AVIATION CO_2 REDUCTIONS

STOCKTAKING SEMINAR

TECHNOLOGY · OPERATIONS · SUSTAINABLE AVIATION FUELS

Clean energy

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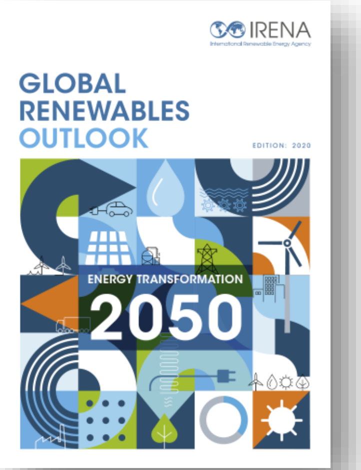
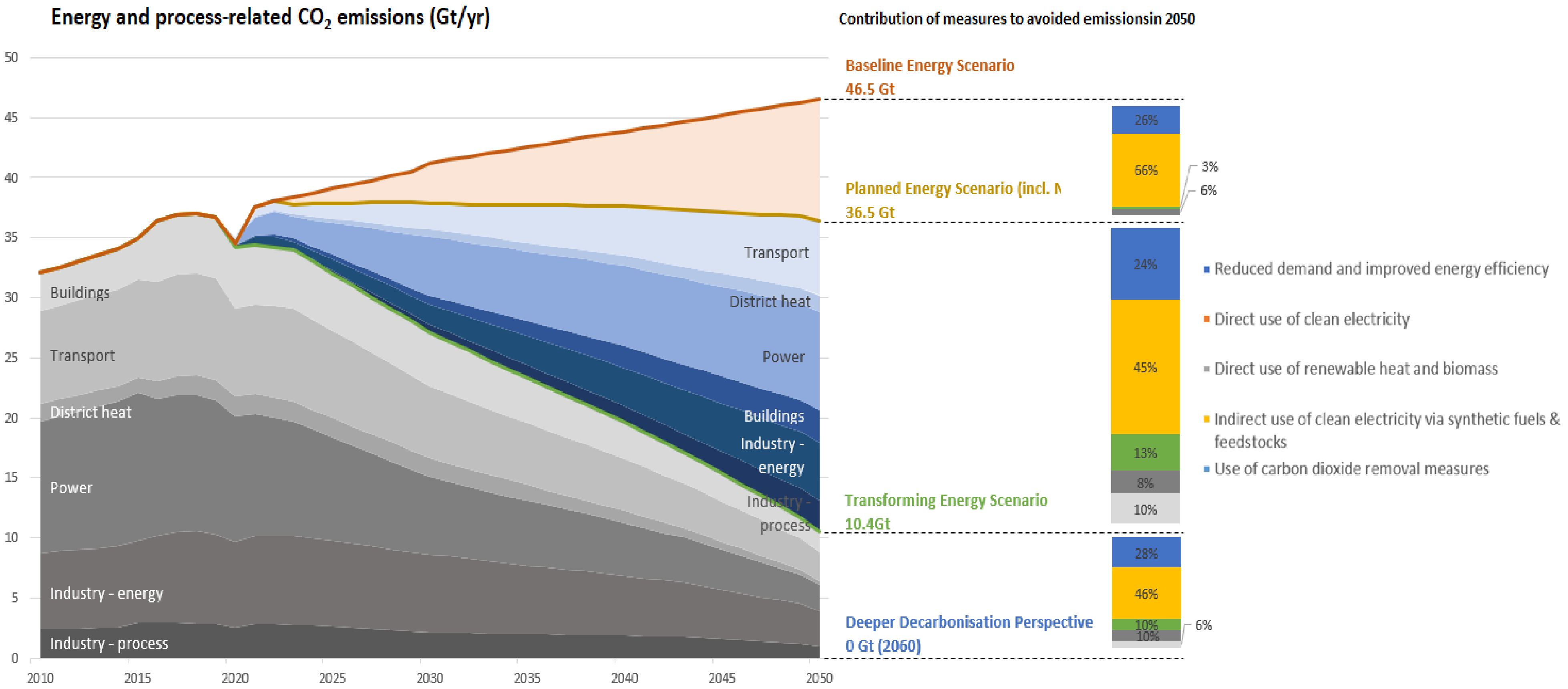
Exploring pathways to reduce emissions



Energy-related CO_2 annual emissions trajectories from 2010 till 2050 and IRENA's scenarios – From IRENA's **Global Renewables Outlook, April 2020**



