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Future of hydrogen in the transition to net-zero

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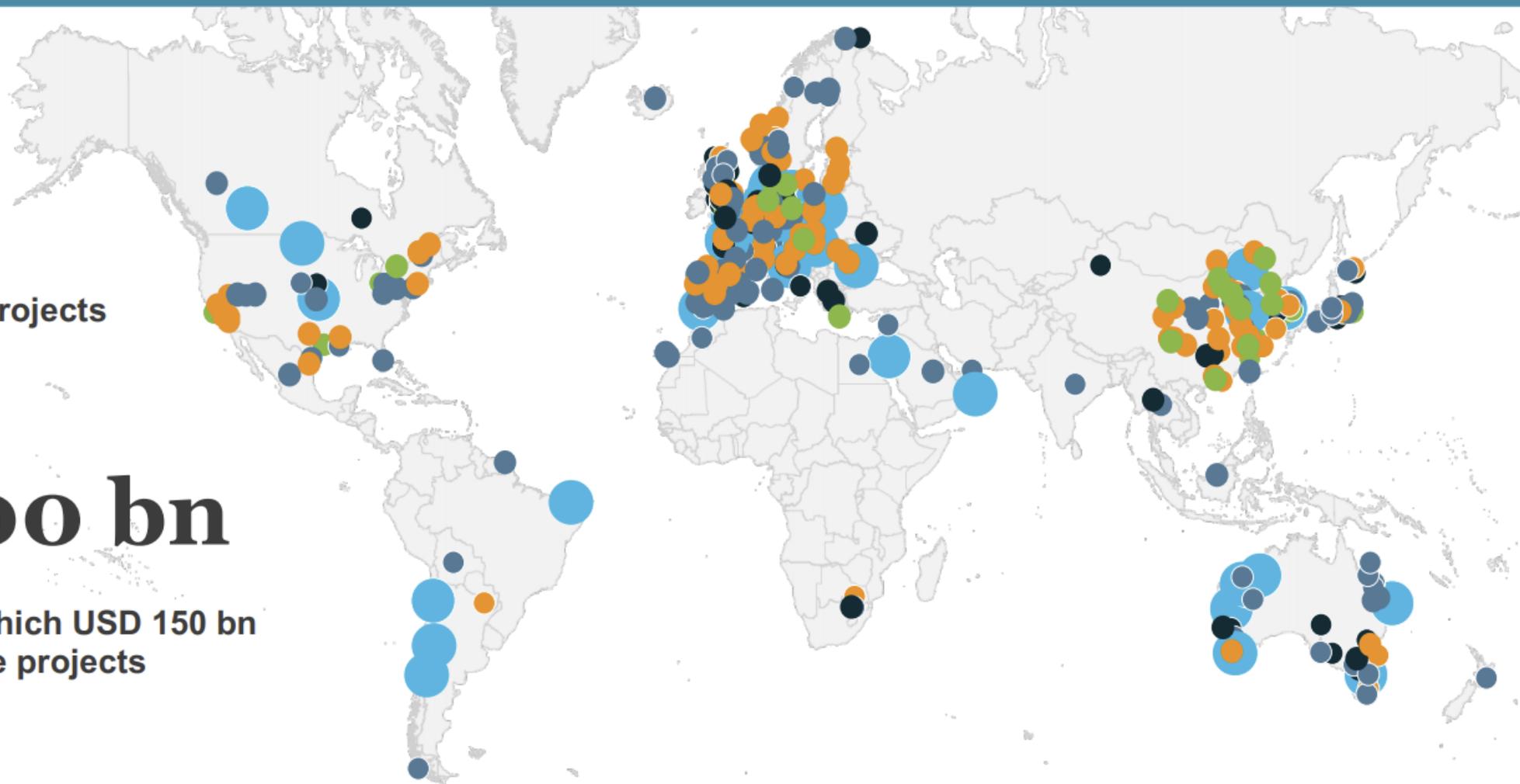
Exhibit 1: Global hydrogen projects and investment across the value chain

