

# An Introduction to Hydrogen as Alternative and Sustainable Fuel



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# Momentum for Hydrogen

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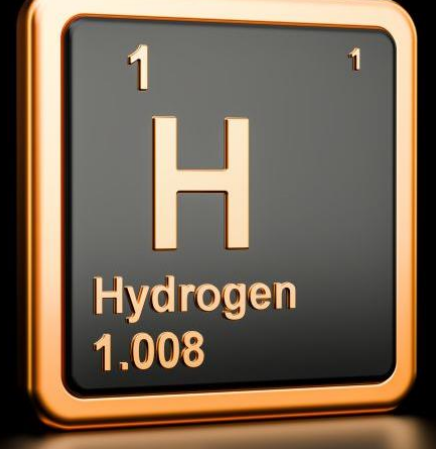
**“Hydrogen is today enjoying unprecedented momentum. The world should not miss this unique chance to make hydrogen an important part of our clean and secure energy future”**

*Dr Fatih Birol, Executive Director  
International Energy Agency*



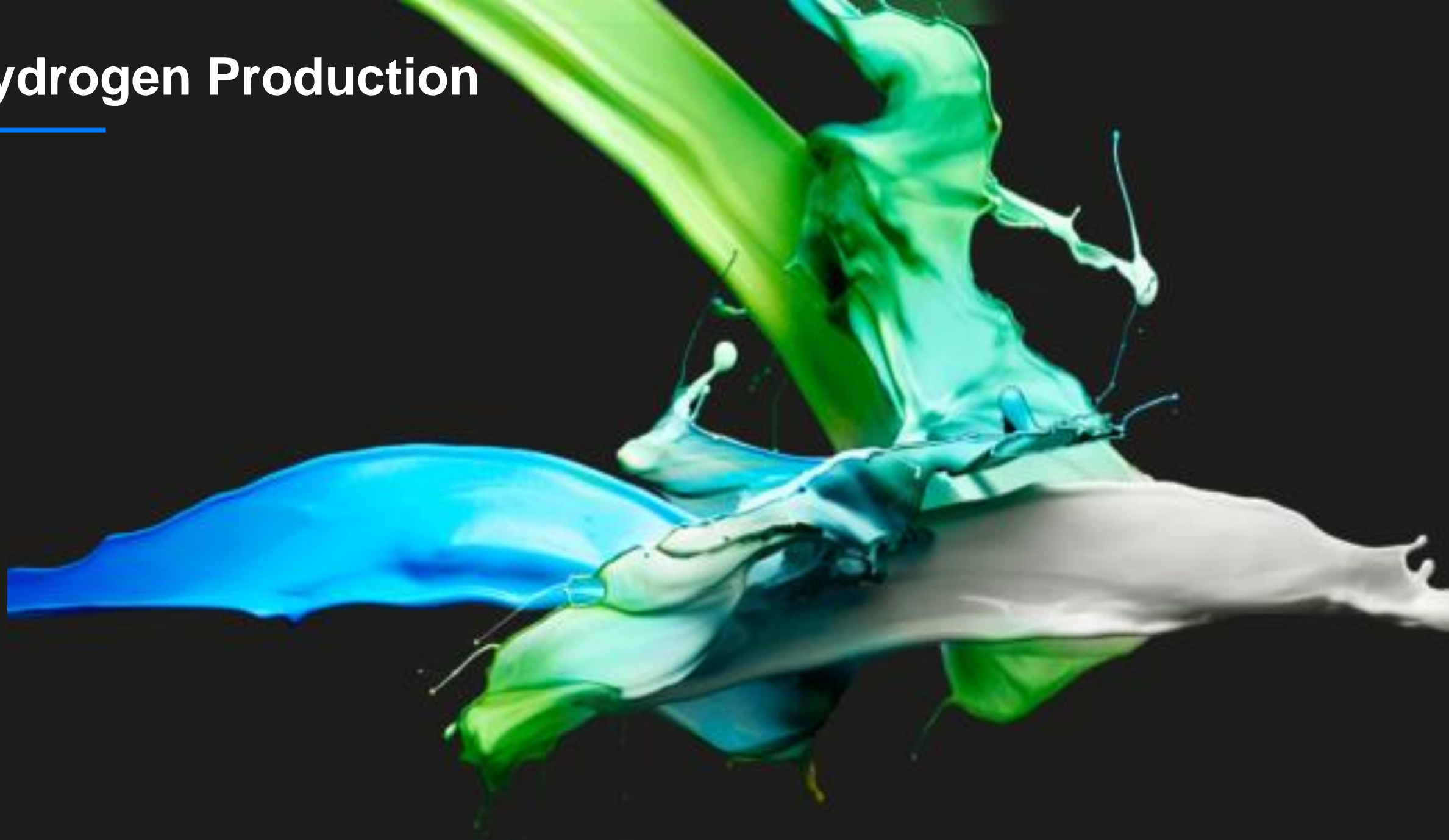
**“On my side, I can assure you that Europe is serious about clean hydrogen”**

