The future of auctions in the energy system

Auctions beyond renewable electricity

AURES II webinar, 15 December 2021

AURES II – an overview

AURES II – **Au**ctions for **R**enewable **E**nergy **S**upport II

- Supported through Horizon2020 framework
- November 2018 – April 2022
- Coordination: Fraunhofer ISI, Germany
- Consortium: 11 institutions from 6 EU Member States + UK

AURES II – 11 institutions from 7 European countries

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AURES II has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817619

AURES II – our objectives

Generate and communicate new insights on the applicability, performance, and effects of **specific auction designs**

Provide **tailor-made policy support** for different types of auction applications

Facilitate **knowledge exchange** between stakeholders

AURES II – inform the discussion on renewable energy auctions

- 16 country case studies
- AURES II Auction Database
- Policy Briefs
- Reports on current topics
- Research papers
- Stakeholder workshops
- Country case cooperation

Today’s agenda

Time	Title	Speaker	Institution
10:00	Welcome and introduction	Vasilios Anatolitis /Bridget Woodman	AURES II project coordinator Fraunhofer ISI / UNEXE
10:10	Evolution in auctions for renewable electricity	Bridget Woodman	University of Exeter
10:20	Auctions for heating and cooling	Jenny Winkler	Fraunhofer ISI
10:40	Auctions for Hydrogen	Pia Kerres	Guidehouse
11:00	Auctions for transport	Vasilios Anatolitis	Fraunhofer ISI
11:20	Approaches for integrated auctions	Bastian Lotz	Guidehouse
11:40	Questions and discussion	All	
12:00	End of webinar		

Organizational issues

- Workshop will be recorded and published, but without the Q&A session
- If you have any questions (or want to provide feedback), you have two options:
  - **Type your questions in the question box**
  - Click on the “raise your hand” button in the software (during the Q&A session)

➔ Looking forward to a fruitful and lively discussion!

Background

AURES II webinar, 15 December 2021

Why go beyond electricity?

- Auctions established as successful instrument to allocate support for renewable electricity
- In this decade system transformation will have to speed up in the whole energy system
- Competitive determination of support will continue to be required by EU COM
- Experience with renewable electricity auctions might be useful for other auctions/support schemes

→ Today: discussion of first ideas for auction opportunities in sectors beyond electricity

→ Your feedback will be used in a summary/scoping report and as a basis for more in-depth analysis in potential successor project

Auctions for renewable electricity – what to expect?

The future of auctions for electricity: scenarios and pathways

More flexible

Less decentralised

More decentralised

Less flexible

Top-down tech

Technical innovation, top down planning, efficient system operation

Large-scale renewable projects owned by large utilities

AUCTIONS held by utilities and major consumers. Merchant power increases

Shiny happy energy citizens

Local governance, active system management, local markets

Growth in local and community scale projects in addition to large projects

AUCTIONS held at different scales and are both public and private – actor and technology diversity

Leviathan

National or transnational governance, systems dominated by a few large utilities

Little system optimisation, low innovation, volatile prices

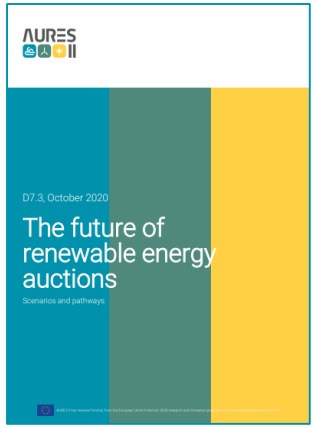
AUCTIONS for CFDs held by utilities. Pressure to meet climate targets lead to reinstating FITs

Make-do-and-mend

Local governance, little network management

Low technical innovation but active social innovation – prosumers, microgrids and some local markets

Little demand for auctions to encourage RES construction. Emergence of community PPAs



http://aures2project.eu/wp-content/uploads/2021/02/AURES_II_D7_3_scenarios_v2.pdf

What about the future?

- Auctions for electricity will change to reflect different pathways of development in electricity systems

- New things?
  - Zero support, offshore hybrid, CO2 saving, seabed leases for OSW, PPAs
- New auctioneers?
  - Utilities, businesses, community groups

- New technologies and sectors …

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Auctions for heating and cooling – a promising instrument?

Heating and cooling in the energy sector

- About 50% of EU energy consumption for heating (and cooling)
- Diverse usage and actors:
  - buildings: space and water heating (192.5 Mtoe, 79% of final energy use)
  - industry: space and process heating (193.6 Mtoe, 70.6% of final energy use)
- Decarbonizing heating implies:
  - expansion of direct (and indirect) electrification, mainly using heat pumps
  - expansion of renewable energy usage (geothermal, solarthermal, (biomass))
  - expansion of district heating (and cooling) systems

→ **Where could auctions play a role?**

Expansion of DHC and increase of RES and heat pumps in DHC

- Infrastructure:
  - New DHC grids
  - Expansion and modernization of existing DHC grids
- Generation:
  - New RES plants and heat pumps in existing grids
  - New CHP plants
- Combined auction for infrastructure and generation:
  - New grids with RES, heat pumps (and/or CHP/waste heat)
  - Expansion and modernization of existing grids with RES, heat pumps (and/or CHP/waste heat)

Expansion of DHC and increase of RES and heat pumps in DHC

- **Infrastructure:**
  - **New DHC grids**
  - **Expansion and modernization of existing DHC grids**

Possible role of auctions:

- Tenders for specific new grids are standard procurement auctions→ single-unit auctions (e.g. in Hamburg Speicherstadt)
- Additional potential:
  - multi-unit auctions for new grids combined with investment support
  - participants could be municipalities/communities/grid operators
  - prequalification criteria to enable deep decarbonization

