Stability market design innovation project – 2nd Engagement Webinar

AFRY & National Grid ESO

8 FEBRUARY 2022

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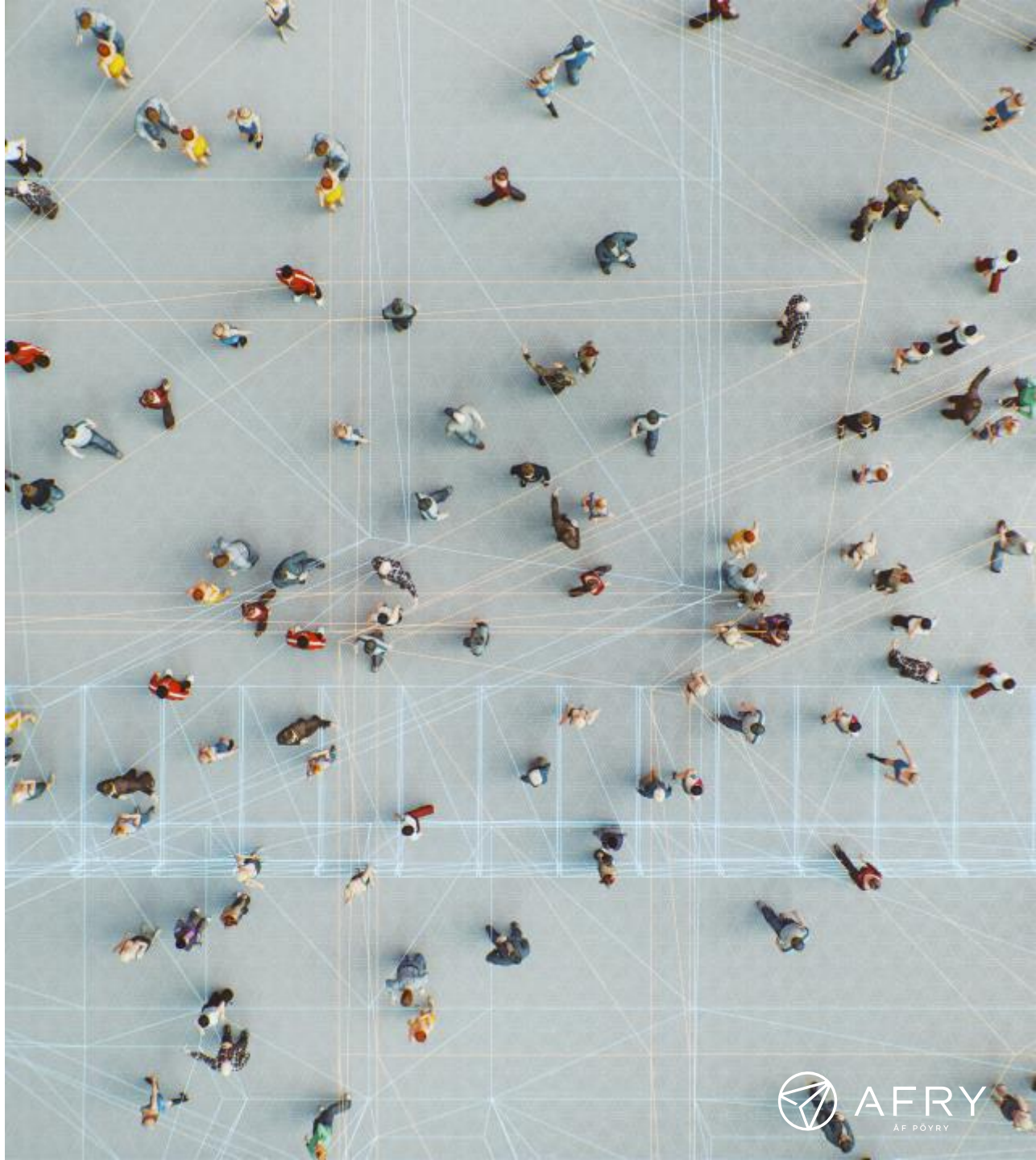
Housekeeping

- Reminder: Please keep your microphones on mute.
  - We will have an opportunity for people to raise hands and speak if they wish at the end of the session.

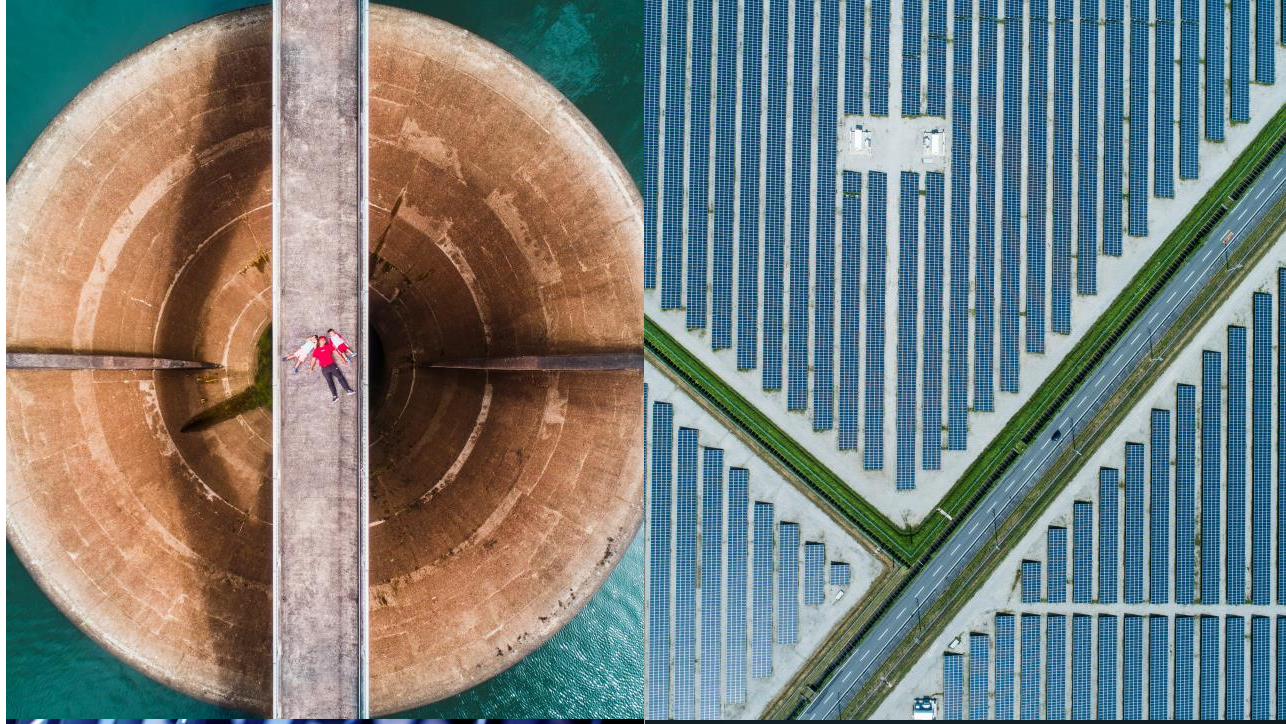
- The Webinar will be **recorded**.

- We will be using Mural to gather **feedback** and for **voting** as we go through the presentation.
  - Link will be **posted in the chat**.
  - Please feel free to leave **comments or questions** as we run through the presentation.
    - We will pick up on questions and comments at the end of the session.
  - **Voting** will happen in Mural – please feel free to leave comments on the specific question if voting for 'other'.
  - The Mural board will remain open for one week (closing 15 Feb) for people to leave additional comments



Agenda

1. Introduction & project journey 4
2. Status quo & the case for change 8
3. Preferred solutions & key questions 18
4. Open discussion (Mural) 30
5. Next steps 32



This project is exploring what an appropriate market solution to resolve stability challenges could entail

What is the Project?

High-level Market Design

The project is a research study exploring desirable design options for a potential GB stability market.

Outcomes

Enable ESO to start planning a stability market.

What next?

