

THE IMPACT OF DEMAND-RESPONSE ON ENERGY CONSUMPTION & ECONOMIC WELFARE

Lucy Yu

CEO, Centre for Net Zero

NOVEMBER 2023



Centre for Net Zero

Powered by Octopus Energy





A FULLY SUSTAINABLE GLOBAL ENERGY SYSTEM

REAL-WORLD DATA

Combining insights from analysis of millions of customer datasets with field trials and experimentation across multiple markets.

DYNAMIC CHANGE

Building models and research for a rapidly changing energy system, rather than static approaches stuck at a point in time.

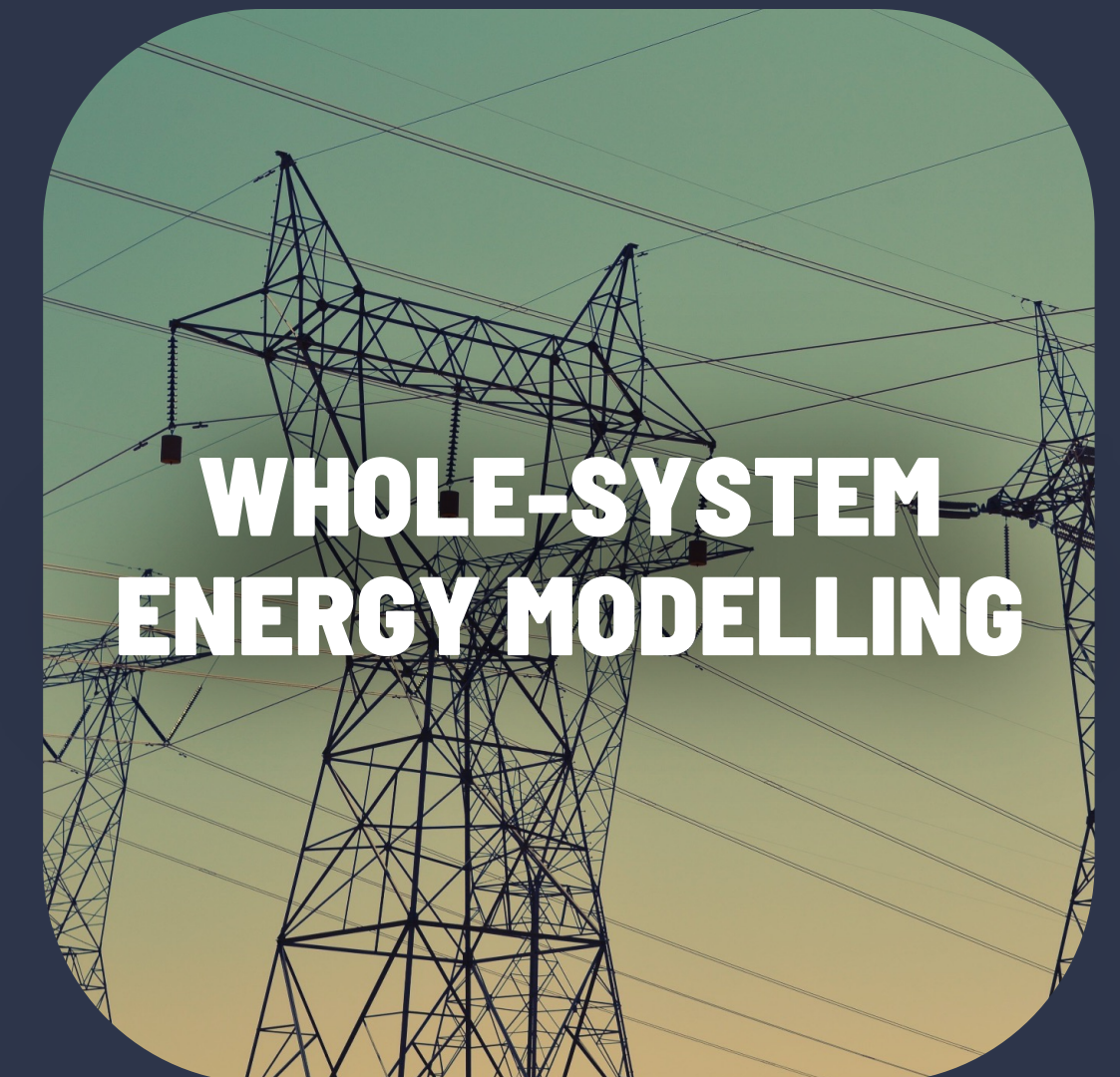
PEOPLE-CENTRED, TECH-ENABLED

Driving bottom-up participation in the energy system which embraces new technology, unlocking an equitable transition for all levels of society and areas of the world.

