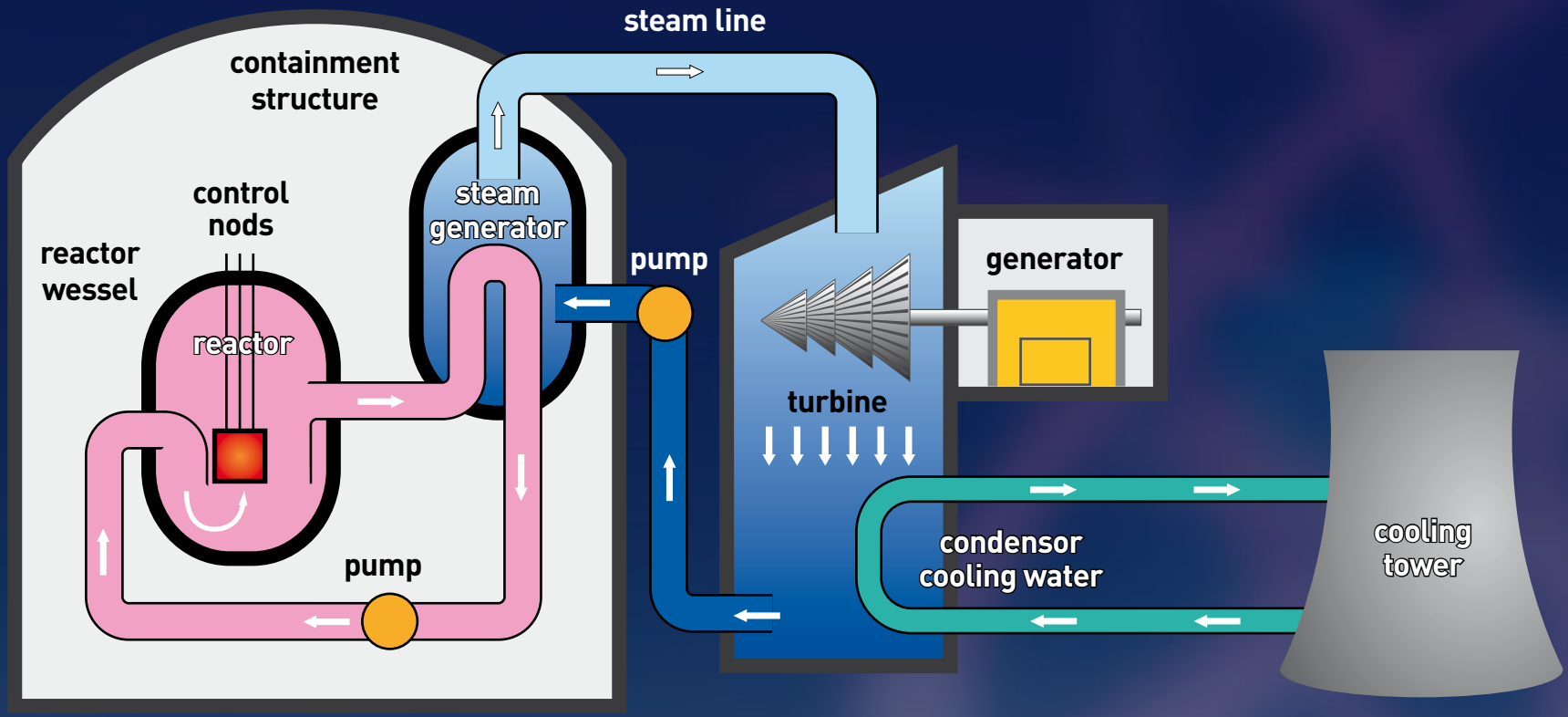
ASGARD

Advanced fuel**S** for **G**eneration IV re**A**ctors:
Reprocessing and **D**issolution:

