IRENA
International Renewable Energy Agency

Key hydrogen issues and actions underway

Dolf Gielen
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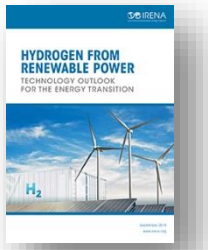
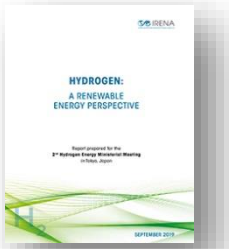
IPHE International H2 Initiatives, 16 June 2020

Collaborative Framework on Green Hydrogen

2018





2019

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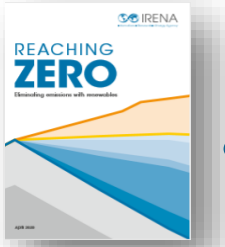
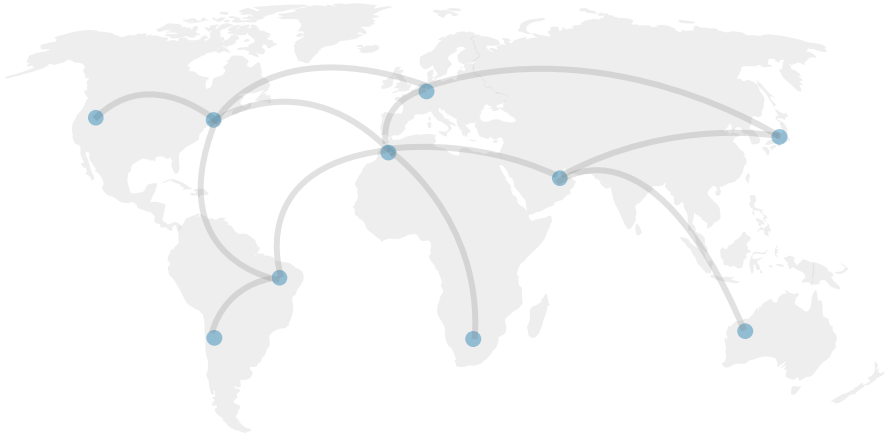


Collaborative Framework on Green Hydrogen

Technology Brief
Electrolyser Technologies

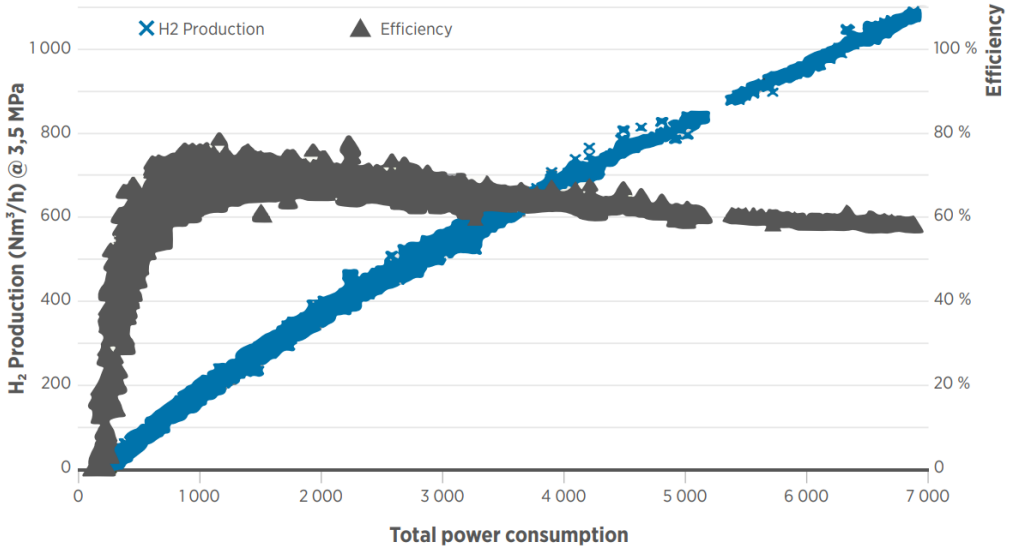
- **Green Hydrogen Ministerial Roundtable** at IRENA's 10th Assembly
  - Members called upon IRENA to **continue its work on hydrogen from renewable power**
- **In response to this call**, IRENA is considering the possibility of establishing a **Collaborative Framework on Green Hydrogen**
  - **Exchange knowledge** on Green Hydrogen, including new projects and developments in this field
  - The platform would **leverage the Agency's work** on the topic and benefit from **wider global cooperation** with other entities
  - Serve as an **effective vehicle for dialogue, co-operation and coordinated action**

