Chapman Nuclear

ENERCOM Conference 2024

Hybrid Fusion Power Plants

John Eric Chapman

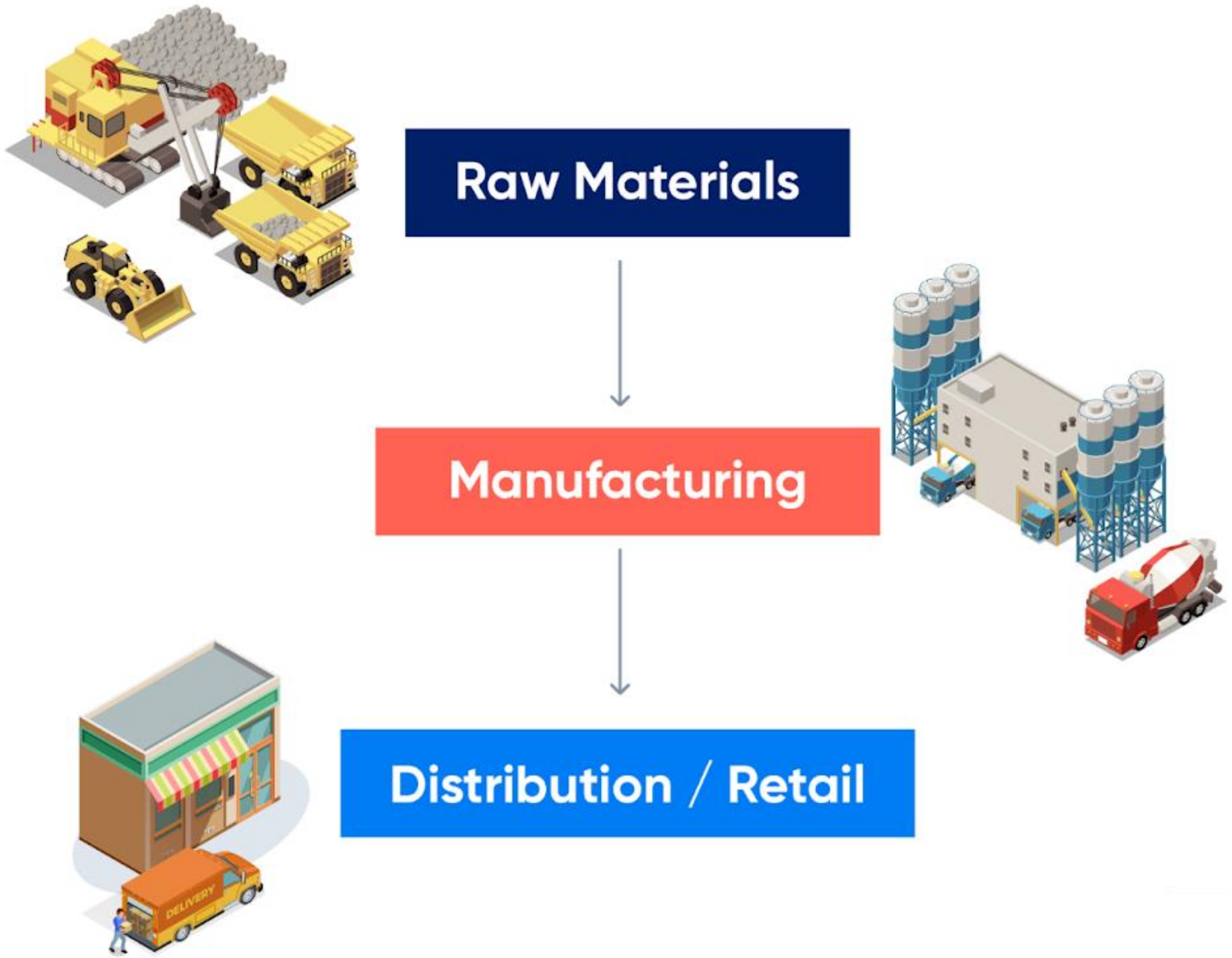
August 2024

Chapman Nuclear

Vertically integrated Fusion Power Company

John Eric Chapman

February 2024



Collaborative Leadership Team

John Chapman

CEO of Chapman Nuclear with 15+ years of experience commercializing industrial innovations for 6 different start-ups spread across every industrial vertical. John is a 3rd generation nuclear worker with a multi-disciplined background focused on qualifying new nuclear equipment

Talmon Firestone

20+ Years of experience in both the fusion and defense industries.
As co-founder & CEO of Astral Systems in the 1990s, Talmon draws upon decades of experience in commercialization of fusion technologies and driving projects

Milton O'Blanc

Forty-seven years of experience in the O&G industry. Milton is an expert in the management and execution of 15 O&G facilities. O&G focus on design, fabrication, installation, maintenance and operations of - oil & gas (onshore & offshore – upstream – midstream – downstream)

Chapman Nuclear

Collaborative Advisement Team

Lawrence Forsley

Senior lead experimental physicist with NASA GRC, research fellow at the University of Texas, Austin, and CTO of Global Energy Corporation.

Dr. Mahmoud Bakr

PhD in Energy Science from Kyoto University and has been involved in R&D for particle generation applications, fusion technology, and advanced nuclear systems design for two decades.

Dr Tom Wallace Smith

As the leading co-inventor the MSF fusion technology, his role is critical in steering the technical aspects of the reactor development

