# Herl Technologies

## High-Efficiency Radiolysis: Nuclear Hydrogen

**Michael McNeely, Ph.D., PMP – President/CEO**
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## New Reality:

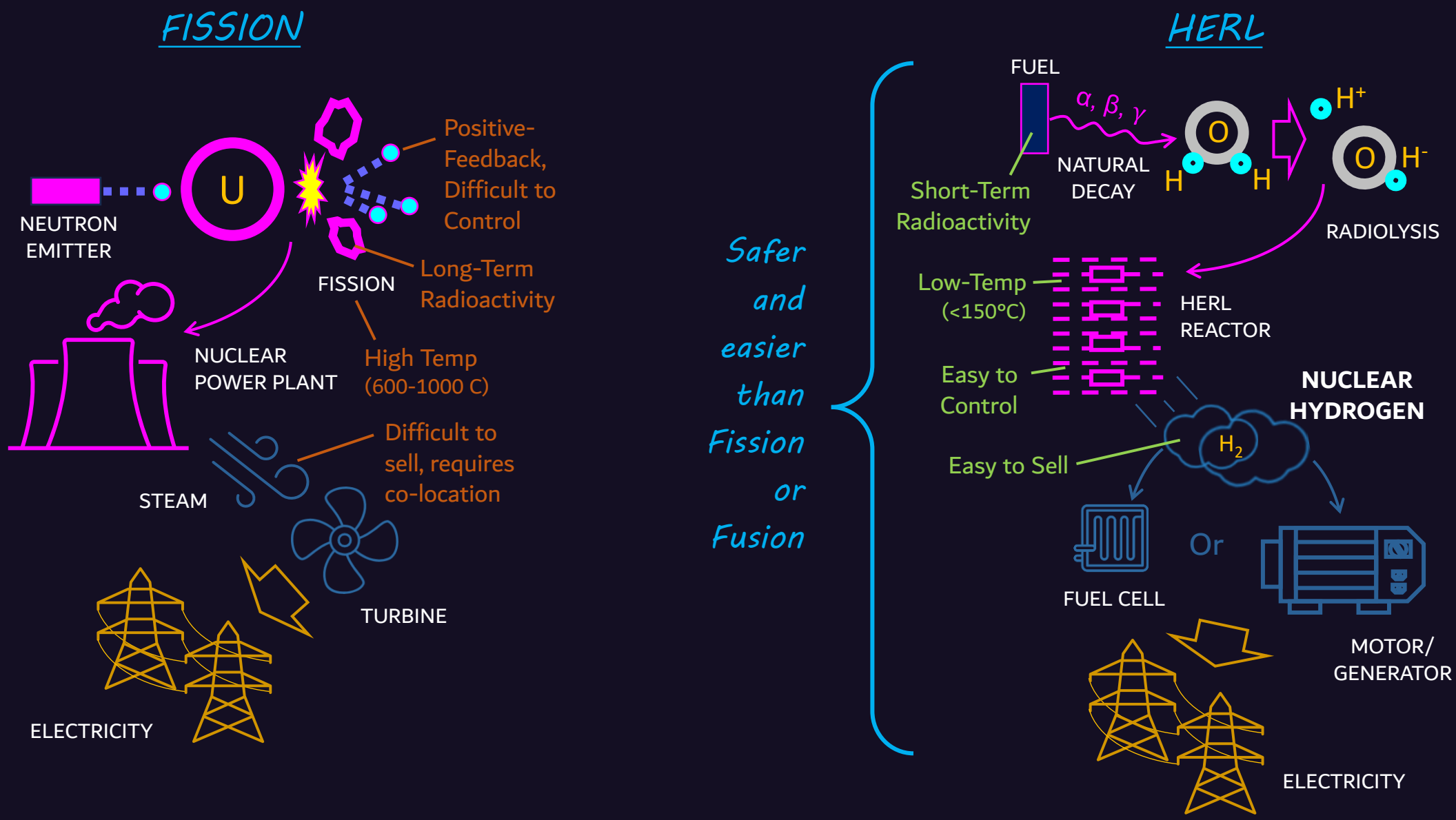
"Energy security, not climate activism, is now the primary driver of global energy transformation"

