Life Is On | Schneider Electric

Unified power and process paves the path to oil and gas net zero

by Constantine Lau and Lucas Pellegrin

Executive summary

While existing technologies are available to help reduce the carbon footprint of oil and gas operations, companies are still challenged to meet decarbonization and sustainability goals.

Many are looking for green hydrogen, carbon capture, and sequestration to decrease their carbon footprint. These solutions can deliver substantive reduction gains when financial incentives are available and infrastructure is broadly established. Fortunately, innovative solutions such as digitalization, energy efficiency improvement, and electrification are available today to facilitate the energy transition, and with the help of Schneider Electric, companies can now achieve net-zero objectives.

Net profit or net zero?

Applying existing technologies enables Oil & Gas companies to achieve both

The main goal of business is to generate profit, but today's investors want more than good returns. They want to know that their investments are going to companies that prioritize environmental, social, and governance (ESG) reporting and demonstrate through key performance indicators (KPIs) that they are reducing their carbon footprint and improving sustainability.

Companies in the oil and gas (O&G) sector have struggled to attract investors, despite delivering solid business performance over the last ten years and publicly declaring ambitious carbon reduction targets. With government policies compelling companies to increase ESG commitments, renewable energy prices declining, and consumers expressing a willingness to pay a premium for green products, O&G companies have more reasons than ever to invest in the energy transition.[1] The time is ripe for change.

Innovative technologies are already successfully applied to reduce greenhouse gas (GHG) emissions. Government incentives and new sustainability commercial models are creating financial incentives for technology development that will expedite the journey to net zero.

Decarbonization options deliver varying emission impacts and abatement costs

Nearly 40% of global GHG emissions originate from fossil fuels, 10% from the O&G sector's Scope 1 and Scope 2 emissions. According to analysts at McKinsey & Co., Scope 1 and Scope 2 GHG emissions in the O&G industry come from various sources, including fugitive/methane emissions, venting (47%), downstream heat and power systems (20%), and downstream fugitive/methane emissions (10%).[2] Although the volume of GHG emissions is considerable, the analysts point out that some technologies already in place are reliably reducing emissions in this sector, see **Figure 1**.

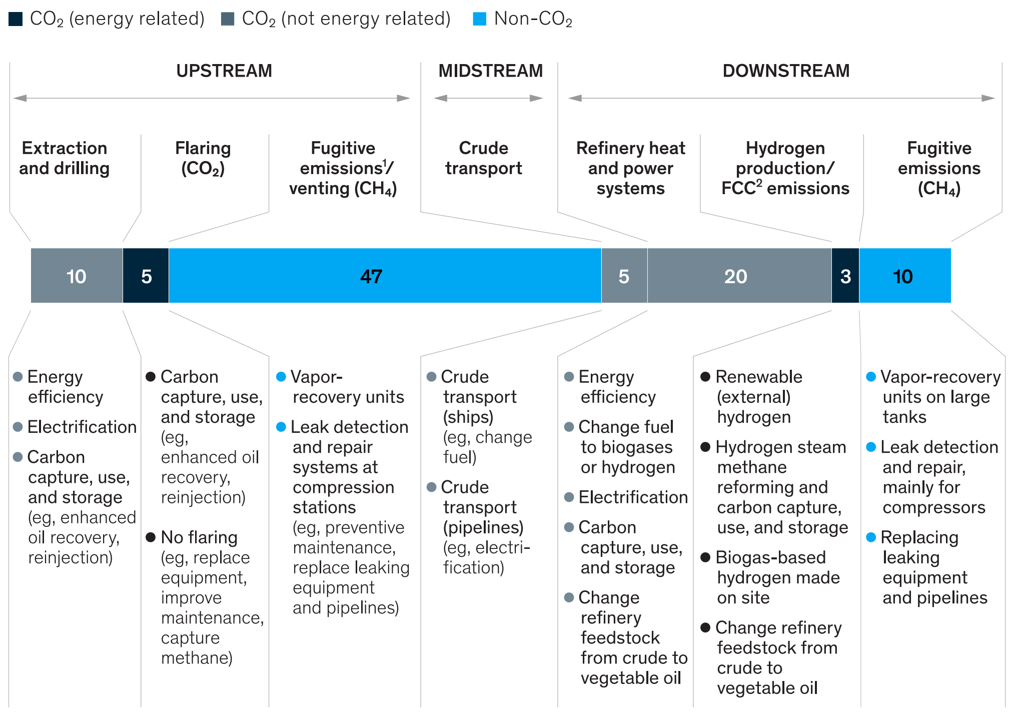
1 "World Economic Forum Net Zero Industry Tracker 2022"
2 McKinsey & Co., "The future is now. How oil and gas companies can decarbonize," January 7, 2020.

Figure 1

Sources of GHG emissions in the O&G industry

Source: McKinsey & Company

Emissions by source, share, and possible solutions, %



[1]Fugitive emissions from midstream are included in upstream (~20% of total oil and gas emissions, mainly methane) to be consistent with IEA *World energy outlook 2018* classification.

Most O&G companies have committed to reducing Scope 1 and 2 targets by 2030, and some have committed to net zero through scopes 1, 2, and 3 by 2050.

