Baker Hughes

The coming transition:

A blueprint for navigating the next 30 years in the energy industry

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The seeds of an energy reinvention

"The energy industry has been built on invention," says Baker Hughes Chairman and CEO Lorenzo Simonelli. "But it's also built on reinvention."

The history of the modern energy industry reveals how our system is based upon a series of new creations and transitions. For example, when Thomas Savery perfected the first commercially available steam engine in the late 18th century, his invention stoked demand for coal. But just as importantly, it also revolutionized the way coal was produced. Savery's machine provided a way to pump water from the depths of mines, ensuring coal would replace biomass to become the dominant fuel of the Industrial Revolution.

A hundred years later oil became ascendent. The development of a casing shoe by Reuben C. Baker and the invention of the Hughes rock bit by Howard Hughes, Sr. revolutionized the exploration of the subsurface and brought about the means to drill through solid rock. Together these new technologies from the early forerunners of Baker Hughes helped make oil the dominant fuel source of the 20th century.

Energy transitions like the one from biomass to coal and coal to oil are generally marked by technology innovation, but they also fuel human prosperity and well-being by providing the affordable energy that drives sustained economic growth. In fact, one could argue the modern world is built on energy transitions.

But transitions are not simply about moving from one dominant form of energy to another. They are also about technologies that unleash new ways of using energy. For example, in the 1850s, mathematics professor Eugenio Barsanti and engineer Felice Matteucci discovered a way to exploit the expansion of a gaseous mix of hydrogen and atmospheric air to develop an internal combustion engine. Only a few years later an employee at the company Fonderia del Pignone, Pietro Benini, used the principles laid out by Barsanti and Matteucci to build a free piston engine powerful enough to replace the steam engines that powered the first wave of the industrial revolution. The engine showed that a transition takes more than just access to a new energy source. It takes technologies that can make the most of the energy sources available.

A reinvention unlike any other

Today, we are living through yet another energy transition that will profoundly change how we move, build and live in the world around us.

