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Green energy and hydrogen availability and cost: are we being too optimistic?

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Be wary of 'quoted' costs of green-H_2; $0.5 /kg not possible

Assuming **zero** electrolyser capex. and non-power opex. and **zero** solar opex. (i.e. an extreme case):

Hydrogen @ $0.5 /kg

requires

Power @ <$9 /MWh

requires

Solar capex. @ ~$190,000 /MW

but

Current solar capex.: ~$950,000 /MW

and

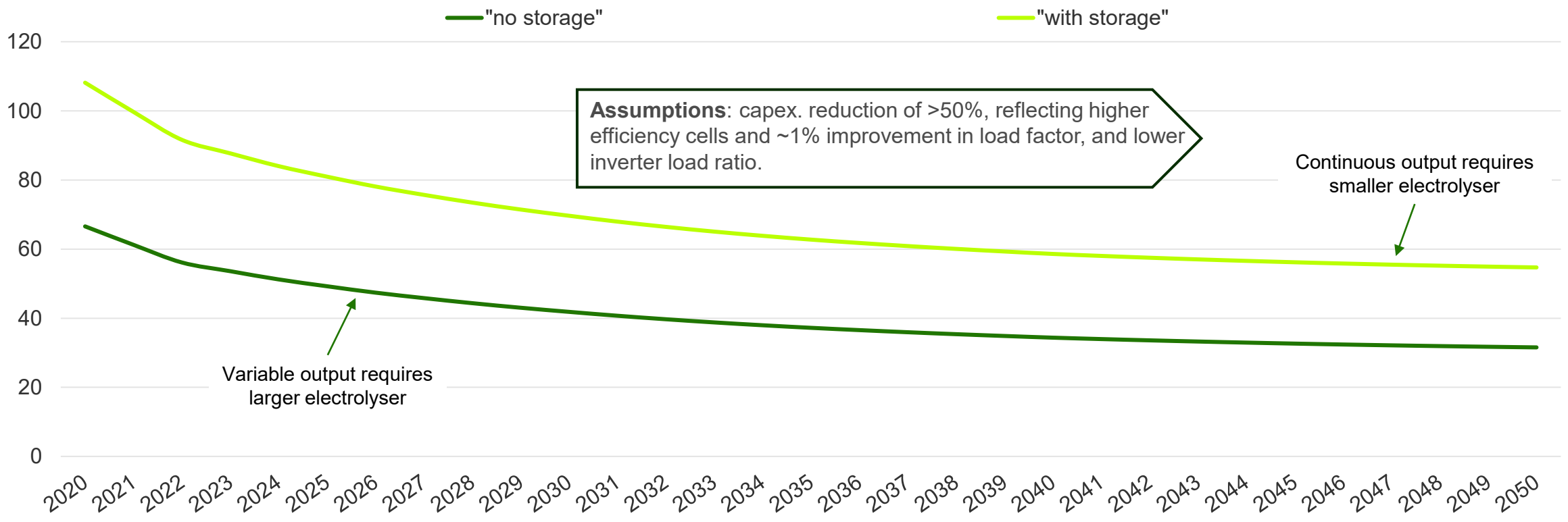
Raw materials only (e.g. steel, Si, Al, Cu, Ag etc.):

~$170,000 /MW (~20% of total)