Expansion of DHC and increase of RES and heat pumps in DHC

- **Generation:**
  - **New RES plants and heat pumps in existing grids**
  - **New CHP plants**

Possible role of auctions:

- Auctions for new CHP plants already in place (Germany, Slovenia, Poland) → country-wide multi-unit auctions
- Auctions for new RES plants and heat pumps (in specific grids) in place (in Estonia and Lithuania)
- Additional potential:
  - Auctions for RES plants and heat pumps (multi-unit)

Expansion of DHC and increase of RES and heat pumps in DHC

- **Combined auction for infrastructure and generation:**
  - **New grids with RES, heat pumps (and/or CHP/waste heat)**
  - **Expansion and modernization of existing grids with RES, heat pumps (and/or CHP/waste heat)**

Possible role of auctions:

- Auction for CHP support if DHC grid fulfills certain RES requirements in place in Germany (multi-unit auction)
- Additional potential:
  - Auctions for investment or operating support for new grids or grid expansion/modernization and required RES plants/heat pumps (multi-unit or single-unit auctions)

Expansion of DHC and increase of RES and heat pumps in DHC

- Experience so far limited:
  - CHP auctions, auctions for individual grids and plants
- Promising potential for auctions
- But: competition between different sites might be difficult due to different framework conditions (e.g. heat density/ generation potential) in each individual DHC grid
- Auctions for individual RES or heat pumps require third party access
- No assessment (yet) whether auctions perform better than other instruments to allocate support

Expansion of individual renewables and heat pumps in buildings/households

- **Industry:**
  - **New decentral heating appliances**

- Possible role of auctions:
  - Country-wide multi-unit auctions
  - operational support might be necessary due to differences in operational costs for some heating technologies compared to conventional technologies
  - Possibly distinction between different technologies and sectors necessary
  - Can there be sufficient competition?

Expansion of individual renewables and heat pumps in buildings/households

- **Buildings**
  - **New decentralized RES/heat pumps in existing buildings**
  - **New decentralized RES/heat pumps in new buildings**

Possible role of auctions:

- Investment support for new appliances
- Multi-unit auctions for homeowners, real estate companies (e.g. in a municipality or nation-wide)
- Single-unit auctions (new heating appliances for all houses in a certain district) for serial renovation companies
- Challenges: small actors and non-comparability of houses

Expansion of individual renewables and heat pumps in industry

- No experience so far
- Possibility for effective and efficient design uncertain
- High variety of technologies, building states and technologies
- For buildings small actors are involved

→ further research necessary for assessing whether there is a potential for auctions

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Hydrogen auctions

Applying RES auction expertise to renewable hydrogen support

Guidehouse and Fraunhofer ISI within AURES II

Why this paper?

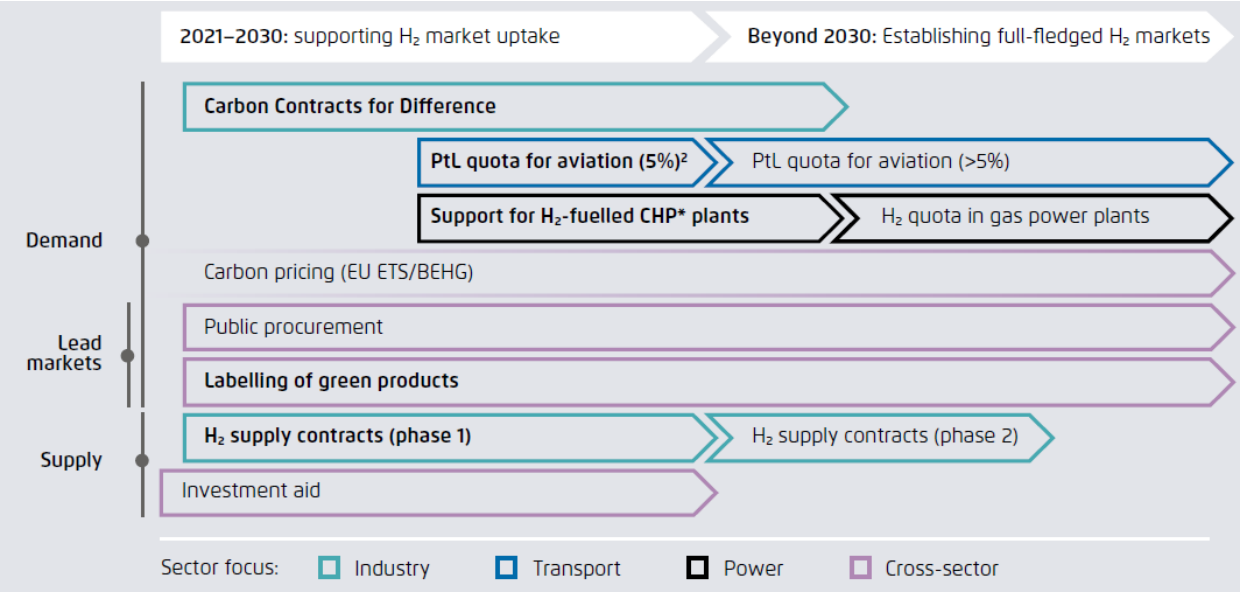
Goal of this paper: provide initial considerations on auctions for renewable hydrogen (H_2) support allocation

- Renewable H_2 is seen as a key solution to achieve climate neutrality
  - EU and national H_2 strategies include significant funding pledges
  - EC proposal for RED II revision includes H_2 sub-targets for industry & aviation
  - Missing piece: implementation

➢ Our focus: practical, near term auction-based policy options for electrolyser deployment/renewable hydrogen use

