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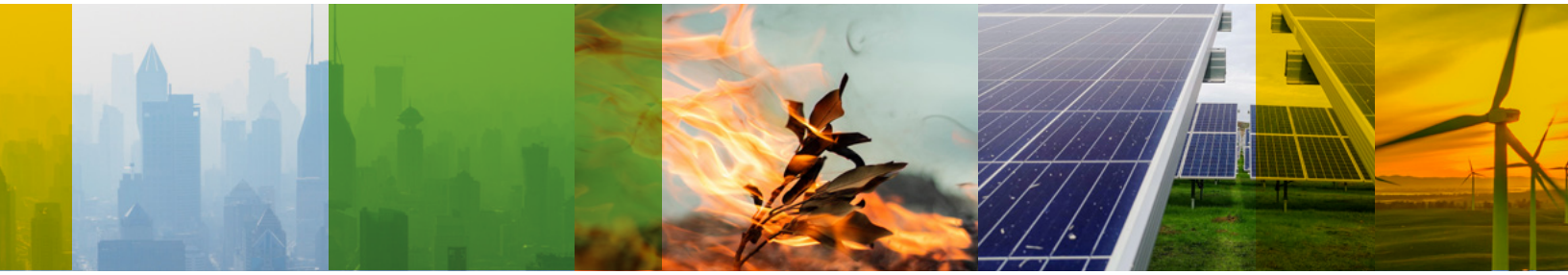

Climate Change Fundamentals

for Facility Management Professionals

IFMA
FM Research & Benchmarking Institute

The International Facility Management Association (IFMA)

Founded in 1980, IFMA is the world's largest and most widely recognized international association for facility management professionals, supporting 23,000 members in more than 100 countries. This diverse membership participates in focused component groups equipped to address their unique situations by region (136 chapters), industry (16 councils) and areas of interest (six communities). Together they manage more than 78 billion square feet of property and annually purchase more than U.S. $526 billion in products and services.

The FM Research and Benchmarking Institute

The International Facility Management Association (IFMA) has embarked on a path to deliver essential research that members can use to forge their roles in the facility management (FM) industry. The IFMA Research and Benchmarking Institute (RBI) powers this mission by supporting members' research and benchmarking needs. Please explore and visit the website (http://research.ifma.org/) regularly to stay updated on new research reports being developed, benchmarking efforts underway, think-tank participation opportunities and sponsorship possibilities.

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Climate Change Fundamentals for Facility Management Professionals

For additional information, contact:
FM Research & Benchmarking Institute
Telephone: 713-993-7633
Email: research@ifma.org

Acknowledgements

Author

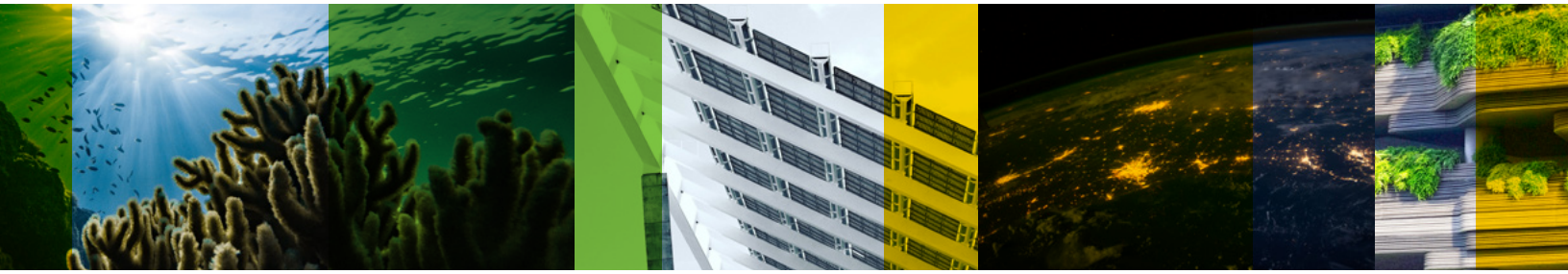
Kathy O. Roper, RCFM, LEED AP, IFMA Fellow

Subject Matter Experts

Dean Stanberry, CFM, LEED AP O+M
Sheila Sheridan, IFMA Fellow, RCFM
Eric Teicholz, IFMA Fellow
Chris Laughman, CFM, FMP, SFP, LEED AP O+M
Barry Giles, LEED Fellow

FM Research and Benchmarking Institute Staff

Nickalos A. Rocha, MPA
nickalos.rocha@ifma.org



BGIS

At BGIS, we believe sustainable operating practices are vital to assist the global effort to mitigate climate change. Through enabling innovation and seeing change as opportunity, we strive to be a role model for sustainable operating practices within the corporate real estate industry.

Our commitment and accomplishments to social and environmental well-being coupled with innovative programs and technologies, drive significant operational cost reductions in our clients' real estate portfolios while enabling us to live our values and contribute positively to the environment and the communities in which we operate. BGIS is proud to sponsor the Climate Change Report as we believe it will serve as a key resource in improving our industry's impact on the environment.

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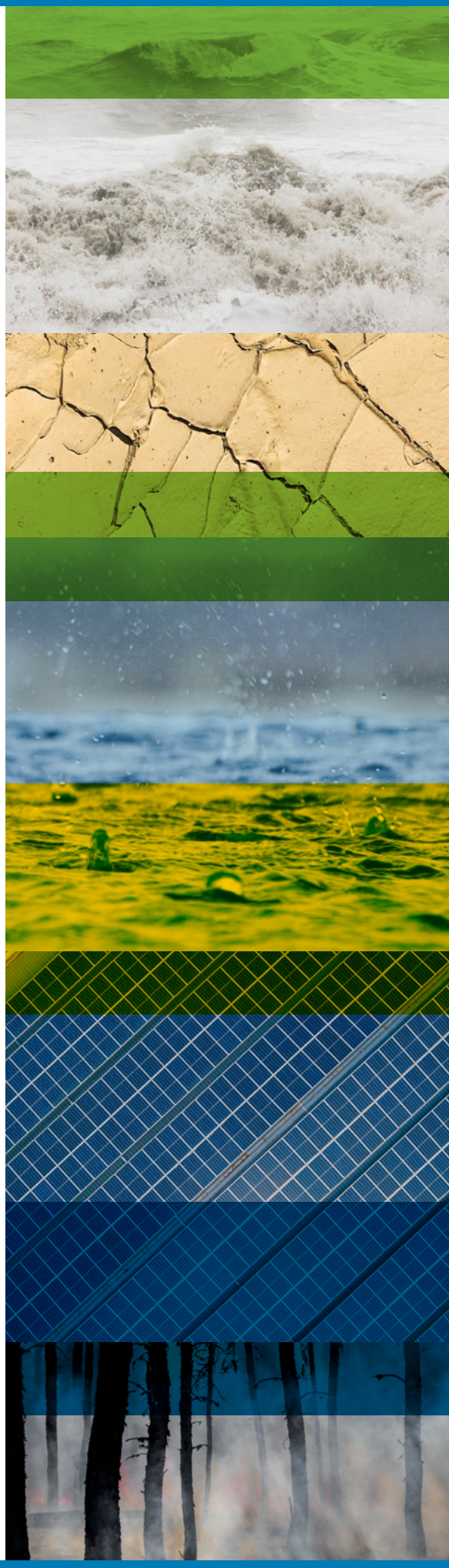


Foreword

Climate change is a reality. It is a global crisis, and if current trends continue, the effects on our ecosystems will have serious consequences. Even while global bodies and governments work to mitigate climate change, the aftermath of extreme environmental shifts poses a threat to life and property, impacting our ability to safeguard both.

Implementing smart technology now as a plan for resilience is one step in the right direction. It is imperative that facility management and corporate real estate professionals work together with private and public entities on long-term solutions, sharing best sustainable practices and industry standards, with an eye toward smart city development.

Providing benchmarking and networking resources, the International Facility Management Association (IFMA) is committed to educating the built environment community on why climate change is occurring and how we can prepare for future risks.

