TESTIMONY OF THE MAYOR'S OFFICE BEFORE THE NEW YORK CITY COUNCIL COMMITTEE ON ENVIRONMENTAL PROTECTION

June 24, 2019

I. INTRODUCTION

Good afternoon. My name is Susanne DesRoches and I am the Deputy Director for Infrastructure and Energy at both the Mayor's Office of Resiliency (MOR) and the Mayor's Office of Sustainability (MOS). I am joined here today by Christopher Diamond, the Director of the Sustainable Design Unit at the Department of Design and Construction (DDC). I want to thank Chairperson Constantinides and members of the committee for this opportunity to testify on behalf of the de Blasio Administration on a package of bills related to renewable energy and geothermal technologies.

II. CARBON NEUTRALITY & CLEAN ELECTRICITY

As part of our Green New Deal, Mayor de Blasio committed New York City to 100 percent clean electricity by 2040 and carbon neutrality by 2050. This requires a shift to renewable energy from many sources — from rooftop solar energy generation and utility-scale renewables to building- and grid-scale energy storage.

New York City has already experienced significant growth in solar power. Since the beginning of 2014, installed solar capacity has increased sevenfold, and we now have enough solar installed across the city to meet the needs of nearly 50,000 households. Installation and equipment costs also continue to go down and have dropped by 25 percent since that start of 2014 — thanks, in part, to the City's solar property tax abatement of up to 20 percent off system costs — making solar more affordable and more accessible than ever.

Energy storage resources are also critical to renewable power generation, and we want to have 500 megawatts (MW) of storage available by 2025. At present there are 16 operational battery storage projects in the city totaling 18,000 kilowatt hours (kWH) with another 26 projects totaling 29,000 kWh in the pipeline. And we expect growth in this sector to accelerate by a combination of the City's commitment to expedite permitting for small and medium lithium battery installations and Local Laws 92 and 94 of 2019, which are part of landmark Climate Mobilization Act, and which mandate solar or green roofs on new buildings.

The Administration is focused on securing as much clean energy as possible for the city. While our solar goals are aggressive, solar in the city alone will not provide enough renewable power to meet the City's electricity needs. To meet our clean electricity goal including efforts to electrify our buildings and transportation, it is clear that New York City will require significant amounts of renewable energy flowing from upstate to downstate, as well as a substantial portion of the State's recently announced 9,000 MW of offshore wind directly connecting into the city.

New York State's existing transmission system does not enable enough renewable energy produced in the northern and western portions of the state to flow to the city. To clean up our grid, we must increase electricity transmission directly into the city and reduce our reliance on old, inefficient fossil fuel-based power plants located in New York City. Upstate New York has about 75 percent carbon-free electricity and in contrast, once Indian Point closes, it is expected that only about 10% of the energy generated in New York City will be carbon-free. Without more transmission, the clean electricity generated by upstate renewables cannot flow to New York City.

The City has been a strong advocate for new transmission, most recently through the Public Policy Transmission Needs process. Our energy modeling shows we need all types of bulk renewable power to green our grid. For example, even if New York City secures half of the 9000 MW of planned offshore wind and 1,000 MW of Canadian Hydropower installs 1000 MW of solar and 500 MW of storage by 2030, our grid will only be 60 percent clean. This clearly underscores urgent need for both the Administration and the Council to encourage our State partners to support new transmission lines to bring these resources to New York City as quickly as possible.

III. THE INTRODUCTORY BILLS

Today's introductory bills align with the Administration's climate goals, and so we are pleased to testify in general support of them.

Introduction 51

This bill would require the Administration to establish and oversee a pilot program for a district-scale geothermal system. There are approximately 20 geothermal systems in operation today in New York City, which are a promising way to reduce emissions from buildings and tap into a cleaner future grid. In fact, MOS is currently working with the utilities to scope a pilot project to build district geothermal systems in lieu of gas infrastructure upgrades. While we support the intent of the bill, we believe the utilities, at present, are better placed to manage the implementation of a complex multi-owner district system as envisioned in the bill.

