WHEN TRUST MATTERS

Operational Metering Requirements

Power Responsive Update 10th March 2025

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Agenda

0. Update on the survey	• Feedback on the responses and missing data	5min
1. Update on modelling approach	• An update on the detailed modelling approach which has been developed and progressed since the last update	15 min
2. Review of modelling assumptions	• Review of assumptions used in the modelling and their importance (impact on results) • Discussion to validate the assumptions with industry	5 min
3. Initial results for discussion	• Overview of initial modelling results which will be further developed to assess the impact of CER metering on NESO	20 min
4. Update on next steps	• Completion of modelling for additional CER technologies • Operational Scenarios to understand impacts on NESO • Survey to understand implementation challenges for aggregators of future recommendation(s)	5 min
5. Q&A	• Questions & answers	10 min

Survey Feedback

Thanks to all those who have responded to the survey – 5 responses have been received.

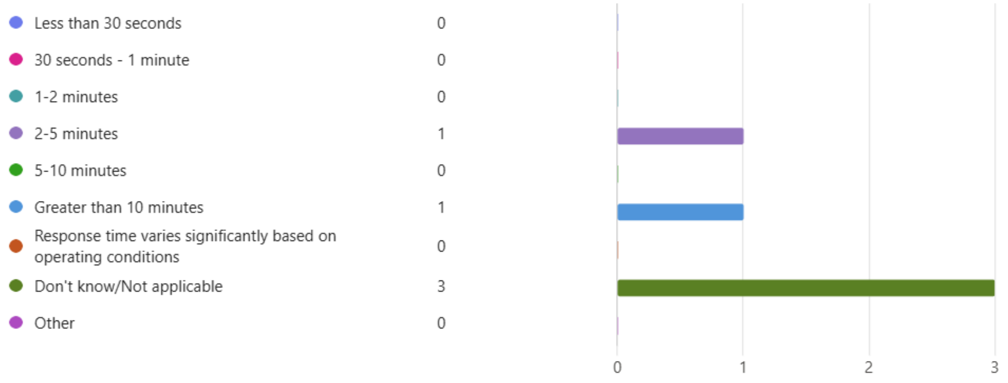
KEY RESPONSES

- Distribution of meter updates – 80% of respondents confirmed that meter updates are evenly distributed across time as uniform (20% don't know)
- Latency – respondents agreed that 5 second latency was possible for at least most, if not all their assets. All agreed 10 seconds was achievable.
- Asset ramp rates – most respondents could not answer heat pump questions, and none could answer Solar and Micro BESS. How can this knowledge gap be addressed?

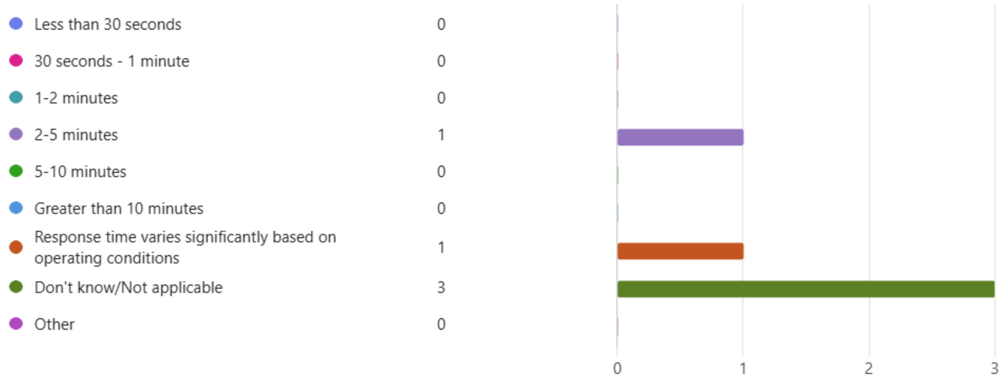
Category	Meter Update Frequency	Ramp Speed	Meter location / Inverter losses impact on accuracy (Grid vs Asset)
Heat Pumps	2 responses	2 responses	0 responses
Solar	0 responses	0 responses	0 responses
Micro BESS	0 responses	0 responses	0 responses

Heat Pumps Feedback

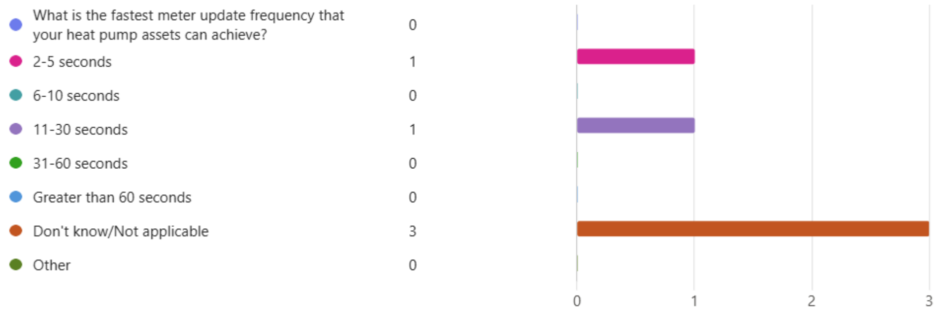
12. 1. What is the typical response time for your heat pumps to fully respond (RAMP UP) to a dispatch signal?



13. What is the typical response time for your heat pumps to fully respond (RAMP DOWN) to a dispatch signal?



10. What is the fastest meter update frequency that your heat pump assets can achieve?



8. Do your heat pumps assets have different performance capabilities for meter update frequency depending on model / manufacturer / integration?

9. If you answered yes to above, please provide more details on the most common causes of variation in capability (e.g. age of asset / difference between manufacturers / firmware / communication limitations) ___________

3 Responses

ID ↑	Name	Responses
1	anonymous	We have work primarily with I&C heatpumps and have seen a wide range of capabilities. Above 200kw, we have seen 5 to 15 seconds metering rates. Latency as as stated above.
2	anonymous	Please note our portfolio applies to all kinds of assets not just heatpumps, this applies to all answers specific to heat pumps from here
3	anonymous	Many heat pump models do not have any on board metering. Those that do often utilise exrapolated information, and can have significant variations in accuracy. Many heat pumps also require additional hardware which is not standard installation.

