CORNWALL INSIGHT
CREATING CLARITY

Global I&C Flexibility: Market Structures and Participation

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1 Contents

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4 Headline Insights

This report explores consumer-led flexibility within the industrial and commercial (I&C) market. We consider the scale and characteristics of current engagement across a range of industry types and in different international energy markets, and the barriers to engagement for I&C businesses.

Our research focuses on engagement with two flexibility signals:

- **Explicit signals**: Typically refer to a request made in real time to change the magnitude or timing of energy consumption or production, categorised here as: **Security of Supply** (ensuring future demand can be met); **Balancing Services** (mechanisms to balance supply and demand in real time); and **Frequency Response** (reacting quickly to prevent disruption).
- **Implicit signals**: Provide incentives set in advance and are managed around consumer preference, e.g., Time-of-Use (ToU) contracts.

Overall, we find that there are ambitious Government targets for I&C flexibility across geographies. Already there are numerous examples of critical industry sectors and leading companies participating via explicit and implicit signals.

Without the flexible resource that I&C flexibility can offer, significant additional spend on other technologies, grid infrastructure, and generation assets may be required to deliver the energy transition.

As such, there is clear value from flexibility for participating industries, energy grids, and wider system users – Globally, the potential demand-side flexibility available from across the I&C space could be worth up to ~$1 trillion per year.

This illustrative projection is based on the costs of developing equivalent flexibility volumes from other sources to match those potentially available from I&C flexibility. Potential projected values ranged from ~$0.2 to $1 trillion, with I&C power demand, flexibility engagement, and different equivalent flexible sources key variables. A summary of our approach and assumptions is set out in Section 8.

The global value of I&C flexibility reflects the important role that demand-side flexibility can play in accommodating the renewable generation required for the energy transition and developing the necessary grid capacity and smart management approaches.

We have developed this projected value to help build the conversation on I&C flexibility and its role in delivering the energy transition. Further research, modelling, and analysis will help drive this important area forward, particularly covering:

- Where this value can be quantified and realised
- What the critical blockers are to unlock it
- What are the transferrable learnings to apply across different country and system contexts

Future work can build on the five overarching themes that characterise our findings from this research, summarised in Figure 1 below.

Figure 1: Key takeaways for I&C flexibility participation

1. **There is a growing requirement & role for I&C flexibility across international markets in the near term**

   Decarbonisation policies are bringing rising requirements for grid flexibility, with I&C electricity demand an important source in the near-term

2. **Implicit signals are key, as opportunities from explicit signals grow from a relatively limited base today**

   Implicit signals via time of use price structures are an important market feature, with security of supply signals the most common explicit opportunity

3. **Today, most I&C flexibility comes from heavy manufacturing and utilities, attracted by operational cost savings**

   Lowering energy costs is a key motivator for industrial flexibility today, with commercial engagement sensitive to changing market structures

4. **Commercial alignment and technical service requirements are barriers to I&C flexibility across markets**

   Challenges are often structural relating to the roles and interactions between network and system operators and other energy market participants

5. **Limited data availability and visibility impedes evaluating I&C flexibility participation and delivery**

   Across assessed markets, information on I&C flexibility participation and performance is fractured and limited, affecting investment confidence

Source: Cornwall Insight

Further details under each of these five areas are provided on the following pages, followed by a country-level focus and an assessment of the prevailing barriers to I&C flexibility.

1. There is a growing requirement and role for I&C flexibility across international markets

Increasing levels of system flexibility is a critical component of evolving power markets across the different areas researched. A growing role is forecast or targeted for the respective I&C sectors in these markets, summarised in Figure 2 below.

Figure 2: Estimated existing and potential I&C flexibility by market

Great Britain	0.8GW in 2024	1.7GW estimated by 2030
Ireland	0.6-0.7GW in 2024	1.2GW estimated by 2030
Germany	0.4-3GW in 2020-24	5GW+ estimated potential
Australia	1.0GW in 2021	1.7GW estimated by 2030

Source: Cornwall Insight analysis; National Energy System Operator (NESO); Commission for Regulation of Utilities (CRU); EirGrid; Regelleistung; International Energy Agency (IEA); RACE for 2030; Australian Energy Market Operator (AEMO). We note that estimates based on publicly available data sources may underestimate the total industrial flexibility capacity in some markets, particularly where data is limited on the impact of implicit signals.

These policy positions are driven by the growing need for system-wide flexibility, include from demand-side sources like I&Cs, to support broader decarbonisation objectives. The implementation of these market transitions present commercial opportunities for energy intensive industries to mitigate their electricity costs and support wider grid decarbonisation.

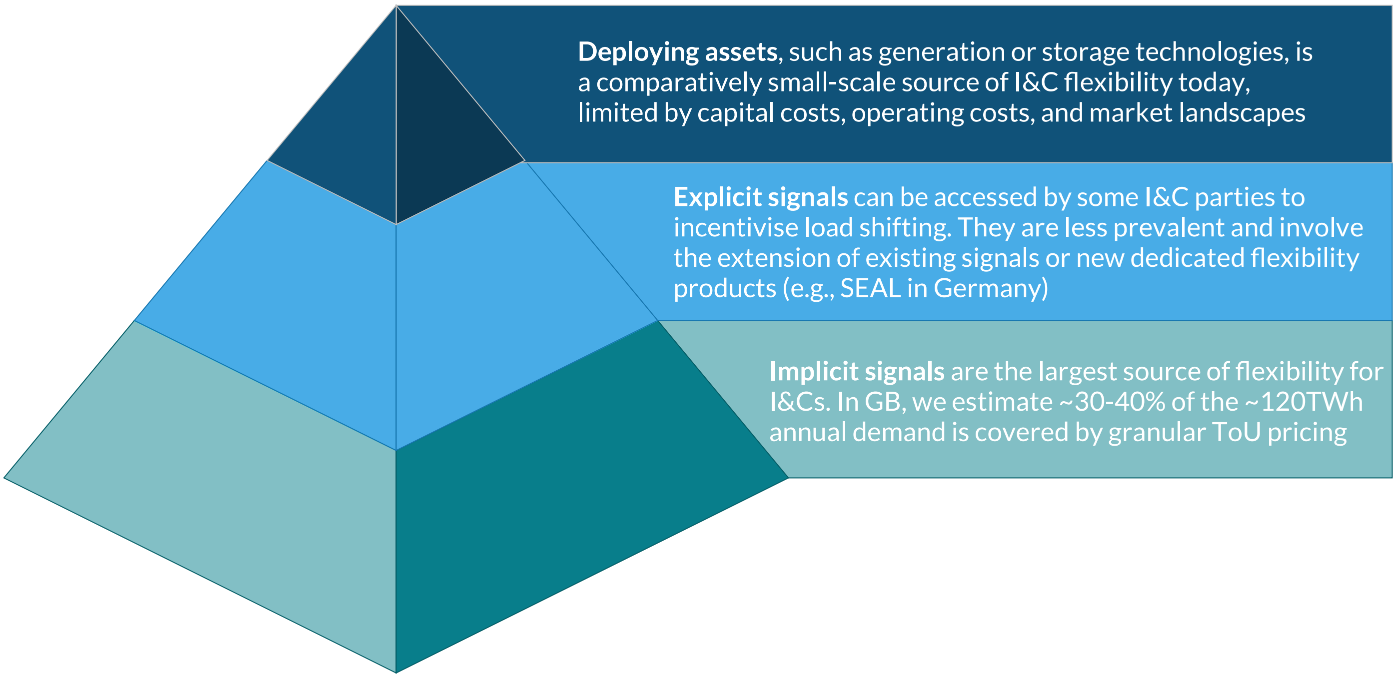
2. Implicit signals are key as opportunities from explicit signals grow from a relatively limited base today

Across the markets examined, implicit signals (e.g., ToU pricing via electricity supply arrangements) represented the greatest driver of flexibility from I&C parties (summarised in Figure 3 below). These represent more mature market structures and are already directly aligned to the electricity cost minimisation efforts for I&Cs.