PROJECT PRESENTATION

NUCLEAR REACTOR: PRINCIPLE

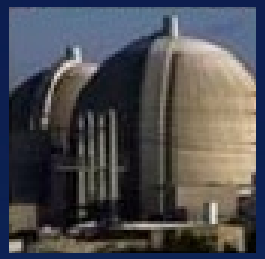


NUCLEAR REACTOR: GENERATIONS

GENERATION I
Early prototypes

Shippingport
Dresden
Magnox

GENERATION II
Commercial power



PWRs
BWRs
CANDU

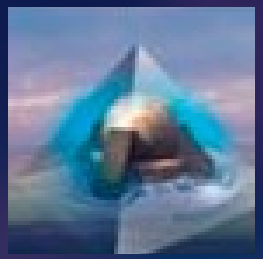
GENERATION III
Advanced LWRs

CANDU 5
System 80+
AP500

GENERATION III+
Evolutionary designs

ABWR
ACR1000
AP1000
APWR
EPR
ESBWR

GENERATION IV
Revolutionary designs



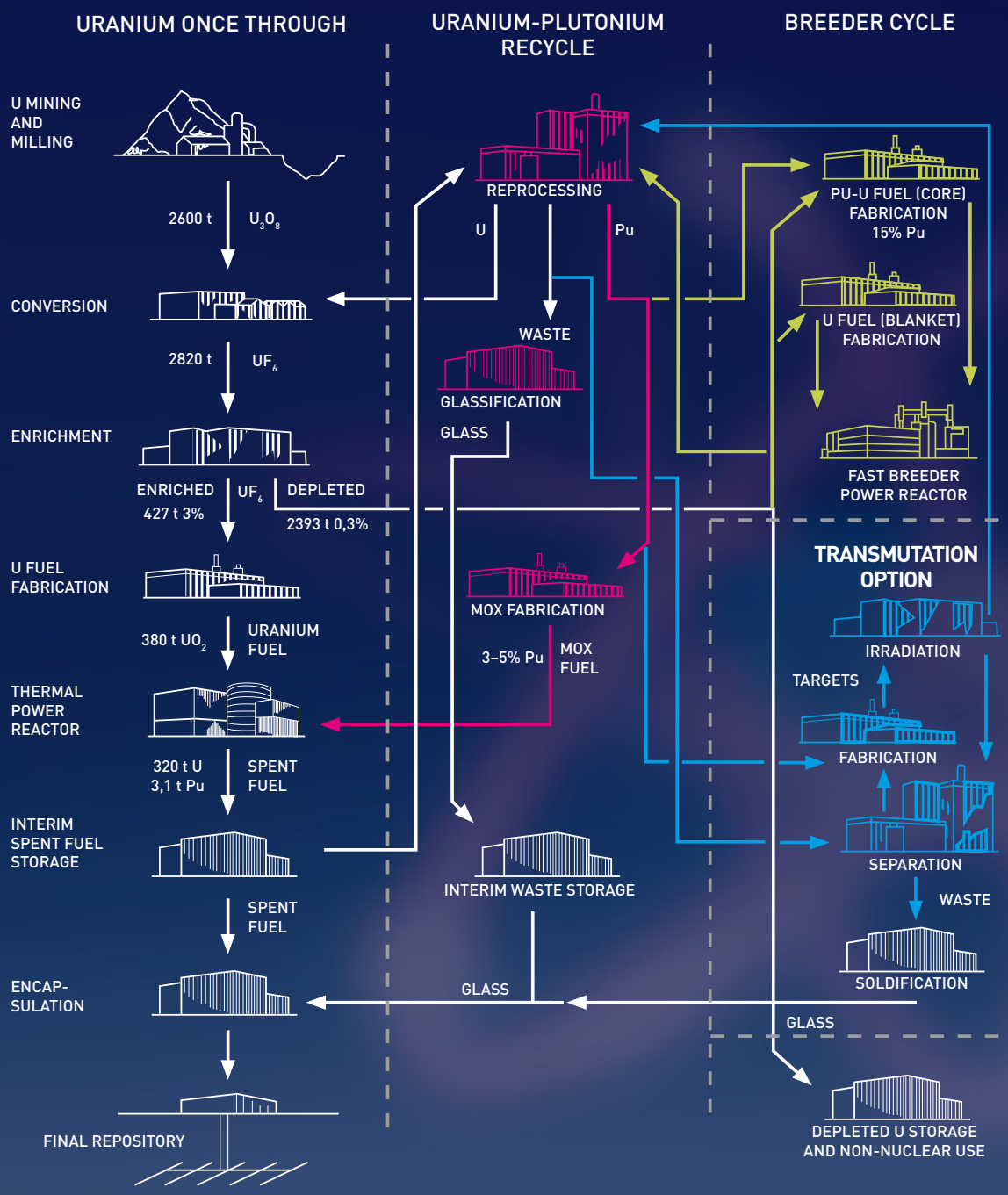
Safer
Sustainable
Economical
More Proliferation Resistand and physically secure

1950 1960 1970 1980 1990 2000 2010 2020 2030

Gen I | Gen II | Gen III | Gen III+ | Gen IV

Generation-IV covers 6 concepts of future Nuclear Power Plants.

