European Network of Transmission System Operators for Electricity

RESPONSES AND INSIGHTS FROM THE INVESTOR SURVEY:

HOW CAN THE ERAA BETTER REFLECT REAL INVESTMENT BEHAVIOUR?

18 July 2025

ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association for the cooperation of the European transmission system operators (TSOs). The 40 member TSOs, representing 36 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E brings together the unique expertise of TSOs for the benefit of European citizens by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the security of the inter-connected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first climate-neutral continent by 2050 by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system keeps consumers at its centre and is operated and developed with climate objectives and social welfare in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its legally mandated tasks, ENTSO-E's key responsibilities include the following:

› Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;

› Assessment of the adequacy of the system in different timeframes;

› Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);

› Coordination of research, development and innovation activities of TSOs;

› Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the implementation and monitoring of the agreed common rules.

Table of Contents

Introduction

ENTSO-E has been tasked to propose amendments to the methodology for performing the European Resource Adequacy Assessment (ERAA), drawing on proposals from the European Commission's *report on the assessment of possibilities of streamlining and simplifying the process of applying a capacity mechanism*, ACER, as well ENTSO-E's own experience in conducting the previous four editions of the ERAA.

One key aspect of the ERAA is the **Economic Viability Assessment (EVA)** that aims to assess the likelihood and conditions under which generation, storage, or demand-side resources may exit or enter the market. The latest EVA results from the ERAA 2024 edition were released on 7 April 2025, and can be found on ENTSO-E's website (ERAA 2024). In its report, the Commission highlighted that some stakeholders have raised concerns that the EVA may be too optimistic on investment behaviour, and special attention should be given to the conditions for investment decision-making process by rational investors.

In that context, the purpose of this survey was to gather insights from **investors, utilities, advisory firms, and financial institutions** actively involved in investment and retirement decisions for electricity assets on how these decisions are made in practice, with a view to identifying how investor behaviour under uncertainty and changing market conditions can be better reflected in the ERAA.

This survey was conducted from 7 until 28 May 2025 and collected 23 responses in total. In addition, 13 respondents submitted more detailed responses for several questions (Q14, Q25, Q27, and Q31) regarding technologies in their portfolio by uploading the completed response workbook.

This document presents the main results of the survey in aggregated and/or anonymised form.

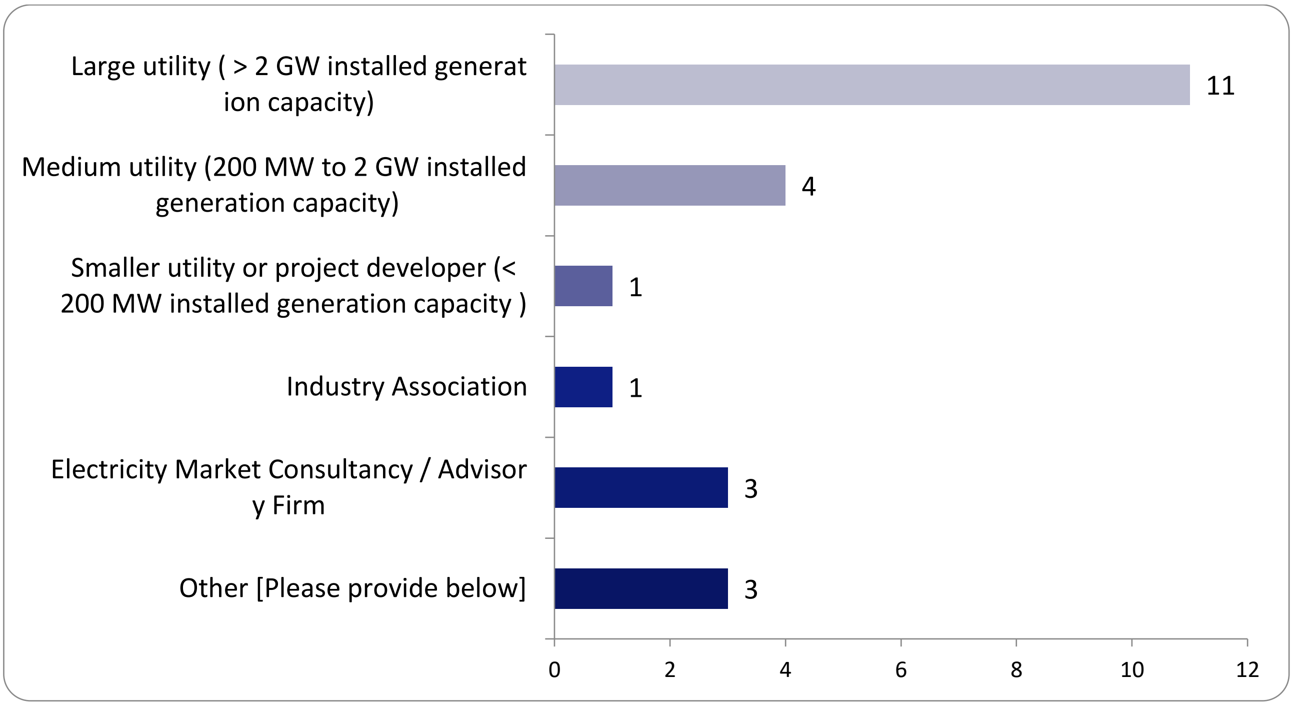
ENTSO-E would like to thank stakeholders for providing their responses.

Respondent Profile

Most questions refer to contact information (i.e. confidential) and opt-in to ENTSO-E's Consultation Hub privacy policy.

Q4: What is your organisation - What type of entity do you (best) represent?

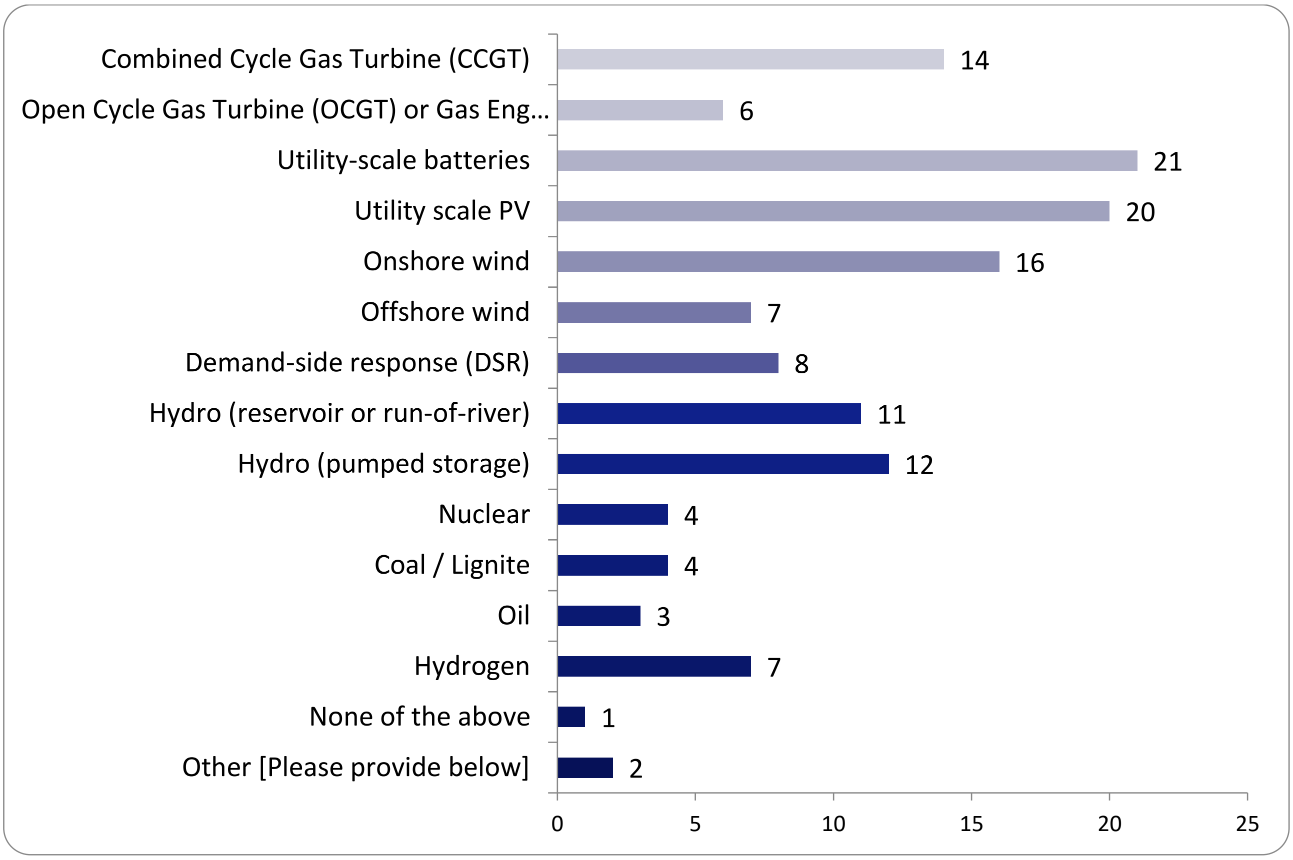
23 responses collected:



Q5: Please indicate which of the following technologies are either in your existing portfolio of assets or under consideration for new investment.

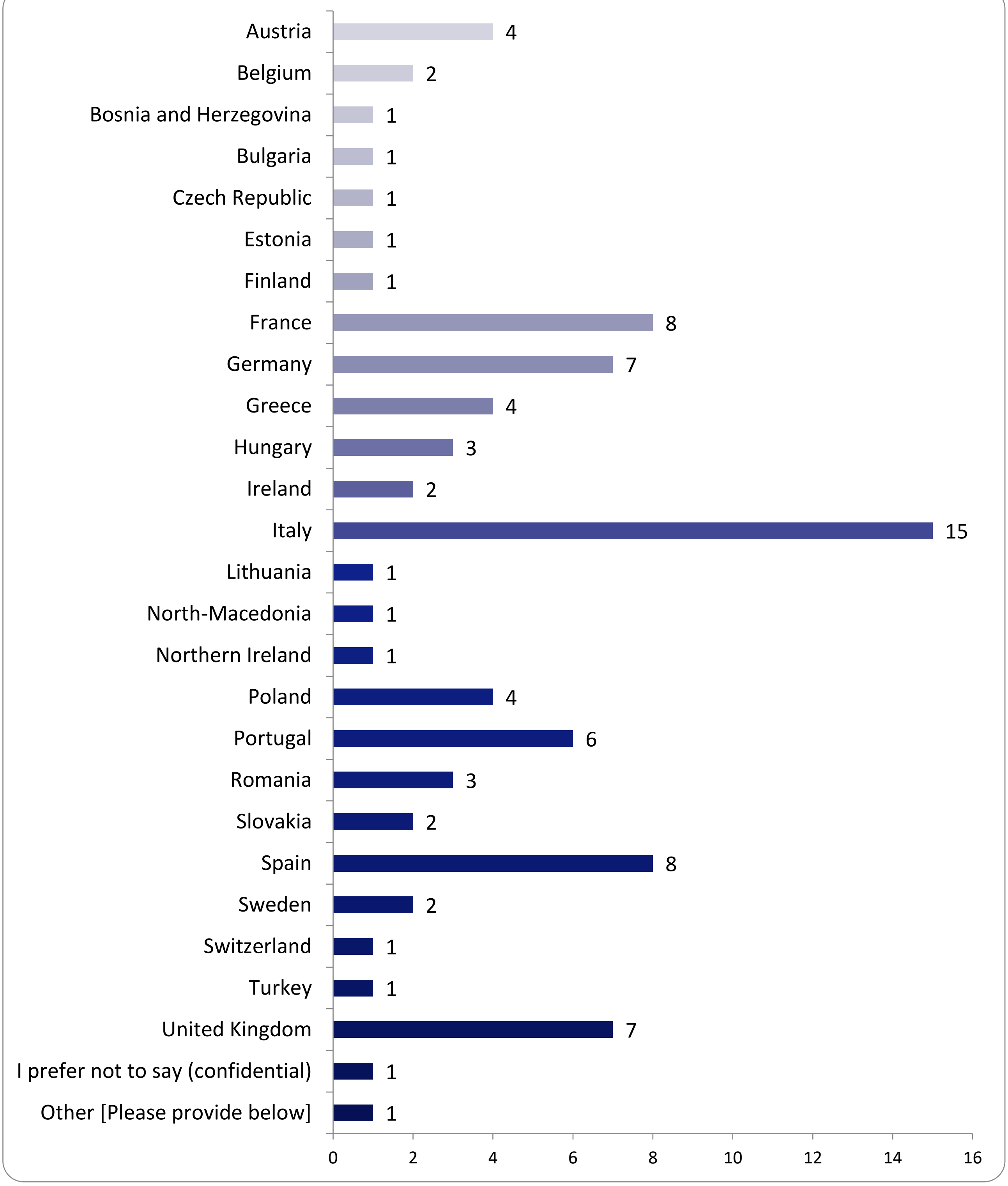
(N.b. 'utility-scale' means connected to the transmission or high-voltage grid; behind-the-meter installations are not considered in this survey)

23 responses collected:



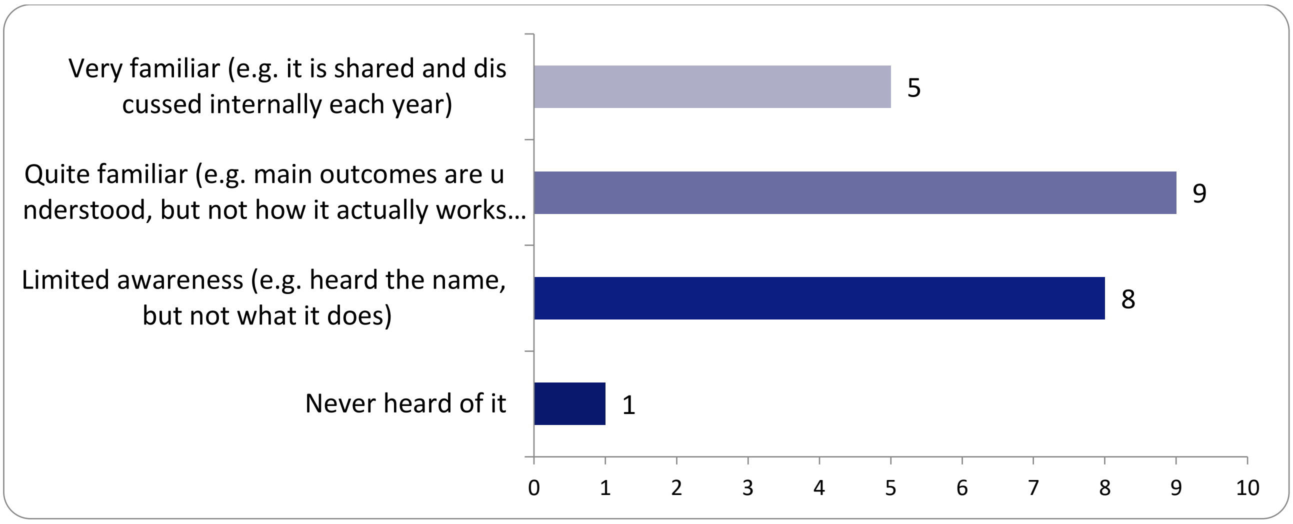
Q6: In which countries/regions do you have active capacities? (i.e. also considering new investments)

23 responses collected:



Q7: How familiar are you (or your organization) with the ERAA product?

