From “Inherently Safe” to “Proliferation Resistant”: New Perspectives on Reactor Designs

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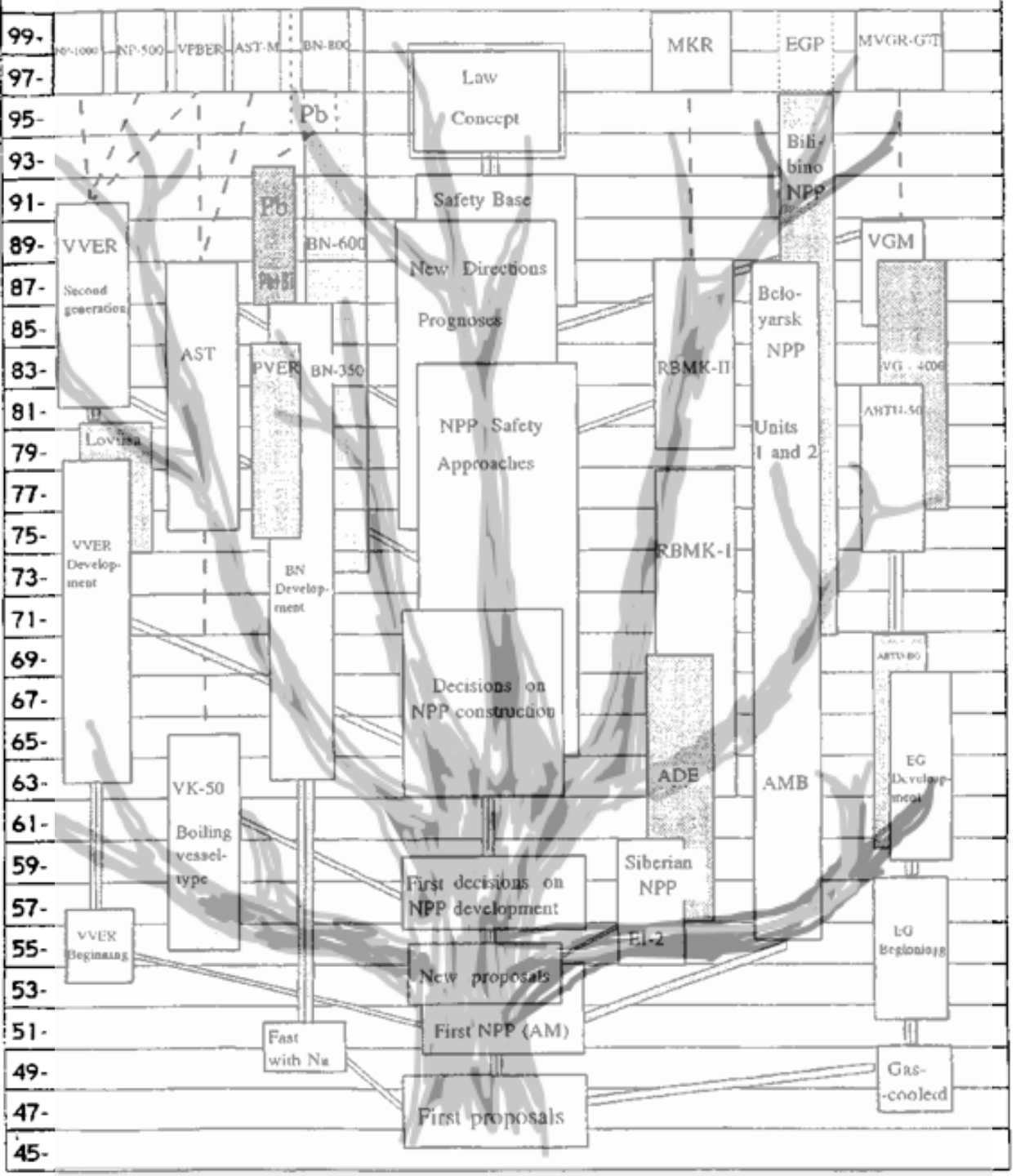

Nuclear Power Development "Tree"

