

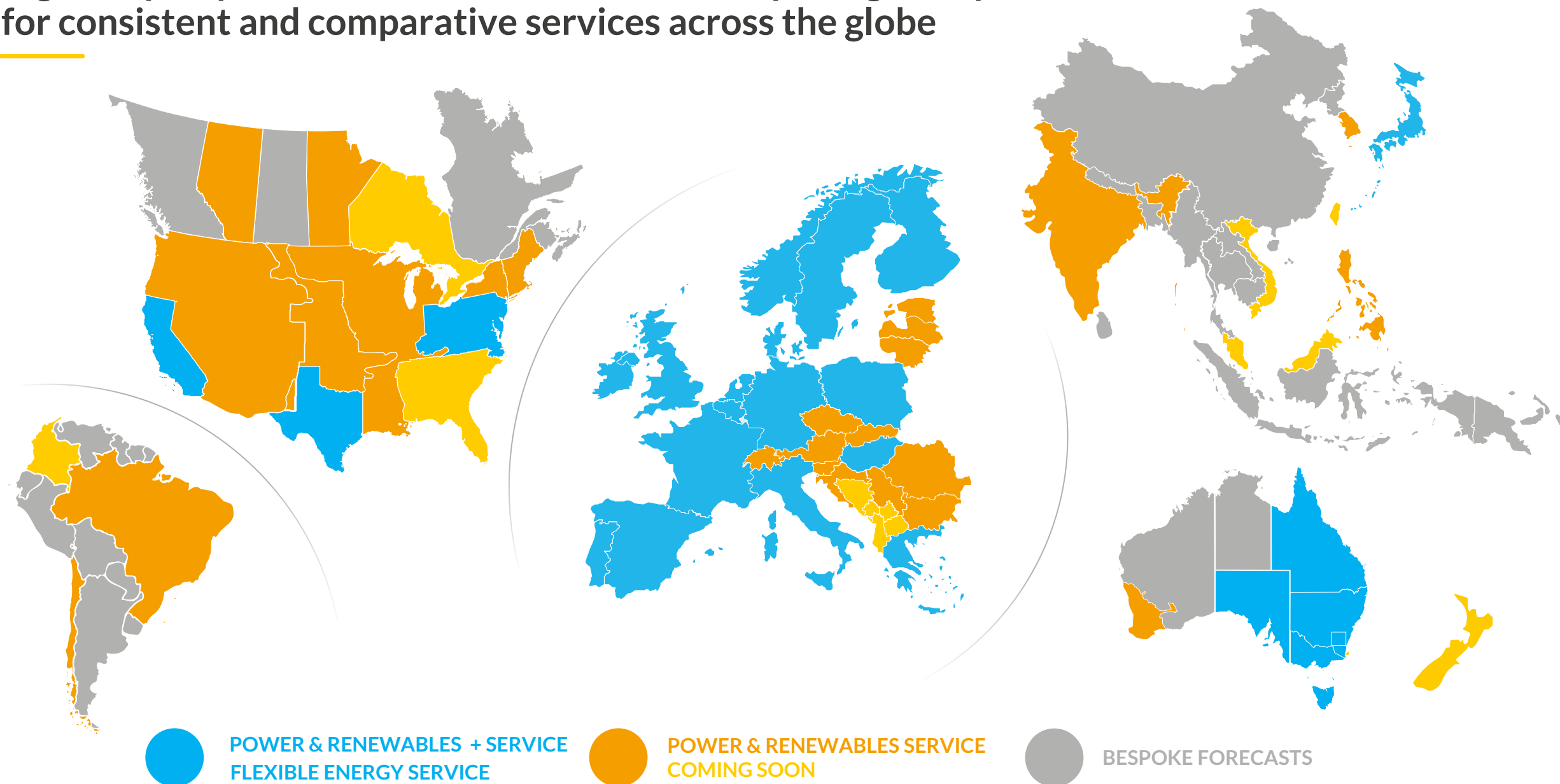
Solar innovation in the Netherlands: Will new technologies power a brighter future?

Public Report

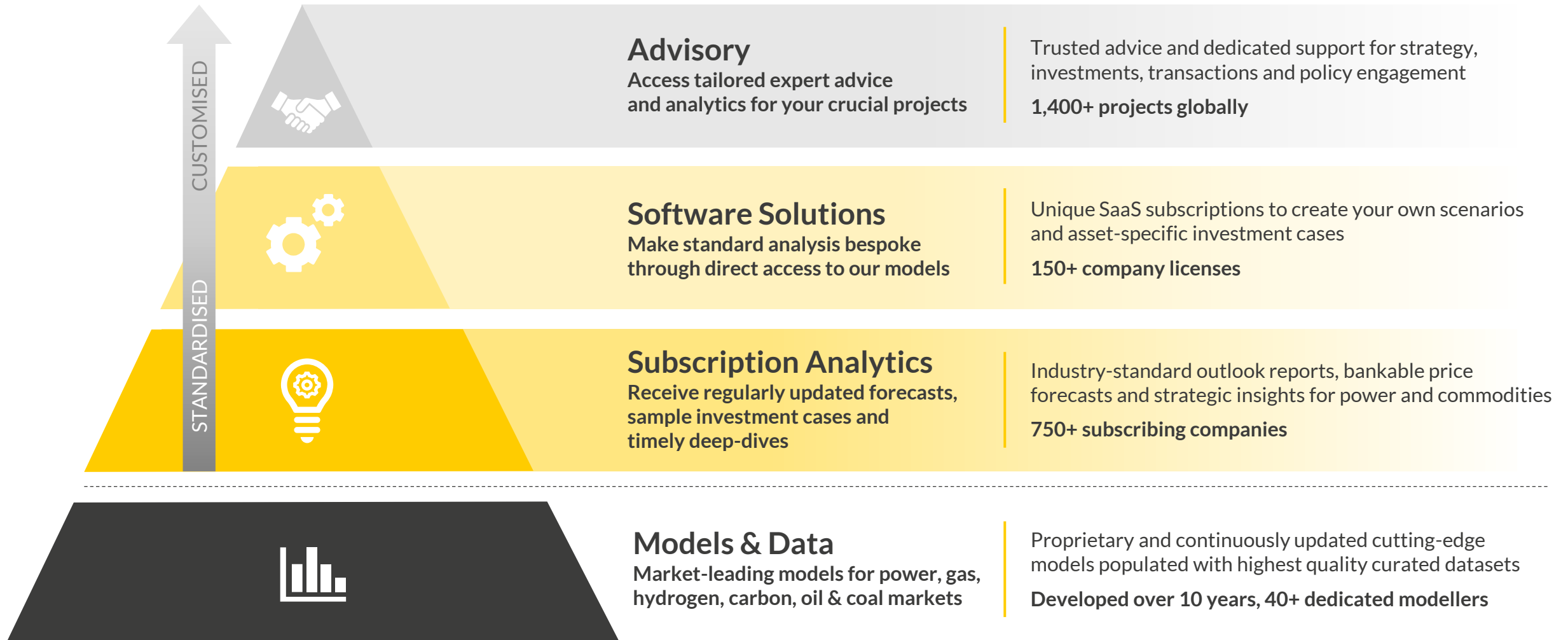
21 January 2025



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Introducing Aurora's speakers



Jesse Hetteema

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Senior Associate –
Netherlands & Belgium



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Analyst –
Netherlands & Belgium

I. Introduction

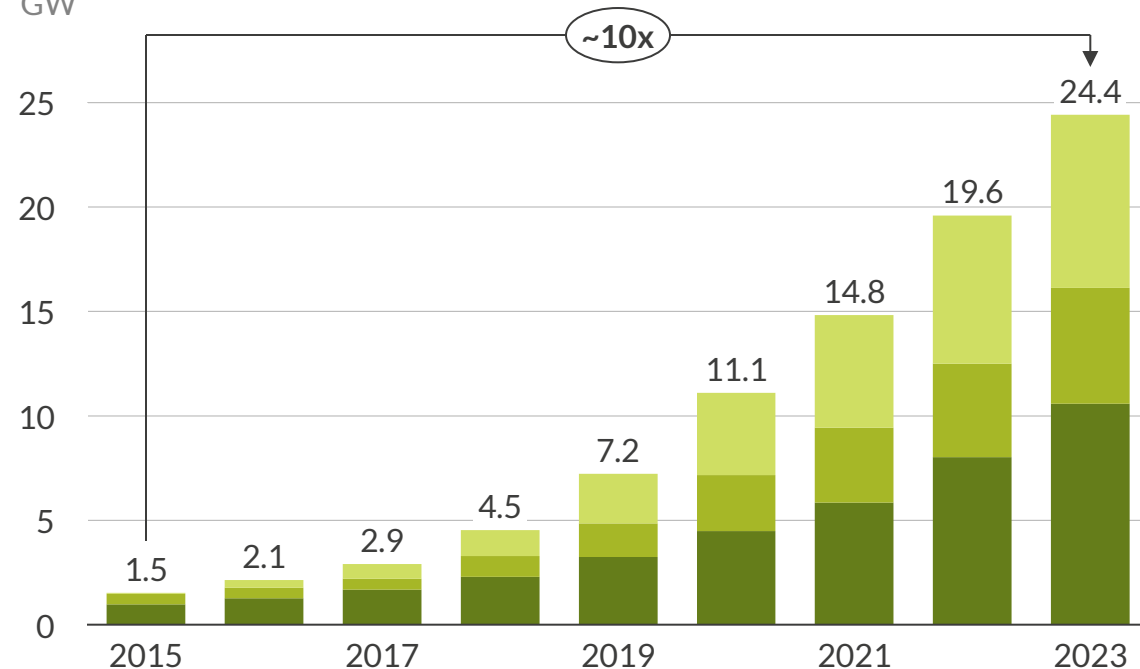
II. Overview of innovative setups

III. Does it pay to be different?

IV. Key takeaways

Solar capacity in the Netherlands has increased more than ten times since 2015, though utility-scale buildout has plateaued since 2020