The fact is that massive changes in the way that societies and companies produce and consume energy are required across the board because reaching net zero emissions by 2050 means eliminating 37 gigatons per year of CO_2 emissions. **Figure 2** shows a macro view of how reductions can be achieved via six technology avenues:[3]

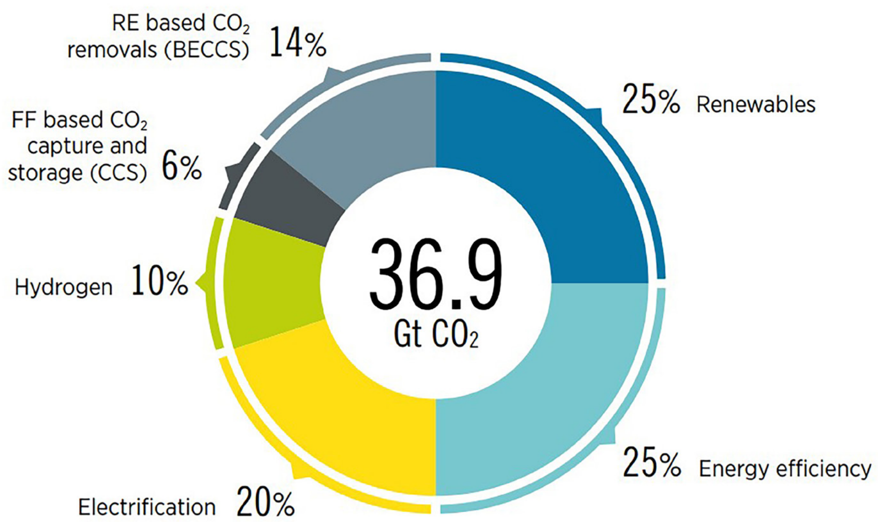
1. Using renewable-based electricity
2. Making process and equipment changes to improve energy efficiency
3. Electrifying end-use segments (e.g., electric vehicles, heat pumps, electrical heating)
4. Using clean hydrogen
5. Using renewable energy/bioenergy
6. Reducing CO_2 generated from fossil fuels by developing carbon capture, utilization, and sequestration (CCUS) solutions

3 International Renewable Energy Agency (IRENA) "World Energy Transitions Outlook 2022"

Figure 2

Reducing emissions by 2050 through six technological avenues

Source: IRENA



Upstream companies have focused on methane leak detection, process electrification, and energy efficiency improvements to achieve near-term reductions in Scope 1 and Scope 2 emissions. These technologies provide straightforward and scalable solutions that deliver substantial, immediate results. Energy efficiency improvements can generate positive ROI and reduce emissions by approximately 30%.[4] As the saying goes, "The cleanest energy is the energy that is not used."

Many companies across the sector are also embracing electrification and renewable energy sources. Because storing renewable energy can be challenging, some electrification solutions are hybrids – using predominately renewable energy supplemented by energy produced with fossil fuels. For companies making this investment, the price of renewable energy dropping dramatically to the range of < $50/MW makes the process more commercially feasible and, consequently, more appealing.

Increasing reliance on renewables, electrification, and energy efficiency can deliver immediate gains towards short- to medium-term decarbonization goals. Still, on a micro level, O&G companies must evaluate the options based on emission reduction goals and economics.

Some companies are taking bigger steps in diversifying from traditional fossil fuel investment, like Total, BP, and Shell, have diversified their business portfolios to include renewable power generation and electricity retail businesses.

4 Schneider Electric's internal data

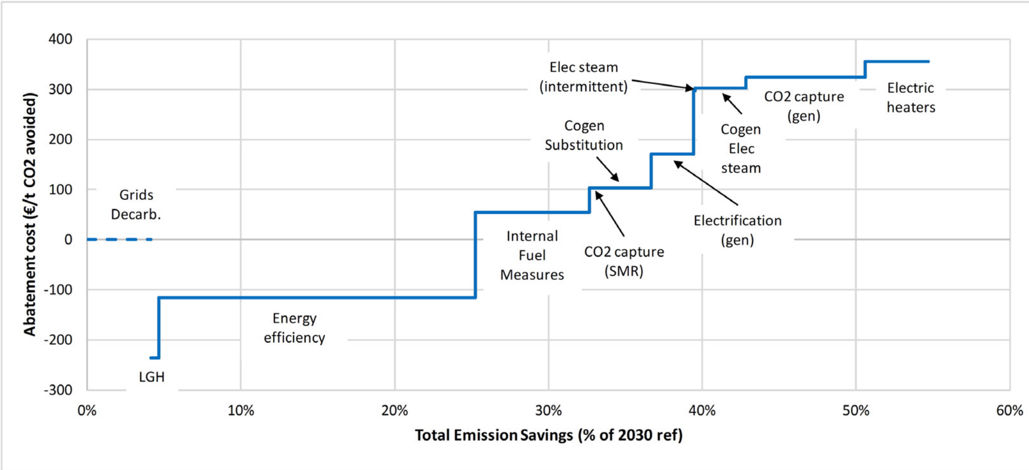
Analysts at Concawe, a division of the European Fuel Manufacturers Association, have studied the many technologies available and determined the costs of implementing them.[5] **Figure 3** shows the abatement costs for a range of CO_2 reduction options.

According to the report, "CO_2 Reduction Technologies. Opportunities within the EU Refining System 2030/2050," process electrification and CCUS fall on the expensive side of the spectrum of decarbonization options. However, process electrification has the advantage of being scalable, and getting started is not cost-prohibitive. With an investment of a few million dollars to electrify its steam boilers, a facility can capture immediate GHG reduction gains.

Figure 3

CO_2 cost abatement for decarbonization technologies

Source: Concawe



CCUS projects, which capture emissions at the end of a process, are advantageous because they do not disrupt operations. However, one drawback is a CCUS investment can cost upwards of billions of dollars.

One potential CCUS development, proposed by ExxonMobil for the Houston Ship Channel, is a hub that will require an estimated $100 billion to build. If constructed, the hub would be able to capture 100 million tons per annum (mtpa) of CO_2 annually by 2040, which includes all the emissions from nearby petrochemical, manufacturing, and power generation facilities.[6] The cost is one of the reasons this project has yet to get off the ground.

Meanwhile, investments are being made in research and development programs for longer-term solutions like expanding the use of hydrogen and biofuels, which can potentially reduce refinery fluid catalytic cracking (FCC) emissions.

5 Concawe, 2019, "CO_2 Reduction Technologies. Opportunities within the EU Refining System. 2030/2050."
6 ExxonMobil, "Charting a bold concept for a lower-carbon future." 2021

The path to net zero. Where the rubber meets the road.

Net zero is an ambitious objective; companies must create a roadmap with incremental milestones.

Determining the best way forward means considering the decarbonization options available and balancing the investment based on CO_2 reduction and abatement costs. Many companies have completed this exercise, designed a roadmap, and are making gains in GHG reduction.

