IEEE SusTech Initiative

Sustainability Through Technology

planet positive 2030

Imagine The Future We Can Build Together

Hot Topics

SusTech 2024 – Sustainability Forum

April 17, 2024

Maike Luiken & Carole Graas

IEEE

IEEE SusTech Initiative
Sustainability Through Technology

Some of the Initiatives led by IEEE and its Committees

IEEE Future Directions (FDC)

https://www.ieee.org/about/technologies.html
Email us at: fdc@ieee.org or c.graas&ieee.org or w.r.tonti@ieee.org

IEEE FUTURE DIRECTIONS

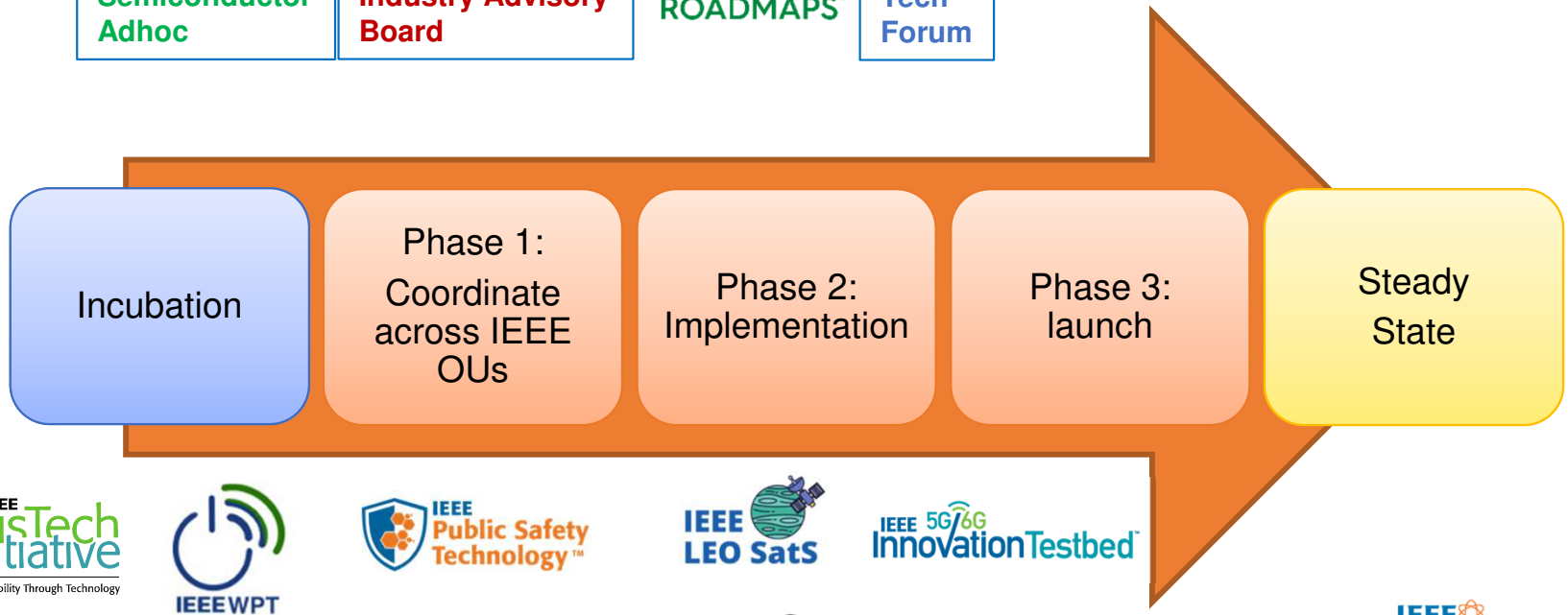
2023 - 2024 FDC Initiatives and Technical Activities

Incubation to Steady State @ 10K feet

IEEE SusTech Initiative
Sustainability Through Technology

5 FDC Technical Activities

- IEEE Global Semiconductor Adhoc
- Future Directions Industry Advisory Board
- IEEE ROADMAPS™
- Future Tech Forum
- TechNav AI



11 FDC Initiatives

- IEEE SusTech Initiative – Sustainability Through Technology
- IEEE WPT
- IEEE Public Safety Technology™
- IEEE LEO Sats
- IEEE 5G/6G InnovationTestbed™
- IEEE Metaverse
- IEEE Digital Privacy
- IEEE SMART LIGHTING
- IEEE Telepresence
- IEEE QUANTUM

