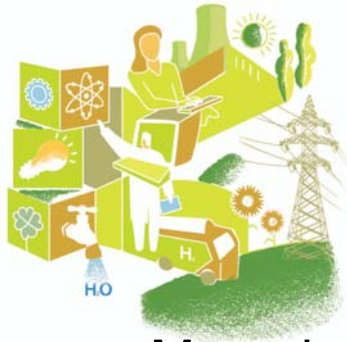




# Presentation of the Strategic Research Agenda of SNE-TP

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SNE-TP, General Assembly  
November 26, 2008, EC, Brussels (BE)



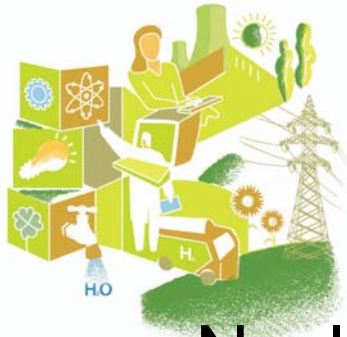
# Acknowledgements

- More than 160 scientists, engineers, researchers from more than 60 institutions contributed to this work,
- We are not yet at the end of task there are still few milestones to be met,
- Nevertheless, I would like to take this opportunity to publically thank all the writers, the contributors and the reviewers for their efforts and their hierarchy for the support given to this work.
- Special thanks to the Group Leaders: Peter Baeten, Bernard Boullis, Giani Bruna, Frank Carre, Luciano Cinotti, Concetta Fazio, Dominique Greneche, Dominique Hittner, Stéphane Marie, Valery Prunier, Joseph Somers, Richard Stainsby, Holger Teichel, Andre Versteegh, Martin Zimmermann
- Special thanks for the final writing team: Alexandre Bredimas, Enrique Gonzalez, Richard Ivens, Marcel Lebadezet, Tomas Lefvert, Henri Paillère, Raano Rintama, Edouard Scott de Martinville, Hamid Aït Abderrahim, (Peter Baeten)



## The European Context

- Energy Policy for Europe:
- 20, 20, 20 by 2020
  - 20% reduction in GHG (1990)
  - 20% renewable energies in the energy mix,
  - 20% reduction in energy consumption
- On the longer term vision for low carbon society by 2050, the EC Technology breakthroughs are needed and these are identified in the SET Plan



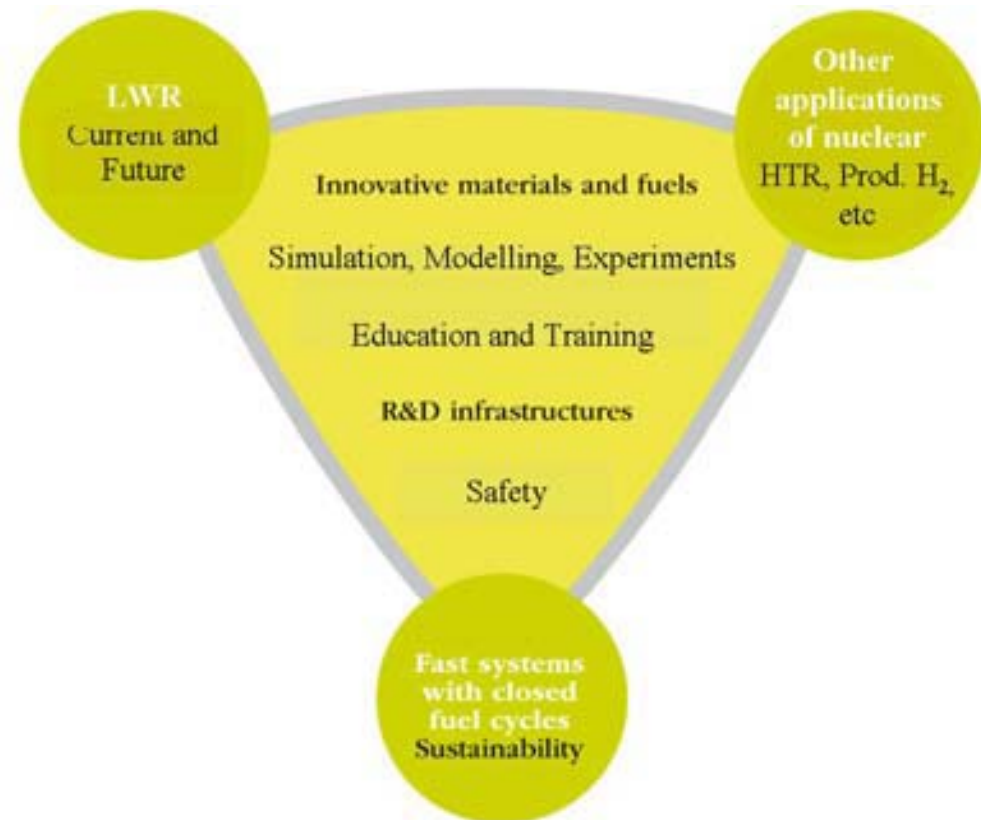
## Nuclear Fission in Europe's low carbon energy policy

