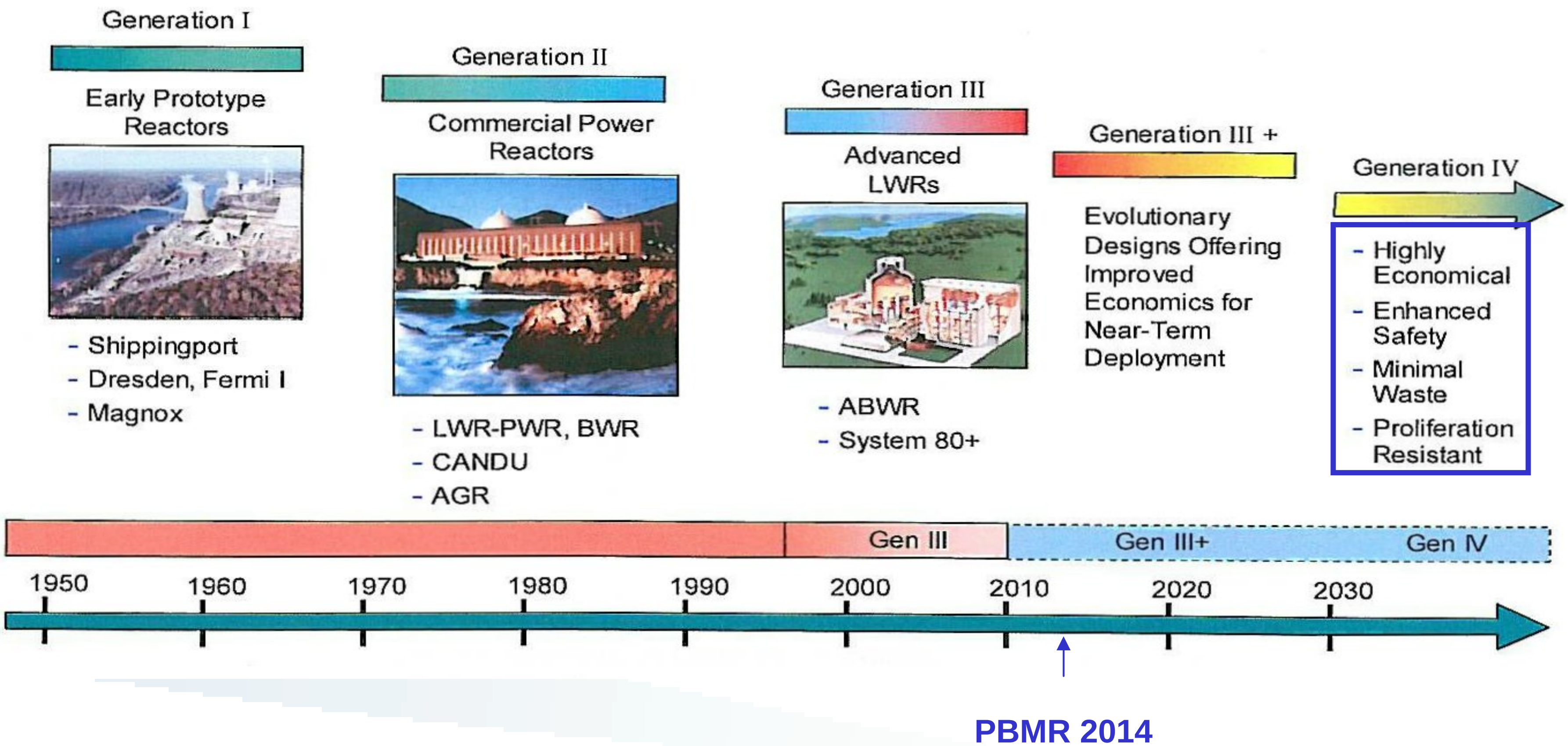
The Future of the Pebble Bed Modular Reactor in South Africa

Evolution History of Nuclear Power

PBMR



The Technology

The PBMR is a small-scale, helium-cooled, direct-cycle, graphite-moderated, high-temperature reactor (HTR). Although it is not the only gas-cooled HTR currently being developed in the world, the South African project is internationally regarded as the leader in the power generation field.

The Project

PBMR (Pty) Ltd intends to:

- Build a demonstration module at Koeberg near Cape Town
- Build an associated fuel plant at Pelindaba near Pretoria
- Commercialize and market 165 MWe modules in single or multi-module configuration for the local and export markets
- Transform PBMR (Pty) Ltd into a world-class company

Current Investors

- South African Government (DPE)
- Eskom
- Industrial Development Corporation (IDC)
- Westinghouse
- Negotiating with other potential investors