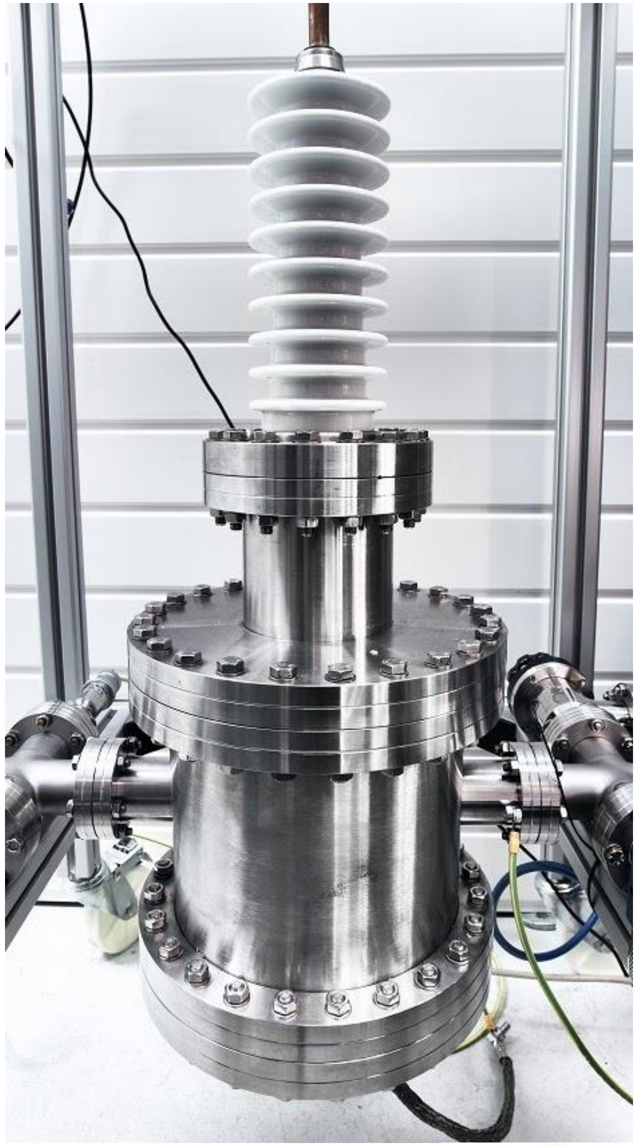
Dr Volo Gulik

Lead nuclear engineer for the Institute for Safety Problems of Nuclear Power Plants NAS of Ukraine, Sector for Materials and Modeling for Nuclear Facilities

Chapman Nuclear

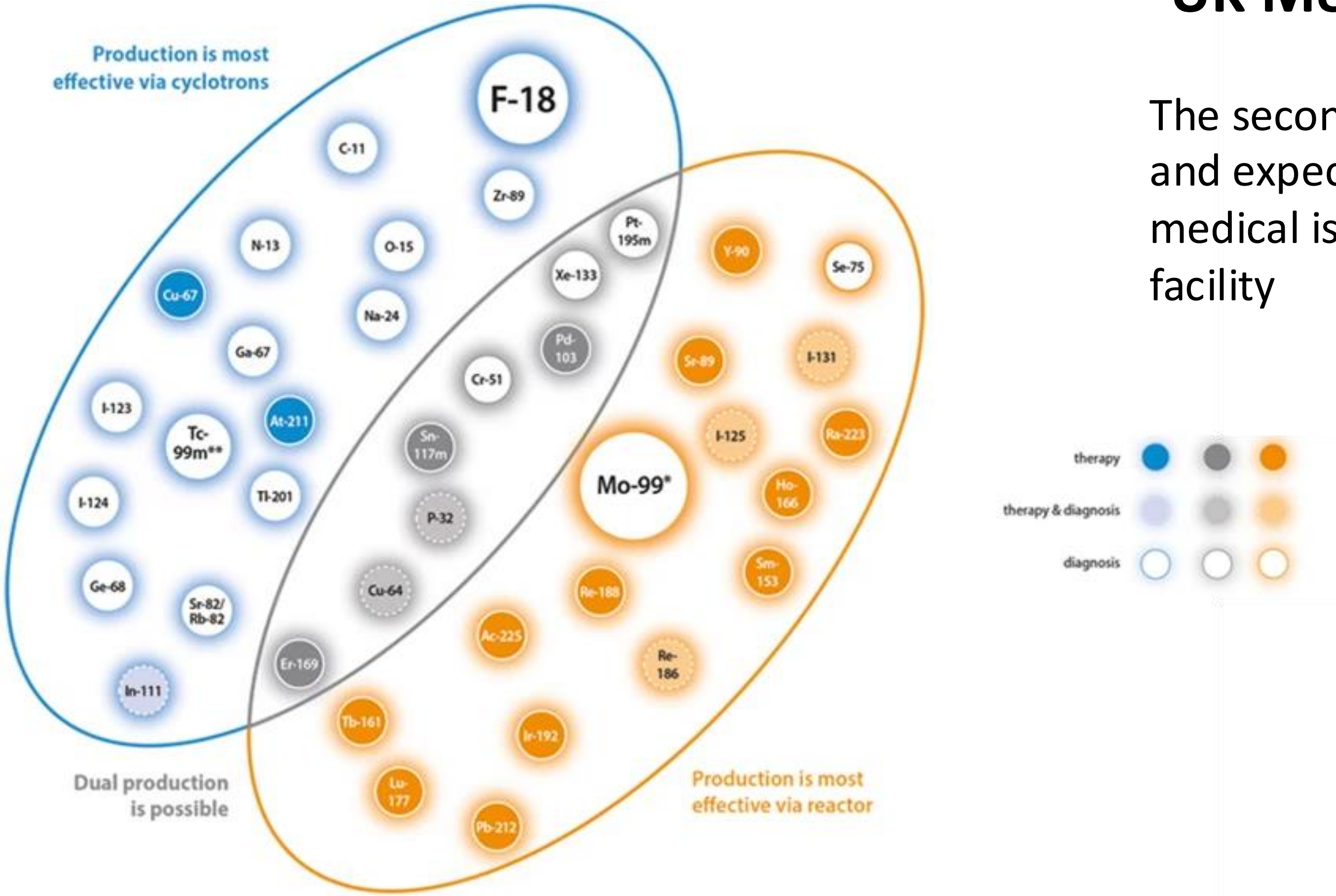
Solid State Fusion Reactors History

- 2018: demonstrated by NASA LCF fusion proof of concept
- 2020: The first Multi-State fusion reactor is theorized, and detailed simulations and design analysis of combining LCF and IEC technologies indicate a significant performance gain.
- 2021: Our first prototype reactor demonstrated a 36% increase in reactor performance over traditional neutron generators.
- 2022: The second round of prototypes, tested in partnership with the University of Bristol, yielded in excess 100 billion DT fusions per second within a compact commercial architecture.
- 2023: Third round of prototypes allowed for greater than 1 trillion DT fusions per second within a commercial architecture and began construction of medical isotope production facility
- 2024+ First patented filed for hybrid LCF fusion-fission power systems, first patent filed for transmutation of existing nuclear waste stores, space applications, fusion neutron materials damage testing, and beyond.



