Advanced/Gen IV Reactors: Opportunities and Challenges

Kevan D. Weaver

USNIC-ANL Special Technical Symposium

Argonne National Laboratory, January 28-29, 2014

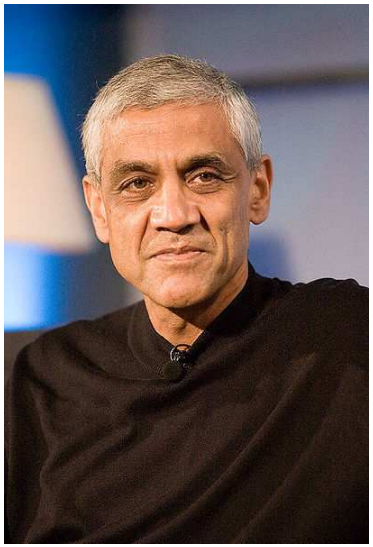
Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

The importance of energy

Bill Gates:

"It's crazy how little we're funding energy."
"I would encourage people who work in this area that the importance of this is right at the top."



Vinod Khosla:

"If it doesn't scale, it doesn't matter. Most of what we talk about today—hybrid, biodiesel, ethanol, solar photovoltaics, geothermal—I believe are irrelevant to the scale of the problem."

Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

SFR technology satisfies the requirements of the Traveling Wave Reactor (TWR)

- TerraPower was formed in 2008 to address growing global energy needs
  - With climate change, pollution, and rising energy demands, a scalable solution is needed
  - All energy forms were considered
    - Fossil (coal, gas, diesel, etc.), wind, solar, etc.
- Nuclear is the only scalable source
  - The TWR is based on SFR technology
  - Gives best economics, safety, sustainability, and proliferation resistance

Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

The TWR challenges

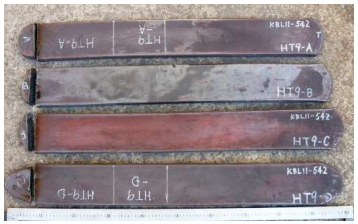
- Challenge #1: Fuels and Materials
  - Requires high fuel burnup, and high neutron dose to in-core materials
- Challenge #2: Supply Chain Development
  - Need suppliers for fuel, etc.
- Challenge #3: Licensing
  - Licensing an advanced, non-LWR reactor is a non-trivial task
- There are other challenges, but the above are the most time sensitive (time constants can be long)

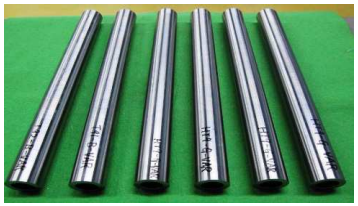
Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

What TerraPower is doing to address challenge #1

- Initiated programs to develop, fabricate, and test fuels and materials
  - Heavy-ion irradiation of materials began in Aug 2011
  - Advanced fuel tests began in the ATR in Nov 2013
  - Materials irradiation testing began in the BOR-60 reactor in Dec 2013
  - Test pin irradiations scheduled to begin in 2016 in BOR-60
- Materials irradiation tests include “pre-irradiated” material
  - Samples have doses up to 150 dpa – provides a jump start





Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

What TerraPower is doing to address challenge #2

- Have engaged and/or signed contracts
  - Enriched uranium
  - Fuel fabrication process development
  - Fuel component “industrial” scale-up
  - Instrumentation and control
  - Design expertise from prior SFR work
  - Work directly with potential suppliers (trade studies, etc.)
  - Large components and test facilities to prove them out

Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

What TerraPower is doing to address challenge #3

- Licensing strategy
  - TWR design and safety analysis proceeding with anticipated regulatory requirements
    - Based on current US LWR regulatory requirements
    - Adapted for unique characteristics of sodium fast reactors (SFRs)
  - Regulatory Requirements
    - Based on US 10 Code Federal Regulations Part 50
    - General Design Criteria for TWR completed
  - Regulatory Compliance Approach
    - Based on NUREG-0800, Standard Review Plan (SRP)
    - Adapted to reflect characteristics of SFR and TWR

Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower

Some things to consider

- Fast-spectrum test reactor (preferably using SFR technology) would be extremely helpful in the testing and licensing of advanced/Gen IV reactors
  - Licensing of the test reactor could serve as a framework for commercial plants (sodium technologies and experience, etc.)
  - No need to perform tests “off-shore”
- Regulatory uncertainty regarding advanced/Gen IV reactors should be addressed sooner rather than later
  - Question is how to address it – public/private partnerships?

Copyright © 2014 TerraPower, LLC.
All Rights Reserved.

TerraPower