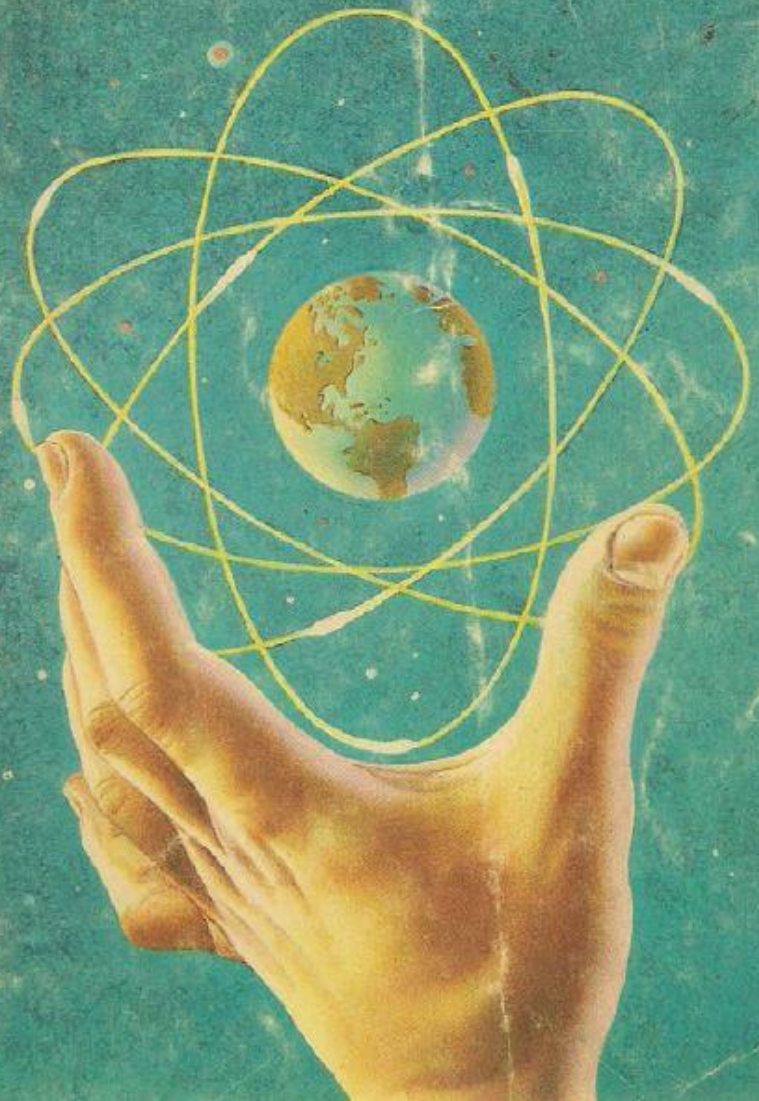
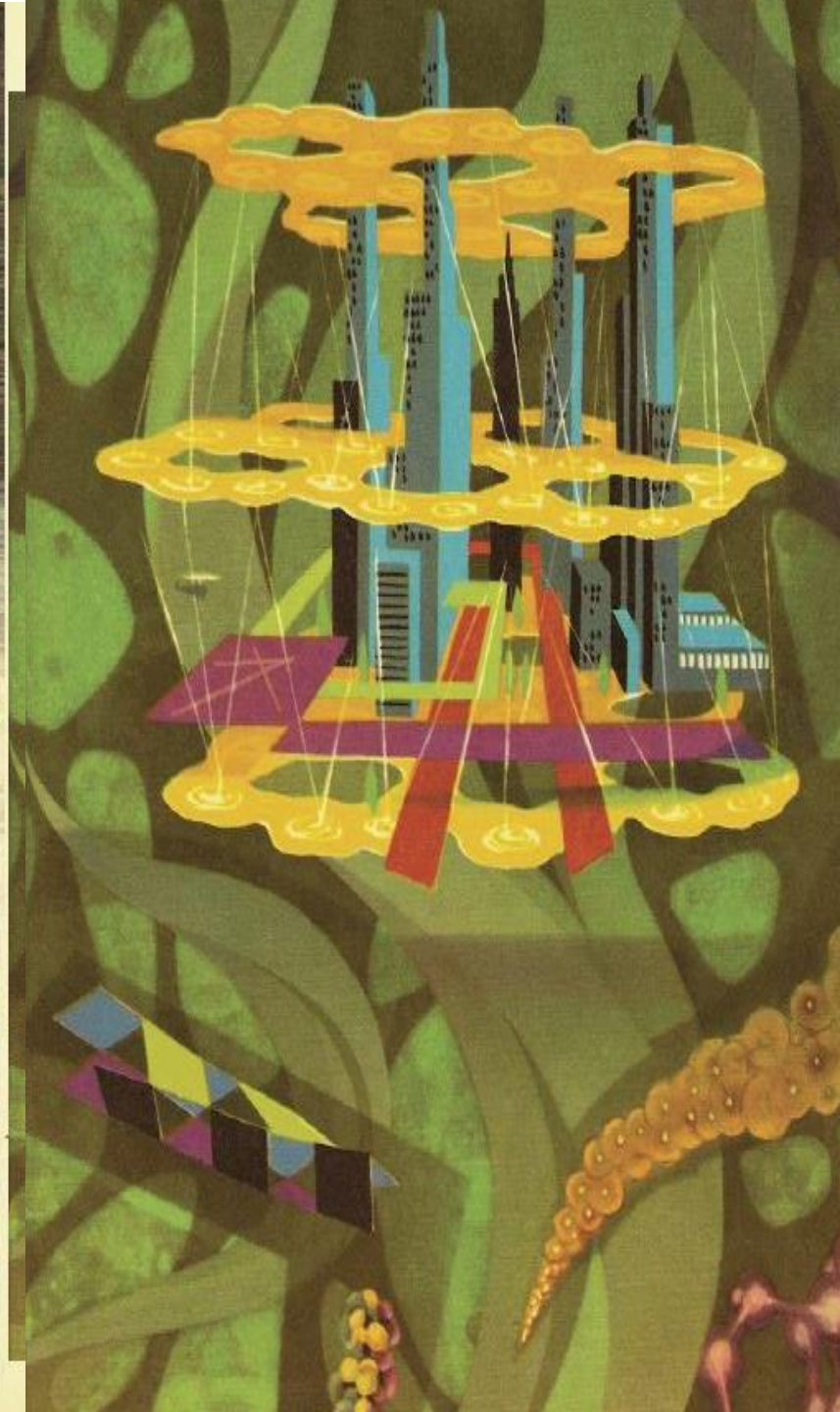
ATOMS FOR PEACE
A MOBILE EXHIBIT
PRESENTED BY...
UNITED STATES
ATOMIC ENERGY
COMMISSION