*Dr Ursula von der Leyen, President  
European Commission*



# Hydrogen Production

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# Hydrogen "Colors"

~€1.6/kg

~€1.7/kg

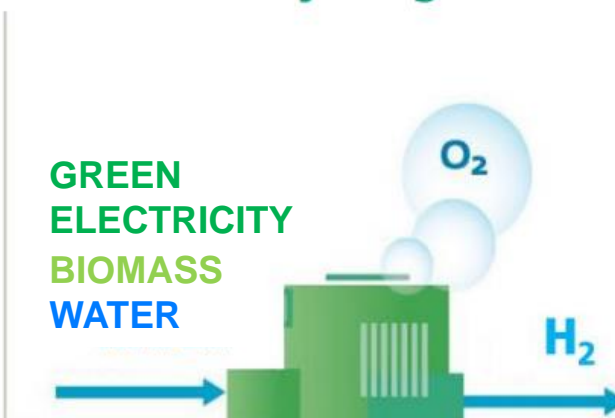
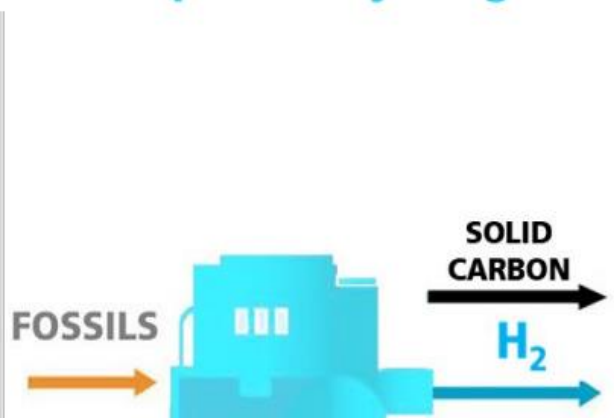
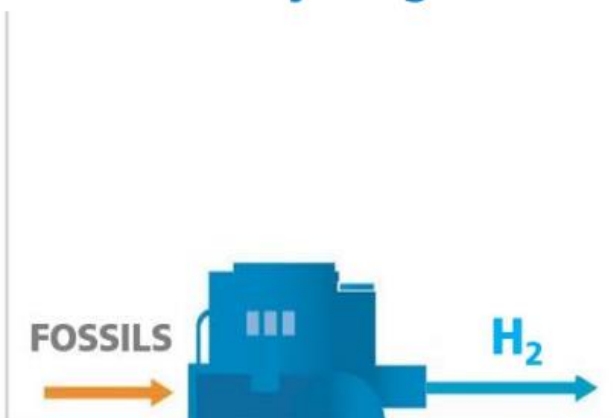
~€3.9/kg

Grey Hydrogen

Blue Hydrogen

Turquoise Hydrogen

Green Hydrogen



96% of today's hydrogen

NON-RENEWABLE FEEDSTOCK

NON-RENEWABLE FEEDSTOCK

NON-RENEWABLE FEEDSTOCK

RENEWABLE FEEDSTOCK

STEAM REFORMATION  
EMISSION OF CO<sub>2</sub>

STEAM REFORMATION  
WITH CCUS (CARBON  
CAPTURE, UTILIZATION  
AND SEQUESTRATION)

