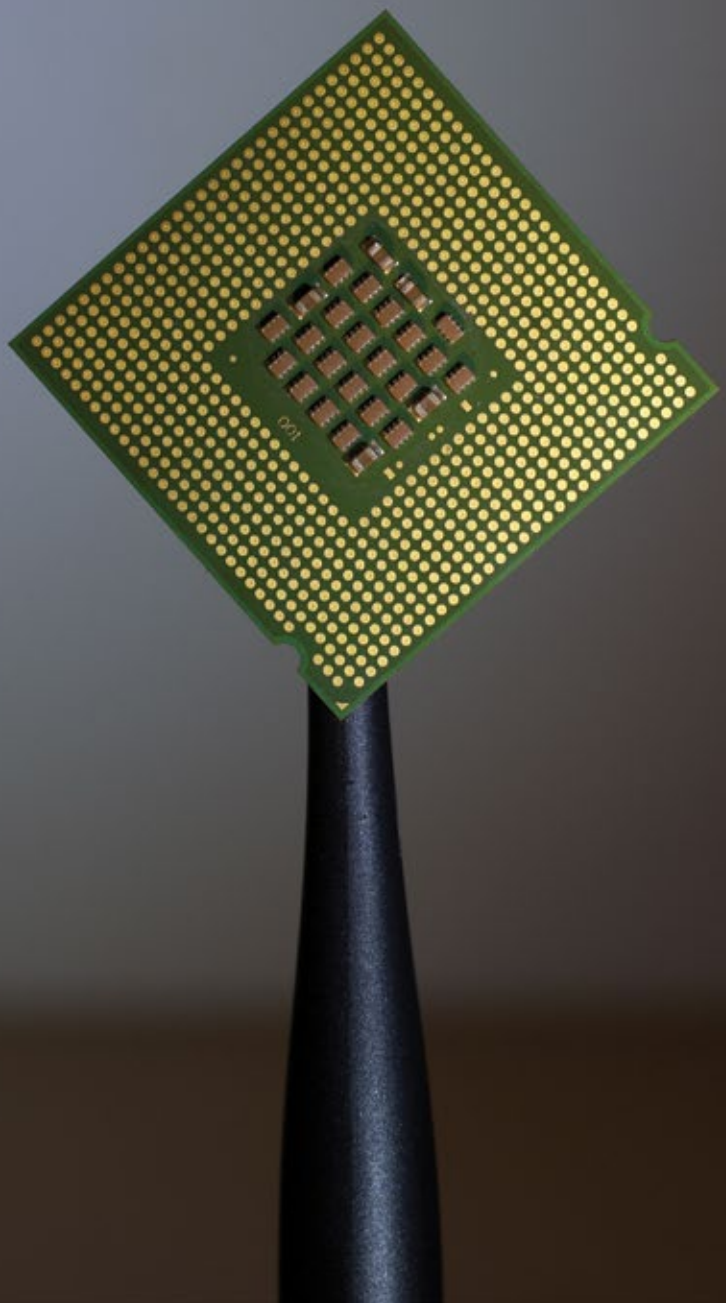
Business and the Fourth Wave of Environmentalism

Findings from Environmental Defense Fund's 2018 Fourth Wave Adoption Benchmark Survey



EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

Introduction

Nearly three decades ago, a new era of environmentalism began as U.S. corporations and nonprofit groups began to forge partnerships to drive progress on sustainability. Today these "Third Wave" innovations, which use problem-solving, market-based frameworks and corporate-NGO partnerships to achieve environmental goals, have become standard practice. As 21st century problems demand 21st century solutions, emerging technologies are driving a new wave of environmental innovation.

Fourth Wave innovations have the potential to make corporate-NGO partnerships more productive and their results more precisely measurable. To understand how emerging technology is shaping the business world and potential implications for environmental progress, EDF decided to conduct a study to ask business and technology leaders how they view the Fourth Wave of environmental innovation, its latest incarnation and its future potential.

In this report, we will explore how business and technology executives recognize the relationship between business strategy, technological innovation and corporate sustainability. Our findings suggest that as the Fourth Wave continues to generate business and environmental solutions for companies, it will become an essential component of their competitiveness.

Economic growth and environmental progress go hand in hand. As Mike Bloomberg says, 'It's not one or the other; it's neither or both.' Happily, Fourth Wave innovations have the power to make 'both' the default choice, because these emerging technologies are bringing business goals and environmental goals into ever closer alignment."

Fred Krupp, President, Environmental Defense Fund

About Environmental Defense Fund

Environmental Defense Fund (EDF) is one of the world's largest environmental nonprofit organizations, with more than two million members and a staff of over 500 scientists, economists, policy experts and other professionals working around the world. EDF finds practical and lasting solutions to the world's most serious environmental problems. Working with leading businesses, innovators, scientists and academics, EDF is catalyzing scalable solutions for minimizing the environmental, economic and human health risks associated with rising greenhouse gas emissions.

The Fourth Wave Adoption Benchmark Survey

EDF retained the opinion research firm KRC Research to administer the first in what is planned to be an annual study of business and the Fourth Wave. This study goes beyond simply reporting on corporate sustainability to explore a more intricate intersection of business, the environment and Fourth Wave innovation. The goals of the survey are to:

- Show how business leaders leverage new technologies to both increase sustainability and drive business results
- Assess how far companies and industries have come in adopting Fourth Wave innovations, and what technologies are considered most relevant
- Provide insights into motivators for business leaders to use technology to better balance environmental and bottom line goals
- Learn how industry, company size and executive seniority affect adoption of Fourth Wave technologies

KRC Research conducted a 15-minute online survey from Dec. 8 to Dec. 26, 2017 of 501 U.S. executives at the vice president level or above in companies with more than $500 million in revenue. Quotas ensured a balanced sample across five different industries (retail, manufacturing, energy, technology and finance) and five functional areas (marketing, finance, operations/R&D, strategy/executive and IT).

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Executive summary

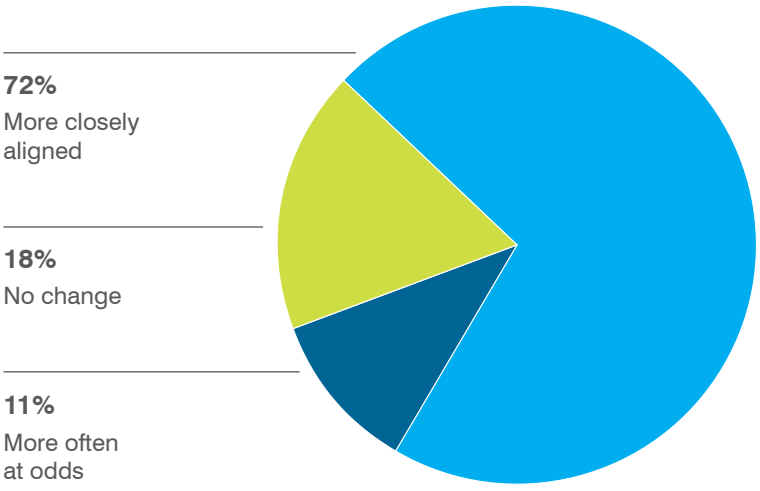
A new wave of environmental innovation has the power to transform industries, democratize information, and make environmentalism a mainstream value. And top business executives across industries are embracing emerging technologies as a means to improve both business and environmental performance. With this report, Environmental Defense Fund (EDF) examines how executives position themselves at this unique intersection of business, the environment and technology.

To better understand how emerging technology is empowering business leaders to raise the bar on sustainability performance, EDF hired the opinion research firm KRC Research to conduct a study of how business leaders view and adopt a set of seven technology innovations defined as "Fourth Wave" in the context of business and environmental goals. This December 2017 survey of more than 500 top executives (vice president or above) at corporations with more than $500 million in revenue found that a majority of executives see emerging technologies driving greater alignment between business and environmental goals.

This report breaks out results by industry, executive level, company size and specific technology. Industries represented include: retail, manufacturing, energy, technology and finance. Company size ranges from $500 million in revenue to $5 billion-plus, and executive respondents are broken out by VP/SVP and C-suite. Technologies examined are: blockchain, data analytics, sensors, automation technologies, sharing technology, mobile ubiquity and dematerialization.

Over 70% of business leaders see greater alignment between business and environmental goals.

Relationship between business objectives and environmental goals now vs. five years ago



Major findings include:

ALIGNED GOALS

More than seven in ten business and technology executives see their business and environmental goals more closely aligned than five years ago; 60% of whom cite Fourth Wave technology as a driver.

EXECUTIVES AGREE

86% of executives agree that Fourth Wave technology can help businesses' bottom line as well as improve their impact on the environment—a figure that increases to 91% among those in the C-suite.

NEW THINKING

Three in four top executives consider the environmental impact of each technology when deciding whether to implement it.

TAKING ROOT

Seven in ten survey respondents reported that Fourth Wave technologies offering environmental benefits have already taken root in their industries.

TECH LEADS

Of the five industries surveyed, not surprisingly, the technology industry leads the field in Fourth Wave implementation, while the financial industry lags.

COMPELLING REASONS

Over three-quarters (77%) of business leaders find the potential to increase their bottom line, improve their brand's reputation, or differentiate themselves from their competitors as extremely or very compelling reasons to implement a new technology with environmental benefits.

DATA ANALYTICS

Data analytics, the most implemented innovation, is seen as having the biggest potential impact on an organization's bottom line, environmental footprint and brand reputation.

MOST PROMISING INNOVATIONS

Executives see sensors and data analytics as the most promising innovations; however, many do not yet fully understand blockchain technology and its potential.

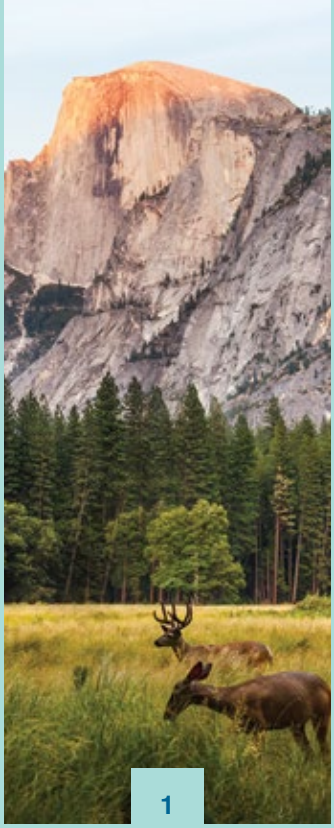
MOST POWERFUL WAVE YET

Most business leaders believe the Fourth Wave of environmental innovation will be the most powerful wave yet, with data analytics, sensors, social platforms and automation technologies together outperforming Third Wave innovations.