- Jeff Currie, Chief Strategy Officer, Carlyle Group Private Equity

## Herl Tech Value Proposition:

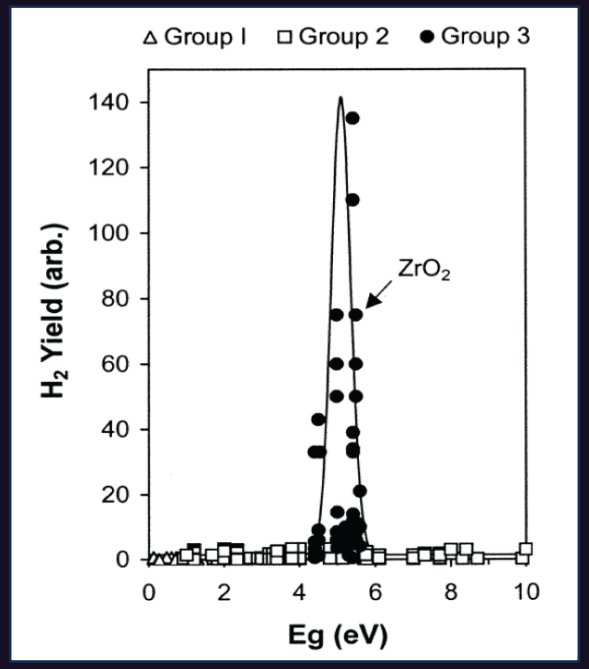
Herl Technologies is unique in its opportunity to simultaneously solve the challenges of both Energy Security and the Hydrogen Economy.

# HERL™ is a New Form of Nuclear Power Based on the Radiolysis of Water



# High Efficiency Radiolysis (HERL™) Enhanced Electrolysis

HERL TECHNOLOGIES is proposing a **unique application of** the concepts of RADIOELECTROLYSIS [1] and RADIATION CATALYSTS [2] with new technology exclusively owned by HERL TECH, **to create a revolutionary method of hydrogen production.**




Research cited by Le Caër showing levels of hydrogen when various water saturated oxide surfaces are irradiated with γ rays.

## What is RADIOELECTROLYSIS ?

A term coined by Dr Genn Saji, Ex-Secretariat of the Nuclear Safety Commission of Japan (retired), for **the excess generation of hydrogen gas caused by the radiolytic ionization of water in the presence of an electric field.**

## What are RADIATION CATALYSTS ?

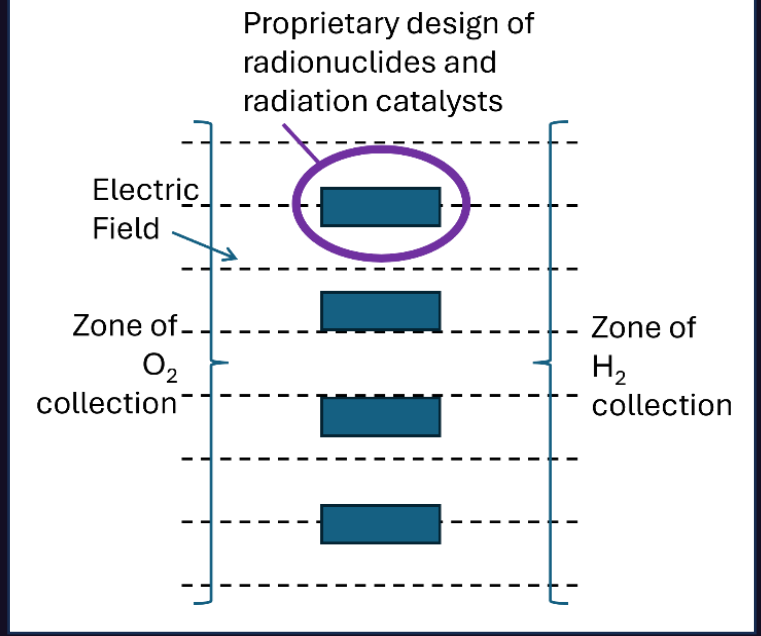
A term used by Dr Sophie Le Caër, Research Director at the Interdisciplinary Laboratory of the Atomic Energy and Alternatives Energies Commission of France, to describe **materials** that have a band-gap energy similar to the hydroxyl (O-H) bond strength of water, **that increase the generation of hydrogen gas in the presence of ionizing radiation.**


