AURORA ENERGY RESEARCH

The Future of Offshore Wind in Italy: Will It Sink or Float?

Italian Market Public Webinar

17 January 2023

Agenda

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I. Introduction

II. Outlook for Offshore Wind Economics in Italy

III. FER2 Subsidy Auction Modelling

IV. Q&A

Introducing Aurora's speakers

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Sources: Aurora Energy Research

The Italian offshore wind market has been lagging compared to Northern European markets due to limited wind resources and deep waters

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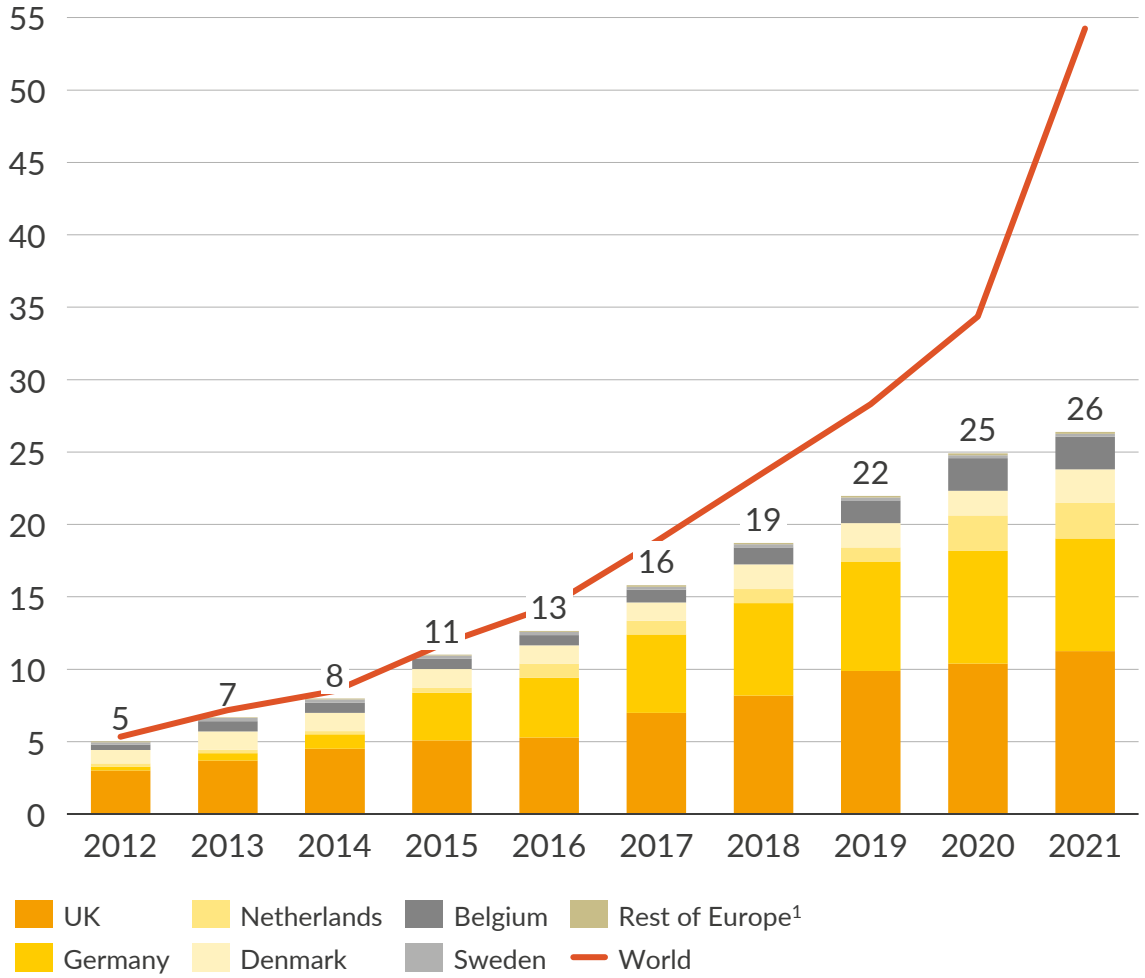
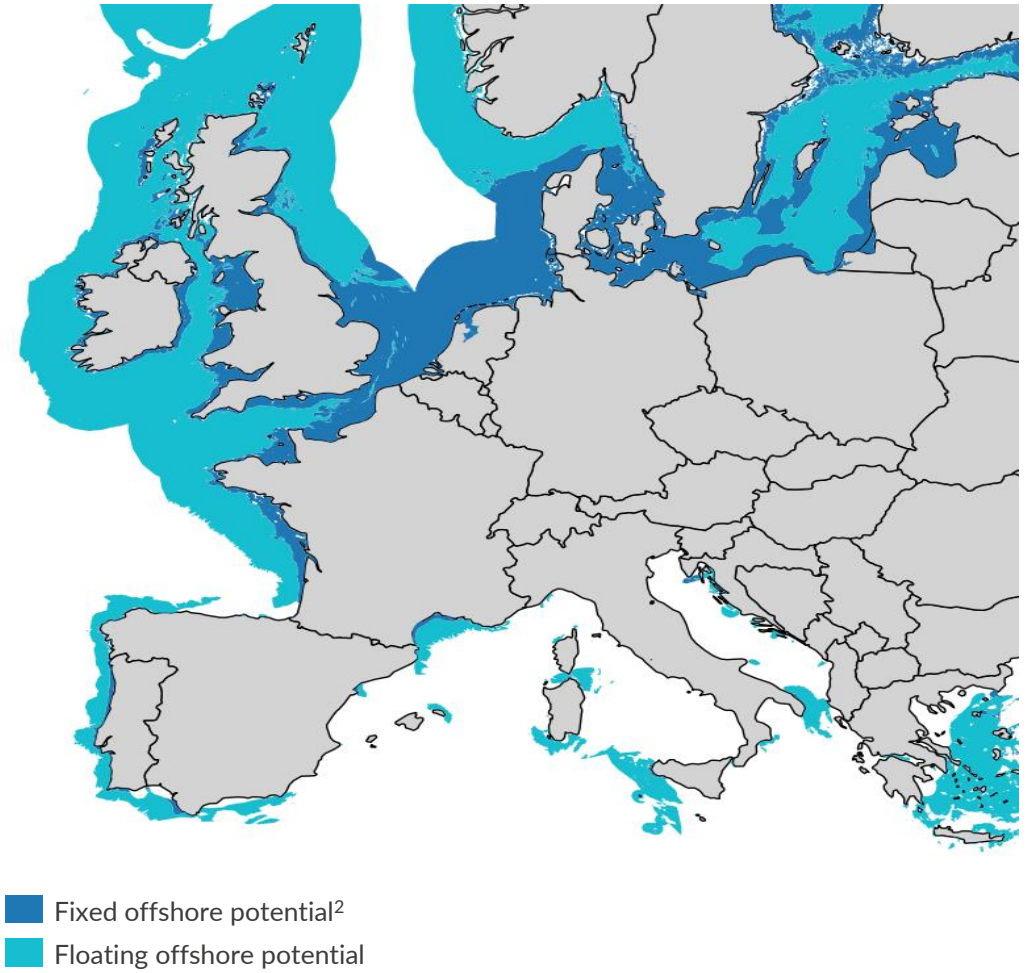
Global and European installed offshore capacity
GW



Fixed and floating offshore wind potential in Europe,
Only territorial waters with wind speed > 7m/s at 100m are shown



1) Includes Finland, France, Ireland, Norway, Portugal and Spain; 2) Water depth < 50m.

Sources: Aurora Energy Research, IRENA

Today we will present our analysis of the market potential for offshore wind in Italy

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1 What is the potential for offshore wind development in Italy?

- Where is current project development concentrated?
- What is the installed offshore wind capacity outlook?

2 What are the economics for offshore wind in Italy?

- How does CAPEX and OPEX evolution compare between fixed and floating offshore wind?
- How would financial performances for offshore wind develop on a merchant basis?

3 What outcomes can we expect from the upcoming floating offshore wind subsidy auctions?

- What is the payment structure envisaged under the FER2 subsidy scheme?
- How would the auction outcomes be impacted by different levels of cost of capital and CAPEX?