Overall, business and technology leaders see their business and environmental goals becoming closely aligned. And while there are differences by industry, they generally agree that this alignment is driven by emerging technology.

Leaders working to raise the bar on corporate sustainability have a new wind at their back.

Recent technological breakthroughs are poised to transform the way business is done. As sensors, information technology and analytics—as well as emerging innovations such as blockchain—increasingly shape business strategy and reward corporate responsibility, the result will be positive change that lets both business and the environment prosper.



1

Late 19th Century

2

Mid 20th Century

3

Late 20th Century

4

Today

The four waves of environmentalism

Environmental protection is entering a new era, its fourth distinct evolution in our history. This “Fourth Wave” of environmental innovation builds upon the success of the three previous waves and is driving greater alignment between business and environmental goals.

The recognition of the need to protect our environment began with the government land conservation efforts in the late 19th century and gained momentum in the Teddy Roosevelt-era. The mid-20th century saw the second evolution with a wave of antipollution efforts which broadened to include legislation to protect wildlife and natural resources. And when Environmental Defense Fund pioneered a groundbreaking partnership with McDonald’s in 1990 to reduce packaging waste, a new focus on market-based solutions gave birth to the Third Wave. For the past three decades, partnerships between U.S. corporations and environmental NGOs have used aggressive goal-setting, problem-solving and market-based frameworks to achieve environmental goals and make sustainability standard business practice.

Now a powerful Fourth Wave of environmental innovation is emerging, giving business the power to scale solutions as never before. It applies cutting-edge technologies to supercharge the work of the previous waves, making environmental partnerships more productive and measurable. Just as innovations such as sensors, automation, data analytics and artificial intelligence can increase efficiency and reduce costs for businesses, they can be used in tandem to lower resource consumption, decrease pollution and greenhouse gas emissions, and reduce waste streams. What is good for the bottom line is often good for the environment as well.

The Fourth Wave of environmental innovation is supercharging corporate sustainability

Executives charged with balancing business and environmental goals recognize the increasingly influential role that technology plays in raising the bar for corporate sustainability. Emerging technologies are enabling businesses to fast-track sustainability as never before: making global supply chains more transparent and trackable; surfacing valuable data on previously invisible emissions; and helping reduce packaging, waste and energy use.

This report examines how seven emerging technologies are changing the way the corner office perceives sustainability.

Exploring Fourth Wave technologies

A broad spectrum of technological innovations has the potential to drive both business and environmental goals for companies. The technologies considered in this report include:

BLOCKCHAIN
uses cryptography to provide a secure means of recording transactions in a public ledger, which makes it valuable for storing and manipulating sensitive data such as financial, medical, identity, voting or chain of custody information.

SENSORS
have proliferated in recent years, allowing detection, visualization and measurement of a wide variety of variables.

DATA ANALYTICS
involves processing information to gain insights. In practice, it can range from simple statistical analysis to sophisticated data mining and machine learning.

AUTOMATION TECHNOLOGIES
allow processes to be controlled without human involvement, often increasing efficiency and reducing waste.

DEMATERIALIZATION
involves the reduction of material use in production, packaging, transportation and other business functions.

SHARING TECHNOLOGY
allows different organizations to collaborate more effectively by sharing information and knowledge.

MOBILE UBIQUITY
allows organizations to communicate and share information with customers, employees, contractors, partners and others through an ever-increasing number of connected mobile devices.

Survey results

Executives at the largest U.S. companies understand the positive impact that emerging technologies can have on their business and the environment.

Leaders see a win-win from emerging technologies

Businesses recognize the potential for new technologies to drive both bottom-line and environmental gains.

Overwhelmingly, executives believe they can simultaneously improve the bottom line while reducing their organization's environmental footprint. Many business leaders have already begun investing in and implementing Fourth Wave technologies such as sensors and automation.

The report also explores how business leaders view the impact of the emerging Fourth Wave, what motivates them to adopt its technologies, and how industries differ from each other in their perspectives and implementation of its principles.

Aligning business and environmental goals: The impact of technology

Executives, especially those in C-suite positions and at larger organizations, clearly recognize the positive impact of new technologies on both business and the environment.

More than ever, investment in emerging technologies is essential to maintaining competitiveness. Data, as well as the capacity to derive useful insights from it, is seen as essential to improving business outcomes. Similarly, data can advance environmental goals such as reducing material inputs, cutting emissions of greenhouse gases and other pollutants, and minimizing waste. Because cost reductions often accompany these achievements, technology is driving a rapid convergence of business objectives and environmental goals. With advances in sensors, cloud computing, artificial intelligence and other areas, opportunities to align the two are much greater than they were even five years ago.

Business leaders recognize this parallel effect of technology on business and the environment. About eight in ten business leaders believe that emerging technologies drive business growth and overall economic growth. In addition, nearly seven in ten believe new technologies help protect the environment. A majority also believes that recent emerging technologies increase quality of life and create jobs. In general, C-suite executives in the survey expressed more optimism about the impact of recent technologies than their VP counterparts, and those working at larger companies were significantly more likely to report positive effects of technology on their company's business, and economic growth in general, than those at smaller companies.

According to the executives surveyed, many of the competitive benefits and environmental gains from Fourth Wave technologies are made possible by data. Nearly five in six business leaders agree that more data leads to better outcomes for business and the environment, and that investing in emerging technology is necessary to stay competitive. And 77% of executives think that sharing data with outside parties will lead to better outcomes for businesses. In terms of environmental benefits, executives in the technology industry are most optimistic (87%) that putting more data in the hands of businesses produces better outcomes; that figure jumps to 91% when looking at executives in an IT role.

Sensors advancing the energy industry

Four years ago, EDF's Methane Detectors Challenge called for tech companies big and small to develop inexpensive sensors that could be permanently mounted on industrial equipment to continuously monitor for methane leaks on natural gas sites—reducing a dangerous pollutant for the environment while also recapturing sellable product for oil and gas companies.

Dozens of pitches streamed in from around the world, and pilot projects are now underway with Shell, Equinor (formerly Statoil) and Pacific Gas & Electric. In September 2017, the Mobile Monitoring Challenge was launched in partnership with Stanford University. The task for technologists: Come up with methane sensors that can be attached to planes, helicopters and drones, which can then cost-effectively fly over large swaths of oil and natural gas installations. Controlled testing will take place in 2018.

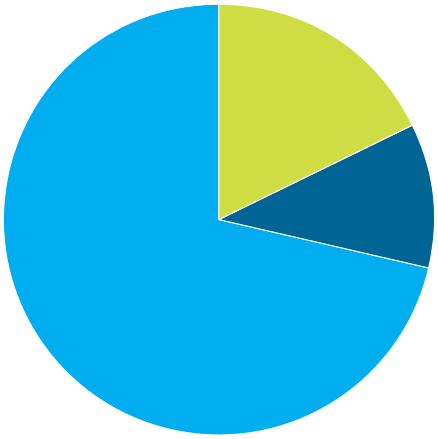
(Source: https://medium.com/the-fourth-wave/methane-to-its-madness-509ff371a8a8)

Sensors are making invisible pollutants visible

Methane sensor technology in the oil and gas industry enables workers to find and fix leaks faster, reducing emissions and protecting product.

Executives across industries say business objectives and environmental goals are more closely aligned than they were five years ago.

While 72% of leaders surveyed see business and environmental goals more closely aligned, 18% report no change and another 11% see these goals increasingly at odds. Meanwhile, retailers are most likely to say that their business and environmental goals have become more aligned in the past five years, and the financial industry is most likely to express skepticism about alignment. Those working at larger companies or within the C-suite were slightly more likely than those at smaller companies or at the VP level to see a divergence, not an alignment, between their organization's environmental and business goals over the last five years.



Relationship between business objectives and environmental goals now vs. five years ago

	Most likely to be:
72% More closely aligned	**Industry:** Retail **Role:** Marketing **Level:** VP **Company Size:** $500M-$1B
18% No change	**Industry:** Technology **Role:** Operations **Company Size:** $2B-$5B
11% More often at odds	**Industry:** Financial **Role:** IT **Level:** C-suite **Company Size:** $5B+

Top reasons business and environmental goals are more closely aligned

- **60%** Technological advancements
- **51%** Customer demands
- **51%** More stringent regulation
- **47%** Increased competition
- **26%** Lack of regulation

