# DEMAND RESPONSE: A TRANSFORMATIVE OPPORTUNITY FOR A CIRCULAR ECONOMY

ENEL X - 2020

# EXECUTIVE SUMMARY

The aim of this document is to highlight the relationship between demand response and a circular economy, by showing how demand response programs, in the form of energy flexibility services, can be an enabler for a circular energy network.

While the environmental and economic benefits in terms of replacing $CO_2$ and capital-intensive peaking plants have been already discussed and promoted by demand response providers and grid operators, circular economy benefits are yet to be clearly identified and measured.

Being a global leader in demand response and having recently developed two new methodologies and tools to measure its own solutions and its clients' circularity, Enel X now has the ultimate goal to measure how demand response programs can actually impact its clients' circularity.

The first section will shortly summarize what is Demand Response and go through the key steps of its evolution so far.

The second section will briefly explain a circular economy and its core principles in order to analyse their correlation with demand response, providing key facts and examples.

Finally, the third section will describe the KPIs that Enel X has defined to specifically measure this correlation.

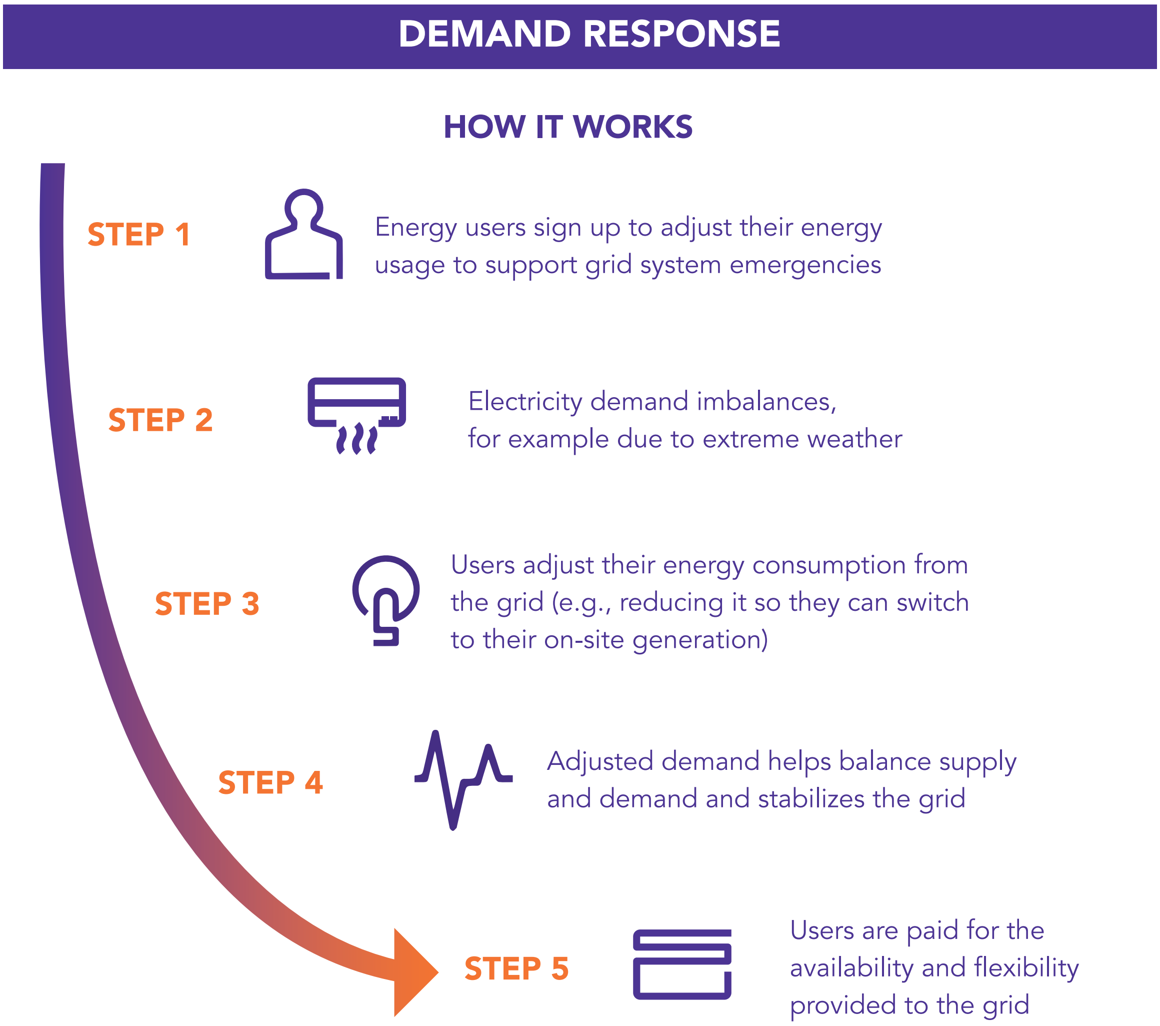


# 1 - INTRODUCTION TO DEMAND RESPONSE

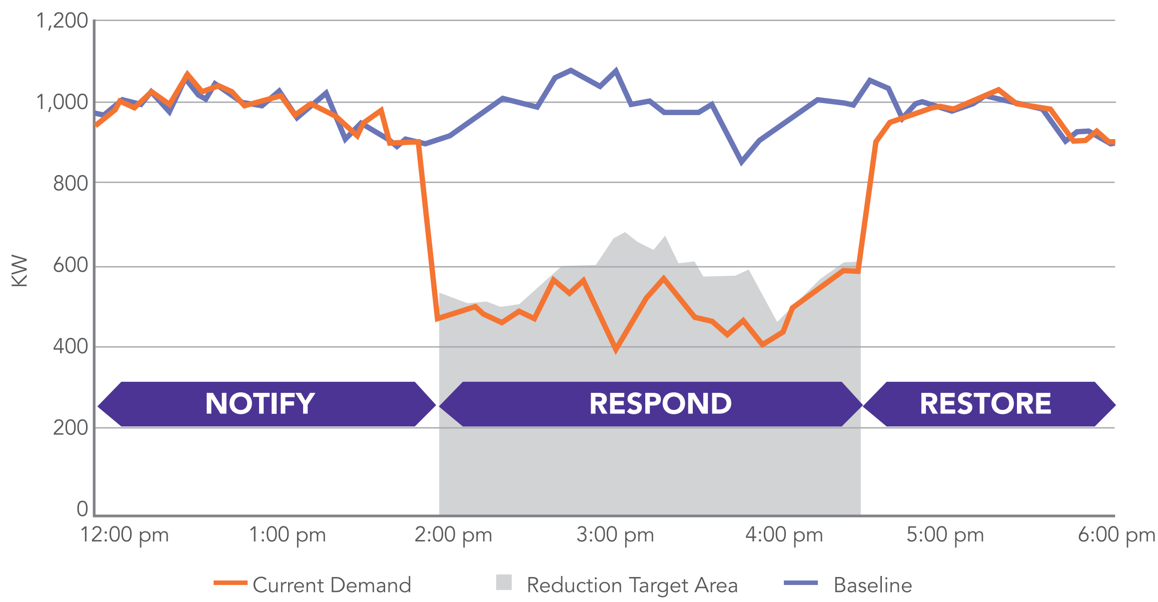
## Demand response definition and how it works

Demand Response (DR) is a concept that incentivize s energy consumption flexibility as a grid system resource, enabling end-users to monetize this flexibility when adjusting their consumption in response to both grid or price signals.

Through demand response, capacity provided by industrial, commercial and residential customers is utilized by utilities and grid operators as an emergency resource designed to increase resiliency of the grid and prevent blackouts, thus avoiding the expensive construction of new physical power plants. Instead of turning on or ramping up another traditional supply source, or even upgrading the grid and building new power plants, utilities and grid operators dispatch end-users to adjust their demand, thus eliminating the need for additional supply and therefore contributing to the reliability of the grid. Through this mechanism, participants get paid for the flexibility provided to the grid.




Demand Response – How it works




Demand Response – The benefits for the grid

While some commercial and industrial (C&I) businesses can participate in demand response directly with their utility or grid system, many leverage aggregators. Aggregators pool the flexible capacity of C&I businesses to form virtual power plants (VPPs) which bolster the overall reliability of DR as a resource to utilities and grid operators and the financial opportunity for businesses.

The following section will lead you through the key milestones of demand response's evolution to provide you with a short yet exhaustive overview of the logic behind this resource, and better understand its sustainability and circular economy features.

## The evolution of demand response

To better explain how the benefits of demand response support a circular economy, it is necessary to observe its historical evolution in the US market, where it was first introduced, as well as the growing diffusion in most-developed markets in Europe.

| | 1950s-1960s | 1980s | 2000s | 2008-today |
|---|---|---|---|---|
| MILESTONE | **INTERRUPTIBILITY**<br>leveraging C&I capacity | **DIRECT LOAD CONTROL**<br>involving residential capacity as well | **ECONOMIC PROGRAMS**<br>creating ISOs & RTOs | **DEMAND RESPONSE TODAY**<br>introducing aggregators in energy markets |
| KEY BENEFIT | **MORE EFFICIENCY** | **MORE FLEXIBILITY** | **RENEWABLES INTEGRATION** | **MORE RELIABILITY** |

Demand response evolution in the USA

## INTERRUPTIBILITY

Between the 1950s and 1960s, US utilities considered the option to introduce large commercial and industrial customers in the electricity market to balance the grid during peak events through interruptibility programs: in case of demand peaks, utilities would contact customers to temporarily and manually switch-off their power consumption on-site. Despite the rare resort to interruptibility, C&I customers would still benefit from lower energy rates or monthly capacity credits – to be used for normal operations – just for their load availability[1].