IMPACT-DRIVEN

Working with governments, policymakers, academics, grid operators and urban leaders from around the globe to deliver system change, aimed at tipping points.

OUR FOCUS FOR RESEARCH & ANALYSIS



THE DEMAND FLEXIBILITY SERVICE

DEEP ANALYSIS



Centre for Net Zero

Powered by Octopus Energy

OVERVIEW



From November 2022 - March 2023, National Grid ESO rolled out its Demand Flexibility Service (DFS)

Households were asked to turn down their energy consumption during 1-2 hour periods, in exchange for payment. Households were paid a fixed incentive which varied between events (from £2/kWh to £4/kWh of electricity).

31 utility providers participated. Octopus Energy was the largest in terms of number of customers involved and total demand reduced.

Octopus called its events 'Saving Sessions'. Our analysis focuses on the 13 DFS events that Octopus Energy participated in.

THREE CORE RESEARCH QUESTIONS



- 1. HOW MUCH DID CUSTOMERS REDUCE THEIR DEMAND?**
- 2. HOW MUCH DOES CHANGING NOTIFICATION PERIOD & INCENTIVE LEVEL CHANGE DEMAND REDUCTION?**
- 3. TO WHAT EXTENT WAS THE DEMAND REDUCTION FROM SAVING SESSIONS WELFARE ENHANCING?**



RESEARCH QUESTION ONE

HOW MUCH DID CUSTOMERS REDUCE THEIR DEMAND?

Demand reduction is the difference between actual consumption and the consumption that would have happened had customers not participated in Saving Sessions.

GB energy industry uses a modified pre-post calculation ('P376'). We worried about potential biases.

In contrast, we estimated demand reduction using a statistical technique - "difference-in-differences" (DID) - that compares changes in consumption over time between two groups of Octopus customers with broadly similar characteristics.