Modelling Approach

FES24 Plexos data was used as the basis for understanding CER behaviour in 2035

FES Plexos Outputs will be used as the primary input to the modelling

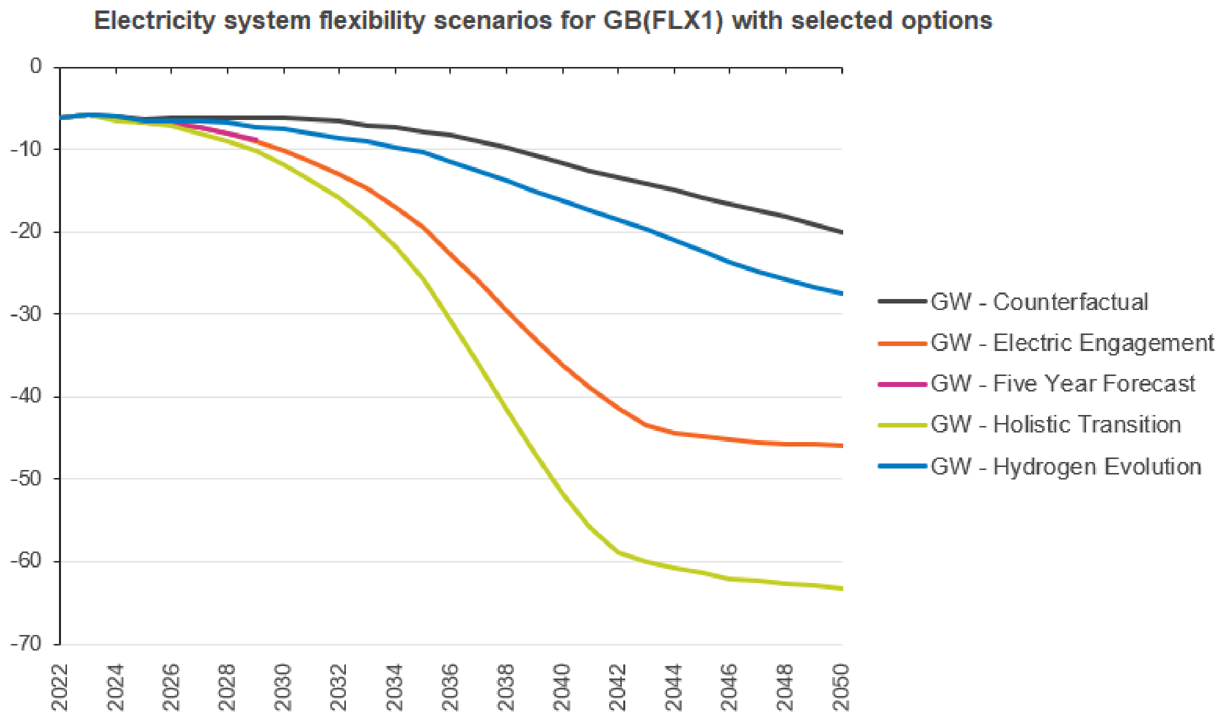
- Until now our analysis had focused on the operational metering characteristics individual portfolios. However, to properly assess the potential impact on NESO from CER Operational Metering, it is necessary to consider how combinations of different technologies might behave and interact in a future decarbonised power system. This is necessary to:

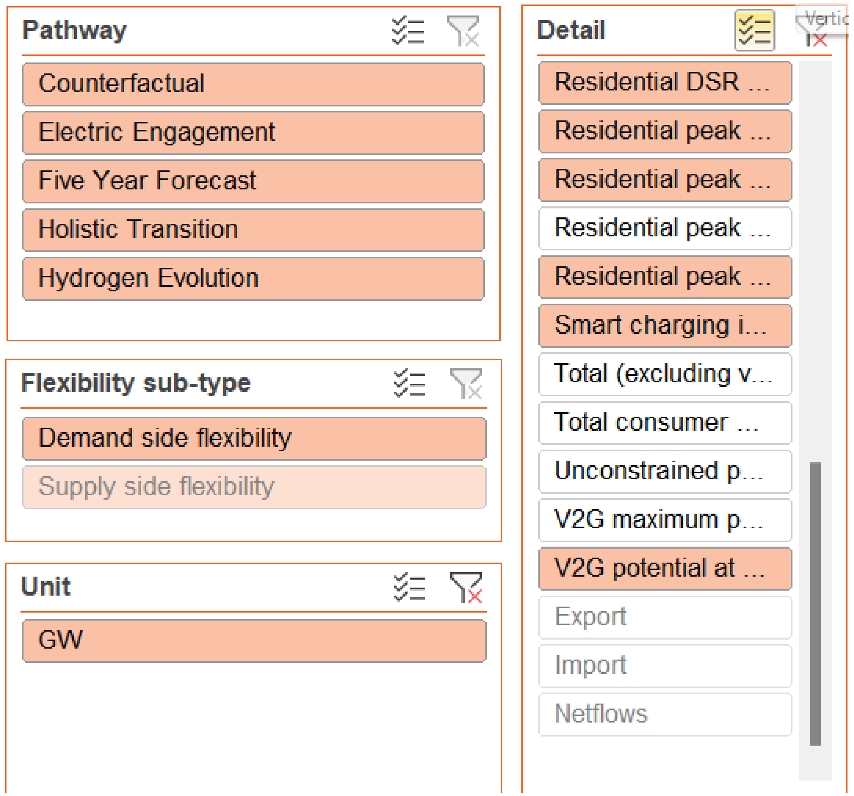
1. Understand the operational impacts in control room (situational awareness, demand predictor), which depend on a much larger number of factors than a single portfolio
2. Understand the impact (if any) of CER meter feeds on required actions to ensure compliance with SQSS e.g. Response and Reserve levels. Sizing of response and reserve levels requires annual data on the magnitude and likelihood any impacts

Scenario selection

Holistic Transition Scenario is our main scenario for analysis (highest uptake of CER assets) but the other scenarios will also be assessed

Residential demand side CER flex capacity at peak for in-scope CER assets (FES 2024)





Problem statements were identified and discussed to inform the modelling choices

Relaxing OM requirements will allow higher participation hence better visibility of CERs and higher market elasticity. CERs will impact the ENCC whether they participate through the wholesale market or the Balancing Mechanism (BM):

- When large volumes of CERs are active in the wholesale market, large swings will cause frequency deviations.
- When CERs are activated in the BM, situational awareness may be affected due to relaxed metering requirements. For example, when CERs fail to meet their (bid and offer) obligations in the balancing mechanism, this will not be visible in real-time, but only after some delay (e.g. 30 seconds).
- This also means that, when an unexpected frequency deviation occurs, no real-time information on CERs portfolios is available and operators may attribute the cause to CERs portfolios, even when they are delivering according to plan, as the real-time OM will show a deviation caused by the delay (especially during ramping times).