One of these is Norway's Neste, which announced its decarbonization roadmap for 2018-2050, see **Figure 4**, for a 150,000 bbl/d refinery in Porvoost. The facility was emitting 3.4 mtpa of CO_2, which served as the benchmark in Neste's roadmap. The company's mid-term energy transition goal is to reduce Scope 1 and Scope 2 CO_2 emissions by greater than 50% by 2030.[7]

For Neste, moving to all renewable electricity by 2023 will reduce emissions to approximately 2.1 mtpa, about 30% of its goal. Improving energy efficiency at the refinery, investing in electrification, and leveraging renewable energy sources for steam and hydrogen supply would enable an additional reduction of 0.4 by 2030. Long-term plans include:

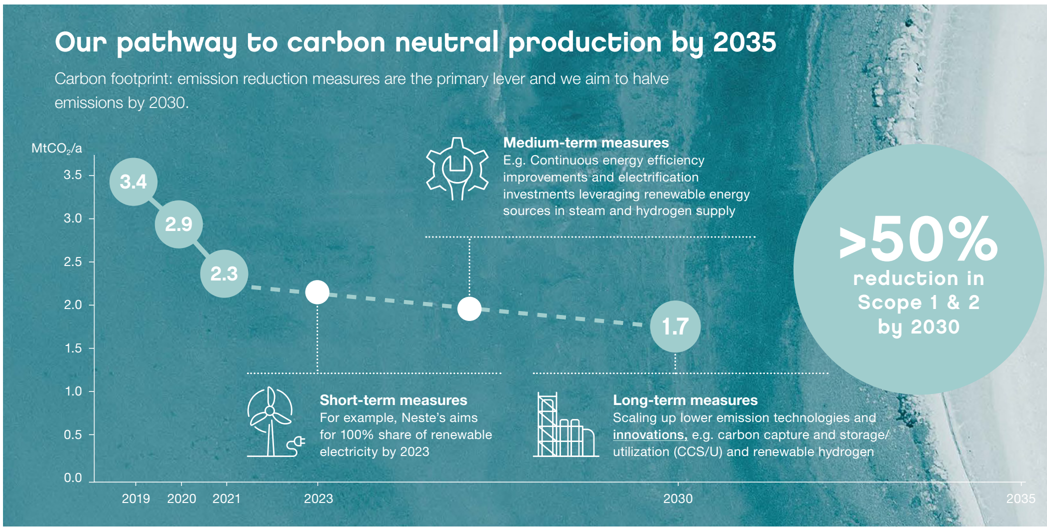
- Scaling up emission technologies
- Exploring CCUS options
- Converting to biorefinery
- Finding a way to convert to green hydrogen biofuel between 2030-2050 enables the company to reach its goal of reducing emissions from 2.1 mtpa to net zero.

Figure 4 shows how the company has mapped out its milestones for achieving its carbon reduction goals by 2050.

Figure 4

Neste Road map for reaching carbon neutral production by 2035

Source: Neste



7 Neste, "2021 Annual Report."

BASF has also announced CO_2 emissions reduction plans to cut GHG emissions by 25% by 2030[8] and become net zero by 2050.

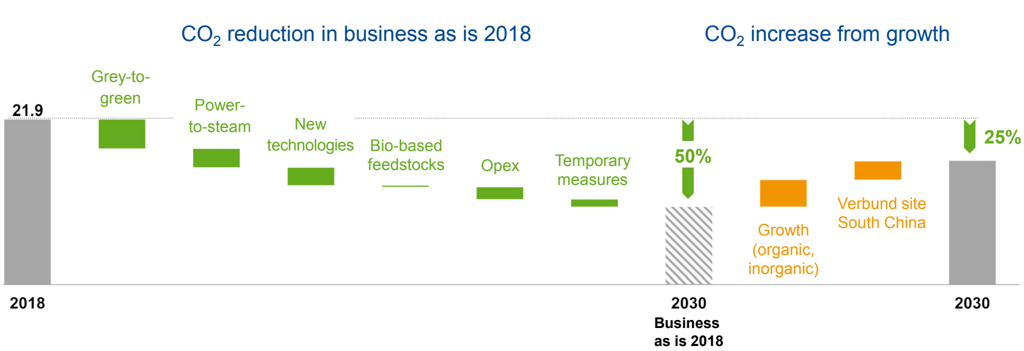
BASF's plans for reducing emissions include using new technologies like electrically powered crackers in its petrochemical facilities to replace ethylene steam crackers and adopting green hydrogen and ammonia technologies.

Figure 5 shows the company's plans for achieving a 25% CO_2 reduction by 2030. The company will employ power-to-steam technology where possible to transform surplus energy into high-grade steam for use as reliable green power on demand. Additional plans include implementing gray-to-green measures and replacing fossil fuels with renewable power sources like offshore wind.

Figure 5

BASF's path forward to achieve -25% in 2030

BASF Capital Market Report, 2022 (Page 48)



Electrification and efficiency drive the energy transition

Because of the many benefits clean electrification offers over alternatives, electricity demand is projected to increase by 300% by 2050.[9] Compared to other options, electricity delivers considerable advantages for consumers, including:

- Zero emissions when powered using renewable sources
- Travels at the speed of light
- Increased flexibility
- Greater efficiency (~95% for electric motors and 99% for thermal energy conversion vs. 25 - 40% for fuel-powered systems)
- Better remote control through digitalization
- Declining renewable energy and storage costs
- Lower maintenance costs with a longer mean time between failures (x10 vs. gas turbine) and shorter mean time to repair (<10% vs. gas turbine)[10]

In refineries and petrochemical facilities, electrification also simplifies system components and eliminates flue gases, which leads to soot buildup that requires continuous maintenance.

