CLEAN AIR TASK FORCE

Fast Track for Low Carbon Hydrogen

Creating investment security with smart regulation and permitting

About Clean Air Task Force

The Organization:

- Founded in 1996.
- Representations in Boston, Washington D.C., Brussels, Berlin and London
- 170+ staff working worldwide, from Berlin to Brazil to San Francisco to China.

The Mission: Lead the way to an affordable, zero-carbon energy system by advocating for pragmatic policies, new business strategies, and advanced technologies.

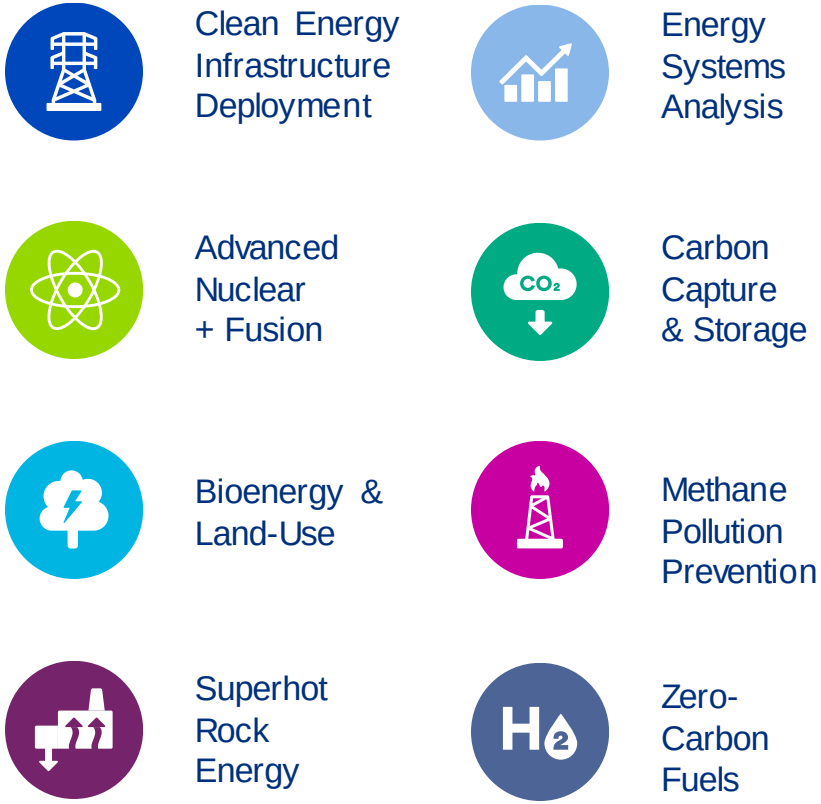
How we work:

- **Change the Narrative:** to communicate the size of the problem and totality of solution requirements.
- **Change Technology:** to have the full suite of options, including affordable and safe nuclear energy and decarbonized fossil fuels.
- **Change Business Models:** to include modular, manufacturable energy systems that can be deployed anywhere quickly.
- **Change Policy:** to develop, demonstrate, and scale up all the technologies and systems needed to achieve zero emissions by midcentury.

