Gas Cooled Fast Reactor (GFR)

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Main GFR Features

- ***Closed fuel cycle system with full TRU recycle***
  - ***Co-located fuel cycle facility***

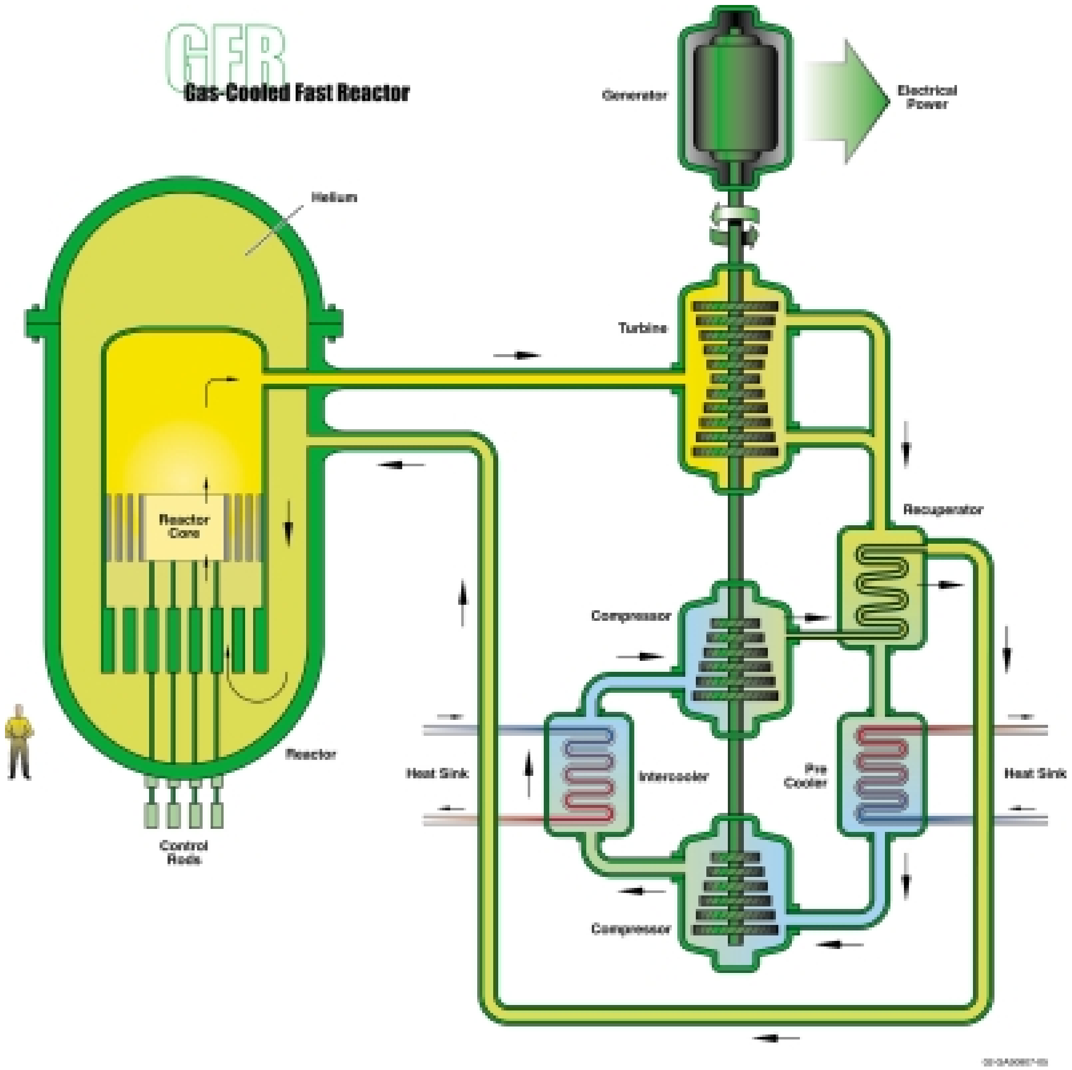
- ***Hardened/fast spectrum core***
  - ***Reduced moderation relative to thermal GCRs***

- ***Direct Brayton cycle energy conversion***
  - ***He coolant, 850ºC outlet temperature (reference)***
  - ***Supercritical CO_2 coolant, 550-650ºC outlet temperature (option)***
  - ***Efficient electricity generation, potential for H_2 production***

- ***Possible indirect cycle***
  - ***He on primary, supercritical CO_2 on secondary***