Solar installed capacity¹
GW

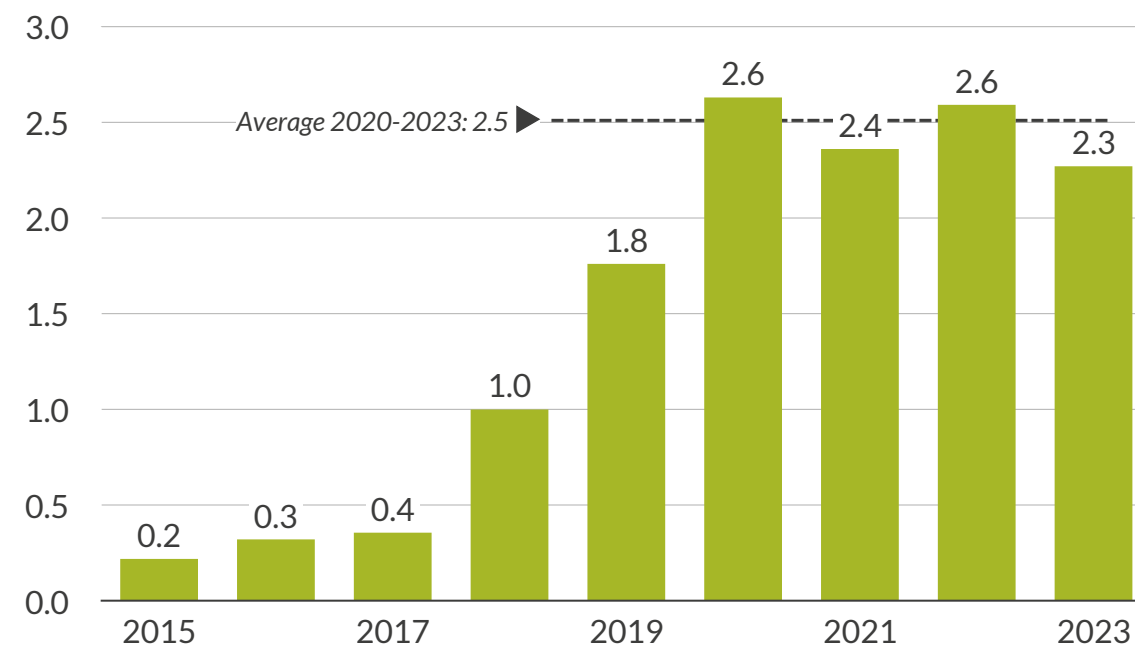


- Solar PV has grown rapidly in the last eight years, driven by the SDE+(+) subsidy scheme and high residential buildout supported through net metering.
- In 2023, residential constituted 43% of installed capacity. Ground-mounted and rooftop utility-scale solar made up the remainder at 23% and 34%, respectively.

■ Residential ■ Utility-scale ground mounted ■ Utility-scale rooftop

1) End-of-year.

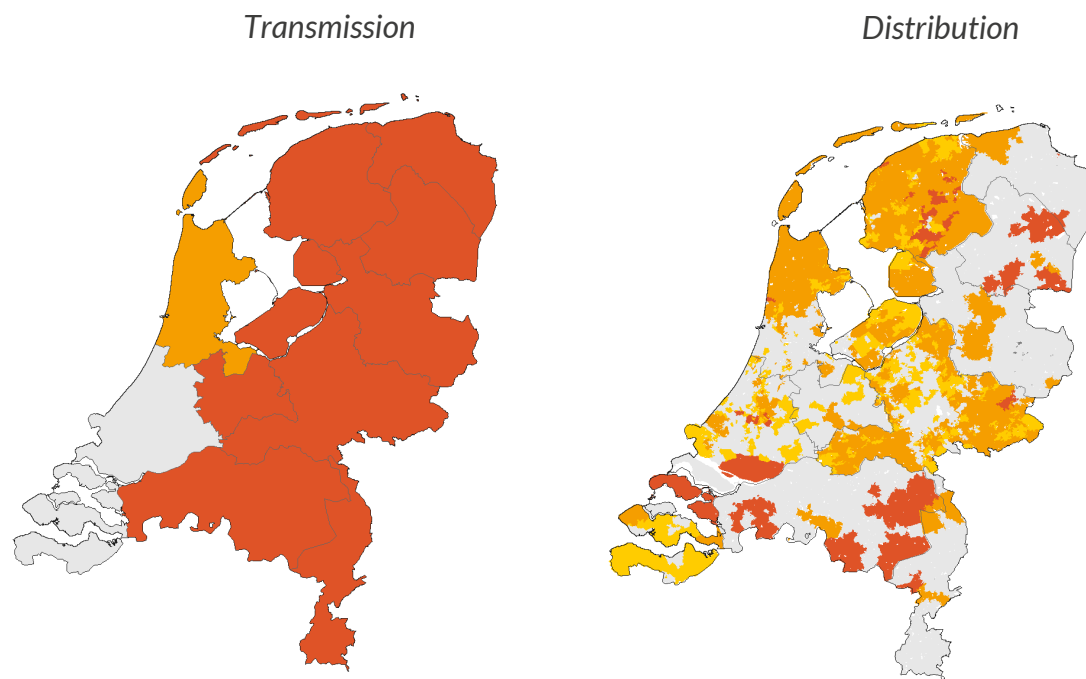
Yearly installed capacity – utility-scale solar
GW/year



- Annual build-out of utility-scale solar increased steadily between 2018 and 2020.
- Since 2020, it has plateaued around 2.5GW/year. Amongst the reasons for this are high interest rates, increased material costs, and grid constraints.

Utility-scale solar is subject to increasing risks, including grid constraints and capture rates, which were 54% of baseload prices during summer 2024

Feed-in connection availability¹

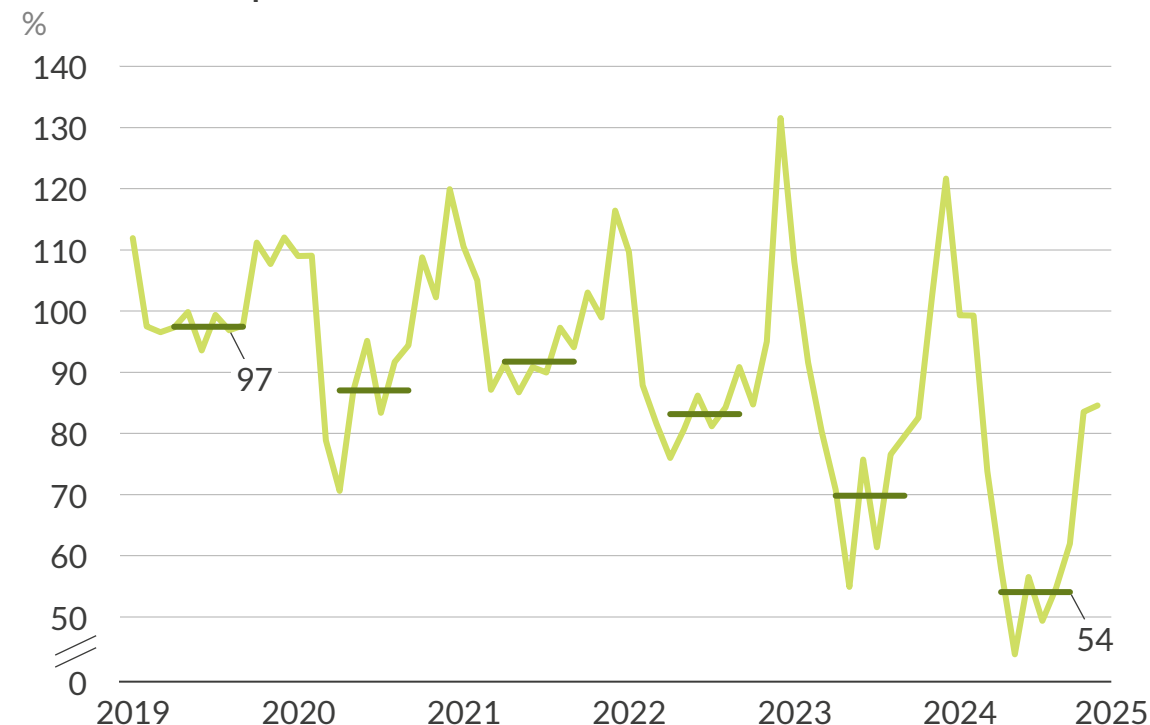


- These maps summarise where feed-in connection availability exists on the Netherlands transmission and distribution networks. Orange and red signify that connections are not currently possible in those regions.
- The transmission network has limited availability, except in the southwest, while the distribution network still has spare capacity in many regions.