METHANE PYROLYSIS  
CO<sub>2</sub> AS SOLID MATERIAL

ELECTROLYSIS,  
BIO MASS PYROLYSIS,  
BIO MASS GASIFICATION



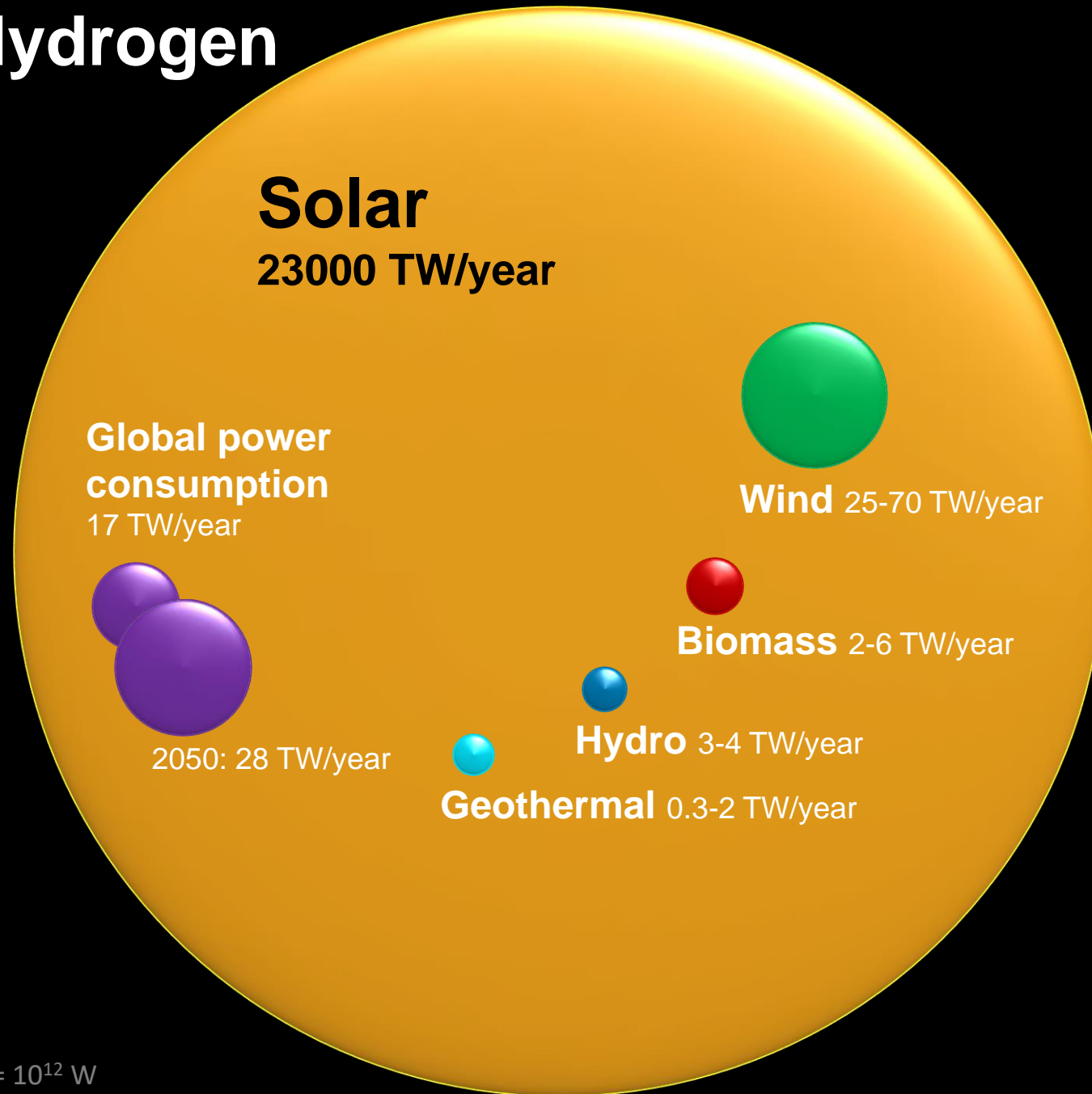


**“Low-carbon hydrogen can be part of the transition, but only **renewable hydrogen** will bring us to climate neutrality.”**