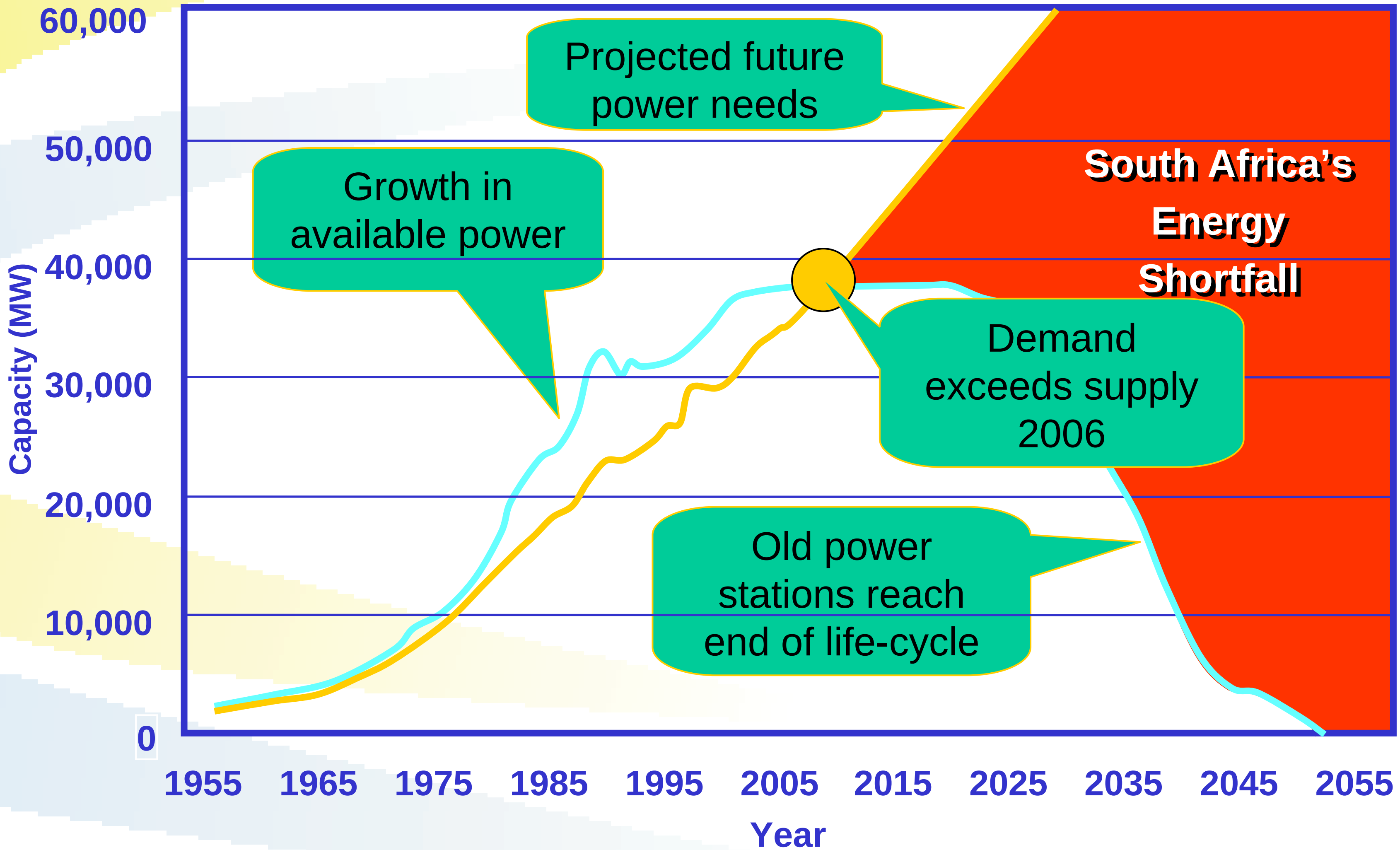
Growth in SA Electricity Demand

P B M R

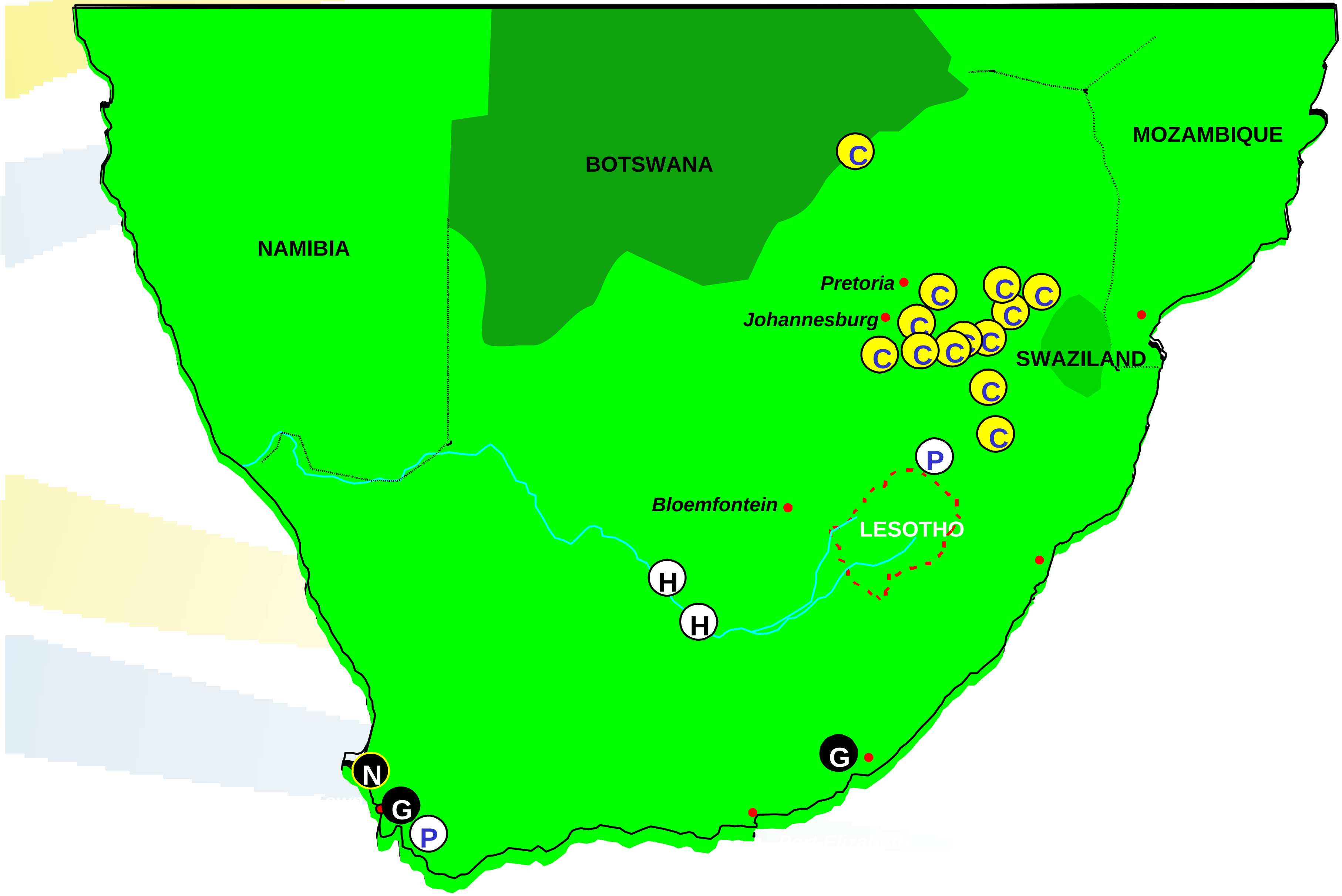
- Compound annual demand growth of 3.4% per year since 1992 (2004 peak 34,210MW compared to 22,640 in 1992)
- National Energy Regulator's Integrated Resource Plan shows:
  - Projected growth of ~2.8%/annum to 2022
  - New build capacity of over 20,000MW required by 2022
  - Growth at 4% would require ~40,000MW
- Eskom predicts growth in demand of 1200 MW p/a over next 20 years