Available capacity
 Limited capacity
 Capacity moratorium
 No capacity

1) The transmission map stems from TenneT and the distribution map from [Netbeheer Nederland](#). The latter includes all regional grid operators and connections larger than 3x80A.









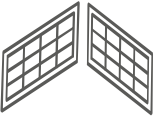














Historic solar capture rate



- Solar tends to have a uniform production profile which peaks around noon when power prices are typically low.
- Cannibalisation already impacts capture prices and will likely depress them further in the future. The effect is particularly pronounced during the summer, where the solar capture rate decreased from 97% in 2019 to 54% in 2024.

Capture rate
 Average Apr-Sep

Innovative solar could be a solution to optimise grid connections and mitigate cannibalisation but requires higher expenditures

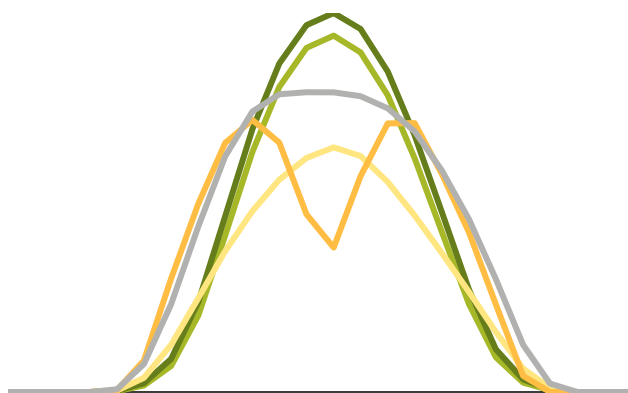
Solar technologies analysed		Set-up of solar park	Market maturity	Energy yield	Costs	Profile discount
	Fixed-tilt, monofacial	<ul style="list-style-type: none"> Base case: most common setup over the past decade 	High			
	Fixed-tilt, bifacial	<ul style="list-style-type: none"> Bifacial panels gather albedo radiation 	Medium			
	Fixed-tilt, east-west, monofacial	<ul style="list-style-type: none"> East or west directed panels produce more in morning and evening hours 	Medium			
	Vertical east-west, bifacial	<ul style="list-style-type: none"> Vertical bifacial panels allow for additional east-west benefits 	Low			
	Single-axis tracker	<ul style="list-style-type: none"> Horizontal single axis trackers direct the panels towards the sun on an east-west trajectory 	Low			
				 Strength	 Neutral	 Weakness

In this session we present our insights on various PV innovations, their costs and revenues, and our outlook on solar in the Netherlands

Overview of innovative setups

- We compare the characteristics across solar innovations, in particular the yield and costs of fixed monofacial to:
 - Fixed bifacial
 - Fixed east-west
 - Vertical east-west
 - Single-axis tracking
- We discuss the methodology and requirements of the SDE++ subsidy scheme.

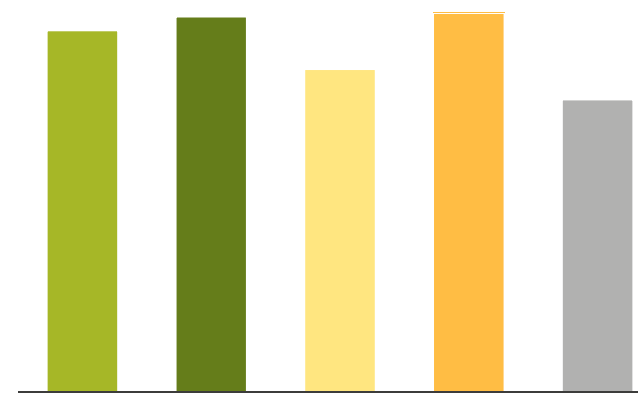
Innovative profiles



Does it pay to be different?

- We analyse the revenue of solar in the Netherlands and evaluate whether innovative setups with a 2025 commissioning date are profitable.
- We assess how innovative setups perform in relation to negative price hours.
- We discuss whether government support for solar will remain necessary and the current outlook for the SDE++ and other support schemes.

Merchant and SDE++ revenues



Agenda

I. Introduction

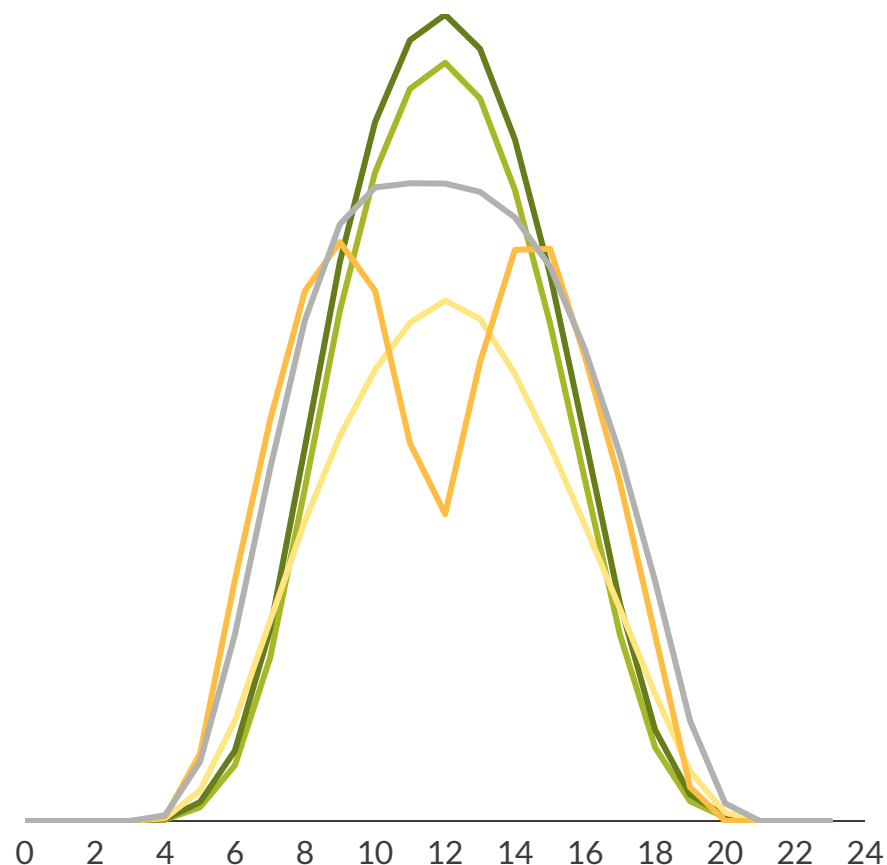
II. Overview of innovative setups

III. Does it pay to be different?

IV. Key takeaways

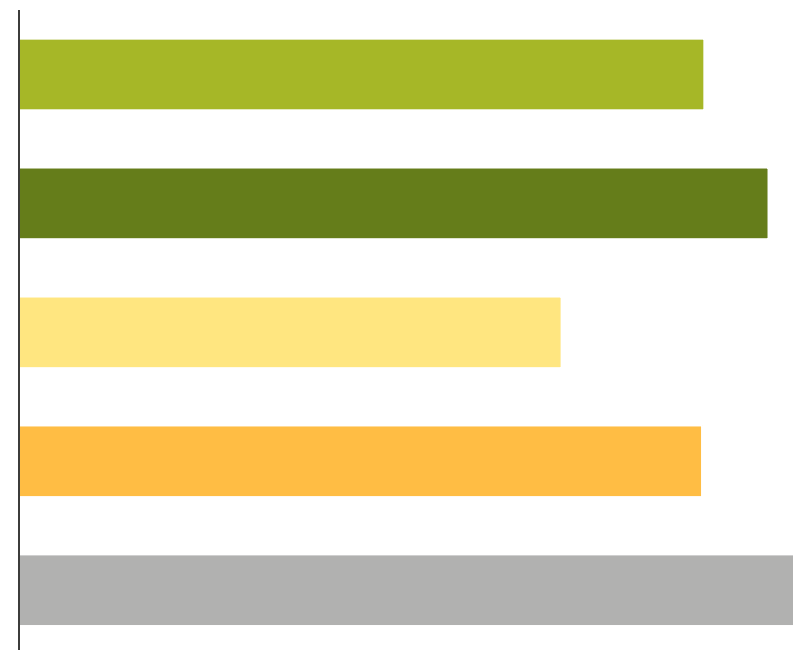
The widest and least-correlated profiles can be captured with vertical east-west, which peaks in the morning and again in the afternoon

Solar load factor profile
MWh/MWp



Average solar load factor
MWh/MWp

Values are provided in our Group Meeting report for clients.