*Dr Ursula von der Leyen, President  
European Commission*

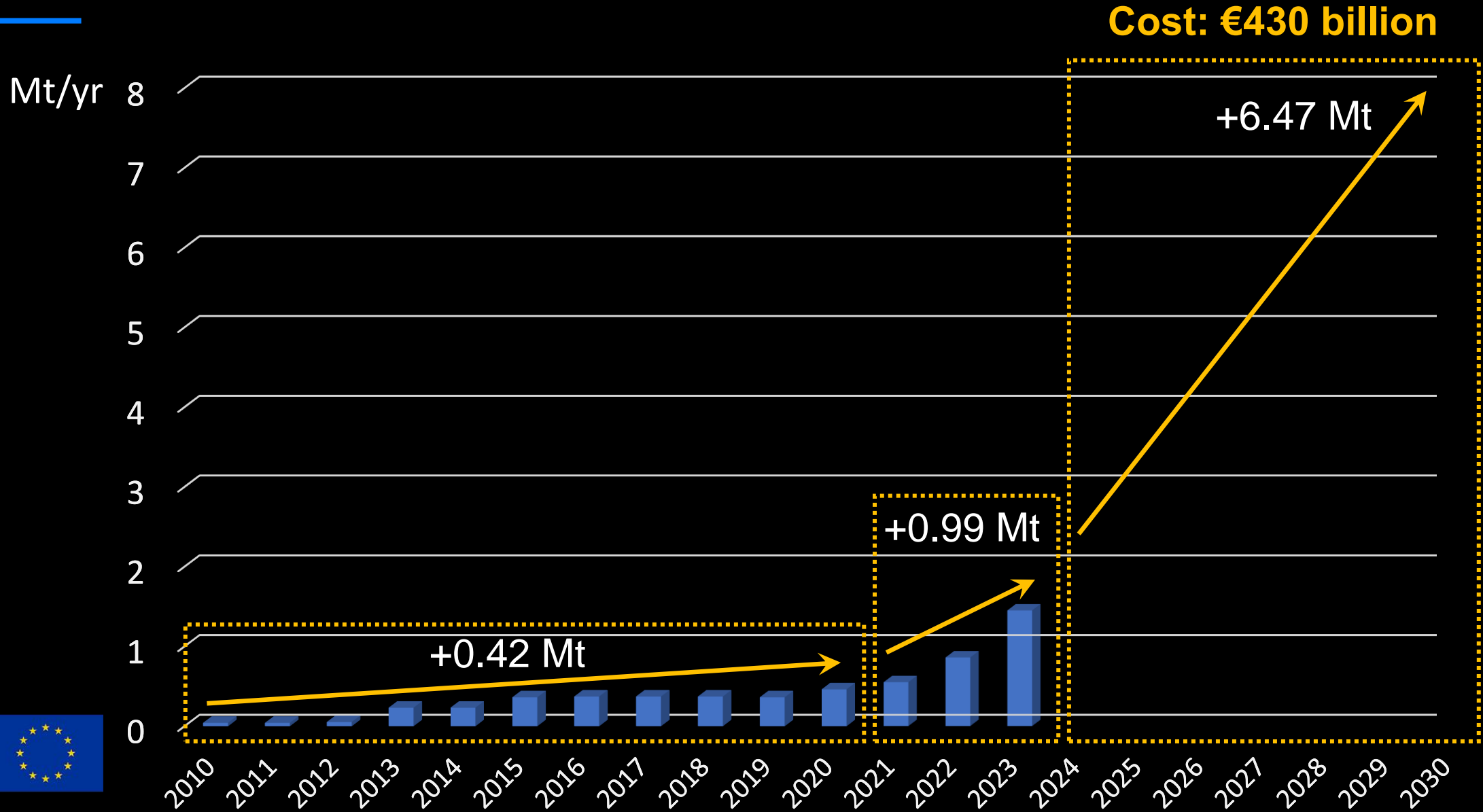
# Renewable Hydrogen

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1 Tera Watt (TW) =  $10^{12}$  W

# Demand for Renewable Hydrogen



A meme featuring Elon Musk on the left, looking confused with his hands outstretched. A speech bubble above him contains the text "Mind-bogglingly stupid". On the right, a dark blue hydrogen fuel cell vehicle is shown parked at a hydrogen refueling station with a sign that says "Hydrogen".