→ **Benefit: Introducing demand flexibility to convert a previously inelastic resource into a dispatchable resource to address reliability needs and increase grid efficiency.**

**DID YOU KNOW?**

**Until 2019, some European countries like Italy, Spain, Portugal, and Estonia were relying solely on interruptibility schemes to balance their grid systems.**

## DIRECT LOAD CONTROL

Despite the massive power capacity provided, decisions on load curtailment in the commercial and industrial segments would imply a certain level of risk that could affect, or potentially disrupt, standard production processes. For this reason, in the 1980s, utilities started to shift their focus and spotted the opportunity to involve smaller commercial and residential customers to take advantage of their flexibility. Direct Load Control was the first "interruptibility" program involving residential consumers and was based on utilities' active load control enabled by communication and automated circuitry installed on water heaters, air conditioners, and swimming pool water pumps, mostly during summer or winter peak load[2].

→ **Benefit: Further extending the sharing of existing energy capacity by involving smaller users with flexibility.**

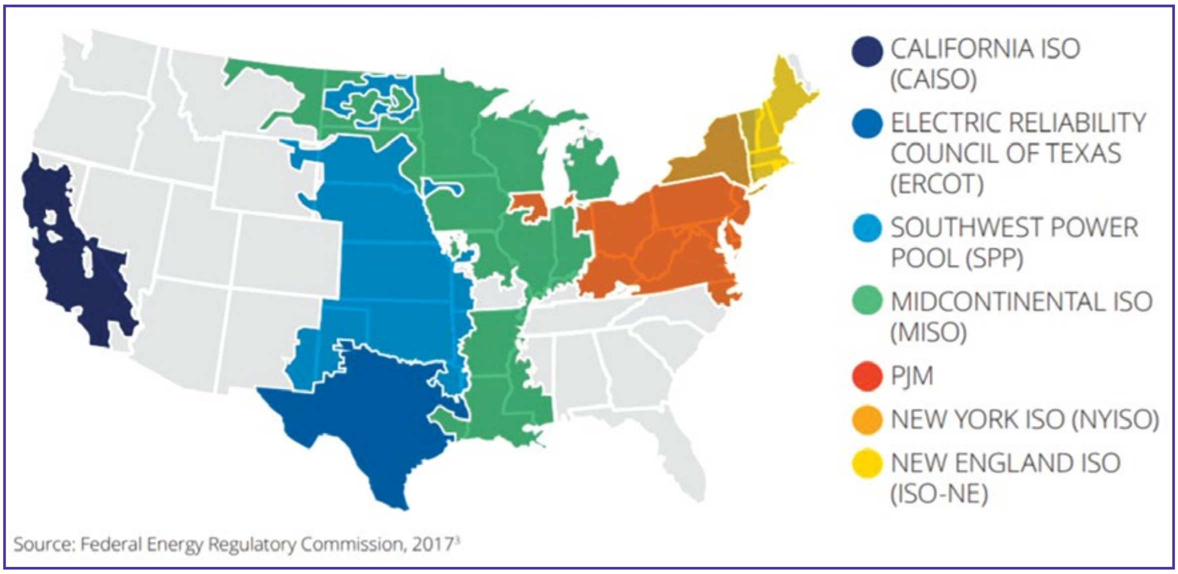
## CAPACITY & ECONOMIC PROGRAMS, ISOs & RTOs

Between the 1990s and 2000s, with the creation of Independent System Operators (ISOs) and Regional Transmission Operators (RTOs), demand response became part of the US wholesale market and gradually began to incorporate economic dynamics as well, with the Federal Energy Regulatory Commission (FERC) promoting the creation of market-based demand response programsthrough the installation of an Advance Metering Infrastructure (AMI). Despite enabling a two-way communication to supply interval meter data and report outages, AMI soon proved

1 Rocky Mountain Institute, 2006 (https://www.swenergy.org/data/sites/1/media/documents/publications/documents/Demand_Response_White_Paper.pdf).
2 Wedgemere Group, 2016 (http://wedgemere.com/wp-content/uploads/2016/01/Evolution-of-DR-Final-Report.pdf).

not to offer the response time and flexibility needed for price-based demand response, leading utilities and aggregators to install their own meters. Therefore, demand response participants were finally able to adjust their own electricity consumption in order to participate in both capacity price-based demand response programs.

→ **Benefit: Adding demand flexibility supporting resource adequacy, and mitigating renewables intermittency and reducing renewables curtailment by integrating dynamic pricing systems.**




FERC – Map of RTO and ISO territories[3]

**DID YOU KNOW?**
**In the US, renewable installed capacity grew from 119.8 GW in 2008 (11% of total installed capacity) to 232 GW in 2017 (19.7% of total installed capacity)[4].**

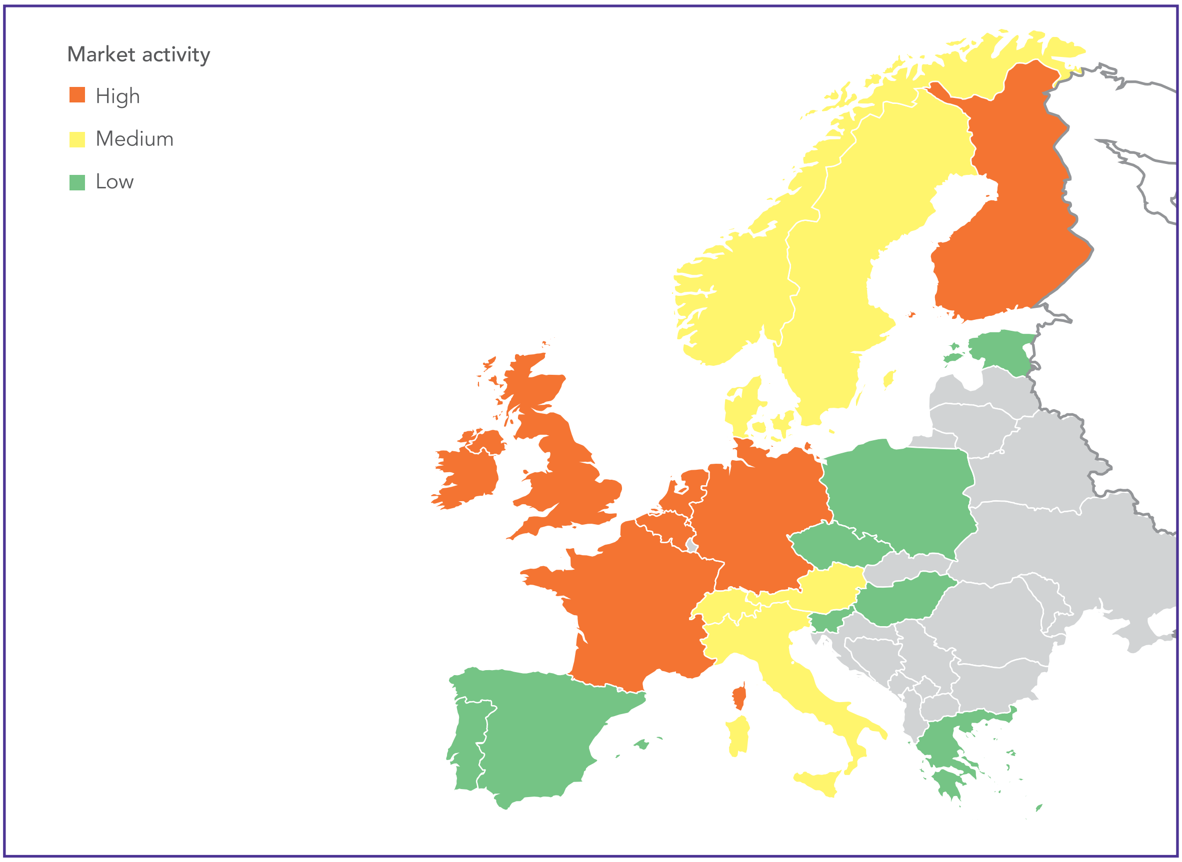
## AGGREGATORS & RETAIL PORTFOLIOS

Finally, throughout the 2000s, regulatory reforms and the increasing popularity of demand response led to the creation of new third-party actors, or "aggregators", who deployed new business models and technologies to aggregate flexible capacity of different customers in a single portfolio and deliver it to ISOs or RTOs as dispatchable load. The introduction of aggregators made it possible for customers without the means to comply with the technical or financial requirements individually, to participate in demand response programs as well.

→ **Enhancing the grid stability by aggregating load across multiple users able to guarantee a minimum curtailment volume.**

3 Wedgemere Group, 2016 (http://wedgemere.com/wp-content/uploads/2016/01/Evolution-of-DR-Final-Report.pdf).
4 NREL, 2009, 2013, 2018 (https://www.nrel.gov/docs/fy09osti/45654.pdf; https://www.nrel.gov/docs/fy14osti/60197.pdf; https://www.nrel.gov/docs/fy19osti/72170.pdf).

While US policymakers have been promoting demand response through specific regulations and rules for decades, EU countries do not show a harmonized approach towards demand response and maturity of the market and – in some countries – demand response is still at its early stages of development due to poor regulatory frameworks with barriers to market participation of aggregators.




2019 EU Market Monitor Map for Demand Side Flexibility

Despite this heterogenicity, Northern Europe countries such as the UK, Ireland, Finland, France, Belgium and Switzerland are setting an example and have already implemented energy flexibility programs:

- France, Great Britain, and Ireland are the highest ranking countries for market activity in Europe. In general, ancillary services provide the most open value streams for demand response resources, where they are primarily monetised[5].
- In Great Britain, one of the most developed markets for demand response services in Europe, the Balancing Mechanism has been opened to small capacity providers and independent aggregators, through becoming Virtual Lead Parties (VLPs) and registering secondary Balancing Mechanism Units (BMU) in the market. The same Secondary BMUs can also participate in the Project TERRE (Trans-European Replacement Reserves Exchange) when it's live, a platform for trading electricity for balancing means in nine participating nations[6].

