

GLOBAL OPPORTUNITY REPORT 2018

Your guide to a world of opportunities

GLOBAL OPPORTUNITY REPORT

2018

Global Opportunity Report 2018, First Edition is published by DNV GL AS.

This report is based on information and sources that the authors regard as credible and accurate. Though both internal and external reviewers have commented on it extensively, we do not make any warranty on the information obtained from third parties.

The text in the report may describe conditions and expectations of future developments based on assumptions and information that are relevant at the time of writing. However, the assumptions of what constitutes relevant risks and opportunities may change dramatically, and the companies behind the report do not make any warranty to the continued relevance or accuracy of the text and will not be obliged to update the material. Readers are cautioned not to place undue reliance on the statements in this publication and are advised to always independently seek further information. The companies behind the report shall in no way be liable for any loss or damage arising from the use of information from this report.

DNV GL AS,
Høvik, Oslo

Copyright © 2018
By DNV GL AS

All rights reserved.

Discover more goexplorer.org

PROJECT PARTNERS



DNV GL

DNV GL is a global quality assurance and risk management company. Driven by our purpose of safeguarding life, property and the environment, we enable our customers to advance the safety and sustainability of their business. Operating in more than 100 countries, our professionals are dedicated to helping customers in the maritime, oil & gas, power and renewables and other industries to make the world safer, smarter and greener.



UNITED NATIONS GLOBAL COMPACT

The United Nations Global Compact is a call to companies everywhere to align their operations and strategies with ten universally accepted principles in the areas of human rights, labour, environment and anti-corruption, and to take action in support of UN goals and issues embodied in the Sustainable Development Goals. The UN Global Compact is a leadership platform for the development, implementation and disclosure of responsible corporate practices. Launched in 2000, it is the largest corporate sustainability initiative in the world, with more than 9,500 companies and 3,000 non-business signatories based in over 160 countries, and more than 70 Local Networks.



SUSTAINIA

Sustainia is a sustainability advisory group and digital studio working to accelerate action towards a sustainable future. We work with people who are changing the world for the better, helping them integrate sustainability into their core by developing cutting-edge strategies, building engaging digital solutions, and amplifying their messages with impact.

NO GOALS LEFT BEHIND

It has been said many times and in many ways that the Sustainable Development Goals (SDGs) create business opportunities. However, few commentators take the extra step of documenting, as we have done, how all 17 Global Goals can be turned into new market opportunities met by concrete business solutions.

In this, the fourth edition of the annual Global Opportunity Report, we show that for all Sustainable Development Goals there are real opportunities which can make a world of difference.

We hone in on the four SDGs that, according to DNV GL's "Future of Spaceship Earth" study, are most likely to miss their 2030 targets: Goal 10 "Reduced Inequalities", Goal 12 "Responsible Consumption and Production", Goal 13 "Climate Action", and Goal 14 "Life Below Water". In the pages that follow, you will find many new business opportunities that directly address these challenging, cross-cutting goals.

Turning risks into opportunities

As the example of Tesla amply demonstrates, it is entirely possible, through innovation, technology and passion, to build an iconic business valued in the tens of billions by tackling arguably the most intractable risk of our times: decarbonisation. While electric vehicles help to limit CO₂ emissions, the other aspect of decarbonisation – removing CO₂ from the atmosphere, is opening intriguing business opportunities, as we describe in our coverage of 'upcycling carbon'.

In another arena, Telenor's focus on inequality in emerging markets is not just responsible corporate governance but a quest to open new markets. Norway's emphasis on electric ships will build an expertise that can be exported whilst preserving the abundant life below the waters of its precious coastline. These cases demonstrate why we believe that addressing the SDGs can unlock an enormous amount of value – a market of some \$12 trillion.

Opportunities at the "edge of markets"

The 2018 edition of the Global Opportunity Report is focused on promoting concrete solutions, such as that of an entrepreneur from Ghana who is leveraging blockchain to secure land rights, and companies recycling waste to produce an alternative to cement to feed the building boom in emerging countries. These are two of the many business opportunities that we have identified, for which we have consulted business leaders and entrepreneurs from around the world.

Many of the solutions to the SDGs can be described as at the "edge of markets", meaning they require collaboration from across fields of expertise. To use the example of Tesla again: it uses IT and energy storage technology that was outside the realm of auto industry to create its vehicles and a new driving experience. To foster a spirit of collaboration, we recently launched the Global Opportunity Explorer, a digital platform and an open access community that showcases solutions and opportunities relating to the SDGs. From the partners behind the Global Opportunity Report, the Explorer allows business

leaders, entrepreneurs, and investors to connect with new partners, projects and markets to innovate and better deliver on the SDGs.

Building a sustainable future in a very different present

We must also acknowledge that the world today is very different to 2015, when the first Global Opportunity Report was launched. Short-termism and isolationism have taken a more prominent position on the political agenda, but the four SDGs featured in this report affect every human being on this planet, and can only be addressed through closer cooperation. A new approach to global economics is needed which will allow humanity, as economist Kate Raworth describes, to "thrive in balance". We will only succeed in building a regenerative future if we push forward together and take collective responsibility.

With this fourth report we have, in collaboration with leaders all over the world, showcased new business opportunities to build a sustainable future. Opportunities and solutions exist today – our call to action to you is to join us and ensure that all goals are met and that no one is left behind.



REMI ERIKSEN
GROUP PRESIDENT
& CEO DNV GL



LISE KINGO
CEO & EXECUTIVE
DIRECTOR, UN
GLOBAL COMPACT





ERIK RASMUSSEN
FOUNDER & EXECUTIVE
CHAIRMAN SUSTAINIA







CONTENTS

3	FOREWORD
6	INTRODUCTION
8	OPPORTUNITY TRENDS
10	GLOBAL OPPORTUNITY EXPLORER
12	FOUR GOALS IN FOCUS

14	REDUCED INEQUALITIES
	OPPORTUNITIES:
	 UNCHAINING LAND RIGHTS
	 ILLUMINATING SUPPLY CHAIN

28	RESPONSIBLE CONSUMPTION AND PRODUCTION
	OPPORTUNITIES:
	 ALTERNATIVE FOOD SOURCES
	 CONSTRUCTION IN PROGRESS
	 REUSE TO REPOWER

46	CLIMATE ACTION
	OPPORTUNITIES:
	 UPCYCLING CARBON
	 KEEPING IT COOL
	 SUSTAINABLE SHIPPING

64	LIFE BELOW WATER
	OPPORTUNITIES:
	 REIMAGINING PLASTICS
	 ALTERNATIVE AQUACULTURE

78	ACKNOWLEDGEMENTS
80	SOURCES AND FURTHER READING

INTRODUCTION

We present newly mapped business opportunities relating to the four Sustainable Development Goals requiring the most attention.

Since 2015, the 17 SDGs have provided a framework for addressing the challenges that humanity faces. The specific targets and indicators behind each goal allow some progress quantification and predictions about delivering results by 2030. DNV GL's report "Future of Spaceship Earth" took this as its starting point and identified the four goals that were lagging furthest behind. We began with these goals and investigated where their business potential lay.

For the fourth edition of this report we conducted a public campaign with a call to action to crowdsource local knowledge in order to show where the pioneering businesses were moving in the SDG space. By analysing the feedback, as well as maintaining a market focus, we have been able to map out the opportunity space for other businesses to move into.

HOW TO READ THE REPORT

What is a Global Opportunity?

Opportunities are avenues of action for systemic change that stakeholders in business, politics, finance, and civil society can choose to pursue when addressing global risks. They create value for societies and the planet, not just for individuals or businesses. An opportunity is different from a single business solution, because it creates systemic change via multi-stakeholder collaboration.

Opportunities are sustainable. We define sustainability as it was originally phrased in the Brundtland Report: *meeting*

the needs of the present without compromising the ability of future generations to meet their own needs.

What is a Business Solution?

A business solution is a concrete example of a company exploiting a global opportunity. It is a readily available

solution that is financially viable, scalable, with the potential to improve quality of life, that also demonstrates positive environmental impact. Solutions can range from a family-run operation to one unit of a multinational operation, and can be anywhere in the world.

SUSTAINABLE DEVELOPMENT GOALS



THE FUTURE WE ARE HEADING TOWARDS

A forecast model from DNV GL's Spaceship Earth has assessed the likelihood of the world achieving the SDGs by 2030. According to the report, none of the 17 SDGs will be achieved in all regions, and four areas are of special concern: inequality, consumption and production, climate, and oceans.

	ROW	BRIS	CHINA	OECD	USA
1. No poverty	●	●	●	●	●
2. Zero hunger	●	●	●	●	●
3. Good health and well-being	●	●	●	●	●
4. Quality education	●	●	●	●	●
5. Gender equality	●	●	●	●	●
6. Clean water and sanitation	●	●	●	●	●
7. Affordable and clean energy	●	●	●	●	●
8. Decent work and economic growth	●	●	●	●	●
9. Industry, innovation and infrastructure	●	●	●	●	●
10. Reduced inequalities	●	●	●	●	●
11. Sustainable cities and communities	●	●	●	●	●
12. Responsible consumption and production	●	●	●	●	●
13. Climate action	●	●	●	●	●
14. Life below water	●	●	●	●	●
15. Life on land	●	●	●	●	●
16. Peace, justice and strong institutions	●	●	●	●	●
17. Partnerships for the goals	Not enough data to assess				

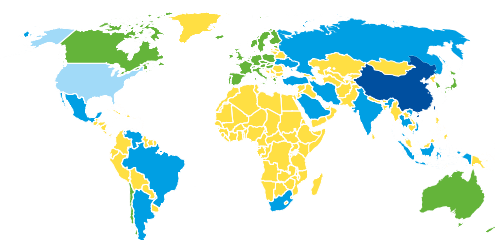
●
Goal likely to be reached
(i.e target fulfilment of
more than 95%)

●
Goal not likely to be reached,
but more than 50% of gap
between today's status and the
goal is likely closed

●
Goal not likely to be reached,
and less than 50% of gap
between today's status and
the goal is likely closed

FIVE REGIONS

Please note that the regions here differ from the official UN regions, but refer specifically to the data from DNV GL's "Future of Spaceship Earth" report.



USA OECD (excl. USA) CHINA BRIS (Brazil, Russia, India, South Africa and ten other Emerging economies) ROW (Rest of the World)

OPPORTUNITY TRENDS

The Global Opportunity Reports consistently reveal that tomorrow's successful businesses will be those that are shaped by the interconnection between traditional sectors and new technology and which are able to capitalize on the convergence of previously separate sectors.

For the past four years, DNV GL, the UN Global Compact, and Sustainia have joined forces to produce the annual Global Opportunity Report. This yearly report is created based on extensive research and consultation with business leaders around the world. In all, we have analysed how 55 opportunities can emerge from leading global risks. We have done this by conducting 17 opportunity panel discussions with industry experts across five continents and gathering insights from surveys of more than 17,000 business leaders from around the globe. The results reveal that challenges facing our society, planet, and business communities can be turned into opportunities if we adopt the right mindset.

As every challenge assessed in the Global Opportunity Report is global in its reach, the potential for these market opportunities is enormous. Responsible and sustainable business is no longer a small niche industry. Rather, these markets have the potential to be the key drivers of business growth in the coming decades.

From this wealth of data and knowledge, we are able to extract two important overall mega-trends across four years of the Global Opportunity Report.

TECH + SUSTAINABILITY RISKS = NEW MARKETS

Based on four years of Global Opportunity Report data, it is clear that new market opportunities emerge at the intersection of technology and sustainability risks. The vast majority of our 55 opportunities employ technological innovations, but the digitalisation of certain products and services will

not be enough to remain competitive in the future market universe. True innovation lies in finding the intersection of a business sector and technology. We have showcased this trend in the illustration on the following page, highlighting how four key markets - health, food, water, and energy - interact with technology to push the boundaries of innovation.

Examples of Intersections:

1. Health > Internet of People

The internet of people (using mobile technologies in health-care) is opening up new opportunities to deliver healthcare to low-income, remote communities via mobile solutions.

2. Food > Smart Farming

Utilising technological advancements like drip agriculture and access to real-time weather data is helping both large- and small-scale farmers produce more with less.

3. Water > Smart Water Tech

Innovative sensor technology and smart grids enable cities to manage their water supplies more efficiently and prevent disruptions to service delivery.

4. Energy > Reuse to Repower

Reusing EV batteries in new stationary settings can help to decarbonise the energy system in addition to traditional hydropower storage, where an increasing reliance on variable renewables requires greater energy storage flexibility.

LIVE ON THE EDGE

While it is clear that all industries must digitalise to remain relevant, they will have to do even more to capitalize on new market spaces. The second trend we have witnessed is that businesses need to move beyond their core and live on the edge of their markets. As evidenced on the next page, market opportunities increasingly exist at the edge of innovation and experimentation. The edge markets that exist between health and food; food and water; and water and energy signify that all industries, while focusing on their core markets, need to move beyond their comfort zone and operate on the frontiers to capitalise on future opportunities.

Examples of market overlap:

1. Health + Food > Antibiotic-Free Food

Growing concern over health issues is creating a drive for greater demand for antibiotic-free food. Therefore, the antibiotic-free food market is growing rapidly as these two sectors overlap to offer opportunities to protect people.

2. Food + Water > Water-Efficient Agriculture

Techniques like effective rainwater harvesting and gravity powered irrigation allow for the continuation of high-yield agriculture while still saving water.

3. Water + Energy > Fresh Water Production

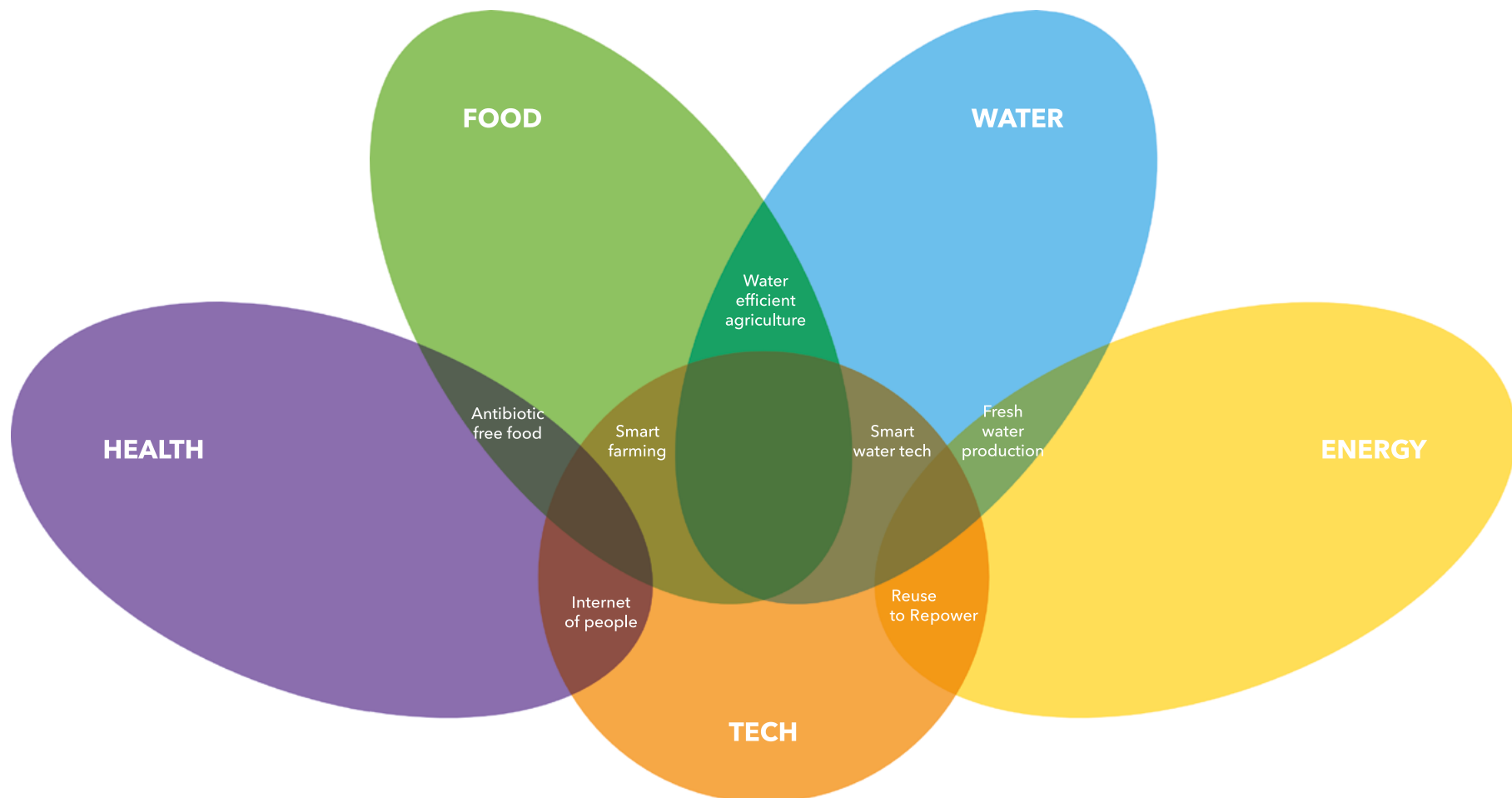
Creating new freshwater sources using renewably powered wastewater treatment and desalinisation offers a crucial opportunity to meet the demand for fresh water while providing new and essential markets for clean energy.

THE FUTURE OF OPPORTUNITIES

Health, food, water, and energy are four of the biggest markets featured in the four years of the Global Opportunity Report. They touch on several of the opportunities and therefore serve as excellent illustrations of how future markets will emerge in two key areas:

① At the **intersection** when specific markets are seeing new areas of overlap with technology changes

② At the **edge** of existing markets when markets meet one another



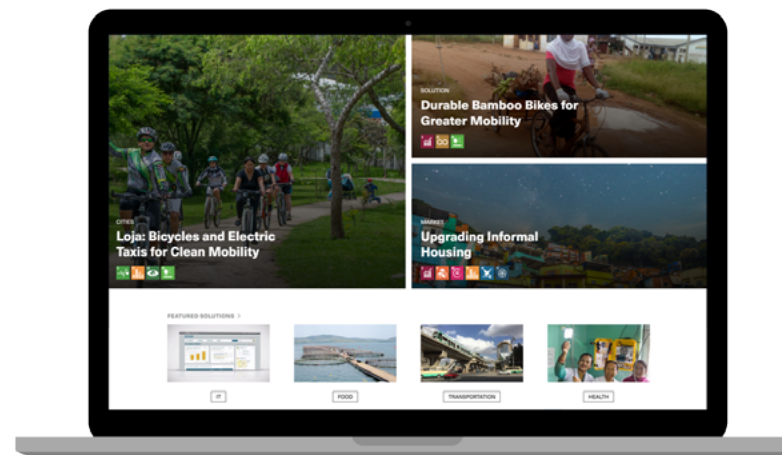
GLOBAL OPPORTUNITY EXPLORER

The opportunities and solutions presented in this report are also featured on the Global Opportunity Explorer together with opportunities from the previous Global Opportunity Reports.

The Global Opportunity Explorer provides the global business community with direct access to the most innovative business solutions and emerging market opportunities to help achieve and understand the Sustainable Development Goals (SDGs), end extreme poverty, reduce inequality and protect our planet. A joint project involving DNV GL, Sustainia and the UN Global Compact, the Global Opportunity Explorer is a digital platform that helps business leaders, entrepreneurs and investors connect with new partners, projects, markets and talents to deliver on the SDGs.

The platform allows you to explore the opportunities that deliver on the Global Goals and find current and projected market sizes together with unique market data from global surveys. In addition to the opportunities, the platform showcases how each of the solutions impact the SDGs and the maturity of the solutions together with the people behind them.

The platform relies on continuous co-creation and crowdsourcing to expand the existing pool of sustainable innovation with the clear ambition of being the world's biggest platform for sustainable best practices. Anyone can nominate and contribute solutions through the platform's submissions page.

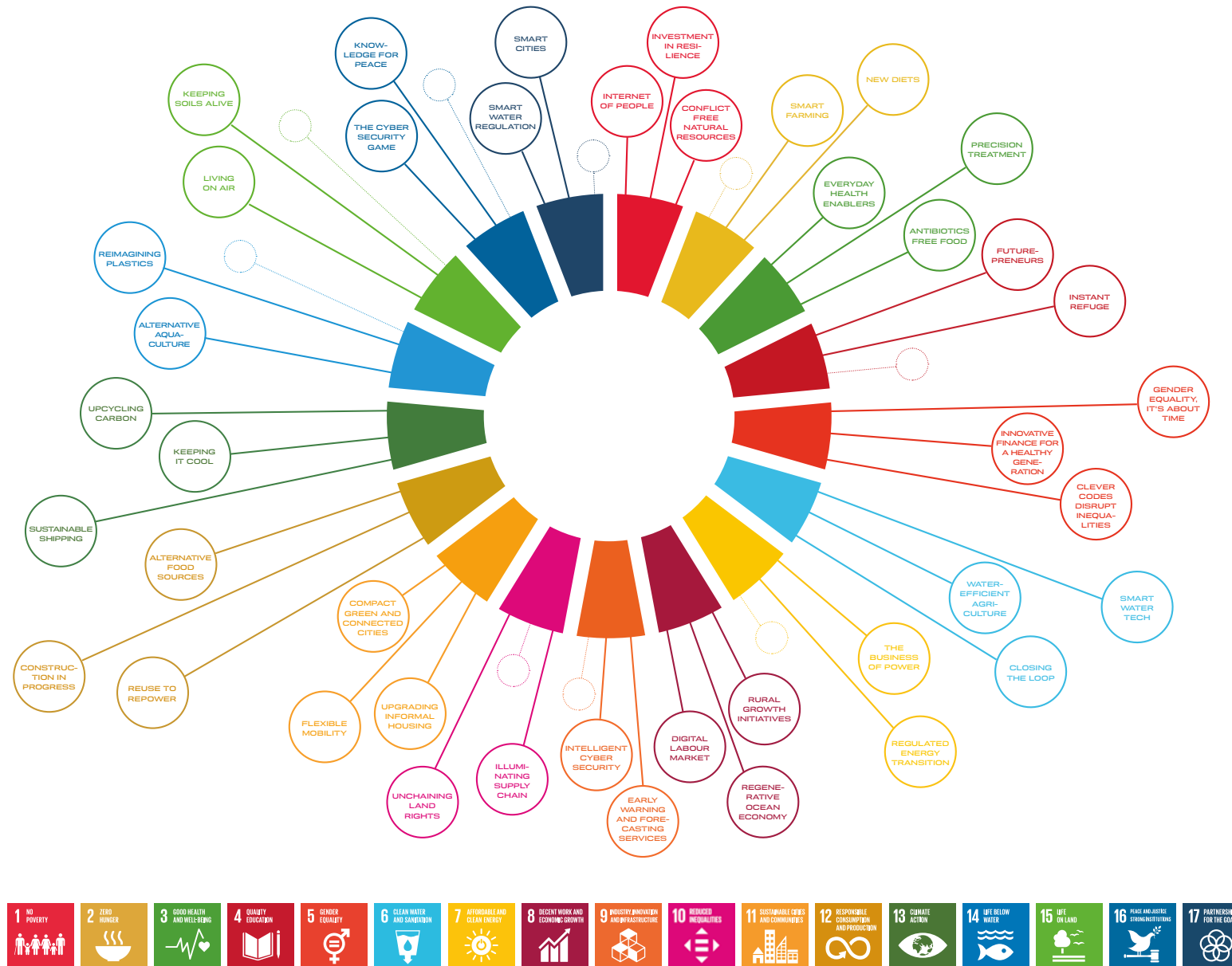


PARTNER COMMUNITY OF THE GLOBAL OPPORTUNITY EXPLORER:



MARKET OPPORTUNITIES FOR THE 2030 AGENDA

The Global Opportunity Explorer (goexplorer.org) showcases additional opportunities and solutions addressing all 17 Sustainable Development Goals.