**“Mind-  
bogglingly  
stupid”**

**Hydrogen**



# Hydrogen Fuel

Energy usable per kg fuel

Hydrogen  
33.3 kWh/kg

Li-Ion battery  
~0.20 kWh/kg

Example of use –  
Heavy duty transportation



+



Energy consumption: 275 kWh/100km  
( $\triangleq$  28 L/100 km diesel)

Travel time: 4.5 hours à 360 km

→ Battery pack weight: **4 tons**



+



→ Hydrogen tank weight: **30 kg**

**BUT:**

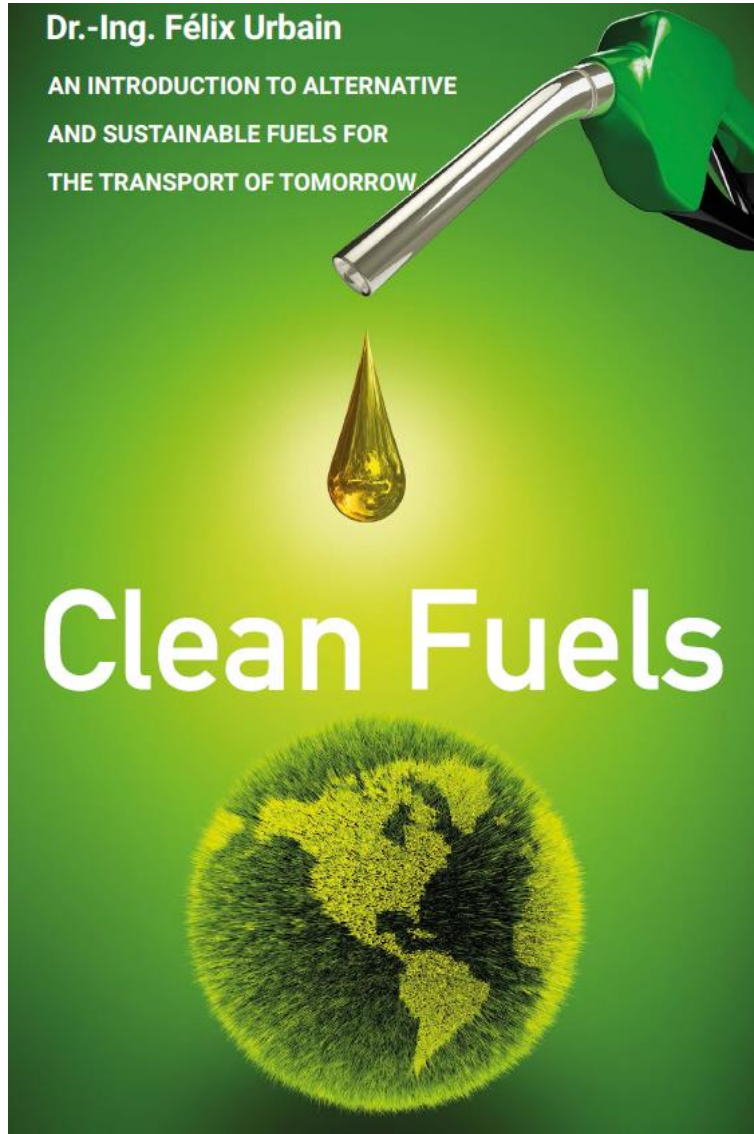
→ Hydrogen tank volume: ~500,000 L

→ Compressed at **500-700 bar:**

**~1,000-700 L**

# More Information on Hydrogen & Co.

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*Why do we need alternatives to oil, gas and coal in the future?*

*What comes after diesel and petrol?*

*Where will the drives of the future be compared to conventional drives?*

*What will be the transport trends of the future?*


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DU GRAND-DUCHÉ DE LUXEMBOURG

**da Vinci**   
ASSOCIATION OF ENGINEERS  
ARCHITECTS  
SCIENTISTS  
INDUSTRIALS





Thank you very much.  
Merci.



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