In comparison, explicit signals form a small part of the current market incentivising I&C flexibility, constrained by signal design parameters or objectives that are typically less aligned with consumer-led flexibility capabilities (e.g., with metering of speed of response requirements that align with the grid-scale battery or generating technologies that traditionally participate).

Security of supply provides most explicit flexibility opportunities today, particularly in Australia, GB, and Ireland. These signals can carry lower impacts on day-to-day operations than other more onerous types of explicit signals. Other markets are also developing security of supply signals – Germany is currently developing a combined Capacity Mechanism, with implementation targeted for 2028. Germany has ambitious targets for I&C flexibility, and the policy objectives are bringing forward reforms to existing arrangements and dedicated new explicit flexibility signals that are aimed at consumer-led flexibility, including I&Cs.

Figure 3: Illustrative scale of flexibility signals and responses



Source: Cornwall Insight

Figure 4: I&C demand-side response (DSR) participation in response to explicit market signal categories

	Security of Supply	Balancing Services	Frequency Response
GB			
IRE			
GER			
AUS			
TEX			

Source: Cornwall Insight analysis.

Key: **Green** – I&Cs known to be delivering DSR to at least one scheme in this category, **Red** – no known I&C participation, includes both where there is no DSR participation and where there is a lack of transparency over the sources of DSR. **Grey** – categories where no scheme exists for I&Cs to participate in.

Changes in the structure of flexibility signals can materially affect participation from I&C parties. For example, between 2021 and 2023, I&C DSR engagement with flexibility signals in the GB market fell by 50%, impacted by changes to how network chargers were allocated. The approach saw a material reduction in value to the Triad signal, which provides an incentive for I&Cs to reduce consumption during peak winter periods in order to significantly reduce their network charges. In part, this was to avoid network users who could not alter consumption having to pay a larger share of the system maintenance and upgrade costs.

In the GB system operator's Future Energy Scenario pathways, I&C flexibility increases from 2% flexibility capacity during peak periods today to approximately 3% in 2030, which remains lower than the highest peak consumption reduction under the Triad signal.

3. Large industry with high energy costs and a greater financial incentive to engage are most likely to be involved

Whilst we have found multiple sectors participating in DSR across the studied markets, these are largely concentrated within the largest energy users in the I&C market, with several heavy manufacturing sectors a recurring presence (including cement, steel, paper, and aluminium). The most prominent sectors for I&C flexibility are those that either have operational processes better suited to load management (e.g., chemicals, cement) or are facing high energy costs and a greater financial incentive to reduce network costs etc. (e.g., steel, aluminium).

Although important, financial incentives are not the only motivation for I&C participation in flexibility opportunities. Broader environmental, social, and governance (ESG) requirements are bringing engagement, alongside site-level benefits such as increased resilience from deploying assets like battery storage or generation technologies.

Figure 5 (overleaf) summarises how different sectors could be participating in a range of flexibility services.

4. Commercial alignment and technical service requirements are barriers to I&C flexibility across markets

Across the markets examined, barriers across policy & regulation and technical & operational areas are present and impacting I&C engagement with flexibility opportunities. Often these barriers are associated with the evolution of energy markets, moving from large scale generation assets connected to a high voltage system to markets with increasing levels of intermittent and distributed generation alongside demand flexibility. These challenges are often structural relating to the roles, responsibilities, and interactions between the relevant network and system operators and the rest of the energy market participants.

Amongst the policy and regulatory challenges identified, the "stacking" of flexibility provision across multiple different markets was common to each market. This access to multiple sources of value is often restricted or limited, which reduces the diversity of routes to market for I&C flexibility and limits participation.

Service design restrictions also commonly place minimum size thresholds for participation (e.g., 500kW in Ireland), which can limit the participation of I&Cs. However, aggregation through flexibility service providers can mitigate this challenge.

5. Limited data availability and visibility impedes evaluating I&C flexibility participation and delivery

Across the markets examined in this report, there is fragmented and limited availability and visibility of I&C flexibility participation and performance. This barrier makes it harder to evaluate the options for I&Cs to participate in flexibility and the practicalities of participation and delivery, which limits investor confidence.

Greater data visibility could help promote more I&C flexibility participation, although it is important to balance this potential benefit against the cost and time intensity of collecting and publishing the data.

Figure 5: I&C sector flexibility characteristics and potential for participation in explicit signals by market

				Aluminium[1]	Iron and steel[2]	Cement[3]	Pulp and paper[4]	Glass[5]
			Response	5min	15-60min	5-60min	1hr	5min
		Response	**Duration**	1hr	1-1.5hr	1hr	1.5-4hr	15-60min
	Security of supply	4hr	>30min					
GB	**Balancing services**	1-4hr	30min					
	Frequency response	0.5s – 2min	30min – 4hr					
	Security of supply							
IRE	**Balancing services**	1hr – 19 days	30min					
	Frequency response	5-90s	15s – 5min					
	Security of supply							
GER	**Balancing services**	<1s	-					
	Frequency response	30s – 12.5min	-					
	Security of supply	3hr – 10 weeks	>30min					
AUS	*Balancing services*							
	Frequency response	1s – 5min	-					
	Security of supply							
TEX	**Balancing services**	10-30min	30min – 12hr					
	Frequency response	0.25s – 10min	15min – 1hr					

Source: Cornwall Insight analysis; smartEn.

Key: Green – based on average response and duration capabilities, I&Cs within that sector can deliver DSR in response to that explicit signal; **Red** – based on average response and duration capabilities, I&Cs within that sector cannot deliver DSR in response to that explicit signal; **Grey** – categories where no scheme exists for I&Cs to participate in. Sector response and duration values based upon 2025 values published by smartEn.

[1] High temperature electrolysis; [2] Electric arc furnace smelting; [3] Raw material preparation and cement milling; [4] Mechanical pulping; [5] Container glass melting with hybrid/storage furnaces.

5 Introduction

As renewable energy capacity increases globally, the requirement to manage supply and demand becomes more complex. Renewable generators have higher levels of intermittency (unplanned fluctuations in generation), increasing the need for energy system flexibility to match supply and demand.

Energy flexibility can be provided by a range of market participants, and there is an increasing recognition of the role I&C businesses can play in engaging with flexible energy consumption. In some energy markets, there is an existing presence of large businesses responding to energy market requirements in return for lower energy bills. However, there is limited visibility of the scale and characteristics of the businesses choosing to engage. This in turn limits understanding of the nature of the opportunity in other global energy markets, the identification of potential barriers to engagement for some sectors, and development of mitigations to these barriers.

5.1 Summary of research objectives

The objective of this research is to understand the characteristics of I&C businesses engaging with energy flexibility in the current market across multiple geographies, and to establish key barriers to engagement for such businesses.

