The Role of LENR in Securing the Earth's Habitability

Thomas W. Grimshaw, Ph.D.
LENRGY, LLC
Austin, TX, USA

David J. Nagel, Ph.D.
NUCAT Energy, LLC
Falls Church, VA, USA

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LENR Advantages as an Energy Source: A Quick Review

- Relatively less expensive
- Extremely abundant (hydrogen fuel)
- Clean: no emissions or effluents
- Safe: no radiation or radioactive waste
- High energy return (output vs. input)
- High energy density
- Flexible: centralized or distributed deployment

Stanley Pons and Martin Fleischmann

https://www.nytimes.com/2012/08/12/science/martin-fleischmann-cold-fusion-seeker-dies-at-85.html

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How Things Have Changed!

- When LENR was announced in 1989, emphasis was on ***energy supply***
  - Fuel shortages and long gas lines of 1970s
  - Dependence on foreign oil was major issue
- Since then, the value of LENR has shifted to fossil fuel ***displacement***
  - Greenhouse gas emissions
  - Global climate change

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Fossil Energy Sources Now Threaten the Earth's Habitability

- Global Climate Change
  Recognized in last few decades
- Impacts at Earth's Surface
  Addressed for over 60 years

LENR energy provides potential solutions to both!

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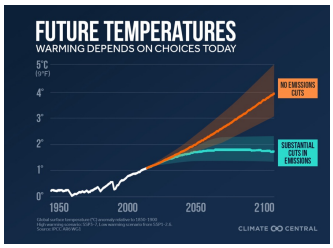
Global Climate Change: Some Basics

- It's real
  (although still not universally accepted)
- Its causes are known
  (greenhouse gases – CO_2, CH_4, N_2O)
- Its impacts are momentous
  (and already underway)
- Mitigation is understood
  (and extremely difficult)



https://indyweek.com/news/northcarolina/ipcc-report-on-climate-change/

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GCC Impacts: A Few Salient Examples

- Increasing atmosphere and ocean temperatures globally
- Rising sea level and protective measures for coastal communities
- Relocation of coastal cities further inland
- Changing ocean currents and weather changes
- Greater hurricane/storm intensities and associated flooding
- Pumping required for redistribution of water resources
- Increases in wildfires and associated air pollution

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LENR Mitigation of GCC Impacts: Four Approaches

1. Displace fossil fuels and their CO2 emissions
2. Remove GHG from fossil fuel emissions with treatment technology
3. Recover GHGs from the atmosphere
4. Respond to unavoidable large-scale GCC impacts

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1. Fossil Fuel Displacement

- Most apparent and best long-term LENR opportunity
- Advantage of centralized and distributed deployment LENR power units
- Market penetration likely to be slow (in relation to GCC rate)
- Probably not soon enough for GCC mitigation
- BUT, subject to **government intervention**
  - Accelerated LENR development/deployment
  - Think “Manhattan Project”!

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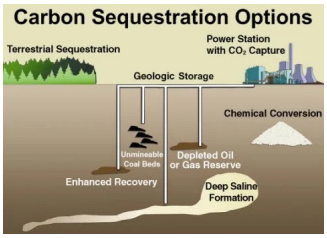
2. Greenhouse Gas Removal from Emissions

- Particularly applicable to stationary power plants
- Similar to sulfur dioxide removal
- CO2 disposal by underground injection



- LENR energy opportunities
  - For powering sequestration technology
  - For construction of underground disposal
  - Technology improvements?

https://blogs.edf.org/climate411/2008/03/03/geo-sequestration/

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3. Greenhouse Gas Recovery from the Atmosphere

- "Closing the door after horse is out of the barn"
- Referred to as "Direct Air Capture"
- Many potential solutions presently in R&D
- None apparently ready for full deployment

- LENR energy opportunities
  - As power source for recovery technology
  - Power for infrastructure construction
  - Technology improvements?

https://twitter.com/DrewMillward/status/1347813651244347394

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4. Responses to Large-Scale GCC Impacts

- LENR energy to deal with…
  - Greater storm intensities and associated flooding
  - Pumping for redistribution of water resources
  - Increases in wildfires and associated air pollution
  - Rising sea level and protective measures for coastal communities
  - Relocation of coastal cities further inland
- **Extremely large LENR opportunities!!**

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How Much Energy Will It Take to Move a City?