NUCLEAR FUEL CYCLE



DIFFERENT FAST REACTORS: COOLANT

There are several coolants (or heat transporters) that can be used.
They all have advantagues and disadvantagues.

Type	Melting point (C)	Boiling point (C)	Density (g/cm)	Thermal conductivity (W / mK)	Heat Capacity (J/molK)	Thermal expansion (m/mK)
Water	0	100	0.99	0.6	74.5	69
Helium	-----	-----	-----	0.15	20.8	-----
Lead	328	1740	11.34	35.3	26.6	29
Sodium	98	883	0.97	172	28.2	71

$$\rho_{Na}(T) = 1012 - 0{,}2205T - 1.923 \times 10^{-5}T^2 + 5{,}637 \times 10^{-9}T^3$$

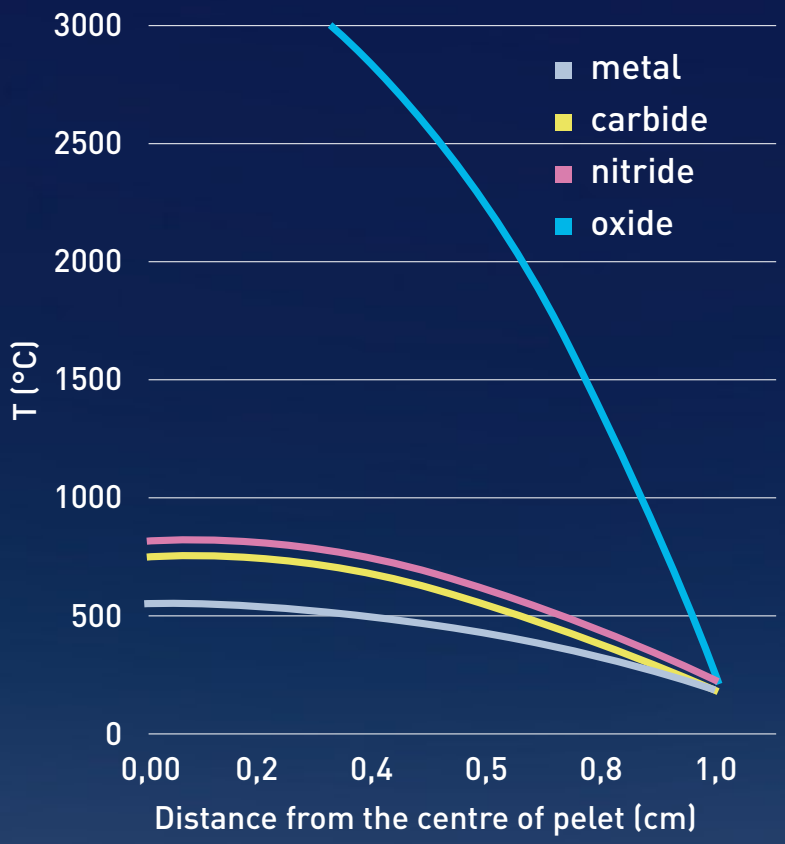
$$\rho_{Pb}(T) = 11367 - 1{,}1944T$$

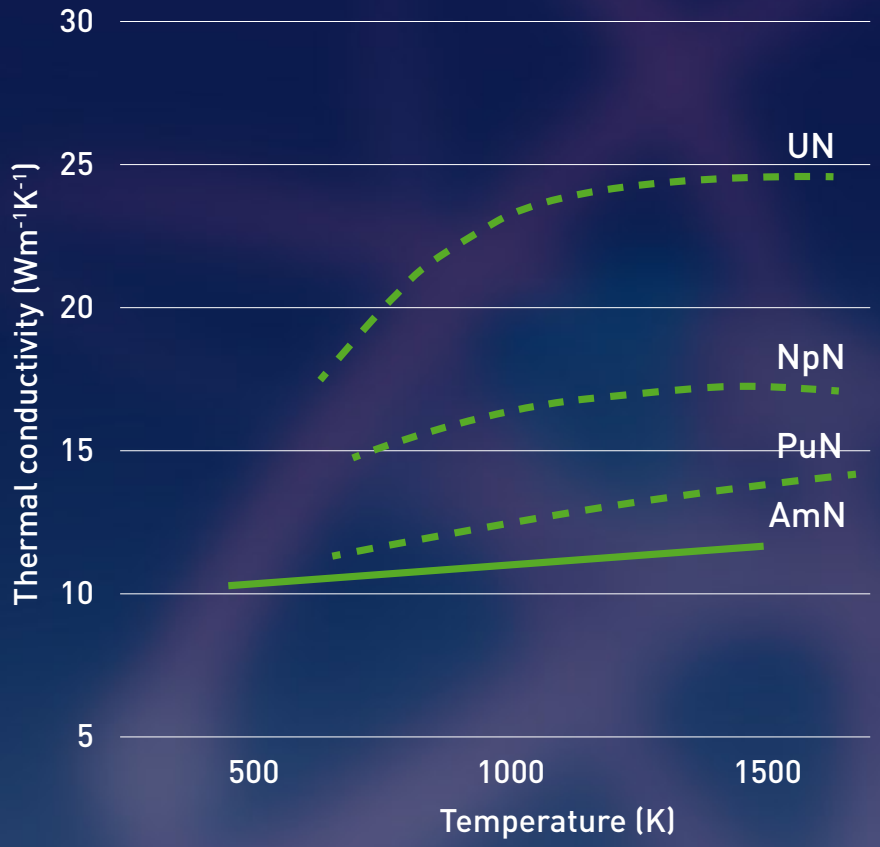
DIFFERENT FAST REACTORS: FUEL

Typically, the nuclear fuel belongs to one of the following categories.
Please note that other fissile elements may partially replace the uranium.

	METALS e.g. U	OXIDES e.g. UO_2	CARBIDES e.g. UC	NITRIDES e.g. UN
Type	U	UO_2	UC	UN
Melting point (C)	1135	2800	2525	2850 (2.5 atm N2)
Density (g/cm^3)	19,05	10,95	13,63	14,32
U-density (g/cm^3)	19,05	9,6	12,97	13,53
Crystal structure		orthorombic	Cubic NaCl	Cubic, NaCl

DIFFERENT FAST REACTORS: FUEL





RATIONALE FOR ASGARD PROJECT

- For many years there were separate communities dealing with new reactor concepts, novel fuels, dissolutions and separations.
- Communication between these communities was, on the whole, rather scarce.