5 EU Market Monitor for Demand Side Flexibility, 2019, smarten, Delta-ee
6 Elexon BSC Mod P344, (https://www.elexon.co.uk/mod-proposal/p344/).

- In Ireland, national TSO EirGrid launched a demand-side services programme in May 2018 to ensure grid stability amid increased renewable integration, called DS3 (Delivering a Secure, Sustainable Electricity System). DS3 provides incentive payments to large energy users that can enact fast-acting distributed energy assets when the system frequency drops to a certain rate. At scale, these distributed assets can alleviate these frequency changes and protect the grid against the challenges presented by increased renewable generation. This is one of two major demand-side response programmes available in Ireland, the other being the Capacity Market created as part of the Integrated Single Electricity Market (I-SEM) commencing in October 2018[7].

### CASE STUDY: DEMAND RESPONSE GAMIFICATION IN THE UK

UK energy provider Northern Powergrid has recently developed GenGame, a demand response gamification program accessible to end-users via mobile app, through which the energy company can influence and manage consumers' power demand and spread adoption of demand response.

So far, 2,000 domestic users have joined the competition to win cash prizes (i.e., from £100 till £350 per month) just by temporarily switching off home appliances and devices such as the A/C and washing machine. The company provided all participants with a smart meter to track their energy consumption through a wireless connection. Once installed, the app would then send a notification to invite users to reduce their electricity consumption whenever needed, enabling a dynamic and flexible involvement of participants[8,9]. Teaming up with Ecotricity, Northern Powergrid and Newcastle University will soon launch GenDrive, a project that will explore residential customers and EV owners can support the national grid through vehicle-to-grid technology and gamification dynamics.

However, the flexibility advantages of demand response are being increasingly recognized and pilot programs are also being rolled-out in some EU electricity markets:

- in Italy, where the national TSO Terna is currently expanding DR pilot projects to mixed generation, consumption and storage units with the participation of commercial, industrial and residential consumers;
- in Spain, where pan-European pilots in collaboration with Ireland and Denmark are being coordinated by EU project RESPOND[10] as well COORDINET where countries such as Spain, Italy, Greece, Czech Republic, Austria, Germany, Netherlands, Belgium and Sweden are involved.

7 Enel X North America, 2018 (https://energysmart.enelxnorthamerica.com/ireland%E2%80%99s-renewable-power-push-creates-new-incentive-opportunities-irish-businesses).
8 Northern Powergrid, 2018 (https://www.northernpowergrid.com/innovation/news/ground-breaking-mobile-app-sees-thousands-of-domestic-energy-customers-actively-participating-in-northern-powergrid-flexibility-market).
9 Gen Game (https://www.thegengame.com/).
10 http://project-respond.eu

enel x

CASE STUDY: DUBLIN AIRPORT BOOSTS SUSTAINABILITY, RESILIENCE WITH ENEL X

The Irish energy system is setting an example for the world. The Emerald Isle has ambitious sustainability targets, such as the aim to generate 40% of the country's electricity needs from renewable sources by 2020. On 9 April 2018, the power system of Ireland and Northern Ireland became the first in the world to handle up to 65% of renewable non-synchronous energy on its grid. This was an important date for EirGrid, the island's grid operator, which aims to reach 75% variable non-synchronous generation on the electricity network by 2020. However this presents a challenge: renewable sources such as wind and solar depend on unpredictable or invariable weather which threatens system stability. Irish businesses are being called upon to take a leading role in this new energy ecosystem by participating in DS3, the acronym of a multi-year blueprint for "Delivering a Secure, Sustainable Electricity System", and includes Fast Frequency Response (FFR) services that offer demand-side response in less than two seconds. Since May 2018, Dublin Airport has participated in DS3 with Enel X and is seeing business benefits: the ability to access this scheme (as well as participate in the I-SEM, Ireland's capacity market, with Enel X) offers Dublin Airport the opportunity to leverage critical technical knowledge that in turn helps it to develop capital investment plans and project proposals that help in the development of more sustainable longer-term infrastructure plans. "Dublin Airport is delighted to support EirGrid in this important initiative to protect the sustainable supply of electricity on the island of Ireland," said Dublin Airport Managing Director Vincent Harrison. "As Dublin Airport continues to grow we are committed to contributing in a positive way to the environment," he added[11]. Energy Manager Ian Clarke agrees: "We are delighted to become part of [a] network of businesses that are enabling Ireland's grid resilience while enhancing our own operational resilience."

enel x

CASE STUDY: ENEL X, LEADING DEMAND RESPONSE IN ITALY

The demand response market is now taking shape in Italy too. In the latest Terna auction in December 2019, Enel X was awarded 349.4 MW, equal to 35% of the total capacity assigned for mixed dispatching services for 2020, thus confirming Enel X's leadership in the Italian demand response market. The tender extended the possibility of offering power dispatching services to include "mixed" generation, consumption and storage units (including e-mobility charging stations for the first time) and residential aggregation, whereas this solution was previously restricted to consumption units only. With its demand management solutions, Enel X is able to provide its customers balancing orders in real time to stabilize the network on the basis of availability to perform the service, when requested by Terna[12].

11 https://www.dublinairport.com/latest-news/2019/05/31/dublin-airport-power-initiative-supports-national-energy-grid
12 Terna, (https://www.terna.it/it/sistema-elettrico/progetti-pilota-delibera-arera-300-2017-reel/progetto-pilota-uvam).

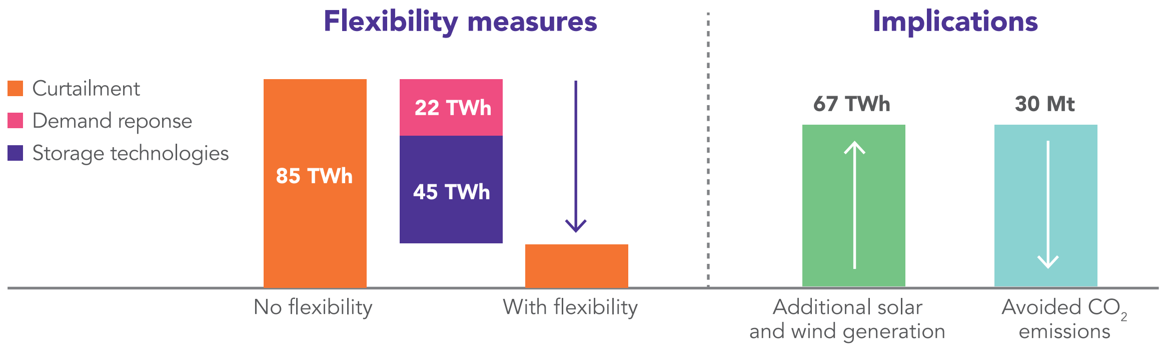
# 2 - WHY IS DEMAND RESPONSE A CIRCULAR ECONOMY ENABLER?

## Going beyond sustainability

Demand response not only represents an opportunity for a more sustainable electricity system, but also triggers circular economy opportunities for the energy industry. On the one hand, demand response promotes sustainability by spotting energy efficiency opportunities, thus enabling $CO_2$ emissions' reduction and ultimately shaping new consumption behaviors through an enhanced consumer awareness.

**DID YOU KNOW?**
**According to the International Energy Agency, by 2040 an increased diffusion of storage and digitally-enabled demand response could decrease renewable energy curtailment from 7% to 1.6%, thus avoiding 30 million tons of CO2 emissions[13].**

To further understand the potential contribution of demand response to renewable integration, the International Energy Agency (IEA) estimated that, in Europe, over 570 GW of wind and solar PV capacity will need to be installed by 2040 to meet the 2° C increase limit on global warming[14]. In this scenario, wind and solar would make up more than 35% of total electricity generation, reaching 1,250 TWh, with an average yearly increase of 4.6%[15]. If no additional flexibility measures such as storage technologies and demand response are implemented, the total curtailment of PV and wind power would exceed 85 TWh, which is equal to 7% of the total PV and wind generation. Through an increased diffusion of storage and digitally-enabled demand response, this curtailment could decrease to 1.6%, enabling to preserve an additional generation of 67 TWh and thus avoiding 30 million tonnes of CO2 emissions. Focusing on the Italian context, as shown in the table below, considering the EU aligned scenario of national wind and solar generation growth, in 2040 almost 3 million tonnes of $CO_2$ emissions will be proportionally avoided, whereas if the increase follows the country specific rate, $CO_2$ savings will account for 2.5 million tons of $CO_2$.




IEA – Estimates of curtailment reduction and avoided emissions in Europe in 2040[16]

13 IEA, 2017 (https://www.iea.org/publications/freepublications/publication/DigitalizationandEnergy3.pdf).
14 IEA, 2017 (https://www.iea.org/publications/freepublications/publication/DigitalizationandEnergy3.pdf).
15 Accenture's estimation on ECA's data concerning 2015 EU solar and wind electricity production, 2018: https://www.eca.europa.eu/Lists/ECADocuments/BP_WIND_SOLAR/BP_WIND_SOLAR_EN.pdf
16 IEA, 2017 (https://www.iea.org/publications/freepublications/publication/DigitalizationandEnergy3.pdf).

On the other hand, circular economy benefits of demand response can be easily linked to an increasing share of renewable sources and the optimization of existing generation and storage assets. Before analyzing this correlation, the following paragraph will provide you with an overview of circular economy and Enel X's point of view on it.