The project outcome is a preferred way forward – future considerations will consider detailed market design & analysis. There will be additional consultation with industry and opportunity to refine based on engagement

Innovation project, study-based

Engaging with wider industry

Started in Sept 2021 - aim to finish in Feb 2022

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The market design journey involves testing various design option candidates

1 → 2 → 3

Alignment, vision, objectives | **Design elements, strengths, weaknesses** | **Industry views, refinement, finalisation**

1a. Scene setting

What are the realities? Establish 'givens' and make assumptions on all relevant topics

1b. Objectives

What do we want to achieve? Establish the design principles for the market

2a. Market building blocks

Define the key design choices that can materially impact market outcomes

2b. Straw-man options

Define conceptual design options to assess – exploring alternative philosophies

2c. Assessment

Appraise design options qualitatively/quantitatively against objectives

3a. Refinement

Highlight the preferred option; make improvements to increase performance against our objectives

3b. NIA desirable option

Recommend a desirable design for stability market and way forward

Stakeholder engagement has fed into our assessment

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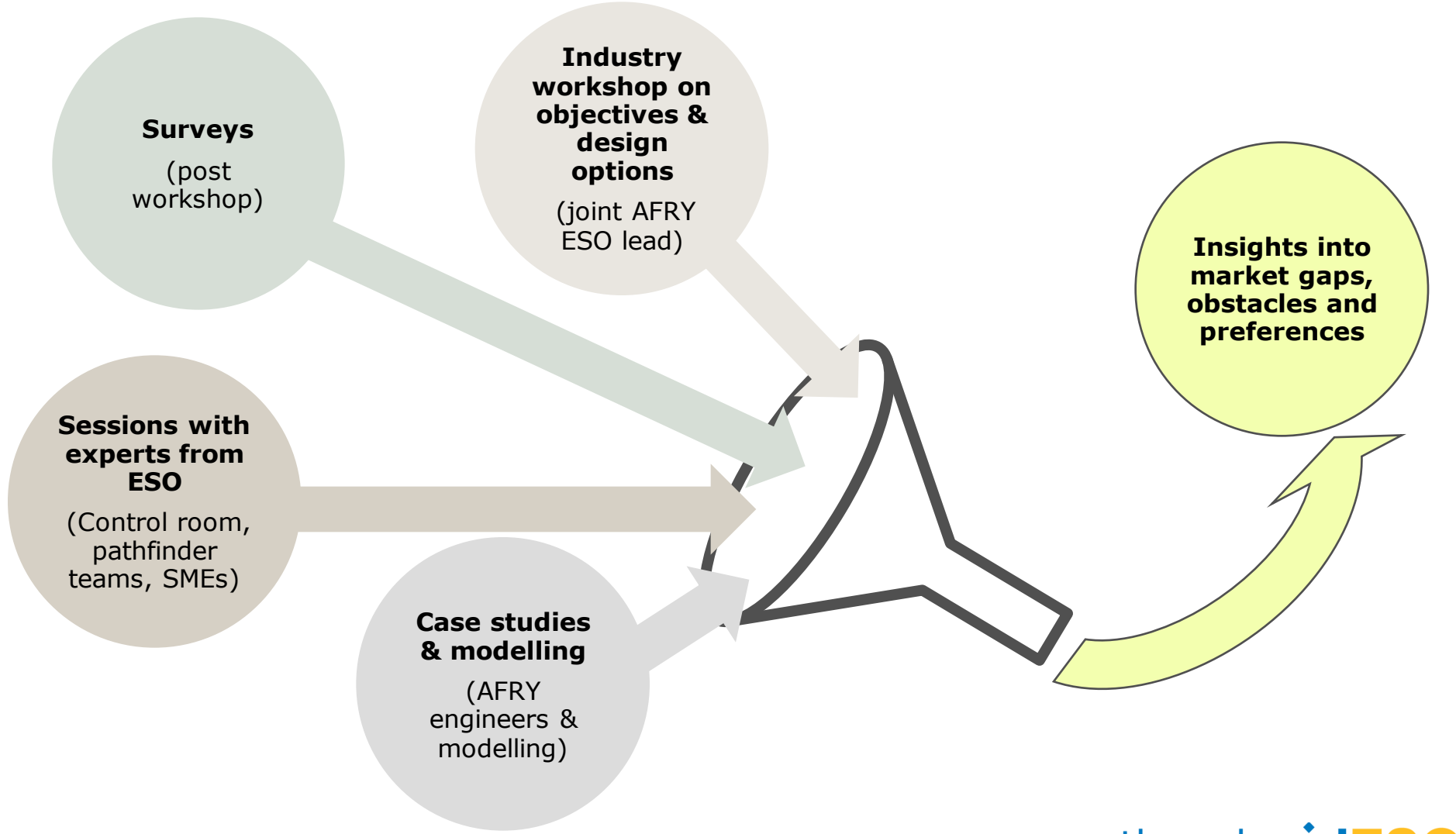
We have relied on a range of sources to support our conclusions so far



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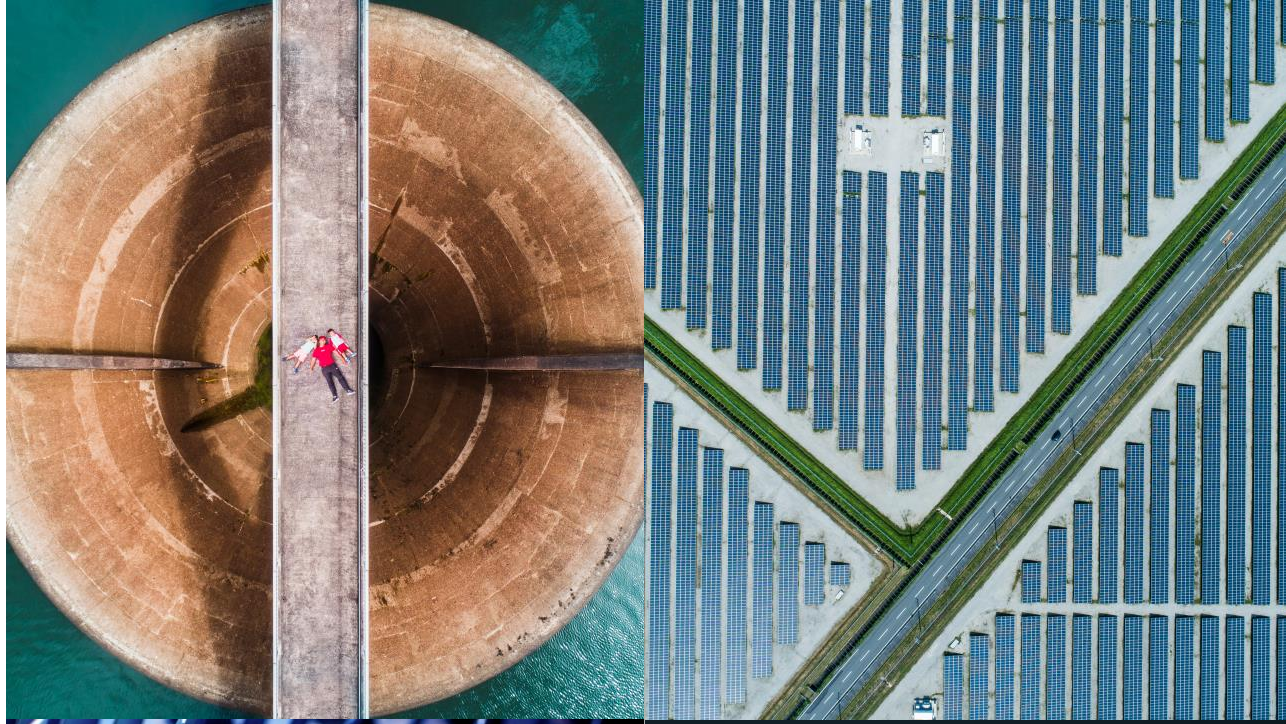

Challenges for managing stability manifest as a result of an evolving system

Historical
Where are we coming from?

Historically, stability was provided as a by-product of generation and was in abundance.

Today
What is happening now?

Rapid growth in renewables, retirals of synchronous generation and changes to the structure of demand.

The management of grid stability has become increasingly expensive and we are exploring new commercial options for stability services including pathfinders.

Future
Where are we going?

As the system evolves towards technologies not inherently capable of providing critical technical attributes to ensure system stability, **how do we incentivise new providers and solutions to emerge, and respect existing providers?**

Targeted (+paid)

Passive (+unpaid)

CASE FOR CHANGE

The relative importance of existing tools for managing stability is shifting

Procurement/provision mechanism		Volume today *(ESO reliance)*	Direction of travel
Pathfinder contracts *Long-term targeted provision*	**Investment timeframes** *(ESO secures long term capability)*	**Small**	**Growing** *(zero base)*
Market schedule *short-term global passive provision*	**Commercial decision timeframes** *(ESO assesses whether intervention is necessary)*	**Large**	**Shrinking rapidly**
Balancing mechanism, trades, and other bi-laterals *short-term targeted provision*	**Operational timeframes** *(ESO intervention to ensure system stability)*	**Medium**	**Growing**

Key question

What is the desired solution?

