

Green Hydrogen Auctions: A Guide to Design

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MONDAY, 9 DECEMBER 2024 • 13:00 – 13:30 CET

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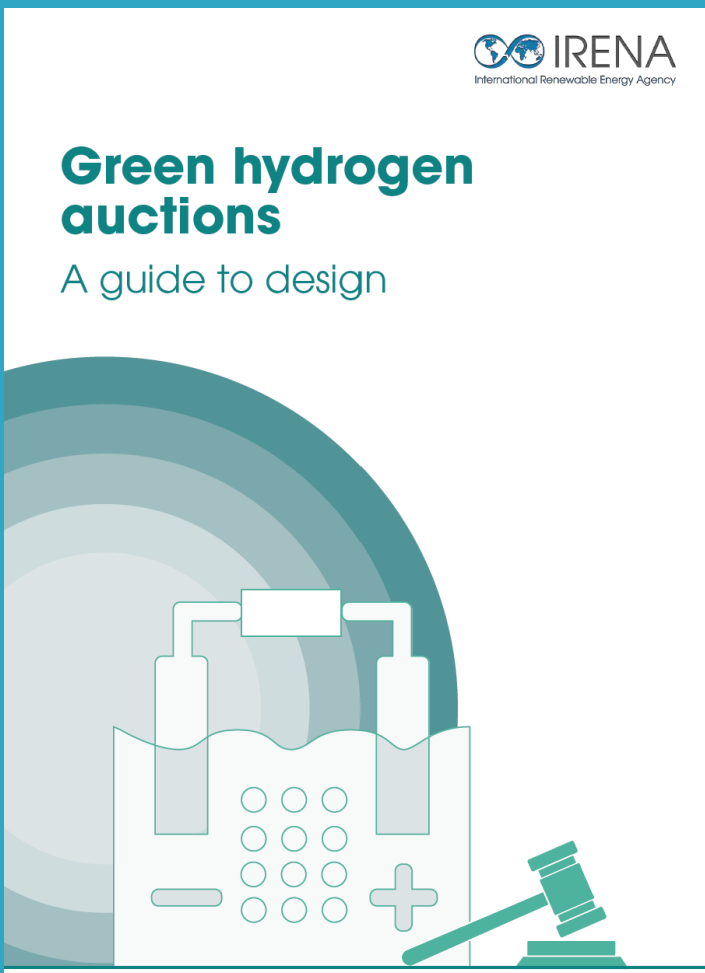
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Green Hydrogen Auctions: A Guide to Design

Main barriers to green hydrogen uptake

Technological	Economic	Institutional	Social
Immaturity of specific hydrogen technologies	High and uncertain production cost	Regulatory framework not ready for green hydrogen sector	Public awareness and acceptance
Energy consumption and losses and hydrogen losses	High delivery cost	Lack of coordination among national public bodies	Fear of missing out on hydrogen
Poor compatibility of existing energy infrastructure with hydrogen	Lack of suitable end uses	Conflicting drivers and lack of policy ambition	Lack of investor confidence
	First movers' disadvantage		
	Lack of know-how, personnel and skill sets		

- These barriers can be addressed by implementing auctions to set competitive support levels, one of the many instruments available.

Strengths of tariff-based schemes



Strengths of auctions



Policy objectives that can be achieved

- Long-term revenue certainty for producers
- Long-term budgetary planning for governments
- Dynamic efficiency – moving through the technology learning curve

- Enable competition that can lead to true price discovery, minimising costs
- Effectiveness and transparency and clear pipeline of future projects
- Flexibility for additional objectives

- Climate and environmental goals
- Decarbonise local industries and increase global competitiveness
- Support system integration of VRE and electrolyzers
- Address infrastructure challenges (e.g. GH transport, network T&D)

Price pressure can lead to projects not being realised, the sector being compressed and inability to invest in capacity building and technological improvement

- Price pressure influence bidder making too-optimistic assumptions on cost reduction, availability of components, and revenue
- Lead to the cancellation of an already awarded project or use inferior, cheaper components, reducing the plant's lifetime or output