Introduction 1076

This bill requires the City to study and identify locations for district-scale geothermal systems and encourage installation and operation of these systems. We fully support this idea but again believe the utilities are better placed to drive this effort as part of New York State's reforming the Energy Vision (REV) process to support consumers to make more informed energy choices and develop new energy products and services. In fact, the Administration is actively pursuing this through the Con Edison rate case currently underway at the New York State Public Service Commission.

Introduction 1375

This bill requires the creation of a database of subsurface conditions to support better engineering of geothermal heat pumps. While the Administration supports the intent of Introduction 1375, we believe it duplicates requirements of Local Law 6 of 2016, which directed MOS and DCC's to develop, a publicly available online screening tool (the Geothermal Pre-feasibility Tool) that can be used to identify areas where ground source, or geothermal heat pump systems may be an option, as well as cost-effective, for a property. That said, we would be happy to work the Council on ways to improve the tool.

Introduction 140

This bill requires the City to conduct a feasibility study on the implementation of a community choice aggregation (CCA) program for energy purchasing. The Administration is supportive of studying the feasibility of CCAs in New York City. Such a study will ensure that the development and implementation of any New York City based CCA is conditioned on guaranteed energy bill savings to our residents, a measurable increase in renewable energy generated in the city and on a timeline that is faster than what is currently planned under the State's Clean Energy Standard.

Introduction 269

This bill requires the City to develop a residential renewable energy pilot for an affordable housing development that utilizes a solar thermal district heating system along with solar photovoltaic systems to supply all of the development's energy needs. The Administration is fully supportive of these types of efforts and we are confident we can do this outside the legislative process. We are happy to brief the Council on these efforts.

IV. CONCLUSION

In conclusion, I would like to emphasize that as we move toward our goals of carbon neutrality and 100 percent clean electricity, we must ensure the transition is fair and equitable in terms of the cost burden to people and communities and that we continue to create good-paying jobs to support the economic vitality that enables us to make our city strong and fair. Together we will have to act both inside our borders and at the state, regional, and federal levels. We look forward to working with the Council on these bills and on the larger effort of enlisting all New Yorkers to participate in this ambitious, once-in-a-generation commitment to ensure a livable climate and a better future.

Thank you.

conEdison, inc.

Testimony of Con Edison before the
New York City Council Committee on Environmental Protection
June 24, 2019

Good morning. Thank you, Mr. Chairman, and members of the Committee for the opportunity to provide comments today. My name is Matthew Ketschke and I am the Senior Vice President of Customer Energy Solutions for Con Edison. I am joined this morning by my colleague, Kyle Kimball, Vice President of Government, Regional, and Community Affairs.

Our comments today are focused on how we can work together to achieve our shared clean energy goals. Con Edison has been a leader in transforming the New York City energy grid - the most complex in the world - to a resilient grid that will facilitate the orderly transition to a clean and affordable energy future.

Our customers are clear: they want more access to renewables, energy efficiency, demand response, storage and information to help them manage their energy usage and bills. We're taking advantage of technology and innovation to provide customers with the tools to help them save money and help us keep our electric, gas, and steam service safe, affordable, and reliable.

Our commitment to clean energy is real. Through our clean energy subsidiaries we are one of the largest solar providers in North America and with 2,600 MW of renewable assets in 17 states, Con Edison's assets avoid 5.4 million tons of carbon dioxide emissions – the equivalent of taking 1.2 million cars off the road.

Since 2001 we have helped our customers connect more than 26,000 solar projects that produce 250 megawatts of clean, renewable power. And our customers aren't done yet. We have another 3,300 applications for customer-sited solar generation in the queue. Those projects would produce an additional 100 megawatts of generation.

