Enabling the transition to net zero

Sulzer's innovative solutions are enabling and accelerating the transition to net zero, by supporting our customers in securing a reliable supply of energy and resources for communities worldwide during the transition phase.

Two interlinked challenges have recently come into ever-sharper focus: on the one hand, the world needs to transition to green and renewable energy to reach net zero. At the same time, we must ensure a sustainable transition that secures the reliable supply of life-critical energy and resources to the billions of people and businesses that depend on them.

This represents one of the key global challenges on the pathway to net zero – the ramp-down of high emissions activities must be carefully managed in parallel with the ramp-up of low-emissions activities, if we are to avoid high economic costs and damage to global economies.

This balance will therefore define global activities to reach net zero in the coming years. Of all the sections of our society and industries that will need to decarbonize as we forge the path to net zero, several areas represent a particular challenge – cement and concrete, heavy transportation, aluminum, steel and chemicals. These sectors provide growing populations all over the world with resources that enable everyday life. It is estimated that these sectors currently account for 30% of global emissions[1].

Decarbonizing heavy industry

Sulzer is directly or indirectly involved in all of these industries, helping them to achieve cost efficiency and environmentally friendly operations. In the heavy transportation sector for example, Sulzer signed a memorandum of understanding in 2022 with BASF to collaborate on the enhancement of renewable biofuels. Sustainable aviation fuels made from organic material like waste cooking oils and fats can cut emissions by up to 85% compared to traditional jet fuel[2] and will therefore support the sustainable transformation of the aviation sector as production is scaled and commercialized.

Sulzer is also currently enabling production at two of the world's largest biofuels production facilities. Combined, the two plants will produce over five billion liters of renewable fuels annually from waste oils, fats and greases, allowing large segments of the transportation sector to move to these revolutionary low-carbon fuels and eliminating millions of tons of CO_2 emissions per year.

There are many more examples from across Sulzer's portfolio of such innovations and contributions that will help our society reach global emissions targets. In renewable energy, Sulzer has been developing ground-breaking solutions to the problem of uneven supply due to unpredictable weather conditions. Sulzer's technologies are being used to convert electricity from wind and solar installations into various forms that can be stored and then used when required, helping to solve this fundamental barrier to the large-scale adoption of renewable energy. In the light transportation sector, the adoption of electric vehicles is rapidly rising as a critical part of net-zero strategies, requiring ever-increasing amounts of lithium. The multi-stage production process for the high-quality lithium used in batteries is long and requires highly specialized pumps throughout all stages of the extraction and purification. Sulzer's pumping expertise is key in this area and used all over the world to optimize the lithium and battery manufacturing processes.

Furthermore, for those emissions that cannot be eliminated, Sulzer offers opportunities to remove carbon from the atmosphere and store it safely underground or permanently sequestered in materials and products. With Sulzer's pumping expertise and advanced separation technology, the company is providing innovative technical solutions for all stages of the CCUS process. We continue to innovate to enable these technologies to achieve their full impact as a commercially viable and critical component of the net-zero strategy.

These solutions will be scaled in the coming years as the global transition accelerates. The Climate Policy Initiative estimates that climate-related financing has almost doubled since 2010, reaching USD 632 billion in 2020[3], with much of this investment going towards developing and scaling clean and renewable technologies. As these technologies are ramped up across the globe and attract more and more investment, Sulzer is perfectly positioned to help deliver the megashifts in infrastructure that will enable net zero.

Enabling circularity and minimizing emissions from traditional energy sources

While we ramp up and commercialize clean and renewable technologies, traditional fuels and energy production will remain crucial. To minimize their carbon emissions to the greatest extent possible, while safely capturing the emissions that we can't eradicate, Sulzer and its partners develop powerful CCUS solutions.

And in addition, we continue to develop innovative means of enhancing the efficiency and sustainability of carbon-intensive fuels. For example, Sulzer's pumping expertise is being used to optimize oil extraction and enable circularity in the oil industry. The solution uses captured, high-pressure CO_2 which is pumped into depleted oil reservoirs to extract the remaining oil with far higher efficiency than the traditional water, reducing both water consumption and the need for further oil exploration. The carbon is then safely and permanently stored underground, enabling circularity and reducing emissions.

1) World Economic Forum: First Movers Coalition
2) First Movers Coalition aviation commitments
3) Climate policy initiative: Climate finance landscape

You can read more about Sulzer's sustainability efforts in our 2022 sustainability report

Decarbonizing the transportation sector

Sulzer is helping to decarbonize the transportation sector by working with its partners and customers to develop and produce renewable, low-carbon fuels. By mimicking the highly useful properties of oil-based fuels but with a far lower carbon cost, these biofuels will be a central pillar of global strategies to decarbonize the fast-growing transportation sector.