FOUR GOALS IN FOCUS



2018



REDUCED INEQUALITIES

Inequality is on the rise around the world. Forty-six percent of global wealth is controlled by the richest 0.7%; whereas half the world's population owns just 1%. More than 70% of the global population resides in countries with increasing inequality. Economic growth is not sufficient to reduce poverty, especially if it is not inclusive, and does not involve the three dimensions of sustainable development. Goal 10 aims to empower those at the bottom of the wealth ladder, regardless of sex, race, or ethnicity.



OPPORTUNITIES:

UNCHAINING LAND RIGHTS

Blockchain technology is unlocking land tenure for the most vulnerable. Secured titles are an important step towards improving livelihoods, enabling access to financial products and safeguarding investments.

ILLUMINATING SUPPLY CHAINS

Digitisation of the supply chain using blockchain and smart contracts improves transparency, enabling more informed purchases for consumers and suppliers. Increased visibility increases fair treatment of all stakeholders in the supply chain.



RESPONSIBLE CONSUMPTION AND PRODUCTION

Today's consumption is unsustainable, and with a forecast global population of 9.6 billion by 2050, the equivalent of almost three planets would be required to provide the natural resources that sustain current lifestyles. Goal 12 is a global goal that touches on nearly all aspects of how we live our lives, and with global supply chains now the norm, the distant impacts of our consumption habits are difficult to perceive. There is an urgent need for solutions that rethink how we produce and consume.



OPPORTUNITIES:

ALTERNATIVE FOOD SOURCES

The integration of insects into food products will reduce the degradation of land, water and oceans, as insects are significantly more efficient at supplying protein for both direct consumption and animal feed.

CONSTRUCTION IN PROGRESS

Rethinking construction to focus on longevity, refurbishment, and material recovery and reuse can transform the sector from a linear to a more circular economy, thereby lowering today's unsustainable levels of consumption and waste.

REUSE TO REPOWER

Doubling the lifetime of EV batteries in stationary energy storage offers support for grid balancing, helps to boost use of renewable energy, and drives the more responsible use of vital natural resources.



CLIMATE ACTION

Climate change is now affecting every corner of the globe; disrupting economies and lives, especially in developing countries. After several years of plateauing, carbon emissions rose again in 2017. A 6% annual reduction in carbon intensity is required to meet the Paris Agreement, but in 2016 only two countries achieved this, indicating a need for accelerated action. Goal 13 promotes a path that both mitigates and adapts to future climate change, minimising the social, environmental and economic damage.



OPPORTUNITIES:

UPCYCLING CARBON

Capturing CO₂ and either recycling it back into industrial processes as a feedstock, or locking it up in new materials provide an opportunity to lower atmospheric carbon concentrations, mitigating some of the worst consequences of climate change.

KEEPING IT COOL

New innovative and energy-efficient methods for cooling everything from homes to data centres provides significant possibilities to reduce carbon emissions and improve living conditions for billions of people.

SUSTAINABLE SHIPPING

Reducing the shipping industry's reliance on fossil fuels through soft and hard measures, such as hybrid power systems and optimisation of operations can help this sector set a new course for decarbonisation.



LIFE BELOW WATER

Healthy marine ecosystems are crucial for the estimated 10% of the global population whose livelihoods depend on the oceans. However, our oceans are in serious trouble thanks to human activity, with pollution, overfishing, and acidification causing irreparable damage and habitat loss. Goal 14 and resolutions adopted by the UN General Assembly in late 2017 support the conservation and sustainable management of the oceans, but sustainable business solutions offer an accelerated way to turn the tide.



OPPORTUNITIES:

REIMAGINING PLASTICS

Eighty percent of marine litter is plastic, emphasising the need for solutions that rethink how we design and use plastic, particularly in single-use applications, which can help reduce the damage plastics do to our oceans.

ALTERNATIVE AQUACULTURE

Transforming aquaculture with alternative feed sources and innovative close-looped land-based systems will enable aquaculture to sustainably support the growing demand for protein without compromising the ecosystems of the oceans.

GOAL 10

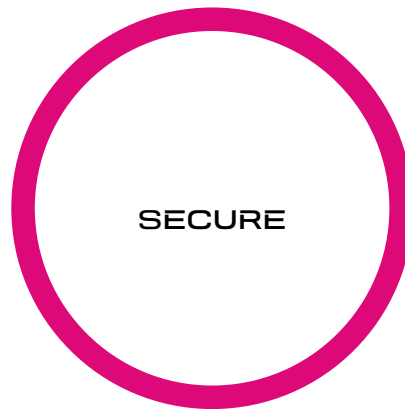
REDUCED INEQUALITIES

While extreme poverty is declining, inequality is on the rise around the world. Forty-six per cent of global wealth is controlled by just the richest 0.7%; whereas 70% of the world's population owns just under 3% of global wealth. Economic and social inequality are intrinsically linked. Health, crime, productivity, and life expectancy are all related to inequality, and more equal societies are shown to be happier societies. Sustainable Development Goal 10 aims to empower those at the bottom of the wealth ladder, regardless of sex, race, or ethnicity.

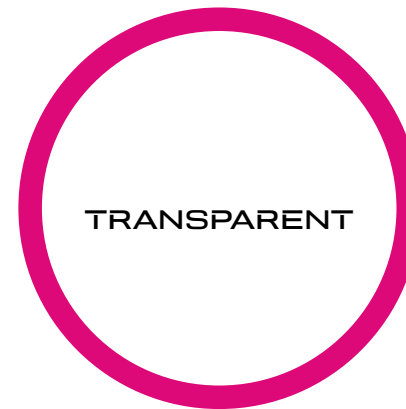


TOWARDS REDUCED INEQUALITIES

The commitment to "leave no one behind" underpins all 17 SDGs. Increasing opportunities and ensuring access to fundamental services can dramatically improve the livelihoods of people at the bottom of the wealth ladder. New technology is an enabler for a more transparent value chain and greater citizen rights, empowering further social responsibility and protecting the most vulnerable. Business can provide the necessary tools and services essential for the opportunities presented here to blossom.



Registering land ownership unlocks huge opportunities to equalise societies. **Unchaining land rights** with the blockchain enables people to get control over their own land.



Illuminating supply chains can bring about transparency to global trade, enabling a fairer value chain and potential to track products from the raw material to the store.

“Blockchain is the cure to many challenges by offering equitable access to opportunity.”

Inequality has been perpetuated in Ghana partly because of unreliable, and inefficient paper-based systems for land registry vulnerable for corruption. BenBen, founded by Emmanuel Noah, is revolutionising land and property management by offering a reliable and traceable solution based on blockchain technology.



EMMANUEL BUETEY NOAH JR.
CEO, BenBen

How can blockchain technology contribute to greater equality?

In developing countries, citizens earning low incomes are faced with higher relative costs of accessing credit and finance. This is especially true when applying for financing using assets such as land and property as collateral - there's just too much uncertainty and risk for a lender to be comfortable. Blockchain technology has the potential to eliminate many barriers around trust and the transparency of assets that marginalise these groups.

How is BenBen changing land ownership in Ghana?

The vision has always been to enable trusted, secure, and risk-free land transactions. In a country like Ghana, where 70% of court cases are land related, blockchain-recorded transactions drastically lower the risk of participating in land transactions. Land is the predominant asset in most developing countries. Secure transactions can encourage land ownership as well as growth in sectors such as housing, agriculture, mining, and even energy.

How can BenBen reach the poorest citizens?

Decentralisation is key when it comes to promoting access and inclusivity. We're currently developing several micro-franchising models that allow trained citizens in rural communities to act as service points for land transactions. Additionally, with Ghana having a mobile phone penetra-

tion rate of 128%, we plan to engage low-income earning landowners via USSD services which are not dependent on internet access.

Some people are critical of blockchain's energy demand and its associated environmental impact. How would you respond to that?

Unfortunately, initial iterations of distributed ledger tech were built with little environmental impact guidelines in place. However, cryptocurrencies such as Ethereum are beginning to test more energy-efficient algorithms, which have the potential to drastically reduce energy costs. In another light, the current prevalence of renewable energy solutions presents a more sustainable method of providing clean computing power. I'd say it's only a matter of time before we see an environmentally sustainable blockchain ecosystem in place.

What's your advice for entrepreneurs looking to solve global challenges?

"If you want to go fast, go alone. If you want to go far, go together." Anyone who wants to take their ideas far past their comfort zone must be ready to work and collaborate with others. Be open to teamwork and be committed to pace yourself - these challenges weren't created overnight, so you shouldn't expect to solve them in a day either.

MAP OF SOLUTIONS

TECHNOLOGIES TO CREATE A MORE EQUAL WORLD

Increasing transparency in supply chains and the way in which we register land rights can bring profound benefits for those at the bottom of the wealth ladder.

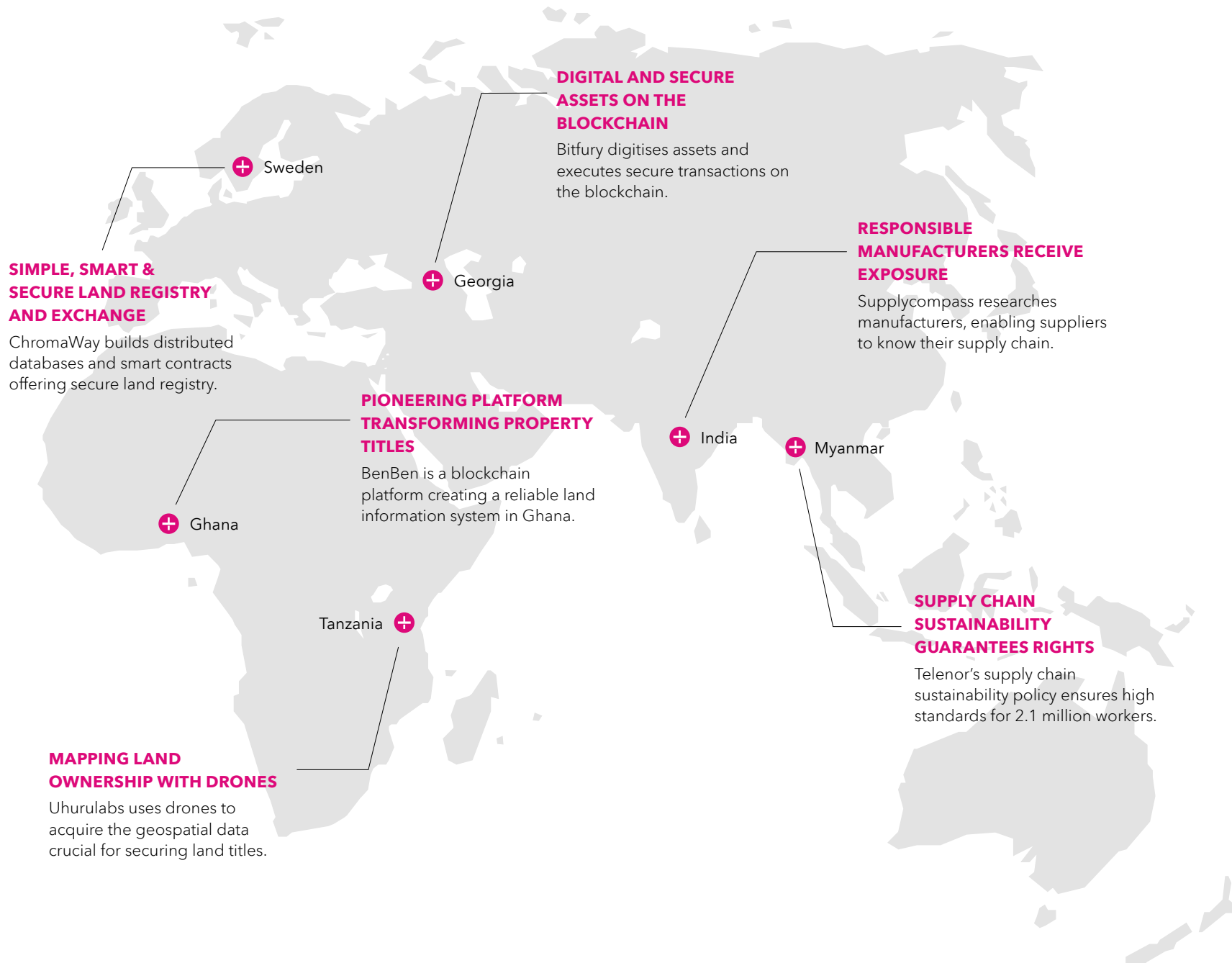
Data stored in a decentralised registry, where everybody can access the information from any device at hand, can help secure the rights holder against fraud and corruption. The solutions presented here range geographically from Sweden to Tanzania, illustrating that the benefits of storing physical archives on a digital database are present in all parts of the world.

Making global trade more transparent will enable a more visible value chain and allow consumers, investors, and companies to act more sustainably. The solutions here use both blockchain and artificial intelligence, innovations enabling this transparency and the tracking of goods throughout the supply chain.

The solutions on this world map are examples of how innovative technologies help to reduce inequalities. Read more about the solutions featured here, and discover further information and many more solutions that tackle Goal 10, on the Global Opportunity Explorer.



INNOVATIVE SOLUTIONS TO REDUCE INEQUALITIES



UNCHAINING LAND RIGHTS

Securing proof of land ownership is an enabling factor for increasing equality. Blockchain technology has the potential to make land registration transparent and tamper-proof. Securing land titles is an important step in empowering people to make investments and improve their financial situation.



One of the largest sources of wealth inequality in developing countries is land ownership. Unequal access to and control over land are both a cause and a consequence of inequality in many regions. In fact, only 30% of the world's population has a legally registered title to their land, and even existing registries are vulnerable to interference, meaning people's rights are not secure. The lack of transparency in land transactions make it difficult to know who the real landowners

are, but new technologies offer solutions bringing increased transparency.

Blockchain can help cut transaction and record-keeping costs, increase accuracy, and reduce fraud risk. Blockchain is a distributed, decentralised ledger, protected from revision by advanced cryptography that guarantees consensus by distributing full copies of the ledger across many blockchain nodes. By registering land rights on the blockchain, landowners can avoid costly transactions with centralised institutions, which can be prone to bribery and fraud.

Formalising land ownership facilitates additional services in the financial sector. It makes it easier for landowners to secure loans and invest in their land and future. Studies in Peru indicate that the lack of land titles is a prohibiting factor in the employment of 28% of women, who remain at home to prevent their land from being seized. In the Brazilian state of Amazonas, land titling has reduced forest clearing by three-quarters. Many offices handling land rights still rely on paper documents, but new approaches can cut costs and reduce fraud.

PRODUCTS AND SERVICES

Digital registration of ownership includes platforms to facilitate interaction with both government institutions and private actors such as mortgage brokers. Services that

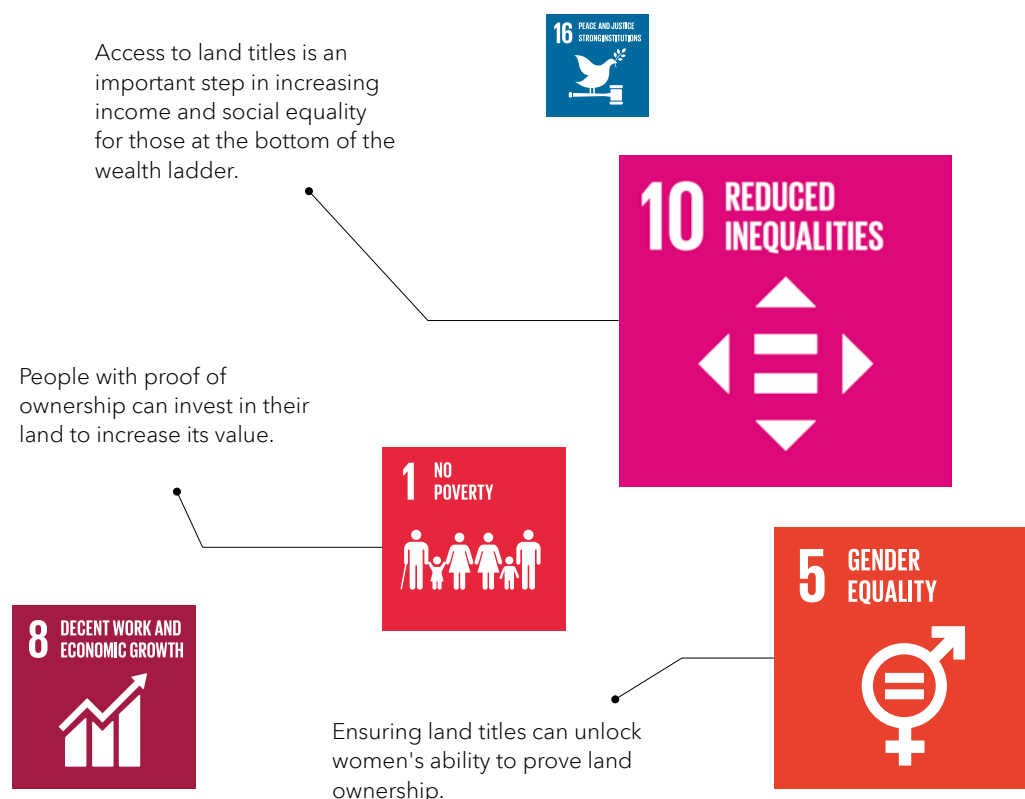
enable users to share land registration with banks offer new opportunities for financial products. Other products in this opportunity space include technology making it possible to measure and register land ownership, such as drones, and mapping tools as well as apps that simplify the process.

MARKET SIZE AND DEMAND DRIVERS

The blockchain market is growing fast, with a compound annual growth rate (CAGR) of 61.5% to 2021, when the market is expected to be worth \$2.3 billion. The increasing demands for improved transparency, efficiency, and reduced exposure to fraud are key market drivers in this opportunity space. Blockchain enables disintermediation – the removal of intermediaries – which delivers a faster and safer transaction system.

While blockchain can deliver many benefits for formalizing land ownership, it must be accompanied by a wider program of land reforms, to protect the poor and marginalized from being further excluded. Ensuring women have equal rights to land is a prerequisite for a blockchain enabled land reform. Authorities must also recognize the validity of blockchain, and the technology must develop to reduce the current electricity consumption.

IMPACT OF OPPORTUNITY



UNREGISTERED LAND



70%

OF THE GLOBAL POPULATION DOES NOT HAVE A LEGAL REGISTER OF THE LAND THEY OWN

\$20T

value of land assets that people in the developing world do not currently have proof of ownership for

90%

of Africa's land is completely unregistered

\$106M

amount the Swedish government could save annually by eliminating land registration paperwork

50%

of the world's countries deny women the ability to own, inherit, or manage land by law or custom

Sources: 1. AID:Tech. 'How blockchain technology is enabling international aid to be delivered transparently'. Report. 2017. 2. World Economic Forum. 'Women own less than 20% of the world's land. It's time to give them equal property rights'. Online. 2017. www.weforum.org 3. Wong, J. I. 'Sweden's blockchain-powered land registry is inching towards reality'. Quartz. Online. 2017. www.qz.com 4. Jochnick, C. 'Ten signs of an impending global land rights revolution'. World Bank. Online. 2017. www.worldbank.org (Upper right): World Bank. 'Why Secure Land Rights Matter'. Online. 2017. www.worldbank.org

SOLUTIONS



PIONEERING PLATFORM TRANSFORMING PROPERTY RIGHTS

BenBen is a blockchain-powered digital land transaction platform that creates trust and secure land titles for people in Ghana.

BenBen is a private sector platform that integrates land registry, land information, and fintech to provide digital land transaction solutions to emerging market economies. Land is registered on the blockchain-powered platform, and the information can then be digitally shared with financial institutions and banks, allowing landowners to access a host of financial products and finance further investment in their land. The land records uploaded onto the platform are provided by the land sector agencies, which are given an API key to the BenBen platform, enabling them to access the data.

GOALS PRIMARILY ADDRESSED



No Poverty

Securing land tenures on the blockchain can enable people to make a steady income from their land and help lift people out of poverty.



Gender Equality

Registration of land rights on the blockchain can help prove women's rights to own land, without risk of tampering.

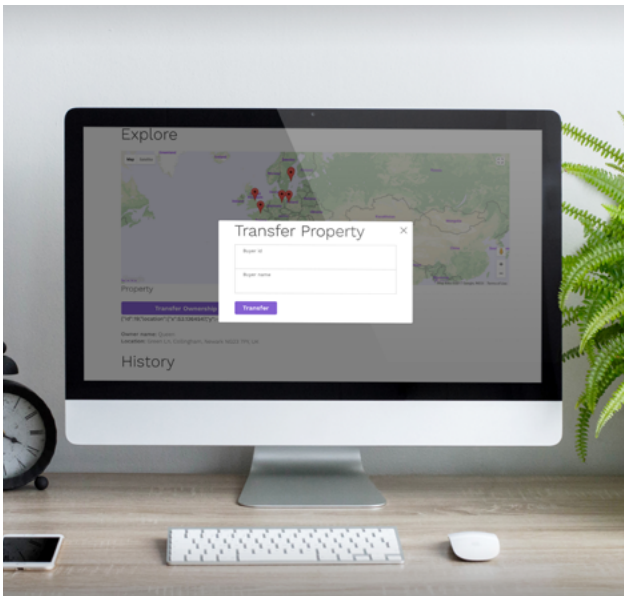


Reduced Inequalities

Tamper-proof land registration will secure land ownership, thereby enabling owners to invest and further benefit from the land they rightfully own.

Solution by: **BenBen**

Deployed in: **Ghana**

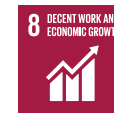


SIMPLIFYING SMART AND SECURE LAND REGISTRY AND EXCHANGE

Delivering next-generation technology, ChromaWay uses blockchain to make real estate transactions more transparent and efficient.

In 2016, Lantmäteriet, Kairos Future, Telia Company, and ChromaWay decided to investigate how blockchain and smart contracts could be used for real estate transactions, evaluating the technology from a legal, business, and IT perspective. Utilising a distributed ledger and straightforward app, the solution enables transparent access to land ownership data. The product provides traditional land registration features in a more intelligent, transparent, resilient, and secure way with the use of smart contracts to execute transactions. The focus is now on building global capacity for blockchain-based land registration and exchanges.

GOALS PRIMARILY ADDRESSED



Decent Work and Economic Growth

The solution provides a technological upgrade of existing systems, improving the efficiency, security, and transparency of real estate transactions.



Reduced Inequalities

Developing an approach for land registration on the blockchain and utilising smart contracts, the solution can have substantial impact in countries with inequality issues.



Partnerships for the Goals

The project is building up capacity and transferring knowledge to other countries, forming partnerships to achieve the other SDGs.

Solution by: **ChromaWay**

Deployed in: **Sweden**

SOLUTIONS



DIGITISING AND SECURING ASSETS ON THE BLOCKCHAIN

Pioneering national government using blockchain for official transactions. Bitfury and the Republic of Georgia are making property transactions secure and transparent.

Bitfury, together with the government of the Republic of Georgia, has implemented a private blockchain-based system, backed by the security of the Bitcoin Blockchain, to make secure real estate transactions. This is the first time a national government has used the Bitcoin Blockchain to secure and validate official actions, bringing increased security to real estate transactions. The ledger is distributed, which mitigates the possibility of corruption, while also providing clients with secure and verifiable electronic receipts. The project will continue to reduce inequalities by addressing the need for transparency and accountability.

GOALS PRIMARILY ADDRESSED



Reduced Inequalities

Cutting the costs of land and property registration provides more equal opportunities for Georgians.