We have to work together to get to a cleaner and affordable energy future. Con Edison continues to ask the Council for your strong support and collaboration for the following prerequisite strategies, programs, and investments, to get to our clean energy future:

- Renewables:
    - We ask for your support for our recently launched Shared Solar program that will install solar panels on our facilities, including in Astoria, and use the resulting bill credits to give a monthly discount to low income customers, so that our clean energy future is accessible to everyone.
    - Utility ownership of large scale renewable generation to take advantage of low-cost capital and other business synergies;

    - The development of the necessary transmission infrastructure to deliver that renewable energy to New York City;
- Technologies to empower smart energy choices:
    - Making energy efficiency programs, non-wire solutions, and non-pipeline solutions a growing and important part of our core business;
    - Smart meter technology and implementation;
    - Investments and programs to accelerate the adoption of electric vehicles;
    - Finally, we ask for your support to ensure that battery storage, which improves grid resiliency and reliability, is permitted by the FDNY and Depart of Buildings and becomes an integral part of our energy infrastructure.

Going back to the issue of utilities owning large-scale renewable assets: for New York State and City to meet their short- and long-term carbon reduction goals, recently codified and expanded with the passage of the Climate Leadership and Community Protection Act, we need a major increase in large-scale renewable energy. We think it makes sense to let customers own and operate these large-scale renewable resources through their utilities. They can be constructed by private developers, but the financing and operating costs will be cheaper for our customers if utilities own them. This is because utility ownership means a guaranteed source of renewable energy, lowering costs and increasing union jobs.

To achieve society's ambitious environmental goals, we will have to make progress on heating and cooling technologies, as buildings are our City's largest emitters of carbon. The enactment of Local Law 97, or the emissions limits bill, promotes renewable technologies and clean energy solutions that present both challenges and tremendous opportunity. As a key player in this equation between the building and its energy use, and the larger effect on the electric grid, we are seeking to be on the advisory board established by Local Law 97.

Providing customers with more choices – like the ability to adopt geothermal and air-source heat pumps to heat and cool their homes and businesses - is an opportunity for us and our customers. Incenting our customers to adopt heat pumps for space cooling and heating is one of our key demand-side solutions. High-efficiency heat pumps have the potential to reduce customer usage on the coldest winter days and throughout the heating season. During the summer months, the heat pumps provide high-efficiency cooling, reducing electric usage and further adding to the environmental benefit.

Con Edison has been incentivizing air-source heat pump technologies for more than 3 years and expects to incentivize more than 5,000 units in 2019, the majority of which will be cold-climate air-source heat pumps and thus capable of both heating and cooling. In early 2019 the Company announced a partnership with a Dandelion, a ground source heat pump company, and began providing $5,000 per Westchester home to incentivize adoption.

As part of the State's latest energy efficiency order we plan to significantly ramp up our offering to facilitate heat pump adoption throughout our service territory. We plan to provide more than $200M to our customers for heat pumps in the next six years and expect heat pumps, air- and ground-source, to be a key part of our renewable solutions to heat and cool buildings in the future. Ground-source heat pumps are highly efficient but there are some limitations to wide scale deployment in a dense urban setting such as New York City. We consider geothermal as one part of a larger toolkit for low-carbon buildings.

This year has been transformational for the State and City's climate legislation agenda. Local Law 97 and now the Climate Leadership and Community Protection Act will fundamentally accelerate the transition to a low-carbon future. We support these efforts and are already working toward achieving these targets while still providing safe, reliable energy for all New Yorkers. We understand the urgency in reaching society's carbon reduction goals and it is important to engineer a smooth transition that is affordable to our customers. Con Edison has an obligation to provide New Yorkers with the energy they need today to keep their homes and businesses energized. We look forward to working with you and other policymakers to ensure an orderly transition to a clean energy future.

Thank you once again for the opportunity to join you here this morning. We would be happy to answer any questions you may have.