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The objectives articulate our framework for success

Primary objectives

Ensuring **cost-efficient provision** of services needed to **maintain system stability and security** in the interest of consumers and to be able to operate a zero-carbon grid

Secondary objectives

Investable: respecting existing and supporting efficient future investments

Transparent: visibility of service values and clear procurement decisions

Technology neutrality: being non-discriminatory between technologies with equivalent capabilities

Practical: ease of implementation, operation and transition

Enduring (stable): suitable and adaptable to future challenges

Freedom of choice: avoiding lock-in, giving ongoing choice in the market for providers and for ESO as buyer, ensuring liquidity and mitigating market power

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Current arrangements are sufficient for the coming years, but a number of weaknesses against our objectives can be identified

System stability & security	Meeting system security in the coming years (~5y horizon) due to **pathfinders**. However, expectations of future needs **evolve rapidly**, no regular procurement exercise at present (ad-hoc pathfinder process).
Cost-efficient	Current routes to market **limit pool of participation and competition**. **No dedicated route-to-market** for providers with **low availability visibility** or **high opportunity/variable costs** of provision close to real time other than bi-lateral arrangements – not perceived as competitive.
Zero-carbon compatible	BM actions for stability are generally **carbon intensive**.
Investable	Pathfinders require **high availability**, placing a **barrier to entry** for providers with high variable or opportunity costs or low availability certainty. **Single buyer risk** for participants is a perceived barrier.
Transparent	Ad-hoc nature of Pathfinder does **not provide visibility** of future requirements. BM is a single market where services are bundled and difficult to disaggregate accurately.
Technology neutrality	Some providers are explicitly excluded from early Pathfinders while others face high barriers to entry (e.g. **high availability requirements**), limited routes to **participation in operational timeframes** (only BM bundled with MW instructions or bi-lateral agreements).
Practical	Current processes already in place, no major changes if sticking to status quo. Pathfinders could benefit from more **standardised process** for assessment.
Enduring	**Restrictive eligibility**, **lack of a LT foresight** hinder market interest and R&D by OEMs which can limit the scope of future innovation.
Freedom of choice	Currently only routes are to **lock-in long term** or rely on balancing actions. **Limited choice** for providers who can only participate in pathfinders or be instructed through balancing actions.

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When transitioning from todays arrangements, the design choices we face have a number of key challenges with implications on a potential solution

ESO as single buyer

Energy Complexities

No traditional marketplaces

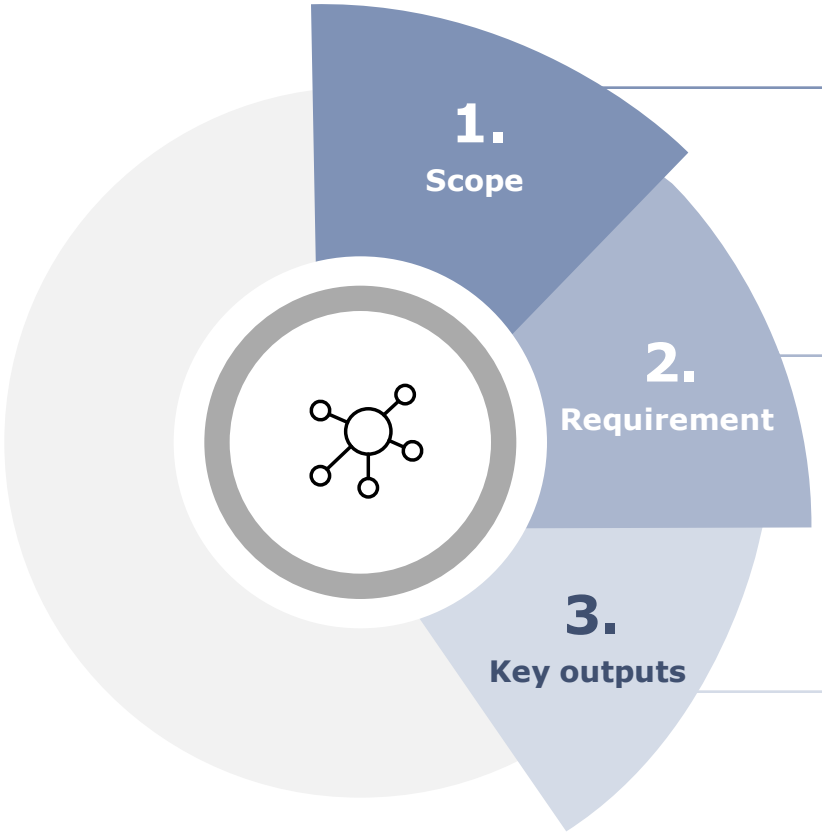
Innovative technologies

Overlapping solutions with TO

Locational need

MODELLING WORK

AFRY has modelled stability constraints under ESO's FES scenarios to understand the nature of future requirements



- We modelled a number of scenarios using AFRY's BID3 power market model, the scenarios were based on **National Grid's Future Energy Scenarios (FES), 2019** edition: Two Degrees, Community Renewables, and Consumer Evolution.
- All scenarios were developed for two years (**2026, 2030**).

- **Inertia** is defined as a **system-wide** stability constraint.
- **SCL** is defined as a **regional** stability constraint (we have modelled 5 key regions for the purposes of this analysis).

- The modelling provides insights into the impact of stability constraints on the wider system, we have assessed key outputs including:
- **redispatch** volumes & cost, **need for additional investment** in order to meet stability requirements, and redispatch impact **on carbon emissions**

Notes: Modelled under FES 2019 scenarios, ESO is currently in the process of updating under latest scenarios. Requirements under latest scenarios expected to be greater due to shifting views on future evolution of the electricity system (in particular towards high levels of non-synchronous generation)

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Pathfinder projects will contribute significantly to system security in the 2020s

System stability & security

Cost-efficiency

Zero-carbon compatible

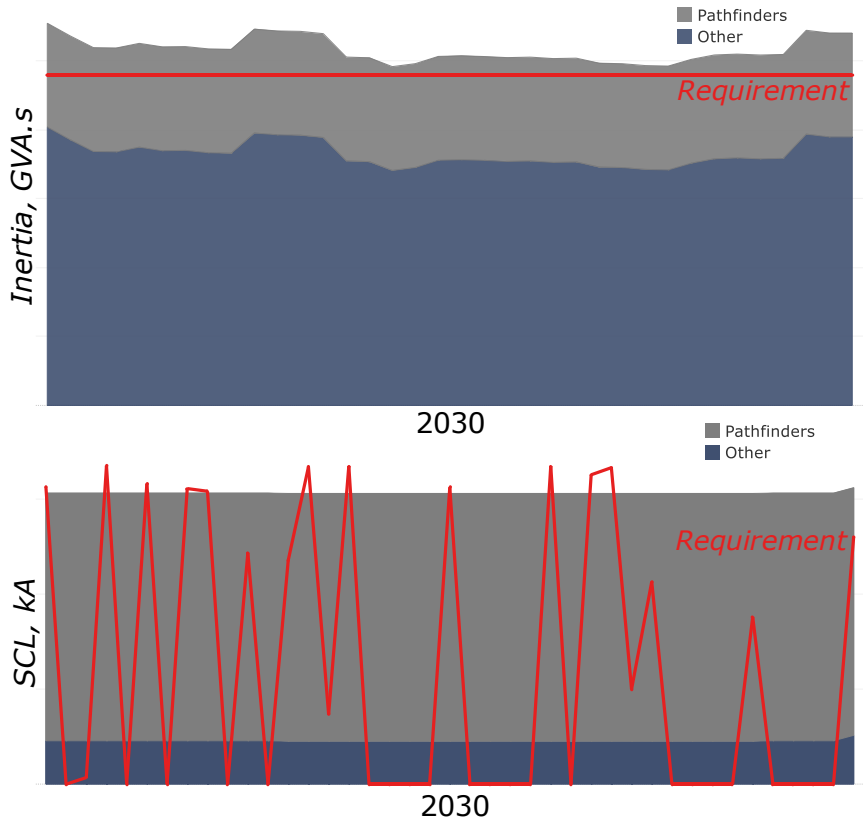
Key considerations for security

Pathfinders have contributed significantly to **security**.

Shortfalls in provision from the market schedule can be **unpredictable**, system must be continually monitored to ensure compliance with stability requirements.

Limited options to utilise providers that are technical capable but cannot be instructed with MW actions (e.g. grid forming converter connected tech).