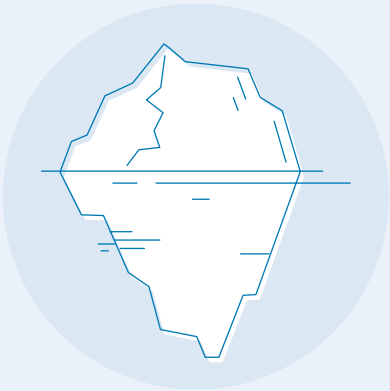
John Carrillo, CFM, IFMA Fellow
Chair, IFMA 2019-2020 Global Board of Directors

Executive Summary

As the primary overseers of the built environment, facility managers (FMs) need to know how the facilities in their charge are contributing to climate change. FMs can implement improvements that impact the workplace, as well as the climate. Whether it is reduction in carbon emissions, savings in water usage, improvements to land use, or other impacts, these methods often result in savings for the facility budget and become a "win-win" for the savvy FM by improving the organization's facilities and reducing impacts to climate change.

This report summarizes several research reports – the findings, causes and key points to monitor regarding climate change for facility professionals. The basic science of *climate change* from research findings indicates major shifts in the average weather conditions at any specific location over time. The primary reason for this change is the burning of fossil fuels in the Industrial Age and a lack of awareness until recent times that this is causing major shifts in the Earth's climate and therefore temperature. Many impacts on human and natural systems have been observed and scientifically documented. This awareness has also caused many global responses, including the two reports utilized as primary sources for this report, which are the Intergovernmental Panel on Climate Change's (IPCC) *Global Warming of 1.5 C* and the U.S. Global Change Research Program's (NCA4) *Fourth National Climate Assessment, Volume II, Impacts, Risks, and Adaptation in the United States*.

Many regulatory and voluntary changes have been and continue to be developed in response to the need for limiting the warming of the Earth. Expect that to continue. Climate change impacts and responses are closely linked to *sustainable development*, which balances social well-being, economic prosperity and environmental protection.



Key Indicators

Knowing and monitoring key indicators of climate change provide *resiliency*, or the ability to plan and anticipate scenarios so that mitigation of risks to the facilities can be made. FMs need to be aware of the indicators which include:

- *greenhouse gases*,
- *sea level rise*,
- ocean acidity,
- weather and climate,
- ice, and
- changes in ecosystems.

Facilities are large contributors to the use of energy, generally reported as utilizing 30-40 percent of total energy, and they are also contributors to a large amount of *carbon emissions*, all requiring reduction. *Corporate Social Responsibility (CSR)* and other business measures are important considerations as social and economic norms are shifting in acknowledgement of climate changes.

As described in more detail within the report, climate change impacts to *water*, *weather*, *energy*, *air quality* and *agriculture* are all concerns for managing the long-term use of buildings and facilities. Additional complexity around financial concerns, cities' interdependencies, poverty and health issues all mean that facilities need to be managed differently now than in the past. Considerations for how buildings are designed, built and operated, as well as transportation issues and *resilience*, all point to new ways of decision-making and new tools for measuring impacts. *Carbon footprint* reporting is one globally accepted tool that many businesses are adopting to understand their use of resources and to monitor and improve impacts. Understanding climate change science, its impacts and areas of concern helps to increase facility proactivity, which can result in business and climate improvements. Look for additional help in 2020 with a new report to be released by IFMA called, *Adapting to Climate Change for Facility Management Professionals*.

Introduction

What is this Report and Why it Matters to Facility Managers

Facility managers oversee built environments and therefore need to know how the facilities in their charge are contributing to climate change. They also can bring improvements that impact the workplace, as well as climate. Methods such as reducing carbon emissions, saving in water usage, and improving land use or other impacts, can result in savings for the facility budget while also improving impacts to climate change.

Anticipating the effects climate change could have to facilities allows the smart FM to plan, budget and avoid, or at least mitigate, any impacts coming in future years. Since buildings are long-term investments, climate change will eventually impact the management of these facilities in one way or another. Understanding the basics of climate change, including the key contributors, and being aware of and monitoring key indicators, will provide FMs with knowledge that is critical to future management of the built environment.

The recent publication of scientific reports on climate change prompted the Environmental Stewardship, Utilities and Sustainability (ESUS) community of IFMA to fund a report summarizing key information, using layman's terms. While most FMs do not have time to read more than 3,000 pages of scientific studies, the kernels of knowledge from these reports contain important information for managing the built environment and keeping facility users comfortable, safe and productive.

The two reports utilized as a basis for this report are the Intergovernmental Panel on Climate Change's (IPCC) *Global Warming of 1.5 C* and the U.S. Global Change Research Program's (NCA4) *Fourth National Climate Assessment, Volume II, Impacts, Risks, and Adaptation in the United States*. The IPCC's report is focused on the impacts of 1.5°C (2.7°F) temperature increase and makes major comparisons and predictions to 1.5°C and 2.0°C. Findings in almost all cases show that keeping the increase at 1.5° is better than higher levels. A major finding of the report is that "human activities are estimated to have caused approximately 1.0°C of *global warming* above pre-industrial levels, with a likely range of 0.8°C to 1.2°C." The report also finds with a high rate of confidence that, "Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate." The NCA4 report is focused on the United States but paints a similar picture to the predictions of the globally focused IPCC report. Detailed illustrations and graphics from the NCA4 report are reproduced here with attribution.

"Global warming is likely to reach 1.5°C (2.7°F) between 2030 and 2052 if it continues to increase at the current rate."

What is Climate Change?

Basic Scientific Findings

Climate is generally referred to as the average weather conditions at a specific location over time. Statistics or data of average temperatures, rainfall, and drought periods, within a geographic area are the measures used for understanding climate conditions. Climate change (CC) is the understanding that variations in climate statistics have occurred. Scientific observations and data collected over time are used to build models which can help to understand and predict future changes and impacts.

It is important to note that climate and weather are not the same thing. There are many naturally occurring processes that influence climate, causing either warming or cooling. These natural cycles have, in the past, resulted in regional and global climates that are very different than the current climate. These natural influences are still at work but have been overshadowed in recent history by human production and the emission of greenhouse gases. Similar observations from around the world have contributed to the scientific understanding of climate change. It is a global impact and what happens in one geography spreads around the atmosphere to impact the entire Earth.

Global warming and climate change are terms that sometimes are used interchangeably, and although closely related, they refer to two different things. Global warming is the long-term trend of rising average global temperatures. Climate change is a broader term meaning that carbon emissions not only warm the Earth, carbon emissions are also changing rain and snow patterns, as well as increasing the intensity of storms and droughts throughout the world.

Climate Change is a global impact and what happens in one geography spreads around the atmosphere to impact the entire Earth.