Peace, Justice and Strong Institutions

While Georgia is the least corrupt nation in the Black Sea region, building capacity to reduce corruption in Georgia could influence other countries in the area.



Partnerships for the Goals

Developing and testing new digital systems for governmental use are important steps towards transferring the system to developing and surrounding countries.

Solution by: **Bitfury**

Deployed in: **Georgia**



MAPPING LAND OWNERSHIP WITH DRONES

Using drones to map land in Tanzania, Uhurulabs ensures the accurate measurement of land and improves possibilities for securing people's land rights.

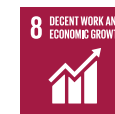
Uhurulabs maps land in Tanzania using drones to provide accurate and effective aerial surveys. Most people in the country have no formal documentation to prove they own their land. This leaves them at risk of losing their land to infrastructure, tourism, and development projects. Acquiring formal documentation for land rights contributes towards better landownership security, allows landowners to obtain bank loans, and helps governments to tax owners correctly. Using drones for mapping in Africa, where only about 30% of the land has been mapped, will enable people to rightfully claim rights over their land.

GOALS PRIMARILY ADDRESSED



No Poverty

Obtaining land measurements can reduce potential conflicts and land theft, enabling landowners to earn a steady income, without fear of losing any land.



Decent Work and Economic Growth

Ensuring land rights with exact measurements can sustain economic growth, as people obtain access to a range of financial services to further invest in their land.



Industry, Innovation and Infrastructure

Employing drones to measure land is an innovative technological solution which enables better access to information and can spark development in a range of other services.

Solution by: **Uhurulabs**

Deployed in: **Tanzania**

ILLUMINATING SUPPLY CHAINS

In an increasingly globalised world, understanding supply chains in the food and retail sector can be difficult and lead to the unfair treatment of workers, who are invisible to consumers at the point of purchase. Increasing transparency via new technologies allows consumers, companies, and others to influence supply chain choices.



The increasing globalisation of the economy has led to complex, international supply chains in the food and retail sector, where aggregated multinational companies often sell products removed from their origin. It is estimated that 80% of global trade flows are controlled by multinationals. The road from raw material to final product is often blurry and opaque, making informed decision-making difficult. Improving product traceability and supply-chain transparency can deliver greater power to conscious consumers and responsible investors, as well as improving the ability of

procurement departments to make informed decisions. Whether it is sustainable timber products or conflict-free diamonds, creating access to provenance data incentivises companies to operate more sustainably and to respect human rights along their supply chains.

Blockchain technology makes it possible to give products a digital passport from the point of origin, and then track that product as it travels through the supply chain. Every time a product changes hands, the transaction is documented on the blockchain, creating an immutable history from production to sale. It is possible to trace every product back to the origin of raw material used and who has been involved in the production using a distributed, decentralised, and tamper-proof database.

PRODUCTS AND SERVICES

Services in this opportunity include improving certification processes, such as those provided by Provenance, which uses blockchain technology to digitally track products and prove fair trade.

Anything that can be digitised can be stored on the blockchain, which presents opportunities for more digital products that can further improve the certification process. Satellite systems can monitor deforestation and, when linked to smart contracts, pay communities to maintain forests. Artificial intelligence and the blockchain can integrate data

from multiple sources, devices, and systems, and enable enterprises to optimise every aspect of their supply chains with respect to economic, environmental, and ethical criteria.

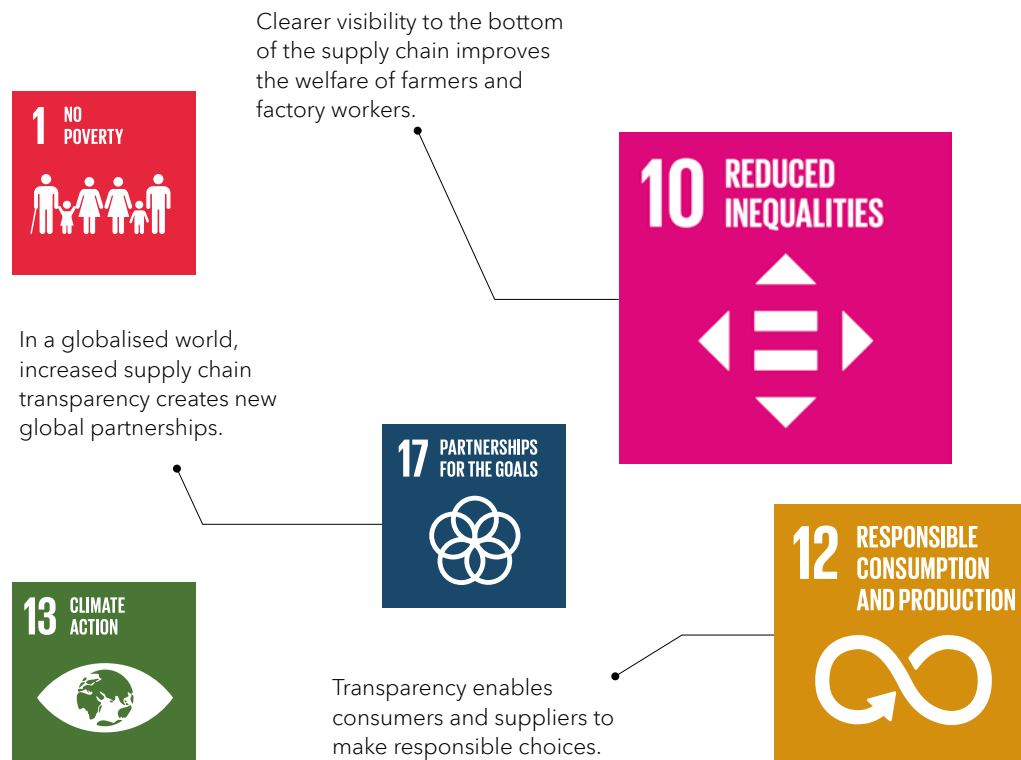
MARKET SIZE AND DEMAND DRIVERS

Transparency pays off. For example, John West, a global producer of canned fish implemented codes enabling customers to trace tuna all the way back to the fisherman who caught it. This opening up of the supply chain netted the company more than \$22 million in increased sales.

This increased demand for transparency and supply chain information is reflected in the growth of eco-labels too. Voluntary sustainability standards are no longer confined to niche markets. Sustainable agricultural products with internationally recognised standards are growing at a higher pace than conventional product markets, particularly in the cotton market, which saw the certified area grow by 250% between 2011 and 2015. Blockchain technology is expected to catalyse further growth in these markets over the next five to ten years, with some estimating CAGRs of more than 70% up to 2022.

While blockchain may have the capacity to improve the transparency of supply chains and reduce inequalities, a lot of electricity is currently required to process transactions. This is a challenge that needs to be addressed before the blockchain can scale sustainably.

IMPACT OF OPPORTUNITY



DEMAND FOR TRANSPARENCY



8 IN 10 CONSUMERS IN THE UK CHECK THE ORIGIN WHEN PURCHASING FOOD PRODUCTS

72%

of millennials in the UK are willing to pay more for sustainable products

\$1.3T

opportunity exists for brands that make their sustainability credentials clear

24.9M

people around the world are victims of forced labour exploitation

71.5%

the expected annual growth in blockchain technology up to 2022

Sources: 1. Nielsen. 'Green generation: Millennials say sustainability is a shopping priority'. 2015. www.nielsen.com. 2. Unilever. 'Report shows a third of consumers prefer sustainable brands'. 2017. www.unilever.com. 3. Alliance 8.7. 'Global Estimates of Modern Slavery'. Report. 2017. 4. BusinessWire. 'Global Blockchain Market Forecasts from 2017 to 2022'. 2017. www.businesswire.com. (Upper right): New Food. '8 in 10 consumers check the origin of their food when purchasing products'. June 2017. www.newfoodmagazine.com

SOLUTIONS



EMPOWERING TRANSPARENCY AND TRACEABILITY

Provenance uses blockchain-based technology that empowers businesses to make themselves, their products, and supply chains more transparent and traceable.

Eighty percent of British shoppers want to know where their food comes from. Provenance – powered by blockchain and open data – enables businesses to build trust in their goods and supply chains, increasing transparency by tracing the origins and histories of products. Digital tagging follows products such as tuna, coffee, or sweatshirts from their very first steps, bringing trustworthy information to the point of sale for the benefit of all. Such transparency and traceability enable producers to share their product's journey, as well as social and environmental impact, with consumers and retailers, thus increasing brand confidence.

GOALS PRIMARILY ADDRESSED



Reduced Inequalities

Provenance increases the visibility of those at the bottom of the supply chain, boosting the economic welfare of low-income farmers and fishermen.



Responsible Consumption and Production

This platform enables consumers to easily select products that have a smaller social and environmental footprint.



Life Below Water

Tracking seafood has been a major use of this technology, encouraging responsibly caught products that do not contribute to the further depletion of wild fish stocks.

Solution by: **Provenance**

Deployed in: **Global**



SUPPLY CHAIN SUSTAINABILITY GUARANTEES RIGHTS

Holistic corporate supply chain policy from Telenor guarantees strong requirements across its entire supply chain of 2.1 million employees.

As a world-leading telecommunications companies, Telenor is working to reduce inequality through a focus on supply chain sustainability, with 97% of its suppliers covered by requirements on health and safety, human and labour rights, environment, and anti-corruption. Capacity building and rigorous monitoring of compliance means that over 80% of non-conformities are mitigated within a year. As the largest telecommunications provider in Myanmar, a country battling with corruption, the policy has been particularly important to improve wages and working conditions, and Telenor has trained over 15,000 workers in the country.

GOALS PRIMARILY ADDRESSED



Decent Work and Economic Growth

Telenor's policy sets out high labour rights and working conditions for all its suppliers, helping to deliver on Goal 8.



Reduced Inequalities

81% of employees impacted by Telenor's supply chain sustainability are based in Asian markets, reducing inequality in one of the world's most unequal regions.



Climate Action

The policy engrains a precautionary principle towards climate change and mandates continuous improvement of suppliers' environmental and climate performance.

Solution by: **Telenor**

Deployed in: **Myanmar**

SOLUTIONS



CONNECTING CONSUMERS TO COMMUNITIES

With the bext360 solution, coffee farmers can move away from paper and receive instant digital payment for their products.

Most coffee farmers operate on a small scale, living on less than \$2 a day. bext360 aims to make it easier for these farming communities to get a fair price, with instant payment for their beans at the farmgate. The solution utilises machine learning and artificial intelligence to source high-quality coffee products directly from the producer, and then employs blockchain technology to create a record of where the beans came from and who paid what for them. This process enables suppliers, retailers, and consumers to know that farmers at the bottom of the supply chain have been paid a fair price for that morning cup of coffee.

GOALS PRIMARILY ADDRESSED



No Poverty

Sustaining a fair price for agricultural products, and fairly remunerating farmers for producing high-quality products, will help to lift coffee farmers out of poverty.



Gender Equality

Since most coffee bean harvesters and growers are women, bext360 helps to promote gender equality, giving women greater access to capital.



Reduced Inequalities

The coffee industry generates \$55B annually, but only \$7B reaches the world's 25 million coffee producers. bext360 improves visibility for those at the bottom of the value chain.

Solution by: **bext360**

Deployed in: **USA**

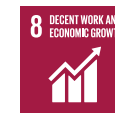


RESPONSIBLE MANUFACTURERS RECEIVE EXPOSURE

Mapping and vetting manufacturers according to their business conduct help suppliers to make more sustainable choices throughout their supply chain.

Unprecedented data availability and changing consumer expectations are driving the demand for more responsibly sourced products. Supplycompass is filling this space with a platform of manufacturers verified as doing responsible business. Manufacturers on the platform are vetted in a three-phase process consisting of a performance data review, verification with inspection visits, including worker interviews, and a final phase where manufacturers sign a code of conduct before being added to the platform. The solution puts the spotlight on socially and environmentally responsible manufacturers in the global supply chain.

GOALS PRIMARILY ADDRESSED



Decent Work and Economic Growth

Transparent information about working conditions enables producers to protect labour rights along their entire supply chain.



Reduced Inequalities

Promoting manufacturers who treat workers well and pay a fair wage, Supplycompass helps sustain better salaries for low-income workers.



Life on Land

By including environmental criteria in the vetting process, Supplycompass promotes manufactures whose operations limit damage to the natural environment.

Solution by: **Supplycompass**

Deployed in: **India**

The background of the slide is a photograph of a large-scale open-pit mining operation. The image shows deep, terraced pits in the earth, with various pieces of heavy machinery like conveyor belts and drilling rigs visible. The entire image is overlaid with a semi-transparent yellow filter. In the upper left corner, the text 'GOAL 12' is written in a white, sans-serif font, underlined.

GOAL 12

RESPONSIBLE CONSUMPTION AND PRODUCTION

Human consumption of goods and services has grown exponentially over recent decades, bringing negative impacts through primary resource extraction, processing pollution, and consumption waste. Achieving economic growth and sustainable development requires us to urgently reduce our ecological footprint by changing the way we produce and consume goods and resources – principles at the core of Sustainable Development Goal 12.





CIRCULAR CONSUMPTION AND PRODUCTION

Businesses and governments are increasingly recognising the need for our production and consumption chains to become more circular, as the division between waste and resources blurs. Europe alone could generate a net economic benefit of \$2.4 trillion by 2030, and see significant environmental and social benefits, by adopting circular economy principles. We find three untapped opportunities in: entomophagy, changing our approach to building materials, and giving new life to old car batteries.

SHIFT

Reducing the meat content in diets will not be easy, but incorporating resource- and energy-efficient **alternative food sources** like insects, could be one way to shift our diets.

CIRCULATE

By employing new circular technologies and approaches, waste in the construction industry and its significant carbon emissions can be reduced. It is **construction in progress**.

REPOWER

By 2035, electric vehicles will account half of all new car sales globally. **Reuse to repower** presents a huge opportunity for car batteries once they are off the road.

"Insects are one of the most sustainable protein sources available and packed full of nutrients."

The edible insect market is crawling with opportunity to feed the world's growing demand for protein. Rose Wang and Laura D'Asaro founded Chirps Chips to convince Americans that insects are delicious, nutritious, and sustainable.



ROSE WANG & LAURA D'ASARO
CEO & COO, co-founders of Chirps Chips

What made you see opportunities in the edible insect market?

I want to back up a bit and help you understand what we have here, and why this is so incredibly exciting. Insects are a food eaten by 2.5 billion people all over the world, in 80% of countries. Some insects taste sour, and others sweet. Some even taste like bacon. We founded Chirps after eating insects abroad and both having the same reaction of "this is really good!" Taste is always a good place to start, but when we look a little closer, it gets even more exciting. Because beyond the flavour, insects are also one of the most sustainable protein sources available and packed full of nutrients. They have more calcium than spinach, more B12 than salmon, and more protein than beef per gram.

What we have here is this whole undiscovered food group that has the potential to solve many of the issues surrounding food's impact on the environment. All that is standing in our way is our perception of insects, and we believe that we can change that. If we can get people over the 'ick factor', we can introduce a new protein source that has the potential to replace animal products in a way that plant-based alternatives have failed.

What are some of the ways in which Chirps Chips offer a more sustainable source of protein?

If we get some of our daily protein from insects instead of larger animal products, then we can reduce our degradation

of agricultural land and water supplies, while producing less greenhouse gas emissions. We are using Chirps as our "gateway bug" to show the food industry that crickets are a much better source of protein than soy and whey protein. In the future, we can use insects to directly replace meat.

Are you embedding the SDGs into your business strategy? If so, what do you see as the main benefits and opportunities they present?

People don't realise that food has such a big impact on our climate. For example, the livestock industry produces more greenhouse gas emissions than all forms of transportation combined. Therefore, if we can reduce our reliance on livestock for protein and still continue to feed the growing human population, then we are massively hitting Goals 11-16.

What's your advice for entrepreneurs looking to solve global challenges?

It takes a village, so don't do anything alone and always doubt and question whether or not you're making an impact. Nothing is ever all good or all bad, but if you keep asking yourself if you're truly making a positive change in the world, then you're more likely to create net positive change.

MAP OF SOLUTIONS

TOWARDS A CIRCULAR ECONOMY

Solutions illustrating how shifting to a more insect-based diet, rethinking construction to be more circular, and utilising discarded car batteries can help end the linear uptake of resources.

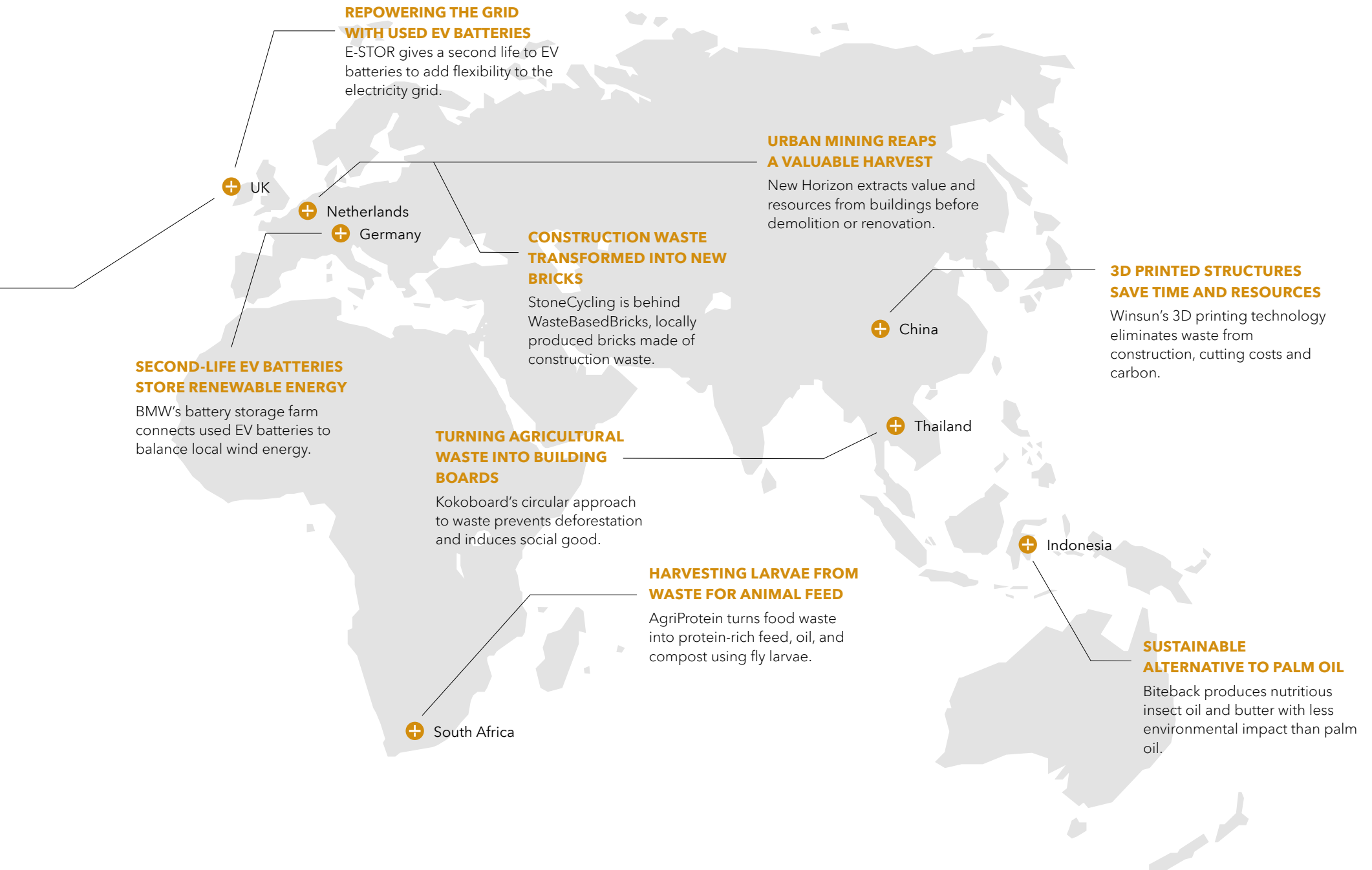
These solutions support Goal 12 by reducing consumption, producing with a conscious mind, and adopting a circular approach. Eating insects that live off the waste we produce, making new buildings out of old demolished material, or giving more value to old car batteries by upcycling them for other purposes are all great examples of responsible consumption and production.

Goal 12 is a global goal that touches on nearly all aspects of how we live our lives. We need to turn the exponential development of global consumption onto a more sustainable path. These solutions are great examples of where we can start.

The solutions on this world map are examples of how a circular approach to consumption and production can change our unsustainable linear economy. Read more about the solutions featured here, and discover further information and many more solutions that tackle Goal 12, on the Global Opportunity Explorer.



SOLUTIONS TO REDUCE OUR ECOLOGICAL FOOTPRINT



ALTERNATIVE FOOD SOURCES

Insects have been a food staple in some countries for centuries, but they are now beginning to disrupt Western agriculture and aquaculture with their high feed efficiencies and attractive environmental credentials. With increasing demand for high-protein food and new products appearing regularly, this is a breakthrough market to watch.



The world population is expected to grow to 9 billion by 2050, which will require a doubling of food production. Rising incomes and urbanisation in developing countries are creating increased protein demand, with dangerous consequences for resource usage. The US food production system is estimated to use 80% of the country's freshwater, 50% of the total land area, and 17% of the fossil energy. Additionally, the global agriculture system is estimated to be

responsible for around 18% of anthropogenic greenhouse gas emissions. There is a clear need to ensure that we feed the growing population in a sustainable way, while also ensuring food security for all.

Entomophagy, or the eating of insects, is one way to supplement protein in a diet, with reduced resource and energy intensity per land area. Insects also have a higher feed conversion efficiency, lower risk of passing an infection on to people, and impressive nutritional stats compared with traditional animal agriculture. As well as directly reducing demand for traditional livestock, insects also have a role to play in making other types of agriculture more sustainable. For example, replacing soya as a cattle feed can reduce deforestation and associated biodiversity loss by requiring less land per kilo of feed. Insects are also a more sustainable aquaculture feed compared with traditional fish or animal-based feeds.

PRODUCTS AND SERVICES

We currently know of about one million species of insects, a handful of which are being used to create oil products (for consumption, as well as use as a lubricant or paint ingredient), animal feed (livestock and aquaculture), and food for human consumption (including flour). Due to their processing abilities, insects are also being utilised to harvest organic waste and produce fertiliser. Scientists estimate there

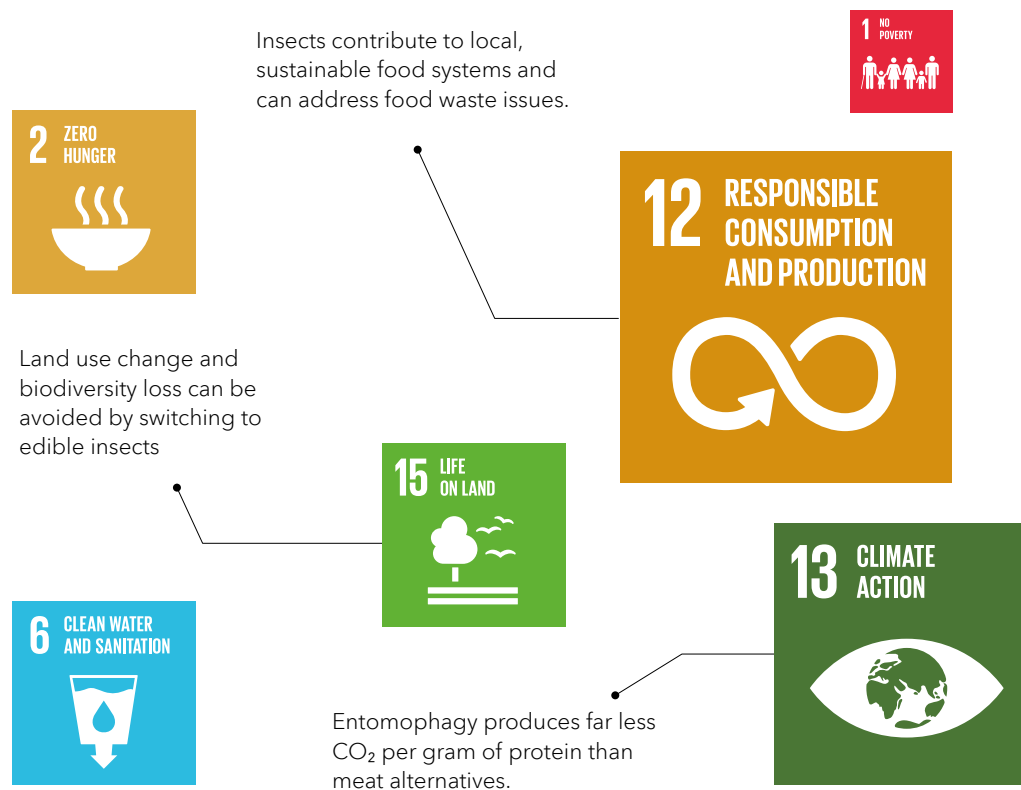
could be a further 29 million undiscovered species, which could encompass many more species with ideal properties for human consumption and/or sustainable agriculture.