Provision of stability services (Two Degrees)



There are nevertheless barriers to participation for existing providers

System stability & security

Cost-efficiency

Zero-carbon compatible

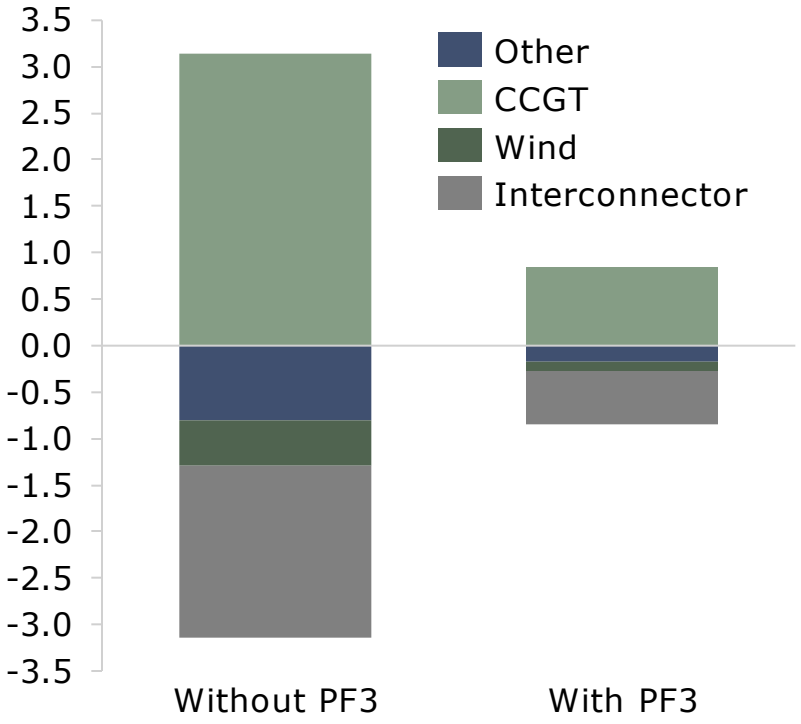
Key considerations for cost-efficiency

Pathfinder can help to reduce redispatch volumes, but costs of **high availability** must be weighed carefully to ensure optimal balance of investment and short-term actions.

Balancing Mechanism alone is not cost optimal to manage stability. **Substituting** non-synchronous for synchronous providers can be **expensive**.

Limited routes to market **inhibits competition** from sources that cannot be instructed through traditional balancing tools.

Re-dispatch[1] (TWh) **from stability actions** (Two Degrees, 2030)



Notes: [1]Scenarios display total redispatch for stability actions only – we have also co-optimised with other constraints and isolated the impact of stability product provision to give a fair assessment of marginal actions for stability needs

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Reliance on balancing mechanism actions bundled with MW results in increased carbon emissions

System stability & security

Cost-efficiency

Zero-carbon compatible

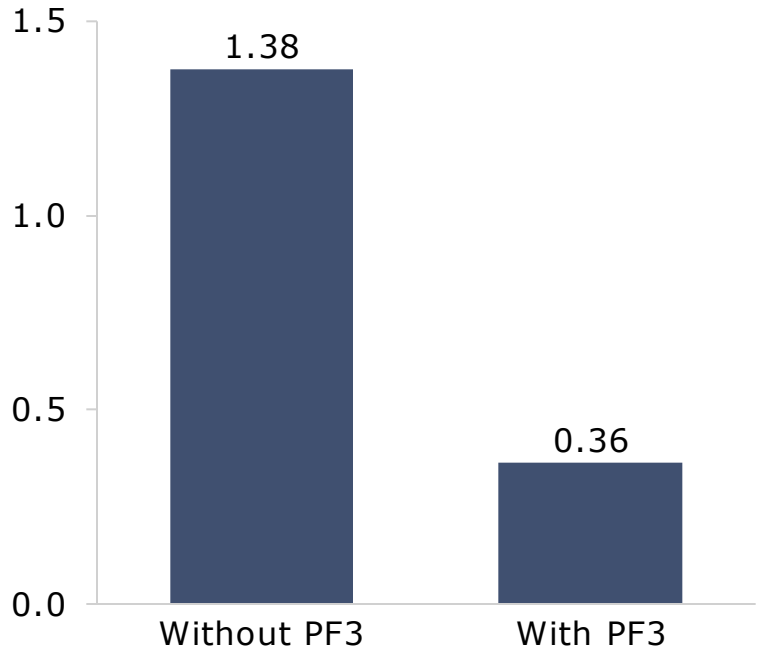
Key considerations for zero-carbon

Pathfinders have procured/are expected to procure **low carbon** technologies.

Reliance on turning up **carbon intensive plant** in BM to secure residual needs in real time is not desired.

Need to create short-term route to market for providers that are able to provide services **independent of MW** position.

CO_2 emissions (Mt) from stability management actions (Two Degrees, 2030)



Note: Excludes carbon emissions from additional MW draw for stability providers under pathfinders, which add limited emissions to the figures shown here

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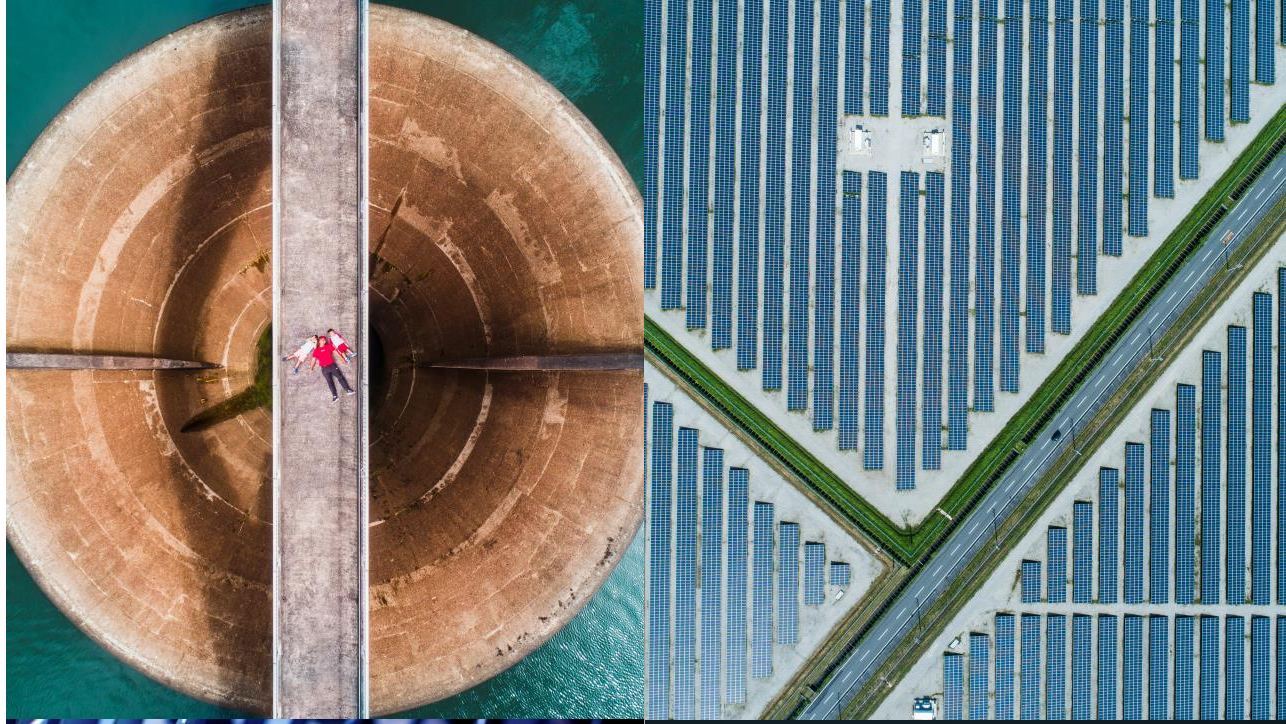

We have explored 4 potential solutions (straw-man options) to assess the merits of potential design decisions

***All straw man options** include Pathfinders (1,2,3) and the BM*

All exclude direct TO participation

All envisage a national market for inertia and regional procurement for SCL & DVC

Our preferred option is a variation on option C

		A	B	C	D
		Short-term *(only)*	**Long-term *(only)***	**Evolution**	**Revolution**
		New ST market. No new Pathfinders.	A new LT market arrangement replaces the Pathfinder arrangements.	New ST market alongside continued Pathfinders, run at ESO discretion.	Introducing a new ST market + new LT market arrangement run at scheduled intervals
Timeframe	**Lead time**	Day-ahead	T-1 Year T-4 Years	ST: Day-ahead LT: ad-hoc	ST: Day-ahead LT: T-4 + T-1
	Frequency Baseload/firm	Daily	Annual	ST: Daily LT: ad-hoc	ST: Daily LT: Annual
	Contract duration	Hourly	1-15 years	ST: Hourly LT: ad-hoc/10y	ST: Hourly LT: 1-15 Years
Product	**Contract type**	Firm	Baseload (Firm) Shape (Firm) Conditional (Non-firm)	ST: Firm LT: baseload (firm)	Baseload (Firm) Shape (Firm) Conditional (Non-firm)
	Complex contract	No	Call option Conditional contract	No	Call option Conditional contract
Pricing	**Pricing Mechanism**	Pay-as-clear	Pay-as-bid	ST: pay-as-bid Pathfinder: pay-as-bid	ST: pay-as-bid LT: pay-as-bid
	Payment type	Availability (£/SP)	Availability (£/SP) Utilisation (£/MWh)	ST: Availability (£/SP) LT: Availability (£/SP) + Implicit utilisation (£/MWh)	ST: Availability (£/SP) LT: Availability (£/SP) + Utilisation (£/MWh)
Eligibility	**New & Existing**	All	New	ST: all LT: "Additionality" (for new prov.)	All
	In-merit & Out-of-merit	All	Not applicable in LT	ST: out-of-merit	ST: all
	Procurement strategy	Gross	Opportunistic	ST: Shortfall LT: Opportunistic	ST: Gross LT: Opportunistic