National Grid Statement
On
Proposal Local Laws to Advance Clean Energy in the City of New York
Before
The Committee on Environmental Protection
The New York City Council

Christopher A. Cavanagh, PE, Principal Program Manager
June 24, 2019

Good afternoon Mr. Chairman and Members of the Committee; My name is Christopher (Chris) Cavanagh, Principal Program Manager – Customer Innovation at National Grid. I am a 1981 Graduate of Cooper Union just north of here and have been working on advanced energy projects in New York City ever since. Thank you for the opportunity for us to present our support for the objectives of these seven energy proposals.

We here all agree that Climate change is the greatest challenge that humanity faces and at the same time it's the greatest challenge of the energy industry.

National Grid believes in the science of climate change and has a blueprint for drastically reducing greenhouse gas emissions (GHG) 80 percent below 1990 levels by 2050 (80x50) called the "Northeast 80x50 Pathway."

Our approach aligns with the City of New York, New York State and the Northeast clean energy transition policies to help reduce greenhouse gas emissions by 2050. We are a strong advocate for policy and regulatory approaches that provide resilient solutions to help achieve emissions targets in a reliable and affordable way on behalf of our Customers. And we look forward to the opportunity to collaborate with the City on many ideas.

For National Grid, climate change isn't a political question, but scientific fact, and we believe that innovation and a diverse set of stakeholders at the table will enable us to reach the clean energy future that we all want. We are happy to join with the NYC Council in its pursuit to help combat climate change and are pleased to support these seven proposed local laws. These proposals cover four areas 1) Community Choice Aggregation 2) Geothermal Heating and cooling 3) Solar Power and Solar thermal Systems 4) Battery Energy Storage.

Community Choice Aggregation

Intro. 140 proposes a study be performed to determine the feasibility of implementing in the City one or more community choice aggregation opt-out programs. National Grid supports the non-utility market for energy supply including for sourcing renewable energy. As the proposal states, such programs are the subject of extensive ongoing evaluations by the NY State

Public Service Commission and there are several implementation issues to carefully consider, especially related to the access and use of customer data. It is recommended that the experiences of other regional municipalities should be considered in the feasibility study.

Geothermal

Intros 51, 1076 and 1375 would support the expansion of the use of geothermal heating and cooling in NYC, especially in district systems. National Grid has already identified the Customer, utility system and environmental benefits of ground-source heat pumps. National Grid is near completion of a two-year demonstration of a district geothermal system at a retirement community in Riverhead, NY. This has been a highly successful demonstration in terms of energy performance and customer satisfaction. It has led to the proposal now before the Public Service Commission to allow National Grid to demonstrate utility ownership of the ground-loop portion of ground-source heat pumps systems, both on Long Island and in New York City, in order to support the growth of the geothermal market. The proposed local laws would support similar systems and the proposed database of subsurface conditions is a great idea that would reduce the financial risk of initiating such projects.

Solar Power and Solar Thermal

Intro. 269 and 426 propose pilot programs in which a district-scale solar thermal heating system is used in conjunction with solar photovoltaic systems to provide all the heating, hot water, cooling and electricity needs for covered buildings participating in such a program. The proposal also considers thermal energy storage. It is well known that the use of solar photovoltaic systems has grown rapidly in recent years and resulted in significant reductions in unit costs. We were pleased to recently provide funding for a solar power system at the Arverne Church of God facility in Far Rockway that served all residents during Superstorm Sandy, to both add resiliency and save energy costs. So too, there is a similar potential for solar thermal technologies and thermal storage technologies, but we would recommend that such polices do not fail to recognize the value of broader community renewables such as remote solar or renewable gas. National Grid has sponsored research at the Gas Technology Institute into evacuated tube solar collectors which heats water from 60°F to more than 140°F even in the winter and the results are pretty impressive, but costs remain too high for cost-effectiveness, but it is improving. Likewise, there are significant potential benefits and value to thermal energy storage and new companies are developing a variety of techniques far beyond simple water tanks that could potentially be supported by the proposed expansion of our Non-pipeline Alternatives initiatives now before the Public Service Commission.