Industrial electrification remains low in the O&G sector, representing only 7% of site energy usage in refineries and 20% in petrochemical facilities.[11] Although process heating makes up 50% of manufacturing energy use, only 5% of process heating is electrified.[12]

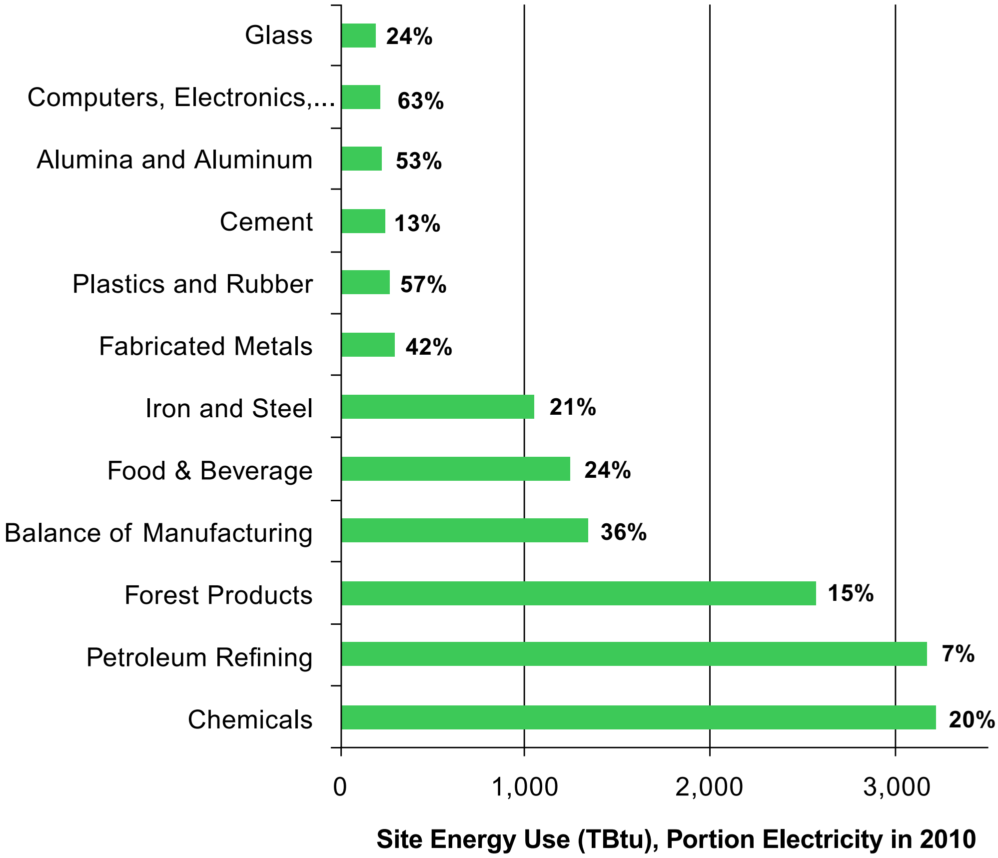
8 BASF, "Our Targets."
9 McKinsey & Co. July 18, 2022. "Unlocking opportunities from industrial electrification"
10 Schneider Electric's internal data
11 Schneider Electric's internal data
12 ACEEE, "It's Time to Electrify Industry's Process Heat—with Heat Pumps," March 2022

Combined, industrial electrification and process heating represent enormous potential carbon reduction gains that could be captured by simply converting the process from traditional to electrified systems, see **Figure 6.**

Figure 6

Industrial electrification for various segments

Source: National Renewable Energy Laboratory



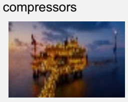
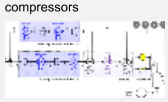
In broad terms, process electrification in the O&G sector falls into one of two key applications: machine drives and process heating, see **Figure 7.**

Figure 7

Two key areas of process electrification in O&G

1 Electrification of Machine Drive

(compressors, pumps, etc.)

Light processes 1-10MW E.g., E-fracking, upstream skids, gas pipeline compressors…	**Heavy processes 10-100MW** E.g., complete offshore topside electrification	**Heavy processes 100+MW** E.g., complete LNG train electrification
Motors, pumps, compressors 	Motors, pumps, compressors 	Motors, pumps, compressors 
Replacing diesel + pump by Switchgear+VSD +motor	Replacing direct drive of compressors by gas turbines by a centralised power gen and electric motors; eventually connection to mainland grid or offshore renewables	Replacing gas-turbine driven compressors by a centralised power gen and electric motors. Potentially connection to grid or renewables

2 Electrification of Heat

(furnace, steam boiler, gas fired heaters, electrolysers, etc.)

Small heaters <10MW E.g., refinery & petrochemicals hot oil heaters, steam boilers, heat-tracing…	**Large heaters Large green H2 100+MW** E.g., refinery & petrochemicals CDU, crackers …
Heaters 	Heaters, boilers, crackers 
Replacing gas heaters by electric or hybrid heaters	Each refinery (600+WW) and petchem plant (2000+ WW) represents 1+GW potential. Major players start to investigate, create consortiums

Electrification can generate mechanical movement for equipment like motors, pumps, valves, and extruders. This equipment can be categorized in terms of energy use as light processes, which use 1-10 MW; heavy processes that use 10-100 MW; and heavy processes that use more than 100 MW.

In upstream O&G operations, light processes include electrical fracking, skids, gas pipeline compressors, motors, variable speed drives, and switchgear.

Heavy processes (10-100 MW) include those carried out on production platforms and processing on floating, production, storage, and offloading vessels (FPSOs). For these applications, the first step is to move from gas turbine-powered compressors to centralized power using electric motors. Eventually, moving to connections to offshore electricity from renewables, like wind, or linking offshore assets to mainland grids.

Heavy processes (greater than 100 MW) include a full-liquefied natural gas (LNG) train and replacing gas turbine-driven compressors with centralized power generation and electric motors. These processes also could eventually connect to a grid or a renewable supply.

The carbon footprint of process heating can be reduced by replacing traditional furnaces, steam boilers, gas-fired heaters, and olefin crackers in downstream O&G operations. Small process heaters (<10 MW) include hot oil heaters, steam boilers, heat-tracing, etc. Even more significant reductions could be achieved by electrifying large heaters (>100 MW) in crude distillation units and olefin crackers used in refining.

