Advanced Nuclear Technology Helping Energize Mankind

Representative Dick Stein

Sponsor Testimony

June 18, 2019

Evolution of Nuclear Power

Generation I

Early Prototypes

- Shippingport
- Dresden
- Magnox

Generation II

Commercial Power

- PWRs
- BWRs
- CANDU

Generation III

Advanced LWRs

- CANDU 6
- System 80+
- AP600

Generation III+

Evolutionary Designs

- ABWR
- ACR1000
- AP1000
- APWR
- EPR
- ESBWR

Generation IV

Revolutionary Designs

- Safer
- Sustainable
- Economical
- More Proliferation Resistant and Physically Secure

1950 1960 1970 1980 1990 2000 2010 2020 2030

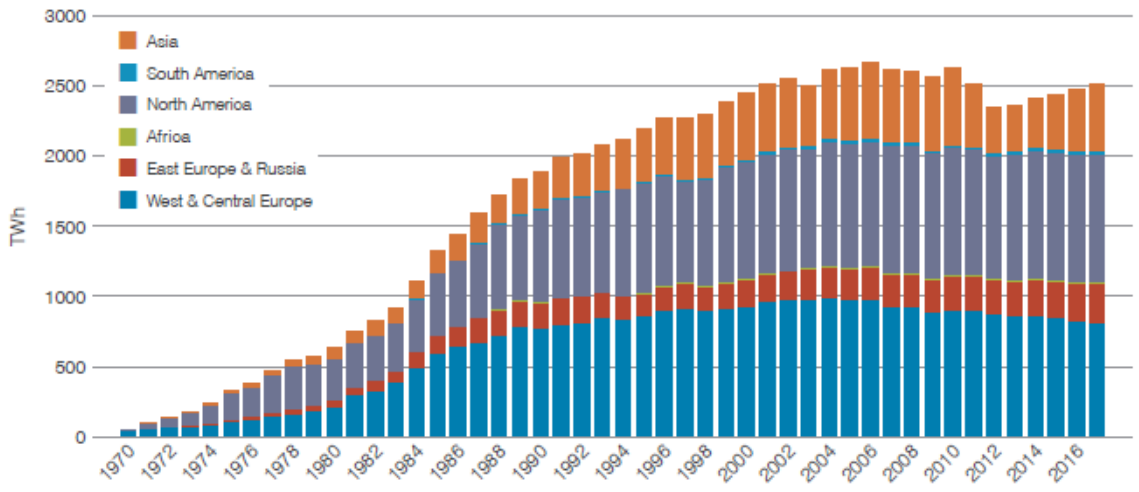
Gen I | Gen II | Gen III | Gen III+ | Gen IV

Nuclear Development Trends

2.1 Global highlights

Nuclear reactors generated a total of 2506 TWh of electricity in 2017, up from 2477 TWh in 2016. This is the fifth successive year that nuclear generation has risen, with output 160 TWh higher than in 2012.

Figure 1. Nuclear electricity production



Source: World Nuclear Association and IAEA Power Reactor Information Service (PRIS)

2.3 New construction

With four construction starts, two reactor construction cancellations and four reactors being grid connected, the total number of reactors under construction fell by two to 59 over the course of 2017.

Table 3. Reactors under construction by region year-end 2017 (change since 2016)

	BWR	FNR	HTR	PHWR	PWR	Total
Asia	4	1	1	4	30	40
East Europe & Russia					11	11
North America					2 (-2)	2 (-2)
South America					2	2
West & Central Europe					4	4
Total	4	1	1	4	49 (-2)	59 (-2)

Source: World Nuclear Association, IAEA PRIS

The four construction starts in 2017 are listed in Table 4.