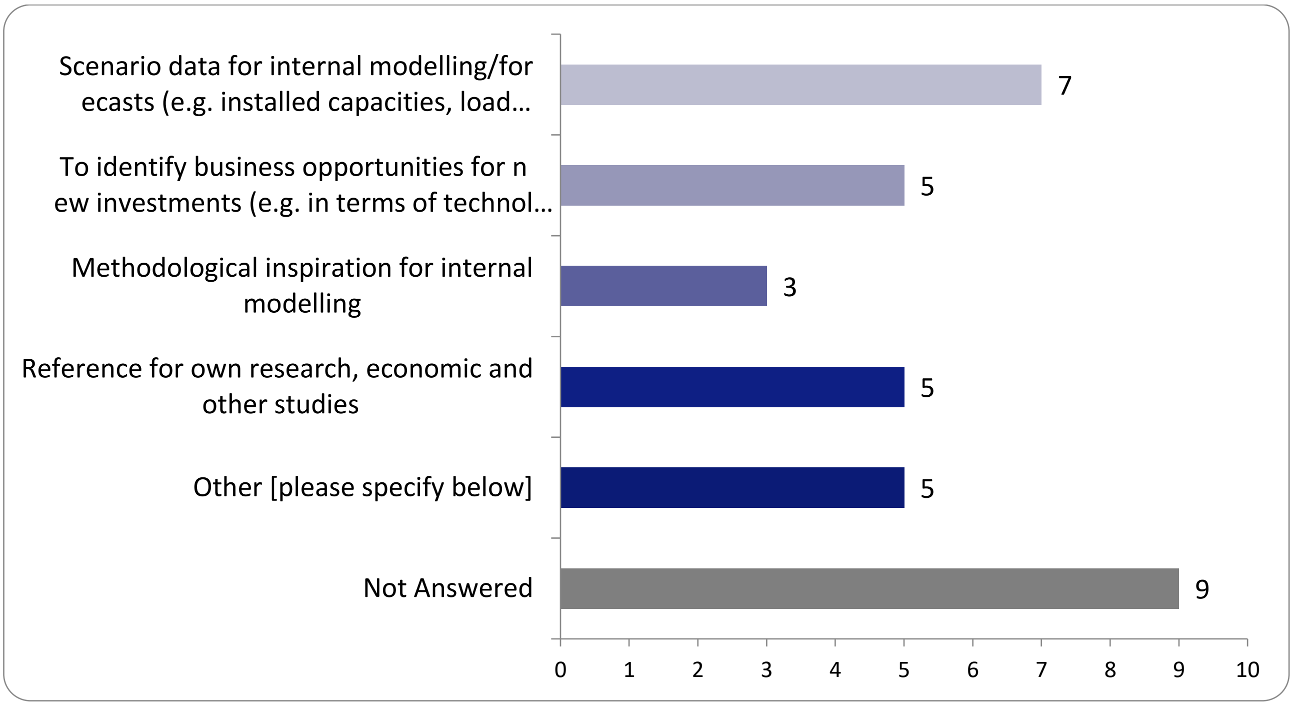
23 responses collected:



Familiarity with the ERAA and the Economic Viability Assessment (EVA)

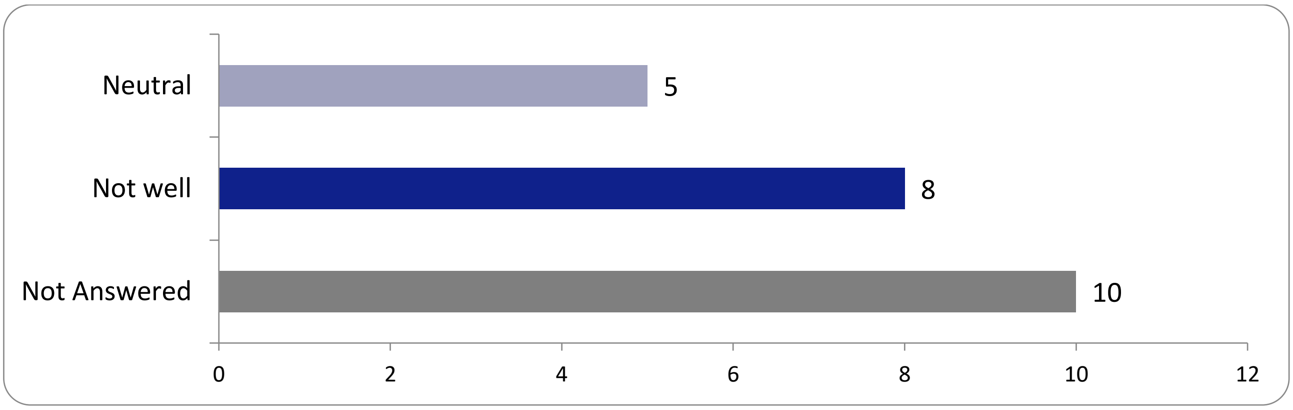
Q9: If you are familiar with the ERAA, what are its main uses within your organisation?

14 responses collected:



Q10: In your view, to what extent does the EVA step reflect real-world decisions in retirement, (de-)mothballing, life extension and investment in new capacity, for the technologies relevant for you?

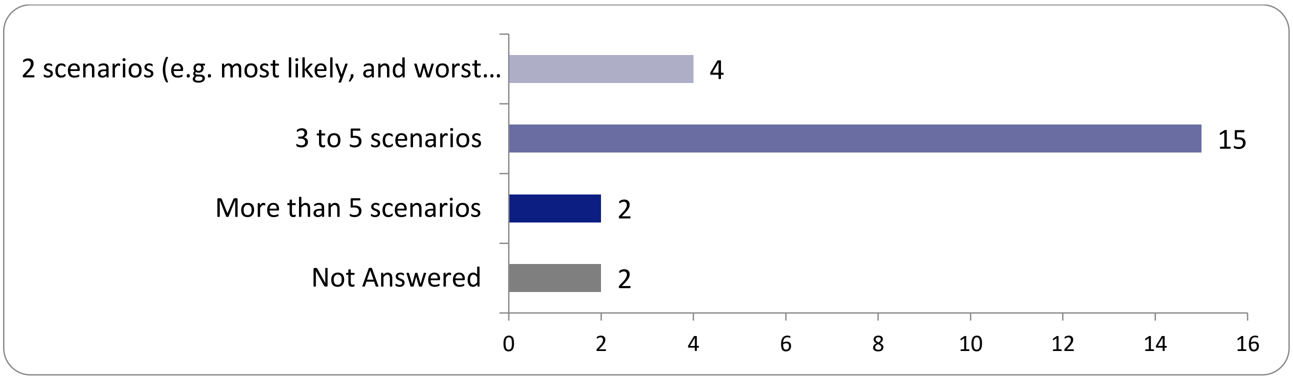
13 responses collected:



Future scenarios and investment under uncertainty

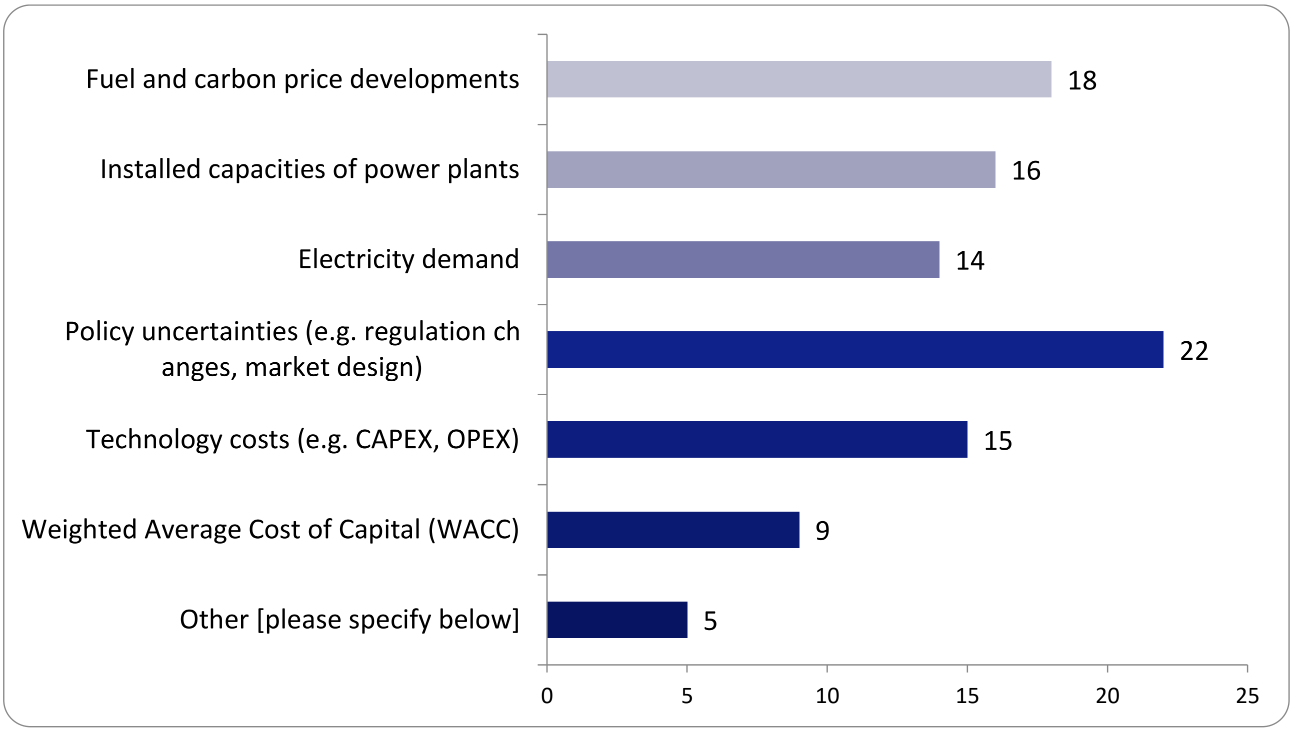
Q11: How many scenarios of the future power system do you typically consider in your long-term investment planning?

21 responses collected:



Q12: What are the key uncertainties (i.e. main drivers) used to define your scenario(s)?

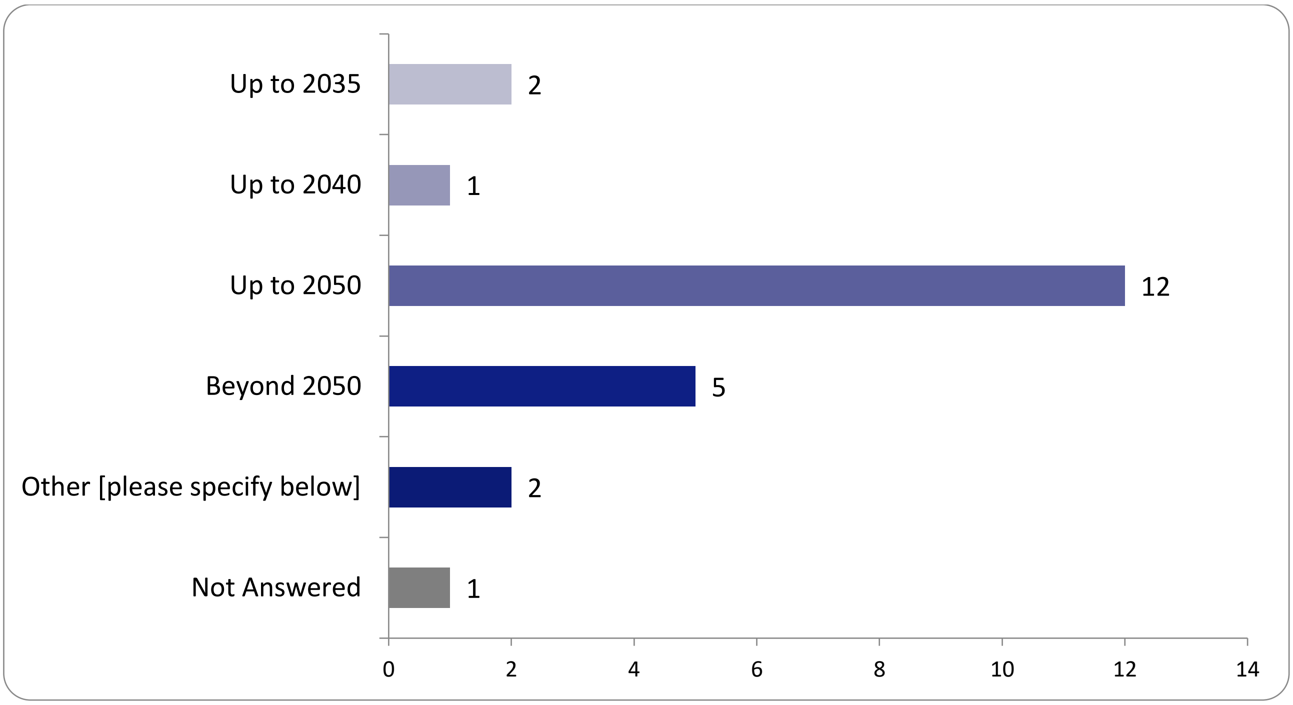
23 responses collected:



Examples of 'other' responses included (a) technology-specific risks (e.g. curtailment, profile costs, balancing costs), (b) National and EU policies, (c) ancillary service requirements, (d) general economic outlook

Q13: Which time horizons do you consider in your scenarios?

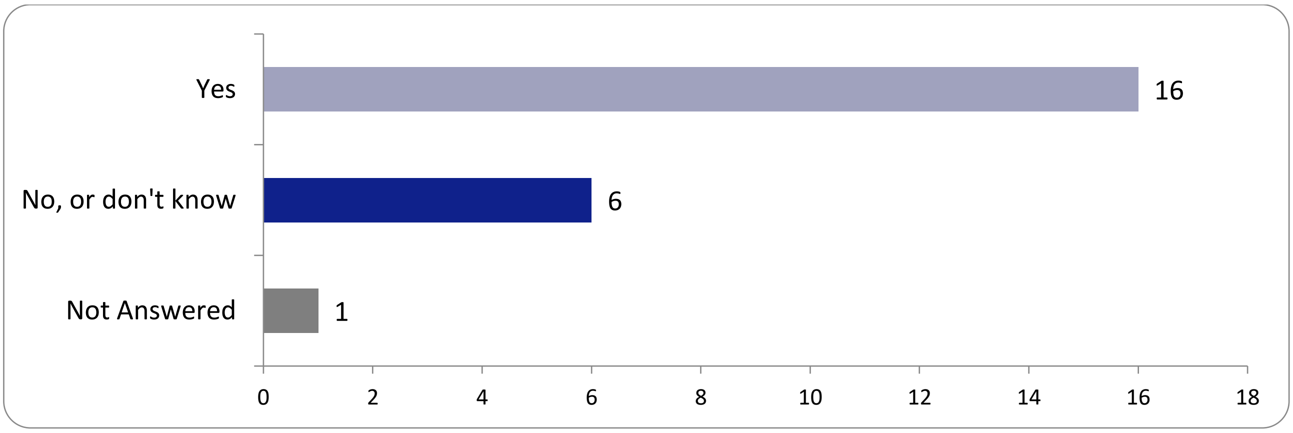
22 responses collected:



'Other' responses mostly indicated the relevant time horizon depends on the type of asset and decision, generally reflecting the (economic) lifetime of the asset.

Q14: Do you consider weather and climate-related uncertainty in your decisions to retire, (de-mothball, extend or invest in new capacity? (e.g. by using multiple climate years)

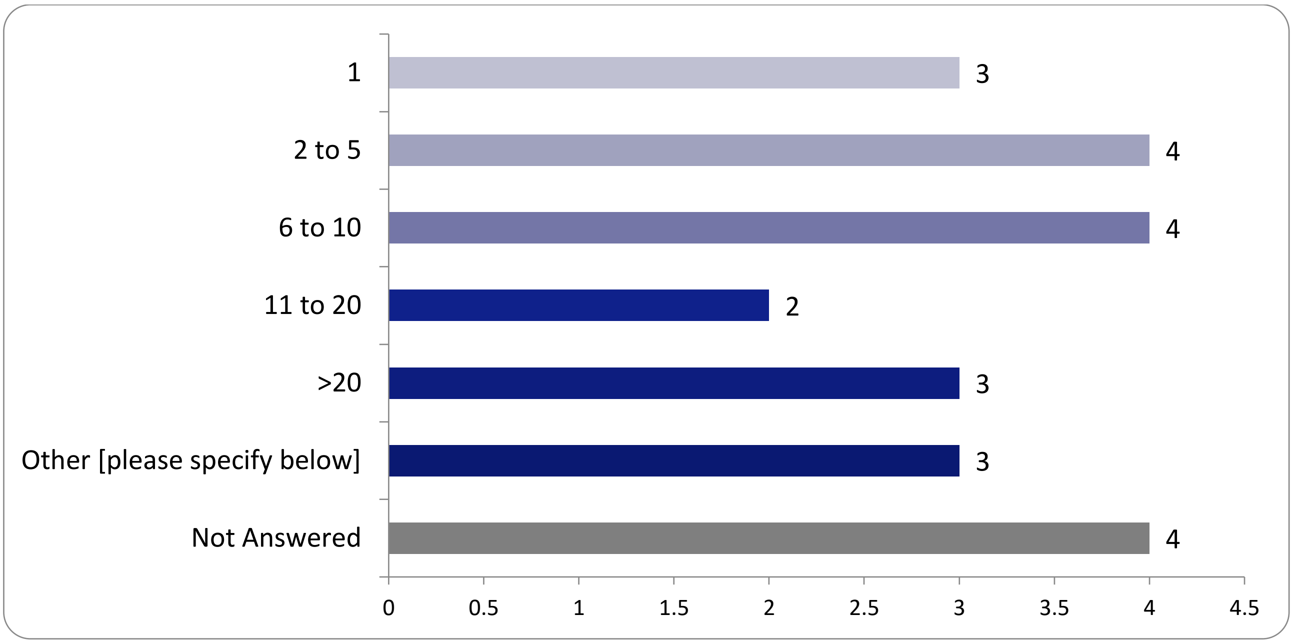
22 responses collected:



Consideration of weather and climate-related uncertainty

Q15: How many potential climate years do you consider?

