

# Nuclear Innovation in America

## - An investor's view

### **Ray Rothrock**

Partner Emeritus, Venrock

Early staged venture capitalist

Forbes Midas List multiple times

former Chair of the National Venture Capital  
Association

Private Investor

Transatomic Power, Chair of the Board

Tri Alpha Energy, Exec Committee of the Board

Partner with other US citizens pressing the case

# Innovation

- Alignment of Big Forces
  - Entrepreneurs
    - Inventions and improvements addressing a huge market
  - Venture capital ecosystem
  - Big global market
  - But, nuclear is special:
    - Nuclear materials, proliferation risks, safety, oversight require US Government oversight and assistance

# Entrepreneurial Nuclear Efforts

(List assembled by Third Way, Washington, D.C)

<b>Transatomic (TAP)</b>	Cambridge, MA	Molten Salt Reactor
<b>Terrestrial Energy (Integral MSR)</b>	Mississauga, Canada	Molten Salt Reactor
<b>Ottawa Valley Research</b>	Ottawa, Canada	Molten Salt Reactor
<b>Massachusetts Institute of Technology (FHR)</b>	Cambridge, MA	Fluoride Salt-Cooled High Temperature Reactor
<b>Flibe Energy (LFTR)</b>	Huntsville, AL	Fluoride Salt-Cooled High Temperature Reactor
<b>Oak Ridge National Laboratory (SmATHR)</b>	Oak Ridge, TN	Fluoride Salt-Cooled High Temperature Reactor
<b>General Electric-Hitachi (PRISM)</b>	Wilmington, NC	Liquid Metal-cooled Fast Reactors
<b>Advanced Reactor Concepts (ARC-100)</b>	Reston, VA	Liquid Metal-cooled Fast Reactors
<b>Thorenco</b>	San Francisco, CA	Liquid Metal-cooled Fast Reactors
<b>Argonne National Laboratory (STAR)</b>	Lemont, IL	Liquid Metal-cooled Fast Reactors
<b>Gen4 Energy (G4M)</b>	Denver, CO	Liquid Metal-cooled Fast Reactors
<b>Virginia Tech and ADNA Corp. (GEMSTAR)</b>	Blacksburg, VA	Liquid Metal-cooled Fast Reactors
<b>University of California, Berkeley (ENHS)</b>	Berkeley, CA	Liquid Metal-cooled Fast Reactors
<b>Terrapower (TWR)</b>	Bellevue, WA	Liquid Metal-cooled Fast Reactors (Variant)
<b>General Atomics (EM2 and MHR)</b>	San Diego, CA	High Temperature Gas Reactor
<b>DOE Next Generation Nuclear Plant</b>	Bethesda, MD	High Temperature Gas Reactor
<b>Hybrid Power Technologies (Hybrid)</b>	Kansas City, KS	High Temperature Gas Reactor (Variant)
<b>University of California, Berkeley (PB-FHR)</b>	Berkeley, CA	Pebble Bed High Temperature Gas Reactor
<b>X-Energy</b>	Greenbelt, MD	Pebble Bed Modular Reactor
<b>Northern Nuclear (Leadir-PS100)</b>	Cambridge, Canada	Pebble Bed Modular Reactor (Lead Cooled)

# Entrepreneurial Nuclear Efforts

Continued (List assembled by Third Way, Washington, D.C)

<b>Upower</b>	Boston, MA	Nuclear Battery
<b>University of Missouri</b>	Columbia, MO	Nuclear Battery
<b>CityLabs (NanoTritium)</b>	Homestead, FL	Nuclear Battery
<b>Widtronix</b>	Ithaca, NY	Nuclear Battery
<b>Lightbridge</b>	Tysons Corner, VA	Designs Advanced Nuclear Fuels
<b>B&amp;W Company and Bechtel Power Corp. (mPower)</b>	Charlotte, NC	Small Modular Reactor (PWR)
<b>NuScale Power (NuScale)</b>	Corvallis, OR	Small Modular Reactor (PWR)
<b>Radix Power and Energy Corp. (RADIX)</b>	Setauket, NY	Small Modular Reactor (PWR)
<b>Holtec (SMR-160)</b>	Jupiter, FL	Small Modular Reactor (PWR)
<b>Westinghouse (SMR)</b>	Fulton, MO	Small Modular Reactor (PWR)
<b>General Atomics (TPS)</b>	San Diego, CA	Small Modular Reactor (PWR)
<b>Helion Energy</b>	Redmond, WA	Fusion
<b>National Ignition Facility</b>	Livermore, CA	Fusion
<b>General Fusion</b>	Burnaby, Canada	Fusion
<b>Lawrenceville Plasma Physics</b>	Middlesex, NJ	Fusion
<b>Lockheed Martin</b>	Bethesda, MD	Fusion
<b>General Atomics</b>	San Diego, CA	Fusion
<b>Tri Alpha</b>	Foothill Ranch, CA	Fusion