Energy Density

"Nuclear is ideal for dealing with climate change, because it is the only carbon-free, scalable energy source that's available 24 hours a day."
-Bill Gates, 2018

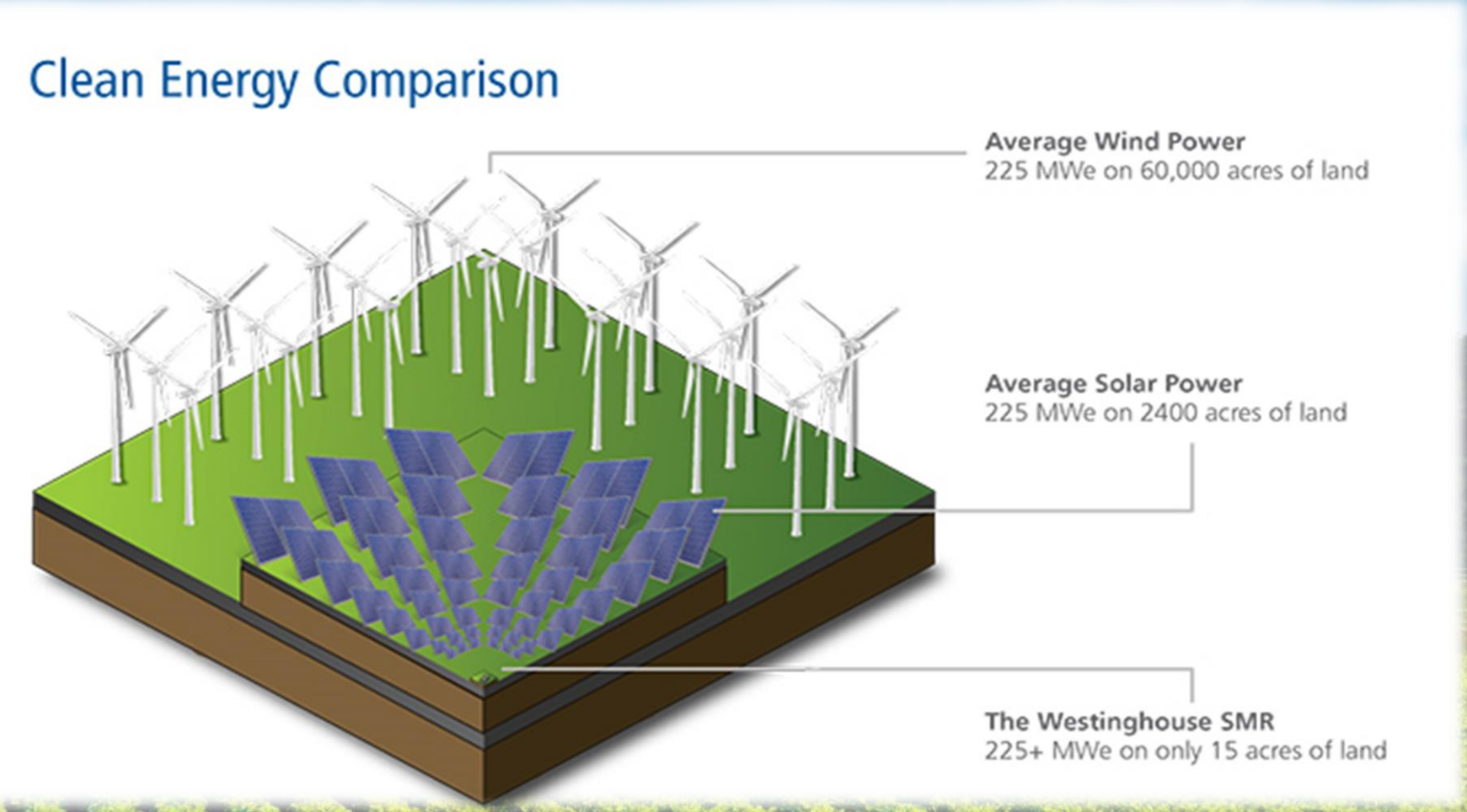
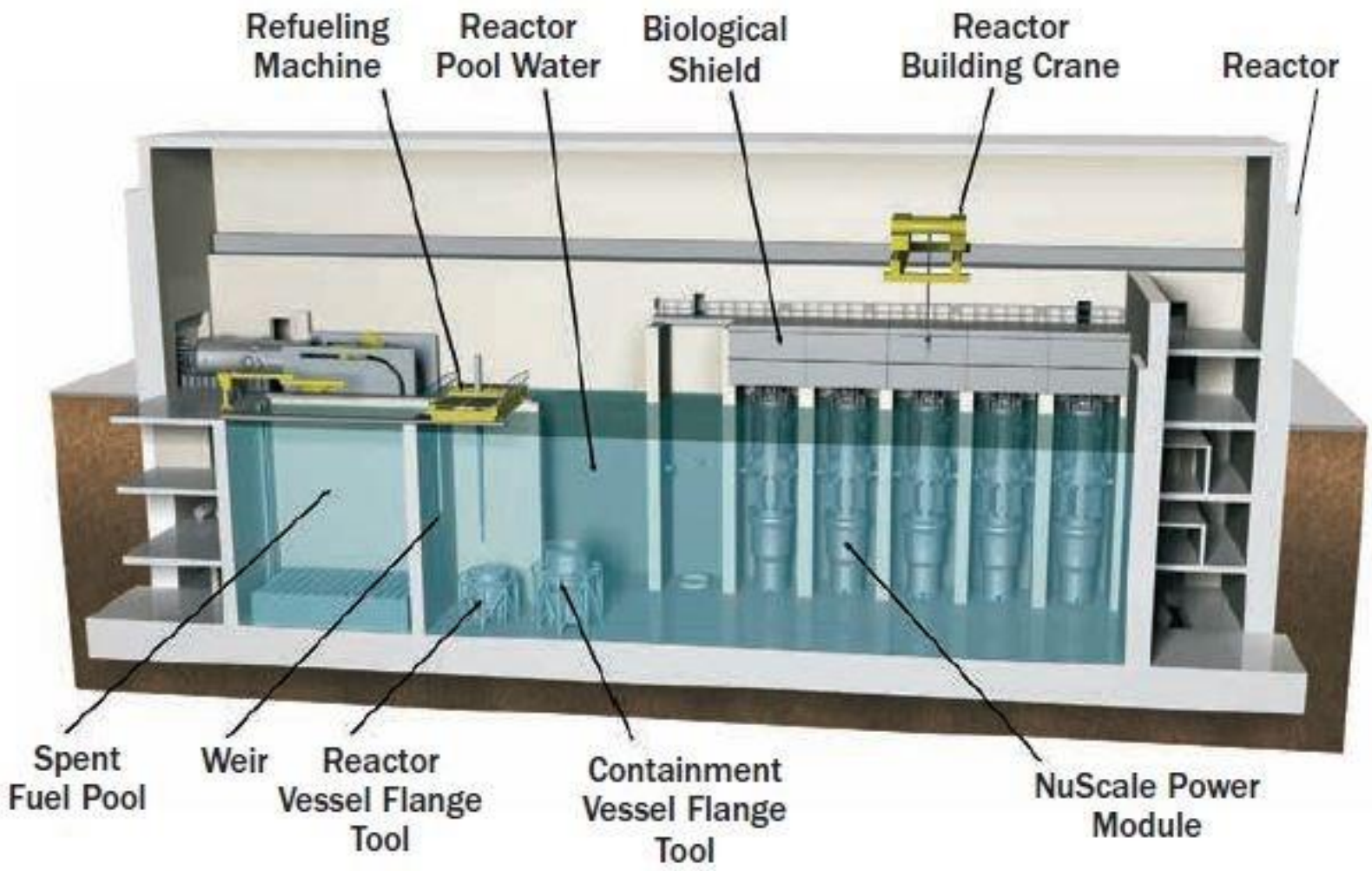