## What is circular economy according to Enel and Enel X

According to Enel and Enel X, the transition towards a circular economy represents an opportunity for sustainable innovation, bringing together different business approaches that promote an economic model based on sustainable solutions (e.g., renewables, reuse and recycling, etc.) and on the circular use of physical assets that implies the maximization of their utilization as well as their valorization at the end of the useful life.

A circular economy can be defined through the following five pillars:

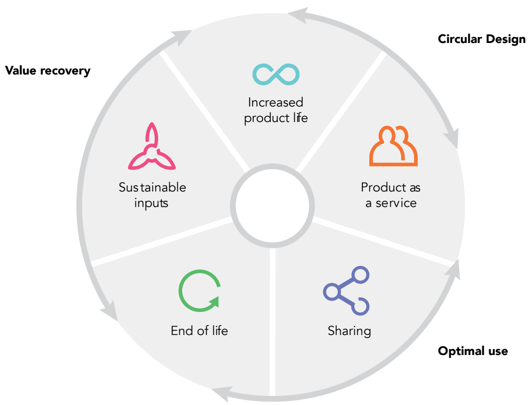
→ SUSTAINABLE INPUTS: the use of inputs from renewable sources (both material and energy) or from reuse and recycling;

→ SHARING PLATFORM: platforms where private individuals can share assets between them;

→ PRODUCT AS A SERVICE: a business model in which the customer purchases a product in the form of a service, like car sharing, from the company;

→ LIFE EXTENTION: every specific action designed to increase the service life of an asset and a product, through modular design, predictive maintenance, etc.;

→ END OF LIFE: every solution aimed at preserving the end of life value of an asset and reusing it in a new cycle through reuse, regeneration, recycling, etc.




If you would like to know more about Enel's and Enel X's commitment and initiatives on circular economy, you can refer to the following links:

CIRCULAR ECONOMY @ ENEL:
https://corporate.enel.it/en/circular-economy-sustainable-future

CIRCULAR ECONOMY @ ENEL X:
https://www.enelx.com/it/en/who-we-are/circular-economy

## Which Circular Economy Business Model applies to Demand Response?

| | Sustainable inputs | Sharing | Product as a service | Life extension | End of life |
|---|---|---|---|---|---|
| **DEMAND RESPONSE** | ● | ● | ○ | ○ | ○ |

Applicability of CE business models to Demand Response

When considering the five pillars of a circular economy, it is easy to connect demand response system to Sustainable Inputs and Sharing. The following pages will analyze this correlation.

## Sustainable Inputs

**Use of renewable energy and material inputs that are renewable, recyclable or biodegradable in consecutive lifecycles.**

### DOES SUSTAINABLE INPUTS APPLY TO DEMAND RESPONSE?

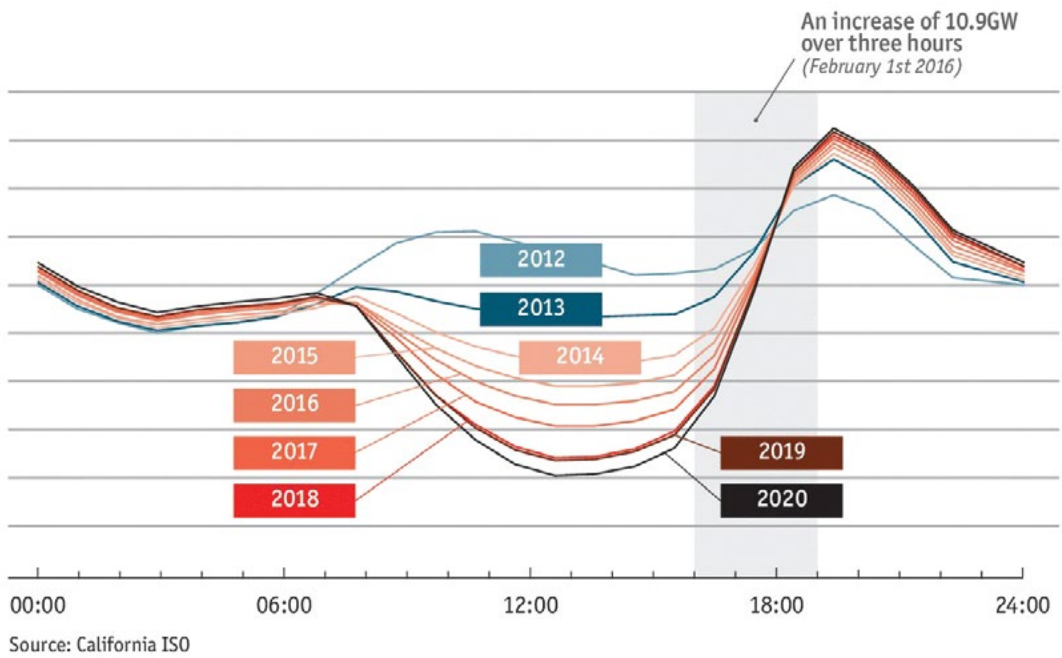
→ Yes!

### HOW?

→ Demand response programs support the integration of renewable energy sources by addressing and mitigating grid intermittencies through load shifting;
→ Access to real-time pricing and the deployment of new smart meters make it possible for demand response, in the form of ancillary services, to reduce renewable energy generation curtailment during peak hours;

Despite the environmental benefits of renewable sources, the growing penetration of electricity generation from solar and wind originally represented a double risk for grid operators and utilities, as:

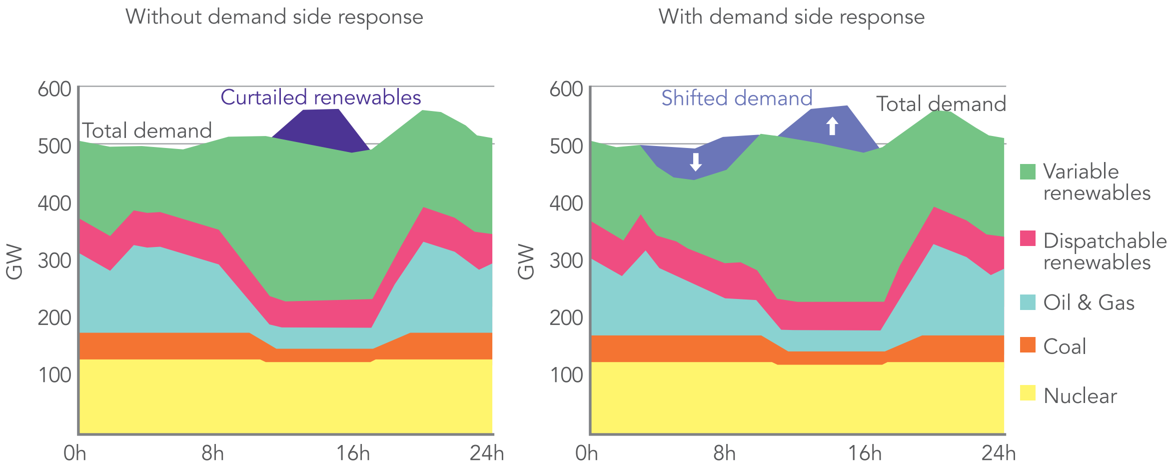
→ Grid operators have the responsibility to ensure grid stability and reliability, which is typically threatened by the unpredictability of solar and wind sources;
→ Excess solar and wind generation impact the wholesale market, especially during the spring time when the weather is sunny and consumers do not turn on air conditioning or heating, thus increasing the risk of negative prices for utilities.




CAISO – Average electricity load requirement of a typical spring day in California[17]

17 The Economist, 2018 (https://www.economist.com/graphic-detail/2018/03/28/what-a-ten-year-old-duck-can-teach-us-about-electricity-demand).

As shown in the duck curve above, grid operators need to set up a resource mix that can react quickly to adjust electricity production and meet the sharp changes in electricity net demand. The net load curves represent the variable portion that grid operators must meet in real time, calculated by subtracting the forecasted electricity production from variable generation sources such as wind and solar. In the past, grid operators used to direct conventional, controllable power plant units to move up or down with the instantaneous or variable demand, but the growing penetration of renewables on the grid are leading to higher levels of non-controllable, variable generation resources.




IEA – Impact of Demand Response on a daily load curve[18]

Another characteristic resulting from renewable sources' variability is the excess amount of energy generated during peak hours. Unlike traditional fossil fuel power plants, renewable energy generation highly depends on weather conditions and cannot simply be turned on and off: what is being generated must be instantaneously consumed or stored, otherwise it will be lost. This principle has historically forced utilities and grid operators to curtail renewable excess energy, whenever the demand did not match the supply, to avoid negative impacts on energy prices. With the support of technology advancement, demand response economic programs have later evolved into ancillary services featuring a two-way, real-time communication between utilities and end-users, drastically shortening the time to reaction and reducing renewables curtailment.

In this context, demand response has already proven to be an effective solution to both renewable integration in the grid as well as renewables excess generation. Furthermore, with solar energy technologies following a trend of cost reductions as production has ramped up in the last few decades, residential users as well are becoming increasingly independent from the grid. For this reason, demand response programs are creating new opportunities by enabling end-users, during a peak event, to temporarily disconnect their consumption from the grid and use their own stored energy instead. All this while reducing their own and the grid carbon footprint.