DATA: CRU Sustainability & Emissions Service – Hydrogen Cost Model

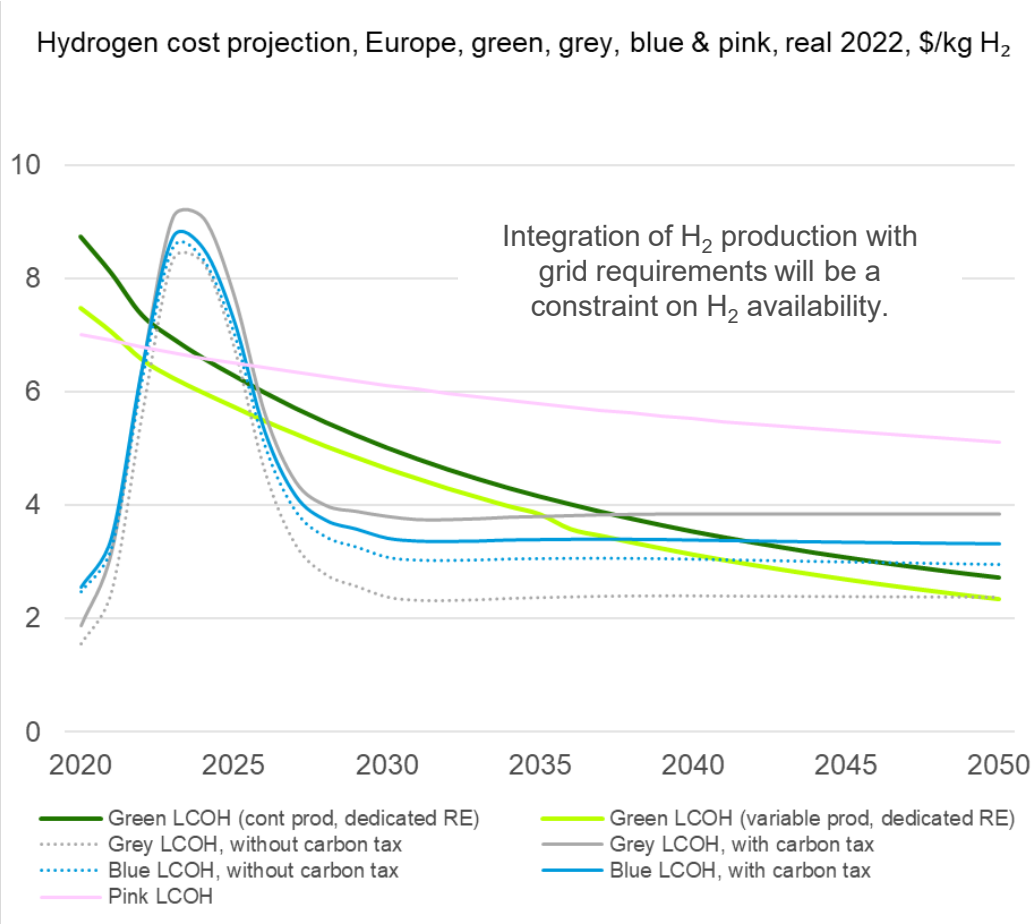
With >efficiency, solar still unlikely <$30 /MWh, even in 2050…

LCOE of solar, Europe (lowest quartile), high technology cost reduction case, storage level based on optimal mix of solar and wind, real 2023, $/MWh



DATA: CRU Sustainability & Emissions Service – Long-term renewable energy cost model

…green-H_2 not available for <$2.5 /kg (real, ex-plant) in 2050



A truer, full cost of green hydrogen **today** given by:

Solar capex. @ $950,000 /MW

and

Solar opex.

and

Storage capex. for continuous supply

trade-off with

Electrolyser [full] system capex.

and

Electrolyser [non-power] opex.