Comments

- Fixed south-facing setups have the highest energy yields around noon, with bifacial panels enhancing peak generation.
- Fixed east-west setups produce less energy at midday but increase production during the morning and afternoon. Vertical east-west setups exaggerate shoulder generation producing an M-shaped profile.
- Single-axis trackers provide a broader generation profile by following the sun throughout the day. Like the standard setup, they peak at midday¹.

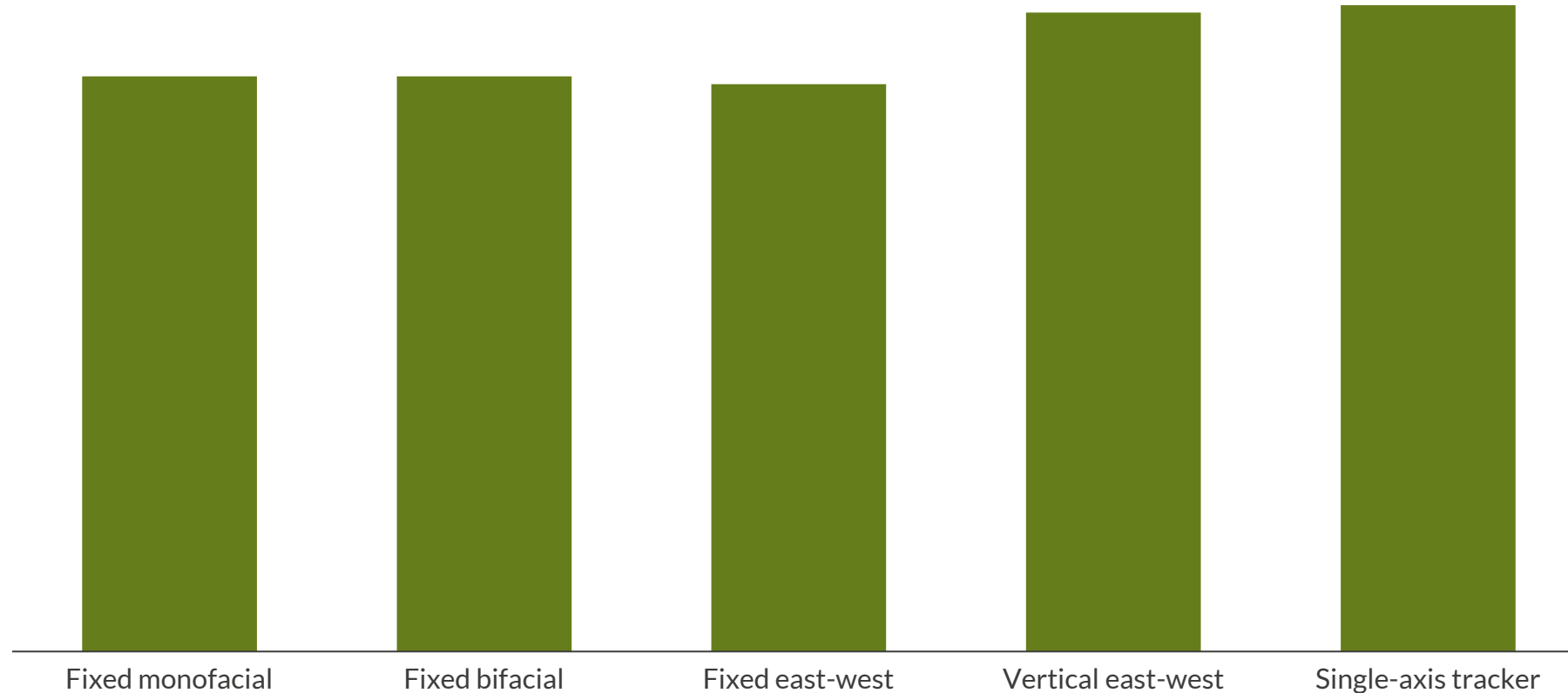
Fixed monofacial Fixed bifacial Fixed east-west Vertical east-west Single-axis tracker

1) The lower midday peak in the single-axis tracker profile is driven by a lower MWp compared to the other technologies.

Innovative setups are more costly, with higher CAPEX compared to fixed monofacial

2024 CAPEX for COD 2025¹
k€/MWp (2023 real)

Values are provided in our Group Meeting report for clients.



■ CAPEX

1) COD = Commercial operation date.

Source: Aurora Energy Research.

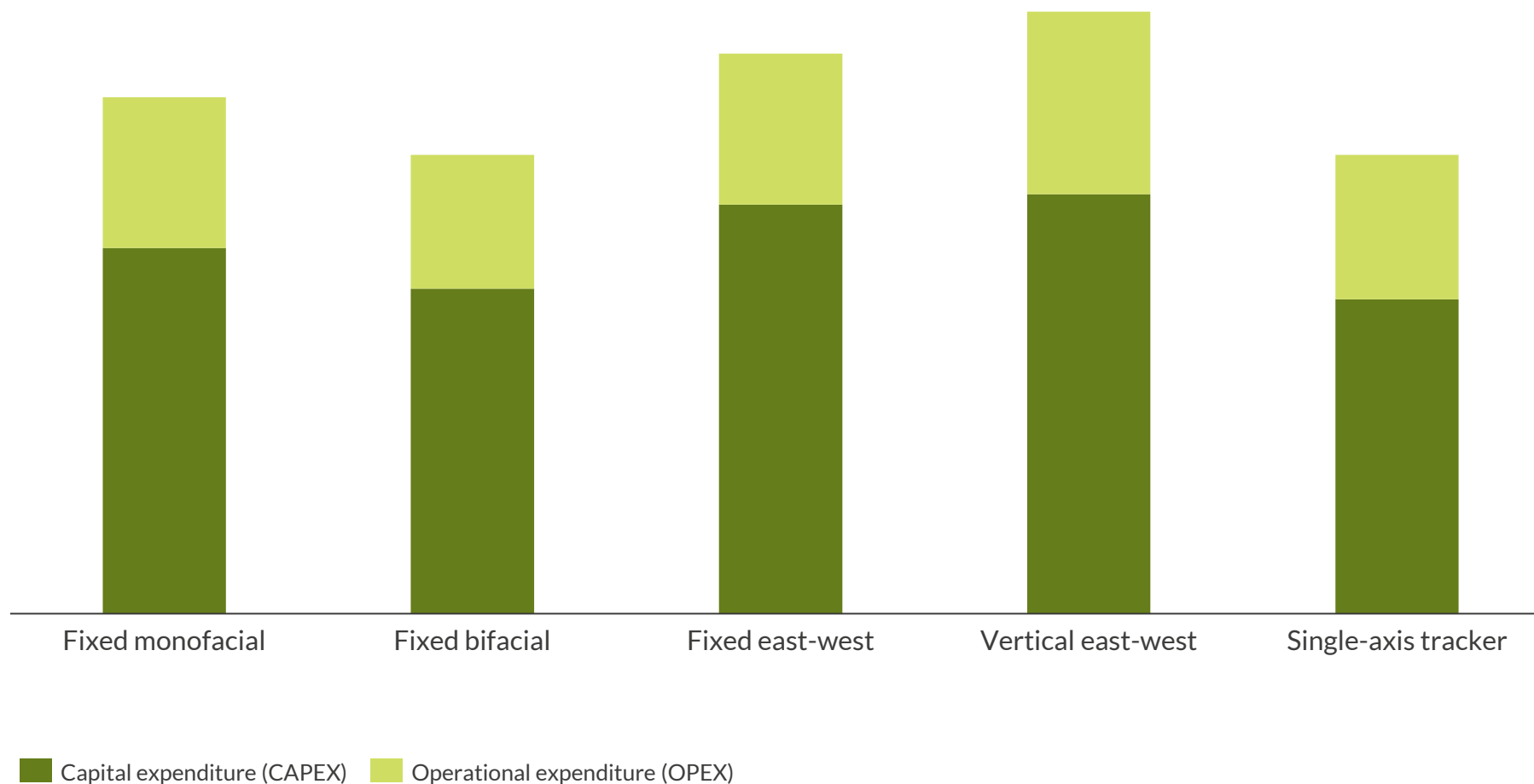
Comments

- Fixed south-facing assets have high market maturity and require relatively lower upfront investment compared to innovative alternatives.
- Fixed east-west setups marginally reduce CAPEX compared to south-facing, thanks to favourable ground coverage and lower wind resistance.
- Vertical east-west and single-axis tracker setups have higher costs primarily due to their lower ground coverage ratios requiring larger areas to achieve equivalent generation capacities. Vertical east-west setups also have higher module costs as bifacial panels with high backside efficiency are more expensive.