The South African Dilemma

PBMR



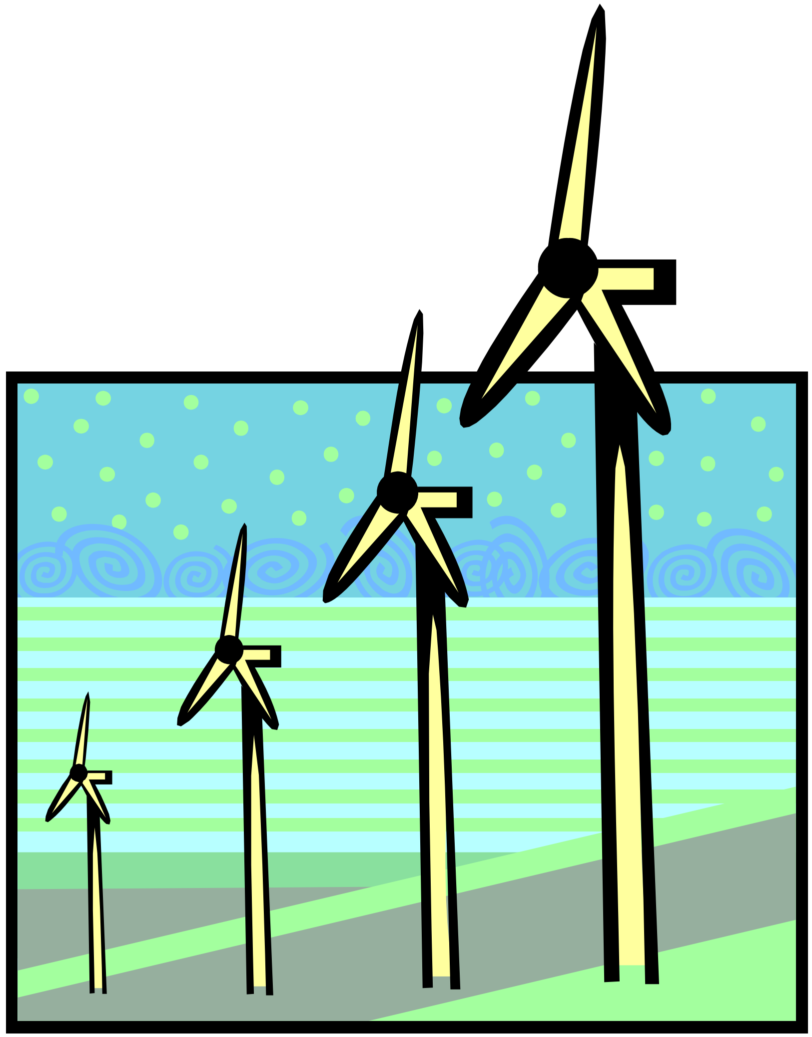
Eskom Power Stations 2001



Diversity of Energy Sources

- The expansion of generating capacity in South Africa should include a diversity of energy sources, including coal, hydro, nuclear, wind, solar, wave, tidal etc.

- To meet energy development challenges, South Africa needs to optimally use all energy sources available and vigorously pursue energy efficient programmes



World Electricity Market

- World capacity in January 2002 was 3,465GW (~100 x Eskom)
- World average growth of 3% per annum since 1980 (equates to 600 PBMRs per year)
- MIT forecasts world demand to triple by 2050
- Current world spending is about $100bn per year on new power stations
- Fossil fuel costs have risen dramatically
- Environmental pressure is increasing

Resurgence of Nuclear Energy

- Thirty nuclear plants are being built today in 12 countries around the world
- Green guru James Lovelock and Greenpeace co-founder Patrick Moore calls for “massive expansion” of nuclear to combat global warming (May 2004)
- George Bush signs energy bill and describes nuclear as one of the nation’s most important sources of energy (Aug 2005)
- US Energy Secretary Samuel Bodman predicts nuclear will “thrive as a future emission-free energy source” (April 2005)
- Tony Blair proposes new generation of nuclear plants to combat climate change (July 2004)

Resurgence of Nuclear Energy

- China plans to build 27x1000MW nuclear reactors over the next 15 years
- India plans a ten-fold nuclear power increase
- France to replace its 58 nuclear reactors with EPR units from 2020, at the rate of about one 1600 MWe unit per year.
- IAEA predicts at least 60 new reactors will become operational within 15 years

Views on Nuclear

"How are we going to satisfy the extraordinary need for energy in really rapidly developing countries? I don't think solar and wind are going to do it. We are going to have to find a way to harness all energy supplies that includes civilian nuclear power."

Condoleezza Rice, US Secretary of State, Sept 2005

Views on PBMR

“The long-term future of power reactors belongs to very high temperature reactors such as the PBMR.” Nils Diaz, Chairman of the US Nuclear Regulatory Commission, July 2004

“I feel we made a mistake in halting the HTR programme.” Klaus Töpfer, Germany’s former Minister of Nuclear Power and Environment. Davos, January 2003

“The PBMR technology could revolutionize how atomic energy is generated over the next several decades. It is one of he near-term technologies that could change the energy market.” Prof. Andrew Kadak, Massachusetts Institute of Technology, January 2002

“Little old South Africa is kicking our butt with its development of the PBMR. This should be a wake-up call for the US.” Syd Ball, senior researcher at Oak Ridge National Laboratory, 11 June 2004.