Transportation has long been identified as one of the most challenging sectors to decarbonize. Statista estimates that the transportation sector accounts for 17% of total global greenhouse gas emissions, behind only the power sector, with this number expected to rise in the coming years[1].

How to decarbonize this growing sector represents a key challenge, heavily reliant on new and emerging technologies and huge shifts in infrastructure across the world. However, the transportation sector is far from homogenous, with different areas of the sector requiring different solutions.

The easiest piece of the puzzle is light transportation – for cars, light trucks and two-wheeled vehicles, the transition is already well underway. This is because these vehicles are smaller, they carry lighter loads, and they generally have frequent opportunities to refuel. This means that energy density (the amount of energy contained in a certain weight and volume) becomes less important, paving the way for alternative on-board energy storage like batteries or hydrogen fuel cells. The International Energy Agency estimates that there will be 125 million electric vehicles on the roads by 2030 and that oil demand from light vehicles will peak in the early 2020s[2], despite growing numbers of total vehicles on the roads. Here you can read more about Sulzer's contribution to lithium extraction and battery manufacturing, helping to enable the widespread adoption of EVs across the globe.

By far the bigger problem is how to decarbonize heavy transportation – ships, planes and heavy goods vehicles. There is a good reason why oil-based fuels have come to dominate our transportation sector – it is because their high energy density makes them the ideal fuel to carry heavy loads over long distances. The energy density of batteries is orders of magnitude lower than petroleum fuels, effectively ruling them out as a viable option to power larger vehicles over long distances. Put simply, batteries are too heavy and store too little energy relative to their weight for them to be used to

transport passenger or cargo planes or ships over thousands of kilometers. Moreover, petroleum fuels' liquid form means that they are far easier to transport to the point of use than energy stored in electricity, which requires significant infrastructure to transport.

For heavy transportation, there is therefore only one viable alternative – low-carbon fuels that mimic the highly useful characteristics of petroleum fuels in terms of energy density and ease of transportation. Biofuels and synthetic fuels show the most promise, as these fuels can be engineered to deliver the properties of petroleum fuels necessary to power heavy transportation, while producing a fraction of the carbon emissions. Sustainable aviation fuels (SAF), for example, can reduce carbon emissions by up to 85% versus their petroleum-based alternatives.

Enabling production at two of the world's largest biofuel facilities

In 2022, Sulzer was selected by Shell to supply pumps for its major new biofuel facility under construction in Rotterdam, the Netherlands. Expected to become one of the largest biofuels production sites in Europe, the Shell Energy and Chemicals Park will create sustainable aviation fuel (SAF) and biodiesel from waste. Once completed, the facility is expected to deliver 820'000 tonnes of low-carbon fuels (LCF) a year, enough to eliminate 2'800'000 tonnes of CO_2 emissions annually – the equivalent of taking one European million cars of the road[3]. Sulzer's industry-leading pumps will enable several critical processes at the facility, including providing boiler feedwater to drive the steam turbine generator.

Similarly, Sulzer is supporting the conversion of an existing US West Coast refinery into another of the world's largest renewable biofuel plants, currently under construction in California. Sulzer's pumping expertise will support central processes to enable the transition, including converting the existing hydrotreater to produce renewable diesel from used oils, fats and greases. Sulzer will also provide a highly specialized set of critical oil recycle pumps to feed the hydrotreater itself. Inside, the organic waste material is reacted with hydrogen to produce the same components found in traditional diesel but at a far lower carbon cost. Once operational, the facility will produce approximately 50'000 barrels of low-carbon fuels per day, reducing carbon life-cycle emissions by 65% – equivalent to taking 1.4 million cars off the roads[4].

A partnership to further enhance renewable fuels

Beyond Sulzer's contribution to the production of these biofuels, the company is also helping to lead the development of new technologies that enable sustainable alternatives to fossil fuels. In 2022, Sulzer and BASF signed a memorandum of understanding to develop collaboration on enhancing renewable fuels and plastic recycling technologies. The strategic partnership will combine Sulzer Chemtech's expertise in licensed processing technologies and mass transfer equipment with BASF's cutting-edge high-performance adsorbents and catalysts to further reduce the carbon intensity of renewable diesel and sustainable aviation fuel.

1) Statista: Transportation emissions worldwide
2) International Energy Agency: Global EV Outlook 2022
3) Shell media release: Shell to build one of Europe's biggest biofuel facilities
4) Phillips 66 media release: Phillips 66 makes final decision to convert San Francisco refinery

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If you can’t eliminate your CO_2 emissions, capture them!