Chapman Nuclear

Upcoming Project -2024

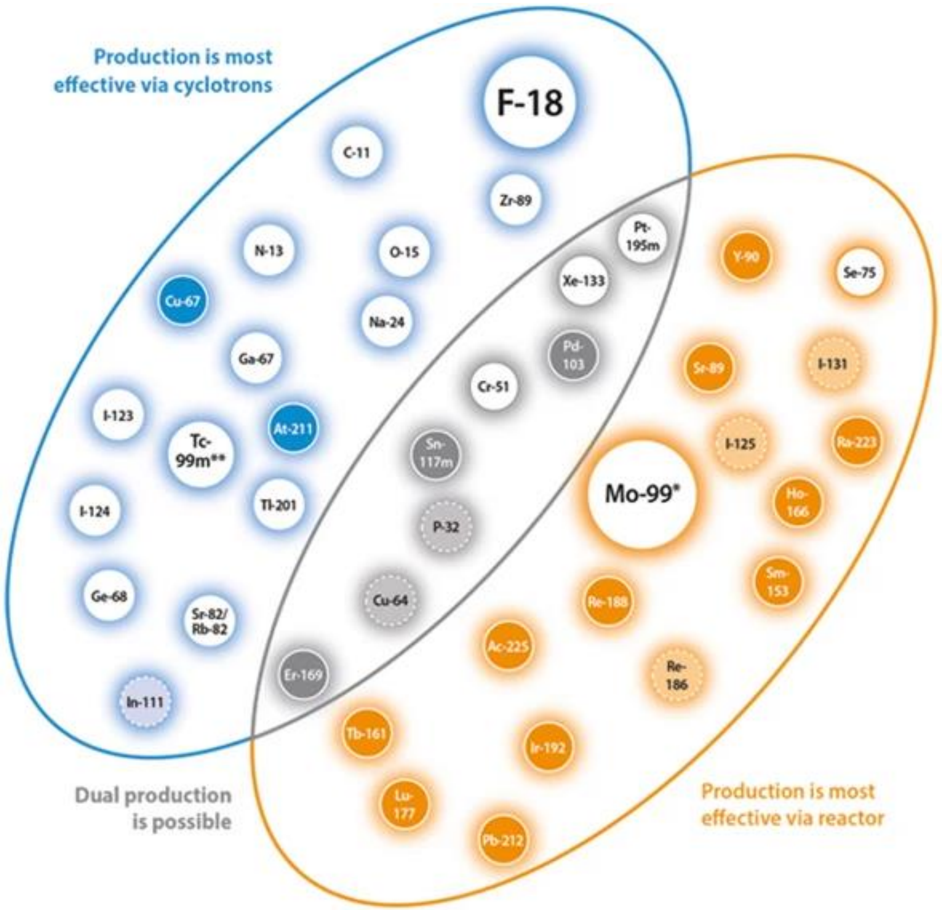


UK Medical Isotope Production Facility

The second neutron generating facility is fully funded and expected to triple the $1M/yr income from medical isotopes produced in the first prototype facility

Chapman Nuclear

Upcoming Project - 2025



USA Medical Isotope Production Facility

A D-T Source will be the strongest neutron source in the world and able to be scaled up to produce ~$3M/yr. producing medical isotopes.

With the addition of fissile material for testing, the lab will double as the research center for the first Nasa Fusion Europa Lander.

Funding for this project is matched in kind up to $4,000,000 from various strategic partnerships

Chapman Nuclear

Upcoming Project - 2026

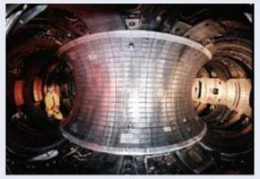
Nasa Jupiter Moon Lander Mission

Mission: Use nuclear fusion as heat source to "drill" 2 miles into icy surface of Europa. Since fusion equipment and fissile reaction can be turned on and off remotely, the fissile fuel will not be used until the lander reaches the surface

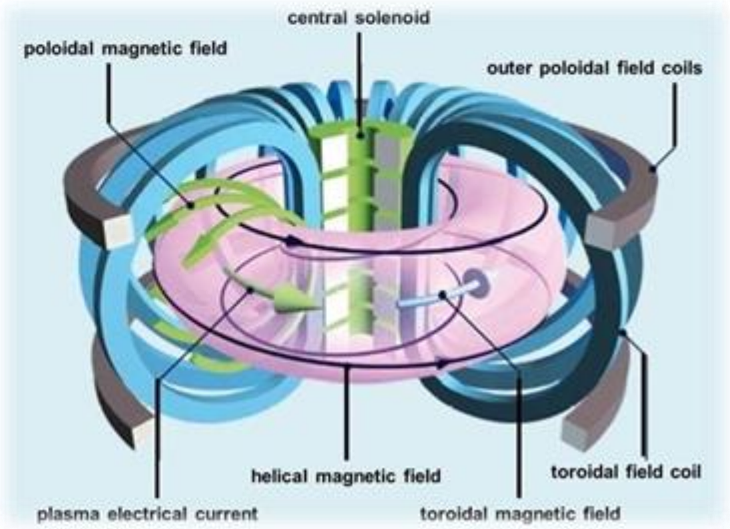
- Test reactor to start construction in 2026
- $8,000,000 projected sponsorship from the steel industry

Chapman Nuclear

Fusion Neutron Sources

Approach	Core Diameter	Fuel	Density (ions/cm^3)	Confinement Time	Fusion Initiation	Example
Lattice Confinement Fusion (LCF) (New Process)	~Centimeters (scalable)	• Deuterated metals (e.g. ErD_3; TiD_2) • Other	10^{22}-10^{23}	Indefinite	n heats "d" (e.g. n from New Process→	
Magnetic Confinement Fusion (MCF) (Tokamak)	Meters	• D-D • D-T	10^{14}	Seconds	Plasma	
Inertial Confinement Fusion (ICF) (LASER Fusion)	<100-micron core	• D-T • Other	10^{26}	Nano-seconds	Laser Implosion Omega→	

Source: NASA GRC Lattice Confinement Fusion Virtual Workshop



- Toroidal Fusion Experiments have many obstacles left to overcome such as a complete lack of fuel available
- There are also inherent drawbacks due to the laws of thermodynamics. Vacuum-based fusion reactors have **EXTEREMELY LOW energy to electricity efficiency.**

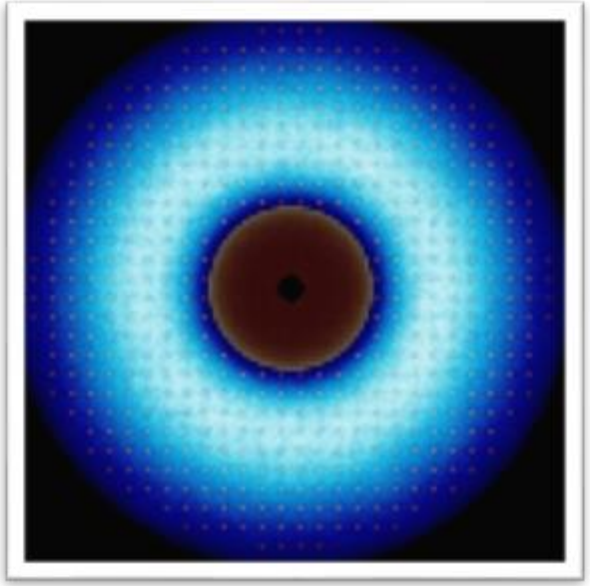
- Legacy Fusion Plant concepts aspire for an energy factor efficiency level of Q=10
- Sub-Critical Reactors are not a distant future. They have been around for over 100 years.