- Nuclear fission contributes 31% of EU electricity today the largest low carbon energy source
  - ➔ **2020 : Maintain competitiveness in fission technology and provide long term waste mgt solutions**
- For the longer term as indicated in the SET Plan, we need to act now for
  - ➔ **complete the demonstration of Gen.IV with closed fuel cycle for increasing sustainability**
  - ➔ **enlarge the nuclear fission applications beyond electricity production, namely towards H<sub>2</sub>, Heat, H<sub>2</sub>O desalination**



# SNE-TP Strategy Structures the SRA

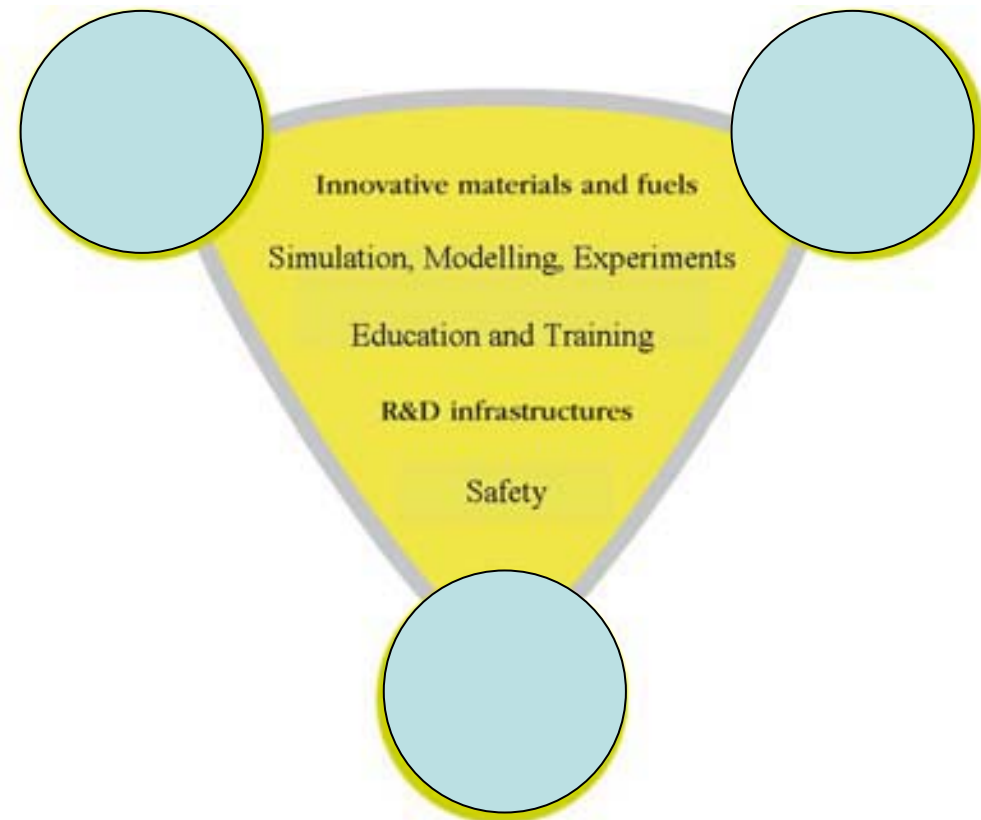
- SNE-TP Vision:
- Nuclear Fission is a leading low carbon energy technology in EU
- It contributes 31% of EU electricity and ambition to maintain this role by:
  1. Maintain safety and competitiveness of today's technologies
  2. Develop Gen.IV FR with closed cycle to enhance sustainability
  3. Enlarge the nuclear fission portfolio beyond electricity production: H<sub>2</sub>, Heat, H<sub>2</sub>O desal.





