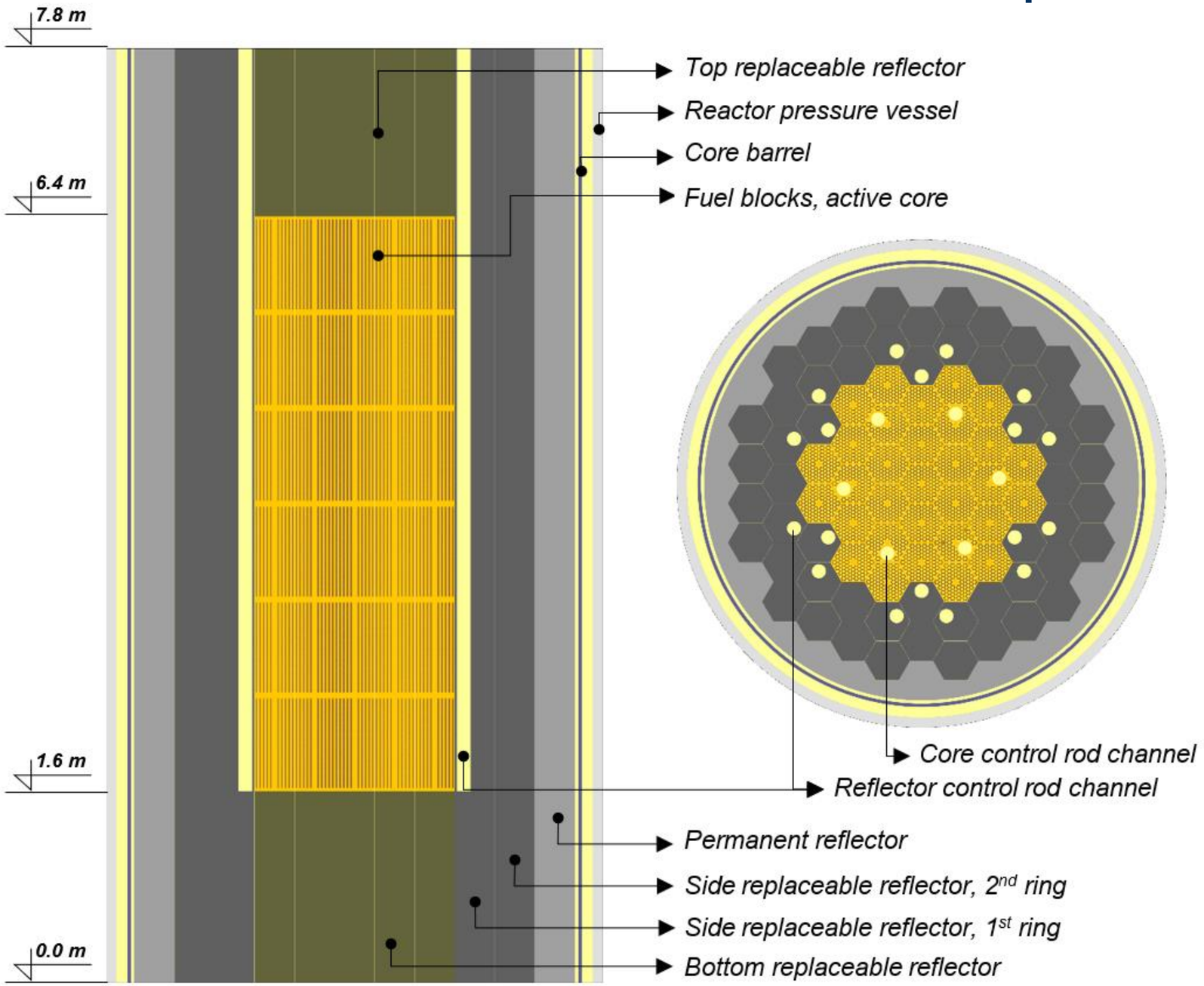
	Reactor name	
Parameter	**Gemini+**	**TeResa**
Thermal Power	180 MW	40 MW
Power density	5.8 MW/m^3	2.36 MW/m^3
Block type	FSV/SC-HTGR/HTR-Module (pin in block)	FSV/SC-HTGR/HTR-Module (pin in block)
RPV inlet temperature	~325ºC	325ºC
Core inlet temperature	335˚C	330˚C**
Core outlet temperature	750-1000˚C**	~800˚C**
Reactor outlet tempe-rature (inlet steam generator/IHX)	750˚C	750˚C*
Coolant pressure	6 MPa	6 MPa
Coolant flow	79 kg/s	18,14 kg/s
Bypass flow	8%	7%
Number of fuel blocks in a column	11	6
Number of columns of fuel blocks	31	31
Core height	11*80 cm = 8,8 m (11 fuel blocks in a column)	6*80 cm = 4,8 m (6 fuel blocks in a column)
Equivalent core diameter	2,12 m	2,12 m
Fuel	UO2/12%	UO2/12%
Burnup	60 MWd/kg	TBD
Burnup period	550 days	1250days (from MCB)
Refueling time	every 1.5 years	after assumed burnup