1 Saji, Genn. (2014). Review on Water Radiolysis in the Fukushima Daiichi Accident: Potential Cause of Hydrogen Generation and Explosion. International Conference on Nuclear Engineering, Proceedings, ICONE. 1. 10.1115/ICONE22-30991.
2 Le Caër, S. (2011). Water Radiolysis: Influence of Oxide Surfaces on H2 Production under Ionizing Radiation. Water, 3(1), 235-253. DOI: 10.3390/w3010235

# Why is HERL safer than Fission or Fusion?

- No extreme temperatures
- No complex heat management needed
- No difficult to control positive-feedback loops
- No long-term radioactivity

*Can lead to faster adoption and deployment to more quickly meet energy demands.*




Concept diagram of a HERL system.

*Preliminary data, system designs and assumptions can be shared under NDA*

# Challenges of Energy Security and the Hydrogen Economy

## Challenges of Energy Security

| | HERL | Solar | Wind/Wave | SMR | Coal/NG/Oil |
|---|---|---|---|---|---|
| Decentralized | ✓✓* | ✓✓* | X | X | X |
| Consistent/Reliable | ✓ | X | X | ✓ | ✓ |
| Protected/Secured | ✓ | X | X | X | X |
| Low/No Carbon | ✓ | ✓ | ✓ | ✓ | XX |

## Challenges of the Hydrogen Economy

| | HERL | Green | Blue | Grey | Red/Pink |
|---|---|---|---|---|---|
| Cost[1] | ✓ | X | ✓ | ✓ | ✓ |
| Net Power | ✓ | X | X | ✓ | ✓ |
| Transportation & Storage | ✓** | X | X | X | X |
| Low/No Carbon | ✓ | ✓ | ✓ | X | ✓ |

[1] The cost of HERL hydrogen is expected to be at least 60% less than green hydrogen, based on voltage needs, and potentially greater than 80% less (e.g., < €1/kg $H_2$ ). However, HERL's value proposition is associated with satisfying needs of both energy security and the hydrogen economy, not just cost alone.

* Solar is the ideal decentralized/distributed energy source when it is placed on or near the facility it is providing power to. HERL can replicate this model, depending on fuel type, by being buried next to the building to be energized.

** HERL can solve hydrogen transportation & storage challenges because it is net-power-positive, has no carbon emissions, can be deployed locally and built-to-suit the needs of the facility it is providing hydrogen/power to.