359

Announced large-scale projects

~USD 500 bn

investment by 2030, of which USD 150 bn is associated with mature projects



28

Giga-scale production

Renewable hydrogen projects >1 GW and low-carbon hydrogen projects >200 ktpa

141

Large-scale industrial usage

Refinery, ammonia, methanol, steel, and industry feedstock

96

Transport

Trains, ships, trucks, cars, and other hydrogen mobility applications

56

Integrated hydrogen economy

Cross-industry and projects with different types of end uses

38

Infrastructure projects

Hydrogen distribution, transportation, conversion, and storage

Recent ambitious company announcements, national commitments and cost reduction targets

Project pipeline & industry targets

- Green pipeline: ~ **50 GW across all announced projects** (timelines not specified), ~ 3 GW capacity by 2023;
- Electrolyser **project size increased dramatically** (from <2MW 2015-2020 to ~70MW), but remain less than 1 GW
- **European Clean Hydrogen Alliance target: 80 GW (2030)**
- **Alliances** (Green Hydrogen Catapult) & consortia (HyDeal ambition) target green H₂ **prices below 2 \$/kg** in 5 years¹

Project examples:



BP & Oersted: 50 MW electrolyser for H₂ production in BP refinery powered by offshore wind from Oersted. (Germany)



Iberdrola & Fertiberia: 800 MW electrolysis by 2027 for ammonia production. 20 MW for co-feed operational in 2021. (Spain)



Shell & Gasunie & Equinor & RWE: Develop 4 GW of electrolyser powered by 10 GW offshore wind by 2030. (Netherlands)



Australian consortium²: Plan to develop 14 GW electrolyser with up to 26 GW wind and solar generation. Recently granted major project status.

Country targets & public support

- **Over 30 countries** released **hydrogen roadmaps**, with 13 full national hydrogen strategies
- **Concrete GW installation targets** (c. 2030) dominated by European players
- **International momentum growing** with many more national hydrogen strategies in development

European country green hydrogen commitments:



EU: 40 GW target by 2030 (6 GW in 2024), with national targets including:



Germany: 5 GW by 2030



Poland: 2 GW by 2030



France: 6.5 GW by 2030



Italy: 5 GW by 2030



Spain: 4 GW by 2030



Portugal: 2.1 GW by 2030



Chile: 25 GW target by 2030

The EU Hydrogen Strategy: future implementation actions

A full value chain approach

Building on the Green Deal and Recovery Plan objectives

The Energy System Integration

The Hydrogen Strategy

- An investment agenda
- Boosting demand and scaling up production
- Develop hydrogen infrastructure and markets
- Research and innovation
- The international dimension

The Hydrogen Alliance

The EU Hydrogen Strategy – a roadmap to 2050

2024

- 6 **GW** of renewable hydrogen electrolyzers
- Replace **existing hydrogen production**
- Regulation for liquid hydrogen markets
- Planning of hydrogen infrastructure

2030

- **40 GW** of renewable hydrogen electrolyzers
- New applications in **steel and transport**
- Hydrogen for electricity balancing purposes
- Creation of “Hydrogen Valleys”
- Cross-border logistical infrastructure

2050

- Scale-up to **all hard-to-decarbonise sectors**
- Expansion of hydrogen-derived **synthetic fuels**
- EU-wide infrastructure network
- An open international market with € as benchmark

Making it happen – an action plan for Energy System Integration

Pillar	Actions oriented towards	Main tools involved (*)
A more circular and energy efficient energy system	<ul style="list-style-type: none"> • Better apply Energy efficiency first principle • Better mobilise waste heat • Better mobilise biowaste 	RED, EED, TEN-E CAP, LIFE funding
A deep electrification of consumption, based on renewable electricity	<ul style="list-style-type: none"> • Increased supply RES electricity • Faster electrification end-use sectors • Roll out EV infrastructure & new loads integration 	RED, IED, AFID, TEN-E, TEN-T, CO2 emissions for cars, Offshore RES, Renovation wave Network code on Demand side flexibility EU funding
RES & low carbon fuels for hard-to-abate sectors (incl. hydrogen)	<ul style="list-style-type: none"> • Promoting RES fuels from biomass • Promoting RES hydrogen • Enabling CCUS incl. for synthetic fuels 	RED, Aviation/Maritime initiatives, EU funding + Hydrogen Strategy Follow-up
Energy markets fit for decarbonisation & distributed resources	<ul style="list-style-type: none"> • Creating a level playing field across carriers • Review gas regulatory framework • Improve customer information 	ETD, ETS, State Aid , gas legislation , Guidance on non-energy price components
A more integrated energy infrastructure	<ul style="list-style-type: none"> • More integrated planning at gas, electricity, heat and hydrogen • Better governance 	TEN-E, TEN-T, RED, EED, TYNDP
A digitalised energy system & supportive innovation framework	<ul style="list-style-type: none"> • Ensure digitalisation support energy system integration • Research and innovation as a key enabler 	Energy Digitalisation Action Plan, Network Code on cybersecurity, Impact oriented research outlook