18 IEA, 2017 (https://www.iea.org/newsroom/energysnapshots/impact-of-demand-on-a-daily-load-curve.html).

**DID YOU KNOW?**

**In Europe, the energy storage market has almost doubled each year since 2015, registering a 49% rise in installed capacity in 2017 and reaching 1.6 GWh of online capacity. Mostly led by Germany and the UK, the storage market has also seen Italy emerging as "a rapidly growing market" in the residential sector[19].**

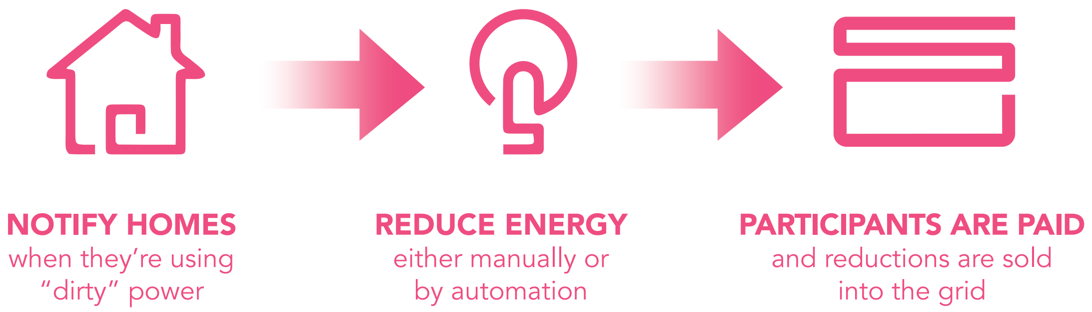
## CASE STUDY: SUNVERGE

Already detecting this opportunity, US-based company SunVerge has developed a system that helps residential customers better manage self-generated solar energy and mitigate volatility 24/7. Integrated with a lithium ion battery, the system automatically detects peak demand periods, switching-off from the grid and using the stored energy instead, enabling a saving of $200 to $500 per year on electricity bills[20].

## CASE STUDY: OHM CONNECT

The Californian start-up OhmConnect allows its community members to reduce their electricity consumption and sell unused energy, taking advantage of smart and connected homes technologies. OhmConnect contacts its members via email or text to inform then when energy is "dirty", asking them to curtail their load, for example by switching-off their lights or air conditioning, in exchange for cash back payments. So far, the benefits generated by the 300,000 customers have enabled four power plants' worth of energy saved. Furthermore, in August 2018, OhmConnect announced its partnership with Google by entering the "Works with Nest" program, allowing its members to connect to their Nest smart thermostat to adjust the temperature during "OhmHours" and save up to 12% on heating and 15% on cooling[21].

### OHMCONNECT – HOW IT WORKS




19 Climate Action, 2018 (http://www.climateaction.org/news/energy-storage-in-europe-increases-by-49-in-one-year).
20 SunVerge, 2015 (http://www.sunverge.com/customer-solutions/; https://www.powerstream.ca/attachments/SunvergeConsumerBrochure_121515.pdf).
21 OhmConnect (https://www.ohmconnect.com/blog-post/ohmconnect-nest-is-the-new-dream-team).

## Sharing

**Promotion of collaboration platforms putting in contact asset owners and users, enabling consumers to achieve savings but also gain profits from a shared thus optimized use of the asset.**

DOES SHARING APPLY TO DEMAND RESPONSE?

→ YES!

HOW?

→ Traditional demand response, more specifically through aggregators, builds up a virtual power capacity provided by end-users through load adjustments and shifting to be shared with the rest of the grid;

→ More sophisticated forms of demand response are enabling two-way flows that rely on end users' storage and self-generation capacity, thus building up a physical power capacity that work with the same mechanisms as a peer-to-peer energy sharing.

Demand response programs do not necessarily create a one-to-one connection between end-users or share energy generation within a local community. Nevertheless, demand response offers opportunities for energy capacity and infrastructure optimization, both at central and distributed generation levels, by enabling a specific pool of customers (DR participants) to virtually share part of their available load as a back-up reserve for the sake of the grid stability, thus avoiding blackouts and benefiting other end-users connected to that same grid (non-DR participants). Industrial, commercial and residential customers, they have all been involved since the beginning of demand response, with the former being crucial in terms of capacity availability and the latter in terms of higher rates of flexibility and responsiveness.

In this context, technology advancement and new regulatory frameworks play a key role in defining customers' readiness for demand response. As a matter of fact, the latest evolutions of demand response in the US were determined by the Energy Policy Act of 2005, which encouraged the use of time-based rates and price-based programs to enable consumers to manage their electric energy use and costs. The adoption of time-based measurement and the diffusion of two-way communication smart meters enabled customers to have a proactive role in the wholesale market, being provided with the possibility to react to real-time price signals and adjust or shift their load accordingly.

**DID YOU KNOW?**

**In 2016, about 71 million AMI smart meters were installed in US households, covering 47% of the 150 million electricity customers in the US[22], ccompared to less than 1% in 2006[23], and is expected to reach 90 million by 2020[24].**

22 US Energy Information Administration, 2017 (https://www.eia.gov/todayinenergy/detail.php?id=34012).
23 FERC, 2008 (https://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf).
24 Greentech Media, 2016 (https://www.greentechmedia.com/articles/read/us-smart-meter-deployments-to-hit-70m-in-2016-90m-in-2020#gs._kxl0IM).

Furthermore, in 2008, the Federal Energy Regulatory Commission (FERC) issued a final rule on competition that removed several barriers to demand response participation in the organized wholesale markets. Among other provisions, it requires all RTOs and ISOs under FERC's jurisdiction to permit demand response aggregators to bid demand response on behalf of retail customers directly into the organized energy market[25].

On that same route, in 2009 the European Union adopted the "Third Energy Package", requiring Member States to ensure the implementation of smart metering for a fair and transparent energy system for European consumers as well as an essential first step towards the implementation of smart grids. So far, EU Member States have committed to rolling out close to 200 million smart meters for electricity, reaching almost 72% of European consumers by 2020[26].

### CASE STUDY: ENEL OPEN METER 2.0 IN ITALY

If we look at the Italian context, in 2017 Enel launched the installation of Open Meters 2.0, a new meter that will replace around 32 million first generation electronic meters, installing 19 million meters by 2019 and reaching a total of 41 million by 2021[27].

Among other innovative features, the measurement of customer data every 15 minutes will provide a much more timely and accurate picture of daily power use and customers' consumption behaviour, who are increasingly aware of how they use electricity and how to identify opportunities for achieving greater energy efficiency. By addressing EU energy efficiency and the Italian electricity, gas and water authority (AEEGSI) requirements, Open Meter is a smart meter technology that enables end-consumers to become aware of their energy consumption but also to become more proactive in the energy systems[28].

The Energy Efficiency Directive 2012/27/EU clearly pointed out the importance of demand response as a tool to improve energy efficiency. The revised Energy Performance of Buildings Directive 2018/844[29] also highlights the energy efficiency benefits of demand response, introducing the need to define a smartness indicator for buildings which should be based on the building's ability to maintain certain energy performance level by using renewable sources and the building's electricity demand flexibility in terms of ability to participate in demand response programs. Nevertheless, despite the technological readiness and the European Union's focus on demand response as an energy efficiency opportunity, most EU Member States still lack a clear definition of aggregators' roles and responsibilities, thus limiting the application and diffusion of demand response programs in Europe.

25 FERC, 2008 (https://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf).
26 European Commission Joint Research Centre, 2018 (http://ses.jrc.ec.europa.eu/smart-metering-deployment-european-union).
27 Enel, 2017 (https://www.enel.com/media/press/d/2017/09/e-distribuzione-installs-over-a-million-electronic-20-open-meters).
28 Enel, 2016 (https://www.enel.com/media/press/d/2016/06/enel-presents-enel-open-meter-the-new-electronic-meter).
29 Official Journal of the European Union, 2018; Energy Industry Review, 2018 (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0844&from=EN; https://energyindustryreview.com/construction/new-energy-performance-in-buildings-directive-comes-into-force-on-9-july-2018/).

## CASE STUDY: POWERFLEX INTEGRATING EV CHARGING WITH BUILDING ENERGY SYSTEM

In the US, the National Renewable Energy Laboratory (NREL) is testing a new technology developed by the Californian start-up PowerFlex Systems that could prevent EV charging from overstressing the grid. 16 charging stations have been installed and connected to the system, preventing building owners from incurring peak demand charges by incorporating driver inputs and real-time load monitoring: when drivers hook up their cars to a PowerFlex charger, they use a mobile app to tell the system which charging point they are using, what kind of vehicle they have, when they need to pick it up and how far they will be traveling afterward. This information allows the system to work out how much power to send to each vehicle, and when, while keeping the overall energy draw within a reasonable limit[30].

While there is still some work to be done to create a level playing field for demand response in European markets, new technological trends are being identified and tested on a global scale. The rise of electric mobility is in fact creating new energy needs. According to Bloomberg New Energy Finance, the global market of electric vehicles reached 1.1 million in 2017 and is expected to surge to 30 million by 2030, accounting for 28% of global new car sales. This sharp increase of electric vehicles in the next few decades is expected to bring even higher peak demand, enhancing the level of stress on the grid.

On the other hand, the rise of electric mobility and increasing amount of batteries and private charging stations could provide advantages for the grid by exporting power from mobile energy storage units through "vehicle to grid" (V2G) programs. V2G programs would allow customers, in exchange for a monetary return, to provide and supply the electricity grid with their EV batteries – of which the collective capacity is already significantly bigger than residential solar batteries[31].