The value of electrifying process heating is already being captured by companies like XTO Energy, an ExxonMobil subsidiary, which is capitalizing on process electrification to achieve carbon reduction goals in its upstream operations. The potential reductions are considerable. Replacing traditional diesel-powered fracking units with electrical fracking fleets could reduce fuel costs by 90% and CO_2 emissions by 50%.[13] So, it is evident why electrification is foundational to the company's plan to reach net-zero operations in the US Permian Basin by 2030.[14]

In downstream processing, major petrochemical companies like BASF, Dow, Shell, and Total have launched strategic pilot projects that will electrify ethylene crackers before 2030. Electrical cracking would reduce CO_2 emissions by 60-90% if sourced from zero-carbon electricity.[15] With six to eight crackers in each plant that at times use 50+ MW, these companies would require around 300 MW of clean electricity, representing a 20x increase in power demand over traditional fossil fuel-fired electrical power.

13 Schneider Electric's internal data

14 ExxonMobil, "ExxonMobil plans for net zero emissions in Permian Basin operations by 2030,"

15 Schneider Electric's internal data

Overcoming conventional views

Historically, power management and process automation have been managed separately, but following this model compromises the facility's ability to capture efficiencies. Understanding how the interconnected functions in a facility impact productivity changes the playing field and allows owners to identify areas for improvement.

Capturing performance data is the first step in moving from facility management that relies on people to pinpoint bottlenecks and inefficiencies to digitally optimized operations that use the power of big data and the industrial internet of things (IIoT) to streamline and enhance productivity.

The confluence of decarbonization, digitalization, and pressure to reduce capital expenditures (CapEx) and operational expenses (OpEx) is pushing the industry to rethink traditional process automation and power management.

O&G companies recognize digitalization as an enabler for achieving business objectives and are keen to capture the benefits, but figuring out how to proceed is not always straightforward.

For many, the obvious first step is integrating power and process management systems.

The next step is to apply this unifying concept throughout the entire plant lifecycle to continuously deliver value.

Unifying power and process has significant benefits

Unifying power management and process automation in the design phase of an O&G facility ties the processes together digitally and allows critical data to be captured and fed into a digital twin through the entire plant lifecycle. By taking in real-time performance data and optimizing operations from the outset, the digital twin can enable:[16]

- Up to 20% savings in overall CapEx (and ensure the project stays on schedule)
- 10% lower process energy costs
- Up to 35% reduction in direct CO_2 emissions
- 15% reduction in downtime
- 3% overall profitability improvement

Digitalization links connected products (e.g., field devices and edge control systems) to apps and analytics, executing data analytics on interconnected systems to deliver value across the entire enterprise supply chain. A value-focused digital transformation leverages connected devices and IIoT to extend the facility's operational life and, at the same time, reduce both CapEx and OpEx.

16 ARC Advisory Group, "Control System Modernization: How Power and Automation Fusion Change Operational Resistance into Operational Resilience."

By dealing with the data collectively, process information can be monitored and analyzed remotely or through a centralized process, enhancing insights and decision-making because knowledge from multiple teams within the plant is no longer siloed or inaccessible.

A high-priority strategy for digital transformation is prescriptive analytics for asset management. This is model-based and often uses artificial intelligence (AI)/machine learning (ML) algorithms to recognize patterns, enabling anomalous conditions in equipment or processes to be detected and recommending the next steps.

Unified power, process solutions, and sustainability

Electrification requires major redesign and integration of process automation and power system infrastructure, so having the right tools and partner is critical. The ETAP® software platform for electrical power systems modeling and simulation simplifies the integration process. EcoStruxure for the O&G, and petrochemical industry uses ETAP to build an electrical distribution digital twin on a unified platform. It integrates it with an AVEVA process digital twin to improve performance throughout the plant's lifecycle, see **Figure 8**.

Using this design tool, the end user and engineering, procurement, and construction (EPC) firms can confirm the viability of the electrical design under various scenarios. For an electrical cracker, designers can ensure the infrastructure can support a 20x increase in electrical power use.[17] For a microgrid/hybrid power scenario, the designers can ensure optimum fossil fuel and renewable electricity use. The software tool can connect the intelligent, single-line diagram developed by the EPC to the end user's existing SCADA.

In a traditional hydrocarbon processing facility, the key function of process automation is to control the plant process, while power management is a support function for operations. This makes sense in a facility that draws only 5-20% of its electrical power from the grid. With an increase in electrification, however, the infrastructure is more complex and requires process and electrical system integration. An integrated and unified model simplifies design and optimizes operations in real time with root-cause analysis, switch plan validation, asset management, cost optimization, and model-based validation. It also enables predictive maintenance.

A rapidly responding system that considers the process and power system dynamics enables intelligent, fast load shedding. Accurately validating shedding schemes prevents compromised production throughput and safeguards plant and personnel safety. Sequence of Events (SOE) with power and process data time stamping enables more accurate fault analysis. Achieve sustainability benefits by reducing spinning reserve requirements and providing savings on fuel cost and maintenance for diesel generators, resulting in an immediate return on investment (ROI).