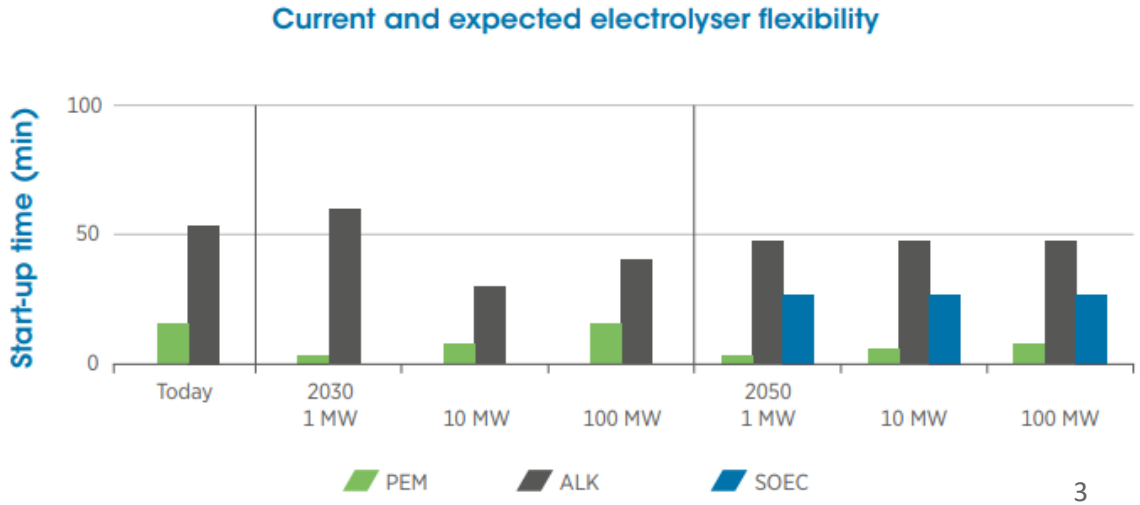


IRENA's Technology Brief: Electrolyser Technologies

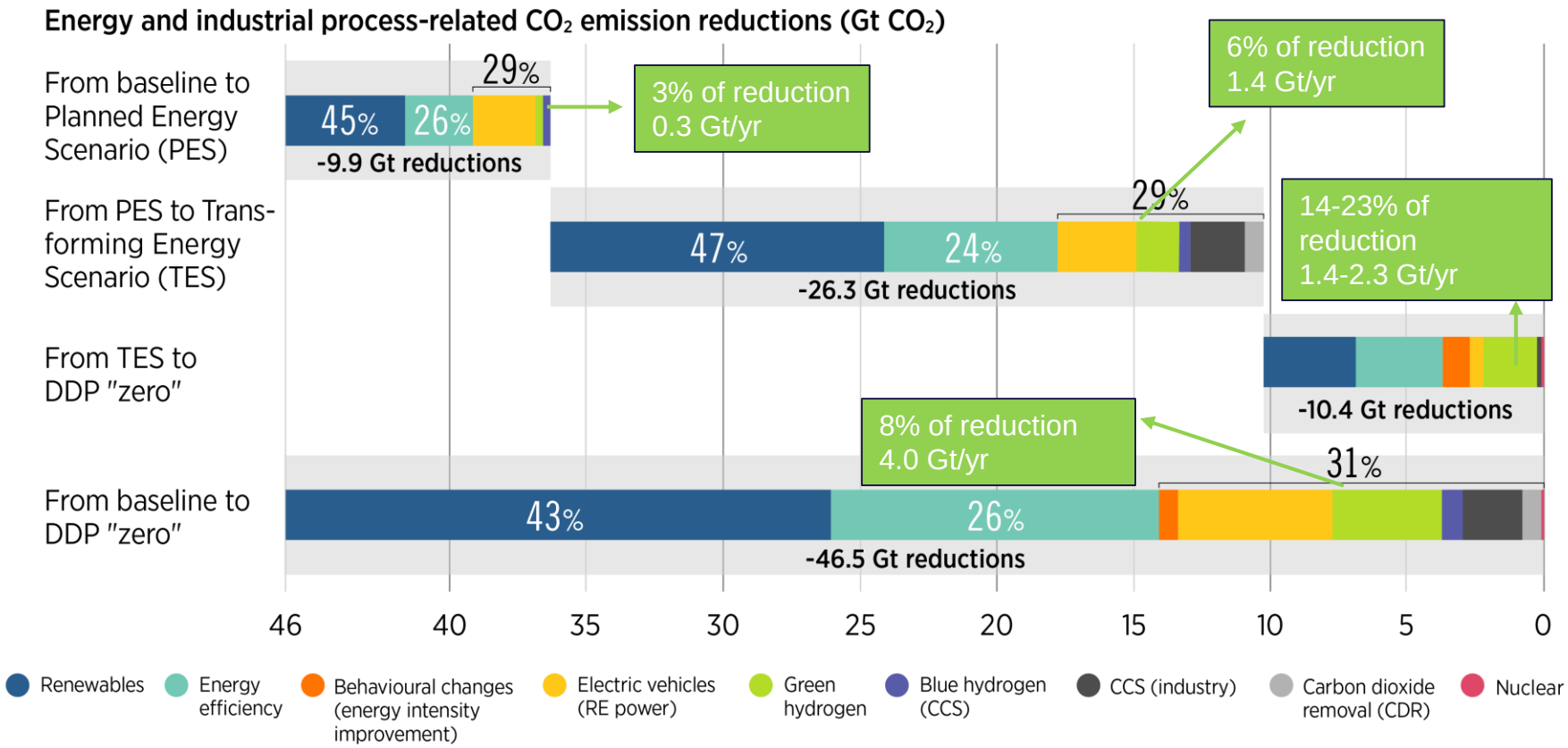
Main Objective: better understanding of **costs, operation** and **ability to provide flexibility**