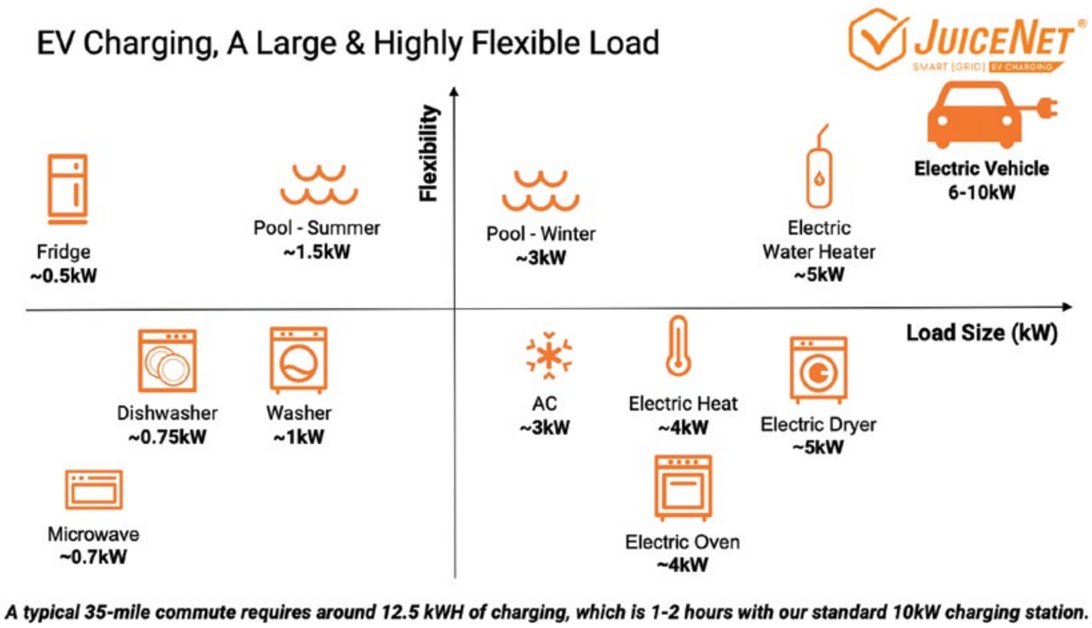
## CASE STUDY: BMW CHARGE FORWARD

Already in 2015, BMW partnered with Pacific Gas & Electric Company (PG&E) to launch the Charge Forward Project to prove that EVs can also reliably serve as a mobile and flexible grid assets. During a peak, BMW was required to provide PG&E with 100 KW of grid resources through a combination of delaying charging for nearly 100 BMW i3 owners located in the San Francisco Bay Area and drawing from a second-life stationary battery system built from reused EV batteries for the duration of 1 hour. Spanning from July 2015 to December 2016, the Charge Forward project dispatched over 200 DR events, reaching a total of 19,500 kWh (80% from the battery and 20% from the vehicles)[32]. In the second phase of the program, started in 2017, BMW started developing the capability to align EV charging with renewable energy generation thanks to PG&E providing a day-ahead forecast of the hourly renewable supply that they're expecting. BMW developed a mobile app to communicate and let customers know how much of their charge was provided by renewable energy. Customers were also eligible to receive up to $900 in incentives for taking part in the program[33, 34].

30 Greentech Media, 2018 (https://www.greentechmedia.com/articles/read/startup-aims-to-solve-electric-car-power-overload-problem#gs.9kCRALo).
31 Forbes, 2017 (https://www.forbes.com/sites/constancedouris/2017/10/05/how-electric-cars-could-help-the-power-grid-become-more-efficient-less-expensive/#1633f5be121e).
32 Greentech Media, 2017 (https://www.greentechmedia.com/articles/read/bmw-and-pge-prove-electric-vehicles-can-be-a-valuable-grid-resource#gs.4s5rVtU).
33 Greentech Media, 2018 (https://www.greentechmedia.com/articles/read/bmw-optimizing-ev-charging-renewable-energy#gs.OuLIQNY).
34 BMQ Charge Forward, (https://www.bmwchargeforward.com/#/home).

## CASE STUDY: EXPERIMENTING VEHICLE-TO-GRID IN ENEL AND E-MOTORWERKS

In 2016, global car manufacturer Nissan and Enel SpA launched the first fully commercial V2G hub worldwide at the Danish utility Frederiksberg Forsyning, who installed 10 V2G chargers and purchased 10 Nissan e-NV200 zero emission vans, to demonstrate that EV loads can balance the grid during peak periods. More recently, in the US, Enel subsidiary eMotorWerks launched a platform that is able to rearrange vehicle charging schedules across thousands of chargers to deliver reductions in electrical consumption for California's demand-side services. Last August, eMotorWerks mobilized 10,000 connected car chargers, amounting to 30 MW of flexible capacity, to participate in day-ahead markets and was planning to enter the real-time markets in September[35].




Average load requirements and flexibility for home devices[36]

## CASE STUDY: OVO AND NISSAN LAUNCHING "VEHICLE TO GRID" IN THE UK

Other utilities have spotted this opportunity and UK energy supplier Ovo launched a "vehicle to grid" program for customers owning a Nissan Leaf with a battery capacity of 30kWh or more, offering a 6 kW bi-directional domestic charger that enables drivers to charge the car during off peak periods and sell the surplus energy from the batteries during peak periods[37].

Through Project 'SCIURUS', Ovo is offering its technology to 1,000 UK households at no cost, with funding for a two-year trial provided by the government's innovation agency Innovate UK[38].

35 Greentech Media, 2018 (https://www.greentechmedia.com/articles/read/emotorwerks-wholesale-markets-ev-charger-network#gs.=3zr2v4).
36 CleanTechnica, 2018 (https://cleantechnica.com/2018/11/11/enels-emotorwerks-pushes-into-european-ev-charging-with-eo-charging-partnership/).
37 OvoEnergy, 2018 (https://www.ovoenergy.com/ovo-newsroom/press-releases/2018/april/ovo-launches-the-worlds-first-widely-available-domestic-vehicle-to-grid-charger.html).
38 OvoEnergy, 2018 (https://www.ovoenergy.com/electric-cars/vehicle-to-grid-charger).

## Product as a service

**Instead of selling the product, the company keeps ownership of the asset, thus designing the product for longevity and selling the corresponding service along with other related benefits.**

DOES PRODUCT AS A SERVICE APPLY TO DEMAND RESPONSE?
NOT REALLY!

WHY?
Demand response is mostly based on the optimized transmission and distribution of electricity to address the limits of generation capacity. Thus, besides a smart metering device measuring the facility consumption and establishing a two-way communication between the customer and the aggregator or utility, demand response does not enable any physical asset to be sold through a Product as a Service model.

## Life extension

**The company design and manufacturing processes are aimed at extending the product's life whenever, instead of wasting energy and material components of used assets, the embedded value is maintained and improved through reparation, upgrading, remanufacturing or upcycling.**

DOES PRODUCT AS A SERVICE APPLY TO DEMAND RESPONSE?
NOT REALLY!

WHY?
In a more sophisticated evolution of demand response, second life batteries could be used as a back-up reserve. The BMW Charge Forward program is a great example of how the remaining capacity of used EV batteries, which currently face major recovery and recycling challenges, can be leveraged to benefit the grid. However, programs like these are still at a very initial stage as the volume of end-of-life batteries is not critical enough for the actual feasibility and benefits to be measured.

## End of life

**Set up of production and consumption systems where what was previously considered as waste is instead recovered, recycled or regenerated to be reused as inputs for new processes**

DOES PRODUCT AS A SERVICE APPLY TO DEMAND RESPONSE?
NOT REALLY!

WHY?
As already mentioned in the Product as a Service section, smart metering devices are the only physical asset that demand response customers must be provided with in order to participate in DR programs. In this context, demand response service providers do not influence nor have any responsibility on the smart meter end-of-life management.

# 3 - THE IMPACT OF DEMAND RESPONSE ON COMPANIES ENERGY CIRCULARITY

## Measuring the benefits of demand response

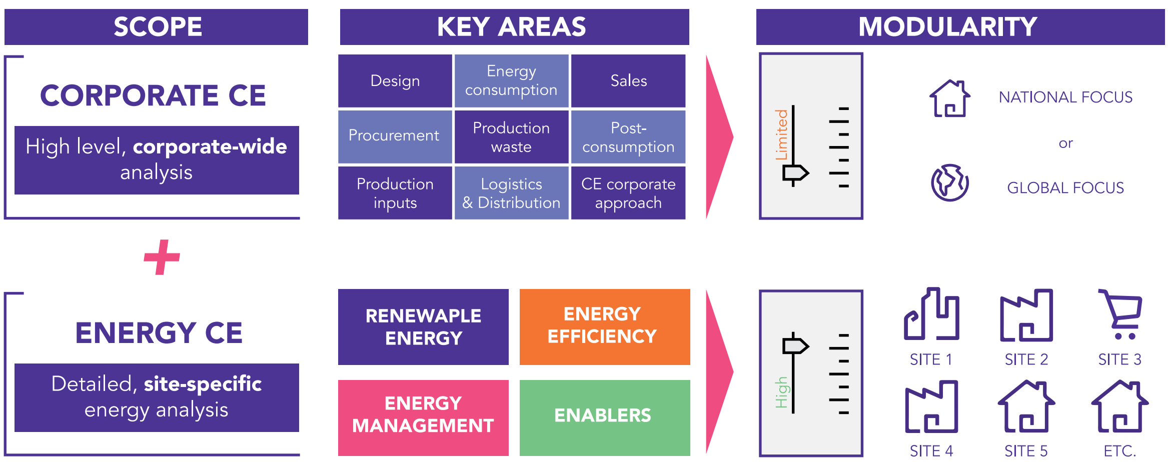
At Enel X, we are very much committed to delivering innovative energy solutions and strongly believe in sustainable innovation and a circular economy. Leveraging our global leadership in demand response, built on both broad and deep experience, we have identified the circular economy benefits of well-designed DR and will work to ensure that organizations around the world are aware of the advantages that DR participation offers at both business and energy systems levels. As we are committed to measuring the circularity of both our solutions and clients, we have started to identify and analyze the key drivers of current demand response participants in Enel X's portfolio. More specifically, we have tried to assess commercial and industrial customer willingness and efforts to participate in DR as an enabler and booster of renewable energy integration and grid stability.

