Fusion Power Plant
– The Part Beyond the Fusion Reactor

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Westinghouse View of Fusion

- Many potential fusion options – Westinghouse is unbiased
- Fusion power plants could be more acceptable than fission plants to the environmental community due to their minimal long-lived waste production and increased safety due to lack of fission products
- Fusion plants would not have fuel supply issues
- Once the fusion engine is developed, it should require far less fuel design (i.e. operate like a coal plant: put coal in and get a predictable amount of thermal energy out)
- Westinghouse would design and supply the clean-up, separations, power generation and fuel manufacture portions of the plant and act as general contractor for the fusion plant as a whole
- There is a service business in the maintenance of fusion plants due to the radioactivity of the fusion chamber from neutron activation

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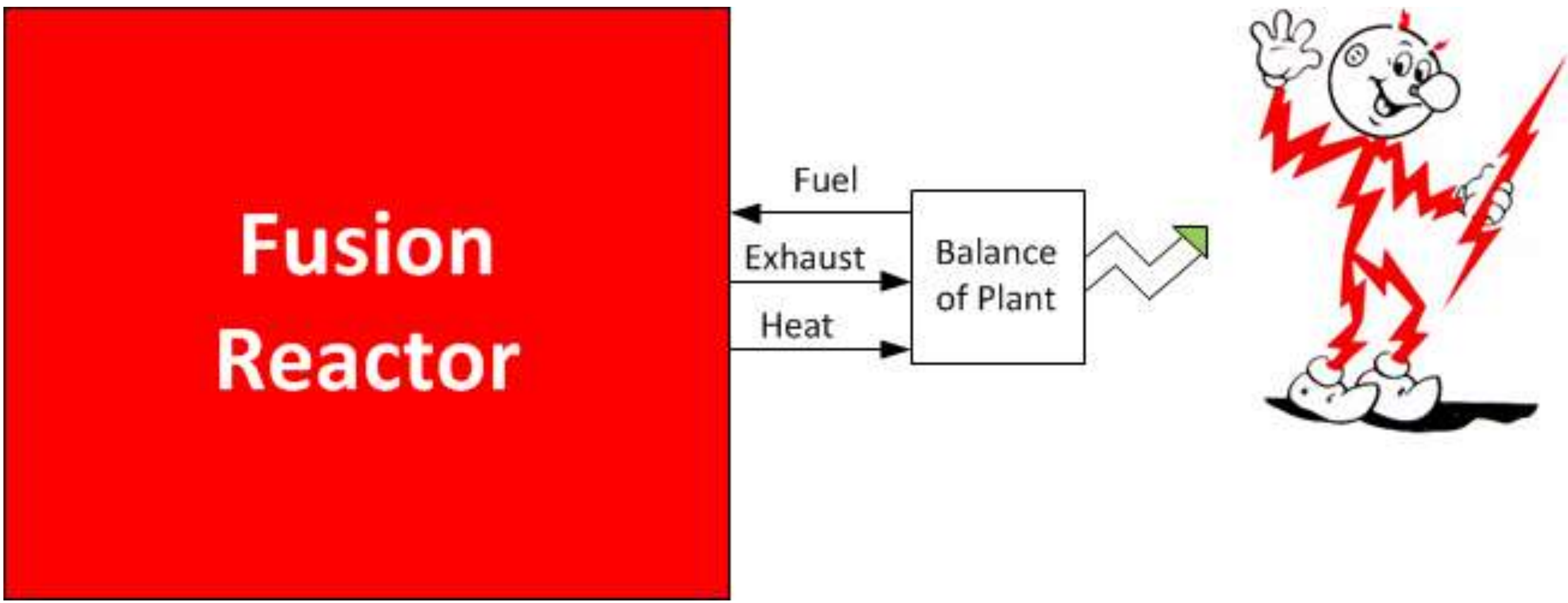
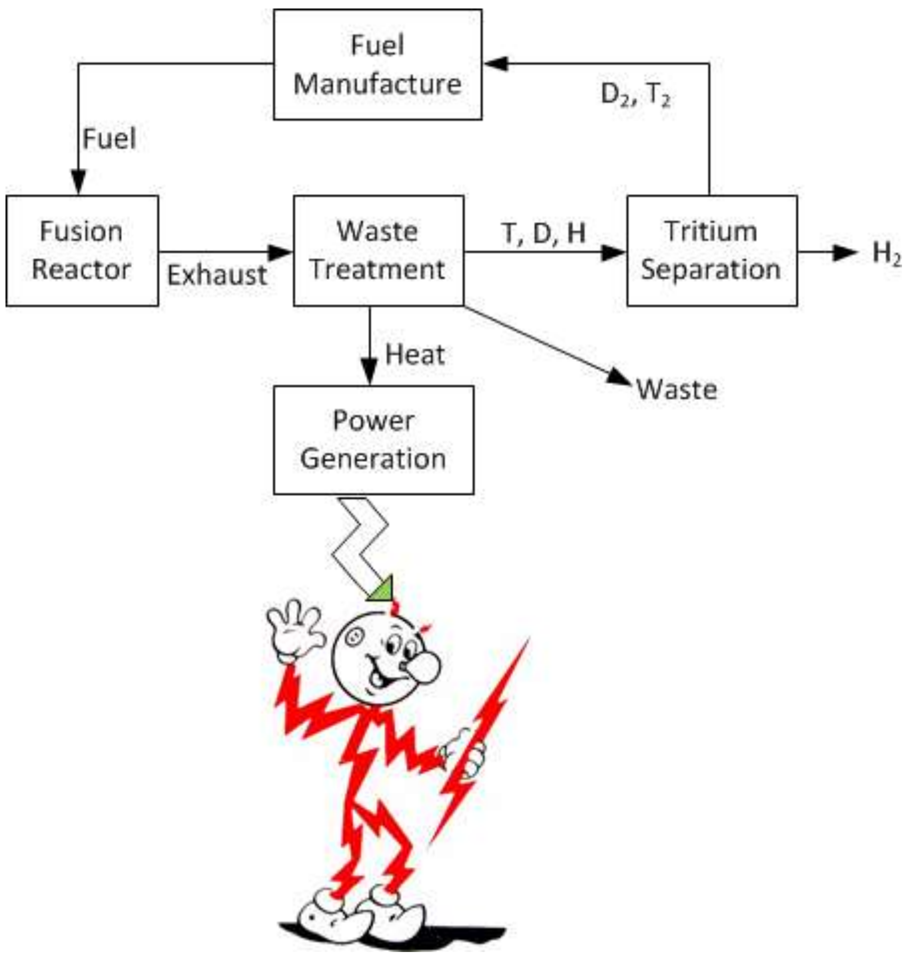
Fusion plants can be a nuclear source of thermal energy to generate electricity

