

Blue Sky Thinking— Analysing Power Market Uncertainty in the Cloud

Public Webinar



Our team



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Agenda

- I. Origin — Aurora's cloud-based power market model
- II. Origin demonstration
- III. Iberia scenario
- IV. Italy scenario
- V. The Netherlands scenario
- VI. Customer Success
- VII. Questions & Answers

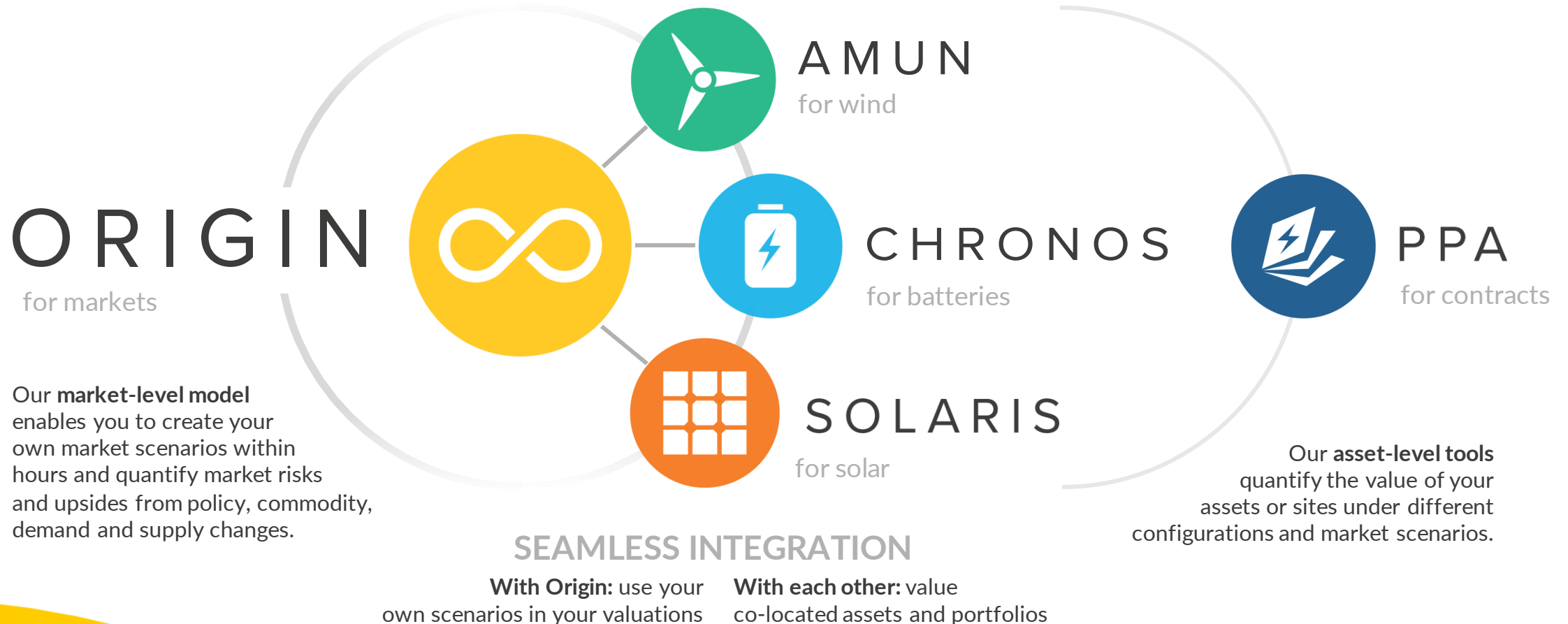
Aurora Software

Global investment analytics platform for the energy transition

Value any asset or portfolio, under any business model and market scenario, anywhere in the world



Seamlessly integrated suite of software products



Powering your key strategic and commercial decisions





Origin allows you to generate your own market scenarios using Aurora's power market model

Exact same cutting-edge model we use ourselves

Fully calibrated and continuously updated with data

Extremely user friendly, requires minimal training and onboarding

Used by leading utilities, developers, funds, TSOs and consultants

Unique iterative investment module, capturing real investment behaviour



Transactions



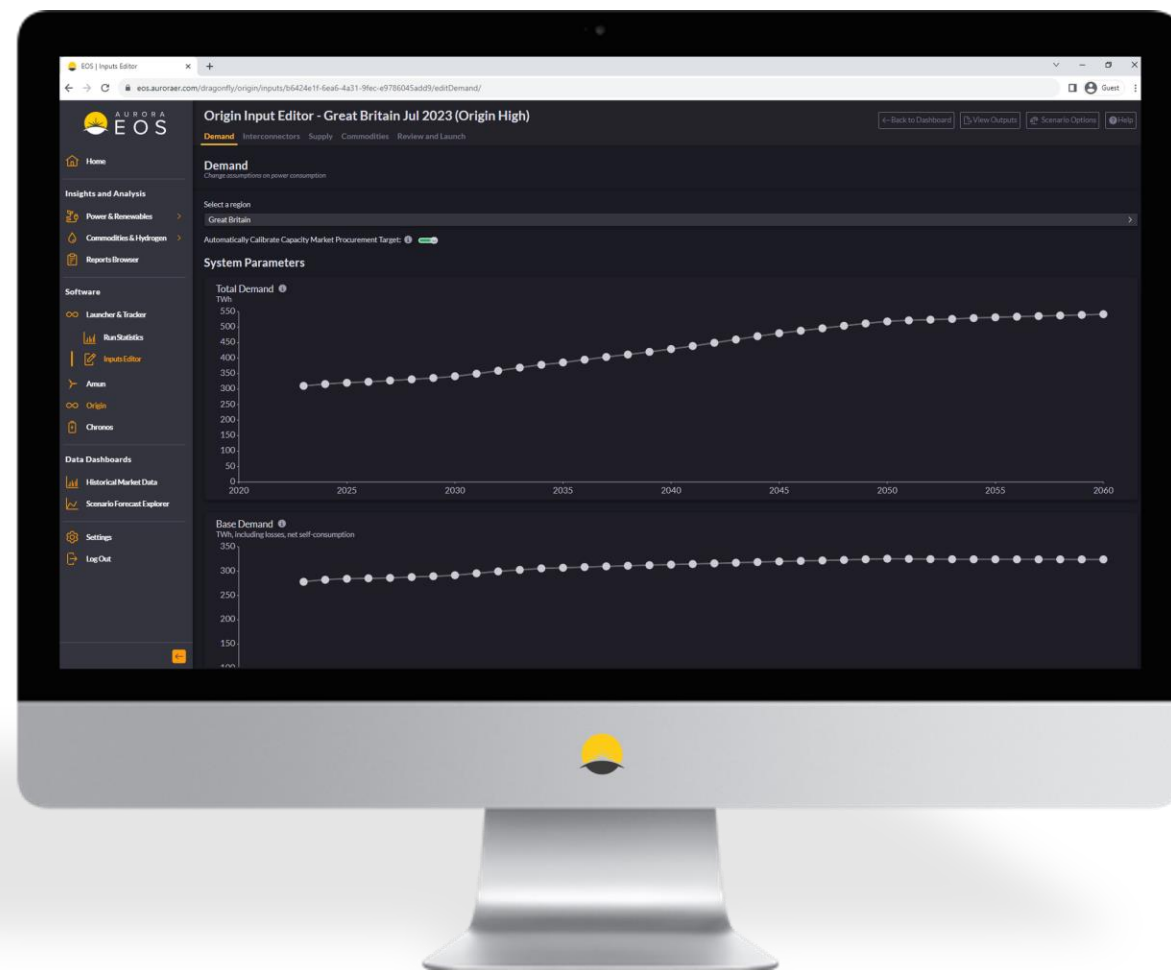
Strategy



Risk Analysis



PPAs



Tackle market uncertainty with **Origin**

Instant and powerful answers for your stakeholders and investors

The rapidly evolving market

- Geo-political turbulence
- Commodity shocks
- Supply-chain disruption
- Technological breakthroughs
- Market design changes
- Macroeconomic shifts
- Yield compression
- Growing merchant exposure

Requires analysis that goes beyond off-the-shelf

- Beat the market
- Gain unique insights
- Answer new questions as they arise
- Test wide range of risks and their combinations
- Develop own market views
- Identify upsides