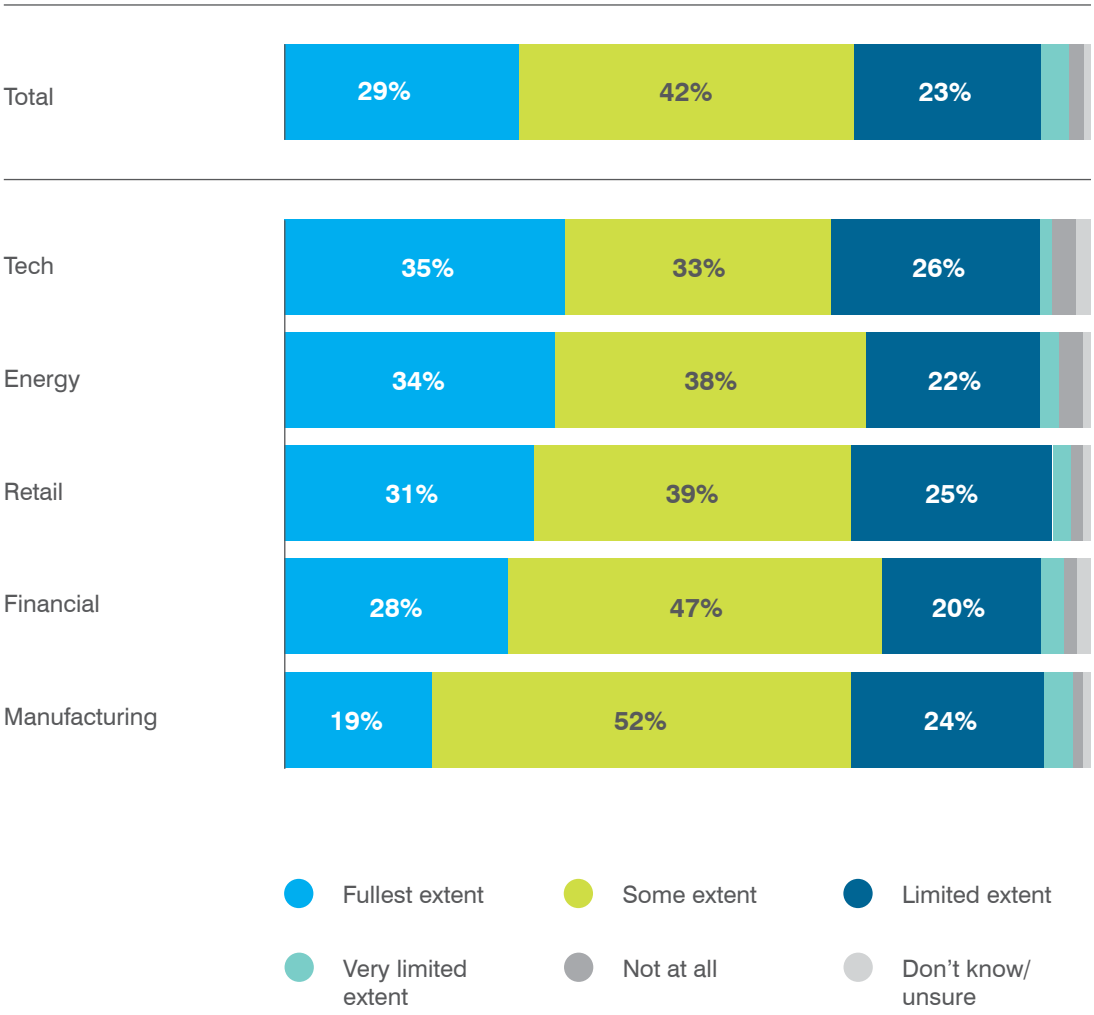
Executives (especially those at the C-suite level or leading the largest companies) were especially likely to cite technological advancements as the top reason for increasing alignment between their environmental goals and business objectives.

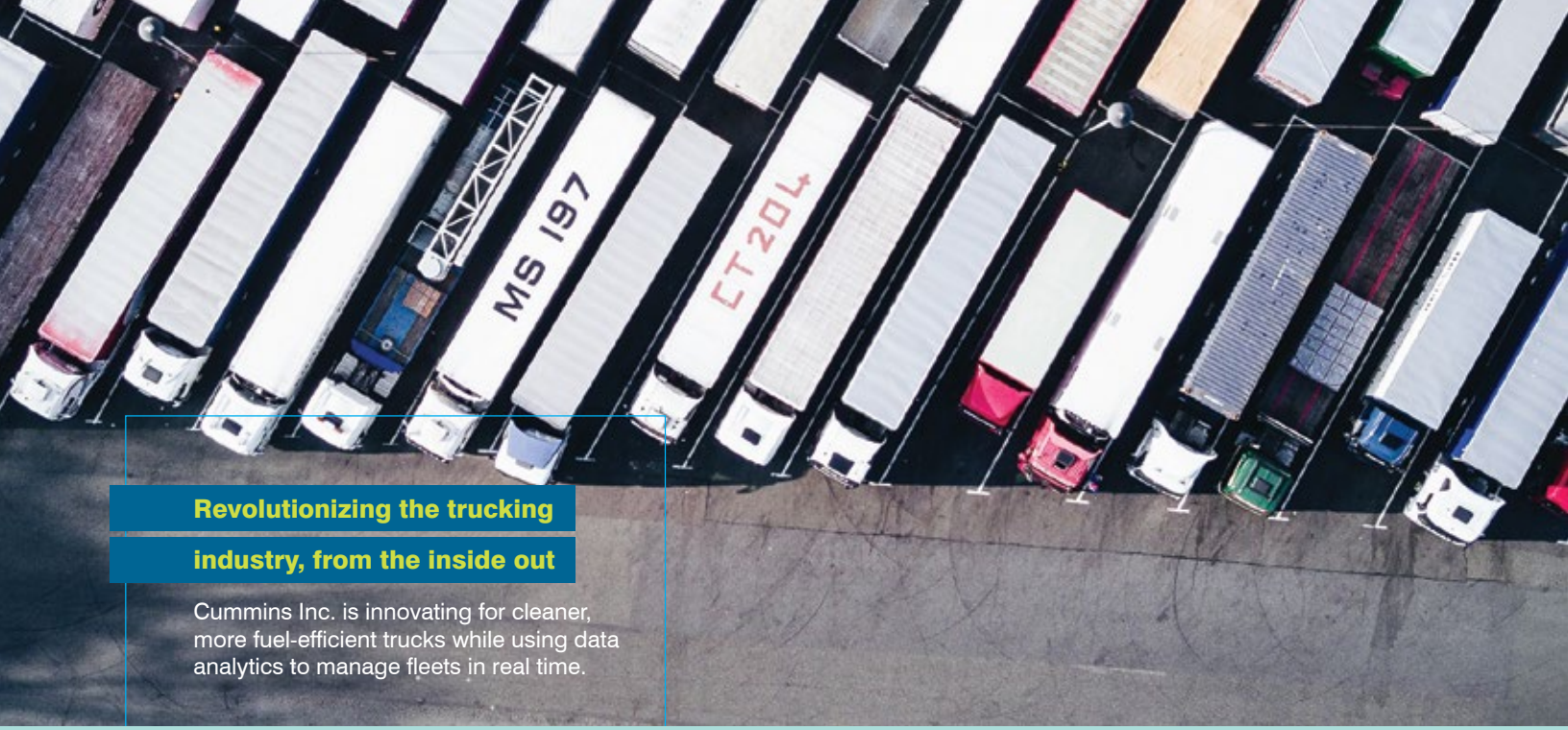
Among those who see business and environmental goals diverging, more than half cite increased competition.

Business and environmental alignment	COMPANY SIZE				TITLE		YEARS OF EXPERIENCE			
	$500M -$1B	$1-2B	$2-5B	$5B+	SVP/ VP	C-suite	5-9	10-14	15-20	20+
Report greater alignment between business and sustainability goals	76%	70%	60%	61%	74%	65%	71%	73%	73%	66%
Of those who report greater alignment, cite technology as the top reason	42%	44%	63%	57%	51%	41%	33%	67%	54%	23%
Agree that emerging technologies can help business improve their bottom line as well as their impact on the environment	87%	84%	88%	88%	84%	91%	94%	82%	87%	84%
Say emerging technologies with environmental benefits have taken full root in their industry	27%	31%	31%	33%	30%	29%	26%	29%	33%	21%

About seven in ten survey respondents reported that Fourth Wave technologies offering environmental benefits have taken root in their industries, at least to some extent. While the financial industry appears to be slightly ahead of other industries in terms of implementation, executives from the technology industry report the highest rate of full implementation of emerging tech with environmental benefits. Manufacturing appears to have the greatest potential to move toward full implementation.

Extent to which Fourth Wave technologies that improve both business and environmental outcomes have taken root





Revolutionizing the trucking industry, from the inside out

Cummins Inc. is innovating for cleaner, more fuel-efficient trucks while using data analytics to manage fleets in real time.

Global manufacturer goes all in on innovation

Cummins Inc., a global manufacturer of diesel and alternative fuel engines, generators, and a host of related products, has bolstered its business by helping its customers produce cleaner, more fuel efficient vehicles and technology.

The company is also using data-enabled services to provide customers the information they need to quickly diagnose and provide service and optimize for efficiency. Cummins' Connected Diagnostics,™ for example, instantly transmits key engine and GPS data through a telematics connection, immediately applying Cummins' analytics to transform the data into actionable information for the operator and fleet manager.

In addition to improving its more traditional diesel engines, the company recently started a new Electrified Power business to develop its electrification capabilities, pledging to have an all-electric powertrain for urban buses on the market by 2019.

Cummins is also partnering to develop a Class 6 medium-duty, plug-in, hybrid electric truck that can reduce fuel consumption by at least 50%. The project was awarded a $4.5 million research grant by the U.S. Department of Energy. Partnerships like this allow Cummins to continue innovating for the efficient lifecycle use of fuels and raw materials in new product design.

Another example of corporate innovation is Cummins' QSK95 engines, which power the new diesel-electric Charger Locomotives built by Siemens. These ultra-low emissions locomotives will be used by passenger rail systems across the United States.