Fixed bifacial and single-axis trackers achieve a lower LCOE compared to our base case

Levelised cost of electricity (LCOE) for COD 2025
€/MWh (real 2023)

Values are provided in our Group Meeting report for clients.



Comments

- Fixed bifacial setups allow for a reduction in LCOE compared to fixed monofacial driven by increased yield.
- In contrast, a vertical east-west setup leads to a higher LCOE due to higher CAPEX and OPEX.
- Single-axis trackers have a similar LCOE to fixed bifacial indicating they have similar cost-to-yield ratios.

Utility solar projects are derisked by the SDE++, which makes no distinction for orientation, but has a separate category for trackers

SDE++ 2024 category

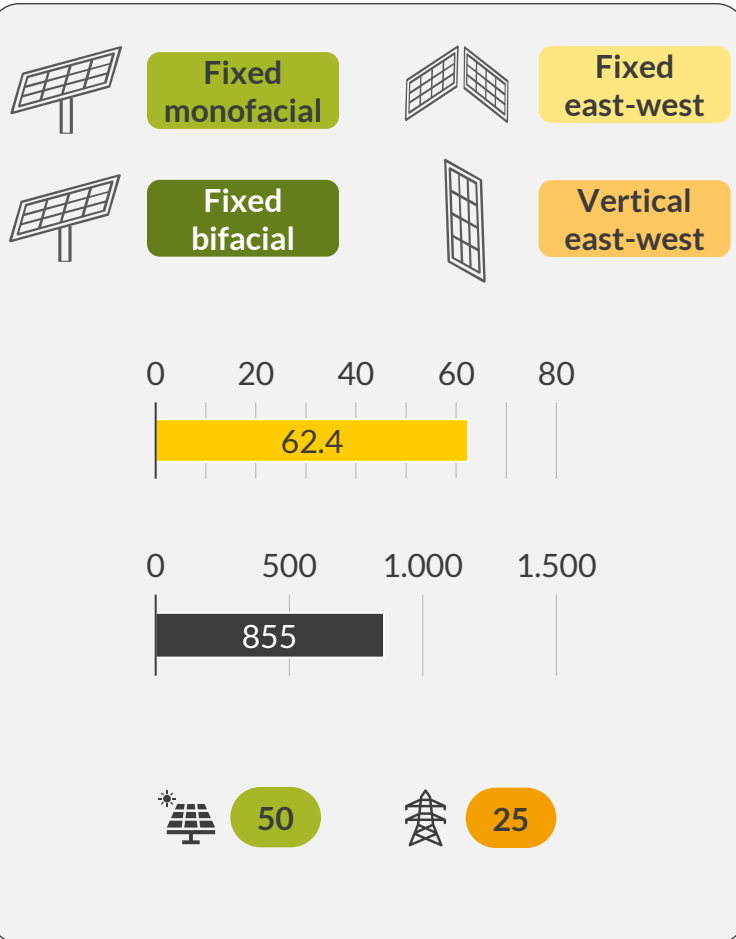
Orientations

Base amount
€/MWh

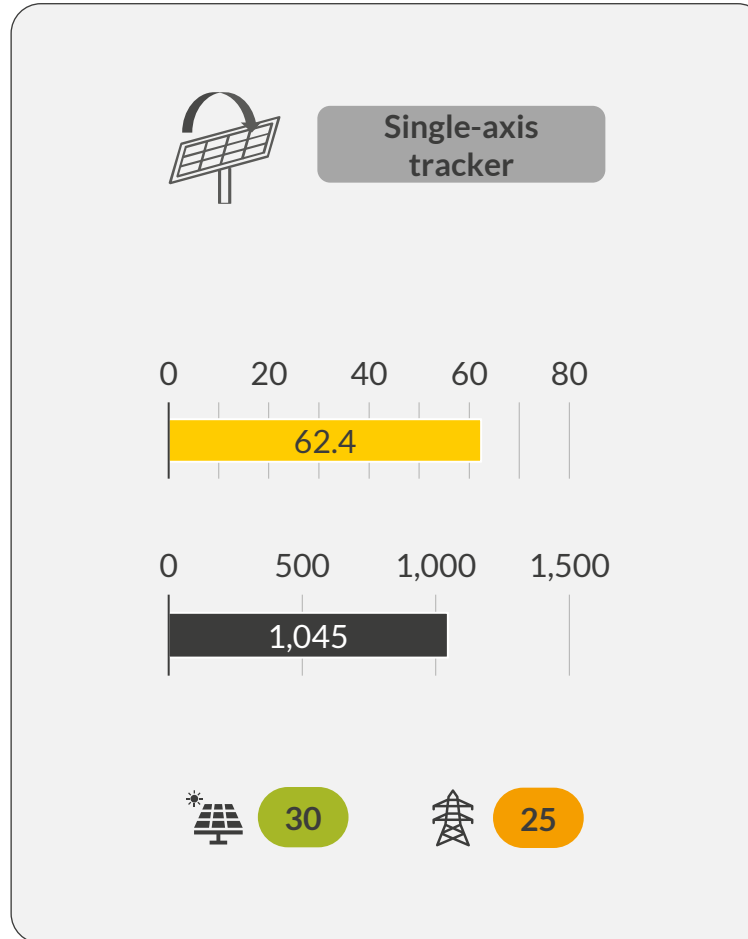
Covered
production¹
DC full load
hours

Asset sizing
MW

Field, fixed-tilt, ≥20MWp



Field, tracker, ≥20MWp



Comments

- The SDE++ is the Netherlands' flagship subsidy scheme designed to promote renewable energy production. It is a key instrument in achieving the Netherlands' climate goals.
- The SDE++ scheme categorises solar projects by DC capacity and mounting type, i.e., fixed-tilt versus tracker setups.
- While our assumptions focus on the largest capacity category, project sizes fall into three bins² with decreasing base amounts reflecting economies of scale.
- Tracker systems are awarded higher covered production, leveraging their broader production profile and balancing higher costs.
- Bifacial plants do not have a separate category, as additional yield³ is incorporated through higher capacities.

1) Production is measured at the asset level, i.e., at the array. 2) The three bins are: 15kWp–1MWp, 1–20MWp, and >20MWp. 3) The SDE++ allows for up to a maximum increased yield of 15% for bifacial projects.

Sources: Aurora Energy Research, Netherlands Enterprise Agency (RVO).

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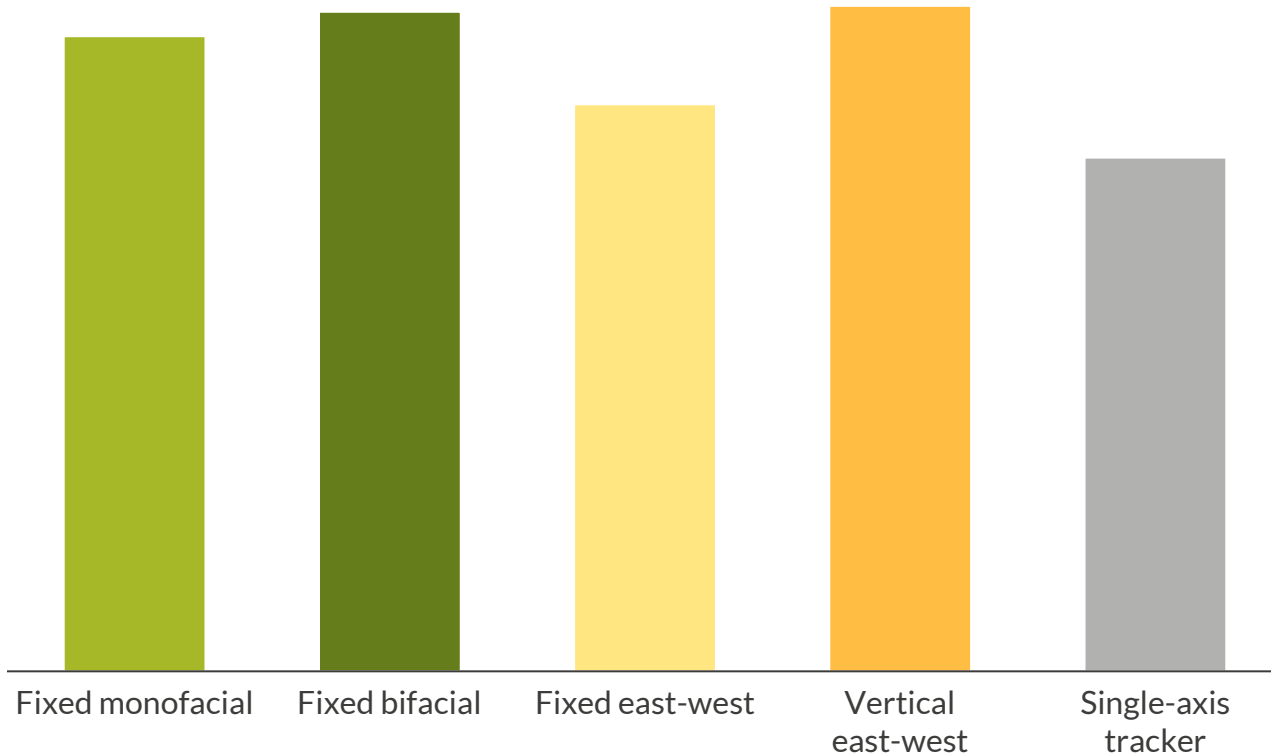
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In Aurora Central, vertical east-west achieves the highest total revenues, above the standard setup