# Why Has Nobody Done this Before?

## Our Guess-

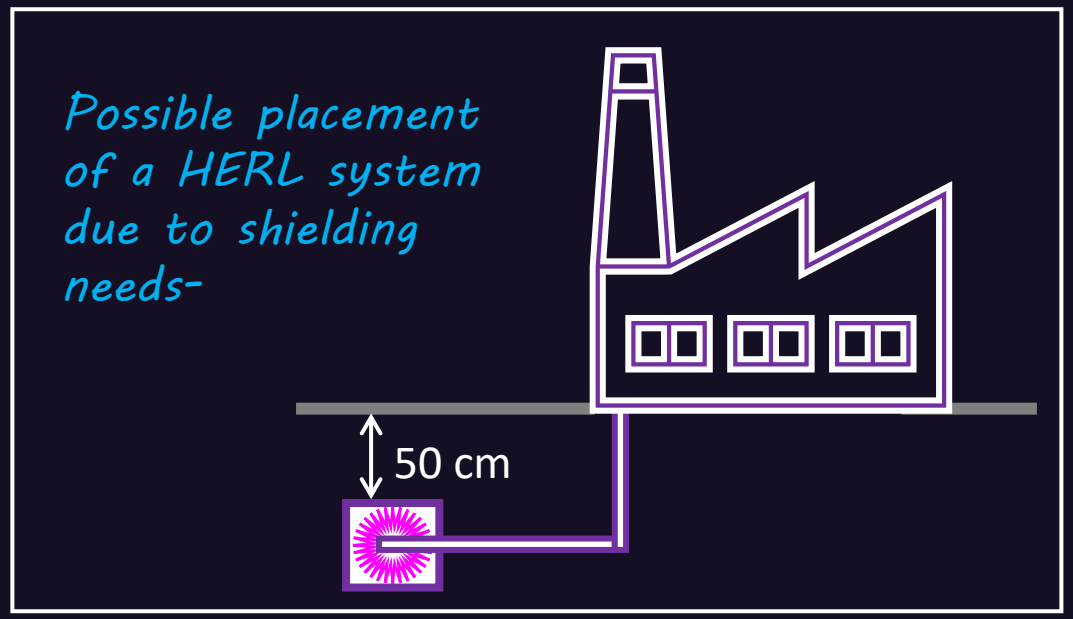
Radiation Catalysts and Radioelectrolysis are not well known in industry and, historically, have not been an area of active research in academia, probably due to limited downstream (translational) opportunities. Both have just been considered academic curiosities, although this is beginning to change with recent academic reports citing improvements over conventional hydrogen production methods.

## Why Now?

Only due to new, patent pending materials science discoveries and resulting designs made by Herl Tech, enabling the use of safer radioactive fuels, will Nuclear Hydrogen move out of academic research and into commercial reality.

# Fuel Options

- Naturally Occurring Radionuclides- Scaled-up extraction methods (already demonstrated at Oak Ridge National Labs, USA [1])
- Synthetic Radioisotopes- 'Industrialized' manufacturing processes (already demonstrated in Qinshan, China [2])
- Fission Products- Current High-Level Nuclear Waste (HLW) recycling projects are underway in the US, UK, Japan and South Korea for Nuclear Battery production.




1 https://www.energy.gov/em/articles/oak-ridge-project-boosting-isotope-supply-cancer-treatments
2 https://www.sustainability-times.com/research/china-just-did-the-impossible-yttrium-90-cancer-isotope-produced-in-commercial-reactor-sparks-medical-and-nuclear-shockwaves/

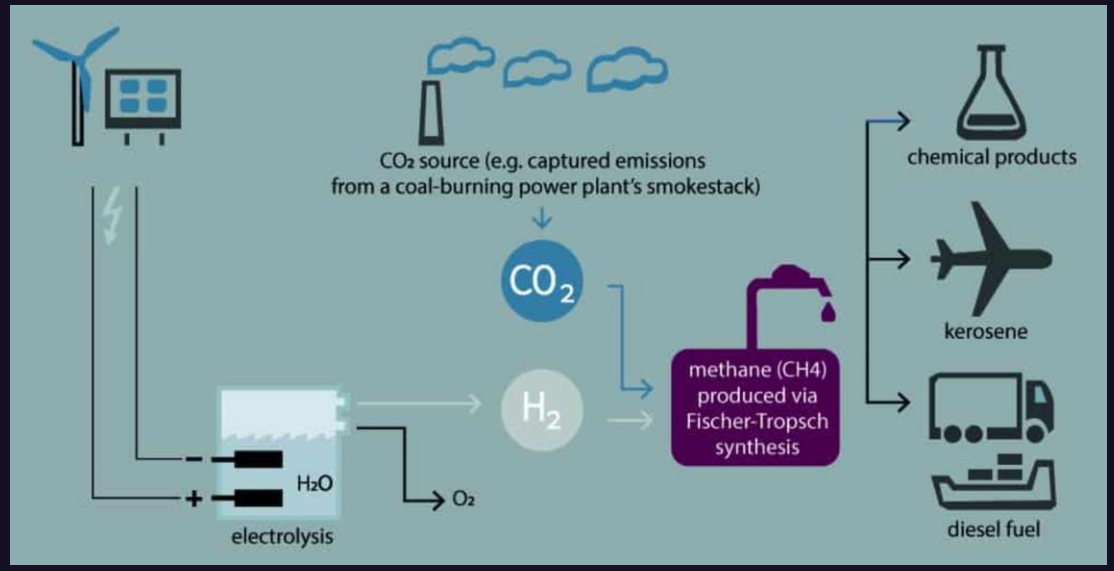
# HERL TECHNOLOGIES Intellectual Property