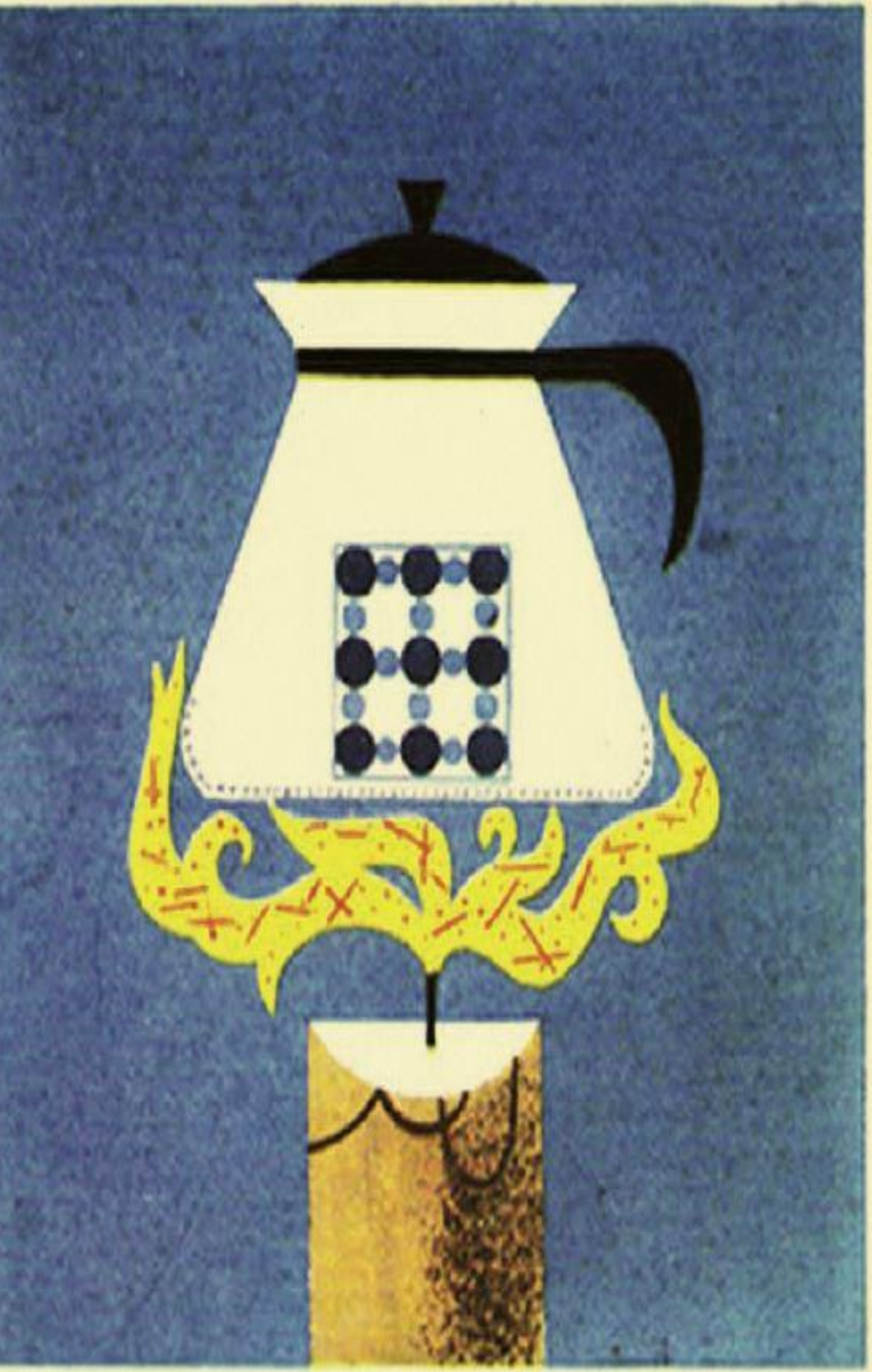
Walt Disney

OUR FRIEND THE ATOM

A Tomorrowland Adventure





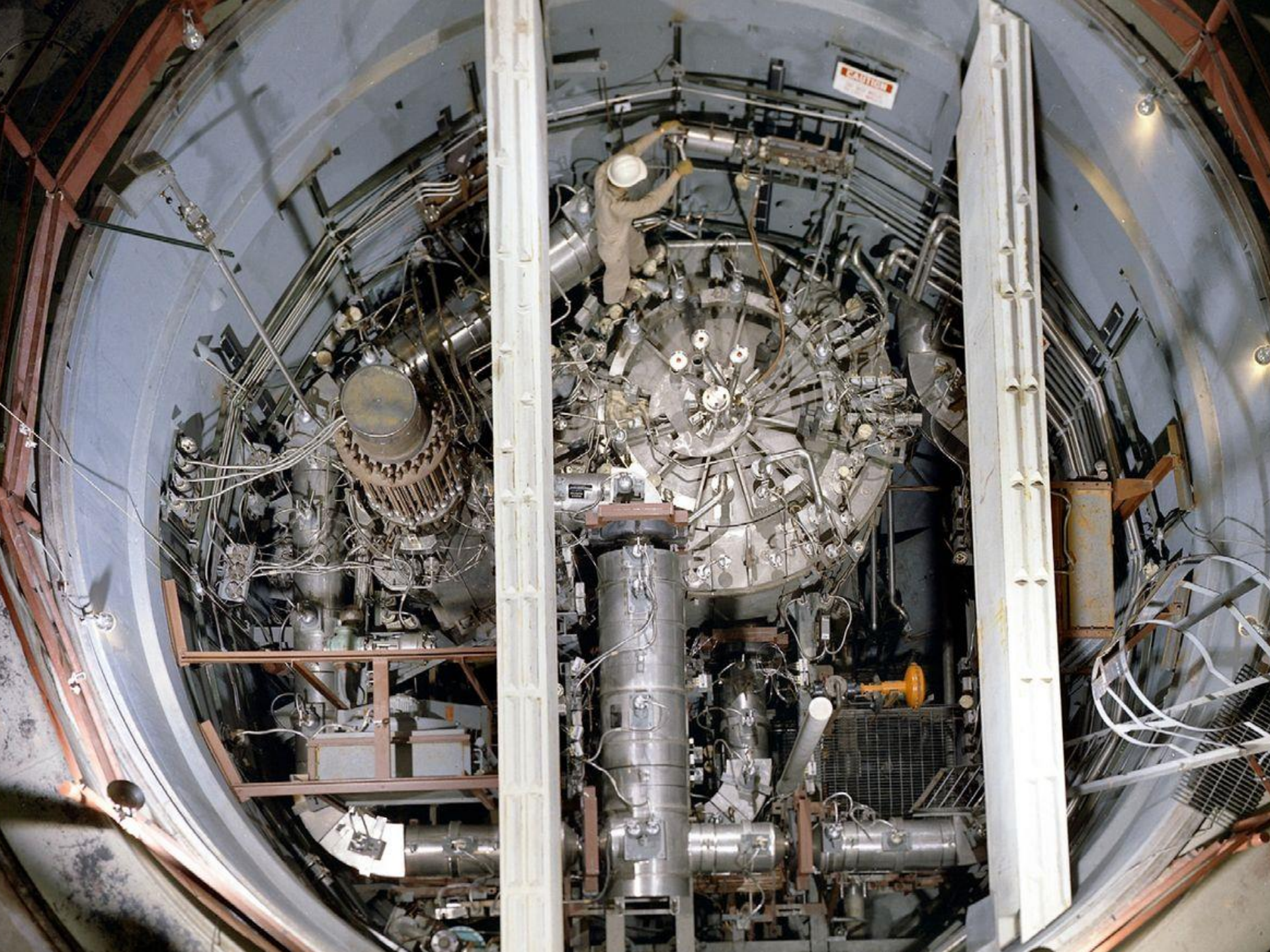


Beijing