5.2 What is Demand Side Response?

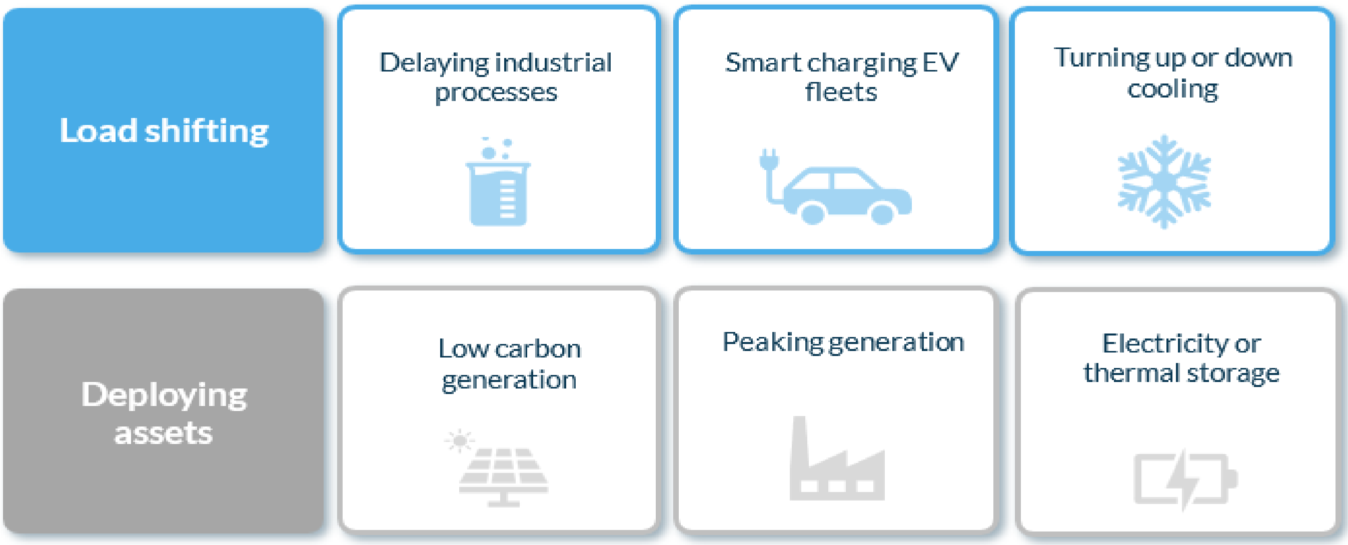
DSR refers to actions taken by consumes to change their electricity usage in time of magnitude in response to a signal, to help manage the electricity system.

There are two typical ways of providing DSR:

- **Load-shifting**: Changing the consumption pattern behind the meter.
- **Deploying generation assets**: consuming electricity from generation assets connected behind the meter, offsetting consumption from the electricity network.

We have provided some examples of DSR for I&C consumers below.

Figure 6: Examples of DSR for I&C consumers



Source: Cornwall Insight

From a system perspective, the impact of load shifting or deploying assets is largely the same. However, the costs of deploying different routes for providing changes in import patterns, the duration and speed of response, and – in the case of load shifting – the impacts on business output will all be different. This will drive the willingness of businesses to invest in technology to deliver demand response and potentially their willingness to dispatch capacity in response to signals.

5.2.1 Types of signal

In this research we focus on flexibility driven by two key types of signal, explicit and implicit (Figure 7). These signals form part of the business case for changing in behaviours or investing in assets and technologies, alongside wider investment signals (such as grants for innovative technologies, not explored further in this paper). We have outlined the two main approaches to flexibility dispatch in Figure 7.

Figure 7: Approaches to flexibility dispatch

Explicit signals

Typically refer to a request made in real time to change the magnitude or timing of energy consumption or production.

Also known as response signals.

Implicit signals

Typically provide incentives which are set in advance and are managed around consumer preference.

Also known as routine signals.

Typical characteristics of explicit signals

- Sent in response to a specific need by a system operator, usually to manage balancing, frequency or security of supply.
- Respond in a designated service window and capacity requirement.
- Have some form of price competition or auction to select designated providers.
- Highly variable.
- Issued at short notice.
- Easily visible as the issuer will need confidence its instructions are being followed.
- Have direct cost implications which may be reported and analysed to ascertain cost-effectiveness.

Typical characteristics of implicit signals

- Have a consistent impact (e.g., daily, monthly).
- Applicable to a specified type of user or all users without competition.
- Inflexible when set in advance, hard to predict and avoid when assessed after the fact.
- Not actively sent, and limited certainty on the DSR which will be delivered at any time.

Source: Cornwall Insight

We further identify three drivers of explicit signals that can be found in most energy markets. These drivers determine the requirements of each signal, which can drive engagement or disengagement from I&C DSR:

- Security of supply: Ensuring future availability of supply to meet future demand.
- Balancing services: Mechanisms to balance supply and demand in real time.
- Frequency response: Reacting quickly to stabilise frequency within the grid's acceptable limits to prevent disruption, following rapid changes in supply or demand.

The following sections review I&C engagement in a range of markets, understanding engagement with these different types of signal.

6 I&C Flexibility by Country

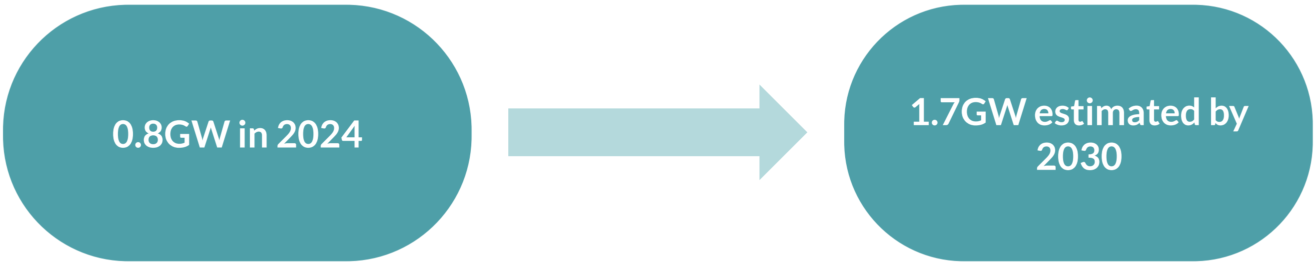
We have undertaken a review of published research available for each energy market to understand the current level of engagement of I&C businesses in DSR, and the extent of information available. This section summarises our key findings.

6.1 Great Britain

In 2024, the GB market was reported to have 0.8GW of I&C DSR (Figure 8),[1] with I&Cs providing the highest volumes of DSR compared to residential appliances, smart charging, and other sources.

I&C DSR is expected to grow in proportion to overall electricity demand as greater electrification of industrial processes increases the potential for flexibility. The system operator[2] estimates that there will be 1.7GW of I&C flexibility during peak periods by 2030, rising to 3.9GW by 2050.

Figure 8: Current and 2030 estimated levels of I&C flexibility in GB



Source: NESO

Between 2021 and 2024, I&C DSR engagement with flexibility signals decreased by 50%,[3] reflecting a significant reduction in value from one of the key flexibility signals. The Triad signal[4] provided an incentive for I&Cs to reduce consumption during peak winter periods in order to significantly reduce their network charges. These charges were restructured to avoid higher system maintenance and upgrade costs for network users who could not alter consumption.[5] Triads acted as both an explicit and implicit signal – the charge fell in a known time period so could be treated alongside other network charges and engaged with regularly or could be acted on in a more targeted and responsive way.

In 2025, the GB market still provided implicit signals (through network charges and ToU tariffs) and explicit signals (Figure 9). These services have evolved with the requirements of the overall energy system - some services have been developed in the last three years (e.g., the Demand Flexibility Service) to increase DSR engagement across the market, whilst others are existing services that are being adapted for DSR (e.g., the Balancing Mechanism). Engagement from I&C consumers can be directly with the service manager (typically the system operator) or through an aggregator or energy retailer.