Opportunities On AI

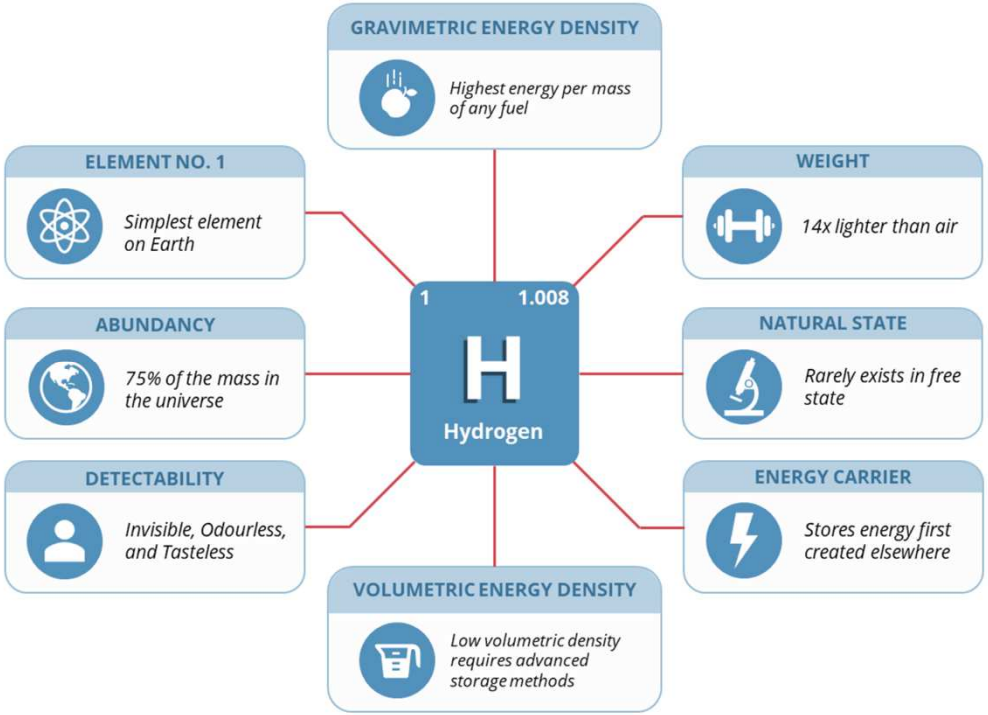
IEEE FUTURE DIRECTIONS

https://cmte.ieee.org/futuredirections/projects/climate-tech/

Topics

- Greenhouse Gas Emissions Reduction
  - Energy System Transformation
    - **(Green) Hydrogen**
    - **Marine Carbon Dioxide Removal (mCDR) & Measurement, Reporting, Verification (MRV)**
- Circular Economy
  - Commodity Transformation
    - **Digital Product Passport** (European Union)

Energy Systems Transformation: Hydrogen



Hydrogen Strategy for Canada, NRC, 2020,
https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

Energy Systems Transformation: Hydrogen

IEEE SusTech Initiative
Sustainability Through Technology

	Production Process	Feedstock & energy source	Pros and Cons	Examples
GREY	 Produced by steam methane reformation without carbon capture and sequestration (CCS)	**Feedstock:** natural gas, gasified coal	Pros: lowest cost, abundant Cons: highest carbon intensity	Canada produces approximately 3 million tonnes of grey hydrogen per year primarily for industrial use.
BLUE	 Produced from fossil fuels by steam methane reformation, pyrolysis or other processes with carbon capture and sequestration (CCS).	**Feedstock:** natural gas, coal, crude bitumen	**Pros:** low-cost, abundant, low CI, pyrolysis offers scale and siting flexibility **Cons:** SMR pathway siting is constrained by CCUS, feedstock is not renewable	Alberta's Quest project
GREEN	 Produced from water by electrolysis using renewable electricity such as hydroelectricity, wind or solar.	**Feedstock:** Water **Energy source:** Renewable electricity	**Pros:** lowest carbon intensity, scalable **Cons:** highest cost, opportunity cost - competes with electrification demand	Air Liquide's 20 MW electrolyzer plant in Becancour, Projects developing in BC to support hydrogen fueling network.
NUCLEAR	 Produced from water by electrolysis or high temperatures from nuclear energy	**Feedstock:** Water **Energy source:** Uranium / nuclear electricity	**Pros**: low carbon intensity **Cons:** limited availability and siting constraints	Feasibility study planned in Bruce County.

Hydrogen Strategy for Canada, NRC, 2020, https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