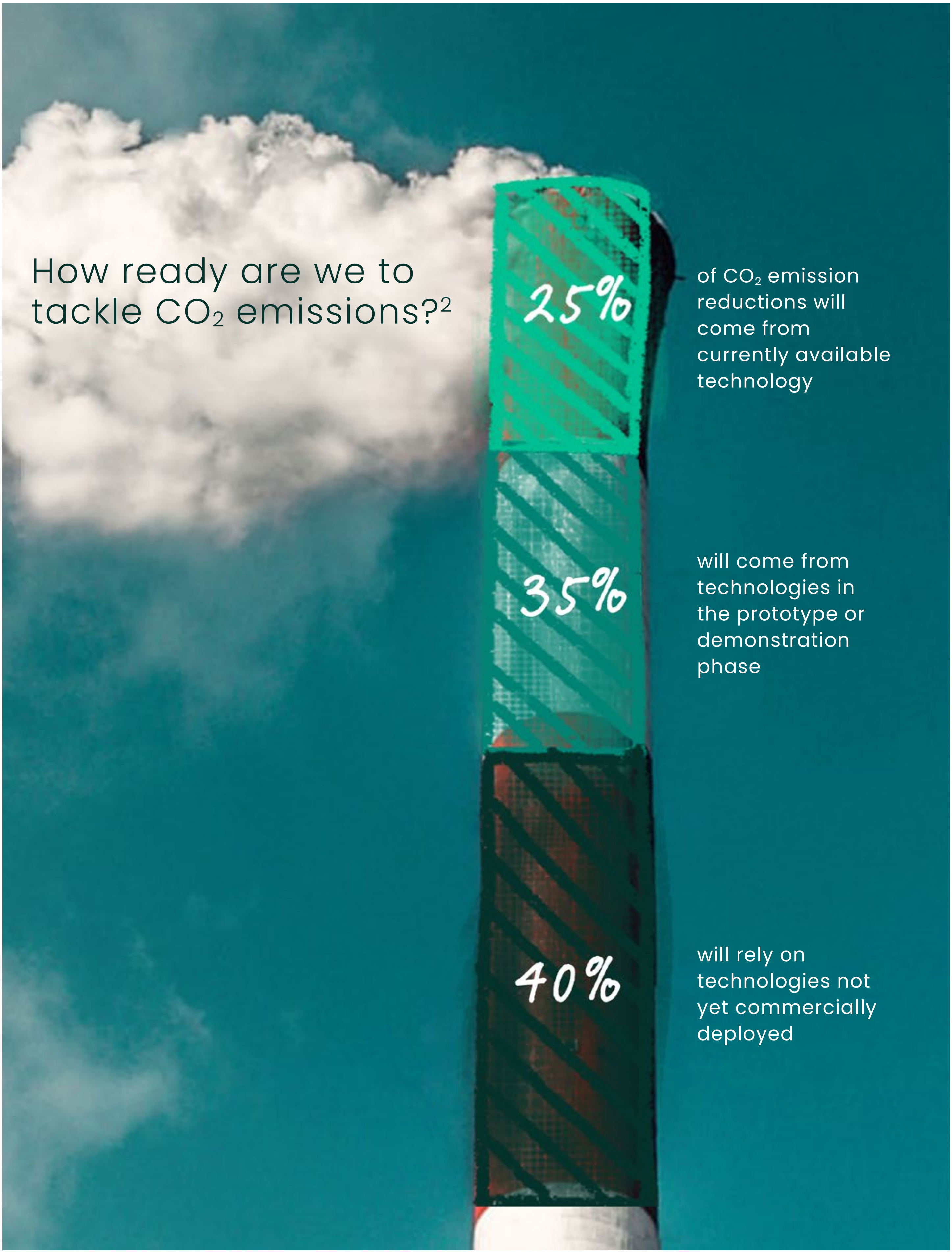
However, the transition we face today requires maintaining a supply of reliable, affordable energy for the global population while simultaneously combatting climate change by reducing the world's carbon emissions. The International Energy Agency's (IEA) Sustainable Development Scenario has laid out a path to holding global temperature rise below 1.8°C, but it requires global CO_2 emissions from the energy sector and industrial processes to fall from 35.8 billion tons in 2019 to less than 10 billion tons by 2050, and then reach net-zero emissions by 2070.[1]

Baker Hughes is aligned to the 1.5°C warming reduction goals of the Paris Agreement. We undeniably have a long way to go, and that's even before we account for the growing global energy demand driven by industrializing emerging economies. The energy industry must ask itself: "How will we meet both the world's demands for energy and also its demands from energy?" People need energy to fuel human progress, but they are also expecting more from energy, which requires technology and innovation to make the production of it cleaner, more sustainable and more efficient.

This change will require nothing less than the boldest reinvention the energy industry has ever undertaken. While existing trends, like the growth of renewables, will certainly play a major role in the current transition, we will need to look beyond both current trends and historical examples to understand how we can bring about the next energy transition.

And we will have to confront some truths many people have ignored.

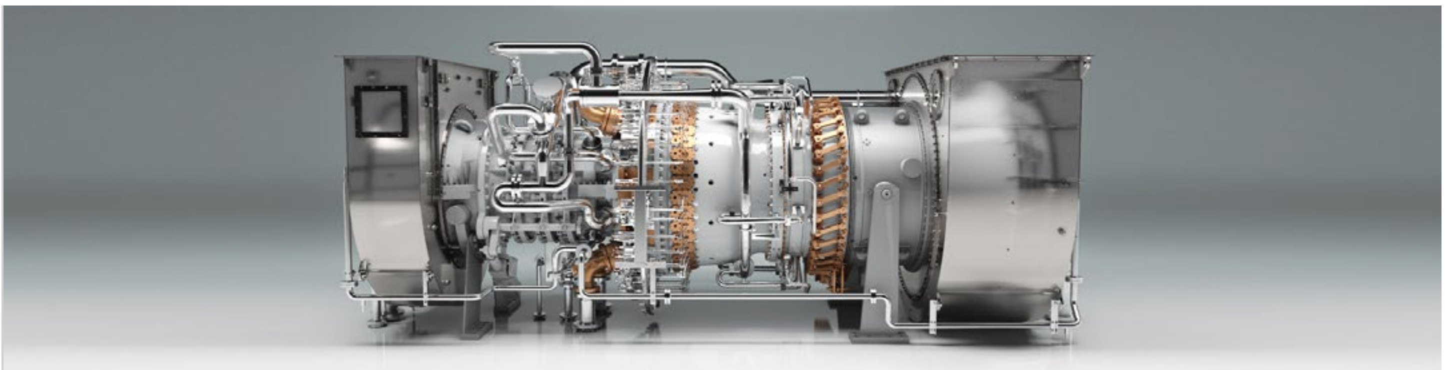
How ready are we to tackle CO_2 emissions?[2]