[1] NESO, 2025 – *capacity available at peak times, includes response to implicit and explicit signals*
[2] NESO, 2025
[3] NESO, 2025
[4] *Triad periods are the three half-hourly settlement periods of highest electricity demand on the GB transmission system between November and February each year, separated by at least 10 clear days. The average consumption of I&Cs during triad periods is used to determine their transmission network charges. Previously the entire transmission network charge was calculated based on triads, but this has now been changed so that transmission network charges for I&Cs are recovered through both a fixed element (£/site/day) and the variable triad element (£/kW).*
[5] Ofgem, 2019

The system operator has set up an onboarding team to support larger consumers in participating in the available flexibility markets,[6] as well as setting public targets for the volume of non-domestic DSR capacity added to the NESO's markets each year to 2030.[7]

Figure 9: I&C engagement with, and examples of, implicit and explicit signals in GB

Type of signal	Example and response	I&C engagement
Implicit	**Network charges** **ToU tariffs –** e.g. range of tariffs offered by energy suppliers	There is no publicly available register which records I&C DSR in response to network charges or uptake of ToU tariffs. However, we estimate that around 30-40% of the I&C market are on some form of ToU tariff. The decline in I&C DSR participation following the reduction of Triads also highlights the historical strength of the signal and its role in delivering flexibility in GB.
Explicit – security of supply	**Capacity Market (CM)** – notice of four hours and duration of a minimum of 30 mins.	0.8GW of DSR were registered in the CM in the 2024-25 auctions. While this DSR is not directly attributed to I&Cs, domestic DSR does not participate in the CM.
Explicit – balancing services	**Balancing Mechanism (BM)** – open for bids 60-90 mins before each 30 min trading window. **Demand Flexibility Service (DFS)** – within-day notice of at least four hours and duration of a minimum of 30 mins.	As of June 2025, there are fewer than 15 I&C BM Units (one or multiple I&Cs which bid into the BM together) registered to provide DSR in the BM. For DFS, I&C businesses achieved a maximum demand reduction of 3.6MW[8] in a half hour period in February 2024, with 22% of participating I&Cs reducing by more than 10kW. However, changes to the scheme to make it more competitive (reducing the paid value) have reduced the levels of I&C and domestic engagement in the last year.
Explicit – frequency response	The required response speed and the complexity of participation are believed to make it technically and commercially unviable for I&Cs to deliver flexibility through GB frequency response services, although it is not prohibited through regulation.	

Source: Cornwall Insight analysis; Elexon; NESO

While there is limited data available about the individual businesses involved in flexibility services, information provided through some industry registers (particularly the CM and BM) demonstrates the broad range of sectors engaging in DSR (Figure 10). These registers indicate that flexibility delivered by I&Cs under these schemes is primarily delivered through load management by changing consumption processes, sometimes combined with behind-the-meter generation such as battery storage.

Figure 10: List of I&C sectors in GB identified as participating in flexibility alongside a description of how that flexibility is delivered

Industry	Type of response	Example company
Cement manufacturing	Load management, such as through interrupting grinding mills – which minimally impacts the end products quality.	CEMEX UK
Chemical manufacturing	Load management of flexible production processes.	INEOS; Exxon Mobil

[6] NESO
[7] NESO
[8] NESO

Industry	Type of response	Example company
Data centers	Load management combined with behind-the-meter generation and storage assets.	Enel X
Hospitals	Switching to backup generation during likely higher priced periods, combined with behind-the-meter generation and storage assets.	NHS
Hotels	Load management, such as turning down HVAC systems without impacting customers.	Marriott
Pulp and Paper recycling and manufacturing plant	Load management, such as the shutdown of predetermined parts of the recycling process in response to system stress events.	UPM Caledonian; Palm Paper
Steel manufacturing	Load reduction from electric arc furnaces as part of steel melting process.	Tata Steel UK; LIBERTY Steel
Supermarkets/food processing	Load management, such as varying electricity consumption for refrigeration, air-conditioning, pumping, and lighting in large cold storage facilities.	Norish Cold Storage
Universities	Load management combined with behind-the-meter generation and storage assets.	University of Warwick; Lancaster University
Water treatment company	Load management, such as the turning down of pumping equipment and non-essential loads at treatment plants.	Severn Trent Water

Source: Cornwall Insight analysis

The case study below provides an example of a paper recycling and manufacturing plant delivering flexible load management through its recycling process in response to signals from the CM.

Case study: Paper recycling and manufacturing plant with flexible load management

Palm Paper's recycling and manufacturing plant is located in King's Lynn, Norfolk. Able to produce 2km/min, it has the capacity to produce 400kt/yr of newsprint. It engages in DSR by scheduling predetermined shutdowns to parts of its recycling process in response to system stress events.

6.2 Ireland

In 2024, the regulator reported 600-700MW of DSR capacity,[9] with roughly a fifth from Large Energy Users (LEUs). By 2030 this is estimated by the system operator to double to 1.2GW[10] (Figure 11), although this is significantly less than the target of 20-30% of daily demand participating in flexibility by 2030.[11] As part of this overall target for demand flexibility, it is expected that a greater proportion will be delivered by LEUs.

Figure 11: Current and 2030 estimated levels of I&C flexibility in Ireland

Source: CRU; EirGrid

There are a variety of implicit and explicit flexibility signals (Figure 12) incentivising DSR participation for the estimated 2,150 LEUs in Ireland and Northern Ireland (NI).[12] There is no differentiation in industry registers between the sources of DSR participating in the explicit signals, so I&C flexibility cannot be separated from domestic flexibility. For implicit signals there have been business specific developments in recent years, including the Beat the Peak Business scheme by ESB Networks, which financially rewards registered businesses for reducing their demand during peak hours on weekdays.[13]

Figure 12: I&C engagement with implicit and explicit signals in Ireland

Type of signal	Example and response	I&C engagement
Implicit	**Network tariffs** **ToU tariffs** (e.g., Beat the Peak Business offered by ESB Networks)	Although there is limited publicly available data quantifying the prevalence of participation in Ireland, the availability of business specific ToU tariffs suggests that corporates are responding to implicit signals. The extent to which this is I&Cs or smaller businesses is unknown.
Explicit – security of supply	**Capacity Remuneration Mechanism (CRM)** – participants are required to pay a difference payment if not delivering demand reduction when prices exceed their strike price, incentivising demand reduction during these higher price periods.	In 2024, there was 532MW of de-rated[14] DSR capacity registered in the CRM, which included both I&Cs and non-I&Cs.
Explicit – balancing services	**Balancing Market** – open to bids from 19 days to 1 hour before each 30 min settlement window.	There are 60 demand units registered in the Balancing Market. The majority of these are aggregators or suppliers for which the source of DSR is unspecified. However, there are at least two I&Cs registered, as well as some aggregators that are I&C specific.

[9] CRU, 2024
[10] EirGrid, 2023
[11] gov.ie, 2022
[12] CRU, 2024
[13] ESB Networks, 2023
[14] *De-rating of capacity applies a percentage scaling factor to account for the reliability of that technology and the chance that it will therefore be able to deliver the contracted capacity if required. Technologies that are weather dependent often have a lower de-rating factor than fuelled generation due to their greater reliance on conditions outside their control.*

Type of signal	Example and response	I&C engagement
Explicit – frequency response	**Primary Operating Reserve** – notice of five seconds and duration of 15 seconds. **Secondary Operating Reserve** – notice of 15 seconds and duration of 90 seconds. **Tertiary Operating Reserve** – notice of 90 seconds and duration of five minutes.	In March 2025, 65MW of DSR participated in reserve services across Ireland and NI. I&C DSR participation in these services is done through aggregators.

