



# THE INDUSTRY CHALLENGE:

ACHIEVING SUSTAINABILITY  
WITHOUT SACRIFICING  
BUSINESS PERFORMANCE

**SHELL  
LUBRICANT  
SOLUTIONS**



# DOES SUSTAINABILITY ALWAYS MEAN A COMPROMISE FOR YOUR BOTTOM LINE?

While society faces a dual challenge - how to transition to a lower-carbon future to tackle climate change, while extending the benefits of energy and socio-economic development to everyone on the planet – business leaders face their own distinct dilemma.

Today, a question partners frequently ask us is: how can we balance our immediate obligation to the balance sheet, with the responsibility to reduce operational carbon emissions?

It's a universal tension that a recent study of global CEOs put into sharp focus. While 99% believe sustainability will be important to future success, 55% admit pressure to operate with extreme cost-consciousness against investing in longer-term strategy is a trade-off.<sup>1</sup>

While putting planet and profit in the same sentence can feel jarring, the two need not be

mutually exclusive. In fact, consumers (73%) believe a company can take actions that both increase profits and improve conditions in the communities in which it operates.<sup>2</sup>

But where and how to begin? From regulations to customer demands, and employee activism to industry targets, the pressure to find time, expertise and budget to implement sustainable operations can be overwhelming.

Some larger businesses may have the advantage of a Chief Sustainability Officer but, for many, responsibility falls to existing senior leaders to 'learn on the job', in an arena where missteps can be costly to reputation and the bottom line. It is worth noting that even in those businesses where a sustainability manager exists, many will not understand the difference certain practices and products, such as lubricants, can make.

In every area, the immediate priority is the resulting cost but actually the bottom line can and does benefit. Business leaders are seeing sustainability drive competitive advantage – 40% report business value through revenue growth, 37% through risk mitigation and 25% through cost reduction.<sup>3</sup>

Demands on B2B companies have intensified, as interest in sustainability makes its way upstream in the value chain, and 53% of B2B leaders now believe sustainability will drive their revenue growth over the next five to ten years.<sup>4</sup>

Satisfying commercial or societal obligations is no longer a binary choice. In fact, neither can be achieved without the other, and it is only those organisations that embed sustainability into business strategy that will be fit for the future.

In this paper, we will start to explore the four key areas business leaders should be looking to prioritise as part of their sustainability efforts moving forward and highlight how these changes will affect

business. Waste management, CO<sub>2</sub> reduction, post-consumer products and biodegradables all hold incredible potential to reduce environmental impact in industrial settings. All while increasing operational efficiency and protecting bottom lines.



**Troy Chapman**

General Manager, Global Marketing B2B & OEM Lubricants at Shell Lubricants

## WHAT INDUSTRY CARES ABOUT

Tapping into partners with expertise can help unlock a route map. What we hear from our own partners across diverse industries are shared challenges, and common pressures and demands from their customers, in four key areas:



### WASTE

reducing and managing waste to ease operational and economic hurdles tops sustainability priorities across industries



### CO<sub>2</sub> REDUCTION

driving energy efficiencies and reducing the carbon footprint of operations



### POST-CONSUMER PRODUCTS

recycling and re-purposing products for industry needs



### BIODEGRADABLES

using new biodegradable lubricants and greases that won't remain in the environment for extended periods like their non-biodegradable counterparts in the case of spills



# MANAGING WASTE EFFECTIVELY

Waste is both an operational and economic reality for industry. Waste management requires careful planning, investment, and a constant awareness of current and upcoming legislation. It is therefore unsurprising that cradle-to-grave waste management is one of the most sought-after sustainability offerings for businesses. However, innovation in this area has led to an abundance of methods to improve waste management processes and protect business from increasingly stricter legal waste requirements. Reducing packaging waste to improve sustainability.



## REDUCING PACKAGING WASTE TO IMPROVE SUSTAINABILITY

Companies employ a variety of different methods to reduce packaging waste, such as redesigning existing packaging and ensuring new designs are environmentally friendly. One widely used strategy is 'lightweighting'. Lightweighting involves reducing the size and weight of packaging to lessen the weight of a transport shipment, thus lowering its carbon footprint.<sup>5</sup>

Research has found that a 10% reduction in packaging weight will result in a transportation fuel reduction ranging from 2% to 8.4%.<sup>6</sup> Globally, container lightweighting can reduce energy demand by 3.6 Exajoules and greenhouse gas emissions by 300 million tonnes CO<sub>2</sub>e over a 15-year lifetime.<sup>7</sup> Lightweighting has also gained favour for economic reasons, in addition to the ecological values it promotes as a responsible packaging practice. Reduced costs are made possible by lower material consumption and greater shipping efficiency, which both benefit the environment and increase profitability.<sup>8</sup>

Lightweighting is not the only cost-effective way firms are cutting down on waste, however. Increased part density is the process of optimising space utilisation by shipping more parts in the same amount of space.<sup>9</sup> The automotive industry is a leader in designing packaging to increase part density in containers. Greater part density translates into the need for fewer containers, fewer shipments and, ultimately, transport cost reduction. Companies with wide supply chains may also benefit from increasing part density of the materials provided to them, as rearranging the product packaging style can minimise the demand for boxes and other containers.