Expected revenues under Aurora Central
mn € (real 2023)



■ Total revenues

Values are provided in our Group Meeting report for clients.

SDE++ assumptions

Fixed monofacial

Fixed east-west

Fixed bifacial

Vertical east-west



50

MW



25

MW



855

hours

Single-axis tracker



30

MW



25

MW



1045

hours

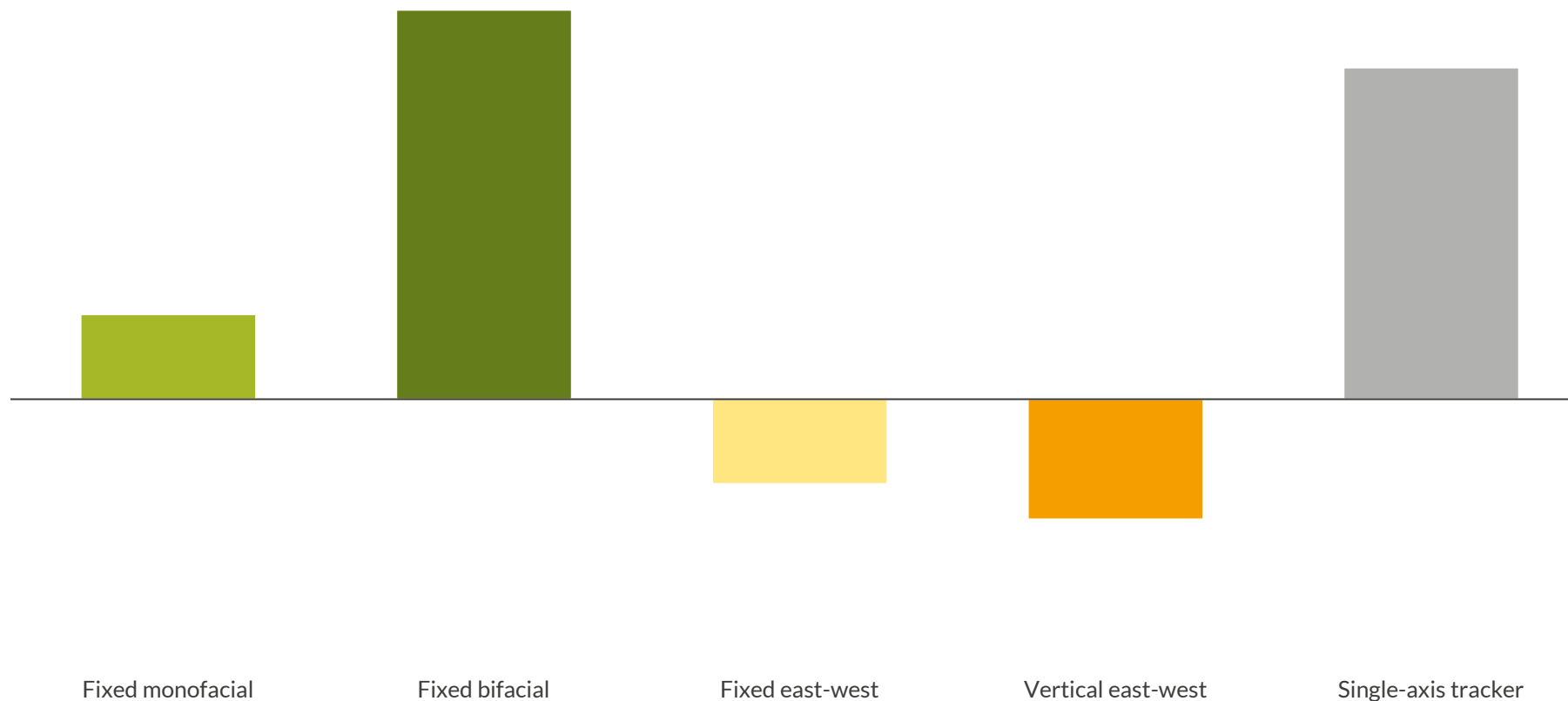
Comments

- Using Aurora Central, we estimate merchant revenues over the 30-year lifetime of the asset, with 'SDE++ top-ups' in years where net market revenues are below the base amount.
- Fixed monofacial, bifacial, and vertical east-west receive most subsidy support related to their projected full-load hours.
- Vertical east-west receives highest merchant revenues due to its unique profile and higher capture prices.
- As single-axis trackers are oversized less, their grid yield is lower, thereby reducing its revenue.

Net present value for fixed bifacial is much higher than monofacial, while both east-west technologies are unprofitable despite SDE++

Subsidised net present value COD 2025
mn € (real 2023)

Values are provided in our Group
Meeting report for clients.