* from system heat balance, D2.10 Assessment of the flexibility of GEMINI+ System_Issue2
** from MELCOR & SPECTRA calculations

GOSPOSTRATEG-HTR: TERESA codes

CODE	PURPOSE/TYPE OF ANALYSES, CHARCTERISTIC
SERPENT2.1.32	neutronic core calculation, Monte Carlo code particle transport calculations using libraries of continuous energy spectrum
MVP/GMVP	neutronic core calculation, Monte Carlo code
MCB (AGH team)	neutronic core calculation, Monte Carlo code
MELCOR	thermal-hydraulic simulation, severe accidents and source term calculations
CATHARE	thermal-hydraulic simulation of multiphase flow dynamics
SEPHIRE	PSA/PRA- system reliability analysis, event tree modeling
ANSYS Fluent	CFD analyses: ANSYS Design Modeller and ANSYS SpaceClaim- tools for creating 2D and 3D geometry; ANSYS Mesher - a tool for creating computational meshes; ANSYS Fluent - thermal-hydraulic analysis
PC-CREAM	ASSESSOR mode - calculation of effective doses MODELS mode - contains several mathematical models that predict the transfer of radionuclides through the environment and allow the estimation of activity concentration in various environmental media as a result of continuous releases
System Balance	M. Spirzewski (NCBJ) code for balancing the thermal system for the TeResa research reactor