**RESEARCH HAS FOUND THAT A 10% REDUCTION IN PACKAGING WEIGHT WILL RESULT IN A TRANSPORTATION FUEL REDUCTION RANGING FROM 2% TO 8.4%**



## UNDERSTANDING LIFE CYCLE THINKING

'Life cycle thinking' considers the environmental impact a product will have throughout its lifetime. By considering the end-to-end life cycle of a product, businesses aim to reduce its overall environmental impact. However, this can involve certain trade-offs, lessening the impact at different stages. For example, in order to produce a product that is recyclable at the end of its life, a more energy intensive manufacturing process might have been required to create it. Care must be taken to avoid simply shifting the environmental impact of a product from one stage to another.

Those across a broad range of industries must not just consider the environmental credentials of the oils and lubricants they buy, but also the energy efficiency of their operations. If the CO<sub>2</sub> footprint of a fuel economy or energy efficiency lubricant for trucks or machines is slightly higher than a standard lubricant, but causes a truck or piece of machinery to run more efficiently, the impact it has on the environment by the end of its lifecycle will be better than the standard lubricant alternative.

This also ties in with circular economy thinking. A circular economy aims to create a world in which nothing is ever wasted, because everything is designed to either last longer or be reused, repurposed, or recycled. It is based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems<sup>10</sup>

## THE PRODUCT LIFE CYCLE



## MEETING REGULATORY REQUIREMENTS

Around the globe, governing bodies are writing waste management requirements into law. The EU has stringent rules covering waste from electronic manufacturers<sup>11</sup>, China has imposed a 'Solid Waste Law'<sup>12</sup> and the US has a significant amount of legislation covering the disposal of different industrial waste materials.<sup>13</sup> Ultimately, businesses must be stringent with their own internal waste management structures to ensure they protect themselves from legal action.

Waste oil is a particularly difficult area for industry. Different types of oils have their own disposal specification and many businesses lack knowledge of how to deal with multiple oils effectively. Bridging this gap is critical, as improperly disposing of waste oil can create contamination and cause damage to the surface of ground soil.<sup>14</sup>

To counteract this, the risks associated with oil spills from machinery in industry can be reduced by:



- Having an in-house oil clean up team that can deal with spills swiftly



- Using spill kit materials to block flow and prevent storm drain discharge



- Applying absorbent to control the spill



- Utilising biodegradable lubricants to reduce the potential impact of spills in environmentally sensitive areas



## WHAT THIS MEANS FOR BUSINESS



Waste management needs to be an essential part of any business operation. Practices such as lightweighting and increasing part density have the potential to both improve bottom lines and decrease waste, showing sustainability does not need to compromise performance. Similarly, life cycle thinking – including considering how a product is disposed of before designing it – can lead to a huge reduction in environmental impact.

On the other hand, the mismanagement of waste oil and other hazardous materials can lead to fines and risk posing damage to the environment, a business's reputation, employees, and customers. Fortunately, there are several ways a business can protect itself and mitigate these risks, and prioritising waste management is an effective first step.

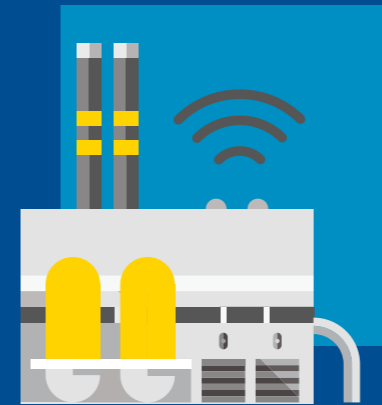
# WORKING WITH CO<sub>2</sub>

In several markets around the world, governments, investors and consumers are pushing industry to act to address climate change, reduce carbon emissions and become more energy and resource efficient. While the appetite to reduce emissions is there, many businesses do not have the resources required to implement sweeping changes to their operations.

However, there are several ways to increase the efficiency of operations and reduce carbon output that have a positive impact on business performance and finances. In fact, innovations that have occurred in the last decade can reduce carbon footprints and support productivity. From new technologies to nature-based solutions and carbon credits, businesses are able to radically reduce their environmental impact, without risking their bottom line.