## Enel X's circular economy client report

Enel X recently developed a new methodology to assess its commercial and industrial client's circularity (CE) by analyzing two key areas: 1. Corporate CE and 2. Energy CE.

For Corporate CE, the questionnaire and the final assessment report developed by Enel X provides customers with an opportunity to further understand their own business strategy and performance in relation to a circular economy.

For Energy CE, the innovative methodology along with the data collection process enables Enel X's customers to gain more confidence with energy consumption data while spotting new opportunities for energy circularity improvements. In this section, the implementation of demand response is positively evaluated as key enabler of Energy CE, with further consideration being developed. Finally, being focused on the site(s) selected by the client, the Energy CE assessment makes it possible for Enel X to develop customized solutions for the client to boost its energy circularity.




Enel X's CE Client Assessment Methodology overview

Sample extract of Enel X's CE Client Report (1/4)

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# INTRODUCTION

## WHAT IS ENEL X'S CE CLIENT REPORT?

The CE Client Report is an assessment model developed by Enel X with the aim to measure clients' circularity from 2 points of view:

> a high level, corporate point view, and
> a site-specific, energy point of view

The high level, Corporate CE Assessment is a qualitative evaluation of the level of maturity and diffusion of Circular Economy principles along business value chain, from design and procurement to sales and post-consumption.

The Corporate CE assessment areas for Manufacturing companies are listed below:

| AREA | DESCRIPTION |
|---|---|
| Design | Maturity and diffusion of circular design principles (e.g., design for modularity and/or disassembly) enabling/facilitating reparation & maintenance or recovery & recycling |
| Procurement | Maturity and diffusion of circular criteria in suppliers procedures as well as of circular business models to purchase materials, equipment, office supplies, etc. |
| Production inputs | Consumption of renewable, recycled or biodegradable materials and of second hand or regenerated components out of all production material inputs |
| Production energy consumption | Consumption and self-generation of renewable energy as well as recovery and reuse of waste energy out of overall energy consumed in the production site(s) |
| Production waste | Diffusion and maturity of reuse or recycling practices to recover own production waste as secondary raw material or alternative fuel, either internally or in other loops |
| Logistics & Distribution | Diffusion of electric mobility solutions both in the production and distribution processes, diffusion of EVs and shared vehicles within the corporate fleet |
| Sales | Diffusion and maturity of circular principles and business models in sales (e.g., possibility to buy product in sharing or as a service, life extension services, etc.) |
| Post-consumption | Diffusion and maturity of reparation & maintenance services for life extension as well as collection for end of life management (e.g., recovery, reuse, recycling, etc.) |
| Non-production energy consumption | Consumption and self-generation of renewable energy out of overall energy consumed in the offices, POS, warehouse, etc. |
| CE corporate approach | Corporate CE maturity in terms of alignment with the business strategy and planning as well as level of engagement of employees, suppliers and consumers on CE topics |

## Sample extract of Enel X's CE Client Report (2/4)

### *INTRODUCTION*

A set of sub-questions has been defined for each area and, also based on the specific applicability for the Client, a maximum weight and scoring has been associated. The weighted average of the single areas score will define the consolidated Corporate CE score.

Based on the nature of the business, the client will be assigned either with the Manufacturing or Services version of the Corporate CE Questionnaire, enabling Enel X to take into consideration the specificities of the business and better evaluate the company's CE performance.

On the other hand, the site-specific, Energy CE Assessment is a quantitative evaluation of the level of implementation and diffusion of Circular Economy principles applied to the energy sources and energy-consuming systems of one site or building specifically selected by the client. The Energy CE Assessment Model mostly evaluates how much of the site or building's energy consumption comes from renewable sources and how energy efficient its systems and devices currently are.

The Energy CE assessment areas are listed below:

| AREA | COMPONENTS |
|---|---|
| **RENEWABLE ENERGY** | Total renewable energy consumption |
| | Renewable electricity - total self generation |
| | Renewable electricity - total self consumption |
| | Renewable electricity - self consumption from storage |
| | Renewable termal energy - total self generation |
| | Thermal energy from CHP and process heat waste recovery systems |
| | Thermal energy recovery rate from CHP and process heat waste recovery systems |
| **ENERGY EFFICIENCY** | Lighting |
| | Space heating |
| | Cooling |
| | Air treatment |
| | Data centers |
| | Water heating |
| | Office equipment (e.g., computers, displays, imaging equipment) |
| | Windows - insulation |
| **ENERGY MANAGEMENT** | Maintenance |
| | Monitoring & verification |
| | Electrical system efficiency |
| | Sensors/dimmering for lighting |
| | Space heating temperature management |
| **ENABLERS** | EV charging infrastructure |
| | Grid services |

A set of sub-questions has been defined for each area and components and, also based on the specific applicability for the client, a maximum weight and scoring has been associated. The weighted average of the single areas score will define the consolidated Energy CE score.

Circular Economy Report 5

Sample extract of Enel X's CE Client Report (3/4)

### *WHY THIS REPORT?*

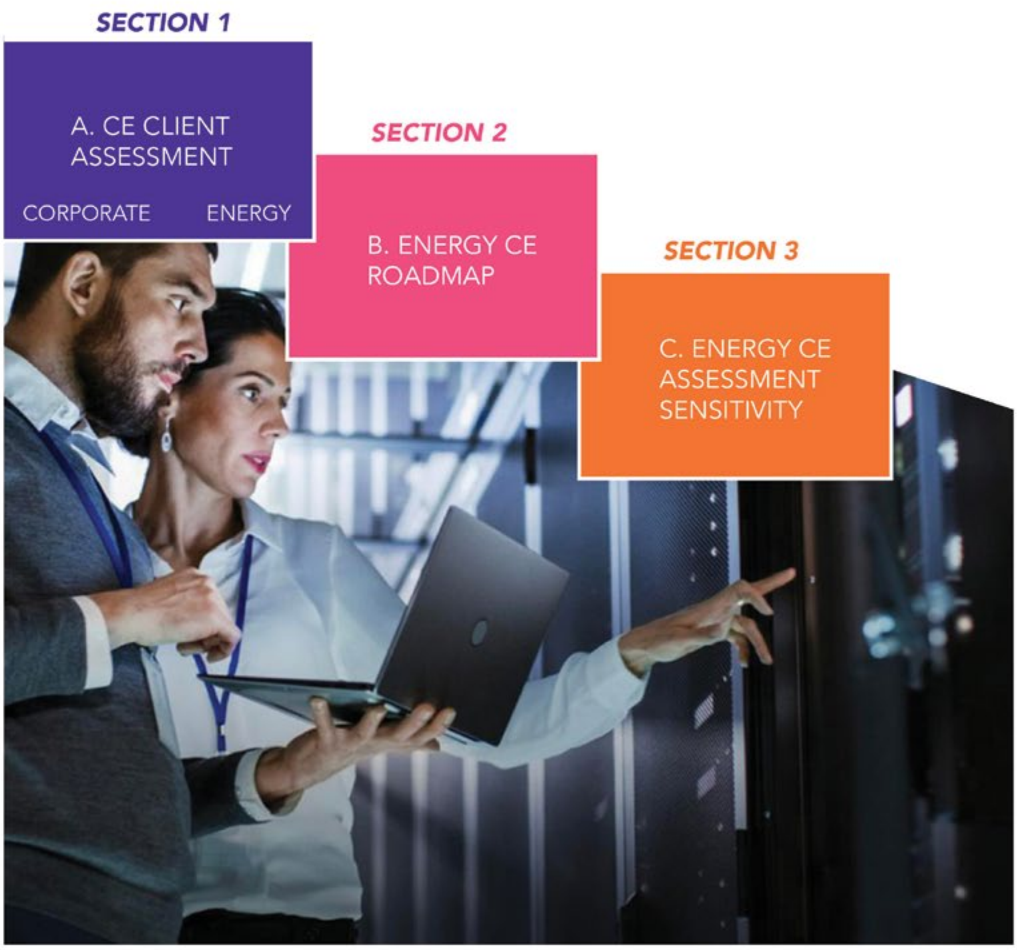
To begin with, this assessment will provide the Client with structured insights on how the company is doing today, highlighting the company's key strengths and criticalities related to Circular Economy.

Furthermore, this assessment will help the Client identify, select and prioritize areas of intervention that will boost the company's as-is level of circularity. More specifically, Enel X will help identify Energy Circularity improvement opportunities and solutions.

### *WHAT'S IN THIS REPORT?*

Sections ***A.1*** to ***A.3*** of this document include the outputs of the CE Client Assessment Corporate and Energy.

Sections ***B*** and ***C*** of this document include the Energy CE Roadmap and the Energy CE Assessment Sensitivity defined to guide the client's path towards Circular Economy.