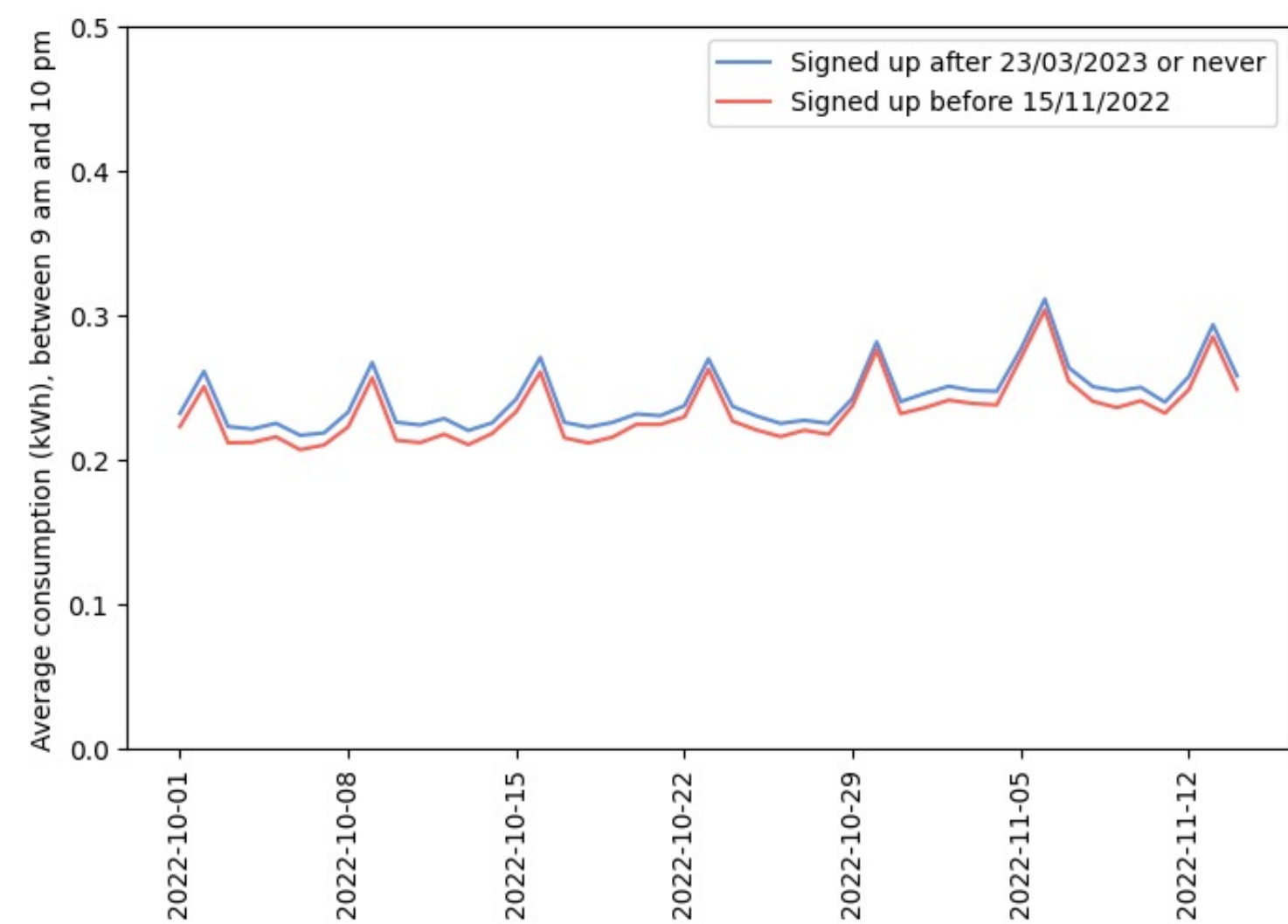
This allowed us to estimate the impact of Saving Sessions on energy demand in a way that is less vulnerable to some of the biases associated with the 'P376' before-after estimates.