- Attempts were made to integrate the fuel community in FP7 ACSEPT and the separation community in FP7 FAIRFUELS, but due to economical constraints the cross-fertilisation was rather limited at the end.

RATIONALE FOR ASGARD PROJECT

- The ASGARD project will bring the different communities working on Gen IV concepts closer together and working with common problems
- This will shorten and clarify communication ways ensuring an efficient progress in the field.
- At the same time scientific work on the highest level will be performed at the most renown nuclear facilities in Europe.

PROJECT BASIC INFORMATION

Project Full title:	Advanced fuels for Generation IV Reactors: Reprocessing and Dissolution
Acronym:	ASGARD
Funding scheme:	Large Scale Collaborative Project
ECGA Number:	295825
Programme and Call:	FP7 EURATOM, FP7 – Fission – 2011
Coordinator:	Christian Ekberg, Chalmers University of Technology, Sweden
EC Project Officer:	Michel Hugon
Start Date – End Date:	01/01/2012 – 31/12/2015, i.e. 48 months

GENERAL OBJECTIVES

To perform novel scientific work to fill in the gaps between existing projects like ACSEPT, FAIRFUELS and EUROTRANS.

Not to overlap but complement other projects.

OBJECTIVES

- Focus on the behaviour of novel fuels raging from production, dissolution, conversion and refabrication
- Performing outreaching public events promoting Gen IV systems
- Provide extensive training and education concerning handling of nuclear materials from the whole fuel cycle