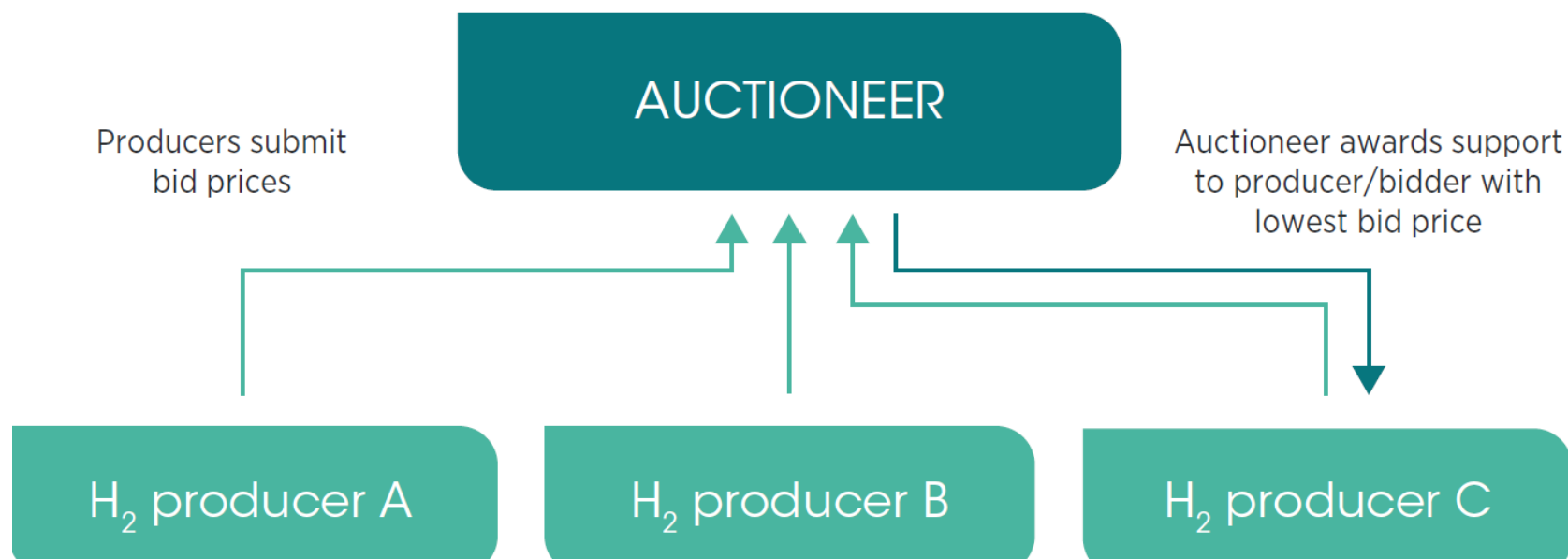
Lack of competition results in high prices

- Auctions are successful in bringing down prices only if there is sufficient competition
- For emerging technologies such as green hydrogen, high levels of competition in early stages may be a challenge

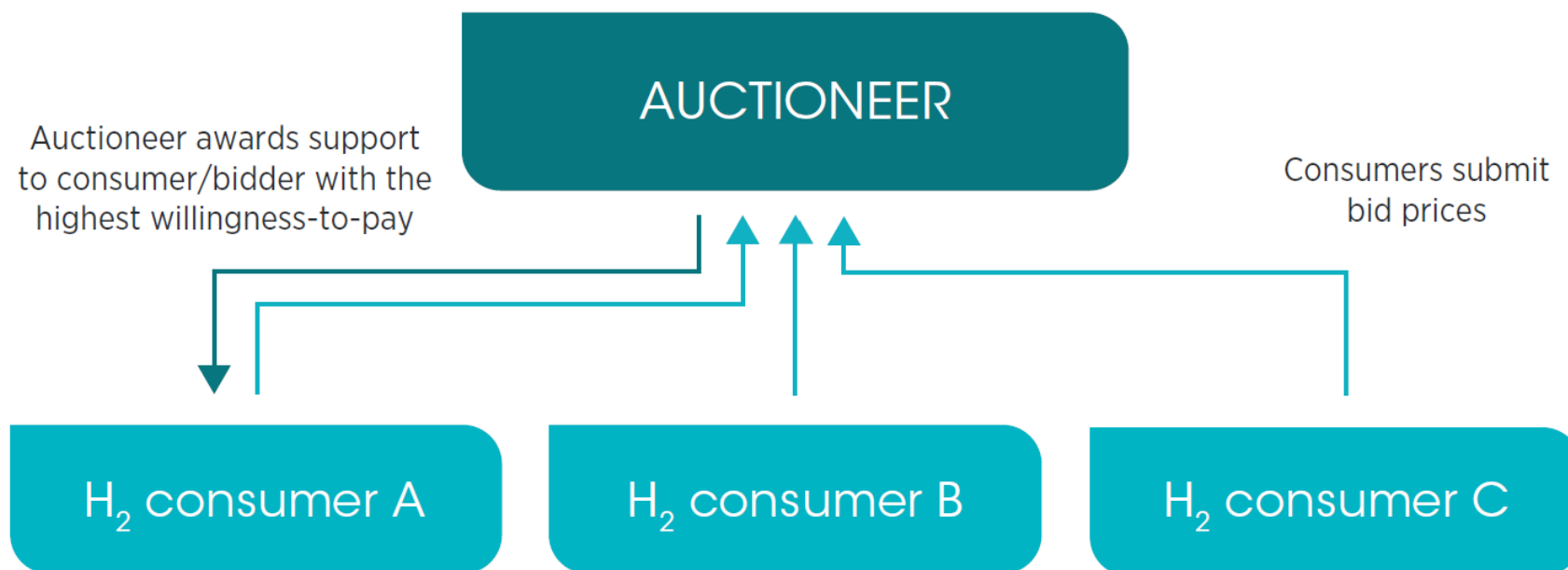
Higher barriers to smaller producers

- Auctions imply that bidders are subject to risks, and they incur pre-development costs but are not guaranteed receiving awards
- Smaller producers that might lack such a risk appetite, these barriers might be too high to participate