Source: Sidorenko 1997

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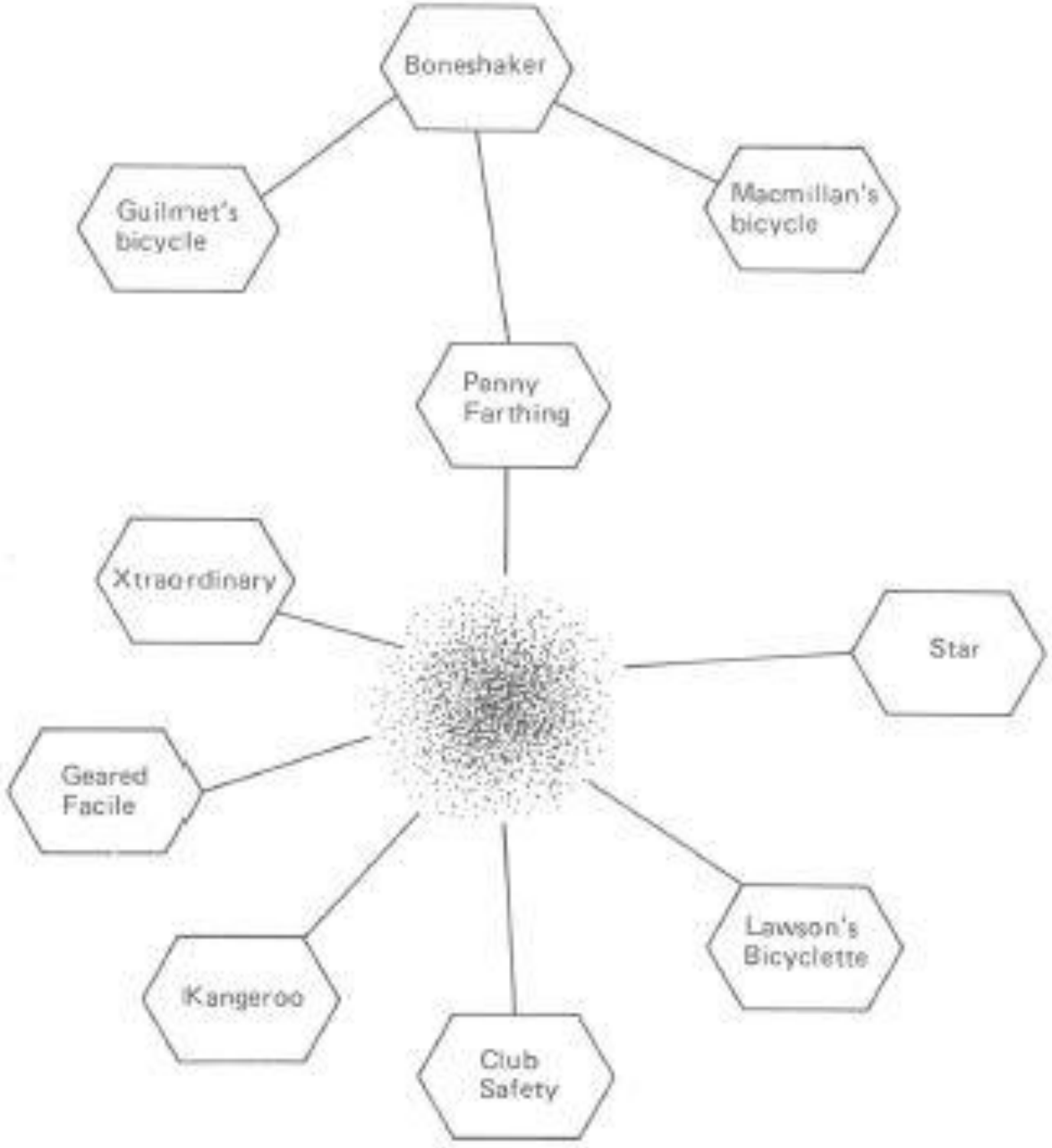