Carbon capture, utilization and storage (CCUS) has a critically important role to play on the path to net zero. For those emissions that are impossible to completely eradicate through carbon reduction strategies, for example from industrial activities like hydrocarbon processing, Sulzer's CCUS solutions can help capture and transform the remaining emissions into valuable resources to be sold and used in a variety of sectors, thereby enabling circularity and the decarbonization of heavy industries.

Governments worldwide are setting ambitious targets aimed at reducing greenhouse gas (GHG) emissions to align with global net-zero commitments. To achieve this, organizations are looking at ways to improve their environmental footprint while remaining competitive in a challenging marketplace.

While the priority of net-zero strategies is to reduce carbon emissions to the greatest extent possible, we know that there are some sectors where the complete abatement of carbon emissions is nearly, if not entirely, impossible. Hydrocarbon processing, chemical manufacturing and power generation with fossil fuels – all of these industries will need to rely on capturing and safely storing those emissions that they cannot abate. Therefore, in the International Energy Agency’s Sustainable Development Scenario, in which global CO_2 emissions from the energy sector fall to zero on a net basis by 2070, CCUS accounts for nearly 15% of the cumulative reduction in emissions[1].

As a result, the growth of the carbon capture market in the period to 2070 is expected to follow an upward trend that is inversely proportional to the emission reduction requirements in the same period, creating significant opportunities for companies like Sulzer with the know-how to enable cost-efficient carbon capture, utilization and storage.

Emissions as resources

The most compelling and cost-effective way to deal with carbon emissions once captured is to utilize at least a part of them as a resource, in line with circularity principles. For example, captured CO_2 can be used to produce sustainable aviation fuels – an energy application that is particularly hard to decarbonize. Carbon is also the key building block of chemicals and polymers and widely used in the healthcare sector and the food industry, e.g. for carbonated drinks. Moreover, it can support the production of carbon-negative concrete by crystallizing the carbon and permanently storing it within concrete.

This creates additional incentives and opportunities for emissions-heavy businesses to capture their carbon – not only does society benefit, but there are also real financial gains to be realized by reusing the captured CO_2 as a valuable resource. Hydrocarbon processing facilities can potentially become independent, closed-loop facilities, where the carbon generated by the main plant's activities is then reintroduced into the system as feedstock to produce chemicals, materials or fuels. As a result, companies in this sector can address changing market needs and environmental regulations while generating new revenue streams and increasing their competitive advantages.

The critical component in carbon capture units is the separation technology that is used to separate the CO_2 from the other flue gases produced during industrial processing. To deliver optimum performance in these separation columns, Sulzer has developed its proprietary MellapakCC™ structured packing, which was designed specifically for carbon capture applications. More precisely, this cost-effective technology increases efficiency by 20% when compared to conventional structured packing, while enabling the capture of the vast majority of carbon emissions.

For example, Sulzer's technology is being used at a coal-fired power plant in Saskatchewan, Canada. The plant employs a highly advanced carbon capture system with internals and packing from Sulzer, which enables the direct capture of up to 90% of the CO_2 emissions produced by the plant. By January 2022, 4'256'840 tons of CO_2 had been captured and permanently sequestered since the carbon capture unit began operating in 2014[2].

Using and permanently storing captured carbon

As well as developing the technology to capture carbon emissions, Sulzer is driving innovation on ever more inventive methods of putting the carbon to good use while simultaneously providing safe storage solutions that prevent its release into the atmosphere. For example, Sulzer is working with Blue Planet on a ground-breaking mineralization process that permanently stores carbon emissions captured from heavy industries in aggregate form, which can then be used to produce carbon-negative concrete.

The technology combines captured CO_2 with industrial waste to obtain synthetic limestone aggregate – one of the three key ingredients of concrete, along with cement and water. The mineralization process permanently locks up to 440 kg of CO_2 into every tonne of aggregate produced. As a result, it is possible to completely offset the CO_2 footprint of cement and produce carbon-negative concrete. With concrete currently accounting for 7% of global emissions, this process represents a big step in the decarbonization of the construction industry.

Another of Sulzer's innovative methods of storing captured carbon is to convert the CO_2 into high-pressure, supercritical form, which can be used to optimize oil recovery from depleted oil wells. Using highly specialized pumps from Sulzer, the CO_2 is pumped into the well to extract oil with far greater efficiency than traditional methods using water. The pumped CO_2 is then stored in the underground oil field, providing a perfect storage medium for the greenhouse gas. This groundbreaking circular process has the power to transform the oil and gas industry by reducing CO_2 emissions while simultaneously maximizing recovery from existing oil fields – reducing the need for further oil exploration.