Facing hard truths

Reinventing the global energy system requires being clear about where we are today and our ambitions.

First, while many people expect that alternative energy will completely replace carbon-intensive fuel sources like oil and gas, we should be clear that there is no realistic scenario where hydrocarbons totally disappear by 2050. Even in the most aggressive of energy transition scenarios, hydrocarbons continue to be part of the energy mix for decades to come.



Second, without major acceleration of technological development, it is unlikely the industry will meet net-zero targets. Technologies in use today may be able to deliver a large amount of emission reductions, even when applied to our current energy mix, but they are insufficient on their own. Producers must adopt a dual strategy that curbs emissions by simultaneously implementing efficiency measures today while investing in long-term research to develop promising zero carbon energy solutions for the future.

Third, this dual strategy will not succeed without collaboration and a variety of cross-cutting expertise from multiple sectors. As an industry we're moving to a future characterized by complexity, efficiency and diversity, but no single player will be able to arrive there alone. While rugged individuals like Savery, Baker and Hughes are lionized by history, the future of energy will depend on collaborations and partnerships. It will take the combined efforts and expertise of energy producers, energy technology companies, energy buyers, industrial energy consumers, non-governmental organizations (NGOs), policy makers and the community at large working closely together to achieve our collective ambitions.

The first wave of change:

Evolution before revolution in emissions

So, what do the very first steps toward the world's next energy transition look like? Waiting for revolutionary changes is not an option, and given that hydrocarbons continue to be key, we must utilize the existing knowledge energy technology companies to make current sources of energy less carbon intensive.

"The fact is, we're already supporting a range of solutions that can help our current customers go in the direction of net-zero emissions," says Allyson Anderson Book, vice president of energy transition at Baker Hughes. "The goal of net zero is now part of the overall efficiency paradigm."

For example, if today's oil and gas operations were 10% more efficient, we would save ~0.5 Gt CO_2 equivalent per year.[3] Upgrading turbomachinery fleets across existing oil and gas and power generation applications including in pipeline, offshore and LNG, can also achieve new levels of operational efficiency and emissions reduction. Experts estimate that a 2.5 percentage point efficiency gains in CO_2 emission reductions could be achieved with just 1% efficiency gains from gas turbines.[4]

Leaning into these types of efficient solutions is at the core of reducing emissions from energy operations. All options – technological or otherwise – should be considered in an attempt to make current operations run cleaner and more efficiently. Even plant upgrades with simply new parts, or the application of existing solutions that reduce emissions at the source of production, can have a significant effect on emissions, and these gains can deliver outsized benefits.

How? By focusing on more efficient production that reduces scope 1 and 2 emissions right now, energy producers can signal their commitment to making progress today, rather than waiting for the mainstream commercialization of alternative, lower carbon energy sources like hydrogen. They can also realize faster returns on investment and lower average abatement costs compared to more significant technology advancements required for new energy sources. And because oil and gas will continue to be essential parts of the global energy mix, making investments in efficiency solutions as soon as possible increases the benefits.

1st wave

Now is the time for quick wins

Many oil and gas companies have recently set their own ambitious emission reduction targets. Upgrading to high-efficiency technology and equipment, as well as managing venting, flaring and fugitive emissions, will be critical for meeting these goals.

In the case of methane, which is approximately 30 times more potent than carbon dioxide at trapping heat in the earth's atmosphere, managing leaks from venting and fugitives is one of the fastest and most effective ways to slow the rate of warming, yet remains a major challenge for many operators.