Sources: Aurora Energy Research

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IV. Q&A

Strong increasing interest in offshore wind in Italy is testified by 63 GW of grid connection requests received in 2022 alone

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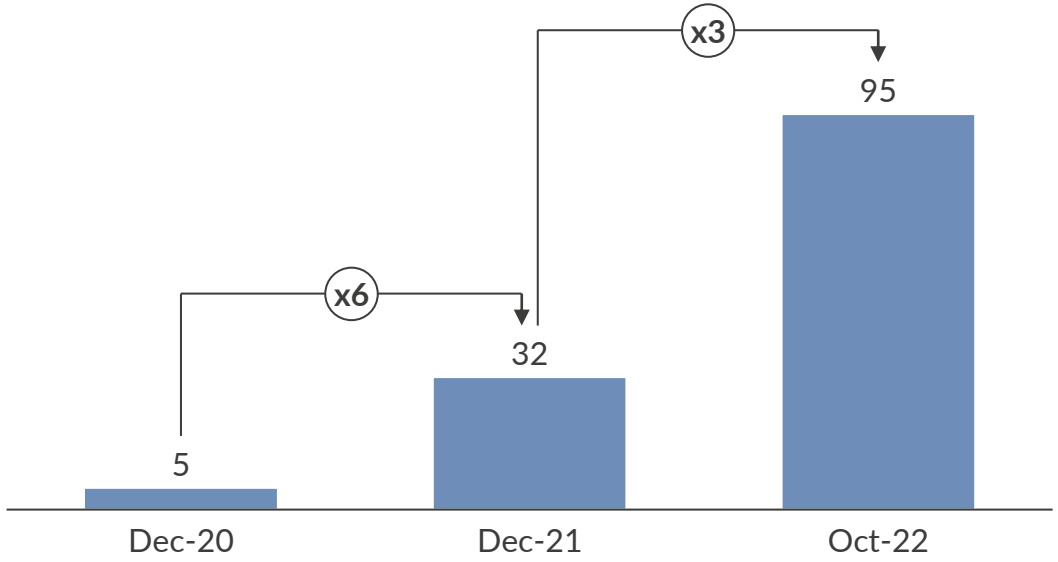
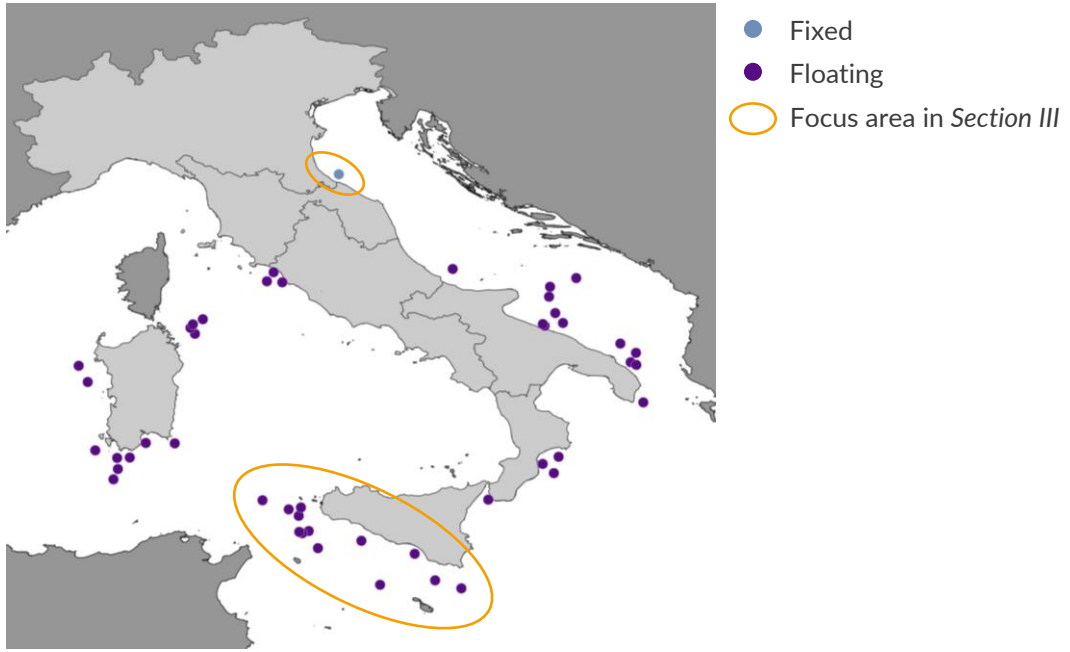
Submitted offshore wind grid connection requests



- Historically, Italy has not experienced much interest in offshore wind due to a combination of lower wind speeds and deep seas
- By December 2020, Terna had received just over 5.3 GW of offshore wind grid connection requests, mostly over the course of 2020 and with 1 project alone accounting for 2.8 GW
- Recent technological improvements, particularly the progressive commercialisation of floating offshore wind technology, and increasing national and EU targets have led to grid connection requests increasing sixfold by the end of 2021, reaching 31.8 GW, tripling again by October 2022 to total 95 GW

Offshore wind grid connection requests – plants with submitted seabed concession and/or VIA[1,2]



- 40 GW of requests is accounted for by the 48 plants further along the authorization process that have applied for a seabed concession and/or VIA
- Only 1 out of these 48 projects, located in zone North, uses fixed-bottom technology, with most projects located across zones South, Sicily and Sardinia where floating technology allows them to capture higher wind speeds
- In *Section III*, in comparing the economics of fixed and floating offshore wind, we will focus on illustrative assets in zone North and Sicily respectively

1) Requests as of 17.11.22; 2) VIA = "*Valutazione di Impatto Ambientale*", Environmental Impact Assessment.

Sources: Aurora Energy Research, Terna

FER2 aims to bring 3.5 GW of floating offshore capacity online by 2030, while Terna-Snam foresee 8.5 GW in 2030

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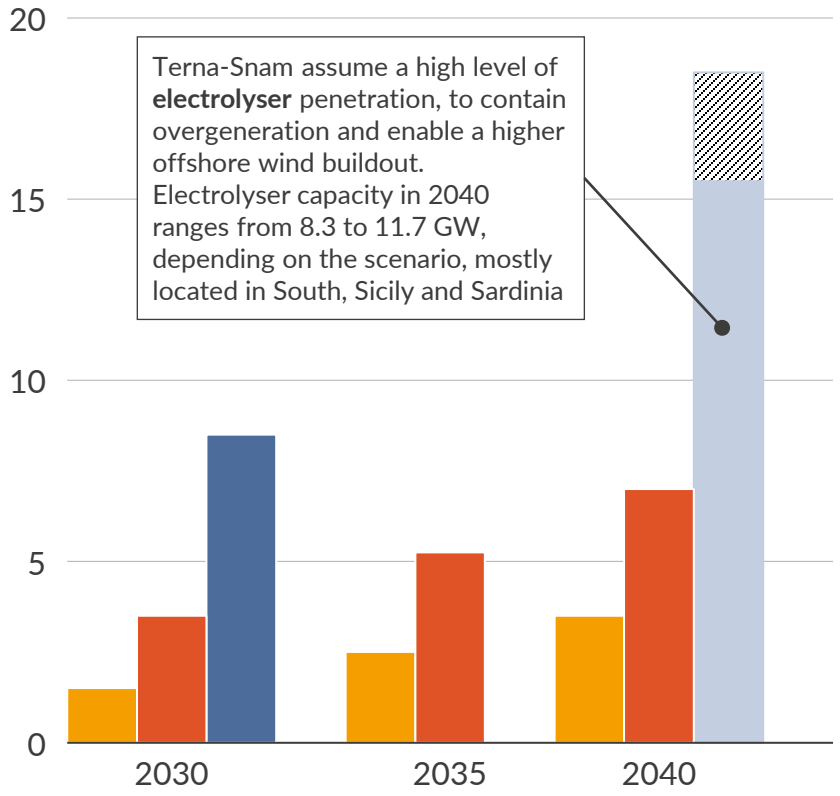
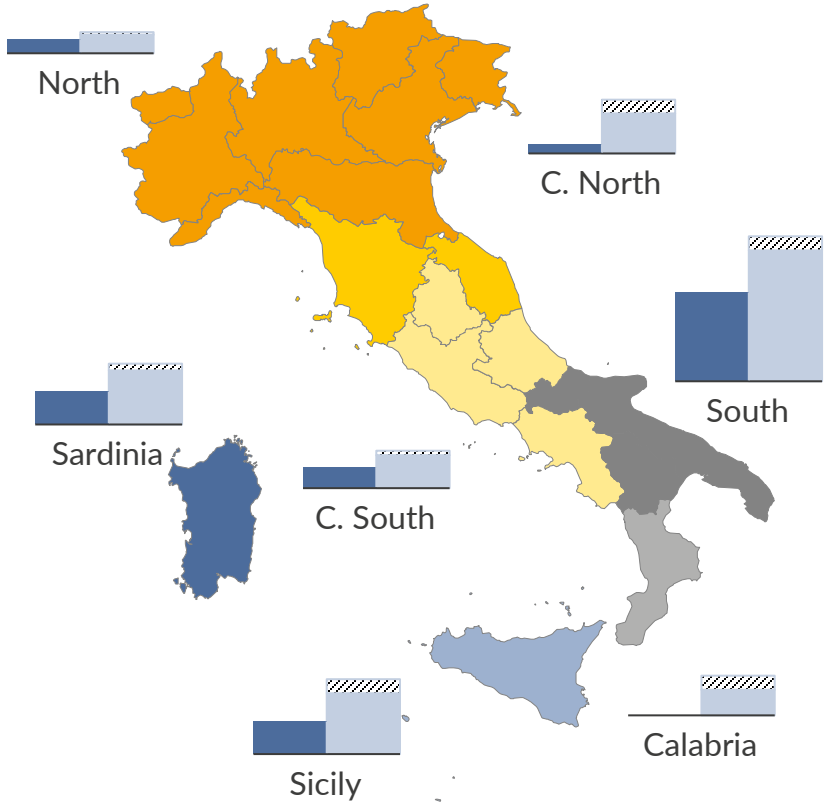
Offshore wind capacity – Scenario comparison