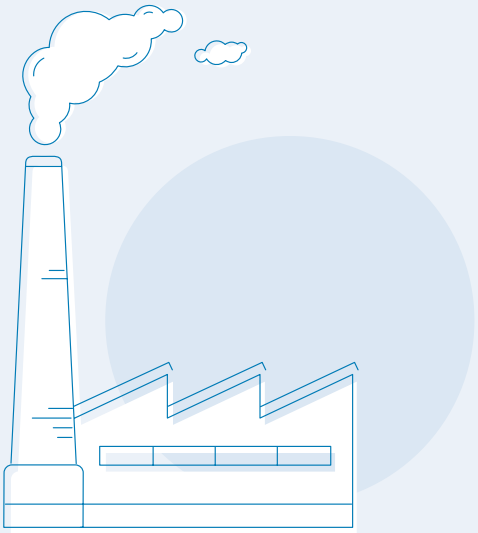
Causes of Climate Change

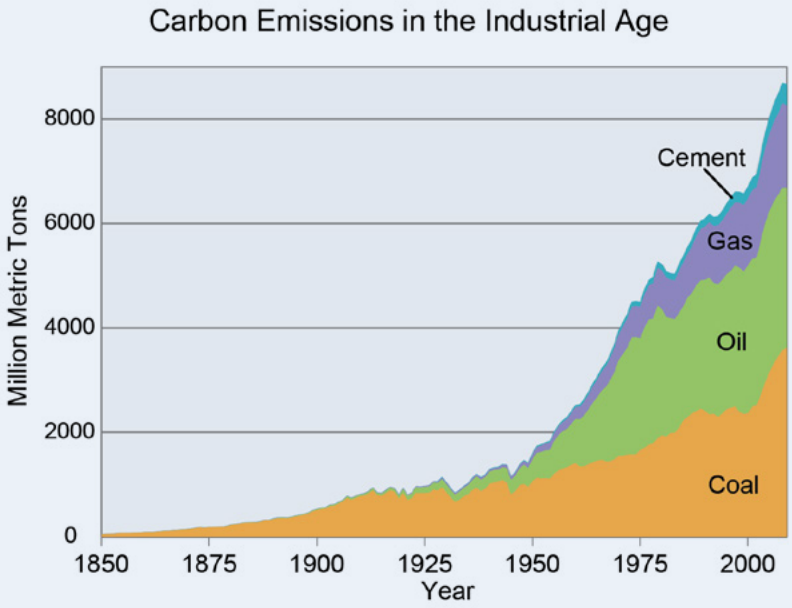
The main causes of climate change have been studied by researchers around the Earth, who document increases in ocean, land and atmospheric temperatures. Human activities, or as scientists call it, *anthropogenic* activities such as greenhouse gas emissions, which trap heat within the Earth, are the primary cause of change documented in the industrial age. The burning of fossil fuels is the main contributor. By several measures, the carbon dioxide in the atmosphere has increased by almost 40 percent since around 1760. Industrial processes such as the burning of coal, changes in land use resulting in deforestation, as well as methane production, all contribute to the greenhouse gases (GHG) impacts, which create climate change.

A GHG is any gas that prevents infrared radiation from escaping into space and thus causes heating in the atmosphere. Most of the gas in GHG is carbon dioxide (CO2) but smaller amounts of methane (CH4) and nitrous oxide (N2O) are also part of GHG measures.

Carbon emission is specific to the CO2 emissions only, whereas GHG refers to all heat-trapping gases. Both terms are used interchangeably relating to heat trapping issues in the Earth's atmosphere.

According to Chapter 2 of the *National Climate Assessment*, "Global climate is changing rapidly compared to the pace of natural variations in climate that have occurred throughout Earth's history. Global average temperature has increased by about 1.8°F (1°C) from 1901 to 2016, and observational evidence does not support any credible natural explanations for this amount of warming; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat-trapping gases, as the dominant cause" (nca2018.GlobalChange.gov). The chart below shows the dramatic increase in carbon emissions since 1850. Note that since around 1900 and the invention of motorized vehicles, oil, gas and cement are contributors to increasing carbon emissions.





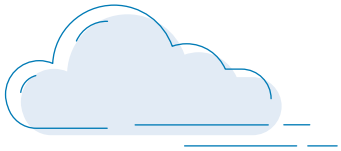
Source: nca2014.GlobalChange.gov

Warming and rising seas, increased flooding and wildfires, species relocating to new areas, unprecedented extinction of fauna and flora species, and changes in when biological events occur (tree budding, animal procreation) are all currently being observed and documented. These indicate that warming of the planet is occurring and is expected to continue.

The IPCC report defines current warming and the 1.5°C, "In the decade 2006–2015, warming reached 0.87°C (±0.12°C) relative to 1850–1900, predominantly due to human activity increasing the amount of greenhouse gases in the atmosphere. Given that global temperature is currently rising by 0.2°C (±0.1°C) per decade, human-induced warming reached 1°C above pre-industrial levels around 2017 and, if this pace of warming continues, would reach 1.5°C around 2040." Additionally, "warming in many regions has already exceeded 1.5°C above pre-industrial levels. Over a fifth of the global population live in regions that have already experienced warming in at least one season that is greater than 1.5°C above preindustrial levels." The global average surface temperature increase of 1.1-1.6°F (0.6-0.9°C) across just the twentieth century alone is roughly eight times faster than the usual post ice-age recovery warming rate (The Climate Reality Project, 2019).

It is also helpful to note that not all carbon is the same, rather carbon has specific isotopes and three varieties: three different isotopes, all with the same number of protons, but different numbers of neutrons. Carbon from plants for example has a distinct ratio of isotopes, Carbon -12 and Carbon - 13. Fossil fuels also have a distinct ratio of isotopes, Carbon - 14. By measuring the carbon in the atmosphere, scientists can measure exactly how much of the carbon in the air today comes from fossil fuels. Therefore, it has been possible to demonstrate without any doubt what carbon in the atmosphere comes from natural sources and what comes from fossil fuels.

The U.S. National Aeronautics and Space Administration's (NASA) assessment of global climate change has researched the sun's impact on possible warming. Beginning in 1978, satellite measurement of the sun's energy output shows a slight reduction in solar energy. Even longer-range estimates of the sun's energy output from analysis of measures such as the amount of carbon in tree rings, indicated that the sun's energy can account for less than 10 percent of the Earth's warming within the twentieth century (NASA, 2019).



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Attempts to Improve Conditions to Deal with Climate Change

Warming from anthropogenic (caused or influenced by humans) emissions from the pre-industrial period to the present will have lasting impacts for hundreds to thousands of years and will continue to cause further long-term changes in the climate system. This is predicted with high confidence from the IPCC report. However, there is a credible prediction that reaching and sustaining *net zero* global CO2 emissions from human sources, coupled with other factors limiting temperature rise, could stop human-created global warming on a time scale of several decades. Actions taken now can further reduce long-term impacts.

Impacts on natural and human systems from global warming have already been observed. Many land and ocean ecosystems have already changed due to global warming. Some impacts may be long-lasting or irreversible, such as the loss of ecosystems and species extinction events. Adaptation and mitigation are already occurring as observed with scientific confidence. Future climate-related risks would be reduced if far-reaching, multilevel and cross-sector climate mitigation was increased and accelerated. This means that action now through mitigation and reduction measures will help to keep climate change increases to a minimum.

Examples of the impacts of 1.5°C versus 2°C warming in the IPCC models show that at 1.5°C increases, global net human-caused CO2 emissions will decline by about 45 percent from 2010 levels by 2030, reaching net zero around 2050 (2045–2055 range). For limiting global warming to below 2°C, CO2 emissions are projected to decline by about 25 percent by 2030 and reach net zero around 2070 (2065–2080). Limiting global warming requires limiting the total cumulative global anthropogenic emissions of CO2 since the preindustrial period, or staying within a total carbon budget of 1.5°C/2.7°F.

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Limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching changes in energy, land, and urban infrastructure, including transport, buildings, and industrial systems. These system transitions are unprecedented in terms of scale, but not necessarily in terms of speed. These improvements require deep emissions reductions in all sectors, a broad portfolio of mitigation options and a significant increase of investments in those options.

The urban infrastructure system transition, consistent with limiting global warming to 1.5°C with no or limited overshoot, would need, for example, changes in land and urban planning practices, as well as deeper emissions reductions in transport and buildings. Technical measures and practices enabling deep emissions reductions include various energy efficiency options. In models limiting global warming to 1.5°C with no or limited overshoot, the electricity share of energy demand in buildings would be about 55–75 percent of 2010 levels in 2050.

Knowledge gaps remain in the integrated assessment of the economy-wide costs and benefits of mitigation required to limit warming to 1.5°C. Some changes in operations could potentially save costs, while reducing energy and therefore emissions. Other changes may require new technology, equipment, training and other improvements that carry a cost. What is known is that change is required. Adapting to and reducing impacts to climate change is happening, faster and faster. Many areas of the world are already mandating specific reductions and technologies to implement those improvements. Expect more countries and localities to legislate aspects of building operations, construction and workplace issues.

IFMA also plans another helpful report for 2020, *Adapting to Climate Change for Facility Management Professionals*, planned by IFMA's Environment Stewardship, Utilities and Sustainability (ESUS) community.