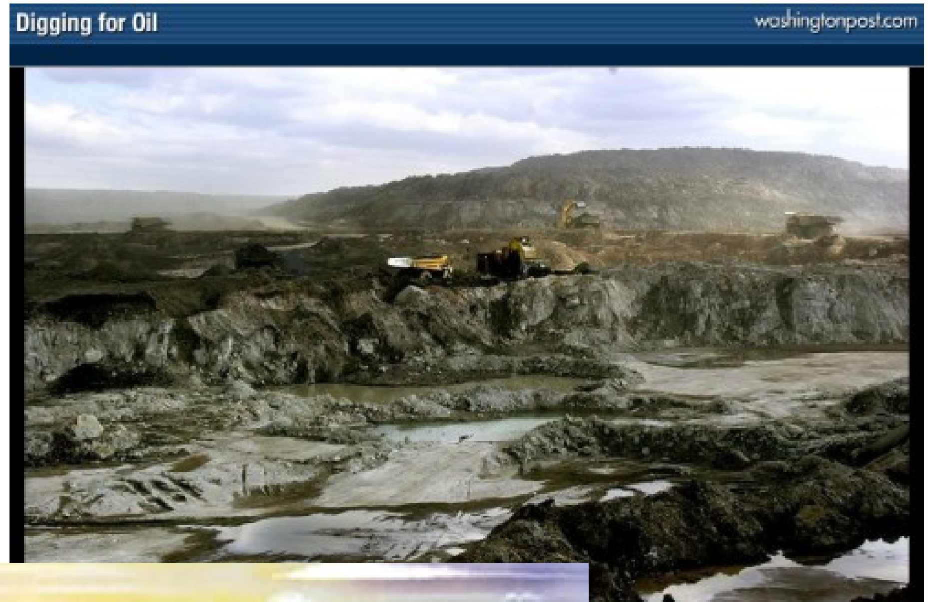
Process heat applications

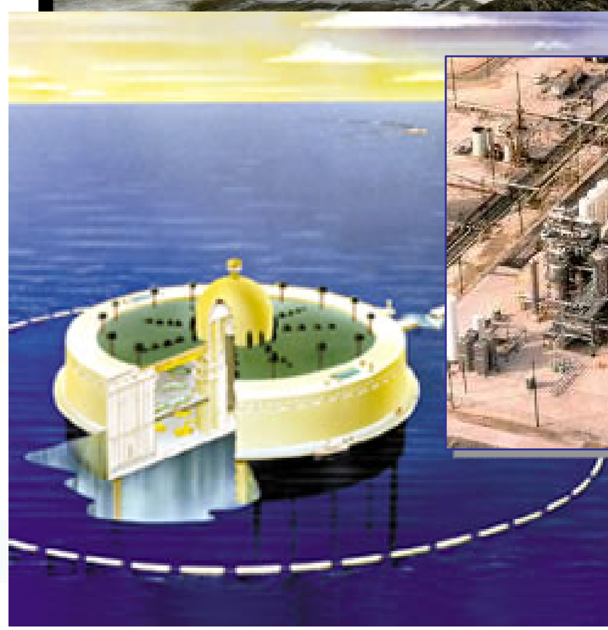
Steam Generation
- Oil Sands
- Cogeneration

Steam Methane Reforming
- Hydrogen
- Ammonia
- Methanol

Water-Splitting (H_2 & O_2)
- Bulk Hydrogen
- Coal-to-liquids
- Coal-to-methane

Desalination





Competitive Advantages of PBMR

- Passive safety achieved through inherent design characteristics
- High efficiency (> 41%)
- Load following (mid merit)
- On-line refuelling
- Short construction times
- Lower associated cost of capital during construction
- Smaller capital cost increments per module
- Distributed generation due to small size
- Small emergency planning zone
- Modularity (additional modules can be added)
- Low proliferation risk
- Low impact on the environment

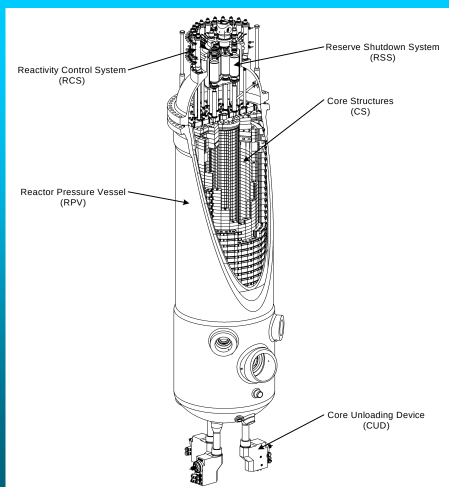
Advantages to South Africa

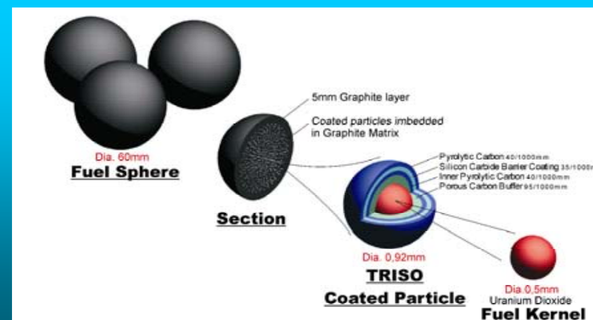
- Ability to site on coast, away from coal fields
- RSA based “turnkey” supplier allows localisation of manufacture on sub-contractors
- Locally controlled technology limiting foreign exchange exposure
- About 56 000 local jobs created during full commercial phase
- R23 billion net positive impact on Balance of Payments

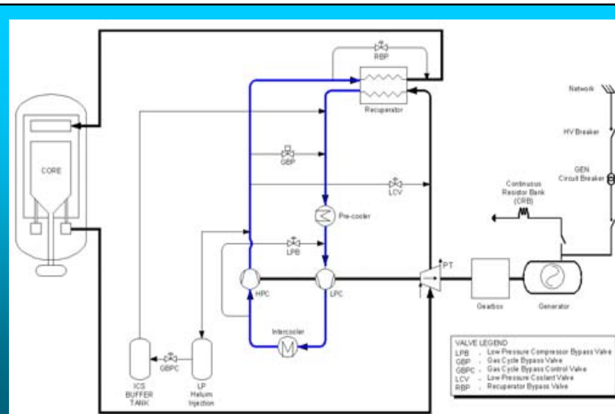
US Licensing Programme

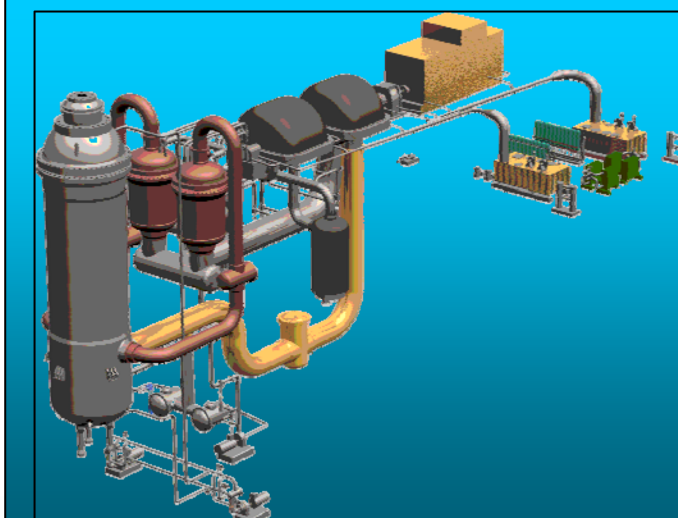
- Pre-application letter submitted to Nuclear Regulatory Commission (February 2004)
- Official kick-off meeting with NRC staff (November 2004)
- Formal Design Certification application scheduled for submission to NRC (2007)
- US NRC final design approval estimated (2011)