19 responses collected:

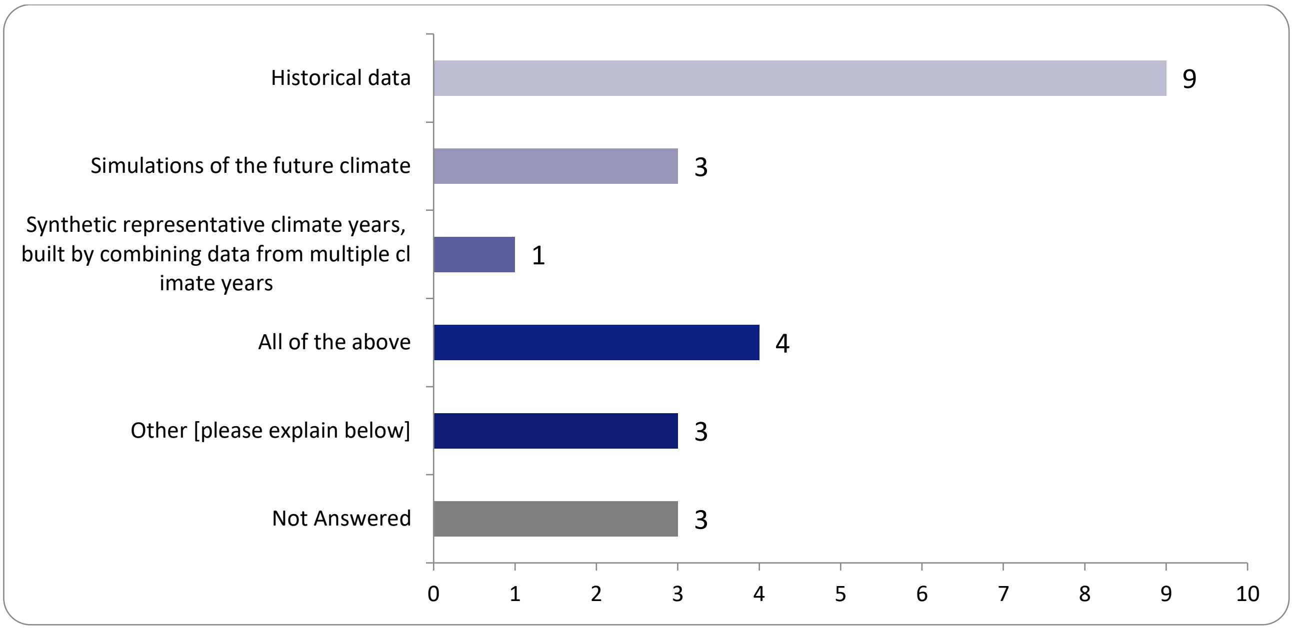


Examples of ‘other’ responses:

- *“We consider average climate years using historical data. Therefore, we are not considering weather and climate-related uncertainty in the long-term forecast. We create different scenarios…with other inputs: capacity, demand, commodity forecasts. We use weather scenarios and weather forecasts for short-term trading and optimization of the revenues”.*
- *“We do not consider any climate-related uncertainties in our scenarios. The only relevant climate impact is related to temperature-change in heat consumption.”*
- *“Normal practice among power price forecast modelling is to use 2 to 5 potential climate years”.*

Q16: What type of data are these climate years based on?

20 responses collected:



Examples of 'other' responses:

- *"We use both climate years based on historical data and synthetic representative climate years, built by combining data from multiple climate years".*

Q17: If you consider multiple (representative) climate years, on what basis do you select them, and how do you weight them in your evaluations for new investments?

There were 9 responses to this open question.

Respondents indicated that if they use multiple climate years they typically either (a) simulate all available years and use the average result, or (b) select one year which is close to the average, or (c) use a smaller number of years representing the range of values (especially for hydro).

Example detailed responses:

- *“We take historical values, identify average/mean values, and exclude extremes.”*
- *“We use only 3 climate years in simple sensitivity analyses. There are so many approximations in the data that it is useless to waste a lot of time trying "to see through binoculars in the fog". Since the hydrological effect is the most important, a simple choice is made between the data from the last 40 years: the wettest; one that is close to the average; the driest.”*
- *“We mostly use years that are reasonably close to the average in the sample or we average the modelling results of all individual years.”*
- *“We find very valuable the ERAA time series based on historical weather variables. Conversely, the new approach based on synthetic/future climate scenarios does not fit with our internal needs”.*

Q18: Do you consider more extreme weather scenarios (e.g. extended cold snaps, heat waves, extended periods with low generation from solar and wind), which may not be represented adequately by typical historical weather data or projections generated by climate models? If so, how are they incorporated into your assessments?

There were 17 responses to this open question, of which 5 clearly indicated they do not consider extreme weather scenarios, and 3 did not provide a valid response (e.g. N/A or blank). The remaining respondents provided a more detailed answer and/or it was not clear what approach was used.

Example detailed responses:

- *"Although extreme weather scenarios might trigger extreme prices, this does not necessarily trigger investments in new power plants or storage, given the low probability of extreme events. Moreover, it is not known ex-ante whether the extreme event would happen at the beginning or the end of the 20-year period of the technical lifetime of an asset"*
- *"Extreme weather events, such as cold snaps, are currently not explicitly reflected in our modelling, since we are only using historical weather years (or combinations thereof) which did not see any such event. However, we do out-of-model approximations of cold snaps to assess how much dispatchable capacity is needed to ensure security of supply."*
- *"We consider that specific extreme weather situations may occur (e.g. dunkelflaute) but we are not able to model them so far."*
- *"We do not add artificial extreme conditions such as extended cold snaps or extended periods without renewables, as these are already included in the actual weather database"*
- *"We use severe historical events that could represent critical issues for the system".*

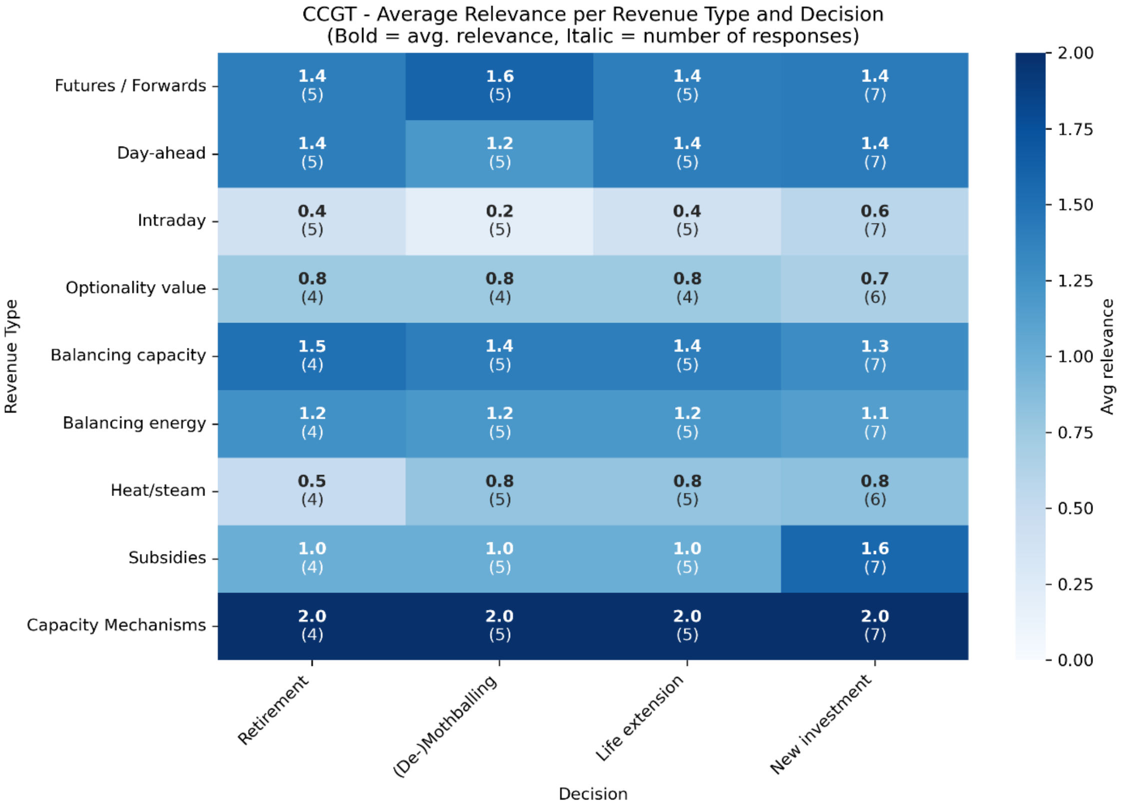
Relevant revenues, investment criteria and risk aversion for different technologies

Q19: To what extent are different revenue streams relevant for assessing the economic viability of technologies in your current asset portfolio and potential new investments?

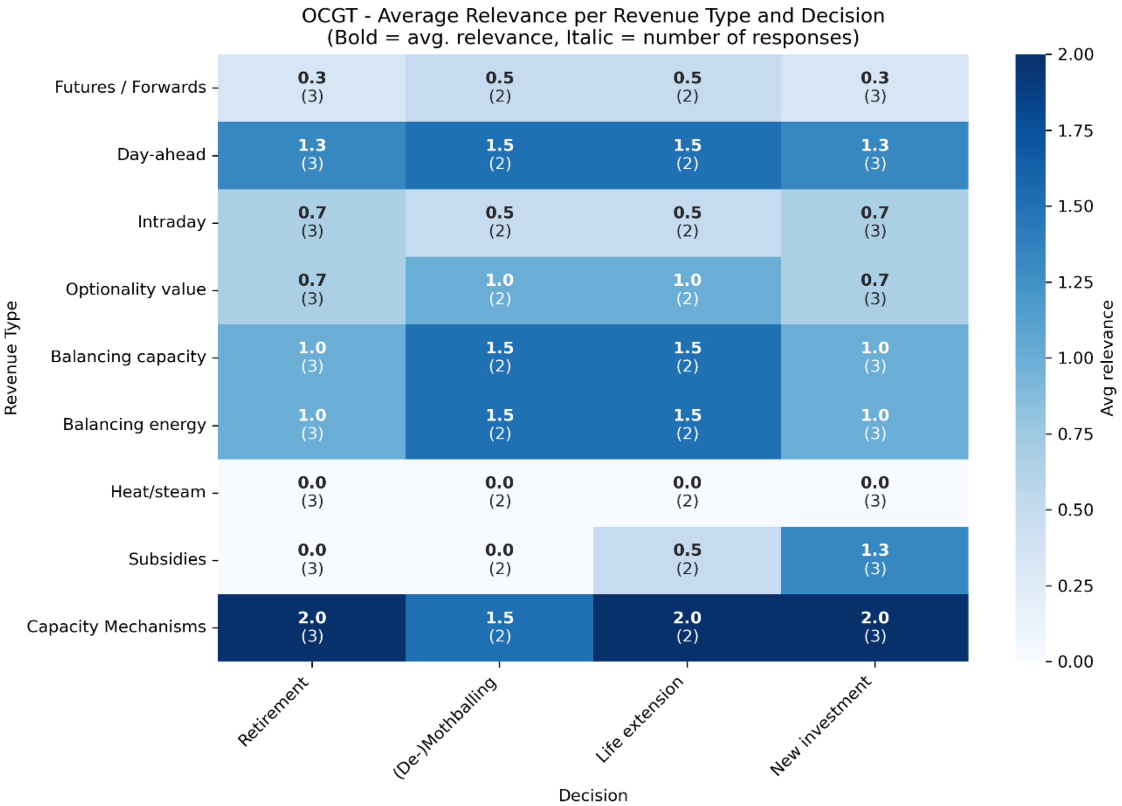
There were 13 responses to this question in total, though the number of responses varied significantly for different technologies and business decisions.

The figures (heatmaps) on the following pages present an overview of the responses for each of the technologies surveyed.

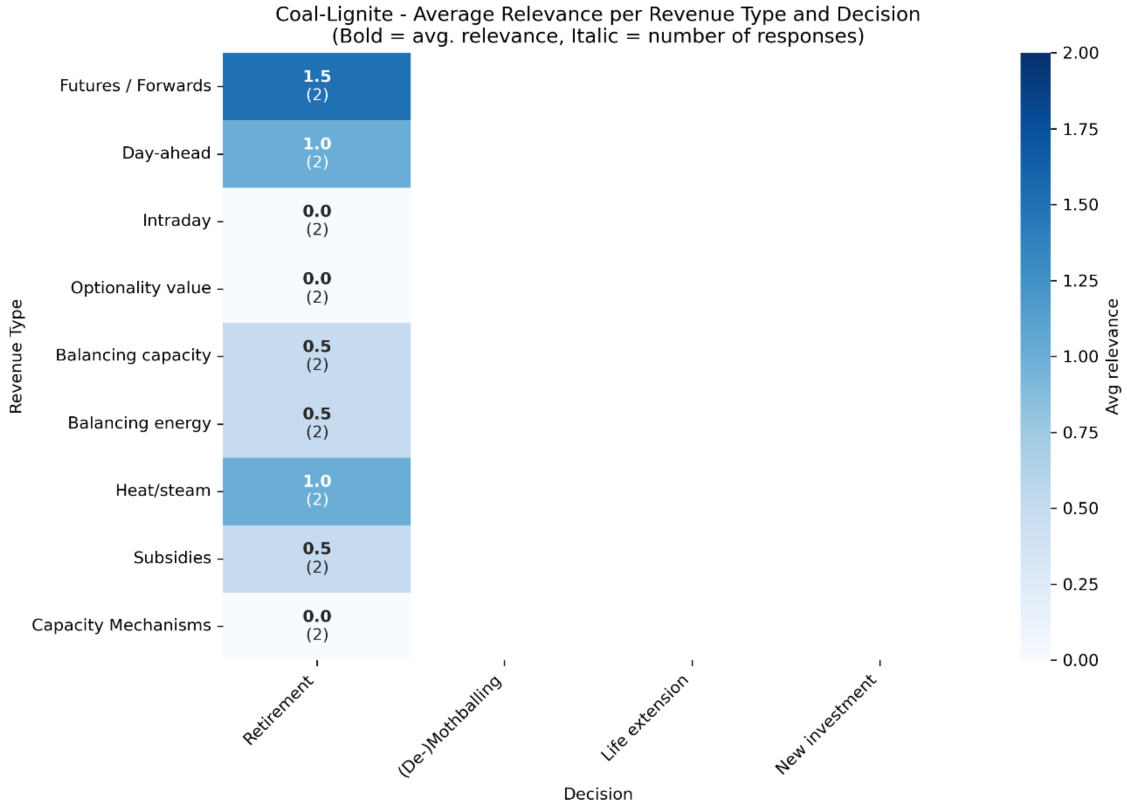
- The rows represent the *type* of revenue, while the columns represent the *business decision* (e.g. retirement, investment)
- The colour shading and bold number in each cell represents the *average value of the relevance responses received*, with the following meaning:
  - **2 = Key relevance:** this revenue is vital for economic viability (e.g. represents more than 50% of total expected revenues, and/or a decision to invest would not be made without it)
  - **1 = Somewhat relevant**: this revenue stream is typically accounted for, but not a driving factor in economic viability (e.g. represents between 5% and 50% of total expected revenues)
  - **0 = Not relevant**: this revenue is so small or uncertain that it is typically neglected when assessing viability (e.g. represents less than 5% of total revenues)
- The number below in brackets indicates the *number of responses* provided for a given decision and technology
- Empty responses and ‘Don’t know’ responses are not included in the averages, and shown as blank.