Energy Systems Transformation: Hydrogen

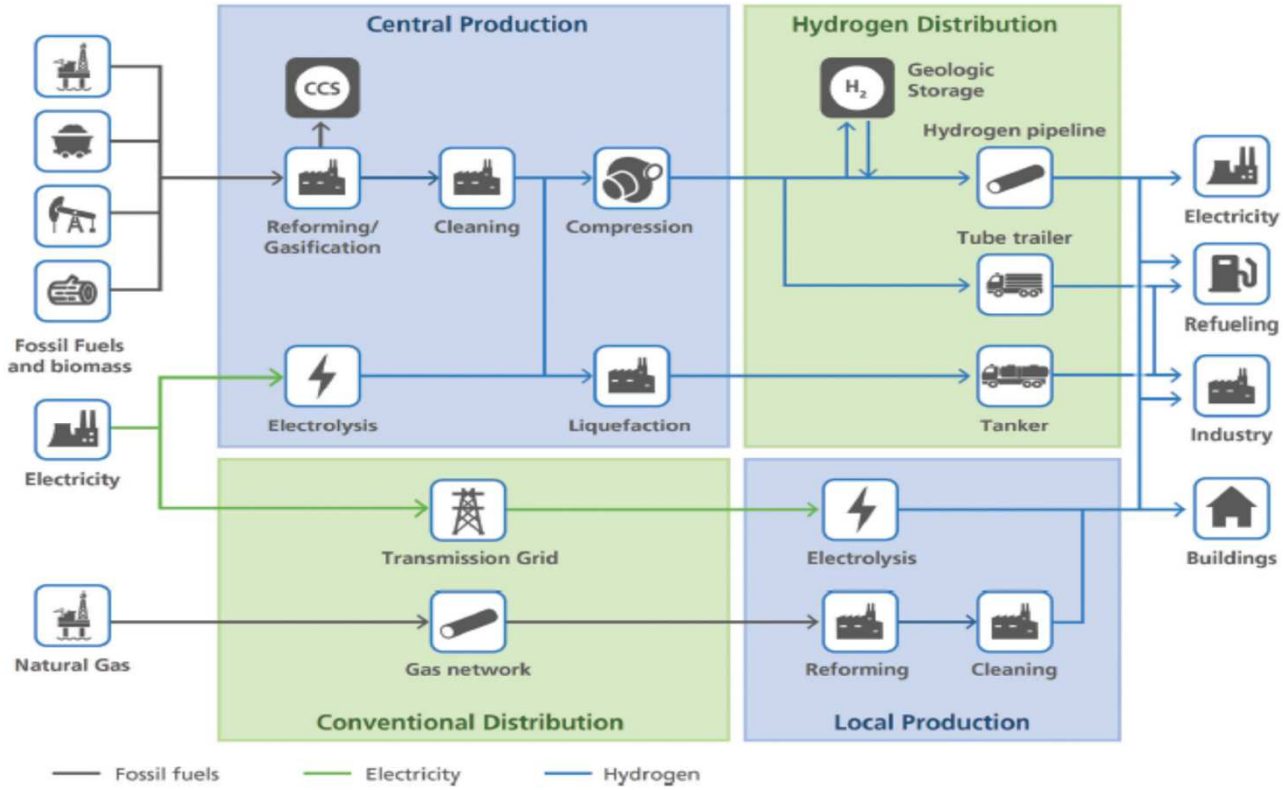


Figure 3- A breakdown of the hydrogen economy showing how different energy resources and systems work together to provide decarbonized energy to various sectors [10].

Hydrogen Strategy for Canada, NRC, 2020, https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

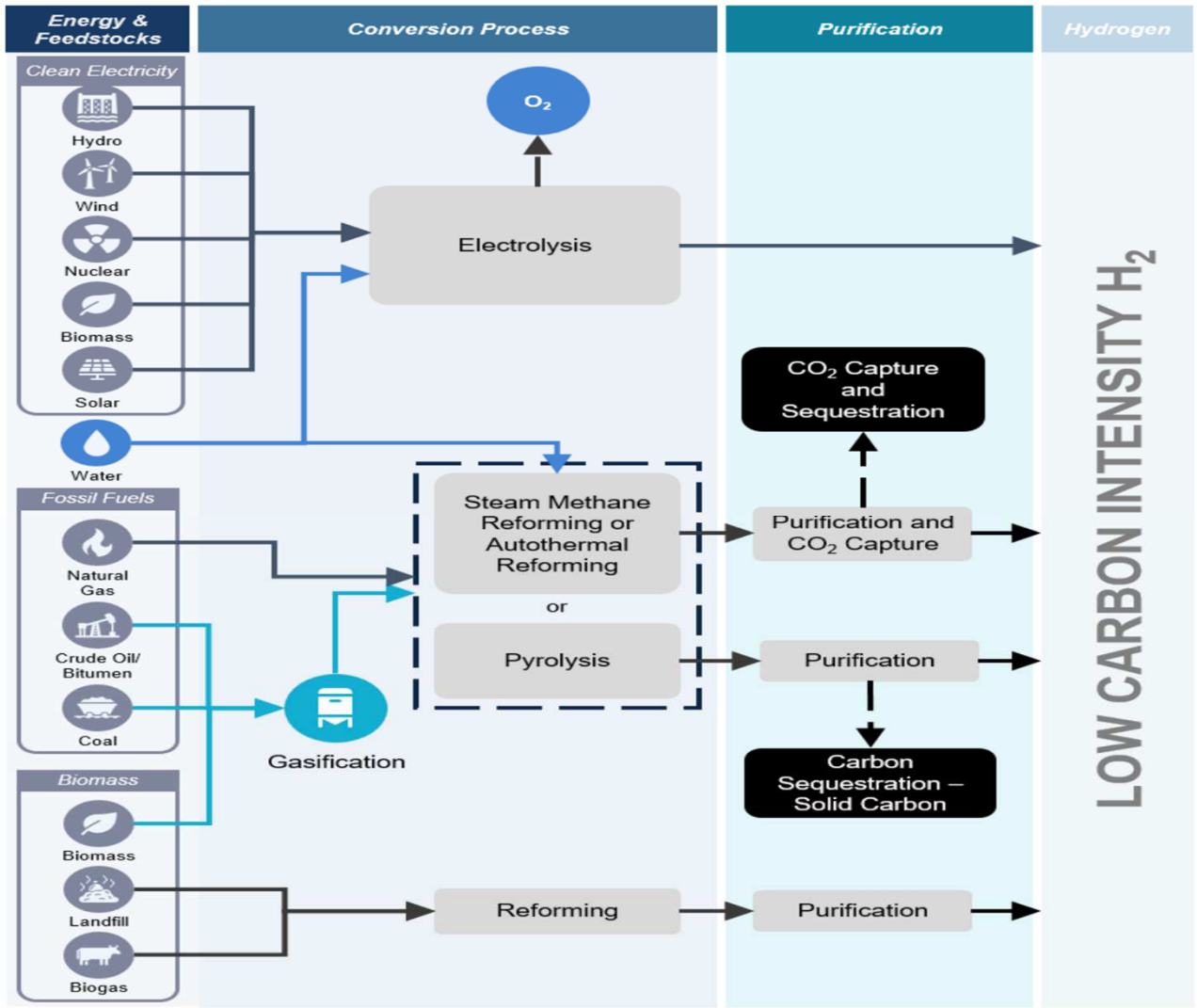


Figure 11 – Hydrogen Production Pathways in Canada

Hydrogen Strategy for Canada, NRC, 2020, https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