Energy Storage

Intro. 49 will require a feasibility study regarding the use of utility-scale battery storage systems at City-owned buildings. Energy storage systems are an enabling technology for the next generation of any kind of renewable energy. National Grid with Tesla is showing the environmental and economic benefits of battery storage in terms of avoided electric infrastructure on Nantucket Island, charged in part with off-shore wind power. National Grid encourages this study but also recommends that the renewable energy storage study not be limited to electro-chemical batteries. For example, the NY Power Authority studied compressed air energy storage under NYC in the 80's. Today, National Grid is evaluating the storage of renewably produced hydrogen as an effective energy storage medium for electricity converted back to electricity with fuel cells or for the production of synthetic gas injected into the distribution system, called the Power to Gas concept.

At National Grid, we've already taken concrete steps to move toward a clean energy future. Modernizing our infrastructure to meet 21st century demands and connecting customers to distributed generation and renewable energy, such as our partnership for renewable gas at the Newtown Creek wastewater treatment plant, will help us toward a future of an integrated, decarbonized energy system that includes renewable energy for all modes of transportation. We are also setting the ground work with a clean energy presence? including dramatic reductions in the quantity of small leaks from our gas distribution system that contribute to Climate change, continuing the success of the NYC Clean Heat program that has phased out the use of #6 and #4 heavy fuel oils in approximately 800 large buildings and in 2017, we provided more than $20 million in energy efficiency services and incentives to save our customers more than 4 million therms per year. We also offer a variety of rebates and incentives on energy efficient products to help customers save energy and money and we process more than 9,000 customer energy efficiency rebates each year but continued near term progress requires augmenting or replacing gas systems with new modern infrastructure such as the Northeast Supply Enhancement project.

And, we're committed to doing more to help our customers make more informed energy choices and develop new energy products and services National Grid looks forward to working with New York City to develop plans and programs and apply our array of energy solutions to help the City achieve our shared aggressive greenhouse gas emission targets. Thank you.

New York City Environmental Justice Alliance
166A 22nd Street, Brooklyn, NY 11232 | www.NYC-EJA.org

On the ground – and at the table

New York City Environmental Justice Alliance testimony to the New York City Council Committee on Environmental Protection on Renewable Energy Oversight and in support of Intro 0140 and Intro 0049 in relation to reducing greenhouse gas emissions through improved clean and renewable energy policies.

June 24, 2019

Good afternoon Chairperson Constantinides, Council Member Levin, and Members of the City Council. My name is Annel Hernandez and I am here to testify on behalf of the New York City Environmental Justice Alliance (NYC-EJA) regarding Renewable Energy Oversight and in support of Intro 0140 and Intro 0049 in relation to reducing greenhouse gas (GHG) emissions through improved clean and renewable energy policies. NYC-EJA is a citywide membership network linking grassroots organizations from low-income neighborhoods and communities of color in their struggle for environmental justice. Through our efforts, member organizations coalesce around specific common issues that threaten the ability of low-income communities of color to thrive, and coordinate campaigns designed to affect City and State policies, including energy policies directly impacting our communities. Because a number of the NYC-EJA member organizations come from communities overburdened by GHG emissions and co-pollutants from power plants clustered in their neighborhoods, our organization is a key advocate of clean and renewable energy targets rooted in a Just Transition.

While New York City has made commitments to reduce GHG emissions and increase investments in climate resiliency, progress so far has been slow to reach frontline communities. These communities also face many obstacles to participating in the clean energy economy. As utility ratepayers, members of these communities have financially contributed to existing energy efficiency and renewable energy programs in New York, only to encounter barriers to their own participation or programs that ultimately fail at systematically addressing the root causes of energy insecurity and energy poverty. The massive systems change required to stave off dangerous climate change impacts requires a consideration of the unique vulnerabilities facing environmental justice communities.