Multidirectional view of technology development

Pinch & Bijker 1987, 29

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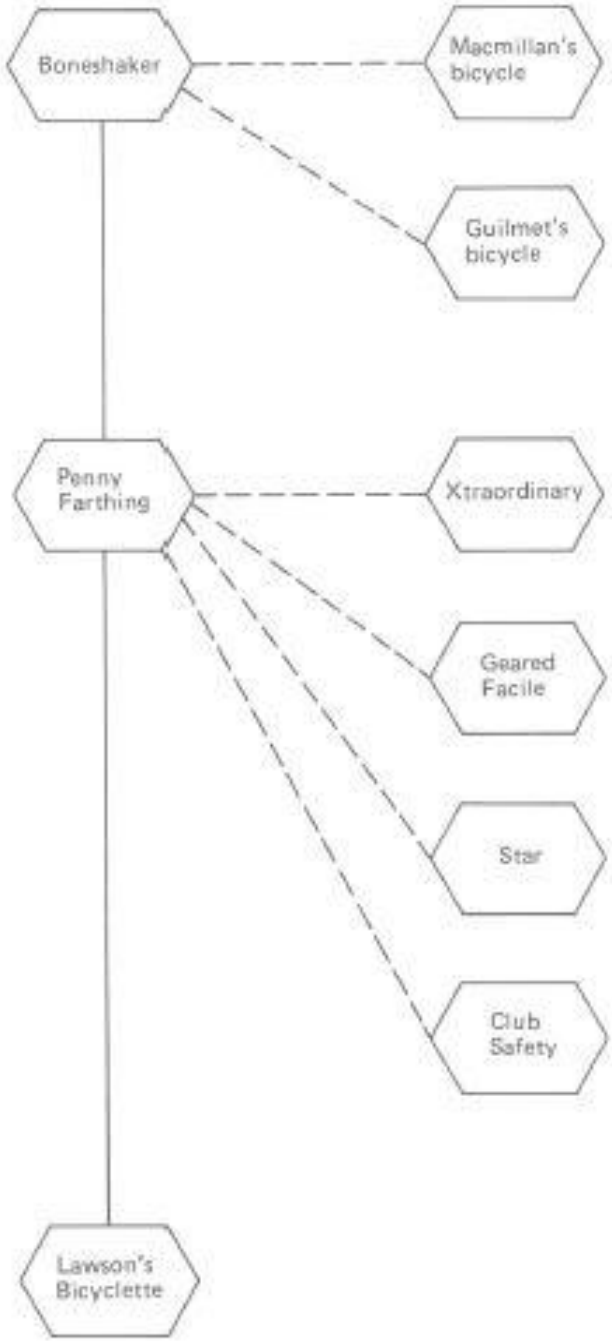

Retroactive Rationalization: streamlined, quasi-linear technology development

Pinch & Bijker 1987, 31

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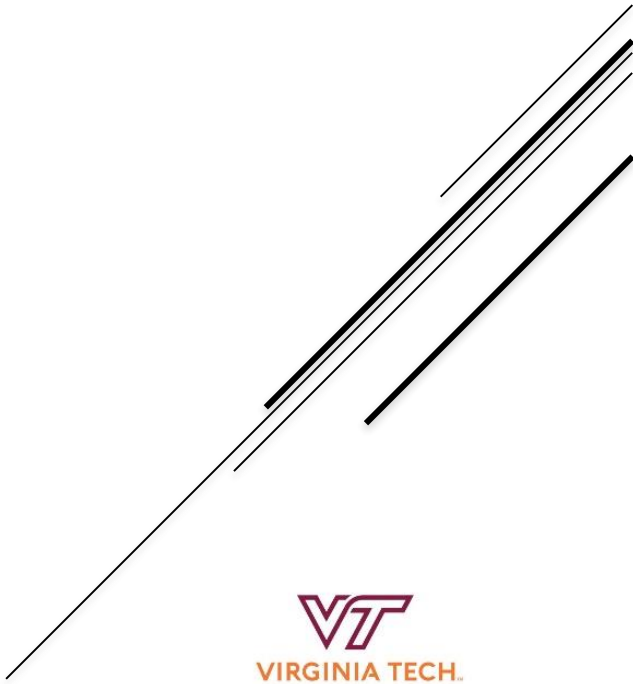
Conceptual Framework