OUR DIFFERENCE-IN-DIFFERENCES STRATEGIES RELY ON THREE COUNTERFACTUAL GROUPS



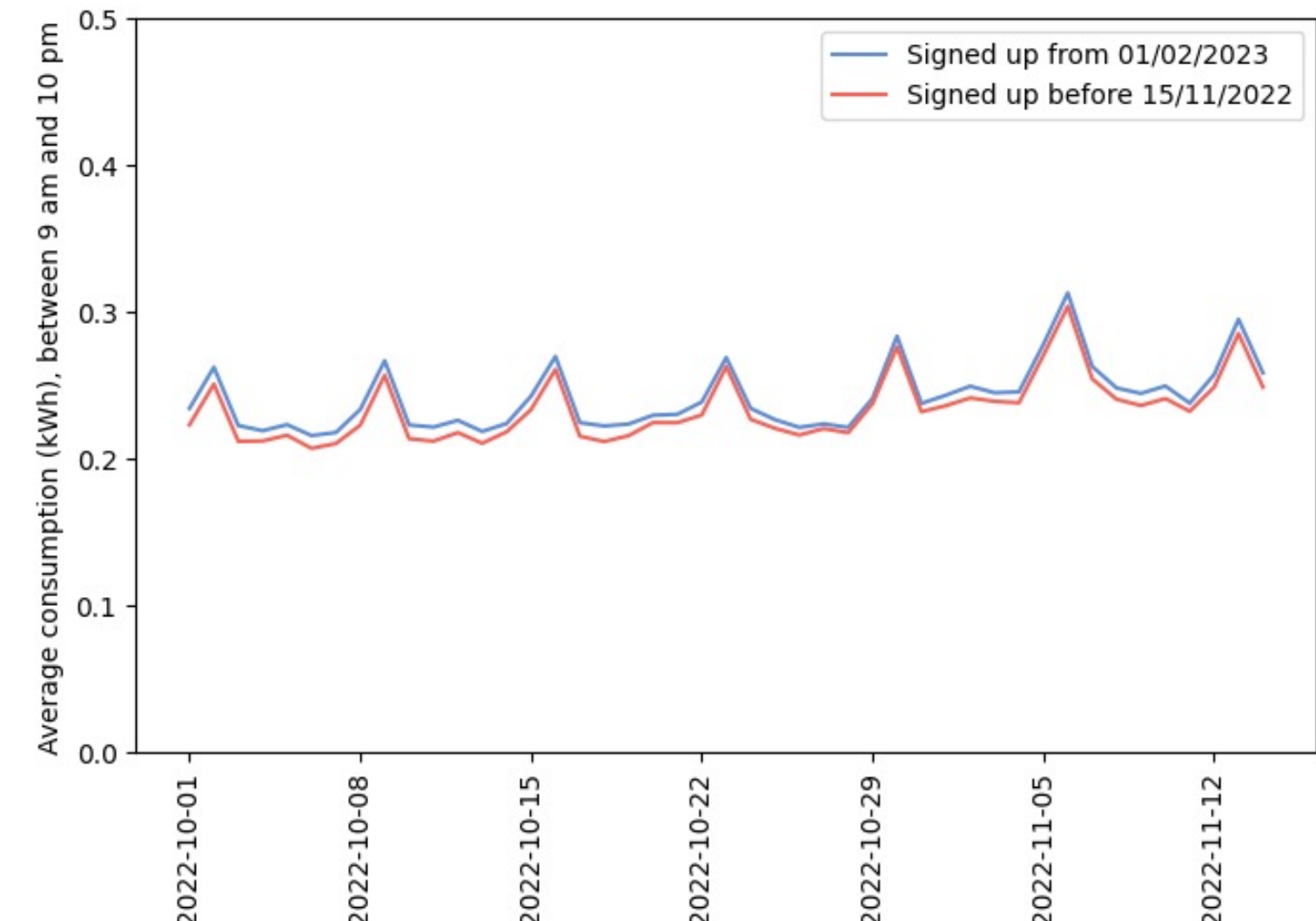
Early sign-up versus never signed up

1) 332k customers who signed up before first event 15/11/2022 *versus* 654k invited customers who never signed up