Reactor Design: PBMR

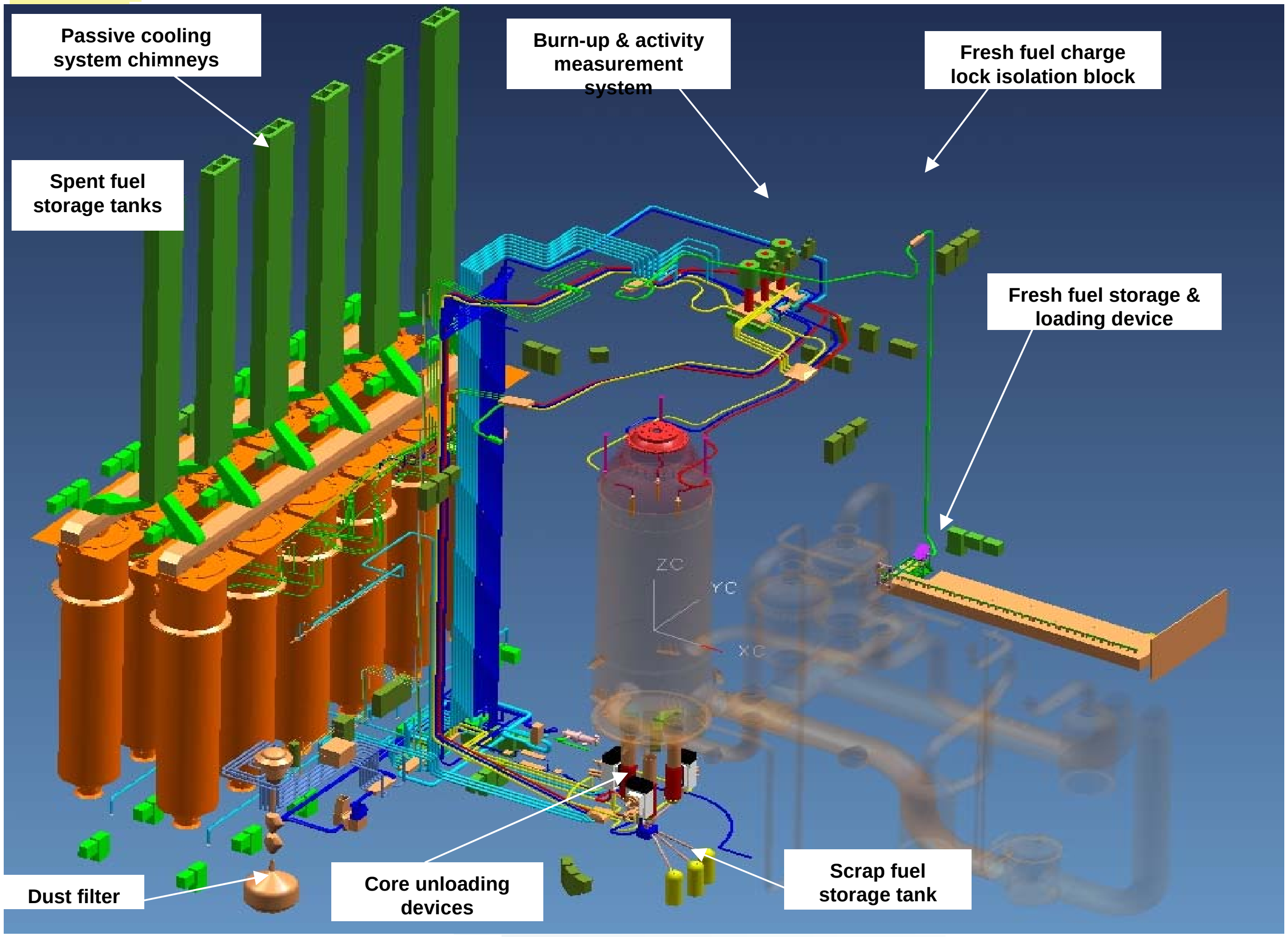


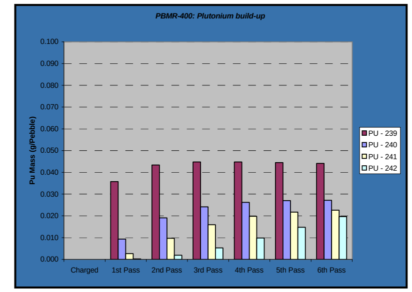


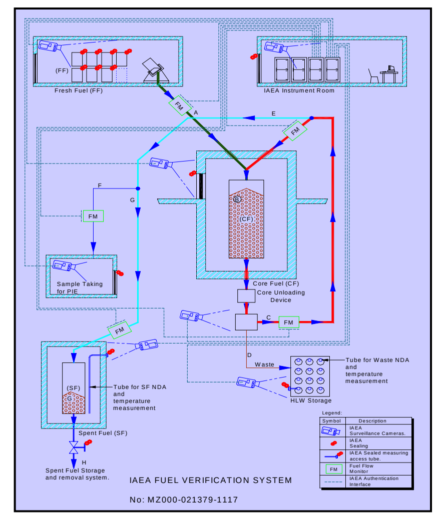




Fuel Handling and Proliferation Resistance



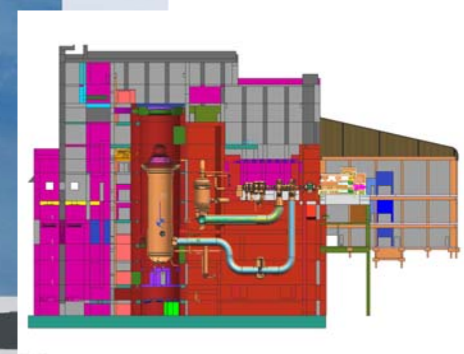




Demonstration Plant Building

Nuclear Island

Conventional Island

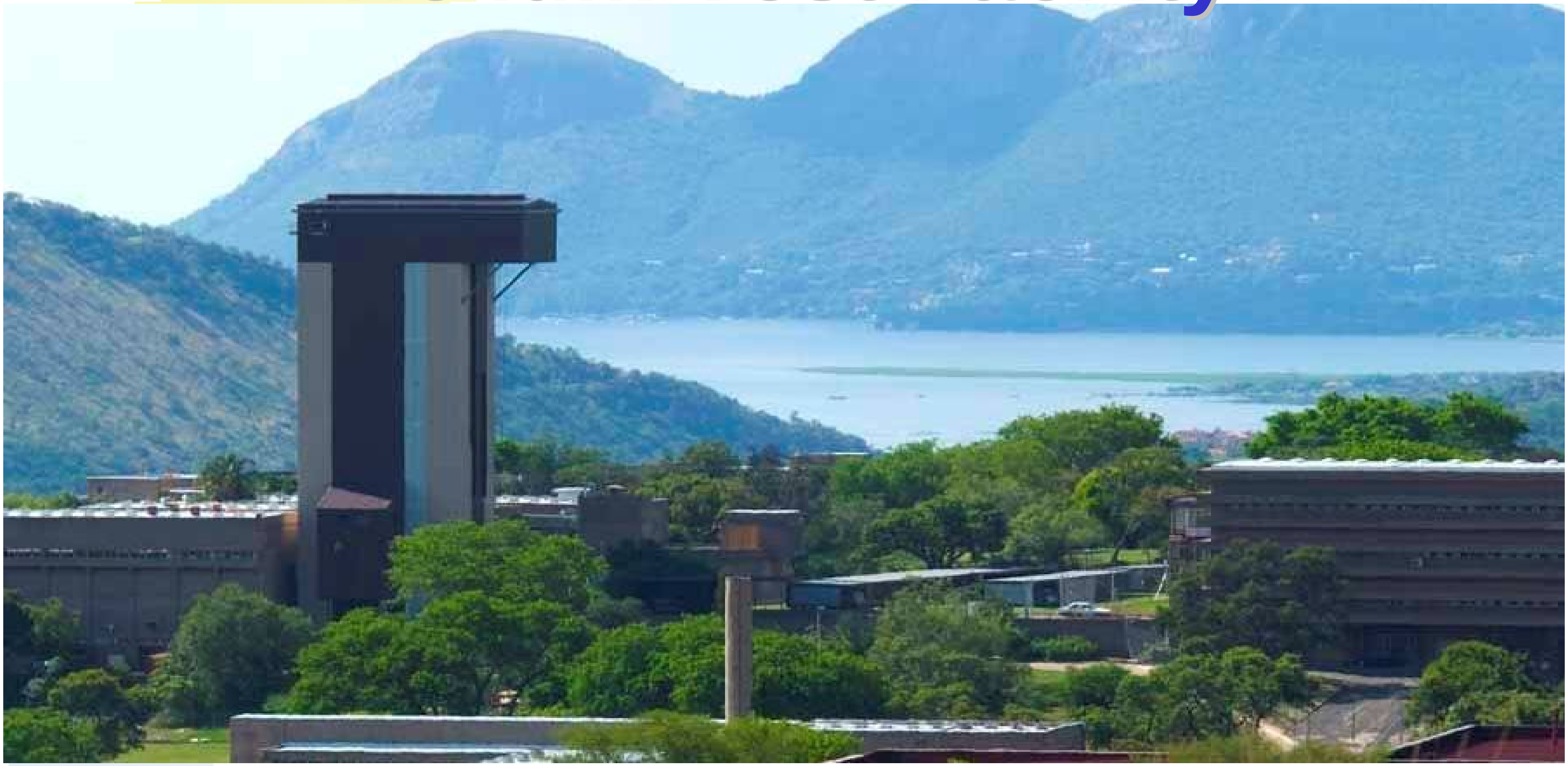


Where is PBMR Now

- 76 International patents registered
- EIA – Demo Reactor & Fuel ROD
- US NGNP contract (conceptual design of reactor)
- US NRC Pre-application licensing
- Canadian Oil Sands
- Institute of Nuclear Power Operators (INPO)
- GEN IV international program
- Safety Analysis Report handed over to Eskom
- License application for Fuel Plant construction
- Major component manufacturing started
- Excavation planned to commence in 2010


REACTOR / GENERATOR BUILDING
PEBBLE BED MODULAR REACTOR
BRADSHAW ARCHITECTS

Helium Test Facility



The 43 m high Helium Test Facility at Pelindaba will test the helium blower, valves, heaters, coolers, recuperator and other components at pressures up to 95 bar and 1200 degrees C.