GW



Offshore wind capacity in Terna-Snam scenarios

GW



Aurora Central
Aurora Net Zero
Range in Terna-Snam 2040 scenarios[1]
Terna-Snam Fit-for-55 scenario (2030)
Terna-Snam 2040 scenario

1) Terna and Snam published two different 2040 scenarios, both taking the 2030 Fit-for-55 scenario as a starting point but differing in their long-term assumptions.

Sources: Aurora Energy Research, Terna, Snam

Outlook for offshore wind

- The draft subsidy scheme FER2 aims at supporting 3.5 GW of floating offshore wind by 2030
- Aurora Net Zero scenario assumes FER2 to be realised as scheduled, with all capacity online by 2030, while Aurora Central is more conservative due to development times concerns
- The Terna-Snam scenarios estimated that 8.5 GW of offshore capacity is necessary by 2030 to reach Fit-for-55 targets and between 15.5 and 18.5 GW by 2040
- Terna-Snam foresee 45% (3.8 GW) of the total 2030 offshore capacity in the zone South, followed by Sicily and Sardinia with 17% each (1.4 GW)

Higher costs of floating are partly compensated by higher LF, leading to converging LCOEs by 2040

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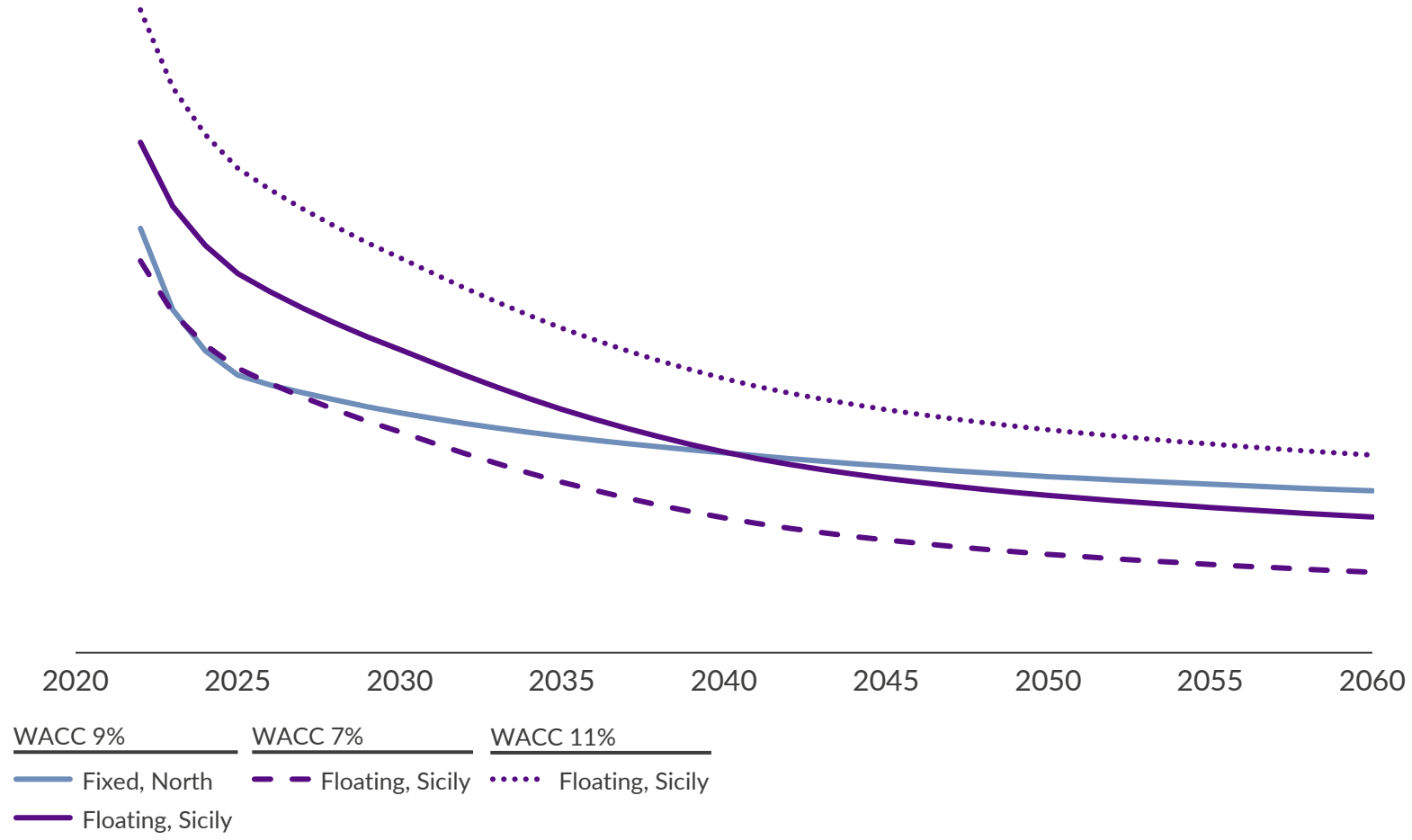
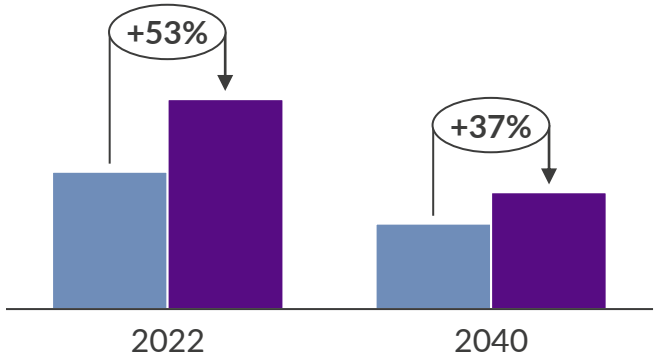
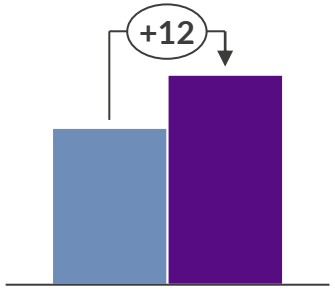
Levelized Cost Of Electricity
EUR/MWh (real 2021)



CAPEX
EUR/kW (real 2021)



Load factor
%



Sources: Aurora Energy Research

Floating offshore sees limited discount of capture prices to baseload prices due to stable generation profiles