Source: Cornwall Insight analysis; EirGrid; Single Electricity Market Operator

There is limited visibility of the sectors and companies participating in I&C flexibility in Ireland, with industry registers recording the suppliers and aggregators rather than specific companies. However, the system operator has identified data centres as a sector that could be crucial in the coming years for delivering demand reduction during emergency situations.[15] In 2023, data centres accounted for 21% of total electricity consumption in Ireland, making them the largest single sector for electricity consumption.[16] Therefore, to better incentivise flexibility from these assets, as well as to protect the electricity system, the regulator introduced a requirement for all new data centres to provide generation and/or storage capacity to match the data centre demand, and for that generation/storage to participate in energy markets.[17] In addition to data centres, our research also identified other I&C sectors which participate in DSR in Ireland (Figure 13).

Figure 13: List of I&C sectors in Ireland identified as participating in flexibility alongside a description of how that flexibility is delivered

Industry	Type of response	Example company
Agricultural & animal feed	Load management in response to CRM signals.	McCauley Feeds
Airports	Behind-the-meter generation assets.	Dublin Airport
Alumina refineries	Behind-the-meter generation and combined heat and power assets.	Aughinish Alumina
Cement and aggregates company	Load management, such as through temporarily switching off energy-consuming equipment like cement mills and pumps during peak demand periods.	Roadstone; Irish Cement
Chemical manufacturers	Load management.	Johnson Matthey
Data centers	Behind-the-meter generation and storage assets.	Enel X
Food/beverage production and cold storage sectors	Load management, such as through the use of storage and siloed production processes, combined with behind-the-meter generation.	Kerry Group; C&C Group; Western Brand
Pharmaceutical manufacturing	Load management combined with behind-the-meter generation and storage assets.	Servier Ireland Ltd; Pfizer; Teva Pharmaceuticals
Water supplier and recycling services	Load management.	Anglian Water; Northern Ireland Water; Uisce Éireann

Source: Cornwall Insight analysis

15 EirGrid, 2024
16 Central Statistics Office, 2024
17 CRU, 2025

The following case study provides an example of a poultry and egg processing business providing DSR in Ireland through load management.

Case study: Poultry & egg processing business using flexible load management

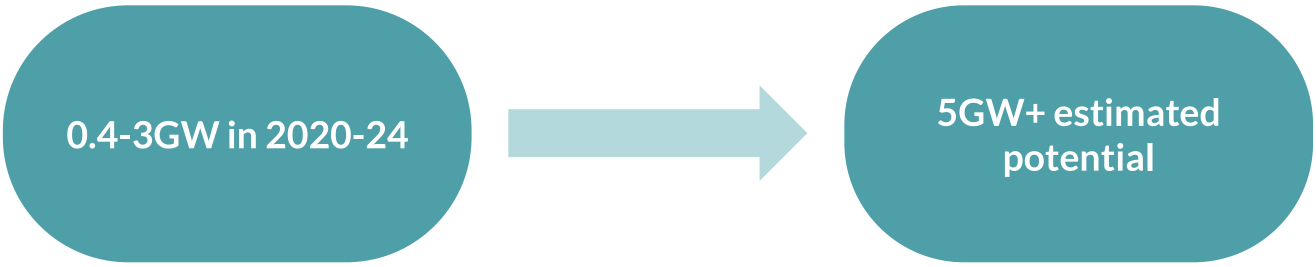
Western Brand operates two sites, Lisnaskea & Ballyhaunis, and produces poultry and egg products. Western Brand have registered 2.9MW of flexible capacity into DSR programmes. This flexibility is provided by assets including compressors/condensers, ovens, freezers, refrigeration, and diesel generators. Western Brand uses advanced metering and controls to maintain operations whilst benefiting from DSR revenues and savings.

6.3 Germany

In Germany, engagement with flexibility is high among energy intensive companies (annual consumption >50GWh), with around 94% (422 out of 450) reported to have participated in load management in 2022.[18] The capacity of load management varies significantly between sites, reported to be anything from 10kW to 90,000kW per site in 2021.[19]

Published data for German balancing services between 2020 and 2024 shows between 0.4GW and 3GW of prequalified DSR capacity (Figure 14). However, this is likely to represent an underestimate of total I&C DSR capacity, as not all capacity will participate in these markets. There is estimated to be substantial potential for additional I&C flexibility in Germany currently, with German I&Cs suggested to be able to deliver 9GW of demand increase or 5-11GW of demand decrease for short periods.[20] However, large energy users currently face barriers to engagement including through competing price signals, where grid fee structures discourage load variation (discussed further in Section 7).

Figure 14: Current and potential levels of I&C flexibility in Germany



Source: Regelleistung, IEA, Kopernikus Project

Work under the German Government flexibility initiative has been focused on specific sectors or companies to date, allowing them to respond to explicit or implicit wholesale market price signals (Figure 15). Since the closure of the "Interruptible Loads Ordinance" (AbLaV) scheme there has not been an alternative aimed at specifically unlocking I&C DSR. Whilst the "Real-time system service product from interruptible loads" (SEAL) scheme is intended as a form of replacement, the technical requirements limit participation for many I&Cs and therefore the theoretical potential of SEAL is only 400MW, significantly below the 1.2-1.5GW achieved under AbLaV. On 1 April 2025, ToU network charges (zeitvariable Netzentgelte) were made available for both business and household consumers with flexible energy devices and compatible digital controllers. Network fees for customers who opt in fluctuate according to predefined time windows, with grid operators defining high, standard, and low tariff periods throughout the day, incentivising participation in DSR to reduce costs and support grid stability.

Figure 15: I&C engagement with implicit and explicit signals in Germany

Type of signal	Example	I&C engagement
Implicit	**Network charges**	There are 4,200 "atypical network users" who receive reduced network charges in return for moving their peak demand outside of the peak period. ToU network charges are available to businesses with flexible energy devices, incentivizing participation in DSR
Explicit – security of supply	A combined capacity market design is currently being discussed but at present there is not a security of supply signal for I&C flexibility in Germany.	

[18] Council of European Energy Regulators, 2024
[19] Federal Ministry of Education and Research, 2021
[20] Kopernikus Project - SynErgie, 2023, International Energy Agency – Energy Policy Review Germany 2025

Type of signal	Example	I&C engagement
Explicit – balancing services	**“Interruptible Loads Ordinance” (AbLaV)** – response within 15 mins. **“Real-time system service product from interruptible loads” (SEAL)** – response within one second.	AbLaV delivered 1.2-1.5GW of industrial load management per year between 2017 and 2022 but expired on 1 July 2022. The technical requirements of SEAL result in it only having a theoretical potential to deliver up to 400MW.
Explicit – frequency response	**Frequency Containment Reserve (FCR)** – response of 30 seconds. **Automatic Frequency Restoration Reserve (aFFR)** – response of five mins. **Manual Frequency Restoration Reserve (mFFR)** – response of 12.5 mins.	Between 2020 and 2024, 0.4-3GW of DSR capacity has prequalified for frequency response services, with the greatest volumes for the mFFR service. This includes both I&C and non-I&C capacity.