Helium Test Facility

PBMR

High Pressure Test Unit of HTTF

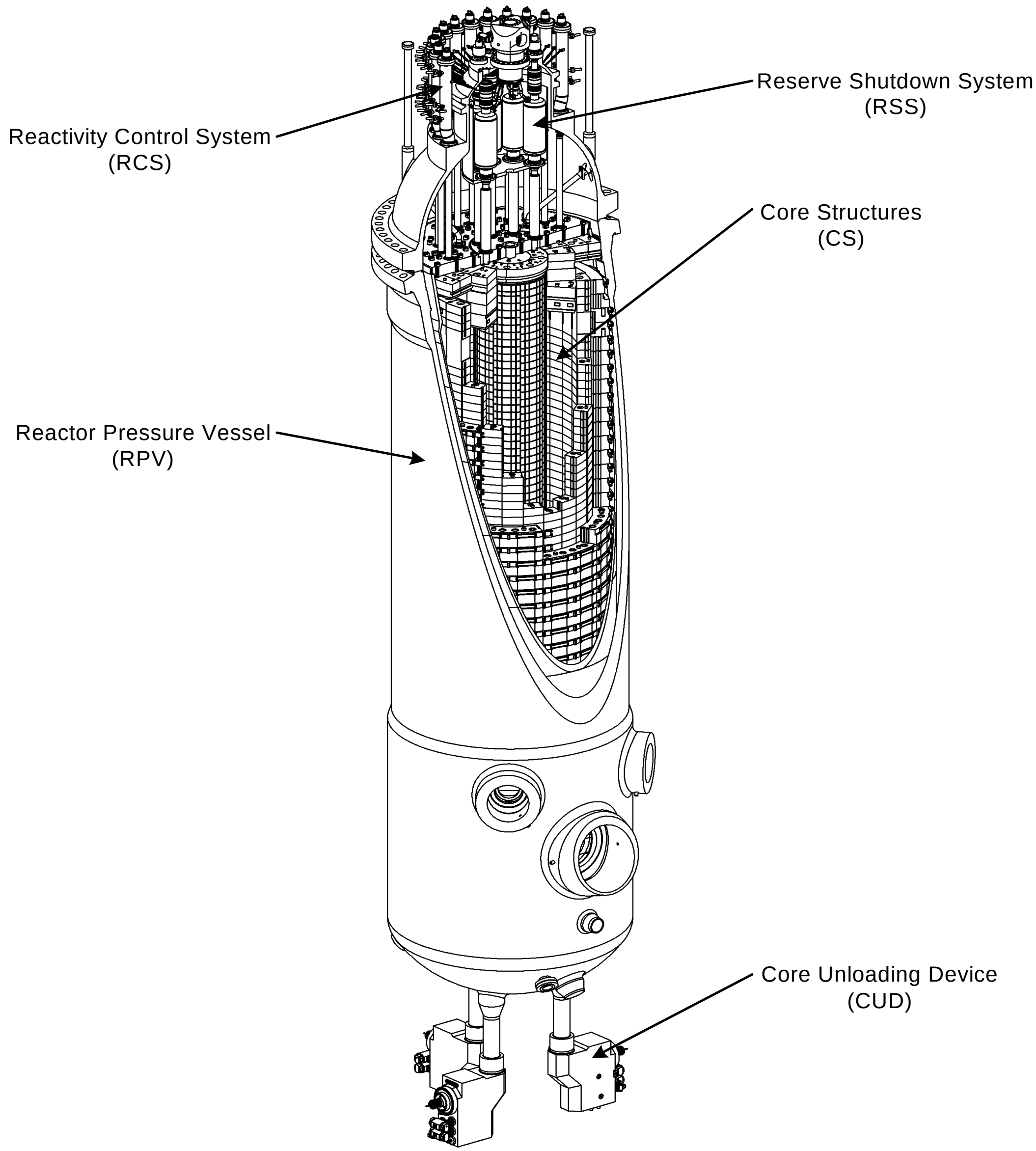
High Temperature Test Unit of HTTF

P B M R

Thank You

End

Reactor Unit



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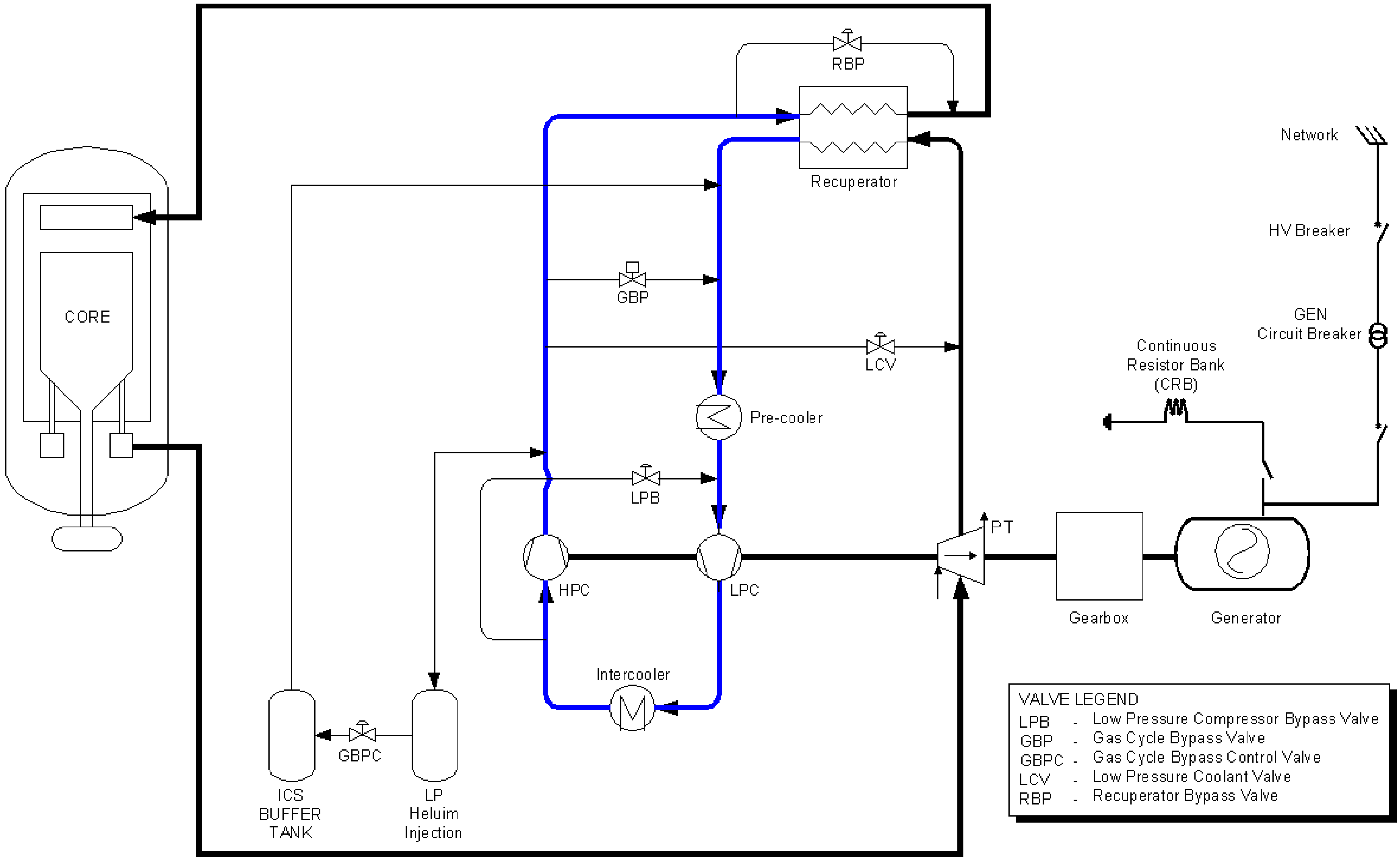
MPS Process Flow Diagram