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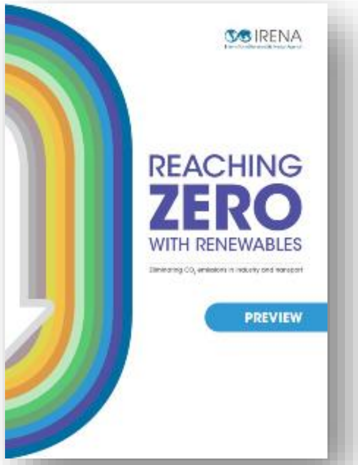
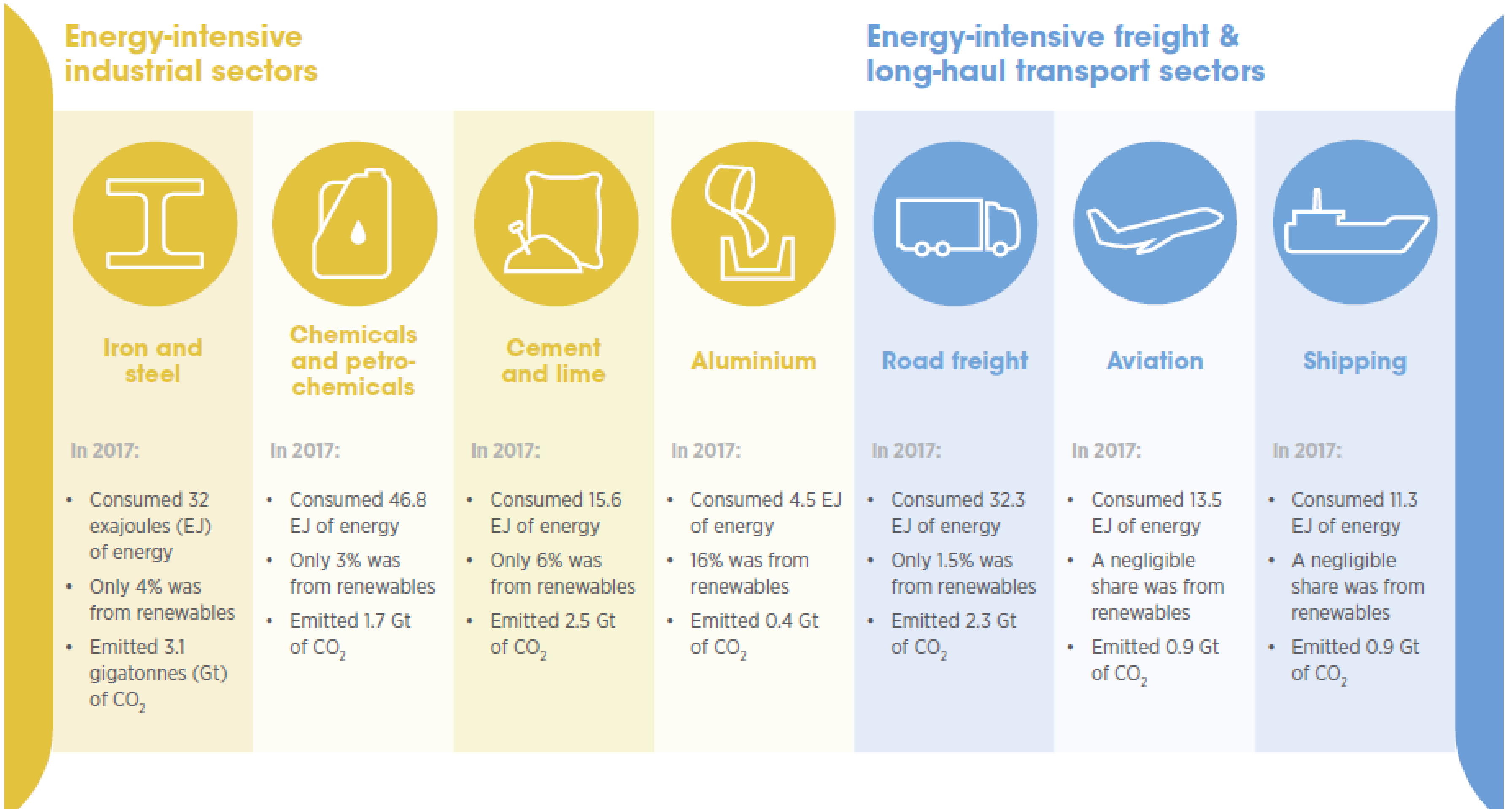
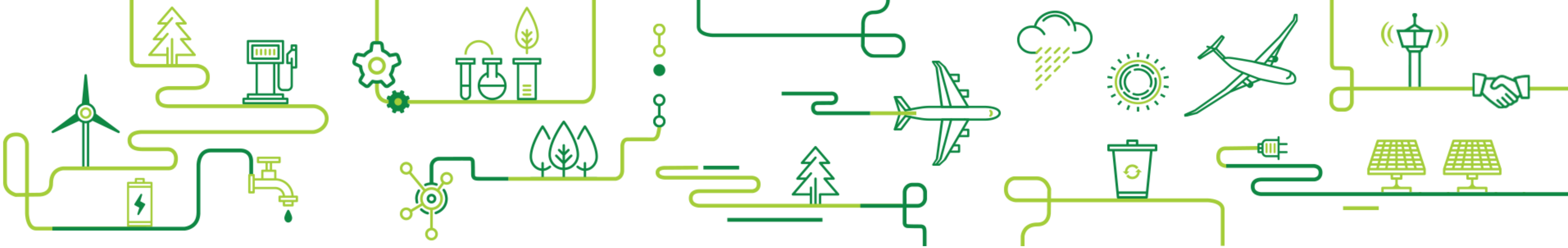
Exploring pathways to zero emissions