FIGURE 5

Cut-Away View of the NuScale Power Reactor Building



Source: © NuScale Power, LLC

"Given this challenge we face today, and given the progress of fourth generation nuclear: go for it. No other alternative, zero emissions."
–John Kerry, 2017

"The new goal is to move to a sustainable energy future and we want to use things like hydro, solar, wind, geothermal, nuclear is also a good option in places…which are not subject to natural disasters, and we want to use energy sources that will be good for a billion years." **–Elon Musk, 2015**

HOW DO SMRS WORK?

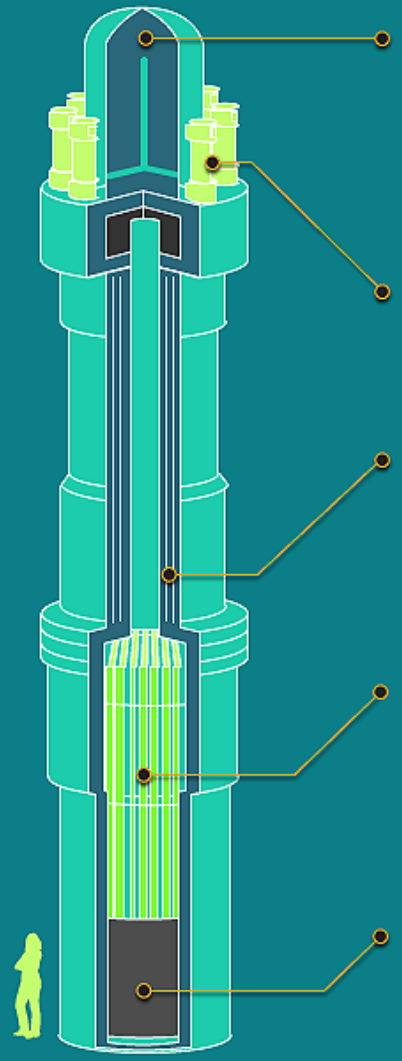
1. **Nuclear power plants generate heat through nuclear fission.** The process begins in the reactor core. Atoms are split apart – releasing energy and producing heat as they separate into smaller atoms. The process repeats again and again through a fully controlled chain reaction.

2. **Control rods made of neutron-absorbing material are inserted into the core to regulate the amount of heat generated by the chain reaction.**

3. **Reactor coolant water picks up heat from the reactor core.** Reactor coolant pumps circulate this hot water through a steam generator, which converts water in a secondary loop into steam.

4. **The steam is used to drive a turbine,** which generates electricity.

5. Throughout the process, **the pressurizer keeps the reactor coolant water under high pressure** to prevent it from boiling.



Pressurizer
Keeps reactor coolant water under high pressure to prevent it from boiling.

Reactor Coolant Pumps
Circulate the reactor's coolant.

Steam Generator
Converts water in a secondary loop into steam to drive a turbine that generates electricity.

Control Rods
Used to control the power of a nuclear reactor, including shutting down the reaction.

Core
The "heart" of the reactor -- where heat is generated by nuclear fission.