■ Total revenues

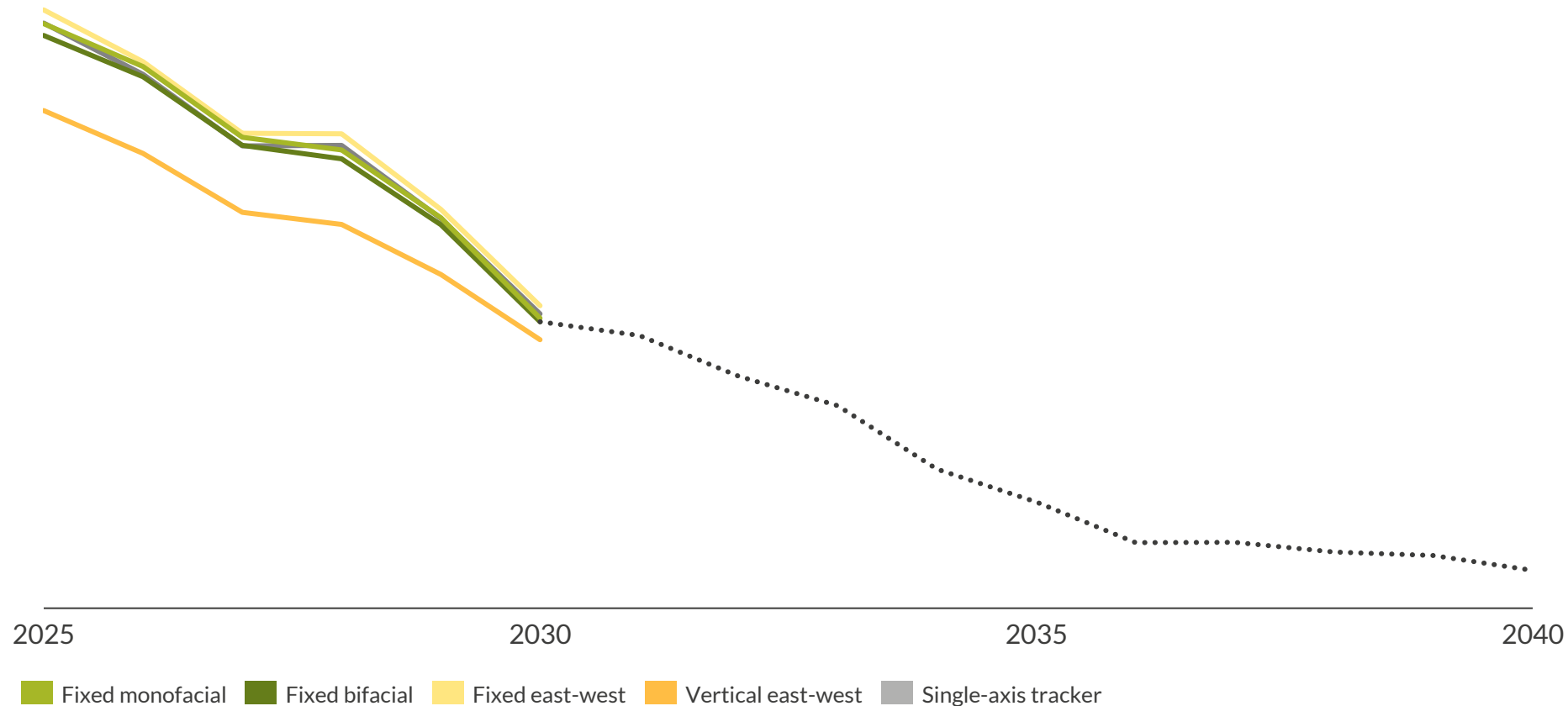
Comments

- Compared to our base case, fixed bifacial has a higher net present value due to its greater yield and, thus, revenues.
- Revenues for east-west technologies are not sufficient to cover investment and operating expenses leading to negative NPVs.
- The high NPV for single-axis trackers is due to lower investment costs in absence of the 50% oversizing requirement. Its day-ahead market revenues dominate other income sources and exceed CAPEX, OPEX, and imbalance costs.

Vertical east-west setups reduce exposure to negative price hours, but otherwise the effects are limited

Negative price hours solar volume impact
%

Values are provided in our Group Meeting report for clients.

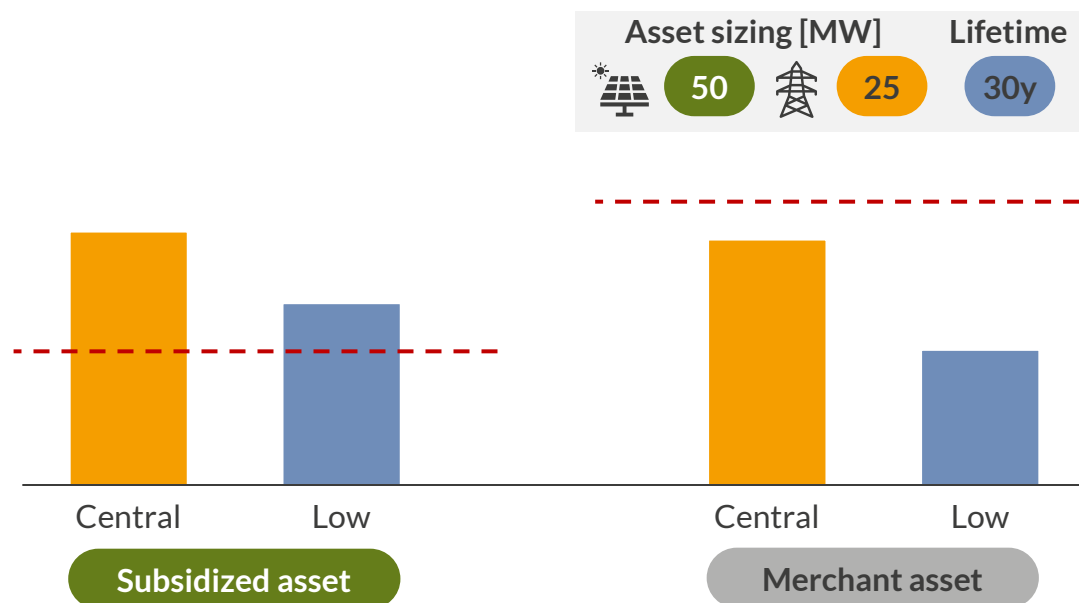


Comments

- The negative price outlook is mainly driven by the massive expansion of renewable capacity within the Netherlands. However, negative prices decrease between 2025 and 2040 due to renewables becoming reactive to price signals, inflexible thermal leaving the system as well as growing base and flexible demand (e.g., EVs, batteries and electrolyzers).
- As negative prices are correlated with solar production, most occur during midday. Given its M-shaped profile, vertical east-west has reduced exposure and lower volume impact.
- Nevertheless, these results indicate that the ability of solar innovation to reduce negative price impacts is limited, which implies lower revenues.

After the phase-out of the SDE++ scheme, continued support will be needed to sustain high solar buildout

Internal rate of return of new solar asset with COD¹ in 2028 across scenarios
% (real)



- Post 2027, the solar business case is solid if subsidies remain in place showing returns above the hurdle rate in both scenarios.
- In contrast, a fully merchant business case will be challenging. Project returns are below the hurdle rate across both scenarios.
- Thus, support will be necessary to sustain high solar buildout, especially to provide downside risk protection, translating into a lower hurdle rate.

1) Commissioning date.

Future of the Dutch support scheme for solar PV

- The outgoing government stated that a 2-sided CfD will be introduced after 2027, and that onshore wind and solar PV will continue to be supported by the SDE++ until then.



- Further details on the scheme are planned to be announced at the start of 2025. Some of the main aims mentioned to date are:
 - Stimulate the uptake of power purchase agreements, for example by allowing part of the asset's production to be "carved-out" of the subsidy.
 - More competition between solar and wind projects, which are almost always granted a contract under the SDE++ due to their low subsidy intensity.
 - Mitigate the impact of subsidised buildout of renewables on grid congestion.
 - Add additional policies to promote circularity and emission reduction throughout the value chain.

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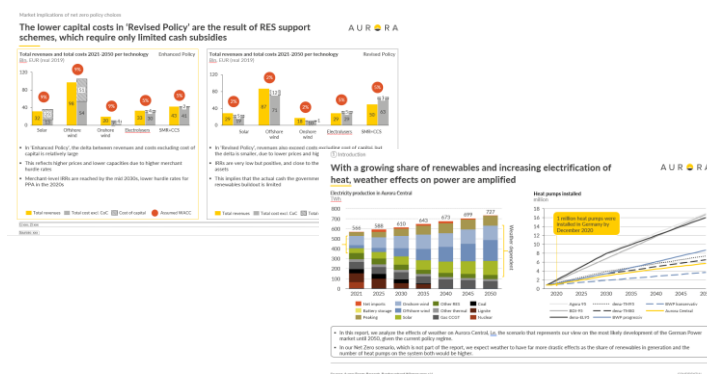
- 1** Innovative solar setups incur higher CAPEX and OPEX but achieve better yields, especially during early morning and late afternoon. Despite the higher costs, their Levelized Cost of Energy (LCOE) is similar to fixed monofacial systems due to the yield improvements.
- 2** Under Aurora's Central scenario, fixed bifacial and single-axis trackers have a higher net present values than fixed monofacial and east-west technologies. The net present value of both east-west technologies are negative even with the SDE++ subsidy.
- 3** Innovative setups provide limited mitigation against negative prices, though vertical east-west setups offering slight advantages. Post-2027, subsidies remain crucial to support buildout of solar PV, as they lower uncertainties and financing costs despite being a small revenue contributor.

Quarterly data and bi-annual market reports to assess business models

- **Policy outlook** detailing policy developments and their impacts
- **Yearly forecasts of wholesale market prices** till 2050 in three scenarios: central, high and low as well as an additional **Net Zero scenario until 2050**
- **Capacity development**, generation mix, capacity buildout, exports in four scenarios
- **Capture prices** of key technologies (onshore, offshore, solar) in three scenarios: central, high and low
- **Imbalance costs** for wind and Solar
- **NL Guarantee of Origin forecast** for wind and solar
- **Utilisation rates** of key thermal technologies along different efficiencies
- **EU-ETS carbon price forecasts**

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- **In-depth thematic reports** on topical issues:
 - Outlook on SDE++ round
 - Business case for co-locating batteries
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- **Three multi-client roundtable discussions** per year in Amsterdam to discuss reports with actors across the Dutch power market (utilities, developer, investors, project finance, government, regulation)