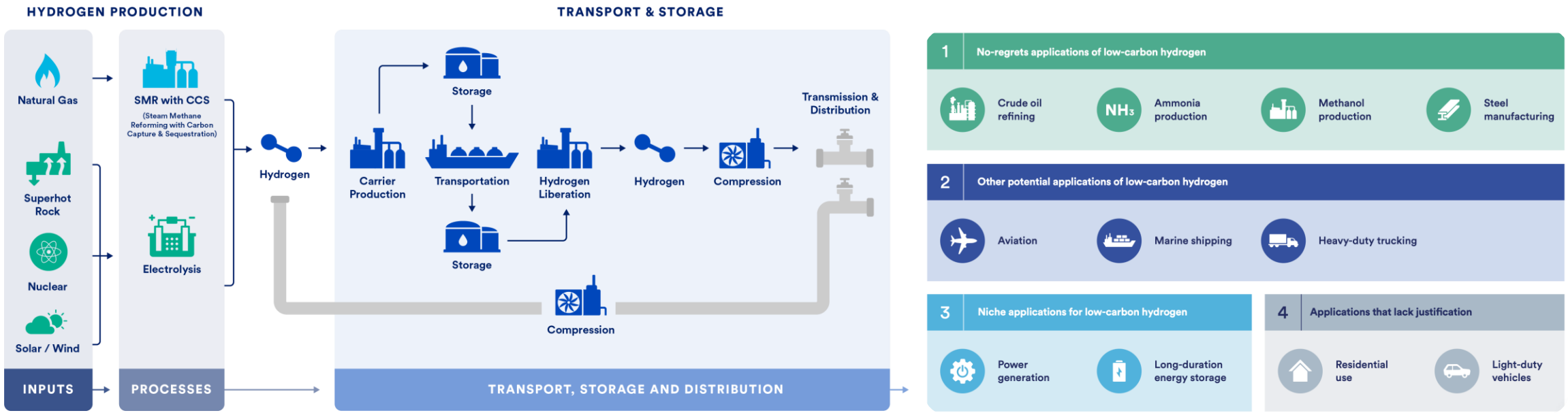
CATF in Europe

An energy secure, economically strong, climate-neutral Europe, that is delivering a blueprint for achieving net-zero emissions that **promotes technology optionality and supports global decarbonisation.**

- **Deep technical, policy, political and subject matter expertise** tapped into large and far-ranging public and private research networks
- **Strong collaborative DNA,** with a long history of developing and supporting advocacy networks of NGOs, think tanks, and industry-civil society coalitions
- **Focus on whatever it takes to realistically address climate management,** considering the full spectrum of technologies, with a track record of bringing less mainstream technologies and approaches (e.g., risk hedging strategies) into the centre of discussion
- **Both global and local,** not bound by national interest, and able to spot and exploit potential synergies between regions, while able to do granular dives into state level policy



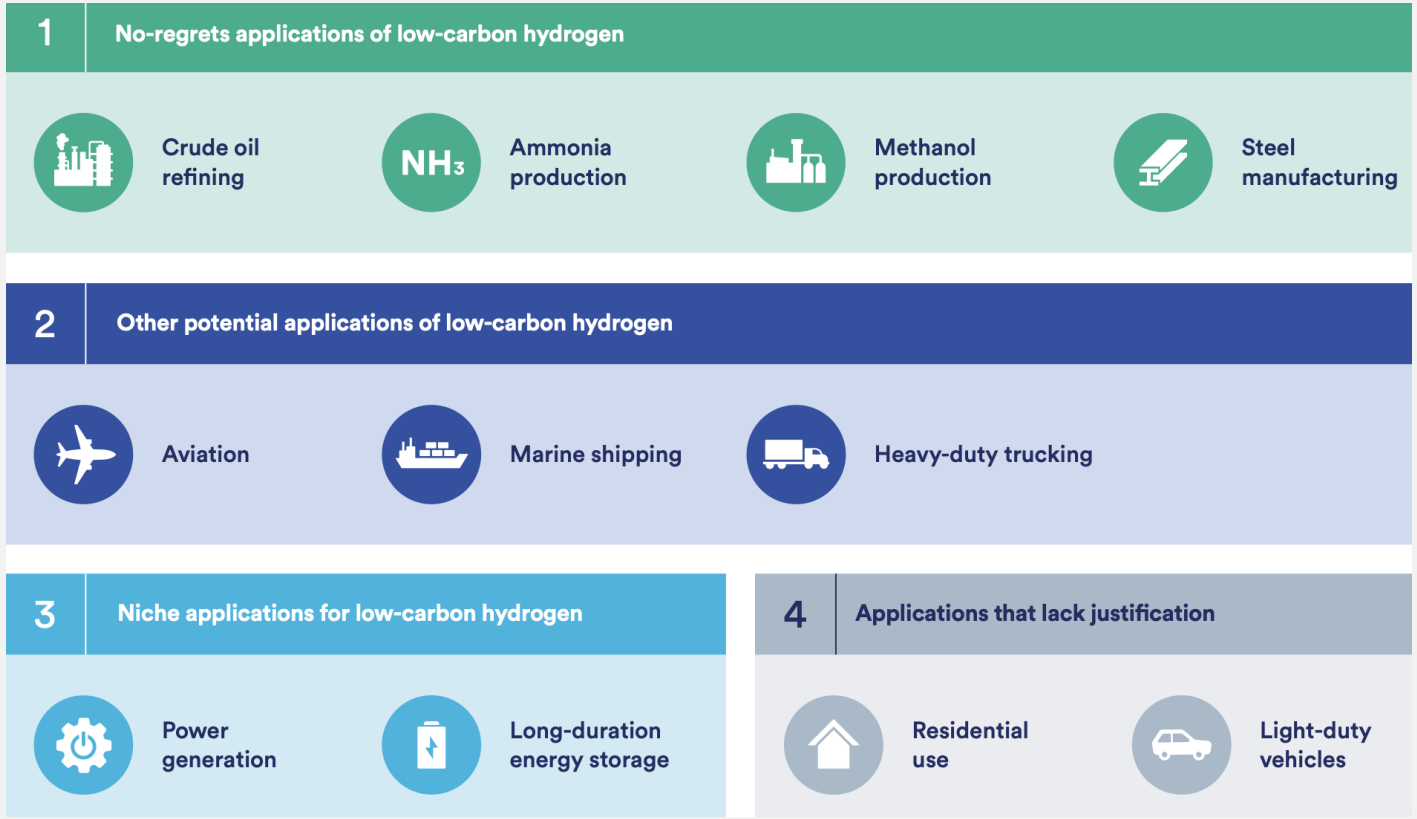
Prioritising End Use Application of Available Clean Hydrogen