Specific challenges that can arise include:

0. Hourly swings of CERs will depend on both the system price, and availability of CERs
1. The largest swings of CER will cause frequency deviations, necessitating new dimensioning for frequency response.
2. Considering the need for the Balancing Mechanism, what is the impact of CER OM data that are activated (per hour and per technology) on the ENCC?
3. CERs participating in the wholesale market and registered in the BM will submit OM data even though they are not activated, what's the impact on the ENCC due to relaxed OM requirements?
4. Operational scenarios will need to be modelled to simulate situational awareness instances.
5. If OM are maintained, less CERs will be playing in the BM, causing high costs in the BM, leading to

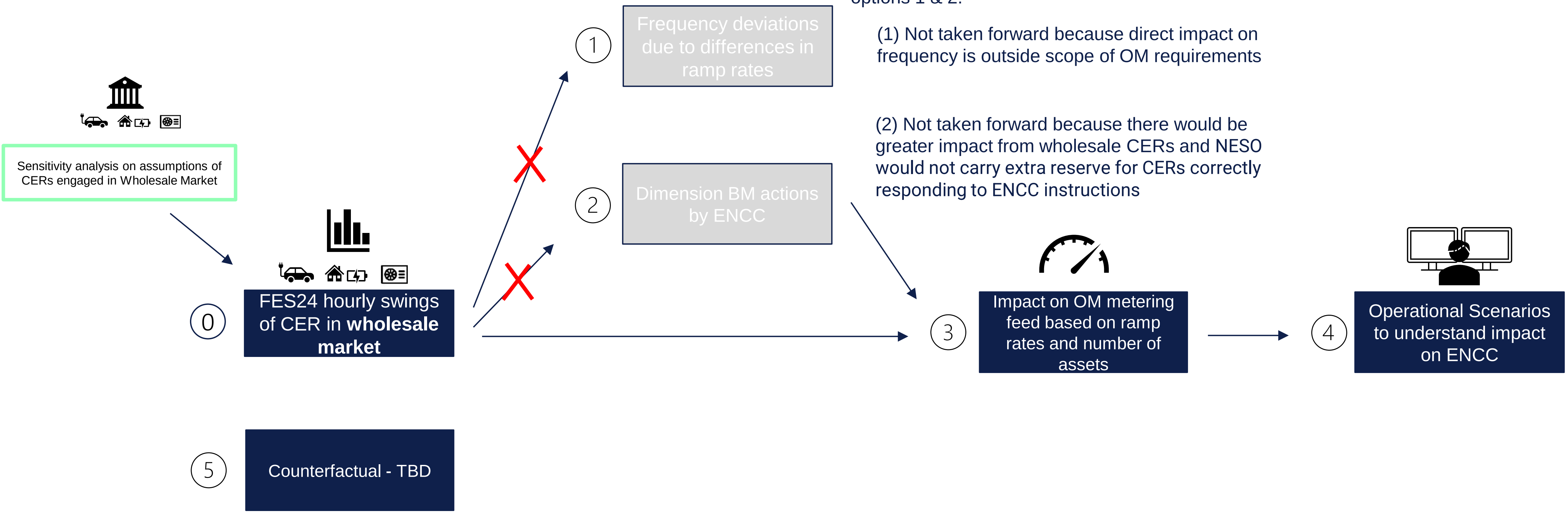
Modelling options overview

FES Plexos Outputs will be used as the primary input to the modelling

NESO feedback is to not take forwards options 1 & 2:

(1) Not taken forward because direct impact on frequency is outside scope of OM requirements

(2) Not taken forward because there would be greater impact from wholesale CERs and NESO would not carry extra reserve for CERs correctly responding to ENCC instructions



Modelling options considered

#	Problem Statement	Modelling Purpose	Selected
0	Hourly swings of CERs	Understand the size and ramp rate of CER swings in the wholesale market, for purpose of making an impact assessment	Yes - precursor to options 1-5
~~1~~	The largest swings of CER will cause frequency deviations due to differences in ramp rates (e.g. compared to thermal generation)	Understand potential frequency deviation caused by CER's ramping faster than thermal generation	No – outside scope of OM requirements
~~2~~	Considering the need for the Balancing Mechanism, it is important to determine the impacts of the CER assets that are activated (per hour and per technology) on the ENCC.	Quantify the error only from assets dispatched in the BM	No - NESO would not carry extra reserve in case CERs responds to signal and are able to deliver; no frequency impact.
3	CERs participating in the wholesale market and registered in the BM will submit OM data even though they are not activated, what's the impact on the ENCC due to relaxed OM requirements?	Assess the impact on the metering feed of new operational metering recommendation, given expected size of swing and % of wholesale market which is BM registered	Yes – precursor to 4
4	Operational scenarios will need to be modelled to simulate situational awareness instances.	Assess the impact on ENCC of the CER OM by analysing operational scenarios	Yes – needed to evaluate impact on ENCC
5	If OM are maintained, less CERs will be playing in the BM, causing high costs in the BM.	Counterfactual, if fewer CER are BM registered what is the effect on BM costs	Provisionally yes – design (Quantitative vs qualitative)