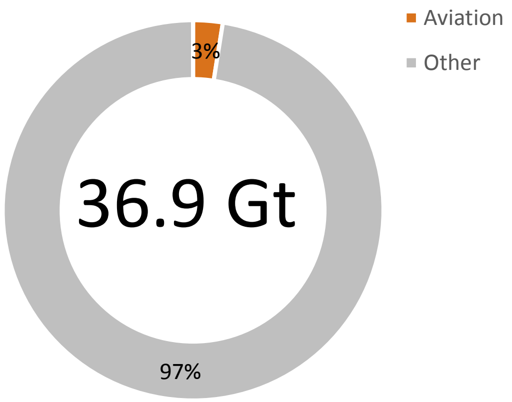
21st Sept. '20



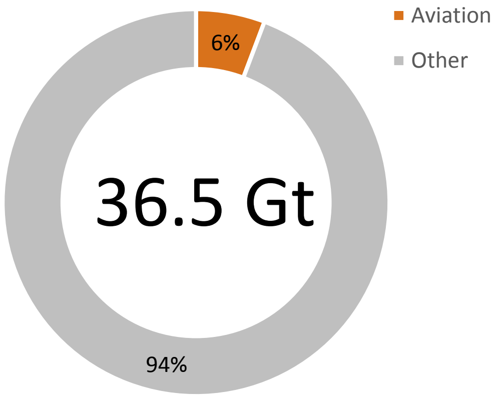


Aviation's CO_2 emissions in context

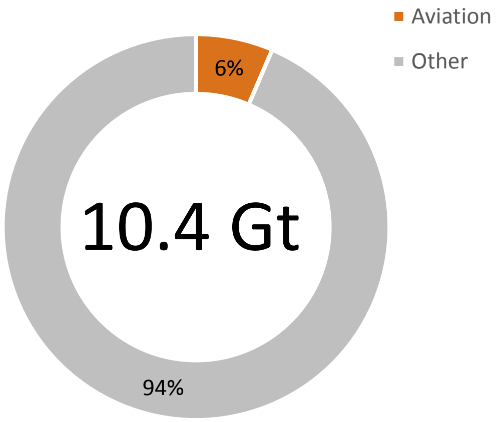
Aviation share of total energy and process-related CO_2 emissions in 2017 (Gt).