CNI Sub-Critical Hybrid Fusion/Fission Nuclear Power Plant

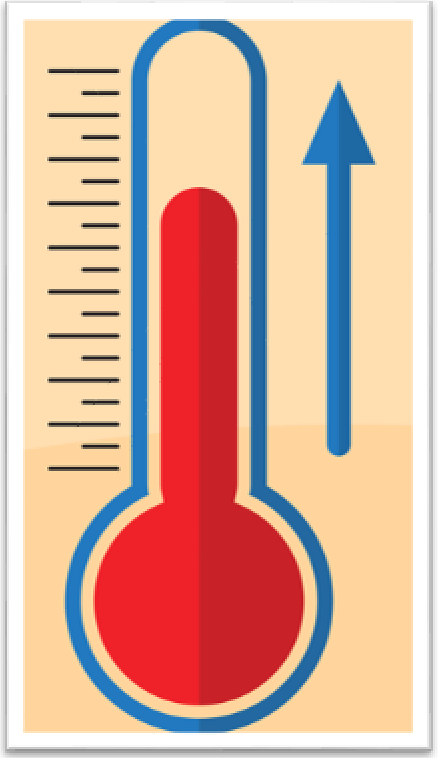
Patent Pending

"Turn the nuclear reaction on and off like a light switch"

Advanced Fusion Neutron Generator



Standard Nuclear Fuel



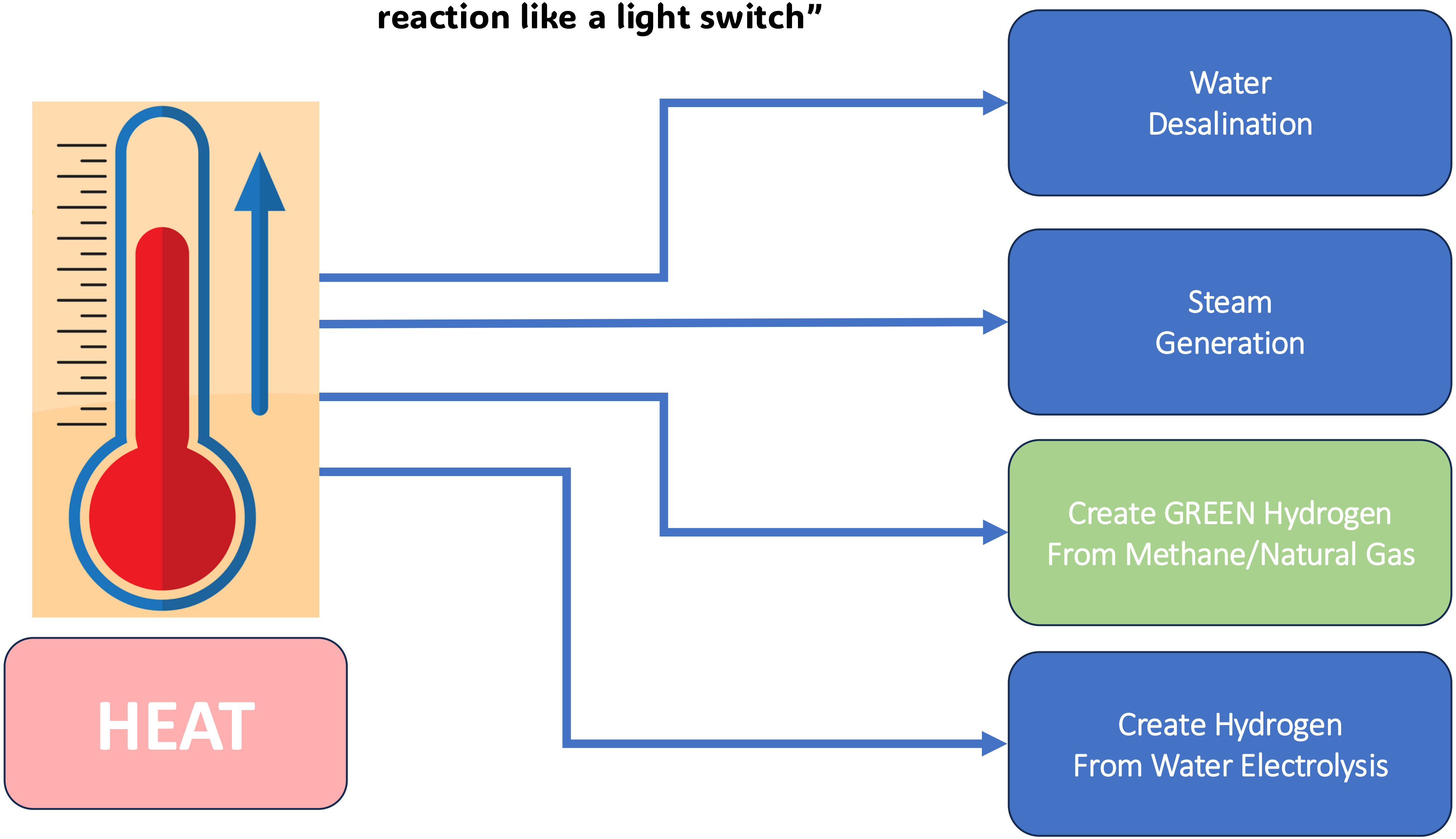
HEAT

Chapman Nuclear

CNI Sub-Critical Hybrid Fusion/Fission Nuclear Power Plant

Patent Pending

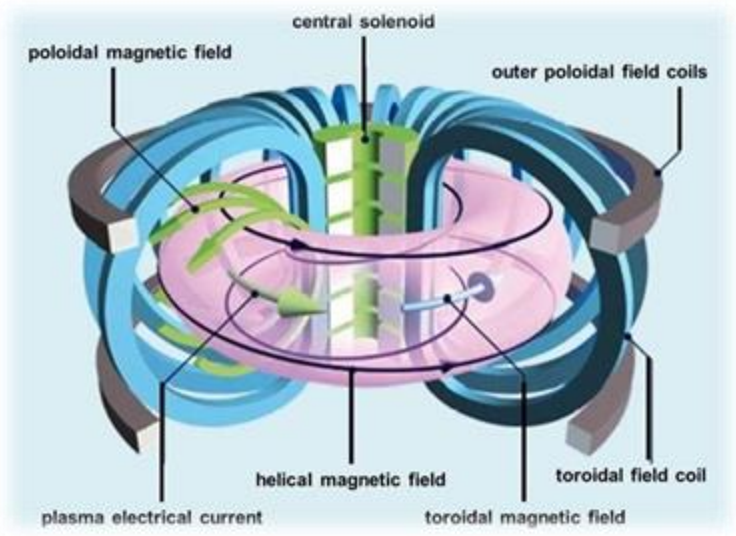
"Turn off the nuclear reaction like a light switch"