There are numerous support instruments in discussion at the moment

- In the end, it will likely be a mix of support instruments
- Some of the discussed instruments involve the use of auctions to select projects
- The auctions-approach could be highly relevant for the timeframe up to 2030
- Beyond 2030, support levels may be reduced as markets become liquid and a larger emphasis can be placed on quotas for specific demand sectors

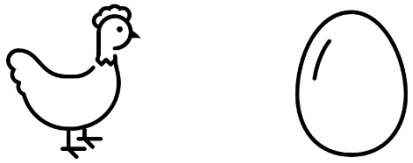


Source: Guidehouse (2021)

Policy intervention is required to ramp-up supply and demand for renewable H_2

There are two main challenges in the near term:

1



Missing market

2

- Support instruments are required for both supply and demand
- Infrastructure is a binding constraint in the near term

Auctions for renewable H_2 can work with no infrastructure and little demand/supply

- We developed four near-term options to meet specific aims
  - Option 1: Demand-side auction for H_2
    - Ramp-up H_2 demand to help achieve the proposed RFNBO target for industry (RED II revision)
  - Option 2: Double-sided auction for H_2 derivatives
    - Support the supply of derivatives and the build-up of a demand market
  - Option 3: Supply-side auction
    - Help move towards EU H_2 strategy capacity target of 40 GW
  - Option 4: Joint auction for hydrogen and renewable energy
    - Support the joint deployment of RES and electrolysers

Options take account of current key issues:

1. no demand & supply
2. no infrastructure

Options were developed for short-term implementation. With developed markets and infrastructure, options may need to be adapted.

Basic assumptions and considerations for all four options

We take certain design decisions based on the below assumptions and considerations.
In practice, all four options can be further adapted to meet other specific needs by policy-makers.

We assume that:

- there will be **enough actors** interested in the demand and supply side in the short term which leads to sufficient competition in the auctions
- policymakers take the potential number of participants and projects into account when setting the **auction volumes** to support
- the **RED II revision** will be implemented as proposed (e.g. amongst others resulting in a need for industry-focused support instruments)
- the EC's **sustainability criteria** will be considered and fulfilled

Other considerations:

- Because options are designed for the next years where there is no infrastructure, we ask in some options for **offtake agreements** to ensure that demand and supply are matched with bilateral transport arrangements
- Hydrogen and derivatives are fundamentally different with regards to transport
  - H_2 is bound to pipelines
  - Derivatives can be traded globally via ships

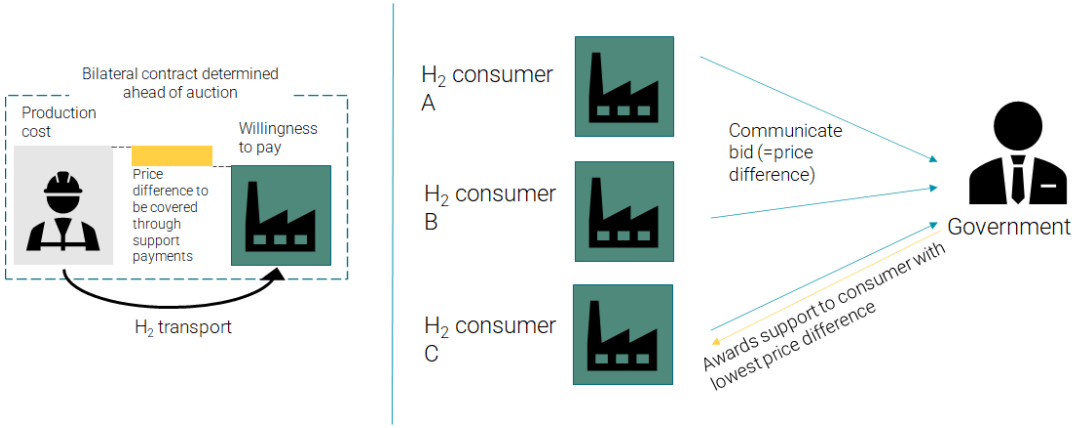
Demand-side auction: enable H_2 use as feedstock or energy carrier in industry

Option 1

- Focus on demand from industry sectors that need renewable H_2 to decarbonize
  - Selection determined by policy priorities (e.g. RED II requirements)
  - Need for separate support windows to differentiate between industries that already use H_2 and those that don't (i.e. that have additional costs from retrofitting processes)
- Incentives for industry to participate:
  - Corporate sustainability targets
  - Aim to "green" a product to appeal to a certain target group
  - Ramp-up corporate learning curve on H_2
  - Avoid rising CO_2 costs under EU ETS
- Focus on pure H_2 (not derivatives)