Supply-side auctions

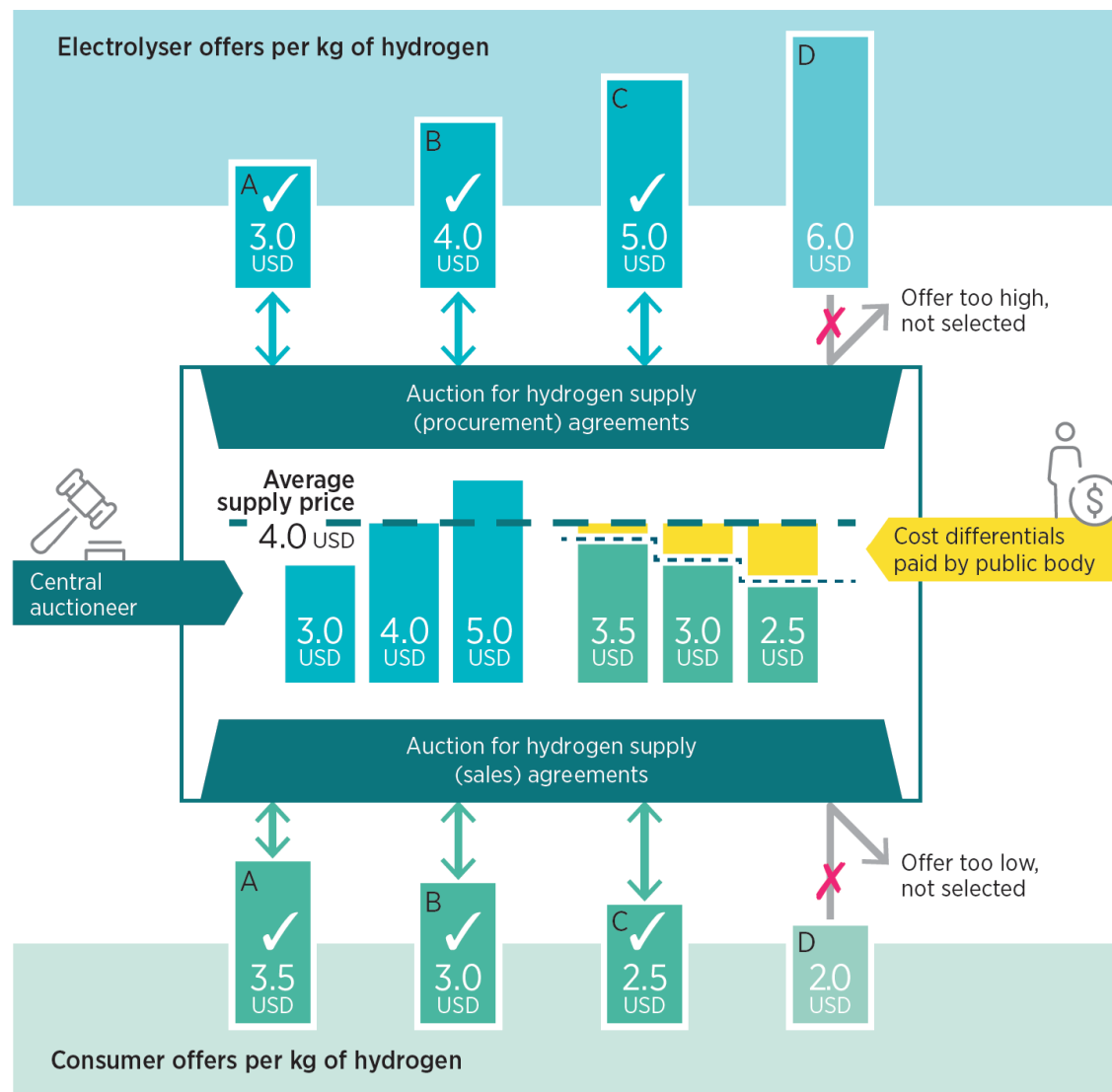


Demand-side auctions

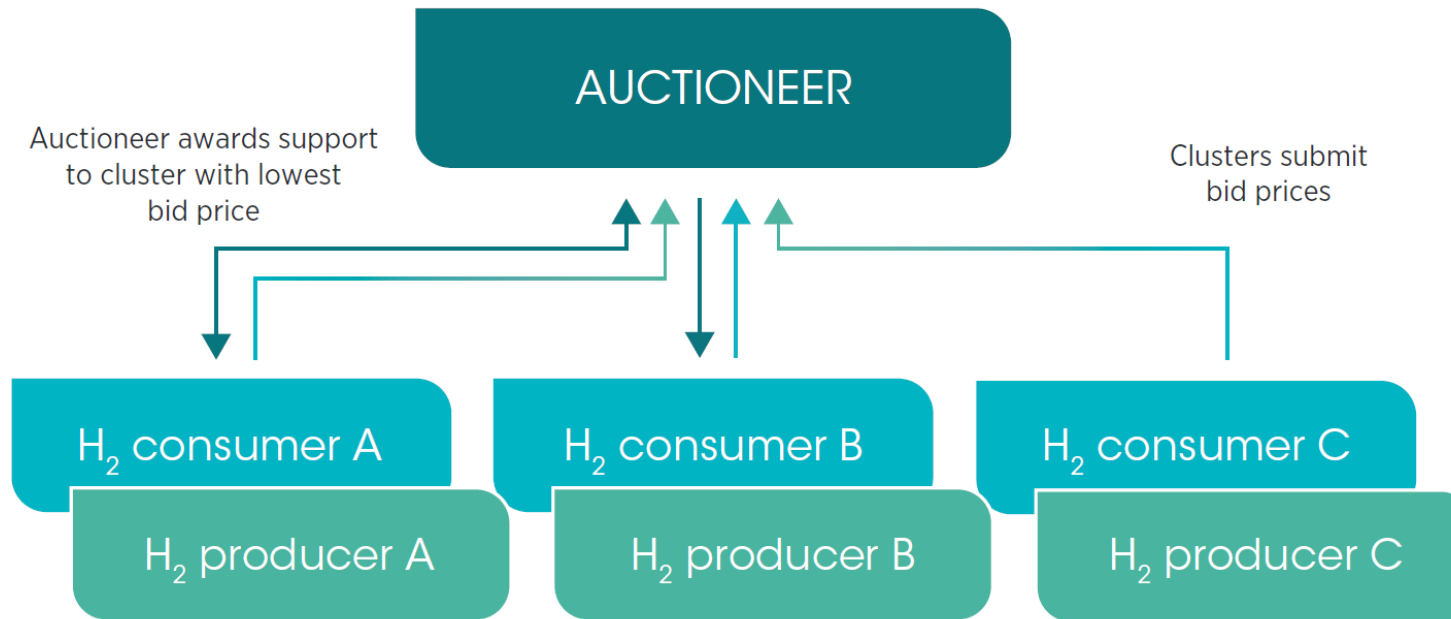


There are different types of auctions to support green hydrogen, with varying geographic reach