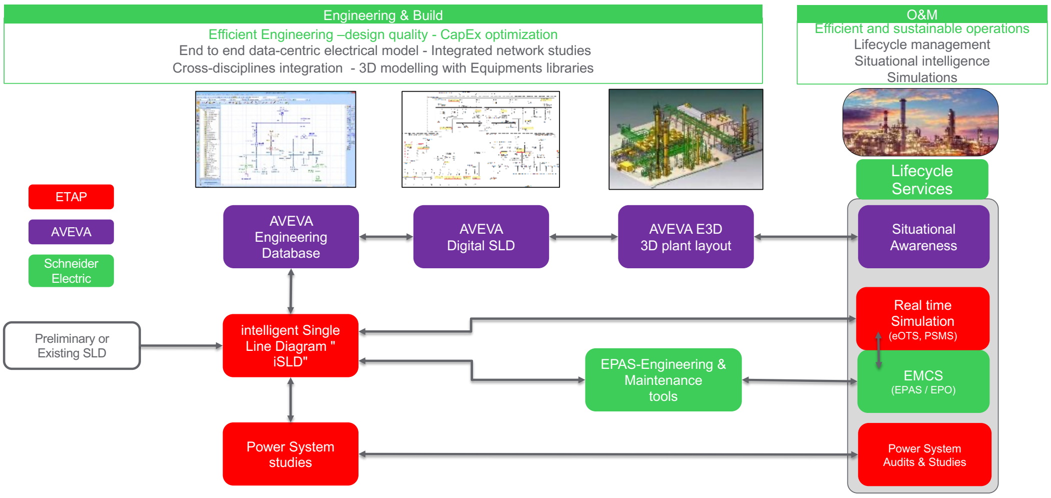
17 Schneider Electric's internal data

Figure 8

ETAP electrical power digital twin integration with AVEVA process digital twin for complete end-to-end digital continuity

Integration of ETAP Power System Digital Twin with AVEVA Process Digital Twin.

A Full End-to-End Digital Continuity



Unified power and process strategies deliver value in eight vital applications.

1. **Unified engineering/Asset information** is a single engineering and design data intelligence infrastructure for manufacturing processes, electrical distribution, and equipment. This value driver provides customizable, multidiscipline 3D design tools to aid in the construction of process plants by creating a digital twin of the plant.

   The 3D model of the physical plant equipment and associated process includes electrical systems to use throughout the business lifecycle of a plant for design, training, maintenance, expansion, etc. The digital twin matures in step with plant construction from front-end engineering and design studies, detailed design, construction, and operations, where it enables continuous asset optimization.

2. **Power and process system optimization** enables power supply and distribution equipment to be designed to match expected plant power demands, ensuring that the power system is optimized – not over or under-designed. This is accomplished through early engagement with energy management experts and supported by process and electrical simulation modeling tools.

3. **Unified simulation through the asset lifecycle** of the plant presents as a “living” digital twin that delivers reliable predictive capabilities over a wide range of design and operating parameters. Once the digital twin exists, unified simulation can be applied and optimized without recreating the models. The model becomes vital for engineering and commissioning, operator training, and real-time optimization.

4. **Single project execution** enables the power system and automation supplier to work closely with EPC firms around a broader project scope during the design phase. This new role consolidates scope under a single power system and automation supplier, enabling better coordination and integration of systems and reducing project risk, especially during plant commissioning.

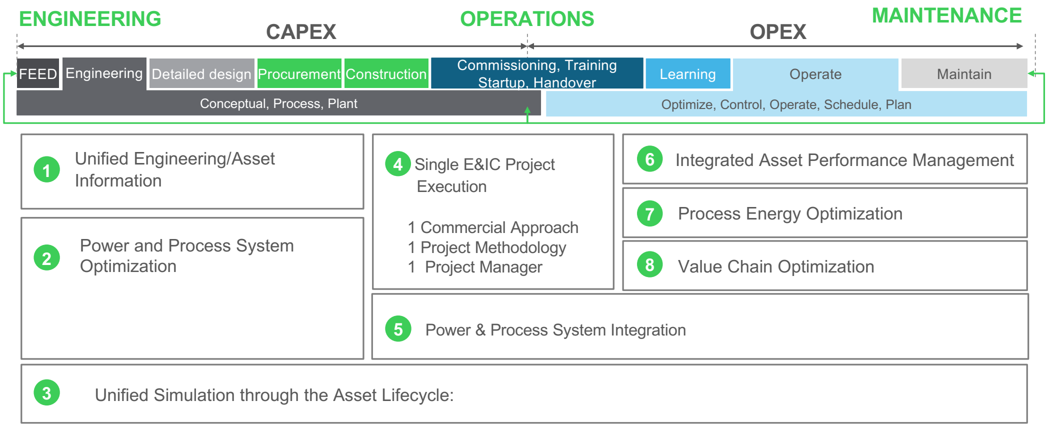
5. **Power and process system integration** includes unification and rationalization of distributed control systems (DCS), safety instrumented systems (SIS), energy management control systems (EMCS), networks, controllers, alarms, historians, and intelligent electronic devices. Integrating energy data with process data in a unifying process automation system allows operators to:
   - Visualize asset health and energy efficiency
   - Conduct rapid diagnostics of motors, pumps, fans, motor-operated valves, and electrical asset problems through a SOE
   - Reduce mean time to repair by allowing production to resume in minutes rather than days
   - Easy navigation from P&ID to SLD
6. **Integrated asset performance management** comprises the activities of diagnostic monitoring and maintenance of plant assets, including electrical supply/distribution, process equipment, turbo machinery, and the automation infrastructure that monitors and controls these assets. Cloud-based or edge-based asset performance management systems created from the digital twin and enhanced by AI and ML models to collect and analyze equipment performance data and offer advice on the best use of assets to achieve operational and sustainability goals.

7. **Process energy optimization** manages the trade-offs between energy types. This begins with understanding the process's fundamental physics and chemistry and the relationships among electricity, gas, steam, and chilled water. Optimizing processes minimizes costs and reduces the plant's carbon footprint.

8. **Value chain optimization** unifies planning and scheduling via enterprise visualization and allows companies to track production costs, energy costs, emissions, and materials in real time through the supply chain. Optimizing feedstock purchases and production schedules enables faster decision-making and improves asset performance.

Figure 9

Eight unified power and process strategies across the asset lifecycle



Incorporating variable speed drives can save up to 50% on energy costs

There are a few thousand pumps in an average refinery and a few hundred fans in an LNG plant so the energy cost can add up quickly. Pumps and motors often are oversized, so more energy is consumed than required. Using variable speed drives (VSDs) instead of on-off switches on motor starters across the line can save up to 50% of energy costs.[18] Most new VSDs also have smart condition-based monitoring capabilities that can help improve asset availability.