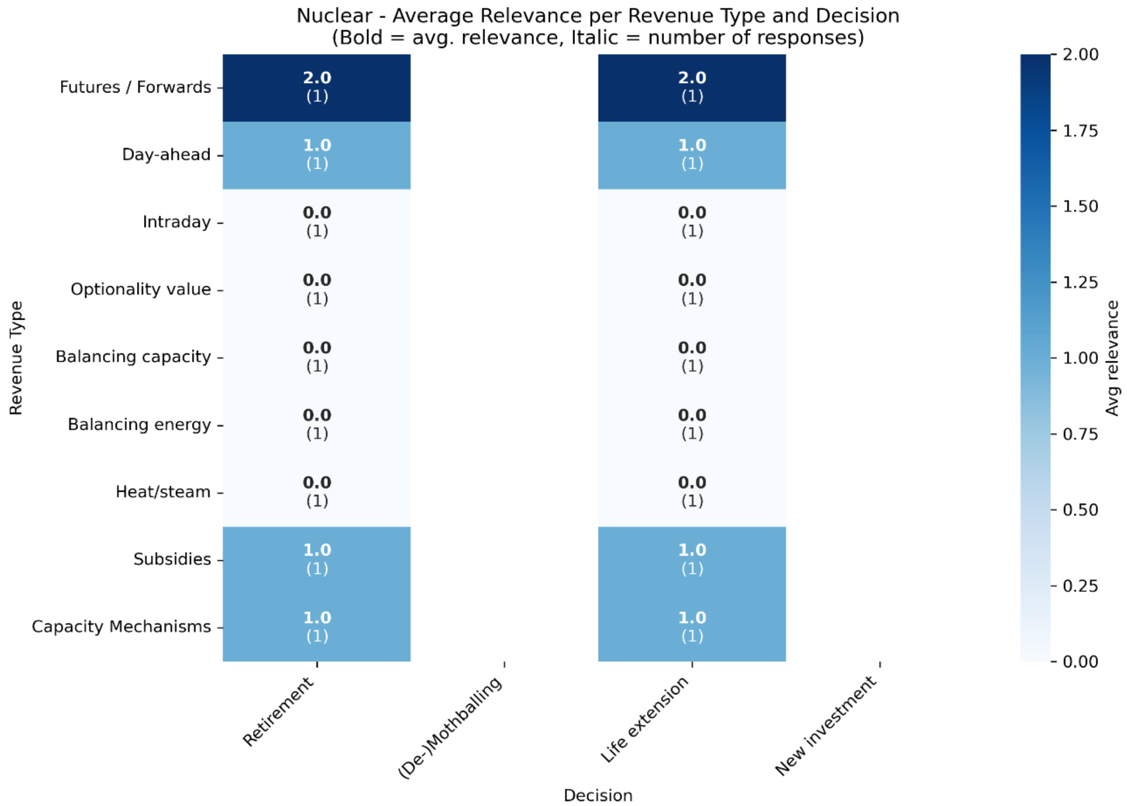


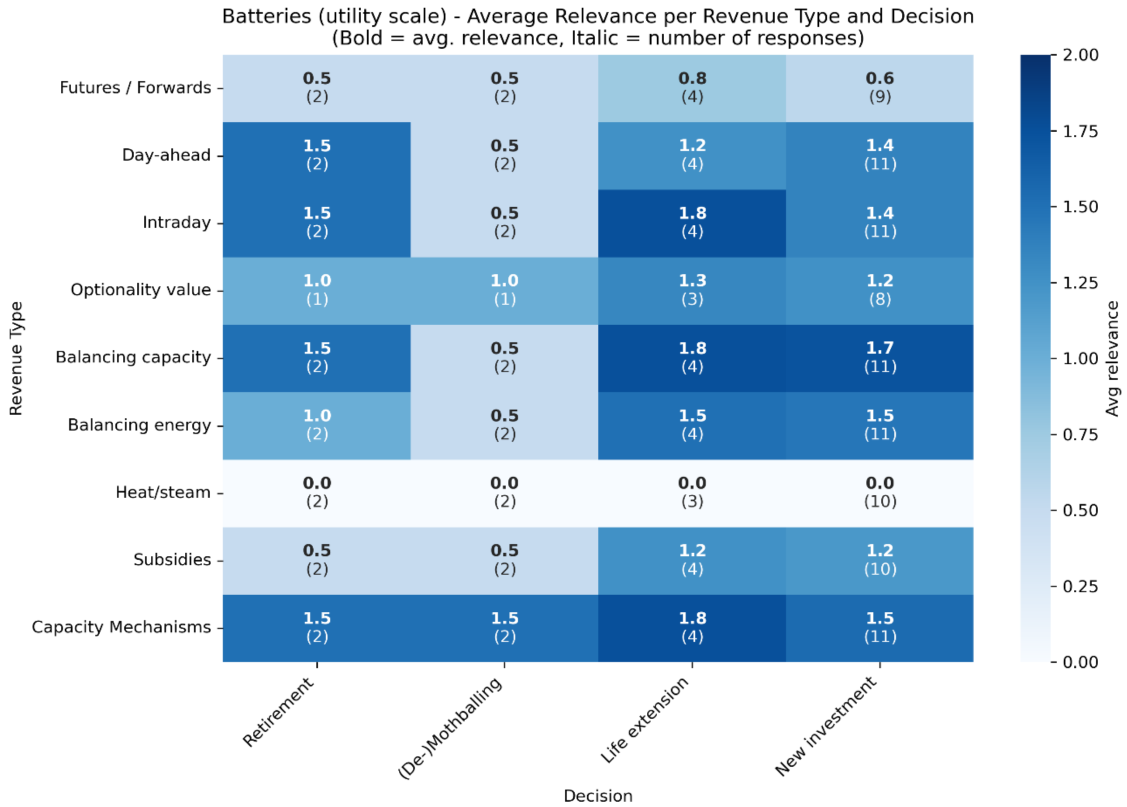
Revenue Type	Retirement	(De-)Mothballing	Life extension	New investment
Futures / Forwards	**1.4** (5)	**1.6** (5)	**1.4** (5)	**1.4** (7)
Day-ahead	**1.4** (5)	**1.2** (5)	**1.4** (5)	**1.4** (7)
Intraday	**0.4** (5)	**0.2** (5)	**0.4** (5)	**0.6** (7)
Optionality value	**0.8** (4)	**0.8** (4)	**0.8** (4)	**0.7** (6)
Balancing capacity	**1.5** (4)	**1.4** (5)	**1.4** (5)	**1.3** (7)
Balancing energy	**1.2** (4)	**1.2** (5)	**1.2** (5)	**1.1** (7)
Heat/steam	**0.5** (4)	**0.8** (5)	**0.8** (5)	**0.8** (6)
Subsidies	**1.0** (4)	**1.0** (5)	**1.0** (5)	**1.6** (7)
Capacity Mechanisms	**2.0** (4)	**2.0** (5)	**2.0** (5)	**2.0** (7)

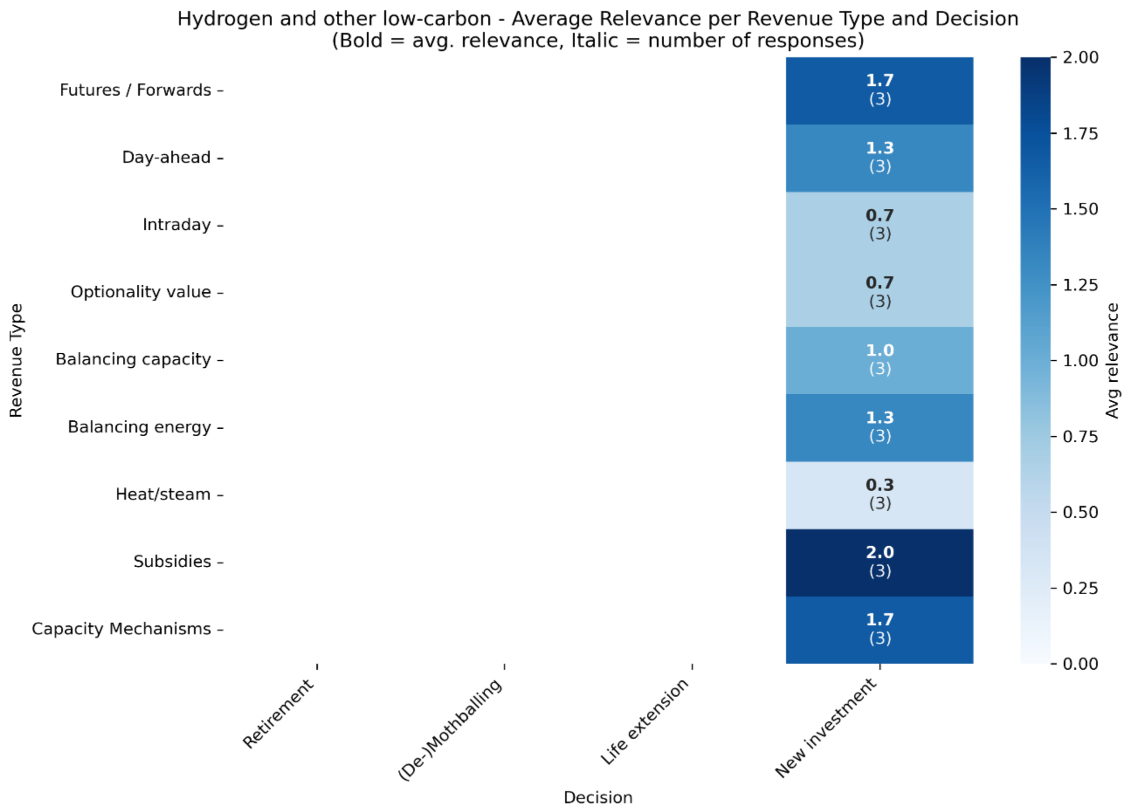


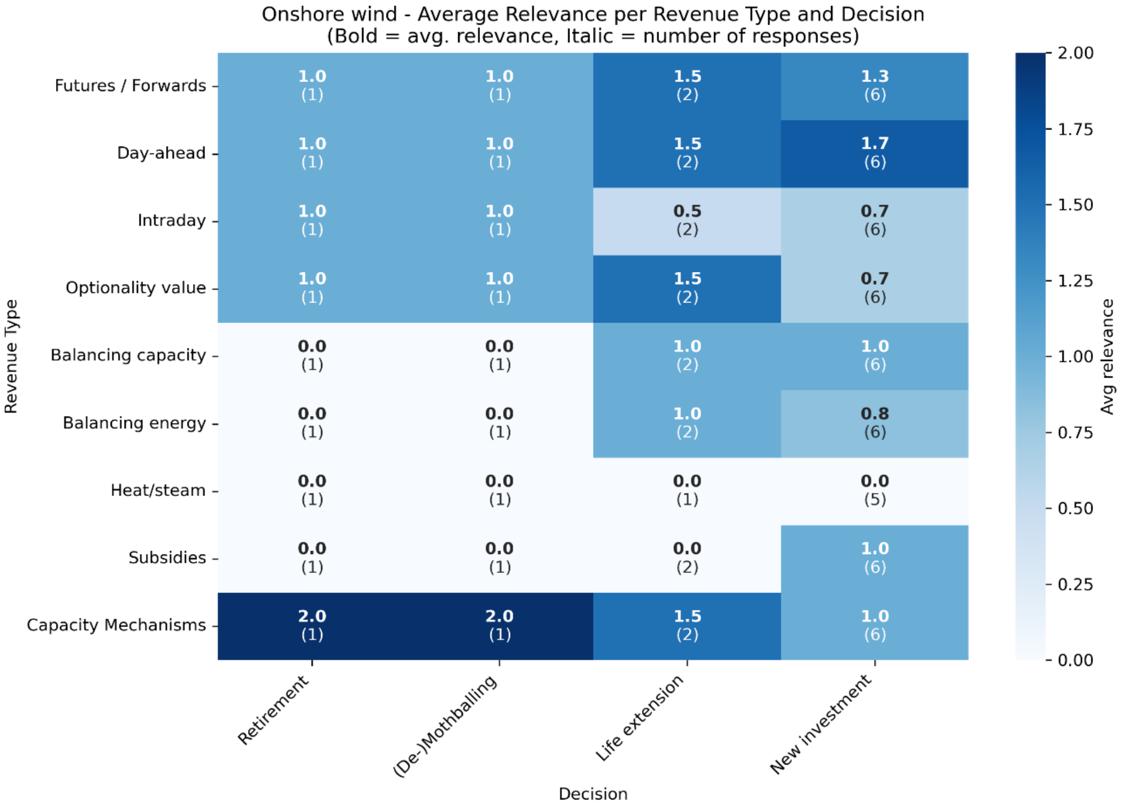
Revenue Type	Retirement	(De-)Mothballing	Life extension	New investment
Futures / Forwards	**0.3** (3)	**0.5** (2)	**0.5** (2)	**0.3** (3)
Day-ahead	**1.3** (3)	**1.5** (2)	**1.5** (2)	**1.3** (3)
Intraday	**0.7** (3)	**0.5** (2)	**0.5** (2)	**0.7** (3)
Optionality value	**0.7** (3)	**1.0** (2)	**1.0** (2)	**0.7** (3)
Balancing capacity	**1.0** (3)	**1.5** (2)	**1.5** (2)	**1.0** (3)
Balancing energy	**1.0** (3)	**1.5** (2)	**1.5** (2)	**1.0** (3)
Heat/steam	**0.0** (3)	**0.0** (2)	**0.0** (2)	**0.0** (3)
Subsidies	**0.0** (3)	**0.0** (2)	**0.5** (2)	**1.3** (3)
Capacity Mechanisms	**2.0** (3)	**1.5** (2)	**2.0** (2)	**2.0** (3)

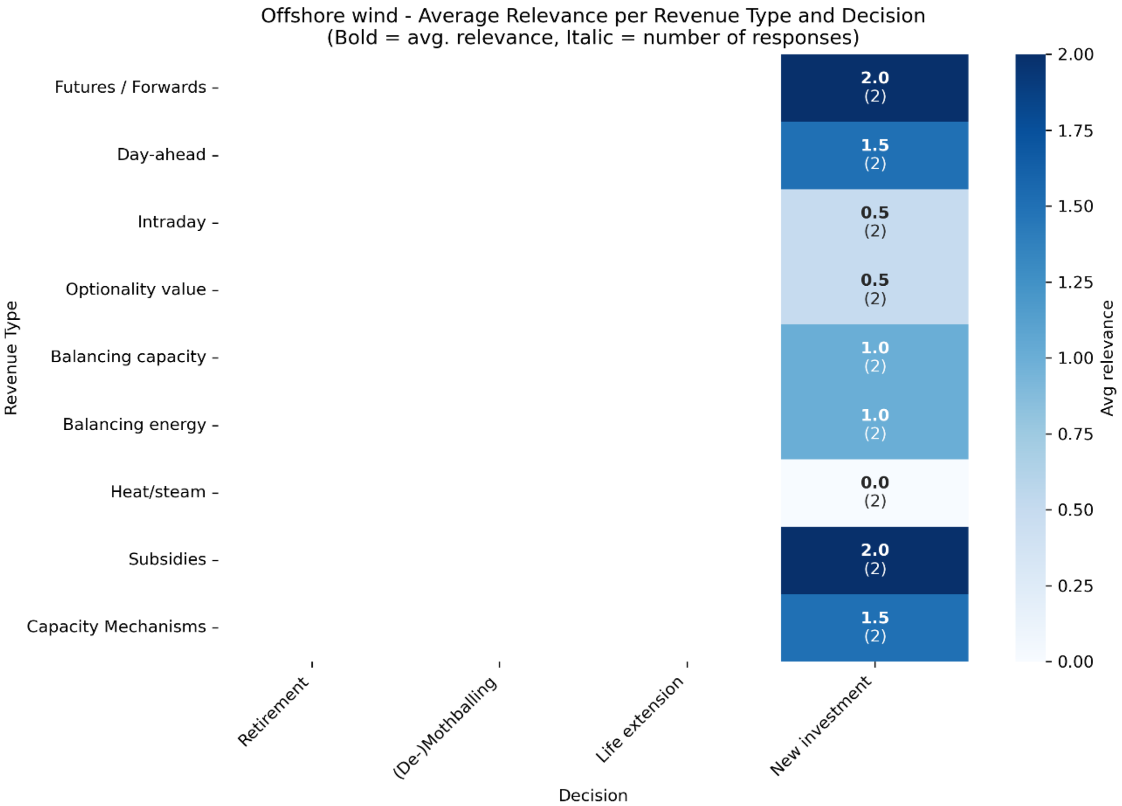

Coal-Lignite - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
1.5 (2)
1.0 (2)
0.0 (2)
0.0 (2)
0.5 (2)
0.5 (2)
1.0 (2)
0.5 (2)
0.0 (2)
Retirement
(De-)Mothballing
Life extension
New investment
Decision
Avg relevance
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00

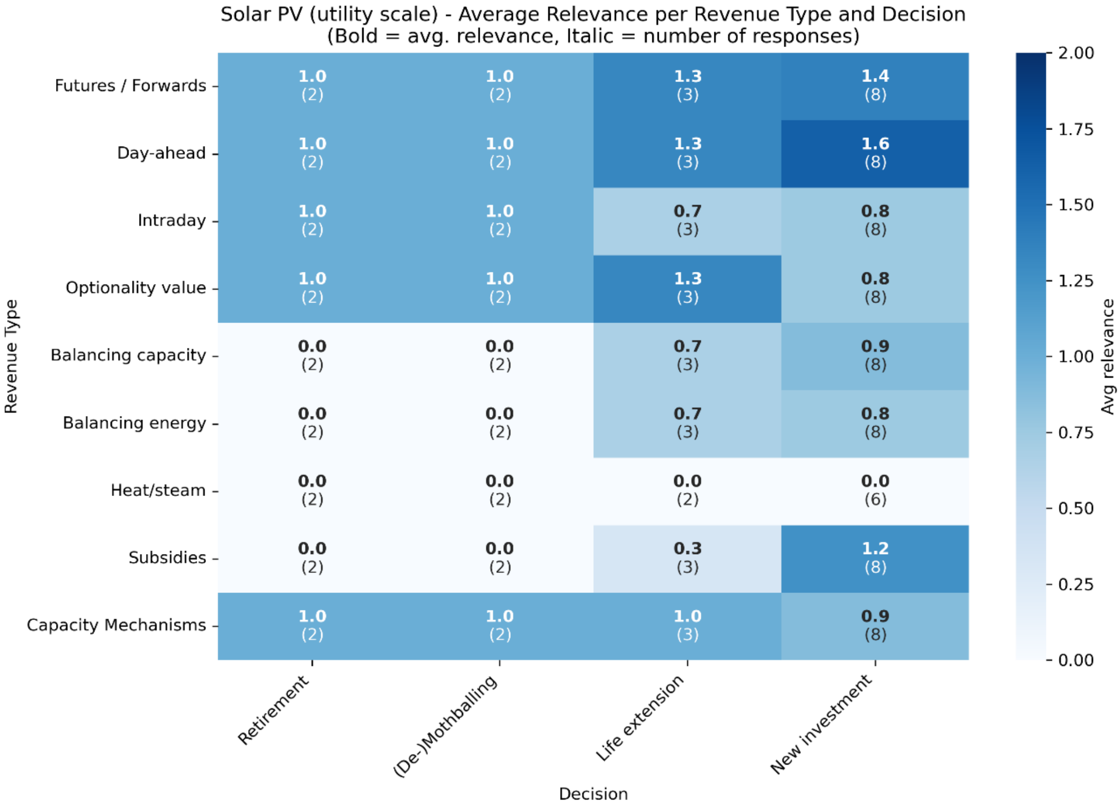

Nuclear - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Retirement: 2.0 (1), 1.0 (1), 0.0 (1), 0.0 (1), 0.0 (1), 0.0 (1), 0.0 (1), 1.0 (1), 1.0 (1)
Life extension: 2.0 (1), 1.0 (1), 0.0 (1), 0.0 (1), 0.0 (1), 0.0 (1), 0.0 (1), 1.0 (1), 1.0 (1)
Retirement
(De-)Mothballing
Life extension
New investment
Decision
Avg relevance
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00


