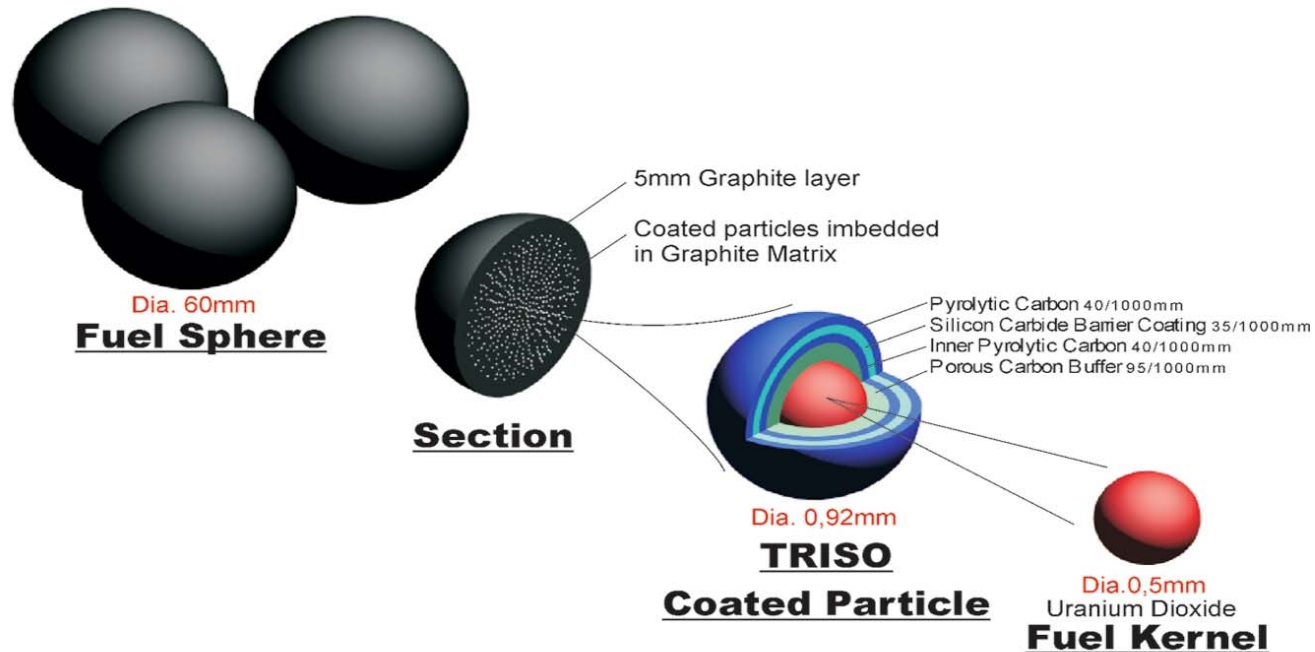


The Revival of NUKEM's HTR Fuel Technology in the Course of the Nuclear Renaissance

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The Revival of NUKEM's HTR Fuel Technology

Content

- General Consideration of HTR Technology
- Historical Background of NUKEM in HTR Fuel Technology
- The Fuel Production Processes
- Recent Activities of NUKEM in the Field of HTR Fuel Technology
- Future Project Prospects and Developments

The Revival of NUKEM's HTR Fuel Technology

Why HTR Technology

- Inherent Safety Philosophy
- Power Supply for fast developing areas of increasing power consumption without sufficient access to the overall power grid
- Power Supply for Industrial Cluster Areas
- Possibility of various process heat applications due to High Temperature He-Gas generation (production of liquid hydrocarbons)
- Application of alternative H₂ generation techniques