One of the most cost-effective ways to manage methane emissions is through better monitoring and management solutions – including both aerial and land-based monitoring solutions. Baker Hughes has implemented a number of effective solutions, for example in the Permian Basin, where land-based methane emissions remain high. Our advanced emission management solutions use computer vision algorithms to efficiently and accurately provide detection and quantification of methane emissions at scale.

In addition, operators can look to upgrade equipment where venting occurs. Some of the biggest opportunities to reduce or eliminate methane venting are derived from the equipment and processes connected to pneumatic controls and compressor seal venting. Installing advanced equipment like no-bleed valves and transitioning to low-emission centrifugal compressors, for example, can improve operational efficiency and have a significant impact on overall emissions.

Reducing flaring also remains a significant opportunity for industry to deliver material reductions in the emission of methane and other greenhouse gases. Approximately 145 billion cubic meters of gas per year are flared in operations around the world, accounting for 2% of total global methane emissions from oil and gas production.[5] Improved flaring can cut up to 12,100 metric tons of CO_2 equivalent emissions per flare annually. Existing flare optimization solutions cut methane emissions and can also be part of flare gas recovery solutions to generate high-efficiency power.
Oil and gas companies have an opportunity to demonstrate today that they are actively taking steps to reduce carbon emissions. The ability of oil and gas industry leaders to proactively attract investors, financing and top talent will increasingly depend on being seen as a leader in decarbonization efforts.

Flare solutions can cut methane emissions while also helping to generate high-efficiency power

40%

lower NOx emissions from the LM9000 gas turbine compared to competing technology[6]

Baker Hughes advanced energy technologies are helping to create a path to a net-zero future

The second wave:

Carbon abatement reaches scale

While there are many technologies currently available that can help manage emissions through efficiency, without major acceleration of technological development and deployment society will fail to meet net-zero targets. Technologies in use today can get us part of the way there, but not all the way. That's why the second phase of any energy transition must involve scaling up breakthrough technologies.

According to IEA, roughly 25% of the cumulative CO_2 emissions reductions necessary to move the world to net-zero emissions will come from existing technologies, while another 40% will come from early-stage technology, and 35% will come from technologies in the prototype or demonstration stages today.[7]

Because the energy mix of the future will still include all energy resources available today, early-stage technologies like carbon capture, utilization and storage (CCUS) will be an important emission-reduction solution. In fact, CCUS has the potential to transform natural gas into a net-zero solution for reliable, affordable power.

There is also great potential beyond gas. If developed and utilized correctly, carbon capture has the potential to mitigate up to 50% of the world's CO_2 emissions, according to Zero Emissions Platform (ZEP), the European Union's technical adviser on carbon capture and storage.[8] The ZEP calculates that we will eventually have the ability to capture up to 90% of CO_2 emissions from power plants, heavy industry and refineries – the heaviest emitters and the hardest sectors of our global economy to abate. But to realize these forecasts, operators will need to adopt an integrated suite of technologies to capture, process, store and monitor CO_2 emissions produced from natural gas first.