# SNE-TP Strategy Structures the SRA

- **SNE-TP Vision:**
- Beyond the 3 pillars structuring the SNE-TP Research agenda, there are common trunk activities needed to meet the challenges to respond to this strategy, such as:
  - Material & Fuel research,
  - Simulation, modelling and validation experiments,
  - dedicated or multipurpose facilities research facilities
  - Last but not least well trained and educated specialists in the various fields related to nuclear fission



# Fission research in support of industrial needs



**First Reactors**



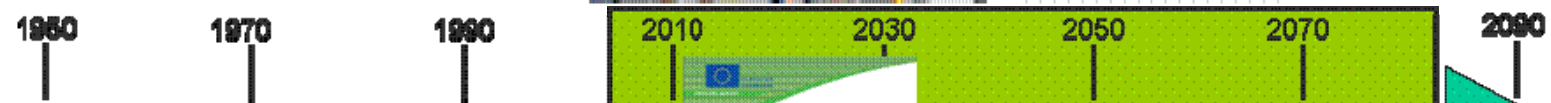
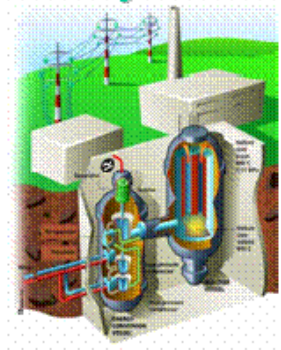
**Current Reactors**



**Advanced Reactors**



**Future Systems**



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**Utility Members of SNE-TP**

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## Current and future Light Water Reactors

- Plant life Management,
- material ageing issues,
- Advanced modelling tools & intelligent plant monitoring systems,
- *High conversion ratio cores*
- *High burn-up fuels*



## Fuel cycle link between **Today** and Tomorrow

- Plant life Management,
- material ageing issues,
- Advanced modelling tools & intelligent plant monitoring systems,
- *High conversion ratio cores*
- *High burn-up fuels*



## Fuel cycle link between Today and **Tomorrow**

- *Recycling: Partitioning and Transmutation*
- *Innovative fuels (incl. MA-bearing) and core performance*
- Improved materials
- Innovative heat exchangers and power conversion systems
- Advanced instrumentation, in-service inspection systems