RESEARCH ORGANIZATION

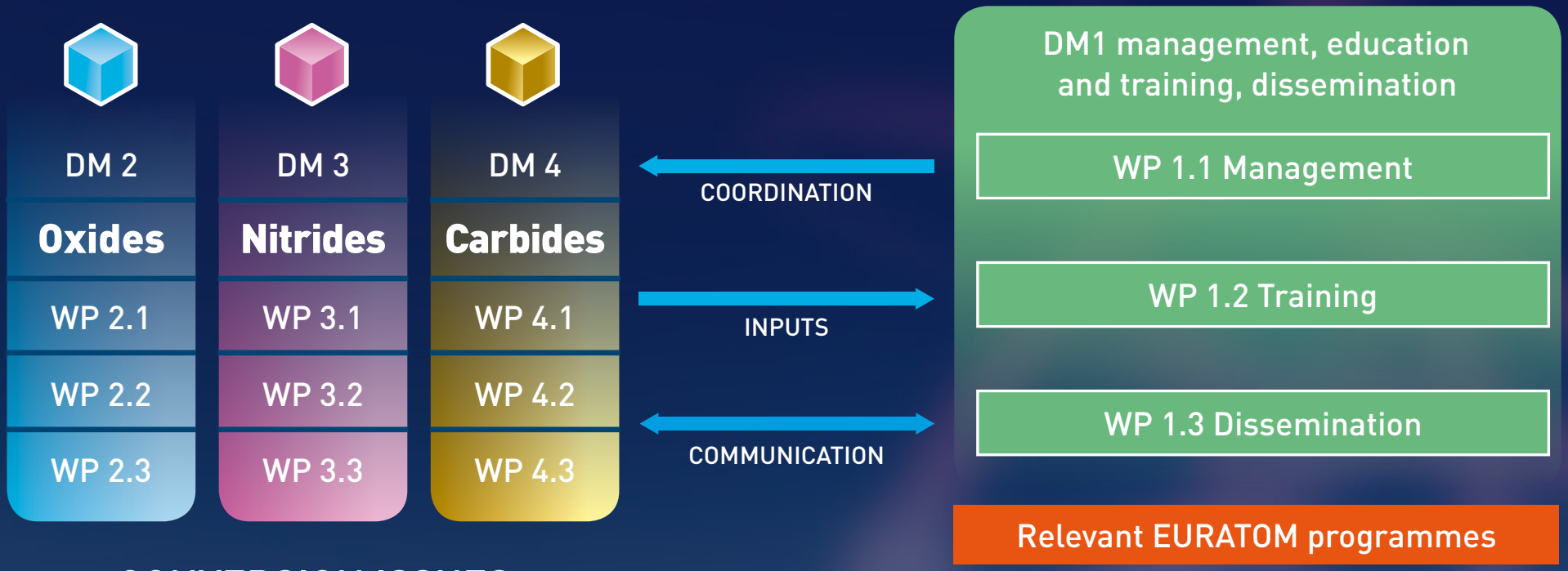
To optimise the research, the work was divided into Domains based on the different fuel types, their manufacture, recyclability and behaviour.

Thus no real position is taken towards which coolant or reactor design should be used even if certain fuels are more suited for certain systems.

THE SCIENTIFIC DOMAINS:

- DM2 Oxides and inert matrix fuels
- DM3 Nitride fuels
- DM4 Carbide fuels

WORK STRUCTURE



CONVERSION ISSUES

DOMAIN 2: OXIDE FUELS

Coordinated by F. Klaassen (NRG)

WP 2.1: Inert Matrix Fuels
WP 2.2: Basic studies on oxide fuels for Generation IV systems
WP 2.3: Conversion from solution to oxide pre-cursors