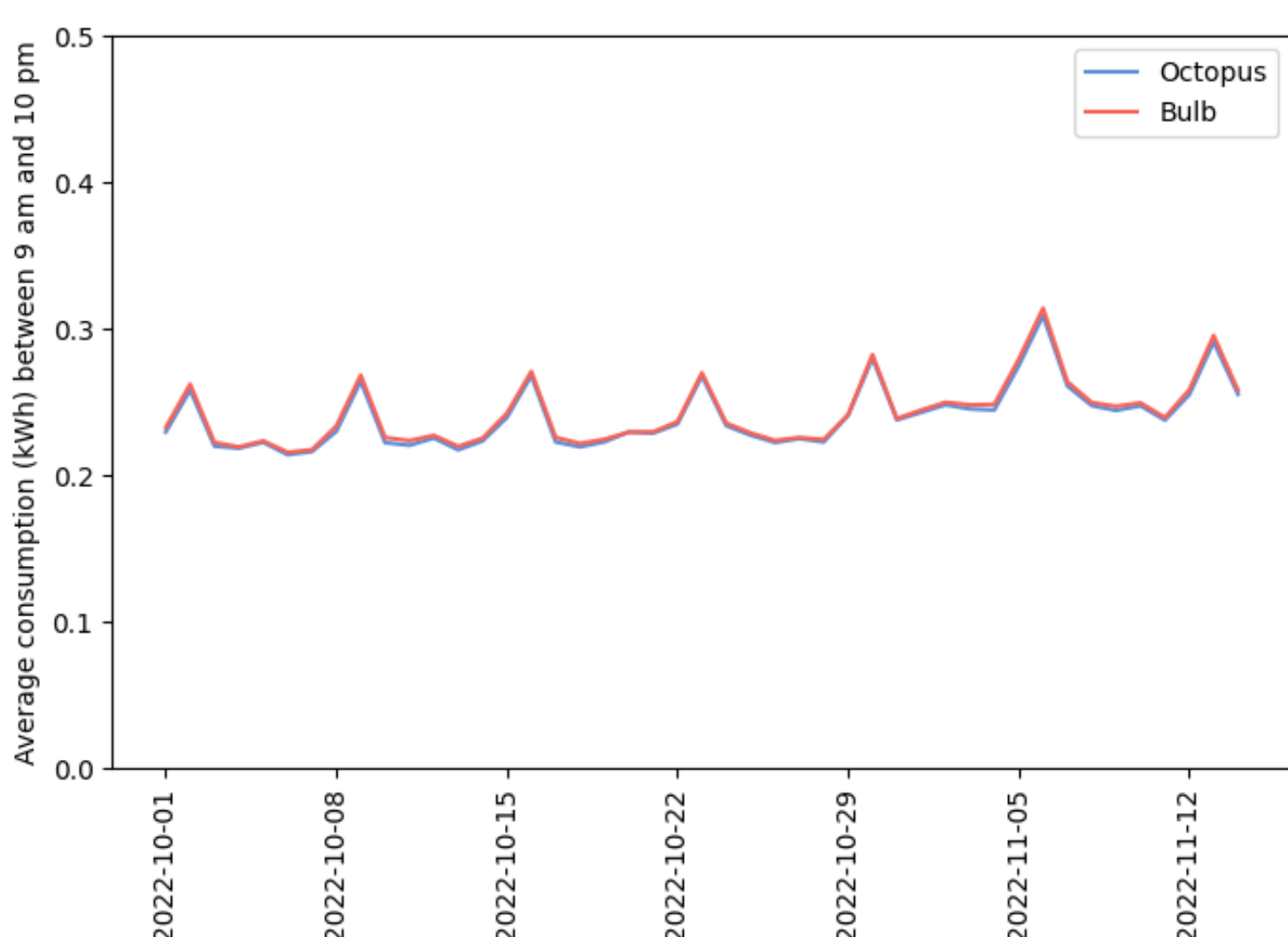
Early sign-up versus later signed up

2) 332k customers who signed up before first event 15/11/2022 *versus* 12k customers who signed up after 01/02/2023



Octopus versus Bulb (a 'natural' counterfactual group)

3) 1.137m invited Octopus customers *versus* 198k Bulb Energy smart customers who allow half-hourly recording ('Octopus versus Bulb')



RESEARCH QUESTION ONE

KEY RESULTS



01 Simply *inviting* customers to sign up to Saving Sessions is associated with a 10% reduction in consumption.

02 Signing up to participate in DFS events reduced demand by ~26% during Saving Sessions.

03 “Opting in” to participate in Saving Sessions reduced demand by ~40% during Saving Sessions.

These effect sizes are much higher than we usually see in energy consumption analysis.

Across Octopus Energy’s customer base during those half-hours, these effects are comparable to a small power plant’s production – 1642 MWh demand reduction in total, over 14.5 hours.

Our 1642 MWh figure is approximately 13% lower than the official 1860 MWh demand reduction as measured by NGE SO - suggests a small upward bias in their “before-after” methodology.



RESEARCH QUESTION TWO

HOW MUCH DOES CHANGING NOTIFICATION PERIOD & INCENTIVE LEVEL CHANGE DEMAND REDUCTION?

Notice: Almost all Sessions featured day-ahead ‘notice’ for the Saving Session the next day, and customers tended to receive the notice around the same time for any given Session.