# Entrepreneurial Nuclear Efforts

## Advanced Reactor Nascent Industry



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# US Venture Capital

- Identified opportunity in a ginormous market
- Innovations in hand/under development
- Entrepreneurs ready, willing and able
- Risk capital ready, willing and able
- Glimmer of Greatness
- Venture innovation works
  - VC-backed companies in last 50 years
    - 22% of GDP
    - 12% of non-public sector jobs
- \$50 billion per year at work

# Silicon Valley Innovation Model

- Many shots on goal; may the best team win
- Speed. Speed. Speed.
- Shared knowledge, talent, resources
- Wins and aspirational role models and leaders
- Other:
  - Close proximity to encourage face to face
  - Sophisticated legal and funding ecosystem
  - Access to talent

# Nuclear Opportunity and Constraints

- Opportunity
  - Many hundreds of entrepreneurs
  - Climate change abatement
  - Better and competitive economics (speed) **ESSENTIAL**
- US Government Role
  - Oversight of all nuclear activities including regulatory
  - Modernize its nuclear R&D (many shots on goal)
  - Modernize its interactions with the innovation community
- Constraints
  - NRC oriented to “water cooled plants only”
    - All or nothing
      - Difficult business model for startup companies
    - No risk based technology assessment capability
    - AEC roots in founding legislation



# Private Capital Sponsoring the US Entrepreneurial Nuclear Effort

- Approximately \$1 billion invested in last 10 years by a dozen companies or activities
- Professional Investors:
  - Venrock, NEA, RedPoint, Charles River, Lux Capital, Founders Fund, Braemar, Intellectual Ventures, Khosla Ventures, The Wellcome Trust, RussNano, Chrysalix, SDTC, Mithral, Y-Combinator
- Billionaires – Gates, Bezos, Samberg
- SWF: Saudi, Russian
- Corporates – Lockheed, General Atomic, Fluor, Toshiba
- Existing Industry Strategic Partners
  - Most are circling
  - Do they have the “innovators dilemma”

# The Opportunity for Nuclear Innovation in America

- Leadership: Federal leadership and sponsorship
- DOE Infrastructure: **Access** to US federal facilities, especially national labs, and experts for research, prototyping, and demonstration
- NRC: Regulatory framework and pathway for licensing **approval**
  - Risk adjusted
  - Technology considered
  - Flexible
- **Strong, steady and clear signal to commercial possibility**

# Case Examples Risk Based Regulatory Processes

- Federal Drug Administration
- Federal Aviation Administration

# A Government/Venture Success Story



- Safe and worthy products get to market in a timely manner
- Works actively with the private sector
- Informs the public with science-based information

# FDA New Drug Process

## *An Illustration*

Stage	Elapsed Time (Yrs)	Capital (Millions)	Purpose	Market Value (Millions)	Probability of Continuing
Pre-Clinical	1-5	\$10-\$50	Pre-human validation	\$10-\$20	10%
<b>Phase I</b>	<b>1-2</b>	<b>\$5-\$20</b>	<b>Safety</b>	<b>\$10-\$50</b>	<b>65%</b>
Phase II	2	\$20-\$50	Efficacy and dose	\$50-\$100	50%
<b>Phase III</b>	<b>3</b>	<b>\$40-\$100</b>	<b>Registration Trial</b>	<b>\$200-\$400</b>	<b>65%</b>
NDA	1	\$50-\$100	Manufacturing	\$500-\$1000	90%



**Benefits:** Orderly, Predictable, Finite, Conclusive

# Alternatives for US Entrepreneurs

- Other modern risk-based regulatory systems
  - Canada Regulatory System
  - UK Regulatory Body

# Conclusions

- Nuclear innovation is alive and well in America
- Private capital is carefully sponsoring the best and the brightest
- DOE is a vast, powerful, and substantial partner for startups
- Regulatory
  - NRC is not currently “set up” to support third-party innovation, but there are multiple paths to change this
  - US FDA and FAA proven risk based regulatory processes that work for the public and the industry
- **American Success = Entrepreneurs + Private Capital + Government Partner**

# Many thanks. . . .

**I very much thank the NRC and the interested parties here today and elsewhere in the nuclear establishment of the United States for the time to present these ideas and opportunities.**

**I am at your service.**

**-- Ray Rothrock**