Community Choice Aggregation (CCA) provides a potential avenue to shift the decision-making power to the consumer, but without an equitable and accessible model the future of CCAs may fall short of its intended goals. CCA's can be an empowering tool for transformative change in the way consumers connect to and purchase their energy, as well as tap into other values they seek to realize through their energy choices. However, these lofty goals cannot be reached without strategies to remove barriers to entry, particularly for lower income households, and safeguards for energy burdened households that have been the target of previous predatory practices related to their energy bills and services. It is also critical that any CCA model developed by the City of New York taps into the synergies of current and existing efforts to expand distributed energy resources (DER) and community distributed generation (CDG) as part of the broader Reforming the Energy Vision (REV) framework. Finally, CCAs, if structured properly, can also provide a meaningful opportunity to advance the goals of New York City community-based groups involved in energy affordability, climate equity, environmental justice, climate justice, economic justice, and community resiliency work. A study is critical to understanding the benefits and pitfalls of implementing CCAs in NYC, as proposed in Intro 0140.

Climate justice is based on the principle that frontline communities are most vulnerable to climate change and, therefore, must play an integral role in planning for the renewable and regenerative energy economy. These are communities where climate vulnerabilities intersect with historic patterns of environmental burdens, many of which could be ameliorated through equitable energy policies and strategic investments.

New York City is home to 16 peaker plants, many with multiple generating units, both publicly and privately owned. Four peaking units operate at two locations in the South Bronx and three more operate in Sunset Park—both neighborhoods where the majority of residents are low-income and working-class people of color already suffering from cumulative burdens due to disproportionate exposure to other industrial pollution. Energy Storage technology is the key component needed to unlock the emission-free renewable energy future that New York City and other major metropolitan areas across the country have recognized as critical to averting the worst impacts of climate change. Renewables are already cost-competitive with and often cheaper than fossil fuels, but they suffer from intermittency issues, leading to reliability concerns for utilities and grid operators. Battery storage changes that narrative, adding the flexibility and control to transform solar and wind into reliable energy. Because periods of high demand are infrequent and often short duration events, peaker power plants represent the most near-term opportunity for battery storage and renewables to cost-effectively replace fossil fuel resources. Renewable and resilient energy systems will advance energy democracy, reduce energy cost burdens, strengthen the resiliency of their communities, and capture the benefits that community-based solar and storage installations can deliver. It is important that we conduct a feasibility study on the installation of utility-scale battery storage systems on city buildings, as proposed by Intro 0049.

Finally, as the City continues to install solar on our public buildings, we should ensure that it is prioritizing installations in environmental justice communities and committing to high-road labor standards. The City is falling short of their 100 Megawatt (MW) goal of solar on public buildings by 2025, and I urge the City Council to hold the NYC Department of Citywide Administrative Services accountable for the delayed implementation. Moreover, Mayor de Blasio's flawed Green New Deal announcement has got it wrong. NYC cannot depend on Canadian Hydro Power "Renewable Energy Credits" to meet our climate goals, when we can instead invest in and build renewable energy here in the five boroughs. Renewable energy paired with energy storage can provide resiliency and reliability, and can create new local jobs in the renewable energy economy. Furthermore, community solar can help create ownership in frontline communities and lower utility bills for low-income New Yorkers. As we take bolder steps to reduce GHG emissions and co-pollutants, the City should guarantee both protections and benefits for low-income neighborhoods and communities of color.

NYC-EJA commends the NYC Council for holding a hearing on the need for a rapid and transformative transition to clean and renewable energy. A just energy policy is central to NYC-EJA's work, and we look forward to a continued collaboration with the City to mitigate the threats of climate change while optimizing economic, health, and environmental benefits for the most burdened and climate vulnerable New Yorkers.

RESOLUTION 864

I am a health professional and food educator taking valuable time away from garden projects in Westchester County NY today to urge this city council to declare a climate emergency. I am active with Extinction Rebellion (XR) an international movement active in 59 countries. I am in direct alignment with Extinction Rebellion's 10 principles and 4 core demands.