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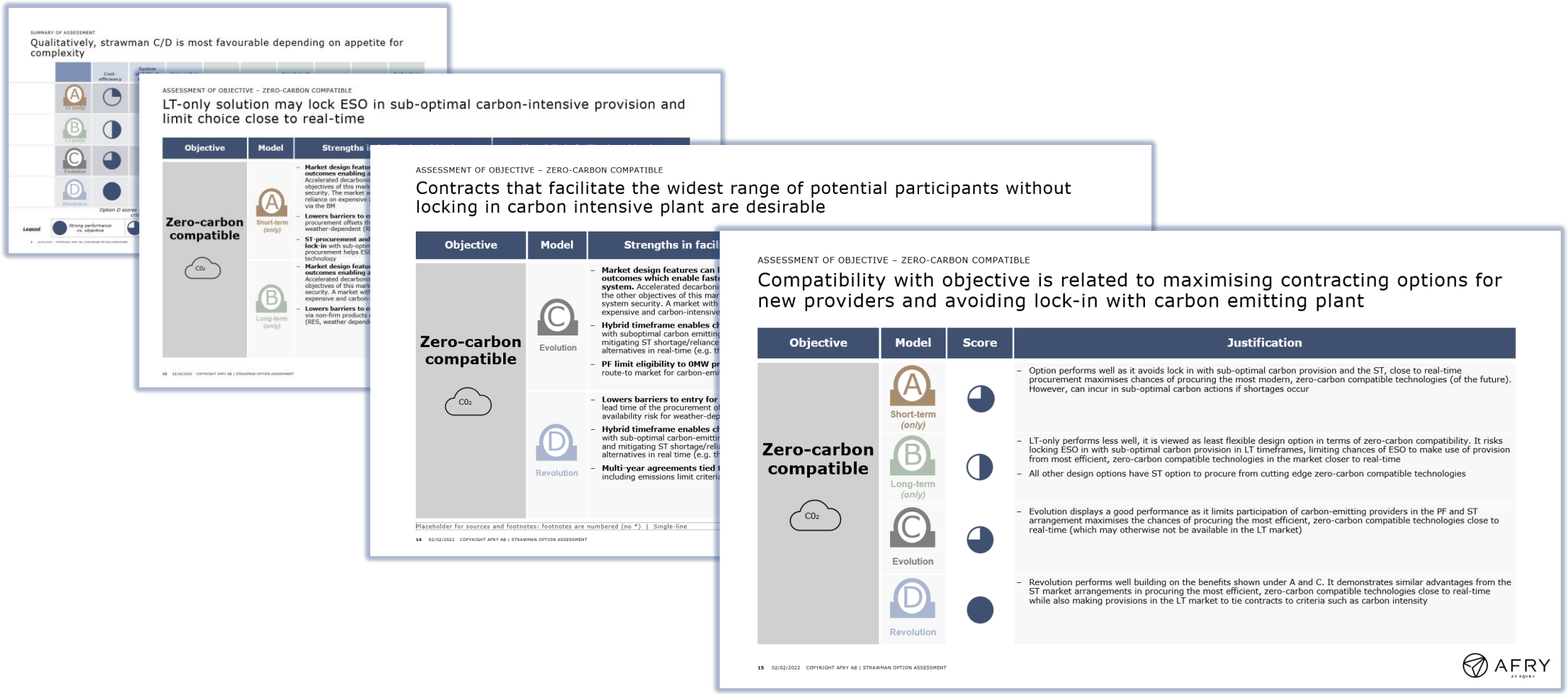
A thorough appraisal of the merits and drawbacks of each model has been undertaken and will be shared



SUMMARY OF ASSESSMENT

Qualitatively, strawman C/D is most favourable depending on appetite for complexity

ASSESSMENT OF OBJECTIVE – ZERO-CARBON COMPATIBLE

LT-only solution may lock ESO in sub-optimal carbon-intensive provision and limit choice close to real-time

Objective	Model	Strengths
Zero-carbon compatible	A Short-term (only)	– Market design featu… outcomes enabling … Accelerated decarboni… objectives of this mark… security. The market … reliance on expensive … via the BM – Lowers barriers to e… procurement offsets th… weather-dependent (R… – ST procurement and … lock-in with sub-optim… procurement helps ES… technology
	B Long-term (only)	– Market design featu… outcomes enabling … Accelerated decarboni… objectives of this mark… security. A market wit… expensive and carbon-… – Lowers barriers to e… via non-firm products … (RES, weather depend…

ASSESSMENT OF OBJECTIVE – ZERO-CARBON COMPATIBLE

Contracts that facilitate the widest range of potential participants without locking in carbon intensive plant are desirable

Objective	Model	Strengths in facil
Zero-carbon compatible	C Evolution	– Market design features can … outcomes which enable fast… system. Accelerated decarboni… the other objectives of this mar… system security. A market with … expensive and carbon-intensive… – Hybrid timeframe enables ch… with suboptimal carbon emitting … mitigating ST shortage/reliance … alternatives in real-time (e.g. th… – PF limit eligibility to 0MW pr… route-to market for carbon-emi…
	D Revolution	– Lowers barriers to entry for … lead time of the procurement of … availability risk for weather-dep… – Hybrid timeframe enables ch… with sub-optimal carbon-emitti… and mitigating ST shortage/reli… alternatives in real time (e.g. th… – Multi-year agreements tied t… including emissions limit criteria…

Placeholder for sources and footnotes: footnotes are numbered (no *) | Single-line

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ASSESSMENT OF OBJECTIVE – ZERO-CARBON COMPATIBLE

Compatibility with objective is related to maximising contracting options for new providers and avoiding lock-in with carbon emitting plant

Objective	Model	Score	Justification
Zero-carbon compatible	A Short-term (only)	◔	– Option performs well as it avoids lock in with sub-optimal carbon provision and the ST, close to real-time procurement maximises chances of procuring the most modern, zero-carbon compatible technologies (of the future). However, can incur in sub-optimal carbon actions if shortages occur
	B Long-term (only)	◑	– LT-only performs less well, it is viewed as least flexible design option in terms of zero-carbon compatibility. It risks locking ESO in with sub-optimal carbon provision in LT timeframes, limiting chances of ESO to make use of provision from most efficient, zero-carbon compatible technologies in the market closer to real-time – All other design options have ST option to procure from cutting edge zero-carbon compatible technologies
	C Evolution	◔	– Evolution displays a good performance as it limits participation of carbon-emitting providers in the PF and ST arrangement maximises the chances of procuring the most efficient, zero-carbon compatible technologies close to real-time (which may otherwise not be available in the LT market)
	D Revolution	●	– Revolution performs well building on the benefits shown under A and C. It demonstrates similar advantages from the ST market arrangements in procuring the most efficient, zero-carbon compatible technologies close to real-time while also making provisions in the LT market to tie contracts to criteria such as carbon intensity