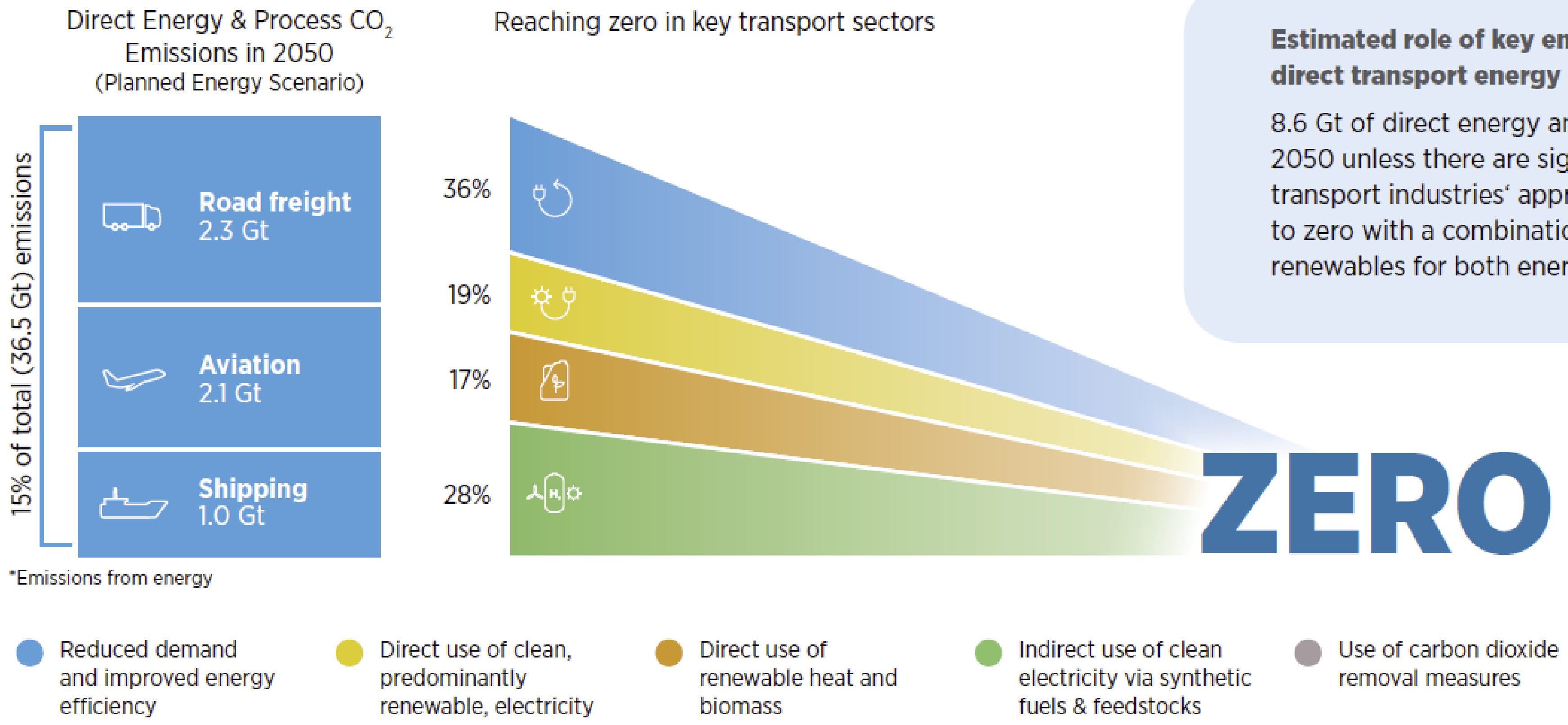
Aviation share of total energy and process-related CO_2 emissions in 2050 PES (Gt).



Aviation share of total energy and process-related CO_2 emissions in 2050 TES (Gt).



Aviation in the global energy transformation



Estimated role of key emission reduction measures to reduce direct transport energy and process emissions to zero

8.6 Gt of direct energy and process emissions will be produced in 2050 unless there are significant changes in policies and in the transport industries' approaches. Those emissions can be reduced to zero with a combination of measures – most of which utilise renewables for both energy and feedstocks.

Options – synergies & competition with other sectors

3 options compatible with reaching zero emissions for aviation

Biojet fuel

- Use fuels produced from sustainable sourced biomass.

E-fuels

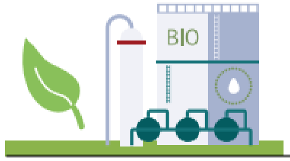
- Use synthetic fuels produced from cleanly sourced CO_2 and green hydrogen.

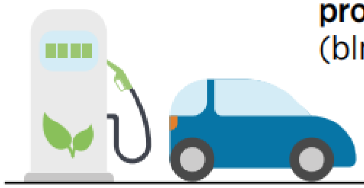
Battery-powered aircraft

- Use propulsion systems powered by batteries charged with renewable electricity.