Construction & Setup

New Energy Supplies

Movement of People and Materials

Demolition & Restoration

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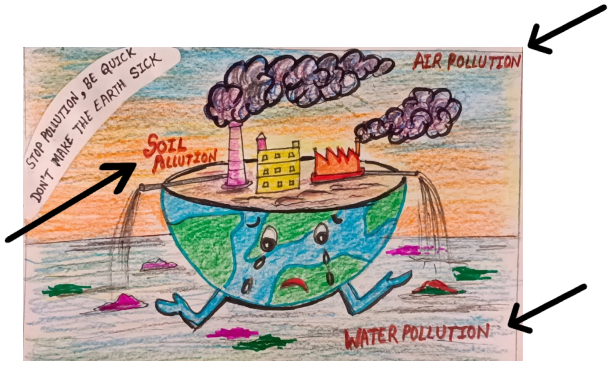
LENR Displacement of Fossil Fuels Also Mitigates Impacts at the Earth's Surface!



https://www.youtube.com/watch?v=ywzqHyIjD_w

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Beyond Fossil Fuel Displacement…

- Many LENR opportunities!
  - ***Current*** fossil fuel operations (LENR as supplement)
  - ***Legacy*** pollution from fossil fuel sources
- Proposed approach…
  - Organize around air, water, land, public health
  - Focus on LENR energy for ***current technologies***
  - Seek technology improvements

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Air Quality Example

- Power plant emissions
  - Sulfur dioxide (acid rain)
  - Flue gas desulfurization (FGD)
  - Scrubber sludge disposal
- LENR energy opportunities
  - Power for FGD operations
  - FGD sludge cleanup
  - Technology improvements?

Power Plant for Electricity Generation

https://wyofile.com/stakeholders-hint-at-deal-to-avoid-partial-jim-bridger-plant-shutdown/

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Water Quality Example

- Abandoned coal mine drainage
  - Acid discharges to streams
  - Groundwater contamination
- LENR energy opportunities
  - Outflow capture & treatment
  - Cleanup of impacted rivers & streams
  - Groundwater pump & treat
  - Technology improvement?

Acid Mine Drainage

https://en.wikipedia.org/wiki/Acid_mine_drainage

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Land Pollution Example

- Refinery sludge landfarm
  - Land treatment using bacteria in soils (Organics and heavy metals)
  - Soil contamination, groundwater pollution
  - Loss of food/fiber producing soils
- LENR energy opportunities
  - Alternative sludge treatment technology
  - Contaminated soil cleanup
  - Groundwater pump and treat
  - Technology improvements?

Land Treatment Operation

https://www.enviro.wiki/index.php?title=Landfarming

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Groundwater Contamination Example

- Petroleum product tank farm
  - Tank leakage into subsurface
  - Hydrocarbon pollution of aquifer
  - Pump and treat contaminated groundwater
- LENR energy opportunities
  - Power for pumps
  - Treatment of polluted groundwater
  - Technology improvements?

Petroleum Product Tank Farm

http://industrial-integration.com/tank-farm-oil-gas/

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Public Health Example: A Special Case

- Nuclear power plants – spent nuclear fuel rods
  - High-level (ionizing) radiation
  - Public health issue for exposure
  - Currently stored at or near power plants
  - Nuclear waste long-term storage issues
- LENR opportunities
  - Transmutation of long-half-life to short-half-life radioactive elements
  - Shorten storage requirement from 1000s of years to decades
  - Construction of storage facilities

Nuclear Waste Storage

Not yet demonstrated as technically feasible or cost-effective!

https://www.theatlantic.com/magazine/archive/2017/10/what-lies-beneath/537894/

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Summary: LENR Opportunities for Maintaining Earth's Habitability

- Dealing with ***Global Climate Change***
  - Displacement of fossil energy sources
  - GHG removal from emissions
  - GHG recovery from the atmosphere
  - Energy for dealing with huge GCC impacts
- Mitigating ***Impacts at Earth Surface***
  - Displacement of fossil energy sources (not only GCC)
  - Energy source for air, water, land and health impacts
  - Mitigation of legacy fossil fuel problems
  - Transmutation of nuclear waste?
- High-Level ***Conceptual Model*** for Detailed Analysis

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Questions?

Thomas W. Grimshaw, Ph.D.
LENRGY, LLC
Austin, TX, USA
thomaswgrimshaw@gmail.com
512-784-1078

David J. Nagel, Ph.D.
NUCAT Energy, LLC
Falls Church, VA, USA
david.j.nagel@gmail.com
703-402-7319

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