Hydrogen is an essential pillar for **hard-to-decarbonise sectors, particularly those that rely on large quantities of hydrogen today.** It will remain a **critical feedstock for industrial purposes**, but its use **should be limited due to its energy-intensive nature and challenging properties.**

Prioritise the deployment of scarce clean hydrogen resources where it will deliver maximum climate benefit:

- Ensure clean hydrogen scaling and deployment as a feedstock or zero-carbon fuel in **no-regrets sectors.**
- Prioritise the decarbonisation of:
  1. Existing production and consumption of hydrogen today, including **refining, ammonia and methanol production.**
  2. Scaled/wider sectoral applications, as clean hydrogen availability permits, including **shipping, aviation and long-haul heavy-duty trucking**



Regulation: The EU delegated act for Germany

- 36-months rule for **off-grid installation** generating renewable energy prior to the installation of the installation producing renewable liquid and gaseous
- Until 31 December 2029 green electricity from the renewable plant can be used for green hydrogen when it has been produced within the **same month**
- After 31 December 2029: **same hour**, member states can decide to require hourly matching from 2027 onwards
- Electricity also could come from an “new” onsite **storage asset**.

Regulation: The EU delegated act for Germany

- Germany's current grid-sourced electricity does **not meet the EU criteria for renewable** hydrogen production, as the grid's carbon intensity is well above 65 gCO2eq/kWh, with less than half of Germany's electricity generation coming from renewable sources.
- Consequently, domestic green hydrogen production will follow two possible scenarios: concluding **Power Purchase Agreements (PPAs)** or pursuing a 'system-friendly' approach. The latter is limited by low full load hours, contributing to high costs and low return of investment and is therefore not attractive for private sector investors
- CATF supports a more comprehensive framework to further increase the attractiveness and competitiveness of PPAs, including a mechanism for making green subsidised electricity available on the 'free' PPA market and **index-based pricing** or a **price adjustment** that could be agreed upon during contract terms.

Germany Hydrogen Strategy Objectives

- Germany's updated Hydrogen Strategy shows an increased ambition for an accelerated and **technology-open** market ramp-up of climate beneficial hydrogen such as **green** and **blue hydrogen**

- Efficient deployment of other, low-carbon hydrogen production based on proven technologies – such as **steam methane** or **auto-thermal reforming** (SMR/ATR) with **carbon capture** and **storage** and **high upstream methane emissions** control, need to be rolled out as key intermediary solutions to bridge any existing volume gaps.