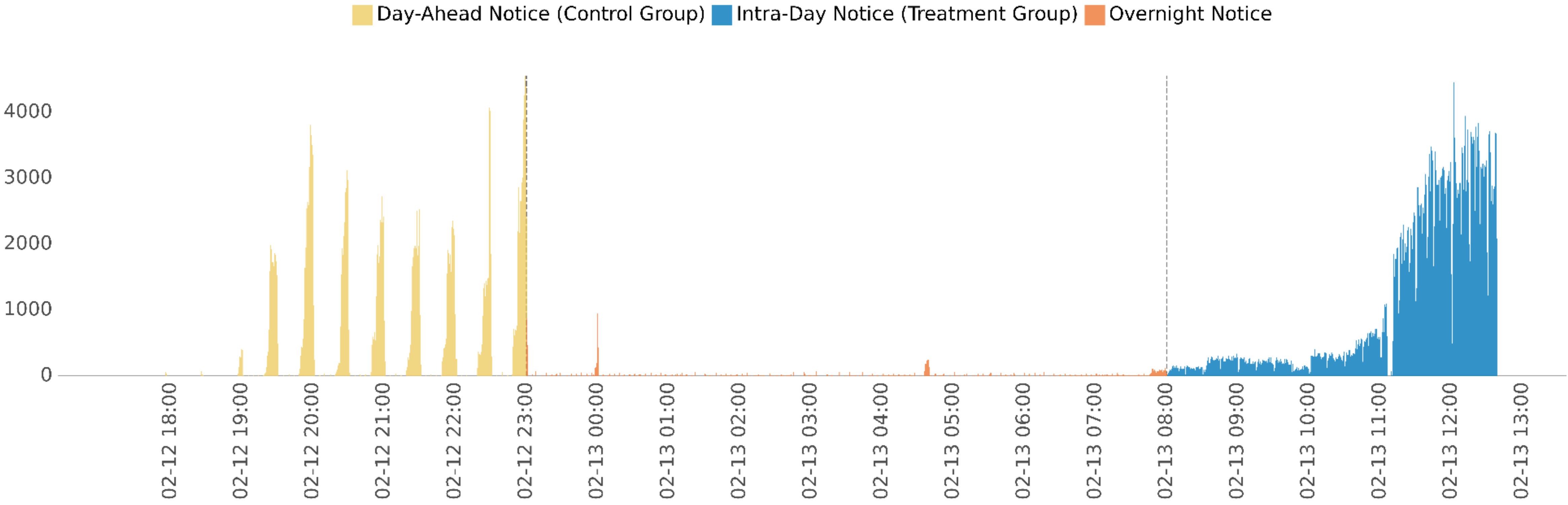
Incentive level: Although the incentive level somewhat varied between Sessions, it never varied between customers *within* a Session.

However, two Saving Sessions (on 13 Feb 2023 and 15 March 2023) featured different notice periods and incentives provided to customers, enabling rigorous analysis of these research questions.

13 FEBRUARY 2023: OUR NATURAL EXPERIMENT CONCERNS A DISCONTINUITY IN WHEN CUSTOMERS WERE SENT THEIR OPT-IN NOTICE



Number of Octopus Energy Customers



"Sent" Timestamp for Earliest (Possibly Only) Opt-In Notice for 10th Saving Session (Feb. 13, 2023)

15 MARCH 2023: OUR RANDOMISED CONTROL TRIAL FOR THE 12TH SESSION INVOLVED TWO TREATMENT GROUPS



Control Group ($N = 627,155$)
Intraday Opt-in Notice Only

Note that this was the only Saving Session where intra-day notice was the norm.

Treatment Group 1 ($N = 19,182$):
Intraday Opt-in Notice plus Day-ahead
“Heads-up” Email



Hi there,

Heads up: there may be a Saving Session tomorrow evening.

If the Session goes ahead, you'll be able to opt in as normal during the day tomorrow, and we'll send you a proper invite email with all the normal details then too.

Why are we sending you this email now? Saving Sessions is part of a wider project run by the National Grid. It's the biggest project of its kind in the UK to test how people can come together to balance the grid and avoid fossil fuels. We don't always know with loads of notice when the grid needs help.

As part of our testing in this project, we'd like to find out how readily people can get involved in a Saving Session with different amounts of notice. We suspect there might be a Session tomorrow. If there is, we'll only open opt-in's on the day. But we thought we'd give you a little pre-warning that there might be one coming up!

Keep your eyes peeled tomorrow, and get ready for a possible Session...

Thanks,
Pete

Treatment Group 2 ($N = 19,220$):
Intraday Opt-in Notice plus Intraday
“Reminder” SMS Text plus Eligibility for
£1.25 Bonus

*SAVING SESSION TODAY 1830-1930.
SPOT PRIZE: Octobot has chosen you
at random to win
1000 OctoPoints if you save energy
in tonight's Session. Opt in before
1830!*

RESEARCH QUESTION TWO

KEY RESULTS



- 01 Demand is lower by ~10% under longer notice. This is a large reduction in customers' typical Saving Sessions response – a reduction in their response of nearly a quarter.
- 02 The day-ahead heads-up email decreased in-Session consumption by ~2-3%. While the email said there 'may' be a Session the next day, this was not guaranteed.
- 03 In terms of Session participation, we also found higher opt-in rates when customers have longer notice.
- 04 We found an economically meaningful association between the incentive and demand reduction (4% lower consumption among the incentive-receivers).