Existing solutions are limited

- 1. Commission bespoke analysis**
 - Long lead times, and limited ability to iterate and experiment
 - Complex and costly to update
- 2. Bring price analytics in-house**
 - High costs to build a dedicated team
 - Huge effort to populate, calibrate, and update a robust in-house model
 - Difficult to develop and maintain in-depth local market expertise

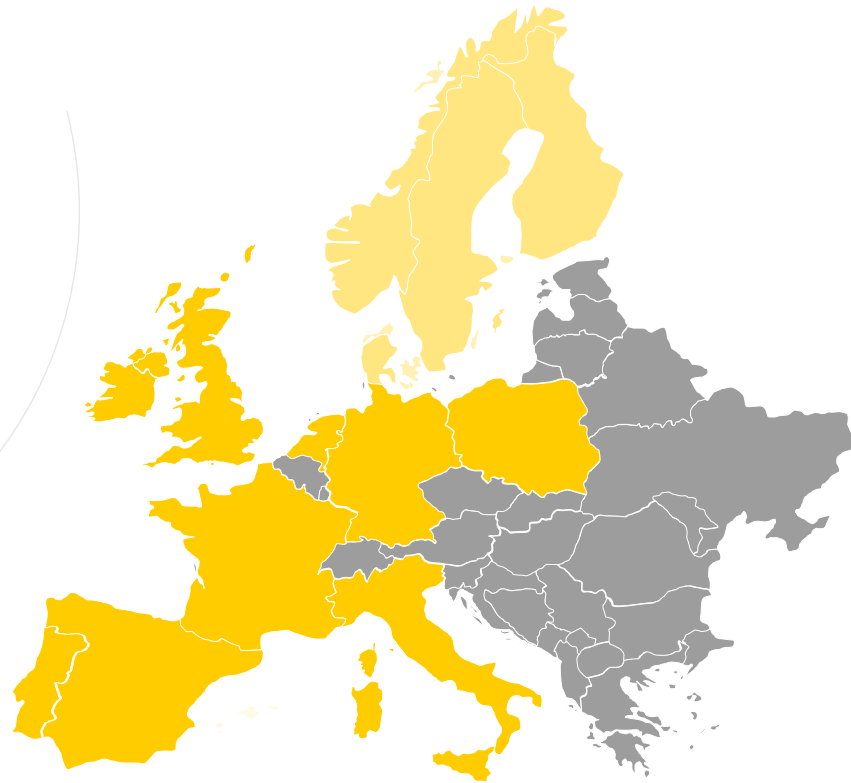
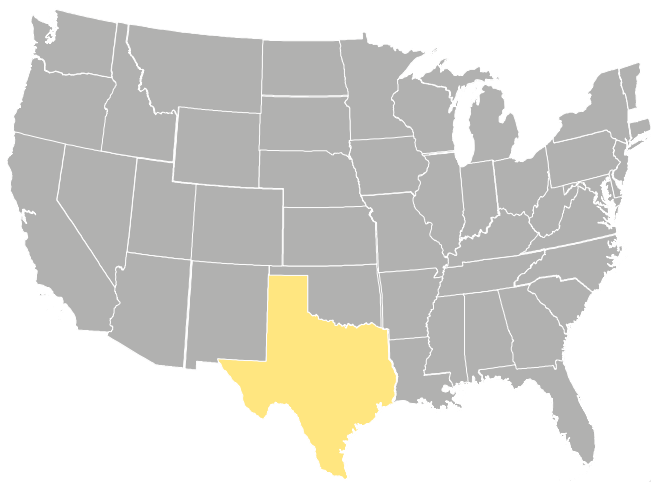
ORIGIN



1. Access **Origin**
2. Select an Aurora scenario
3. Modify inputs
4. Launch your run
5. Visualise results

Answer your key market questions in hours, with no fuss, fully supported by **Origin Customer Success** experts

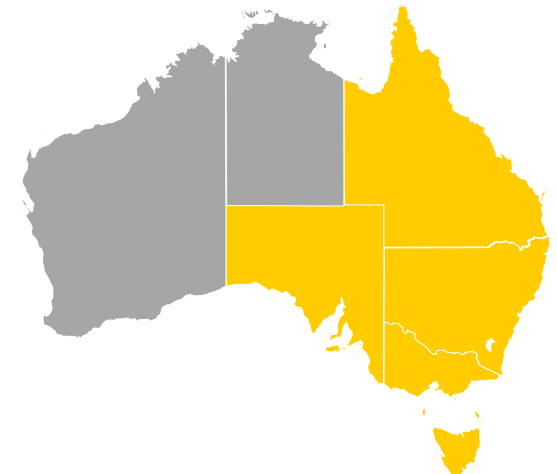
Where can you find Origin



CURRENTLY
AVAILABLE



COMING SOON...



Aurora's model in the hands of industry leaders



30+ subscribing companies across Europe and Australia

Used by leading funds to assess the robustness of their portfolios against market & commodity changes

Active in major financings, successfully building compelling, evidence-backed equity stories

Maximises transaction value with bespoke scenarios that challenge vendor assumptions

Supports investment in markets and technologies based on a bespoke view on market evolution, risk, and upside

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II. Origin demonstration

III. Iberia scenario

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Build and launch your own scenarios in **Origin**

A simple and intuitive 4 step process

Step 1.

Select Aurora/Bespoke scenario in **Scenario Dashboard**

Demand

- Including EV or heat pump, split by flexible or smart charging
- Hydrogen: Capacity of electrolyser & H₂ -fired gas turbine

Commodity prices

Including fuels + Carbon pricing
+ Auto update of based on futures

Interconnections

Transmission capacity between market zones

Technology Assumptions

Capacity timelines

- Investment (CAPEX)
+ Operational costs (OPEX)
- Load factors for renewables, at regional level
- Build limits to reflect space or grid constraints

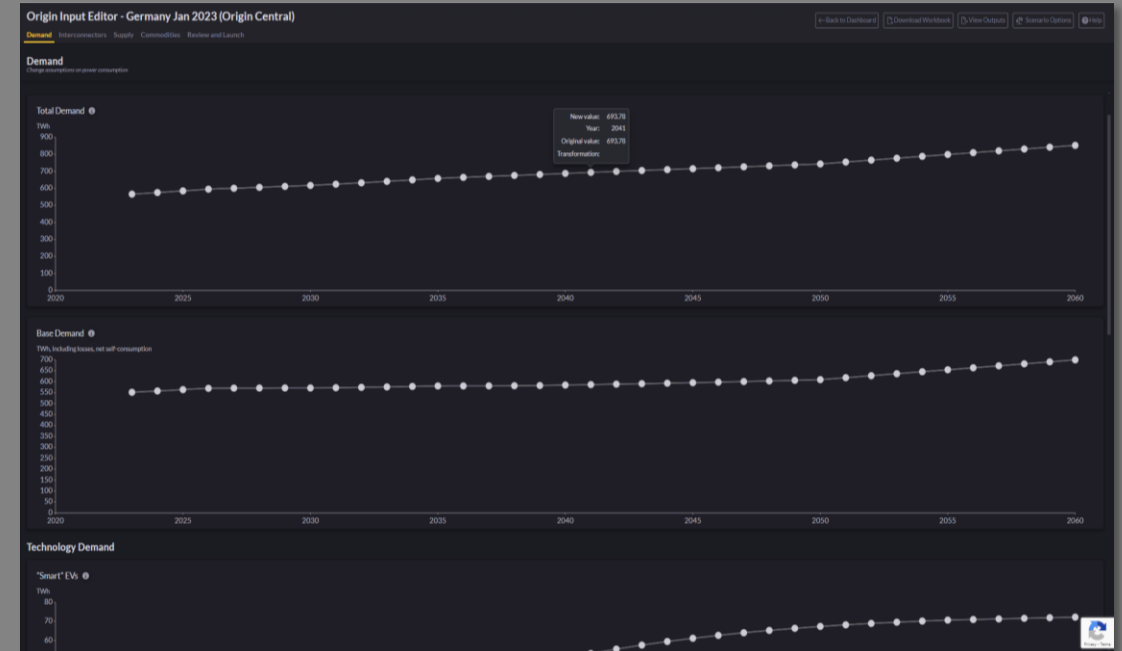
Model determined capacities simulates real investment behaviour, bringing online profitable technologies, and retiring unprofitable assets

Origin
power market
model features
2 modes

Fixed capacities where you define future generation (to simulate shocks or assess risks sensitivity)

Step 2.