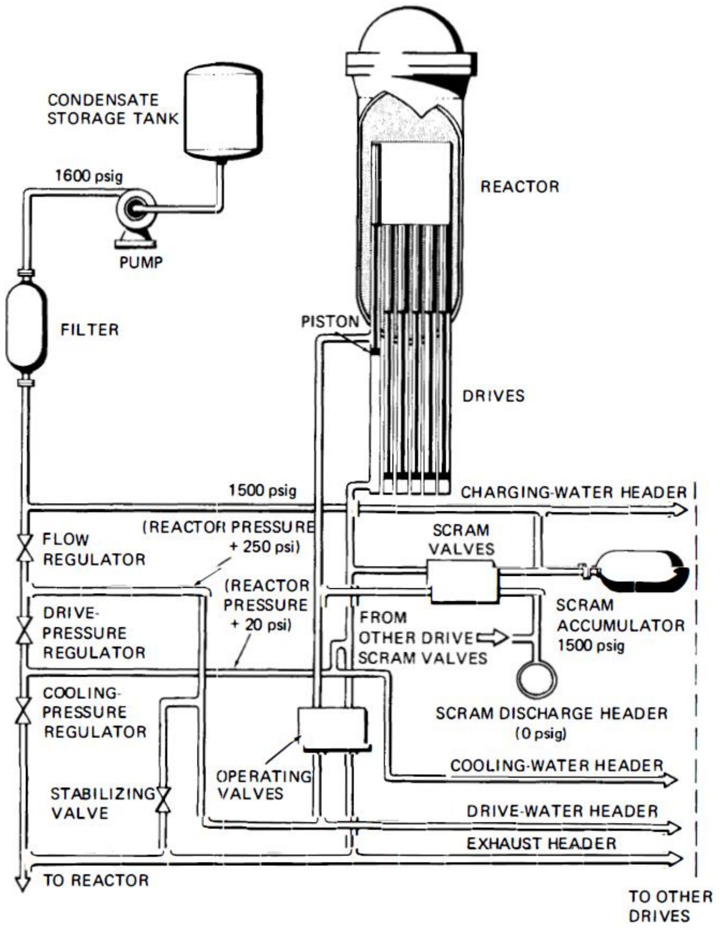
Chapman Nuclear

Bulky All or None Systems Removed

Complex Safety Systems can be removed from the design



Standard Fusion
Source: NASA GRC LCFVW



Legacy Reactor Control Rod System

Source: Nuclear Power Plant Design Analysis Alexander Sesonske 1973

Excessive safety systems are one of the main cost drivers for traditional nuclear power.

Traditional systems can never be modular because they can't be shipped with fuel already loaded requiring complex on-site labor

SMRs can never be truly modular because they require extensive system integration on-site with safety systems

Chapman Nuclear –
Hybrid Fusion Natural Gas (HFNG) Plant Cost Comparison

EQUIPMENT COSTS Standard NPP VS HFNG		
	Standard NPP	HFNG
Cooling System	12%	4%
Electrical & Generating Equipment	12%	0%
Mechanical Equipment	16%	6%
Instrumentation & Control System	8%	8%
Construction Materials	12%	3%
Labor Onsite	25%	18%
Project Management Services	10%	10%
Other Services	2%	2%
First Fuel Load	3%	1%
Total	$1.00	$0.52
Efficiency Factor	33%	70%

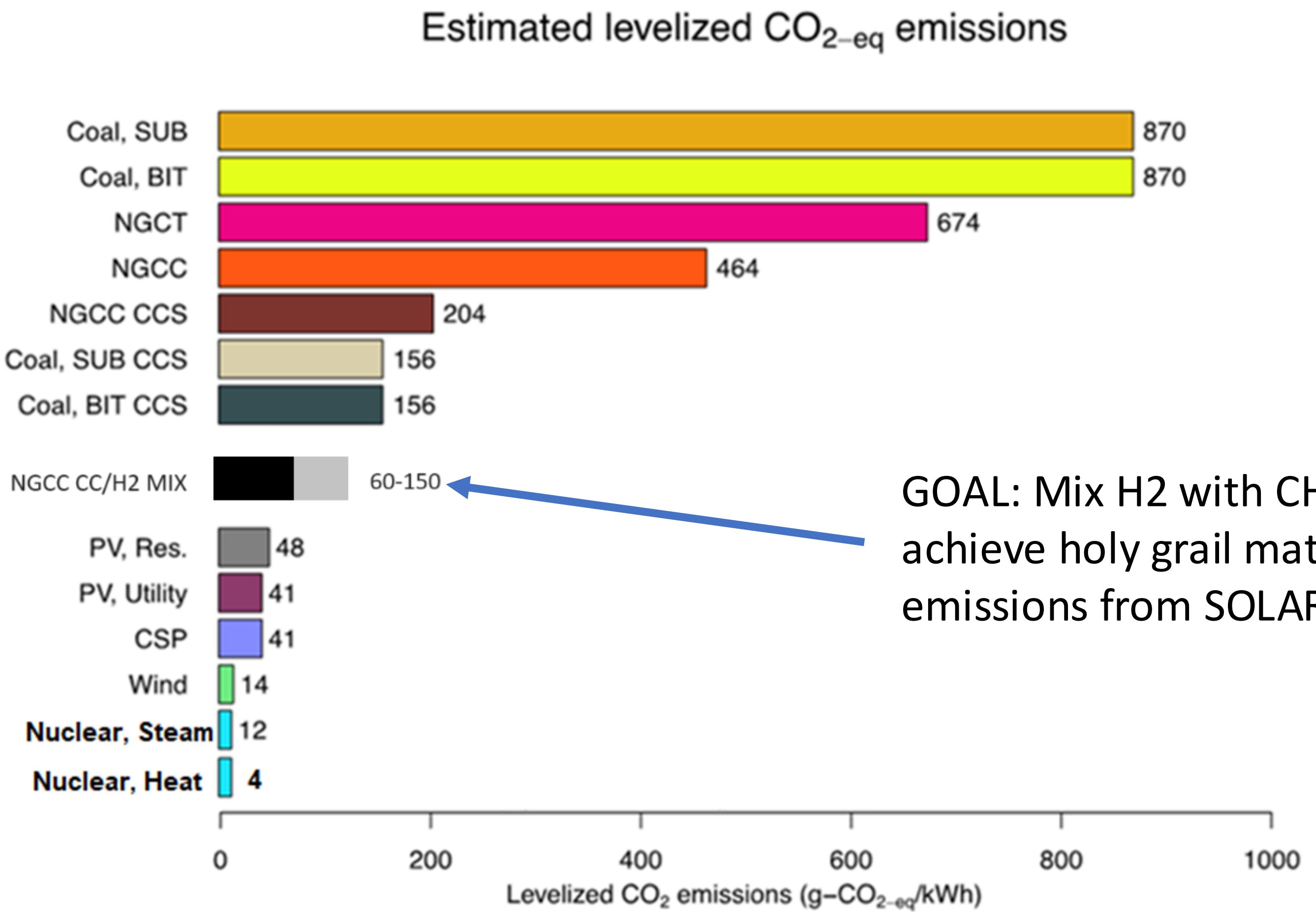
HFNG Conversion uses heat instead of generating electricity