Task 2.1.1
Dissolution of molybdenum

Task 2.1.2
Aqueous reprocessing of Mo

Task 2.1.3
Treatment of isotopically tailored molybdenum

Task 2.1.4
Dissolution and separation of MgO

Task 2.2.2
Oxide spent fuel composition

Task 2.2.1
Basic dissolution of (Pu, Am) oxide

Task 2.3.1
Co-conversion by sol-gel routes

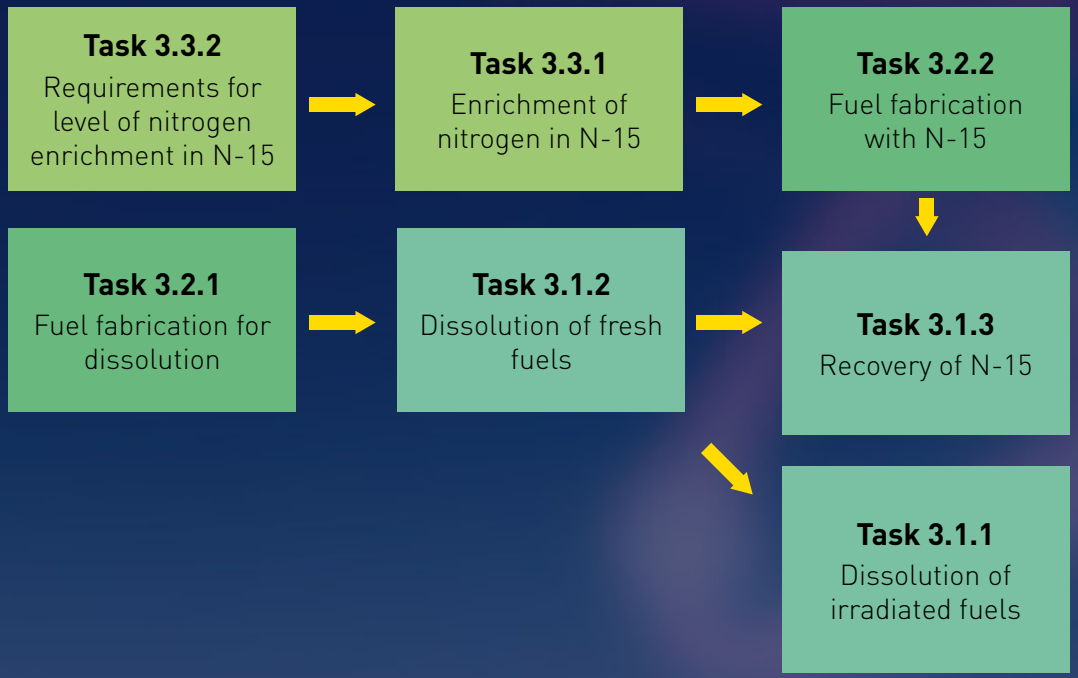