## Provisional Patent covering:

- **Designs** for optimal use of Radioelectrolysis and Radiation Catalysts
- **Materials and Methods** for accessing the ionization energy of Alpha and Beta particles
- **Data** supporting ability to access Alpha and Beta energy

## Other applications of HERL

- Power to Gas (LNG from $CO_2$ + $H_2O$)
- Higher-Level Organic Synthesis (eg $C_3H_7OH$)
- Removal of forever chemicals from water
- Industrial Sterilization Processes




https://as-schneider.blog/2022/03/02/what-are-power-to-x-solutions/

# Opportunity

## Revenue

- HERL Technology Licensing
  - Electrolysis Companies
  - Chemical Synthesis Companies
  - Water Purification Companies
- Hydrogen Production Systems
  - Hydrogen refueling stations
  - Hydrogen co-injection with NG
- **Power Generation Systems**
  - EaaS
  - EaaP

Goal

**All Income Sources Provide Recurring Revenues**

## Competition

- Electrolysis Companies
- Use of Excess Nuclear Power Plant Electricity & Steam to drive Electrolysis
- Fission (SMR), Fusion & Nuclear Batteries
- Other Renewable Energy Systems

## Markets

| | 2023-24 US$ B | 2032-34 US$ B | CAGR % |
|---|---|---|---|
| Hydrogen Generation | 176 | 278 | 5·8 |
| Solar | 273 | 436 | 6 |
| Wind | 89 | 260 | 10 |
| Total Renewables | 1,085 | 2,271 | 9·5 |

Hydrogen https://www.fortunebusinessinsights.com/industry-reports/hydrogen-generation-market-100745
Solar https://www.fortunebusinessinsights.com/industry-reports/solar-power-market-100764
Wind https://www.environmentenergyleader.com/stories/future-trends-in-wind-energy-2608-billion-growth-by-2034,44970?
Renewable https://straitsresearch.com/report/renewable-energy-market

# HERL TECH Founders

## Michael McNeely, PhD, PMP- President/CEO

- Dr McNeely is a serial inventor & entrepreneur
  - Over 40 patents
  - Founded 3 companies which he initially led as Pres/CEO
- PhD degree in BioEngineering from the University of Utah
- Certified as a Project Management Professional (PMP) from the Project Management Institute (PMI) #3907087, exp 2027

## Mr Smith, MS- Corporate Position TBD

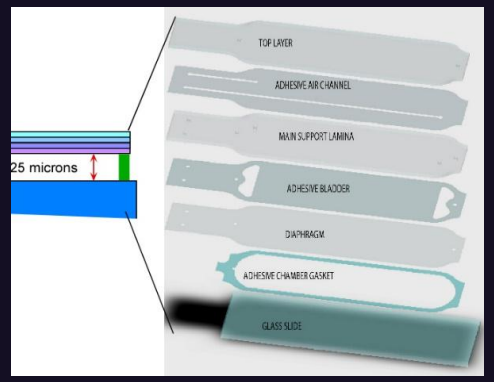
- Mr Smith is a citizen of Japan with an MS degree in a scientific field from a premier Japanese technology university
- He is an executive at a major energy market advisory firm
- He has been an invited speaker to multiple Investor and Industry conferences on Energy and the Hydrogen Economy