MARKET SIZE AND DEMAND DRIVERS

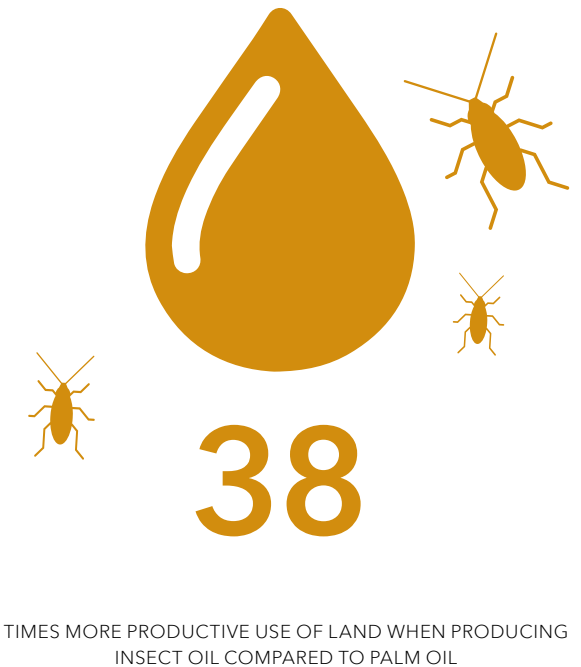
The global market for edible insects is predicted to rise to \$772.9 million by 2024, with a CAGR of 6.1% over the forecast period 2016-2024. Some sub-sectors expect more aggressive growth, with industry gains of up to 40% CAGR. The use of insect-processed animal proteins for aquaculture opens an impressive \$90 billion market as new EU regulation will come into force in 2018.

Cultural, legal, and regulatory barriers to further insect consumption still exist in many areas of the world. Certain societies still find insect consumption daunting, and even culturally inappropriate, although products once removed from the original form – such as cricket-flour-based products – are starting to change that. The ethics of high-density insect farming also needs careful consideration, as well as the effects on wild insect populations and biodiversity.

IMPACT OF OPPORTUNITY



SIGNIFICANTLY MORE FROM LESS



100

times less GHGs emitted from insects than from pigs or cattle

\$33M

the size of the global market for edible insects in 2015

31%

beetles' share of global edible insects market value in 2016

102%

CAGR of insect feed production to 2022

Sources: 1. FAO. 'Edible insects - Future prospects for food and feed security'. Report. 2013. 2. Global Markets insights. 'Edible Insects Market Size By Product'. 2016. www.gminsights.com. 3. Persistence Markets Research. 'Global Market Study on Edible Insects'. 2016. www.persistencemarketresearch.com. 4. Research and Markets. Worldwide Insect Feed Market: Market Size and Forecasts (2017-2022). 2017. www.researchandmarkets.com (Upper right); P.A. Marone, Chapter 7 - 'Food Safety and Regulatory Concerns, In Insects as Sustainable Food Ingredients'. Academic Press, San Diego, 2016.

SOLUTIONS



SUSTAINABLE
ALTERNATIVE TO PALM OIL

Biteback is a nutrient-dense, environmentally friendly substitute for palm oil, which is causing mass deforestation in Southeast Asia. The alternative? Insects.

Biteback has developed a process to extract oil from edible insects. Insects require little feed, water or land, and produce almost no greenhouse gases – a much more sustainable alternative to palm oil. In just one year, insects yield almost 38 times more oil than oil palms do using the same amount of land. As well as being eco-friendly, insect oil is healthy. And with oil present in most industrial food, there are health gains to be made. Insect oil is rich in healthy fatty acids, minerals, and vitamins, low in cholesterol, and does not require pesticides or fertilisers – a win for people and the planet.

GOALS PRIMARILY ADDRESSED



Zero Hunger
Insect oil is rich in nutrients, such as iron. Eating insect oil can therefore supply the world with a vital nutrient and alleviate anemia caused by iron deficiency.



Responsible Consumption and Protection
Palm oil is found in 50% of all packaged items. Switching to insect oil will minimise the use of natural resources and allow more sustainable oil production.



Life on Land
A hectare of land can produce either four tonnes of palm oil or 150 tonnes of insect oil in a year. Choosing insect oil reduces both deforestation and the loss of biodiversity.

Solution by: **Biteback**
Deployed in: **Indonesia**



HEALTHY COOKIES AND CHIPS FROM
CRICKET FLOUR

Chirps Chips uses flour made from crickets to create tortilla-style chip snacks that are nutritious and eco-friendly.

Using crickets milled into a flour to make tortilla chips, Chirps Chips' snacks are healthy and have a low environmental impact. The chips, called "Chirps," contain beans, chia seeds, corn, peas, and cricket flour. Crickets are 70% protein, and the flour derived from them is high in calcium and iron. Embracing cricket protein can reduce the food sector's environmental footprint, as compared to livestock, insects have a far lower carbon, energy, and land intensity per gram of protein. Chirps Chips is normalising cricket consumption, removing the "ick" factor, and demonstrating insects' healthy, affordable, and sustainable properties.

GOALS PRIMARILY ADDRESSED



Zero Hunger
Insects are a readily available, underutilised source of nutrients. By making chips, Chirps Chips helps to normalise the consumption of insects in the Western world.



Good Health and Well-being
Insects are high in protein, nutrients, and fibre, and can help alleviate malnutrition. Chirps contain three times as much protein and half as much fat as potato chips.



Life On Land
By using insects to make a flour alternative, Chirps Chips could reduce the demand for new agricultural land to grow traditional flour sources such as wheat.

Solution by: **Chirps Chips**
Deployed in: **USA**

SOLUTIONS



HARVESTING LARVAE FROM WASTE FOR ANIMAL FEED

Turning food waste into protein-rich feed, oil, and compost using fly larvae is a sustainable alternative to ocean-depleting fishmeal.

The company AgriProtein is on a mission to stop the unsustainable use of fishmeal and start restoring our seas. The company's waste bioconversion plants will each divert more than 90,000 tonnes of organic landfill waste and upcycle nutrients in organic food waste to produce larvae feed. This results in three products: a soil enhancer for crop producers called MagSoil, and two feed products MagOil and MagMeal. MagMeal is an early stage "super feed" aiming to limit the global use of fishmeal. It takes 1.5 kg of fishmeal to make 1 kg of farmed fish, threatening to further deplete the oceans' fish stocks.

GOALS PRIMARILY ADDRESSED



Responsible Consumption and Production

By diverting organic waste from landfills and utilising it for larvae feed, waste generation is significantly reduced, contributing to Goal 12.



Climate Action

Unlike fishmeal, MagMeal can be produced where it is used and therefore has an environmental cost saving of \$2,000 per tonne compared to fishmeal.



Life Below Water

For every tonne of AgriProtein's MagMeal substituted for fishmeal, three tonnes of fish remain in the ocean, safeguarding ocean life and marine ecosystems.

Solution by: **AgriProtein**

Deployed in: **South Africa**



MODULAR, DUAL-PURPOSE INSECT FARM

Terreform builds modular insect farms that can also function as shelters, aiming to maximise nutrient resources and provide disaster support in distressed regions.

Terreform seeks to solve multiple global issues with one solution: modular insect farms. By sculpting the insect farm into a shelter structure, the farms can serve as temporary shelters, and can easily be turned into permanent farming systems. The project intends to help prevent a global food crisis by producing insects as an alternative source of protein. It is significantly more sustainable to harvest insects for food than it is to harvest other animal products. Insect-sourced protein will serve as a vital component in solving global food distribution problems; Terreform is proving that insect farms can look good and do good in the process.

GOALS PRIMARILY ADDRESSED



Zero Hunger

The Food and Agriculture Organization of the UN has cited insect-sourced protein as one of the integral solutions to help solve global hunger.



Clean Water and Sanitation

Harvesting insects requires three hundred times less fresh water per gram of protein than that used for cattle or pigs, contributing to the sound management of freshwater.



Responsible Consumption and Production

Insects can be fed organic waste streams, helping to tackle the growing issue of food waste, which contributes substantially to global carbon emissions.

Solution by: **Terreform**

Deployed in: **USA**

CONSTRUCTION IN PROGRESS

As we build the world around us at ever-growing speed, the highly-emitting construction sector must adopt circular approaches and adapt to disruptive technologies in order to cut emissions. Upcycling waste into construction materials will result in a six-fold value increase, strengthening the industry's foundations.



The construction industry accounts for 6% of global GDP and employs 100 million people worldwide. It is also the largest global consumer of raw materials, with constructed objects accounting for 25% to 40% of the world's carbon emissions. Cement production, half of which occurs in China, represents almost 5% of all carbon emissions. These figures are likely to grow as construction keeps up with economic growth and urbanisation. The acceleration in construction is most evident

in China, where more concrete was used between 2011 and 2013 than in the United States during the entire 20th century.

Despite being such a valuable and pervasive industry, the industry's low-risk approach means that outdated techniques and economic inefficiencies are widespread. In the United States, for example, 40% of all solid waste comes from the construction industry, and globally, roughly a quarter of building materials deployed on site are wasted due to over-ordering. Reducing waste volumes and incorporating the remaining waste streams into circular models can unlock value for innovators and reduce the construction industry's environmental impact. One example of such an approach is StoneCycling, which builds houses with bricks made from old construction waste – all sourced locally.

PRODUCTS AND SERVICES

This opportunity brings a range of new products and services such as 3D printing of construction material. Winsun in China has demonstrated a process that can source 50% of the printing material from construction and mining waste. In addition, the process minimises waste in the construction process and reduces the overall material usage by up to 60% compared to traditional construction methods.

The “product as a service” concept is also growing in this sector, blurring the boundaries between products and

services. Instead of selling the product itself, the benefits of the product are sold, with the provider retaining ownership and therefore responsibility for a product at the end of its life cycle. This can include anything from building materials that make up a structure, components for heating systems, or even electricity-generating photovoltaic cells.

Urban mining is another new service that arises from the circular approach to old buildings, with a focus on extracting existing raw materials from buildings scheduled for demolition or refurbishment. Studies have calculated that urban mining could deliver property developers returns of 10% on refurbishment investment.

MARKET SIZE AND DEMAND DRIVERS

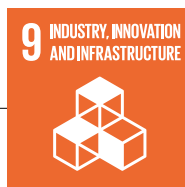
Global construction output is forecast to grow by 85% to \$15.5 trillion by 2030, 57% of which is accounted for by China, the US, and India. International agreements and national strategies will be key drivers for ensuring future buildings fit into circular models. Additionally, there is a growing demand from architects and developers for new buildings to meet carbon neutrality standards. Although still small in scale, the 3D concrete printing market is estimated to grow from \$24.5 million in 2015 to \$56.4 million by 2021, at a CAGR of 15%.

IMPACT OF OPPORTUNITY



Cutting waste generation through more efficient processes and new recycling methods.

Adoption of environmentally sound practises reduces emissions per unit of value added.



Circular approaches to construction ensure more efficient use of natural resources.



SMALL IMPROVEMENTS YIELD SIGNIFICANT SAVINGS



1%

RISE IN PRODUCTIVITY WORLDWIDE COULD SAVE \$100
BILLION A YEAR

70%

of the buildings that will stand in
India in 2030 are yet to be built

1 TON

of construction and demolition
waste is produced per person
each year in Europe

30%

energy savings are possible by
harnessing today's capacity of
the building sector

104,000

tonnes of recycled crushed
concrete helped used to build
London's 2012 Olympic Park

Sources: 1. Arup, Bam & CE100. 'Circular Business Models for the Built Environment'. Report. 2017. 2. European Commission. 'Circular economy'. Ec.europa.eu. 3. World Economic Forum. 'Shaping the Future of Construction'. Report. 2016. 4. Ellen MacArthur Foundation. 'Circularity in the Built Environment'. Report. 2016. (Upper right): World Economic Forum. 'Shaping the Future of Construction'. Report. 2016.

SOLUTIONS



TURNING AGRICULTURAL WASTE INTO BUILDING BOARDS

Kokoboard is turning trash into cash and alleviating rural poverty by upcycling agricultural waste products into building materials and trendy products.

In Asia, more than 24 million tons of agricultural waste are produced every year, and are mostly incinerated, releasing carbon to the atmosphere. Kokoboard has instead found a use for such waste streams, turning coconut husks, peanut shells, and rice straw into construction boards, sequestering more than 200 tons of CO₂ annually. Based on a mission to improve social and economic well-being locally, as well as protect the environment on which we depend, Kokoboard is also upcycling its products further into trendy lifestyle and homeware goods. In addition, the company sells the plans for its machinery, allowing others to replicate its good work.

GOALS PRIMARILY ADDRESSED



No Poverty
Farmers who produce a great deal of agricultural waste can improve their economic well-being by selling their waste to companies for upcycling.



Life On Land
Southeast Asia loses 1% of its forests every year, leading to significant biodiversity loss. Kokoboard removes one driver of deforestation by providing alternatives to timber.



Partnerships for the Goals
Kokoboard is working with farmers to show the value of their waste streams, tackling SDG 12 in partnership.

Solution by: **Kokoboard**
Deployed in: **Thailand**



3D PRINTED STRUCTURES SAVE TIME AND RESOURCES

Winsun's 3D printing technology uses industrial solid waste to replace cement in the production of a new type of low-carbon building.

Despite the 17% annual growth of China's enormous construction industry, which has increasing influence internationally, the sector has lacked innovation in new building techniques. Since 2014, Winsun's mission has been to change that, using 3D printing to produce more than 22 million m² of prefabricated building materials from industrial solid waste. The "ink" used is made from 100% recycled materials, saving 18,000 tonnes of cement in 2016 alone. The structures are highly energy efficient, can withstand magnitude 9 earthquakes, and save significant time and resources during construction, with less waste and pollution of the environment.

GOALS PRIMARILY ADDRESSED



Good Health and Well-being
By using 3D printing structures in factories, air pollution from construction is vastly reduced, a benefit to all those suffering from respiratory illnesses.



Affordable and Clean Energy
Winsun's buildings are 40% more energy efficient than conventional alternatives, reducing the energy demand on China's coal-dominated electricity grid.



Industry, Innovation and Infrastructure
Winsun is demonstrating innovative techniques that can help reduce the environmental footprint of an industry that is quite literally building our future.

Solution by: **Winsun**
Deployed in: **China**

SOLUTIONS



CONSTRUCTION WASTE TRANSFORMED INTO NEW BRICKS

StoneCycling uses local construction waste to produce bespoke building materials that both look good and do good.

In the EU, construction waste accounts for one-third of all waste generated. StoneCycling is taking steps to reduce that waste, using material from old construction projects to produce bespoke bricks with unique colours, shapes, and textures. The inputs for the products are waste ceramics, glass, and insulation, as well as rejected clay from traditional brick manufacturing – all locally sourced. Reusing materials diverts construction waste from landfill and reduces the demand for virgin materials. The company has bold plans for 2018 and aims to upcycle more than 1,000 tonnes of waste into new bricks.

GOALS PRIMARILY ADDRESSED



Responsible Consumption and Production

Reducing waste generated in the construction process, StoneCycling is making the most out of resources with its WasteBasedBricks.



Partnerships for the Goals

StoneCycling works closely with leading architects, designers, construction companies, and developers to create a more circular world, changing the perception of waste.

Solution by: **StoneCycling**

Deployed in: **Netherlands**



URBAN MINING REAPS A VALUABLE HARVEST

In a new way of thinking, New Horizon aims to transform demolition into a process of mining resources, thereby retaining the value of building elements and raw materials.

The Dutch company New Horizon works to promote a circular approach to the reuse of resources tied up in existing buildings. Facilitating the urban mining of valuable resources, the company creates value from waste streams released during demolition. It wants to transform the use of the terms “demolish” and “waste” to “dismantling” and “raw materials.” New Horizon carries the entire risk for its clients during the demolition process, making it more attractive for developers to reuse materials. Actively promoting and creating demand for raw materials still present in buildings, the company also guarantees a destination for these materials.

GOALS PRIMARILY ADDRESSED



Responsible Consumption and Production

One ton of construction and demolition waste is produced per capita in Europe each year, and transitioning to a circular approach will reduce the need for new raw materials.



Climate Action

The production of new building materials is very energy intensive and associated with large CO₂ emissions, so reusing old material will reduce the sector's high emissions.



Life Below Water

Extensive sand extraction physically alters rivers and coastal areas. A circular approach to construction can slow the increasing demand for sand.

Solution by: **New Horizon**

Deployed in: **Netherlands**

REUSE TO REPOWER

As the mobility sector transitions to an electric future, we will soon see a wave of used batteries becoming obsolete when their capacity becomes too low to use in electric vehicles (EVs). However, by repurposing mobile EV batteries in new stationary settings, it is possible to double battery life cycles to more than 20 years.



The huge growth in the number of electric vehicles (EVs) on our roads means a growing supply of used batteries, which are considered depleted when their capacity is reduced to 80%. While no longer suitable for mobile energy storage, these batteries could still have long lives in stationary settings. Second-life batteries can be used at utility-scale, commercial-scale, and even in community or local power applications. Extending the battery life contributes to reducing waste and resource exploitation.

Even though established recycling technology exists, repurposing EV batteries to delay the recycling process extends the value of each battery and reduces the overall environmental impact. The University of California, San Diego, was among the first large energy users to demonstrate the potential of second-life batteries in 2013, when it networked 108 kilowatts of batteries from BMW's Mini E, connecting to the microgrid that provides almost all of the campus's electricity needs.

PRODUCTS AND SERVICES

Second-life batteries can be used in a range of applications, including residential electricity storage. By integrating used EV batteries, homes can store energy from solar and other renewable sources, or draw from the grid when electricity is cheapest, providing benefits for grid balancing and consumer costs. Such systems are already on the market, such as Nissan and Eaton's collaboration: xStorage.

Expanding into the used EV battery market is attractive for car manufacturers, as it extends the batteries' revenue lifetime and increases the EV resale value. Innovative models, such as providing batteries as a service, are already being adopted by firms such as Renault. The company leases batteries instead of selling them, meaning that once batteries reach the end of the road, the manufacturer can re-engineer or recycle them for future use.

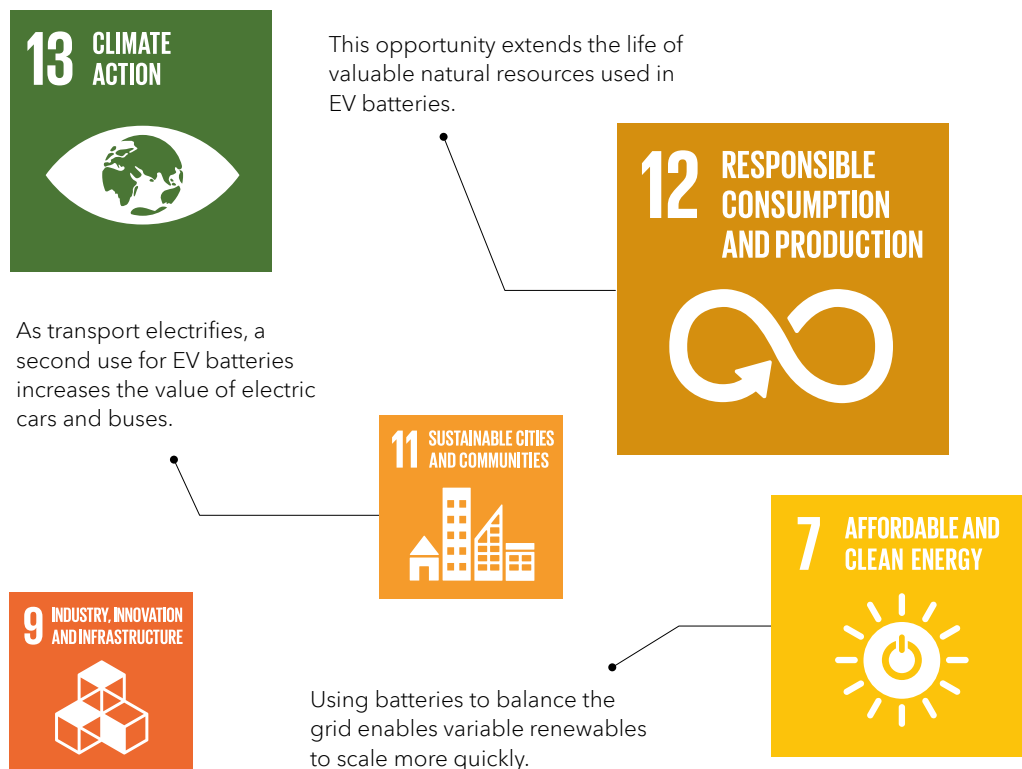
Second-life battery applications can help to scale EV technology, lower costs and balance demand on the grid, and can be used in combination with renewable energy to lower carbon emissions.

MARKET SIZE AND DEMAND DRIVERS

There are expected to be as many as 37 million EVs on the road by 2025. The global electric vehicle market is forecast to grow at a CAGR of 41% between 2014 and 2023. Worth an anticipated \$93.1 billion by 2025, the lithium-ion battery market is growing at a CAGR of 17%, representing significant business opportunities.

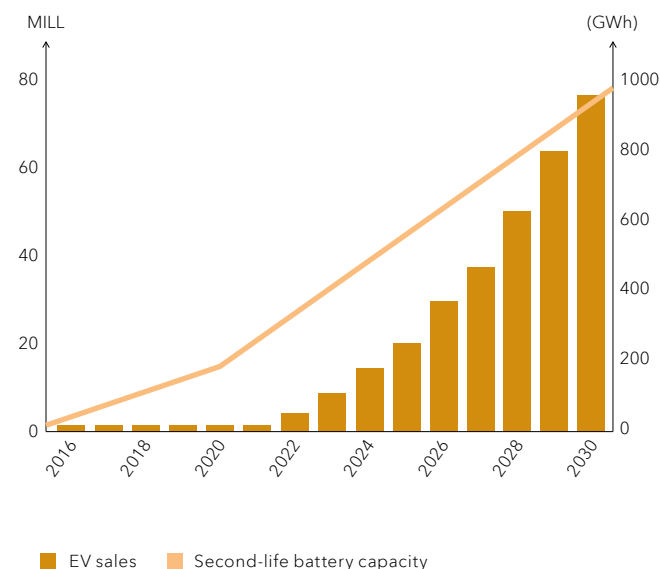
Second-life batteries can become an important element in virtual power plants, a market expected to grow from an estimated \$193 million in 2016 to \$709.2 million by 2021, with a CAGR of 29.68%.