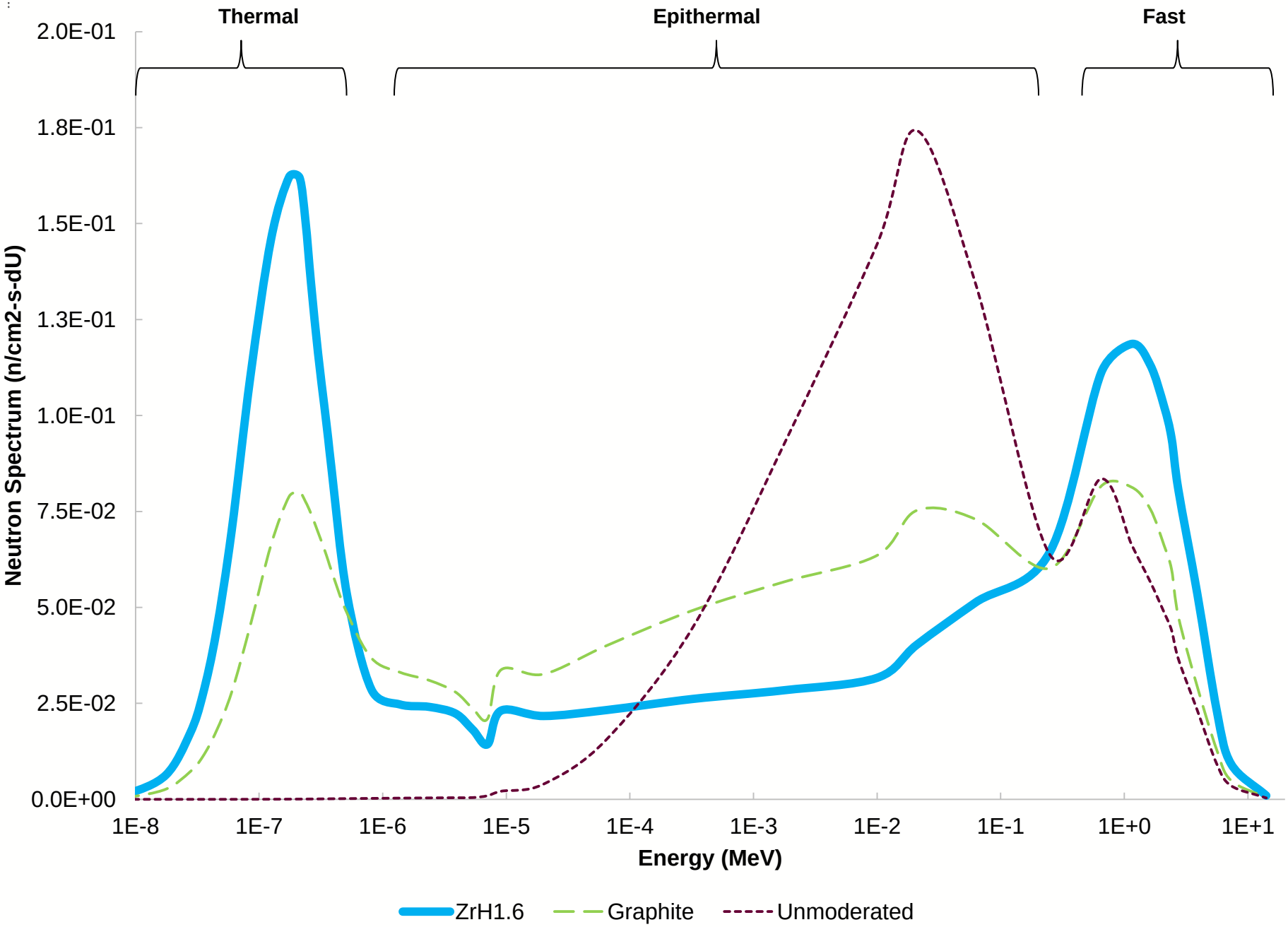
КОКОН БЛО
МБК
II
УКОЗЕО
КОКОН БЛО
МБК
II
УКОЗЕО

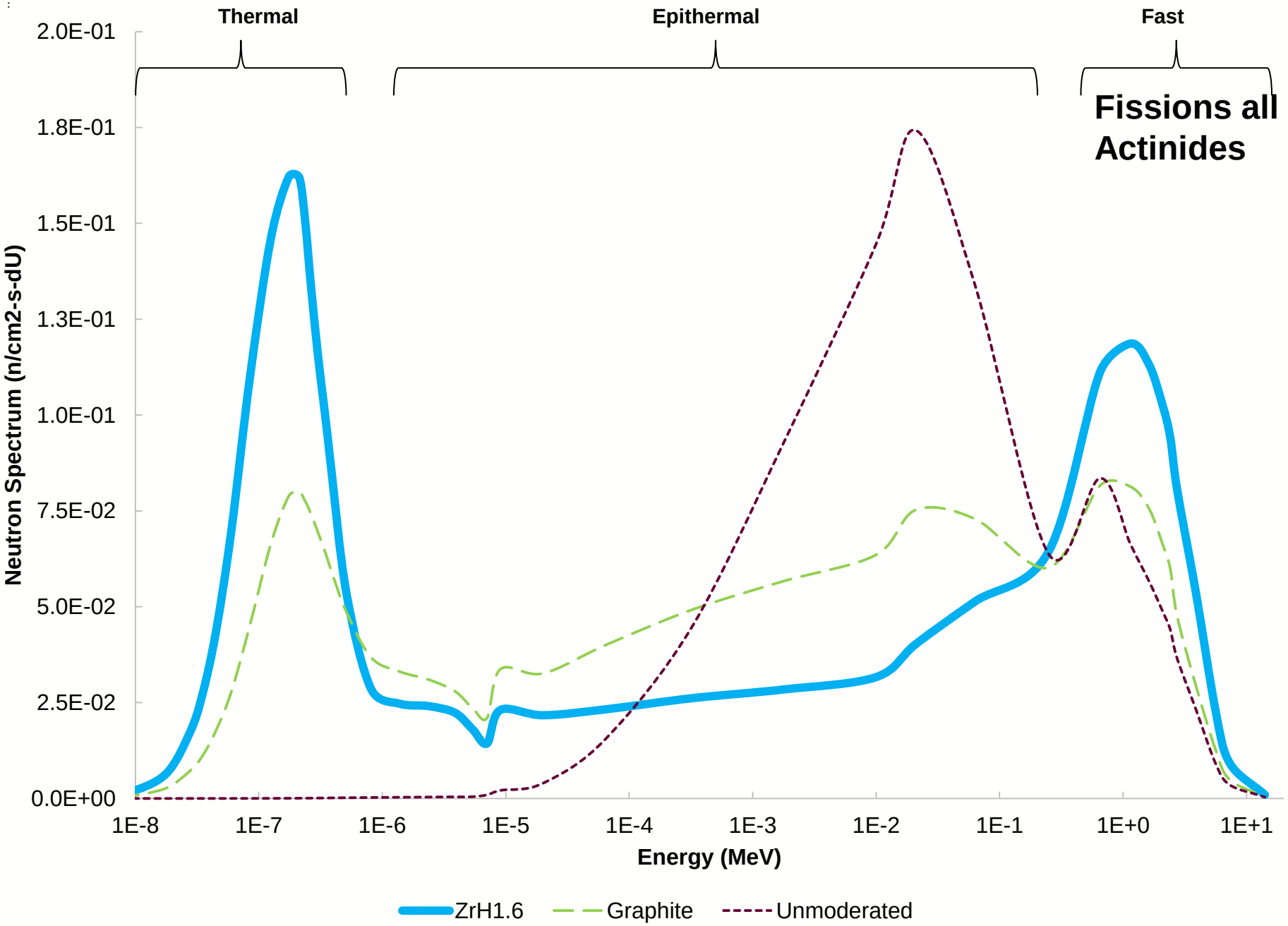
Molten Salt Nuclear Reactors

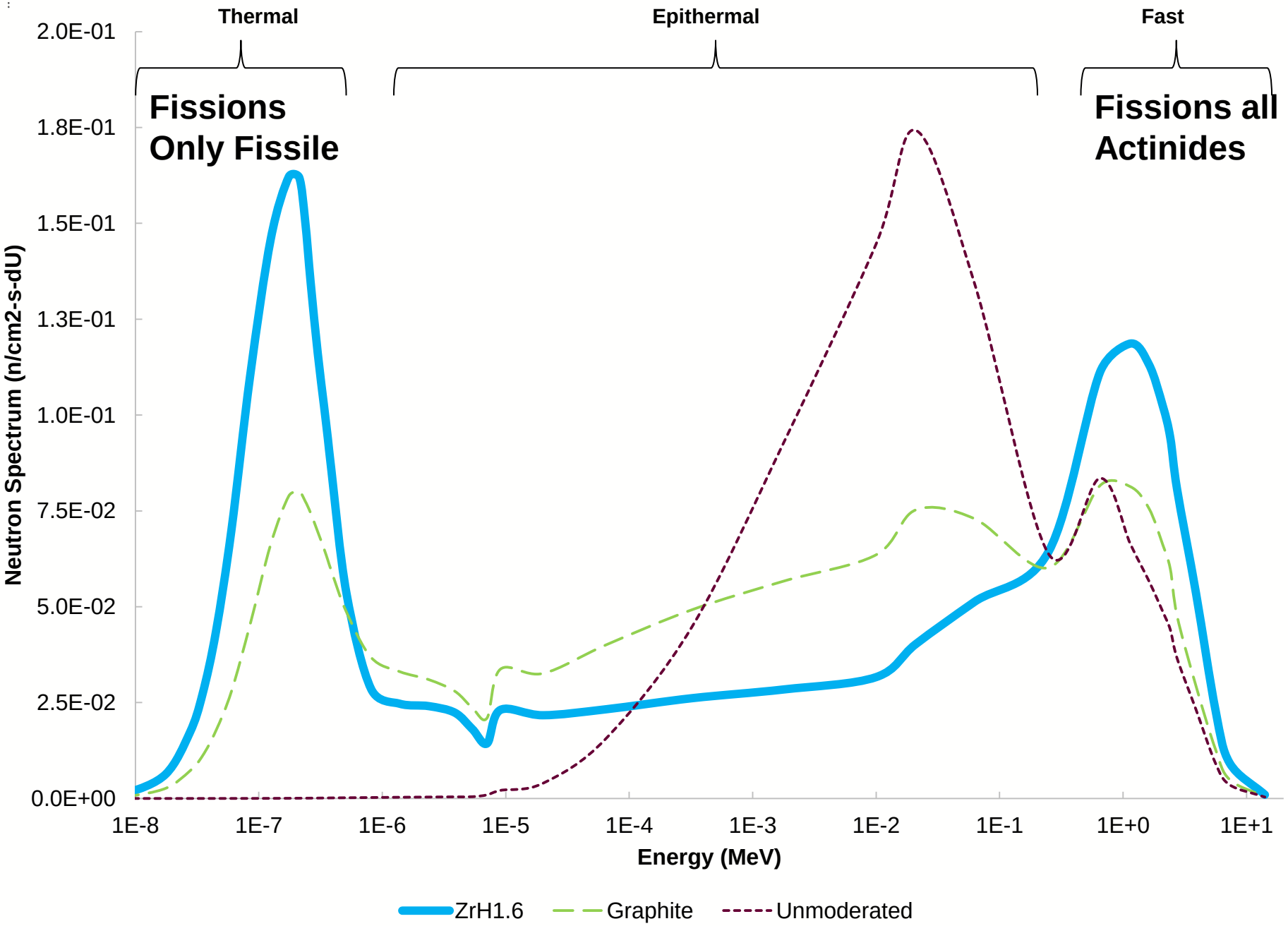
	SCWR Supercritical	VHTR Pebble-gas	MSR Molten salt	SFR Sodium fast	LFR Lead fast	GFR Gas fast
High Burnup						
Low Pressure						
Thermal Spectrum						