Source: Cornwall Insight analysis; Entelios; Regelleistung; TransnetBW

I&Cs across a variety of energy intensive sectors are participating in flexibility, predominantly through load management (Figure 16). Many of these I&Cs have been supported through the SynErgie Kopernikus Project. However, there is little visibility on the scale of the load management for most of the companies involved or the exact implicit or explicit signals that they are managing demand in response to.

Figure 16: List of I&C sectors in Germany identified as participating in flexibility alongside a description of how that flexibility is delivered

Industry	Type of response	Example company
Aluminum production	Load management, such as through turning smelters into a ‘virtual battery’, which relies on adjustable heat exchangers that can maintain the energy balance in each electrolysis cell irrespective of changing power inputs, alongside behind-the-meter generation.	TRIMET
Beverage bottling plants	Load management of beverage filling process.	Veltins; Brandenburger Urstromquelle
Cement mills	Load management, such as through the buffering of the production process using raw material and product siloes. Flexibility potential is higher in the winter when there is less demand from the construction industry.	Thyssenkrupp Polysius
Chemical industry	Load management, such as through the buffering of chlorine-alkaline electrolysis through storage of chlorine or intermediaries, alongside operating the electrolyser alongside a battery as a virtual power plant.	BASF; Covestro
Gas separation	Load management of production and liquefaction of gases.	Linde
Glass container production	Load management, such as through varying electric boosting input by 5-15%.	Heinz-Glas
Paper and pulp industry	Load management, such as through using pulp storage to flex pulp production.	UPM Nordland Paper
Plastics production	Load management of injection molding production line.	Allgaier Kunststoffverarbeitung

Industry	Type of response	Example company
Steel manufacturing	Load management, such as through short periods of demand reduction or load shift of electric arc furnaces, due to only ~50% power-on time.	Hirschvogel Group; thyssenkrupp Steel

Source: Cornwall Insight analysis

The case study below provides an example of a German aluminium manufacturer which has updated equipment across multiple sites to facilitate greater potential for delivering flexible load management.

Case study: Major aluminium manufacturer with flexible load management

TRIMET, an Essen-based aluminium manufacturer, is Germany's largest private-sector electricity consumer and accounts for 1.6% of Germany's annual electricity demand. While aluminium electrolysis traditionally depends on a stable and constant supply of electricity, TRIMET developed a flexible manufacturing process to allow for fluctuating energy inputs, allowing its furnaces to consume up to 25% more or less electricity in response to system need.

The key innovations include adjustable heat exchangers to ensure a stable temperature in the electrolytic furnaces (referred to as a 'virtual battery') and conductor rails to compensate for fluctuations in magnetic field due to current flow to avoid this impacting on the aluminium melt. Across 120 furnaces this can deliver 22.5MW of flexible capacity for up to a maximum of two days (slightly over 1GWh in total). Additionally, TRIMET can completely shut down the production line for 90 minutes as a last resort for grid stabilisation.

6.4 Australia

In 2021, there was reported to be 997MW of I&C DSR participation (Figure 17),[21] with this highly concentrated in the non-ferrous metals sector (800MW), suggesting relatively low levels of engagement from other sectors. However, this reported I&C DSR capacity was acknowledged to likely be an underestimate due to limited visibility of participation in certain markets, particularly the response of I&Cs to implicit signals.

Figure 17: Current and 2030 estimated levels of I&C flexibility in Australia

Source: RACE for 2030; AEMO

There are a range of implicit and explicit signals available to promote I&C DSR, although there is limited visibility of the exact participation levels (Figure 18). The Wholesale Demand Response Mechanism (WDRM) is an explicit signal specifically targeted at reducing the aggregated demand from large energy users during periods of high prices or supply scarcity. The WDRM signal is only open to I&C DSR, making it unusual compared to the majority of explicit signals that are available to I&Cs. There has been limited uptake since the scheme opened in 2021, with a single aggregator participating, unlocking a relatively small volume of DSR (Figure 18), due in part to very stringent baseline criteria (Figure 24).

In 2021 it was estimated that there was the potential for I&Cs to deliver an additional 1.5GW of DSR capacity through load shifting during peak periods.[22] In 2024, the system operator estimated that there will be 1.7GW of DSR by 2030, rising to 2.9GW by 2050.[23]

Figure 18: I&C engagement with, and examples of, implicit and explicit signals in Australia

Type of signal	Example	I&C engagement
Implicit	**Critical peak demand (CPD) tariff**	ToU tariffs to reduce the CPD charge component of network tariffs are available, but we have not found any data on the scale of uptake of these tariffs by I&Cs.
Explicit – security of supply	**Reliability and Emergency Reserve Trader (RERT)** – notice from three hours to 10 weeks and duration of at least 30 mins.	In Q424, 605MW of DSR was contracted under the RERT from both aggregators and individual companies.
Explicit – balancing services	**Wholesale Demand Response Mechanism (WDRM)** – by 12:30 every day participants submit spot market bid price above which they will provide DSR the next day.	As of June 2024, there were 15 units registered for the WDRM, delivering 63MW of capacity. Across 2024, the WDRM delivered 481TWh of demand reduction, with 103MWh delivered in Q424.
Explicit – frequency response	**Frequency Control Ancillary Services (FCAS) Contingency markets** – notice varies from one second to five minutes across the different markets.	On average across 2024 there was 31MW of DSR capacity per quarter in FCAS markets. DSR represented 12% of total capacity in FCAS during Q424.

Source: Cornwall Insight analysis; AEMO

[21] RACE for 2030, 2021
[22] RACE for 2030, 2021
[23] AEMO, 2024

A review of existing research identified a series of sectors that are already participating in I&C flex (Figure 19).[24, 25] This is further informed by the register of assets participating in DSR through the RERT. However, we note that a large amount of the DSR delivered through the RERT and WDRM is delivered through aggregators, reducing the visibility of which businesses and sectors are involved.

Figure 19: List of I&C sectors in Australia identified as participating in flexibility alongside a description of how that flexibility is delivered

Industry	Type of response	Example company
Aluminium smelters	Load management, such as through modulating production.	Tomago Aluminium; Rio Tinto; Alcoa
Cement production	Load management, such as through the use of siloes to buffer production.	Cement Australia
Non-coal mining	Behind-the-meter generation and storage.	Newmont
Packaging industry	Load management.	Amcor
Paper mills	Load management, such as through stockpiles and delayed production.	Opal Australian Paper
Steel manufacturing	Load management, such as through short-term reductions of electric arc furnace demand due to them only having ~50% power-on time.	BlueScope
Universities	Behind-the-meter battery storage combined with automation based on forecasted market prices.	Queensland University
Water supply, sewage & drainage services	Load management, such as through the use of flexible load assets, e.g., water pumps, aerators, etc.	Sydney Water

Source: Cornwall Insight analysis

The following case study provides an example of a water supply and sewage company providing DSR through load shedding.

Case study: Water supply and sewage company with flexible load management

In 2021, Sydney Water delivered 4-5MW of load shedding capacity from water pumps, blowers, and aerators across their six largest waste treatment plants (out of 29 total). This load management was delivered in response to high prices, monitored by Sydney Water's operations centre. Sydney Water's potable water pumping stations already provide flexibility in response to implicit signals through ToU tariff pricing but were estimated to be able to deliver an additional 5MW of load shedding capacity, across 20 sites, in response to explicit signals.