Energy Systems Transformation: Hydrogen

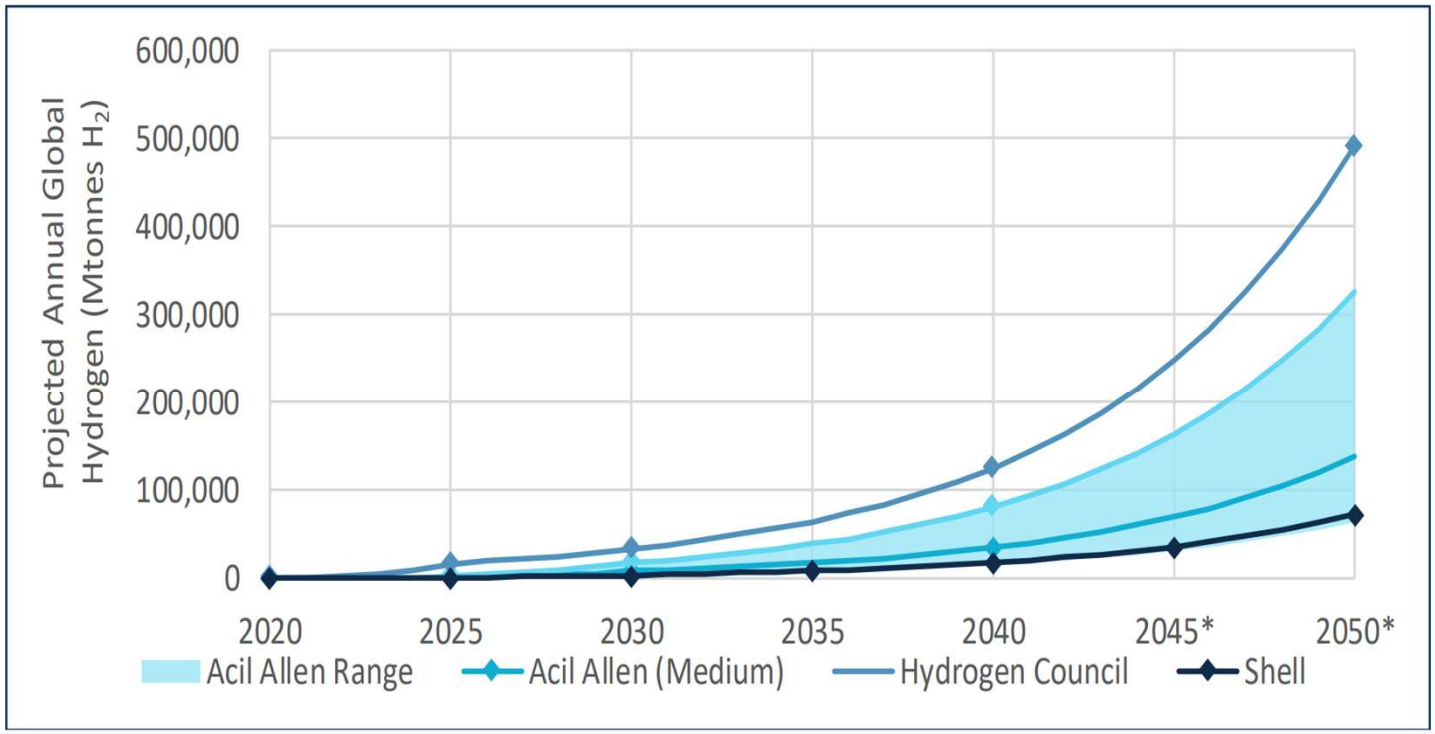


Figure 9 – Ranges of Estimates for Annual Global Hydrogen Demand

Hydrogen Strategy for Canada, NRC, 2020, https://natural-resources.canada.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

Energy Systems Transformation: Hydrogen ?

***Pink Hydrogen* - produced from Nuclear Energy**

***Green Hydrogen* – produced from Renewable Energy**

Why Hydrogen as part of the Energy Systems Transformation?