Batteries (utility scale) - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Decision
Retirement
(De-)Mothballing
Life extension
New investment
Avg relevance
0.5 (2) 0.5 (2) 0.8 (4) 0.6 (9)
1.5 (2) 0.5 (2) 1.2 (4) 1.4 (11)
1.5 (2) 0.5 (2) 1.8 (4) 1.4 (11)
1.0 (1) 1.0 (1) 1.3 (3) 1.2 (8)
1.5 (2) 0.5 (2) 1.8 (4) 1.7 (11)
1.0 (2) 0.5 (2) 1.5 (4) 1.5 (11)
0.0 (2) 0.0 (2) 0.0 (3) 0.0 (10)
0.5 (2) 0.5 (2) 1.2 (4) 1.2 (10)
1.5 (2) 1.5 (2) 1.8 (4) 1.5 (11)
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00

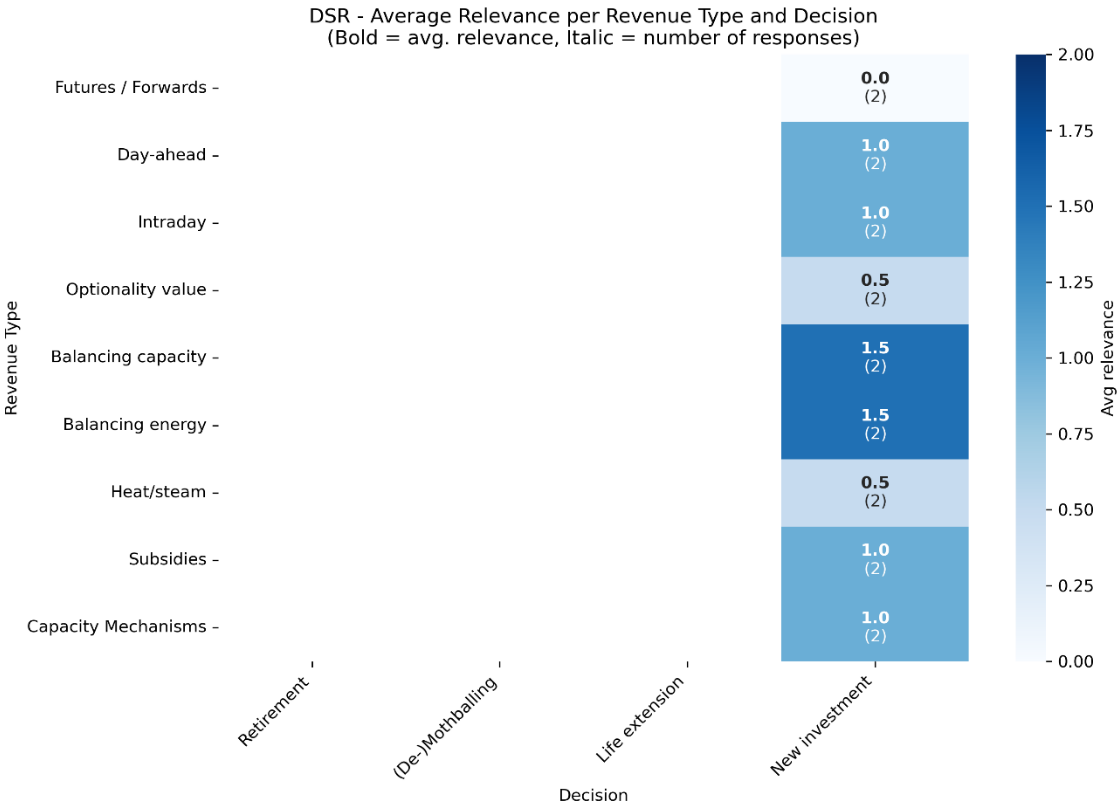

Hydrogen and other low-carbon - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Decision
Retirement
(De-)Mothballing
Life extension
New investment
Avg relevance
1.7 (3)
1.3 (3)
0.7 (3)
0.7 (3)
1.0 (3)
1.3 (3)
0.3 (3)
2.0 (3)
1.7 (3)
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00


Onshore wind - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Decision
Retirement
(De-)Mothballing
Life extension
New investment
Avg relevance
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1.0 (1) | 1.0 (1) | 1.5 (2) | 1.3 (6)
1.0 (1) | 1.0 (1) | 1.5 (2) | 1.7 (6)
1.0 (1) | 1.0 (1) | 0.5 (2) | 0.7 (6)
1.0 (1) | 1.0 (1) | 1.5 (2) | 0.7 (6)
0.0 (1) | 0.0 (1) | 1.0 (2) | 1.0 (6)
0.0 (1) | 0.0 (1) | 1.0 (2) | 0.8 (6)
0.0 (1) | 0.0 (1) | 0.0 (1) | 0.0 (5)
0.0 (1) | 0.0 (1) | 0.0 (2) | 1.0 (6)
2.0 (1) | 2.0 (1) | 1.5 (2) | 1.0 (6)

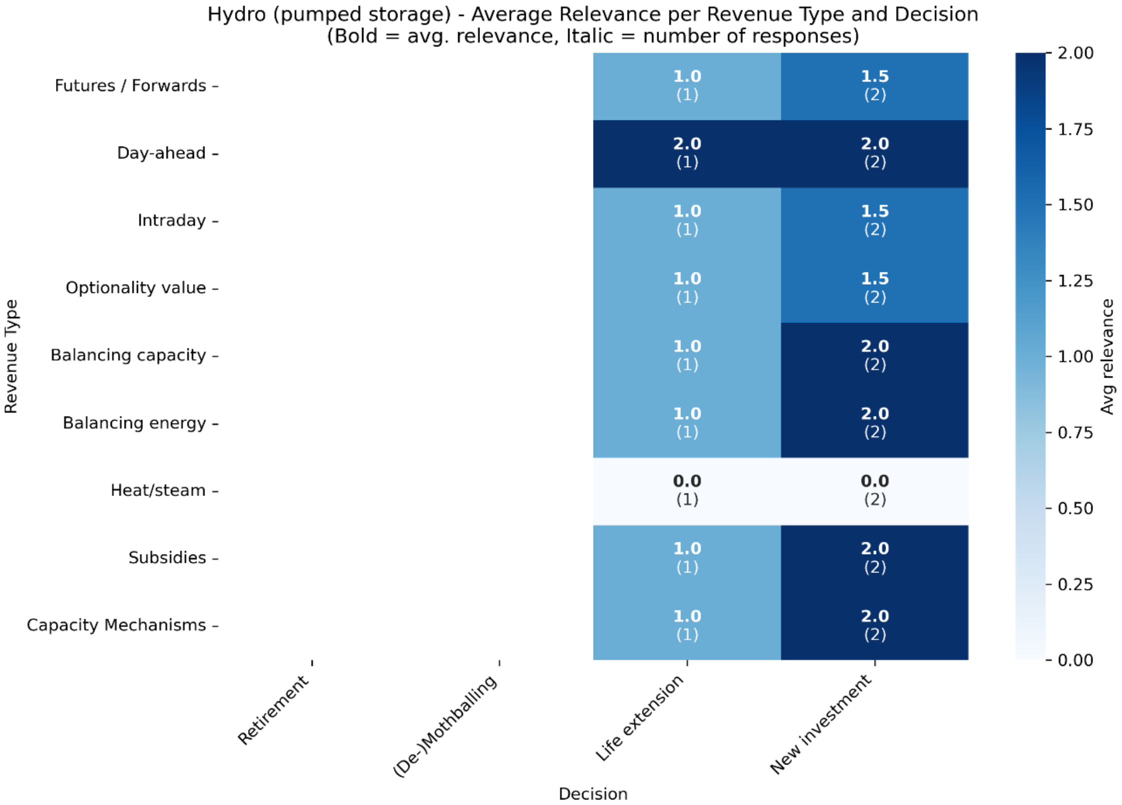

Offshore wind - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Decision
Retirement
(De-)Mothballing
Life extension
New investment
Avg relevance
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2.0 (2)
1.5 (2)
0.5 (2)
0.5 (2)
1.0 (2)
1.0 (2)
0.0 (2)
2.0 (2)
1.5 (2)

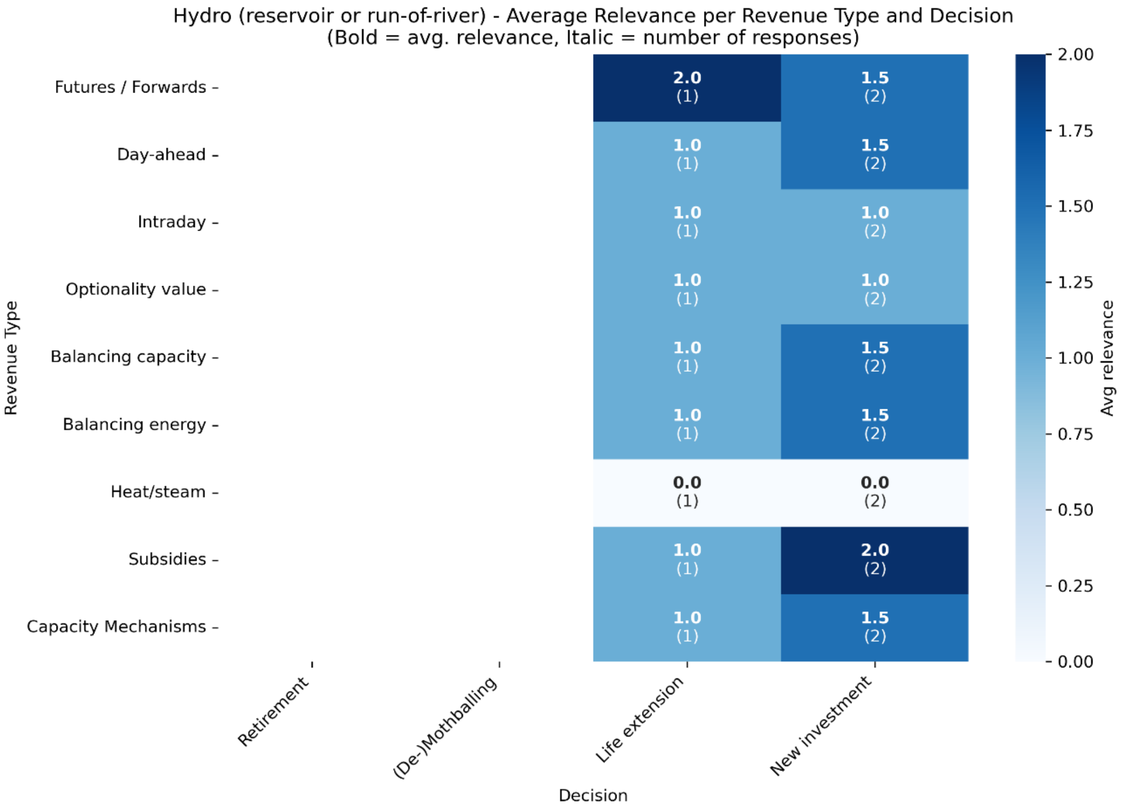


Revenue Type	Retirement	(De-)Mothballing	Life extension	New investment
Futures / Forwards	1.0 (2)	1.0 (2)	1.3 (3)	1.4 (8)
Day-ahead	1.0 (2)	1.0 (2)	1.3 (3)	1.6 (8)
Intraday	1.0 (2)	1.0 (2)	0.7 (3)	0.8 (8)
Optionality value	1.0 (2)	1.0 (2)	1.3 (3)	0.8 (8)
Balancing capacity	0.0 (2)	0.0 (2)	0.7 (3)	0.9 (8)
Balancing energy	0.0 (2)	0.0 (2)	0.7 (3)	0.8 (8)
Heat/steam	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (6)
Subsidies	0.0 (2)	0.0 (2)	0.3 (3)	1.2 (8)
Capacity Mechanisms	1.0 (2)	1.0 (2)	1.0 (3)	0.9 (8)



Revenue Type	Retirement	(De-)Mothballing	Life extension	New investment
Futures / Forwards				0.0 (2)
Day-ahead				1.0 (2)
Intraday				1.0 (2)
Optionality value				0.5 (2)
Balancing capacity				1.5 (2)
Balancing energy				1.5 (2)
Heat/steam				0.5 (2)
Subsidies				1.0 (2)
Capacity Mechanisms				1.0 (2)


Hydro (pumped storage) - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Decision
Retirement
(De-)Mothballing
Life extension
New investment
Avg relevance
1.0 (1)
1.5 (2)
2.0 (1)
2.0 (2)
1.0 (1)
1.5 (2)
1.0 (1)
1.5 (2)
1.0 (1)
2.0 (2)
1.0 (1)
2.0 (2)
0.0 (1)
0.0 (2)
1.0 (1)
2.0 (2)
1.0 (1)
2.0 (2)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00


Hydro (reservoir or run-of-river) - Average Relevance per Revenue Type and Decision
(Bold = avg. relevance, Italic = number of responses)
Revenue Type
Futures / Forwards
Day-ahead
Intraday
Optionality value
Balancing capacity
Balancing energy
Heat/steam
Subsidies
Capacity Mechanisms
Decision
Retirement
(De-)Mothballing
Life extension
New investment
Avg relevance
2.0 (1)
1.5 (2)
1.0 (1)
1.5 (2)
1.0 (1)
1.0 (2)
1.0 (1)
1.0 (2)
1.0 (1)
1.5 (2)
1.0 (1)
1.5 (2)
0.0 (1)
0.0 (2)
1.0 (1)
2.0 (2)
1.0 (1)
1.5 (2)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00

Q20: Are there any additional types of revenue (value) streams you consider when making business decisions for a particular technology, which were not included in Q19?

There were 12 responses to this open question, of which two responded that there were no other considerations. Various common responses included long-term contracts and access to financing.

Examples of detailed responses:

- *“The existence of long-term contracts is a key enabler for investments in new capacity. These can be "traditional" capacity mechanisms or "innovative" mechanisms with infrastructure-like contracts”.*
- *“The revenue streams considered may be different for the purpose of building the reference scenarios against which investments are assessed, and for the purpose of performing the detailed assessment of these investments and making business decisions. The latter requires to finely account for additional revenue streams, such as ancillary services or intraday and balancing energy revenues, and for the actual market/contract design that is applicable for the considered project, impacting its revenue and risk profile”.*
- *“According to our experience, projections on future revenue streams in EVA should be as simple as possible. Day-ahead extreme prices are the key uncertainty and difficulty to forecast in EVA”.*

Q21: Are there any additional types of <u>fixed or variable costs</u> you consider when making business decisions which are not included in the list below?

