Reducing energy intensity in pursuit of net zero targets: Five essential response levers

by Amit Kar and Vychan Noble

Executive summary

The growing energy needs of a rapidly developing world cannot be sustainably met without reducing energy intensity. Industry has an acute challenge in this regard: it must reduce energy intensity four times faster than the improvements it achieved over the last decade. And this rate of improvement must be sustained through 2050 to meet global Net Zero targets. At Schneider Electric (Energies & Chemicals segment) we have identified five key response levers which must be addressed if industry is to rise to the occasion. Energy efficiency and management is the first and most important of these in the near term. Most models agree it will account for half of demand side decarbonization. While technology and market enablers of other decarbonization pathways remain unproven, energy efficiency is both technically feasible and commercially attractive, now.

In this paper we delve into the key considerations around energy efficiency – as well as the four other levers – and the role it plays in meeting the challenge for industry. Digitalization emerges as a key enabler of efficiency, and we introduce some high-potential innovations in this area. In exploring the other levers we determine that some still have a long way to go before contributing reliably to the Net Zero ambition, adding to the pressure to pursue energy efficiency today.

Introduction

Meeting net zero targets as laid out in the International Energy Agency's (IEA) Net Zero Emissions by 2050 Scenario (NZE) will take more than breakthroughs in energy production. Achieving change at the required rate will involve significant and parallel advances in the way we consume energy. The IEA has indeed assessed that the global economy needs to reduce energy intensity overall by an average of 4% annually going forward to 2050.

Energy efficiency is perhaps the most effective path forward in meeting both rising energy demand and the required energy intensity reduction. It may allow the world to meet growing economic needs without increasing primary energy production. In this paper we lay out some of the key considerations related to energy efficiency, and what it means to industry. It reflects the experience of the Energies & Chemicals segment team at Schneider Electric, informed and improved with input from customers and partners.

The challenge of lowering energy intensity

According to the IEA, energy intensity (the power required to produce a unit of GDP) fell at an average annualized rate of 1.7% per year over the last decade across the global economy. For the industrial sector it fell at just under 1% annually over the same period. To put this in perspective, while the global economy needs to improve energy intensity at twice the rate achieved over the last decade, the industrial sector needs to do four times better.

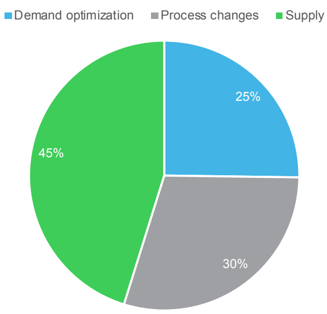
Energy efficiency is one of the keys to improving energy intensity, as discussed later in this document. We recognize, however, that there are other factors which influence industry's ability to improve. At Schneider Electric, we have identified four additional response levers that must also be addressed to facilitate energy efficiency and help deliver NZE targets. This document will address all five levers, with an emphasis on the first:

1. Energy Efficiency and Energy Management
2. Capital Investment and Financing
3. Energy Transition Technology
4. Managing Resource Constraints
5. The Role of Policy and Regulation

1. Energy efficiency and energy management

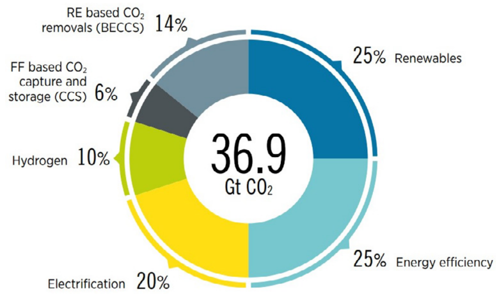
Schneider Electric's 'Back to 2050' study (published in 2022) determined that half of global NZE abatement will be delivered through the decarbonization of demand. Almost half of demand decarbonization will come via energy optimization – in other words, energy efficiency. The rest will come from process changes, mainly electrification. Our view on energy efficiency, is similar with that expressed by International Renewable Energy Agency (IRENA) in their 'World Energy Transition Outlook 2022'.