- **Project cost and equipment cost trends**
- **Efficiency and lifetime**
  - Trade-off between fixed and operational costs, efficiency degradation
- **Compressor and on-site storage linkages** with operation
- **Additional revenues**
  - Ancillary services and byproducts (low- pressure oxygen and heat)
- **Role of upcoming technologies** such as high-temperature electrolysers
  - Higher efficiency
  - Operation coupled with RE (CSP or Geothermal)
  - Potential role for E-fuel production





The bulk of emission reductions: Renewables and efficiency



Mitigation potential per technology and scenario
TES 50% electrification, 1700 GW electrolyzers in 2050

The role of green hydrogen differs by scenario due to the focus of emission reductions as reductions progress from Baseline (BES) to Planned (PES) to Transforming Energy (TES) and finally to zero (Deep Decarbonisation Pathway DDP)

From Baseline to Planned just 3% of reductions are from green H_2

From Planned to the Transforming Energy Scenario, 6% are from green H_2

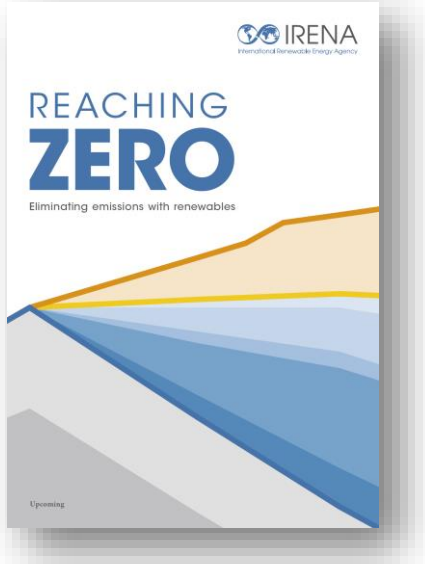
From Transforming Energy to the Zero Emissions scenario between 14-23% are from green H_2

In total, 8% of reductions, equivalent to 4.0 Gt/yr of CO_2 emission reductions, are possible from green H_2

Blue H_2 also plays a role, reducing emissions by about 0.8 Gt/yr

Example: Iron making

- Green hydrogen has a key role to play: Industrial applications (ammonia, iron, methanol etc.) and transport sector applications (trucks etc.). E-fuel production using green H_2 for aviation and shipping
- Today iron making is coke and coal based
- Interesting opportunities to use hydrogen (from renewable energy)
- Hydrogen-based Direct Reduced Iron (DRI) is technically feasible



Summer 2020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RESEARCH AND ANALYSIS
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Renewables-based decarbonization and relocation of iron and steel making

