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Hydrogen Conference

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AURORA KEYNOTE

Hydrogen offtake agreements: Key considerations for developers

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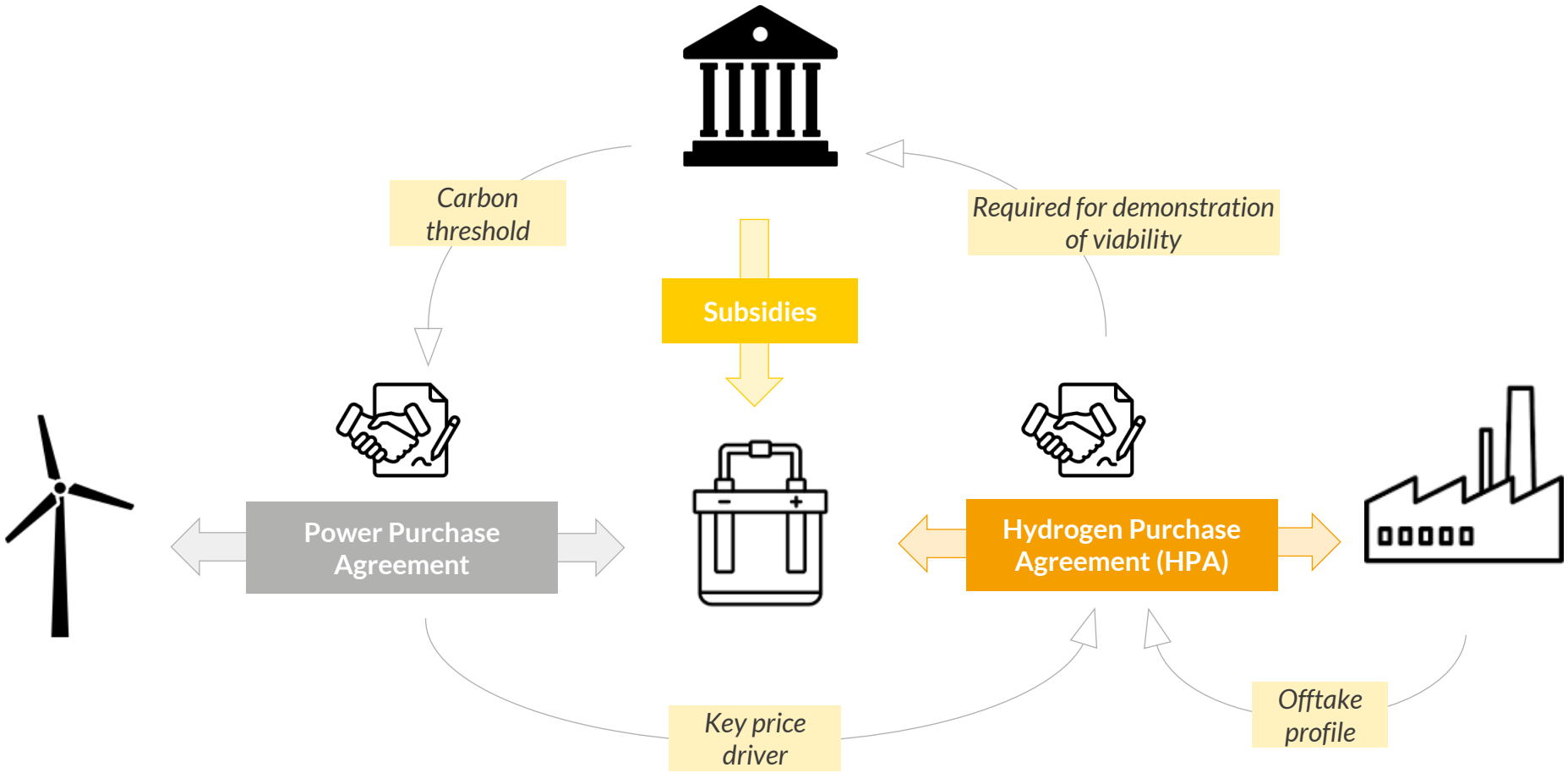
Securing an offtake agreement with a creditworthy counterparty is an essential component in ensuring a hydrogen production project is financeable



Source: Aurora Energy Research

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Key considerations when setting up a HPA

- What are the key considerations for buyers and sellers in HPAs?