Impact of key transformations on decarbonization



Source: Schneider Electric 'Back to 2050'; published 2022

Reducing emissions by 2050 through six technological avenues



Source: IRENA (International Renewable Energy Agency) ; World Energy Transitions Outlook 2022

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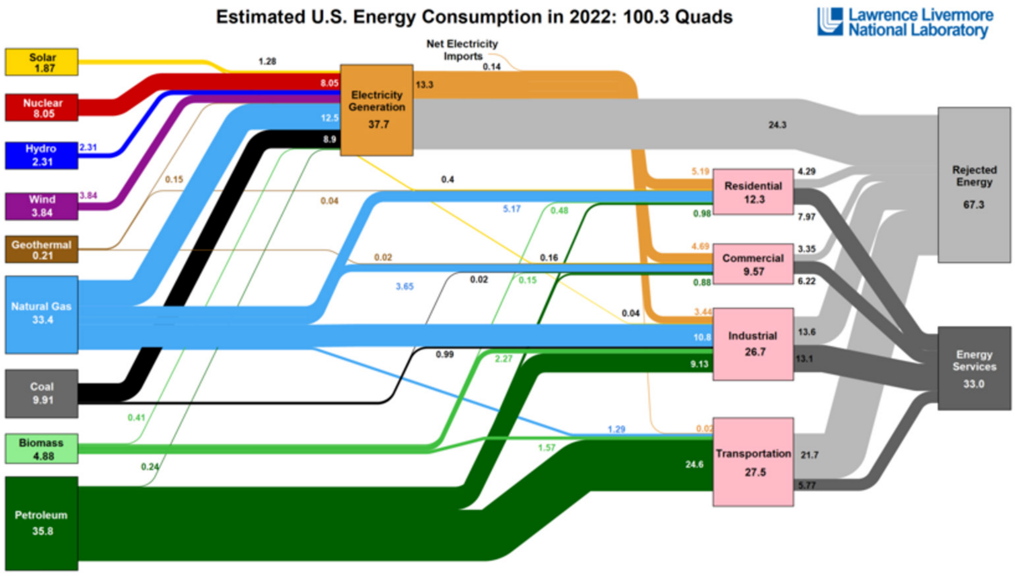
Co-Simulation of Power and Process

In manufacturing, the two most important operational considerations are the process itself and how it is powered. Getting these things right has historically been the main priority for industrial operators from design and build to operate and maintain. Historically the design and optimization of power and process has been done in separate environments. Changes in one domain inevitably require a response in the other, but handling this complexity has relied on the best efforts of humans, traditionally working off documents and diagrams.

Schneider Electric is changing all this, by exploiting data integration – what we call Co-Simulation of Power and Process. Schneider Electric's ETAP provides the electrical digital twin, exposing the transient behaviors of complex power distribution networks. AVEVA Process Simulation is a process digital twin, providing insight into the true behaviors of a plant. Schneider Electric is connecting these applications by bringing data from each across to the other. This allows the power distribution network to be tuned and optimized in ETAP while ensuring critical process parameters are honored. In this way, energy use can be rapidly and accurately optimized, eliminating power losses and waste, while safeguarding production objectives.

Optimizing demand through energy efficiency, paired with improvements in energy production and transport efficiencies can be a gamechanger. This offers a ready, feasible, and commercially attractive, decarbonization pathway when compared with options still in the research or finance sourcing stages, or early phases of development and scalability. It also, raises possibilities to address one of the biggest failings of the global energy system: the fact that two-thirds of energy produced is lost on the journey from primary source to final use.



Source: LLNL July, 2023. Data is, based on DOE/EIA SEDS (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 0.65% for the residential sector, 0.65% for the commercial sector, 0.49% for the industrial sector, and 0.21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527.

Source: Lawrence Livermore National Laboratory; Estimated US Energy Consumption in 2022

1.1 The potential of digital innovation

Proactive energy efficiency monitoring and optimization has the potential to make significant decarbonization progress across industrial operations. New data-driven techniques such as predictive asset optimization and integrated simulation, deliver system-wide efficiency gains. They achieve this by improving the performance and reliability of major equipment. In legacy assets, this might require the addition or improvement of sensing and data collection mechanisms. Nonetheless it is otherwise a relatively low-cost route to enabling energy efficiency.

Schneider Electric is pioneering the integrated simulation of power and process to greatly reduce electrical energy losses while maintaining process objectives, by sharing data across electrical and process digital twins (*See sidebar: Co-Simulation of Power and Process*).

Establishing data-driven approaches to improve efficiency of operational assets is a well-established strategy. However, implementation and use practices are often underdeveloped and fail to deliver their full potential. Structured data can only take energy optimization efforts so far. A comprehensive control tower methodology is needed, aggregating structured and unstructured data, and creating an agile operational organization which can exploit new insights to drive informed actions.

Unlike its counterparts in discrete manufacturing, energy industry businesses have yet to fully engage with the control tower model. As the nature of the energy system changes, organizations within the sector will need to evolve to achieve the required decarbonization and efficiency targets, while maintaining operational profitability.