# Additional Background - Dr McNeely

## Past Companies-

### BioMicro Systems, Inc

- Founder, initial Pres/CEO, later CTO
- Developed the MAUI™ Hybridization System
- Partnered with AsOne Corp (Japan)
- Sold to Roche Diagnostics in 2010




MAUI™ Hybridization System

### GattaCo Inc

- Co-Founder, initial Pres/CEO, later Director Global Business Development
- Developed the A-PON® Plasma Separator
- Plug & Play Japan Alum
- Collaboration with Mitsubishi Pharma
- Used by SpaceX during Inspiration4 flight
- Current Advisor

A-PON® Plasma Separator

### Macko Labs Inc

- Consulting
- HERL Technology Development

## Radiation Science Research-

Dr McNeely spent 18 months studying Radiation Safety, Nuclear Physics & Radiochemistry at the Radioisotope Research Facility of Tokyo Metropolitan University as a part of a project funded, in part, by Fukushima Prefecture. The purpose of the project was to develop a low-cost Radio Bio-Assay for the detection of radioactive particles in urine. Principles studied are directly relevant to HERL.

# Key Risks

- **Fuel Availability-** 'Ideal' fuels (low-gamma) are currently limited in their availability and time will be needed to scale-up to satisfactory levels. High-gamma fuels can be used in the interim but may then be limited to co-deployment with SMRs or otherwise remote settings.

- **Regulatory-** HERL is expected to, eventually, enjoy less stringent regulatory scrutiny than SMRs due to its favorable risk profile compared to fission. However, there will be an initial regulator 'education' period of unknown duration due to HERL being a new technology.

# HERL 5-Year Development Plan

## Development

## Current Project

- Establish core Development and Management Team
- Obtain MOUs w/ R&D Partners
- Secure Fuel & Catalysts
- Construction & Testing of Functional Prototypes
- Digital Modeling & Simulation

ELIMINATE TECHNICAL RISKS !!!

- Addit'l Testing & Modeling
- Initiate 0.1kg $H_2$/day Bench-Top System design
- Validate 0.1kg System

- Initiate 1kg $H_2$/day Pilot System design
- Validate 1kg System
- Scale-Up Manuf. of 1kg System
- Initiate Power Design (HERL+ ICE or FC)

- Initiate 10kg System
- Validate Power System
- Scale

2026 Pre-Seed $1M raise

2027 Seed $5M raise

2028 Series A $15M raise

2029 Series B $50M raise

2030 Series C, IPO or Acquisition

## Financial

- Additional financial support available via grants within 18 months
- 27H2- Partner Revenue possible
- 29H1- Launch of 1st $H_2$ Generation System
- 30H2- Launch of 1st Power Generation System

All values shown are hypothetical
Dates assume closing of Pre-Seed in Dec '25 – Jan '26

# Pre-Seed Fund Raising Details

| | |
|---|---|
| **Issuer:** | HERL TECH INTERNATIONAL PTE. LTD. |
| **Amount of Financing:** | US$1,000,000 |
| **Type of Security:** | SAFE |
| **Valuation Cap:** | US$5M PRE-Money |
| **Discount:** | 20% |

# 12-Month Milestones

- Register Singapore holding company
- Convert U.S. provisional patent to PCT international patent application.
- Negotiate MOUs with nuclear research technical partners (UK/EU)
- Expand core management and staff
- Secure supply of test reactor fuel and radiation catalysts
- Construction and testing of v0 HERL Reactor functional prototype

# THANKS !!!

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**https://herl.tech**