Drivers of PPA prices

- How is HPA pricing linked to underlying PPA pricing?
- How do offtake profiles impact prices and terms of HPAs?

Interaction with Subsidies

- What requirements must projects comply with to be eligible for subsidies?

Hydrogen projects face a number of risks which should be allocated through agreements with those best suited to manage them

Source: Aurora Energy Research

Key commercial and legal clauses in a HPA include the price, volume, and quality of hydrogen

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Key Commercial Clauses

Component	Description
Price	Price per kg of Hydrogen
Tenor	Contract length
Volume	Offtake profile
Quality	Purity and sustainability requirements
Delivery and Transport	Delivery location, liability during transport

Focus in next section

Focus in final section

Further Legal Clauses

Component
Liability and penalties
Termination rights
Force Majeure
Dispute resolution
Governing Law & Jurisdiction

1) e.g. linked to natural gas and/or carbon or electricity prices

Source: Aurora Energy Research

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Renewable hydrogen projects require setting up both a Power Purchase Agreement and a Hydrogen Production Agreement

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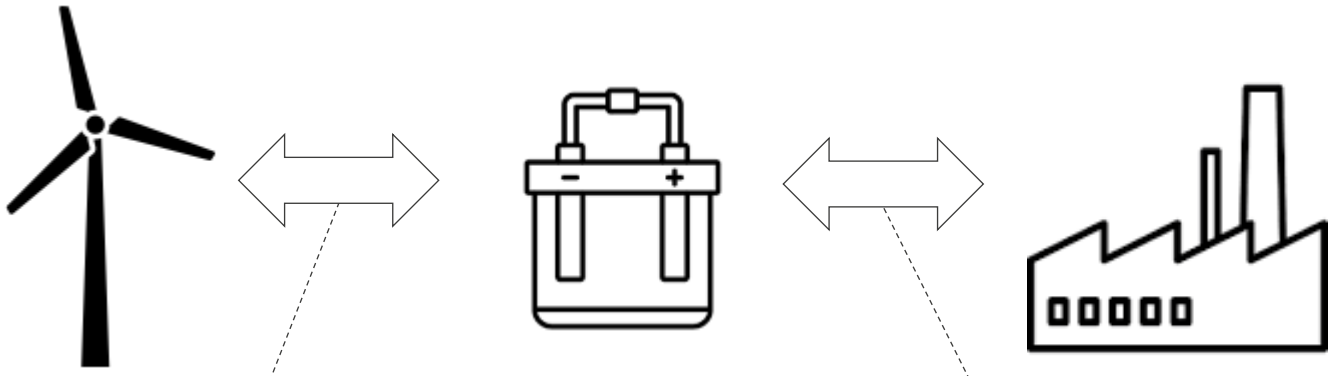
Purchase agreements

A Power Producer

B Hydrogen Producer

C Hydrogen Offtaker



Power Purchase Agreement (PPA)

- Electrolyser grid connected or co-located with RES
- PPA pricing, tenor, volume
- Interaction with RES power CfD

Hydrogen Purchase Agreement (HPA)

- Hydrogen offtake profile
- HPA pricing, tenor, volume
- Interaction with H_2 support mechanism