Battelle
The Business of Innovation

CURTISS WRIGHT

B&W

EWI®
We Manufacture Innovation

AT&F
WE INVEST IN CUSTOMER SUCCESS®

LINCOLN ELECTRIC


AECON


Tioga


moltex energy
safer, cheaper, cleaner


CardinalHealth
Essential to care™


Helion Energy


orano


Numerex™


NUSCALE


TRANSATOMIC


Flibe
ENERGY


tae
TECHNOLOGIES


MIFTI

STARCORE
NUCLEAR

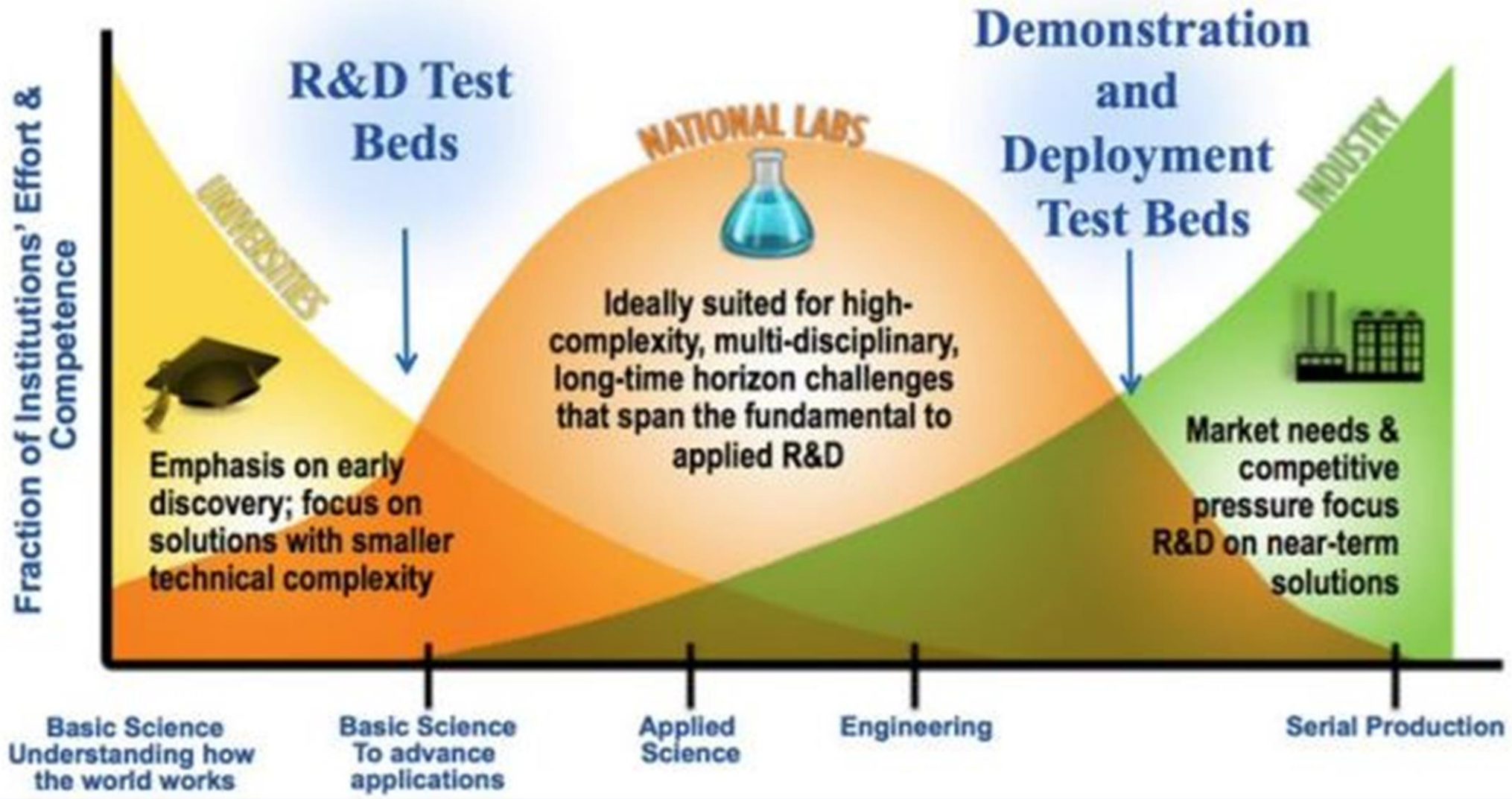

TerraPower


generalfusion

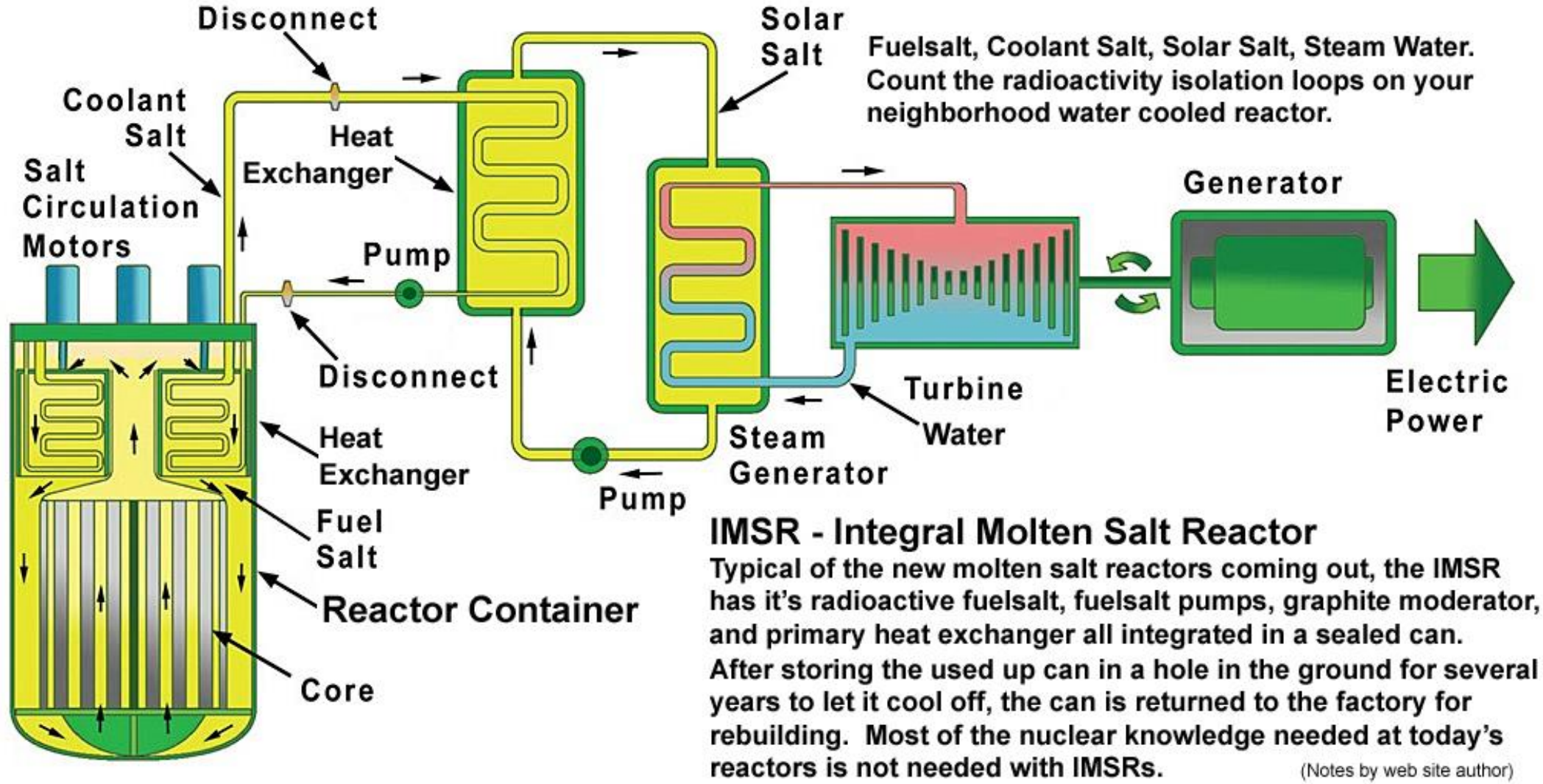

TERRESTRIAL
ENERGY


ELYSIUM
INDUSTRIES INC

Bridging the "Valleys of Death"



IMSR cans are typically used up like a battery in 4 to 7 years and swapped out for a fresh can.