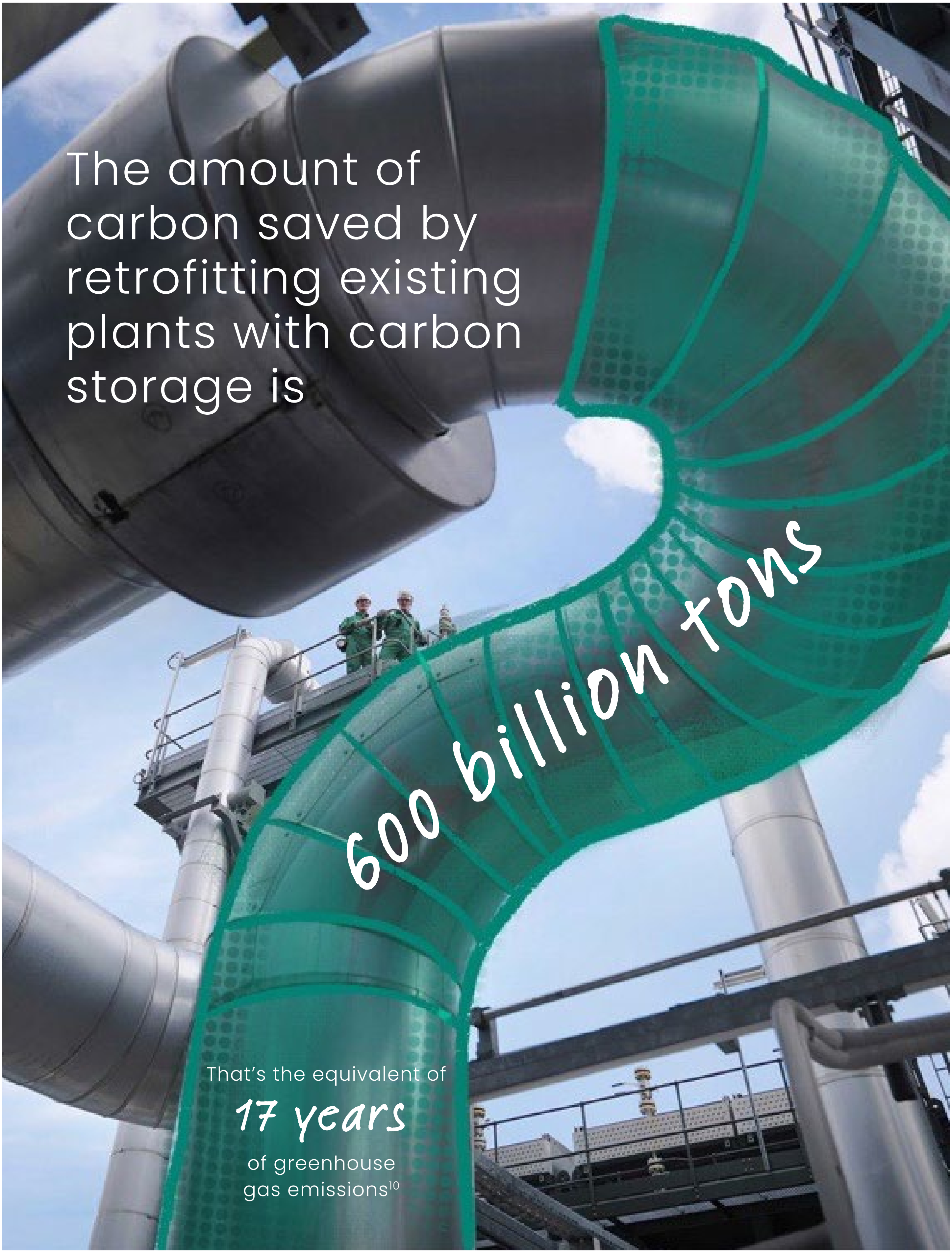
That's one reason why Baker Hughes is investing in a variety of new CCUS solutions to cover a variety of application needs, such as compact capture and mixed salt process technology. This continued investment in the development and industrialization of innovative technology plays a key role in ensuring that new energy frontiers such as CCUS are cost-competitive and sustainable once the market reaches maturity.

2nd wave

Meeting the Paris Agreement goals will require 2.35 billion tons of installed CCUS capacity by 2040.[9] The reason the world will need so much capacity is, in addition to CCUS' association with hydrocarbons, it will also play an important role in the development and adoption of highly anticipated newcomers in the global energy supply, like hydrogen. Blue hydrogen, made from natural gas through the process of steam methane reforming (SMR), will lean heavily on carbon capture technology. Because blue hydrogen involves splitting natural gas to get hydrogen and then letting the carbon go, the process does little to get the world to net-zero carbon emissions without carbon capture and storage.

"CCUS is starting to cross the line of demonstration and going towards the commercial side of things," says Luca Rossi, vice president of commercial, new frontiers at Baker Hughes. "We already have our technology in large-scale CCUS projects and are actively discussing new projects with customers. It's become an important part of operators' thinking through potential carbon solutions. There's still a lot of potential, but things are really developing at a faster pace thanks to policy incentives and pressures."