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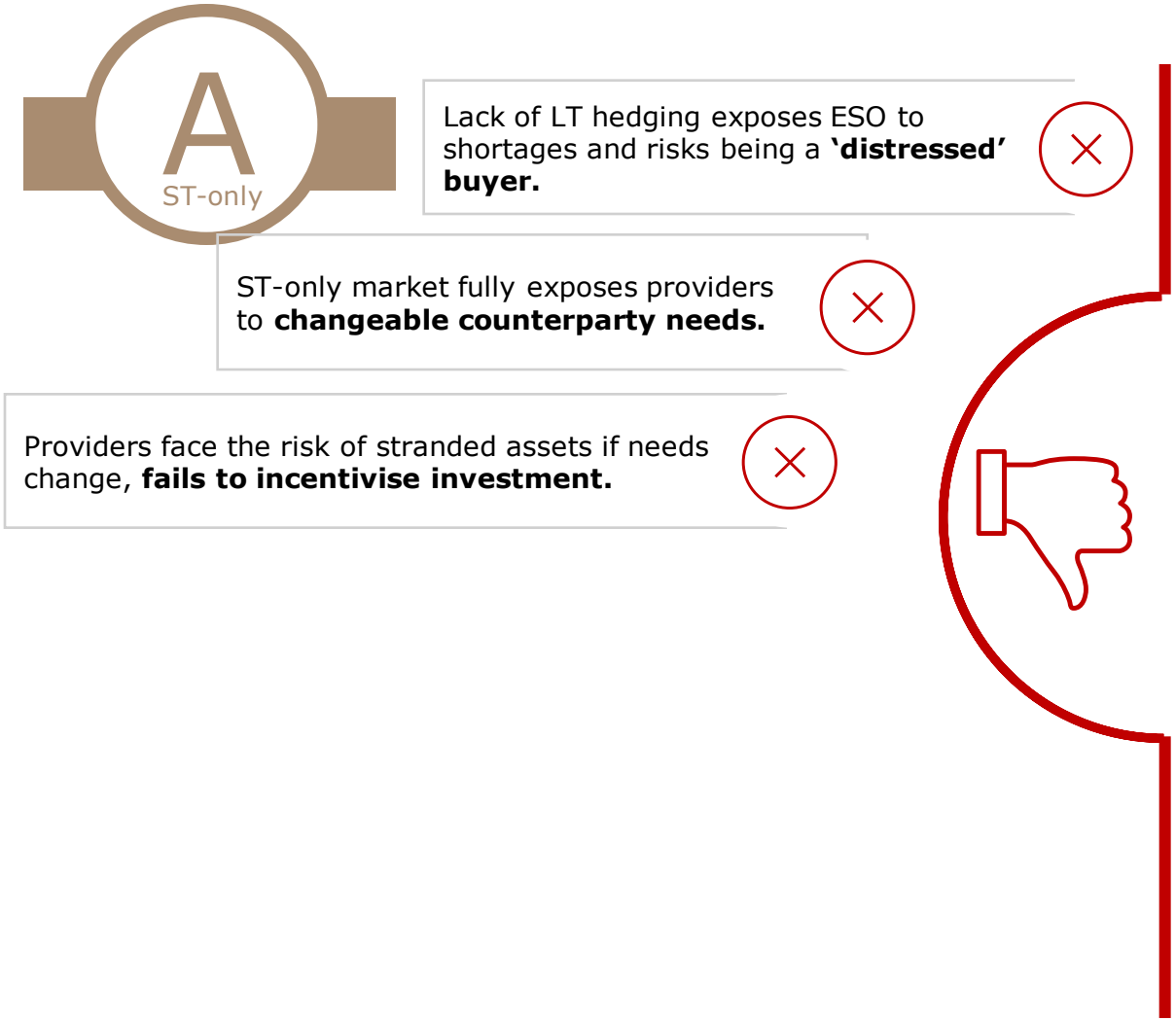
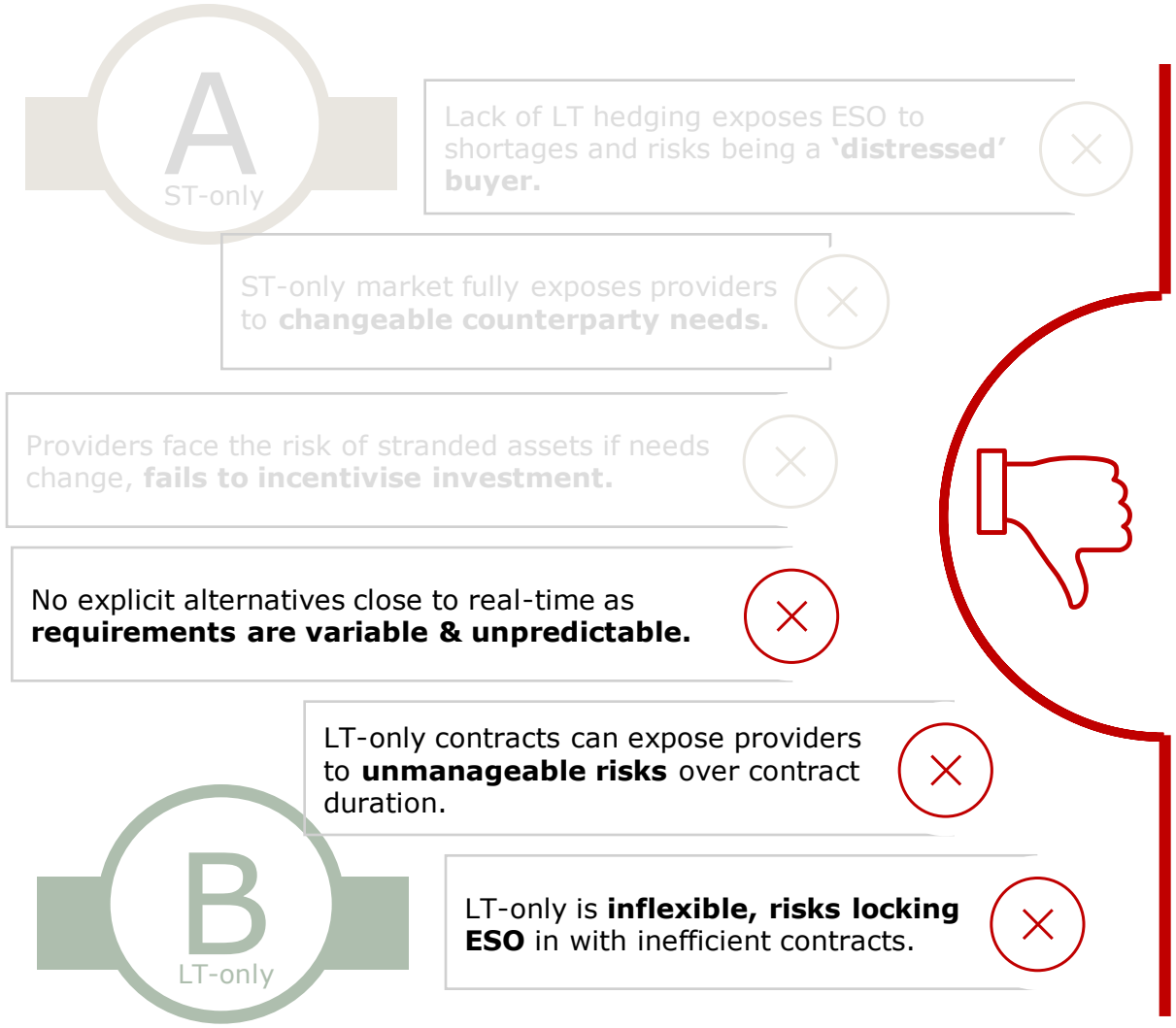
Option A has weaknesses related to system security



Option B presents difficulties in accommodating all providers



A more complex version of option C (or simplified D) is desirable

A
ST-only

Lack of LT hedging exposes ESO to shortages and risks being a **'distressed' buyer.**

ST-only market fully exposes providers to **changeable counterparty needs.**

Providers face the risk of stranded assets if needs change, **fails to incentivise investment.**

No explicit alternatives close to real-time as **requirements are variable & unpredictable.**

B
LT-only

LT-only contracts can expose providers to **unmanageable risks** over contract duration.

LT-only is **inflexible, risks locking ESO** in with inefficient contracts.

C/D
Hybrid

LT offers a route-to-market for **investment.**

Close to real-time flexibility for additional provision to maintain **system security.**

Close to real-time market **lowers barrier to entry** for providers who cannot commit in advance.

Opportunistic buying strategy represents opportunity to **save on costs** and **broadens eligibility** pool.

Hybrid market timeframes & opportunistic buying, provide a **route-to-market for a wide pool of participants** required to meet requirements, **maximising resources** available to ESO.

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There is no universal consensus in feedback received from participants to date, but some key themes have emerged and have been considered

You said…	…We considered
Participants expressed a preference in a **hybrid market timeframe** (long and short term).	A **hybrid** timeframe as being the most desirable option.
Pathfinder contracts have favoured **investment in new-build assets** over existing providers.	Short term option to be more attractive for existing providers and allow **broader participation.**
Prospective providers highlight unpredictable opportunity costs, variable costs and maintenance costs leading to **long-term price risk**.	Short term option for those unable to **manage long term risk** + variable compensation mechanism for long term contracts.
Respondents share a view that **all providers** should be able to participate if they are bringing a **tangible benefit**.	**Global eligibility** for providers, with a **value-for-money** assessment.
Majority of responses were in agreement over the difficulties with locational aspects of the services, with respondents **favouring simplicity** and maintaining national procurement where possible.	**Single contract type** for long term and **single contract type** for short term.