Overall cost of the nuclear side of the plant goes down by roughly half

Pyrolysis is almost twice as efficient use of heat than making electricity from steam

- Even though the cost is $1950/kWh, the cost effectiveness gives this almost twice the value due to heat processing of pyrolysis.

Levelized Carbon Intensity (per energy type)



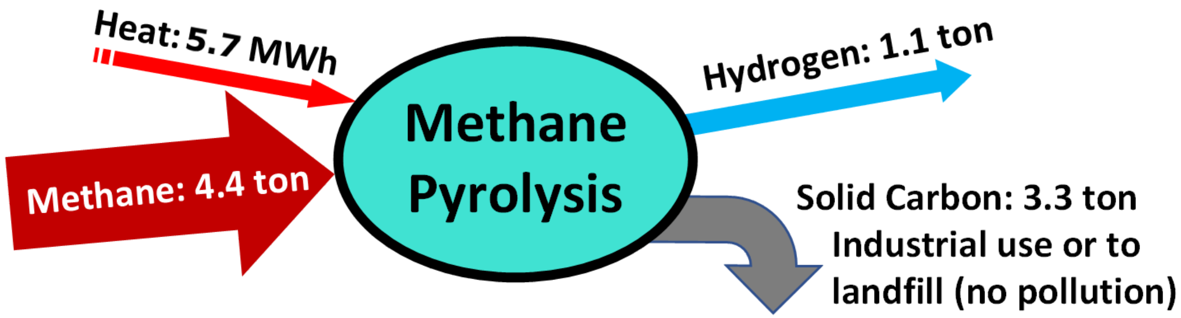
GOAL: Mix H2 with CH4 to achieve holy grail matching emissions from SOLAR!

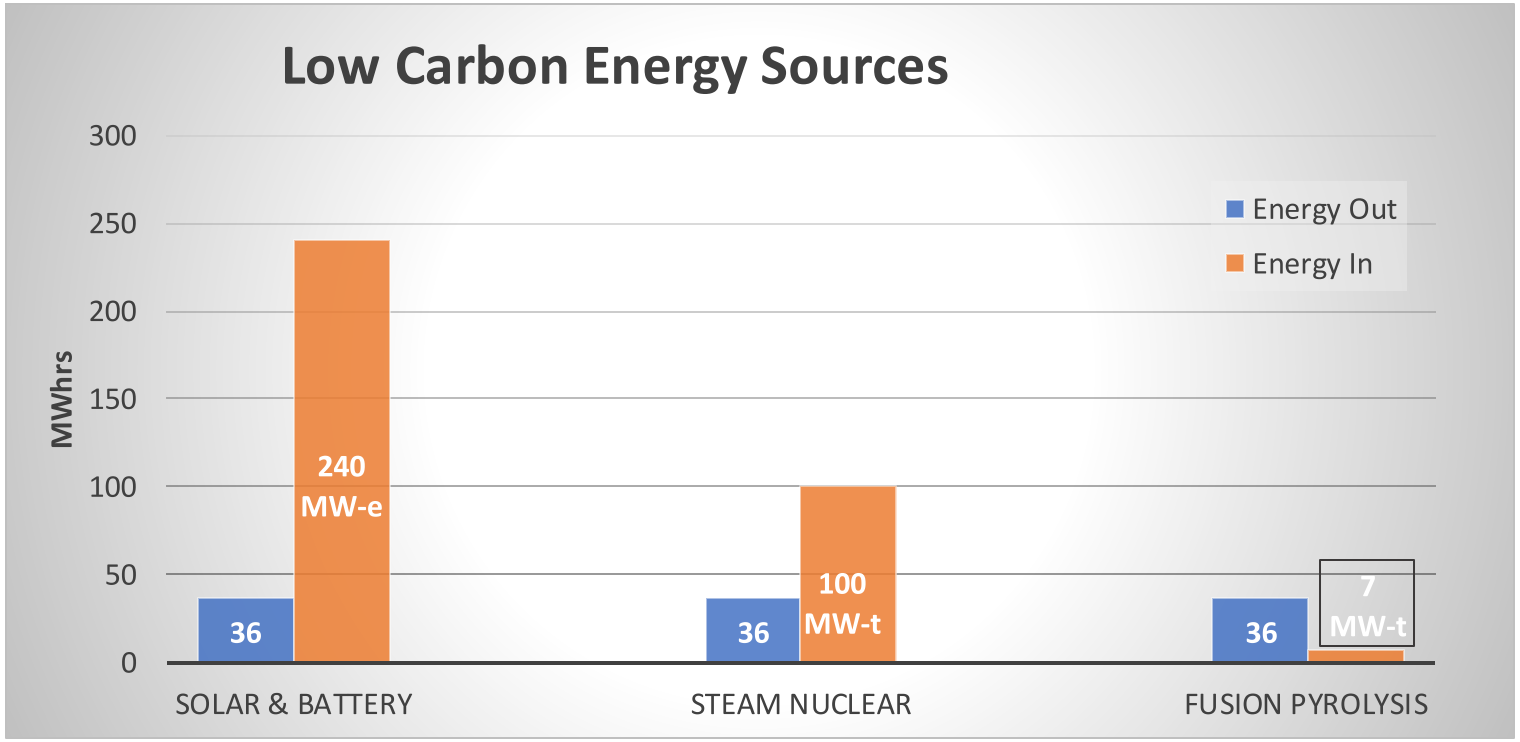
In the figure SUB is sub bituminous coal, BIT is bituminous coal, NGCT is natural gas combustion turbine, NGCC is natural gas combined cycle, CCS is 90% carbon capture and sequestration, PV is solar photovoltaic, Res is residential, CSP is concentrating solar power, and wind refers to onshore wind.