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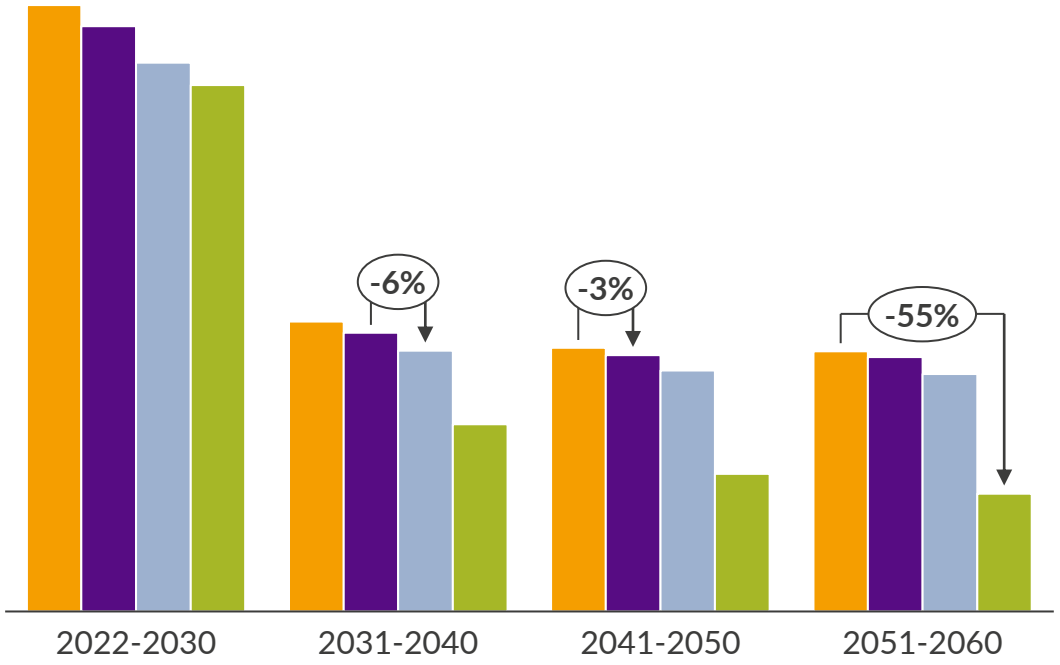
Average baseload and capture prices in zone South[1] – Aurora Central
EUR/MWh (real 2021)

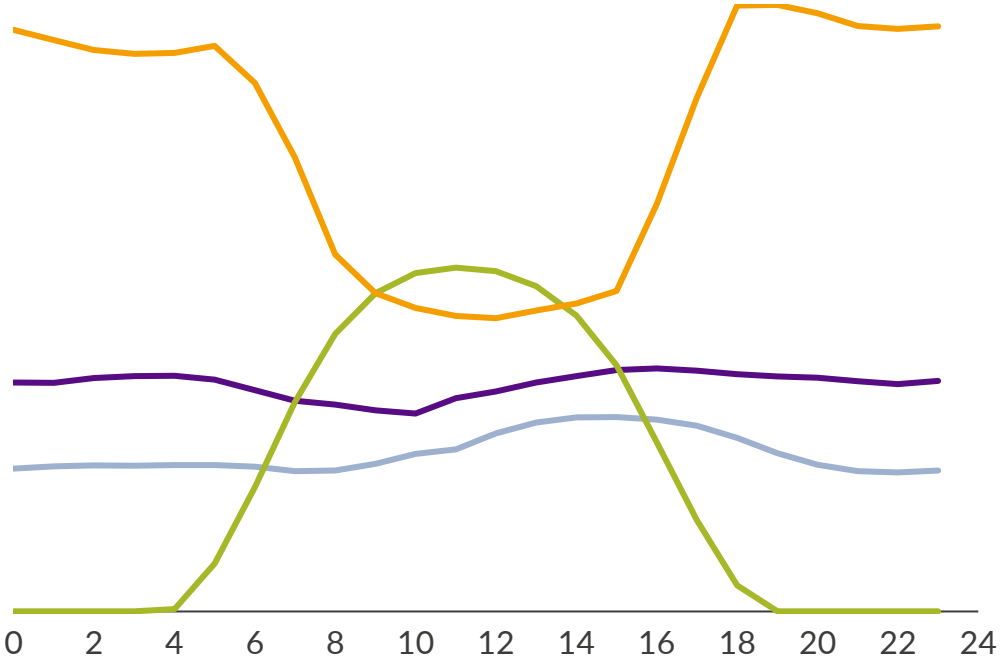


- Floating offshore wind achieves capture prices aligned with baseload prices, experiencing the lowest cannibalization across RES technologies
- While capture price discounts to baseload for offshore wind remain within a few percentage points, for solar PV they increase up to 55% in the 2050s

Baseload | Floating offshore wind | Onshore wind | Solar PV[2]

Average hourly load factor – Zone South
%

Average baseload price in 2040
EUR/MWh (real 2021)



- The increasing buildout of solar PV assets, whose generation is concentrated around noon, leads to decreasing prices during day hours
- Wind assets, both onshore and offshore, benefit from more stable generation profiles, that allow them to capture high baseload prices during night hours

Baseload | Floating offshore wind | Onshore wind | Solar PV[2]

1) Capture prices are uncurtailed generation-weighted averages; 2) Single-axis tracking solar PV.

Sources: Aurora Energy Research

As a result, offshore capture prices are highly dependent on the zone and expected market conditions

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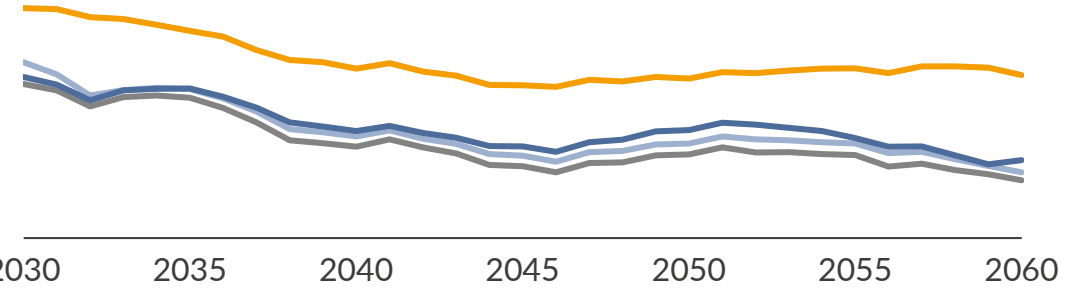
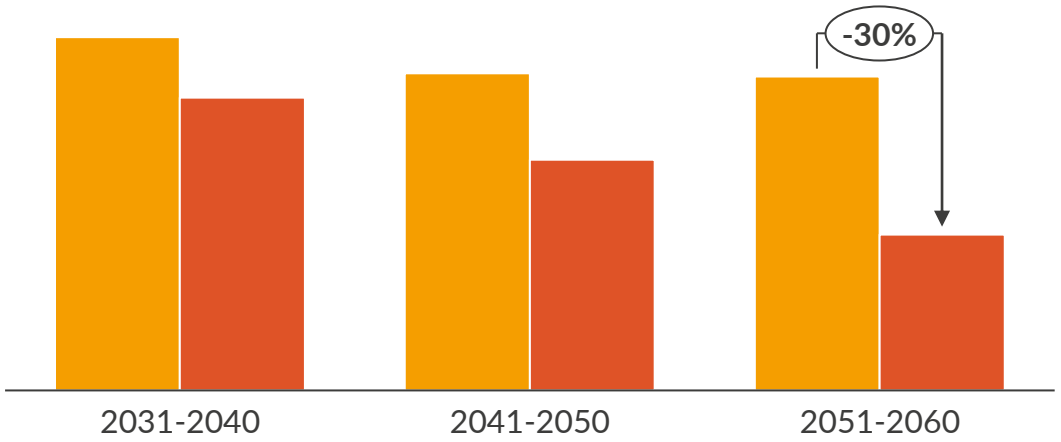
Offshore wind capture prices[1] – Aurora Central
EUR/MWh (real 2021)



Discount to zonal baseload price[2]
2030-2060 average

- Offshore capture prices differ by zone as zonal baseload prices diverge in the medium and long term, with floating offshore in zone South and in the Islands lower than fixed offshore in zone North
- Capture prices in the North and in Sardinia remain above zonal baseload prices, while moderate cannibalization exerts downward pressure on capture prices in zone South and in Sicily

Floating offshore wind capture prices[1] – Zone Sardinia
EUR/MWh (real 2021)



- As offshore capture prices mostly follow the development of baseload prices, market conditions heavily impact the expected merchant returns of an asset
- Floating offshore capture prices in Sardinia under Aurora Net Zero are 30% below Aurora Central in the 2050s, driven by lower baseload prices and increased cannibalization from the higher offshore buildout (three times the Central scenario capacity)

Fixed offshore: North
Floating offshore: South, Sicily, Sardinia
Aurora Central, Aurora Net Zero