Pricing structure

1 HPA prices indexed to costs

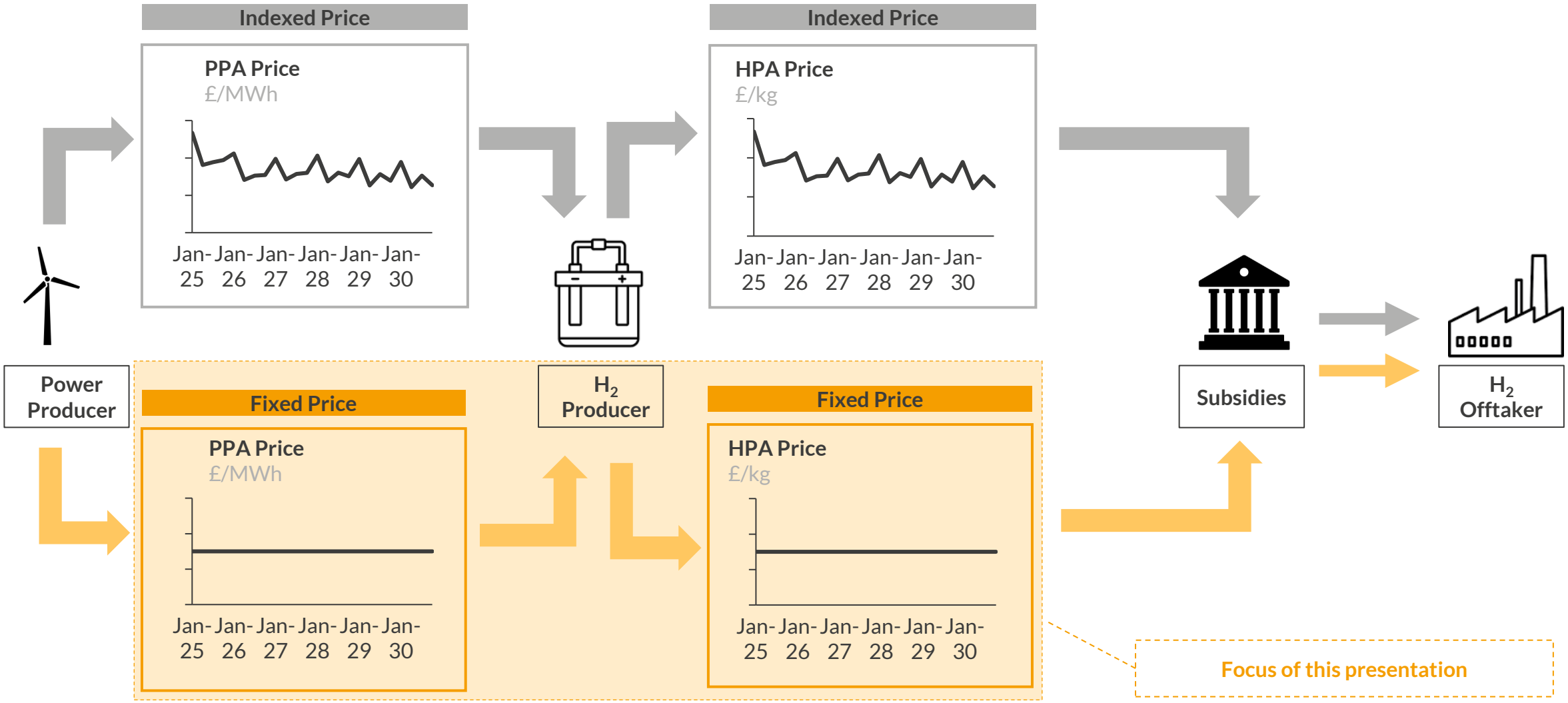
2 Fixed PPA prices

3 Tolling Model

Focus of this presentation

Source: Aurora Energy Research

Under a typical HPA, H2 prices may be indexed to production costs or sold at a fixed price, in which case producers must carefully manage costs



Source: Aurora Energy Research

Offtake prices will be driven by the cost of producing hydrogen, however will also factor in subsidies available to producers