Double-sided auctions



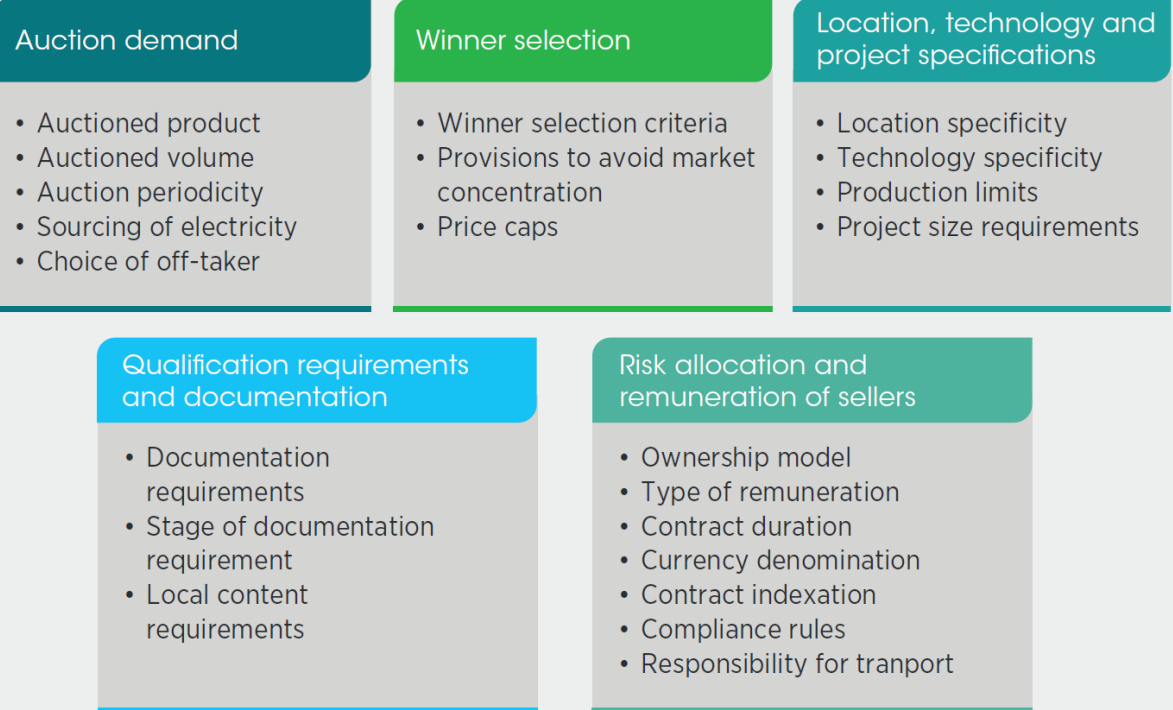
Joint supply- and demand-side auctions



Framework for the design elements of auctions for green hydrogen



Proposed framework for green hydrogen auctions



- Design needs to be tailored to country, energy system, market conditions and policy objectives
- There is often a trade off between achieving the lowest price and the set objectives
- Focus of the following slides is on supply-side green hydrogen auction

Auction demand

- Auctioned product
- Auctioned volume
- Auction periodicity
- Sourcing of electricity
- Choice of off-taker

Trade-offs to consider when determining the auctioned product

	Electrolyser capacity	Green hydrogen production
Description	The procurement/support is for electrolysers installed	The procurement/support is for green hydrogen produced
Dynamic efficiency (moving down the technology learning curve)	● Supports the learning curve for installing electrolysers only	● Supports the learning curve for installing electrolysers and producing green hydrogen
Budgetary planning for government	● Straightforward based on electrolyser capacity installed and can be capped using a ceiling price	○ Less straightforward and depends on bids received (volume and bid prices), quantities produced, remuneration type, and caps introduced
Higher number of potential bidders increasing the level of competition	● Minimal risk on developers increases the number of bidders and therefore competition	● Producers take on the risk of green hydrogen production impacting number of bidders and competition
Climate and environmental goals	● Does not guarantee the production or use of green hydrogen	● Guarantees the production and off-take of green hydrogen
Socio-economic goals – greening local industries	● Does not guarantee the production or use of green hydrogen locally	○ Does not guarantee that the green hydrogen is used by any specific downstream sector that the government intends to support, such as steel production
Socio-economic goals – development of domestic green hydrogen economy	● Supports the development of a domestic green hydrogen economy including jobs and businesses with the potential to export green hydrogen, but could miss out on the added value brought on by expanding the value chain to end uses	● Supports the development of a domestic green hydrogen economy including jobs and businesses with the potential to export green hydrogen, but could miss out on the added value brought on by expanding the value chain to end uses
Support system integration of VRE	○ Unless specified by the auction, no guarantee that renewable power is used, and green hydrogen is produced	○ Can support system integration if other design elements are introduced (e.g. additionality)
Address infrastructure challenges	○ Can address infrastructure challenges if other design elements are introduced (e.g. location-specific at proximity of renewable power plant and end uses)	○ Can address infrastructure challenges if other design elements are included (e.g. location-specific at proximity of end uses)

● = very positive impact, ● = positive impact, ○ = no impact, ● = negative impact, ● = very negative impact

Location, technology and project specifications

- Location specificity
- Technology specificity
- Production limits
- Project size requirements