- Safety
- Security
- Socio-technical imaginaries

Examples

- RBMK
- NuScale SMR
- TerraPower TWR



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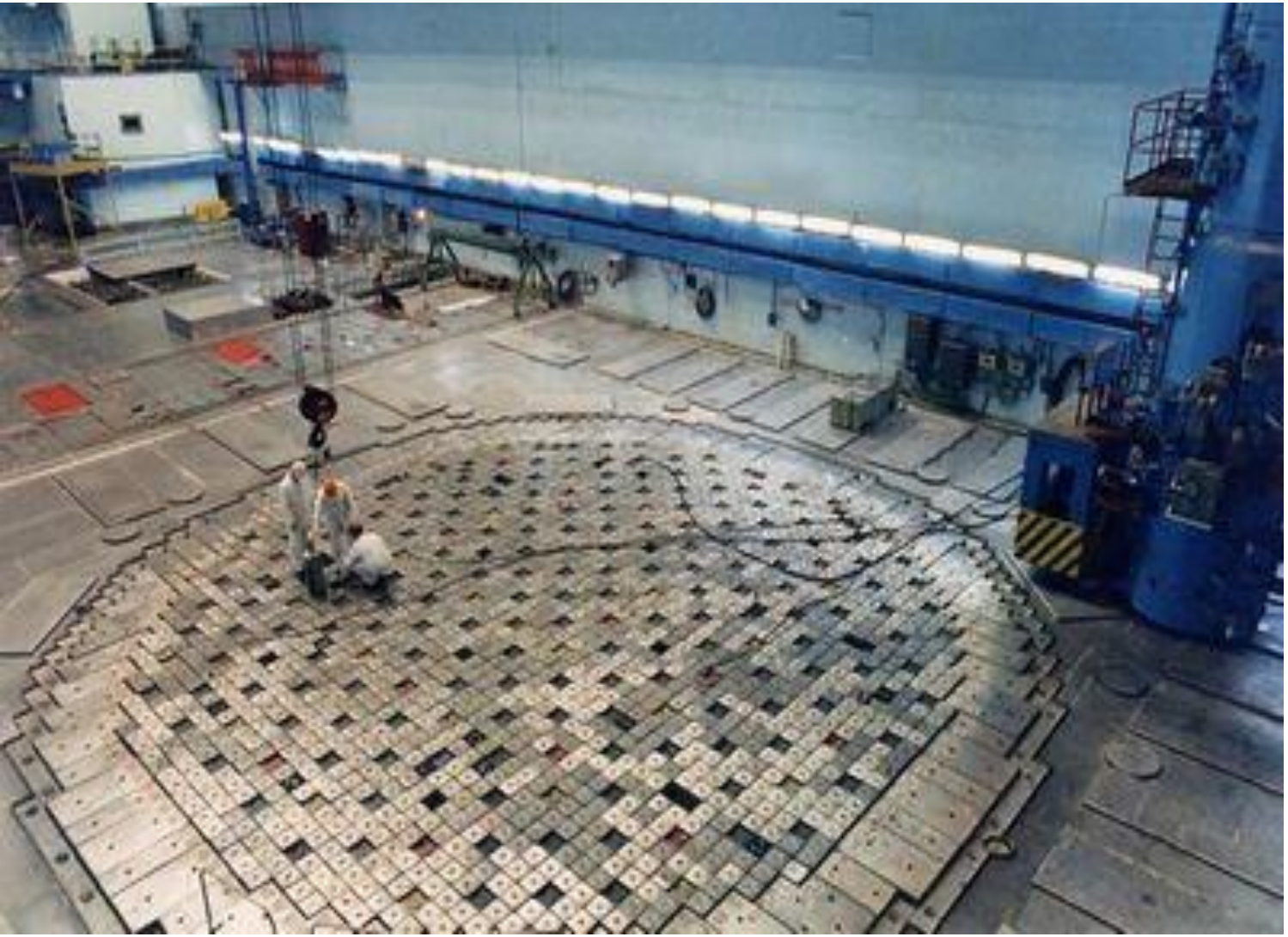

RBMK: high power channel/boiling water reactor *(РБМК*: *реактор большой мощности канальный/кипящий)*