SOURCE: The University of Texas at Auston – Energy Institute

- Nuclear produces ¼ of the emissions as residential solar
- Coal has 72 times the CO2 emissions as nuclear and 144 times the emissions of nuclear heat

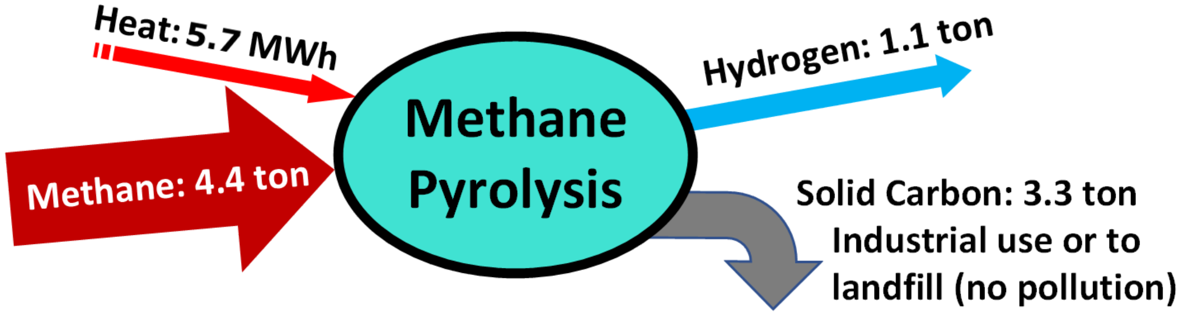
Thermal Pyrolysis

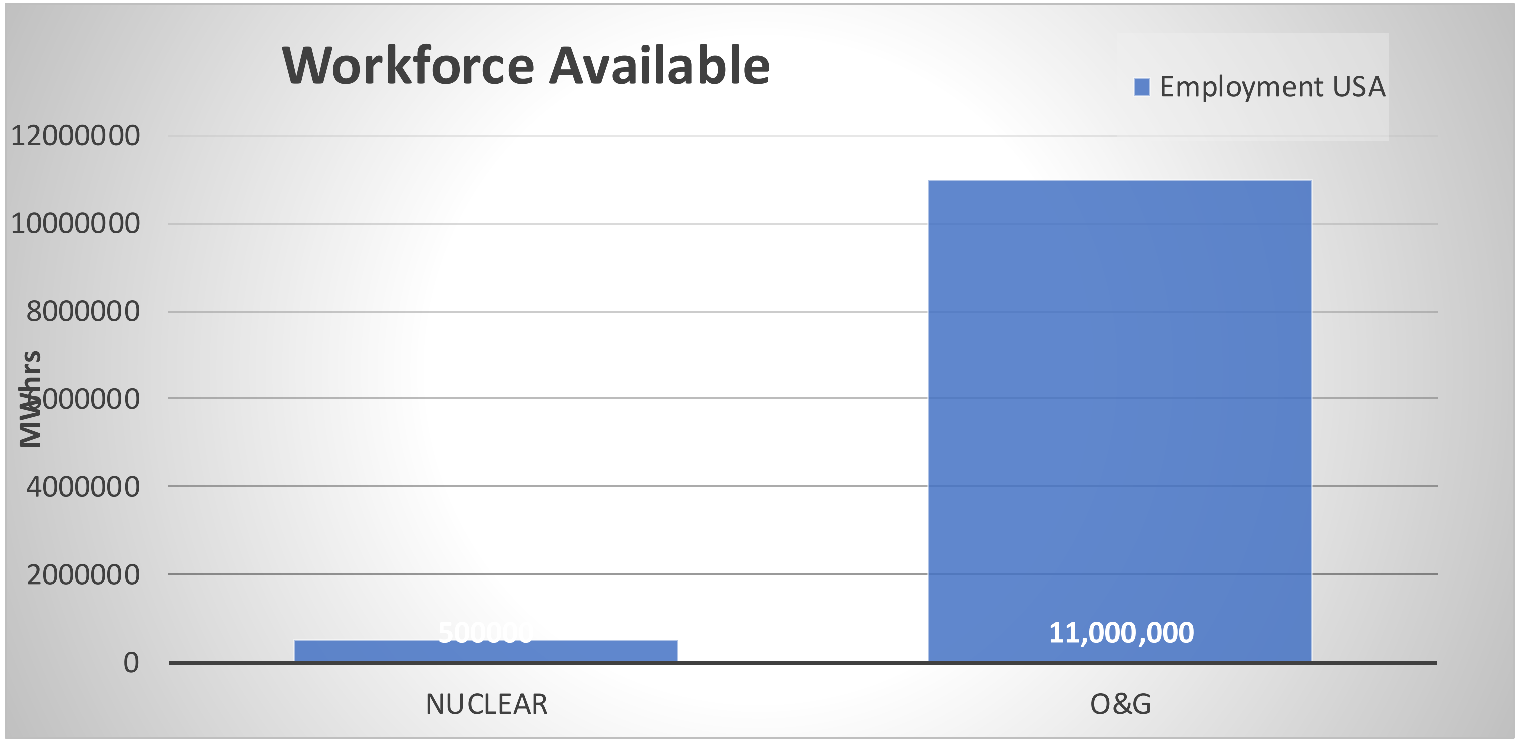




- **Pound for pound CNI Fusion Reactors reduce nuclear fuel needed by ~90%, which REDUCES NUCLEAR WASTE BY 90%**

Thermal Pyrolysis Advantages

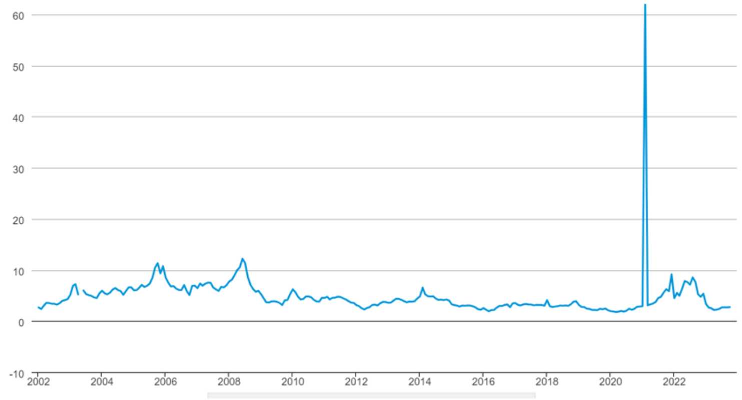




- **Oil & Gas employ roughly 5%, 1 in 20 people working in the U.S.A.**
- **O&G workers outnumber nuclear workers by 16:1 ratio**
- **Average age of nuclear worker is 62 years old!**