- For electricity storage
- For electricity transport
- To capture stranded (renewable) electrical power -> produce (and transport) hydrogen for:
  - Later production of electricity,
  - Direct use in industrial processes, or
  - Injection into natural gas system for heating etc. (called Power to Gas, limited %)

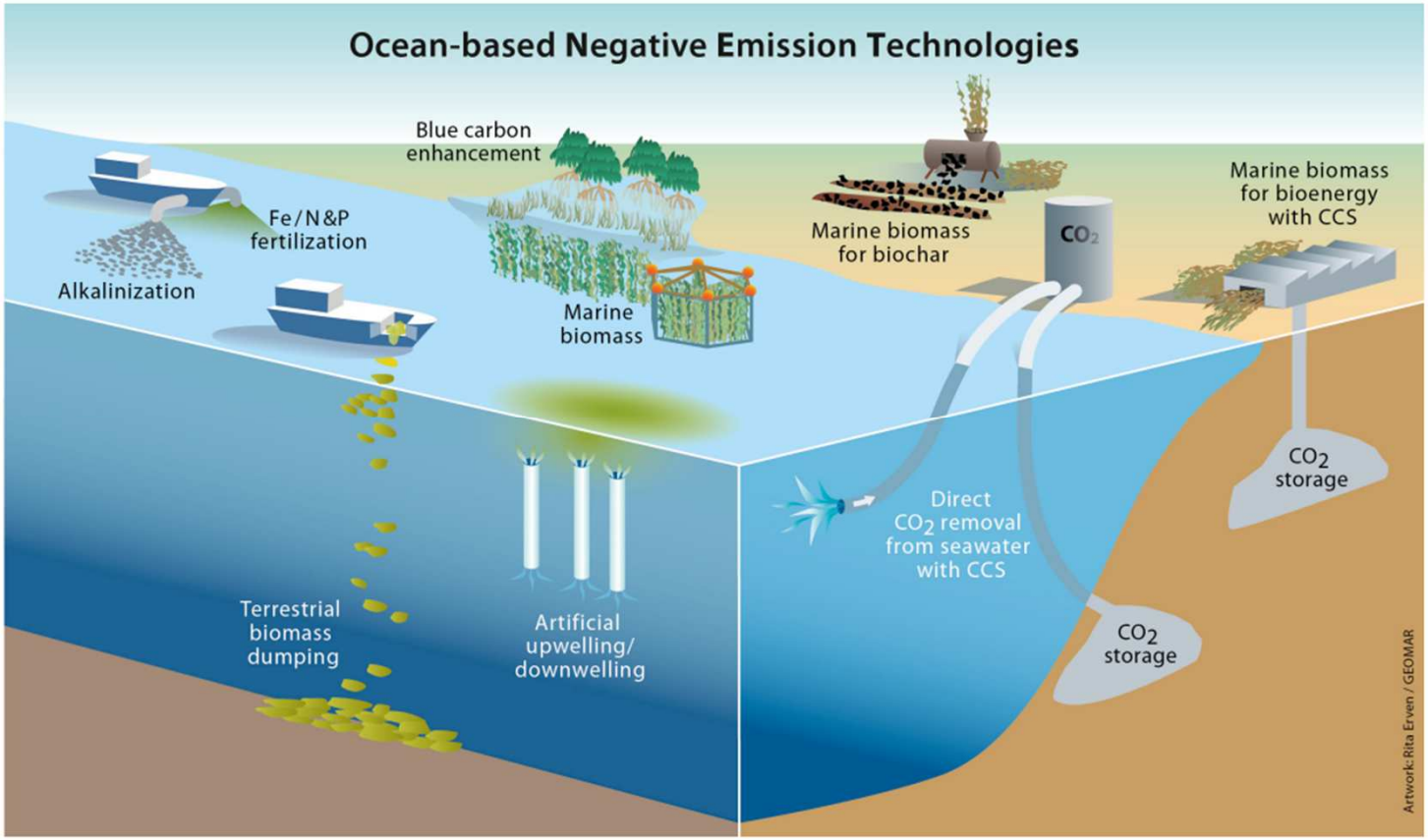
Consider:

- Many ways to produce hydrogen – conversion losses, CO_2 production …
- Water needs for production and/or cooling i.e. electrolysis (see Alberta: https://watersmartsolutions.ca/wp-content/uploads/2023/06/WaterSMART_Hydrogen-Study_Report_V1.pdf)
- Potentially potable water and heat as co-products from conversion to electricity (fuel cell)
- Fugitive Hydrogen – H2 is a very small molecule, hard to contain
  - Not a GHG, but Indirect impact / indirect GHG impact
    - On low Ozone layer
    - On longevity of methane in the atmosphere
- Production of water vapor … a very potent GHG
- Hydrogen transport – not simple (gas (truck or pipeline), ammonia, methane, ….)
- cost