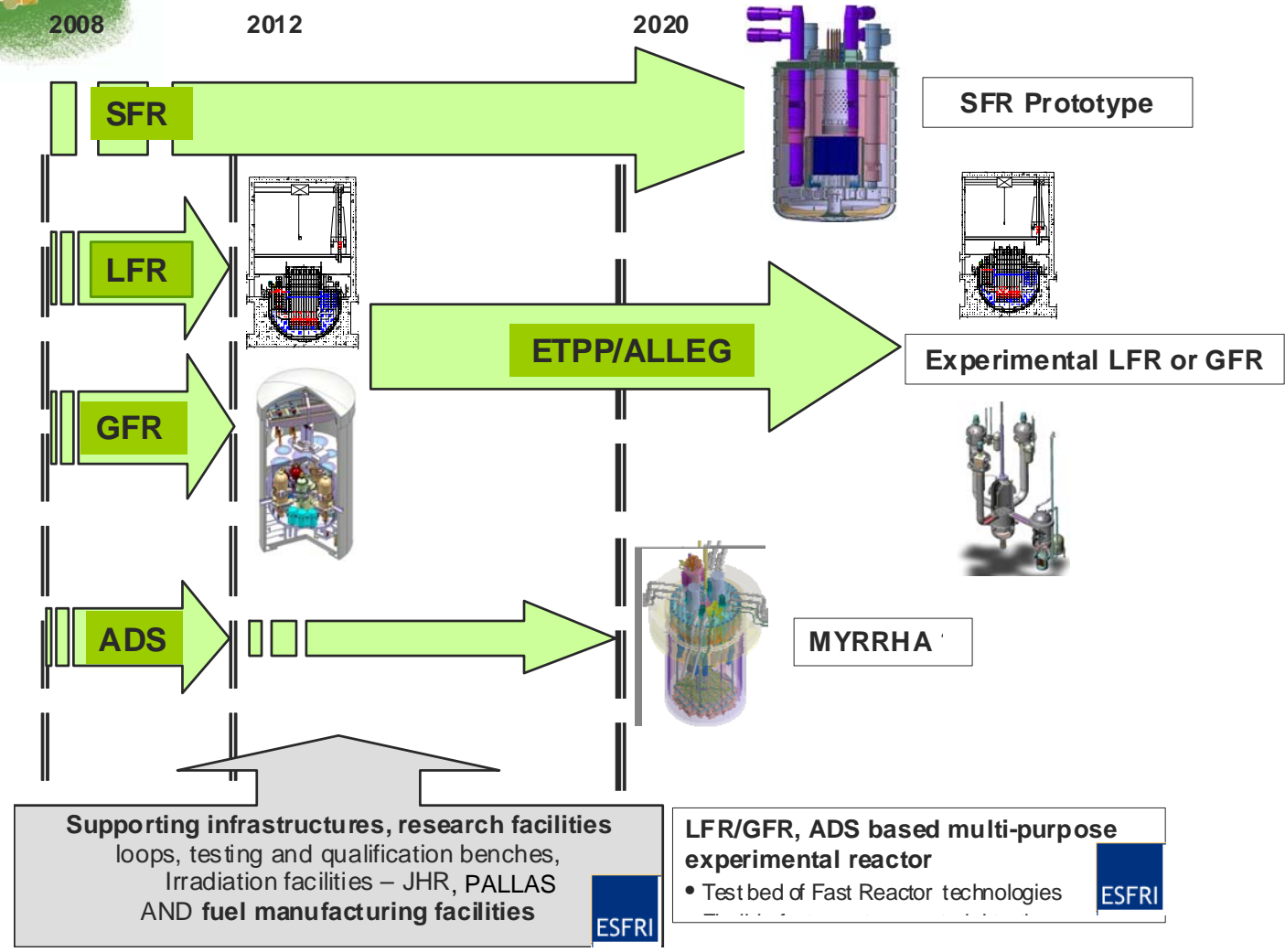


## Generation IV Fast Neutron Reactors & Closed fuel cycle

- *Recycling: Partitioning and Transmutation*
- *Innovative fuels (incl. MA-bearing) and core performance*
- Improved materials
- Innovative heat exchangers and power conversion systems
- Advanced instrumentation, in-service inspection systems



# SNE-TP Roadmap for "Gen IV Fast Systems"



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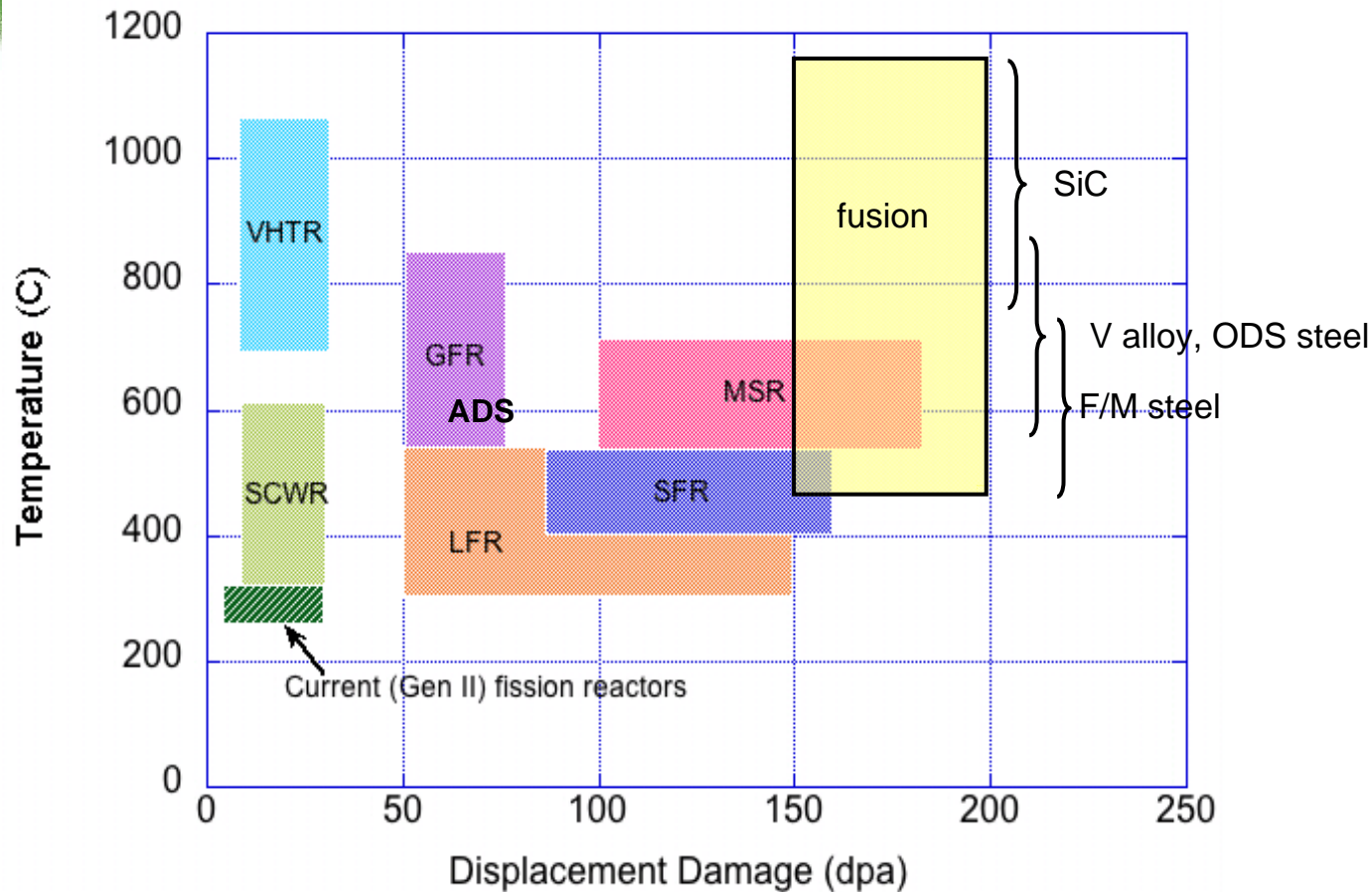