Change **Origin** input assumptions



Origin empowers users to change a wide range of parameters and assumptions to simulate multiple power market scenarios

Supported
by our
Customer
Success
team!

Step 3.

Review your input changes, and **launch** the same model used by Aurora

Wholesale market prices

- Yearly averages (baseload vs. peakload) + daily/hourly data
- Summary of price distribution via percentiles & standard deviation

Technology data

Generation & capacity data by technology, including monthly data for RES + fleet CP of RES

Demand

- Annual + peak electricity demand
- Breakdown of demand for transport (EV), heat, and electrolysis

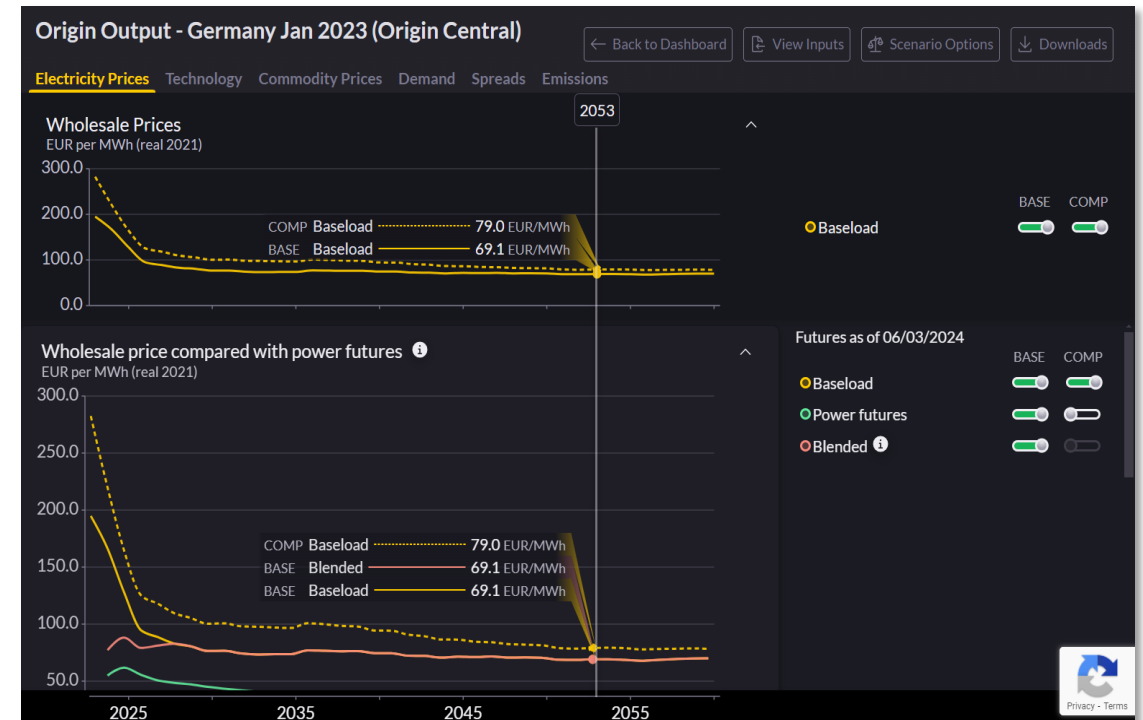
Emissions

Power sector carbon emissions, clean spark and clean dark spreads

Capacity market price forecasts

Step 4.

Origin Outcome Explorer—assess impacts and compare scenarios quickly and interactively



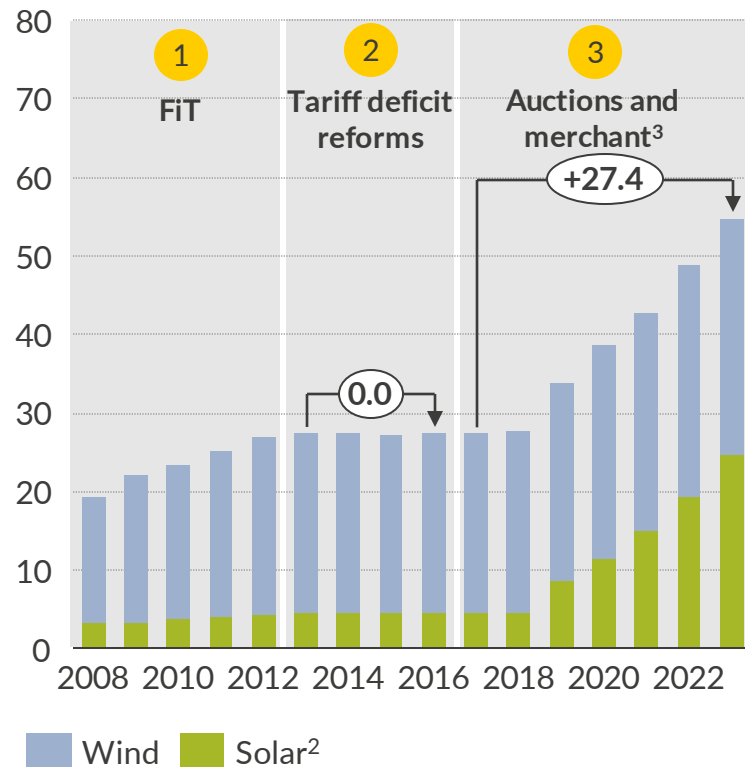
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Regulatory reforms stalled RES penetration between 2013-16; since then, over 70 GW have been approved¹ causing uncertainty around buildout

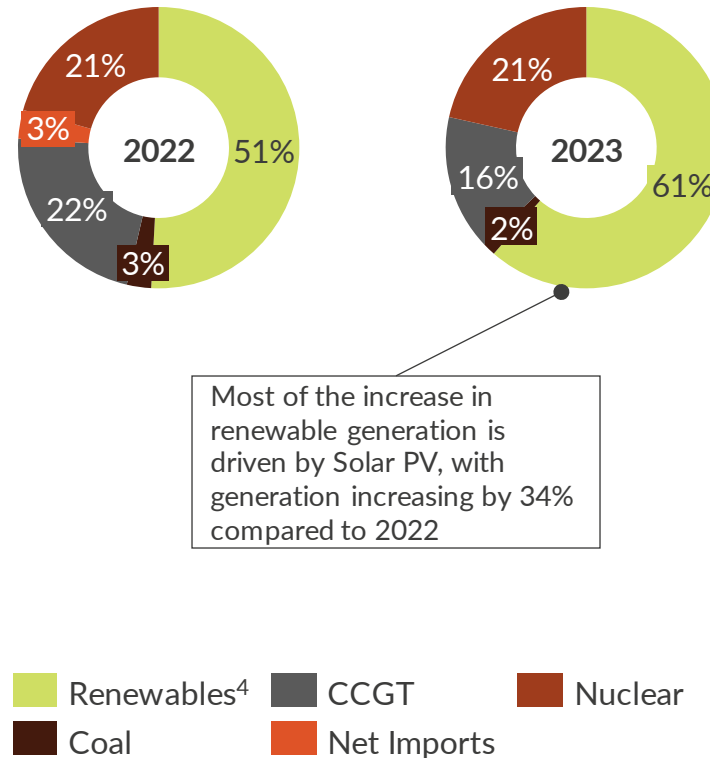
Historically, regulatory changes have stalled renewables growth...

Accumulated wind and solar installed capacity²
GW



...whilst in recent years, the system is becoming ever more dominated by renewables...