1) International Energy Agency: CCUS in clean energy transitions
2) Sask Power status update January 2022

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Delivering reliable energy supply from intermittent renewable sources

Sulzer is developing solutions to one of the major challenges that confronts renewable energy forms such as wind and solar – ensuring that the variable renewable energy supply caused by unpredictable weather conditions can be evened out and controlled to match energy demands. Sulzer's innovations allow energy to be stored as it is produced and then released when needed, helping to provide a solution to this key barrier to the large-scale adoption of renewable energy.

Renewable energy installations are a critical part of the transition to clean technologies and global strategies to reach net zero. The International Energy Agency (IEA) estimates that the share of renewables in global electricity generation jumped to 29% in 2020[1]. Wind in particular saw a significant increase, rising by 275 TWh (+17%) year on year, followed by solar which rose by 145 TWh (+12%). The IEA expects this trend to continue and accelerate in the coming years, with renewables set to account for almost 95% of the increase in global power capacity through to 2026.

However, there are two major issues confronting the large-scale adoption of renewable energy installations like wind and solar. The first is the key challenge of the variable nature of their supply, which is caused by changing weather conditions. We cannot control when the wind will blow and the sun will shine, which results in an uneven flow of electricity that does not respond to the needs of the grid. The second challenge is transport – electricity requires significant, costly and material-rich infrastructure to transport it over long distances. This traditionally creates a barrier to building large-scale solar or wind farms in deserts or offshore, where sun and wind are in abundance, and then transporting the electricity over long distances to the point of need.

Storing renewable energy

However, Sulzer has been developing solutions to these two issues in collaboration with its customers. For example, Sulzer is supporting a ground-breaking offshore energy storage project from FLASC power, a renewable energy company based in the Netherlands. FLASC's vision is to store renewable energy where it is produced and deliver it later to consumers to meet peak demand times, thereby turning an intermittent renewable resource into a predictable source of clean energy.

Sulzer is delivering a customized solution that stores the renewable energy in the form of high-pressure air and water, to be released on demand. In essence, water is pumped into multiple vessels that contain air, causing the air pressure to increase. This pumping process is repeated until the vessels are filled with a mixture of air at extremely high pressure and water. When the energy is required by the grid, the water is released at high speeds through a hydraulic turbine, generating electricity for delivery to the grid.

The main components of this system are the pumps and hydraulic turbines that are used to pressurize the air, capturing, storing, and then releasing the generated energy. Sulzer locations around the world have been working to develop a highly specialized package of products that can be connected together to deliver a scalable platform that is both energy-efficient and cost-effective, enabling FLASC to deliver on its vision of a reliable supply of clean energy.

Decarbonizing shipping with green methanol

Additionally, as an alternative method of storage for renewable energy, Sulzer is supporting European Energy with the construction of the world's first large-scale commercial e-methanol plant. European Energy is applying an innovative process to convert renewable electricity from solar panels or wind turbines, among others, into another form of energy that is easier to store, namely e-methanol. The plant in Kassø, Aabenraa, located in the southern part of Denmark, will be supplied with power from the adjacent 300 MW solar park owned by European Energy. It represents the first step in bringing this e-fuel to market at scale to support the maritime and road transportation industries as well as the chemical sector.

Traditionally, methanol was produced by gasifying natural gas and coal. Alternative renewable energy-to-methanol conversion processes have been extensively researched in recent years due to the traditional methanol production process's high carbon footprint.

Using its global leadership and expertise in separation and mixing technology, Sulzer will deliver two custom-design distillation units to European Energy's cutting-edge facility. These will play an essential role in the plant's ability to produce e-methanol of extremely high purity for use in combustion engines and as a chemical feedstock, for example to produce plastic while requiring minimal energy input.

This innovative facility will help to progress the decarbonization of the global freight industry by producing 32'000 metric tonnes of carbon-neutral hydrocarbon-based fuels per year. Half of the total plant output, 16'000 metric tonnes per annum, will be delivered to A. P. Moller-Maersk to fuel the company's first container ship capable of operating on green methanol. The 172 m (564 ft)-long feeder vessel will be able to hold over two thousand 6m (20 ft equivalent) container units and will sail in Northern Europe.

With its high energy density along with its transportability thanks to its low weight, e-methanol provides a simultaneous solution to the two challenges faced by renewable energy – how to store the produced energy for later use, and how to transport the energy from the renewable installations to the point of need.

1) International Energy Agency: Global energy review 2021

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