Key Contributors

What are Key Contributors to Shifts in Global Climate?

"Global climate is changing rapidly compared to the pace of natural variations in climate that have occurred throughout Earth's history. Global average temperature has increased by about 1.8°F from 1901 to 2016, and observational evidence does not support any credible natural explanations for this amount of warming; instead, the evidence consistently points to human activities, especially emissions of greenhouse or heat-trapping gases, as the dominant cause" (NCA4, 2018). The impacts that have already begun will continue even with adaptations and remediations. That is the nature of long-term climate impacts.

For facility professionals, the impact is heavily focused on buildings' emissions, but a broad range of additional impacts result from decisions made in workplace management. Buildings have been found to contribute 37 to 39 percent of energy consumption, which then leads to carbon emissions in energy development as well as energy use. The U.N. Environment *Global Status Report 2017* states that 82 percent of final energy consumption in buildings was supplied by fossil fuels in 2015.

Transportation is also a key contributor estimated around slightly more than a quarter of all GHG emissions. Commuting for occupants of buildings, transport to receive supplies and services, as well as fleet management and air travel policies all fall into the large transport sector. The U.S. EPA reports that from 1990-2015, transportation increased more than other sectors contributing to GHG emissions (EPA, 2019).

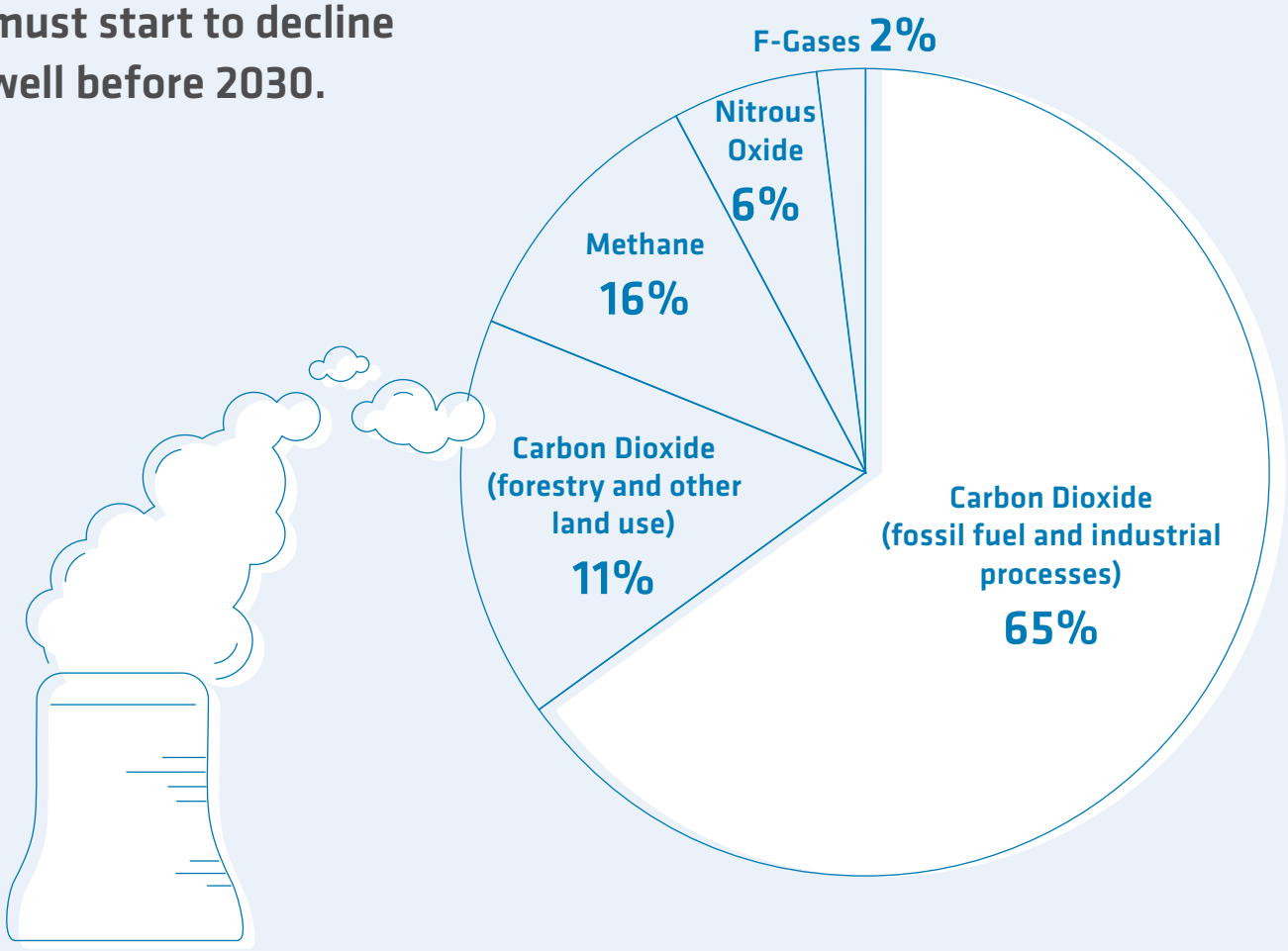
Responses are already occurring. The need to limit global warming to 1.5°C, even if supplemented by very challenging increases in the scale and ambition of emissions reductions after 2030, is a goal. The IPCC report states that avoiding overshoot and reliance on future large-scale deployment of carbon dioxide removal (CDR) can only be achieved if global CO2 emissions start to decline well before 2030.

Buildings have been found to contribute 37 to 39 percent of energy consumption, which then leads to carbon emissions in energy development as well as energy use.

The lower the emissions in 2030, then the lower the challenge in limiting global warming to 1.5°C after 2030 with no or limited overshoot. The challenges from delayed actions to reduce greenhouse gas emissions include: the risk of cost escalation, lock-in in carbon-emitting infrastructure, stranded assets, and reduced flexibility in future response options in the medium to long term. These may increase uneven distribution impacts between countries at different stages of development.

Climate change impacts and responses are closely linked to sustainable development, which balances social well-being, economic prosperity and environmental protection. The United Nations Sustainable Development Goals (SDGs), adopted in 2015, provide an established framework for assessing the links between global warming of 1.5°C or 2°C and development goals that include poverty eradication, reducing inequalities, and climate action.

Global CO2 emissions must start to decline well before 2030.



Source: IPCC (2014) via EPA website - Global Greenhouse Gas Emissions Data

Key Indicators

What are Key Indicators to Know and Watch?