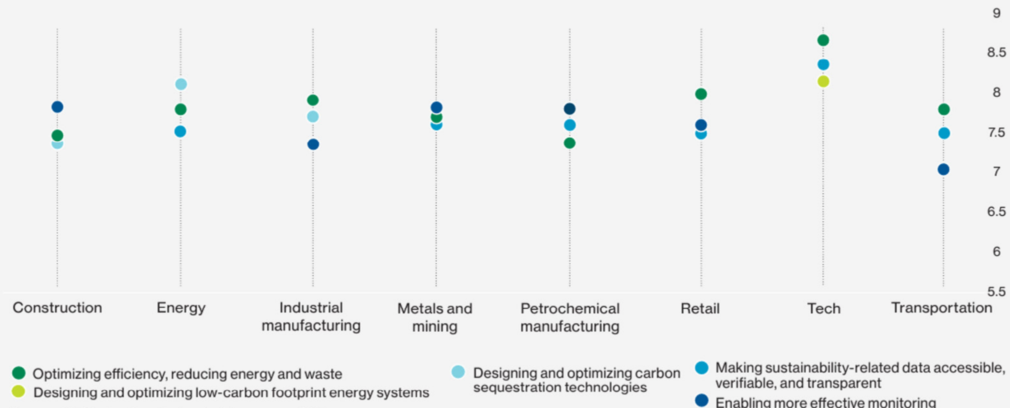
Implementing new digital systems must include a commitment to legacy expertise, and a deeper partnership between front line and back-office functions. Production is the key driver for operators, and any loss of faith in new technologies will stall if not derail adoption. Back-office expertise is more likely to be grounded in technology-savvy skill sets and strategies – but less familiar with production practicalities. It is the responsibility of back-office stakeholders to build and maintain trust with front line workers, to unite operational and business functions when introducing digital systems that drive energy efficiencies.

It should be noted that the data itself is quickly becoming an area of concern across both energy efficiency and power demand. According to some industry experts a new data center is commissioned somewhere in the world every two or three days. And the IEA estimates global power demand from data centers could go beyond 1,000 TWh by 2026 in an extreme scenario. This is double 2022 levels and an increase equivalent to Germany's total power demand. If two-thirds of primary energy continues to be lost on the way to final use, the value created by data-driven energy efficiencies (presumably through some of these data centers) is significantly undermined by the negative impact of the data centers themselves. Two steps forward, one step back.

Challenges will continue to arise, but there is consensus on the central role digitalization will play in decarbonization: it is essential. The precise impact of data and its use will vary across sectors and use cases, but across the board digital technologies are expected to unlock a new world of efficiency and sustainability.

Figure 1: Digital technology will play a key role in meeting decarbonization targets

Across all industries, companies seek technological advancements to optimize efficiency and reduce energy and waste. On a scale of 1 to 10, with 10 being the highest, respondents ranked the top three ways digital technology aids in achieving their decarbonization goals.



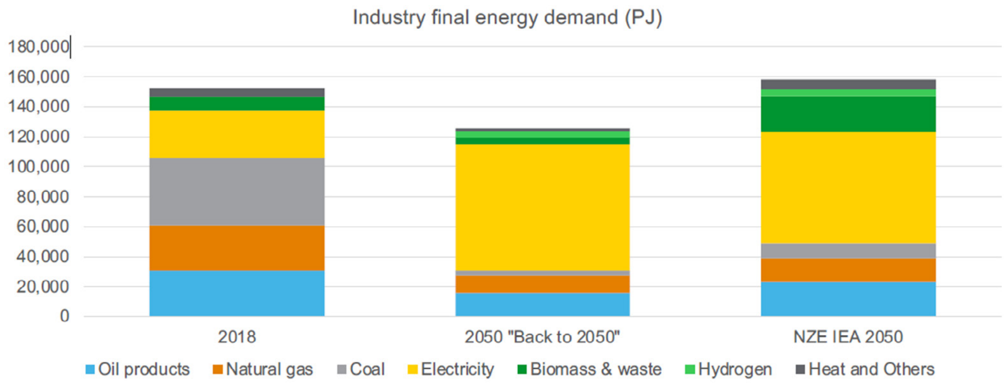
Source: MIT Technology Review Insights survey, 2023

Source: Massachusetts Institute of Technology; 'Digital technology: the backbone of a net-zero emissions future'; published 2023

1.2 The contribution of consumption behavior at all levels

The proliferation of data centers will add to total final use demand for the foreseeable future, as will other aspects of global development. While we work to increase technical efficiency, we also need to question another aspect of power demand: consumption behaviors. At all levels, from individual to enterprise, opportunities to educate and reward energy efficient behaviors exist. A stark illustration: The average person in regions such as North America and the Arabian Gulf consumes multiple times as much energy as their European counterpart. Environmental and economic factors – climate, access to energy-driven resources and typical resource-use behaviors (i.e., predominance of public transport) – account for some of this disparity. Regulation plays a part, as do public information campaigns targeted toward conscientious energy consumption. Clearly more work must be done to understand the contributing factors to replicate them across geographies. At the corporate level, opportunities to incentivize and reward positive behaviors are becoming increasingly common as energy efficiency becomes ingrained across management and operations.