Topics

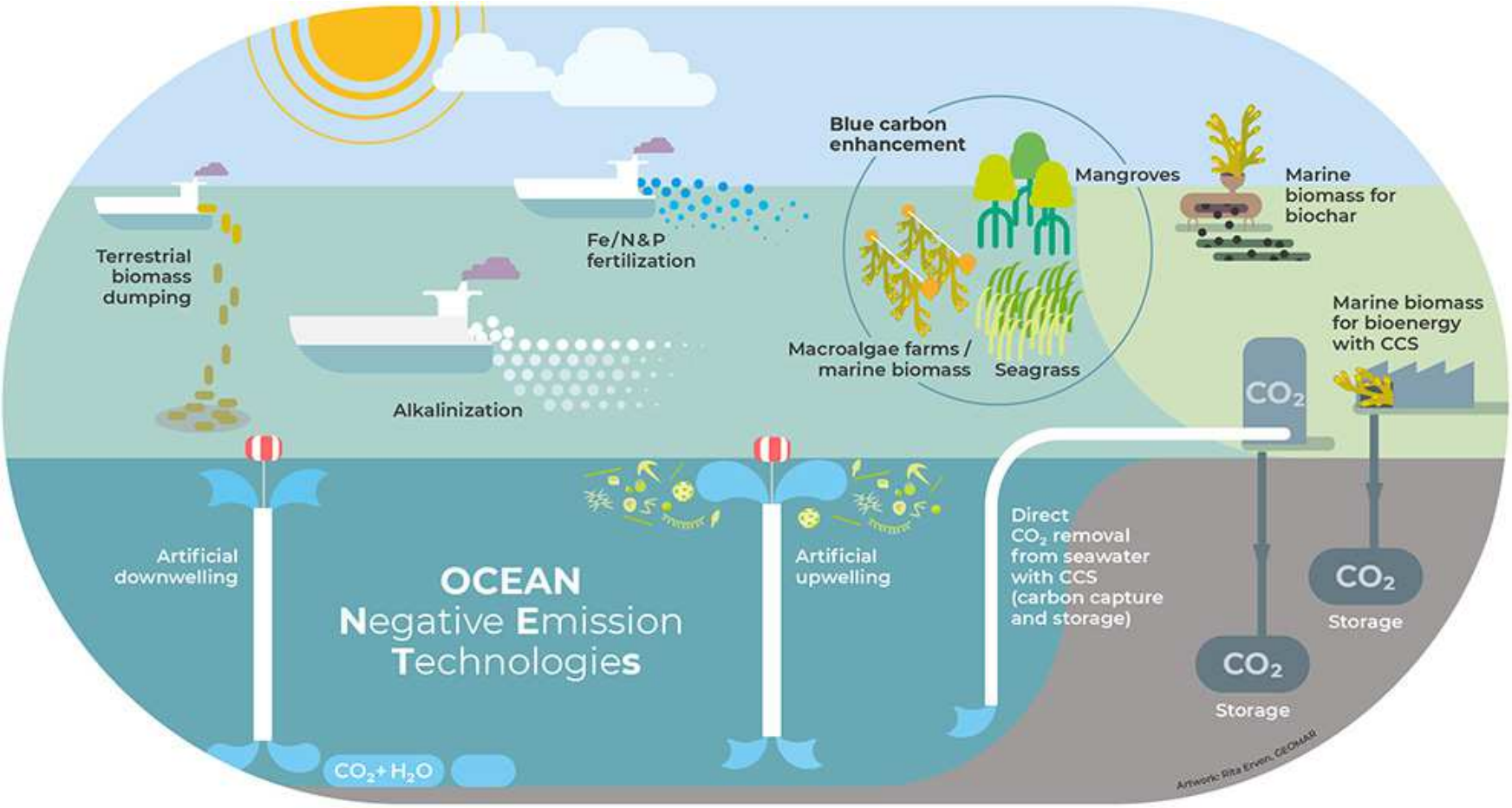
- Greenhouse Gas Emissions Reduction
  - Energy System Transformation
    - **(Green) Hydrogen**
    - **Marine Carbon Dioxide Removal (mCDR) & Measurement, Reporting, Verification (MRV)**
- Circular Economy
  - Commodity Transformation
    - **Digital Product Passport** (European Union)

CO_2 Sequestration: mCDR



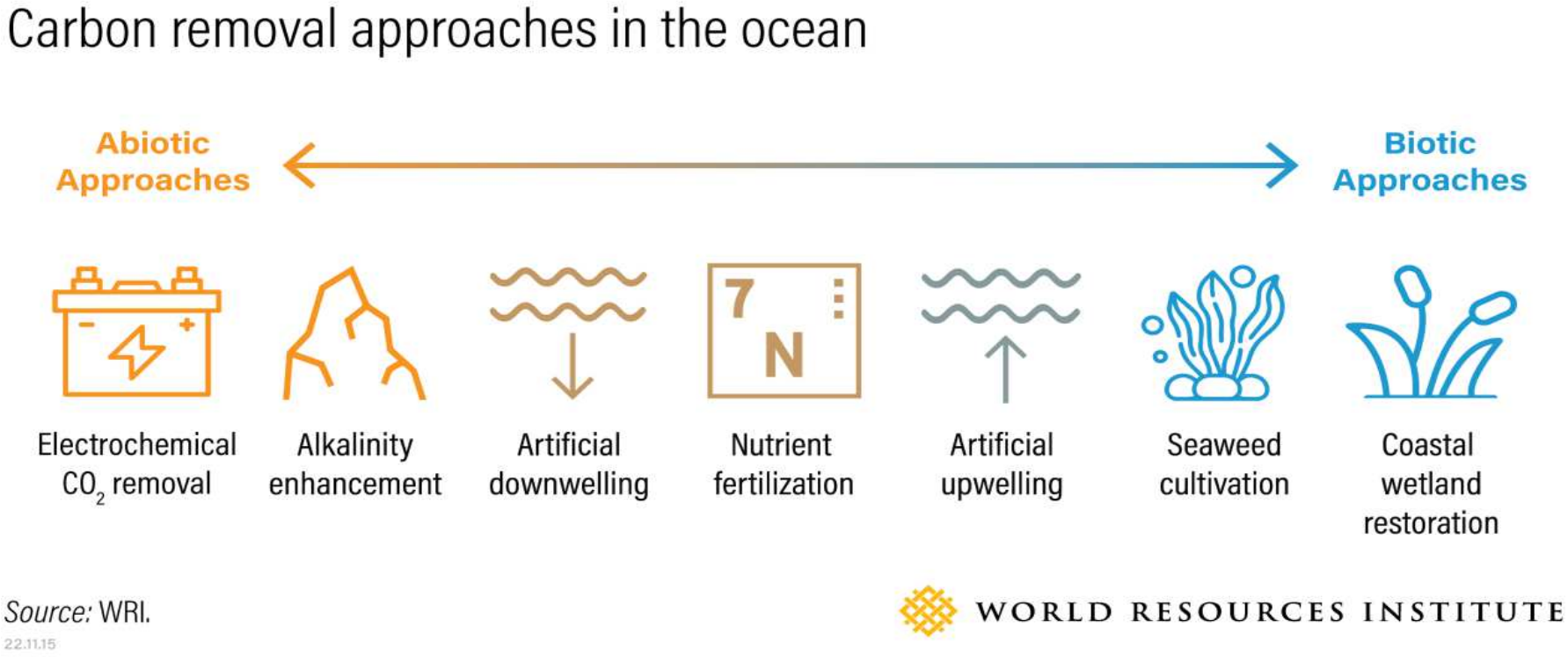
James R. Collins, Marine Biogeochemical Scientist, EDF
Sarah R. Cooley, Director of Climate Science, Ocean Conservancy
Lisa Suatoni, Deputy Director Oceans, NRDC,
Ocean Carbon Dioxide Removal Methods, 2022
Oceans-CDR-22-12-B_03_locked.pdf (oceanconservancy.org)