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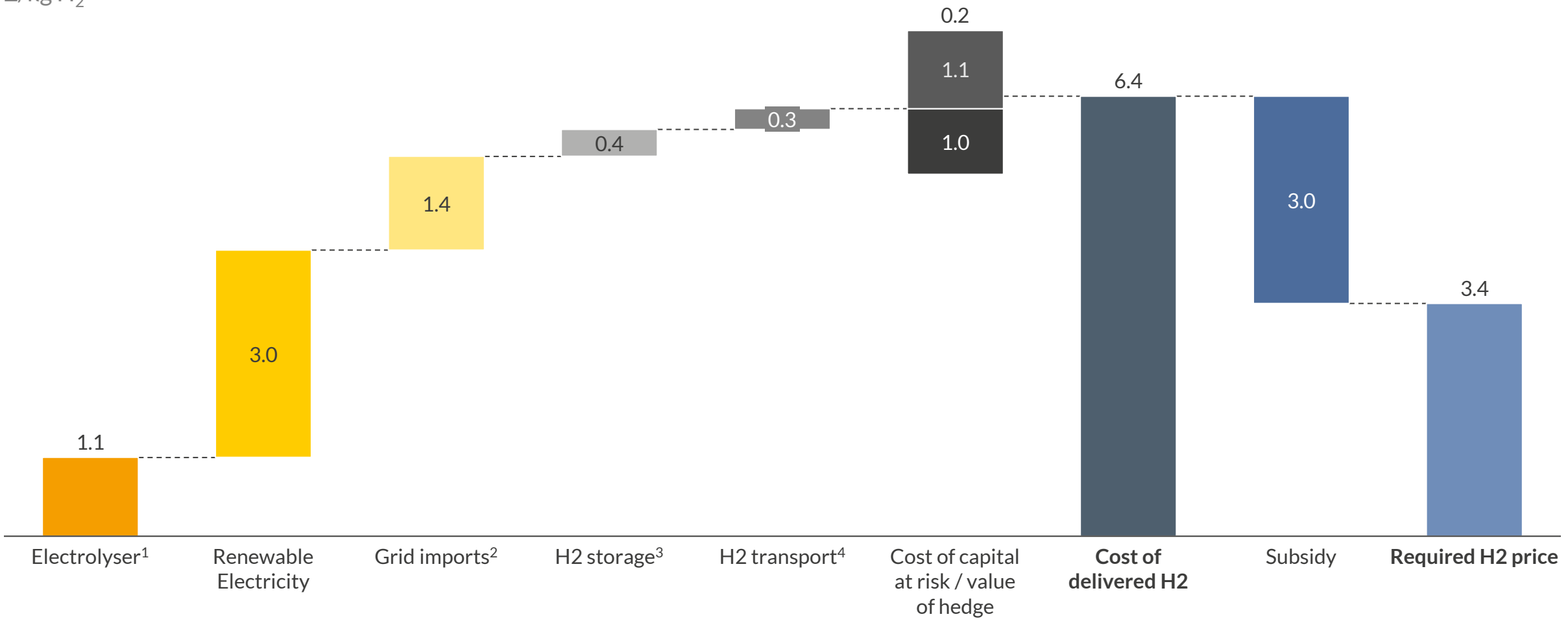
Cost of H2 production (Co-located electrolyser with grid connection, GB, 2030)

£/kg H_2



1) Includes electrolyser CAPEX and OPEX; 2) Includes fuel costs and grid fees and levies; 3) Assuming compressed H2 at 350 bar.4) Assuming pipeline transportation.

Source: Aurora Energy Research

Three significantly different hydrogen offtake profiles can be considered: As produced, Baseload, and Daily Pattern