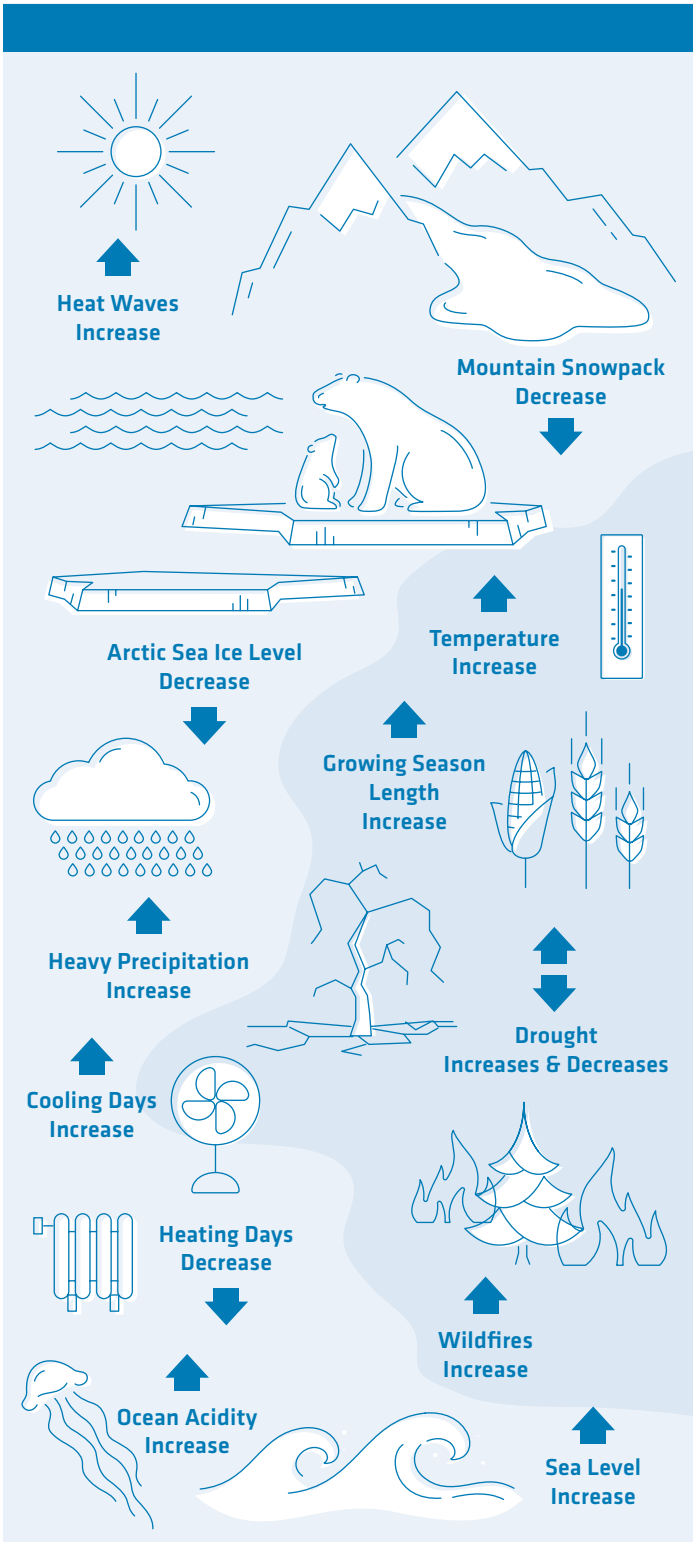
The IPCC report focuses on minimizing global warming to less than 1.5°C since climate change impacts are less at 1.5°C than 2°C. This is fairly obvious as less warming is better. Indicators include:

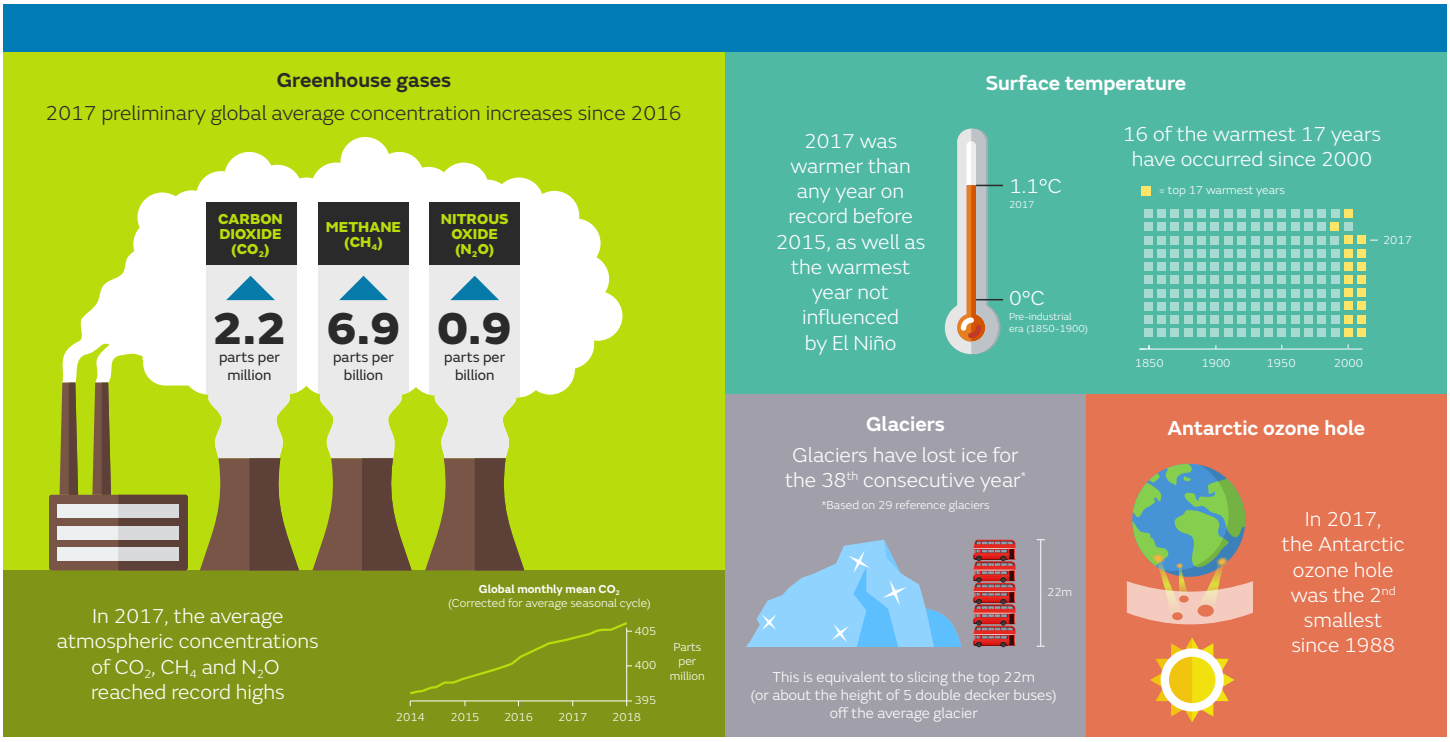
- greenhouse gas levels,
- temperatures across land and sea,
- extent of Arctic sea ice,
- long-term indicators of how climate and environmental conditions are changing (trends),
- assessment of risks and vulnerabilities, and
- preparation and action to improve resilience to climate change impacts.

The Global Climate Observing System (GCOS) is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO), the United Nations Environment Programme (UN Environment), and the International Science Council (ISC). It regularly assesses the status of global climate observations of the atmosphere, land and ocean and produces guidance for its improvement (gcos.wmo.int, 2019). GCOS uses the following seven indicators for analysis: (https://gcos.wmo.int/en/global-climate-indicators)

1. Temperature and Energy
2. Surface temperature
3. Ocean heat
4. Atmospheric Composition
5. Atmospheric CO2
6. Ocean and Water
7. Ocean acidification
8. Sea level
9. Cryosphere
10. Glaciers
11. Arctic and Antarctic sea ice extent

Like GSOS, there is evidence of warming in the United States as shown on the following graphic.





Source: MetOffice, 2017 (https://www.metoffice.gov.uk/climate-guide/climate-change)

The U.S. Environmental Protection Agency (EPA) outlines the following six indicators related to climate change causes and effects:

1. Greenhouse Gases
2. Weather and Climate
3. Oceans
4. Snow and Ice
5. Health and Society
6. Ecosystems

Each indicator has a detailed summary available for review. For more details visit: https://www.epa.gov/climate-indicators. Impacts to any geographic area will vary, but throughout the globe, these key indicators have broad effects. Geographic area impacts should be known by facility managers and attention to local climate change updates is needed to be able to respond appropriately for managed facilities.

Additional indicators include glacier decline and ozone hole monitoring especially in the Antarctic. The above infographic from MetOffice in the UK provides details on greenhouse gases and the Earth's surface temperature.