Notes: We have also carefully considered views not presented here, these were the top emerging themes where a broad consensus existed

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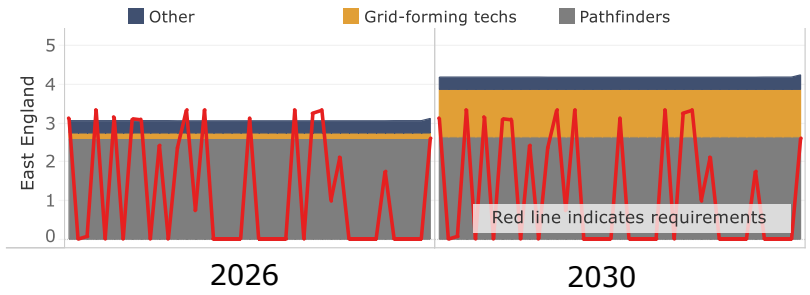
AFRY has modelled additional scenarios where broader participation exists, reinforcing our understanding of what constitutes a desirable outcome

System stability & security

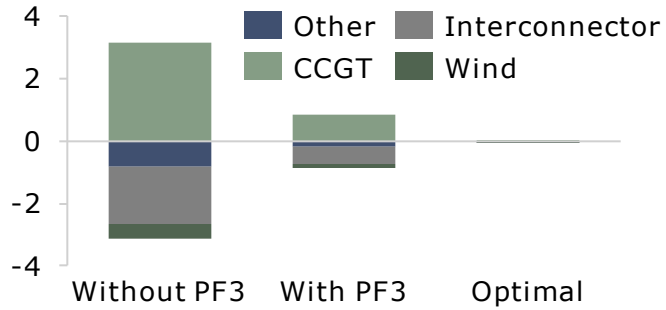
SCL provision (Two Degrees, excl. baseload generation, kA vs hour of sample day)



- By 2030 there could be significant contribution from **grid forming** technology for both SCL and inertia provision.
- We need to ensure arrangements **facilitate** these potential new sources.

Cost-efficiency

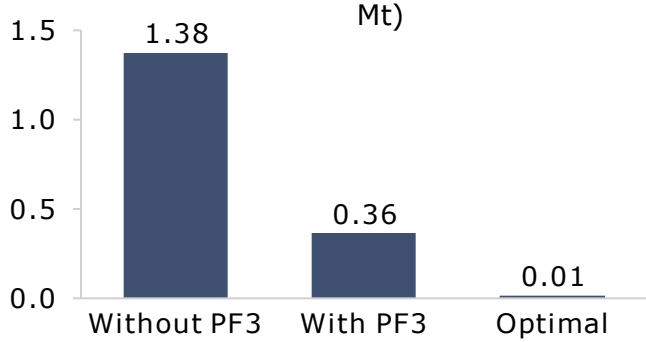
Redispatch actions for stability provision (Two degrees, TWh)



- Continuing with long-term procurement (to ensure security) can bring significant benefits in terms of reducing reliance on **costly balancing actions**.
- Ultimately, accommodating a **broader range of technologies** and providers should lead to more efficient outcomes.

Zero-carbon compatible

Carbon emission from stability redispatch actions (Two degrees, Mt)



- Reducing reliance on redispatch where there are a limited pool of providers (mostly **carbon intensive**) can bring significant benefits in terms of carbon reduction.
- The ability to procure services close to real time without **being required to bundle with MW** can allow providers to meet constraints most efficiently.

Notes: Optimal scenario incl. additional investment and wider participation from 0 MW providers

Open question	
Preferred option	

PREFERRED SOLUTIONS AND KEY QUESTIONS

The preferred design option has two (potentially three) timeframes with different objectives and characteristics

		Long-term market	Short-term market	RATIONALE
Timeframe	Requirement determination	Annual	Daily	NG ESO will carry out periodic offline studies and forecasting to determine requirements – on an annual basis (deviates from C with ad-hoc approach).
	Frequency of procurement	Ad-hoc	Daily	While the requirement determinations are run annually, there may be no strict need for a regular procurement round if no new requirements are identified. The Short Term market is run daily.
	Procurement lead time	Ad-hoc T-[5/4]: Prequalification T-[4/3/2] : Procurement T-1: Procurement (if needed to correct forecast error) *What is the lead time for new assets?*	Day-ahead *TBC exact timing*	The Long Term market will operate with prescribed lead times to accommodate investment decisions. A 'prequalification' stage may be necessary, recognising network connection lead times. The ST market operates in operational timeframes, better reflecting providers that face opportunity costs. It also provides a stability route-to-market for providers who don't have the ability to commit availability in LT timeframes.
	Contract duration	1-20 yrs *How* closely *should LT contracts match the lifetime of the asset?*	Daily 23:00 D to 23:00 D+1	New providers in the LT procurement are able to strike long-term contracts. 15 years is an option that aligns with the Capacity Market. Existing providers in the T-1 should be evaluated on a case-by-case basis, 1-year contract to be the default and avoid problems of lock-in, this is intended to influence closure decisions in the event of a capability shortfall due to closure forecast errors.

Open question	
Preferred option	

PREFERRED SOLUTIONS AND KEY QUESTIONS

The preferred design aims to provide flexibility in the product and contract type

		Long-term market	Short-term market	RATIONALE
Product	Contract type	Baseload	Settlement period/EFA blocks/day base	The contract types are designed around the nature of the requirements and the characteristics of the providers.
	Product ratio	User-defined	User-defined	In both time-frames, market providers offer services as desirable for them with user-defined product ratios (lending itself more to pay-as-bid).
	Product bidding	Bundled bid	Bundled bid	Each bid is made for packages of services (quantity & availability for each service, with a single price offer for the package).
	Contract obligation	Completion milestones 90%/95% availability	100% availability	Failing to deliver availability results in facing non-performance process.

Open question	
Preferred option	

PREFERRED SOLUTIONS AND KEY QUESTIONS

The payment types across LT & ST accommodate a wide pool of participants, other pricing mechanisms aim to provide transparency and mitigate market power

		Long-term market	Short-term market	RATIONALE
Pricing	Payment type	Availability (£/SP) Utilisation (£/*TBC*) *What's the preferred 'utilisation payment'? (e.g. imbalance price for energy consumption)* *Should LT allow buyback from providers?*	Availability (£/SP)	LT market mainly targeting providers with high-capex low variable cost. There should be arrangements for providers to manage their LT energy consumption costs, currently we envisage this to be in line with pathfinder 1 where providers receive the imbalance price for power draw from the grid. We would assume these volumes are not exposed to final consumption levies/costs. These costs would however be considered in an economic assessment (pre-FCL). ST market targeting high availability & variable cost or low availability & variable cost providers.
	Pricing mechanism	Pay-as-bid	Pay-as-bid	Due to the bundled nature of the products and the locational nature of the services, pay-as-bid is preferred. This prevents ESO from having to determine multiple clearing prices for each product and zone and allows providers to offer synergies where they are possible without partial acceptance risk.
	Price regulation	TO alternative costs	Real-time alternative costs	Partially manages potential manifestation of market power. In the LT this cap is implicit at the level of the TO owned asset solution depreciated over the time horizon on a like-for-like basis, similar to todays pathfinders. In the ST this is a dynamic cap, at the level of the real-time alternative cost of meeting the stability requirement.

Open question	
Preferred option	

PREFERRED SOLUTIONS AND KEY QUESTIONS

Our desired design broadens participation whilst protecting consumers

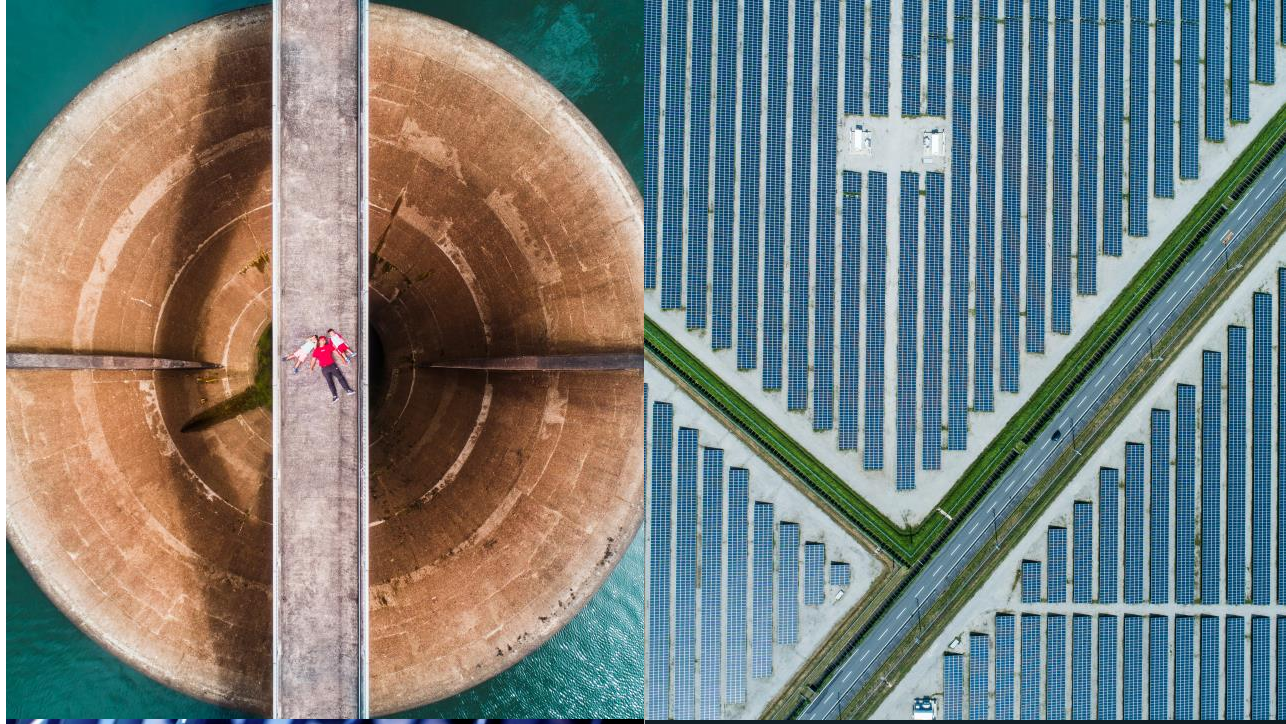
	Long-term market	Short-term market	RATIONALE
Eligibility* — Procurement strategy	Shortfall + Opportunistic	Shortfall + Opportunistic	ESO's procurement strategy will be based on opportunistic buying - under the principles of ensuring system security at least-cost. Under opportunistic buying - once the shortfall has been met, ESO may wish to procure additional volumes if it expects a discount relative to ST procurement (for the LT market) and BM actions (for the ST market).
Eligibility* — New & Existing	-For shortfall: Additionality criteria -For opportunistic: All providers	-For shortfall: Additionality criteria for shortfall -For opportunistic: All providers	ESO will buy services if they are needed to maintain system security and/or are economically advantageous: -The **additionality criteria** will apply in the context of procuring capability to meet the shortfall in requirements. -When procuring beyond the shortfall, **all providers** are eligible. However, they will need to demonstrate they are more cost-effective than the alternative (which may be provision from the market schedule) – *note this does not guarantee all participants will be paid for the service*.
Eligibility* — TO & Commercial assets	Direct participation: Commercial Indirect participation: TO	Commercial only	**Indirect** participation (alternative costs) for regulated TO assets is assumed in this competitive stability market, similar to current pathfinder processes.