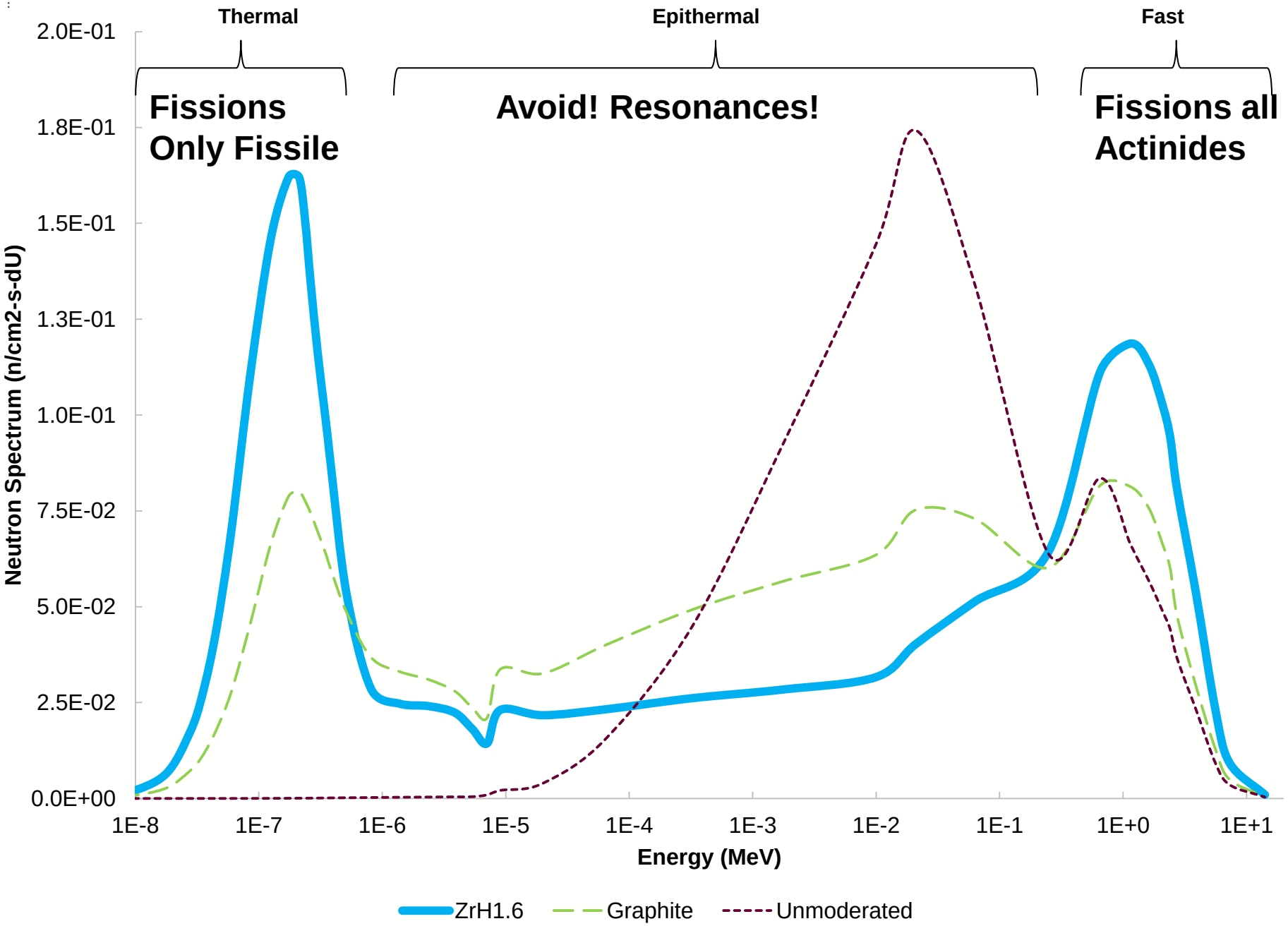


	1960's Design	Transatomic
MODERATOR	GRAPHITE	Zirconium Hydride
SALT	FLiBe+UF_4	LiF+UF_4
FUEL ENRICHMENT	33%-93%	1.8% or spent Fuel
POWER DENSITY (MW_{th}/m^3)	4	86


Thermal
Epithermal
Fast
2.0E-01
1.8E-01
1.5E-01
1.3E-01
1.0E-01
7.5E-02
5.0E-02
2.5E-02
0.0E+00
Neutron Spectrum (n/cm2-s-dU)
1E-8
1E-7
1E-6
1E-5
1E-4
1E-3
1E-2
1E-1
1E+0
1E+1
Energy (MeV)
ZrH1.6
Graphite
Unmoderated


Thermal
Epithermal
Fast
Fissions all Actinides
2.0E-01
1.8E-01
1.5E-01
1.3E-01
1.0E-01
7.5E-02
5.0E-02
2.5E-02
0.0E+00
Neutron Spectrum (n/cm2-s-dU)
1E-8
1E-7
1E-6
1E-5
1E-4
1E-3
1E-2
1E-1
1E+0
1E+1
Energy (MeV)
ZrH1.6
Graphite
Unmoderated


Thermal
Epithermal
Fast
Fissions
Only Fissile
Fissions all
Actinides
2.0E-01
1.8E-01
1.5E-01
1.3E-01
1.0E-01
7.5E-02
5.0E-02
2.5E-02
0.0E+00
Neutron Spectrum (n/cm2-s-dU)
1E-8
1E-7
1E-6
1E-5
1E-4
1E-3
1E-2
1E-1
1E+0
1E+1
Energy (MeV)
ZrH1.6
Graphite
Unmoderated