A case study

Dolf Gielen | Deger Saygin | Emanuele Taibi | Jean-Pierre Birat

Abstract
The article assesses the future role of hydrogen-based iron and steel making and its potential impact on global material flows, based on a combination of technology assessment, material flow analysis, and microeconomic analysis. Renewable hydrogen-based iron production can become the least-cost supply option at a carbon dioxide (CO_2) price of around United States dollars (USD) 67 per tonne. Availability of low-cost renewable electricity is a precondition. Australia is the world's largest producer of iron ore and at the same time a country with significant low-cost renewable electricity potential. A shift to direct reduced iron (DRI) exports could reduce global CO_2 emissions substantially and at the same time increase value added in Australia, while maintaining steel production in countries that are currently processing ore into iron and steel, such as China, South Korea, and Japan. The approach could be expanded to other parts of the world and other energy-intensive industry sectors. Such relocation analysis in a climate context can become a new industrial ecology research area. Iron and steel industry CO_2 emissions can be reduced by nearly a third, around 0.7 gigatonnes (Gt) CO_2 per year. To achieve these emission reductions, investment of USD 0.9 trillion, or 0.7% of the total energy sector investment needs, would be required, global DRI production would have to increase seven-fold from today's level, and the hydrogen energy used would equal 1% of global primary energy supply. Such a shift could develop from 2025 onward at scale, if the right policies are put in place.

KEYWORDS
commodity trade, decarbonization, hydrogen, industrial ecology, iron and steel, renewable energy

1 | INTRODUCTION

1.1 | Industrial competitiveness in times of decarbonization policies

The Paris Climate Agreement and the subsequent Special Report of the Intergovernmental Panel on Climate Change (IPCC, 2018) have created a new level of urgency that has prompted policy makers to revisit industrial greenhouse gas emissions. There is a renewed effort to find and deploy innovative solutions to decarbonize industry, a sector that has made limited progress to date.

High costs have hampered action to date. Morfeldt, Nilj, and Silveira (2015) estimate a carbon dioxide (CO_2) price range of United States dollars (USD) 25 - 120 per tonne[1] for the blast furnace (BF)-CO_2 capture and storage (CCS) route to be globally cost competitive by 2050. Ruijven van et al. (2016) estimate a CO_2 tax of USD 300 in 2020 rising to USD 324 per tonne by 2050 to reduce global iron and steel sector emissions by 80–90% compared to the 2010 level. Mousa, Wang, Riesbeck, and Larsson (2016) calculate a USD 50–200/t CO_2 tax for cost-competitive BF charcoal injection. Vercoulen et al. (2018) estimate a 70% reduction in East Asia iron and steel sector CO_2 emissions in 2050 with a CO_2 tax of USD 200/t.

[1] All tonnes (t) refer to metric tons.

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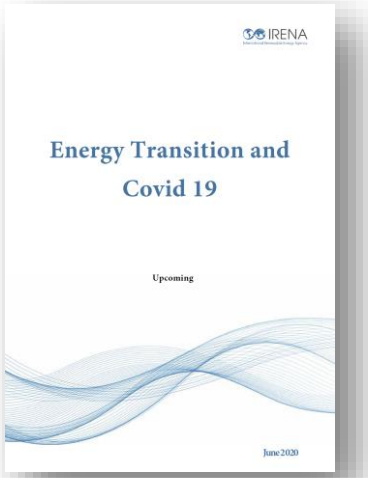
- DRI is a bulk commodity
- Solution: replace iron ore imports with imports of DRI produced at the mining site
- Consider import of DRI that is produced with renewable H_2 from countries such as Australia and Brazil.
- Abatement cost approximately 70 USD/t CO_2

Relevant IRENA publications



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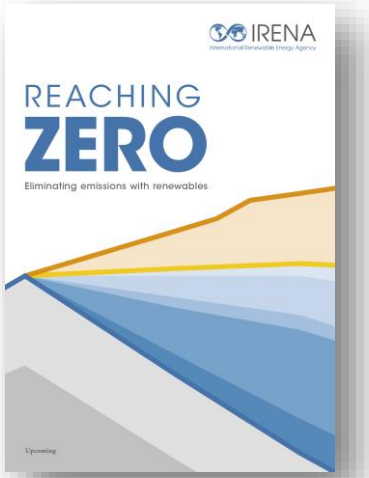