Used EV batteries could be an important element of a decarbonised energy system where an increasing reliance on variable renewables requires greater flexibility from energy storage. While the lack of practical performance data adds some uncertainty to the economic future of second-life batteries, there is a rapidly growing market, and the oncoming wave of used EV batteries will mean a wealth of opportunities for those ready to take them.



FLEXIBLE STORAGE FOR RENEWABLES

SECOND-LIFE BATTERY CAPACITY TO REACH ALMOST 1,000 GWH IN 2030



1/3

of the energy storage capacity mandated in California by 2020 can come from second-life EV batteries

95GWH

of battery capacity will come out of EVs by 2025

1/6

the price of using second-life EV batteries compared to new stationary batteries

57%

of the world's energy storage capacity in 2040 will consist of batteries storing solar power

Sources: 1. Berkeley Law. 'Reuse and Repower'. Report. 2014. 2. Bloomberg New Energy Finance. Lithium-ion Battery Costs and Market. Report. 2017. 3. Bloomberg New Energy Finance. 'Electric vehicles - It's not just about the car'. 2016. www.bnef.com. 4. World Economic Forum. 'Batteries can be part of the fight against climate change'. 2017. www.weforum.org. (Upper right): Reid, G. & Julve, J. 'Second Life-Batteries As Flexible Storage For Renewables Energies'. Report. 2016.

SOLUTIONS



REPOWERING THE GRID WITH USED EV BATTERIES

Giving a second life to EV batteries, E-STOR is a scalable, modular setup that adds flexibility to the electricity grid and offers EV charging solutions.

Ninety-five percent of energy for transport comes from fossil fuels, but that is changing as the market for electric vehicles (EVs) expands. With a growing number of used EV batteries becoming available for reuse, Connected Energy is building E-STOR, a solution that uses second-life Renault EV batteries for grid-scale electricity storage. Such storage is playing an greater role in the wider grid, with governments and companies pushing its development thanks to its ability to save costs and support renewables. The units can also be connected to EV fast-charging stations to help scale that technology.

GOALS PRIMARILY ADDRESSED



Affordable and Clean Energy

As electricity grids rely more on variable renewables, grid-scale storage is becoming a key factor for reducing dependency on fossil fuels at peak times.



Sustainable Cities and Communities

E-STOR's use of rapid-charging stations where grid connections are limited can help to scale sustainable transport systems.



Responsible Consumption and Production

Finding a second use for batteries before eventual recycling is a truly circular way of using valuable resources.

Solution by: **Connected Energy**

Deployed in: **UK**



ACCELERATING HOME ENERGY STORAGE

Reliable and affordable residential energy storage utilising used EV batteries accelerates the green energy transition.

One trend in the low-carbon energy transition is the change from consumers to prosumers, where households generate their own renewable electricity. xStorage home battery systems – built using second-life Nissan Leaf batteries – enable prosumers to store excess renewable electricity for use at times when the sun isn't shining. This allows the 24-hour use of renewable energy in the home, saves the cost of buying from the grid at peak times, and protects against outages. The units, storing up to 7.5 kWh, are built in collaboration with Nissan and the power management firm Eaton.

GOALS PRIMARILY ADDRESSED



Affordable and Clean Energy

Boosting residential storage offers increased benefits for prosumers who generate their own renewable energy.



Responsible Consumption and Production

Embracing circular principles, xStorage ensures that batteries are reused in another setting before being recycled.



Partnerships for the Goals

xStorage is the result of a collaboration between Nissan and Eaton, bringing together each company's strengths to create a product for a more circular economy.

Solution by: **Nissan and Eaton**

Deployed in: **UK**

SOLUTIONS



SECOND-LIFE EV BATTERIES STORE RENEWABLE ENERGY

BMW's battery storage farm at its Leipzig production facility connects old EV batteries into a large-scale storage system that balances local wind energy.

EVs are forecast to account for 95 GWh of used battery capacity by 2025, no longer suitable for mobility uses, but major manufacturers are starting to see this as a new resource, not a problem. BMW is driving change in the industry with its battery storage farm, which connects 700 BMW i3 high-capacity batteries to onsite wind resources and the local grid, with enough storage capacity to power 50,000 homes for one month. The modular system provides grid balancing and increased security of supply, saves on energy costs by absorbing electricity when prices are low, and increases the adoption and growth of renewable energy and EVs in Germany.

GOALS PRIMARILY ADDRESSED



Industry, Innovation and Infrastructure

BMW's cyclical approach, using old products to assist its transition to a low-carbon economy, can show other firms how to become more sustainable.



Responsible Consumption and Production

The life-cycle approach demonstrates a new circular business model and reduces the environmental footprint of EVs.



Life on Land

Mining the resources needed to produce batteries has been linked to soil and water pollution. Finding a second use for EV batteries can help alleviate these concerns.

Solution by: **BMW**
Deployed in: **Germany**



SUSTAINABLY RECOVERING BATTERIES' RESOURCES

Recycling spent lithium-ion batteries with new methods creates new value without costing the earth.

Only 5% of lithium-ion batteries are recycled at the end of their useful lives, and smelting processes to do so are typically incredibly energy intensive and polluting. Li-Cycle has developed a new chemical technique to recycle some of the 11 million tonnes of spent lithium-ion batteries that will be discarded by 2030. The process uses significantly less energy and produces far less waste and pollution than conventional methods, allowing batteries to be recycled at less financial and environmental cost. The firm claims to have the potential to reduce greenhouse gas emissions by more than 1 billion tonnes of CO₂ equivalent by 2040.

GOALS PRIMARILY ADDRESSED



Clean Water and Sanitation

Li-Cycle's innovative recycling methods are more water-efficient and result in far less water pollution than typical recycling methods.



Industry, Innovation and Infrastructure

The electric vehicle industry offers a path to a greener future, and this solution ensures that the full life cycle of each car can be sustainably managed.



Responsible Consumption and Production

Offering an affordable way to increase recycling rates of valuable natural resources will be critical to delivering on Goal 12.

Solution by: **Li-Cycle**
Deployed in: **Canada**

GOAL 13

CLIMATE ACTION

The global economy has been powered by fossil fuels for the past 300 years, so weaning ourselves off the fuels that have already started to cause shifts in climates around the world is no simple task. Sustainable Development Goal 13 is all about the opportunity for the public and private sectors to accelerate mitigation action while protecting the most vulnerable from the consequences of climate change.







CHANGING CLIMATES CHANGING FORTUNES

On 12 December 2015 in Paris, the Paris Climate Agreement was adopted by 196 parties. They agreed to limit global temperature rise to well below two degrees Celsius. Policy tools have been put in place to help society transition to a low-carbon future, but it is businesses that have and will continue to deliver emissions reductions. With the cost of climate change estimated to be anywhere between \$12 and \$60 trillion, there is clearly a huge opportunity for businesses everywhere to innovate and deliver low-carbon solutions.

REDUCE

To reduce climate change, there is an opportunity in **upcycling carbon** instead of just releasing it to the atmosphere.

COOL

Space cooling is the fastest-growing end energy consumer; to slow this trend, we need to reassess how we are **keeping it cool**.

SHIP

A range of technologies and measures are available to achieve **sustainable shipping** – electrifying the shipping industry is an important step in decarbonising the sector.

"Unique fuel switch opportunity is decoupling power consumption and cooling."

As cities swelter in ever-increasing heat waves, cooling demand is on the rise – as is its environmental impact. Lars Munkøe rose to meet this challenge by co-founding Purix in Italy, launching a green and attractive air-conditioning alternative to the market.



LARS MUNKØE

Co-founder and Director of Purix

Worldwide, the cooling sector is a major emitter of greenhouse gas emissions. How does Purix reduce the climate impact of cooling technologies?

Purix-patented technology substitutes electricity consumption with low-carbon and low-cost energy sources such as solar thermal energy, district heating, or industrial waste heat. This unique fuel switch opportunity is decoupling power consumption and cooling.

Unlike conventional air-conditioners, Purix systems use water as a natural refrigerant, instead of industrial refrigerants, which are hazardous substances with high global warming potential.

What are the greatest challenges you see in your industry today?

We see a lack of awareness about the availability of commercial, green, and competitive cooling technology among end users, architects, design companies, installers, utility companies, and public organisations.

Some have suggested that only the companies that build the SDGs into their business will survive. Do you agree?

Sustainability is the core backbone of Purix. We believe that a merging of business with the Sustainable Development Goals is a robust, strong, and long-term business driver from a commercial, legislative, and technical perspective.

You are part of the Green Cooling Initiative (GCI), which aims to promote green cooling worldwide. How have you pursued this goal so far?

GCI represents a community and stakeholder for sharing insights, developments, and initiatives related to commercial applications of natural refrigerants and energy sources for cooling.

Purix and GCI have a global target audience and stakeholders in common, with the purpose of increasing the awareness and use of commercially available green cooling technologies and products.

Purix actively searches for partnerships between governments, the private sector, and civil society with the purpose of increasing the use of green cooling technology.

What's your advice for entrepreneurs looking to solve global challenges?

The core of the philosophy at Purix throughout the R&D, industrialisation, and commercialisation phases, has been to thoroughly understand the market mechanisms of the value chain and business drivers of the addressed segment first. Secondly, being a technology provider, we believe in a highly scalable and agile supply chain, in order to reach out to a global and competitive market.

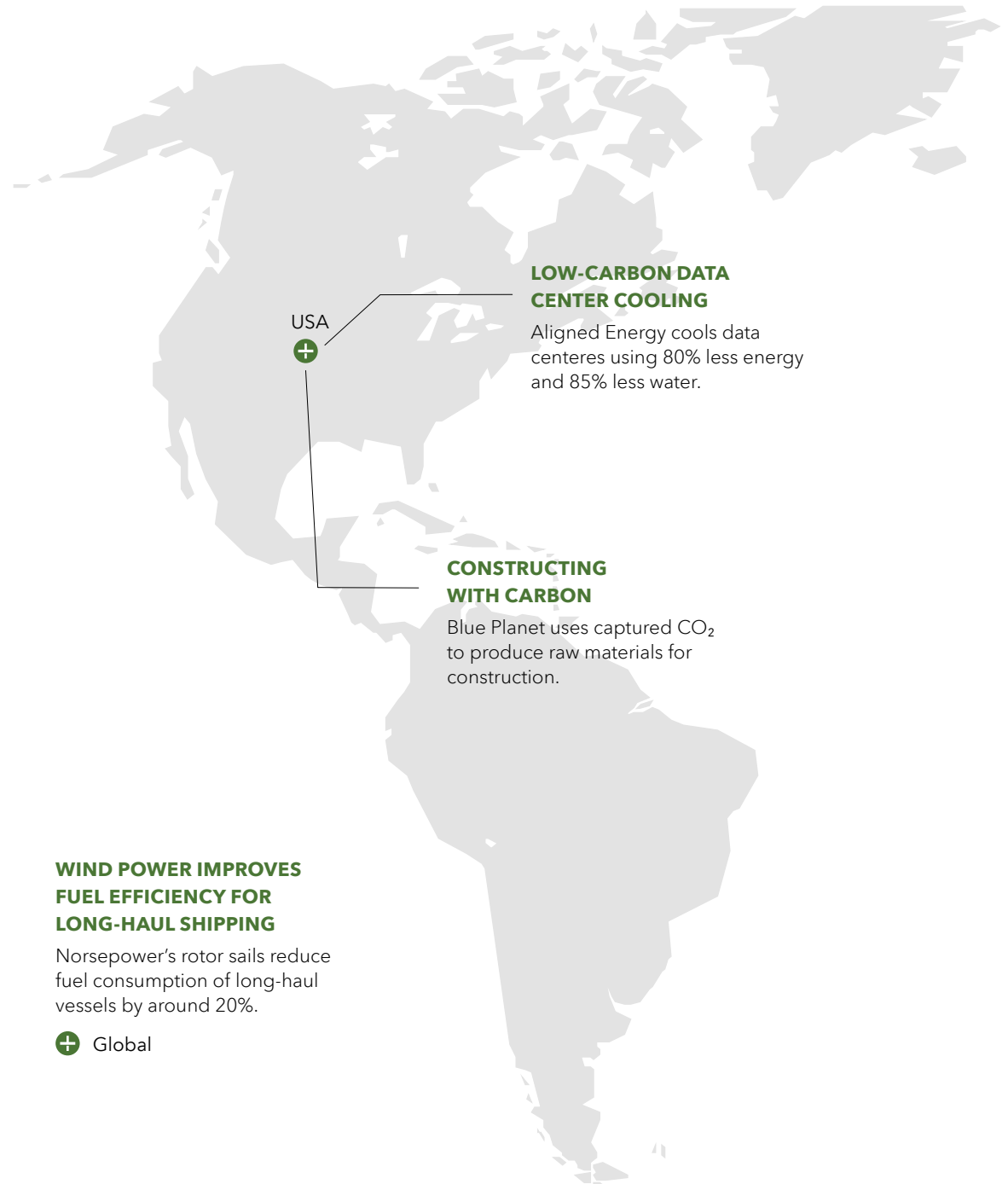
SOLUTIONS TO SLOW GLOBAL EMISSIONS

There is an urgent need for new solutions that minimise the social, environmental, and economic damage caused by climate change. These solutions reduce emissions and make it possible to cool buildings or ship goods sustainably.

Solutions that turn planet-warming emissions into profit present a new take on carbon capture and storage solutions that have been around for decades. Turning CO₂ into new products and making biofuels from CO₂ are examples of these new innovative solutions. Cooling in an increasingly warmer world will require new solutions using little or no electricity. Solutions utilising new technologies, designs, and energy sources for cooling are readily available.

Shipping is the world's preferred and most efficient mode of transporting goods, but the race is on to make it more sustainable. Autonomy, wind power, and electrification are some of the solutions for setting the course to decarbonise the shipping industry.

The solutions on the world map are examples of how innovative new technologies offer ways to mitigate climate change. Read more about the solutions featured here, and discover further information and many more solutions that tackle Goal 13, on the Global Opportunity Explorer.



LOW-CARBON DATA CENTER COOLING

Aligned Energy cools data centers using 80% less energy and 85% less water.

CONSTRUCTING WITH CARBON

Blue Planet uses captured CO₂ to produce raw materials for construction.

WIND POWER IMPROVES FUEL EFFICIENCY FOR LONG-HAUL SHIPPING

Norsepower's rotor sails reduce fuel consumption of long-haul vessels by around 20%.

+ Global

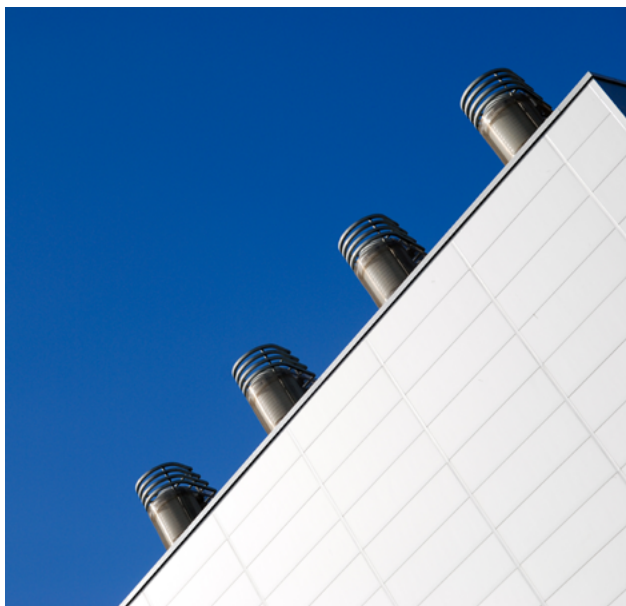
COMBATING CLIMATE CHANGE



OPPORTUNITY

UPCYCLING CARBON

Urgently cutting carbon emissions at source is essential to mitigating catastrophic climate change, and negative emissions are needed to keep us on the well below 2°C pathway. Business is increasingly discovering ways to upcycle carbon, generating more value, emitting less and accelerating carbon negative technologies.



In 2017, atmospheric concentrations of carbon dioxide exceeding 410 parts per million were recorded at the Mauna Loa Observatory in Hawaii – a level not seen on Earth for the last 15 million years. For centuries, our entire economies relied on burning fossil fuels to generate useful energy, and the release of CO₂ was considered an inconsequential by-product. We now know however, that this accumulation will change life on Earth, and without fast action, climate change

will have catastrophic consequences. To achieve net-zero emissions by 2050, business is investing in clean technology, reducing risks and building resilience. The maturing carbon price is enabling business to reimagine carbon as a resource in commercial activities, gaining more value from less carbon.

According to some scenarios, keeping global warming below 1.5°C by 2100 will require a combination of negative emissions technologies and other mitigation options. Depending on the scenarios used, some research suggests that the carbon-based products industry has the potential to capture 1-7 Gt CO₂ per year, bridging 3-20% of the gap between the current commitments under the Paris Agreement and the well below 2°C goal. According to the 2017 UN Emissions Gap Report, material science and manufacturing could yield a breakthrough to fast-track the development and bring down costs of wider CO₂ removal technology, driving towards a zero-carbon, circular economy.

PRODUCTS AND SERVICES

As the social and economic drive to reduce carbon emissions increases, companies are looking to maximise value from less carbon. Since carbon is a fundamental ingredient in the global manufacturing industry, CO₂ is being integrated into existing processes, especially for production of chemicals, fuels, construction materials and plastics. One firm in India is using waste industrial CO₂ to make bio-oils, while a British

company uses it to make sofas and car parts, and others are creating new plastics from the greenhouse gases. Ongoing research is working on converting carbon into fuels and even edible proteins, where renewable energy can make these innovations both economically and environmentally feasible.

MARKET SIZE AND DEMAND DRIVERS

Carbon-based products can tap into a vast number of growing markets, such as methanol production, which has a forecast 7-9% CAGR to 2030. It is estimated that up to 10% of annual CO₂ emissions can be captured in these products, with a potential annual revenue opportunity of \$800 billion to \$1.1 trillion. Key market drivers in this opportunity space are technological advances allowing concentration of atmospheric CO₂, as well as regulation and market-based policy tools that are delivering effective carbon prices.

Utilising atmospheric carbon in new products does not tackle the root cause of climate change, and may only have a small climate mitigation impact. It must not be seen as a silver bullet or a reason not to pursue other solutions that accelerate progress towards a carbon-neutral economy. However, removing carbon from the atmosphere, and upcycling it into new products can be a way to decouple growth from carbon emissions, and provide competencies to accelerate the development of wider carbon negative technologies.

IMPACT OF OPPORTUNITY



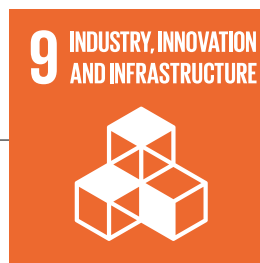
Taking carbon from the atmosphere and using it in new products reduces the greenhouse effect.



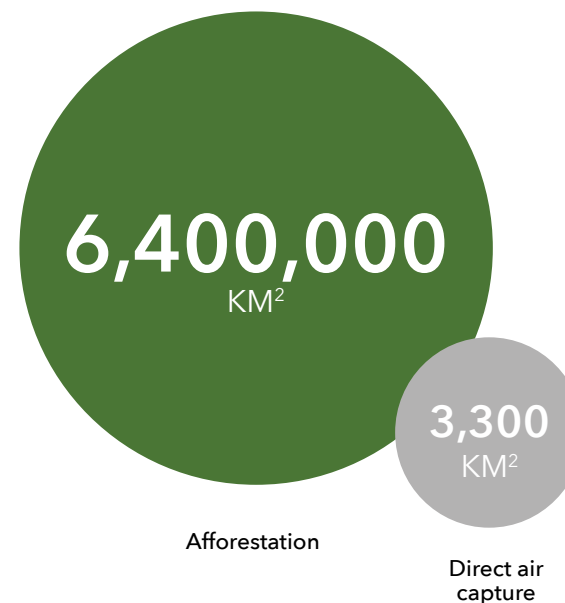
Reducing atmospheric CO₂ limits ocean acidification.



New products that use carbon emitted from industry can turn climate risk into opportunity.



SPACE EFFICIENT CARBON CAPTURE



<\$1.1T

potential annual revenue opportunity from carbon-based products

<7GT

CO₂ potential sequestration from the carbon-based products industry per year

67

jurisdictions - representing around half of the global economy - are putting a price on carbon

90%

of carbon dioxide emissions from power plants and industrial facilities can be captured

Sources: 1. CO₂ Sciences and The Global CO₂ Initiative. Global Roadmap for Implementing CO₂ Utilization. Report. 2016. 2. United Nations Environment Programme. The Emissions Gap Report 2017. Chapter 7: Bridging the Gap - Carbon dioxide removal. 2017. 3. World Bank Group. 'State and Trends of Carbon Pricing 2017'. Report. 2017. 4. Center for Climate and Energy Solutions. Carbon Capture. www.c2es.org (Upper right); Smith et al 2015. 'Biophysical and economic limits to negative CO₂ emissions'. Nature Climate Change 6, 42-50. 2016.

SOLUTIONS



CAPTURED CARBON
CREATES NEW VALUE

New technology is being used by Indian firm Carbon Clean Solutions to capture carbon dioxide from industrial processes and use it to manufacture new products.

In the effort to decarbonise industries that are emitting a great deal of CO₂, there is an opportunity to make use of the carbon as a resource. Noticing the potential in this symbiotic relationship, Carbon Clean Solutions developed the technology to capture carbon dioxide from industry and use it as a feedstock to produce commercially viable chemicals, bio-oils, materials, and fuels. Carbon Clean Solutions is the only company to have delivered its technology to a site in India without subsidies, and to be showing the potential scalability of its technology everywhere.

GOALS PRIMARILY ADDRESSED



Industry, Innovation and Infrastructure
Retrofitting sustainable improvements such as carbon capture helps to bring down the environmental impact of heavily polluting industries.



Climate Action
Carbon Clean Solutions’ technology reduces the cost of CO₂ capture by 40%, accelerating the development of this sector, which is crucial to combating climate change.

Solution by: **Carbon Clean Solutions**
Deployed in: **Global**



UPCYCLING CO₂
INTO NEW PLASTICS

Econic’s innovative new catalyst technology uses captured CO₂ to make plastics, sequestering carbon and reducing emissions from manufacturing.

The demand for plastics, the manufacture of which typically uses fossil fuel feedstocks, is growing rapidly. Econic’s catalyst systems allow up to 50% of the necessary fossil-fuel-based raw materials to be replaced by CO₂ in the manufacture of polyols – a building block for plastics. These polyols can then be used in a range of products, from running shoes and sofas to building insulation and car parts. In addition to offering products in which 50% of the raw materials are replaced with CO₂, the company also offers a “tunable” catalyst system, which allows customers to tailor the amount of CO₂ incorporated into their polyols according to the performance requirements.

GOALS PRIMARILY ADDRESSED



Industry, Innovation and Infrastructure
By using waste CO₂ from industry as a resource, Econic is reducing the CO₂ emissions per unit of value added, helping to create more sustainable industries.



Responsible Consumption and Production
Using waste products as feedstocks for the plastics industry is one strategy for moving towards a circular economy and helping to reduce dependence on fossil fuels.



Climate Action
Econic predicts that if its technology achieves a market penetration of 30% by 2026, 3.5 million tonnes of CO₂ emissions could be avoided annually.

Solution by: **Econic**
Deployed in: **UK**

SOLUTIONS



PRODUCING PLASTIC FOAM FROM WASTE CO₂

Covestro uses waste CO₂ from other industrial processes as a chemical feedstock for manufacturing plastic foams.