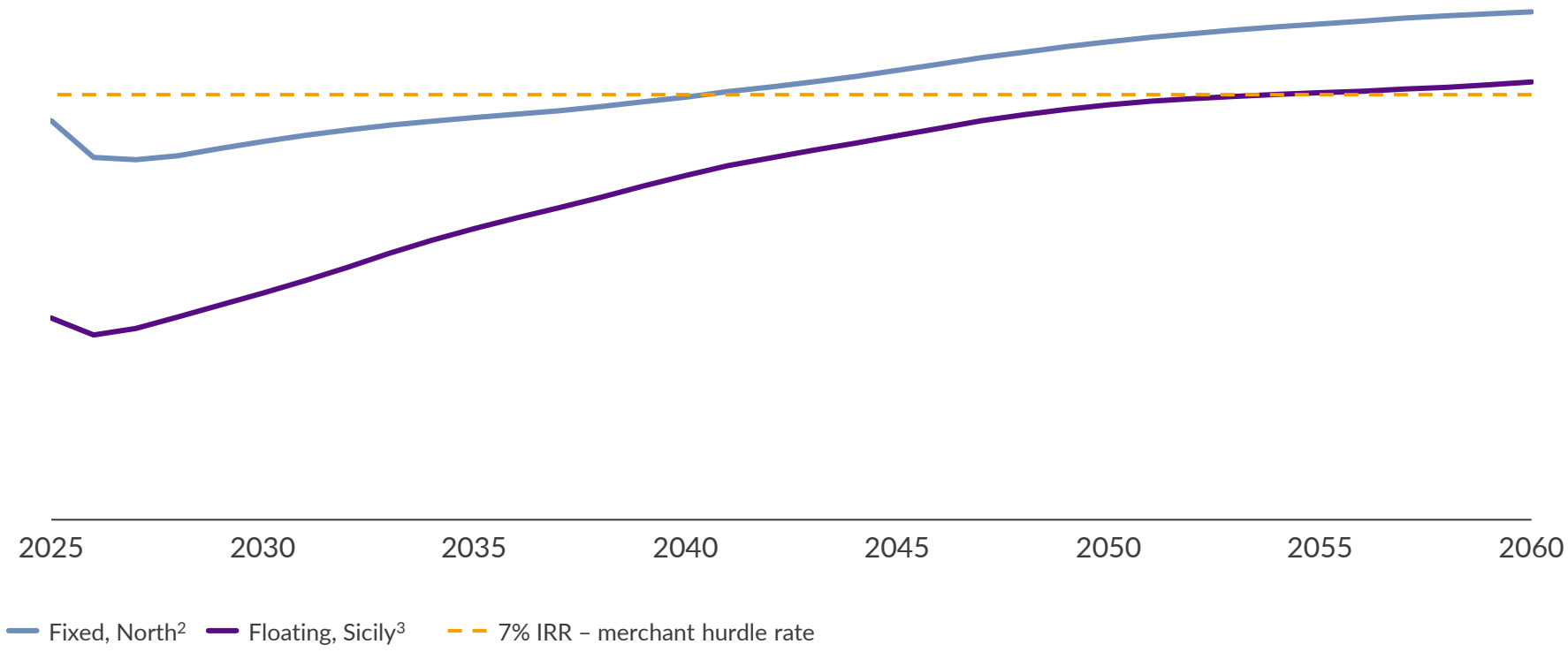
1) Uncurtailed generation-weighted average capture prices; 2) A negative discount indicates that capture prices are higher, on average, than baseload prices.

Sources: Aurora Energy Research

However, we are still far from the merchant viability of these projects, that would require subsidies to be realized

Merchant Internal Rate of Return (IRR) for fixed and floating offshore wind[1]

%



1) Revenues and costs are assumed as constant after 2060. Year refers to start of operations; 2) Assumptions: 1 GW utility scale, 2 years of construction time, 27-year lifetime, 33% load factor; 3) Assumptions: 1 GW utility scale, 3 years of construction time, 30-year lifetime, 45% load factor.

Sources: Aurora Energy Research

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Outlook for IRRs

- Fixed offshore in zone North, despite a higher LCOE after the late 2030s, exhibits greater IRRs than floating due to higher zonal capture prices
- Profitability is lowest in 2026/2027, when power prices return to values close to pre-crisis levels, leading to very low IRRS for both floating and fixed offshore
- In the long term, asset profitability gradually improves due to reductions in CAPEX; however, IRRs are still not high enough to support merchant projects, making subsidies essential to support buildout
- As both offshore technologies are not viable on a merchant basis, we will focus our analysis in the next section on floating offshore which will receive subsidies through FER2

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A new draft version of the subsidy scheme FER2 was published in August, allocating 3.5 GW for floating offshore wind

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FER2 draft highlights

- Payment based on a Contract-for-Difference (CfD) mechanism; plants smaller than 250 kW can take the CfD or be remunerated directly for the energy generated
- Reverse auctions to run between 2022 and 2026, with at least yearly rounds for all technologies other than floating offshore (which will have a minimum of three auctions over the period)
- 1 Bids to be placed with minimum 2% discount to the subsidy tariff, which will be reduced by 3% year-on-year for new auctions after 2022[1]
- Subsidy payment is interrupted in case of zero or negative zonal prices
- Plants must already be in possession of the right to build and operate, have a fully accepted grid connection quote and follow the relevant technology-dependent environmental constraints
- Under request of the participant, a positive Environmental Impact Assessment (VIA) can be presented as a substitute for the full authorization

Technology	Type	Size kW	Total capacity MW	Operational start date months after auction results	Subsidy duration years	Auction cap EUR/MWh
Offshore wind	Floating	Any	3,500	43	25	185
Geothermal	With innovation	Any	100	51	25	100
	Zero emission	Any	40	60		200
	With innovation, refurbished	Any	150	36		100
Biogas	Selected[3]	<300	150	31	20	233
Biomass		<300				246
		<1000				185
Thermodynamic solar	Small	<300	5	55	25	300
	Medium	<5,000	75		25	240
	Large	<15,000	75		25	200

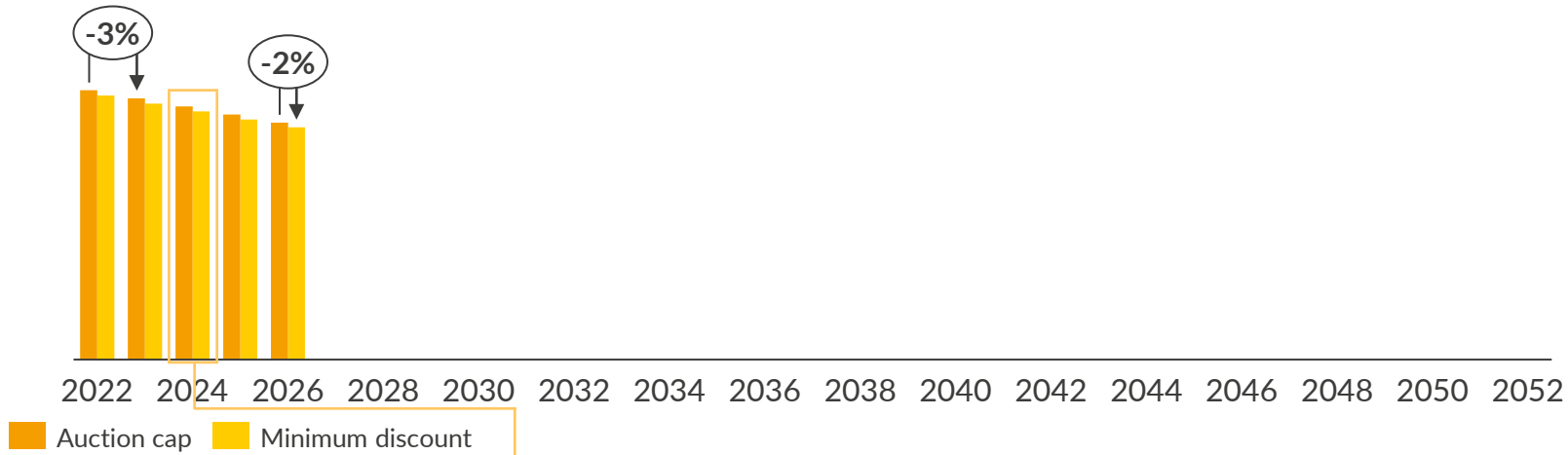
x *Deep dive on the next slides*

1) If auction cap is reached and % reduction is the same, priority is given to plants located in "suitable" locations according to DL 199/2021 art 20; 2) For every month of delay, the awarded subsidy tariff decreases by 0.5% for a maximum of 9 months. After this, a plant can gain access to the subsidy again but at a 20% reduction. Non-fulfilment of auction results must be communicated within 12 months of result publishing; 3) Specific products must be used in biogas/biomass to gain access to subsidies.