Options for the location specificity of green hydrogen auctions

	Site specific	Guidance in the form of incentives/ requirements to guide siting to or away from predetermined zones	Free siting
Description	Only projects in specific zones/locations/ pre-developed sites can participate	Bidders can choose the location with guidance in the form of incentives/ requirements from the auctioneer to or away from pre-determined zones	Bidders can choose the location for their projects freely
Competition and reduced costs on developers leading to lower bid prices	<ul style="list-style-type: none"> ● Pre-developed sites can reduce risks and costs on bidders and the prices they offer 	<ul style="list-style-type: none"> ○ Lower CAPEX may lead to lower costs, yet electricity transmission/ distribution costs might increase costs ○ Risks of grid-related issues (technical issues or grid congestion) can be allocated to the bidders or the auctioneer ● Electricity price risks low for the green hydrogen producer 	<ul style="list-style-type: none"> ○ Risks of grid-related issues (technical issues or grid congestion) can be allocated to the bidders or the auctioneer ● Risk of unexpected increases in the electricity prices allocated to the green hydrogen producers ● If renewable energy shares are high, lower LCOH due to longer full-load hours of electrolyser use
Reduce the total cost of support	<ul style="list-style-type: none"> ● Costs associated with resource and impact assessments, land, grid, water, etc. passed on to the auctioneer 	<ul style="list-style-type: none"> ● Renewable energy sourcing risk outsourced to the renewables generator (except for PPA counterparty default risks) 	<ul style="list-style-type: none"> ○ Renewable energy sourcing risk subject to availability of renewables in the market
Effectiveness (realisation rates)	<ul style="list-style-type: none"> ● High realisation probability if site is pre-developed and regulatory issues already addressed 	<ul style="list-style-type: none"> ○ There are no guarantees that the sites selected will lead to project realisation 	<ul style="list-style-type: none"> ● Regulatory issues related to permitting for example can potentially arise that might hinder the realisation of the project
Socio-economic goals – development of domestic green hydrogen economy	<ul style="list-style-type: none"> ● Sites could be located in underdeveloped regions to increase impact on domestic economy and reduce impact on environment or in dedicated industrial development zones 	<ul style="list-style-type: none"> ● Incentives/requirements provided can guide siting to underdeveloped regions 	<ul style="list-style-type: none"> ● Sites with lowest production cost for producers might not be optimal from a societal point of view
System integration	<ul style="list-style-type: none"> ● Locations can be selected such as to avoid electricity grid constraints and ensure the transport of the hydrogen 	<ul style="list-style-type: none"> ● Incentives/requirements provided can guide siting on locations with lower integration costs 	<ul style="list-style-type: none"> ● Projects could be located in areas with already stressed electricity grids and suboptimal transport infrastructure

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Winner selection criteria

Winner selection

- Winner selection criteria
- Provisions to avoid market concentration
- Price caps

	Price-only auction	Multi-criteria auction
Short description	Bidders with the lowest bid prices are awarded	Bidders are awarded based on a multitude of different criteria
Dynamic efficiency	🔴 Selection purely based on the bid price might hinder more expensive electrolyser technologies to be awarded and thus limits the potential for technological innovation and learning	🟢 Technological innovation could be included in the selection criteria
Lower bid prices and total cost of support	🟢 Bidders with the lowest bid prices/support needs are awarded	🔴 Bid price is not the only criterion/main objective when selecting bidders, which may increase the cost of support
Transparency regarding the way projects are selected and support is awarded	🟢 Easy-to-understand selection process and to justify payments to the producers	🔴 May be complicated to understand selection process and to justify payments to the producers when they are not the lowest bid
Effectiveness (project realisation rates)	🔴 Selection purely based on the bid price could sometimes lead to aggressive, unsustainably low bid prices (underbidding)	🟡 There is a need for additional compliance mechanisms to ensure projects deliver as per the bid
Socio-economic goals - development of domestic green hydrogen economy	🔴 The development of the green hydrogen sector might not be targeted by selecting lowest-price projects	🟢 The development of a domestic green hydrogen sector can be included as a criterion in the selection process
Socio-economic goals - development of local green industry	🟢 Green hydrogen-consuming industry might profit from cheapest bids	🔴 The development of a local industry that consumes green hydrogen might be slowed due to higher prices
Climate and environmental goals	🔴 Not addressed, as achieving the lowest price possible is the aim of the bidders	🟢 Environmental and socio-economic goals can be explicitly included as criteria in the selection process
System integration	🔴 Cheapest projects might have adverse effects on system integration 🟢 The lowest-price projects can be designed to produce when renewable electricity is cheapest, leading to a higher system integration	🟢 System integration can be included as a criterion in the selection process

Qualification requirements and documentation

- Documentation requirements
- Stage of documentation requirement
- Local content requirements

Stage of the project development process when the auction takes place

	Early project development with light documentation required	Advanced project development with elaborate documentation required
Description	Projects can be at the early development stage when participating in the auction with light to no documentation required	Projects required to be at an advanced development stage when participating in the auction with elaborate documentation required
Competition and reduced costs on developers leading to lower bid prices	● Lower costs on developers and increased competition leading to lower bid prices	● Increased costs on the bidders and lower competition which is reflected in higher bid prices
Reduced total cost of support	○ Prices bid can be lower but higher risks that future complications might arise, with implications on overall system costs	● Prices bid can be higher but lower risks that future complications might arise, with implications on overall system costs
Effectiveness (realisation rates)	● Higher risk of projects not being realised or delivering as per the bid due to potential permitting or price issues after the award	● Lower risk of projects not being realised or delivering as per the bid
System integration	● In the case of grid-connected electrolyzers, grid-related issues are identified only after the auction takes place	● In case of grid-connected electrolyzers, TSOs and distribution system operators are informed ahead of time regarding new capacity to be added to the grid
Address infrastructure challenges	● Not requiring such documentation at early stages increases risks that infrastructure will not be developed on time	● Documentation required increases chances that infrastructure will be developed on time