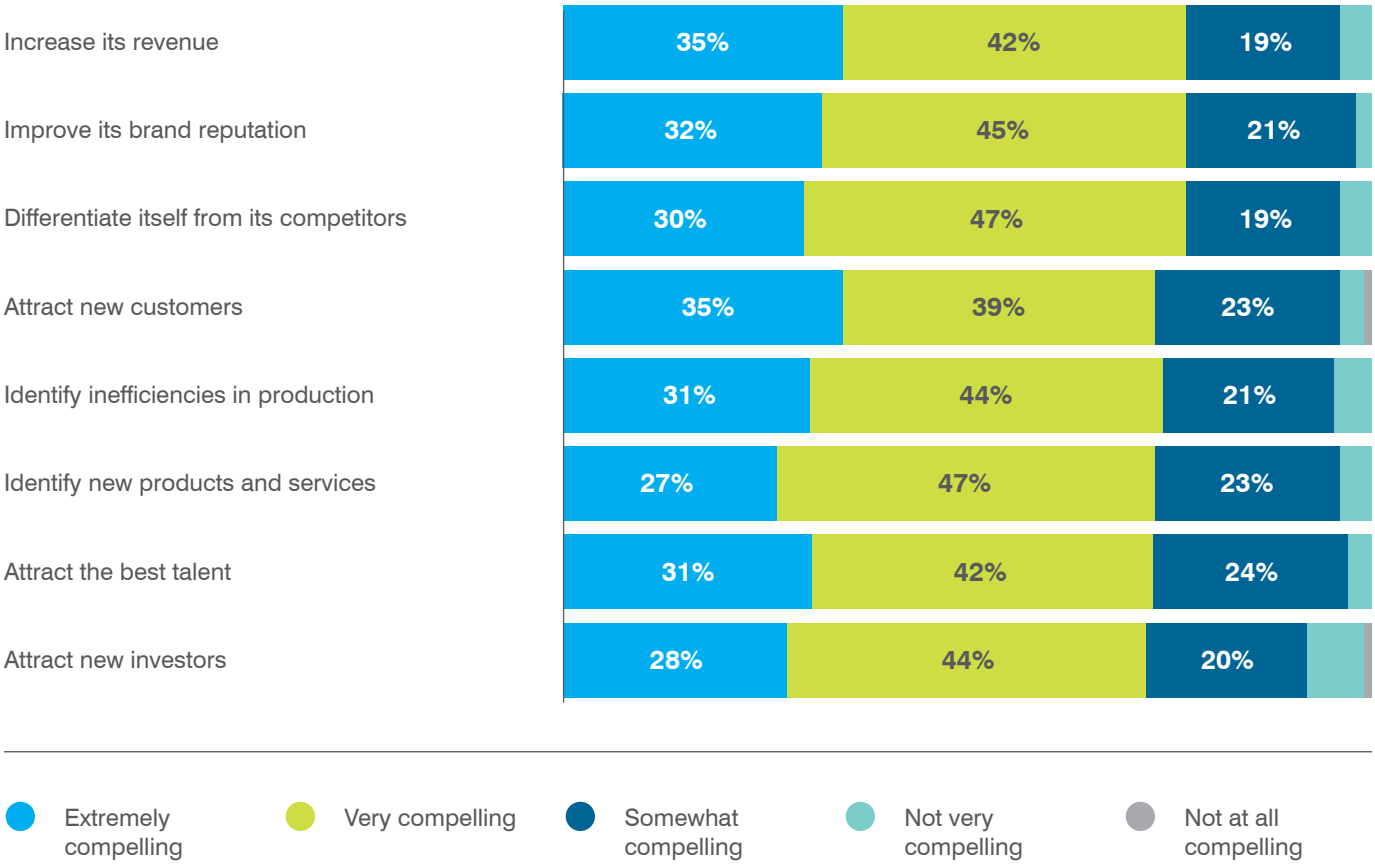
> **"These achievements all resulted from Cummins' continued spirit of innovation and our pledge that everything we do leads to a cleaner, healthier, safer environment."**
>
> Tom Linebarger,
> Chairman and CEO

(Source: Cummins website)

What motivates business leaders to adopt Fourth Wave technologies?

Differentiation and reputation are on a par with revenue as incentives to implement technologies that improve environmental impact.

Top reasons for implementing these technologies



Executives across the board agree, having environmentally sustainable business practices helps them attract and retain top talent.

INDUSTRY					EXECUTIVE LEVEL	
Retail	Manufacturing	Energy	Tech/IT	Financial	C-suite	VP/SVP
84%	84%	88%	87%	77%	84%	84%

COMPANY REVENUE				YEARS OF EXPERIENCE			
$500M -$1B	$1-2B	$2-5B	$5B+	5-9	10 to 14	15 to 20	20+
82%	75%	84%	87%	81%	90%	83%	83%

Greening the global shopping cart starts with the supply chain

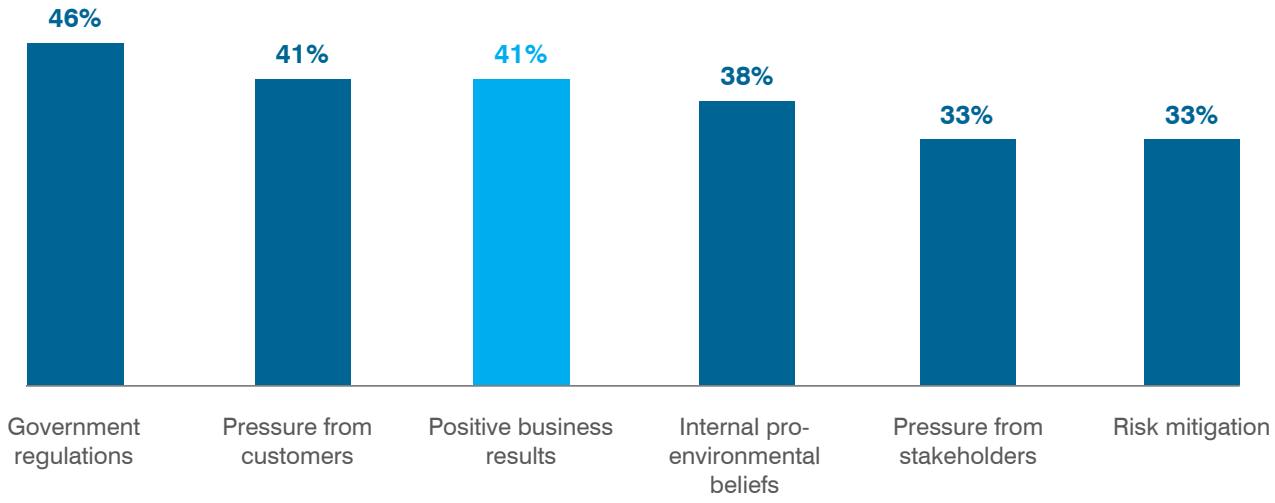
For Walmart—with up to half a million products in every store from more than 100,000 suppliers—product sustainability is a massive undertaking.

While the bottom line ultimately plays some role in virtually any business decision, improved reputation, competitive differentiation and attracting new customers have become leading factors driving the adoption of new technologies to protect the environment.

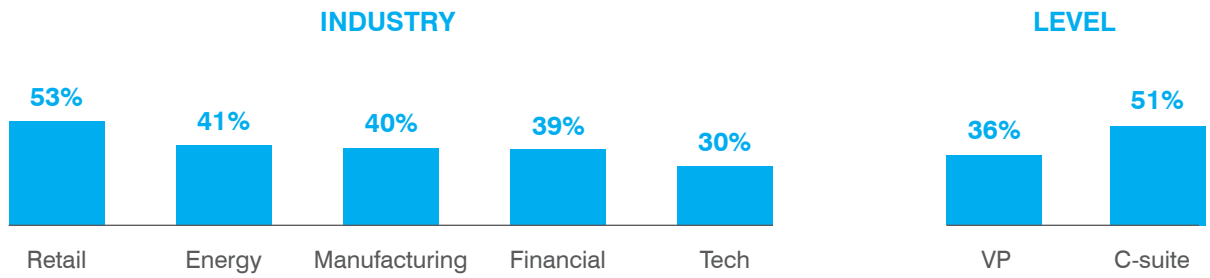
Nearly eight in ten executives cite improving brand reputation and differentiating themselves from competitors as compelling reasons for implementation of new technologies with environmental benefits, while more than seven in ten say they implement new technologies to attract new customers.

C-suite execs find the ability to identify inefficiencies in production a particularly compelling motivation to implement new technologies. Interestingly, those in marketing are most likely to be skeptical that implementing new environmentally beneficial technologies will lead to improved brand reputation.

Top motivators in driving executive decisions that have a positive impact on the environment



% selecting positive business results as a top motivator



Despite advances in technology and external pressure from customers and stakeholders, government regulations remain a top motivator for companies, especially the largest ones, to make decisions that benefit the environment. Almost half of executives cite government regulations as drivers to implement Fourth Wave technologies, while more than 40% cite pressure from customers and positive business results. Significantly fewer executives in the energy industry pointed to regulations as a top motivator compared with those in tech, finance, manufacturing and retail. Retail and C-suite executives were most likely to point to positive business results as a top motivator for pro-environmental decision-making.

Although regulations are a main motivator, uncertainty about where environmental regulations are headed does not seem to deter companies from making investments in Fourth Wave technologies. Instead, executives tend to make return on investment (ROI) and the availability of infrastructure their primary considerations. The lack of a clear and quick path to ROI presents the biggest barrier to adopting Fourth Wave technologies, particularly among companies with less than $5 billion in revenue. The largest companies are most likely to recognize the clear potential for ROI, hesitating only if they doubt how quickly they can realize gains.

Five industry profiles

Leaders from all industries recognize the positive impact of new technology on their business and the environment, but there are differences in how they see this impact.

RETAIL:
Burnishing the brand

The retail industry (including food and drug stores), leads other industries in terms of recognizing the benefits of emerging technology for both business and the environment. In fact, 31% indicated that Fourth Wave technologies have already taken root in their operations to the fullest extent – the highest of all the industries surveyed. Of the industries represented in this survey, retail business leaders are most likely to attribute pro-environmental decision-making to the fact that it produces positive business results. They are also most likely to report a recent alignment in their industry's business and environmental goals. When asked about their motivation for pursuing technology with environmental benefits, retailers cite improving brand reputation as more compelling than helping the bottom line.

When it comes to knowledge and implementation of specific Fourth Wave technologies, retail is the only industry that is further ahead in adopting automation technologies than analytics. Retailers clearly recognize automation as having great potential: 87% believe it can improve their business operations and 84% believe it can reduce their environmental impact. A low amount (38%) of retail executives reported successfully implementing or being in the early adoption phase of using blockchain. Also, 58% of retail leaders surveyed were either unaware of potential uses or unfamiliar with blockchain, a technology that is emerging as a major factor in supply chain efficiencies.

The retail industry scored the highest for constantly trying to find new ways to reduce its environmental impact, which correlates to 78% of retail executives saying their business and environmental goals are more aligned than five years ago, and 65% of respondents attributing that to an increase in Fourth Wave technological advancements.

Executives are less familiar with blockchain, but recognize its potential

Blockchain digitally tracks food products from an ecosystem of suppliers to store shelves and ultimately to consumers.