Demand-side auction: auction design

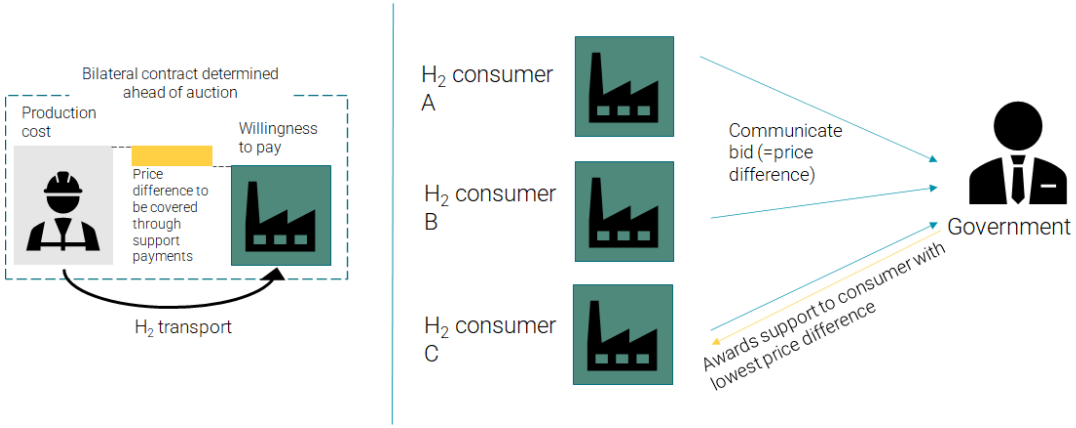
Option 1



- Industry offtaker determines a **bilateral offtake contract** with a hydrogen supplier ahead of the auction
  - It is a pre-qualification requirement to ensure that transport is considered
- Based on negotiations with supplier, the industry offtaker can determine the price difference to be covered by the support (= **bid**)
  - Bid = Costs of renewable H_2 production + H_2 infrastructure/transport costs - price of current energy carrier
- Industry-specific **ceiling prices** are necessary given differences in cost gap between H_2 and the energy carrier it replaces
  - There is currently no market price for renewable hydrogen, hence a proxy is needed to determine a feasible ceiling price: calculation is based on level of abatement costs

Demand-side auction: auction design

Option 1



Auction can award either:

- **Fixed Feed-in-Premium**
  - Advantages: relatively simple, provides high cost predictability for the government, provides high incentive for bidders to negotiate best supply contracts
  - Disadvantage: increases the risk of the winner's curse because long-term price forecasts are necessary but related to high uncertainties
  - RES-E price fluctuations must be considered in the bilateral offtake contract
- **Contract for Difference**
  - Advantages: effectively reduces risks for the bidder
  - Disadvantages: lower predictability of total support costs for government (government needs to ensure support for times of high delta between strike price and market price)
    - In case the support is levy-financed this is less an issue, in case it is state budget financed, it is a problem

Double-sided auction for derivatives: meeting industry demand for derivatives

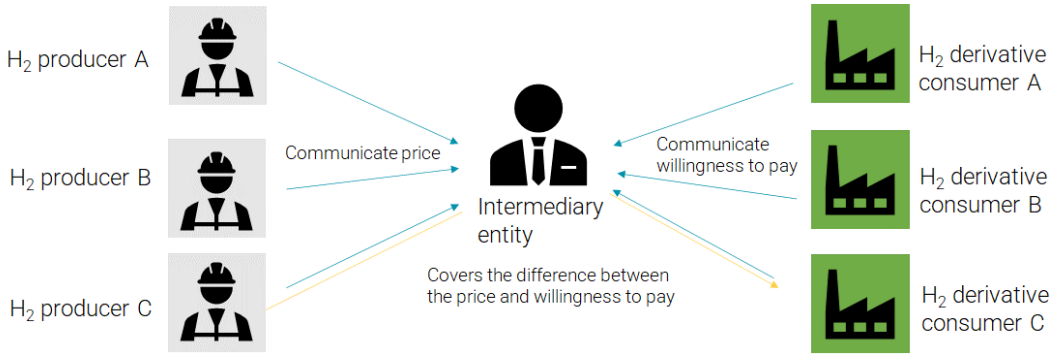
Option 2

Provide security to producers to invest in new electrolysers and industry offtakers to switch to green derivatives

- Derivatives are easier to transport
  - Location of electrolyser is not bound to location of offtaker
  - Derivatives could also be imported from outside the EU
- Double-sided auction would function as a platform for match-making
  - Markets and new supply routes for green derivatives have not established yet
  - Auction could target large groups of actors on both sides, thereby enhancing competition and lowering prices
- Design is comparable to H2Global concept in Germany

Double-sided auction for derivatives: auction design

Option 2



- Producers have high CAPEX & OPEX
  - Countries with investment support schemes have competitive advantage over others (may favor EU producers with access to the EU Innovation Fund)
- Offtakers communicate willingness to pay to intermediary
- Intermediary closes contracts with both sides
  - No bilateral offtake agreements required
- Difference between production price and willingness to pay is covered by intermediary through dedicated funds
- Many design questions remain open:
  - How does the landing of derivatives work, e.g. at a dedicated harbor or one of several industrial clusters?
  - How is the landing point determined?
  - What are feasible contract durations? Producers require long-term security which can be provided through the contracts, however offtakers may only want to be bound for e.g. 5 years to take advantage of expected price degressions.

Supply-side auction: ramp-up electrolyser capacity in parallel with demand

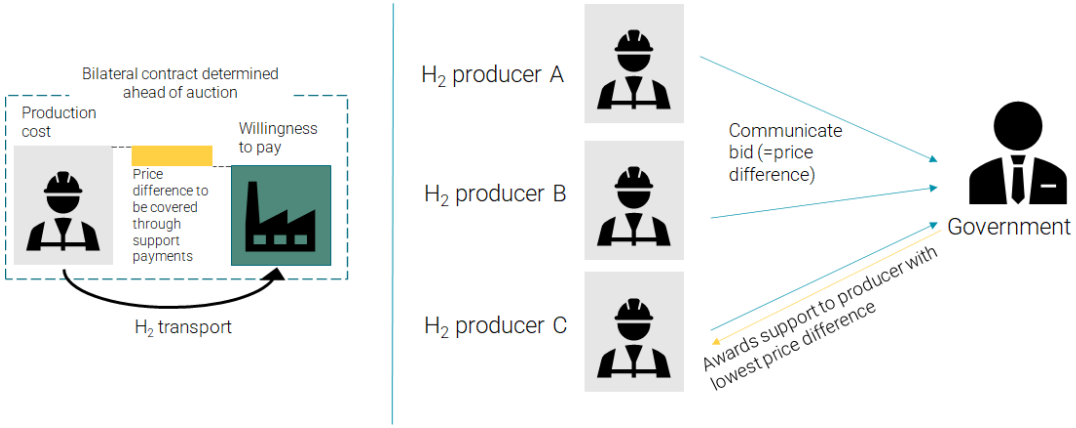
Option 3

Supply-side auction to help move towards EU H_2 strategy capacity target of 40 GW