## Other applications of nuclear energy

- Optimization of design of nuclear reactor (V) HTR and heat process applications for:
  - Production of H<sub>2</sub>
  - Production of synthetic fuel  
2<sup>nd</sup> gen. biofuels, Coal to Liquid
  - Desalination, paper, cement



# Introduction to Cross-Cutting Materials R&D



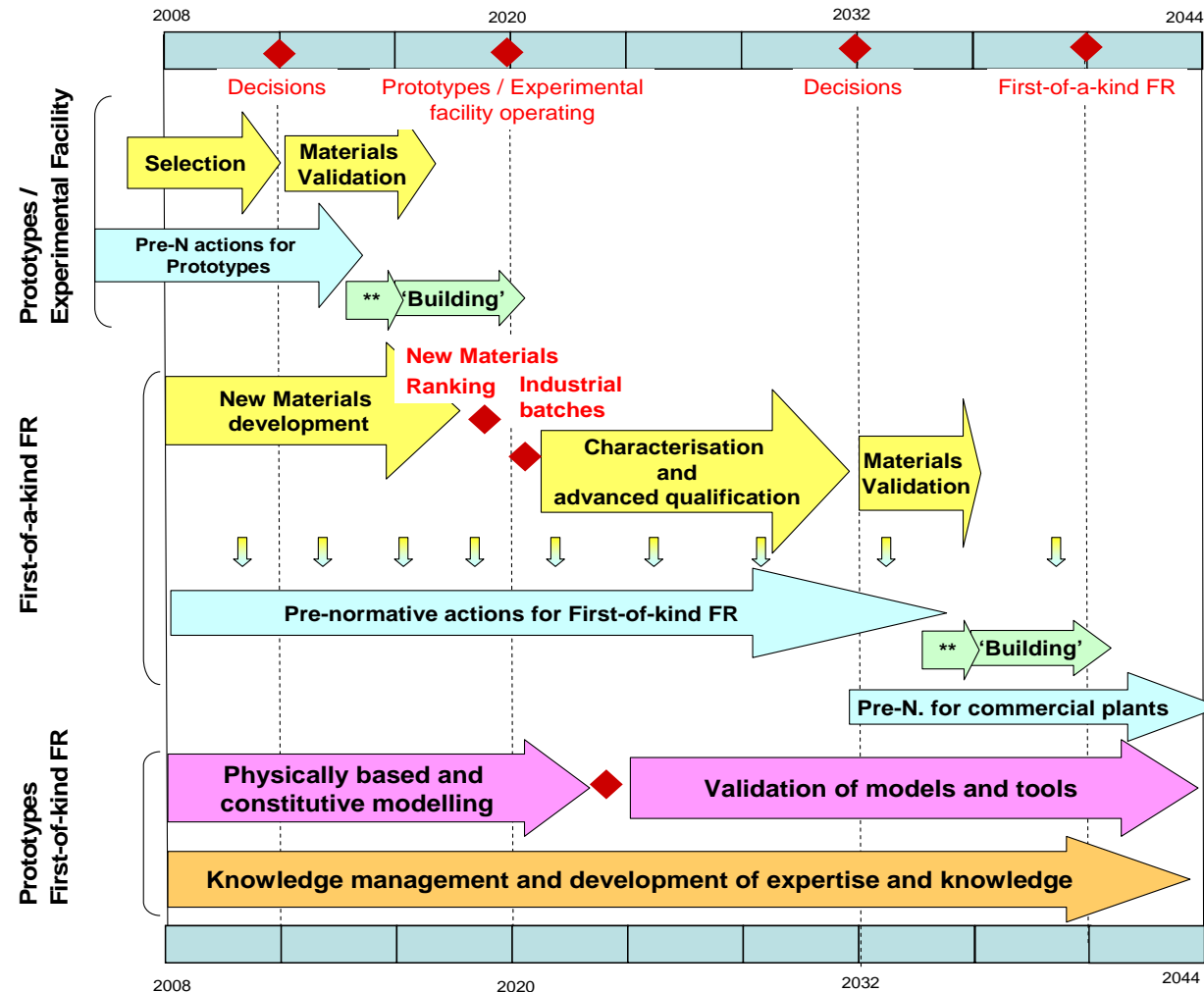
*All Gen IV and Fusion concepts pose severe materials challenges*