Although energy efficiency remains a complex topic with practical hurdles to overcome, there is no doubt that it will play a critical role in lowering energy intensity to a level that brings IEA's NZE targets within reach, within schedule. Consumption behaviors have key roles to play in this success scenario, for consumers and industry alike. Focusing on the latter, we at Schneider Electric believe final energy demand for industry can be lower than current levels, and the IEA NZE 2050 scenario, through the right combination of efficiency, behavioral and process changes.



Source: Schneider Electric 'Back to 2050'; published 2022

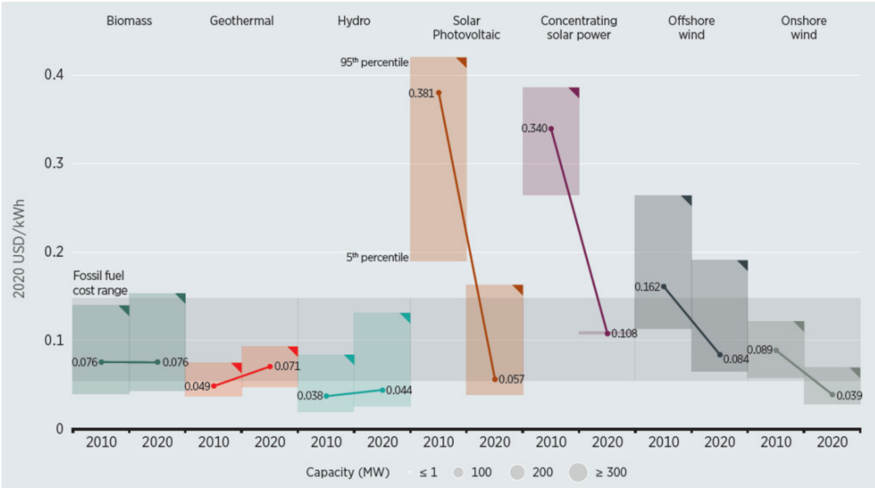
2. Capital investment and financing

Finance markets are steadily raising requirements to ensure new capital investments align with NZE targets. The energy industry must align business models and exploiting technology to get to the front of the line for new financing. Clean energy and energy transition capital is available to be deployed but several factors create bottlenecks to actual construction of assets, distribution, and effective utilization.

2.1 The challenge of longer investment payback

Expectations of return on investment (ROI) continue to be a challenge. Investors in traditional hydrocarbon businesses, are accustomed to returns in three years or less, slightly longer in other parts of the world. Renewable projects cannot match this in any region, even in the US with the substantial stimulus provided by the Inflation Reduction Act.

Capital continues to chase production, growth, and opportunities in hydrocarbons. Incentivizing policy will play a critical role in de-risking investment in the emerging new energy system, including removing barriers to project deployment. The levelized cost of energy (LCOE) for renewables is falling to the point where they can compete with traditional fossil fuels for new generation capacity when conditions allow high utilization. However, storage, transportation and markets remain challenging, so the commercial risk remains higher for investors when compared to hydrocarbons. A classic horse and cart situation. With such characteristics at play, investors and prudent business leaders should take a closer look at energy efficiency in all circumstances.



Source: https://energypost.eu/wind-solar-continuing-cost-declines-will-help-meet-rising-renewables-targets/

2.2 Influence of geography on the nature of investments

The extent and nature of existing industrial stock and infrastructure influences how capital is spent. In broad terms, developed economies have a larger legacy industrial asset base, so investments are mainly in a brownfield context. By comparison, developing economies have relatively greater greenfield potential. This informs the pursuit of energy efficiency in different ways across regions. In mature economies, opportunities are mainly to retrofit and rejuvenate existing assets and operations for increased energy efficiency. In emerging economies, there is more opportunity to incorporate novel approaches to energy efficiency in new designs. This does not necessarily ensure finance accessibility for developing economies, particularly given demands on investment ROI as mentioned above, and the relative instability of certain regions. However, as markets mature and stabilize, this could become a distinct advantage for developing economies with respect to realizing the energy intensity impact of efficiency.