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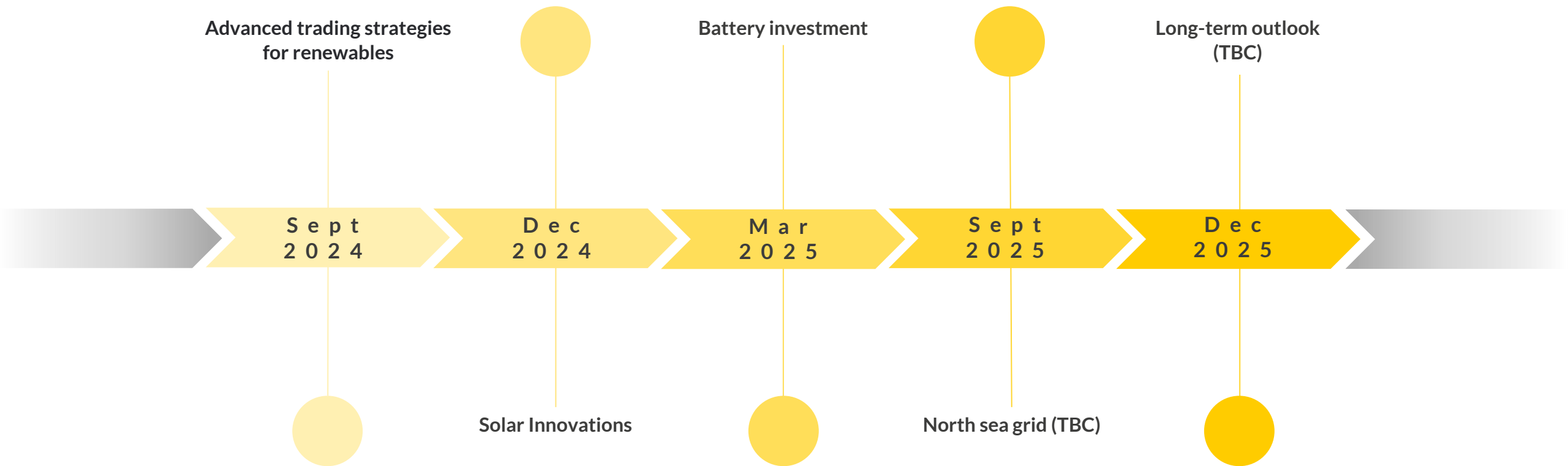


3 Group Meetings per year

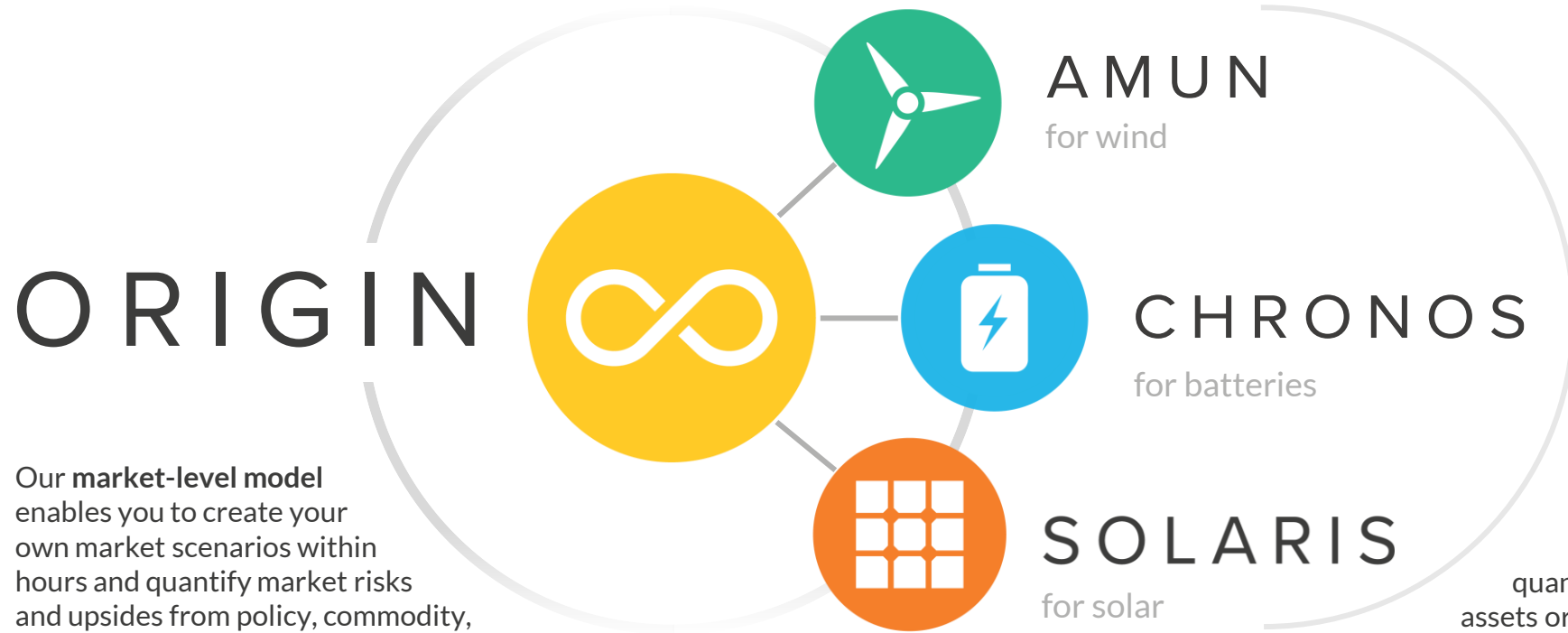
These roundtable events facilitate networking with key market participants such as developers, investors, financiers, utilities, grid operators, and government officials

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Transactions



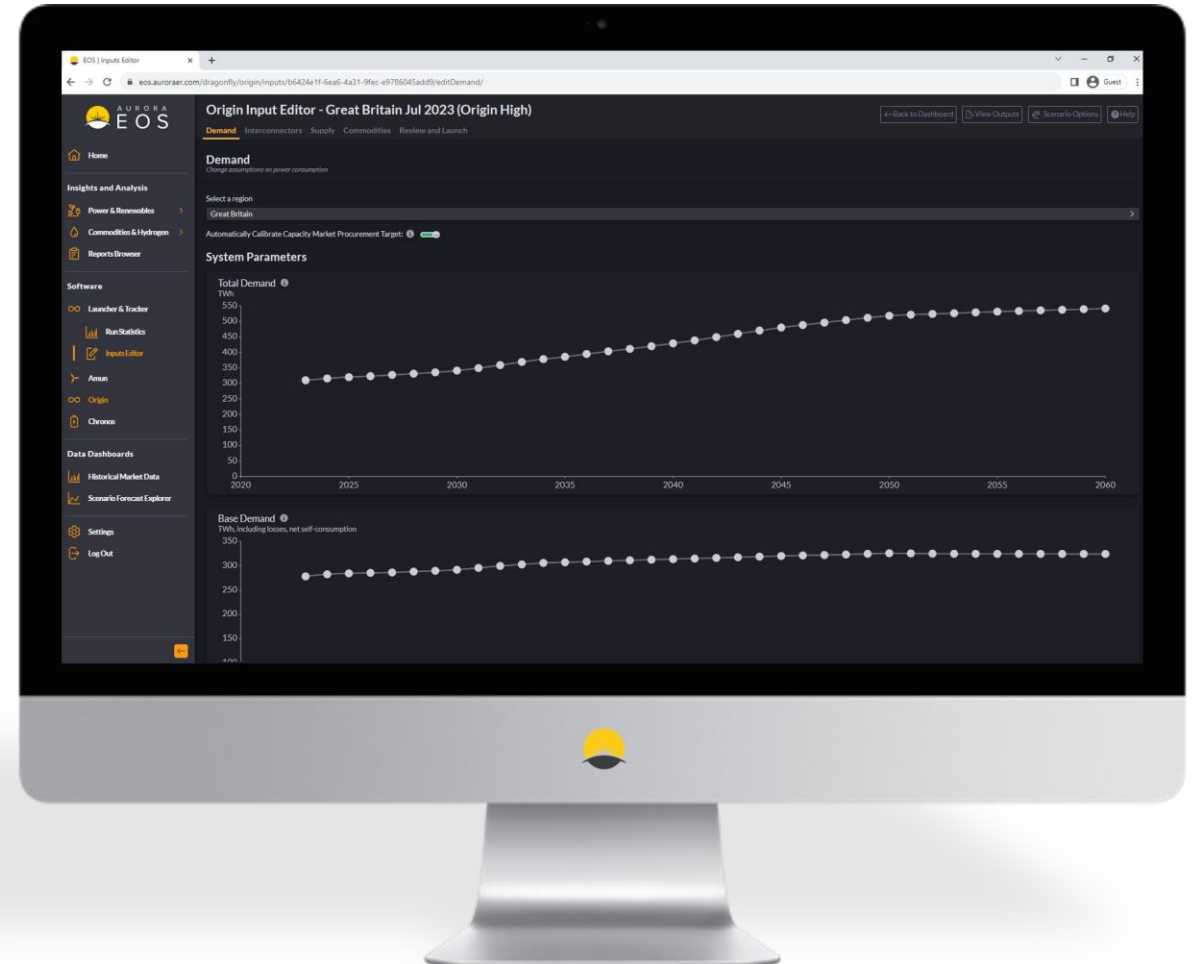
Strategy



Risk Analysis



PPAs



Details and disclaimer

Publication

Solar innovation in the Netherlands: Will new technologies power a brighter future?

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