CO_2 Sequestration: mCDR



Pew Charitable Trust: https://www.pewtrusts.org/en/trend/archive/winter-2022/how-to-reverse-the-ocean-climate-crisis

CO_2 Sequestration: mCDR



https://www.wri.org/insights/ocean-based-carbon-dioxide-removal

Topics

- Greenhouse Gas Emissions Reduction
  - Energy System Transformation
    - **(Green) Hydrogen**
    - **Marine Carbon Dioxide Removal (mCDR) & Measurement, Reporting, Verification (MRV)**
- Circular Economy
  - Commodity Transformation
    - **Digital Product Passport** (European Union)

Wien, Novembre 22, 2023

Digital Product Passport –

Perspective of the European Commission

Ilias IAKOVIDIS

Advisor, Digital aspect of Green Transition,

DG CONNECT, European Commission

Thomas Ebert

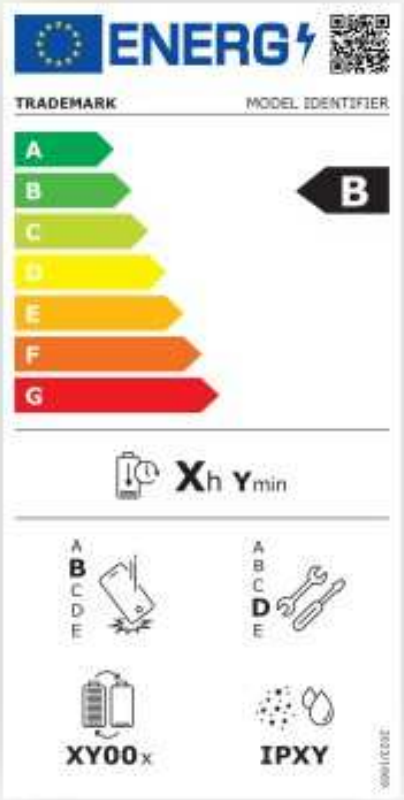
Policy Analyst – Seconded National Expert DG

CONNECT, European Commission

European Commission

Ecodesign requirements

- **extending the lifetime** of all smartphones in the EU by one year would save **2.1 million tonnes of CO_2 per year by 2030**, the equivalent of taking a million cars off the roads.
- to improve circularity (e.g. durability, reparability, refurbishment, recycling)
- resistance to accidental drops or scratches and protection from dust and water
- batteries have to retain at least 80% of initial capacity after 800 cycles
- rules on disassembly and repair, including obligations for producers to make critical **spare parts** available within 5-10 working days, and **for 7 years**
- non-discriminatory access for professional repairers to any software or firmware needed for the replacement
- availability of **operating system upgrades** for **at least 5 years**



(EU/2023/1669)

Key product value chains

Food, water & nutrients

Electronics and ICT

Batteries & vehicles

Construction & buildings

Packaging

Textiles

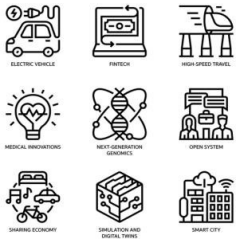
Plastics

COM/2020/98 final

European Commission

Digital Product Passport – Expected Benefits

Tracking of **raw materials extraction/production**, supporting due diligence efforts



Enable **manufacturers** to connect products' **digital twins** to their products, embedding all the information required.