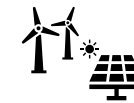
Electricity generation mix²
% of TWh



...leading to uncertainty around increasing RES capacity and firm capacity retirements

Key uncertainties in Spain:

1. Capacity mix



Large renewables pipeline



Most CCGTs require a capacity market to remain profitable



Nuclear power plants to be decommissioned by 2035

2. Demand evolution



Flexible and inflexible demand

3. Regulatory factors



Taxes, clawback mechanisms, gas price cap, permitting deadlines

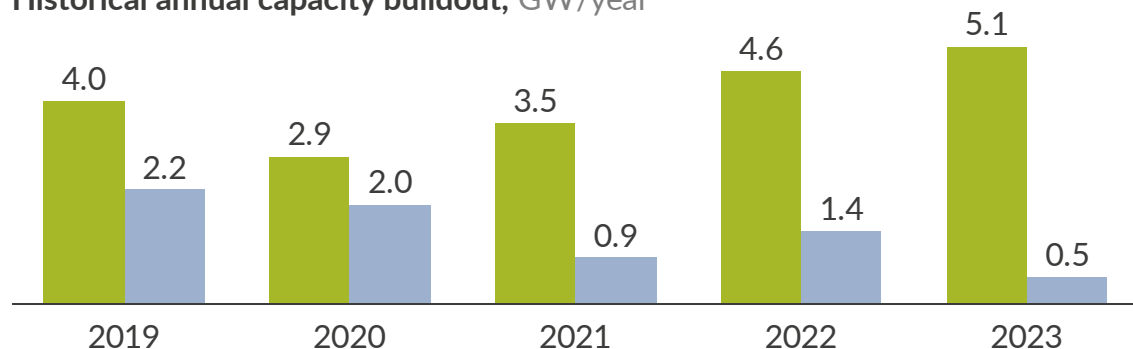
1) Refers to Environmental Impact Assessment approvals as of January 2023. 2) Data for the Iberian Peninsula and only includes utility-scale solar PV. 3) Includes fully merchant and PPA structures 4) Includes Onshore Wind, Solar PV, Solar CSP, Hydroelectric power, energy from renewable cogeneration, waste, biomass, geothermal and small hydro technology.

Sources: REE, Aurora Energy Research

Solar is the technology that is most at risk of decreasing revenues due to increased cannibalisation, compounded by curtailment risk

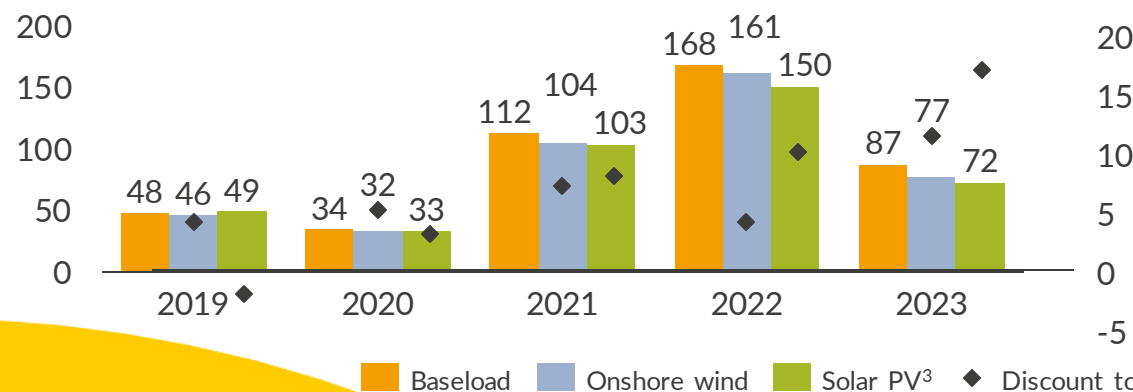
Ground-mounted solar PV deployment reached a historical maximum of 5.1 GW in 2023, whilst onshore wind deployment is suffering delays

Historical annual capacity buildout, GW/year

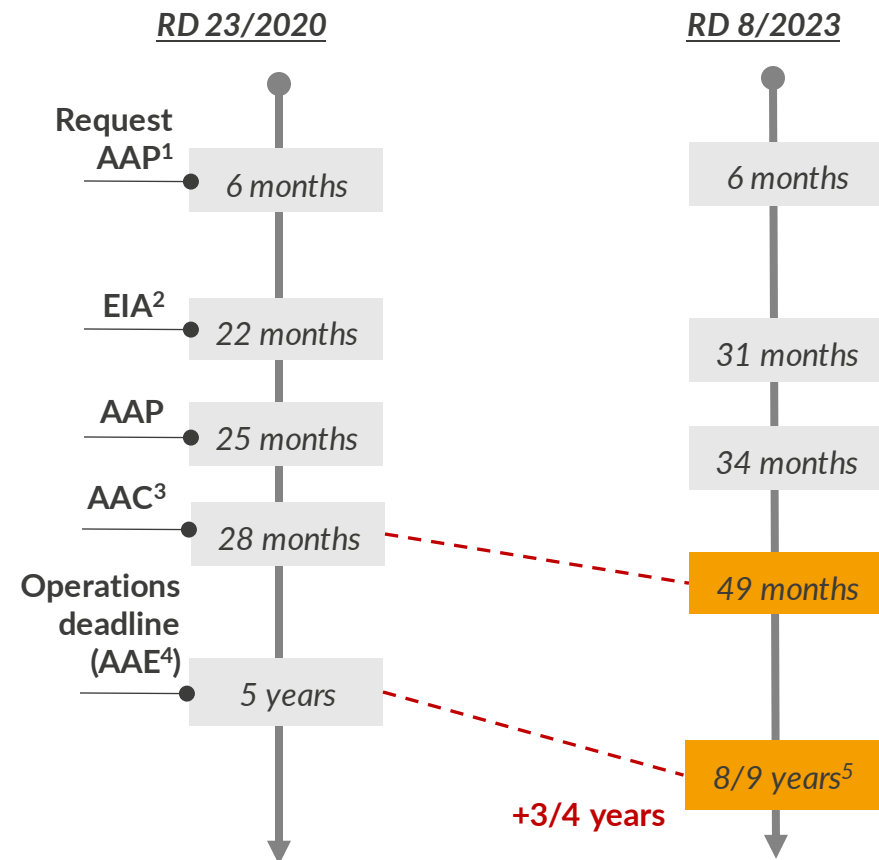


Solar is the technology that is most at risk of decreasing revenues due to increased cannibalisation; discount to baseload reached 17% in 2023

Historical baseload, renewables capture prices €/MWh (nominal)



In Dec 23 the government extended regulatory deadlines for operations, until 2028, leading to expected additional RES capacity deployment



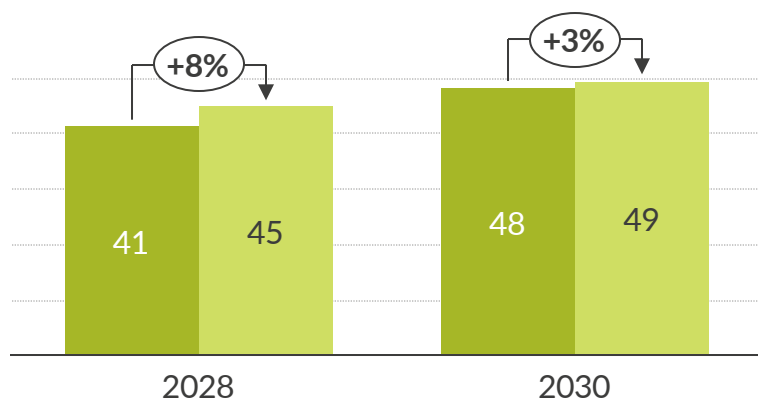
Using Origin, we will analyse how the deployment of additional Solar PV capacity in the 2020s will affect solar capture prices

1) Administrative Authorisation for Construction. 2) Administrative Exploitation Authorization. 3) Prior Administrative Authorisation. 4) Environmental Impact Assessment. 5) 9 years for pumped storage and offshore wind, 8 years for rest of projects. This extension to 8/9 years must be explicitly requested by the project developer.
Sources: Aurora, REE, MITECO.