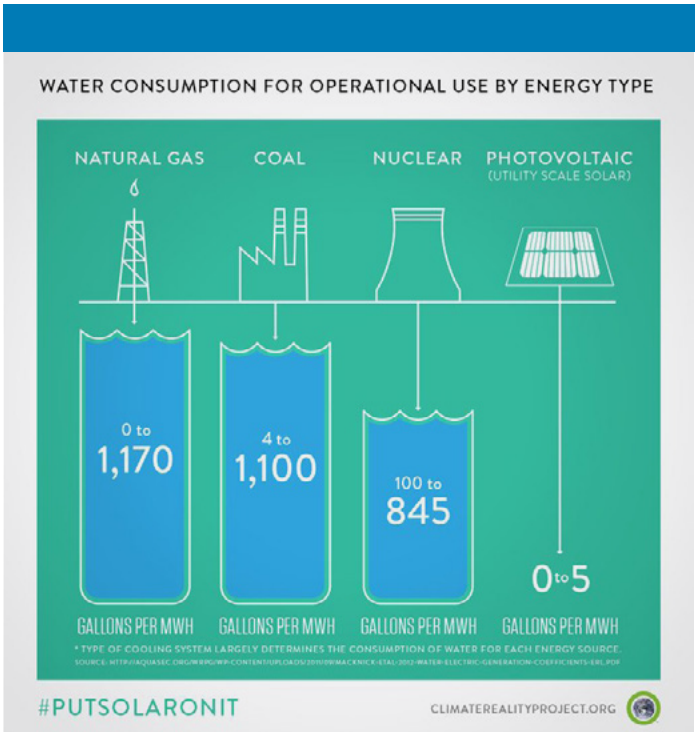
Projected Impacts of Climate Change

One of the primary impacts to the management of facilities is the diverse scenarios of risks associated with climate change and many aspects of change listed in this section.

Whether focused on real estate or infrastructure, the impacts will require that FMs address issues ahead of damaging impacts in order to protect people, organizations and the business that is conducted day-to-day. Risk is a key issue since the amount and timing of climate change impacts are not accurately predictable. However, it is known that impacts are coming, so effective *facility management* dictates that strategic plans include adaptations mitigating negative impacts. Additional information on resilience may be found at DFID, 2011 – Defining Disaster Resilience: a DFID approach paper.

It is also important to understand that work is already underway to improve climate change and reduce its potential impacts. The U.N. Framework Convention on Climate Change (UNFCCC) stated in its 2019 report "that developed countries were decoupling GHG emissions from economic growth and that they remained on track to achieving their 2020 targets." The report also states that it had, "engaged over 140 Parties and had delivered approximately 2 billion tonnes of GHG emission reductions through 8,100 projects" (UN FCCC, 2019).

FMs will be required to address issues ahead of damaging impacts in order to protect people, organizations and the business that is conducted day-to-day.



Source: The Climate Reality Project

Water

Significant changes in water availability and quality have resulted from recent climate impacts. Increasing droughts, floods and other precipitation changes hamper the water supply and can result in shortages. With increasing temperatures, water quality is impacted by cycles of increased rainfall bringing pollutants into the water, as well as evaporation causing higher water temperature and reduction in availability in some areas. Existing water infrastructure was not designed to handle major climate change impacts, so the entire water system in some areas is vulnerable. Similarly, water management practices have not been updated in most areas, and are based on pre-climate change expectations, further enhancing risks. Water is also used in energy production. See The Climate Reality Project's graphic.

Energy

Energy production and use is the largest impactor that facilities control. Reduction of energy use is widespread throughout FM, however, "buildings final energy demand increased by five EJ from 2010 to 2016 as energy-efficiency efforts have not kept up with rising floor area" (UN Environment, 2017). As reported in the GatesNotes 2019 Annual Newsletter, "as the urban population continues to grow in the coming decades, the world's building stock is expected to double by 2060—the equivalent of adding another New York City monthly between now and then."

Security and reliability of energy systems are critical factors in all economies. Impacts could affect economic and national security if large enough. Energy systems are also changing, which can impact both reliability as well as the vulnerability of energy. It is important to be aware of climate impacts on energy systems, so that telecommunications, transportation and other systems are impacted as little as possible. Vulnerabilities to organizations' operations is a major concern for FMs and creates day-to-day monitoring requirements.

The IPCC global models limiting global warming to 1.5°C are projected to involve an annual average investment in the energy system of around U.S. $2.4 trillion (2010) between 2016 and 2035, representing about 2.5 percent of the world's GDP. The impact of facilities on these huge numbers is major. While saving operational costs, reducing energy usage also impacts these global models.

The world's building stock is expected to double by 2060—the equivalent of adding another New York City monthly between now and then.

Weather Patterns

Weather is impacted by many different influences. The trends are important to understand since day-to-day weather has less influence on how facility operations are run, but trends may be cause for major renovations, alterations or even relocation from specific areas. A 2018 NASA study shows that warming of the tropical oceans could lead to a 60 percent increase in the frequency of extreme rainstorms by the end of the century (NASA 2019). Approximately 4 percent of the global terrestrial land area is projected to undergo a transformation of ecosystems from one type to another at 1°C of global warming, compared with 13 percent at 2°C increase. This indicates that the area at risk is projected to be approximately 50 percent lower at 1.5°C compared to 2°C, according to IPCC's report.

Air Quality

Millions of people around the world already live in locations where air pollution exceeds health standards for air quality. Worsening quality will increase the health incidences of these populations, as well as those nearby. Respiratory and cardiovascular health are primarily affected in these populations. Liability for air quality issues within managed facilities may also become more difficult to manage with worsening air quality. Air quality is a factor in worker productivity, with lower air quality related to lower productivity rates. A Harvard study demonstrated that workers in green building conditions with lower CO2 levels produced between 61-101 percent higher cognitive function scores (Harvard University Sustainability, 2019).

Longer and larger wildfires in some areas of the world are a direct result of warmer, drier seasons. These longer dry, warm seasons also increase pollen production and reactions associated with pollen in individuals. Visibility is another concern with wildfires and reduced air quality, which can impact worker productivity, create commute issues and even affect indoor air quality maintenance.

Many emissions also include pollutants that impact human health. Minimizing emissions can mitigate climate change and have immediate benefits to air quality and human health. Methane as an ozone precursor can potentially mitigate climate change as well as improve air quality if reduced.

A 2018 NASA study shows that warming of the tropical oceans could lead to a 60 percent increase in the frequency of extreme rainstorms by the end of the century.

Agriculture

Drought and flooding both have extreme detrimental impacts to agriculture. Crops and livestock are vulnerable to extreme events. Soil and water resource challenges are contributors to lower productivity agriculturally, which can impact local, regional or even entire continents in extreme cases. With high confidence, the NCA4 report expects that shifting precipitation patterns will accelerate the depletion of water supplies, therefore impacting crops and livestock.

Unpredictable climate is also expected to drive the loss of coastal resources and reduce the productivity of fisheries and aquaculture, especially at low latitudes. One global fishery model, for example, projected a decrease in global annual catch for marine fisheries of about 1.5 million tons for 1.5°C of global warming compared to a loss of more than 3 million tons for 2°C of global warming (IPCC, 2018).

Rising Sea Levels

The IPCC report projects that sea level rise will continue for generations. Continued warming increases the exposure of small islands, low-lying coastal areas and deltas to the risks associated with sea level rise for many human and ecological systems. These risks include increased saltwater intrusion, flooding and damage to infrastructure. Risks associated with sea level rise are higher at 2°C compared to 1.5°C. The slower rate of sea level rise at global warming of 1.5°C reduces these risks, enabling greater opportunities for adaptation, including managing and restoring natural coastal ecosystems and infrastructure reinforcement.

Cities such as New York City, Houston, Miami, and San Francisco have all taken steps to mitigate the risks associated with rising sea levels, focusing on infrastructure preservation or relocations. Low lying cities throughout the world are examining potential impacts and preparing mitigation measures. Facilities not governmentally owned will need to determine plans prior to expected sea level intrusion.

Other Concerns

CITIES

Coordination of buildings, commuting and infrastructure issues fall to local municipalities. Many cities are working faster and more stringently than larger governmental groups to enact policies that reduce climate change impacts. Once local programs are successful, the larger governing bodies may take notice and expand programs more broadly.