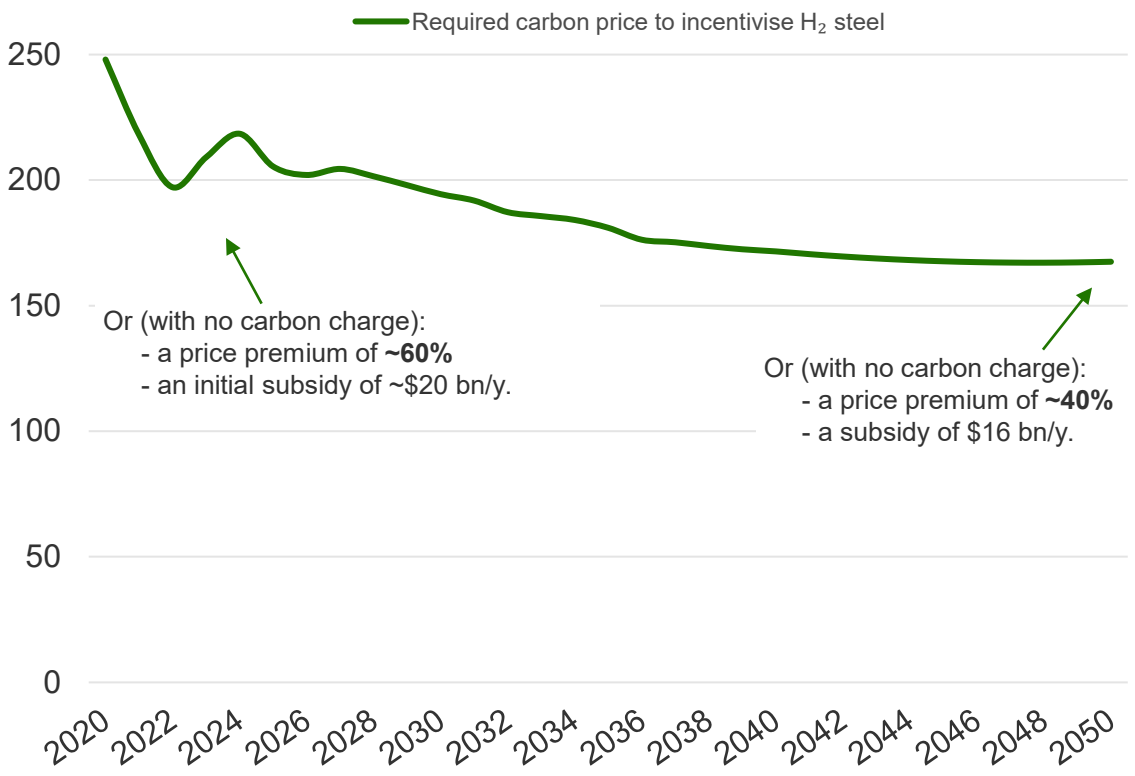
gives

Hydrogen @ ~$6.3 /kg (w/o storage or distribution)

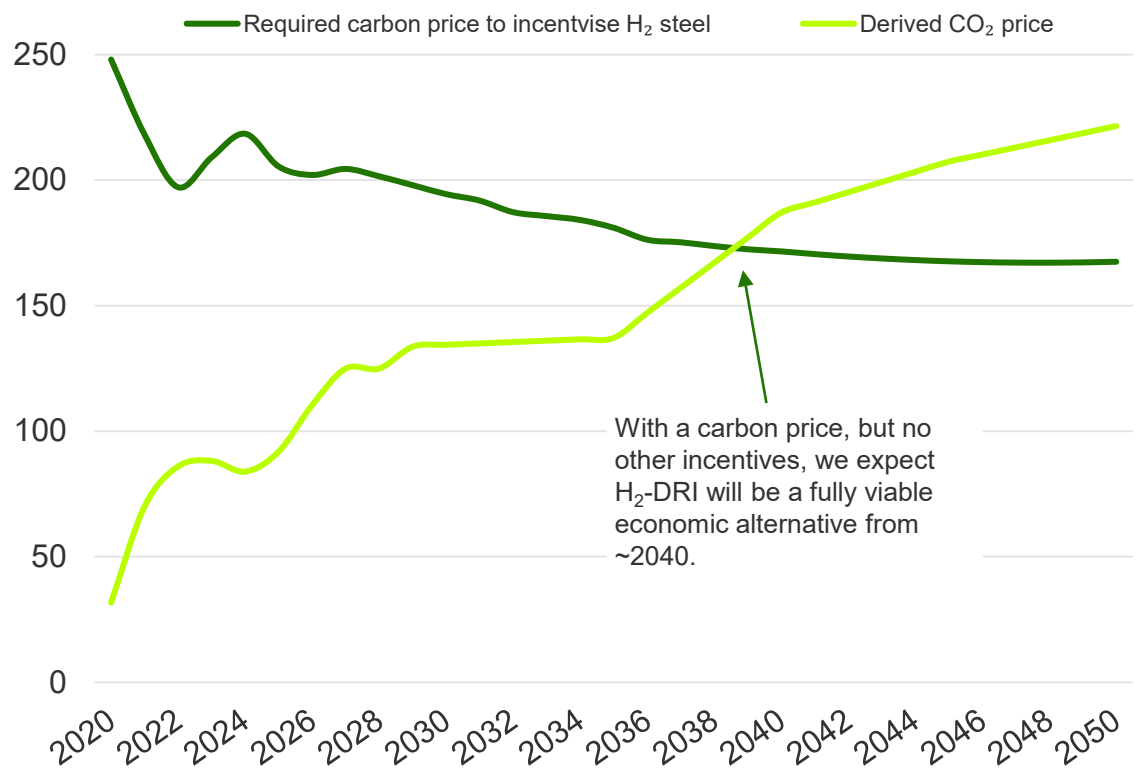
DATA: CRU Sustainability & Emissions Service – Hydrogen cost model