Sources: Aurora Energy Research, MiTE

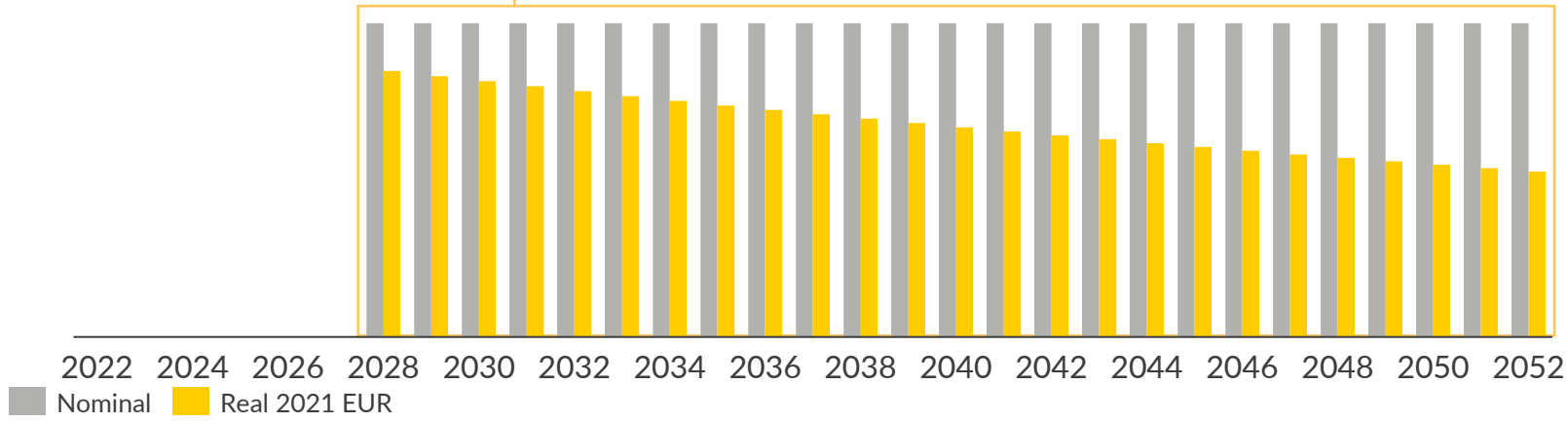
The scheme offers a 25-year Contract-for-Difference (CfD) with auction cap decreasing over time and payment not adjusted for inflation

FER2 maximum bid level by auction year
EUR/MWh (nominal)



- According to the FER2 decree, the bid cap will be reduced by 3% year-on-year for new auctions after 2022
- Additionally, it also states that bids must be placed with a minimum 2% discount to the bid cap
- These two factors effectively reduce the subsidy amount to 160 EUR/MWh (nominal) for a potential auction held in 2026

FER2 illustrative remuneration
EUR/MWh



- The construction time assumed in the decree is maximum 43 months, after which penalties apply in case the plant is not yet operational
- Remuneration is fixed in nominal terms; payment in real terms is therefore decreasing over time and inflation assumptions heavily influence the business case
- After the 25-year CfD, additional upside could come from merchant tail or a potential PPA

Sources: Aurora Energy Research, MiTE

We calculated potential FER2 bids for the existing pipeline, considering the plant-specific subsidy level needed to break even

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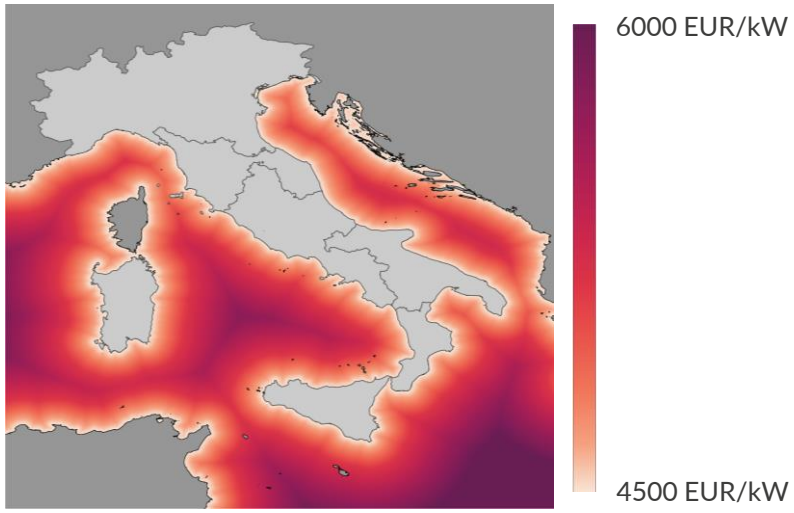
Floating offshore CAPEX (2022[1])
EUR/kW (real 2021)

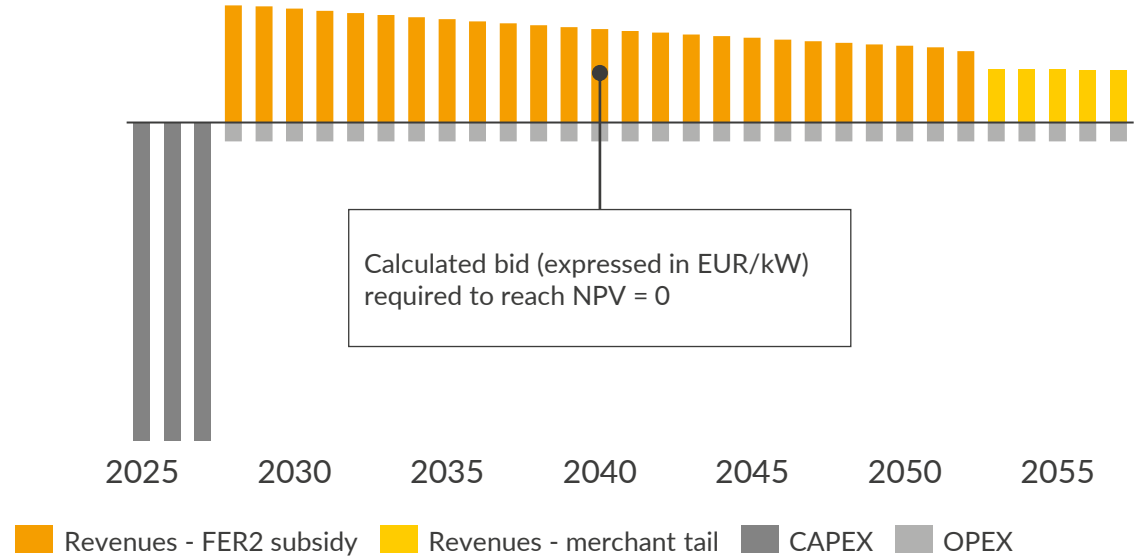


- To account for CAPEX variations given different locations, we scale the "Installation and development" and "Grid connection" CAPEX components based on distance to shore and relative offshore cable length
- Additionally, we assume a threshold of ~72km after which laying DC cables to connect the offshore substation to shore is more economically convenient than laying AC cables[2,3]
- Water depth was found to have little effect on CAPEX, based on published research[2] and sensitivity studies[4], thus its effect is not considered as distance to shore and cable length are the most influential variables

Calculation of FER2 bids and auction modelling methodology

- By combining the plant-specific load factors, CAPEX and capture prices and the FER2 auction design, we calculate the minimum bid each plant needs to submit to recover its costs for a specific WACC, also considering revenues arising from the 5-year merchant tail after the end of the 25-year subsidy
- We then produce merit-order curves to simulate the outcomes of the FER2 auctions taking place in different years and forecast which plants will be awarded a subsidy contract

Illustrative cash flow for plant with COD 2028
EUR/kW (real 2021)



1) Values are for year when construction begins; 2) *Martinez et al* (2021); 3) AC cabling is more expensive but requires a less expensive substation configuration than DC, making DC cables the optimal solution at greater distances; 4) CAPEX changes by less than 1% when varying the water depth between 100m and 2000m.
Sources: Aurora Energy Research

In the first auction, we limit participation to plants that have requested both the seabed concession and VIA