## USING NEW TECHNOLOGY TO IMPROVE PRODUCTIVITY AND OPERATE SUSTAINABLY

Lubricants that increase the fuel efficiency of machines can lower the carbon footprint of those industries where intensive machinery use is required. Growing demand for lower emissions and cost reductions has seen the development of more advanced engine and machinery system designs. These high-efficiency machines need similarly effective lubricants, that can deliver high thermal and pressure stability, to ensure performance under testing conditions. In fact, modern engines are also becoming smaller and more intricate, and are therefore more susceptible to damage. This makes high-quality lubrication ever more important as these machines need comprehensive protection to avoid breakdown.



## SMART FACTORIES:

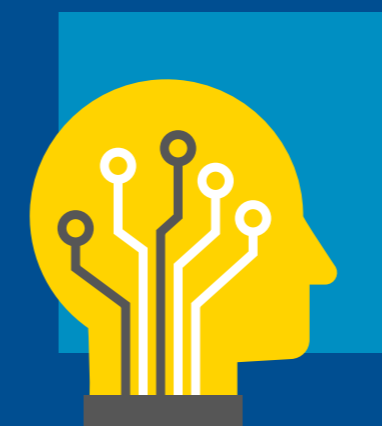
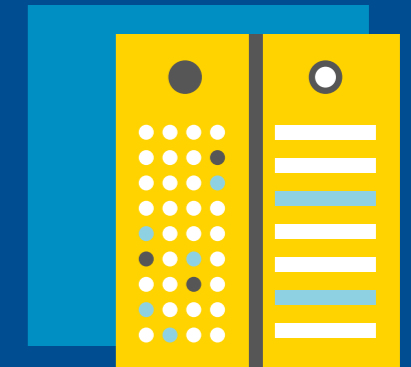
Within a 'smart factory', technological advances allow for remote monitoring, maintenance and servicing as well as communication between different machines enabling businesses to make data-driven decisions. Rapid advancement in internet capability is enabling a wider implementation of the Internet of Things (IoT) technology in industry, to help businesses run their operations in a smarter, more sustainable way.

The IoT is the name given to any system of devices connected to the internet that can send or receive data between themselves without any human interference. The IoT allows real time communication between machines. This means no machine must work above or below its necessary capacity in the context of a business's entire operation. The IoT therefore holds an abundance of opportunities for increasing output.

Advances in the realm of smart factories can power the potential to increase productivity, boost operational efficiency and lower CO<sub>2</sub> output. They can also allow for early identification of maintenance problems, including routine changes to fuel, oils, and lubrication. By identifying maintenance issues early, particularly those that hamper the energy efficiency of a piece of machinery, CO<sub>2</sub> emissions can be reduced while supporting operations.

## BIG DATA:

Research from IBM suggests that there is 300 times more data in the world today than there was in 2005.<sup>15</sup> A substantial amount of data provides the opportunity to analyse the outputs of machinery and industrial processes, focusing on specific ways to optimise the operations of industrial firms. For example, having machinery data fed to an operations manager in real-time allows that manager to minimise idle time and to predict – and prevent – instances where equipment may run less sustainably. A data-driven approach also enables the optimisation of loads, so jobs run as efficiently as possible and don't cause excess CO<sub>2</sub> emissions to be produced.



## MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE:

Machine learning and artificial intelligence can help collect and then process these vast amounts of operational data mentioned above, adapting recommendations in real-time to help improve equipment performance.

The growth of digitalisation in industry has made maintenance more crucial than ever, as machines must be running at peak performance. Only through connected technologies, such as IoT sensors, and with premium lubrication tailored to each subsystem, can operators reach and maintain the highest levels of efficiency and productivity.

## EMPLOYING NATURE-BASED SOLUTIONS

Direct CO<sub>2</sub> reduction often comes in the form of offsetting through the purchase of carbon credits. These credits can be traded, or purchased from projects that help to absorb CO<sub>2</sub> from the atmosphere, known as nature-based solutions (NBS).

NBS projects protect and restore natural ecosystems so that nature can absorb more CO<sub>2</sub> from the atmosphere.<sup>16</sup> One carbon credit represents the avoidance or removal of one tonne of CO<sub>2</sub> from the atmosphere. These carbon credits are marketed, traded, and bought as a way to help compensate for emissions. In several countries, businesses are required to submit reports detailing their emissions. In the UK for example, big businesses are required under law to submit their annual emissions, including the number of carbon credits they have bought or sold.<sup>17</sup>

NBS can be a positive way for companies that are not yet in a position to provide a significant upfront cost to digitise their entire operation to lower their carbon footprint. However, companies should be focusing on avoiding and reducing emissions wherever possible before offsetting. NBS is a solution in addition to pursuing robust decarbonisation strategies.