Efficiency opportunities abound across the energy landscape, but some sectors can start to benefit more easily than others. Midstream is one sector ripe for energy efficiency quick wins. Midstream operations can realize substantial energy efficiency gains through the application of data analysis and optimization software. For the purposes of data-driven energy efficiency gains alone, investment in sensors, data aggregation and analysis software are very low comparison with the savings they unlock.

With a view towards an energy efficient future, investments must address the design phase of new assets as well as the operation of existing ones. To instill energy efficiency into the heart of industrial operations will ultimately require a new approach to the equipment and processes that drive operations.

2.3 Rigid capital allocation

In some cases, investment parameters and regulations limit the distribution of available funds, leading to a counter-productive cycle. Funds may be held back all together when they cannot be deployed to meet specific decarbonization requirements – for example, funds earmarked for solar projects may not be dispersed to fund a biomass project, even if the latter is more promising – which translates into inadequate supply growth. This undermines reliable energy supply while driving up pricing of existing sources – mostly fossil fuels – which then makes green investments less attractive. Regulation needs to play a facilitating role in the energy transition but in situations such as the example above, it is unintentionally creating barriers which aggravate the energy trilemma.

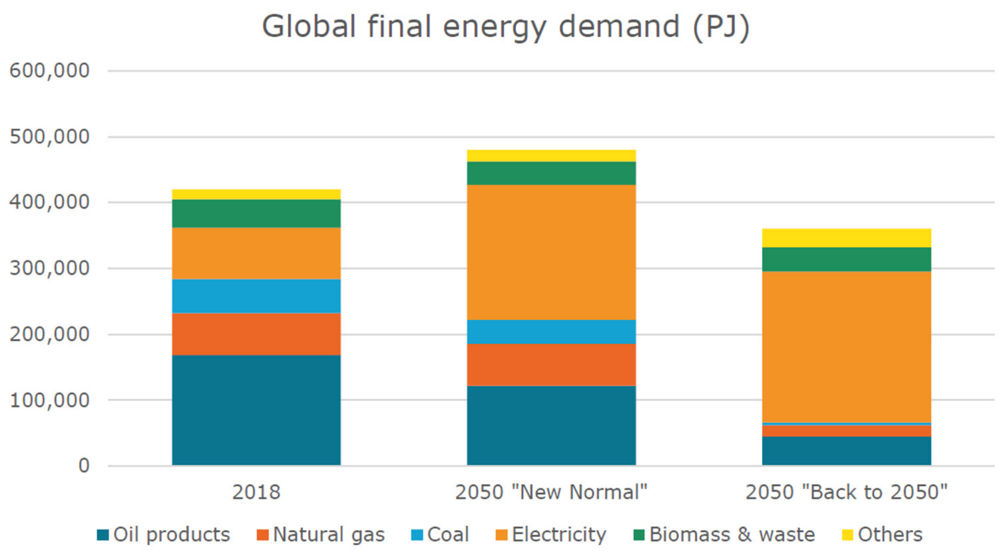
Clearly capital needs to be deployed more effectively in pursuit of reduced energy intensity and, in this cause, strategies must serve both the big, long-term transformational projects and the close-at-hand incremental efforts, such as improving energy efficiency. Investors must take stock from an enterprise level and develop a portfolio approach both for their investments in industrial assets, and for the digital initiatives that will unlock the energy efficiency gains required to meet NZE targets.

3. Energy transition technology

As noted in Schneider Electric's 'Back to 2050' study, the beginning of the twenty-first century may be one of the most dynamic eras of technology innovation, comparable in magnitude to the industrial revolutions of the 1800s. Technology is a transformation driver, without a doubt.

Energy transition technology, a focus area of current technology evolution, has seen advances across renewable energy sources, energy storage technologies and lithium-ion batteries, in both electronics and electric vehicle development. Perhaps most importantly, emerging energy technologies are still, for the most part, first generation technologies, meaning further efficiency and cost improvements are realistically expected. These factors will deliver increasing advantages over traditional fossil fuel sources, even as we continue to work toward lower emission hydrocarbon-based solutions.

Process change will also be a key facilitator of energy transition on the demand side, mainly through electrification. Schneider Electric's 'Back to 2050' study projects the use of electrification in industry rising to as much as 80% of final energy demand. It will have a major impact along with measures like carbon removal and storage technologies.