Schneider Electric's remote electrical asset monitoring solution helped a US petrochemical plant detect undersized VSDs and malfunctioning transformers causing premature aging and replaced them, averting unscheduled plant shutdowns.

Power system optimization reduces CapEx and carbon footprint

Upstream, midstream, and downstream assets are large energy consumers, so matching power consumption with efficient power systems is critical. Between 2009 and 2013, US refineries experienced 2,200 unplanned shutdowns; electrical power system failures caused 21%. Because plant shutdowns are costly, many plants are designed with excess power and supply and distribution systems that solve the power problem but introduce unnecessary costs.

Power system optimization ensures that power generation, distribution systems, and equipment are appropriately sized to meet power demands over various operations. Electrical engineering and process domain experts work together, applying process and electrical simulation modeling tools to determine actual power requirements that drive down CapEx overinvestment and reduce OpEx during plant operations.[19]

When engaging Schneider Electric energy management experts early in a front-end engineering design study, the benefits are dramatic and can deliver significant benefits, including:[20]

- Decreased electrical infrastructure CapEx by up to 20%
- Faster project design, startup, and commissioning
- Lower OpEx over the entire plant lifecycle through improved operational efficiency

Power generation and electrical distribution equipment make up a significant percentage of the project cost, and because they are integrated into a large facility, they impact the physical footprint. Optimizing power generation facilities is particularly important as they can cost 4-5x that of electrical distribution equipment.[21]

Minimizing the space requirements for power generation and electrical distribution equipment is especially important where space is at a premium, such as on an offshore platform or floating production storage and offloading (FPSO) facility or within a prefabricated modular power building (E-House).

18 Schneider Electric's internal data

19 William Vukovich, Patrick Christensen, and Thomas Yeung (AICHE 2015, Hydrocarbon Processing)

20 Schneider Electric's internal data

21 Schneider Electric's internal data

Power system design should be optimized early in the design process with the EPC firm and owner/operator to realize the greatest benefit because the power system's size is integral to tuning the entire system. Modeling the power requirements allows for optimizing trade-off decisions, such as generating power, taking power from the grid, or managing loads differently. In turn, these options impact the size and layout of power generation and electrical distribution equipment, including standard elements within the power system model, including:

- Generators
- Transformers
- Motors and their controls
- Medium-voltage (MV) and low-voltage (LV) switchboards
- Motor control centers
- Uninterruptible power supplies

The power system optimization produces a finely tuned MV/LV architecture associated with the power management system that provides sufficient equipment and feeder capacities such that systems are integrated and ready to install when required by the project schedule.

Unified Operations Center – the single version of the truth for visualizing integrated production and sustainability information

Some major enterprise-level challenges are a lack of visibility of group performance, long production times for plans and energy data, inconsistent production reports, and transferring measurements between plants. On top of that, real-time energy and sustainability data usually lack visibility. A Unified Operations Center (UOC) integrates power and process data, visualization, and optimization enterprise-wide. This allows production cost, energy cost, and materials to be tracked as they move through the supply chain, enabling faster decision-making and optimized asset performance. One Middle East O&G company that implemented a UOC solution claimed a $1 billion benefit in the first few years.[22]

A real-time historian like OSIsoft PI can collect data from all the individual plants within the enterprise and provide near real-time production and sustainability data that allows intelligent and intuitive processing at the UOC.

Visualization and monitoring are simple and effective solutions for reducing energy costs. Operators with access to various energy data sources displayed in KPIs they can relate to can make better operational decisions. Automation loop tuning and performance monitoring can add value by ensuring each control loop performs to its designed performance.

Emissions measurement and reduction is a solution to “You cannot improve what you cannot measure.”

CO_2e measuring, tracing and advisory delivers real-time GHG emissions measurements based on Schneider Electric and AVEVA software and service methodology. A commercial end-to-end solution backed by Schneider Electric energy and sustainability experts, CO_2e measuring, tracing and advisory, is designed to change behavior and improve decisions using real-time feedback to achieve net-zero goals.

22 AVEVA, Success Stories

Sensors or inferential GHG emissions measurements at the plant unit level aggregate to the plant level. Then the plant data is fed to the enterprise-level UOC. CO_2e measuring, tracing and advisory provides data validation, cleansing, and by calculation of emission operational data. Next, it continuously measures emissions with visualization from operating displays to enterprise reporting. To demonstrate actual GHG reductions, the software establishes a benchmark and then uses real-time reports from the OSI PI technology real-time historian to measure emissions. More powerful functions can be utilized by integrating with AVEVA's modeling, simulation, and optimization capability.

Planning and scheduling software helps evaluate lower carbon crude feedstocks

Planning optimization software provides valuable intelligence for sourcing feedstocks and energy to minimize the CO_2 Intensity Index for products and overall production, explicitly accounting for the cost associated with carbon tax or credits. Using planning and scheduling optimization software, O&G companies can evaluate low-carbon feedstock, and refinery planners can purchase spot crude based on crack margin vs. carbon intensity content.

Derive value from unifying process automation systems and energy management control systems in electro-intensive environments

A unified system makes diagnosing process disruptions caused by electrical systems easier. Schneider Electric is one of the few control system suppliers that can deliver an integrated control platform spanning power and process to:

- Provide control room operators with complete electrical system visibility, alerting them to conditions that could compromise the electrical distribution network before a process starts.
- Identify how the intelligent Fast Load Shedding (iFLS) Electrical Management Control System (EMCS) will impact a process and facilitates analysis of faults, trips, and shutdowns through a common database with a sequence of events analysis.
- Combine the capabilities of the DCS, SIS, and EMCS in a single control architecture that streamlines the control and monitoring infrastructure, removing redundant databases, superfluous engineering tools, separate operator stations, hardwiring, and network components.

Microgrid optimization helps manage hybrid energy sources through the energy transition

Microgrids are optimized by precisely managing energy from multiple distributed energy sources and interconnected loads controlled as a single entity operating in parallel with the grid or an intentional island mode.