Covestro has developed a chemical process enabling them to convert waste CO₂ into a raw material for the manufacture of plastics and foams. The company has engineered a new catalyst capable of binding CO₂ into polyols - the building blocks of polyurethane foam - resulting in a 20% reduction in the petrochemicals use. Production of the foam, commonly used in mattresses and upholstery, uses less energy than conventional processes, and utilises waste CO₂ from a neighboring industrial facility plant. The company intends to expand into producing rubber and synthetic fibers using a similar process in the future, creating more value from less fossil carbon.

GOALS PRIMARILY ADDRESSED



Industry, Innovation and Infrastructure

Using CO₂ as a chemical feedstock is more energy-efficient than the petrochemical processing of petroleum, creating a retrofit for the plastics industry which is more sustainable.



Responsible Consumption and Production

Partially replacing the petroleum-based components of plastics with CO₂-based components makes the mattress industry less dependent on nonrenewable and polluting oil.



Climate Action

When using CO₂ as chemical feedstock, Covestro avoids 2.7 kg of CO₂ emissions per kg of polyols produced.

Solution by: **Covestro**

Deployed in: **Germany**



CONSTRUCTING WITH CARBON

Blue Planet's technology uses CO₂ as a raw material to make carbonate rocks, replacing natural limestone rock, the principal component of concrete.

Carbon dioxide from industrial flue gas is converted to carbonate by combining CO₂-containing gas with a water-based capture solution, thereby avoiding costly purification methods involved in other carbon capture methods. The carbonated solutions formed are then applied to coat particles and form limestone building materials, comparable to the natural formation of limestone in the ocean. Materials sold by the company include aggregates, sack concrete, and roofing granules.

GOALS PRIMARILY ADDRESSED



Industry, Innovation and Infrastructure

Converting industrial waste CO₂ gas into building materials improves the resource efficiency of both industries and reduces the CO₂ emissions per unit of value added.



Responsible Consumption and Production

Blue Planet utilises the waste streams from industry to create a new product, helping to make both production and consumption more responsible.



Climate Action

The production of concrete is estimated to be responsible for around 5% of global greenhouse gas emissions. Blue Planet's technology can help to reduce this total.

Solution by: **Blue Planet**

Deployed in: **USA**

OPPORTUNITY

KEEPING IT COOL

As the planet warms and populations become increasingly urbanised, the demand for cooling is on the rise, but existing technology is outdated and heavily polluting. With the increasing need to reduce carbon emissions, this growing market presents more and more opportunities to reduce the need for cooling and make cooling efficient.



Today, air conditioning (AC) and refrigeration accounts for as much as 17% of global electricity demand, and in the US alone, AC units lead to the emission of 117 million tons of carbon annually. While air-cooling systems have become more efficient over time, they still use significant power, placing huge demand on electricity grids at peak times. In addition, AC systems typically emit fluorinated gases, which have global warming potential many times higher than CO₂. In cities, AC can raise temperatures by more than 1°C locally,

worsening the heat island effect. This vicious cycle means that keeping cool is making us hotter.

The growing demand for cooling, which is expected to overtake the global demand for heat by 2060, can be attributed primarily to a growing middle class, living in hot urban environments, where AC in buildings and cars is a necessity.

New innovations such as solar-thermal technology, which uses solar heat to cool buildings, consumes 30% to 90% less electricity than conventional AC. New research indicates that adding improved efficiency in refrigeration and phasing out fluorinated gases used for cooling could eliminate a full 1°C of warming by 2100. Emissions equivalent to 89.7 gigatons of CO₂ could be avoided via better management of refrigerants already in circulation. Despite a high economic cost, this signals the importance of substituting fluorinated gases, increasing efficiency, and innovating new solutions to keeping cool.

PRODUCTS AND SERVICES

Solar cooling systems are becoming more widespread at all scales, and some cities, such as Vienna and Copenhagen, are installing district cooling systems that vastly improve efficiency. Across commercial facilities in the United States, thermal storage solutions are being used to shift peak

demand loads, allowing cooling to be produced at less than half the cost and reducing carbon emissions by up to 96%.

With the exponential growth in demand for data storage, data centres are a quickly growing market that require masses of cooling. The strategic positioning of such facilities and other commercial spaces near cool bodies of air and water that can exchange heat is driving new solutions.

In urban settings, design is playing a growing role in reducing the need for expensive cooling systems. In India, where cooling accounts for 40% of electricity demand in some cities, products are coming to market that mimic plants' natural evaporation processes to cool spaces with minimal energy input.

MARKET SIZE AND DEMAND DRIVERS

The value of the global AC market is forecast to exceed \$24 billion by 2020, and 1.6 billion new units are expected to be sold by 2050. Even today, more than 60 million air conditioners are sold in China each year. The data centre cooling market alone is expected to grow to more than \$14 billion by 2021 at a CAGR of 15%.

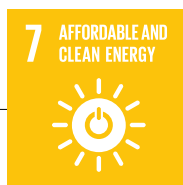
As the global middle class expands and moves into urban areas that are becoming warmer due to climate change, the demand for innovative cooling solutions that deliver on the triple bottom line increases by the day.



Low-energy cooling solutions with alternative refrigerants reduce the climate impact of this sector.



Renewable innovations that reduce power demand for cooling help to transition to a low-carbon energy system.



Access to low-cost cooling reduces heat-related illnesses and deaths across the globe.



BOOMING COOLING DEMAND



1.6 B

NEW AIR CONDITIONERS INSTALLED BY 2050

15%

CAGR for data centre cooling market forecast to 2021

\$24B

value of global air conditioning market by 2020

>1°C

added to outdoor urban environments by waste heat from air conditioning

72%

increase in energy demand for cooling in Europe by 2030

Sources: 1. MarketsAndMarkets. 'Data Center Cooling Market by Solution'. 2017. www.marketsandmarkets.com. 2. MarketsAndMarkets. 'Air Conditioning Market worth 24.28 Billion USD by 2020'. 2015. www.marketsandmarkets.com. 3. Salamanca et al. 'Anthropogenic heating of the urban environment due to air conditioning'. 2014. J. Geophys. Res. Atmos., 119, 5949–5965. 4. The Guardian. 'World set to use more energy for cooling than heating'. 2015. www.theguardian.com. (Upper right): Shah et al. 'Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning'. Berkeley Lab. 2015.

SOLUTIONS



LOW-CARBON DATA CENTER COOLING

Aligned Energy uses a combination of techniques to cool data centers in a way that is both cost-efficient and more sustainable than traditional cooling systems.

The data centres that support our online lives consume huge amounts of energy for cooling – almost 2% of the global electricity supply in 2015, resulting in great cost not only to the environment, but also to the businesses that run data centres. Aligned Energy offers improvements to the triple bottom line through 80% and 85% cuts in energy and water use respectively. Its system has also been assessed as one of the most secure and reliable on the market, minimising chances of downtime, which can cost serious money and reputational damage in the industry.

GOALS PRIMARILY ADDRESSED



Clean Water and Sanitation

This cooling system increases data centres' water-use efficiency, addressing the issue of water scarcity.



Affordable and Clean Energy

By using up to 80% less energy than traditional systems, this solution reduces the energy intensity of this power-hungry industry.



Climate Action

With a lower energy intensity comes a lower carbon intensity, helping to reduce the carbon footprint of data centres.

Solution by: **Aligned Energy**

Deployed in: **USA**



LOW-ENERGY NATURAL COOLING

Using a technique from the Egyptian era, Ant Studio has created an evaporative cooling system that is both low energy and cost efficient.

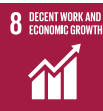
During the summer in India, factory workers suffer from intolerable workplace temperatures of up to 50°C, resulting in both social and economic productivity losses. To lower the temperature, Ant Studio has created an eco-friendly cooling installation that is both a sustainable and inexpensive alternative to electric AC, using earthen cones and water as the main components. By stacking the cones, a large surface area for cooling is created. The design then uses the air velocity from factory generators to facilitate the evaporative cooling, lowering the temperature by 6-8 degrees Celsius.

GOALS PRIMARILY ADDRESSED



Affordable and Clean Energy

With innovative cooling solutions reducing the need for electric air conditioning, the demand on electricity grids at peak times is lowered, thus reducing fossil fuel consumption.



Decent Work and Economic growth

By installing Ant Studio's evaporative cooling system in factories, conditions for workers are greatly improved and ensure increased productivity.



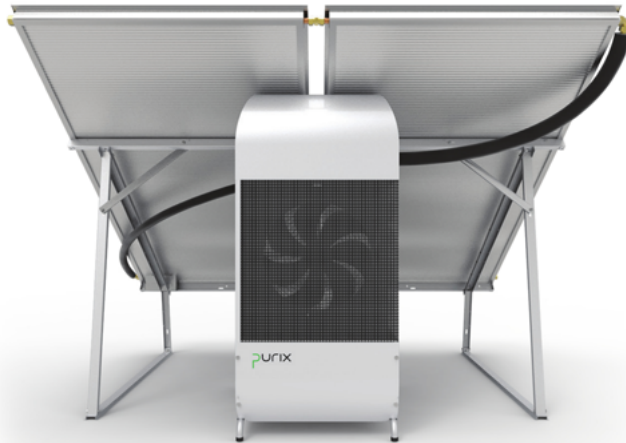
Climate Action

As conventional ACs are responsible for significant greenhouse gas emissions, switching to natural alternatives will markedly lower the climate footprint of cooling.

Solution by: **Ant Studio**

Deployed in: **India**

SOLUTIONS



AIR-CONDITIONING POWERED BY NATURE

Purix's solar air-conditioner is a sustainable alternative to conventional cooling. Powered by the sun, the air-conditioner reduces electricity consumption by up to 85%.

With global living standards improving, the demand for cooling – and corresponding energy use – will increase along with the negative environmental impact. In response to the growing need for alternatives, Purix designed a solar air-conditioner. Unlike conventional ACs, the Purix solar air-conditioner does not include an energy consuming compressor unit. Instead, solar thermal energy absorbed by solar panels produces water vapour, which is used by the Purix chiller as a refrigerant to produce chilled water that is distributed to cooling devices. The water returns to the chiller in a closed-loop system.

GOALS PRIMARILY ADDRESSED



Good Health and Well-being

Alternatives to traditional ACs improve dry, unhealthy indoor environments and reduce noise pollution, increasing mental and physical well-being.



Clean Water and Sanitation

Despite converting solar heating into chilled water, the Purix air-conditioner does not require a water supply, and therefore contributes to sustainable water management.



Affordable and Clean Energy

By powering air-conditioners with the sun, Purix uses up to 85% less electricity than traditional air-conditioners, significantly reducing the strain on electric grids.

Solution by: **Purix**

Deployed in: **Italy**



COOLING FROM WASTE HEAT

Wien Energie uses waste heat from incineration plants to produce district cooling, a space-saving, environmentally friendly alternative to conventional cooling.

As heat is an inevitable byproduct of waste incineration and electricity production, waste heat has traditionally been used for district heating. However, in the warmer months when heating is no longer needed, Wien Energie uses waste heat to provide district cooling. By using waste heat instead of electricity to power absorption refrigeration machines, Wien Energie is able to provide cooling either through a connected district cooling network, or through a district cooling centre installed directly in a customer's building. Compared to conventional air-conditioning units, district cooling uses 4 to 10 times less primary energy.

GOALS PRIMARILY ADDRESSED



Affordable and Clean Energy

Utilising a byproduct of incineration for cooling cuts electricity consumption and guarantees a future-proof supply of energy.



Climate Action

Innovative cooling systems reduce environmental damage due to reduce electricity and harmful refrigerants usage.

Solution by: **Wien Energie**

Deployed in: **Austria**

SUSTAINABLE SHIPPING

International trade relies on shipping, and despite technological improvements, emissions continue to increase as trade increases. Decarbonising short-haul shipping is an expanding market opportunity driven by developments in battery technology and alternative fuels, with the potential to help the sector's low-carbon transition.



Maritime transport is essential to the world's economy, handling more than 90% of the world's trade as the most cost-effective and least carbon-intensive method of transporting goods. Increases in fuel consumption due to greater demand for shipping are outpacing recent efficiency improvements. In 2015, shipping was responsible for 2.6% of global carbon emissions. And although the IMO has already introduced measures which aim to improve shipping's emissions, there

still remain opportunities for the sector to improve its carbon footprint and overall environmental impact. Using current technologies more extensively throughout the maritime sector, could make a significant impact on shipping's emissions. Through a combination of efficiency measures, speed reductions, changes in the fleet composition, logistical measures and use of alternative fuels, the global fleet could reduce its tonne mile consumption by 35-40% by 2050. To reach these emission reductions the world fleet will need a significant transformation with about 50% of the world's fleet shifting towards alternative fuels such as liquified natural gas and biofuels.

Although short-range shipping accounts for just 15% of maritime emissions, decarbonising it offers a quick-win solution and can act as a stepping stone for tackling long-range shipping emissions by testing technologies in a living laboratory.

PRODUCTS AND SERVICES

A plethora of new products will be needed to reduce emissions from the sector. As well as full electrification, installing hybrid power solutions incorporating hydrogen and renewables can achieve impressive cost and carbon savings. An example is the the Norsepower Rotor Sail Solution, which can reduce fuel consumption by up to 20% through harvesting the wind to generate electricity.

New products that optimise operations offer many benefits, from advanced paints that reduce drag to autonomous ships with more efficient routing. Such ships are in development, such as the YARA Birkeland – the world's first zero-emission, autonomous container feeder, expected to be fully operational in 2020. However, a high penetration of autonomous ships will require significant changes in the regulatory framework. Building fast, easy, and safe connections to high-voltage electricity when in harbour is becoming increasingly important. Innovative new products and services in this space are emerging, such as wireless charging technologies, primarily for short-range ferries.

MARKET SIZE AND DEMAND DRIVERS

Sustainability is a growing priority for the sector's multinational clients, creating demand for more sustainable shipping alternatives. As progress towards an internationally agreed strategy to tackle climate change in shipping continues, low-carbon alternatives offer economic benefits resilient to a turbulent future.

Decarbonising the shipping industry will involve a range of different approaches, including soft measures, such as speed, capacity, and route optimisation. While a zero-carbon shipping sector is not yet within reach, the new technologies coming to market are a step in the right direction, and by rapidly implementing them in short-haul scenarios, this transition will accelerate.

IMPACT OF OPPORTUNITY



New technologies are helping to accelerate the transition of the shipping sector away from its reliance on fossil fuels.



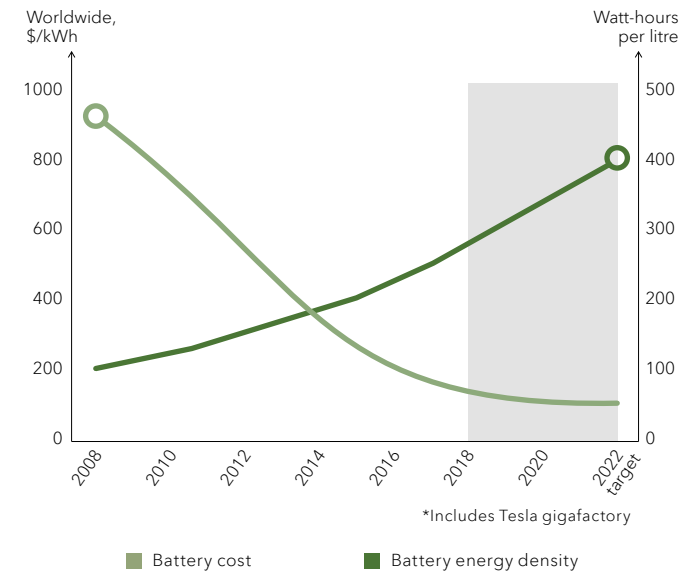
New fuels that produce less particulate matter will improve air quality and respiratory health.



Sustainable shipping solutions mean less impact on ocean ecosystems.



INCREASING ENERGY DENSITY



DECREASING COSTS AND INCREASING ENERGY DENSITY IS MAKING LITHIUM-ION BATTERIES INCREASINGLY MORE ECONOMIC ATTRACTIVE AND SUITABLE FOR SHIPPING

40K

annual truck journeys YARA hope to replace by using an autonomous electric container vessel.

60%

increase in overall demand for seaborne transport by 2050

37%

of trade between EU countries are made by short-sea shipping

1/3

of all ships will be powered by batteries in 2050 if current trends continue

Sources: 1 YARA. Yara Birkeland design revealed and test model demonstrated for the first time. 2017. www.yara.com 2. and 4. DNV GL. 'Maritime Forecast to 2050 - Energy Transition Outlook 2017'. Report. 2017. 3. The European Community Shipowners' Associations (ECSA). 'Short Sea Shipping The full potential yet to be unleashed'. Report. 2016. (Upper right): The Economist. 'The growth of lithium-ion battery power'. August 2017. www.economist.com

SOLUTIONS



ELECTRIFYING SHIPPING

Cavotec develops and manufactures innovative automation and electrification technologies for ports and maritime sectors.

In collaboration with a group of partners, Cavotec has successfully tested a combined wireless induction charging and automated mooring system with a hybrid passenger ferry off the west coast of Norway. Vacuum-based automated mooring technology allows the ship to dock precisely so that the wireless induction chargers can boost the ship's batteries in port. This in-port electrification has the potential to reduce the greenhouse emissions of the maritime transport sector, which currently accounts for around 2.5% of global emissions. It will also improve local air quality and the respiratory health of local residents and workers.

GOALS PRIMARILY ADDRESSED



Good Health and Well-being

Using less fuel in port reduces emissions of nitrogen oxides, sulphur dioxide, and particulates, which all cause health risks and degrade ports' air quality.



Climate Action

CO₂ emissions from the maritime transport sector could be reduced by up to 75% by applying operational measures and implementing existing technologies.

Solution by: **Cavotec**

Deployed in: **Global**



HYBRID SHIPS REDUCE EMISSIONS AT SEA

Hybrid energy systems for cargo ships, which couple efficient fuel cells with advanced batteries, are helping to bring down costs and emissions in the maritime sector.

The Norway-based FellowSHIP project is an R&D collaboration between DNV GL, Wärtsilä, and Eidesvik, who set out in 2002 to experiment with innovative technology for shipping. The project partners worked together to develop, install, and test fuel cell technology on the vessel. Originally equipped with dual-fuel engines and conventional diesel electric propulsion, Viking Lady was then gradually hybridised by installing a 320-kW molten carbonate fuel cell and then a 450-kWh lithium-ion battery.

GOALS PRIMARILY ADDRESSED



Industry, Innovation and Infrastructure

Combining fuel cell and battery technologies to create hybrid ships can bring down costs and emissions for the international shipping industry.



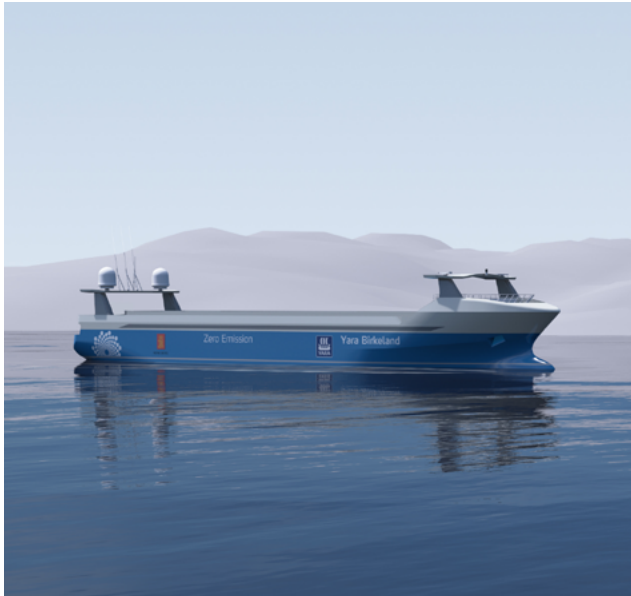
Climate Action

Shipping currently accounts for around 3% of the world's greenhouse emissions. Hybrid technologies like "Viking Lady" show how these emissions can be reduced.

Solution by: **Eidesvik, Wärtsilä and DNV GL**

Deployed in: **Norway**

SOLUTIONS



ZERO-EMISSION,
AUTONOMOUS VESSEL

The world’s first zero-emission, autonomous container feeder from Kongsberg will result in 40,000 fewer diesel-powered truck journeys per year.

In the container shipping world, many of the behemoth ships are fed by smaller feeders that move cargo from port to port by land and sea, often with heavily-polluting diesel emissions. The YARA Birkeland is a zero-emission, fully electric and autonomous solution to that problem. With a 7 to 9 MWh battery powering propulsion, the ship can carry up to 120 shipping containers at any one time. The vessel will cost \$25 million, triple that of a conventional equivalent but, without the need for fuel or crew, it promises to cut annual operating costs by up to 90%. By taking trucks off the road, it will also contributes to safer, less-congested roads.

GOALS PRIMARILY ADDRESSED



Good Health and Well-being
Autonomous, electric near shore shipping eliminates harmful NOx and SOx emissions to the air, reducing the risk of respiratory diseases.



Life Below Water
The discharge of ballast water can damage marine life. No such problem for the YARA Birkeland, which uses the batteries for ballast instead.



Partnerships for the Goals
YARA has partnered with Kongsberg to find a sustainable alternative to 40,000 diesel-powered truck journeys per year.

Solution by: **Kongsberg**
Deployed in: **Norway**



WIND POWER IMPROVES FUEL EFFICIENCY
FOR LONG-HAUL SHIPPING

Using the power of the wind, rotor sails increase efficiency and cut costs and carbon in the shipping industry.

The Norsepower Rotor Sail Solution is a modernised version of the Flettner rotor – a spinning cylinder that uses the Magnus effect to harness wind power to propel a ship. When wind conditions are favourable, Norsepower Rotor Sails allow the main engines to be throttled back, saving fuel and reducing emissions while providing the power needed to maintain speed and voyage time. Rotor sails can be used with new vessels or retrofitted on existing ships. Based on independently verified results, the technology provides potential fuel savings of up to 20%, cutting ship operators' costs substantially.

GOALS PRIMARILY ADDRESSED



Affordable and Clean Energy
Hybrid solutions are a first step towards scaling renewables across industry, a key factor for achieving Goal 7.



Climate Action
The rotor sail solution results in significant CO₂ emission savings – up to 1,200 tonnes per vessel annually – thus lowering this sector's carbon footprint.

Solution by: **Norsepower**
Deployed in: **Global**

GOAL 14

LIFE BELOW WATER

Our oceans, which cover 70% of the planet, regulate our climate, and support the livelihoods of 3 billion people, are under threat from pollution, acidification, and overfishing. We all rely on the services and resources our oceans provide. Sustainable Development Goal 14 aims to protect marine environments and sustainably manage their resources. By doing so, we can ensure that future generations will be able to benefit from our oceans as we do.

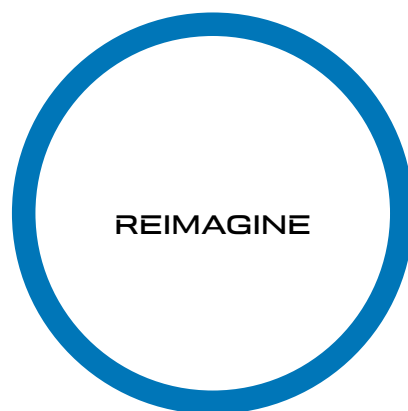




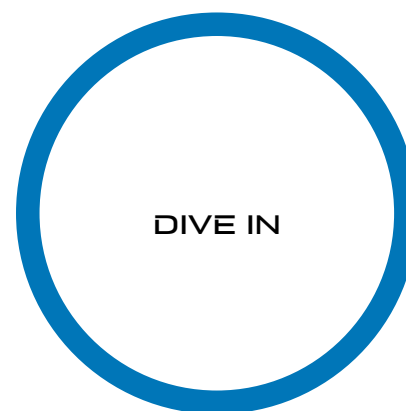


OPPORTUNITIES FOR HEALTHIER OCEANS

Often branded as the ultimate “common good,” our oceans provide us with \$2.5 trillion in “gross marine product” each year. However, the long-term productivity and health of our marine environments is under unprecedented threat. In 2017, global leaders agreed to do more to conserve and sustainably use our oceans, but it is business that has the lead role to play both in reimagining our blue economy to use resources more sustainably, and in finding new opportunities in the litter that drowns the oceans today.



