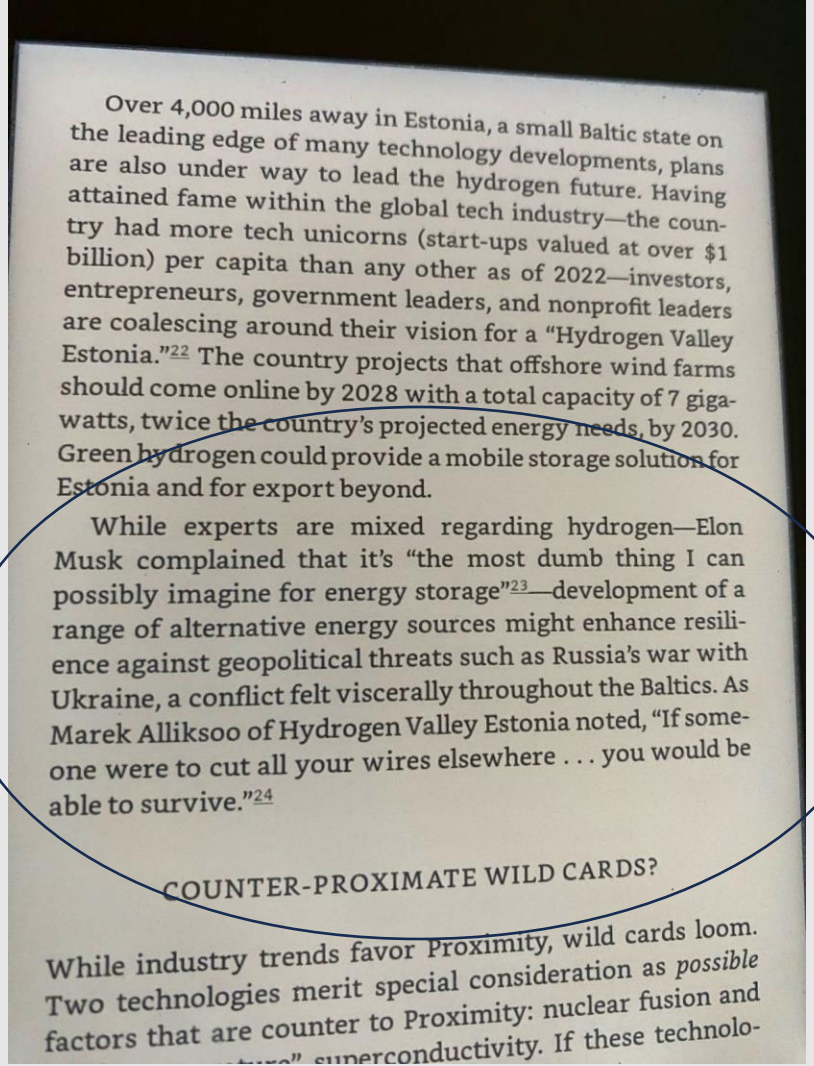
Hydrogen and (Energy) Security

Hydrogen Valley Estonia

Marek Alliksoo – 18.10.2024
8th University of Tartu Hydrogen Day



Over 4,000 miles away in Estonia, a small Baltic state on the leading edge of many technology developments, plans are also under way to lead the hydrogen future. Having attained fame within the global tech industry—the country had more tech unicorns (start-ups valued at over $1 billion) per capita than any other as of 2022—investors, entrepreneurs, government leaders, and nonprofit leaders are coalescing around their vision for a "Hydrogen Valley Estonia."[22] The country projects that offshore wind farms should come online by 2028 with a total capacity of 7 gigawatts, twice the country's projected energy needs, by 2030. Green hydrogen could provide a mobile storage solution for Estonia and for export beyond.

While experts are mixed regarding hydrogen—Elon Musk complained that it's "the most dumb thing I can possibly imagine for energy storage"[23]—development of a range of alternative energy sources might enhance resilience against geopolitical threats such as Russia's war with Ukraine, a conflict felt viscerally throughout the Baltics. As Marek Alliksoo of Hydrogen Valley Estonia noted, "If someone were to cut all your wires elsewhere . . . you would be able to survive."[24]

COUNTER-PROXIMATE WILD CARDS?

While industry trends favor Proximity, wild cards loom. Two technologies merit special consideration as *possible* factors that are counter to Proximity: nuclear fusion and superconductivity. If these technolo-

Carbon zero by 2050

From "Proximity" by Robert C. Wolcott and Kaihan Krippendorff

Which is more difficult to attack physically or virtually – 4000 distributed RES or 1 centralised (nuclear) power plant?