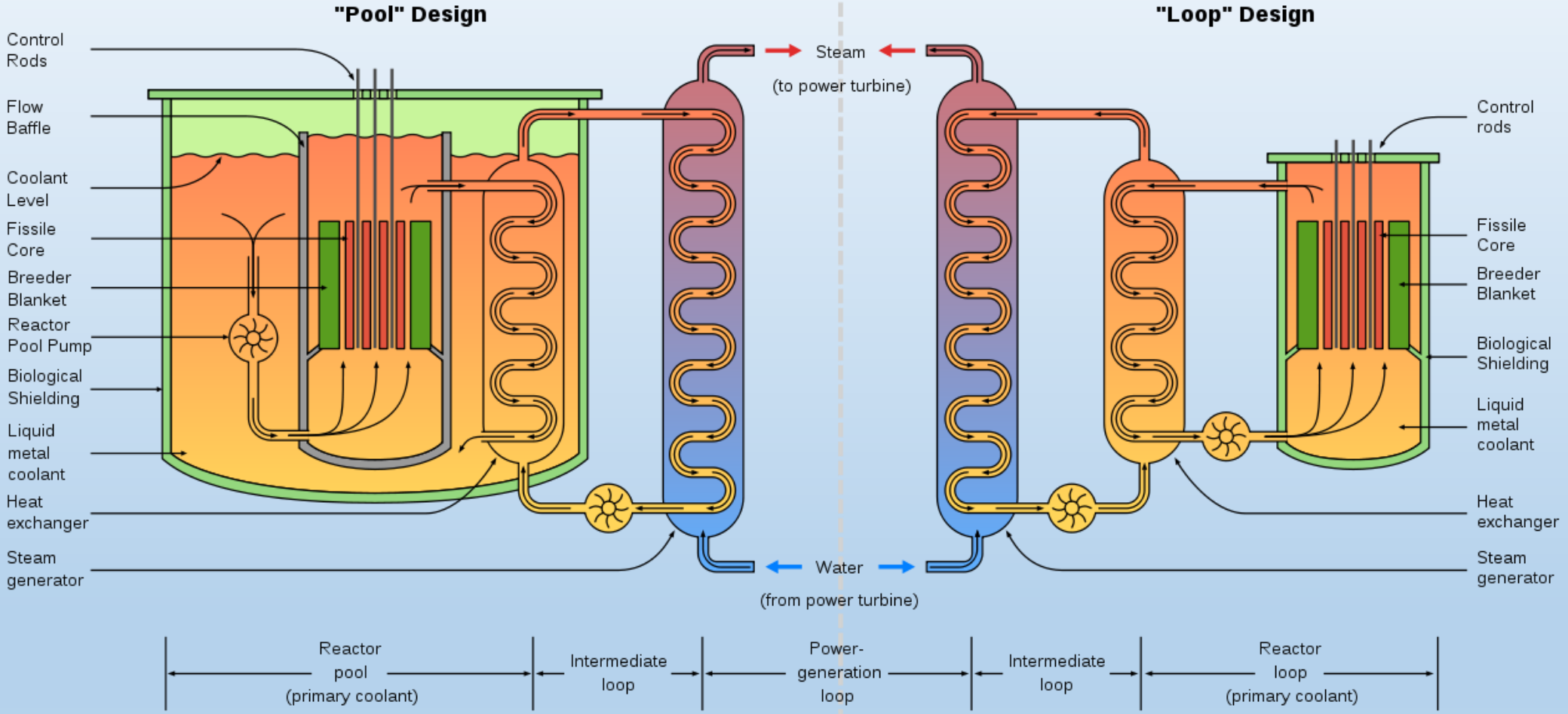
IMSR - Integral Molten Salt Reactor

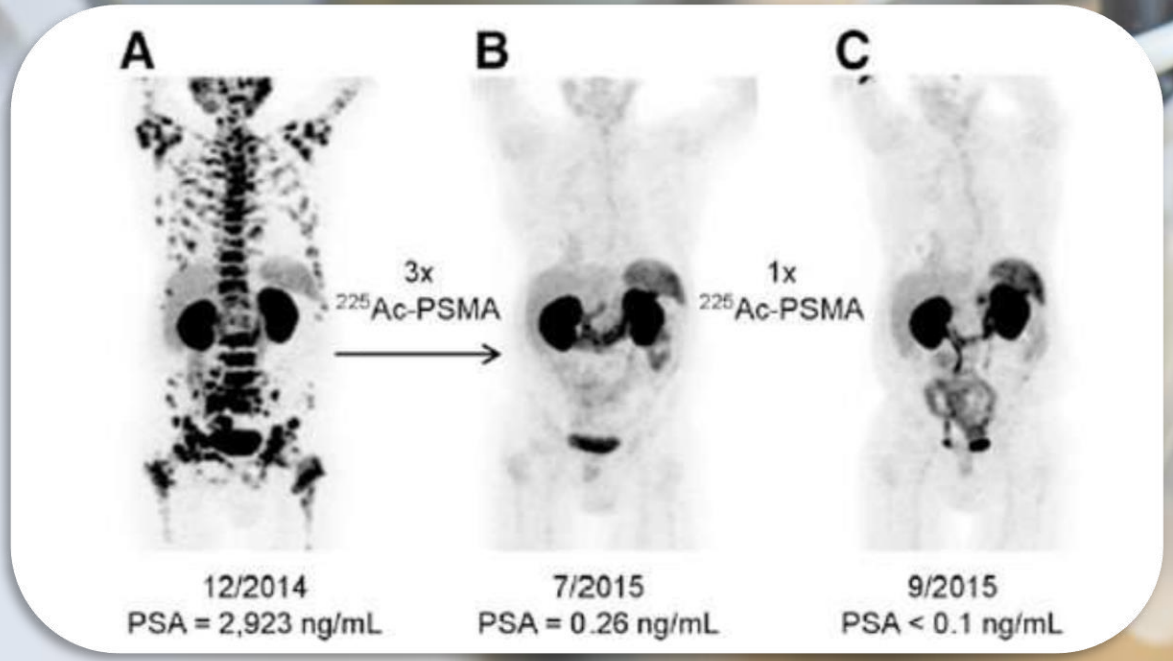
Typical of the new molten salt reactors coming out, the IMSR has it's radioactive fuelsalt, fuelsalt pumps, graphite moderator, and primary heat exchanger all integrated in a sealed can. After storing the used up can in a hole in the ground for several years to let it cool off, the can is returned to the factory for rebuilding. Most of the nuclear knowledge needed at today's reactors is not needed with IMSRs. (Notes by web site author)