Increasing the solar build out between 2025 and 2027 results in lower solar capture prices during the 2020s; prices recover in the late 30s

Due to the elevated number of projects in the pipeline, the highest uncertainty regarding total capacity is around Solar PV buildout

Total Solar PV¹ capacity per scenario in 2028 and 2030, GW



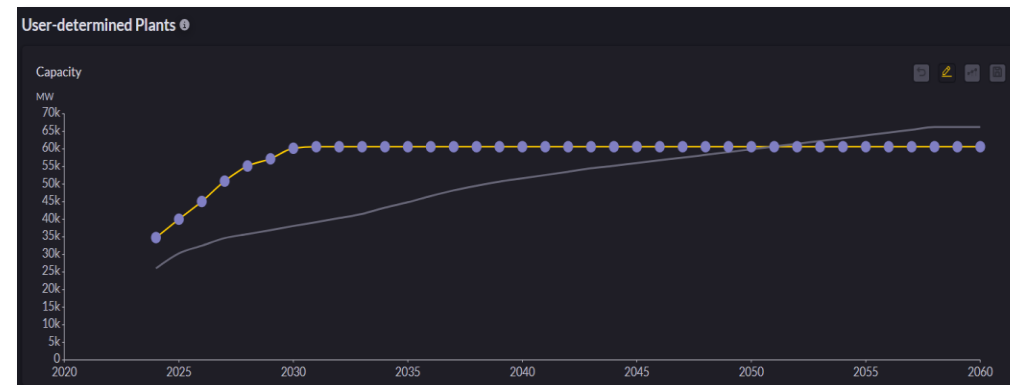
The base case considered for this scenario assumes the following:

- 2024-2025: An average of 4.5 GW per year
- 2026-2030: An average of 3.3 GW per year

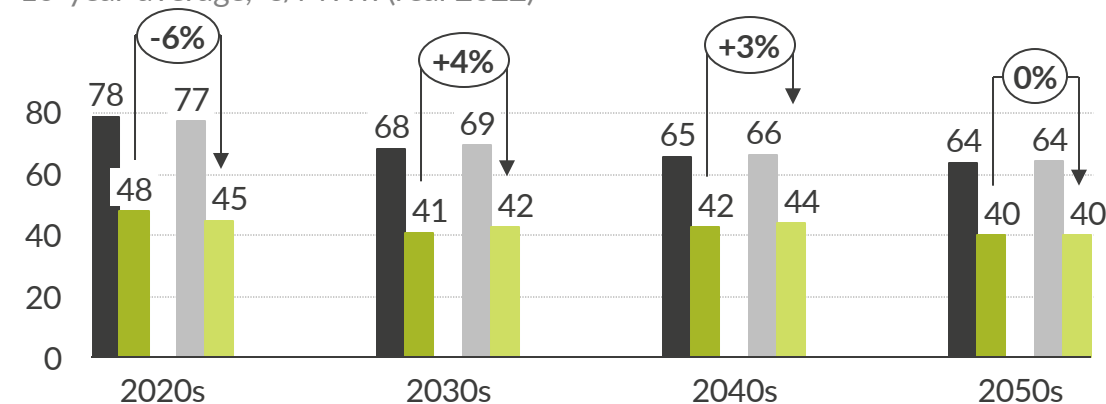
The Extended deadline scenario considers:

- 2024-2028: An average of 4.5 GW per year
- 2029-2030: An average of 2.2 GW per

Origin allows us to introduce additional capacity exogenously; if projects achieve the hurdle rate additional capacity could be built



Baseload and Solar PV capture prices², 10-year average, €/MWh (real 2022)



Baseload Base Case
 Baseload Extended deadline scenario
 Solar PV Base Case
 Solar PV Extended deadline scenario

1) Refers to utility scale capacity. 2) Uncurtaild generation weighted average across fleet. Note this does not refer to Aurora Central. 3) Commercial Operations Date. 4) internal Rate of Return. 5) Net Present Value, discounted at 11.5%.

Agenda

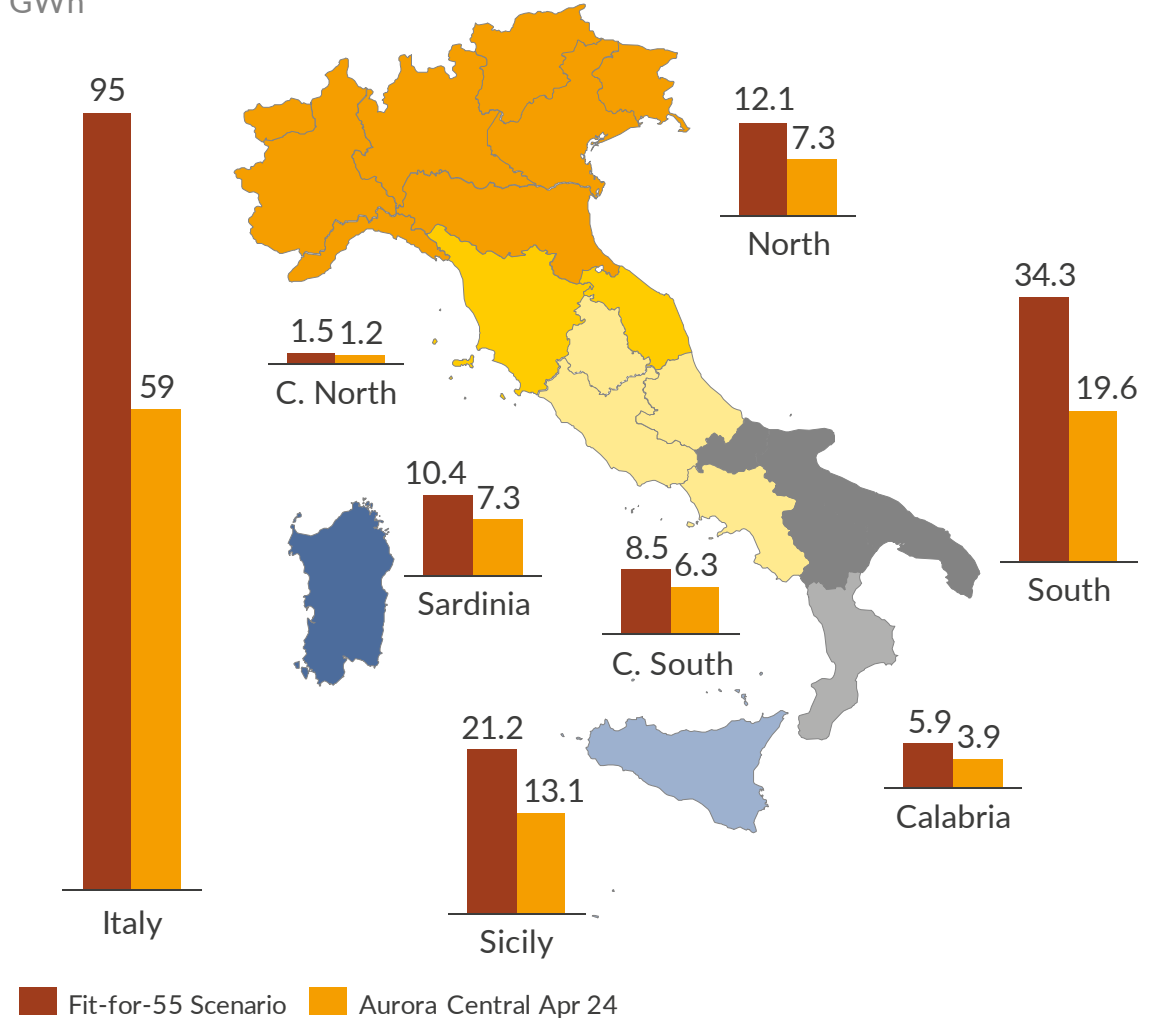
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The MACSE scheme will provide fully contracted revenues for a provisional target of ~71GWh of storage capacity by 2030

The MACSE storage support scheme will be finalized in the coming months, providing fully contracted revenues to awarded assets over entire lifetime, in exchange for making the capacity available to the system and to third party market participants.