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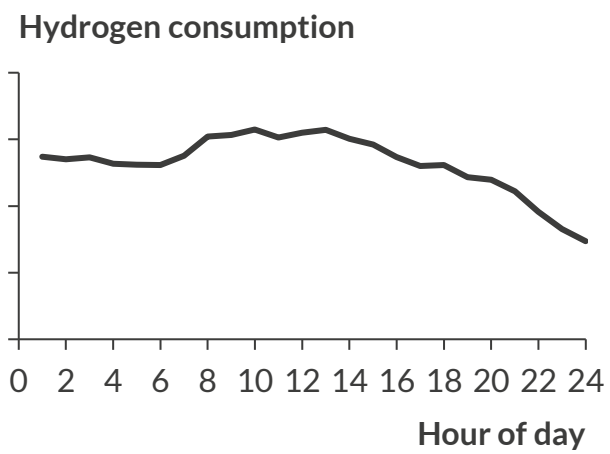
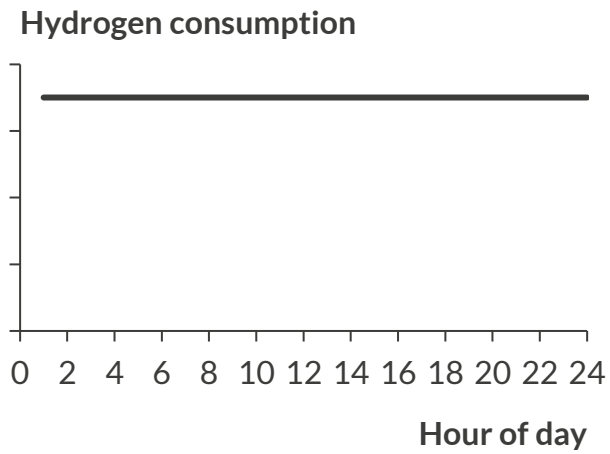
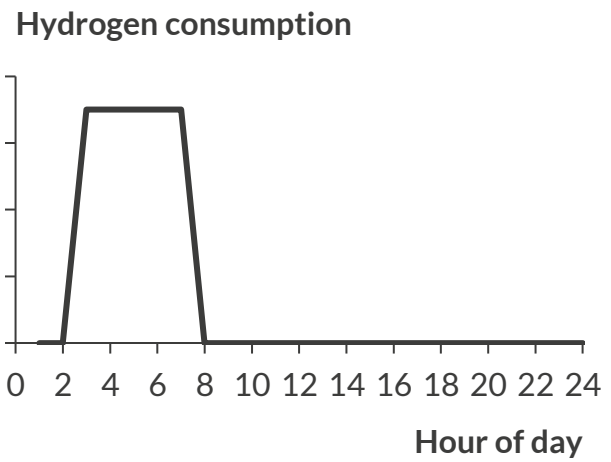
1 As Produced



2 Baseload



3 Daily Pattern



Power source	Onshore wind + Solar PPA	Onshore wind + Solar PPA	Onshore wind + Solar PPA
Grid imports	✗	✓	✓
Onsite H2 storage	✗ [1]	✗	✓ [2]
Example offtaker	N/A at present	Industrial plant	H_2 bus depot

1) Assuming offtaker has access to seasonal storage whose costs are not included in the HPA; 2) Daily storage, costs included in HPA price

Source: Aurora Energy Research

Meeting a baseload H2 offtake at low carbon intensity can lead to reduced utilisation of renewable and electrolyser assets

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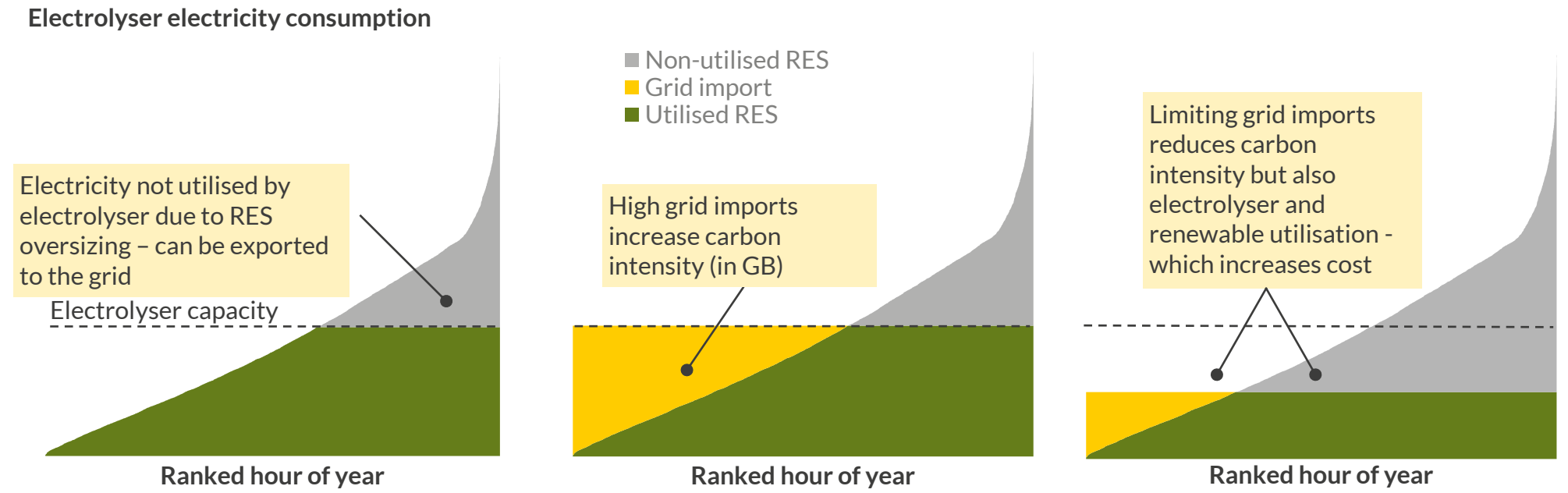
1 As Produced | **2 Baseload A – 100% load factor[1]** | **3 Baseload B – limited grid imports[2]**