Igor V. Kurchatov,
Savelii M. Feinberg

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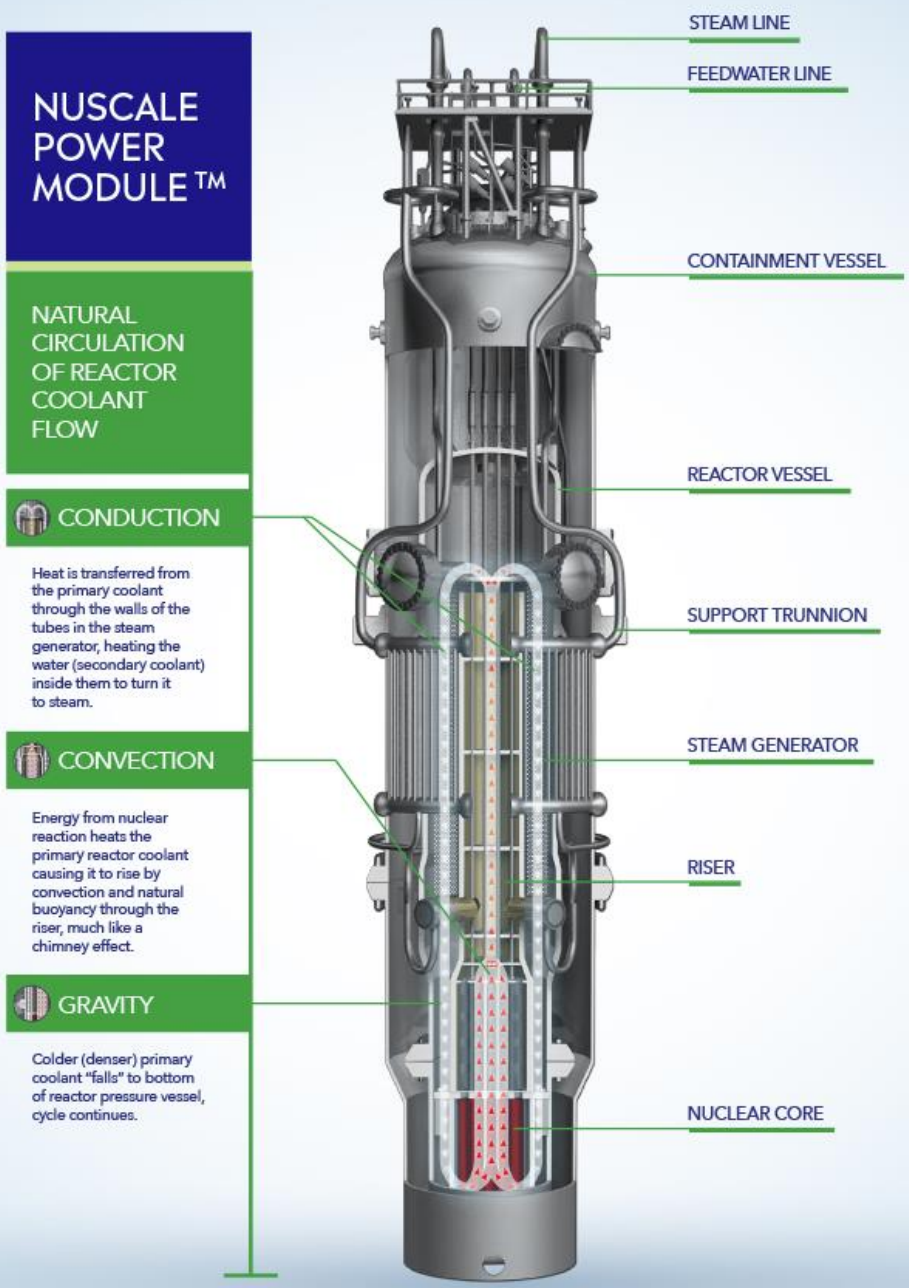
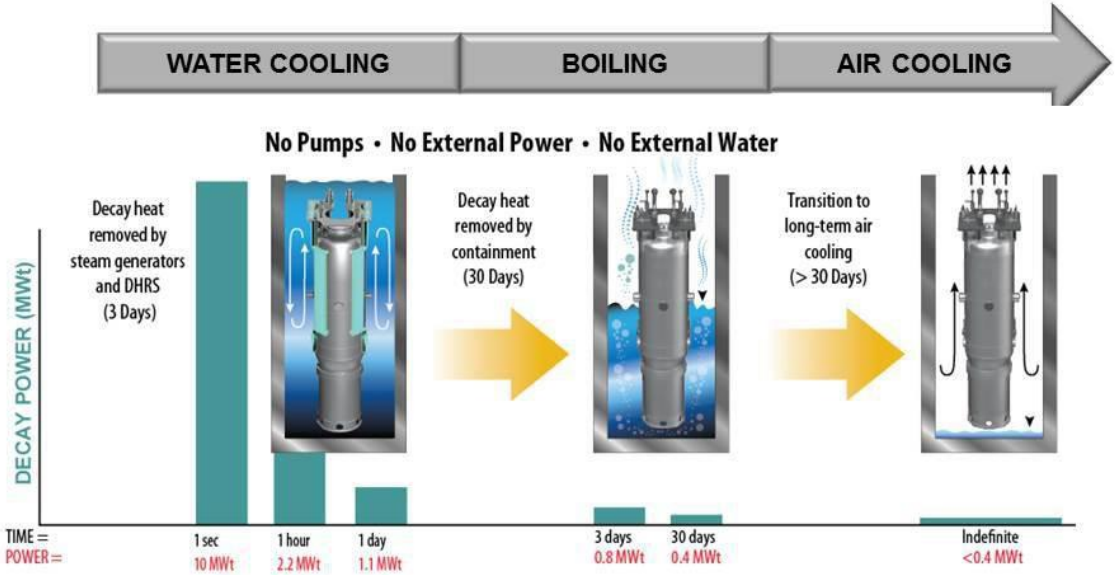


NuScale's SMR

José N. Reyes

Innovative Advancements to Reactor Safety

*Nuclear fuel cooled indefinitely without AC or DC power**



- *30 days is a minimum based on very conservative estimates.*

**Alternate 1E power system design eliminates the need for 1E qualified batteries to perform ESFAS protective functions – Patent Pending*