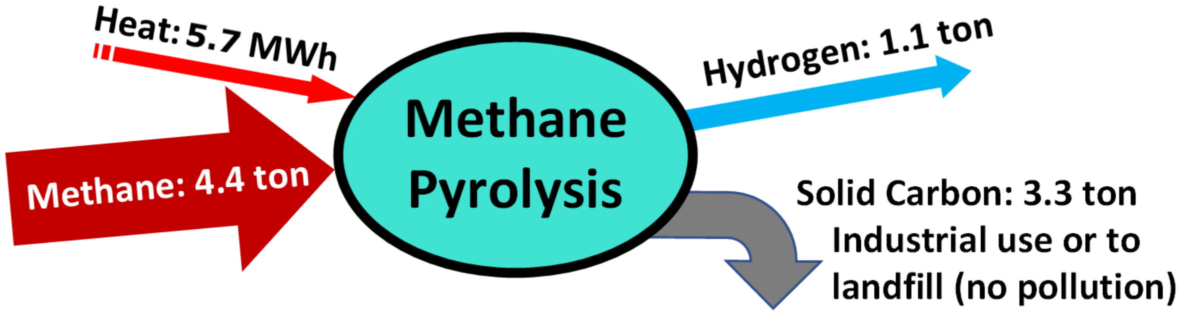
Fuel Costs

Natural Gas: October 2023, Texas power producers paid $2.71/Mcf or $0.0679/Kg



Nuclear Fuel: 2021, DOE estimated $1,663/kg of fuel or $1.5/ MWh of thermal energy.

Process	Amount required x price*	Cost	Proportion of total
Uranium	8.9 kg U_3O_8 x $94.6/kg	$842	51%
Conversion	7.5 kg U x $16	$120	7%
Enrichment	7.3 SWU x $55	$401	24%
Fuel fabrication	per kg	$300	18%
Total		$1663	



Nuclear Fuel Cost:
$1.5/MWh * 7 MWh =
$10/tonH2

Natural Gas Cost:
$0.07/kg*1000 =
$70/tonH2

Chapman Nuclear -

What is the first step towards building a fusion power plant?

Building a natural gas power plant, of course!

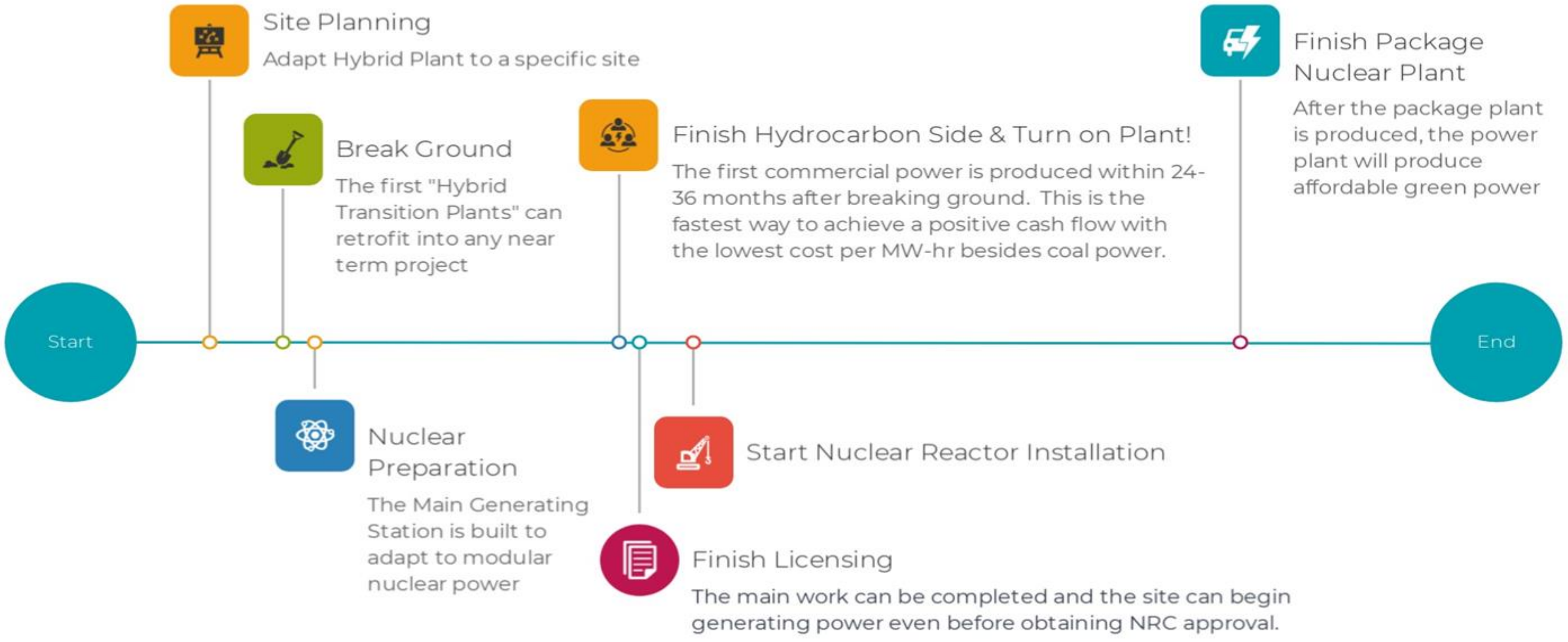


Figure Source: Contensol

- Phase 1: Build Natural Gas Power Plant
- Phase 2: Build Heat System
- Phase 3: Optional: Liquifying Hydrogen

Hydrogen Production (per H2 production method)

(EMMISSIONS EXCLUDING UPSTREAM, ONGOING, & DOWNSTREAM CARBON COSTS

	HYDROGEN TYPES	CARBON INTENSITY
FUSION HYDROGEN	**Hydrogen from Natural Gas & Fusion Power**	**0.8 Kg-C/Kg H2 OR -11.9Kg-CO2/Kg H2**
Hydrogen From Fossil Fuels	Grey Hydrogen from Natural Gas	+12 Kg-CO2/KgH2

U.S. Energy Information Agency (EIA): Levelized Costs of New Generation Resources in the Annual Energy Outlook 2022

Carbon Intensity (CO2e) per kg H2	Maximum Credit Amount per kg H2
Greater than 4 kg	$0.00
2.5-4 kg	$0.60
2.5-1.5 kg	$0.75
1.5-0.45 kg	$1.00
Less than 0.45 kg	**$3.00**

Hybrid Fusion is here
$90,000 USD tax credit/day

- Methane reforming & Pyrolysis of Natural Gas (NG) have the lowest cost of any method to produce hydrogen on an industrial scale.
- MUST start construction of Natural Gas plant by 2030 to qualify for tax credits.
- These tax credits extend for the lifetime of the plant