Carbon intensity	Zero ✓	High ✗	Medium ✓
Electrolyser utilisation	Medium ✗	High ✓	Low ✗
RES utilisation	High ✓	High ✓	Low ✗

1) In the Daily Pattern case a certain amount of H_2 needs to be produced every day rather than every hour; this reduces the need for grid imports compared to the Baseload case, as renewable generation across days is less volatile than across hours; subsequently the need for and impact of grid imports is reduced; the points made on this slide hold also in this case, although to a less extreme extent; 2) in the remainder of the presentation we assume grid imports are limited to ensure low carbon intensity

Source: Aurora Energy Research

Baseload and Daily Pattern profiles imply a significant premium – driven by grid imports, storage, and potentially reduced utilisation of assets

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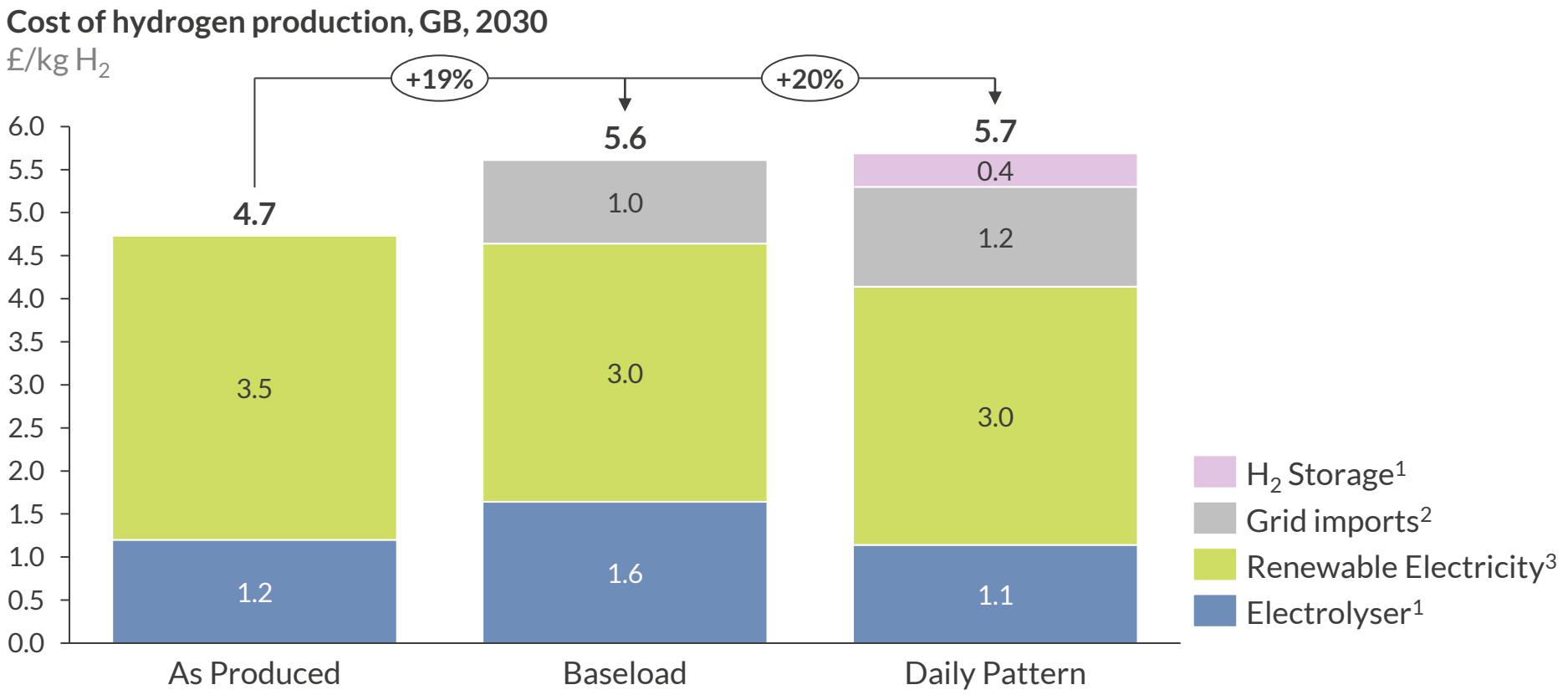