Task 2.3.2
Co-conversion by impr. of solid matrixes

Task 2.3.3
Basic studies on radiation and photochemical conv.

DOMAIN 3: NITRIDE FUELS

Coordinated by J. Wallenius (KTH)

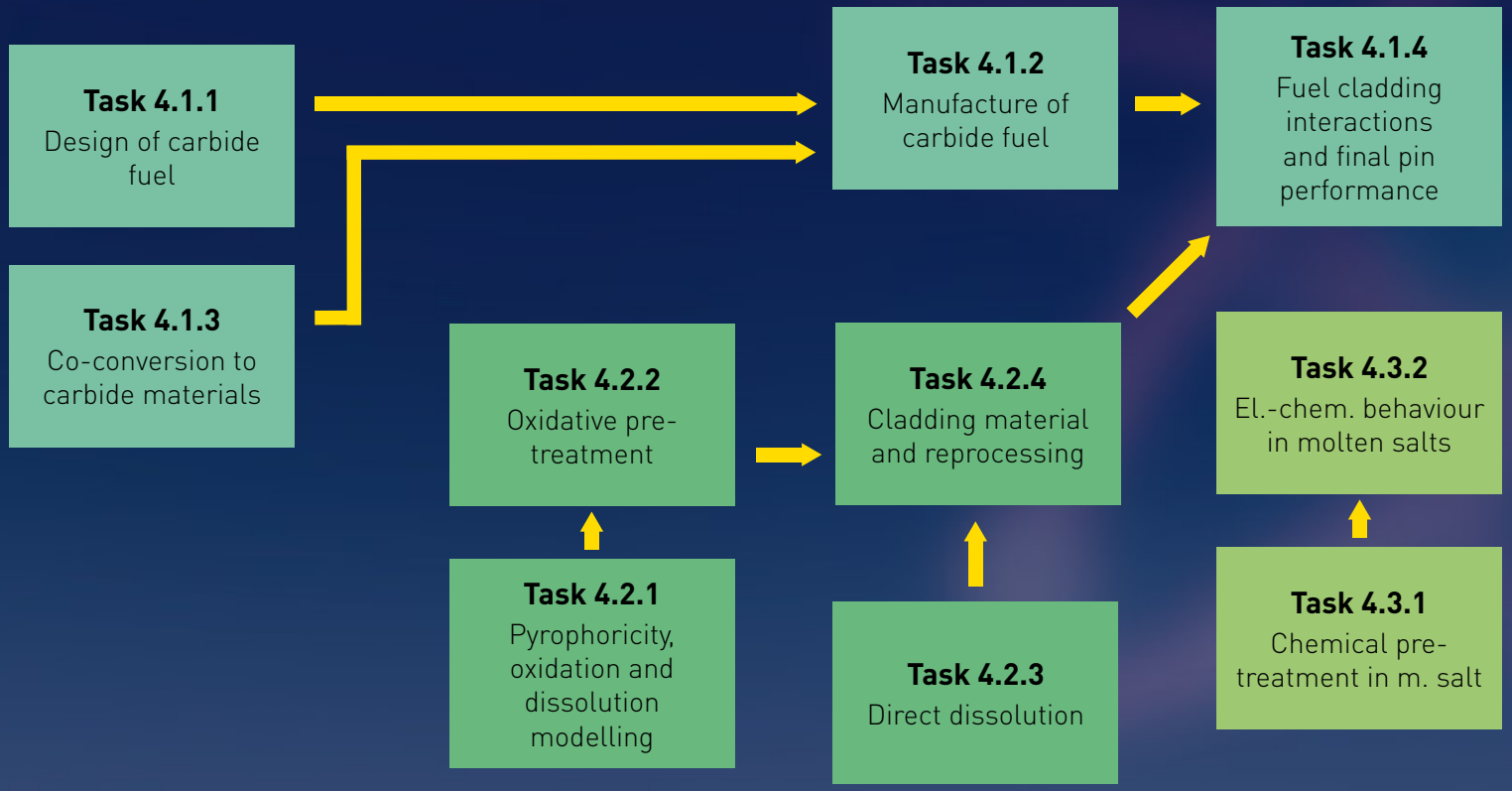
WP 31: Dissolution of fresh and irradiated nitride fuels
WP 32: Fabrication of nitride fuels
WP 33: Enrichment of nitrogen in N-15