Creating global supply chain transparency with blockchain

Walmart, JD.com, IBM and Tsinghua University are working with food supply chain providers and regulators to develop the standards, solutions and partnerships to enable a broad-based food safety ecosystem in China. IBM brings its IBM Blockchain Platform and expertise to the table, while Tsinghua University is acting as a technical advisor sharing its expertise in the key technologies and the China food safety ecosystem. IBM and Tsinghua are collaborating with Walmart and JD.com to develop, optimize and roll out the technology to suppliers and retailers that join the alliance.

“Blockchain holds incredible promise in delivering the transparency that is needed to help promote food safety across the whole supply chain. This is a fundamental reason why IBM believes so strongly in the impact this technology will have on business models.”

Bridget van Kralingen, senior vice president, IBM Industry Platforms

(Source – IBM press release, http://www-03.ibm.com/press/us/en/pressrelease/50816.wss)

MANUFACTURING:
Reacting to external forces

The manufacturing industry (including apparel, textiles, chemicals, pharmaceuticals, consumer/household products, food, beverage, industrials, materials, and motor vehicles and parts) lags behind the other industries surveyed in terms of seeing the benefits of implementing Fourth Wave technologies that reduce environmental impact. Only 19% have integrated Fourth Wave technologies to the fullest extent, however, 52% have implemented to some extent.

Manufacturers are most likely to be motivated to adopt Fourth Wave technology by external pressures such as customer demands and government regulations.

Survey respondents cite a lack of quick ROI or supporting infrastructure as the top factors standing in their way. More than one-third of manufacturing executives state they have already integrated data analytics, sensors and automation technology into their processes. They see sensors and automation technology as having the most potential benefit for their business and its environmental footprint.

Attracting new customers was cited as the most compelling reason for manufacturers to implement Fourth Wave technologies, while increased alignment between business objectives and environmental goals was attributed to customer demands.

ENERGY:
Courting investment

Of all industries, energy is the most compelled to implement new tech in order to attract new investors.

Of all executives, those in the energy sector (which includes power, utilities, oil and gas) are most likely to report that Fourth Wave technologies are being adopted and implemented in their industry. More than half (52%) of executives say that advances in technology will lead to solutions that are both business and environmentally friendly. A third of energy executives report that they believe Fourth Wave technology has taken full root in their field, and 72% state that business and environmental goals are more closely aligned than five years ago.

The top motivator for energy executives to drive decisions that have a positive impact on the environment is pressure from customers; the top hindrance is lack of clear ROI.

However, energy executives are slightly behind the pack when it comes to actually implementing the seven cited Fourth Wave technologies. It is possible, however, that because the energy industry is on the cutting edge of various technological advancements in energy exploration, production and storage, its executives may be considering and implementing Fourth Wave technologies beyond those we surveyed. Clearly, energy executives see the potential of Fourth Wave technologies: they saw high potential for improving business opportunities and environmental impact across technologies. Also, the energy industry sees the most promise in blockchain, with 50% of executives reporting that blockchain has been successfully implemented or is in the early adoption phase.

TECHNOLOGY:
Leading the way

The technology industry (including aerospace, defense, technology, software, IoT and AI) leads the way in implementing Fourth Wave technologies, with a third of executives saying that these innovations have taken full root in their industry.

86% of tech executives agree that emerging technologies can help business improve their bottom line as well as their impact on the environment, and 80% agree that new tech can help establish environmental protection as a mainstream value.

Of the industries surveyed, tech is the most motivated by regulations, as well as pressure from customers and stakeholders to make pro-environmental decisions; however, tech leaders also cite stakeholders' lack of concern with the environment as the leading hindrance to adoption.

The technology industry leads in fully implementing Fourth Wave innovations, with 45% of all technology leaders saying their organizations have integrated both data analytics and automation tech into their processes. Technology leaders see the most business potential in sharing technology (90%), and view automation technology as the innovation with the most potential to improve their environmental impact (85%).

Despite this momentum, the perception of alignment between environmental and business goals has increased the least for the tech industry over the past five years, with only 66% of executives reporting increased alignment.

Executives in the technology and IT industries are optimistic:

80%
of executives agree that new technologies can help establish environmental protection as a mainstream business value

86%
agree that emerging technologies can help business improve their bottom line as well as their impact on the environment

80%
think that businesses that use technologies to improve their impact on the environment are leading companies within their industry

85%
find that technology that enhances business efficiency is also enhancing corporate sustainability

87%
find that having environmentally sustainable business practices helps them attract and retain top talent

FINANCIAL:
Looking for ROI

Of the executives surveyed from the financial industry, 67% see a greater alignment between business objectives and environmental goals with 74% citing technological advancements as the driver; and 55% are hopeful that advances in technology can lead to solutions that are both business and environmentally friendly. Additionally, 80% of financial executives think new technology can help establish environmental protection as a mainstream value.

The financial industry lags when it comes to full implementation of Fourth Wave technologies, with only 28% of executives reporting that these technologies had taken root in their industry. However the opportunity is there, as 47% reported that this technology was integrated at least to some extent. Financial executives lead the pack with 44% recognizing the potential effect of blockchain on the way businesses impact the environment.

More than half (55%) of financial executives reported that government regulations are the top motivator for making pro-environmental decisions at their organizations, with lack of clear (39%) and quick (38%) ROI as the top hindrance.

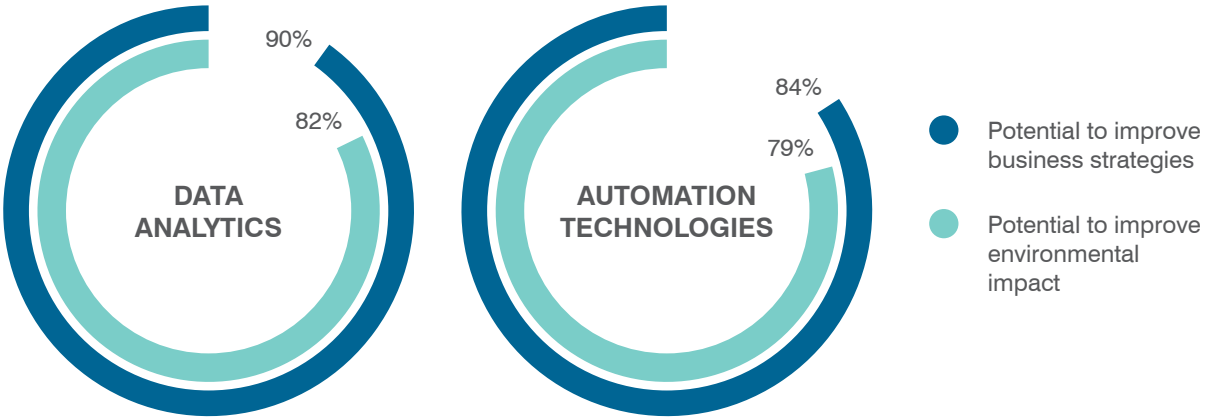
The financial industry is matched only by the technology industry in its implementation of data analytics. Financial leaders believe data analytics has the most potential to improve their industry's business strategies (94%), and automation technology has the most potential to improve their impact on the environment (85%).

Good data is the lifeblood of good decision-making. This is especially important for high-stakes, long-term business and environmental issues."

Curtis Ravenel, Global Head of Sustainable Business & Finance, Bloomberg

Familiarity with Fourth Wave technologies

Executives who are familiar with Fourth Wave technology believe that data analytics and automation have the most potential to improve both business strategy and its impact on the environment.



Executives were asked about their familiarity with and attitudes toward important Fourth Wave technologies, including data analytics, sensors, automation technologies, sharing technology, mobile ubiquity, dematerialization and blockchain.

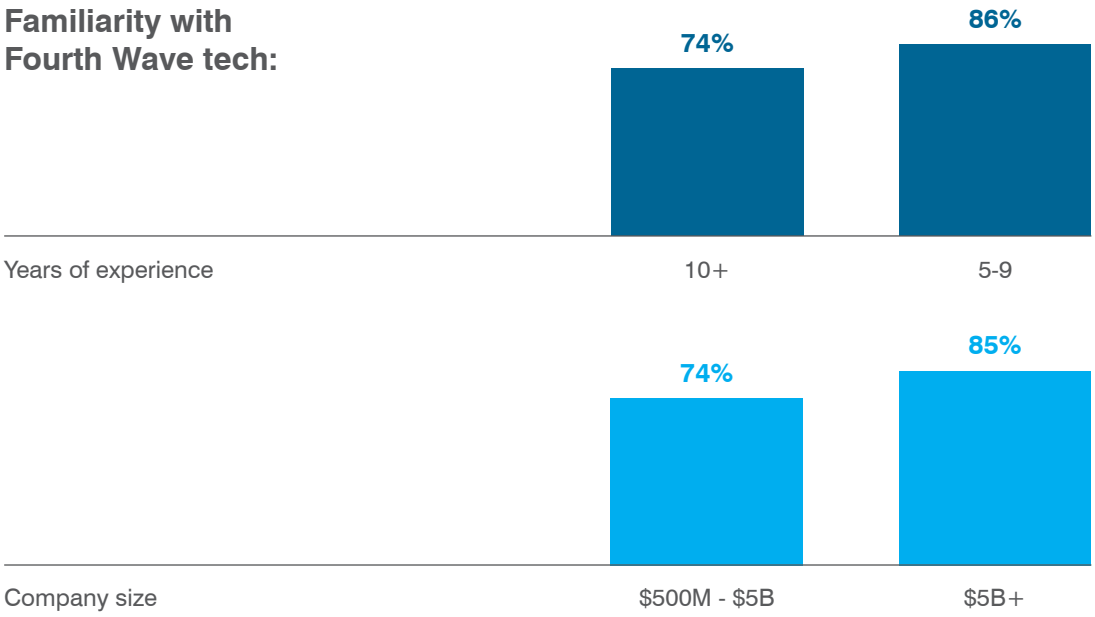
The survey found that data analytics, sensors and automation technology are the most mature of the current Fourth Wave innovations—leading the way in terms of familiarity and perceived potential to improve business and environmental outcomes. These technologies have proven themselves in the field: for instance, EDF recently worked with Google to put sensors on Google Street View cars to measure and map methane leaks in Boston, Chicago, Dallas and other cities, creating a faster, cheaper way to find and assess leaks under streets and sidewalks.[1]

1 https://www.edf.org/climate/methanemaps

EDF and Google Earth Outreach team up to pinpoint climate pollution

Vehicles equipped with measurement technologies visualized widespread methane leaks in pilot cities.