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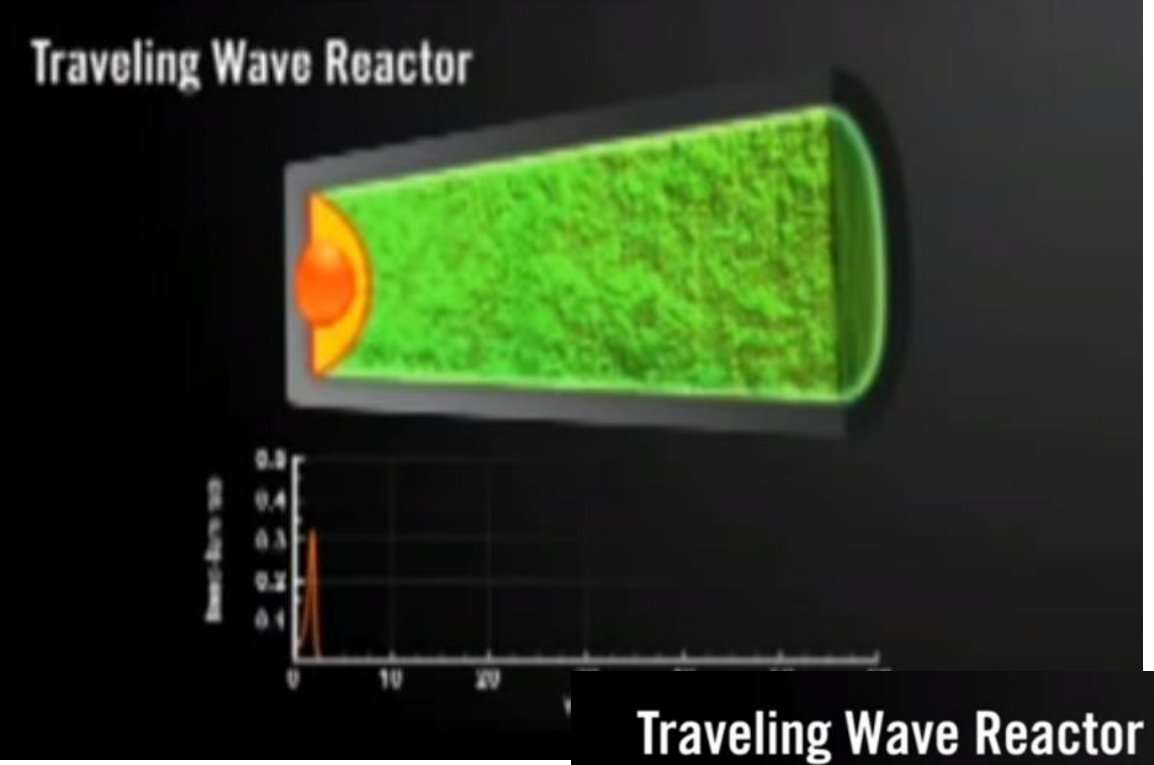
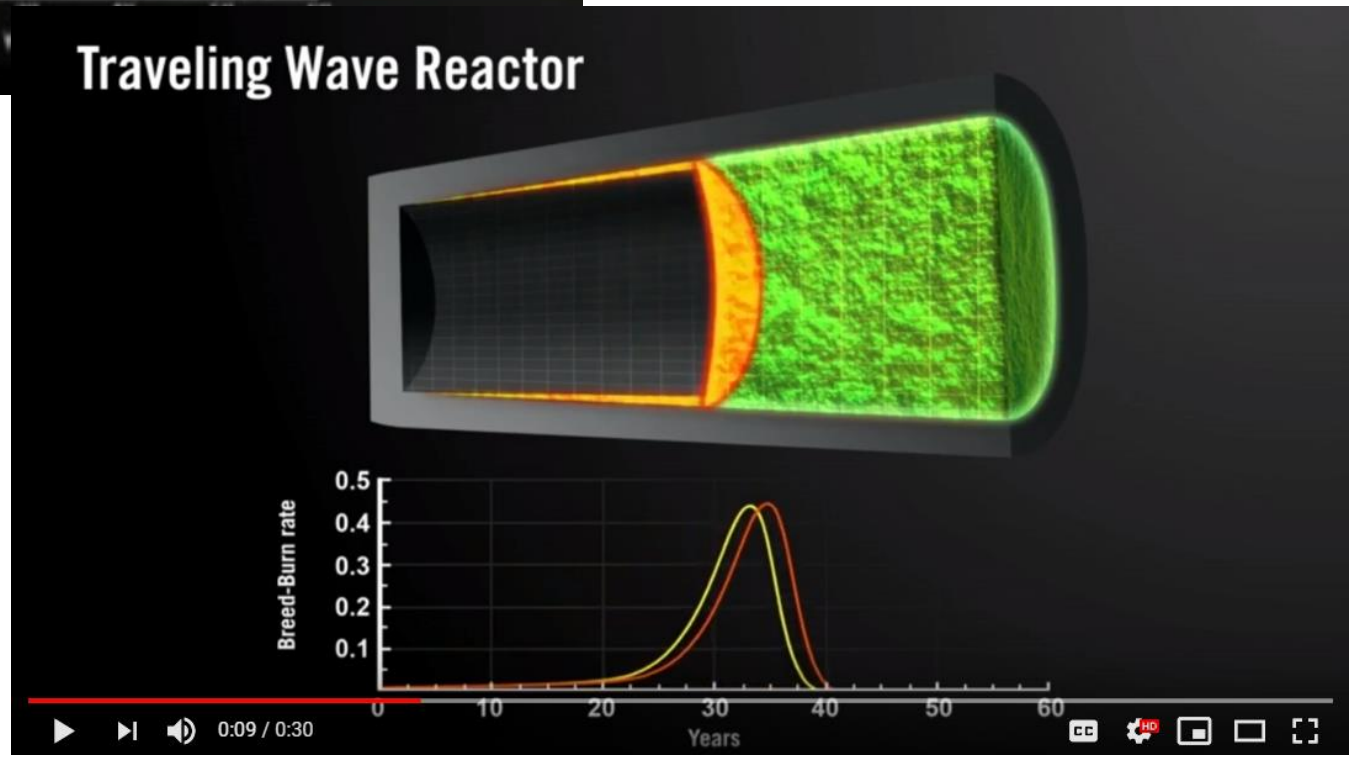