GOSPOSTRATEG-HTR: TERESA* pre-conceptual core design



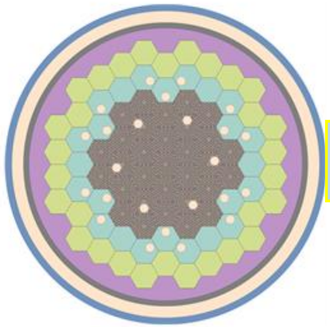
Neutronic

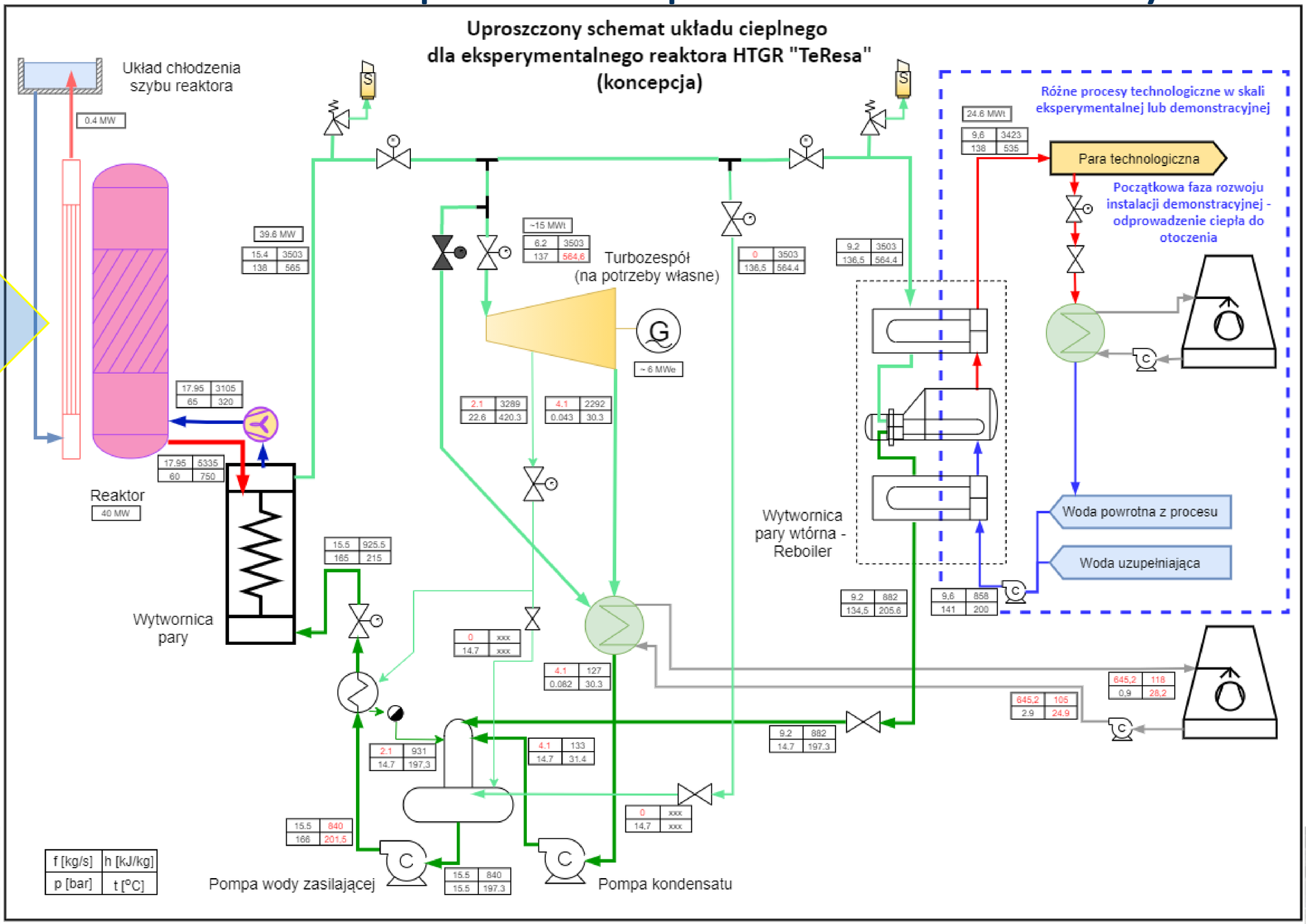
T-H

PSA

*based on the GEMINI+ concept

GOSPOSTRATEG-HTR: pre-conceptual TERESA facility



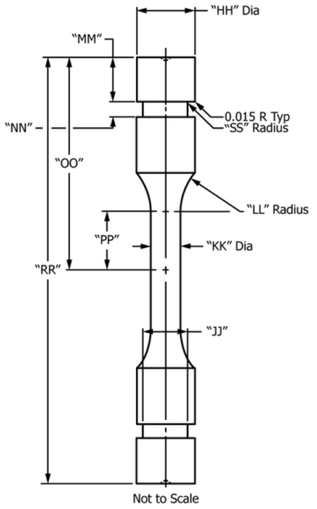


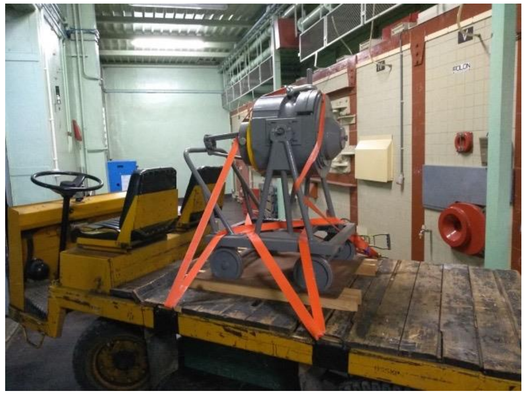
GOSPOSTRATEG-HTR *Material tests*

Identification and description of measurement procedures for testing and validation of HTR reactor construction materials