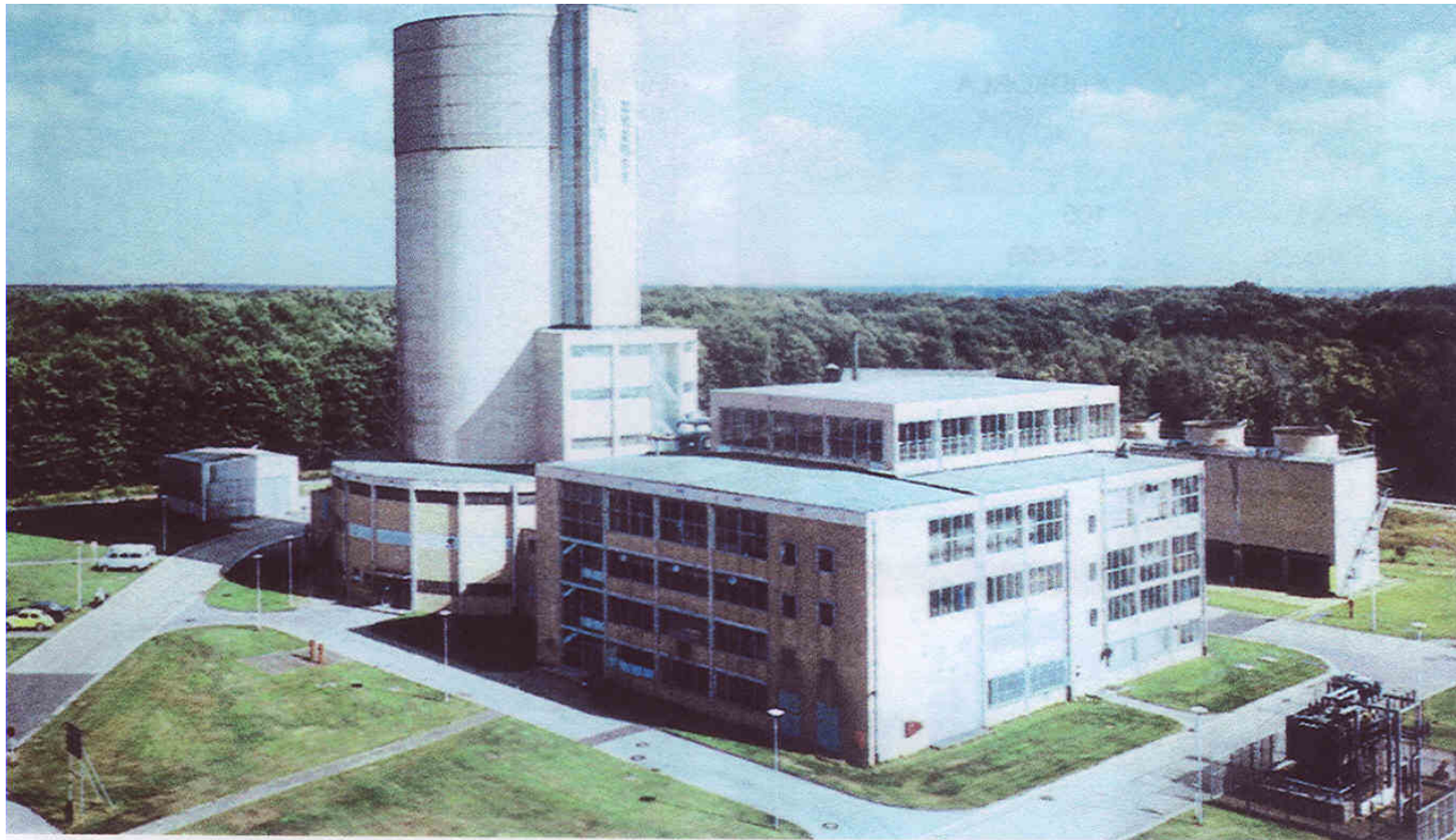
HTR Technology represents an optional Solution for special applications but not a competition to LWR Technology

The Revival of NUKEM's HTR Fuel Technology

Historical Background of NUKEM

- Start of the German HTR-Program in the early 1960's as part of the German civil nuclear development program
- Foundation of partnership for the implementation of the program
 - Research Center Jülich (KFA) → Irradiation Tests
 - Brown Boveri and Cie (BBC), HRB and Siemens Interatom
 - Reactor Design
 - NUKEM/HOBEG → Fuel
 - SGL (former SIGRI) → Structural Graphite