Cities are also adding technologies to bring synergy to energy use, commute options, and a host of newly designed data gathering options that will provide improvements throughout the city. Staying aware of these innovations can be daunting, but listen for new ideas and options, especially in rapidly expanding locations like Amsterdam, New York City, Santiago, and Singapore. These "smart cities" are already focusing on mobility, security, utilities and other coordinated data gathering to provide better quality of life and improved sustainability and reliability.

FINANCIAL

A number of financial organizations such as ING Group, Standard Bank Group, Triodos and Westpac, are already investigating and addressing standards for businesses to report financial health in the face of global climate change (UN Environment Programme, 20). The cost of adaptations, as well as capitalizing on opportunities, makes worldwide financial impacts of great importance to society. Political action by local, national and global bodies may dictate new equipment, locations or other facility impacts that will require internal funding.

POVERTY AND HEALTH ISSUES

Developing and low-income countries are often most heavily impacted by changes in climate. Typically, they have less investment in disaster preparedness and natural resources may be severely impacted with climate change. Global efforts to assist these areas are underway, but knowledge of potential issues often helps to motivate improvements.

Natural disasters like flooding, crop failure, and earthquakes can cause mass deaths and lead to numerous health issues. In low-income communities, citizens may already be fragile and more vulnerable to changes or disasters than the mainstream population. Warmer and wetter conditions may also impact the spread of infectious diseases, especially with international travel. Additionally, extreme climate events may impact food security and disruptions in food availability.

What This Means for an FM

Every aspect of facilities, from design, through construction and throughout operations, has major impacts to the global environment. Recognition and adaptation to climate change mean that FMs can no longer operate with a "business as usual" attitude. Reductions in facilities' impacts and awareness of occupants are important basics required to create change. A focus on reducing impacts as well as improving operations and efficiencies is required in today's management of facilities.

Commercial Structures Contribution to Climate Change

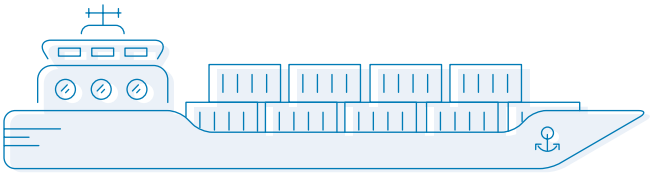
There are direct and indirect effects to construction, operation and use of buildings that must be considered when dealing with climate change adaptability. The USGBC states, "one billion as the number of square feet of buildings that are demolished and replaced with new construction each year" (USGBC, 2019). The very decision to build a new building has a very large and long-term impact. Could another building be reused? Is it possible to avoid new construction? Will other technologies allow new construction to be avoided? All are questions that could potentially have a major reduction in overall environmental impact, since the use of energy becomes embodied for the life of the new structure and beyond, as its components are eventually dismantled.

Demolition materials such as asphalt, bricks, concrete, glass, metals, plastics, wood, and others, contribute to waste, which is disposed of in either landfills or incinerators. Pollution of land and air ensue, and the transportation required to remove such waste is also a factor. The U.S. Environmental Protection Agency estimates that more than 170 million tons of debris were generated in the construction and demolition of buildings in the U.S. alone during 2003. Of that total, 61 percent were produced by nonresidential buildings (EPA, 2019).

Transportation

Heavy precipitation, coastal flooding and other extreme events pose risks to transportation infrastructure. Transportation services and assets (roads, bridges, trains, traffic systems) are all being analyzed for improvements in the face of climate change. These mega-systems are required for normal operations and use of facilities.

Another factor producing major impacts and carbon emissions is the various ways that people and products move into and out of facilities. Managing workplaces requires coordination of occupant commutes, the shipping and delivery of purchased items into facilities, and disposal of waste from the facility. Some FMs are also charged with management of fleets, even aircraft, and sometimes employee travel.



Reduction of all transportation categories is needed to reduce climate impacts.

Resilience

Climate change resiliency is a new term that addresses the preparedness aspects of climate change. Along with multiple adaptations in how buildings are operated and maintained, dealing with eventual impacts of climate change must also be considered. There are many ways that facility management is contributing to improvements and resiliency in the face of climate change. Centered on the physical assets of an organization and the ability of those physical assets to maintain business operations, these challenges may include, but are not limited to:

- Employee and community safety
- Community shelter offered by commercial buildings
- Workflow continuity
- Supply chain continuity
- Uninterrupted operations
- Capability of going off grid with on-site water and electricity sources

(At the time of this report being drafted, IFMA has chartered a Resilience Working Group to examine the challenges listed above and identify resources for IFMA members.)

The impacts of climate change on cities is magnified due to the number of people living, working and visiting major cities. Interdependent systems within the infrastructure, as well as social systems could be damaged or break down from adverse climate impacts. Coordinated efforts between businesses and local and national governments will be required to plan to deal with these urban issues. The complexity and multiple inputs within urban locations cause larger uncertainty. As with any risk planning, the higher the uncertainty, the more critical the planning and forecasting should be.

In the U.S., about 40 percent of carbon emissions can be attributed to the construction, operation and maintenance of buildings.