- Demand and supply parties must negotiate a bilateral offtake contract before participating in the auction
  - It is a pre-qualification requirement
  - It ensures that transport is considered (provides certainty that the binding constraint is fulfilled)
  - It ensures that supply and demand ramp-up in parallel
- Depending on national policy priorities, end use sector can be determined as part of auction design
  - Compliance must be demonstrated through the bilateral offtake contract
- Electrolyser would likely be installed in close geographic proximity to the offtaker

Supply-side auction: auction design

Option 3



- Auction can award either investment support or operating aid
  - Investment support alone does not ensure H_2 production due to high OPEX share
  - Operating support should be considered, but electrolysers should have incentives for system friendly renewables consumption
- A ceiling price is implemented to ensure that bids are not overstated

Joint H_2 and RES auction: use integrated solution for deploying RES & electrolysers

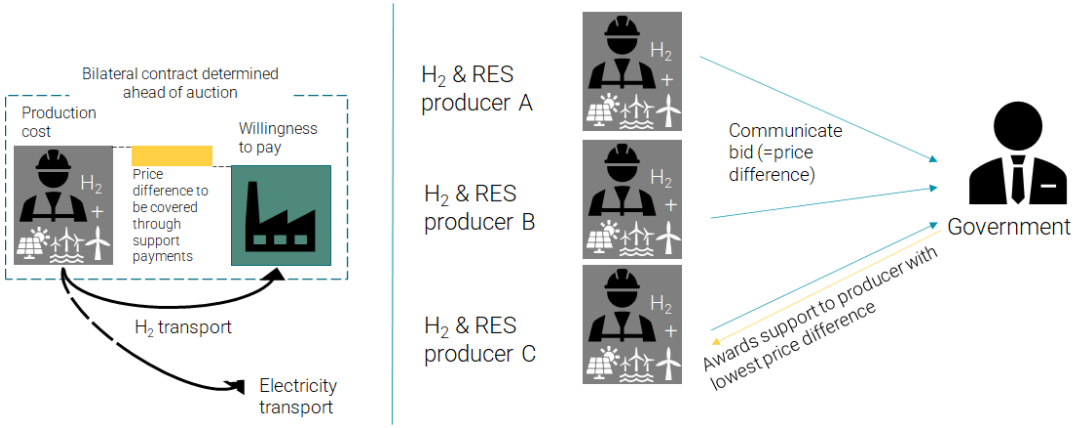
Option 4

Joint auction can support the simultaneous deployment of hydrogen and a renewable energy source

- Important choice regarding the technical set-up is the connection type of electrolyser: on-grid or off-grid
  - Off-grid: Electrolyser is restricted to the full load hours of the RES plant
  - On-grid: Can run independent of full load hours as it can source from the grid
  - Choice has strong impact on the operating hours and hence the H_2 production costs
- Auction can pre-determine project design

Joint H_2 and RES auction: auction design

Option 4



- Auction design similar to supply-side auction
- Only H_2 scope of project receives support
  - Exact criteria will be defined by Delegated Act to be published until the end of 2021

Review of design options

Each option has a different purpose:

- Option 1: Ramp up demand for H_2
- Option 2: Double-sided auction for derivatives
- Option 3: Ramp up supply of H_2
- Option 4: Increase electrolyser and RES capacity at the same time

- We took design decisions for each option that can be amended by policymakers as needed
  - E.g. regarding the form of support, the pre-qualification requirements, etc.
- All options respect the fact that hydrogen markets are currently in their infancy and that there is limited infrastructure
  - This poses challenges with a view to demand and supply matching and the level of competition
- The options are designed for the short-term and need adaptation once markets have established and infrastructure is available

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Auctions for the support of charging infrastructure

Decarbonisation of the transport sector

Motivation

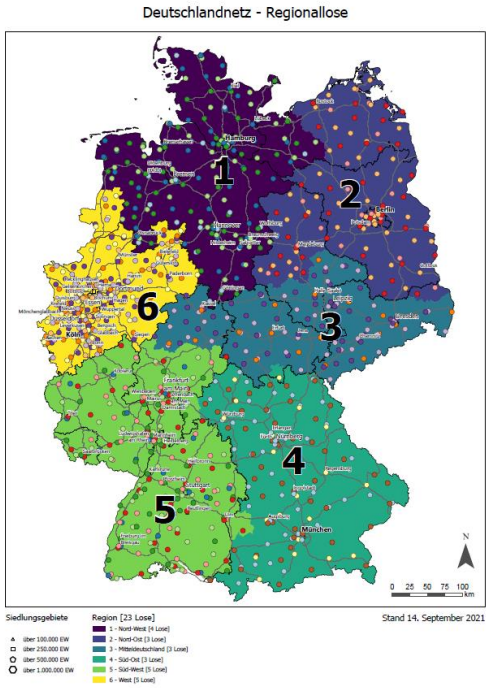
- Transport is currently responsible for about one quarter of energy-related greenhouse gas (GHG) emissions in the EU ➔ Green Deal seeks a 90% reduction in these emissions by 2050
- In 2020, passenger cars were responsible for about 12% of the total EU GHG emissions and about 60% of transport GHG emissions
- Multitude of potential instruments to support the decarbonisation efforts
  - CO2 fleet targets for newly sold cars
  - CO2 fleet targets for trucks
  - **Infrastructure for alternative fuel vehicles**
  - Quotas for sustainable zero carbon fuels
  - Carbon pricing
- Focus in the presentation and report on:
  - Infrastructure for private and light-duty (plug-in) electric vehicles (EVs)
  - Germany's auctions under the Fast-Charging Law
- Other cases:
  - SA.55201 – Charging infrastructure for electric vehicles (Schleswig-Holstein, Germany)
  - SA.49276 – Development of a recharging infrastructure for plug-in hybrid and purely electric vehicles (Romania)
  - SA.63718 - Development of a recharging infrastructure for electric vehicles and hydrogen refuelling stations (Poland)