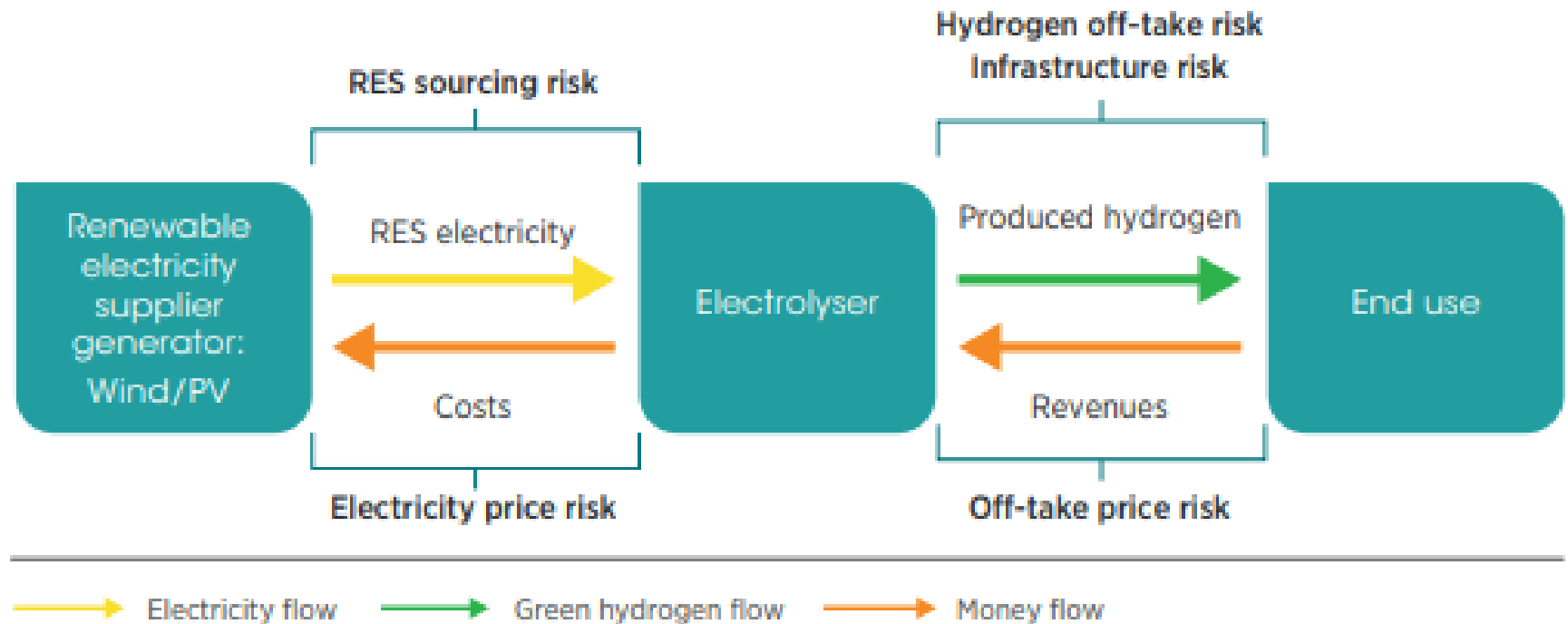
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Risk allocation and remuneration of sellers

Risk allocation and remuneration of sellers

- Ownership model
- Type of remuneration
- Contract duration
- Currency denomination
- Contract indexation
- Compliance rules
- Responsibility for transport

Allocating the right balance of risks among bidders, off-takers and the public body managing the auction



Notes: RES = renewable energy source; PV = photovoltaic.

Policy objectives
that can be
achieved

Climate and environmental goals

- Technology-neutral auctions
- Winner selection criteria based on price only
- Ceiling price

Develop a local green hydrogen economy with localised value chains to enhance energy security or participate in the international trade of green hydrogen and diversify energy exports

- Schedule of auctions to attract investments in upstream activities
- Auctions that aim at developing specific technologies
- Winner selection criteria and qualification requirements aimed at local content
- Provisions to avoid market concentration

Attract foreign investments in energy-intensive industries and support their international competitiveness

- Design elements that aim for competitive prices while supporting innovation and industrial development (e.g. hard currency denomination or including indexation clauses to inflation)

Auctions should also be designed in a way to address challenges and barriers (e.g. system integration of VRE and hydrogen transport)

For system integration of VRE

Location, technology and project specifications

- Location specificity
- Technology specificity
- Production limits
- Project size requirements

- **Site-specific auctions** - locations selected to avoid grid constraints
- Guidance as **incentives or requirements** to guide siting to or away from pre-determined zones

Winner selection

- Winner selection criteria
- Provisions to avoid market concentration
- Price caps

- In liberalised power markets, **selecting projects based on price only** can lead to higher system integration.
- Setting a **maximum amount of annual full-load hours for electrolyzers** or a **maximum amount of support for hydrogen**