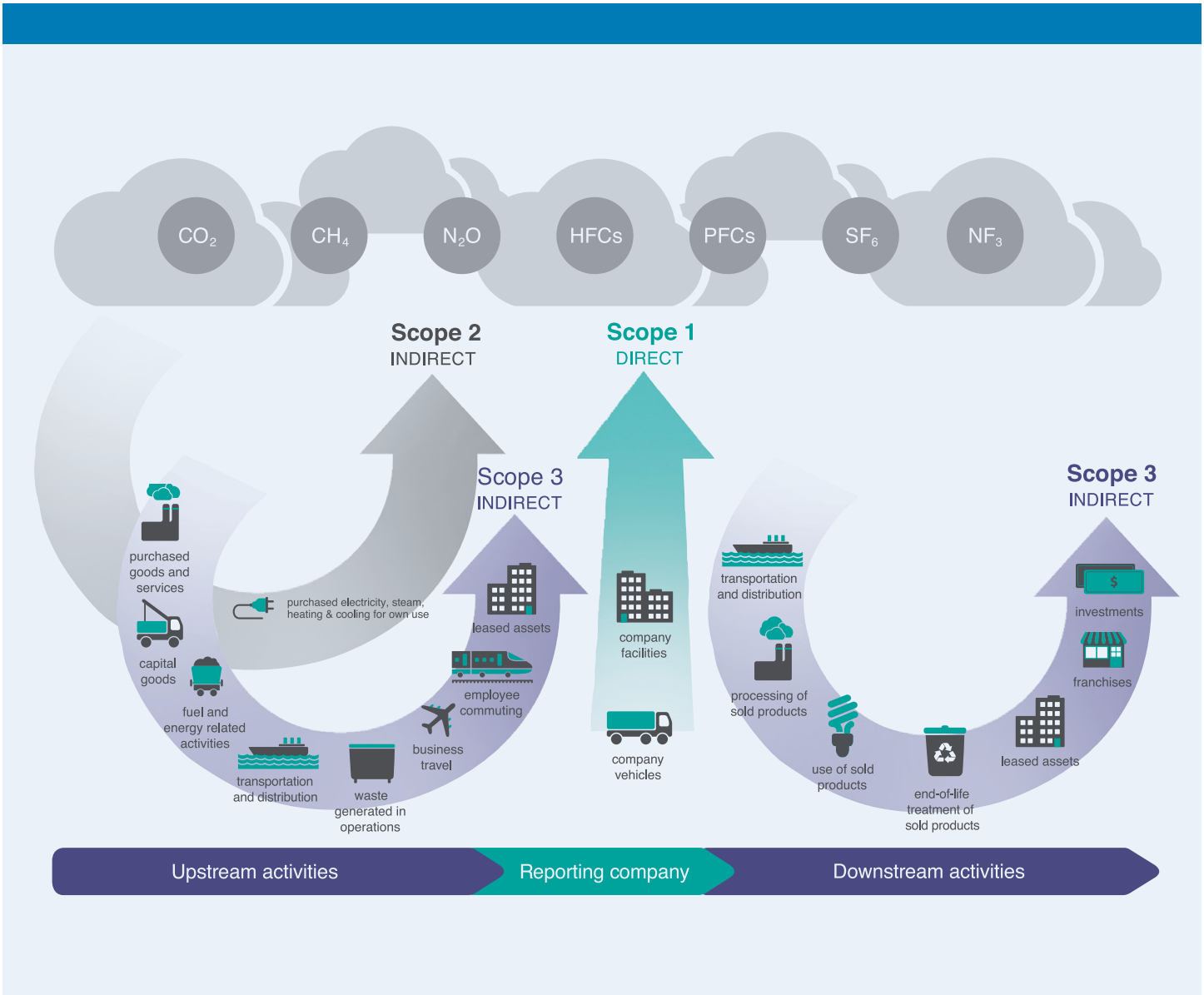
Carbon Footprint

Most definitions of carbon footprint include the total amount of greenhouse gases produced to directly and indirectly support organizational activities, usually expressed in equivalent tons of carbon dioxide (CO2). As organizations become more socially aware and globally conscious, the global footprint can be a tool to help understand, monitor and minimize GHG emissions. As an FM, the carbon footprint may be a tool required by management to enable reductions in emissions, as well as costs. It is important to know that carbon footprint is the standard measurement of the production of greenhouse gases. In the U.S., about 40 percent of carbon emissions can be attributed to the construction, operation and maintenance of buildings (IFMA Sustainability How-To Guide – Carbon Footprint, 2016).

In an international effort to standardize emission measures the Scope 3 Standard developed emissions standards across 15 categories covering common business activities such as purchased goods and services, business travel and employee commuting. The categories also cover activities such as leased assets, transport and distribution, the use and disposal of products, and the impact of financial investments. The Scope 3 Standard uses a uniform approach for companies to account for emissions. It improves the consistency for reporting and provides a valuable basis for improved international conformity.

The Scope 3 Standard was developed by the GHG Protocol, which is a collaborative initiative between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The standard developed through an inclusive, multi-stakeholder process that engaged businesses and other stakeholders in the requirements and guidance. The Carbon Trust was an active stakeholder in the development of the Scope 3 Standard, including participation in the Steering Committee and Technical Working Groups. The Carbon Trust provided direct support to GHG Protocol to develop the new Scope 3 calculation guidance document (see: https://ghgprotocol.org/scope-3-technical-calculation-guidance).

Another tool for reporting broad sustainability efforts is the Global Reporting Initiative which is used for many international organizations. Not only carbon emissions are tracked but a full spectrum of items including safety, corporate social responsibility and innovation.



Source: Greenhouse Gas Protocol, Scope 3 Calculation Guidance

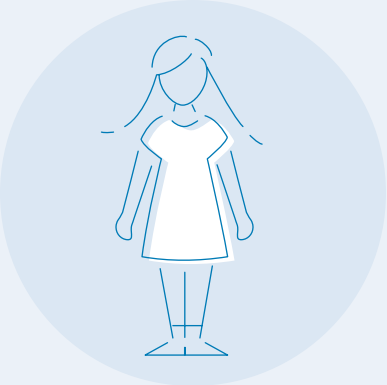
Conclusion

There is no doubt among scientists and researchers specializing in climate and meteorology that the Earth is undergoing dramatic change in climate that mostly cannot be attributed to normal fluctuations.

Therefore, the construction, operation and management of buildings and the workplace habits falling under the responsibility of facility managers is rapidly changing and will continue to evolve as governmental requirements, corporate mandates and social expectations evolve. Continuous improvement and updates have become requirements for facility professionals.

Areas of impact to the organizations that FMs support must always be considered and reduction of risks associated with climate change are top priority. Understanding climate change science, its impacts and areas of concern, helps to move FMs into proactive action. Since facilities and buildings are large impactors, proactivity regarding climate change adaptations gives the industry the focus required to adjust practices and plans to meet future needs based on climate change impacts. Finally, the impacts and adaptations made today will have long lasting effects for future generations.

As a basis for understanding climate change and its impact to facility management, this report, *Climate Change Fundamentals for Facility Management Professionals*, was developed as the first in a series from the Environmental Stewardship, Utilities and Sustainability community within IFMA. Plans for a second report, *Adapting to Climate Change for Facility Management Professionals* are underway. This second report will focus on methods for climate change adaptation and ways to reduce impacts caused while managing workplaces. Please look for this report in the coming months.



Call To Action

For additional inspiration and consideration of how climate change affects future generations see and hear a 16-year-old explain the importance of climate change:

Link to Video

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Abbreviations & Acronyms

CDR	carbon dioxide removal
CH4	methane
CO2	carbon dioxide
CTCN	Climate Technology Centre and Network
EJ	Exajoule (measure of energy 1 EJ = 1018 J)
ESUS	Environmental Stewardship Utilities and Sustainability Community
EU	European Union
FM	facility management/facility manager
GDP	gross domestic product
GCOS	Global Climate Observing System
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	greenhouse gas
ICA	international consultation and analysis
IFMA	International Facility Management Association
IPCC	Intergovernmental Panel on Climate Change
LDCs	least developed countries
MRV	measurement, reporting and verification
N2O	nitrous oxide
NASA	U.S. National Aeronautics and Space Administration
NCA4	U.S. Global Change Research Program, Fourth National Climate Assessment report
UN	United Nations
U.S.	United States
USGBC	U.S. Green Building Council

Definitions

Anthropogenic is the scientific term for activities caused or created by humans which impact nature. Back to linked word

Carbon emissions includes carbon dioxide (CO2), a non-poisonous gas formed by combustion of carbon and the respiration of living organisms and is considered a greenhouse gas. Emissions means the release of greenhouse gases and/or their precursors into the atmosphere in a specified area and time. Back to linked word

Carbon footprint is the total greenhouse gases, especially carbon dioxide, emitted by something (such as an organization's activities or a product's manufacture and transport) during a given time period and usually expressed in equivalent tons of carbon dioxide (CO2). Back to linked word

Climate change is a broad term meaning that carbon emissions not only warm the Earth, carbon emissions are also changing rain and snow patterns, as well as increasing the intensity of storms and droughts throughout the world. Back to linked word

Corporate Social Responsibility (CSR) developed early in the twentieth century as a concept that businesses should assume responsibility in terms of the objectives and values of society. It has expanded to include responsibility for consequences of actions beyond profit-and-loss statements, to include economic, as well as legal, moral, physical and social aspects of the environment. Back to linked word

Facility management (FM) is a profession that encompasses multiple disciplines to ensure functionality, comfort, safety and efficiency of the built environment by integrating people, place, process and technology. Back to linked word

Facility manager (FM) is a professional who carries out facility management duties, whether as an employee or service provider to an organization. Back to linked word

Global warming is the long-term trend of rising average global temperatures. Back to linked word

Greenhouse gases (GHG) are any gaseous compounds such as carbon dioxide or methane that absorb infrared radiation, trap heat in the atmosphere, and contribute to the greenhouse effect. Back to linked word

Greenhouse effect results from the conversion of solar radiation into heat when solar radiation in the atmosphere is absorbed by the planet's surface, and reradiation as infrared energy which is absorbed and partly reradiated back to the surface by atmospheric gases (greenhouse gases). The effect is warming of the surface and lowering atmosphere of a planet such as Earth or Venus. Without some greenhouse effect Earth would be too cold to inhabit but too much causes problems to the fragile atmosphere's balance.

Net zero means neither a surplus nor deficit when totaling losses and gains. Specific for buildings, it means producing enough energy through alternative means such as solar panels or passive heating, to offset all energy consumed. Back to linked word

Resilience has wide meanings depending on industry but generally means "the capacity to adapt to changing conditions and to maintain or regain functionality and vitality in the face of stress or disturbance," from the Resilient Design Institute (RDI). Back to linked word

Sustainable development refers to any economic development conducted without depletion of natural resources. Back to linked word

IFMA

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Environmental Stewardship
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