*GC0137 is expected to form the technical basis of grid-forming capability, defining the types of power and fault current responses required

nationalgridESO AFRY ÅF PÖYRY

Agenda

1. Introduction & project journey 4
2. Status quo & the case for change 8
3. Preferred solutions & key questions 18
4. Open discussion (Mural) 30
5. Next steps 32



Open discussion/Q&A – link in the chat

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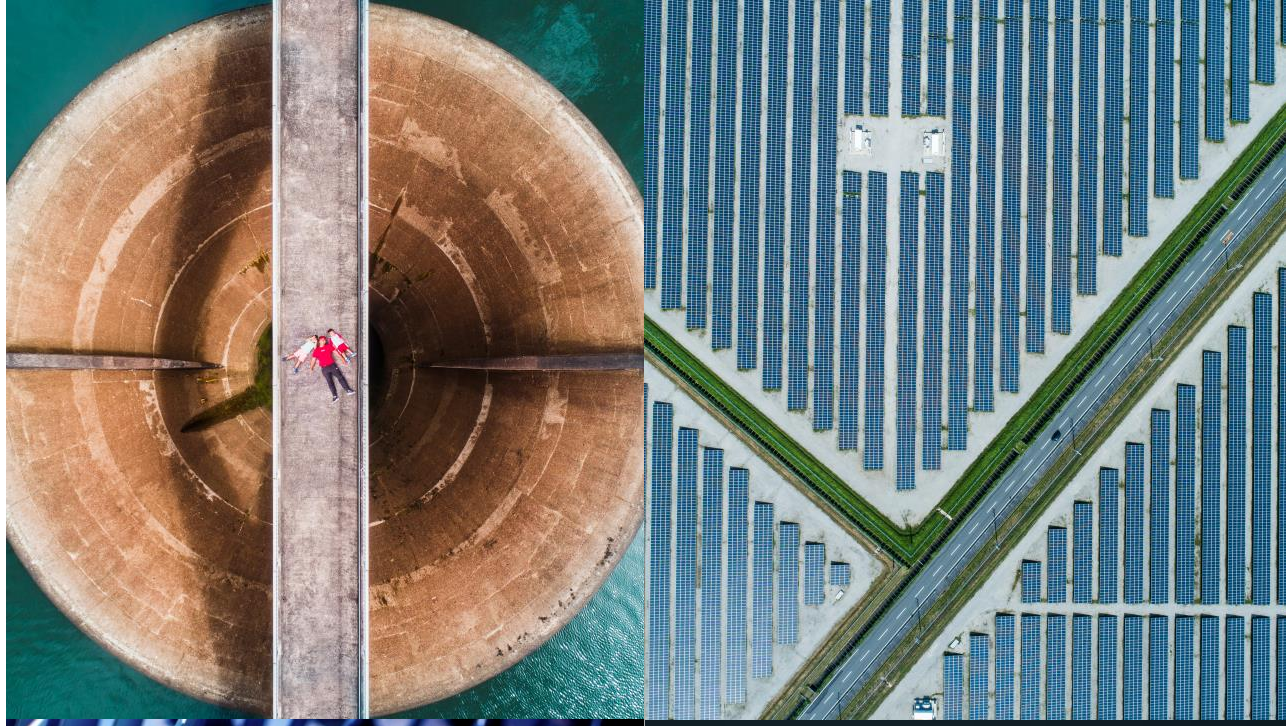
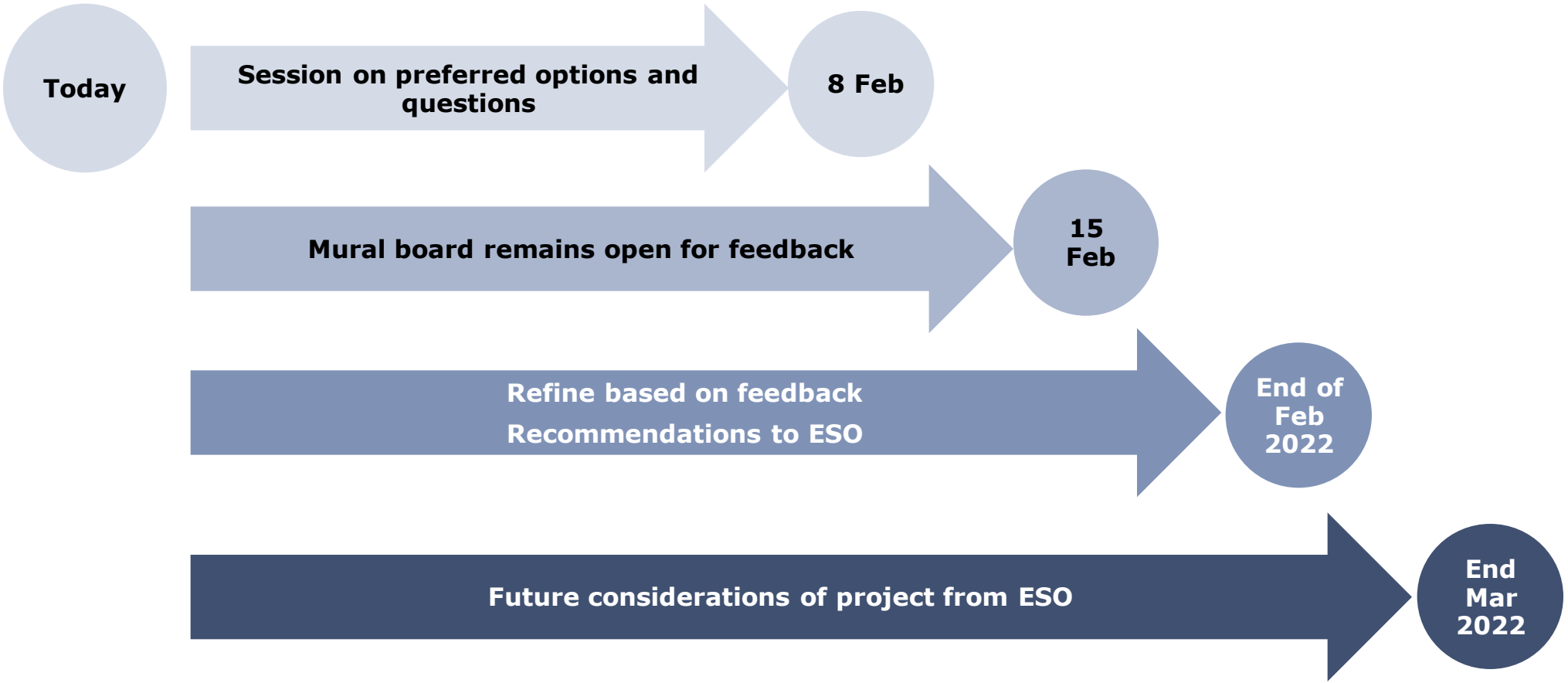


Next steps


Today
Session on preferred options and questions
8 Feb
Mural board remains open for feedback
15 Feb
Refine based on feedback
Recommendations to ESO
End of Feb 2022
Future considerations of project from ESO
End Mar 2022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