Variable costs:

- *Fuel costs*
- *CO2 emission costs*
- *Other variable OPEX costs (e.g. consumables, by-product handing)*
- *Taxes and levies related to variable production*
- *Minimum activation price (for DSR resources only)*

Fixed costs:

- *Capital investment costs (annualised)*
- *Annual fixed costs, including:*
  - *labour costs,*
  - *fixed maintenance and repair costs*
  - *insurance and asset management costs*
  - *taxes and levies*
  - *transaction and control costs*
  - *fuel supply service contracts*
  - *fixed electricity transmission and distribution charges*
  - *other annual costs including environmental compensation costs, local resident compensation costs etc.*

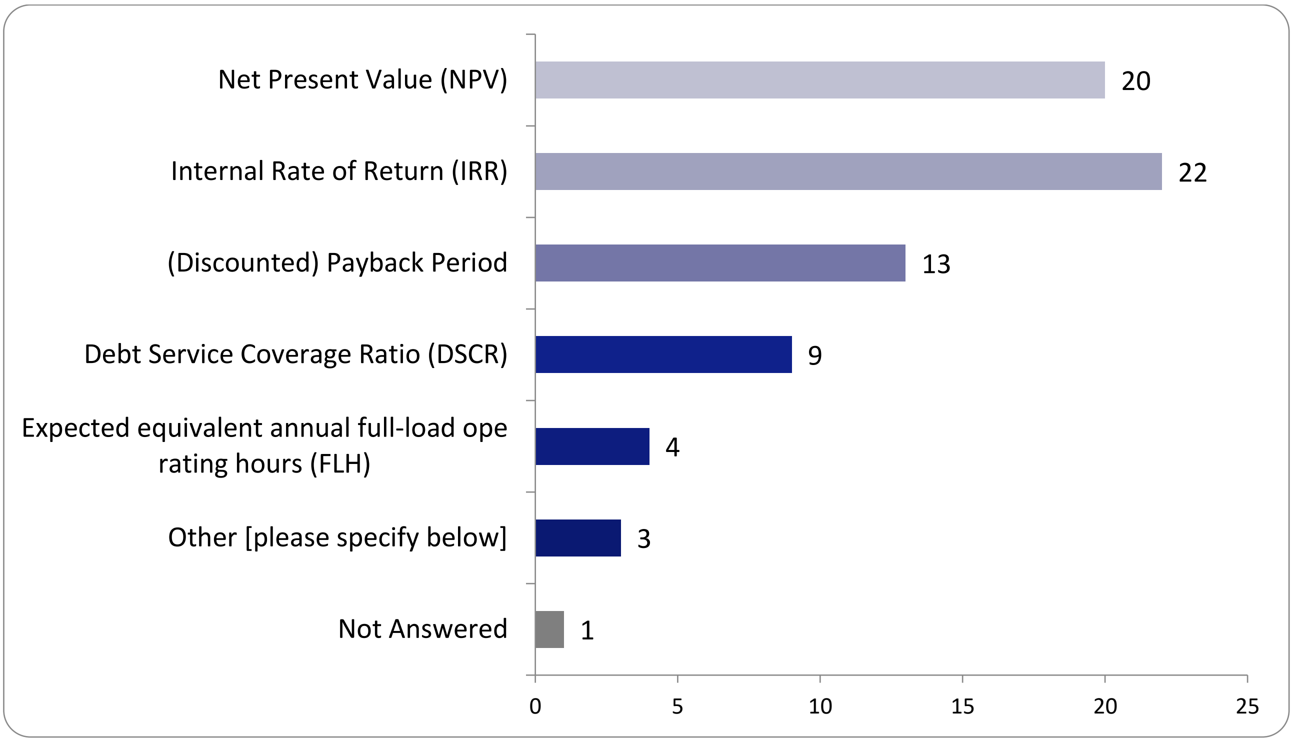
There were 14 responses to this open question, of which three responded that there were no other costs considered.

Examples of detailed responses:

- *"Variable costs: variable grid fees for production / consumption (including consumption for losses); Variable costs : route to market fees (remuneration of a service provider that will sell energy and / or balancing services on the energy or balancing markets)*
  Annual costs: IT/telecom subscriptions fees (annual); Fixed costs: Working Capital Requirements".
- *"OPEX increase due to the new working patterns that thermal units will have to face, in the light of variable renewable energy sources (VRES) share increase (steeper ramps, higher number of turn-up and shut-down, etc.): these new patterns shorten thermal units technical life, increasing OPEX to needed to guarantee reliability.*
  We also consider other variable regulated costs (e.g. imbalances costs, variable electricity transmission and distribution charges)".
- *"Performance warranties, ESG costs, Route-to-market costs (including imbalance or cash-out)".*

Q22: Which direct and indirect profitability metrics or investment criteria do you apply when considering investments to prolong existing or develop new capacity?

22 responses collected:

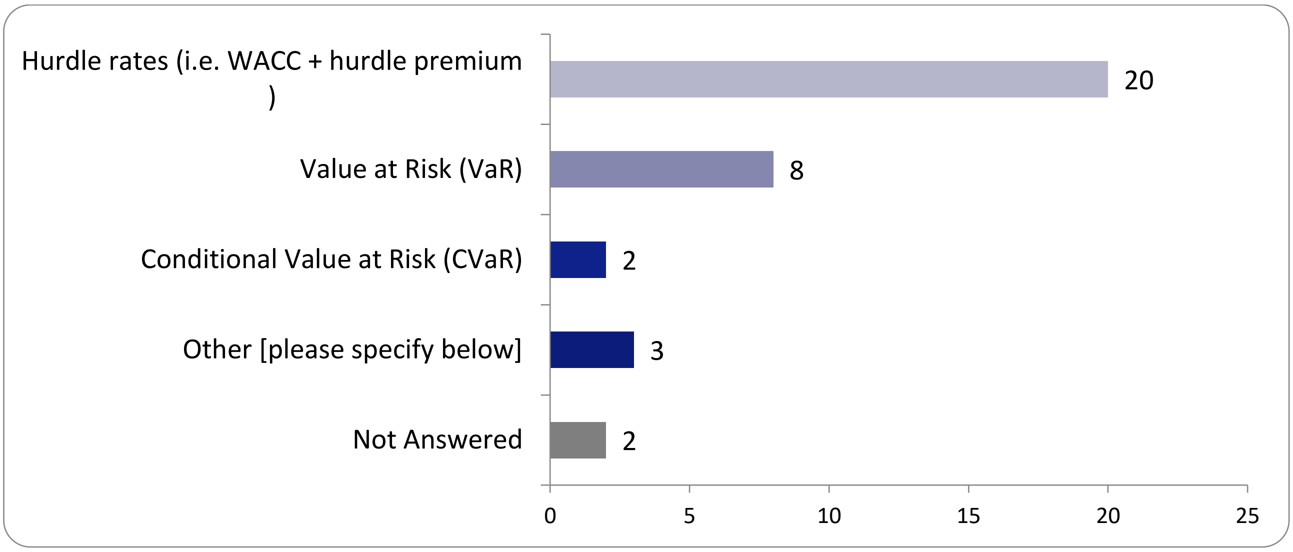


Examples of 'other' responses:

- *"In addition to using a reasonable hurdle rate, it is common to use a limit criterion on the number of years to reach IRR>0".*
- *"Cash Yields (unlevered and levered for a certain period); All of the above metrics on a contracted and uncontracted revenue basis and on a levered and unlevered basis".*
- *"Investment Criteria: Level of maturity of the new capacity under assessment; Expected lifecycle and extraordinary costs during operation; Financing terms and conditions and execution risk; PPA contractual arrangements robustness; Technology assessment; Construction arrangements".*
- *"ROCE".*
- *"WACC".*
- *"NPV and IRR are the key metrics for EVA although internal decisions could use other metrics depending on the investment decision."*

Q23: Which approach(es) do you typically use to adjust for price and revenue risk in the investment criteria above when considering entry and exit decisions?

21 responses collected:



Examples of 'other' responses:

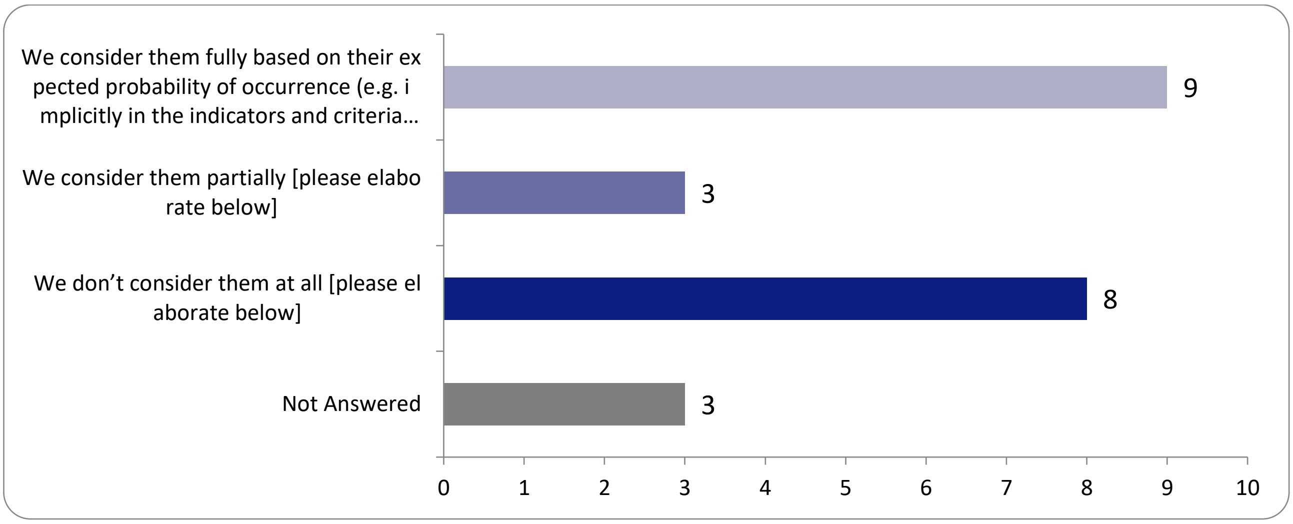
- *"IRR".*
- *"Succes rates"*
- *"Risk management requires different approaches. Our decisions confer high weigh to conservative scenarios. Energy-only markets are highly exposed to risks".*
- *"Robustness analysis based on sensitivity and scenario assessments".*
- *"Weighting results introducing sensitivities on different scenarios".*

Q24: Can you provide any typical values applied for the investment criteria and thresholds for the technologies in your current and prospective portfolio (where relevant)?

There were insufficient (complete) responses to this question to provide meaningful results.

Q25: When evaluating investments in supply-side (generation) assets, how do you account for the potential occurrence of scarcity prices and associated revenues?

20 responses were collected:

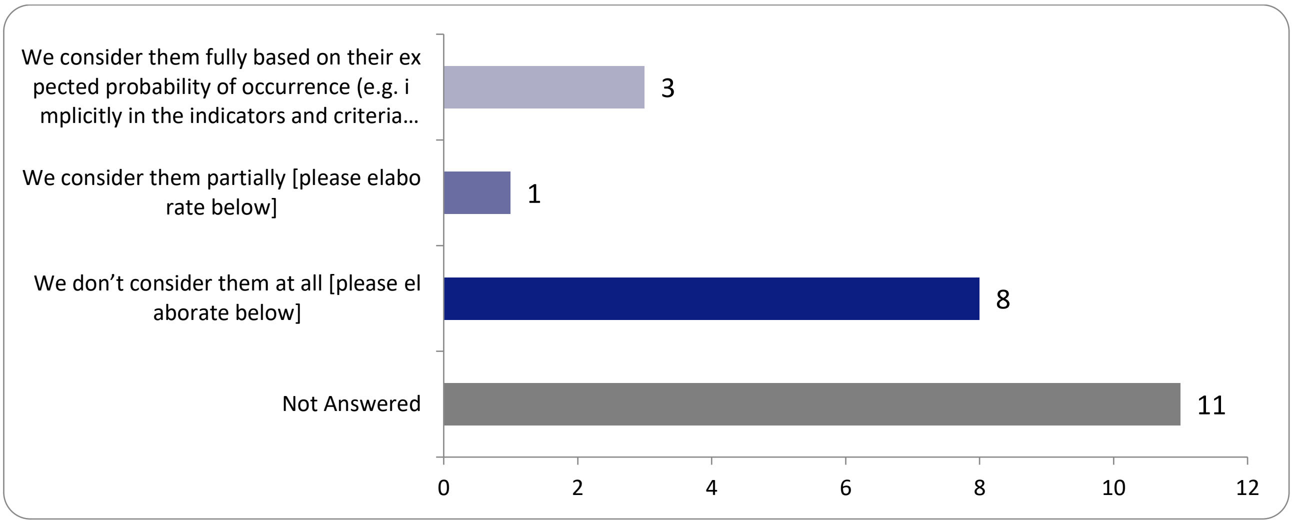


Examples of reasons as to why scarcity prices and associated revenues are partially or not considered:

- *“Frequent scarcity prices cannot be relied upon to make investment decisions because the uncertainty is too great. The dependence on weather conditions and decisions by other stakeholders also does not help. Therefore, it is preferable to rely more on average trends”.*
- *“Extreme spot market prices does not instantly trigger investments in new power plants or storage, as one cannot build power plants overnight. Even a prolonged period of observing high prices might not trigger the interest of investors, especially if these are linked to extreme weather events with low predictability. One cannot predict ex-ante whether the extreme event would happen at the beginning or the end of the 20-year period of the technical lifetime of the asset”.*
- *“We don't consider them at all in our base case. Nevertheless, we keep them as an upside in our internal view”.*
- *“Some scenarios consider scarcity prices whereas others don’t. As the amount and level of scarcity prices are extremely difficult to predict for long time horizons, we consider different price scenarios to assess such uncertainty”.*
- *“In certain events and under certain conditions, regulatory clawbacks could lead to lower price caps (e.g. Directive (EU) 2019/944, article 66a ‘Access to affordable energy during an electricity price crisis’). Additionally, one should consider the high uncertainty of the occurrence of scarcity prices”.*

Q26: When evaluating investments in demand-side (DSR) assets, how do you account for the potential occurrence of scarcity prices and associated costs?

12 responses collected:

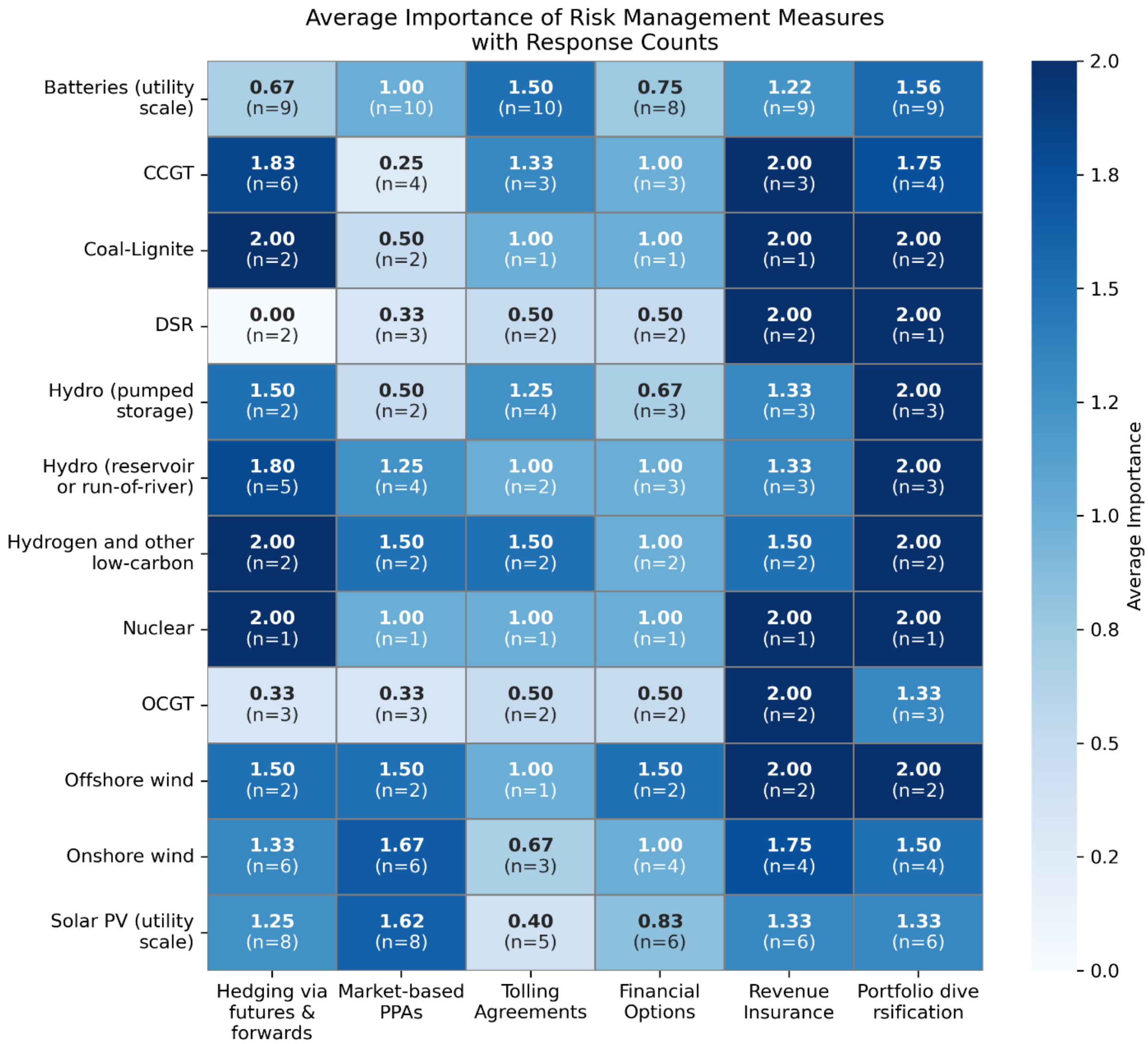


Examples of reasons as to why scarcity prices and associated revenues are partially or not considered:

- *“DSR should not be treated differently from production. So, it is not fair to receive an annual bonus for providing a low-probability explicit service while backup production receives nothing. We should follow the example of the current major DSR: hydro pumping or batteries. And even in these cases, it will be the average expected margin between the selling and purchasing price that matters most”.*
- *“Demand-side assets are no homogenous category, even for industrial demand. A steel facility will behave differently from a chemical plant. Hence, it seems to superficial to represent DSR with standard costs in the study”.*
- *“Revenue estimations that are done by external advisors are based on a "mean" market behavior and stable fundamentals. As such, they don't reproduce specific events which could lead to spikes in prices. They cannot predict neither the probability of occurrence, nor the final value of price during the event”.*
- *“For a conservative evaluation we assume only balancing cost as further element on top at the estimated of day ahead/intraday prices”.*

Q27: How important are the following market-based measures (excluding regulated support such as CfDs, capacity mechanisms, and feed-in tariffs) for managing price and revenue risk for different technologies?