(*) Non-exhaustive list

Making it happen – an action plan for the Hydrogen Strategy

Full value chain approach,	Actions oriented towards	Main tools involved (*)
An investment agenda	<ul style="list-style-type: none"> • Create project pipeline • €220-340 bln renewable power, €24-42 bln electrolysers, €65 bln infrastructure 	Clean Hydrogen Alliance, InvestEU, IPCEI, State aid, Cohesion policy
Boosting demand and scale up production	<ul style="list-style-type: none"> • Comprehensive terminology and EU-wide certification of hydrogen • Support schemes and CCfD for renewable and low-carbon hydrogen • Demand-side policies in end-use sectors 	RED, EU ETS, Transport policy, Industrial strategies
Develop hydrogen infrastructure and markets	<ul style="list-style-type: none"> • Planning of hydrogen transport, storage and dispatch infrastructure • Ensure access, develop liquid hydrogen markets and integrity of internal gas market 	TYNDPs, TEN-E, TEN-T, AFID, CEF, decarbonisation of gas package
Research and Innovation	<ul style="list-style-type: none"> • Scale up electrolysers • Develop hydrogen value chain • Innovative hydrogen technologies 	Clean Hydrogen Partnership, ETS Innovation Fund, Horizon Europe,
The international dimension	<ul style="list-style-type: none"> • International standards, regulation and definitions for hydrogen • Promote cooperation 	IEA, IRENA, CEM, G20, Neighbourhood policy, EU-Africa Green Energy Initiative, bilateral energy dialogues, € benchmark

(*) Non-exhaustive list

Fit for 55 package

1. Revision of the [Renewable Energy Directive](#) – COM proposes to:
 - Allow for accounting renewable fuels of non-biological origin (including renewable H₂) towards the targets set in this Directive provided that they meet the GHG emissions savings requirement of at least 70% (The Commission will develop Delegated Acts specifying the methodology for assessing GHG emissions savings from the use of RFNBOs)
 - Introduce a target of GHG intensity reduction of at least 13% in transport sector by 2030
 - Introduce dedicated sub-targets for renewable H₂ in industry and transport:
 - A. *A new 2030 target for a 50% share of renewables in hydrogen consumption in industry – including non-energy uses;*
 - B. *The target for RFNBOs (including renewable H₂) in transport is at least 2,6% by 2030*

Cont'd..

3. The Regulation on [CO2 emissions standards for cars and vans](#) requires average emissions of new cars to come down by 55% from 2030 and 100% from 2035 compared to 2021 levels.

4. Revision of the [EU ETS Directive](#) - COM proposes to
 - A. Introduce a new (pilot) ETS for road transport and buildings: In order to address the potential distributional effects of the introduction of this new (pilot) ETS, COM aims to set up the '[Social Climate Fund](#)' – it is expected that some €72.2 million will be generated by revenues from the new ETS, and these funds will be allocated to Member States to support low-income households.