Carbon price needed to incentivise H_2-DRI falls as H_2 costs fall

Required carbon price to incentivise H_2 steelmaking, Europe, real 2023, $/tCO_2$



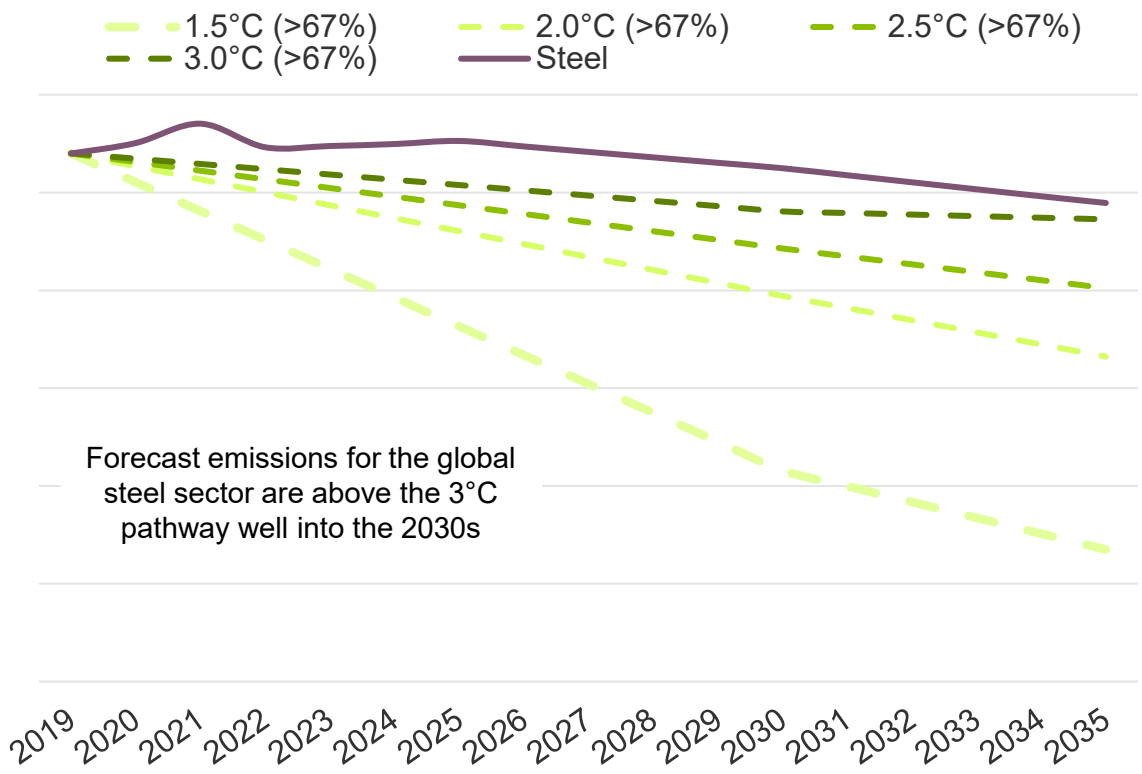
Required carbon price to incentivise H_2 steelmaking and carbon price, Europe, real 2023, $/tCO_2$



DATA: CRU Sustainability & Emissions Service – Carbon Abatement Curve and Long-term Carbon Price forecast

The steel sector is above a 3°C trajectory into the 2030s

Annual emissions by temperature pathway & from the steel sector, global, index



Key takeaways:

- Hydrogen unlikely available for <$2.5 /kg (ex-plant) in 2050:
  - $2.5 /kg is equivalent to ~$21 /GJ versus a steady-state coal reductant price of ~$3 /GJ (n.b. after accounting for process gas credits)
- Hydrogen availability will be constrained by grid optimisation needs
- Overall costs of H_2-steelmaking are high (i.e. both capex. and opex.) and will need a combination of carbon price, subsidy and price premium to progress
- Current forecasts show the steel sector is well above a 3°C temperature pathway well into the 2030s:
  - High emissions into the 2030s will consume the available carbon budget
  - H_2-steelmaking will not progress fast enough to address this

DATA: CRU Sustainability & Emissions Service – Emissions tracker; CRU Long-term Steel Service; The IPCC Sixth Assessment Report (AR6) – Longer Report and IPCC AR6 summary for policy makers

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