Their first demand it to TELL THE TRUTH. That the Government must tell the truth about the climate and wider ecological emergency, it must reverse all policies not in alignment with that position and must work alongside the media to communicate the urgency for change including what individuals, communities and businesses need to do.

We are in an unprecedented situation when it comes to life on earth. We must act boldly and without hesitation. I realize how dramatic this sounds, but let's take a quick look at the science. The IPCC, Intergovernmental Panel on Climate Change, came out last year with a devastating report stating that we have less than 12 years to significantly cut emissions or face irreversible climate disruption. Have each and every one of you read this report? It should be required as part of your job as an elected public servant. As other science experts will tell you today, the IPCC doesn't go nearly far enough. It neglects to consider positive feedback mechanisms already speeding the process up. Rapidly melting ice in the Arctic and in Greenland are examples of positive feedbacks that are accelerating the situation.Wildfires are another feedback loop not included in the IPCC report.

In the middle or our country, 85% of this years crops have not been planted because it has been raining non stop since March. A warmer atmosphere holds more water. The US just had the wettest 12 months in history. Its not just superstorms that will create catastrophe, its unstable weather patterns that will cause our current industrial food system to collapse. Crop failures can and will lead to societal collapse.

The inaction of our government is no longer excusable. Climate delayers are no different than climate deniers. These are not normal times, this is an emergency. When a building is on fire, you don't take baby steps to the exit. We have run out of the luxury of time to react incrementally, we must take bold action.

We must tell the truth. The first part in addressing a problem is to acknowledge that there is one. Resolution 864 is an important first step toward confronting the hard truth of the climate crisis. This city council can start by declaring a climate emergency. Immediately.

Dr.Susan Rubin

www.drsusanrubin.com

Testimony on Resolution 864-2019, to declare a climate emergency in NYC.

Hi, my name is Ken Schles. I'm a father of two, a photographer and a writer who has lived in NYC for nearly all of my 58 years. In October of 2016 I had a heart attack while cycling in Prospect Park, Brooklyn. I'm fit, don't smoke, have low cholesterol, exercise regularly and live a vegan lifestyle. It's well documented that burning fossil fuel creates small particulate matter that infiltrates vascular walls and causes plaque formation.[1,2] It damages lung tissue and exacerbates asthma, which kills 11 people a day in the US.[3] Increasing heat waves magnify both the frequency and severity of heart disease, stroke and asthma leading to higher morbidity and mortality rates.[4,5] According to the World Health Organization 4.2 million people die prematurely from ambient air pollution per year—or 7.6% of all annual deaths.[6,7]

But we're just beginning to feel the effects of climate change. It will take thousands of years for the effects of increased atmospheric carbon to fully materialize.[8] They call the climate crisis a hyper object because its magnitude is impossible to conceptualize. True, but because of my health scare, I recognize the climate crisis as something that affects individuals intimately as lost potential, diminished lives and broken families. New Yorkers are hobbled with increased healthcare costs and lost wages, increased tax burdens to fund hospitals, increased costs to harden infrastructure and provide storm damage remediation.

Climate change risks not only life and limb, but also destroys our cultural heritage. I have photographic work in the collections of Metropolitan Museum of Art, The Museum of Modern Art and the Museum of the City of NY as well as in cultural institutions throughout the world. Last year work of mine in a collection bound for

---

1 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4740122/
2 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6202600/
3 https://www.asthmamd.org/asthma-statistics/
4 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4155032/
5 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4687168/
6 https://www.who.int/airpollution/en/
7 https://www.who.int/gho/phe/outdoor_air_pollution/burden/en/
8 https://scripps.ucsd.edu/programs/keelingcurve/2013/12/03/what-does-400-ppm-look-like/

the Museum of Fine Arts in Houston was destroyed, along with 36,000 other objects in the Woolsey fire that ravaged Malibu, California.[9] Nearly 300,000 people were evacuated.[10] The fire caused $1.6 billon dollars in damages. Another piece of mine, in the collection of the US State Department, was destroyed in the US Embassy in Yemen, a minor casualty of a war that precipitated one of the greatest humanitarian disasters of this century[11] and is the result, arguably, like the war in Syria, a war initiated by water scarcity due to climate change.[12]