RESEARCH QUESTION THREE

TO WHAT EXTENT WAS THE DEMAND REDUCTION FROM SAVING SESSIONS WELFARE ENHANCING?

We do this by calculating the marginal value of public funds (MVPF), a way to measure “bang for the buck” of Government (or in this case, NGESO) spending on a policy.

We find that the welfare implications of the Session depend greatly on the extent to which it reduces the probability of ‘lost load’ (a blackout or brownout) versus ‘simply’ displacing carbon-intensive electricity generation.

RESEARCH QUESTION THREE

KEY RESULTS

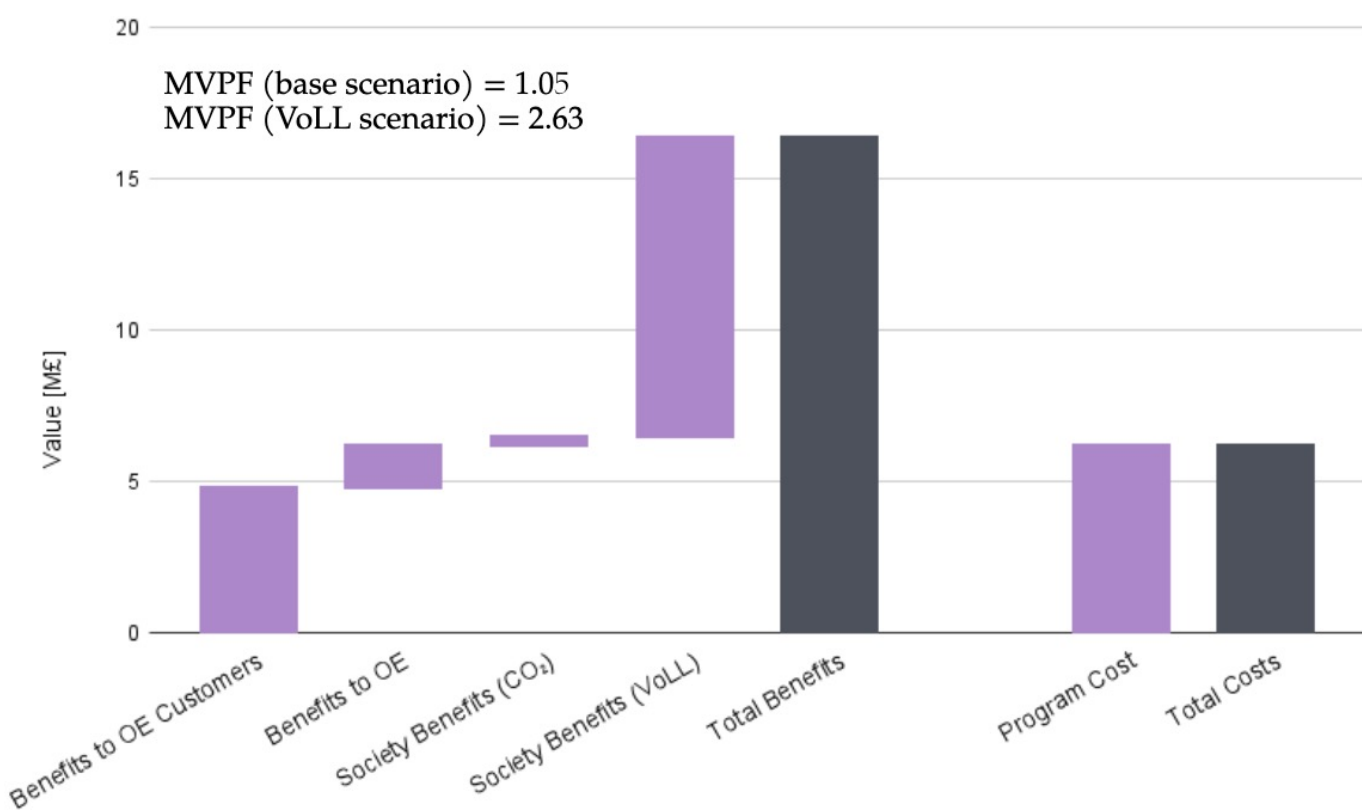


01 Overall, the Saving Sessions demonstrated a marginal value of public funds between 1.05 and 2.4, depending on when the grid is approaching a blackout, indicating that the program yielded positive benefits relative to its costs.