S. Zinkle, SMINS 2007, Karlsruhe

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# R&D Material: Proposed roadmap



**\*\* Application of the codes** : Contracts between contractors and manufacturers, material procurements, components design and fabrication,...



# Fuel Research

## Gen II and III

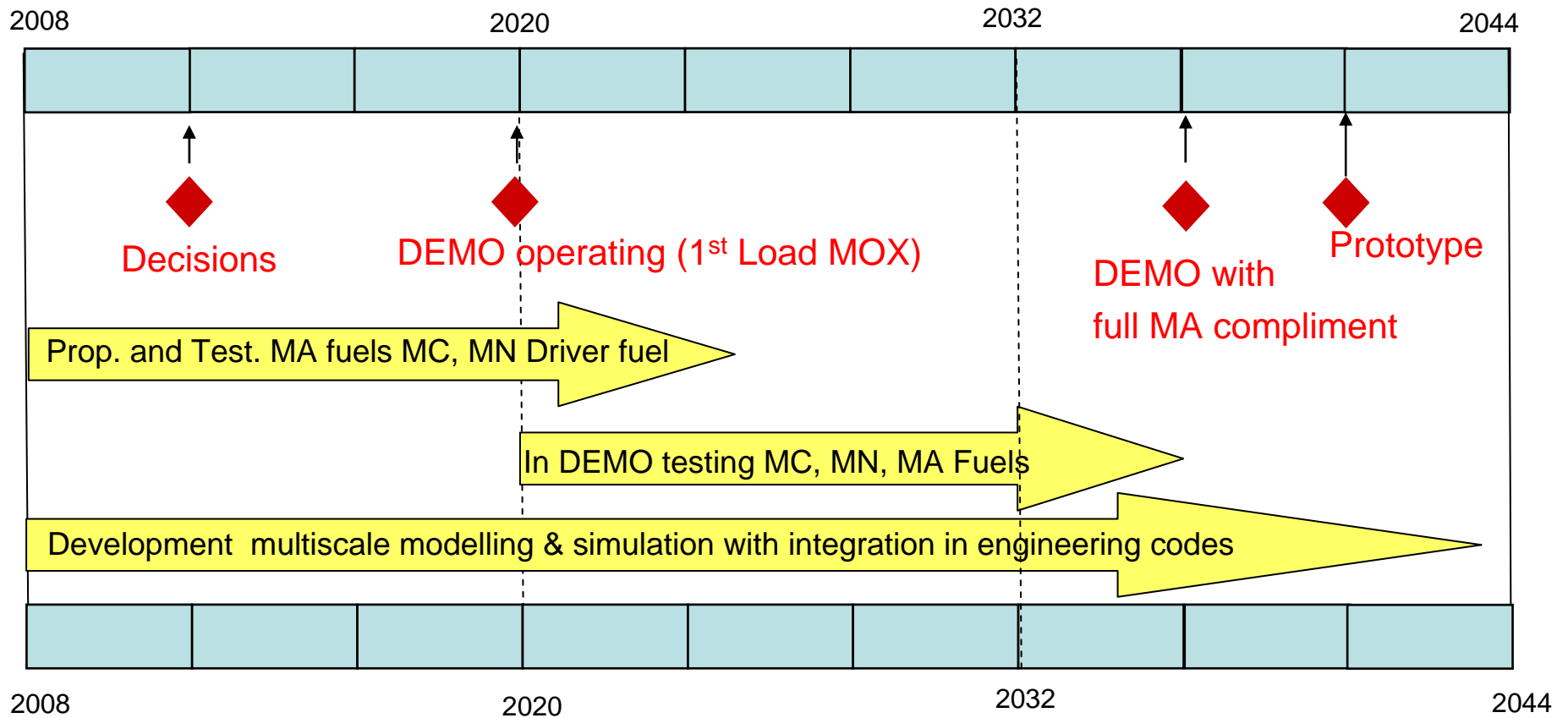
- Largest experience with UO<sub>2</sub> and MOX fuels
  - Provides data and best understanding so far
  - Challenges for higher BU