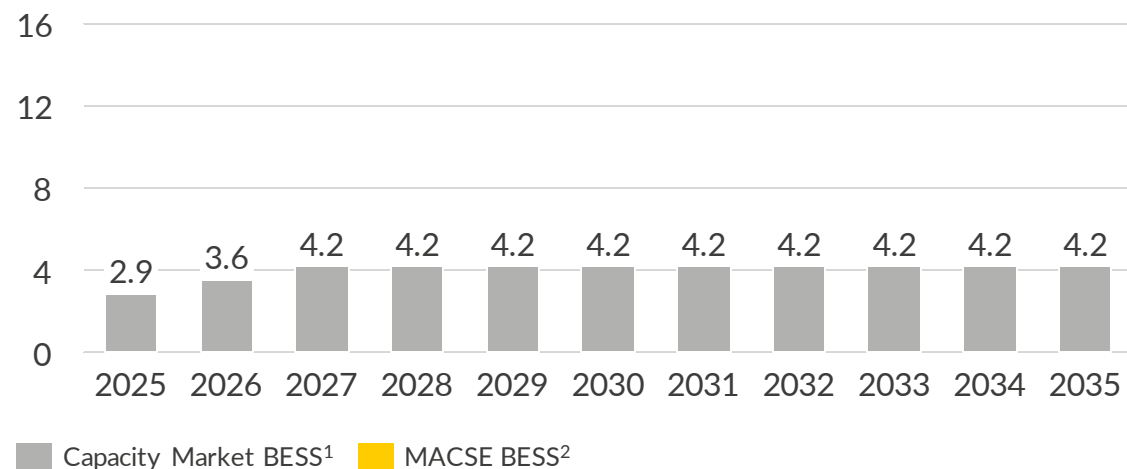
Storage capacity requirements by 2030¹, Terna Fit-for-55 scenario GWh



1) Capacities do not include existing pumped storage.

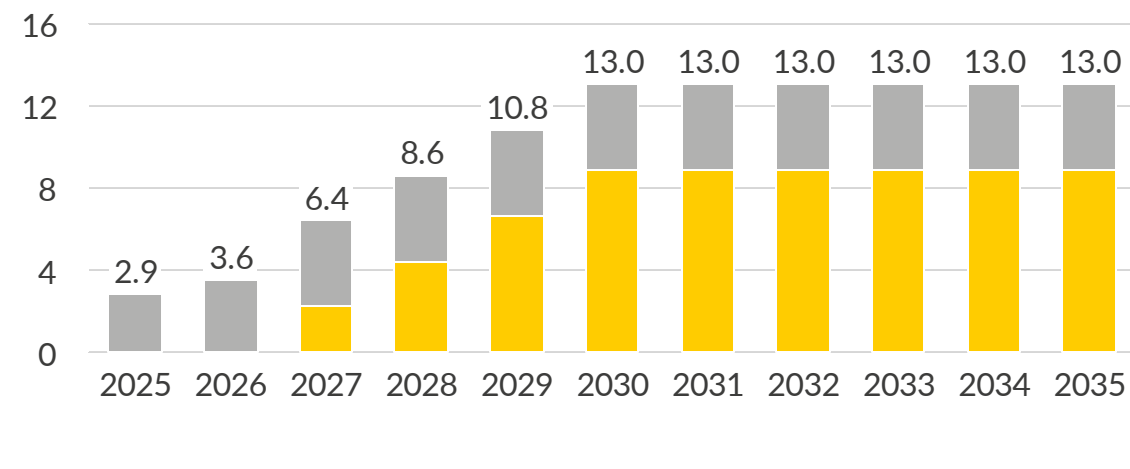
Through **Origin**, our team simulated scenarios where the MACSE target is fully achieved vs non-procurement of the scheme

Input battery capacity—scenario No MACSE
GW



- In a scenario where the MACSE fails to procure battery storage capacity, input battery capacity increases with new Capacity Market auctions and then remains constant after 2027.
- Batteries are free to build if the NPV of the investment is >0, given the input cost assumptions and the market revenue results.

Input battery capacity—scenario Full MACSE
GW



- In a scenario where the full MACSE contingent of ~9GW of 8h batteries (~71GWh) is procured by 2030, input battery capacity increases to 13GW by 2030.
- Batteries are free to build if the NPV of the investment is >0, given the input cost assumptions and the market revenue results.

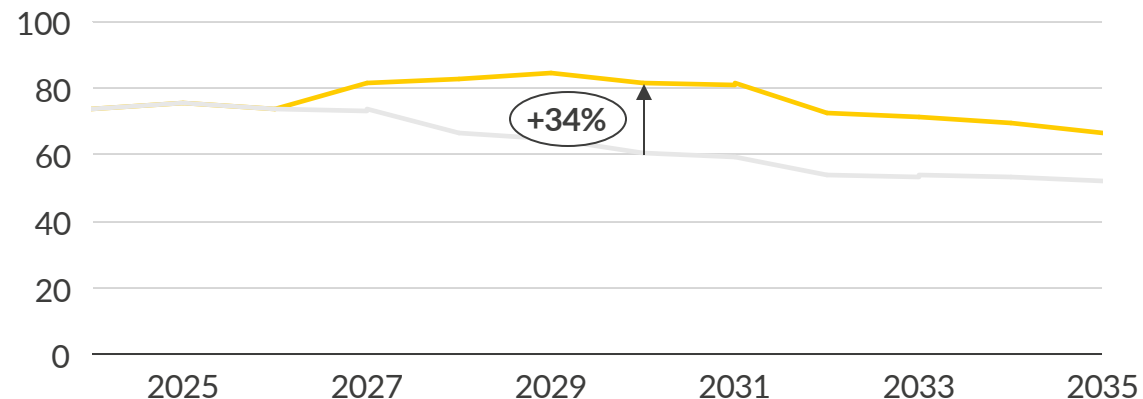
Different baseline battery penetration assumptions allow to quantify the impact of the MACSE scheme on buildout of merchant batteries and renewables capture prices, curtailment and overall profitability

1) Capacity Market batteries are assumed to be of 4h duration; 2) MACSE batteries are assumed to be of 8h duration.

The degree of success in the implementation of MACSE leads to significant impacts on RES economics and development of merchant batteries