Sample extract of Enel X's CE Client Report (3/4)

# B. ENERGY CE ROADMAP

*Enel X's solution portfolio widely address most of the energy circularity evaluation areas*

## B.1. ENEL X SOLUTIONS FOR THE IDENTIFIED AREAS OF IMPROVEMENT

| ENEL X SOLUTION | | ENERGY CE KEY AREAS | | | |
|---|---|---|---|---|---|
| | | RENEWABLE ENERGY | ENERGY EFFICIENCY | ENERGY MANAGEMENT | ENABLERS |
| ADVICE | Consulting/Auditing service | X | X | X | X |
| | Energy related certificates | X | | | |
| | Premium customer service | | X | X | |
| | Procurement | | X | X | |
| | Utility bill management | | X | X | |
| SUPPLY | CHP | X | X | | |
| | Energy infrastructure | | | X | X |
| | PV + storage | X | | | |
| OPTIMIZE | Industrial equipment (UPS, PFC, IHW, etc.) | | X | X | |
| | Monitoring and verification | | X | X | |
| | Private Lighting | | X | X | |
| | Product and system optimization (HVAC, IHW) | | X | X | |
| FLEXIBILITY | Demand Response | | | | X |
| | Storage Solutions | X | | | X |
| | Direct marketing | | X | | X |
| | Mini-grid solutions | X | | | |
| | Operations & Maintenance | | | X | |
| MOBILITY | Private Charging Station | | | | X |
| | B2B Fleets | | | | X |

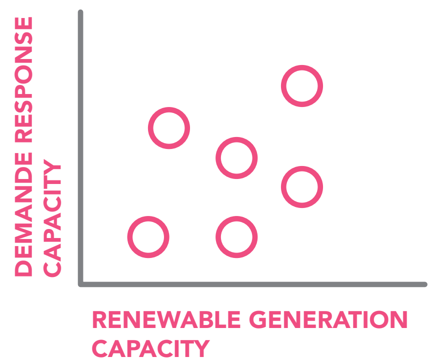
22 Circular Economy Report

## Defining circular economy indicators for demand response

Going beyond the current Energy CE assessment methodology, we focus on the impact that participation to demand response might have on commercial and industrial customers' circularity. To do so, we leveraged the two Circular Economy models that fully apply to demand response, Sustainable Inputs and Sharing, and came up with two high-level indicators:

- the Sustainable Inputs Indicator, and
- the Sharing Indicator

### Sustainable inputs




### Sharing

**COMPANY'S CAPACITY AVAILABLE FOR DR**

**÷**

**COMPANY'S TOTAL ELECTRICITY CAPACITY**

These two indicators are a first attempt to help companies understand and possibly quantify the positive impact that their participation in demand response programs could have.

| | SUSTAINABLE INPUTS INDICATOR | SHARING INDICATOR |
|---|---|---|
| **How is it calculated?** | It is the statistical correlation between the absolute values of demand response capacity and VRE installed generation capacity (in MW, from 2014 to 2017) | It is the ratio between the client's site availability for demand response and the site total capacity (in MW, for one specific year) |
| **What does it measure?** | It aims to prove the correlation between the above-mentioned parameters in a specific country, and is thus a national indicator | It aims to measure the client's contribution to the creation of a virtual power plant, and is thus a client-specific indicator |
| **Further considerations** | If the renewable energy generation curtailment trends are available, these could either enhance or diminish the efficacy of the correlation | If the Sustainable Inputs Indicator is positive and significant, the Sharing Indicator indirectly assesses the client's contribution to the renewable generation capacity in the country where the it operates |
| **What is the output value?** | A numerical value ranging between -1 and 1 | A numerical value ranging between 0 and 1 |

For countries where the Sustainable Inputs indicator can be considered relevant, an international comparison can be delivered by summing up the two indicators, thus creating a consolidated Demand Response Circularity Indicator that would work as follows:

$$\alpha \in (0,1) \rightarrow f(\alpha,\beta) = \alpha + \beta$$

$$\alpha \notin (0,1) \rightarrow f(\alpha,\beta) = \beta$$

Where:

- → $\alpha$ represents the Sustainable Inputs Indicator;
- → $\beta$ represents the Sharing Indicator; and
- → $f(\alpha,\beta)$ represent the Demand Response Circularity Indicator and is a numerical value ranging between 0 and 2.

To provide the basis for a preliminary simulation, a set of Sustainable Inputs Indicators has been estimated for few selected countries. Enel X's ambition is to regularly update and constantly integrate this database enabling benchmarking and comparisons at industry level, country level or even a global level.

| Country | Sustainable inputs indicator (correlation) | Curtailment trend | Period in scope |
|---|---|---|---|
| USA | -0.594415151 | n.a. | 2014-2017 |
| Ireland | 0.922161888 | Increase | 2014-2017 |
| France | 0.967362864 | n.a. | 2014-2017 |
| UK | 0.824922687 | Increase | 2014-2017 |

# EXAMPLE 1: DEMAND RESPONSE CIRCULARITY IN IRELAND

## SUSTAINABLE INPUTS INDICATOR (SII)

The correlation between demand response capacity and renewable electricity generation capacity is relevant, but the VRE generation curtailment has no linear correlation with either of them (the ratio between generation and curtailment kept increasing between 2014 and 2017).

**SII = 0.922161888 (correlation)**

## SHARING INDICATOR (SHI)

Below we have calculated the Sharing Indicator for a set of Enel X's curtailment customers in Ireland.

| N. | Client industry | Total site capacity (MW) | Capacity available for DR (MW) | Sharing Indicator (SHI) |
|---|---|---|---|---|
| 1 | Construction materials A | 1.2 | 1.1 | 0.944 |
| 2 | Construction materials B | 9.9 | 6.8 | 0.691 |
| 3 | Oil&Gas | 6.8 | 4.6 | 0.675 |
| 4 | Mining | 16 | 9.4 | 0.585 |

## DEMAND RESPONSE CIRCULARITY INDICATOR

In this case, the Sustainable Inputs Indicator is higher than 0, therefore the Demand Response Circularity Indicator for the clients listed in the previous table will be equal to the sum of their own Sharing Indicator and the country-level Sustainable Inputs Indicator.

| N. | Client industry | Sharing Indicator (SHI) | Sustainable Inputs Indicator | DR Circularity Indicator |
|---|---|---|---|---|
| 1 | Construction materials A | 0.944 | 0.922161888 | 1.866 |
| 2 | Construction materials B | 0.691 | | 1.613 |
| 3 | Oil&Gas | 0.675 | | 1.597 |
| 4 | Mining | 0.585 | | 1.507 |

## EXAMPLE 2: DEMAND RESPONSE CIRCULARITY IN THE US

### SUSTAINABLE INPUTS INDICATOR (SII)

There is definitely no correlation between demand response capacity and renewable electricity generation capacity in the US, most likely due to the fact that the DR market was already consolidated in the late 2000s.

**SII = -0.594415151 (no correlation)**

### SHARING INDICATOR (SHI)

Below, the Sharing Indicators for a set of Enel X North America's customers operating in different industries has been calculated, showing an individual contribution to create a virtual power plant that support grid stability ranging from 46.5% to 87%.

| N. | Client industry | Total site capacity (MW) | Capacity available for DR (MW) | Sharing Indicator (SHI) |
|---|---|---|---|---|
| 1 | Manufacturing | 6,787.4 | 5,905.5 | 0.870 |
| 2 | Retail | 525.5 | 321.5 | 0.612 |
| 3 | Education | 204.6 | 125.0 | 0.611 |
| 4 | Pharmaceuticals | 554.6 | 258.0 | 0.465 |

### DEMAND RESPONSE CIRCULARITY INDICATOR

Contrary to the Irish case study, the Sustainable Inputs Indicator for the US is lower than 0. The Demand Response Circularity Indicator for the clients listed in the previous table is therefore equal to their own Sharing Indicator.

| N. | Client industry | Sharing Indicator (SHI) | Sustainable Inputs Indicator | DR Circularity Indicator |
|---|---|---|---|---|
| 1 | Manufacturing | 0.870 | -0.594415151 | 0.870 |
| 2 | Retail | 0.612 | | 0.612 |
| 3 | Education | 0.611 | | 0.611 |
| 4 | Pharmaceuticals | 0.465 | | 0.465 |

# EXAMPLE 3: DEMAND RESPONSE CIRCULARITY CROSS-NATIONS

## DEMAND RESPONSE CIRCULARITY INDICATOR

The Demand Response Circularity Indicator can be leveraged to benchmark and compare DR clients' circularity at the country level, but also at a global level. In the latter case, the consolidated indicator would undoubtedly reflect parameters that do not depend on the clients (i.e., investments on utility scale renewable generation). Nevertheless, the indicator can still provide a high-level picture of the impact that companies from all over the world can have at national level.

Starting from the clients analyzed for Ireland and the US in the Example 1 and 2, the table below shows a consolidated ranking for Demand Response Circularity. Ideally, Enel X's ambition is to define a global ranking covering all the countries and clients served.

| N. | Country | Client industry | Sharing Indicator (SHI) | Sustainable Inputs Indicator | DR Circularity Indicator |
|---|---|---|---|---|---|
| 1 | Ireland | Construction materials A | 0.944 | 0.922161888 | 1.866 |
| 2 | Ireland | Construction materials B | 0.691 | | 1.613 |
| 3 | Ireland | Oil&Gas | 0.675 | | 1.597 |
| 4 | Ireland | Mining | 0.585 | | 1.507 |
| 5 | USA | Manufacturing | 0.870 | -0.594415151 | 0.870 |
| 6 | USA | Retail | 0.612 | | 0.612 |
| 7 | USA | Education | 0.611 | | 0.611 |
| 8 | USA | Pharmaceuticals | 0.465 | | 0.465 |

## The future of demand response is growing and expanding in the industrial, commercial, residential and electric mobility segments

Being aware of the complexity of this exercise, our current goal is to start measuring the demand response-related circularity of Enel X's existing clients and work together with them to test it, integrate it and refine it, with the ambition of making it a global indicator available to the public and, hopefully, inspiring existing and prospect clients to set new, more challenging circular economy targets thanks to demand response.

**If you would you like to be part of this challenge, please contact Enel X to understand how demand response can really make a difference by improving your circularity!**

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