Irradiation System for High TemperAture Reactor (ISHTAR) design

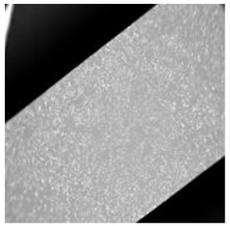
Materials: graphite (IG110, NBG-17, NCBJ facility), metal alloys (Hastelloy: X, N, B-3, C-273; Haynes 230)

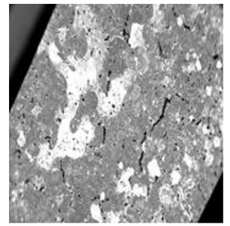




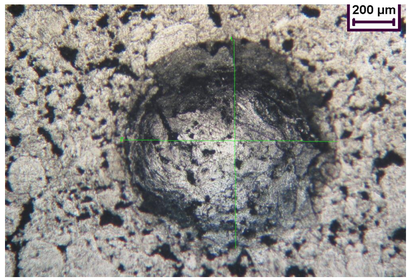
Equipment modernization

Implementation of testing procedures





Irradiations in the MARIA reactor

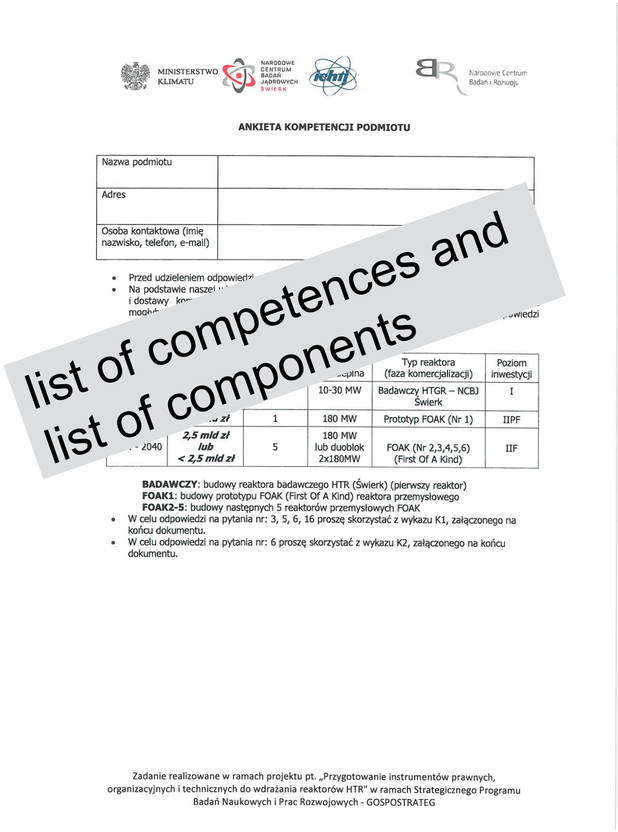


GOSPOSTRATEG-HTR Legal regulations for the HTR investments implementation

Procedure of changes in polish legal acts initiated by Ministry of Climate and Environment, started on 20-07-2021!

GOSPOSTRATEG-HTR Public and industrial communication

Survey of the Polish industry capabilities



MINISTERSTWO KLIMATU | NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK | ichtj | Narodowe Centrum Badań i Rozwoju

ANKIETA KOMPETENCJI PODMIOTU

Nazwa podmiotu	
Adres	
Osoba kontaktowa (imię nazwisko, telefon, e-mail)	

- Przed udzieleniem odpowied…
- Na podstawie naszej … i dostawy … mogł… …wiedzi

			…ujna	Typ reaktora (faza komercjalizacji)	Poziom inwestycji
			10-30 MW	Badawczy HTGR – NCBJ Świerk	I
		1	180 MW	Prototyp FOAK (Nr 1)	IIPF
… - 2040	*2,5 mld zł lub < 2,5 mld zł*	5	180 MW lub duoblok 2x180MW	FOAK (Nr 2,3,4,5,6) (First Of A Kind)	IIF

BADAWCZY: budowy reaktora badawczego HTR (Świerk) (pierwszy reaktor)
FOAK1: budowy prototypu FOAK (First Of A Kind) reaktora przemysłowego
FOAK2-5: budowy następnych 5 reaktorów przemysłowych FOAK

- W celu odpowiedzi na pytania nr: 3, 5, 6, 16 proszę skorzystać z wykazu K1, załączonego na końcu dokumentu.
- W celu odpowiedzi na pytania nr: 6 proszę skorzystać z wykazu K2, załączonego na końcu dokumentu.