TerraPower

TerraPower's TWR: "candlestick," "smoldering cigar"



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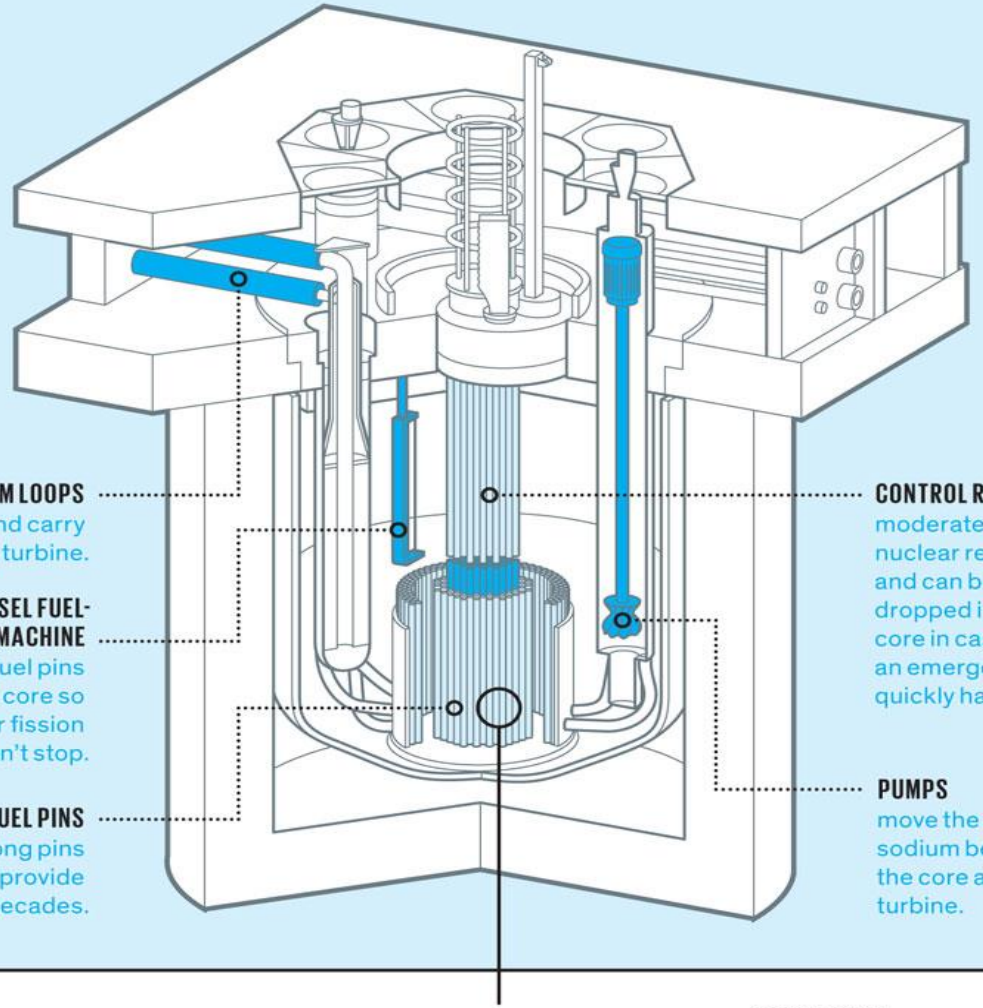
TerraPower's reactor is the latest in a long line of attempts at sodium-cooled reactors. The company is confident that extensive computer simulations and physical tests, combined with a new approach to the old idea of the traveling-wave reactor, has resulted in a design that will finally succeed. Here's how it works.