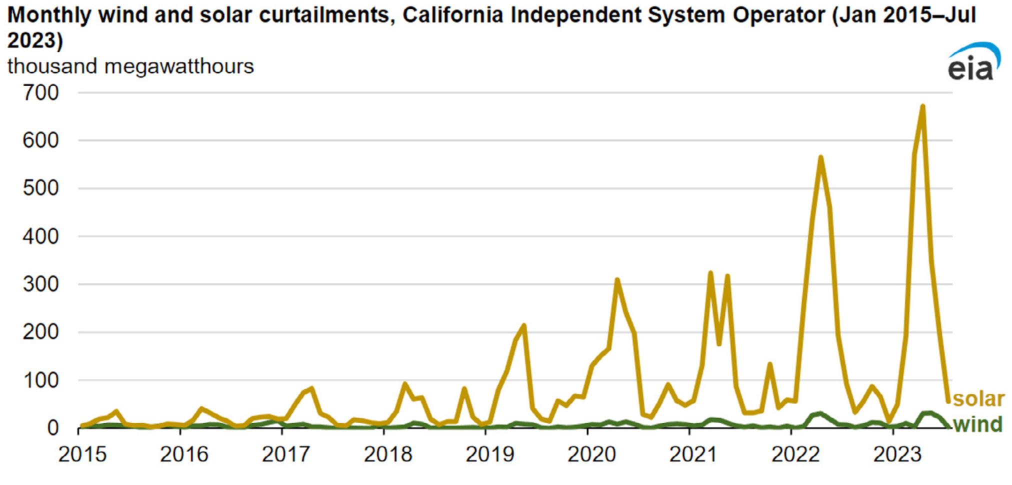
Source: Schneider Electric 'Back to 2050'; published 2022

3.1 Agility and being less wasteful

The changing energy landscape, with its widening mix of primary sources and increasing electrification, requires industry to be more agile and less wasteful. These sectors will face operational realities more like those experienced in discrete manufacturing. They will do well to absorb learnings from discrete manufacturing in navigating greater variability in supply, demand, and pricing – for instance the control tower concept, as mentioned earlier. The kind of production agility required in the future will be greatly aided by the advent and growth of Open Automation, an area of focus for Schneider Electric. From the perspective of procurement, a global marketplace for industrial materiel aggregation and resale would help reduce the unacceptably high legacy levels of physical waste, particularly in oil and gas. The energy industry can learn from similar recent developments in the aerospace sector and others.

3.2 The awkward problem of too much clean energy!

Much discussion and debate around energy transition technology focuses on creating economic viability and market stability for the new domains of energy – hydrogen, CCUS, storage, etc. But in some cases, there is a different, energy efficiency-related challenge: unusable renewable generation capacity that leads to energy curtailment. In a world that does not yet have adequate global clean power potential, some areas have more than they can manage. In these places, the curtailment of clean power generation typically occurs due to grid capacity constraints. Development of effective Long Duration Energy Storage (LDES) systems and transmission infrastructure would allow these energy-abundant regions to maximize their clean energy potential. Surplus capacity could be utilized, either for deferred consumption or to sell to other regions still reliant on carbon-intense energy sources. Insights gained from technologies such as AI-enabled digital twins of grids and energy supply chains could optimize decision-making and enable cleaner energy solutions for all.



Source: US Energy Information Agency (EIA); Data Source: California Independent System Operator (CAISO)

4. Managing resource constraints

Pathways to NZE exist, and the enabling technological advancements continue to evolve and scale. However, resource constraints will need to be addressed to keep the energy transition on track and enable a lower emission, lower intensity energy future. Constraints around sourcing of critical minerals such as copper and lithium, and rare earth elements, are a primary concern related to climate technology development. Policy makers will need to anticipate rising need for critical minerals and rare earths as well proactively address related vulnerabilities such as price volatility, supply security and geopolitical disruptions.

4.1 Lubricating the energy supply chain

Supply chains, manufacturing capacity and related infrastructure development also face hurdles on the path to NZE. Clean energy technology supply chains are key enablers of the energy transition. The IEA projects that US $1.2 trillion of cumulative investment is required to bring enough capacity online for supply chains to achieve NZE 2050 targets.

Manufacturing capacity in clean energy technologies has been geographically concentrated to date. Increased efforts to diversify have been supported by major policy announcements in many countries, for example the US Inflation Reduction Act. However, notoriously lengthy permitting and project delivery timelines threaten to delay progress. And while the use of renewable energy and electrification is growing rapidly in many countries, the infrastructure required for their deployment is lagging. The grid capacity needed to connect expanding renewable power generation with demand centers is insufficient (as mentioned in section 3.2) and has the potential to dampen progress. One innovation that will play a growing role to fill the gaps in grid capacity is the microgrid. At Schneider Electric we are leveraging our deep expertise in electric energy management, alongside our industrial software portfolio, to stand up microgrids for customers around the world. (*See sidebar: EcoStruxure™ Microgrids*).