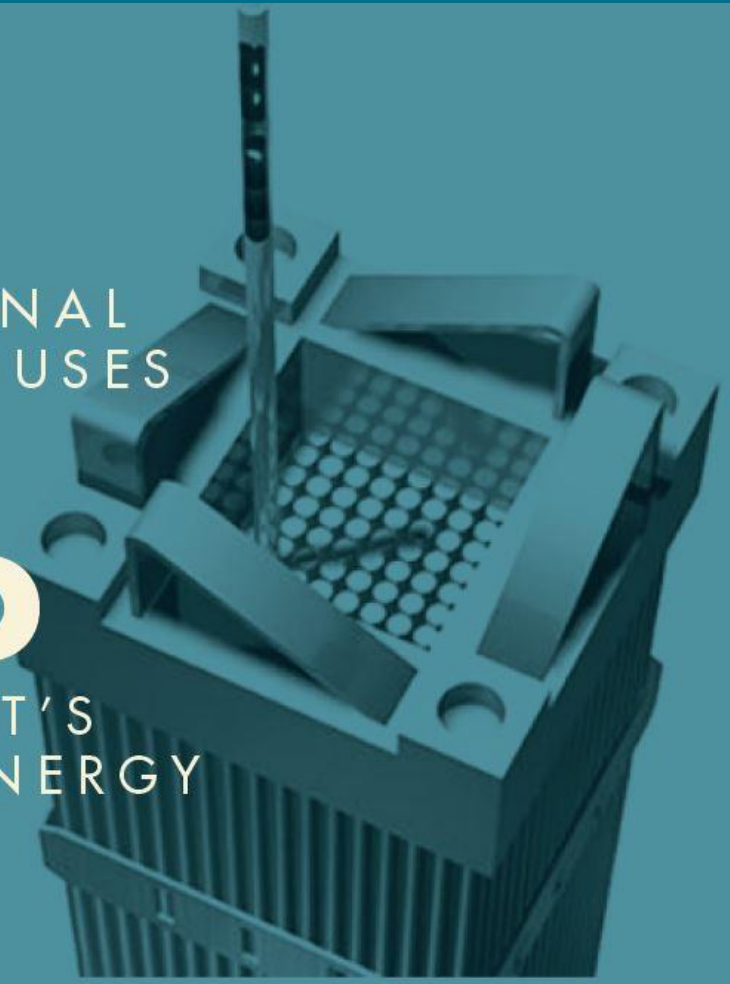

Thermal
Epithermal
Fast
Fissions
Only Fissile
Avoid! Resonances!
Fissions all
Actinides
2.0E-01
1.8E-01
1.5E-01
1.3E-01
1.0E-01
7.5E-02
5.0E-02
2.5E-02
0.0E+00
Neutron Spectrum (n/cm2-s-dU)
1E-8
1E-7
1E-6
1E-5
1E-4
1E-3
1E-2
1E-1
1E+0
1E+1
Energy (MeV)
ZrH1.6
Graphite
Unmoderated

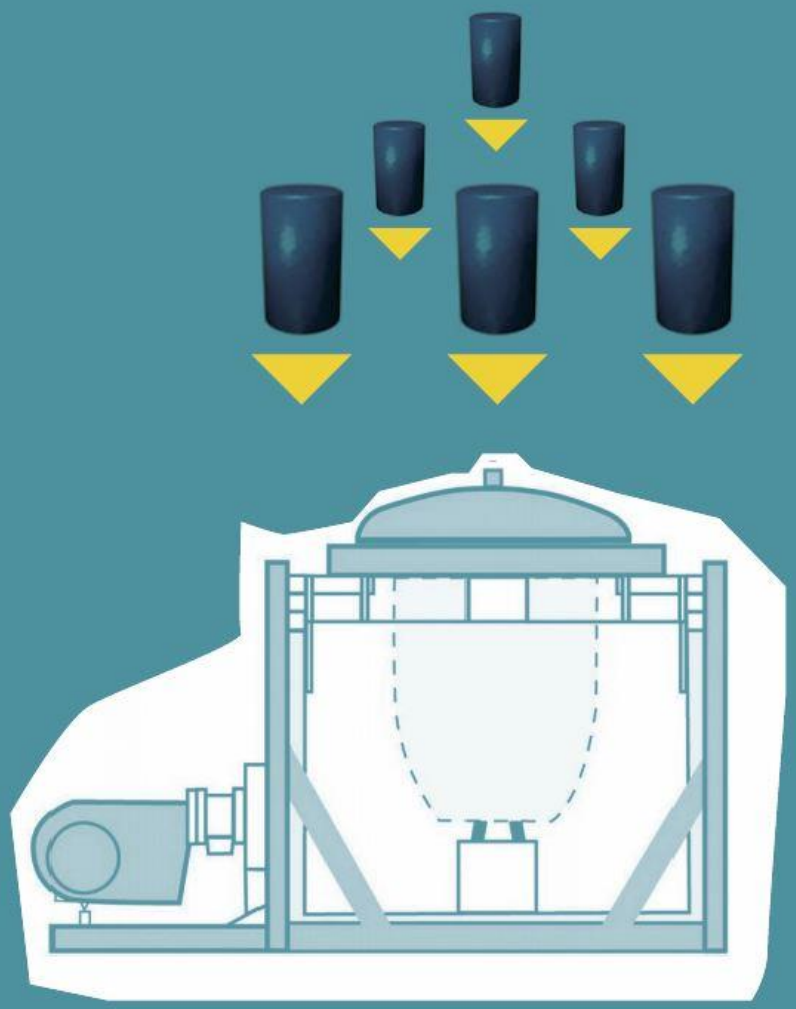
URANIUM PELLET

A CONVENTIONAL REACTOR ONLY USES

4%

OF THE PELLET'S POTENTIONAL ENERGY





Annual Long-lived Waste

CONVENTIONAL REACTOR

20,000 KG

(20 METRIC TONS)