Modelling Assumptions

Key Modelling Assumptions

General

- "Engaged" in FES = sends operational metering *(Q: % of CERs registered in BM? Sending meters to the BM)*
- All CER units will be halfway through their hour-to-hour change at exactly the hour boundary.
- The technologies will have a constant rate of ramp up/down during the portfolio ramp time

Technology	Ramptime portfolio [min]	Ramptime asset [s]	Meter read interval	Power per asset [MW]	Latency [s]	Accuracy meter [%]
EV_engaged	10	10	10s, 30s, 60s	0.007	5	2%
V2G	10	10	10s, 30s, 60s	0.007	5	2%
Res_HP	5	300	10s, 30s, 60s	0.0035	5	3.5%
Micro_BESS	10sec	10	10s, 30s, 60s	0.007	5	2%

Technology capability

- 10 min randomised delay to EV charging and V2G on ramp up AND ramp down (EV Smart Charge Points Regulation - exemption in case EV-V2G are responding to an instruction by the CR).
  - In the wholesale market, EV and V2G portfolios change their load/generation in 10 minutes across the hour boundary
- Micro BESS can ramp up and down in 10s – No applicable Regulation
  - As worst case all Micro BESS are ramping up/down in 10s at the hour boundary
- Residential Heat Pumps ramp up/down in 5 minutes - No applicable Regulation

Preliminary Results

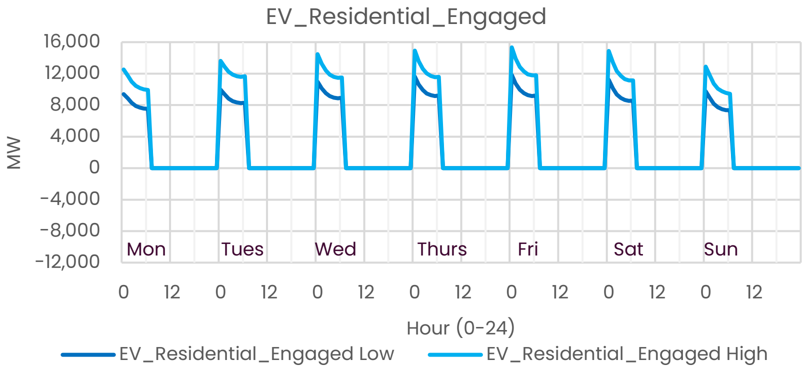
FES24 CER Load profiles – EV Engaged and V2G

The level of engagement (fixed profile or fully price responsive) influences the variability in load throughout the year

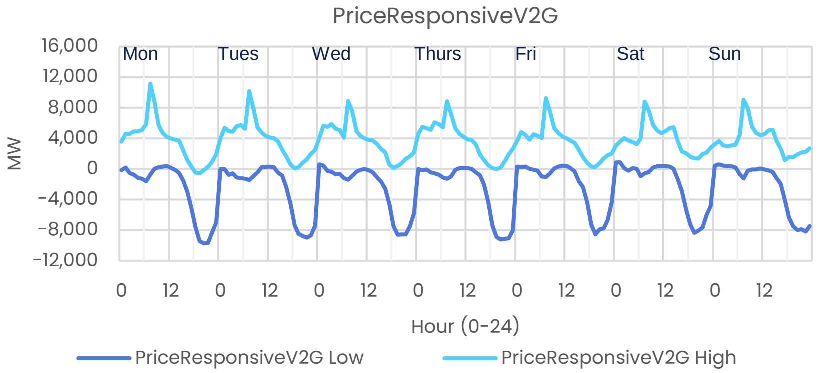
- **FES modelling uses a fixed profile for engaged EVs – i.e. Time of Use Tariff**
- **V2G is modelled with both a fixed and a flexible component**
- The result of these assumptions can be seen in the load profiles:
  - V2G load is generally more spread across the day (focussing on night and around mid-day)
  - V2G generally discharges in the evening and sometimes during the morning peak

Variation in load at each hour, Jan – Dec 2035

High and low show the average load at each hour +/- 1 standard deviation, across the 52 weeks



Engaged EV has fixed hourly profile which starts at 0:00 and ends at 7:00



V2G has both a fixed and a price responsive component

FES24 CER Load profiles – Heat Pump and Micro-BESS

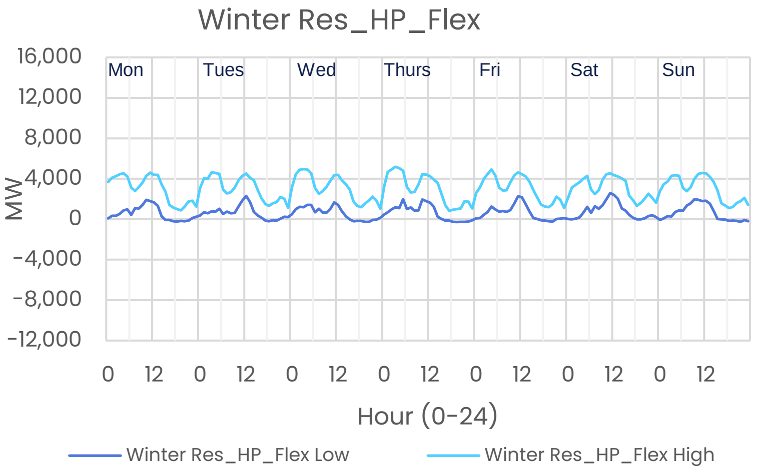
The profile of residential HP in summer is different than in winter.

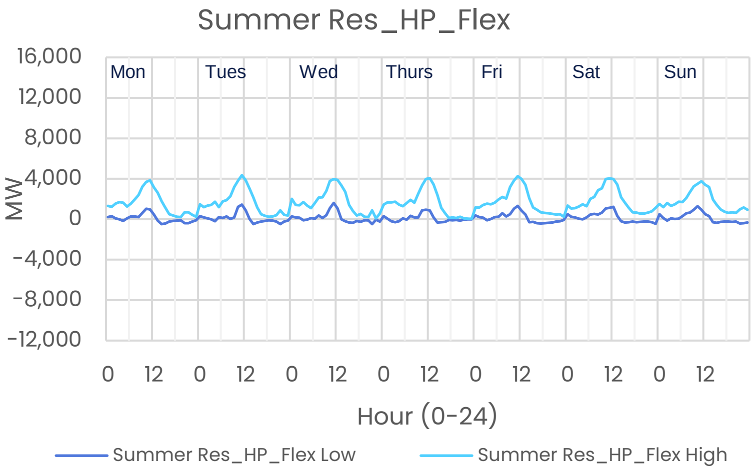
In winter (October to March), heat pump load avoids the evening and morning peak, while in summer (April to September) it heats almost solely during mid-day.