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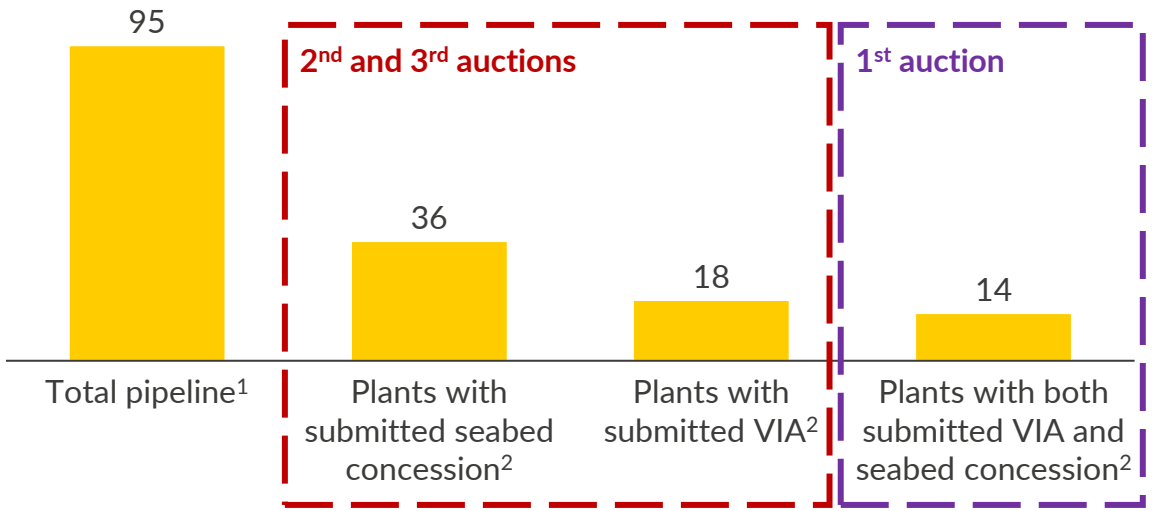
Offshore capacity by authorisation status



- We limit participation in the first FER2 auction to the 17 plants (14.4 GW) that have submitted both the seabed concession and VIA, as plants are required to have an accepted grid connection request, seabed concession and VIA to enter the auctions
- We open participation in the 2nd and 3rd auctions to all plants that have submitted either the seabed concession or VIA, for a total of 39.9 GW across 47 plants, assuming the requests will be approved by the auction date
- Although it is optimistic to assume that all 47 plants will take part in the 2026 auction, given the number of plants in the pipeline it is likely that the auctions will experience a high level of competition

Summary of auction simulation parameters

	2024 auction 2028 COD	2026 auction 2030 COD	2028 auction 2032 COD
Auction capacity GW	1	1	1.5
Participating capacity[3] GW	14.4	39.9	39.9
Participating plants[3]	17	47	47
Auction cap EUR/MWh (nominal)	173.9	162.8	151.7

- We simulate 3 auctions[4], occurring in 2024, 2026 and 2028, leading to CODs in 2028, 2030 and 2032 respectively
- Of the 3.5 GW of total FER2 capacity, we allocate 1 GW to the first two auctions and 1.5 GW to the third, on the assumption that more capacity will be able to participate in the final auction and thus reach a higher target
- We vary WACC values between 7% and 11%, taking 9% as our central case, to account for both the subsidised nature of the revenues and the cost uncertainty associated with a developing technology
- We also run a sensitivity analysis on CAPEX variations and their effect on auction clearing prices, to account for technological uncertainty

1) Submitted grid connection requests for offshore wind as of October 2022; 2) Floating offshore requests as of 17.11.22; 3) Values are for total potentially participating capacity and plants, and do not account for already awarded capacity not participating in subsequent auctions. This is, however, accounted for in the simulated auction outcomes; 4) According to the draft FER2 decree, a minimum of 3 auctions will be held for floating offshore wind.

Sources: Aurora Energy Research, Terna, MiTE

In the 2024 auction, the marginal plant would bid well below the 174 EUR/MWh cap, assuming a 9% WACC

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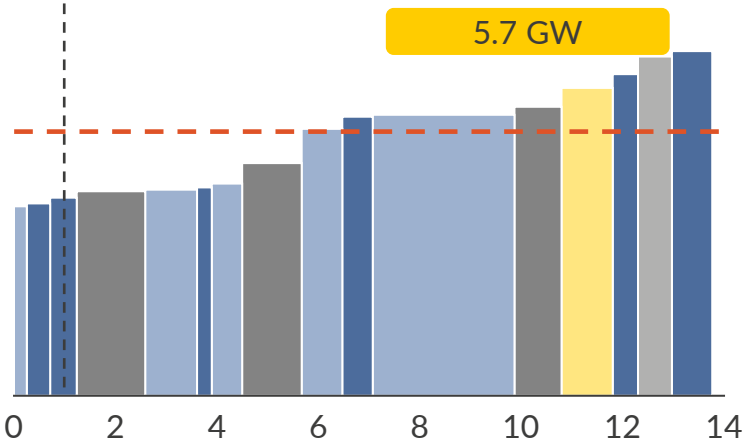
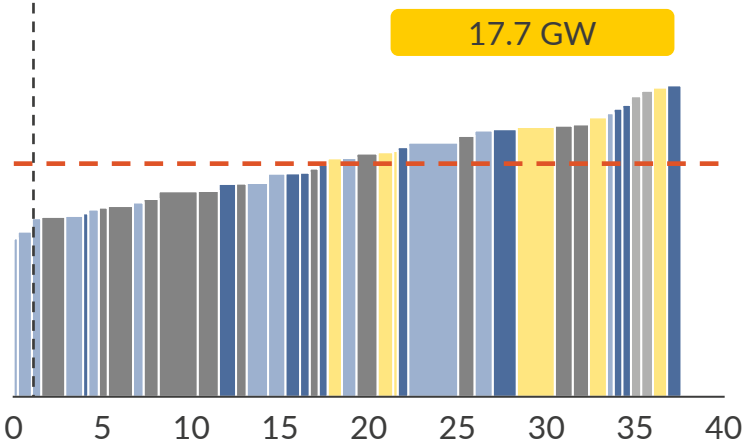
WACC = 9%

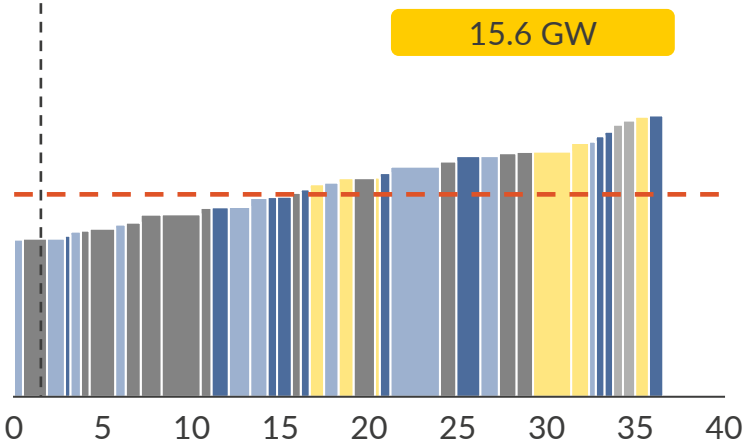
2024 auction - Minimum bids by plant
EUR/MWh (nominal)



2026 auction - Minimum bids by plant
EUR/MWh (nominal)



2028 auction - Minimum bids by plant
EUR/MWh (nominal)



C. South | Calabria | Sardinia | South | Sicily | Auction cap | Auction volume | Capacity below auction cap

Cumulative capacity
GW

- The first auction in 2024 would see three plants, one in Sicily and two in Sardinia, being awarded a total of 1237 MW
- In the 2026 auction, two plants totalling 1032 MW in Sicily would be awarded a FER2 contract
- The 2028 auction awards 1854 MW to two plants, one in Sicily and one in zone South
- Expected high participation, particularly in the last two auctions, ensures competitive outcomes in the auction process; lack of participation due to permitting issues would instead increase the potential for strategic bidding of participating plants
- Marginal bids would have a discount to the auction cap ranging from ~15% in the 2024 auction to ~10% in 2028 auction

Sources: Aurora Energy Research

Similarly to the WACC, CAPEX has a substantial impact on auction participation and bid levels