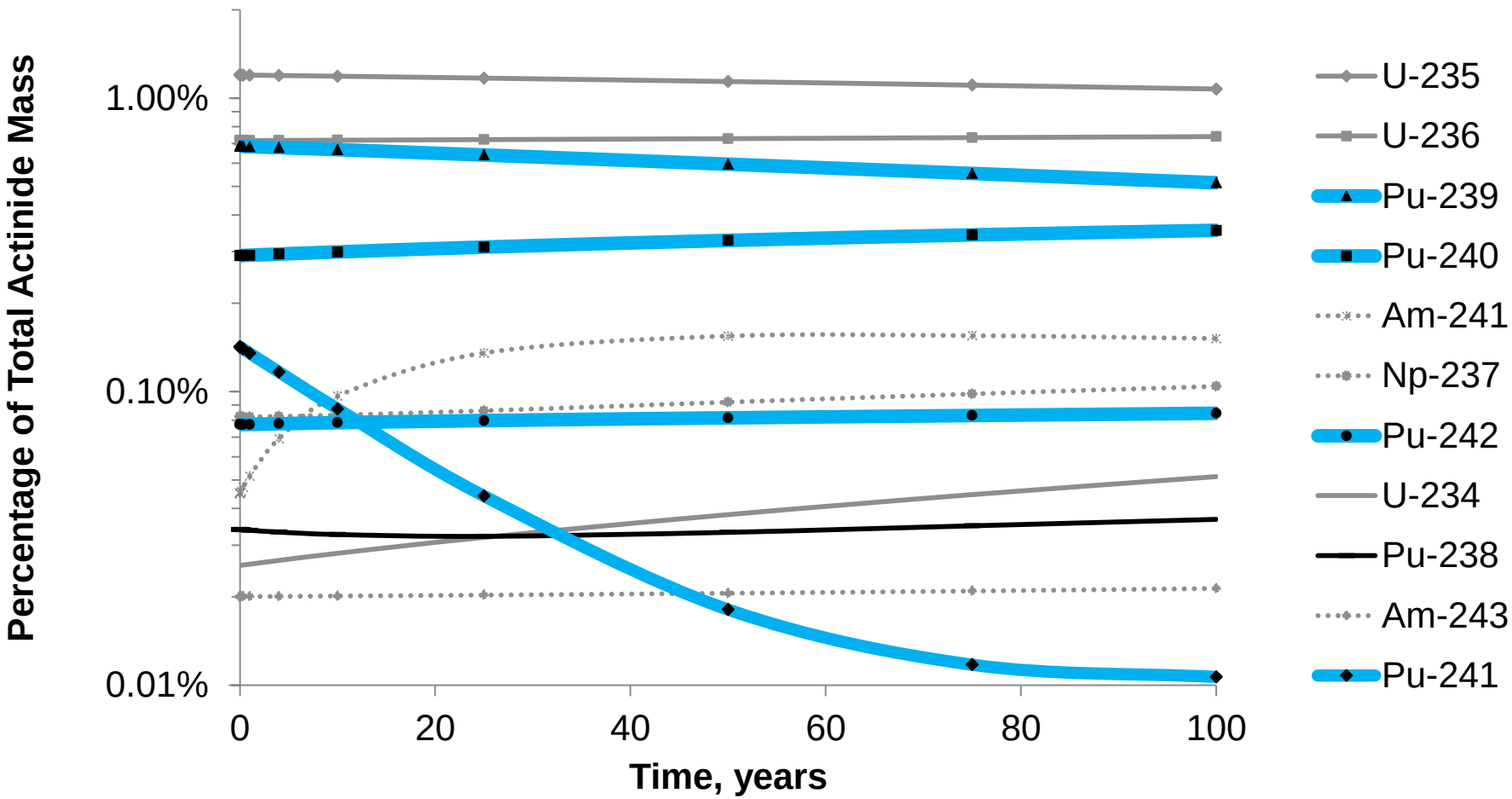
VS.

TRANSATOMIC

20 KG

TODAY WE CAN TURN
270,000
METRIC TONS OF WASTE INTO
72
YEARS OF POWER
FOR THE ENTIRE PLANET!

Actinide Mass Percentages



Isotopic mass percentages as a function of time. Uranium-238 is not included in this figure, as it is >95% of the mass of fuel at all times.

Key Personnel

Dr. Leslie Dewan
- PhD MIT Nuclear Science & Engineering
- SB MIT Nuclear Science & Engineering
- SB MIT Mechanical Engineering
- MIT Presidential Fellow
- DOE Computational Science Fellow
- Forbes 30 Under 30
- MIT Tech Review 35 Innovators Under 35
- TIME 30 Under 30

Ray Rothrock
- Chairman National Venture Capital Assoc.
- Venrock, Managing General Partner (ret)
- Has backed over 40 start-up companies
- Harvard MBA
- Yankee Electric Nuclear Engineer
- MS MIT Nuclear Science & Engineering
- SB Texas A&M Nuclear Engineering

Mark Massie
- Pending PhD MIT Nuclear Science & Engineering (Reactor Physics)
- MS MIT Nuclear Science & Engineering
- SB U. Tennessee Nuclear Engineering
- DOE Nuclear Engineering University Program Fellow
- DOE Advanced Fuel Cycle Initiative Fellow
- Has worked at ORNL
- Forbes 30 Under 30

Russ Wilcox
- Founder and CEO of E Ink Corp.
- Harvard MBA
- Harvard College Applied Mathematics
- E&Y New England Entrepreneur of the Year

Wendolyn Holland
- Holland Consulting
- Previous SRNL Director Strategic Development and Technical Partnerships
- DOE Senior Advisor for Commercialization, Energy Efficiency and Renewable Energy
- Kellogg MBA
- Yale University

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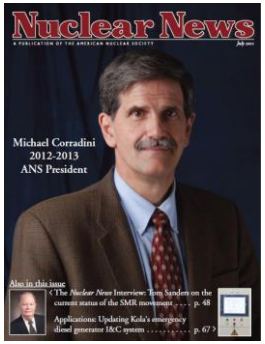
Prof. U. Wisconsin Nuclear Dept.
President of the ANS (‘12-’13)



Dr. Jess Gehin
Oak Ridge National Lab

Dr. Richard Lester
Department Head
MIT Nuclear Science & Engineering

Dr. Regis Matzie
Ex-CTO Westinghouse

NOTE: advisors serve in an individual capacity and do not represent their institutions

1
2
3
4
5

And beyond …

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A MOBILE EXHIBIT
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UNITED STATES
ATOMIC ENERGY
COMMISSION
EXIT
KINNEY

Transatomic Power

One Broadway, 14th Floor
Cambridge, MA 02142

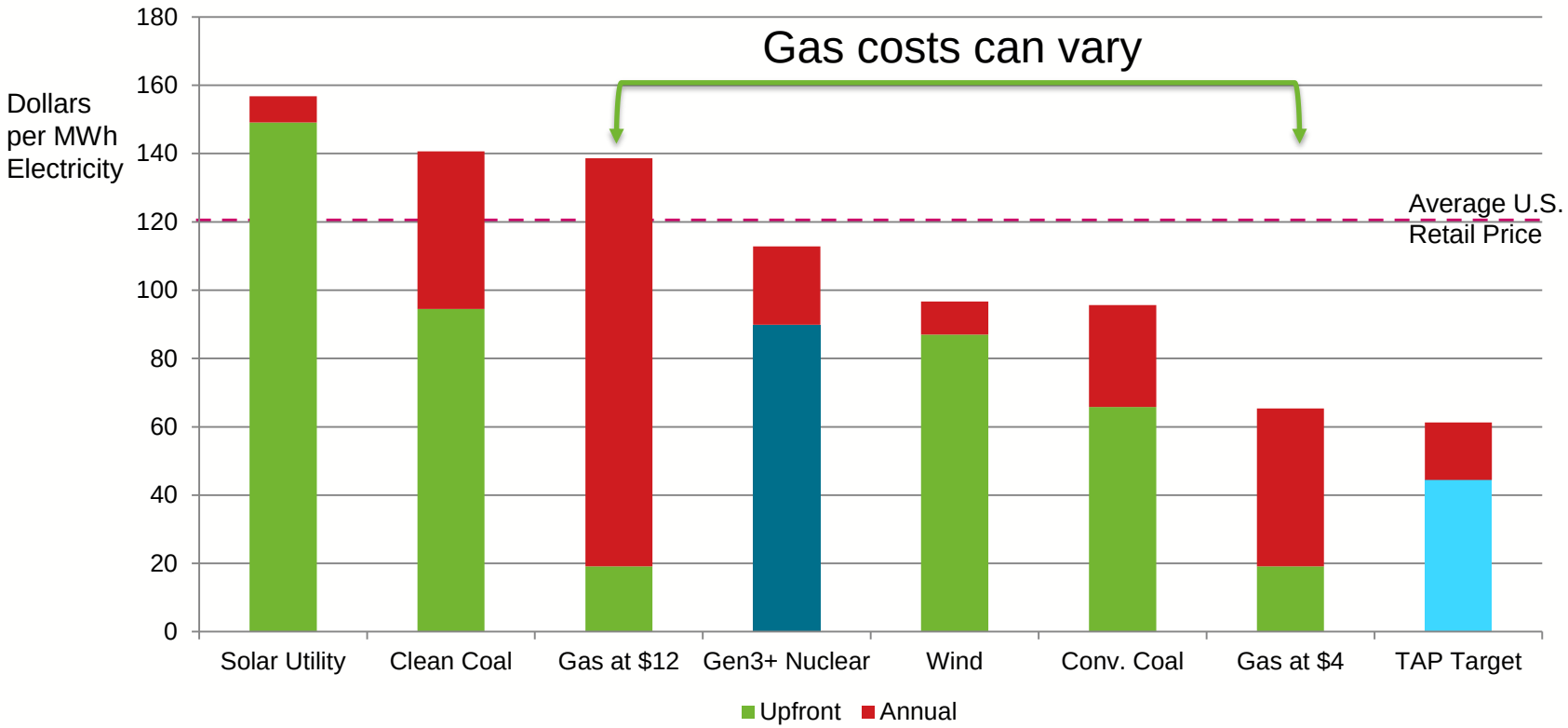
617-520-4850
http://www.transatomicpower.com/