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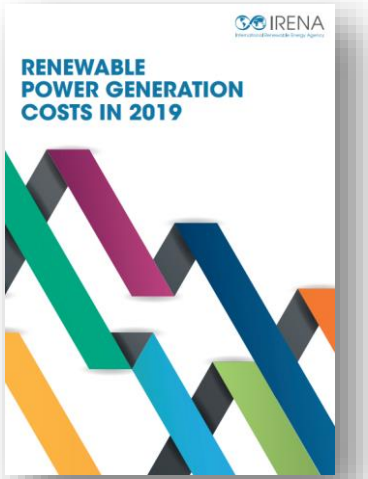

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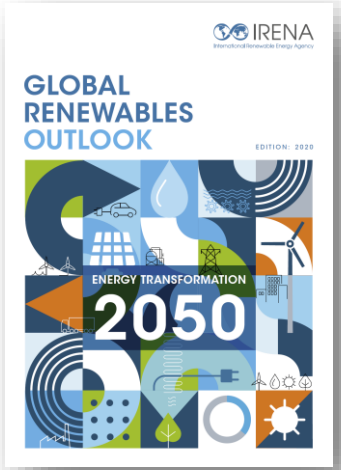

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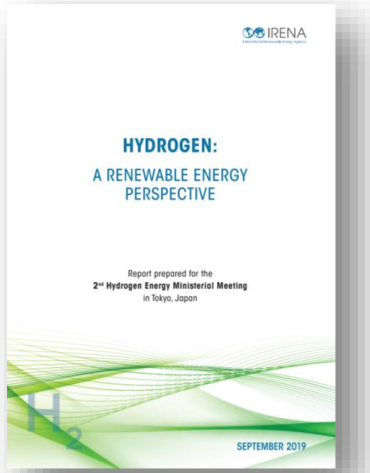

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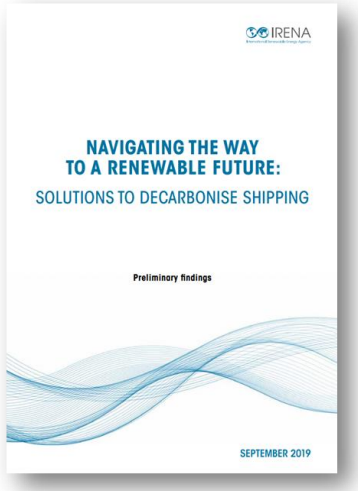

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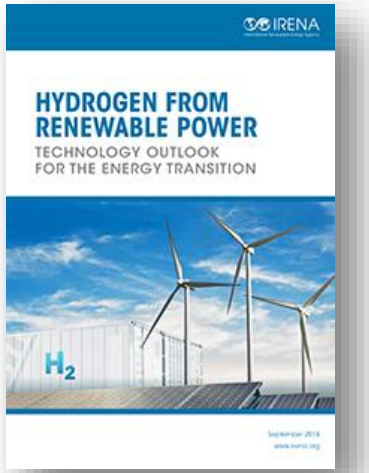

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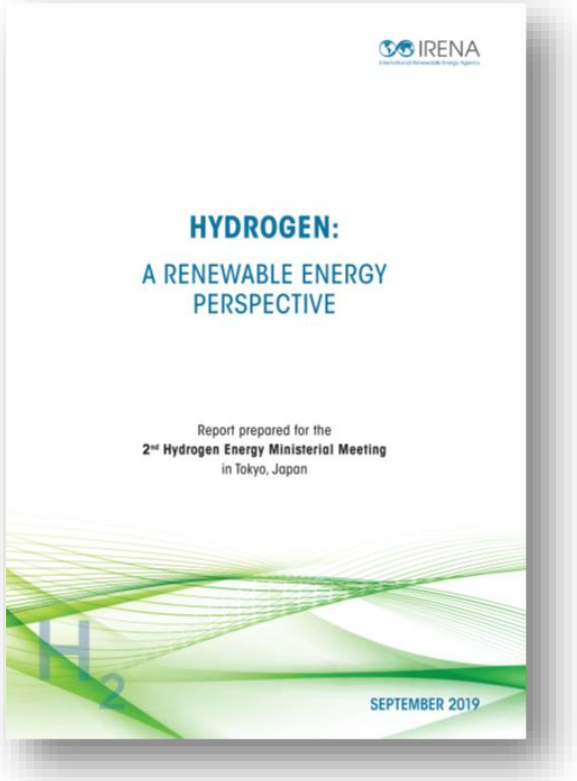

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