By 2050, there will be more plastic in the sea than fish. To reverse this trend, we must **reimagine plastic** and find circular uses for plastics.



Alternative aquaculture is all about finding new ways to drive the blue economy in closed-loop systems with new sustainable feedstock sources.

“Consumer demand for better choices fuels business opportunity.”

Throw-away culture is choking our oceans, which are the end of the line for a major part of the world’s disposable plastics. Bee’s Wrap was created by Sarah Kaeck as a reusable, compostable, and delightful alternative to save food without the waste.



SARAH KAECK
Business Owner at Bee's Wrap, Inc.

What opportunities do you see in the market for plastic alternatives?

I'm excited by the passion many of our customers have for eliminating the waste they produce in their day-to-day lives, and particularly for eliminating disposable plastics. In the five years we've been in business, there's been a huge surge in understanding around the problem of plastic pollution. Consumer demand for better choices fuels business opportunity, and good products will in turn drive consumers to make better choices.

What are the barriers for people to adopt sustainable alternatives to single-use plastics?

Breaking out of the status quo can be hard, and I think some people are daunted by the scale of the challenge. Plastic is everywhere, particularly once you start looking, I was looking for it with an eye toward reducing or eliminating plastic consumption. More broadly speaking, as long as the true societal and environmental costs of plastic pollution are hidden from consumers, sustainable alternatives will always appear, at first glance, more expensive.

It is often said that the only way we can scale sustainable solutions is if they offer an improvement over traditional products. In what way is Bee's Wrap an improvement over single-use plastics?

There's a rational and an emotional reason for using Bee's Wrap. Rationally, it is a wonderful way to store food; we hear

all the time from customers who swear by Bee's Wrap for bread, veggies, cheese, you name it. It's also pleasurable to use and reuse, whether you're someone who loves the prints, the tactile experience of the textiles, the scent of beeswax, or the satisfaction of reducing your footprint.

What are the drivers we need in society and business to scale plastic alternatives like Bee's Wrap to the mainstream?

Education. We often don't realise that every time we purchase a plastic container, that item is now in our ecosystem for a very long time, breaking down and moving through the system in harmful ways. In purchasing that item, we are complicit in deepening the problem. Having a true understanding of the impact of our choices will bring us a long way. Knowing that our choices do matter sounds cliché, but is very real and will be the driver for better options.

What's your advice for entrepreneurs looking to address some of the global challenges?

There is a lot going on in our lives. Keep the solutions you are presenting to your audience simple and easy to use, understand, and participate in.

MAP OF SOLUTIONS

SUSTAINABLE USE OF THE OCEANS

Conservation and the sustainable use of the oceans are the goals these solutions work to accomplish by preventing plastic from reaching the oceans and protecting ecosystems with sustainable aquaculture.

There are a range of solutions available today that aim to replace plastic with more sustainable products and do not harm the oceans' ecosystems. Recyclable products for packaging and making fabrics out of plastic bottles are a couple of examples of these.

Utilising the enormous resources the oceans offer in a sustainable manner to feed an ever-growing global population requires new innovative solutions. Vertical ocean farming, circular land-based aquaculture systems, and reductions in the environmental footprint of fish farms are prime examples of solutions to conserve the oceans.

The world map depicts examples of solutions that maintain the oceans' essential role in human well-being and social and economic development worldwide. Read more about the solutions featured here, and discover further information and many more solutions that tackle Goal 14, on the Global Opportunity Explorer.

REDUCING AQUACULTURE'S ENVIRONMENTAL FOOTPRINT

Calysta's protein feed for aquaculture is made via a natural fermentation process.

VERTICAL OCEAN FARMING CREATES HEALTHY ECOSYSTEMS

GreenWave's vertical ocean farming techniques maximise output and ecosystem services.

TURNING TRASH INTO FASHION

Thread International upcycles plastic waste from Haiti and Honduras into useful materials.

INTEGRATING REUSE INTO EVERYDAY PURCHASES

Algramo offers reusable, cut-price packaging for retail products to reduce plastic waste.



SOLUTIONS TO PROTECT OCEANS AND MARINE AREAS

CARBON NEUTRAL AQUACULTURE

Matorka's fish farm uses local renewable energy to grow Arctic char in land-based systems.

⊕ South Africa

MODULAR, LAND-BASED AQUACULTURE

FarmInABox is a modular, land-based, aquaculture system, with a circular design.

NATURAL ALTERNATIVE TO PLASTIC WRAP

Bee's Wrap is a preservative fabric impregnated with beeswax that replaces plastic wrap.

⊕ Global

TACKLING PLASTIC SACHET WASTE

Unilever's commitment to 100% recyclable material and alternatives to single-use sachets.

⊕ Global

REIMAGINING PLASTICS

Plastics are an integral part of the global economy, but the current linear value chain results in high proportions of underutilised resources that end up in the oceans and threaten marine ecosystems. Innovation opportunities are emerging in material design and the reprocessing of plastics to unlock latent value and protect the oceans.



Plastics were first developed over 170 years ago, and we have since created a wide range of synthetic polymers that are now integrated into almost every part of our lives. They possess unparalleled design versatility and have resulted in many environmental and societal benefits – everything from food packaging extending shelf-life to lightweight vehicle components that reduce transportation fuel consumption. However, the multi-billion dollar plastics industry also creates significant costs inherently linked to the polymer properties.

The design versatility and low production costs prohibit easy recycling and typically create short life cycles. Thirty percent of all plastics are estimated not to be reused or recycled, and more than eight million tonnes of plastics end up in the oceans annually – equal to dumping a garbage truck of plastic every minute.

The Ellen MacArthur Foundation suggests that from plastic packaging alone, around 95%, or \$80 billion to \$120 billion annually, is lost to the economy after a short first use. Advanced processes in mechanical and chemical recycling processes can unlock the up to \$120 billion lost every year through inefficient waste. Solutions like Thread International use recycled polyester material to manufacture materials, sourcing the plastic from Haiti and Honduras and preventing waste from ending up in the street, landfills, or seas.

MARKET SIZE AND DEMAND DRIVERS

Over the past 50 years, annual plastic production has increased from 15 million tonnes in 1964 to 311 million tonnes in 2014. Worldwide, the plastics market is expected to reach \$650 billion by 2020, and global production is predicted to double in the next 20 years.

The drivers for a different plastic economy include technological breakthroughs, increasing clean energy availability, increasing environmental costs from plastic waste, and a changing regulatory landscape. The UK, France, and

Costa Rica are all implementing policies to cut selected single-use plastics by 2021, creating opportunities for more sustainable alternative materials to single-use plastics.

PRODUCTS AND SERVICES

Plastics can be made from anything containing carbon and hydrogen. Fossil fuels have been the primary choice of feedstock until now, but that could change. Econic, for example, uses up to 50% waste CO₂ as feedstock to produce new plastics.

Transforming the single-use plastic culture also offers opportunities in product design. Reusable coffee cups and beeswax wrapping can replace single-use, hard-to-recycle coffee cups and plastic wrapping.

Then there is the opportunity for industry to rethink how plastic is made and innovate towards more sustainable products. Lego, a company based entirely on plastic, is on a mission to completely change the plastic it produces by 2030.

Finally, the end-of-life processes for plastics offers the potential for innovation. Improved collection, sorting, and recycling technologies can increase the value extracted from existing plastics.

IMPACT OF OPPORTUNITY



Very little plastic is properly recycled today – solutions here can reduce the amount of plastic wasted.

By embracing new practises, the multi-billion dollar plastics market can tackle marine litter, of which plastic contributes up to 80%.



Addressing plastic pollution reduces microplastics in water supplies and plastic pollution blocking drainage systems.



REUSE POTENTIAL



\$9B

IS THE VALUE THAT NEW, INNOVATIVE DELIVERY MODELS AND EVOLVING USE PATTERNS CAN UNLOCK WHEN ENABLING REUSE OF AT LEAST 20% OF PLASTIC PACKAGING (BY WEIGHT)

80%

of marine litter accounted for by plastic

<\$120B

annual value lost through inefficient end-of-life processes

6.84%

CAGR of top 10 plastics market to 2021

6%

of world's oil production used to make plastics

Sources: 1. DNV GL. 'Technology Outlook 2025'. Report. 2017. 2., 4. & upper right. World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company. 'The New Plastics Economy – Rethinking the future of plastics'. Report. 2016. 3. MarketsAndMarkets. 'Top 10 Plastics Market worth 586.24 Billion USD by 2021'. 2017. www.marketsandmarkets.com.

SOLUTIONS



INTEGRATING REUSE INTO EVERYDAY PURCHASES

This Chilean social enterprise is dedicated to lowering the cost of food and other essential items for low-income families in Chile.

Algramo works directly with manufacturers to sell products in reusable containers, often in bulk, which the company estimates can save up to 50% on consumer costs. In cities where recycling facilities are rare, relying on recycling to reduce plastic waste is unrealistic. This B Corp hopes to foster a reuse and recycling culture, in order to make a dent in the use of single-use plastics. An average Chilean family using Algramo's products has the potential to avert around two kilograms of plastic waste per month.

GOALS PRIMARILY ADDRESSED



No Poverty

The poor spend the greatest proportion of their income on food. Reducing this cost increases disposable income and resilience to economic shocks.



Responsible Consumption and Production

Reduced costs act as an incentive for consumers to return empty packages, creating a more sustainable consumption culture for plastic containers.



Life Below Water

Around a third of all packaging escapes collection systems and much of it ends up causing damage to marine ecosystems. Reusing containers on a daily basis helps to reduce this figure.

Solution by: **Algramo**

Deployed in: **Chile**



NATURAL ALTERNATIVE TO PLASTIC WRAP

Using simple, organic ingredients, Bee's Wrap produces a sustainable alternative to plastic wrap for food storage that is reusable, biodegradable, and compostable.

Bee's Wrap provides its customers with a plastic-free alternative way to keep food fresh. Combining GOTS certified organic cotton, beeswax sourced from sustainably managed hives in the United States, organic jojoba oil, and tree resin, the result is a malleable food wrap, that can be used again and again. At the end of its lifetime, the wrap can be composted or even used as natural and effective fire starters for wood stoves. Unlike plastic wrap, Bee's Wrap is biodegradable and consequence-free for the environment and marine species.

GOALS PRIMARILY ADDRESSED



Decent Work and Economic Growth

Certification labels like GOTS ensure that all workers along the entire supply chain receive decent wages and work in dignified conditions.



Responsible Consumption and Production

Organic, non-toxic, and biodegradable production means less waste and chemical release in production and minimises the impact on human health and the environment.



Life on Land

Organically produced cotton uses only natural substances and obligates farmers to use sustainable and responsible methods for cotton production methods.

Solution by: **Bee's Wrap**

Deployed in: **Global**

SOLUTIONS



TURNING TRASH INTO FASHION

Thread takes trash from some of the poorest neighbourhoods on the planet and transforms it into textiles, providing income opportunities and cleaning the environment.

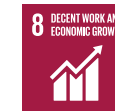
In 2010, Ian Rosenberger – founder of Thread – wrote in his journal, “If Haiti can turn trash into \$ = good.” This sentence was the foundation of Thread, which employs collectors in Haiti and Honduras to pick up plastic bottles that are turned into fabrics along a 100% transparent supply chain. With Thread, 38.9 million plastic bottles have been removed from streets and canals, significantly reducing damage to the environment and marine ecosystems. In addition to providing thousands of income opportunities and limiting plastic waste, Thread also has an interest-free micro-loan programme to keep its suppliers in business.

GOALS PRIMARILY ADDRESSED



No Poverty

Thread has created 3,845 income opportunities in Haiti and Honduras, providing adequate wages to workers in poor communities to help lift them out of poverty.



Decent Work and Economic Growth

By providing them with interest-free support, Thread enables its suppliers to grow their business and improve financial literacy.



Reduced Inequalities

Guaranteed transparency in the entire supply chain ensures fair workforce practices and helps to close the pay and inequality gap.

Solution by: **Thread**

Deployed in: **Haiti and Honduras**



TACKLING PLASTIC SACHET WASTE

Unilever is developing new technology to tackle the global issue of plastic sachet waste, committing to 100% recyclable plastic packaging by 2025.

Unilever has committed to making all of its plastic packaging fully reusable, recyclable, or compostable by 2025, accelerating progress towards a circular economy. To achieve this, Unilever has developed a new technology, the CreaSolv® Process, which enables the recovery of plastic from sachets, channelling the plastic back into the supply chain. Sachets are sold in the billions, allowing low-income consumers to buy products in small amounts. Finding a solution to recycling sachets gives consumers access to the same products while ensuring less plastic ends up in landfill and the oceans.

GOALS PRIMARILY ADDRESSED



Clean Water and Sanitation

Keeping plastic in a circular production model will reduce microplastic contamination of drinking water, which silently affects billions of people globally.



Responsible Consumption and Production

Treating plastic packaging as a valuable resource to be managed efficiently and effectively will bring global consumption models closer to becoming fully circular.



Life Below Water

Plastic pollution is impacting even the most remote, fragile marine ecosystems. Reducing plastic waste streams is crucial to mitigating against further aquatic demise.

Solution by: **Unilever**

Deployed in: **Global**

OPPORTUNITY

ALTERNATIVE AQUACULTURE

Aquaculture is expected to grow significantly to meet the forecast aggressive demand for fish and shellfish. Improving environmental standards through modular, land-based systems, as well as alternative feedstocks and closed-loop systems, can provide new business opportunities and conserve natural marine ecosystems.



Aquaculture is the farming of aquatic organisms such as fish, shellfish, and plants. It is a significant part of the global food supply network, helping to feed the 1 billion people who rely on fish as their main protein source. It has been practised for thousands of years on a small scale but has taken off globally since the late 1800s. Considering that 85% of wild fisheries are overexploited, it is clear there is a need for sustainable aquaculture.

Negative environmental and social impacts have accompanied the industrialisation of aquaculture over the past 50 years and must be addressed. The capture of wild-caught juveniles, use of fishmeal as a feedstock, and excess nutrient pollution are all issues the industry is grappling with. There have, however, been advances in methodology that have led to improved environmental standards, especially in smallholder-scale farms.

MARKET SIZE AND DEMAND DRIVERS

The global aquaculture market is estimated to be worth around \$176 billion and is expected to grow at a CAGR of 4.6% up to 2022, making aquaculture the world's fastest growing food industry. The market has grown by 1,570% in the past four decades and is being driven by a combination of increasing demand for fish-based protein and a reduction in wild fishery capacity. As a result, we now consume more fish from aquaculture than from wild fisheries.

PRODUCTS AND SERVICES

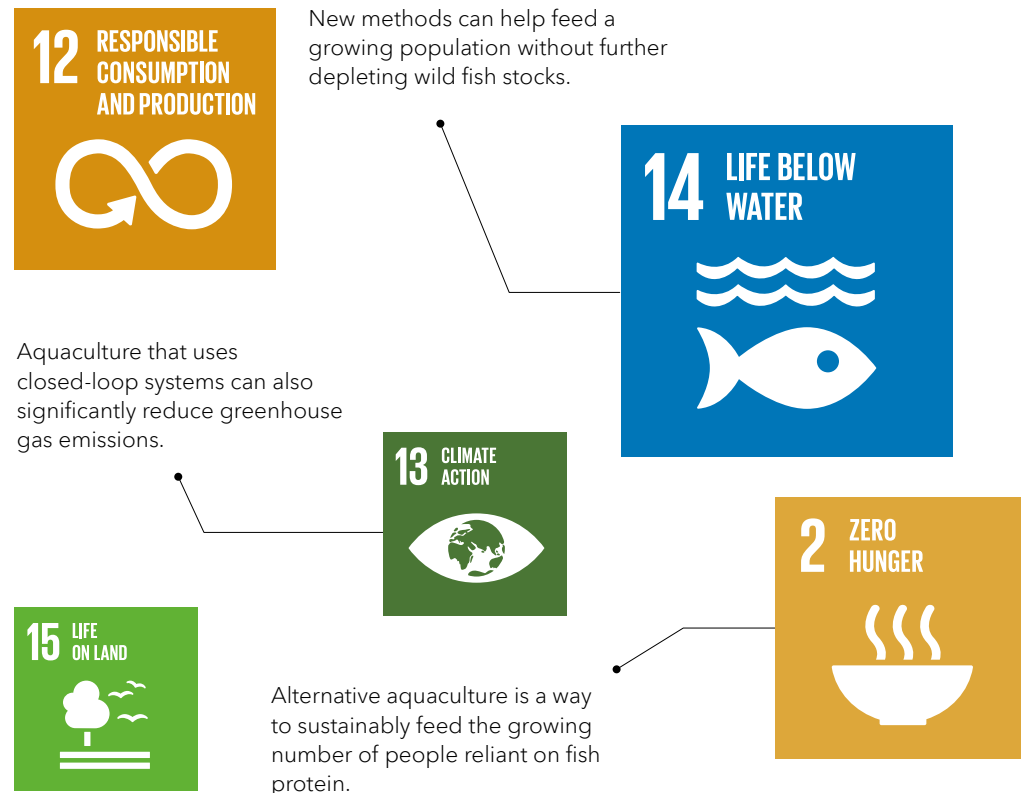
Innovations from the smallest to the largest scale can help aquaculture become a more sustainable industry, and those making use of these new opportunities are also more likely to receive greater economic returns, especially in the long run. For smallholders and coastal communities, adopting closed-loop systems and best practices can sustain a steady output without damaging natural ecosystems or putting

unnecessary pressure on marine species. Aquacultures can even be set up in symbiosis with aquaponics, growing fish and vegetables simultaneously.

Land-based, modular systems such as FarmInABox offer low- and medium-income communities the opportunity to harvest a reliable output of fish, without the environmental consequences associated with ocean fish farming. By using waste or insects as feed, and collecting waste for fertiliser, fish farms can become integrated into a circular community approach.

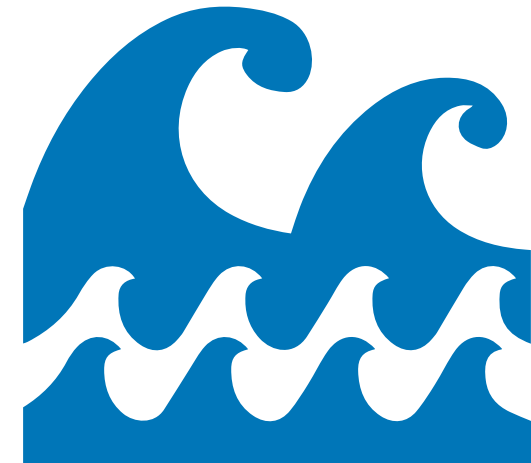
Across all scales of aquaculture, alternative feed sources offer an opportunity to eliminate the need for wild fish feed, which can exacerbate overfishing rather than contribute to the solution. AgriProtein and Calysta are two great examples of this.

Aquaculture processes can also better harness the ecosystem services and inter-trophic links to maximise output, revenue, and environmental standards. Shellfish can provide excellent filtering services for polluted water, and can work in combination with plant-based production and fish harvesting. These integrated approaches to aquaculture are expected to unlock another \$2 billion for the industry, but knowledge transfer can be the biggest barrier to overcome for developing countries.



ALTERNATIVE AQUACULTURE

0.015%



IS THE FRACTION OF GLOBAL OCEAN SPACE REQUIRED WHEN USING AQUACULTURE TO PRODUCE TOTAL CURRENT LANDING FROM WILD-CAPTURE FISHERIES

6%

market-share increase that land-based aquaculture will see in the next decade

1,570%

increase in the value of global aquaculture in the past four decades

230M

tonnes will be the global demand for fish by 2050

\$219B

expected aquaculture market size by the year 2022

Sources: 1. Paynter, D. 'Replacing Farms With Fish Farms: The Odd Solution To Both Hunger And Climate Change'. 2017. www.fastcompany.com. 2. Marine Biological Association. 'Two views on a revolution in aquaculture'. 2017. www.mba.ac.uk. 3. Aqua Spark. 'Fish is the new beef'. www.aqua-spark.nl. 4. Research and Markets. 'Global Aquaculture Market - Forecasts from 2017 to 2022'. Report. 2017. (Upper right). Gentry et al. 'Mapping the global potential for marine aquaculture'. Nature Ecology & Evolution 1, 1317-1324. 2017

SOLUTIONS



MODULAR, LAND-BASED
AQUACULTURE

FarmlnABox is a ready-to-farm aquaculture system offering a simple way for anyone to farm fish sustainably, with a low entry cost and low technical requirements.

Based just outside Johannesburg, David Fincham Aquaculture offers a solution for small-scale farmers to enter the aquaculture industry with low financial risk. FarmlnABox is designed to be simple, easily transportable, and fast to set up. As a result, the flat-packed, modular system can be scaled according to site demand and be operational within days. The farms are built in greenhouses with 15 FarmlnABox per greenhouse. The company also offers training and workshops for students, governments, and farmers.

GOALS PRIMARILY ADDRESSED



Reduced Inequalities
David Fincham Aquaculture has developed a scalable tilapia-farming system with low entry costs enabling communities to explore the potential of aquaculture.



Responsible Consumption and Production
Using circular design principles in the aquaculture systems minimises unsustainable inputs and polluting outputs, ensuring environmental responsibility in fish production.



Life Below Water
Land-based aquaculture provides a more sustainable alternative to wild fish harvesting or polluting ocean fish farming, reducing pressure on natural stocks.

Solution by: **David Fincham Aquaculture**
Deployed in: **South Africa**



REDUCING AQUACULTURE'S
ENVIRONMENTAL FOOTPRINT

FeedKind is an aquaculture feed produced via natural fermentation processes by Calysta and offering a more sustainable alternative to fish-based feed.

Calysta's natural microorganisms produce FeedKind protein via fermentation as an alternative aquaculture feed. The product has a high nutrient density, with 71% crude protein and 9% crude fat, outperforming other protein ingredients in animal trials for growth rates. It has also been shown to use 77% to 98% less water than alternative ingredients, including soy and wheat proteins, and requires no agricultural land to produce. The company estimates that if one commercial scale FeedKind protein plant replaced soy products for fish feed, it could free up enough land to feed 250,000 people.

GOALS PRIMARILY ADDRESSED



Zero Hunger
FeedKind uses just a fraction of the land per gram of protein, freeing up more space for growing other produce to feed an expanding global population.



Responsible Consumption and Production
The UN Food and Agricultural Organization estimates that aquaculture will account for two-thirds of the fish we eat in 2030. It is vital we produce this sustainably.



Life Below Water
Around one-third of the global fish harvest is used to make fish feed and fish oil. Alternatives like FeedKind can reduce pressures on wild species and ecosystems.

Solution by: **Calysta**
Deployed in: **USA**

SOLUTIONS



VERTICAL OCEAN FARMING CREATES HEALTHY ECOSYSTEMS

GreenWave's vertical ocean farming systems assist ocean farmers in producing healthy, local foods, while capturing carbon and providing biomass to generate biofuel.

GreenWave's vertical ocean farming grows kelp, scallops, and mussels on floating ropes stacked above oyster and clam cages below. These underwater vertical gardens are able to grow 10 to 30 tons of sea vegetables and 250,000 shellfish per acre per year. The kelp is also a strong carbon sink, absorbing five times more carbon than terrestrial plants, and requires zero input, unlike terrestrial equivalents. This approach creates resilient, biodiverse ecosystems using the entire water column. GreenWave wants to spread its practices, and will partner with any interested boat-owner with \$20,000 for start-up costs.