Electrolyser load factor	70%	51%	73%
Share of grid imports	0%	15%	15%
Max. CO_2 intensity ($kgCO_2/kgH_2$)	0	1.7[4]	2.3[4]

1) Including CAPEX and OPEX; 2) Includes grid import costs and network fees and levies with exemptions for electrolysers; 3) assuming in this illustrative example the same price for renewable electricity in all three cases; however renewable generators might require a premium in the Baseload and Daily Pattern case since a smaller share of the total output of their plant is contracted; 4) based on grid carbon intensity profile in 2030

Sources: Aurora Energy Research

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At present, subsidies are required to ensure H2 projects are economically viable and HPAs must be structured to ensure these can be accessed

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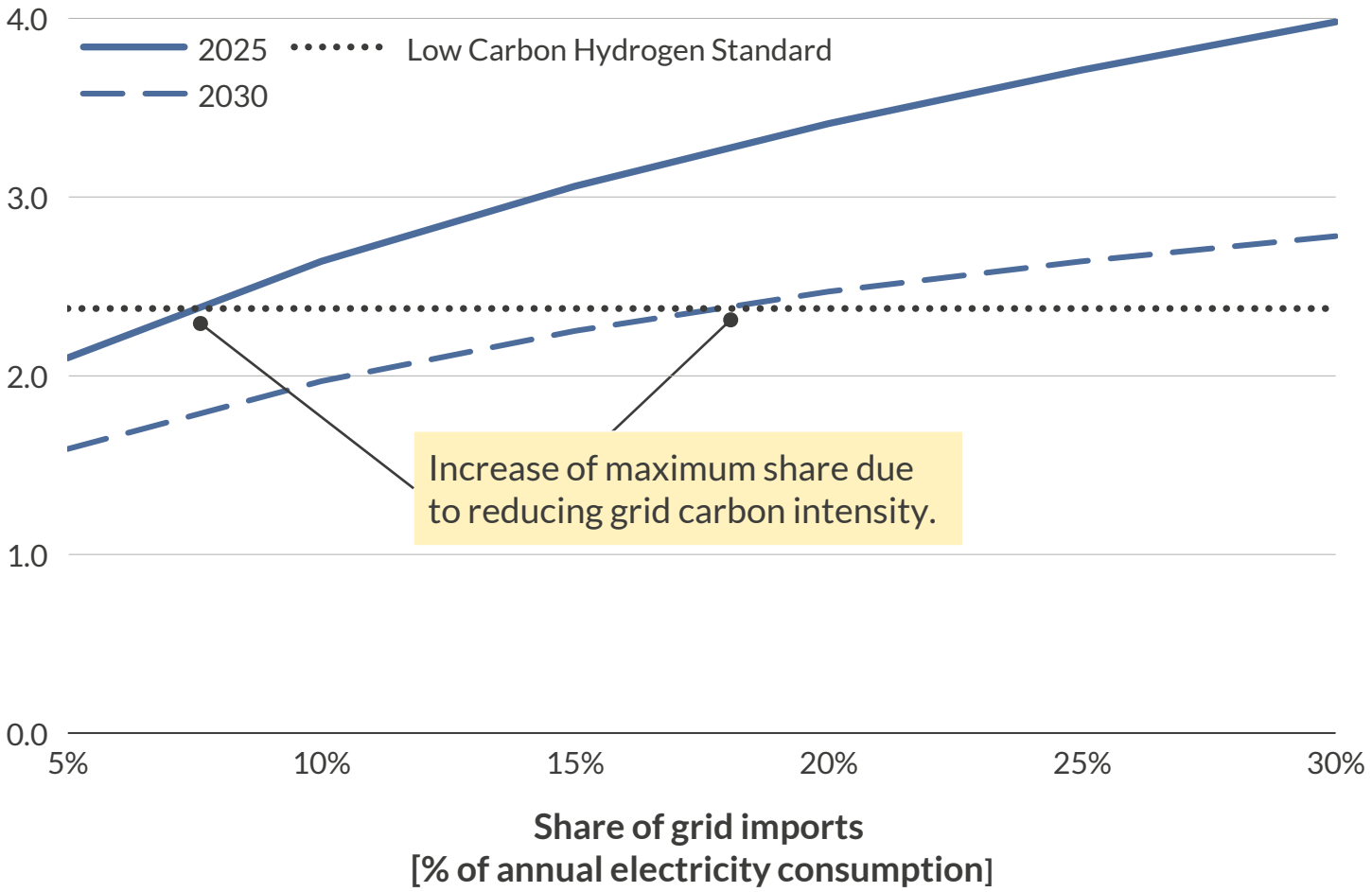
Maximum monthly carbon intensity

kg CO_2 / kg H_2



Eligibility criteria for subsidies

1 Carbon intensity

- UK: **Low Carbon Hydrogen Standard**
- EU: **Delegated Act** of Renewable Energy Directive
- Implies **limits** to level of **grid imports** (left)

2 Further requirements

- **Eligible offtakers**[1]
- Further **social and environmental standards**[2]

Implications for HPAs

- Compliance with standards included in HPA[3]
- Increased production cost but overall significantly lower price due to subsidies