**NATURE-BASED SOLUTIONS CAN BE A POSITIVE WAY FOR COMPANIES THAT ARE NOT YET IN A POSITION TO PROVIDE A SIGNIFICANT UPFRONT COST TO DIGITISE THEIR ENTIRE OPERATION TO LOWER THEIR CARBON FOOTPRINT.**

**NEW TECHNOLOGY AND INNOVATION TO INCREASE PRODUCTIVITY AND DRIVE DOWN CO<sub>2</sub> EMISSIONS IS WITHIN THE REACH OF EVERY BUSINESS, BIG OR SMALL.**



## WHAT THIS MEANS FOR BUSINESS

From digital applications that allow remote monitoring of machines to NBS which offset emissions using carbon credits, there are several ways industries are reducing their carbon footprint. New technology and innovations to increase productivity and drive down CO<sub>2</sub> emissions, such as big data and the IOT, is within the reach of every business, big or small. Importantly, this can be done in a way that protects bottom lines and does not require extremely high upfront costs.



# THE POTENTIAL OF POST-CONSUMER WASTE

Once a material or finished product has served its intended use and has been diverted or recovered from waste destined for disposal, it is then considered 'post-consumer'. Many industrial companies recycle their materials but do not see the benefit of where they go. Regenerated oil is one example of waste that can be recycled from an industrial setting and utilised in other places.

## THE POTENTIAL FOR RECYCLED OIL

Oil recycling makes environmental and economic sense. The manufacture of lubricating oil is the most energy-intensive process in a crude oil refinery, and used lubricating oils are often burned in industrial or commercial boilers, releasing multiple pollutants including carbon dioxide. However, new technology means that the base oil of a lubricant can be re-refined to remove water, contaminants and additives. This then enables a base oil, of the same quality as the virgin base oil, to be produced. Lubricants formulated using re-refined base oils in turn can meet the same performance standards as those using virgin base stocks.

Being able to re-refine used lubricants means the world's dependency on raw materials is reduced. This has numerous benefits for sustainability and can also make economic sense for a business. Furthermore, the recycling of used lubricants is a significant step in the right direction for a circular economy; the more demand there is for re-refined lubricants, the more industrial processes will work within the principles of a circular economy.

Regenerated oil and re-refined oil are two different things. Re-refined oil, as discussed above, is oil that can be re-used as a virgin base oil to create lubricants. Regenerated oil, however, can be taken untreated and reused for other purposes. Regenerated oil can be turned into a number of things:

- Industrial burner oil (where the used oil is dewatered, filtered and demineralised for use in industrial burners)
- Mould oil to help release products from their moulds (e.g. pressed metal products, concrete)
- Hydraulic oil for selected hydraulic applications
- Bitumen based products
- An additive in manufactured products
- Incorporated into other products or refined back into new lubricating oil



## PARTNERING FOR PROGRESS

Products that have already been used in the market and repurposed for industry needs are a compelling selling point for sustainability. Post-consumer waste products like regenerated oil and plastic can solve consumer needs and, in the long-term, suppliers will start looking to provide recycled oil alternatives back to industry. Innovative businesses are coming to the fore to provide solutions for industry, however, without the willingness of those industrial business leaders to partner and power this progress, the solutions will only go so far.



## WHAT THIS MEANS FOR BUSINESS

Steel and aluminium stand out as industries that have successfully developed their manufacturing processes to incorporate large quantities of post-consumer recycled materials.<sup>19</sup> Aluminium cans can contain a high percentage of recycled content, while many products made with steel contain at least a quarter reclaimed and recycled steel.<sup>20</sup> The value of steel and aluminium to industry consistently guarantees that they are worthwhile components of kerbside recycling programmes.

Other companies, including Shell, are utilising plastic waste by turning it back into the chemicals it is made up from.<sup>21</sup> In fact, Shell's own ambition is to use one million tons of plastic waste in our chemicals plants by 2025.<sup>22</sup> The technique, known as pyrolysis, is considered a breakthrough for hard-to-recycle plastics and several companies are hoping to scale this solution to industrial and profitable quantities.

# REACHING FULL POWER WITH BIODEGRADABLES

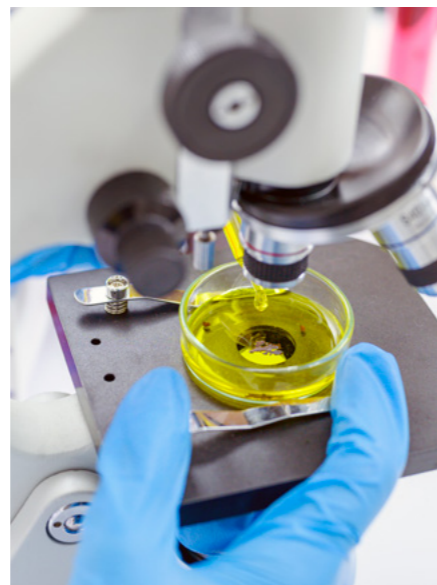
Biodegradable lubricants have the molecular ability to be degraded biologically (i.e. by the action of biological organisms). Significant innovations have occurred in the biodegradables space translating to products suitable for use in environmentally sensitive areas that perform well in industrial settings.