Executives with fewer years of experience and those at the largest companies have the most familiarity with Fourth Wave technologies.



About eight in ten business leaders in the survey said they were familiar with the applications of data analytics, sensors and automation technologies in their industry, and about three in four expressed familiarity with sharing technology and mobile ubiquity. Although familiarity is lower for dematerialization and blockchain (these applications remain foreign to about 35% of top business leaders), executives in operations and strategy roles are most likely to recognize the applicability of blockchain to their work. These underappreciated technologies have the greatest growth potential, as business leaders start to recognize the impact they can have on their businesses and the environment. Blockchain, for example, has the potential to revolutionize America's electricity markets. In LO3 Energy's microgrid project in Brooklyn, New York, residents use a simple app to trade electricity they generate from solar panels to neighbors in need of extra power. In Europe, companies are rolling out blockchain technology to enable energy trading between utilities, between residential customers or simply to help owners of electric cars pay seamlessly when they charge up their vehicles at private charging stations.[2]

2 https://www.edf.org/blog/2018/01/10/how-blockchain-could-soon-upend-americas-power-markets

Amazon and the dematerialization of pet food

Amazon is driving improvements in the sustainability of packaging across their supply chain, starting with their own packaging and operations. As of December 2017, Amazon's sustainable packaging innovations have eliminated 215,000 tons of packaging material and avoided 360 million shipping boxes.

Amazon is collaborating with vendors across their supply chain on dematerialization in the pet food category. They worked with the largest global manufacturers in pet food to convert retail packaging to ready-to-ship ecommerce packaging. The new packaging designs have reduced the number of packaging components by 50%, reduced packaging volume by 34%, and reduced air shipped by 82%. They also reduced damage in the distribution network by 84% and downstream damage for customers by more than 30%. Amazon sees migrating retail packaging to ecommerce packaging as a triple win, because it reduces packaging material, damage, and cost to the business and customers.

"We are working hard on initiatives to further reduce packaging waste while protecting orders for customers. The primary challenge we see is that packaging designed for brick-and-mortar retail is in many cases not optimal for online fulfillment."

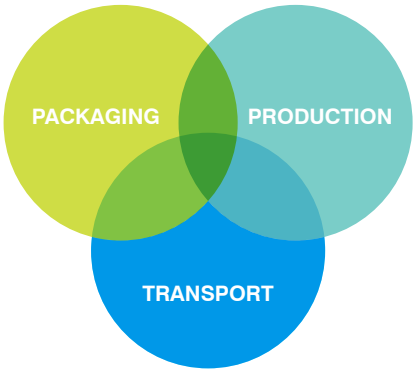
Brent Nelson, Senior Manager of worldwide packaging at Amazon

(Source: https://www.amazon.com/p/feature/ufsuudkyu5db88d#?category=packaging&scroll=417.6505432128906 and https://jamestowncontainer.com/amazons-insights-for-creating-ecommerce-packaging/)

Dematerialization is starting to have an impact as well. For instance, after a series of lifecycle assessments, Stonyfield made changes in yogurt packaging, switching from plastic lids and inner seals to single-layer aluminum foil closures because the foil tops are lighter and require less energy and water to produce.[3] As designers streamline product packaging through efforts like this one, they create containers that generate less waste from warehouse to table, cut carbon emissions by reducing the weight and volume of packaging and use less raw material.

3 http://business.edf.org/files/2014/04/innovationsreview2008.pdf

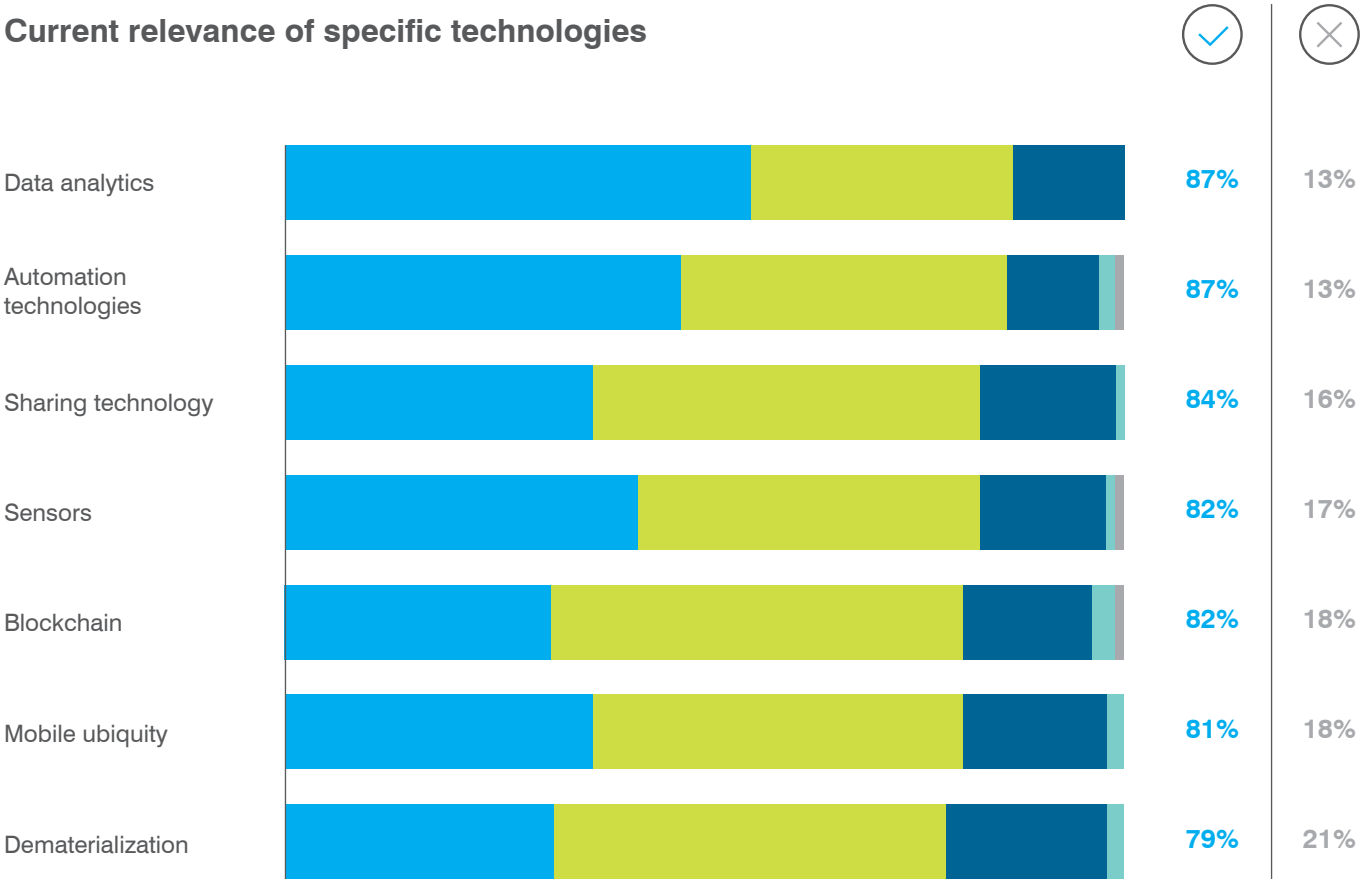
DEMATERIALIZATION involves the reduction of total material and energy used in the production, packaging and transportation of products and services, creating increased business efficiencies and reduced environmental impact.



Relevance to businesses

Analytics and automation are the Fourth Wave technologies considered most relevant to today's businesses.

Current relevance of specific technologies



Automation technologies predict peak demand for energy use

Increasing energy efficiency in buildings lowers company costs and emissions.

Among executives who are familiar with Fourth Wave technologies, about eight in ten believe that each one has relevance to their organization's core business. But data analytics, automation and sharing technology are considered most relevant, especially among C-suite executives. Those in IT departments are most likely to see the relevance of these technologies across the board.

The utility of analytics may be widely recognized because of its clear operational and cost-saving benefits. For example, building owners and managers already use data analytics to manage their buildings' physical plants, coordinate vendors and communicate with occupants. A company called Gridium[4] makes modern software to help a variety of companies, including LinkedIn, Honda, the InterContinental Hotel San Francisco and the Foothill De Anza Community College District, to predict peak demand charges, optimize utility rates, spot bill credits and minimize waste.[5]

4 Gridium's web site: https://gridium.com/
5 EDF conducted a webinar on using data analytics in buildings on June 8, 2017: http://edfclimatecorps.org/events/2017/06/08/10-things-love-about-building-data-analytics

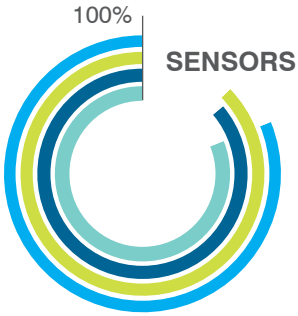
Maturity model for adoption of Fourth Wave technologies

Data analytics is the leading technology in terms of business and environmental impact.