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on **off**

- Ukraine's Ministry of Energy conversation in Nov 2022 on key take-ways (having 5M+ people without heat and power at the time):

- Distributed energy and hydrogen
- Deeptech and dual-use focus
- Digitalisation

Still producing

From energy storage and national resilience to supporting microgrids

As highlighted by NATO back in 2018-2019

- In a post-fossil fuel era, research and development is required on various different means of energy production. NATO partners across the globe, such as Japan, are ambitious in pioneering as a “hydrogen society”. The vision in Tokyo is that hydrogen can be a decisive response to the country´s energy and climate challenges. One of the articles in this Operational Highlights provides an overview of hydrogen as part of a resilient energy strategy for NATO defence.
- This monumental change is also visible within NATO militaries. Promising examples from the US military bases in Mississippi, California, and Massachusetts show the integration of solar and wind-powered micro grids to support the bases and provide them energy independency and security.
- Nothing new here, we wouldn’t be on the Moon nor on Mars without fuel cells

Whose interest is it to not have energy security?

The environmental challenges that NATO has faced are compounded by climate-related disinformation. Malign actors seek to erode the public pressure and political will for ambitious climate action, as well as to divert focus and resources away from climate change adaptation and mitigation efforts.

Kremlin-backed actors have been found to be pushing climate change denialism across the Alliance, all while actively attempting to derail climate change mitigation policies and renewable energy investments.[90] Russian state media routinely amplify uncertainty around climate change and downplay the phenomenon as exaggerated or even positive. They frame global warming as a "hoax" and emission-reduction plans as a form of "Western imperialism" engineered to undermine the development of emerging economies.[91] Denial of anthropogenic climate change persists in Russia largely due to the entangled ties between the fossil fuel industry and political power, and the country's ongoing dependence on fossil fuels as a dominant source of government revenue. Individuals who challenge scientific consensus on climate change continue to hold political power.[92]

From "NATO Climate Change and Security Impact Assessment 2024"

<u>Sounds familiar right?</u>

- It's a hoax
- It's not possible
- Strawman arguments
- Repetition of out-dated/incorrect "facts"
- "Deny, deceive, delay"

Winners:
Hostile nations
O&G giants
Disaster profiteers

A notable increase in Russian disinformation related to the European green energy transition has been observed since the beginning of Russia's full-scale invasion of Ukraine. According to NATO's Information Environment Assessment for the period May 2022 to May 2024, Russia was found to be the main driver of hostile communications in online conversations about the green energy transition on social media and web news media.[93] In 2023, efforts to spread mis- and disinformation were evident in the run-up to the COP28 UN Climate Change Conference in Dubai. According to a 2023 report by the Climate Action Against Disinformation (CAAD) – a coalition of over 50 leading climate and anti-disinformation organisations – Russia and the PRC were listed among the countries found to be spreading climate-related disinformation. Russian state-backed accounts weaponised climate debates, with influence campaigns targeting Western countries and emerging and developing

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Hydrogen is one of the oldest tricks in the book for energy security

- “There is nothing new about producing hydrogen from wind power — in Denmark, at least. Back in 1894, the inventor Poul la Cour used electricity from a wind turbine to split water into oxygen and hydrogen gas. The gases were separately collected in tanks, stored in bottles, and used to light buildings, such as the Askov Folk High School.” – from “Green hydrogen is Danish hydrogen”
  - Those lights never went out during its years of use (throughout 2 world wars)
- Renewable energy and h2 are the ideal forms – decentralised, distributed, democratisized.
- Can be generated throughout numerous means, transported and consumed in a variety of ways

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Hydrogen in ~~energy~~ security

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U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND

Hydrogen Fuel Cell Technology and Its Military Applications

Kevin Centeck

Fuel Cell Technologies, Ground Vehicle Power & Mobility

Ground Vehicle Systems Center

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US DoD has a long history with h2

- Fuel Cell Technologies Team's Mission
- – Explore and evaluate fuel cell power generation technologies and their support equipment that enable tactical advantages for ground vehicle systems.
- Fuel Cell Technologies Team Overview
- □ Recent and Ongoing projects
  - □ Solid Oxide Fuel Cell (SOFC) + JP-8 Reformation Auxiliary Power Unit Fuel Cell All Terrain Transport (FCATT, Hydrogen based)
  - General Motors Colorado ZH2 & SURUS
  - Tactical Hydrogen Operational Refueler (THOR) and JP-8 reformation systems
  - GM Hydrogen Ecosystem (Silverado ZH2 + Hydrogen Generation Capability)
- Expertise focused on SYSTEM level development, test, and demonstration. Some limited independent research and development at lowest levels.