The Revival of NUKEM's HTR Fuel Technology Historical Background



AVR Reactor at FZ-Jülich 15 MWe (1967 – 1988)

The Revival of NUKEM's HTR Fuel Technology Historical Background

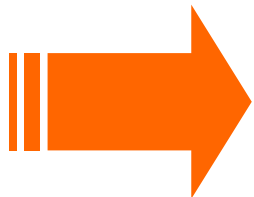
THTR Reactor
at Hamm Uentrop
300 MWe (1983 – 1990)



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Historical Background of NUKEM

- NUKEM's responsibility within such program
 - Design of the HTR Fuel
 - Fuel Specification
 - Development of the Fuel Production Processes
 - Definition of Quality Standard for HTR Fuel



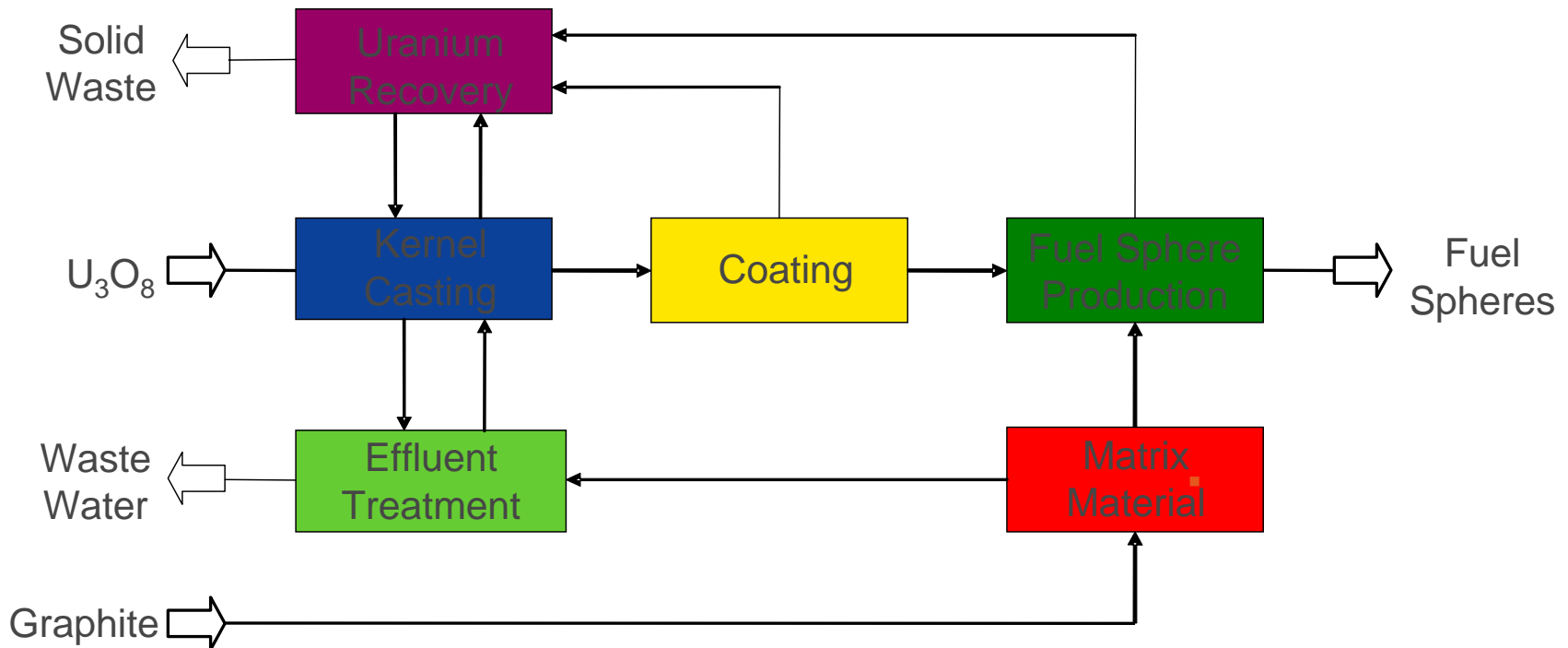
During the 70's and the 80's successful manufacture of more than 250,000 spherical FE for the AVR and more than 1,000,000 spherical FE for the THTR