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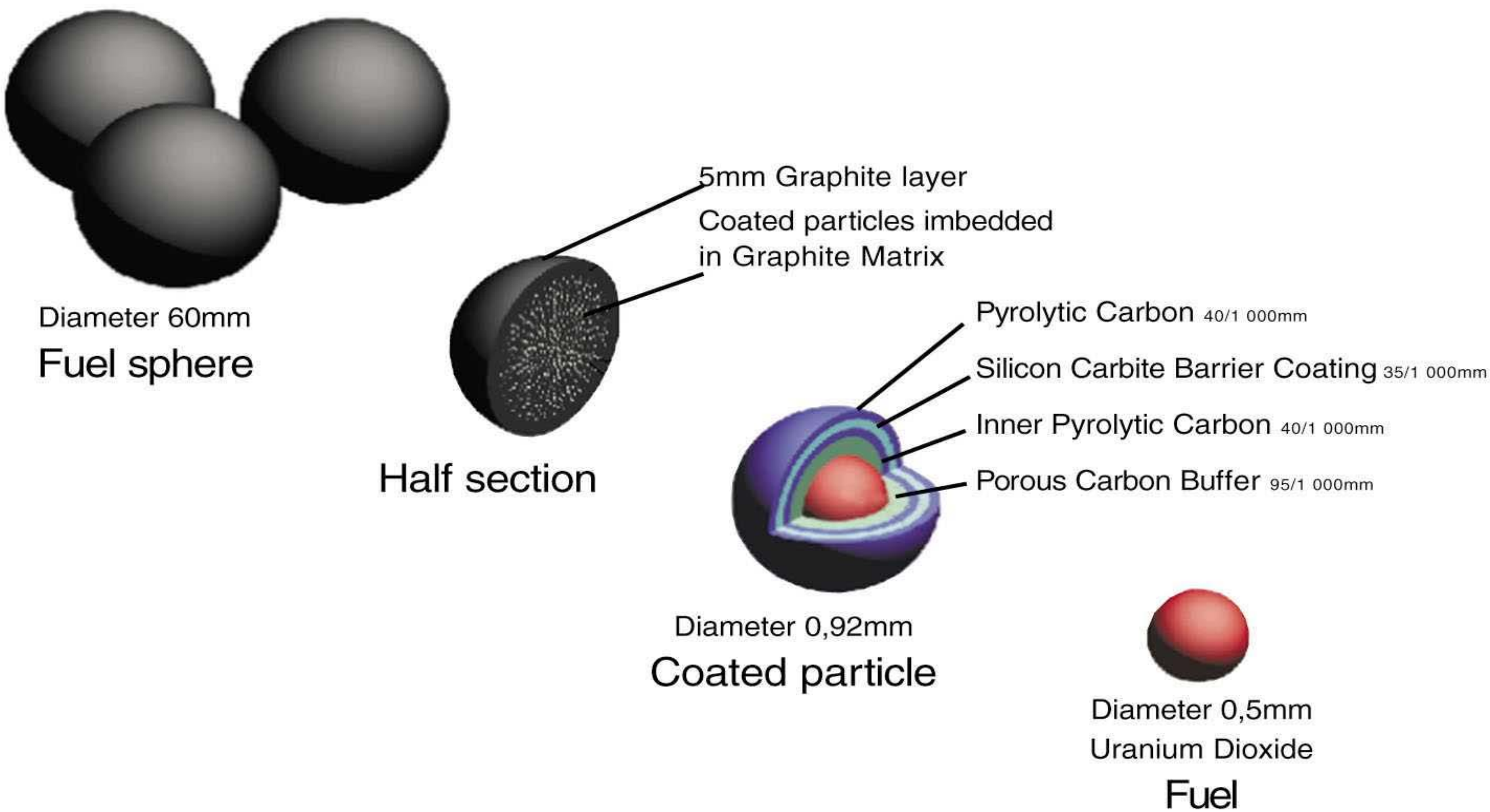
Fuel element design for PBMR



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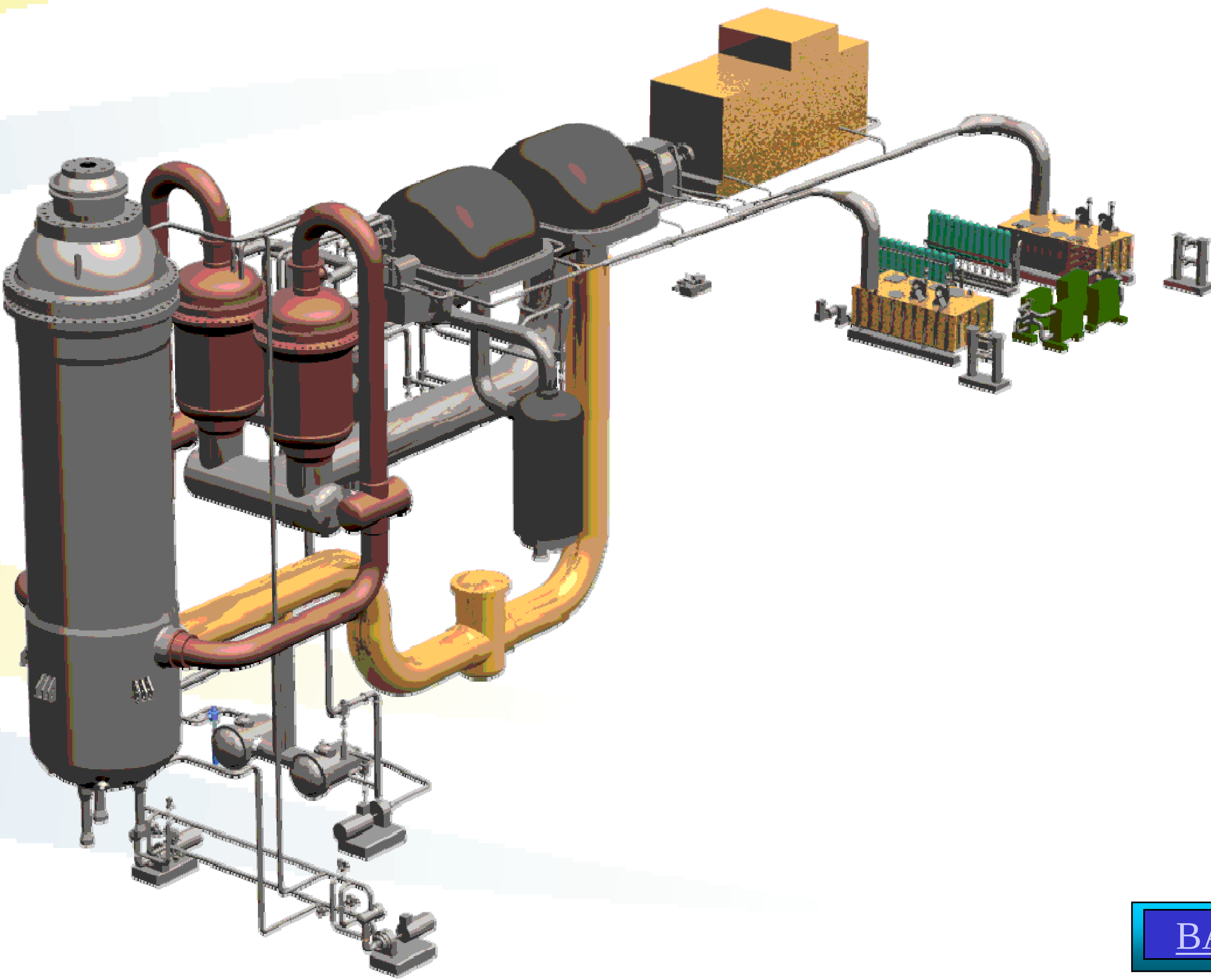
Main Power System



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