- ***Estimated deployment time: 2025***

GFR Plant Schematic (direct cycle)



Reference GFR Parameters (He cooled)

System Parameter	Reference Value
Power level	600 MWth
Net efficiency	48%
Coolant pressure	70 bar
Outlet coolant temperature	850 °C
Inlet coolant temperature	490 °C
Nominal flow & velocity	330 kg/s & 40 m/s
Core volume	11 m^3 (H/D ~1.7/2.9 m)
Core pressure drop	~0.4 bar
Volume fractions of Fuel/Gas/SiC	50/40/10 %
Average power density	55 MW/m^3
Reference fuel composition	UPuC/SiC (50/50 %)
Breeding/Burning performances	fissile breakeven
In core heavy metal inventory	30 tonnes
Fissile (TRU) enrichment	~20 wt%
Fuel management	multi-recycling
Fuel residence time	3 $\times$ 829 efpd
Discharge burnup ; damage	~5 at%; 60 dpa
Primary vessel diameter	<7 m

Rationale for GFR

- ***GFRs share the sustainability attributes of fast reactors***
  - ***Effective fissioning of Pu and minor actinides***
  - ***Ability to operate on wide range of fuel compositions***
  - ***Capacity for effective fuel utilization***
- ***Helium coolant offers advantages of***
  - ***Chemical inertness***
  - ***Small coolant void reactivity ($<\beta_{eff}$)***
  - ***Eased in-service inspection***
  - ***Potential for very high temperature and direct cycle conversion***
- ***High temperature enables new applications, including thermochemical hydrogen production***
- ***Supercritical CO_2 coolant offers advantages of***
  - ***Relatively small coolant void reactivity***
  - ***Eased in-service inspection***
  - ***Potential for high thermal efficiencies at lower temperatures***

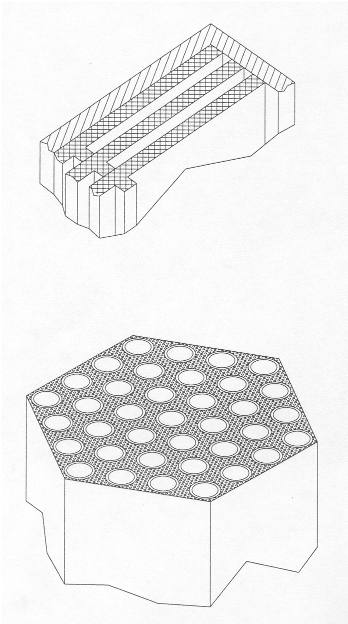
GFR R&D Needs

- ***High actinide-density fuels capable of withstanding high temperature and fast fluence***
  - ***Modified coated particle or dispersion type fuels, e.g.,***
    - ***(U,TRU)C/SiC***
    - ***(U,TRU)N/TiN***
  - ***Fuel pins with high-temperature cladding***

- ***Core structural materials for high temperature and fast-neutron fluence conditions (ceramics, composites, refractory alloys)***

- ***Safe accommodation of low thermal inertia and poor heat transfer properties of coolant***
  - ***Reliance on active and "semi-passive" systems for decay heat removal***
  - ***Passive reactivity shutdown is also targeted***

GFR R&D Needs, cont'd



- ***Fuel/core configuration for enhanced passive safety***
  - ***Thermal inertia***
  - ***Decay heat conduction and radiation paths to cooled vessel***
  - ***Prismatic block, pebble or plate options***