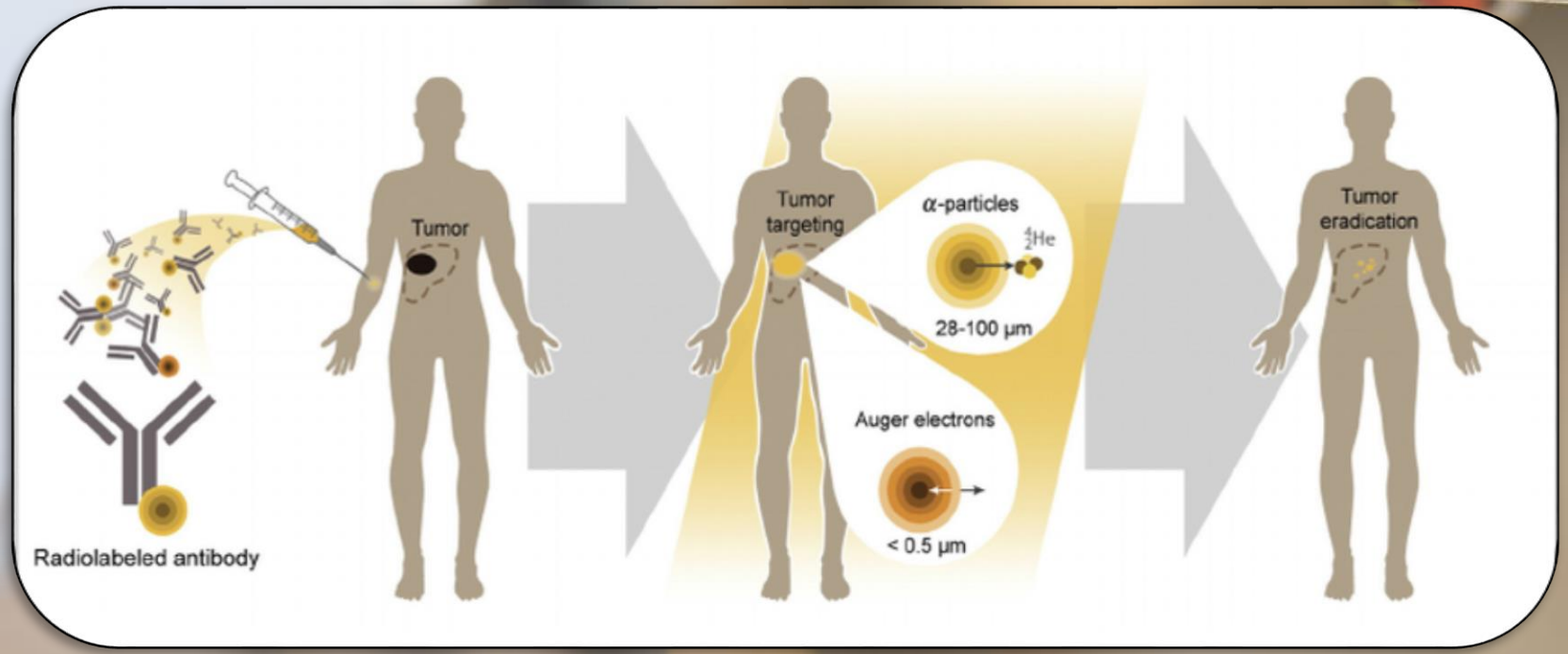
Molten Salt Reactor Power Station Basic Component Schematic

Terrestrial Energy

Liquid Metal cooled Fast Breeder Reactors (LMFBR)




A
B
C
3x
225Ac-PSMA
1x
225Ac-PSMA
12/2014
PSA = 2,923 ng/mL
7/2015
PSA = 0.26 ng/mL
9/2015
PSA < 0.1 ng/mL


Tumor
Radiolabeled antibody
Tumor targeting
α-particles
4/2He
28-100 µm
Auger electrons
< 0.5 µm
Tumor eradication

National Attention

- **Nuclear Energy Leadership Act**, March 27, 2019
- **Sen Lisa Murkowski, "We once led the world in nuclear energy, but have surrendered that position to Russia and China. It is imperative that we reverse that trend and develop advanced nuclear technologies domestically."**
- **Sen Cory Booker, "This bipartisan bill will spur development of demonstration projects at the Department of Energy, which could become an important source of carbon free electricity generation."**
- **The narrative is changing for nuclear.**

Thank you for your attention.