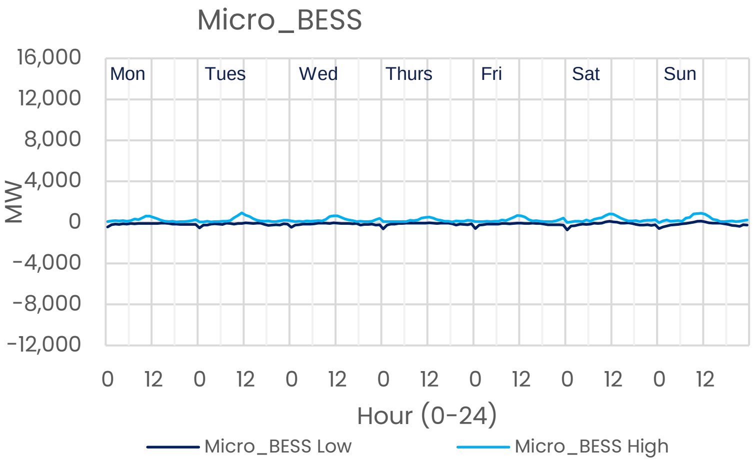
On average the Micro BESS charges during midday when prices are low and regularly discharges at midnight when the (system) load is high especially due to EV.

<u>Variation in load at each hour, Jan – Dec 2035</u>

High and low show the average load plus and minus the hourly standard deviation across the 52 weeks





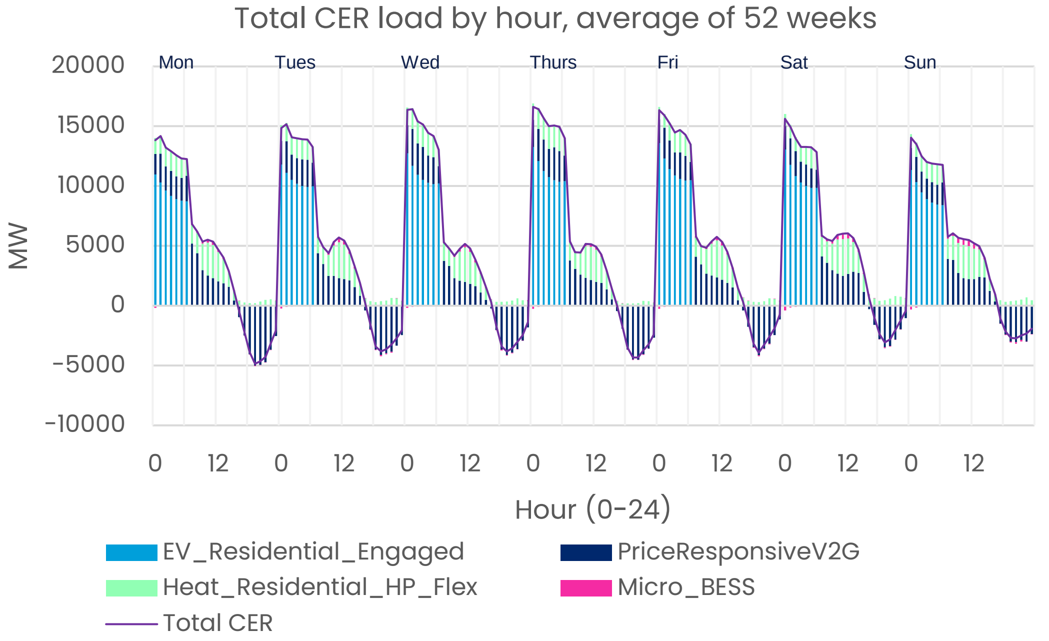


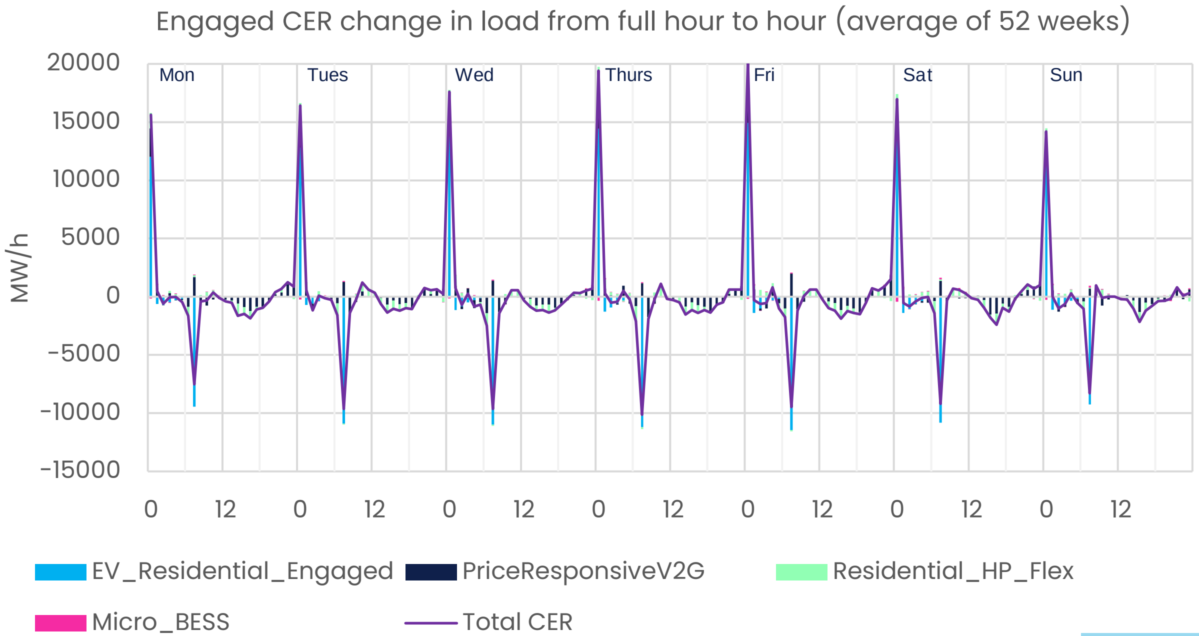
The FES Team is preparing the data for Solar PV.