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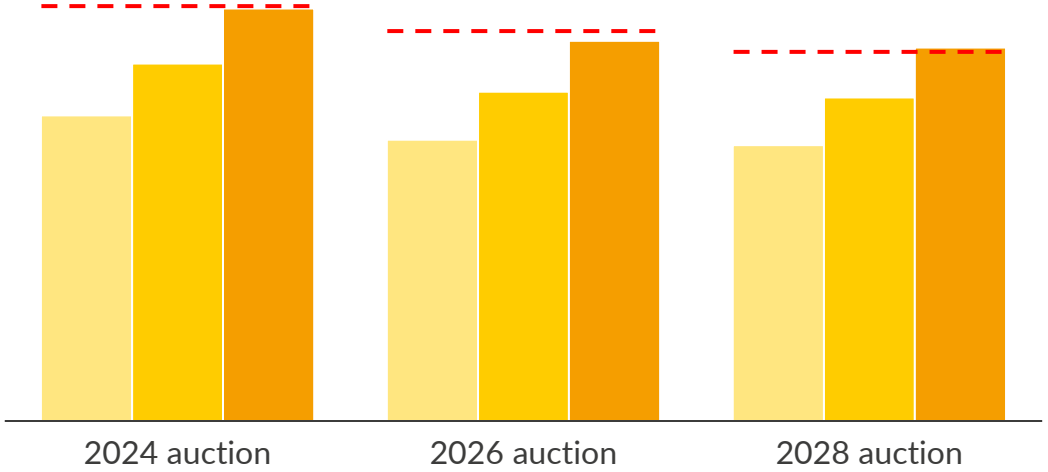
WACC sensitivities

Auction results summary – Marginal bids
EUR/MWh (nominal)

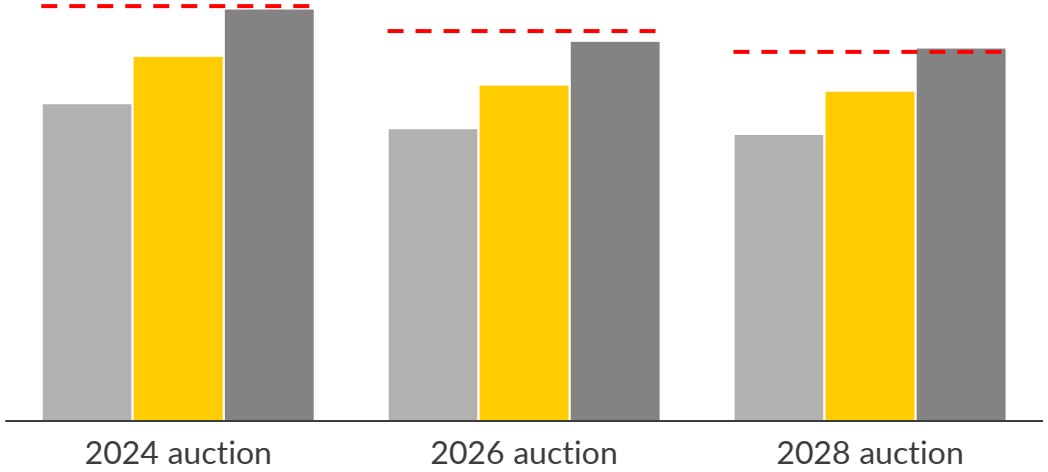


- A WACC of 7% allows nearly all plants in the considered pipeline to participate in the FER2 auctions. Awarded bids are on average 21 EUR/MWh lower than in the 9% WACC case
- A 9% WACC leads to good levels of competition in all auctions, with a total of 4 GW of awarded capacity split between Sardinia, Sicily and South
- With an 11% WACC, competition is very limited in the first two auctions and the third one ends undersubscribed. Awarded bids are on average 22 EUR/MWh higher than the 9% WACC case

WACC 7% | WACC 9% | WACC 11% | Auction cap

CAPEX sensitivities

Auction results summary – Marginal bids
EUR/MWh (nominal)



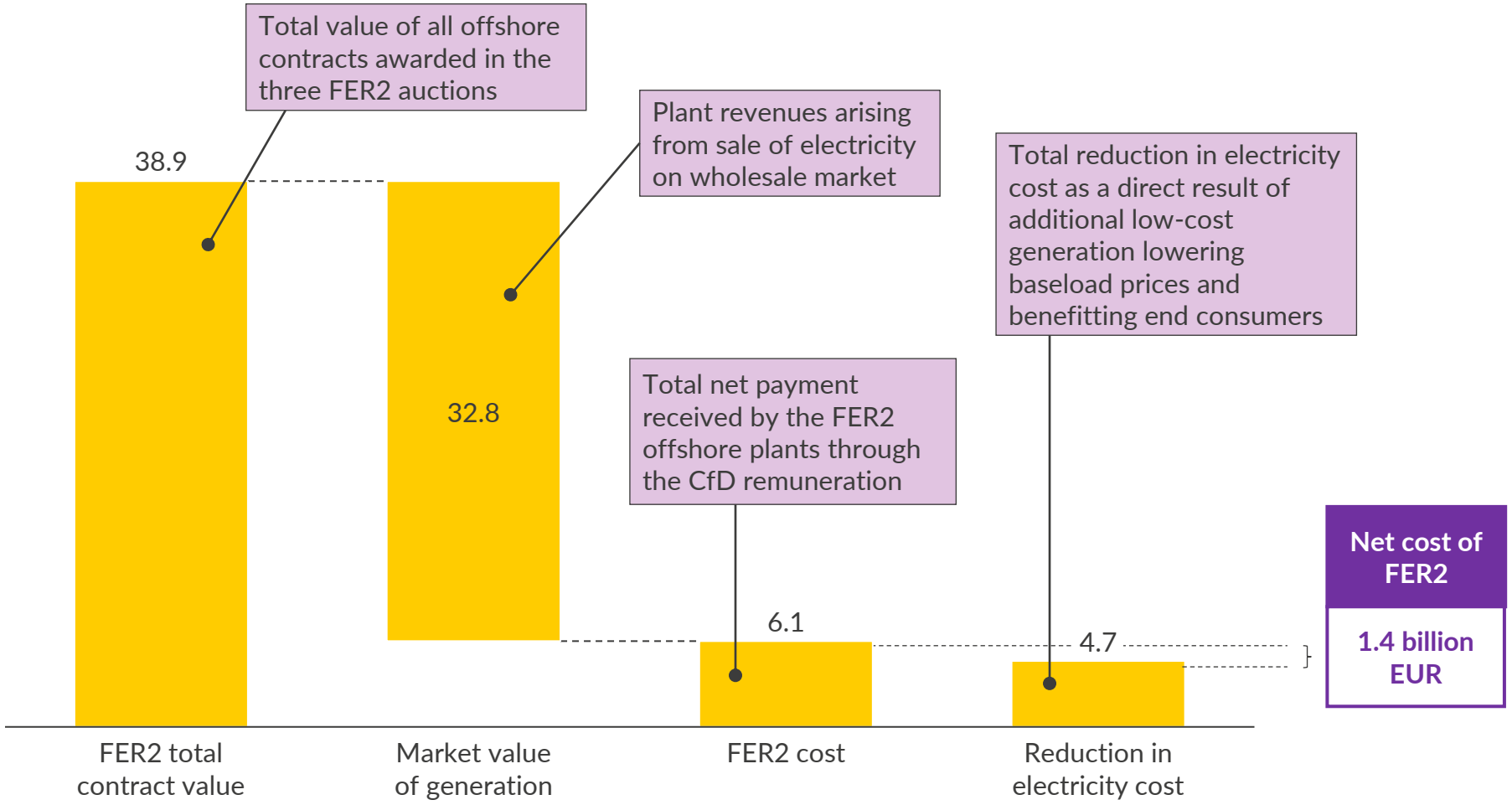
- As floating offshore wind is still a technology in its infancy, CAPEX represents one of the parameters with the most uncertainty
- Varying CAPEX by ±15% affects highest awarded bids by ±20 EUR/MWh in the 2024 auction and ±18 EUR/MWh in the following auctions
- While a lower CAPEX projection leads to increased competition, a 15% higher CAPEX would result in the 2028 auction being undersubscribed, as the minimum bids are higher than the auction cap

CAPEX -15% | CAPEX - Base case | CAPEX +15% | Auction cap

Sources: Aurora Energy Research

The FER2 results lead to a total net cost of the scheme of 1.4 billion EUR, when accounting for the reduction in electricity cost

FER2 cost for floating offshore wind[1]
billion EUR (real 2021)



1) Calculated based on minimum awarded plant bids with 9% WACC and CAPEX base case.

Sources: Aurora Energy Research

- The total value of FER2 contracts for offshore is 38.9 billion EUR, of which 32.8 billion EUR will be earned by awarded plants directly through wholesale market revenues
- The total cost of FER2 (for offshore plants) will therefore be of 6.1 billion EUR
- The simulated auction outcomes result in 4.7 billion EUR of total system savings arising from FER2 between now and 2060 which directly benefit electricity consumers
- This leads to a total net FER2 cost of 1.4 billion EUR

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Q&A

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Details and disclaimer

The Future of Offshore Wind in Italy: Will It Sink or Float?

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