## Gen IV FR, ADS and VHTR

- All reactors will need a DEMO (2020) and then a PROTOTYPE (2030+)
  - MOX fuel for FR and UO<sub>2</sub> for VHTR for DEMO (2020)
  - DEMO to provide ultimate qualification of advanced fuels for PROTOTYPE
    - Carbide/nitrides for FR and ADS
    - MA fuels for FR and ADS
    - UCO or TRU fuels or VHTR
    - Need to start today even if deployment after 2020
- Reactor system should cover fuel qualification and licensing
  - Package of fuel/cladding/assembly

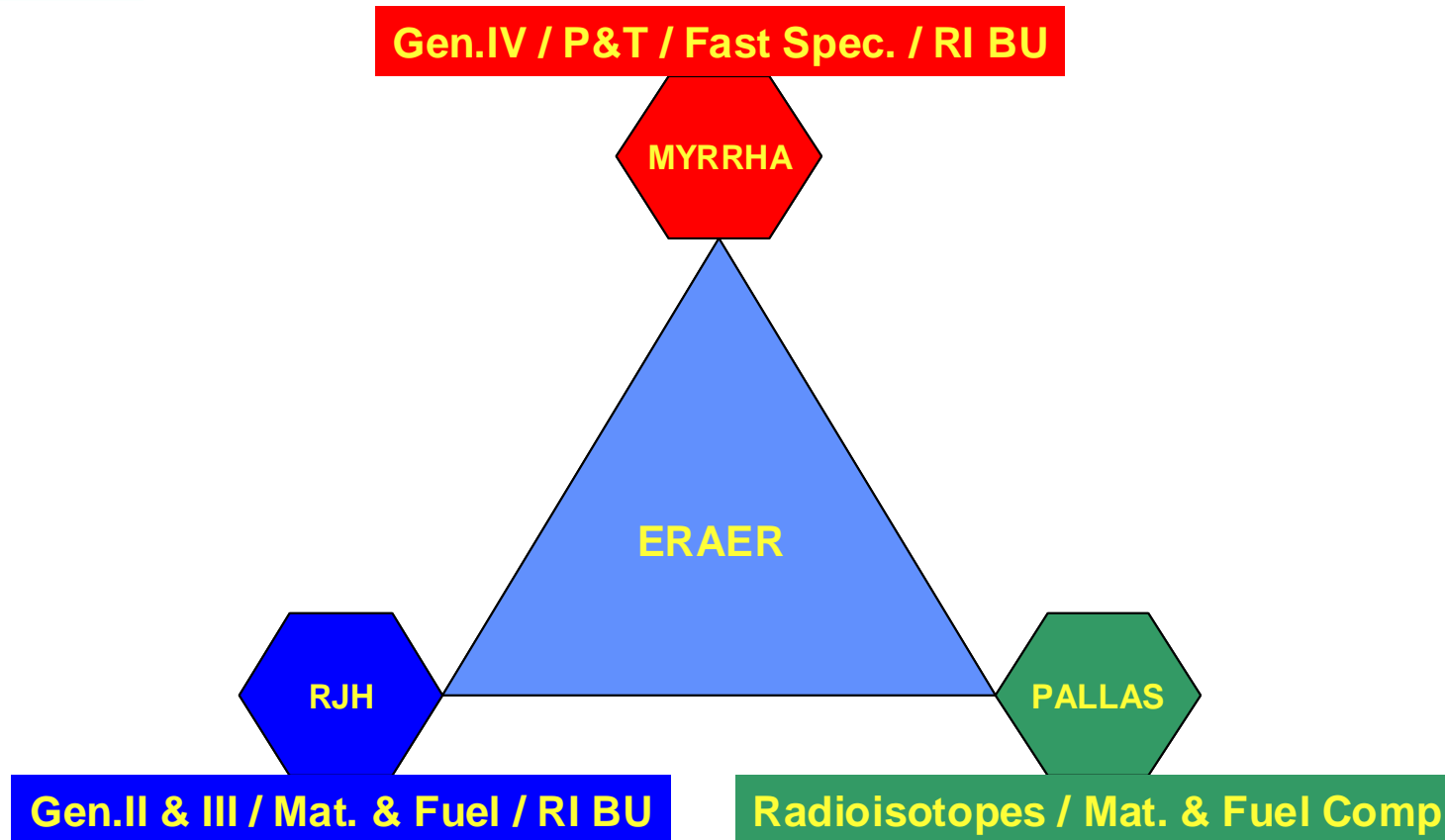


# Proposed Fuels Research Roadmap for SNE-TP





# Large Infrastructures (1) Research Reactors



**ERAER = European Research Area for Experimental Reactors**

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# Large Infrastructures (1)