EVs in Germany

- Around 500,000 EVs and almost another 500,000 PHEVs in Germany in October 2021
- Purchase of EVs supported with up to 9,000 € (BEV) and up to 5,625 € (PHEV) ➔ but: **lack of charging infrastructure**, especially in rural areas, thus not attractive (“chicken-egg-problem”)
- ➔ support for charging infrastructure in Germany:
  - smaller solutions: support budget of around 800 mn € allocated via first-come-first-served/competitive procedure
  - **large, fast-charging infrastructure: support of 900 locations with up to 4-16 HPC-points each via competitive procedure/auctions (➔ AURES II scope) + 200 locations on the highways**

Auction design (1/2)

- Scope: allocation of support for HPC charging infrastructure (rated power of at least 200 kW per charging point)
- Sealed-bid, static, pay-as-bid auction conducted in three rounds: 1) prequalification round, 2) submission of preliminary bid, and after negotiations with each bidder, 3) submission of final bid
- Site-/location-specific: 23 lots in 6 regions; each lot further divided into several “search areas” (radius of 2 km) with given number of HPC charging points
- Prequalification criteria:
  - Bidder needs sufficient experience with charging infrastructure
  - No need for specific sites (yet)
  - Performance bond after being awarded
- Bidder concentration rules:
  - Only 10 bidders per lot admitted after the first round (prequalification)
  - Each bidder can only be awarded for 1 lot per region AND 3 lots in total



Auction design (2/2)

- Award rule: multi-criteria (65% price – 35% “quality”)
  - Price: remuneration of CAPEX (only once) and OPEX (per quarter) as lump sums; should be based on true costs ➔ bid price: one absolute number in €
  - Quality: 1) availability of sites (15%), 2) user-friendly equipment (15%), and 3) design concept (5%)
- Remuneration:
  - Lump sums for CAPEX and OPEX as awarded in the auctions
  - Customer tariffs capped at 44 ct/kWh (indexed)
    - Payments to government of 17.85 ct/kWh
    - Electricity price of around 17 ct/kWh
    - ➔ Range of around 9 ct/kWh
- Support period: 8 years
- Obligations for bidders:
  - Use of renewable electricity (can be GOs)
  - Storage instead of grid connection possible
  - (Merchant) operation of at least 8 years after the end of support period

(Expected) Results

- First results available: in total 400 applications for the 23 lots; on average, around 17 applications per lot (“double-digit number of applications per lot”)
- (Static) efficiency:
  - Apparently enough competition, but limitations wrt number of bidders and lots/regions might have decreased competition and thus efficiency
  - Multi-criteria award procedure might harm efficiency
  - Combinatorial bids not foreseen
  - Lack of transparency and simplicity, but a lot of flexibility for bidders
  - Capped customer tariffs

(Expected) Results

- Effectiveness:
  - Oversubscribed (a priori effectiveness achieved!)
  - Realisation rates not yet clear (penalties high enough? ➔ avoid real option bidding and/or “strategic bid”)
- Actor diversity:
  - Seller concentration rules
  - Several lots designed for small, local actors
- Impact outside of the auction design
  - Interaction with existing market actors and HPC locations

Conclusions (and questions)

Conclusions

- Good first step to ramp up infrastructure for EVs
- Impact on other market actors should be evaluated
- Actor diversity seems more important than static efficiency
- Quite complex scheme with a lack of transparency

Questions

- Any other country examples? Auctions not only for infrastructure?
- Will auctions continue to play a role in the transport sector?
- Complexity vs. flexibility?
- Are the penalties high enough (wrt effectiveness)?

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Integrated auction approaches

What are integrated auctions?

Auctions that bring different technological solutions and system services into direct competition for remuneration to provide pre-defined goods or services, e.g., CO_2 savings, availability of capacity, reduced load at specific times.

Integrated auctions can help policymakers discover the most cost-effective (combination of) options that help achieve specific policy goals, including:

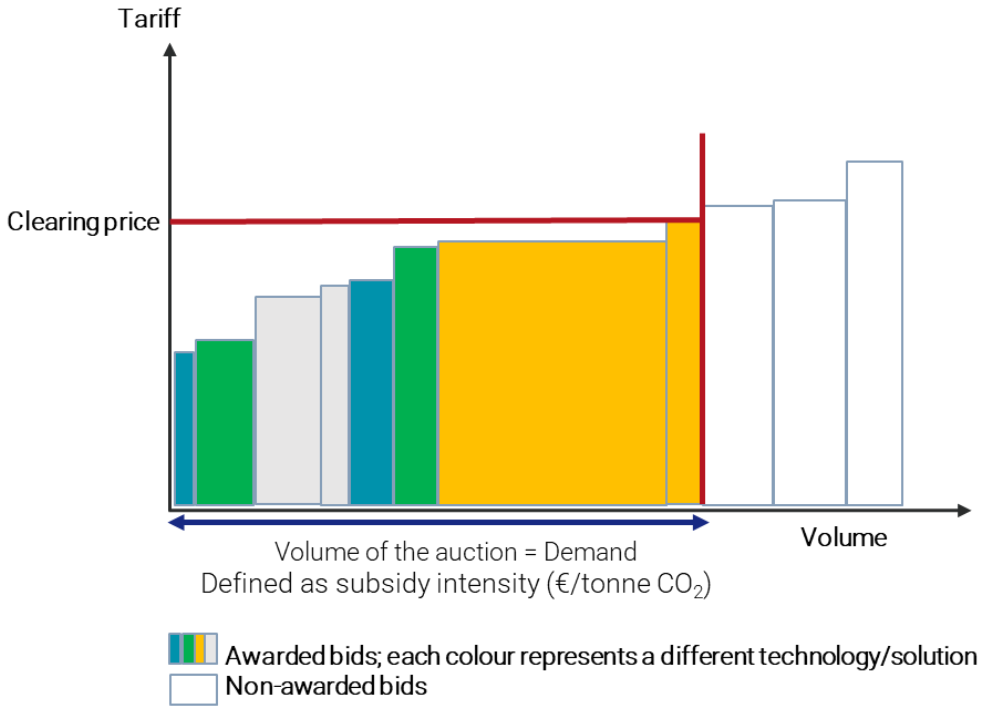
- ✓Reducing carbon emissions in the most cost-efficient way possible,
- ✓Reducing or shifting load peaks and thus avoiding the need for grid expansions,
- ✓Optimizing the procurement of capacities in the electricity market.