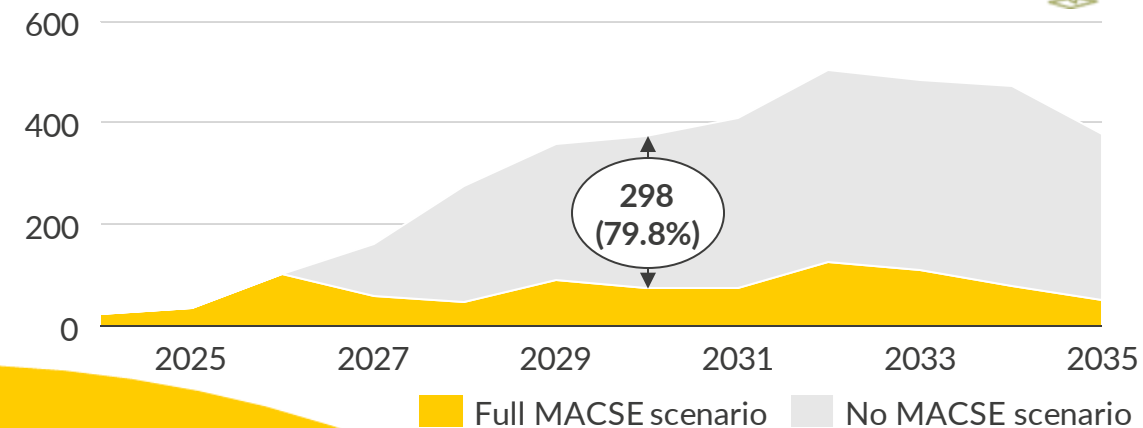
Solar tracker PV capture prices, Sicily

€/MWh



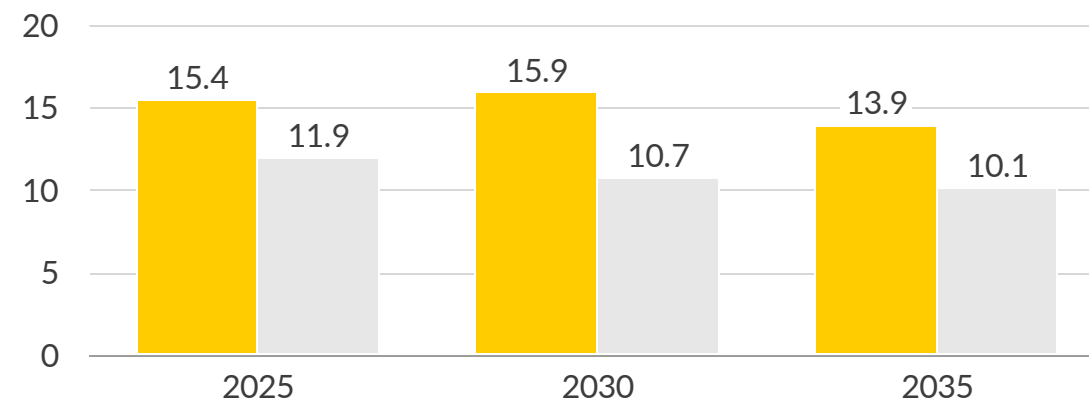
Solar PV economic curtailment, Sicily

GWh



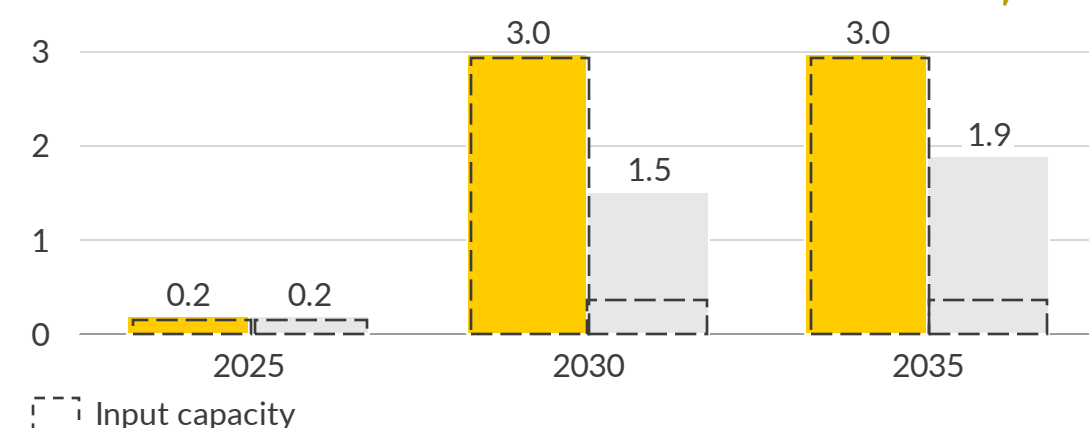
Solar tracker IRRs by COD, Sicily

%



Installed battery capacity, Sicily

GW



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The Dutch government targets to build two new nuclear plants with a combined capacity of 3 GW in the 2030s

Overview of taken steps

- 
- Dec 2021 • Dutch coalition agreement includes the ambitions of two new nuclear reactors
 - Dec 2022 • Letter to parliament on policy decisions and planning for the nuclear expansion for 2035
 - Jul 2023 • Dutch government falls over asylum and refugee crisis
 - Nov 2023 • Right wing parties clear winner in the election
 - Dec 2023 • Technology providers start feasibility studies on two nuclear reactors
 - Feb 2024 • Government's new planning delays nuclear tender process by 1.5 years

Outgoing government's nuclear plan

- **Total planned capacity:** 2.0 - 3.3 GW
- **Number of reactors:** 2
- **Number of sites:** 1
- **Potential technology providers:** France, USA, South Korea
- **State involvement:**
 - State-owned company (e.g. Energie Beheer Nederland)
 - Regulated asset base (RAB) model

Potential Nuclear Power Plant (NPP) sites



Existing NPP: Borssele



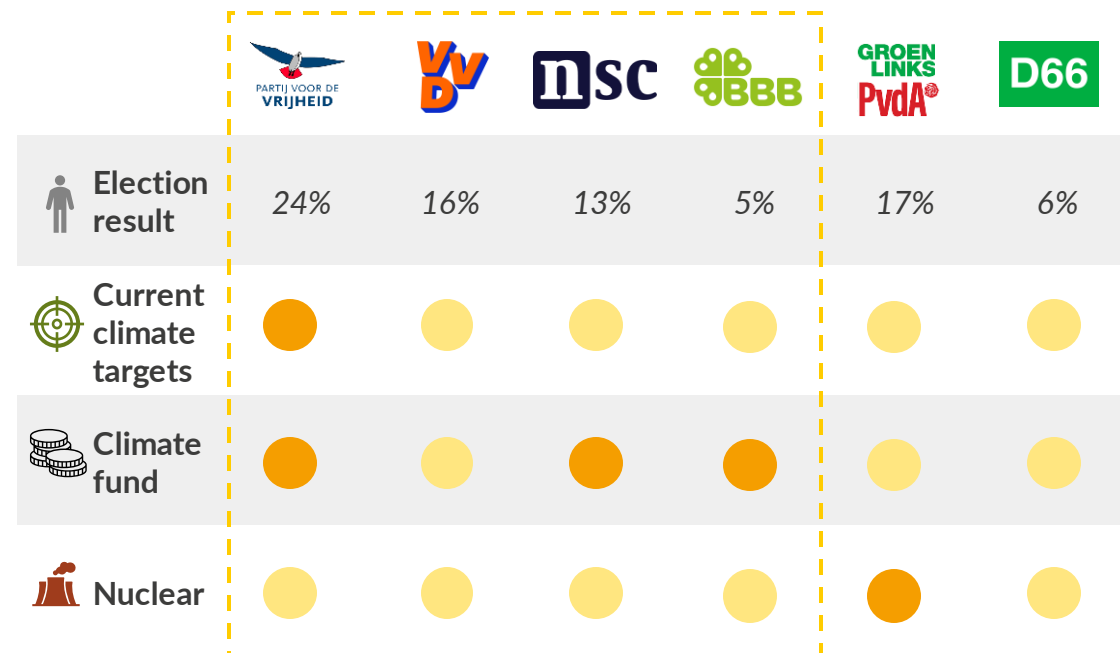
Sites up for selection for new NPPs:

- Borssele - preferred location
- Maasvlakte Rotterdam



A political majority is in favour of additional nuclear plants, but the current plan requires further detail and is in risk of substantial delays

A potential coalition of PVV, VVD, BBB and NSC may push for a more ambitious nuclear agenda during the next government's term

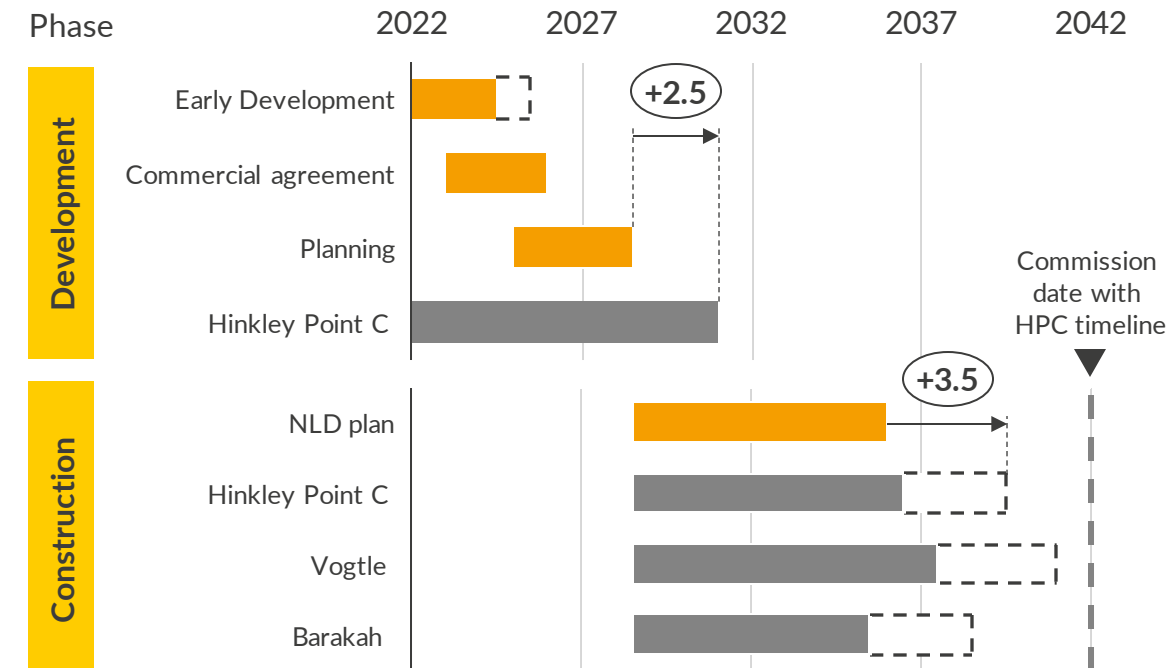


- All major parties in the Nov-23 elections, except GL/PvdA, are in favour of building additional nuclear plants and further exploring SMRs.
- However, speed in concretisation of plans is at risk as a government is still being formed and the parties in the coalition under discussion have different opinions regarding climate targets and funding.