German Hydrogen Strategy: Sector-Coupling

- **Industry:** hydrogen to replace natural gas, oil, and coal as a feedstock; application in high temperature processes (e.g., steel production and chemicals).
- **Transport:**
  - ***Aviation*** **-** the sector will require low-carbon hydrogen to upgrade biomass-based sustainable aviation fuels (bio-SAF), synthesise jet fuel from hydrogen and captured carbon (synthetic SAF), and, potentially, to power small size aircraft that directly utilise hydrogen fuel.
  - ***Trucking*** **-** CATF analysis shows that hydrogen fuel cell electric vehicles (FCEVs) can play an important role alongside battery electric vehicles (BEVs) in decarbonising the trucking sector.
  - ***Maritime shipping*** **–** ammonia and methanol could be alternative fuels.

German Hydrogen Strategy: Sector-Coupling

- **Heating:** Using the heat from electrolysers for heat supply. Note: This implies that hydrogen is not used for heating directly.
- **Power sector:** Germany will soon publish its power plant strategy, which is understood to include building new hydrogen-ready gas-fired power plants. This entails numerous technological, infrastructure and system challenges beyond simply operating turbines on hydrogen. Electrolytic hydrogen in power generation comes with a very low round-trip efficiency, effectively "losing" three units of clean electricity.
- **Grid:** Electrolysers could help to optimise and stabilise the grid, but this grid service tasks should consider the economics and feasibility of such an application. Simulations show that smaller electrolysers are more suitable for grid placement however considerably larger systems would be needed to scale production efficiently.

Germany Hydrogen Strategy: Imports

- Germany will announce an **import strategy** for hydrogen and derivates
- CATF analysis reveals that for hydrogen imports to Northwest Europe, hydrogen pipeline transport is the lowest cost option when imported from nearby locations (e.g. Norway). For imports from further afield, ammonia transported via ship clearly emerges as the lowest-cost option, when applied for direct use.
- Commercially transporting liquefied hydrogen via ship has not been established while ammonia is a widely internationally traded commodity with around 10% of annual production being transported by sea.
- Hydrogen import from Norway could be the first step into the right direction, further collaboration with other regional neighbours (e.g., the UK and Netherlands) could help to ramp up the hydrogen market faster.
- SMR with CCS in Germany could be the bridge technology to close the gap between objectives and implementation
- Hydrogen standards and certification will be imperative to reduce costs for imports of hydrogen and derivates to ensure it is truly low carbon .

There is a challenging road ahead for hydrogen imports

- **Importing hydrogen over long distances will be expensive and relatively inefficient no matter by ship or pipeline**.
- Between transporting hydrogen via ship or pipeline, **pipeline transport consistently ranks as the most cost-effective option in the short and long-term**.
- **Hydrogen transported by liquid carriers like ammonia incur a significant energy penalty** — and thus cost penalty — at the point of import when liberated (ammonia 'cracking') that will likely stay significant even with scale and technical improvements.
- **The transport of 'uncracked' ammonia rather than pure hydrogen offers the cheapest pathway** for transporting hydrogen molecules, beating even pipeline delivery of pure gaseous hydrogen although the product delivered is different.