Why can integrated auctions be useful?

Achieving net-zero emissions by 2050 will require

- the continued expansion of RE deployment and thus solutions to integrate increasing capacities into the system, and
- dedicated planning and scale-up of other technological solutions beyond (variable) RE deployment, e.g., demand response & efficiency measures, flexible capacities, CCS.

Governments need to make use of a mix of these technological options to allow for a cost-efficient and system-friendly decarbonization and energy transition.



SDE++ (Netherlands)

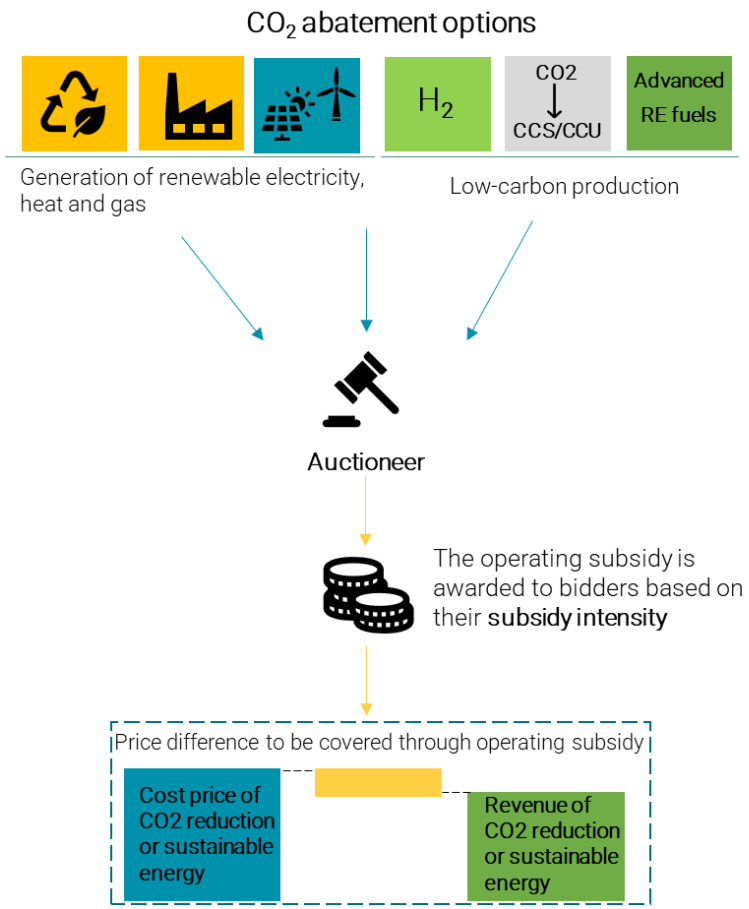
Main Goal: Achieve CO_2 savings in a cost-optimal manner through competition between GHG abatement options in terms of the achieved CO_2 reduction per Euro of support.

Approach:

- Bids are ranked and awarded based on the lowest bid price, which is defined as the subsidy requirement in € per tonne of CO_2 emissions avoided (sliding premium for 12 to 15 years)
- 5 technology categories (RES-E, RES-H&C (CHP), renewable gas, low-carbon heat, and low-carbon production)
- So far, two auction rounds have taken place in 2020 and 2021 (budget: € 5 billion each).

Outcome: In the SDE++ 2020 round, Solar PV and CCS received 87% of subsidies worth €4.7 billion.

Methodological challenges arise in the context of comparing CO_2 reductions (via emission factors) for very diverse measures and technologies over the whole support period of up to 15 years.



Brooklyn Queens Demand Management Program in the U.S. (Con Edison, NY)