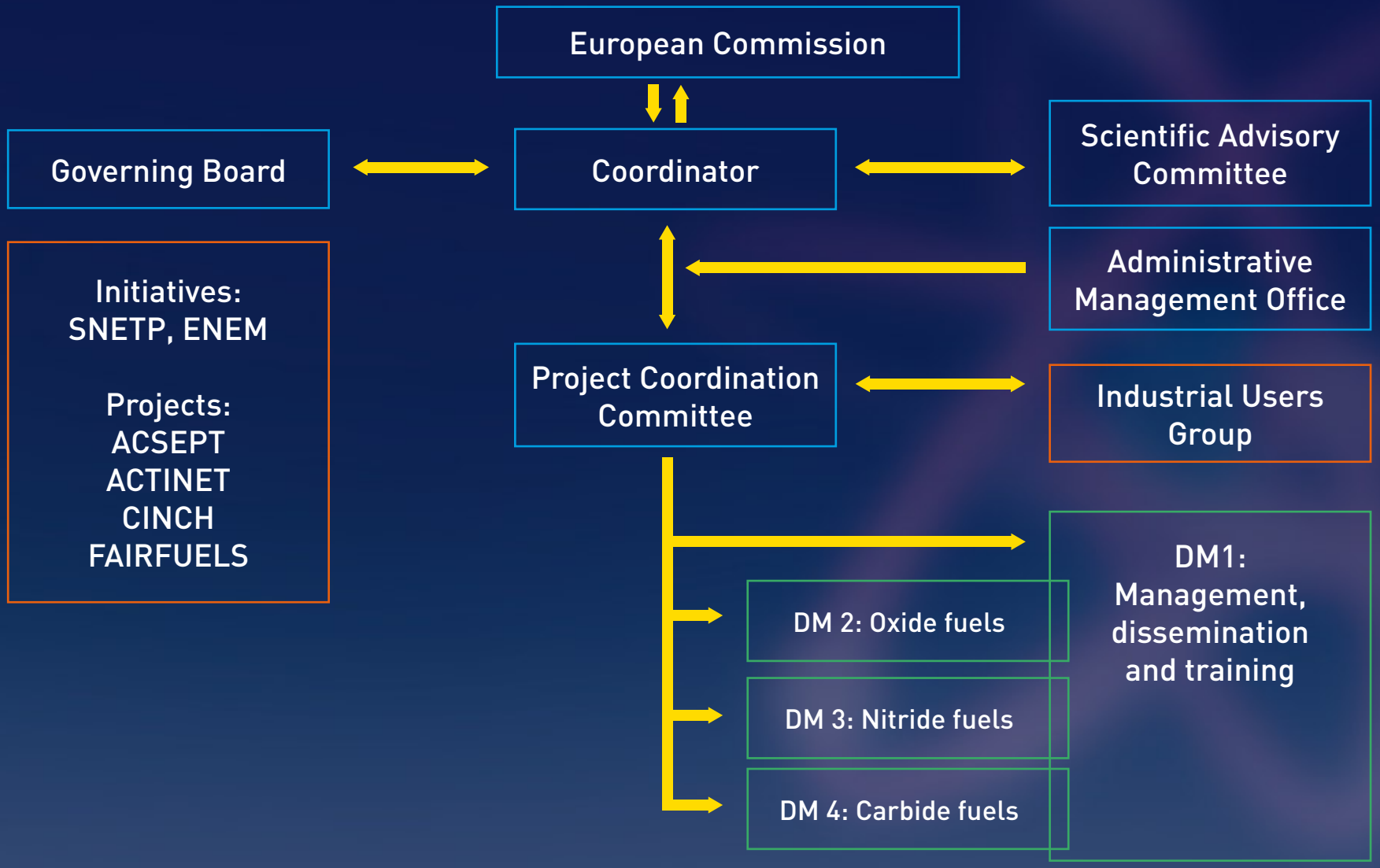
DOMAIN 4: CARBIDE FUELS

Coordinated by M. Sarsfield (NNL)

WP 41: Design and manufacture of carbide fuels for Generation IV FR systems
WP 42: Reprocessing of carbide fuels
WP 43: Molten salt processing of carbide fuels



ORGANISATION OF THE PROJECT



CONSORTIUM

No.	Participant organisation name	Short Name	Country
1	Chalmers University of Technology	CHALMERS	SE
2	Forschungszentrum Jülich GmbH	JÜLICH	GE
3	Instytut Chemii i Techniki Jadrowej	ICHTJ	PL
4	National Nuclear Laboratory Limited	NNL	UK
5	Paul Scherrer Institut	PSI	SUI
6	Nuclear Research and Consultancy Group	NRG	NL
7	Karlsruher Institut für Technologie	KIT-INE	GE
8	Commissariat à l'énergie atomique et aux énergies alternatives	CEA	FR
9	České Vysoké Učení Technické v Praze	CTU	CZ
10	Kungliga Tekniska Hoegskolan	KTH	SE
11	Evalion s.r.o.	EVALION	CZ
12	Westinghouse Electric Sweden	WESTINGHOUSE	SE
13	Institul National de Cercetare-Dezvoltare Pentru Tehnologii Izotopice si Moleculare	INCDTIM	RO
14	University of Leeds	LEEDS	UK
15	University of Manchester	UMAN	UK
16	University of Cambridge	UCAM	UK

CONSORTIUM


SE
WESTINGHOUSE
KTH
CHALMERS
GB
NNL
LEEDS
UMAN
UCAM
NRG
GE
NE
ICHTJ
PL
JÜLICH
BE
CTU
EVALION
CZ
SK
KIT-INE
CEA
PSI
SUI
FR
RO
INCDTIM

ASGARD CONTRIBUTION

- ASGARD contributes significantly to increasing the sustainability of nuclear energy by bridging the investigations of the fuel recycling research
- ASGARD will investigate the fabrication and dissolution behaviour of novel fuels for fast critical reactors
- The knowledge advances of ASGARD will show to governments, European utilities and technology providers that there are several options to the manufacturing and recycling of the novel fuels
- It is of a vital interest for the ASGARD project that its scientifically sound results will be meaningful for the fuel manufacturing industry

SCIENTIFIC ADVISORY COMMITTEE - SAC

Expert group consulting decisions of the GB and providing guidance and advice to the PCC.

Organization	Name
SKB	Kastriot Spahiu
Nuclear Fuel Engineering Laboratory Institute for Nuclear Research	Grigore Horhoianu
IFE – NUSP / NMAT	Barbara Oberländer
SCK-CEN / MYRRAH Project	Hamid Ait Abderrahim

INDUSTRIAL USERS GROUP – IUG

Expert group consulting and analyzing industrial applicability of ASGARD results (focus on fuel manufacturing industry and nuclear waste repositories)

Organization	Name
WESTINGHOUSE	Lars Hallstadius
Institute for Nuclear Research Pitesti	Marin Constantin
Vattenfall	Jan Blomgren
AREVA	Dominique Favet
AREVA	Patrick Blanpain

THANK YOU FOR YOUR ATTENTION!

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