EcoStruxure™ Microgrids

A microgrid is a self-contained, site-scale electrical network that co-locates demand and generation. It allows onsite generation and consumption of power when it is most needed, also avoiding the losses associated with long-distance transmission. A microgrid will connect, monitor, and control a site's distributed energy resources (DER) while enhancing performance, sustainable footprint, and resilience. They can be operated while connected to the utility grid or in disconnected "island" mode. When the grid goes down, electricity prices peak, or proximate renewable sources are plentiful, microgrids respond.

Micrograds are a powerful tool to elevate energy efficiency as they:

- Enable greener operations by integrating on-site renewables such as wind and solar.
- Save energy expenses by optimizing demand, storing electricity for delayed consumption or to supply back to the grid,
- Improve reliability, thus keeping facilities running during grid outages.

4.2 Workforce Transformation

As the energy transition accelerates, competition for people with the required skills will grow. Industry faces talent demand on two significant fronts: retaining core talent for traditional fossil fuel businesses; and sourcing the new skills required to drive emerging energy organizations. The energy industry expects to lose a substantial portion of its existing workforce due to retirement in the coming years. The United States energy market alone may see as many as 400,000 employees retire over the next 10 years.

Given the competition for digitally savvy talent across the global marketplace, the energy industry will be challenged to reposition itself as an enticing industry of choice for the next generation of career-minded talent. And when the next generation of workers comes onboard, they will need to be trained, developed, and deployed in substantially new ways. They will need to be given digital tools up to par with their expectations and given roles that allows them to exploit those tools to the maximum. For example, the co-simulation of power and process to optimize energy, mentioned above, is an early example of how integrating data from previously siloed disciplines will cause operators to think and act differently in the future.

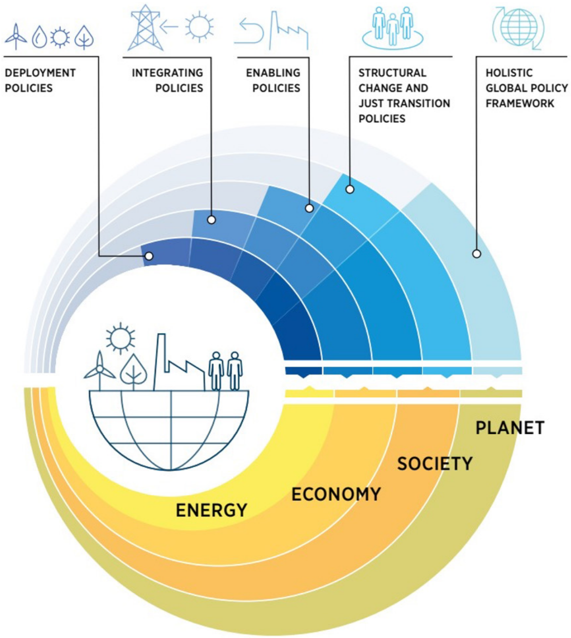
To be sure, the resource constraints to be addressed on the path to the future energy system offer opportunities in additional to challenges. With declared NZE targets within sight, however, the pressure is on to resolve these challenges agility and speed.

5. The role of policy and regulation

The IEA and IRENA forecast that the world requires three times more renewable energy capacity (or at least 11,000 GW), and must double the average annual rate of energy efficiency improvements to over 4% every year by 2030, to limit global warming to 1.5°C. At COP28, the Global Renewables and Energy Efficiency Pledge called out the priority of meeting the collective goal of the Paris Agreement and recognized the need to accelerate renewables deployment and energy efficiency. More than 120 countries signed this pledge, which now creates accountability to delivering the targets.

The target of doubling annual energy efficiency improvements is "highly ambitious, but achievable," according to James Newcomb, a senior expert at the Rocky Mountain Institute research group. Fortunately, regulation, technology and financial incentives are growing in effectiveness. Technologies, from high-efficiency lightbulbs to heat pumps and advanced energy management, are supported by policies at many levels, encouraging industry to adopt efficiency solutions and new operating models. Ultimately, the commercial incentivization of energy efficiency will rise to meet regulatory policy inclusive of accountability requirements. This change will inform future license to operate and will be facilitated both by the increased digitalization of energy efficiency data monitoring and reporting, as well as improved outcomes driven by AI-generated insights.

"At IEA, we call energy efficiency 'the first fuel' – which shows the significance of energy efficiency," said Fatih Birol, executive director of the IEA. If we are to achieve a reduced energy intensive future, energy will play a critical role, as a cost-effective path forward complementing electrification, digitalization, and other solutions. Policy and regulation will mature to support the central role energy efficiency will play.