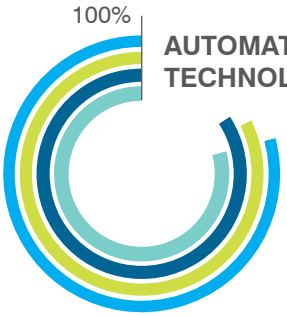
Mapping out each technology's potential

- Familiarity
- Current relevance to business
- Potential to improve business strategies
- Potential to improve environmental impact

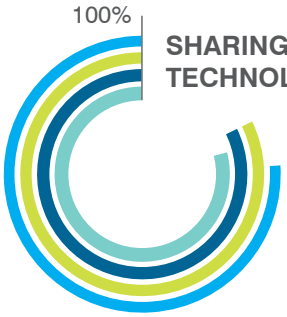
Successfully implemented **50%**
Early adoption **38%**



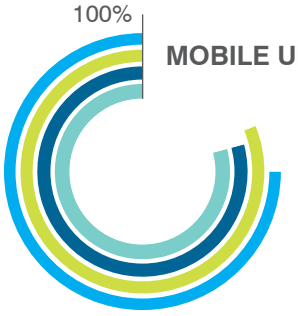
Successfully implemented **38%**
Early adoption **43%**



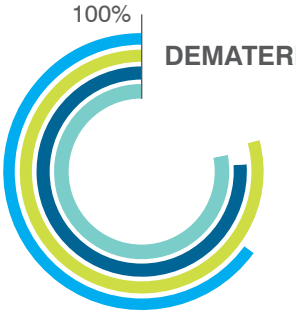
Successfully implemented **47%**
Early adoption **38%**



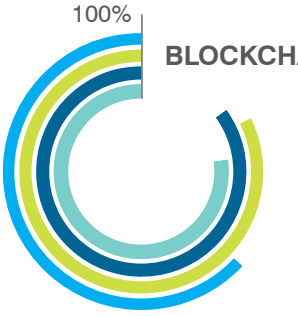
Successfully implemented **36%**
Early adoption **44%**



Successfully implemented **33%**
Early adoption **47%**



Successfully implemented **31%**
Early adoption **36%**



Successfully implemented **31%**
Early adoption **36%**

AT&T deploying data for smarter cities

In 2017, AT&T's Smart Cities initiative worked with the EDF Climate Corps program to estimate the potential environmental and economic benefits delivered by its Digital Infrastructure product. The project provided insights that can help show progress in achieving its 2025 Sustainability Goal, which calls for enabling carbon savings ten times its own footprint. First, the EDF Climate Corps fellow developed a quantitative excel model that estimated the environmental and economic impact of the product and improved it through interviews and data collection from corporate ecosystem members and city officials.

After determining from internal and external interviews that it was essential to effectively communicate the results produced by the model to the target audience, the fellow developed a sustainability communications process flow for the AT&T Smart Cities team.

Through the process, AT&T recognized the importance of putting sustainability at the core of the AT&T Smart Cities business model and integrating the quantitative model into AT&T Smart Cities products. The model estimated that a large-scale deployment of Digital Infrastructure in Atlanta alone could potentially bring an economic benefit of approximately $144 million to the city of Atlanta and its citizens as well as save over 51,000 metric tons of CO_2 annually.

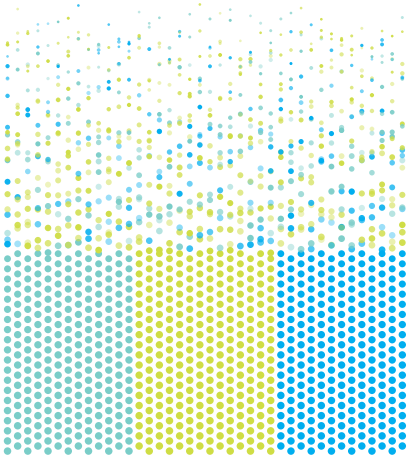
"Technology can also speed the transition to a low-carbon economy —from networks that use less energy and water to better ways to conserve fuel through smart traffic management. Our 2025 goal: To enable carbon savings for our customers that are 10x the footprint of our operations."

Randall Stephenson, Chairman and Chief Executive Officer, AT&T

(http://edfclimatecorps.org/engagement/att-maham-masood-sadiq-2017 and http://www.about.att.com/content/dam/csr/sustainability-reporting/PDF/2017/ATT-RLS-Letter.pdf)

Data analytics, sensors and automation technology are the most mature of the current Fourth Wave innovations--leading the way in terms of familiarity and potential to improve business and environmental outcomes. Although familiarity is lower for dematerialization and blockchain, executives identified these technologies as having the greatest growth potential.

The survey found that half of top companies successfully integrate data analytics into their processes, with another 36% in the early adoption phase. The tech industry leads in successful integration of data analytics. Just under 60% of executives in operations and IT, and 60% of C-suite executives across industries and job functions, report successful implementation and integration of data analytics into business processes.



DATA ANALYTICS

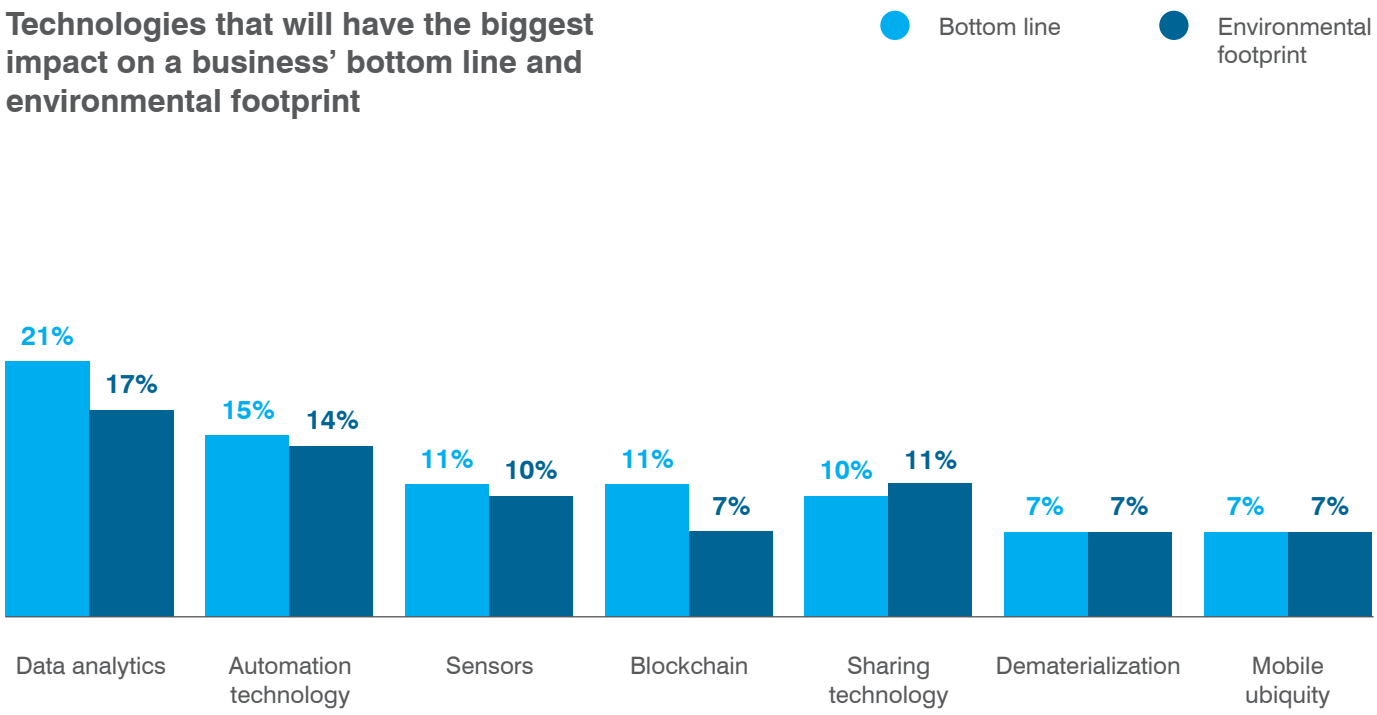
can range from simple statistical analysis to sophisticated data mining and machine learning.

Potential for impact on business and the environment

Executives see data analytics as having the biggest potential impact on the bottom line, as well as on their organization's environmental footprint and brand reputation.

However, other technology areas were also seen as powerful contributors in all three areas, indicating that executives generally see a healthy potential for Fourth Wave innovations to improve various aspects of their business, including their impact on the environment.

Technologies that will have the biggest impact on a business' bottom line and environmental footprint



Blockchain uses cryptography to provide secure tracking

This enables businesses to link transactions in a public ledger and surface new efficiencies in managing global supply chains.

The largest deficit in recognizing the potential of Fourth Wave technology lies with blockchain: although 85% of business leaders cited the potential for blockchain technology to improve operations and business, about one-fourth believe there is little or no potential for the technology to improve their organization's impact on the environment.

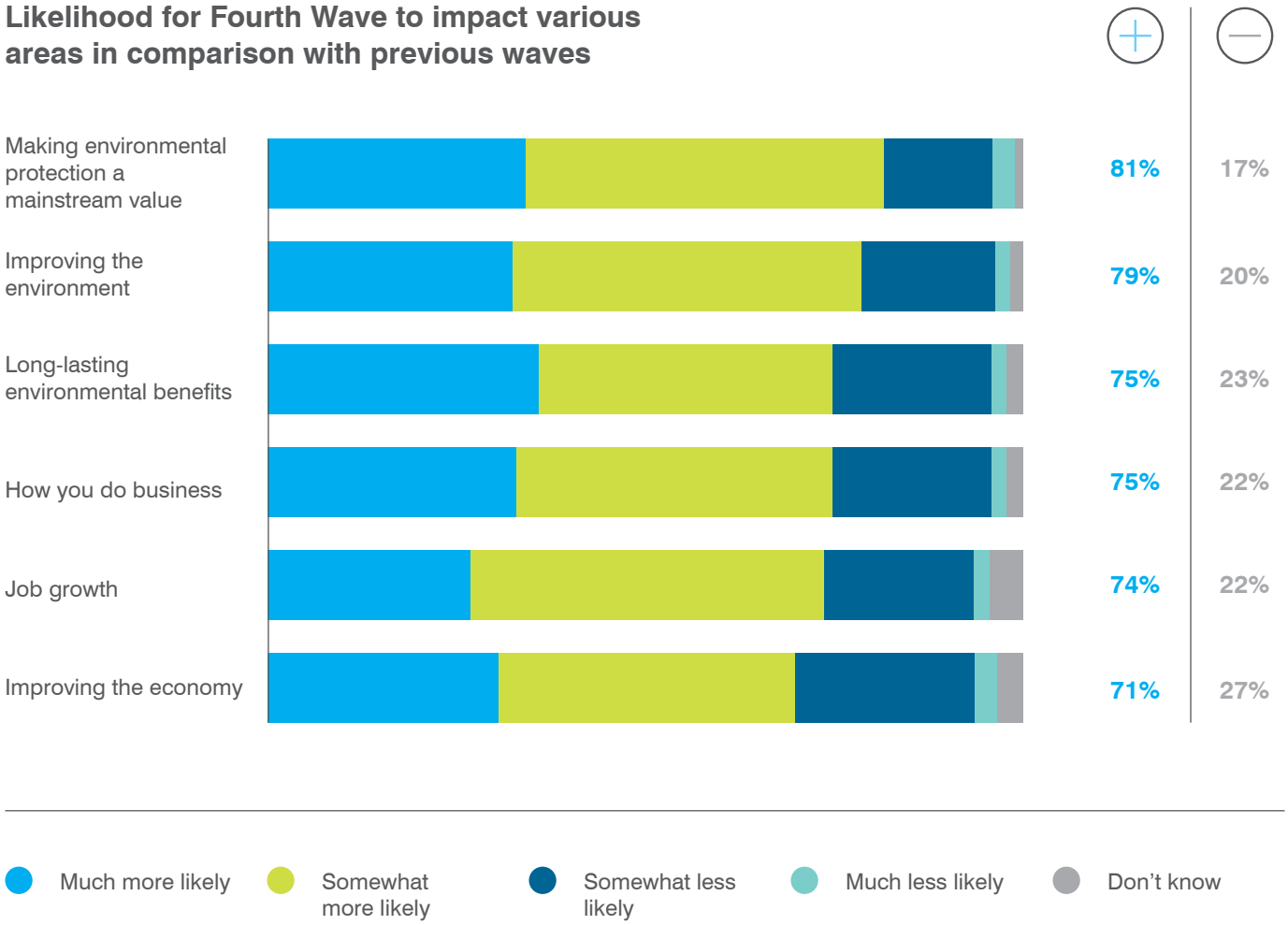
While blockchain is the least implemented of Fourth Wave technologies, most executives indicate that their companies are at least aware of its potential. Executives are optimistic that implementation of emerging technologies such as mobile ubiquity, blockchain and dematerialization will catch up to more established technologies within the next five years.