Total FES24 CER Load Profiles

Using the FES data the CER load for each hour of each day was averaged across a year to produce a weekly average CER load

- The weekly average CER load (left) shows that EV residential smart charging dominates load CER load
- Overall, CER load is concentrated between 0:00-07:00 and avoids the evening peak, at which time V2G and Micro BESS switch to generation
- The biggest swings in CER load (right) are at midnight and at 07:00

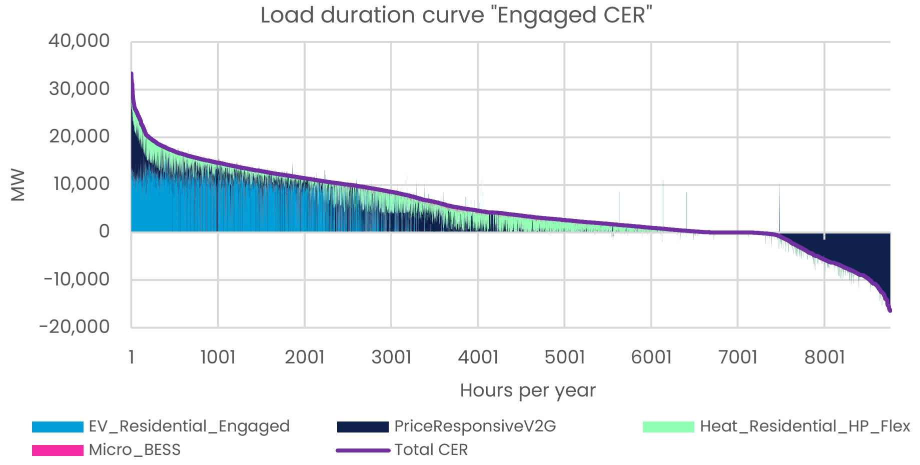


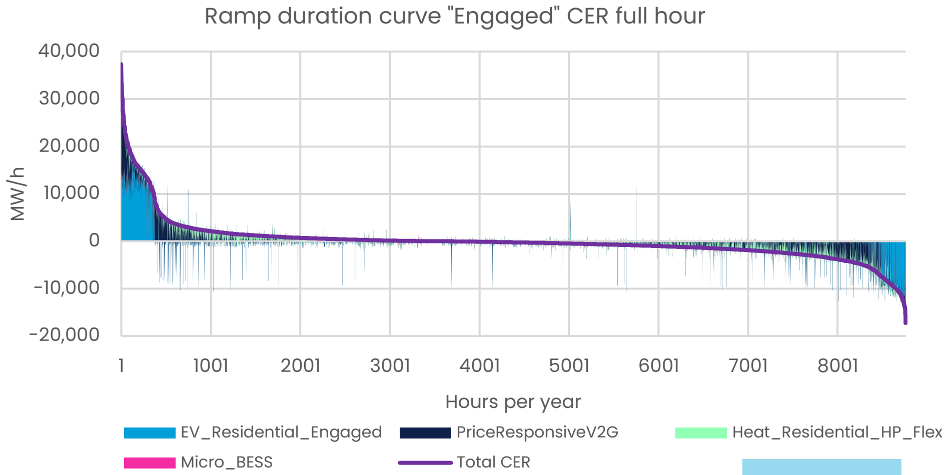


FES24 CER Load and Ramp Duration Curves

Using the FES data the CER load for each hour of each day was averaged across a year to produce a weekly average CER load

- The top graph shows that Total CER load has occasionally very large spikes
  - These spikes are caused by EV and V2G charging at the same moment during the nights
  - Residential HP occasionally largen these spikes during winter nights
- The generally steady daily profile of EV and V2G causes high ramp events around 00:00 when they start charging and 7:00 when they stop.
- The bottom graph shows the ramp (i.e. changes from hour to hour) over the full hour, however most of changes will occur at the hour boundary. This is presented in the next slide.