Tracking the life story of a product, enabling services related to its **remanufacturing**, **reparability, re-use/re-sale/second-life, recyclability**, new business models

Benefit **market surveillance authorities and customs authorities**, by making available information they would need to carry out their tasks

Make available to **public authorities and policy makers** reliable information. Enable to link **incentives** to **sustainability performance**

Allow **citizens** to have access to **relevant and verified information** related to the characteristics of the products they own or are considering to buy/rent (e.g. using apps able to read the identifier

European Commission

Digital Product Passport – Design

DPP-system

(to be developed before DPP deployment)

Digital Product Passport

DPP-data

(to be identified when developing product-group specific secondary legislation)

- All standards and protocols related to the IT architecture, like standards on:
  - Data carriers and unique identifiers
  - Access rights management
  - Interoperability (technical, semantic, organisation), including data exchange protocols and formats
  - Data storage
  - Data processing (introduction, modification, update)
  - Data authentication, reliability, and integrity
  - Data security and privacy
- The DPP registry

Possible Track & Trace identifiers

- Economic operator's name, registered trade name
- Global Trade Identification Number or equivalent
- TARIC code
- Global location number
- Authorised representative
- Reference of the back-up data repository
- …

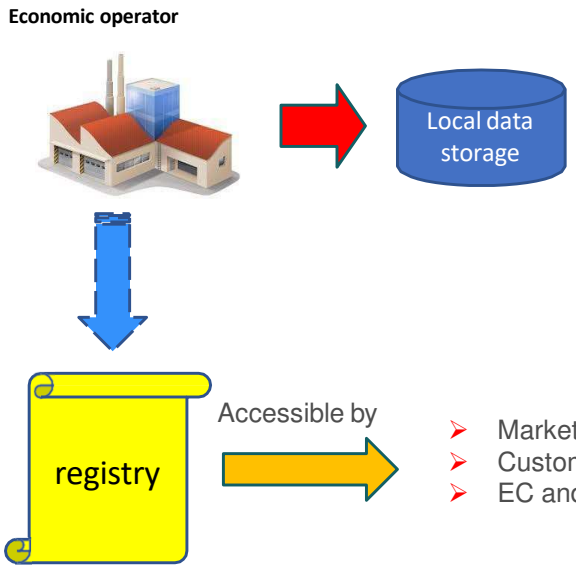
Example of potential attributes

- Description of the material, component, or product
- Recycled content
- Substances of concern
- Environmental footprint profile
- Classes of performance
- Technical parameters
- …

European Commission

DPP – Architecture

Decentralised system (information stays where it belongs)



- Product related data
- Circularity/sustainability information
- Supply-chain related information
- Certificates/manuals
- Identifiers (these go also to the registry)

- Market surveillance authorities
- Customs authorities via the EU Single Window Environment for Customs
- EC and Member States (statistical analyses)

- Unique product identifier (what)
- Unique operator identifier (who)
- Unique facility identifier (where)
- Additional information (when relevant)

- Better protection of confidential and sensitive information
- Size of a central database would be enormous and very difficult (and costly) to set up and manage
- Dynamicity of product-specific information can be better managed locally

European Commission

DPP in Legislation

- Battery regulation (EU 2023/1542)

From 18 February 2027 each LMT battery, each industrial battery with a capacity greater than 2 kWh and each electric vehicle battery placed on the market or put into **service shall have an electronic record ('battery passport').**

- Under negotiation:

- Ecodesign for sustainable products regulation (ESPR; COM/2022/142 final): see working plan (textiles and footwear, iron and steel)
- DPP and digital labelling in other proposals:
- Construction Products (COM(2022) 144 final); Toys (COM/2023/462 final); Detergence and surfactants (COM(2023) 217 final); Packaging (COM(2022) 677 final); end-of-life vehicles (COM(2023) 451 final)
- Critical Raw Materials Act (COM(2023) 160 final); classification, labelling and packaging (COM(2022) 748 final)

European Commission

IEEE SusTech Initiative
Sustainability Through Technology

Some of the Initiatives led by IEEE and its Committees

IEEE FDC SusTech Initiative

IEEE FUTURE DIRECTIONS

Future Directions SusTech Initiative

A community of researchers and technologists solving the climate crisis

IEEE SusTech Initiative
Sustainability Through Technology

Energy

Low-C Emissions Energy Technologies Roadmapping

- Energy Storage
- Grid Modernization
- Renewables Scale-up

The Ocean

Measurement, Reporting and Verification (MRV) of Marine Carbon Dioxide Removal (mCDR)

- Webinars
- Technology Working Groups

Buildings

Registration Open!

Roadmap to Low-C Emissions Building Materials & Architecture

Upcoming Workshop IEEE SusTech2024

Arctic Regions

Energy and Climate Technologies for the Arctic

Register Now!

Upcoming Workshop Anchorage AK May 3-4, 2024

July '23 | October '23 | April '24 | May '24

IEEE

IEEE SA STANDARDS ASSOCIATION

planet positive 2030
Imagine The Future We Can Build Together

IEEE SA STANDARDS ASSOCIATION

planet positive 2030

Imagine The Future We Can Build Together

IEEE SusTech Initiative

Sustainability Through Technology

Maike Luiken
maike.luiken@ieee.org

John C. Havens
j.c.havens@ieee.org

Wei-Jen Lee
wlee@uta.edu

Maike Luiken
maike.luiken@ieee.org

Carole Graas
c.graas@ieee.org

You are invited. Join IEEE Initiatives Today!