## THE EVOLUTION OF LUBRICANTS

Biodegradable lubricants are either synthetic (man-made) or derive from vegetable oils, and degrade significantly faster than mineral oils such as petroleum, reducing rapidly to components that are more readily broken down by natural micro-organisms. The selection of base fluid is critical for a lubricant or grease's ability to biodegrade. In general, mineral oils tend to be less biodegradable than esters.<sup>23</sup> However, not all esters perform equally, with ester type and branching causing significant variations in biodegradability.

As well as significant reductions in price, an increase in environmental awareness from industry has become a driving force for the advancement of biodegradable lubricants, particularly when machinery is being used in environmentally sensitive areas.<sup>24</sup>



## HOW DO BIODEGRADABLE LUBRICANTS STACK UP?

Biodegradable lubricants made from natural vegetable oils, such as rapeseed or sunflower seed, have come on a long way in the last two to three years. Some challenges do remain, and biodegradable lubricants still need to be monitored in use as their service life can vary compared to mineral oils, depending on the type and

application. However, more innovation in this space could mean synthetic ester-based lubricants can provide extended service life compared to mineral oils, which may go a long way to offset their initial cost.<sup>25</sup>

It is important to consider the performance in use of oils and greases - some of the top-performing, fluids can offer excellent in-use benefits such as greater energy efficiency, which overall make additional contributions to overall life cycle CO<sub>2</sub> reduction.

## WHAT ARE THE PERFORMANCE BENEFITS OF BIODEGRADABLE LUBRICANTS?

Freedom from deposits, oxidation resistance, greater efficiency, reduced equipment maintenance and longer fluid life are the other possible benefits from using alternative lubricant base stocks to mineral oil. Some of the performance advantages include better:

- ✓ Volatility profile
- ✓ Oxidation stability
- ✓ Low deposit forming tendency
- ✓ Viscosity profile
- ✓ Additive responses
- ✓ Ability to perform in severe climates e.g. high or low temperatures<sup>26</sup>



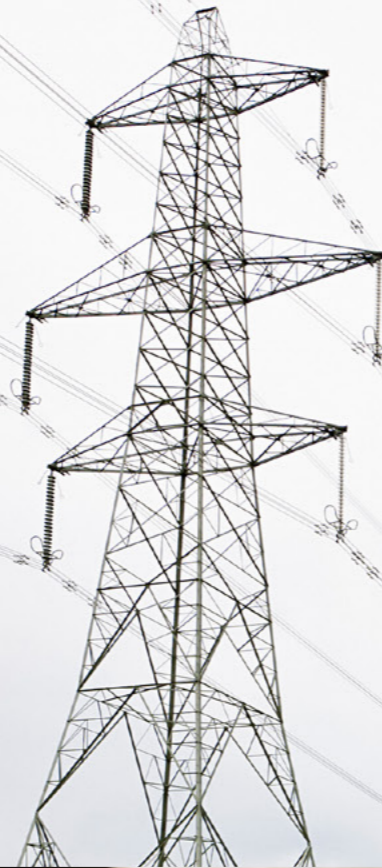


## INDUSTRY APPLICATIONS FOR BIODEGRADABLES

Industry applications for biodegradables are extremely varied, and such fluids are typically used in a range of sectors such as marine, construction, mining, forestry, agriculture, and rail. Biodegradable lubricants are evolving to the point where they can be used in almost every system that a conventional lubricant is traditionally found. At present, biodegradables are particularly relevant in the following applications:

- Total Loss systems (chainsaw lubricants, corrosion preventatives, mould release oils)
- Hydraulics for excavators working in environmentally sensitive sites
- Water pumps and grease applications where accidental or partial release into the environment is unavoidable

More recently, the introduction of smaller, faster and more efficient equipment operating at higher speeds, temperatures, stresses and pressures, has accelerated the trend towards ever greater performance and the need for even better compatibility, which favours higher quality synthetic (biodegradable) lubricants.<sup>27</sup>



## WHAT THIS MEANS FOR BUSINESS



Biodegradable lubricants are less hazardous for the environment and for employees. Issues related to toxicity and hazardous accidental spills of mineral oils made from petroleum are significantly reduced by using these lubricants. This alone can give peace of mind to business leaders from a safety and regulatory perspective. As the technology improves around these lubricants, biodegradables are matching standard lubricants in quality and performance.