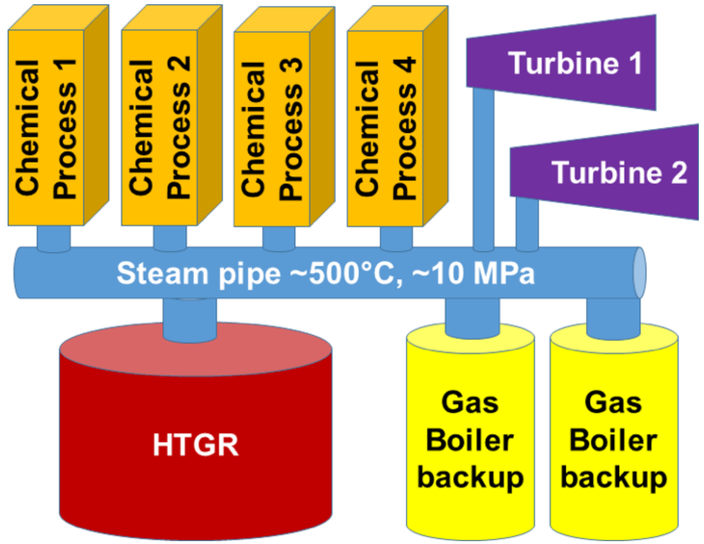
Zadanie realizowane w ramach projektu pt. „Przygotowanie instrumentów prawnych, organizacyjnych i technicznych do wdrażania reaktorów HTR" w ramach Strategicznego Programu Badań Naukowych i Prac Rozwojowych - GOSPOSTRATEG

list of competences and list of components

Research HTR

First of a kind HTR

Next of a kind HTR



GOSPOSTRATEG-HTR Public and industrial communication

Seminar for the Industry, 23.11.2021

Time	Description
9.00	Welcome: • Representative of the Ministry of Climate and Environment - Andrzej Sidło, • Director of National Center for Nuclear Research - prof. Krzysztof Kurek • President of the Polish Space Agency - prof. Grzegorz Wrochna.
9.20	High-temperature reactor - characteristics and applications– prof. Mariusz Dąbrowski, NCBJ
10.00	High-temperature reactor - components and required competences-– dr Agnieszka Boettcher, NCBJ
10.40	Introduction to the projects of the European Space Agency– Patrycja Karwowska, POLSA
11.20-11.30	Coffee break
11.30	Presentation of foreign companies: • Toshiba Energy Systems & Solutions Corporation - dr. Akito Nagata • Mitsubishi Heavy Industries - Kazumasa Suyama • USNC - Ziemowit Iwański
12.30	Presentation of the Polish company: • Energoprojekt SA- Olgierd Sikora, Piotr Łatecki
12.50	End of the Meeting

116 registrated participants!

– most of them from Industry

GOSPOSTRATEG-HTR Public and industrial communication

Series of expert lectures for the public

Reaktory wysokotemperaturowe (HTR) dla Polski
Wykłady eksperckie

24.11.2021 (środa), 17:00
Wacław Gudowski
Co to jest HTR i dlaczego potrzebujemy go w Polsce?
Ekonomia, przemysł, potencjalne zastosowania.

01.12.2021 (środa), 17:00
Piotr Darnowski
Zasada działania reaktora HTR.
Podstawy fizyki reaktorowej i aspekty bezpieczeństwa HTR.

08.12.2021 (środa), 17:00
Eleonora Skrzypek
Jak zbudowany jest reaktor HTR?
Podstawy techniczne.