Aux. Slides

Plant Characteristics

Reactor Type	Molten Salt Fueled Reactor
Fuel	Uranium or spent nuclear fuel (SNF)
Fuel Salt	**$LiF-UF_4$ based salt**
Moderator	**ZrH, clad with SiC-based composite**
Neutron Spectrum	Thermal
Thermal Capacity	1250 MWth
Gross Electric Capacity	550 MWe
Net Electric Capacity	**520 MWe**
Outlet Temperature	**650ºC**
Gross Thermal Efficiency	**44% using steam cycle with reheat**
Uranium Ore Utilization	75X higher per MW than LWR
Long-lived Actinide Waste	Up to 96% less per MW than LWR
Station Blackout Safety	Walkaway safe without outside intervention
Estimated Overnight Cost	**$1.7 billion**

Key Cost Win is Attainable: Cheaper than Coal



Transatomic Power benefits from (a) high conversion efficiency; (b) low pressure design; (c) low fuel expense; (d) size versatility; (e) load following capability.

Levelized Cost of Electricity EIA DOE Annual Energy Outlook for 2017; Transatomic Power
Bottom of bars is amortization of upfront capital; top of bars is the variable fuel and O&M expense.

Fission Product Removal

Fission Product	Removal Process	Approximate removal rate, kg per year	Waste Form
Kr, Xe, tritiated water vapor	Helium sparging via off-gas	100	Compressed, bottled gas
Zn, Ga, Ge, As, Se, Nb, Mo, Ru, Rh, Pd, Ag, Tc, Cd, In, Sn, Sb, Te	Plating and filtration, some removal via off-gas	200	Metallic
Zr	Molten salt / liquid metal extraction	200	Solid oxides
Ni, Fe, Cr			
Np, Pu, Am, Cm (trace)			
Y, La, Ce, Pr, Nd, Pm, Gd, Tb, Dy, Ho, Er, Sm, Eu			
Sr, Ba, Rb, Cs			

Annual kg of Pu in waste is orders of magnitude less than LWR

Greatly constrains waste Pu as a proliferation risk

Radionuclide Inventory Comparison

Chemical Group	Elements in the Group	Peach Bottom Unit 3 (1138 MWe BWR), kg per 100 MWe		Sequoyah Unit 1 (1148 MWe PWR), kg per 100 MWe		TAP Reactor (520 MWe MSR), kg per 100 MWe*
		LBU	HBU	LBU	HBU	
Noble Gases	Kr, Xe	32	77	26	45	<0.1
Halogens	Br, I	1	3	1	2	<0.1
Alkali Metals	Rb, Cs	18	44	14	25	3
Tellurium Group	Se, Sb, Te	3	7	2	4	<0.1
Alkaline Earths	Sr, Ba	14	33	11	19	8
Noble Metals	Co, Mo, Tc, Ru, Rh, Pd	44	112	18	32	<0.1
Lanthanides**	Y, Nb, La, Pr, Nd, Pm, Sm, Eu, Am, Cm	43	109	34	61	22
Cerium Group	Zr, Ce, Np, Pu	106	201	85	126	137
Total in Primary Loop (kg per 100 MWe)		261	586	191	314	170
Total in Primary Loop (kg in entire loop)		2968	6665	2196	3600	884

** Steady-state values in the primary loop, assuming fission product removal as described in Section 2.6.3.*
*** By convention in NUREG-1246, Cm and Am are placed in the lanthanide group.*

Defense in Depth – Inherent Safety

	1 GWe LWR	520 MWe TAP
Negative Void Coefficient	Yes	Yes
Negative Temperature Coefficient	Yes	Yes
Moderator Failsafe	Water drains or boils off	Moderator rods lose function at high heat due to marginal loss of hydrogen
Radionuclide Inventory	2-7 tons in primary loop	<1 ton in primary loop
Driving Force / System Pressure	150 atmospheres	1 atmosphere
Driving Force / Coolant	Peak fuel temperature is 1900°C above coolant boiling point; steam explosion risk	Peak fuel temperature is 500°C below boiling point; wide safety margin
Driving Force / Runaway Exothermic Hydrogen Generation	Peak fuel temp is 800°C above exothermic generation point; fire explosion risk	Peak fuel temperature is 500°C below exothermic generation point; wide safety margin; no water in core

Defense in Depth – Physical Barriers

	LWR	TAP
Fuel Material Barrier	Oxide matrix	Salt carrier solidifies <500°C
Cladding Barrier	Zirconium cladding	--
Vessel and Cooling Boundary	Stainless steel vessel and heat exchanger	Hastelloy-N vessel and heat exchanger
Auxiliary Tank	--	Freeze plug passively drains fuel to underground auxiliary tank
Primary Containment Structure	Yes	Yes
Catch Basin and Intermediate Loop	Usually none	Yes
Secondary Containment Structure	Yes	Yes
Exclusion Zone	Yes	Yes