Techno-economic Realities of Long-Distance Hydrogen Transport

A Cost Analysis of Importing Low-Carbon Hydrogen to Europe

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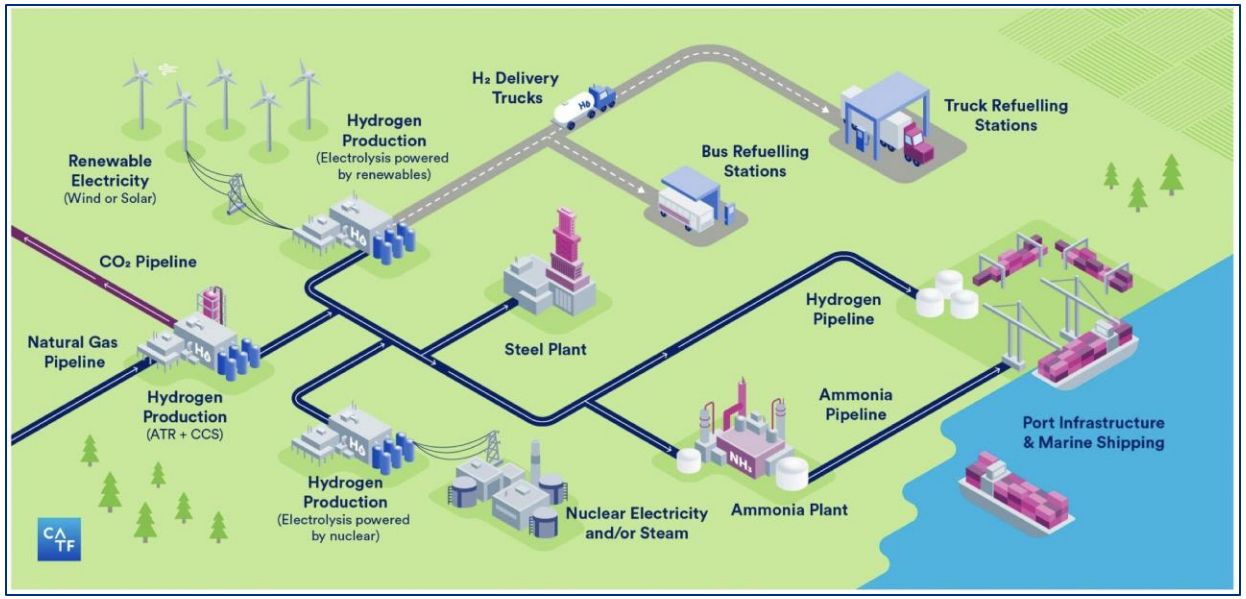
The Hydrogen Business Case

- The off-taker should be at the centre of any hydrogen project, with production volumes secured through a designated off-take and price hedging strategy; the project's cost and revenue structures need to consider excessive market variability.
- Government support can help to lower financial risks, but private investment needs to be leveraged. Banks and private equity firms need projects to have long-term offtake agreements with good quality counterparties, operate under clear regulations and industry standards and be able to sell into established markets to be bankable.
- Off-take restrictions should be considered to guarantee that subsidised low-carbon hydrogen is funnelled into the most difficult-to-decarbonise sectors rather than utilised in lower priority sectors where other more energy- and cost-effective decarbonisation pathways are already available.

The Hydrogen Business Case

- Have renewable electricity PPA access or CCS installation for gas power plants.
- Transparent and liquid hydrogen market requires price point information for each sectors and benchmark prices established (e.g. Hydrix as a first approach in this direction).
- Financial support schemes (e.g., European Hydrogen Bank or H2Global) can help to ensure cost-efficient price discovery and establish cross-border hydrogen trading.
- Supply-chains can be modelled after the EU Hydrogen Valleys 'ecosystem' framework.



CATF Recommendations for EU Hydrogen Valleys

RECOMMENDATION 1:

Prioritise 'no regrets' end-use sectors, particularly those sectors that are already producing and consuming carbon-intensive hydrogen today.

RECOMMENDATION 2:

Make use of all clean hydrogen production pathways and allocate support based on entire value chain emissions reductions, cost, and scalability.

RECOMMENDATION 3:

Site clean hydrogen production close to where hydrogen is consumed, and ensure a constant, reliable supply to end users.

RECOMMENDATION 4:

Provide socio-economic benefits to the local community.

RECOMMENDATION 5:

Match public funding to the most promising Hydrogen Valley developments that meet the foregoing recommendations, which in turn should spur a final investment decision.

RECOMMENDATION 6:

Establish a comprehensive EU Hydrogen Valleys database to promote transparency,accountability, and cross-Valley collaboration.

Outlook: What is needed

- Decision-making speed: IRA two weeks, EU IPCEI: three plus X years
- Planning-decisions for hydrogen projects need to be fast-tracked
- Blue hydrogen needs a clear legal definition to create investment security.
- Carbon Capture will ensure new CO_2 business models for synfuels for the aviation and the shipping industry

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Vielen Dank!

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