Hospitals and airports use microgrids to improve resilience and energy efficiency, and refineries have been using cogeneration technology for a long time. O&G companies have begun adopting microgrid strategies to optimize energy sources and tradeoffs using steam, fuel, and electrical grid energies. What will be new for these companies is incorporating renewable energies into the energy management system. Some onshore well pads and offshore platforms already incorporate solar and offshore wind energy, and microgrids may soon be adopted in downstream O&G operations.

AI predictive analytics can simplify unified process and electrical asset management

Schneider Electric's **EcoStruxure Autonomous Production Advisor** combines the power and flexibility of cloud and edge computing with the value-generating capabilities of AI and ML to deliver such services as AI-driven predictive analytics solutions for upstream artificial lift assets like rod pumps and electrical submersible pumps (ESPs). **EcoStruxure Asset Advisor** is a remote predictive analytics service solution for electrical assets, such as VSD, switchgears, motor control centers (MCC), transformers, battery storage, etc.

Integrating EcoStruxure Autonomous Production Advisor and Asset Advisor allows artificial lift assets from the pump to the VSD, switchgear, transformer, and battery storage to be completely monitored. This replaces traditional automation architectures and strategies that rely on highly experienced workers to oversee onshore O&G wells with hundreds or even thousands of pump units across tens of hundreds of miles with limited connectivity.

EcoStruxure Autonomous Production Advisor has been deployed in onshore wells with another customer in Southeast Asia and offshore wells with a customer in the Middle East to resolve three main challenges:

1. Collecting expertise from their most senior operators, automating it, and deploying it on more assets to achieve asset optimization goals
2. Actively managing the asset lifetime to optimize well intervention schedules
3. Optimizing well production by reducing unplanned downtime and maximizing oil volumes

Applying process automation increased production by 13% and reduced energy consumption for the pump extracting oil by 33.75%.[23] Reducing stress on the system also extended the expected production life of the well.

Smart software models increase energy efficiency and reduce emissions

Operators must work under many constraints in a large and complex refinery, petrochemical, and LNG plants, where the number of variables are too large for even the most experienced operators to manage continuously. Contending with traditional variables like throughput, reliability, and safety is complicated by the need to address energy costs, emissions targets, and renewable power sources.

One way O&G companies can see immediate returns on their investment and achieve rapid CO_2 reductions is to grab the low-hanging fruit of energy efficiencies.

Using proven smart software technologies like advanced regulatory control and process control can reduce the variance of operation conditions. Real-time optimization can be applied when stable operations are achieved to enable the plant to run close to the optimal target.

A Japanese refinery reported a 5% reduction in energy costs after implementing a real-time optimization strategy. And the largest refinery in India reported savings of $7.2 million through better visualization and $5 million via real-time optimization.[24]

23 Schneider Electric's internal data

24 Schneider Electric's internal data

Power Purchasing Agreements – Sourcing renewable power from the electrical grid is a zero CapEx decarbonization option

When carbon-free or renewable power sources (like hydro, solar, wind, nuclear, etc.) are available, sourcing clean electrical power from the grid is one of the fastest and most efficient ways of decarbonizing without capital outlay.

Chevron captured value using this approach in 2019 when it signed a 12-year green power purchasing agreement to supply its West Texas Permian electricity load (approximately 65 MW) from renewable sources.

In 2022, BASF entered virtual power purchasing agreements for 250 MW wind and solar power energy supply for 20+ sites across the US. The agreements are designed to offset carbon-intensive grid-supplied electricity. According to US Environmental Protection Agency estimates, this will offset more than 472,500 metric tons of CO_2 emissions annually.[25]

Green hydrogen plants can run on renewable-powered electrification

A full 100% of the power in hydrogen polymer electrolyte membrane (PEM) fuel cells used in a green hydrogen plant comes from electricity. Traditional hydrogen units are 5-20 MW, but bigger ones in the 100 MW range are being planned, with proportionally greater power demand and larger energy infrastructure.

Safety and efficiency depend on accurate power quality monitoring and control, so process engineers and operators need real-time information from process automation and electrical management control systems.

Schneider Electric's ETAP and AVEVA design software help design a larger energy infrastructure, and simulations developed from the digital twin will help operators manage hydrogen production on a scale that previously has never been seen.

Digitalization and electrification help make CCUS more efficient

For operational efficiency, safety, and profitability, digital technologies will be critical for planning, process automation, predictive maintenance, flow surveillance (anomaly detection), and control systems in CCUS operations.

Digital twin technology can support these goals, for example, by providing a visual representation of installations and the associated power system and grid and accurately monitoring the liquefied CO_2 flow in pipelines using exception-based surveillance (e.g., leak detection, pressure/temperature tracking).

This energy-efficient solution uses variable speed drives and multi-station optimization using a model-based software solution. It can display services graphically so owners can visualize operational, financial, and environmental KPIs and historical data linked to CCUS operations.

25 BASF, "BASF enters power agreements for clean energy supply of more than 20 BASF sites across the United States." August 3, 2022

An IT/OT interface that integrates various data sources (including sensor data) and facilitates machine learning AI-based descriptive and predictive analysis is essential for CCUS operations. And the process can be further decarbonized by as much as 60% by replacing natural gas-powered engines in compressor stations with electrical motors or sourcing from an electrical grid. Sourcing from renewable power delivers a reduction of 100%. For direct air capture (DAC) of CO_2, which uses chemical process technology that is highly energy intensive, electrification and digitalization solutions will introduce efficiencies that will help make DAC processes sustainable.[26]

Making a move to more manageable and responsible operations

Engaging an experienced partner on the journey to net zero can be the difference between implementing a solution that captures efficiencies and reduces the carbon footprint of operations and one that misses the mark.

O&G companies should look for a partner that provides solutions to better enable asset management combined with digital technologies to deliver efficiencies and performance improvements that help O&G companies achieve short- and medium-term decarbonization objectives.

About the authors

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26 Rajesh Sharma & Alan Acquatella, "Digitalization Will Help Carbon Capture and Sequestration Industry to be More Efficient, Safe, and Profitable." July 2022