There were 13 responses to this question in total, though the number of responses varied significantly for different technologies. The figure below shows an overview of the responses. The rows represent the *technology*, while the columns represent the *measure.* The colour shading and bold number in each cell represents the *average value of the responses received* ranging from 0 (Not important) to 2 (Very important). The number below in brackets indicates the *number of responses* provided for a given technology and measure. Empty responses are not included in the averages.



Q28: How do these mitigation options interact with the risk adjustment approaches mentioned in Q23?

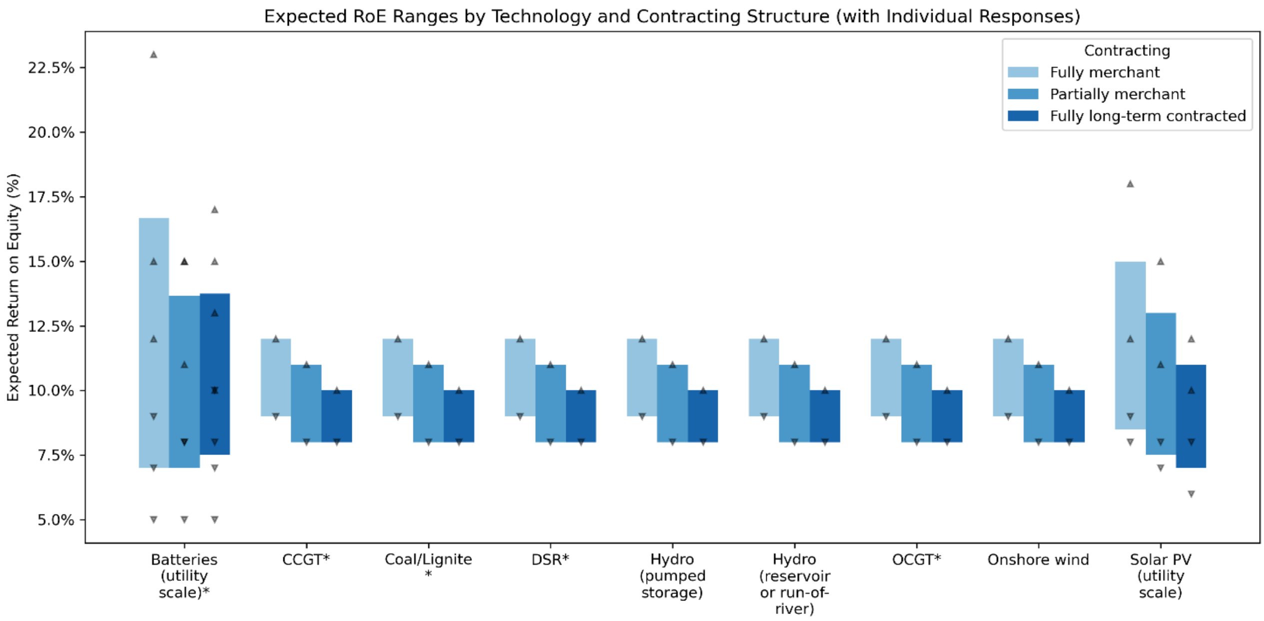
There were 15 responses to this open question.

Examples of detailed responses:

- *"All the suggested options are useful but not sufficient for mitigating the forward risk. furtherly all the mentioned options are not liquid solutions".*
- *"Tolling agreements or any mechanism that provides revenue certainty can reduce project risk. As a result, a lower project IRR can be acceptable due to the improved risk profile".*
- *"Price and revenue risks already actively managed/mitigated by market-based measures (esp. within liquid period) should not be addressed in addition by e.g. hurdle rate adjustments or Value at Risk calculus".*
- *"Market-based mechanisms that reduce price and revenue risks allow to fund the investment with external Debt, reducing Capital exposure and enhancing equity IRR. For batteries and pumped storage hydro, these mechanisms are still underdeveloped. As a result, such investments primarily depend on merchant revenues, which involve high financial risk and significant capital exposure, making investment decisions particularly challenging".*
- *"The high price volatility in the spot market created by the increase in renewable penetration has created huge international competition to win long-term contracts (CfD, PPA, PTC - Production Tax Credits, etc.). This is the main hedging strategy, along with vertical integration between production and retail market statistics. Of course, having a portfolio of assets diversified by production technologies and different countries helps a lot. Hedging solutions via futures markets are useful operational aids, but not essential for making investment decisions".*

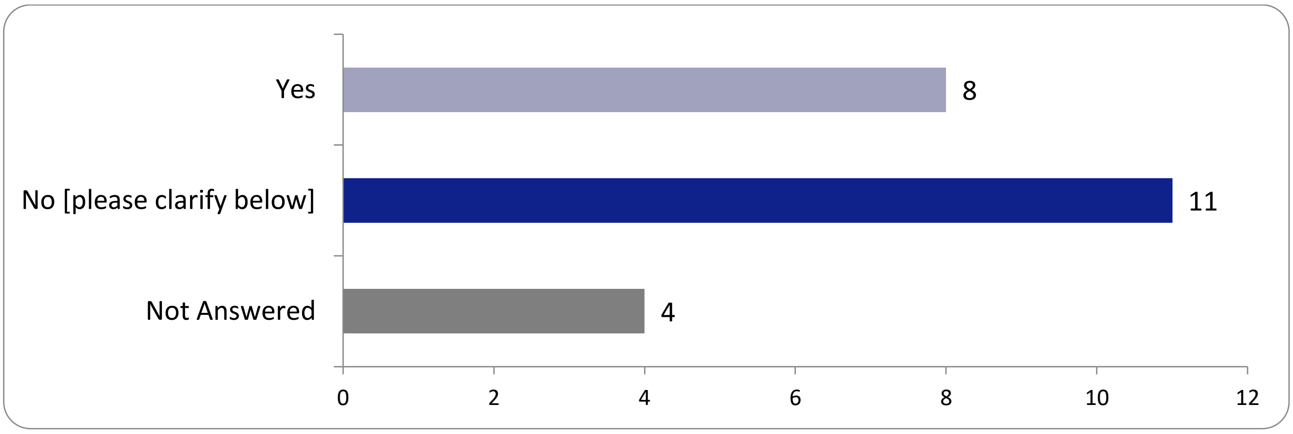
Q29: What is the typical range of return on equity (RoE) you would expect for the following investment types?

There were 5 responses received to this question. More responses were received for some technologies than for others. The figure below shows an overview of responses. The coloured bars represent the range between the average of the responses received for the lower and upper ranges on RoE for each technology and contract type (where provided). The downward and upward facing triangles show the individual responses for the lower and upper RoE ranges.



Q30: Are the approaches for accounting for price and revenue risk mentioned in Q23 sufficient to capture all investment risks?

19 responses collected:

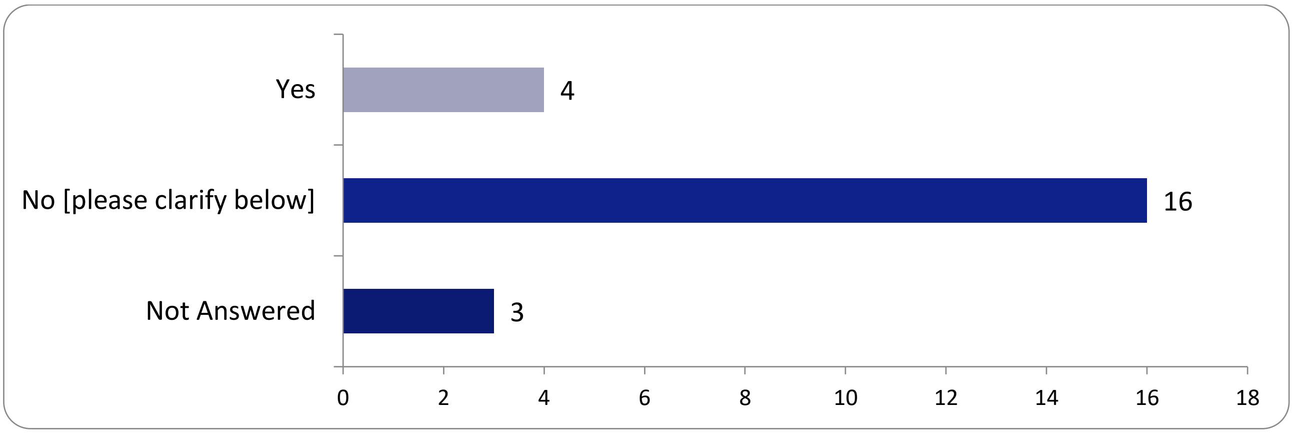


Examples of which risks are not accounted for:

- *“There are two streams: (i) economic, (ii) regulatory. In field of economic stream approach mentioned in Q23 is sufficient. However, in regulatory field the risks are not always predictable and feasible - with this regard, EU Green Deal is the source of this kind of risk. Country specific information: frequent local regulatory framework changes (NRA competence)”.*
- *“There is a variety of risks, which is to some extent very asset or project specific and hardly quantifiable and/or appropriately considerable via hurdle rate adjustments or Value at Risk calculus, e.g. permitting risk, risk of changing regulatory environment, risk of change in subsidy schemes, risk of large delays along new build projects, overall future plant cost uncertainty, uncertainty of technical asset performance etc”.*
- *“Using a Hurdle premium factor in addition to a weighted average cost of capital (WACC) “base” model helps overcoming the limitations of a pure capital asset pricing model (CAPM) and shall simulate with more realistic results the decision-making process followed by investors. In fact, market players always show a certain level of risk aversion regarding their investment decisions, in the attempt to price the volatility and the uncertainty of the revenue projections. Nonetheless, [respondent] believes that only a revenue-based approach allows to evaluate the economic performance of each unit participating in the electricity-only market and, consequently, to estimate its profitability in given conditions as a basis for future investment/divestment decisions”.*

Q31: When considering potential decisions in new capacity, are the results of quantitative (risk-adjusted) modelling of business case assessments sufficient to make a final investment decision?

20 responses collected:



Examples of which other factors are considered to make a final investment decision:

- *“It is common to carry out sensitivity analyses of relevant risk factors and, in some cases, determine the cash flow at risk. These are aids in making the decision to invest once the fundamental indicators have been met (NPV and number of years until reaching IRR>0). Ultimately, it will be the strategic and political sensitivity of the Investment Committee that decides”.*
- *“We do not use solely risk-adjusted modelling, but also comprehensive qualitative analyses like: compliance check, strategic outlook on legislative/regulatory development, etc. Investment decision is conditional to fulfilment of main prerequisites of business plan, including continuous implementation and post-implementation phase monitoring”.*
- *“In the economic evaluation of the interest in investing in new capacity, operators also take into account strategic positioning considerations, analyzing whether a given technology (especially if characterized by an innovative profile, as it is the case with electrochemical storage batteries or, in the long term, with new nuclear plants) brings added value in terms of strategic diversification and investor’s expertise, in addition to the evaluation of the economic feasibility of the individual plant being considered”.*

Market entry and exit barriers

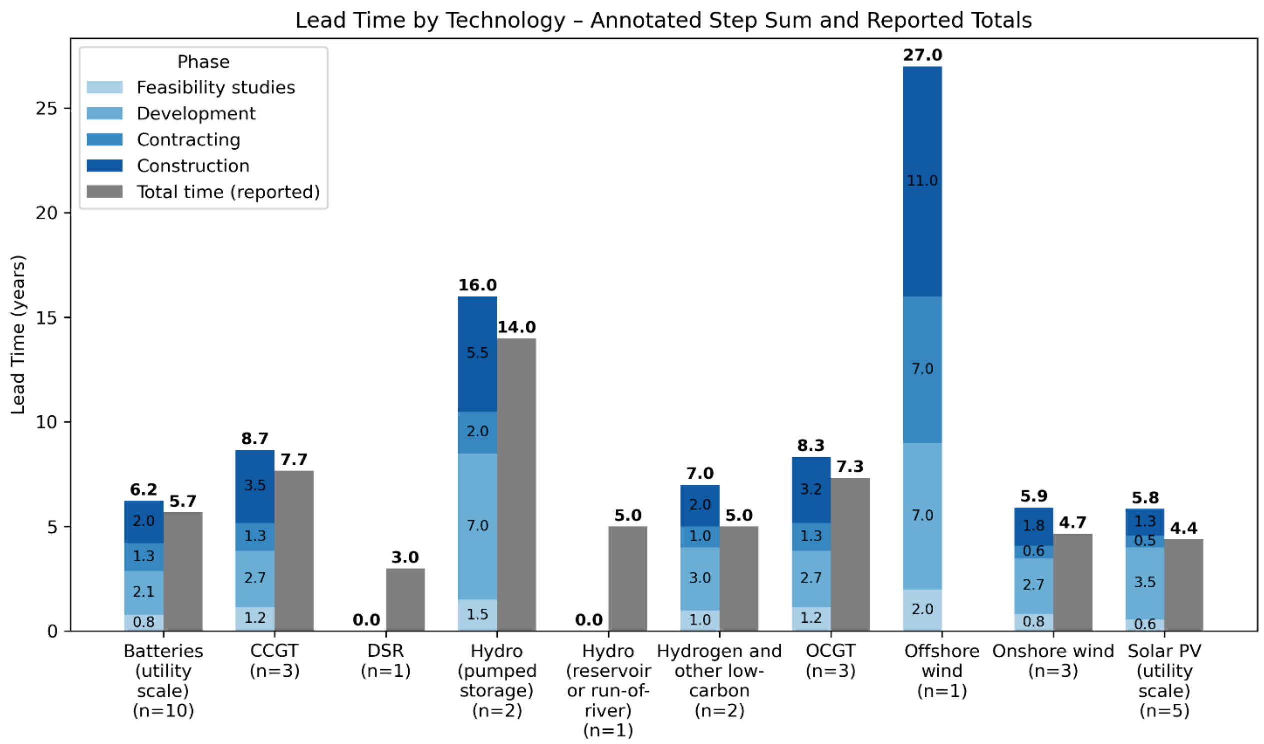
Q32: When considering bringing new capacity on the market, how long do you expect the full process to take from start to finish?

Where possible, please estimate the duration (in years) for each of the following steps:

- *Feasibility studies (i.e. grid & site studies, technology type and size selection)*
- *Development (i.e. technical design studies, grid connection, permitting)*
- *Contracting (i.e. equipment tendering and contract negotiations, financing, FID)*
- *Construction (including commissioning)*

13 responses were received to this question in total, with responses varying per technology. The figure below shows the overall results, with the number of responses per technology shown alongside the technology. As respondents were able to provide both (a) the time per step/phase (which could potentially overlap) as well as (b) the total time to market, the results are shown in two ways:

- the coloured stacked bars shows the mean value of all responses received for the different phases (steps) required to bring new capacity to market.
- the grey bars indicate the mean value of all responses for the total reported time required.



Several 'other' remarks were also received:

- referring to new CCGTs and OCGTs: *"…duration dependent on brownfield vs. greenfield; dismantling"*
- referring to new batteries: *"grid capacity and connections are the most important bottleneck"*
- referring to new hydro capacity: *"Project duration strongly depends on the complexity of the project and dimension of the future asset regarding impact on nature, location (remote region), size of the required dams and extend of underground facilities"*

Q33: Are there any other financial or non-financial (e.g. legal, practical, administrative) barriers to market exit which should be considered in the ERAA?

There were 14 responses to this open question, where most agree on the following barriers: Regulatory and legal; Administrative; Financial (e.g. FOM); Market and portfolio considerations; and Policy, social, and environmental.

Examples of detailed responses:

- *"Retiring a production asset from service, that is not covering **fixed maintenance (FOM)** costs or requires significant renovation investment, is not just an economic decision. First, a **portfolio management of generation** - retail market may justify keeping it because the backup alternative via the market may be more expensive and risky; second, the market is not completely free, it may require **government authorization** or the need to avoid displeasing the government".*
- *"**Permitting procedures** can act as a significant barrier to market exit, particularly if the outcome is unfavourable or if the process is excessively lengthy and burdensome".*

Q34: Are there any financial or non-financial (e.g. legal, practical, administrative) barriers to market entry which should be considered in the ERAA?

