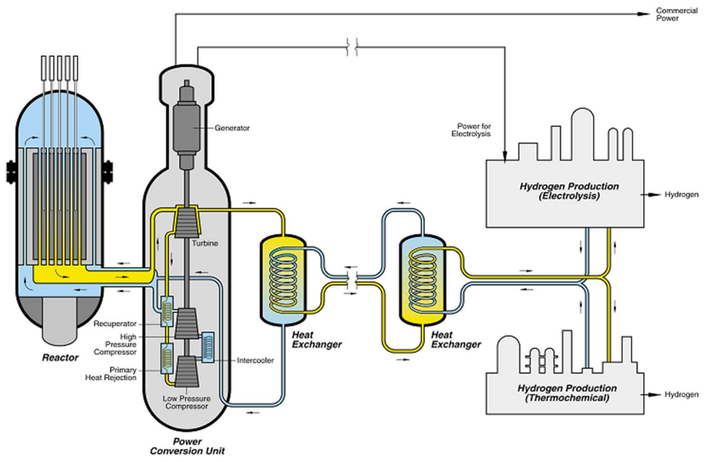
Future Generation Reactors

Argonne's Nuclear Engineering programs are making important contributions to the development of future generation reactor systems and their underlying technologies

Motivation for Future Use of Nuclear Power

- Proven and reliable, zero-emission energy option that already supplies significant energy worldwide! Existing "Generation II" plants produce:
  - *16% of electricity worldwide*
  - *20% of U.S. electricity*
  - *50% of Illinois electricity*
  - *80-90% of Chicagoland electricity*
- Great potential to meet growing energy demand worldwide (worldwide energy demand projected to double by 2050 at current 1.6% annual rate) without contributing to climate change.
- Future nuclear reactor designs address key issues:
  - *Sustainability*
  - *Waste minimization*
  - *Competitive economics*
  - *Safety assurance*
  - *Proliferation resistance*



The **Very High Temperature Reactor** (VHTR) enables high temperature applications of nuclear energy including the efficient generation of electricity and hydrogen; its main application is delivery of heat at high temperature for efficient generation of electricity and hydrogen, and possibly for use in industrial applications.

Generations of Nuclear Reactors

Generation I

Early Prototype Reactors

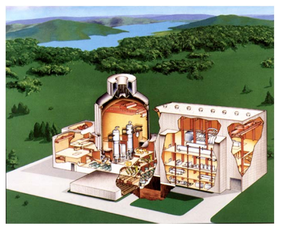
Generation II

Commercial Power Reactors

- Existing commercial reactors: producing 20% of U.S. electricity, 70% of emission-free electric power
- Excellent plant performance and safety record (90%+ capacity factor)
- Life extension has achieved favorable economics
- Used fuel currently stored at plant sites (long term disposition key issue)

Generation III

Advanced LWRs



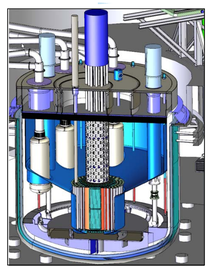
- Improved operability, maintainability, and safety assurance
- Licensing streamlined through design standardization
- Plant design, construction, operation aided by modern information technology and project management tools

Generation III+

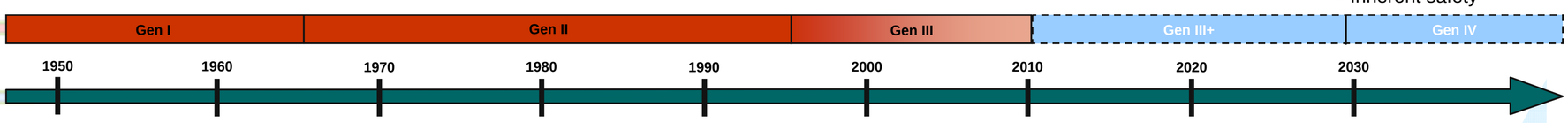
Evolutionary Designs

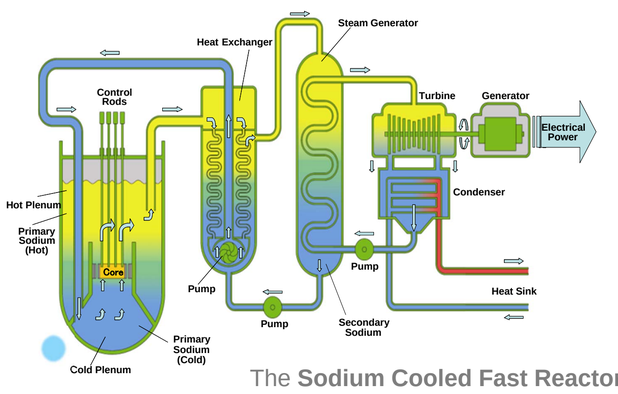
Generation IV

Future Generation Designs



- Strong performance: *extracts 100's of times more energy from fuel*
- Sustainable energy supply: *creates additional fuel*
- Improved waste management: *100-fold waste reduction*
- Inherent safety





The **Sodium Cooled Fast Reactor** (SFR) enables multi-recycle of actinides to avoid nuclear waste accumulation and improve uranium utilization; its main missions are consumption of actinides recovered from discharged light water reactor (LWR) fuel and generation of electricity.

Generation-IV Reactor Systems

Substantial advances in performance are targeted with Gen-IV reactors and advanced fuel cycles

- *100-300 times more energy yield from the same amount of nuclear fuel*
- *ability to consume existing nuclear waste to produce electricity*
- *ability to create more fuel than is consumed for a sustainable energy supply*
- *100-fold reduction in amount of high-level waste*

System	*Neutron Spectrum*	*Fuel Cycle*	*Power*	*Applications*
Very High Temperature Gas Reactor (VHTR)	Thermal	Open	Small to Medium	Electricity, Heat Supply
Supercritical Water Reactor (SCWR)	Thermal, Fast	Open, Closed	Large	Electricity
Gas-Cooled Fast Reactor (GFR)	Fast	Closed	Large	Electricity, Heat, Actinide Mgmt.
Lead Cooled Fast Reactor (LFR)	Fast	Closed	Small to Medium	Electricity, Actinide Mgmt.
Sodium Cooled Fast Reactor (SFR)	Fast	Closed	Small to Large	Electricity, Actinide Mgmt.
Molten Salt Reactor (MSR)	Thermal, Fast	Closed	Large	Electricity, Actinide Mgmt.

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