 - B. Extend the scope of the Innovation fund to provide support to projects through CCfDs (the scope and the functioning of the scheme is TBD)

UK Hydrogen Strategy

- A **'twin track'** approach to supporting multiple technologies including both **green and blue** hydrogen, with further detail to come in 2022 on the Government's production strategy;
- Collaboration with industry to develop a **UK standard** for low carbon hydrogen, giving certainty to producers and users that the hydrogen the UK produces is consistent with net zero and supporting the deployment of hydrogen across the country;
- Undertaking a review to support the development of the necessary **network and storage** infrastructure;
- Working with industry to assess the safety, technical feasibility, and cost effectiveness of **mixing 20% hydrogen** into the existing gas supply, which could reduce emissions from domestic gas use by 7%;
- Launching a hydrogen sector development action plan in early 2022 setting out how the Government will support companies to secure **supply chain opportunities, skills and jobs** in hydrogen; and
- Continued commitment for the hydrogen **heating** trials and an aim to consult on 'hydrogen-ready' boilers in 2021, which will inform a UK Government decision in 2026 on the role of hydrogen in decarbonising heating.

The Strategy also commits to making £105 million available through the Net Zero Innovation Portfolio to support polluting industries to significantly slash their emissions, as a first step to build up Britain's low carbon hydrogen economy.

UN Climate Champions 'guiding principles' for climate-aligned hydrogen

focusing the use of near-zero carbon hydrogen where other solutions like efficiency and direct, renewable electrification are unavailable;

full lifecycle emissions and pollution accounting and independent verification against rigorous carbon intensity thresholds to meet a high burden of proof;

redoubling efforts in pursuit of renewable hydrogen, as the only resource strictly and reliably compatible with climate goals;

moving fast to unlock needed cost reductions through deployment and investment, without overcommitting to partial or inefficient infrastructure investments;

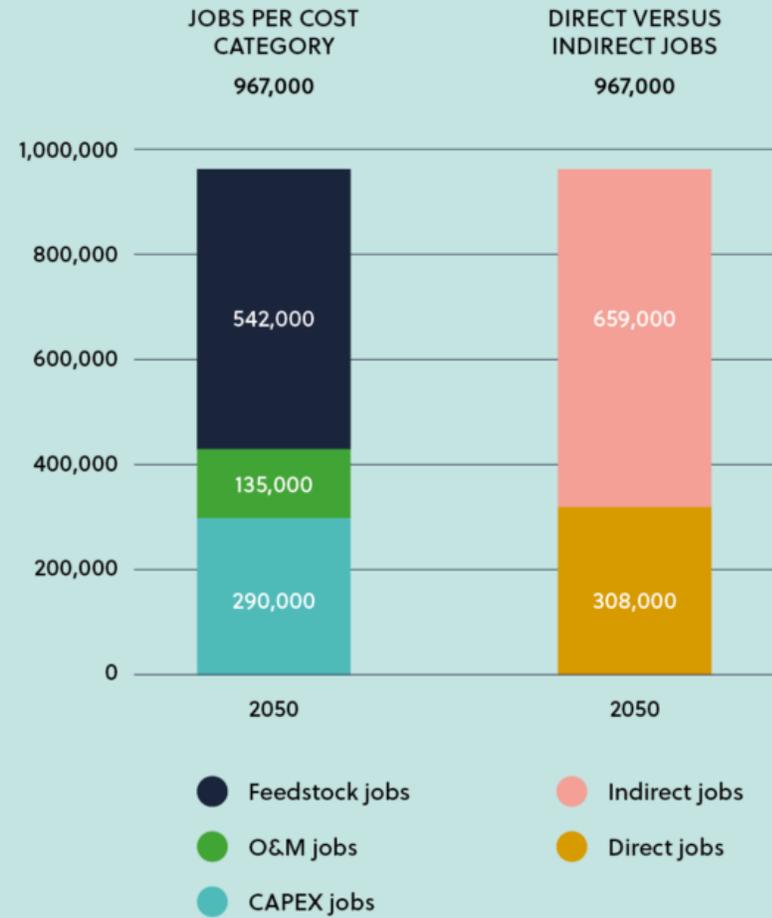
ensuring proactive focus on inclusive and supported workforce transitions, and the essential pursuit of equity in international development and socioeconomic and health outcomes

transparent decision making to ensure accountability to citizens and consumers



Green hydrogen jobs

Potential employment in Europe from green hydrogen growth





Women in Green Hydrogen

Promoting diversity in Green Hydrogen

Connect.
Empower.
Change.

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