The Revival of NUKEM's HTR Fuel Technology Production Experience and Status of Qualification

- Production Experience for AVR
 - 256.000 Fuel Spheres
 - Small modifications in the production process
 - 12 different Types of spherical Fuel Elements (different in Kernel Material, Coating or Matrix)
- ➔ Demonstration of a high flexibility in the application of the production process
- Production Experience for THTR
 - 1.000.000 Fuel Spheres (1000 Batches of fuel kernels, 4000 Batches CP)
 - Yield > 95%
- Full Qualification of LEU Fuel Elements for the HTR – 500 and HTR Module

The Revival of NUKEM's HTR Fuel Technology

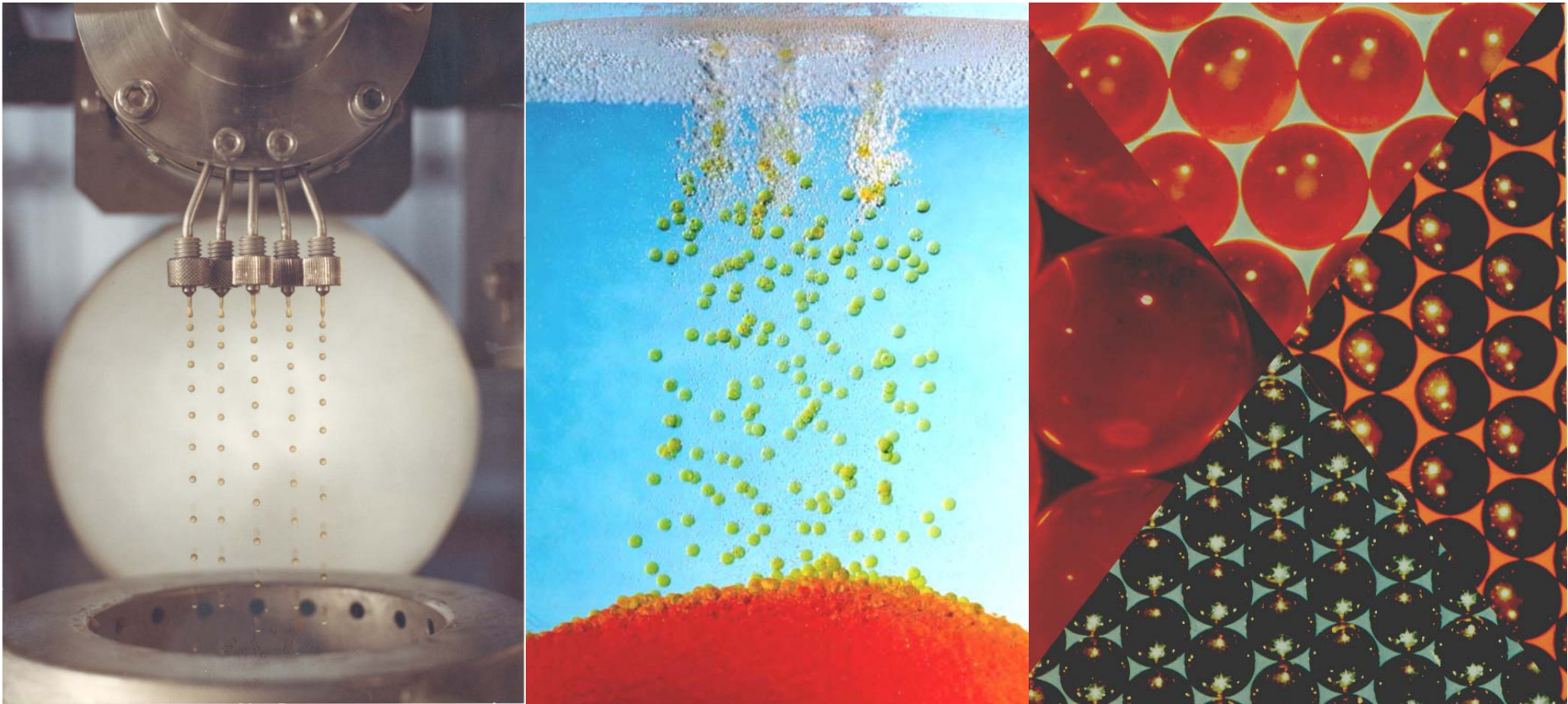
The Fuel Production Processes



Overview of the HTR Fuel Production Processes

The Revival of NUKEM's HTR Fuel Technology

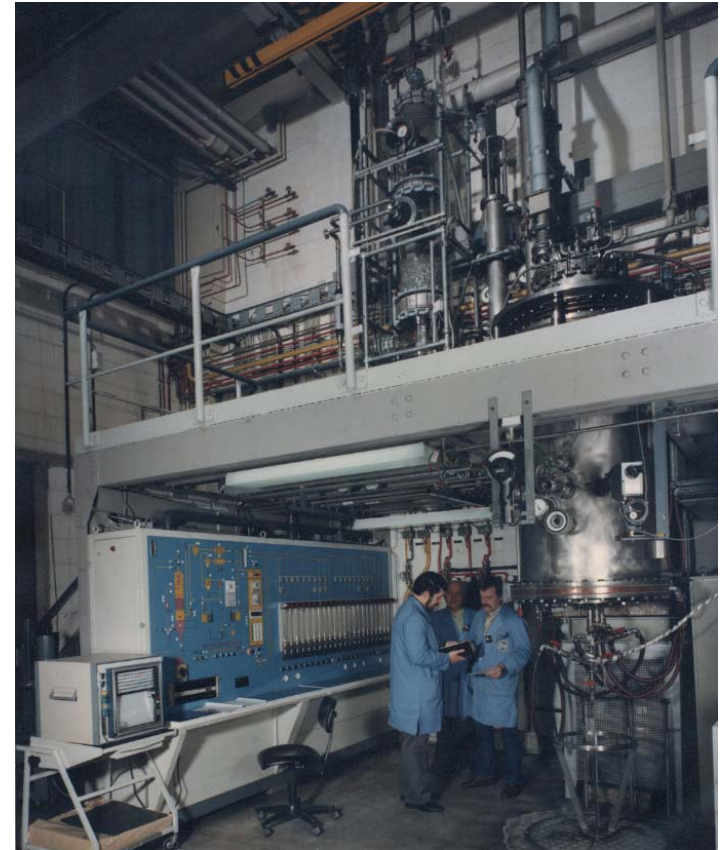
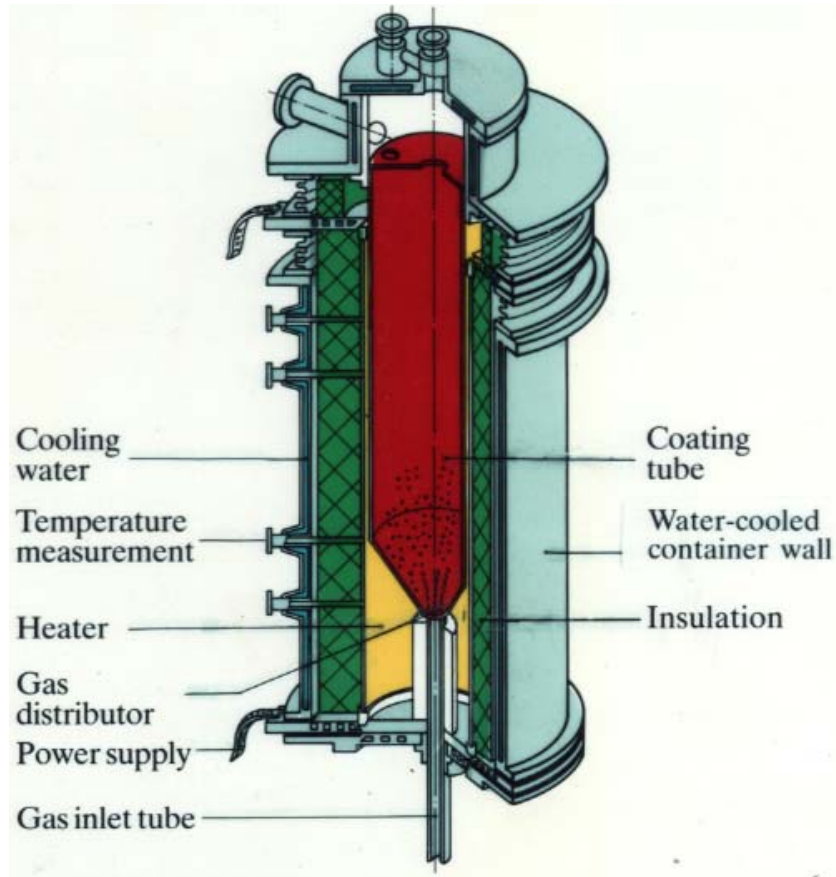
The Fuel Production Processes