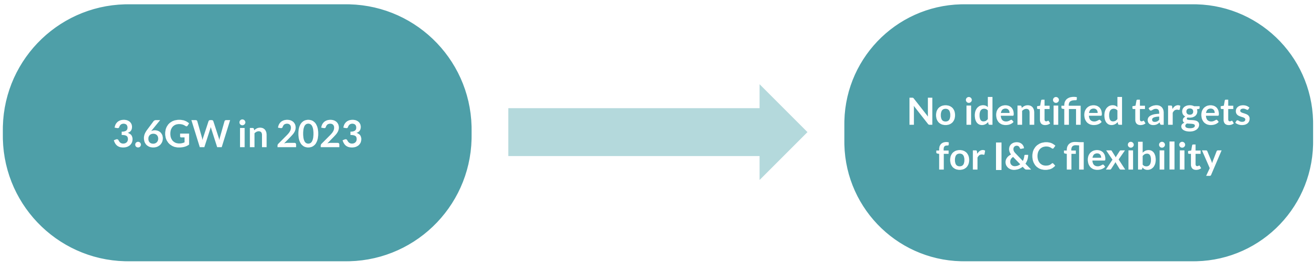
Together, this would result in Sydney Water delivering 10MW of DSR capacity in response to explicit price signals, which would further increase to 18MW at weekends. Overall, this would bring Sydney Water's load shedding capacity to 25-45% of its total demand.

[24] RACE for 2030, 2021
[25] Australian Renewable Energy Agency (ARENA), 2024

6.5 Texas

The Federal Energy Regulation Commission found that there was 3.6GW of capacity participating in DSR programmes in the ERCOT (Electric Reliability Council of Texas) market in 2023 (Figure 20).[26] During peak periods, the Commission found that >80% of DSR was provided by I&Cs. Whilst we have not identified any targets or estimates for the level of I&C flexibility by 2030, overall electricity demand is expected to significantly increase (40-75% by 2030), and more intermittent generation could result in a growing need for greater DSR.[27]

Figure 20: Current and targeted levels of I&C flexibility in Texas



Source: Federal Energy Regulation Commission

There is limited visibility and data on I&C flexibility in ERCOT, and the market signals I&Cs are responding to. We have compiled the available information on implicit and explicit signals that I&Cs could be responding to in ERCOT (Figure 21), alongside any known on overall DSR participation (including non-I&Cs and aggregators).

Figure 21: I&C engagement with implicit and explicit signals in Texas

Type of signal	Example	I&C engagement
Implicit	**4-Coincident Peak (4CP) load reduction**	As of 2021, approximately 250-350MW of load reduction was attributed to 4CP participation.
Explicit – security of supply	ERCOT does not have a security of supply route to market for I&C flexibility to participate in.	
Explicit – balancing services	**ERCOT Emergency Response Service (ERS)** – notice of either 10 or 30 mins and duration of 30 mins to 12 hours. **ERCOT Contingency Reserve Service (ECRS)** – notice of 10 mins and duration of 2 hours. **Non-Spinning Reserve Service** – notice of 30 mins and duration of four hours. **Aggregated Distributed Energy Resource (ADER) pilot project** – utility or aggregator determines participation terms and incentive structure.	In July 2022, the ERS delivered ~1GW of DSR – from both I&Cs and non-I&Cs. In 2023, I&Cs provided 95MW from on-site generation and storage into dispatchable reliability systems. The ADER pilot project has secured 15MW of capacity since 2022 – mainly from non-I&C Tesla Powerwalls.
Explicit – frequency response	**ERCOT Responsive Reserve Service** – notice of 10 mins and duration of 30 mins. **Primary Frequency Response (PFR)** – notice of one min and duration of one hour. **Fast Frequency Response** – notice of one min and duration of 15 mins.	In 2023, I&Cs provided 95MW from on-site generation and storage into dispatchable reliability systems.

[26] Federal Energy Regulation Commission, 2024
[27] Public Utility Commission of Texas, 2024

Type of signal	Example	I&C engagement
	Under-Frequency Response – notice of quarter of a second and duration of one hour. **Regulation Services** – notice of five seconds and duration of one hour.	

Source: Cornwall Insight analysis; Federal Energy Regulatory Commission; Public Utility Commission of Texas

There is also limited visibility on the specific I&Cs and sectors participating in energy flexibility programs in Texas. Our research (Figure 22) suggests that for those I&C sectors that are participating in flexibility, a significant proportion is being delivered through the use of behind-the-meter generation or storage assets rather than through load shifting. This is in contrast to the other markets considered here, which predominantly deliver flexibility through load management.

Figure 22: List of I&C sectors in Texas identified as participating in flexibility alongside a description of how that flexibility is delivered

Industry	Type of response	Example company
Cement production	Load management, such as through buffering cement grinding with siloes for storing raw materials and products. Opportunities for load management are greater during the off-season.	Texas Lehigh Cement Company
Petroleum refining	Behind-the-meter generation to reduce grid consumption during peak periods.	Chevron
Pulp & paper production	Load management, such as through the siloing of the production process to shift 12-18% of demand from peak periods, alongside behind-the-meter generation.	Kimberly-Clark
Steel production	Load management, such as through short periods of demand reduction or load shift of electric arc furnaces, due to only ~50% power-on time.	Steel Dynamics
Supermarkets	Behind-the-meter generation (e.g., rooftop solar and micro-grids) to enable the stores to continue operating during a power outage and reduce grid reliance at peak times.	H-E-B; Walmart

Source: Cornwall Insight analysis

The case study below provides an example of Texan supermarkets using behind-the-meter assets to reduce consumption from the grid during peak periods.

Case study: Texan supermarkets using behind-the-meter assets to manage power outages

Grocers such as H-E-B and Walmart have invested in natural gas microgrids and rooftop solar to increase energy resilience and reduce reliance on grid power during peak periods. This is aimed at providing protection against the impact of power outages. H-E-B has fitted solar panels onto 60 of its stores, enabling them to safeguard operations. In addition to enhancing energy security, both H-E-B and Walmart have occasionally been able to sell excess power back to the Texas grid, generating additional revenue.

7 What barriers does industry face in engaging with energy flexibility?

We have undertaken a review of published research across the energy markets covered in this report to understand the key barriers to the engagement of I&C businesses in providing flexibility, and the extent to which those barriers are common across markets and sectors. This section summarises the key barriers alongside case studies for specific sectors.

There are two broad categories of barrier that I&Cs face for engaging in flexibility:

- Technical & operational barriers
- Policy & regulatory barriers

Our review also identified an overarching challenge associated with the evolution of energy markets, moving from large scale generation assets connected to a high voltage system to markets with increasing levels of intermittent and distributed generation alongside demand flexibility. These challenges are often structural relating to the roles, responsibilities, and interactions between the relevant network and system operators and the rest of the energy market participants.

The technical & operational barriers identified in this report (Figure 23) relate to the physical equipment and operational procedures that I&Cs utilise in their business activities and the ways in which these inhibit or limit flexibility provision and engagement. These barriers have a high degree of commonality between the energy markets covered in this report, with Figure 23 outlining the barriers at a high level and the following case study showcasing how these barriers specifically effect the chemicals sector.

Figure 23: Key technical & operational barriers to I&C participation in flexibility

Barriers	Description
Disruption to commercial output	Many industrial processes cannot be disrupted or have energy usage altered without impacting on commercial output.
Safety requirements	Many industrial sectors have processes that rely on tightly controlled conditions and cannot make frequent or rapid load adjustments whilst maintaining safety thresholds.
Additional costs	Participation in flexibility and amending processes or equipment to facilitate flex participation can come at an additional cost to businesses.
Lack of awareness	Many I&Cs are not aware of the potential benefits and revenues available from providing flexibility. Additionally, the technical and operational practicalities associated with providing flexibility are poorly understood by many I&Cs.
Poor data visibility	The availability and visibility of I&C flexibility participation and performance is fractured and limited. This impacts on investment confidence and limits the ability of I&Cs to know what the options are for flexibility and practicalities of delivering it.
Organisational inertia	I&Cs can be resistant to change and have a preference for maintaining traditional operating methods and processes. This inertia can limit the adoption of new technologies and practices to facilitate flexibility provision.