The key to unleashing the wide potential of carbon capture and storage lies in developing clear regulatory frameworks for its development and deployment. Flexible policy will help reduce the investment risk, allowing for the acceleration of the deployment cycle of new CCUS solutions. Given CCUS' importance to maintaining a diverse energy mix, strong signals from policy makers regarding carbon capture are a crucial midterm development in the current energy transition.



The amount of carbon saved by retrofitting existing plants with carbon storage is

600 billion tons

That's the equivalent of

17 years

of greenhouse gas emissions[10]

The third wave:

Arriving at a diverse energy mix

A true energy transition won't happen overnight, but a commitment on the part of regulators, operators, communities and energy technology companies will eventually move the needle so that the most carbon-intensive forms of energy achieving net-zero emissions by 2050.

But emerging sources of energy will take time to develop, and even the most promising sources of energy will not be a panacea. Instead, these new energies will eventually become additional puzzle pieces to the energy mix that together form a complete, decarbonized mosaic.

A good example is hydrogen. While it has undisputed potential, there are several steps required before it matures into a major part of the new energy mix. Hydrogen has already shown its potential as a reliable fuel source. Hydrogen is already widely used in some parts of the economy, particularly in oil refining as well as steel, ammonia, and methanol production. Currently all the hydrogen used in these industries is supplied from hydrocarbons, so there is still large potential to reduce emissions by adopting hydrogen from cleaner sources or by applying carbon capture technologies.

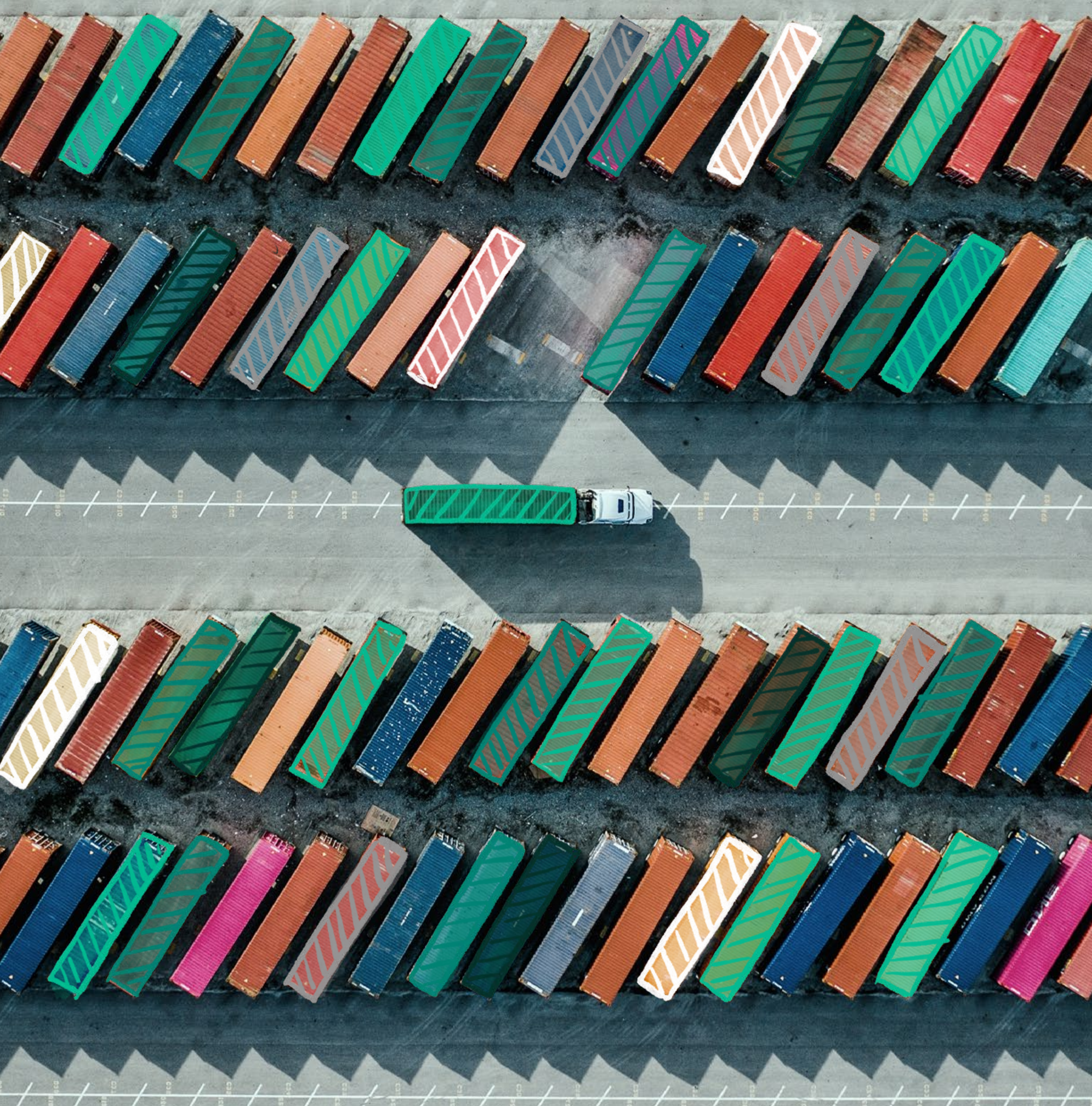
It is also a promising energy storage solution, with potential to be the lowest cost option for short and medium-term storage of energy generated by renewables. This also means hydrogen has the potential to allow for the transportation of renewable energy over long distances from regions with abundant solar and wind resources. And hydrogen can be used to drive turbines to generate electricity. Baker Hughes and SNAM have recently tested a gas turbine that will burn 10% hydrogen in a mixture of natural gas and hydrogen, and Baker Hughes has a turbine that can run on 100% hydrogen.[11]