To address barriers related to green hydrogen transport

Auction demand

- Auctioned product
- Auctioned volume
- Auction periodicity
- Sourcing of electricity
- Choice of off-taker

- Auctions can be designed to **procure derivatives or green products**

Risk allocation and remuneration of sellers

- Ownership model
- Type of remuneration
- Contract duration
- Currency denomination
- Contract indexation
- Compliance rules
- Responsibility for transport

- Auctions can be designed to **procure derivatives or green products**
- Can **allocate the costs and risks** associated with transport to the **public entity facilitating the auction**

Auctions should be designed in a way to ensure environmental and social sustainability and should adhere to the concept of additionality

Qualification requirements and documentation

- Documentation requirements
- Stage of documentation requirement
- Local content requirements

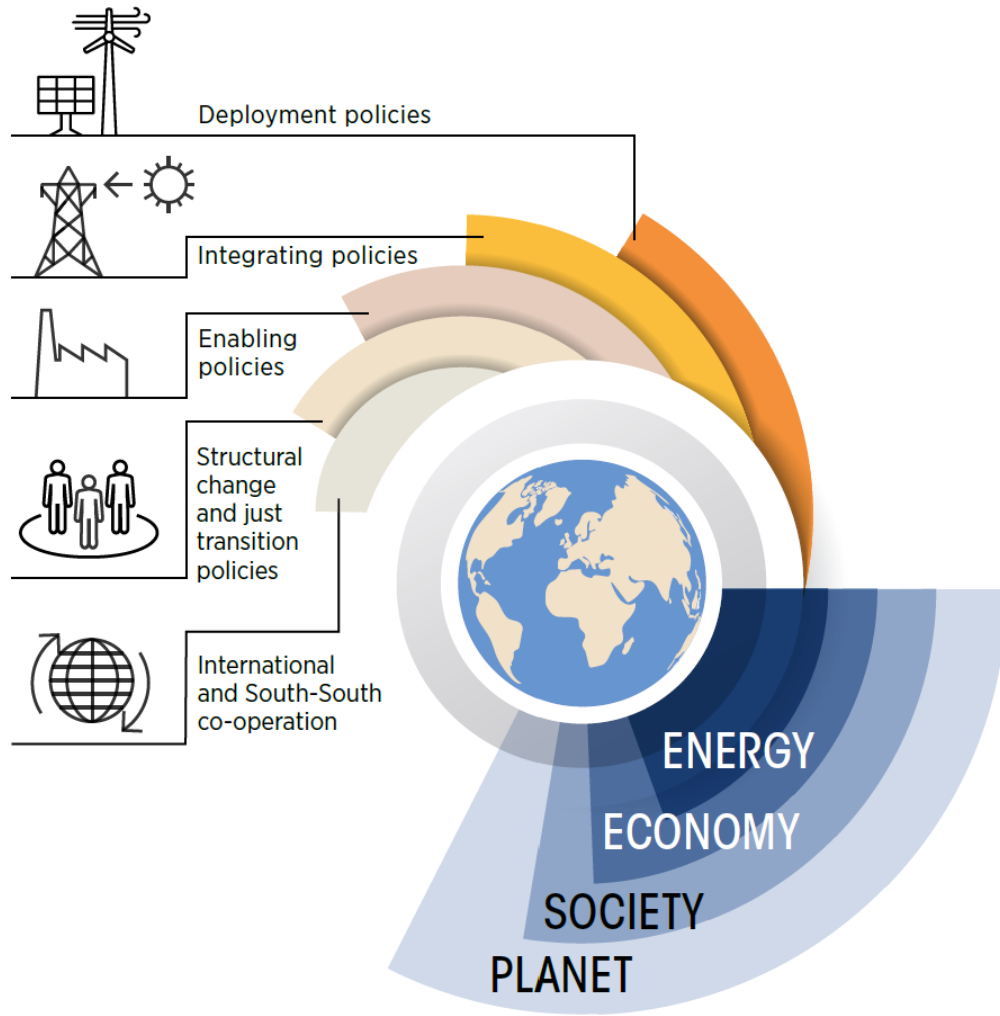
- **Proof of balanced use of land and water resources** (credible arrangements to access water resources sustainably, proof of a land lease agreement, and passing an environmental and social impact assessment)
- **Social contracts focusing on the welfare of local communities** (revenue-sharing agreements, job opportunities for community members and investments in community development)
- **Additionality requirements** to ensure that hydrogen production does not displace the use of renewable electricity

Winner selection

- Winner selection criteria
- Provisions to avoid market concentration
- Price caps

These criteria can also be embedded as **winner selection criteria**, assigning weights to each of the objectives considered and scoring projects accordingly

Auctions alone are not enough.



The success of auctions relies on them being part of a broader mix of policies effective policy coordination among the different sectors and strong international collaboration



Q & A
5 min

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