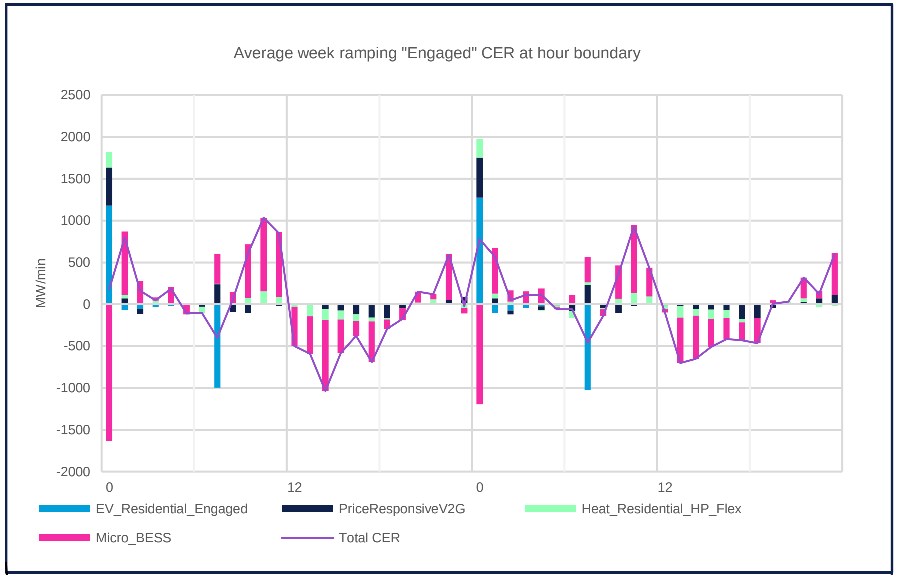




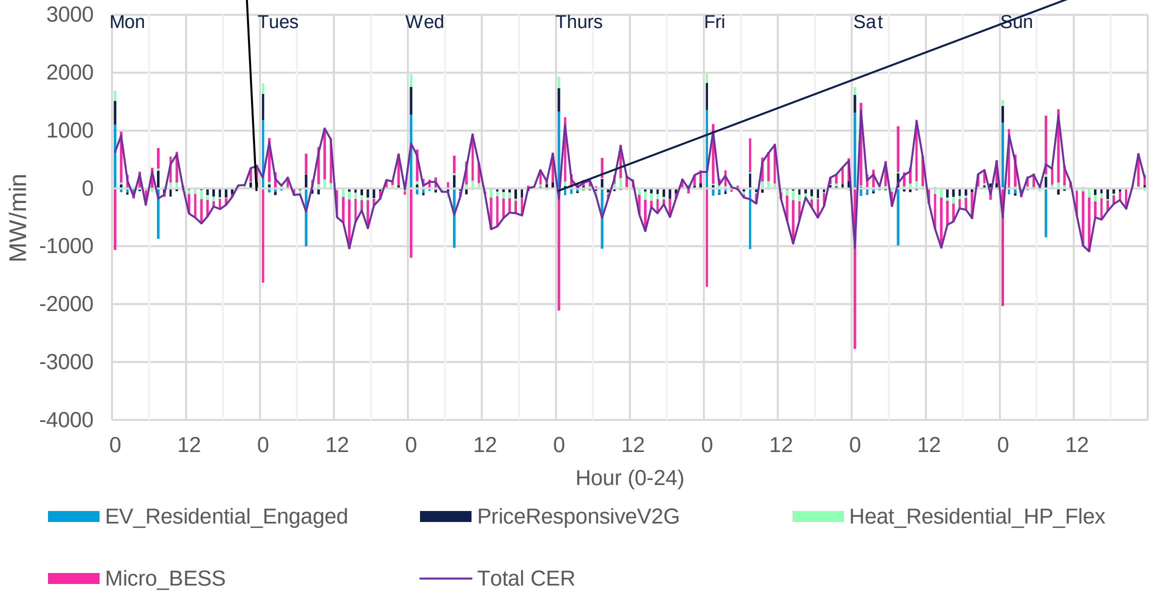
Ramping rate at hour boundary

Ramp rate is a key factor in quantifying the “error” caused by delay in metering catching up with the change in state of the portfolio.

- The Micro BESS is a much smaller MW volume than the EV Residential Engaged (see slide 15).
- However, Micro BESS is not limited by a randomiser (10 min for EV and V2G) for their wholesale behaviour.
  - They are therefore assumed to ramp up and down very fast (10 seconds) at the hour boundary
- This creates a bigger discrepancy between the meter reading and the true state of the portfolio for Micro BESS, however this error persists for a much shorter time compared to CER types with longer ramp times (this concept is discussed in the previous presentation).
- The relative importance of error magnitude and error duration will be discussed in scenario workshops between NESO and DNV in the coming weeks



Engaged CER ramp rate at the hour boundary (52 weekly average)

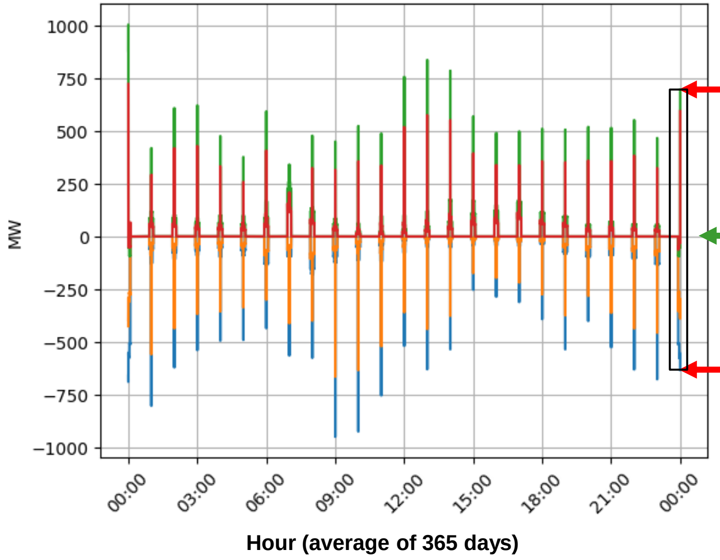


Translating FES24 profiles into meter lag “error” at the hour boundary

The FES24 load profiles were input into the previously developed error model
We can analyse the FES24 profiles with different meter intervals, portfolio ramp rates, and meter correction methods

- The graph show the 1% and 99% percentile over all 365 days of each aggregation (correction) method (i.e. unadjusted and Adjusted aggregated metering, 10s read interval). The range between the lines therefore contain 98% of all possible values for that particular second of a day.
- Blue and green lines show meter “error” with no correction method applied, red and yellow with a correction method applied.

Range (1st to 99th percentile) of combined CER meter “error” for each second of the day, averaged over 365 days.



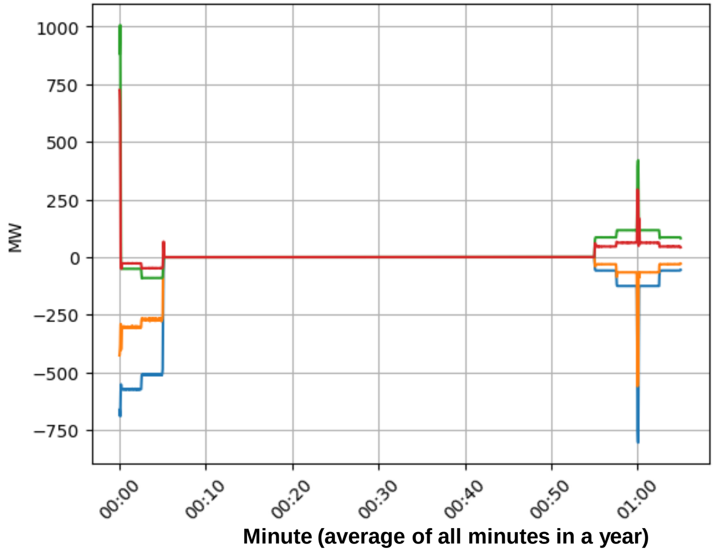
Worst case (+ve error)
99% of hours in the year are below this point (99 percentile)

Best case (no error)

Worst case (-ve error)
99% of hours in the year are above this point (01 percentile)

Percentile	Method
-- 01	Unadjusted
-- 99	Unadjusted
-- 01	Adjusted aggregated metering
-- 99	Adjusted aggregated metering

Range (1st to 99th percentile) of combined CER meter “error” for each second of 00:00 to 01:05 hours, averaged over 365 days.