## ERAER including the FR prototypes





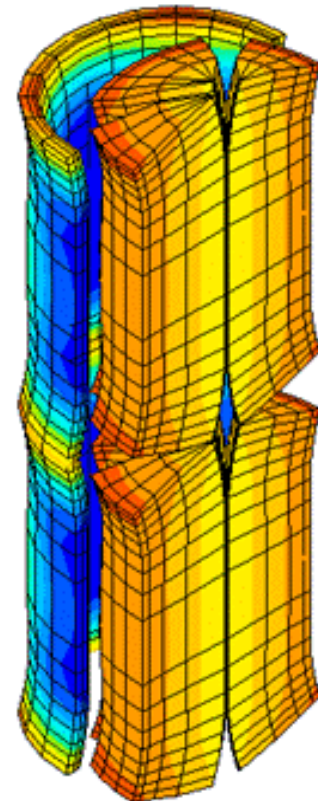
## Large Infrastructures (2) Fuel cycle research & supporting facilities

- “Pin-scale facility” for experimental pins
- “Pilot-scale” ( MA-bearing) pin fabrication facilities
- “Industrial” facility for the core of exp. reactors
  
- Dedicated facilities such as liquid metal and gas loops



# Modelling, Simulation & Methods

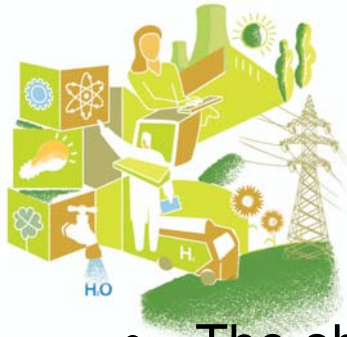
- Taking advantage of the increased computational power, development of more advanced physical models and computational approaches becomes possible for very detailed simulation of reactor behaviour in nominal, incidental and accidental conditions:
  - coupling thermal-hydraulics, neutronics and fuel performance codes,
  - best estimate methods with statistical analysis: mechanical analysis of components.
- To exploit fully the potential of these tools, we need:
  - new basic data
  - specific separate and integral effect validation experiments
  - advanced measurement techniques





# Nuclear Safety

- Nuclear reactor research in Europe has always had a strong focus on safety, and this will continue.
  - Further research to increase knowledge in the basic nuclear sciences,
  - Research on human and organizational factors
  - Plant-relevant issues such as:
    - Instrumentation and Control (I&C)
    - Electrical equipment,
    - External hazards,
- Specific Research must also be carried to:
  - **support long-term operation of NPP's**
  - **contribute to the design of intrinsically safe Gen-IV FNRs.**



# Pre-normative Research, Codes and Standards

- The objective of pre-normative is the development of European design code and standards based on the improvement of existing codes, research activities to convert the results of European nuclear fission research into harmonized guidelines or codes for GEN II-III, GEN IV and ultimately fusion nuclear power plants.
- For GEN II-III the identified needs focus on:
  - civil work,
  - protection against fire,
  - Electrical components.
- For GEN IV power plants, that are in the development stage lead to separate the pre-normative activities into three steps:
  - short term issues (2012): focus on tools for design and construction of 2020 SFR and VHTR prototypes, based on existing data
  - medium term issues (2020): R&D results to answer to the technical challenges, create new basic data for the GEN IV reactors conditions,
  - long term issues (beyond 2020) aims to consolidate feedback from prototypes and further on from the development of commercial power plants.



## Next Steps

- SRA Executive Summary is ready for distribution
- SRA Full Document (~60 pages):
  - In final editing,
  - To be submitted to Ex.Com. + Gov.Board 15.12.2008
  - Final Version will be available for public consultation and comments on [www.snetp.be](http://www.snetp.be) from 31.01.2009
  - End of public consultation 28.02.2009
- Technical annexes with detailed roadmaps will be made available progressively on the TP website



# Thank you