GOALS PRIMARILY ADDRESSED



Responsible Consumption and Production

After years of unrestrained marine exploitation, GreenWave offers a paradigm shift to zero-input, restorative seafood farming.



Climate Action

Kelp and other vegetables are known as the sequoias of the ocean and have high rates of photosynthesis and productivity, making them an attractive carbon sink.



Life Below Water

GreenWave restores rather than damages marine environments through a zero-input approach. The shellfish it farms naturally filter pollutants in water.

Solution by: **GreenWave**

Deployed in: **USA, Canada**



CARBON-NEUTRAL AQUACULTURE

Matorka's farm produces Arctic char fish in land-based systems without genetic modification, hormones, or antibiotics, unlike many commercial fish farms.

The Icelandic company is using land-based aquaculture to reduce the negative environmental consequences associated with wild fish farming. The carbon-neutral fish farm relies on excess hot water from nearby geothermal power stations for its energy needs and has a strong focus on fish health, meaning zero use of antibiotics, hormones, or chemicals. Matorka is in the process of designing another 3,000-tonne multi-species aquaculture system, incorporating further circular design principles to make use of wastewater and unused organic material.

GOALS PRIMARILY ADDRESSED



Good Health and Well-being

The production of antibiotic-free fish at Matorka reduces the growing health risk posed by antibiotic resistance.



Responsible Consumption and Production

Circular, land-based aquaculture systems have less intensive inputs and produce fish protein at a lower environmental cost than wild fisheries or ocean-based aquaculture.



Life Below Water

Using land-based aquaculture systems, Matorka does not contribute to the pollution or genetic modification of wild fish stocks, unlike cage-based aquaculture in the ocean.

Solution by: **Matorka**

Deployed in: **Iceland**

WE WOULD LIKE TO THANK

DNV GL, UN Global Compact and Sustainia would like to thank the following for their contributions to the report:

STEERING COMMITTEE

BJØRN K. HAUGLAND
Executive Vice President & Chief
Sustainability Officer, DNV GL

LISE KINGO
CEO & Executive Director, UN Global
Compact

OLE LUND HANSEN
Chief, Local Networks, UN Global Compact

ERIK RASMUSSEN
Founder & Executive Chairman, Sustainia

RASMUS SCHJØDT PEDERSEN
CEO, Sustainia

SUBJECT MATTER CONSULTANTS FOR THE GLOBAL OPPORTUNITY REPORTS

NINA JENSEN
General Secretary, WWF Norway

SVEN MOLLEKLEIV
Senior Vice President, DNV GL Group and
Honorary President at Norwegian Red Cross

RUNE TORHAUG
Director of EU Government and Public
Affairs, DNV GL

BJØRN TORE MARKUSSEN
Head of Veracity, DNV GL - Digital Solutions

JAHN HENRY LØVAAS
Executive Director, Life Sciences, DNV GL
- Business Assurance

NIKOS SPÄTH
Head of Section Media & Public Relations,
DNV GL - Maritime

SVERRE ALVIK
Programme Director - Energy Transition, DNV
GL - Group Technology and Research

BENTE PRETLOVE
Programme Director - Climate Action, DNV
GL - Group Technology and Research

JON EIVIND THRANE
Head of Group IT Office, DNV GL

METTE VÅGNES ERIKSEN
Group Sustainability Manager, DNV GL

SIMON ADAMS
Communications Manager, DNV GL -
Maritime

MAURICE JOHN MEEHAN
Director of Global Shipping Operations,
Carbon War Room

PROJECT TEAM

ANDERS VESTERGAARD JENSEN
Senior Analyst, Sustainia

NICHOLAS CRAIG
Project Coordinator, Sustainia

JACK ROBINSON
Project Coordinator, Sustainia

ÁNGEL F. HERRERA
Head of Design, Sustainia

EMIL DAMGAARD GRANN
Director, Sustainia

PERNILLE JÆGERFELT
Analyst, Sustainia

MARTIN LARSEN
Head of projects and partnerships, Sustainia

HENRIETTE WEBER
Director, Sustainia

JOACHIM MARC CHRISTENSEN
Communications Manager, Sustainia

AMY AU
Digital Communications Manager, Sustainia

MICHELLE GORDON
Design Assistant, Sustainia

DEEPIKA MITAL
Project Coordinator, DNV GL

EMILY WOODGATE
Digital Content Manager, Group
Communications - Digital Communications,
DNV GL

COLLEEN CONNORS
Manager, Brand & Communications,
UN Global Compact

JUSTIN GERDES
Proofreader



SOURCES AND SUGGESTED FURTHER READING

INTRODUCTORY CHAPTERS

DNV GL. Future of Spaceship Earth. Report. 2015. www.dnvgl.com

DNV GL, UNGC and Sustainia. Global Opportunity Report 2015. Report. 2015. www.dnvgl.com

DNV GL, UNGC and Sustainia. Global Opportunity Report 2016. Report. 2016. www.dnvgl.com

DNV GL, UNGC and Sustainia. Global Opportunity Report 2017. Report. 2017. www.dnvgl.com

Business and Sustainable Development Commission. Better Business Better World. Report. 2017. report.businesscommission.org

Raworth, K. Doughnut Economics - Seven Ways to Think Like a 21st-Century Economist. Cornerstone. 2017

GOAL 10 REDUCED INEQUALITIES

Beyer, A. C. Happiness, Equality and Communication. In International Political Psychology. 79-103. Palgrave Macmillan UK. 2017.

Credit Suisse Research Institute. Global Wealth Report 2017. 2017. www.credit-suisse.com

DNV GL. Future of Spaceship Earth. Report. 2015. www.dnvgl.com

Fajnzylber, P., Lederman, D., & Loayza, N. Inequality and violent crime. The Journal of Law and Economics. 45(1): 1-39. 2002.

Feder, G., & Noronha, R. Land rights systems and agricultural development in sub-Saharan Africa. The World Bank Research Observer. 2(2): 143-169. 1987.

Sustainable Development Knowledge Platform. Sustainable Development Goal 10. 2017. www.sustainabledevelopment.un.org

Sustainable Development Solutions Network. SDG Index & Dashboards Report. 2017. www.sdgindex.org

World Economic Forum. Outlook on the Global Agenda 2015. 2015. www.weforum.org

OPPORTUNITY: UNCHAINING LAND RIGHT

AID:Tech. How blockchain technology is enabling international aid to be delivered transparently. 2017. www.aid.technology

Arsenault C. How to protect Peru's rainforest? Indigenous land titles, researchers say. Apr 3rd 2017. www.reuters.com

Kairos Future. The Land Registry in the blockchain - testbed. Report. March 2017. www.chromaway.com

Sandner P. Solving Challenges in Developing Countries with Blockchain Technology. Jul 9th 2017. www.medium.com

Shin L. Blockchain Summit Asks, How Can Bitcoin And Blockchain Technology Empower Women? Jul 31 2017. www.forbes.com

Transparency International. Corruptions Perceptions Index 2016. Report. 2017. www.transparency.org

Villa M. Women own less than 20% of the world's land. It's time to give them equal property rights. 11th Jan 2017. www.weforum.org

Wong J.I. Sweden's blockchain-powered land registry is inching towards reality. Apr 3rd 2017. www.qz.com

World Bank. Why Secure Land Rights Matter. 2017. www.worldbank.org

OPPORTUNITY: ILLUMINATING SUPPLY CHAIN

8.7 Alliance. Global Estimates of Modern Slavery. 2017. www.alliance87.org

Hackenberg, J. AI and blockchain: Solving supply chain's transparency problem. 2017. www.supplychaindigital.com

Levy, R. The true cost of a cup of coffee: Wealth concentration and worker exploitation in the Nicaraguan coffee industry. SIT Digital Collections. 2010.

New Food. 8 in 10 consumers check the origin of their food when purchasing products. 2017. www.newfoodmagazine.com

Nielsen. Green Generation: Millennials Say Sustainability Is A Shopping Priority. 2015. www.nielsen.com

Provenance. Blockchain: the solution for transparency in product supply chains. 2015. www.provenance.org

Research and Markets. Blockchain Market - Forecasts from 2017 to 2022. 2017. www.researchandmarkets.com

UNCTAD. GVCs and Development: Investment and Value Added Trade in the Global Economy. 2013. unctad.org

UNCTAD. World Investment Report 2017. 2017. unctad.org

Unilever. Report shows a third of consumers prefer sustainable brands. 2017. www.unilever.com

Lernoud, J. et al. The State of Sustainable Markets - Statistics and Emerging Trends 2017. Report. 2017. www.intracen.org

GOAL 12 RESPONSIBLE CONSUMPTION AND PRODUCTION

DNV GL. Future of Spaceship Earth. Report. 2015. www.dnvgl.com

Ellen MacArthur Foundation. Towards A Circular Economy: Business Rationale For An Accelerated Transition. 2015. www.ellenmacarthurfoundation.org

Global Footprint Network. Earth Overshoot Day. 2017. www.overshootday.org

McKinsey. Growth within: A circular economy vision for a competitive Europe. 2015. www.mckinsey.com

Sustainable Development Knowledge Platform. Sustainable Development Goal 12. 2017. www.sustainabledevelopment.un.org

Sustainable Development Solutions Network. SDG Index & Dashboards Report. 2017. www.sdgindex.org

Walker, C. Perpetual Plastics - 3D Printing With Waste. Chemicals and Materials Blog. Elsevier. 2017. www.chemical-materials.elsevier.com

OPPORTUNITY: ALTERNATIVE FOOD SOURCES

European Biotechnology. World Nutrition: Insects will be on every table. 2017. european-biotechnology.com

FAO. Edible insects: Future prospects for food and feed security. 2013. www.fao.org

Global Market Insights. Edible Insects Market Size By Product. 2016. www.gminsights.com

Godfray, H. et al. Food security: the challenge of feeding 9 billion people. science 327, no. 5967: 812-818. 2010.

Guardian Sustainable Business. The Story of Palm Oil. 2014. www.theguardian.com

National Geographic. From Pest to Pot: Can Insects Feed the World? 2016. www.nationalgeographic.com

New Food. Global edible insects market: Trends & future prospects. 2016. www.newfoodmagazine.com

Persistence Market Research. Global Market Study on Edible Insects. 2016. www.persistencemarketresearch.com

Pimentel, D., & Pimentel, M. Sustainability of meat-based and plant-based diets and the environment. The American journal of clinical nutrition, 78(3), 660S-663S. 2003.

Research and Markets. Worldwide Insect Feed Market. 2017. www.researchandmarkets.com

Reverberi, M. Exploring the legal status of edible insects around the world. 2017. www.foodnavigator-asia.com

Stork, N. E. How Many Species of Insects and Other Terrestrial Arthropods Are There on Earth? Annual review of entomology. 2017.

Van Huis, A. Potential of insects as food and feed in assuring food security. Annual Review of Entomology, 58: 563-583. 2013

World Health Organization. The state of food security and nutrition in the world 2017. 2017. www.who.int

Yen, A. L. Insects as food and feed in the Asia Pacific region: current perspectives and future directions. Journal of Insects as Food and Feed. 1: 33-55. 2015.

OPPORTUNITY: **CONSTRUCTION IN PROGRESS**

Arcadis. Office Refurbishment In Global Cities: Which city provides the highest return? 2015 arcadis.com

Franconi and Bridgeland. How even skyscrapers can be circular. GreenBiz. greenbiz.com

Gould, H. The Rotterdam couple that will live in a house made from waste. Guardian Sustainable Business. 2016. theguardian.com

ING. Circular construction: Most opportunities for demolishers and wholesalers. 2017. ing.nl

Shan, T. and Yau, J. China's Construction Industry and its Drive Towards Internationalisation. PWC. 2017. pwc.blogs.com

Teulings ,R. How the circular economy drives a healthier future in the built environment. Future of Construction. 2016. futureofconstruction.org

World Economic Forum. Shaping the Future of Construction: Inspiring innovators redefine the industry. 2017. weforum.org

United Nations Environment Programme. Towards zero-emission efficient and resilient buildings: Global Status Report. 2016. globalabc.org

International Finance Corporation. Creating Markets for Climate Business - An IFC Climate Investment Opportunities. 2017. www.ifc.org

OPPORTUNITY: **REUSE TO REPOWER**

DNV GL. Energy Transition Outlook 2017. Report. 2017. www.dnvgl.com

Curry, C. Lithium-ion Battery Costs: Squeezed Margins and New Business Models. Bloomberg New Energy Finance. 2017. about.bnef.com

Eckart, J. Batteries can be part of the fight against climate change - if we do these five things. World Economic Forum. 2017. weforum.org

Gardiner, J. The rise of electric cars could leave us with a big battery waste problem. Guardian Sustainable Business. 2017. Theguardian.com

Jiao, N. and Evans, S. Business models for sustainability: the case of second-life electric vehicle batteries. Procedia CIRP. 40: 250-255. 2016.

Markets and Markets. Virtual Power Plant Market - Global Trends & Forecasts to 2021. 2017. marketsandmarkets.com

Pratt, D. Nissan and Eaton add new xStorage Home options as European pre-orders begin. Energy Storage News. 2016. www.energy-storage.news

Reid, G. and Julve, J. Second Life-Batteries As Flexible Storage For Renewables Energies. Bundesverbandes Erneuerbare Energie E.V. 2016. bee-ev.de

Spector, J. The Road to a Thriving Second-Life EV Battery Market. Green Tech Media. 2016. greentechmedia.com

Zipp, K. Giving electric vehicle batteries a second life in solar projects. Solar Power World. 2017. solarpowerworldonline.com

GOAL 13 **CLIMATE ACTION**

DNV GL. Future of Spaceship Earth. Report. 2015. www.dnvgl.com

Field, C.B.,et al. Technical summary. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. 35-94. 2014.

IPCC. Summary for policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. 1-32. 2014.

New Climate Economy. Seizing The Global Opportunity. 2015. www.newclimateeconomy.report/

Sustainable Development Knowledge Platform. Sustainable Development Goal 13. 2017. www.sustainabledevelopment.un.org

Sustainable Development Solutions Network. SDG Index & Dashboards Report. 2017. www.sdgindex.org

United Nations Development Programme. Pursuing the 1.5°C Limit: Benefits and Opportunities. 2016. www.undp.org

Whiteman, G., Hope, C., & Wadhams, P. Climate science: Vast costs of Arctic change. Nature. 499(7459): 401-403. 2013.

OPPORTUNITY: **UPCYCLING CARBON**

Carrington, D. Climate change to cause humid heatwaves that will kill even healthy people. The Guardian. 2nd August 2017. www.theguardian.com

CO2 Sciences and The Global CO2 Initiative. A Roadmap for the Implementation of Carbon Utilization Technologies. 2016.

DNV GL. Energy Transition Outlook 2017. Report. 2017. www.dnvgl.com

DNV GL. Future of Spaceship Earth. Report. 2015. www.dnvgl.com

Fuss, S., et al.Betting on negative emissions. Nature Climate Change. 4(10): 850-853. 2014.

IPCC Technical Summary. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. 2014.

Minx, J., et al. Fast growing research on negative emissions. Environmental Research Letters 2017.

Neelis. M. et al. Impacts Of A Global Carbon Price On Consumption And Value Creation. 2016. Ecofys. ecofys.com

Pekkala, P. Turning atmospheric CO2 problem into a carbon resource. The Making Of Tomorrow. 2017. www.makingoftomorrow.com

Readfern, G. Carbon dioxide's 400ppm milestone shows humans are rewriting the planet's history. The Guardian. 10th May 2016. www.theguardian.com

Styring & Jansen. Carbon Capture and Utilisation in the green economy. Centre for Low Carbon Futures. 2011.

Tripati, A. K., Roberts, C. D., & Eagle, R. A. Coupling of CO₂ and ice sheet stability over major climate transitions of the last 20 million years. Science. 326(5958): 1394-1397. 2009

The World Bank, Ecofys and Vivid Economics. State and Trends of Carbon Pricing 2017. 2017. ecofys.com

UN Global Compact and WRI. Global Climate Action Playbook. Report. 2018. www.unglobalcompact.org

United Nations Environment Programme. The Emissions Gap Report 2017. Chapter 7: Bridging the Gap - Carbon dioxide removal. 2017. www.unep.org

Volans. Carbon Productivity. www.carbonproductivity.com

OPPORTUNITY: **KEEPING IT COOL**

Bawden, T. Global warming: Data centres to consume three times as much energy in next decade, experts warn. The Independent. 23rd January 2016. www.independent.co.uk

Dahl, R. Cooling concepts: alternatives to air conditioning for a warm world. Environmental health perspectives. 121(1): a18. 2013.

Drawdown. Materials: Refrigerant Management. 2017. www.drawdown.org

Friedman, L. If You Fix This, You Fix a Big Piece of the Climate Puzzle. New York Times. 13th July 2017. www.nytimes.com

Henley, J. World set to use more energy for cooling than heating. The Guardian. 26th October 2015. www.theguardian.com

Plester, J. Why air conditioning is a vicious circle. The Guardian. 22nd August 2016. www.theguardian.com

Salamanca, F., et al. Anthropogenic heating of the urban environment due to air conditioning. Journal of Geophysical Research: Atmospheres, 119(10): 5949-5965. 2014.

Shah, N. K., et al. Opportunities for simultaneous efficiency improvement and refrigerant transition in air conditioning. 2017. www.escholarship.org

Lim, X. How heat from the Sun can keep us all cool. Nature, 542(7639): 23-24. 2017

OPPORTUNITY: **SUSTAINABLE SHIPPING**

European Commission. Reducing emissions from the shipping sector. 2018. ec.europa.eu

DNV GL. Maritime Forecast to 2050 - Energy Transition Outlook 2017. Report. 2017. www.dnvgl.com

The Norwegian Shipowners' Association & DNV GL. Sustainable Development Goals: Exploring Maritime Opportunities. Report. 2017

The International Council on Clean Transportation. Greenhouse Gas Emissions from Global Shipping, 2013-2015. 2017. www.theicct.org

Lloyd's Register & University Maritime Advisory Services. Zero-Emission Vessels 2030. How do we get there? 2017. www.lr.org; u-mas.co.uk

Psaraftis, H., N. Green Maritime Logistics: The Quest for Win-win Solutions. Transportation Research Procedia. 14: 133-142. 2016.

Winnes, H., et al. Reducing GHG emissions from ships in port areas. Research in Transportation Business and Management. 17: 73-82. 2015.

GOAL 14 **LIFE BELOW WATER**

DNV GL. Future of Spaceship Earth. Report. 2015. www.dnvgl.com

Ellen MacArthur Foundation. The New Plastics Economy: Rethinking the future of plastics and catalysing action. 2017. www.ellenmacarthurfoundation.org

Ellen MacArthur Foundation. The New Plastics Economy: Catalysing Action. 2017. www.newplasticseconomy.org

Harrabin, R. More acidic oceans 'will affect all sea life'. BBC. 23rd October 2017. www.bbc.com

Sustainable Development Knowledge Platform. Sustainable Development Goal 14. 2017. www.sustainabledevelopment.un.org

Sustainable Development Solutions Network. SDG Index & Dashboards Report. 2017. www.sdgindex.org

Tyree, C. and Morrison, D. Invisibles: The plastic inside us. Orb Media. 2017. www.orbmedia.org

World Wildlife Fund. Reviving the Oceans Economy: The Case for Action. 2015. www.worldwildlife.org

United Nations Environment Programme. 'Turn the tide on plastic' urges UN, as microplastics in the seas now outnumber stars in our galaxy. 23 February 2017. www.un.org

World Health Organization. Global and regional food consumption patterns and trends: Availability and consumption of fish. 2017. www.who.int

OPPORTUNITY: **REIMAGINING PLASTICS**

Andrady, A., L. and Niel, M., A. Applications and societal benefits of plastics. Phil. Trans. R. Soc. B. 364: 1977-1984. 2009

Ellen MacArthur Foundation. The New Plastics Economy: Rethinking the future of plastics. January 19, 2016. www.ellenmacarthurfoundation.org

Ellen MacArthur Foundation. The New Plastics Economy: Rethinking the future of plastics and catalysing action. 2017. www.ellenmacarthurfoundation.org

Grand View Research. Plastic Market Worth \$654.38 Billion By 2020. 2015. www.grandviewresearch.com
Institute for European Environmental Policy. Single Use Plastics. 2017. www.ieep.eu

Tyree, C., & Morrison, D. Invisibles. The plastic inside us. Orb Media. 2017. orbmedia.org

United Nations Development Program. Costa Rica paves the way to end single-use plastics. 2017. www.undp.org

United Nations Development Program. Dimensions of Pollution - Marine. web.unep.org

OPPORTUNITY: **ALTERNATIVE AQUACULTURE**

Research and Markets. Global Aquaculture Market - Forecasts from 2017 to 2022. 2017. www.researchandmarkets.com

Food and Agricultural Organisation. The state of world fisheries and aquaculture. 2016. www.fao.org

Food and Agricultural Organisation. FAO puts sustainability on the menu in the world's fastest growing food sector: fish. 2015. www.fao.org

Gentry R., R., et al. Mapping the global potential for marine aquaculture. Nature Ecology & Evolution. 1: 1317-1324. 2017.

Paynter, B. Replacing Farms With Fish Farms: The Odd Solution To Both Hunger And Climate Change. Fast Company. 2017. www.fastcompany.com

National Center for Coastal Ocean Science. Coastal Aquaculture Planning Portal. Coastalscience.noaa.gov

Wise Guy Reports. Global Aquaculture Market - Forecasts from 2017 to 2022. 2017. www.wiseguyreports.com

PHOTO CREDITS

Photo credits for all interview and solution photos are given to the solution providers:

GOAL 10

REDUCED INEQUALITIES

BenBen, www.benben.com.gh
ChromAway, www.chromaway.com
Bitfury*, www.bitfury.com
Uhurulabs, www.uhurulabs.org
Provenance, www.provenance.org
Telenor, www.telenor.com
Bext360, www.bext360.com
Supplycompas, www.supplycompass.com

GOAL 12

RESPONSIBLE CONSUMPTION AND PRODUCTION

Biteback, www.bitebackinsect.com
Chirps Chips, www.chirpschips.com
AgriProtein, Operations Colleagues, www.agriprotein.com
Mitchell Joachim, Terreform ONE, www.terreform.org
Kokoboard, www.kokoboard.com
Winsun, www.winsun3d.com
Peter Cuypers, StoneCycling, www.stonecycling.com
New Horizon, www.newhorizon.nl
E-STOR, www.c-e-int.com
Nissan & Eaton, www.electricalsector.eaton.com
BMW, www.bmw.com
Li-Cycle*, www.li-cycle.com

GOAL 13

CLIMATE ACTION

Carbon Clean Solutions*, www.carboncleansolutions.com
Econic, econic-technologies.com
Covestro, www.covestro.com
Blue Planet*, www.blueplanet-ltd.com
Aligned Energy, www.alignedenergy.com
Ant Studio, www.ant-studio.org
Purix, www.purix.com
Wien Energie/lan Ehm, www.wienenergie.at
Cavotec, www.cavotec.com
DNV GL, www.dnvgl.com
Kongsberg, www.kongsberg.com
Norsepower: ©Norsepower www.norsepower.com

GOAL 14

LIFE BELOW WATER

Algramo, www.algramo.com
Bee's Wrap, www.beeswrap.com
Thread, threadinternational.com
Unilever*, www.unilever.com
FarmInABox*, www.tilapiafarming.co.za
Calysta, www.calysta.com
GreenWave, www.greenwave.org
Matorka, www.matorka.is

* ©iStock photo



goexplorer.org