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Experience

SILENT MOBILITY, SILENT WATCH, & EXPORTABLE POWER

- **Silent watch – providing 2.5kW of export power for 24 hours on 4kg of h2**
- **Undetected distance (~100 m) during night ops (a 75-90% improvement)**

1st Prototype Tactical Hydrogen Operational Refueler (THOR)

- SAE J2601 700 bar T20 fueling
- Contained within a 20 foot ISO shipping container that can be handled by existing Army trucks
- 54 kg of DOT approved hydrogen storage

Cylinder after RPG test

1st Prototype JP-8 Reformer

- 18-30 kg H2 per day
- Skid mounted, forklift, 600 lbs
- Low power requirement during operation (~600W)
- Scalable system design

"If we can creep up on the enemy and can do it stealthily in our vehicle, we can accomplish our mission more efficiently."

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Redundancy

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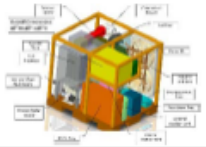
HYDROGEN GENERATION OPTIONS (VIABLE SUPPORT)



Multi-Fuel Reformer

- Use when other fuels are widely available in a region
- Best choice for reforming on the move

Benefits

- Produce a common fuel from multiple sources
- Reduce fuel transportation by using local resources

Aluminum Powder

- Only requires a water source

Benefits

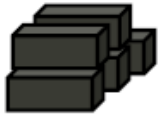
- Reduce logistics through reuse of waste products
- Can use gray and/or salt water

Electrolysis

- Use when access to electrical infrastructure or renewables is available

Benefits

- Reduce logistics through reuse of waste water
- Mature, commercially available



Solid State Hydrogen

- Use when increased range and energy dense storage is required

Benefits

- Can be transported with dry cargo
- Requires no capital investment in hardware

Multiple options for hydrogen generation based on the operational scenario and available local resources

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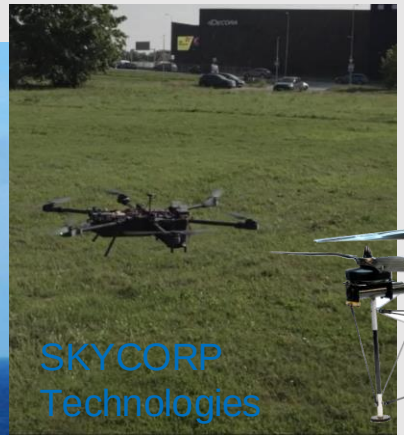
There’s plenty more

- Ultra-silent submarines with increased autonomy (i.e. class 212A launched 2002 using SINAVY PEM FC tech or Spanish S-80, or Swedes or …)
- Unmanned Undersea Vehicles, Unmanned Sea Vehicles
- Tanks (M1 Abrams, 2010 – FC’s as support for on-board electrics)
- Fuel cell drones
- Fuel cell generators (and FC’s in data centres)
- Wearable fuel cells (more energy, less weight compared to LiPO’s), ex: H3-TEYA
- + Methanol use-cases


Boeing Insitu Scaneagle3


SKYCORP Technologies


EnergyOR

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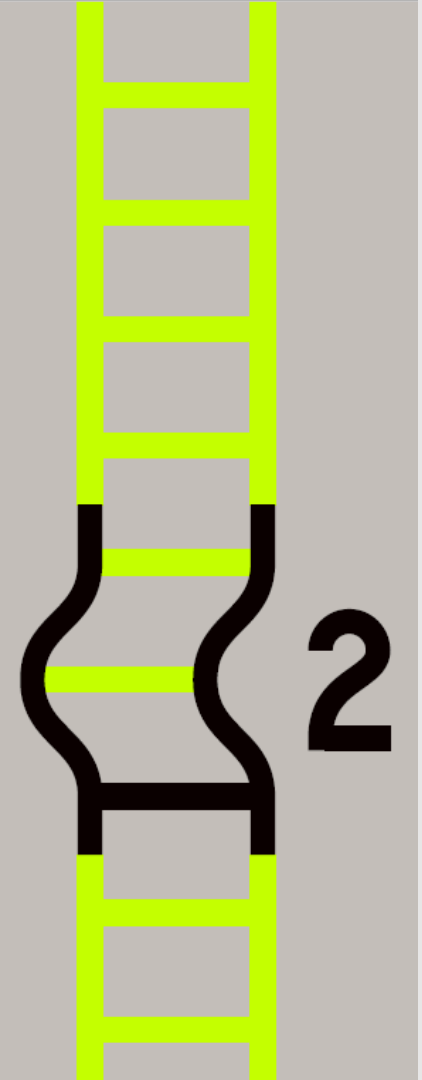

From Zero to Green!

And resilient!

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