MOLTEN SODIUM LOOPS cool the core and carry heat to the steam turbine.

IN-VESSEL FUEL-HANDLING MACHINE shuffles the fuel pins around the core so that nuclear fission doesn't stop.

FUEL PINS 169 three-meter-long pins of uranium metal provide enough fuel for decades.

CONTROL RODS moderate the nuclear reaction and can be dropped into the core in case of an emergency to quickly halt fission.

PUMPS move the molten sodium between the core and steam turbine.

PACKING A PUNCH: The reactor's fuel, uranium-238, is quite stable. Bombarding it with neutrons eventually creates plutonium-239, a very unstable isotope that almost always breaks into a cascade of smaller atomic nuclei and free neutrons when struck again.

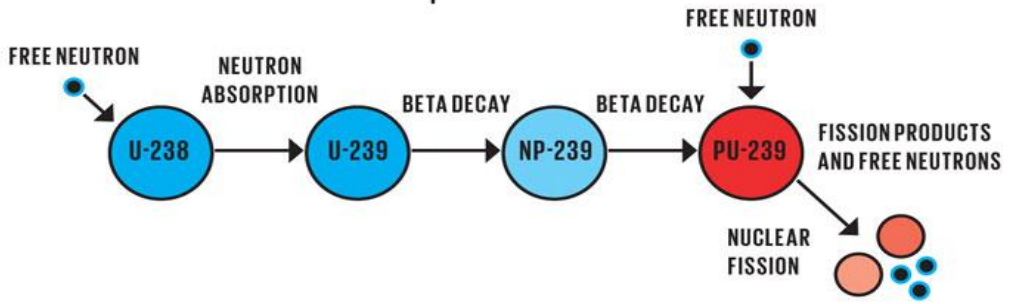


Illustration: James Provost

Source: Michael Koziol, "TerraPower's Nuclear Reactor Could Power the 21st Century" *IEEE Spectrum*, June 1, 2018

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TerraPower
A nuclear innovation company

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The Physics

A New Class of Nuclear Reactor

Engineers and researchers have long dreamed of a self-fueling source of energy. As early as 195[illegible], Saveli Feinberg imagined a nuclear reactor that could breed fuel within its core. TerraPower will use proven fast reactor technology, high-performance computing simulations and real testing in current fast reactor test facilities to make the traveling wave reactor (TWR) concept a reality. The TWR technology is a uniquely designed nuclear reactor. It is able to operate for an

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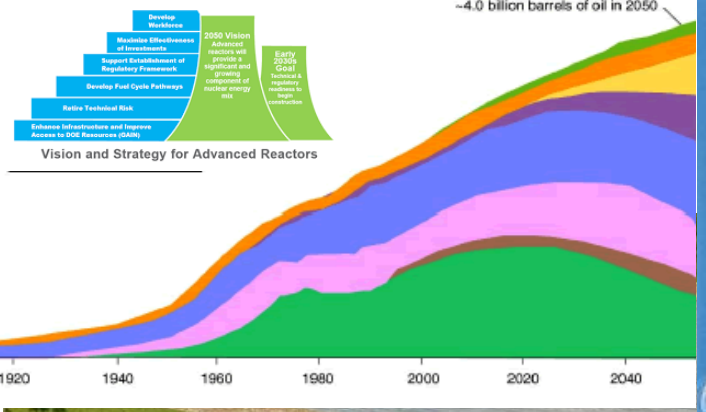
~4.0 billion barrels of oil in 2050
Develop Workforce
Maximize Effectiveness of Investments
Support Establishment of Regulatory Framework
Develop Fuel Cycle Pathways
Retire Technical Risk
Enhance Infrastructure and Improve Access to DOE Resources (DAIN)
2050 Vision
Advanced reactors will provide a significant and growing component of nuclear energy mix
Early 2030s Goal
Technical & regulatory readiness to begin construction
Vision and Strategy for Advanced Reactors
1920
1940
1960
1980
2000
2020
2040


ПУСТЬ АТОМ СЛУЖИТ МИРУ, А НЕ ВОЙНЕ!


Thank you!
Contact: sschmid@vt.edu


*artist's interpretation