# FAQs

## Q WHAT IS THE DIFFERENCE BETWEEN ENERGY EFFICIENCY AND CO<sub>2</sub> REDUCTION?

A Energy efficiency relates to being able to produce more of something while not burning any extra fuel and, therefore, not producing any more CO<sub>2</sub>. CO<sub>2</sub> reduction means physically reducing the amount of CO<sub>2</sub> you produce. This can be done through methods such as carbon capture and storage, the name given to a combination of technologies that captures and stores carbon dioxide deep underground, preventing its release into the atmosphere.

## Q HOW CAN WASTE MANAGEMENT PARTNERSHIPS AND PROGRAMMES SUPPORT MY BUSINESS?

A Waste management partnerships can help lift your business over both an economic and regulatory hurdle as you can ensure waste is being disposed of correctly and effectively without having to drain your own resources in the process.

## Q IS THE PERFORMANCE OF BASE OILS MADE FROM RECYCLED OR POST-CONSUMER SOURCES EQUAL TO THE NON-RECYCLED OILS I USE NOW?

A The performance of many base oils made from recycled or post-consumer sources can actually be equivalent to or better than the oils you use now. Products created with sustainability in mind from the start also work towards reducing your carbon footprint and those that have been regenerated from biodegradable sources are ideal in environmentally sensitive areas.

## Q WHAT ARE NATURE-BASED SOLUTIONS?

A Nature-based solutions are projects which protect, transform or restore land. In this way, nature absorbs more CO<sub>2</sub> emissions from the atmosphere. Such activities can lead to the marketing, trading and sale of carbon credits.

## Q WHAT IS 'INCREASED PART DENSITY' AND HOW IS IT USED TO REDUCE PACKAGING WASTE?

A Increased part density sees firms optimise space utilisation by shipping more parts in the same amount of space. Greater part density translates into the need for fewer containers, fewer shipments, and ultimately, transport cost reduction.

## Q WHAT ARE BIODEGRADABLE OILS MADE FROM?

A Many biodegradable lubricants are made from natural vegetable oils such as rapeseed or sunflower seed oils. However, we are now also seeing a new wave of highly effective biodegradable lubricants made from esters, an organic compound produced by the reaction between an acid and an alcohol.

## Q WHAT SUSTAINABILITY COMMITMENTS HAS SHELL MADE?

A Shell has set itself an ambition to become a 'net-zero emissions energy business' by 2050 or sooner, if possible. We aim to do this in step with society's progress towards the goals of the Paris Agreement. You can find out more about Shell's ambition here: <https://www.shell.com/energy-and-innovation/the-energy-future/shells-ambition-to-be-a-net-zero-emissions-energy-business.html>

## Q WHERE CAN I FIND MORE RESOURCES COVERING SHELL'S SUSTAINABILITY SERVICES?

A You can find out more about Shell Lubricant Solutions' B2B offerings here: <https://www.shell.co.uk/business-customers/lubricants-for-business.html>

# THE TOP FIVE SUSTAINABILITY FACTS ABOUT LUBRICANTS YOU PROBABLY DIDN'T KNOW

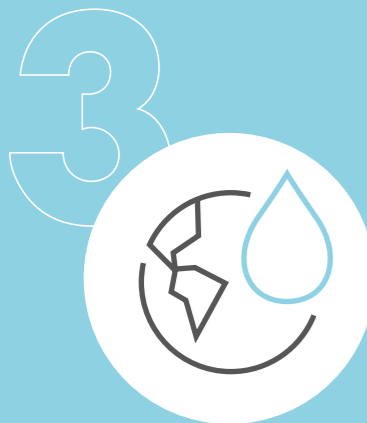


## Advancements in lubricants have the potential to reduce emissions and save on fleet costs<sup>28</sup>

Research has found that the fuel savings from improving and using effective engine lubricants equate to the average annual saving per vehicle of between €37-€67 per year for cars and €720-€1282 per year for heavy trucks.

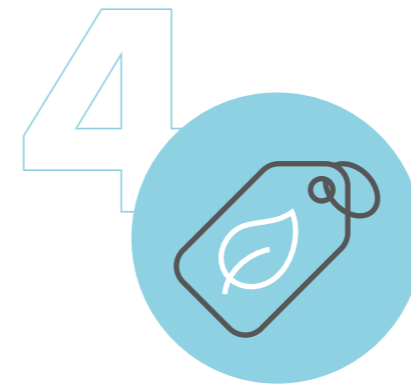
## Biodegradable oils are less flammable and are less harmful to plants or animals

Biodegradable lubricants such as synthetic or vegetable oils are much more considerate to the environment, and are less toxic to plants and animals. A greater number of biodegradable lubricants for different specifications such as hydraulic fluids are being developed with greater biodegradability and less toxicity that can operate in more environmentally sensitive areas.<sup>29</sup>



## Without proper disposal procedures in place, 50% of all lubricants used worldwide end up in the environment<sup>30</sup>

The main cause of lubricant loss is accidental release or spills, which results in toxic oils contaminating forests, fields and waterways with limited detection.<sup>31</sup> Biodegradable lubricants mean that any lubricant released into the environment can be broken down easily in soil and water.