It’s All a Matter of Perspective



What Westinghouse Sees



Westinghouse Areas of Interest

- Licensing
- Fuel fabrication
- Fuel materials handling
- Materials of construction for fusion areas
- Gas handling, cleanup and separations
- Power conversion and BOP
- Maintenance of operating plant
- Waste disposal

Westinghouse Studies to Date

- Tritium extraction and purification system
- Off-gas handling system
- Supercritical carbon dioxide (s-CO_2) Brayton power cycle
- Compatibility of structural materials with molten lithium coolant
- Modeling of printed circuit heat exchanger
- Qualitative assessment of printed circuit heat exchangers
- s-CO_2 turbine compressor design

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Westinghouse has assessed the separations and power conversion areas

Data Needs for Interfaces Between Fusion Plant and Balance of Plant

- Expected lifetimes of components
- Expected neutron fluxes and activation products
- Maintenance requirements
- Power requirements
- Water or coolant needs
- Steam or other utility needs
- Fusion fuel needs
- Off-gas generation
- Coolant/tritium breeder flows (Li or LiPb flows)
- Direct support system needs
  - Laser banks

Fusion reactor needs will directly affect BoP costs and overall cost of electricity

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Recommendations for Future Work

- Development of alternate methods for T,D,H/Li or LiPb separation
  - Current LiCl-KCl salt eutectic extraction, electrolytic reclamation costly, difficult to operate and large – significant technology weakness
  - Alternate technology such as purged metal membrane to reduce complexity
- Heat exchangers
  - Current heat exchangers would be large and expensive
  - Exploration of alternate technologies (for instance, printed circuit heat exchanges or others needed for reduced cost and to explore operating issues)
  - Issues exist for licensing and operation
- SiC for first wall and heat exchangers
  - Resistant to neutron damage
  - Fabrication and joining still open issues
- Instrumentation that could stand up to high neutron fluxes required
- Materials that minimize or eliminate tritium leakage required
  - Tritium leakages are a major issue with current fission plants; fusion plants would make orders of magnitude more tritium and many of the materials would not contain tritium at their high operating temperatures

Much bench and pilot scale work required to finish and verify system design

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Commercialization Considerations - Stages of Development

- Small scale, macro energy output (10 to 100 watt thermal), repeatable demonstration of fusion approach
- 1 to 10 MWt scale integrated demonstration reactor and supporting systems (power conversion would be optional but most likely dump thermal energy)
  - Operation for 5 to 10 years to prove out system and get data on operating, maintenance and materials issues
- 100 to 300 MWe demonstration plant with power conversion
  - Operation for 5 to 10 years to prove out system and get data on operating, maintenance and materials issues
- Full scale 1 GWe plant

Full scale fusion powerplants at least 15 to 20 years away

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Commercialization Considerations - What Industry Wants to See

- Utilities make electricity at the lowest price possible
  - They are not in the R&D business
- Vendors sell powerplants to utilities for a profit
  - Typically there are at least some guarantees attached to performance
  - They need to make money on the sale of the plant
  - Simplicity is good
- Fusion reactor developers want to see?
  - Need a business plan
  - What will you sell? How will you protect your technology?
- DoE goals
  - Clean power source for the US
  - Exportable technology for US that is non-proliferable

For a technology to succeed, everyone has to profit

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