Kernel Production Process

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The Fuel Production Processes



Coating Process

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The Fuel Production Processes



Fuel Sphere Production Process

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Recent Activities in the field of HTR Fuel Technology

- End of 90's consultancy services by NUKEM's HTR Experts for IAEA in connection with a review about feasibility, suitability and safety of HTR-Technology
- Since the year 2000 deep involvement in the PBMR Pilot Fuel Plant Project in South Africa:
 - Detailed Feasibility Study for the Pilot Fuel Plant (2000/2001)
 - Performance of Basic Design in 2003/2004
 - Provision of Detail Design and enquiry specifications in 2006/2007
 - Technical assistance and support during procurement of the equipment since 2007 ongoing

The Revival of NUKEM's HTR Fuel Technology

Recent Activities in the field of HTR Fuel Technology

- As a result a strong engineering team of approx. 40 highly qualified engineers was established at NUKEM
- Consequently the know-how transfer was ensured and permanent consultation with the HTR Expert Team is ongoing
- Important requirements on “equivalence” for the spherical HTR Fuel according to the fuel specification can be met
 - Today's fuel qualification process at PBMR takes full credit from the development of the standard quality of the Fuel for the HTR Module
 - New Fuel Plant needs to deliver fuel, which is equivalent to that made in the former NUKEM/HOBEG

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Future international Prospects and Developments

- China's HTR Demonstration Project launched in 2006 is targeting for a 200 MWe HTR-PM to be put into operation in 2013
- US DOE has issued an announcement by the Idaho National Laboratory, responsible for the development of the NGNP, proposing to build a HTR
- Korea has launched the Nuclear Key Technology Hydrogen Development and Demonstration Project (NHDD-Project) within its 12 years R&D program considering the HTR Technology as promising technique for the alternative generation of Hydrogen and liquid Hydrocarbons
- India after turning towards the acceptance of the international guidelines, is facing various nuclear power reactor projects waiting for kick off; HTR Technology is one of them not only due to India's immense Thorium resources
- And other countries considering HTR Technology not only due to its safety features

The Revival of NUKEM's HTR Fuel Technology Conclusion and Outlook

- In the special field of HTR Fuel Technology NUKEM has managed a successful recovery and transfer of know-how
- A strong competence team including approx. 40 highly qualified engineers has been established
- Original and new ideas for the improvement of economics and efficiency of the complex production processes are in progress



NUKEM is experiencing its own nuclear renaissance in the special field of HTR Fuel Technology and is fit to deliver further on comprehensive engineering services, technical support and assistance for future HTR Fuel projects!