There were 16 responses to this open question, where most agree on the following barriers: Regulatory and permitting; Grid access and infrastructure; Financial (e.g. CAPEX investments, financing challenges); Policy and political risks; and Strategic and modelling considerations.

Examples of detailed responses:

- *"The electricity market has limited freedom. One of the biggest "competitors" is the **state** itself, which promotes long-term contracts for technologies that it considers important for decarbonization. In many cases, investors simply participate in this policy and when they decide to invest independently, the biggest barrier they encounter is obtaining a connection to the grid".*
- *"**Permitting and administrative** procedures, as well as **supply chain timings**, undermine the investment economic viability".*
- *"Numerous barriers, either **financial** (such as capital rationing constraints) or non-financial (e.g. related to **political and regulatory** risk or to strategic considerations) may exist when making an investment decision, which is always at the end of the day, to a greater or lesser extent, a (reasoned) bet on the future. These are unfortunately very difficult to model in a quantitative exercise such as the ERAA, but a general guideline should be… to be cautious on market entry – the practical implementation of this recommendation being open to discussion".*

Q35: What are the main factors you consider when deciding whether to take capacity off the market temporarily (mothball), or permanently?

There were 13 responses to this open question.

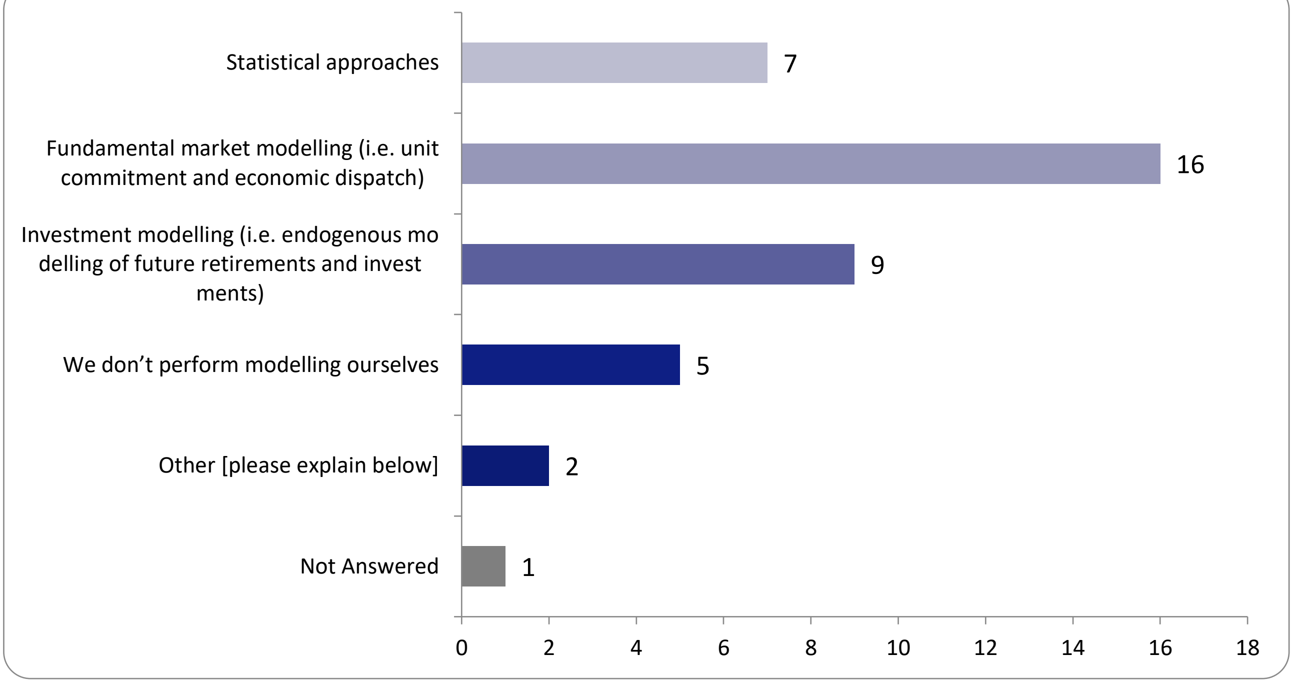
Examples of detailed responses:

- *"Opportunity costs/income trading-off an additional business opportunity or an expected recovery of market prices against age/technical condition of an operational asset".*
- *"Economic viability/profitability; governmental exit targets (e.g. mandatory exit from coal based power generation); corporate level sustainability targets".*
- *"Unless they are driven by legal requirements (e.g. mandatory coal phase-out enshrined in the law), these decisions are mainly determined by the absence of profitability of the assets, as recorded in a recent past or anticipated for the future".*
- *"Cost and what to do with the O&M human resources".*

Specific modelling approaches for electricity price forecasting and economic viability assessment

Q36: Which type(s) of modelling does your organisation perform when developing price forecast and assessing the future economic viability of existing and potential new-build assets?

20 responses collected:

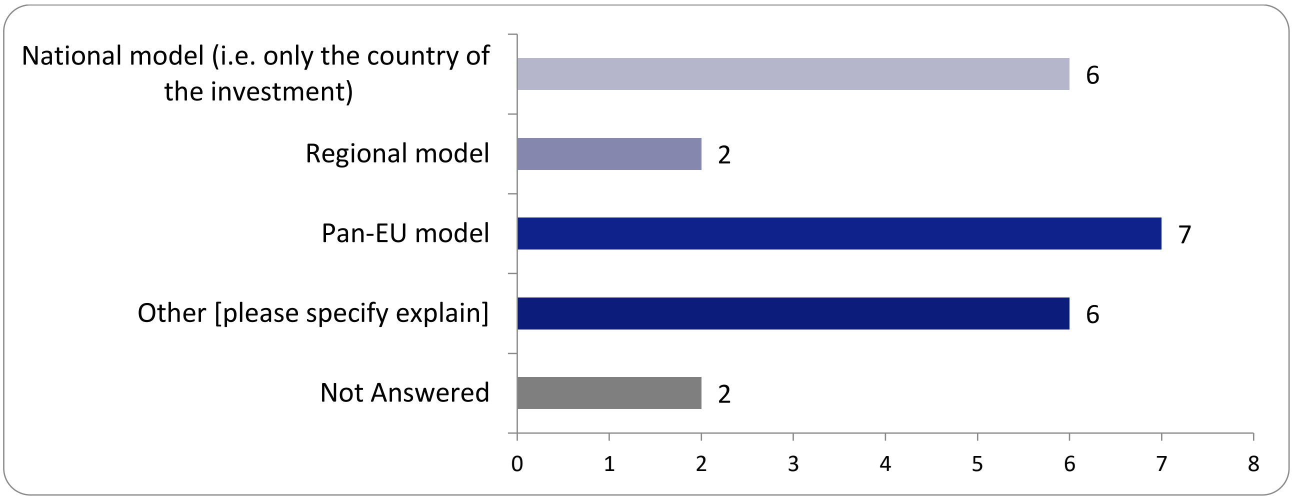


Examples of 'other' responses:

- *"We use different price forecast based on fundamental market modelling and investment modelling".*
- *"We know that the fundamental market modelling is more and more often insufficient to produce a sustainable and robust valuation for a FID. as above mentioned we introduce different evaluation scenarios in order to analyze the "possible" range of return on investment".*

Q37: Which geographical scope do you consider when modelling prices and assessing potential future business cases?

21 responses collected:

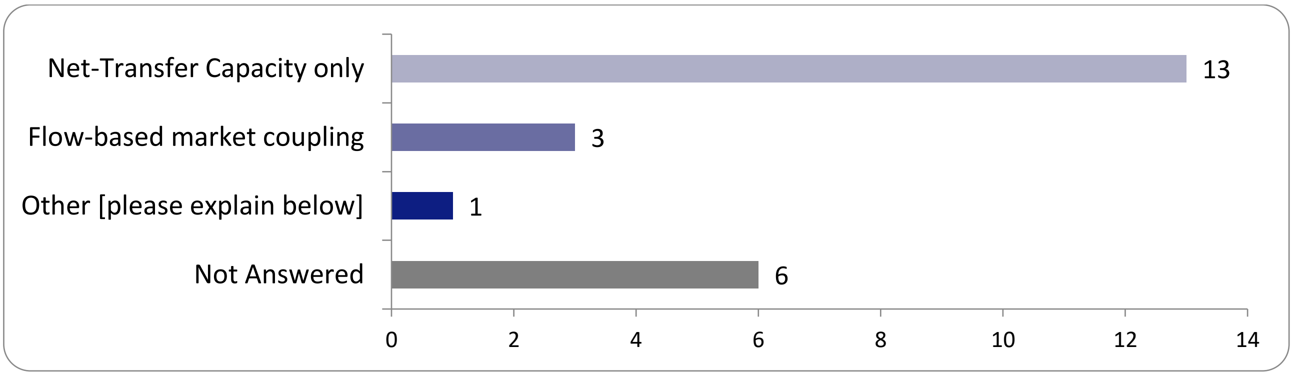


Examples of 'other' responses, where 5 explained that they include national and regional scopes.

- *"Mostly national for generation assets but sometimes regional when the market is on multiple countries. It is rather related to bidding zones".*
- *"Although zoom of modelling at regional/national is needed. In this sense, ERAA should be complemented by a NRAA periodically updated".*

Q38: How do you consider transmission capacities between bidding zones for regions/countries where flow-based market coupling is (expected to be) applied in reality (e.g. CORE)?

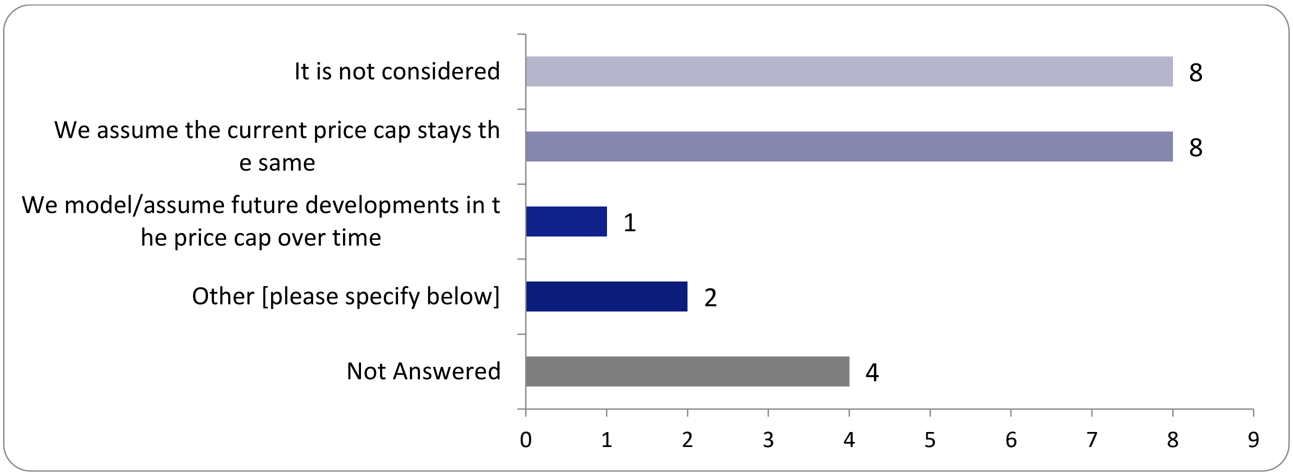
17 responses collected:



'Other' response: *"Both" are considered*

Q39: To what extent do you consider the day-ahead market price cap, when modelling future evolution of electricity prices and potential revenues?

19 responses collected:

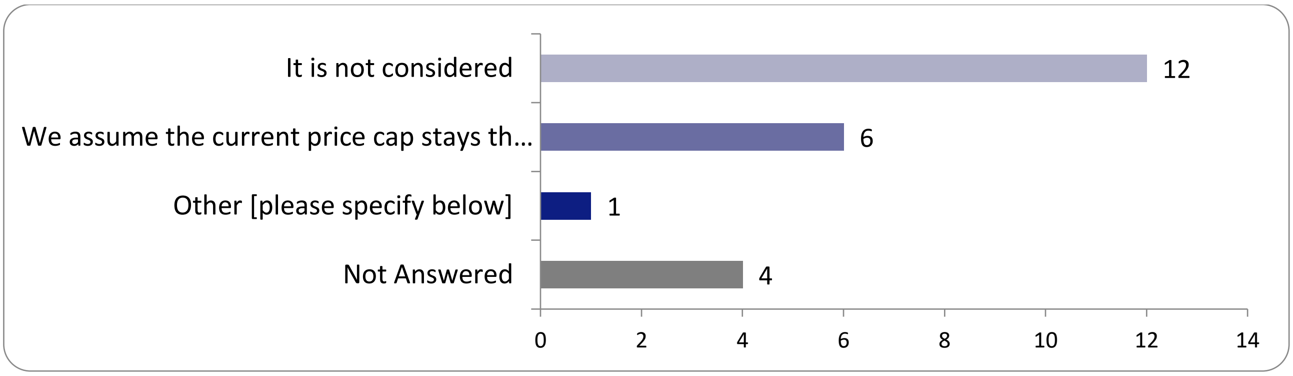


'Other' responses:

- *"When taking investment decisions, investors may also factor in the risk that the government could try to intervene to limit their margins when rare scarcity pricing events do occur. Moreover, occurrence of negative prices can also be driven by external factors more sustained in time because in these cases regulatory reaction may not be as fast as when price spikes occur".*
- *"We assume a static level above the current day-ahead market price cap".*

Q40: To what extent do you consider the intraday market price cap, when modelling future evolution of electricity prices and potential revenues?

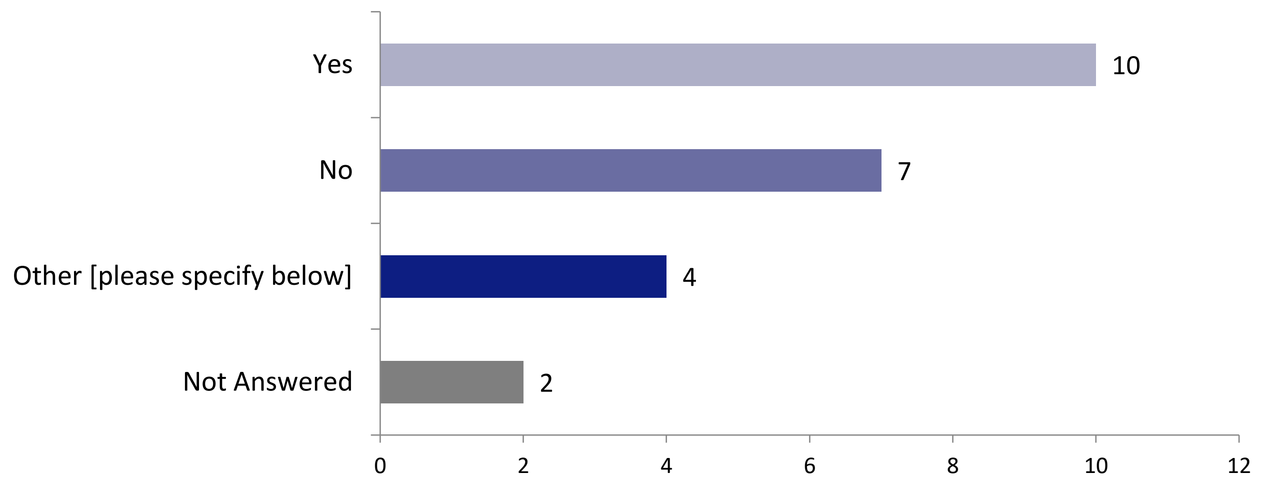
19 responses collected:



'Other' response: "*In the ERAA context, modelling stress situations with such [detailed] assumptions may be worthless (or even misleading). Moreover, this approach decreases the performance of simulation runs, which could be better utilized for modelling other features".*

Q41: Do you estimate and account for future ancillary service requirements from TSOs (e.g. balancing reserve), as a driver for your investment decisions?

21 responses collected:



Examples of 'other' responses:

- *"Yes, but ancillary services are small markets with high risk of cannibalization. For a proper estimation, stability in ancillary services design is key. System needs (local and balancing) at national level must be forecasted and procurement schemes must be designed in advance. Regarding balancing, they should converge as much as possible to EU standard products (FCR, aFRR, mFRR). Regarding local services (non-frequency and congestion management) joint participation of both existing and new assets allows efficient procurement and proper investment signal for entry/exit. Additionally, one should consider that artificial split of products is not profitable for assets in the long run, because the underlying needs are the same from the TSO point of view."*
- *"Yes, they are an additional element to consider when evaluating investment decisions. We consider today's ancillary services, but with a certain degree of caution regarding those that are planned but not yet certain. In any case, they are not considered key elements for this type of investment".*
- *"No; as long as the TSOs do not commit to binding minimum purchase quantities".*