"There's a lot of interest today in the potential of hydrogen, so many people are talking about it," says Rod Christie, executive vice president of turbomachinery & process solutions at Baker Hughes. "But right now, the technology is not at the scale where you can justify a real transition from hydrocarbons to hydrogen. And it's not just about the status of CCUS, it's also about regulation."

The same applies even more to other potential uses of hydrogen, including commercial transportation in trucks,

3rd wave

ships and rail, as well as high-end heating requirements. That's because infrastructure either needs to be newly developed or adapted to support hydrogen. Nevertheless, experts estimate that hydrogen could potentially meet 18% of global energy needs by 2050, but it will require investment, advancing technology and stimulating policy to achieve this goal.[12]



From here to the future

There is no path to a decarbonized energy future, either in the short term or the long term, without a sense of collaboration. It will take the collective efforts of energy producers, buyers, policy makers, service providers and the community at large to develop the solutions that will fundamentally transform our energy systems.

Together the industry's collective expertise, abilities and technologies can achieve the type of change required to realize a carbon-neutral future. To get there we will need to focus on achieving the highest-efficiency solutions right now while advancing the path to lower carbon energy future in the mid and long term. By leveraging the expertise of the people who know energy, we have the power to change it for the better.

Source Information:

[1] International Energy Agency, "Sustainable Development Scenario"

[2] International Energy Agency, "Global energy sector CO_2 emissions reductions by current technology readiness category in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2019-2070

[3] IEA report "The Oil and Gas industry in Energy Transitions" and IEA World Energy Outlook

[4] Baker Hughes internal analysis

[5] World Bank, Press Release No: 2019 2019/EEX/200, https://www.worldbank.org/en/news/press-release/2019/06/12/increased-shale-oil-production-and-political-conflict-contribute-to-increase-in-global-gas-flaring

[6] Baker Hughes - https://www.bakerhughes.com/company/news/baker-hughes-lm9000-confirmed-worlds-most-efficient-simple-cycle-gas-turbine-after

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[8] https://www.youtube.com/watch?v=aHtbDmzjYgg

[9] Baker Hughes, "More energy, less carbon: how CCUS is critical to our energy future"

[10] International Energy Agency, "CCUS in clean-energy transitions"

[11] https://www.iea.org/reports/the-future-of-hydrogen

[12] https://hydrogencouncil.com/en/study-hydrogen-scaling-up/

Endnotes