02 Specifically, the MVPF when ignoring the value of lost load is 1.05 – an MVPF that suggests that DFS is welfare-enhancing, but only just so.

But when we ascribe the UK’s official value of lost load to each kWh of demand reduction, we find a large MVPF of DFS of 2.63.

Figure 11: Summary of costs and benefits for the whole Saving Session campaign.



Note: The MVPF of Saving Sessions we calculated using the costs and benefits outlined in [Sections 5.3.1](#) and [5.3.2](#) and the VoLL are calculated in [Section 5.3.2](#). The benefits to OE customers for the whole campaign are calculated under the assumption that OE retains the same amount of money for each MWh payment, this is £0.75 for each MWh awarded (see [Table AT.31](#)). Therefore, these will be obtained as the difference between the auction price (for Live events) or the Guaranteed Acceptance Price (for Test events) and £0.75. As a result, the Benefits to OE are calculated as the product of these £0.75 and the total demand reduction calculated using the P376 baseline methodology (see [Table AT.30](#)), as NGESO used this methodology to provide payments to suppliers. The Society Benefits are calculated using the “real” demand reduction obtained through our DiD methodology (see [Table AT.30](#)). As explained in [Section 5.3.2](#). We have ignored fiscal externalities in this analysis as they are likely to be very small. Lastly, costs are calculated as a results of the payments that NGESO provides to OE as explained in [Section 5.3.1](#), using the P376 baseline methodology (see [Table AT.30](#)).



ADDITIONAL FINDINGS

TYPES OF CUSTOMERS WHO PARTICIPATED IN THE DFS

01

Customers on smart tariffs and living in less deprived areas were slightly more likely to take part.

- Smart tariffs: 9% of customers in our analysis who signed up before the first event were on smart tariffs, compared to 3% of customers who did not sign up.
- Deprivation of area: 10% of invited customers who signed up before the first event lived in very high deprivation postcodes, whereas 14% of invited customers who never signed up lived in very high deprivation postcodes.

02

While we find meaningful demand response from all groups of consumers taking part, the impact on consumption of being signed up to Saving Sessions was higher from those on smart tariffs and in less deprived areas.

- Customers on smart tariffs reduced their consumption by 37% more than customers not on smart tariffs.
- Customers in very low deprivation postcodes reduced consumption 36% less compared to those in very high deprivation postcodes.

KEY CONCLUSIONS



- 01** Domestic consumers can provide meaningful demand side response.
- 02** Shorter notice period meaningfully reduces the magnitude of this response.
- 03** The welfare benefits that the DFS provides depends on whether it reduces the probability of 'lost load' versus 'simply' displacing carbon-intensive electricity generation.



UPCOMING WORK

CROWDFLEX

A multi-year project in GB, led by National Grid ESO, designed to unlock year-round intelligent demand & locational flexibility.

FLEXIBILITY EVENTS: UK, JAPAN, FRANCE

Understanding event-based flexibility across multiple years and in different markets - UK, France, Japan.



ROOFTOP SOLAR FOR UNABLE TO PAY

Testing the impact of solar and batteries on low income & fuel poor households: energy consumption, bill savings, and wider welfare improvements. .

TEMPERATURE FLEX: HEATING & COOLING

Exploring what good automation looks like for heating and cooling systems – optimising flexibility and comfort. A cooling trial is planned in Texas.



FLEXIBILITY COALITIONS

Understanding the potential of people-led aggregators of different property portfolios - modelling the impact, followed by a real-world demonstrator.



EV FLEX

Exploring consumer incentives for the adoption of automated EV charging, and the benefits to the grid & consumers.



BASELINING

Developing accurate consumption models to fairly and consistently reward flexibility from consumers, helping to unlock intelligent demand in the energy system.



Please get in touch if you want to discuss the findings of this analysis in further detail
info@centrefornetzero.org.

You can find out more about our range of ongoing research on our website.

CENTREFORNETZERO.ORG



Centre for Net Zero

Powered by Octopus Energy