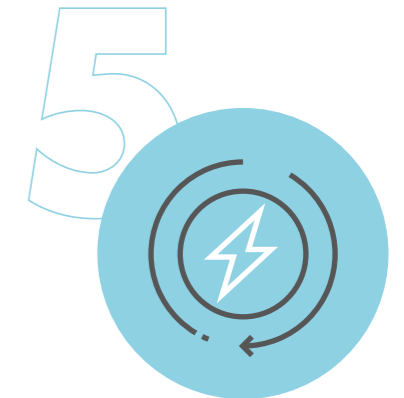


## Biodegradable lubricants can help businesses meet consumer sustainability expectations and environmental regulations

Consumers are increasingly looking for businesses to take responsibility for environmental issues such as climate change. Using biodegradable products within production allows consumers to be at ease when buying a product, knowing that waste from these products are biodegradable and not harming the planet. Environmental regulations are also in place that hold businesses accountable for environmental damage to natural habitats, protected species, land or water.<sup>32</sup>

## The production of biodegradable plastics often requires half as much energy than non-degradable plastics

Bioplastics are made from natural substances such as cornstarch meaning they can save energy in the manufacturing process. The manufacturing of natural polymers requires 65% less energy compared to a similar polymer made from petroleum.<sup>33</sup>



# FOOTNOTES

## HOW STRONG IS THE BUSINESS CASE FOR SUSTAINABILITY?

1. The United Nations Global Compact – Accenture Strategy CEO Study on Sustainability, 2019
2. Edelman Trust Barometer, 2020
3. The United Nations Global Compact – Accenture Strategy CEO Study on Sustainability, 2019
4. The United Nations Global Compact – Accenture Strategy CEO Study on Sustainability, 2019

## MANAGING WASTE EFFECTIVELY

5. Henkel.com. 2020. Lightweight Contenders: How Innovations In Packaging Are Turning The Tide On Waste. [online] Available at: <<https://www.henkel.com/spotlight/2019-12-16-lightweight-contenders-how-innovations-in-packaging-are-turning-the-tide-on-waste-1012674>>
6. Shaw, R., 2020. Lightweight Packaging: Benefits For Producers And Consumers. [online] Assemblies Unlimited, Inc. Available at: <<https://www.assemblies.com/lightweight-packaging-benefits/>>
7. Shaw, R., 2020. Lightweight Packaging: Benefits For Producers And Consumers. [online] Assemblies Unlimited, Inc. Available at: <<https://www.assemblies.com/lightweight-packaging-benefits/>>
8. Shaw, R., 2020. Lightweight Packaging: Benefits For Producers And Consumers. [online] Assemblies Unlimited, Inc. Available at: <<https://www.assemblies.com/lightweight-packaging-benefits/>>
9. Conserve Energy Future. 2020. Biodegradable Plastics: Advantages, Disadvantages And Various Uses Of It. [online] Available at: <<https://www.conserve-energy-future.com/advantages-disadvantages-uses-biodegradable-plastics.php>>
10. Conserve Energy Future. 2020. Biodegradable Plastics: Advantages, Disadvantages And Various Uses Of It. [online] Available at: <<https://www.conserve-energy-future.com/advantages-disadvantages-uses-biodegradable-plastics.php>>
11. BBC News. 2020. Electronic Waste: EU Adopts New WEEE Law. [online] Available at: <<https://www.bbc.co.uk/news/world-europe-16633940>>
12. letsrecycle.com. 2020. China 'Solid Waste Law' Changes From September - Letsrecycle.Com. [online] Available at: <<https://www.letsrecycle.com/news/latest-news/china-solid-waste-law-changes-from-september/>>
13. US EPA. 2020. Regulatory Information By Topic: Waste | US EPA. [online] Available at: <<https://www.epa.gov/regulatory-information-topic/regulatory-information-topic-waste>>
14. Nowak P, Kucharska K, Kamiński M. Ecological and Health Effects of Lubricant Oils Emitted into the Environment. Int J Environ Res Public Health. (2019).