Source: IRENA (International Renewable Energy Agency) ; World Energy Transitions Outlook 2022

Closing: Energy efficiency can be achieved with three strategy pillars

Success in meeting the declared NZE targets depends on our ability to reduce energy intensity overall by an average of 4% per year going forward to 2050. This will require breakthroughs in energy production as well as parallel advances in the way we consume energy. Energy efficiency plays a pivotal role. It is already an important management metric, a product development requirement, a system engineering objective, and operational target across much of industry. As a ready, commercially attractive decarbonization pathway, energy efficiency will grow in importance in the years ahead, even as others evolve and stabilize.

Delivering the potential of energy efficiency toward reducing energy intensity is a multi-faceted, long-term challenge. We have addressed some of the key levers in this document to bring some focus on the actions that might prove most effective. Whatever plans organizations follow, we believe three things must be kept at the heart of every company's strategy:

Digitalization will be a critical enabler in constructing the primary pillars of a stable, efficient, and increasingly carbon-neutral power system. Digital technology will enhance visibility across the integrated energy supply chain and through to end uses. It will empower solutions across energy loss and waste, deliver data-led improvement and solution strategies, aid in de-risking much-needed climate investment, and more. In the period ahead, and with specific focus on energy efficiency, industry must accelerate the adoption of digital innovations such as integrated simulation, Ai/ML and Open Automation, which can reveal and exploit operational "sweet spots", optimizing power demand while meeting process and production objectives.

Maximizing energy efficiency as a key enabler of a lower carbon, climate-friendly future will require a **foundation of trust and agility** to enable true collaboration across the ecosystem. From policy makers to energy industry executives, from energy producers to end users, from industrial decision makers to technology innovators and community activists, everyone will have a role to play in finding, developing, and scaling the solutions needed to achieve progress. These nascent partnerships will require a level of trust and cooperation that has not yet been reached at scale – a necessity if we are to accelerate the reduction of energy intensity from now to 2050.

Sustainability must become an irrevocable, top priority for industry, in the same way Safety has in the last few decades. This means placing it at the heart of people engagement, business and operating models and organizational strategies. When this happens the incenting and rewarding of efficiency-related behaviors at all levels will become business as usual. And energy efficiency will take its place as a protected attribute of the energy system of the future.

Rising to meet any major challenge requires building momentum and maintaining it. The drive to reduce energy intensity must start now, but of the five levers discussed in this document only energy efficiency has the necessary qualities today: it is technically feasible and commercially attractive. The others will mature, and complimentary decarbonization pathways will become viable and play their part. But building momentum on our Net Zero journey means focusing now on unleashing the massive potential of energy efficiency.

About the authors

Amit Kar is the Global Director and Digital Solutions Leader for the Energies & Chemicals segment at Schneider Electric. He has 20 years' experience exploiting the power of Digitalization to tackle the management and operational challenges of industry. By translating technology into value, Amit illuminates the business impact of Digitalization. He marries a visionary understanding of technology trends with a practical approach, helping customers develop strategies to capture value today while laying out a roadmap for the future. His global industrial experience has emphasized the energy sector and includes some of the world's most challenging projects and operational environments, from West Africa to the Middle East and South East Asia. He also has experience in technology start-ups, from early internet communities to digital content delivery and fintech.

Amit obtained a BSc in Industrial Management from Carnegie Mellon University, and an MBA from New York Institute of Technology. He joined Schneider Electric from AVEVA in early 2022. He is also a professional photographer and keen tennis player.

Vychan Noble joined Schneider Electric as a Strategic Account Executive in the Energies & Chemicals segment in 2017. Before joining Schneider Electric, Vychan was IBM Global Client Director at IBM, with over 17 years of experience in ICT of which 11 of those in support of Energies & Chemicals.

Vychan has driven integrated solutions, linking technology services and various products across industry companies. In addition, he has established several collaborative innovation engagements to address material business and technical challenges. He is a strategic thinker with the ability to apply innovation and in a pragmatic and integrated way. Vychan has always been active in international and multi-disciplinary teams, developing and delivering solutions worldwide.

In 1997 Vychan completed a Bachelors of European Business Studies at the HEAO Enschede, Netherlands. In 2001 he completed an Executive MBA/MSc (cum laude) at the Rotterdam School of Management. Vychan has also completed various additional managerial courses at Harvard, INSEAD, and most recently, Sustainability Leadership at Cambridge University.

Vychan was born and raised in Australia. He has been living in Europe since 1992. He currently lives in the Netherlands.

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