Source: Cornwall Insight analysis

Case study: Technical & operational barriers in the chemicals sector

Many of the continuous manufacturing processes in the chemicals and petrochemicals sectors have a minimum capacity utilisation threshold, below which the safe handling of materials and economic viability become compromised. Dropping below this threshold can destabilise processes, impact on catalyst efficiency, and change reaction yields. Many of the integrated manufacturing machines and processes also have limited ramping capabilities, are sensitive to ambient temperatures, or require long response times to safely adjust loads, all of which restricts their ability to deliver flexibility.

The policy & regulatory barriers identified in this report (Figure 24) relate to the energy market landscape for the jurisdictions covered here and key policies and regulations within those markets that restricts or deters I&C participation in flexibility. Whilst there is some commonality in these barriers, many of them are inherently market specific.

Figure 24: Key policy & regulatory barriers to I&C participation in flexibility

Barriers	Description	Energy markets
Aggregator market access	Independent aggregators in ERCOT are required to work through suppliers and cannot bundle flexibility across different market zones. This reduces the opportunities for competitive flexibility offerings and customisation by limiting innovation and reducing access for distributed I&C loads.	TEX
Access to multiple markets	The "stacking" of flexibility provision across multiple different markets is often restricted or limited. This reduces the diversity of routes to market for I&C flexibility and limits participation.	All
Minimum size for participation	Minimum size thresholds for participation (e.g., 500kW in Ireland) limit the participation of I&Cs with smaller participation.	All
Absence of a security of supply explicit signal	Explicit signals from security of supply mechanisms provide a solid base revenue for I&C flexibility in markets like GB and the absence of these signals can therefore weaken the business case for I&C flex participation.	GER, TEX
Strict baselining requirements	For the WDRM in Australia there are strict baselining requirements that require the I&C to have a very stable and predictable load. This requirement is estimated to exclude 80% of potential I&C loads and discourage new entrants.[28]	AUS
Competing implicit signals	In Germany some I&Cs are classed as "band load users" and face a grid fee tariff structure designed to incentivise high, steady energy usage. This discourages load variation and makes it more financially disadvantageous to participate in flexibility services.	GER

Source: Cornwall Insight analysis

[28] ARENA, 2024

8 Global Flexibility Value Assessment Methodology

As part of our analysis, we aimed to:

- Use third-party data to develop a picture of global I&C electricity demand and the share of this that could contribute to DSR.
- Evaluate the value associated with this this flexible element of I&C demand.

We developed our assessment based on establishing the alternative cost to deliver an equivalent volume of flexible power to that potentially offered by the I&C space.

To do so, we undertook the following steps:

1. **Identify the global annual electricity demand volumes from the I&C sector overall**
    - To do so, we collated data for total global electricity demand alongside OECD- and country-specific snapshots of the absolute and share of electricity demand associated with industrial sectors.
    - We collated these data points to establish ranges for the annual demand from industrial sources. Alongside the broad range of data, we note that there was not a single, uniform definition of "industrial demand" used across the data reviewed. Different sources included varying treatment of demand from elements including non-domestic buildings, data centres, electrolysis, and commercial uses. The ranges developed account for these different assessment approaches in the underlying information.
    - Third-party research used came from a range of sources, including the IEA, Energy Transition Commission, Ember Energy, and the Energy Institute.
2. **Establish the proportion of this demand that could be used flexibly**
    - As with step 1, we have drawn on this range of third-party data and research to establish reasonable benchmarks for the extent to which I&C parties can deliver flexibility. The ranges developed represent a high-level benchmark across the diverse I&C space and are informed in part by the industry-specific case studies discussed in Sections 4 and 6 of the report.
        - As discussed throughout the report, the level of potential flexibility engagement varies significantly across different sectors, types of industrial process, and approach to flexible technologies.
3. **Determine the costs associated with providing the same level of flexibility from other sources**
    - Building on the projected level of flexibility from the I&C sector, we then worked to establish an illustrative valuation for this flexibility, at a global scale.
    - This is based on benchmarking the levelised cost of energy (LCOE) for battery storage (BESS) and gas peakers, which represent technologies that could be deployed to provide an equivalent level of firm flexible volumes as that offered by I&C actions.
    - This analysis is based on our in-house LCOE assessments and third-party information from sources including Lazard. Projections reflect the respective efficiencies associated with BESS and gas peakers.
    - Using the ranges of flexible demand established under Step 2 above, we have matched these against similar ranges for the equivalent volumes required from BESS and gas peakers, and the total cost associated with deploying those technologies.
4. **Translate this to a value range for global I&C flexibility**

  - Having developed an approximate projection of the range of costs associated with deploying equivalent volumes of flexibility, we then worked to translate the total LCOE cost into an illustrative annual value that could be provided by I&C flexibility.
    - This considered asset lifespans, the variable value of demand turn-up and turn-down flexibility, and sensitivities in demand, flexible capacities and associated costs, global energy spend, and flexibility market sizing.
  - This value represents the system-level benefits generated by demand-side flexibility from the sector. For example, reflecting deferred network reinforcement, network management benefits, and overall peak demand reduction.
    - We note that this range does not represent revenue received from I&C parties directly.

8.1 Limitations to our methodology

As noted in Section 4, there is scope for further research, modelling, and analysis to iterate and improve on the illustrative projection developed as part of this study. Whilst we consider the methodology set out above to be appropriate for this level of analysis, there are several limitations to this study that subsequent analysis could engage. This includes the following points:

- Establishing the proportion of demand that can be used flexibly can be a source of error
  - Available flexibility is constrained by factors including alignment with system need, ramp, and speed and frequency of activation. This study has not conducted novel modelling and instead drawn on existing analysis in third-party publications
  - Dedicated modelling and analysis in this area could develop equivalent firm capacity values for different sources to industrial flexibility that reflect these constraints
    - For an example of this form of assessment, see recent analysis on the equivalent firm capacity of domestic flexibility
    - Assumes equivalent levels of firm flexible volumes of I&C DSR and BESS/peakers. Assuming that I&C DSR is fully substitutable with other sources of flexibility will overvalue I&C flexibility
- Our comparison has used BESS and gas peakers as representative alternative sources of flexibility due to their prevalence in assessed markets and key role in delivering system services today and in the near-future. However, other technologies and solutions are available.
  - Household flexibility has potential to deliver material levels of flexibility across international markets and could be delivered at lower cost than building BESS and peaker assets.
- We have used LCOE as a simple proxy for the all-in system cost of developing new flexible assets. However, this does have its limitations for this purpose, particularly concerning utilisation rates, standby value, and non-energy services.
  - Refining the capex and opex requirements for alternative sources of flexibility (including considering sources beyond BESS and gas peakers) via integration with whole-system modelling would be a useful addition to this study. Reducing the cost of equivalent technologies would lower the illustrative value assigned to I&C flexibility.
- System-level modelling that is specific to each of the assessed markets (and beyond) would improve the overall accuracy and applicability of this assessment, particularly concerning broader system benefits such as deferred network reinforcement.
  - This will impact the overall value associated with I&C flexibility as it is not necessarily the combination of all plausible marginal investments that is avoided – it can be the cheapest option that would have deployed.

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