Wykłady zostaną przeprowadzone w formie transmisji online, za pośrednictwem YouTube

Finansowanie:

Ministerstwo Klimatu i Środowiska | Narodowe Centrum Badań Jądrowych Świerk | ichtj | Narodowe Centrum Badań i Rozwoju

P

+folders
+short movies on NCBJ YouTube
+games
+WNE Paris 2021

Reaktory wysokotemperaturowe - źródło ciepła dla przemysłu

Ministry of Climate and Environment | NCBJ | ichtj | Narodowe Centrum Badań i Rozwoju

NATIONAL CENTRE
FOR NUCLEAR RESEARCH
ŚWIERK

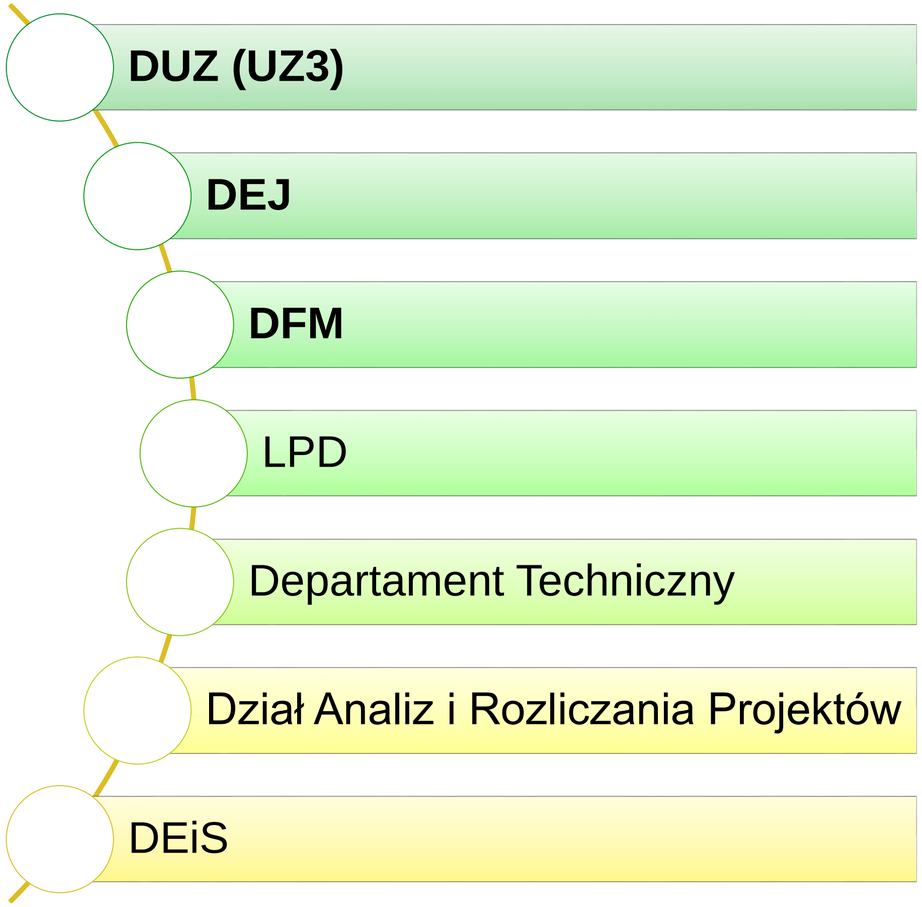
Research HTR

Reactor MARIA
30 MW, high n flux

www.ncbj.gov.pl

GOSPOSTRATEG-HTR in numbers

Budget	21 370 998.00 PLN
Czas realizacji	36+2 month
End of the project	31.03.2022r.
Number of employees	~110/month
The number of orders completed	~170
WP no. at NCBJ	6



GOSPOSTRATEG-HTR

ACKNOWLEDGEMENT

This work is one portion of the studies in the strategic Polish program of scientific research and development work "Social and economic development of Poland in the conditions of globalizing markets GOSPOSTRATEG" part of "Preparation of legal, organizational and technical instruments for the HTR implementation" financed by the National Centre for Research and Development (NCBiR) in Poland.

Project management at NCBJ:

dr Agnieszka Boettcher - project manager
dr inż. Agnieszka Celińska
Paweł Sęktas, MA
prof. Mariusz Dąbrowski
MSc. Małgorzata Frelek-Kozak
MSc. Marek Migdal

Thank you!

Contact:
Sekretariat.HTR@ncbj.gov.pl
agnieszka.boettcher@ncbj.gov.pl

NARODOWE CENTRUM BADAŃ JĄDROWYCH ŚWIERK

www.ncbj.gov.pl

Ministry of Climate and Environment

NCBJ

Narodowe Centrum Badań i Rozwoju