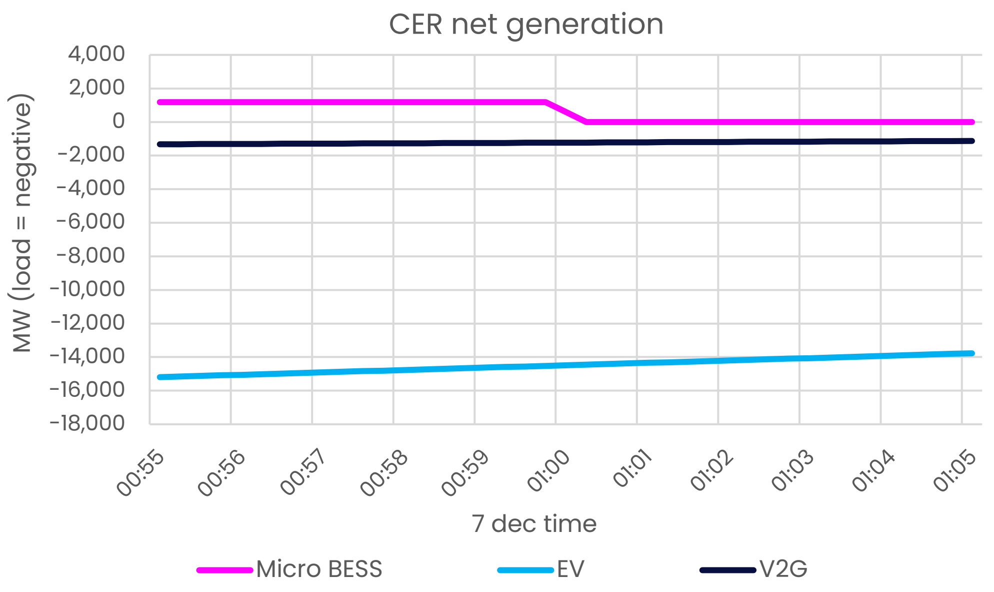


Translating FES24 profiles into meter lag "error" at the hour boundary

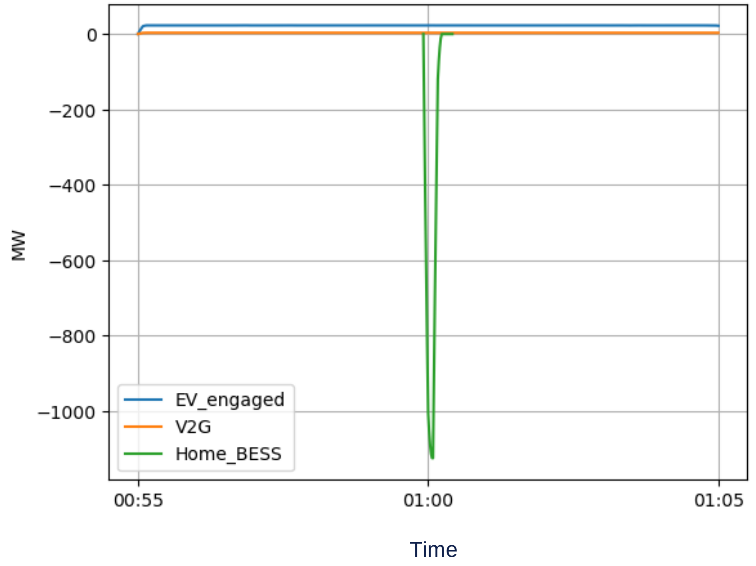
We can analyse individual hours within the year to understand the behaviour each CER type and potential impacts on control room

Change in load from different CER technologies across the hour boundary

(7th Decemeber 2035)



FES24 meter lag "error" at the 01:00 hour boundary on 7th December 2035



- EV and V2G: metering signal is slightly above actual load for a significant time (10 minutes)
- Micro BESS: metering signal is significantly below the actual load for a brief time (5-10 seconds)

Next Steps

Project schedule and stakeholder engagement

Work packages	Scope	Starts in	Duration (Months)	Stakeholder Engagement	January 1	February 2	March 3	April 4	May 5	June 6
WP3 - Impact Assessment - cont	Impact Assessment of CERs based on FES, risk mitigation and impact on costs Counterfactual: Optimising costs and savings	January	3	Power Responsive Webinar (Feb, March) Ad-hoc engagement						
WP4 - Monitoring & Implementation	Assess practicalities of adopting recommendations across different asset types and providers e.g. processes, data requirements, communication systems.	Mid-February	2.5	Survey PR Webinar (April)						
WP5 - Reporting & Recommendations	Recommendations & Final reporting	May	1	PR Webinar (May)						

Final Presentation

WP4 Presentation

WP3 Report-1 Interim Presentation

WP3 Report-2 Interim Presentation

WP3 Presentation

WP4 Survey released

Update:

- The modelling workflow is now developed; timeline for completion of modelling for additional CER technologies is dependant on developing the ENCC Operational Scenarios and understanding the detailed requirements of the FRM team.
- A survey to understand implementation challenges for aggregators of future recommendation(s) will be developed in the coming weeks (week of 28 April/05May)
- Once any impacts on NESO have been evaluated, appropriate recommendation options will be finalised and the survey will be distributed to industry (by end of May)

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