## WORKING WITH CO<sub>2</sub>

15. Quintero, D., Bolinches, L., Gandakusuma Sutandyo, A., Joly, N. and Tetsuo Katahira, R. (2016). IBM Data Engine for Hadoop and Spark.
16. [www.shell.com/energy-and-innovation/new-energies/nature-based-solutions.html](http://www.shell.com/energy-and-innovation/new-energies/nature-based-solutions.html)
17. [www.gov.uk/guidance/measuring-and-reporting-environmental-impacts-guidance-for-businesses](http://www.gov.uk/guidance/measuring-and-reporting-environmental-impacts-guidance-for-businesses)

## THE POTENTIAL OF POST-CONSUMER WASTE

18. American Carbon Registry. (2019). Methodology for the Quantification, Monitoring, Reporting and Verification of Greenhouse Gas Emissions Reductions
19. Harvard Business Review. 2020. Recycling For Profit: The New Green Business Frontier. [online] Available at: <<https://hbr.org/1993/11/recycling-for-profit-the-new-green-business-frontier>>
20. Harvard Business Review. 2020. Recycling For Profit: The New Green Business Frontier. [online] Available at: <<https://hbr.org/1993/11/recycling-for-profit-the-new-green-business-frontier>>
21. Shell.com. 2020. Shell Uses Plastic Waste To Produce Chemicals. [online] Available at: <<https://www.shell.com/business-customers/chemicals/media-releases/2019-media-releases/shell-uses-plastic-waste-to-produce-chemicals.html>>
22. Shell.com. 2020. Plastic Waste. [online] Available at: <<http://www.shell.com/plasticwaste>>

## REACHING FULL POWER WITH BIODEGRADABLES

23. Battasby, N. S., Chemosphere, 2000, Vol 42, 1011–1027
24. Nagendramma, P. (2012). Development of ecofriendly/biodegradable lubricants: An overview. [online] ResearchGate. Available at: [https://www.researchgate.net/publication/251670456\\_Development\\_of\\_ecofriendlybiodegradable\\_lubricants\\_An\\_overview](https://www.researchgate.net/publication/251670456_Development_of_ecofriendlybiodegradable_lubricants_An_overview)
25. [oilcare.org.uk/avoid-pollution/biodegradable-lubricants/](http://oilcare.org.uk/avoid-pollution/biodegradable-lubricants/)
26. Nagendramma, P. (2012). Development of ecofriendly/biodegradable lubricants: An overview. [online] ResearchGate. Available at: [https://www.researchgate.net/publication/251670456\\_Development\\_of\\_ecofriendlybiodegradable\\_lubricants\\_An\\_overview](https://www.researchgate.net/publication/251670456_Development_of_ecofriendlybiodegradable_lubricants_An_overview)
27. Nagendramma, P. (2012). Development of ecofriendly/biodegradable lubricants: An overview. [online] ResearchGate. Available at: [https://www.researchgate.net/publication/251670456\\_Development\\_of\\_ecofriendlybiodegradable\\_lubricants\\_An\\_overview](https://www.researchgate.net/publication/251670456_Development_of_ecofriendlybiodegradable_lubricants_An_overview)

## THE TOP FIVE SUSTAINABILITY FACTS IN LUBRICANTS YOU PROBABLY DIDN'T KNOW

28. Atiel.org. 2020. [online] Available at: <[https://atiel.org/images/downloads/pdfs/Ricardo-Lubricants\\_contribution\\_to\\_fuel\\_economy\\_final.pdf](https://atiel.org/images/downloads/pdfs/Ricardo-Lubricants_contribution_to_fuel_economy_final.pdf)>
29. Irep.ntu.ac.uk. 2020. [online] Available at: <[http://irep.ntu.ac.uk/id/eprint/18206/1/196132\\_169%20Morledge%20Pre%20Publisher.pdf](http://irep.ntu.ac.uk/id/eprint/18206/1/196132_169%20Morledge%20Pre%20Publisher.pdf)>
30. Mbohwa, C., Madanhire, I. (2016). Mitigating Environmental Impact of Petroleum Lubricants
31. Pure Advantage. 2020. Biodegradable Lubricants: Oiling The Wheels Of Change - Pure Advantage. [online] Available at: <<https://pureadvantage.org/news/2017/05/23/biodegradable-lubricants/>>
32. Ec.europa.eu. 2020. [online] Available at: <[https://ec.europa.eu/environment/legal/liability/pdf/eld\\_guidance/ireland.pdf](https://ec.europa.eu/environment/legal/liability/pdf/eld_guidance/ireland.pdf)>
33. Conserve Energy Future. 2020. Biodegradable Plastics: Advantages, Disadvantages And Various Uses Of It. [online] Available at: <<https://www.conserve-energy-future.com/advantages-disadvantages-uses-biodegradable-plastics.php>>