● In favour ● Opposed □ Coalition under discussion

1) The comparison is made by applying the development time to 2022 start date.

Given typical development and construction time in the West, the Dutch nuclear plan is in risk of substantial delays

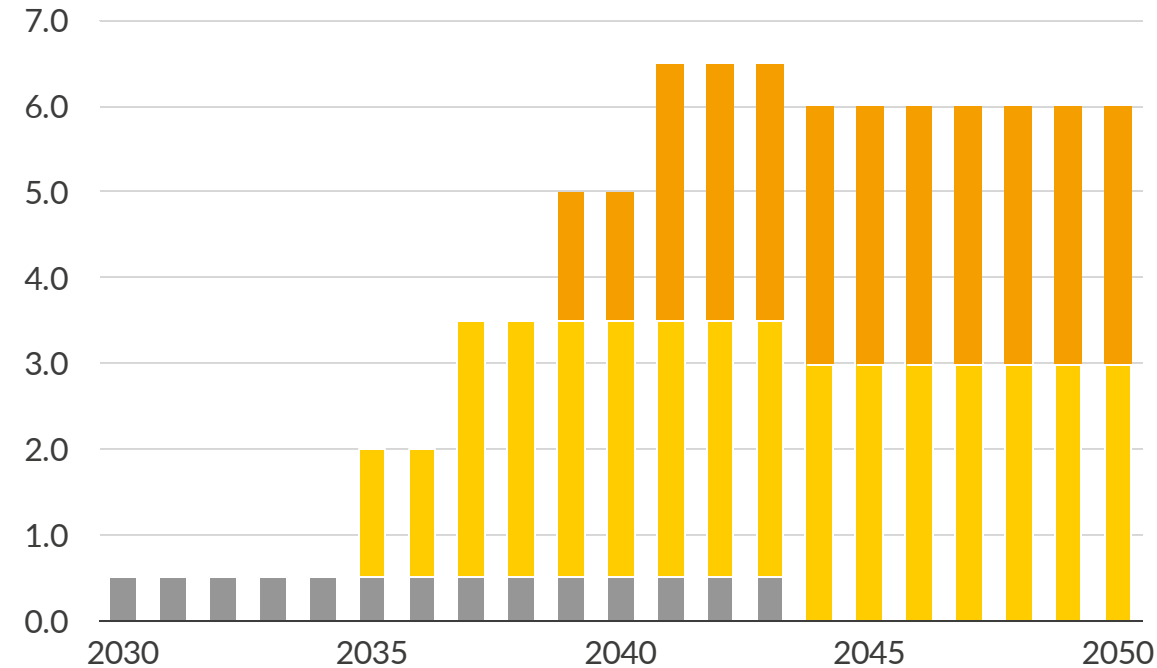


- Considering the development and construction timeline of Hinkley Point C, the earliest commercial operation of the new Dutch reactors would only be in 2042.¹
- While the early development phase of the Dutch reactors is already facing a delay of 1.5 years, the Dutch energy minister still considers commissioning in 2035 realistic.

■ Dutch plan ■ Comparable projects □ Delays

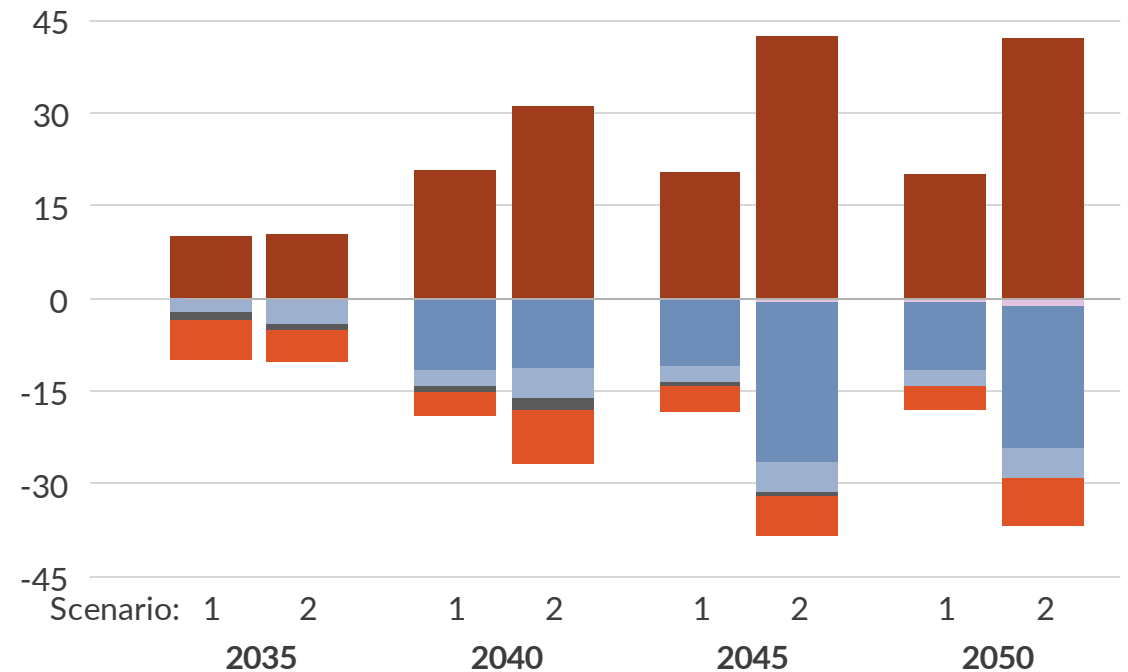
Our **Origin** suite allows to analyse the uncertainty of the nuclear expansion and quantify the impact on the Dutch power system

Installed nuclear capacity
GW



- We compare our Central scenario to two nuclear sensitivity scenarios with respectively 2 and 4 additional modern nuclear plants of 1.5GW.
- Since there will likely be some lead time before the full capacity is available, we assume plants come online every two years starting in 2035.

Generation delta with respect to Central
TWh



- Additional nuclear capacity brings down baseload prices, as nuclear generation replaces pricier generation from gas and hydrogen thermal plants.
- More nuclear reduces the buildout of renewables¹, as a lower power price makes it less interesting to invest in renewables. The lower electricity price also leads to an increase in flexible demand, electricity generation and exports.

Central scenario Nuclear scenario 1 Nuclear scenario 2 Nuclear Hydrogen Offshore wind Onshore wind Gas CCGT Interconnectors²

1) Renewable capacity builds out endogenously in our model, meaning decreased revenues leads to lower build out. 2) For generation, interconnectors represent the net imports or exports.

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Origin Customer Success:

Getting started, made easy!

Comprehensive support from our dedicated team of energy modelling experts

Implementation

Origin is designed to be user-friendly, requiring minimal training or contextual insights

- Integrate **Origin** into internal tooling
- Use out-of-the-box, simulation-ready scenarios
- Benefit from guided scenario creation workshops

Training

Tailored training ensures proficiency after your **Origin** service activation

- Develop bespoke **Origin** expertise
- Attend sessions tailored for you
- Delve into thematic deep dives and new feature training

Ongoing Support

Our global network of **Origin** experts are on-hand to help you unlock business value

- Receive regular guidance and support
- Compare your scenarios with our forecasts
- Get detailed interpretation of results

Community Events

Participate in regular sessions where we learn from you, and you learn from each other

- Network with local, regional and global peers
- Attend online and offline events
- Contribute to our **Origin** development roadmap

Investors use **Origin** to manage portfolio strategy



Create your own base case

- Inform your portfolio strategy
- Evaluate your next move
- Support capital raising
- Underpin investment decisions



Perform sensitivity analysis

- Stress-test investment decisions
- Assess risks and upsides
- Quantify market uncertainties
- Bridge with counterparty assumptions



Integrate with in-house tooling

- Benchmark your own modelling
- Regularly reassess your models based on market movements
- Seamlessly link Origin outputs into your financial models

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Any questions?

LEARN MORE



OR REACH OUT FOR
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