What's next with Fourth Wave?

Most business leaders believe the Fourth Wave will be the most powerful wave of environmental innovation yet.

More than seven in ten business leaders believe that the Fourth Wave has more potential than any of its predecessors to have positive impacts on the environment and the economy, and 81% see increased potential to make environmental protection a mainstream value.

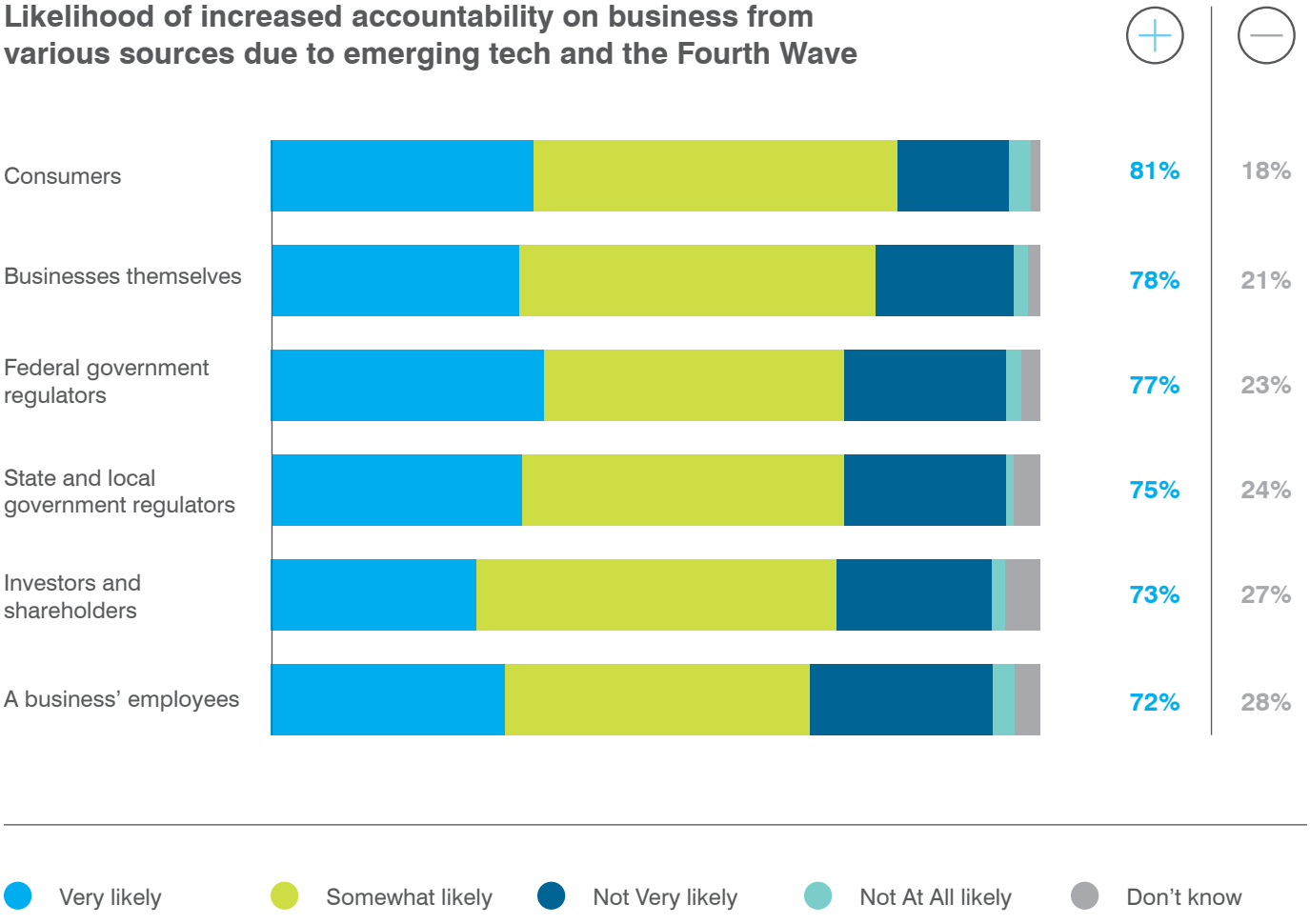
Likelihood for Fourth Wave to impact various areas in comparison with previous waves



Executives say that the Fourth Wave's potential to effect change is at least equal to that of previous major environmental advancements. About eight in ten business leaders believe that data analytics, sensors, social platforms and automation technologies will have at least some effect on the way businesses impact the environment; as a result, they say, these Fourth Wave innovations will be on a par with the perceived effect of cap-and-trade systems and the legislative advancements of the 1970s. C-suite executives are especially excited about the promise of sensors and data analytics, although there remains a lack of clarity surrounding blockchain technology and how it can produce environmental benefits.

Business leaders anticipate more pressure from consumers and regulators as a result of emerging Fourth Wave technologies. Executives say that the call for increased accountability will come from consumers (81%), businesses themselves (78%) or federal regulations (77%). Those in the C-suite in particular believe that much of the increased accountability will come from within businesses, including from their employees. Overall, those in IT and operations anticipate a greater level of accountability, while those in marketing, strategy and finance anticipate pressure from internal and external sources.

Likelihood of increased accountability on business from various sources due to emerging tech and the Fourth Wave



Conclusion

Corporate executives see business and environmental goals becoming increasingly aligned, and while there are differences by industry, most agree that this alignment is driven by emerging technologies found at the center of what we describe as the Fourth Wave of environmental innovation.

We examined executive familiarity of and perceptions around seven key technologies: Blockchain, sensors, mobile ubiquity, dematerialization, data analytics, and automation and sharing technologies. Overwhelmingly, business leaders, especially those in the C-suite, recognize the positive impact these technologies can have on both business and the environment. Additionally, seven in ten survey respondents report that Fourth Wave technologies have already taken root in their industries, at least to some extent. Of the five industries represented, executives from the technology industry report the highest rate of full implementation of emerging technology that has environmental benefits, and manufacturing appears to have the greatest potential to move toward full implementation.

Of the seven technologies studied, data analytics, automation and sharing technologies are the most mature, leading the way in terms of familiarity and potential to improve business and environmental outcomes, especially among C-suite executives. Data analytics—which is viewed as having the biggest potential impact on an organization's bottom line, environmental footprint and brand reputation—is the technology most likely to have already been implemented. And, although familiarity is lower for dematerialization and blockchain, they have the greatest growth potential, as business leaders are beginning to recognize the impact they can have on their businesses and the environment.

Motivation for implementing new technology with environmental benefits is becoming more closely tied to business strategy. Over three-quarters (77%) of executives surveyed cite the potential to increase their bottom line, improve their brand's reputation, or differentiate themselves from their competitors as extremely or very compelling reasons to implement a new technology with environmental benefits. Executives across the board agree that having environmentally sustainable business practices helps them attract and retain top talent, especially in the technology and energy sectors.

Finally, most business leaders see the Fourth Wave as the most powerful wave of environmental innovation yet. They believe that data analytics, sensors, social platforms and automation technologies together will go far beyond the impact of previous environmental innovations, including cap-and-trade systems and the legislative advancements of the 1970s.

As emerging technologies continue to generate both business and environmental value for companies, business leaders are well poised to raise the bar on corporate sustainability.

Looking ahead

21st century problems require 21st century solutions.

In any era, the hard work of environmental and social change uses the best available tools, and today those tools include technological innovations that can help drive transparency, leadership and action. As sensors, analytics, and digital collaboration tools—as well as emerging innovations such as blockchain— increasingly shape smart policy, rein in free riders and reward corporate responsibility, the result will be positive change that lets people and nature prosper.

There is more work to be done in terms of education, innovation, collaboration and demonstrating positive results for both business and the environment, but the Fourth Wave is well on its way. With momentum building rapidly, this is the moment for business and technology leaders to raise the bar for sustainability leadership by leveraging cutting edge innovation and technology to better align business and environmental goals. Fourth Wave innovations can supercharge these efforts by surfacing valuable information and impacts that were previously invisible, improving transparency and resiliency across global supply chains, and enabling powerful collaborations with partners from industry, advocacy groups, and the communities where you do business.

We urge you to join and help lead this next wave of environmental innovation. Together, we can use the same disruptive innovation and technology that is changing our lives and revolutionizing virtually every sector of the economy to scale solutions to our most urgent environmental challenges.

Tom Murray, VP, EDF+Business

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