- Sustainable biomass feedstocks & biofuels
  - GRO's Transforming Energy Scenario for 2050: 100 billion liters of biojet fuel/SAF
- Green hydrogen and synfuels
  - GRO's Transforming Energy Scenario for 2050: 1700 GW
- Batteries

Bioenergy is the largest renewable energy source in use today and has significant potential to scale-up by 2050





Indicator	Historical progress 2015-2017/2018/2019		Where we are heading (● PES/2030 and 2050)		Where we need to be (● TES/2030 and 2050)	
Share of TPES provided by bioenergy (%) (total)	8.7% (2015)	→ 9.5% (2018)	9% (2030)	10% (2050)	12% (2030)	23% (2050)
Share of TPES provided by bioenergy (%) (modern)	4.1% (2015)	→ 5.1% (2018)	8% (2030)	10% (2050)	12% (2030)	23% (2050)
Liquid biofuel production (bln litres)	129 bln ltr (2015)	→ 153 bln ltr (2017)	285 bln ltr (2030)	393 bln ltr (2050)	378 bln ltr (2030)	652 bln ltr (2050)

Hydrogen: A key part of future energy systems

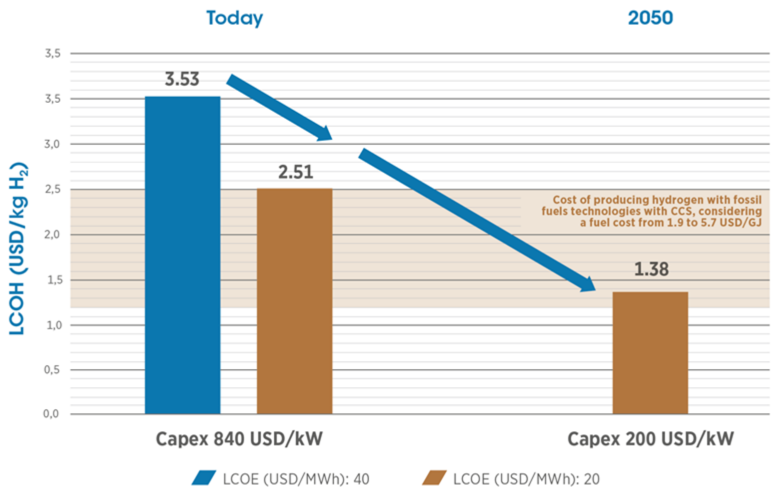
Indicator	Historical progress 2015-2018	Where we are heading (PES / 2030)	Where we are heading (PES / 2050)	Where we need to be (TES / 2030)	Where we need to be (TES / 2050)
Blue H_2 (Mt and EJ)	0.6 Mt / 0.08 EJ (2015 - 2018)	10 Mt 1.25 EJ (2030)	40 Mt / 5 EJ (2050)	30 Mt 3.75 EJ (2030)	80 Mt / 10 EJ (2050)
Green H_2 (Mt and EJ)	1.2 Mt / 0.16 EJ (2015 - 2018)	9 Mt 1.1 EJ (2030)	25 Mt / 3 EJ (2050)	25 Mt / 3 EJ (2030)	160 Mt / 19 EJ (2050)
Green H_2 production costs (USD/kg)	4.0 - 8.0 USD/kg (2015 - 2018)	2.5 - 5.0 USD/kg (2030)	1.6 - 3.3 USD/kg (2050)	1.8 - 3.2 USD/kg (2030)	0.9 - 2.0 USD/kg (2050)
Electrolysers (GW)	0.04 GW (2016)	100 GW (2030)	270 GW (2050)	270 GW (2030)	1700 GW (2050)
Electricity demand to produce H_2 from renewables (GW)	0.26 TWh (2016)	450 TWh (2030)	1200 TWh (2050)	1200 TWh (2030)	7500 TWh (2050)

* Reduction in **Planned Energy Scenario (33 Gt in 2050)** in relation **to Baseline (43 Gt in 2050)**

** Additional reduction in **Transforming Energy Scenario (9.5 Gt in 2050**)
in relation to **Planned Energy Scenario (33 Gt in 2050)**

Key Points in 2050 (TES)

- **Hydrogen production costs:** 0.9-2.0 USD/kg H_2
- **Electrolyser capacity:** 1700 GW
- **Electricity to produce green hydrogen:** 7.5 PWh
- **Solar and Wind capacity:** at least 4 TW



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Thanks for your attention

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www.irena.org/industrytransport

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INNOVATION WEEK 2020
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5th – 8th October 2020