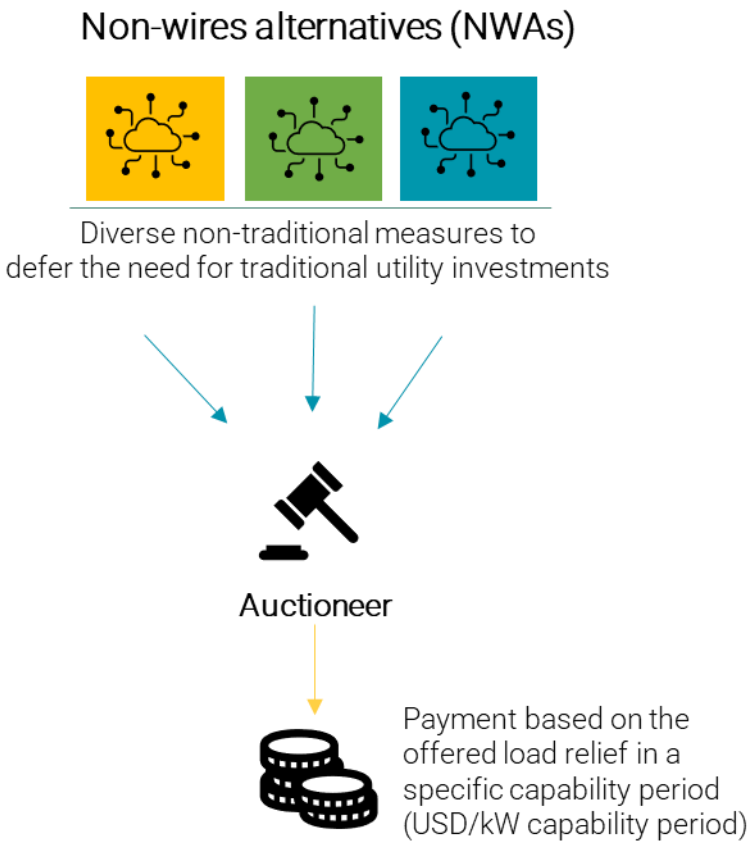
Main Goal: Reduce or shift load peaks and thus defer grid investments through non-wire alternatives.

Approach: In 2016, a technology-neutral auction was launched, both demand- and supply- side measures & storage, could participate.

- descending clock format with uniform pricing
- two time windows (16:00-20:00 and 20:00-24:00 o'clock), to which a ceiling price was applied (= auction's opening price).
- bid price in USD per kW, plus call price of USD 5 per kWh

Outcome:

- 22.69 MW of load reduction were procured to cover peak load in 2018. More than half of awarded bidders came from demand-side measures.
- High non-realization rates among battery storage projects (lack of clarity on required permits), which was filled by demand-side measures.
- Relatively short lead times made participation for supply-side measures more difficult.



PJM Base Residual Auction in the U.S.

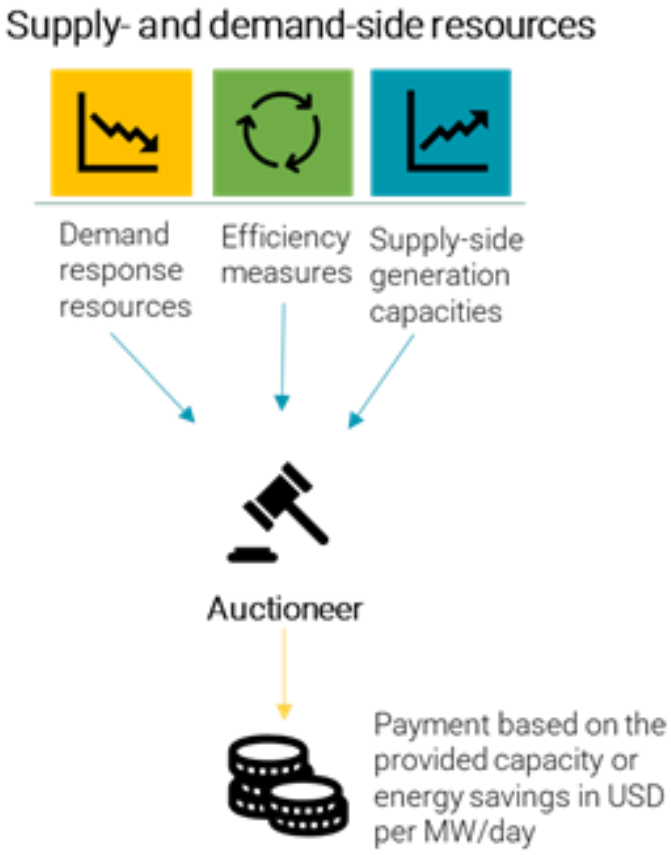
Main Goal: Optimize the procurement of supply- and demand-side resources in the capacity market of the regional transmission organization PJM

Approach: Since 2009, demand response and efficiency measures directly compete with supply-side generation capacities in PJM's BRA.

- Successful bidders need to supply electricity or reduce their load, if PJM determines that this is necessary to address load peaks
- Remuneration based on provided capacity (or through energy savings) in USD per MW/day as determined by the auction's clearing price
- Efficiency measure need to fulfill certain reliability & the measure needs to be evaluated, measured and verified regularly

Outcome: Clearing prices fluctuated significantly. Moreover, RPM has consistently procured more capacities than intended or needed.

Volumes procured from demand-side resources have increased over time (from 0.42% to 3.3% of the total procured capacity between delivery years 2012/13 and 2022/23), with most demand-side volumes being successful.



What to consider when designing integrated auctions?

Integrated auctions would typically include resources with different characteristics that should be considered in the auction design.

Design options should be thoroughly assessed against the aim to avoid unintended outcomes, e.g., windfall profits for lower-cost technologies, exploitation of market power.

This may require for example:

- differentiated and customised prequalification requirements matching the diverse features
- technology-specific realisation periods considering differing implementation times
- technology-specific ceiling prices to avoid windfall profits for lower-cost technologies
- appropriate verification procedures and methodology to ensure completion and compliance of the project (e.g. baseline required for efficiency measures)

When and (when not) to use integrated auctions?

Policymakers should carefully assess when to use integrated auctions and in which cases it would be more advisable to rely on separate auctions per technological solution.

Integrated auctions tend to be more advisable when:

- the technological solutions and services can provide the same good, for instance, peak shaving, CO2 savings, or energy system flexibility.
- competing options can address the same (scale of) problem, e.g., bottlenecks in distribution grid.
- awarding a certain type of technological solution is not required, e.g., adding RE electricity to meet other policy goals, RE quota to be achieved.

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