1) E.g. UK scheme rules out risk intermediaries to avoid speculators taking advantage of the subsidy scheme; 2) E.g. required in the EU scheme H2Gloabal, which is designed for H_2 imports from outside the EU; 3) This could be required for the buyer's sustainability reporting or compliance with regulation, such as obligations for fuel suppliers to source a certain share of their fuel from renewable sources. It could also be the case if the government itself is the buyer as in the case of H2Global.

Sources: Aurora Energy Research, DSNEZ

Conclusions

1. As a merchant market for low carbon hydrogen does not exist, long term offtake agreements with creditworthy counterparties are required to make hydrogen projects bankable and to ensure projects can access available subsidies.

2. Key commercial and legal clauses in a hydrogen purchase agreement that must be determined will include the offtake price, volume, and quality of hydrogen, on top of further legal clauses designed to manage other risks.

3. Offtake prices will be determined by the cost of producing hydrogen, and will take into account any subsidies that are available to the hydrogen producer to allow them to sell hydrogen at lower costs. Offtake Profiles will also have an impact on prices: baseload and regular daily pattern offtake will come at a significant premium compared to offtake as produced.

4. Government support transforms project business cases and allows producers to offer hydrogen below production cost. Projects will have to ensure eligibility requirements, such as carbon intensity thresholds and eligibility of offtakers are met.

Sources: Aurora Energy Research

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