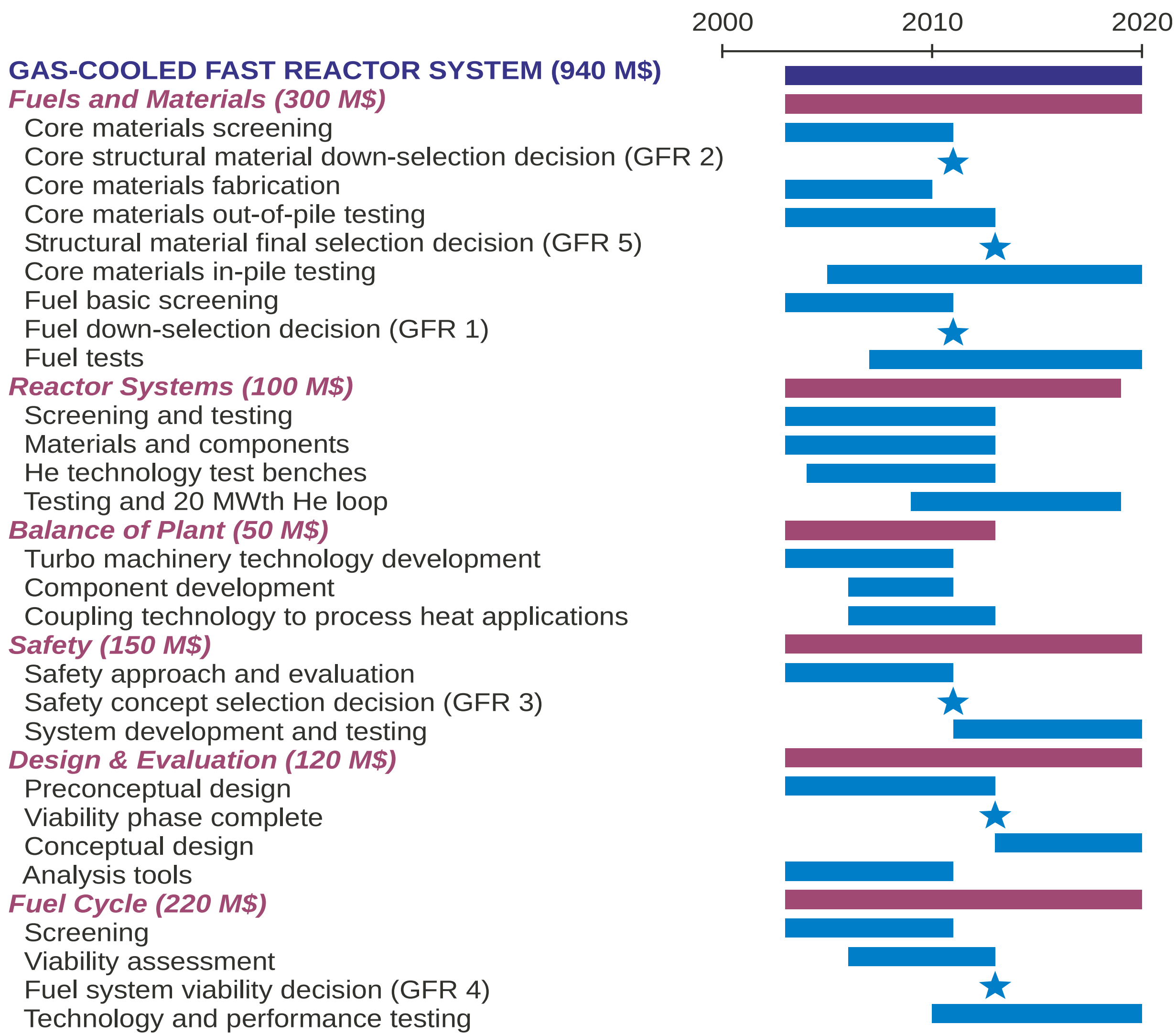
- ***Fuel recycle technology***
  - ***Separation of fuel from matrix***
  - ***Adaptation of aqueous and dry recycle options***
  - ***Recovery of ^{15}N for nitride fuel option***
  - ***Remote fuel refabrication***
  - ***On-site integration of separations, refabrication, and waste form production steps***

GFR R&D Activities

- ***Basic approach***
  - ***Early focus on concept development, emphasizing safety-in-the-design***
    - » ***Characterize technical uncertainties***
    - » ***Focus technology development***
  - ***Technology development (fuels, materials, etc.)***
    - » ***Initial screening based on available data***
    - » ***Viability tests of candidate fuels and materials progressing from out-of-pile tests to irradiation and post-irradiation experiments***
    - » ***Fuel cycle tests start at small scale with simulated materials progressing to larger scale and irradiated materials***
  - ***Technology selection and confirmatory testing in follow-on phase***

- ***R&D scope elements***
  - ***Plant safety/concept development***
  - ***Fuel development***
  - ***Spent fuel treatment***
  - ***High temperature materials***
  - ***Safety/design calculation tools***

GFR R&D Schedule



GFR Technical Issues

- ***Achievable degree of passive safety***
- ***Capability of materials to withstand targeted temperature and fast fluence conditions***
- ***Effectiveness of recycle technologies***
  - ***Actinide recovery factors***
  - ***Waste quantity and durability***
- ***Feasibility of economic design***

The GFR R&D plan seeks to overcome these challenges and realize the potential of the GFR for sustainable, economic generation of electricity and other energy products