A 2018 study by the World Wildlife Fund notes the world's wildlife population is down by 60% on average since 1970.[13] We are living through what the NY Times dubbed the insect apocalypse.[14] The Pulitzer Prize winning author Elizabeth Kolbert described our era as "the sixth extinction,"[15] a time when species demise is between 1,000 and 10,000 times the normal background rate.[16]

Last year the IPPC report gave us 12 years to reduce our greenhouse gas output, but even in the few months since the report's publication scientists have made some surprising findings: the oceans are warming faster than previously thought,[17] they are becoming hypoxic, rife with dead zones.[18] According to NASA, the West Antarctic ice sheet is contributing to sea level rise at a faster pace while it signals a "rapid decay."[19,20] The Greenland ice sheet, which contains enough water to raise global sea levels by 23 feet is melting at rate 44% faster than in the 20th century.[21] Since that report was published Greenland is experiencing record ice melts that are

---

9 https://www.bjp-online.com/2018/11/heiting-collection-destroyed/
10 https://en.wikipedia.org/wiki/Woolsey_Fire
11 https://www.nytimes.com/interactive/2018/10/31/magazine/yemen-war-saudi-arabia.html
12 https://climateandsecurity.org/2016/08/03/a-storm-without-rain-yemen-water-climate-change-and-conflict/
13 https://www.worldwildlife.org/pages/living-planet-report-2018
14 https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html
15 https://en.wikipedia.org/wiki/The_Sixth_Extinction:_An_Unnatural_History
16 http://wwf.panda.org/our_work/biodiversity/biodiversity/
17 http://science.sciencemag.org/content/363/6423/128.summary
18 https://oceanservice.noaa.gov/podcast/feb18/nop13-hypoxia.html
19 https://www.pnas.org/content/116/4/1095
20 https://sealevel.nasa.gov/news/152/huge-cavity-in-antarctic-glacier-signals-rapid-decay
21 https://www.pnas.org/content/116/6/1934

further disrupting weather patterns.[22] It is expected that 80 million people will be put at risk due to coastal flooding by 2040,[23] (include NYC residents in that number) and a significant fraction of the world's population will experience chronic or absolute water scarcity.[24] At our present trajectory climate modeling shows by 2050 a climate equivalent to the Eocene, last experienced 50 million years ago. Extend that out another two hundred years and we see a planet uninhabitable by humans.[25]

According to NOAA, damages from Hurricane Sandy cost over $72 billion. It shut down the NY Stock exchange for two consecutive days and caused the disruption of critical electric and water services and took 159 lives. This was just one storm. It was the most costly weather event in US history up until that point in time. That was 2012. In the years since, thousands have lost their lives and there has been trillions of dollars more in damages. Hurricane Maria alone cost $91.8 billion and took over 3,000 lives.[26] Cyclones Idai and Kenneth in Mozambique displaced over 1,000,000 children.[27] Storms, floods, fires and the damages they cause, the lives they take are growing apace.

During the Pliocene CO2 levels were as high as they are now. The earth on average was 5.5 to over 7 degrees F warmer, the poles were 18 degrees F warmer and the seas up to 131 feet higher than they are today—it is only because it takes time for the heat in the atmosphere to build up and the ice caps to melt that NYC is not currently hotter or underwater.[28,29] Permafrost is melting much faster than anticipated creating feedback loops that may eventually triple the amount of carbon currently in the atmosphere.[30]

---

[22] https://www.washingtonpost.com/weather/2019/06/14/arctic-ocean-greenland-ice-sheet-have-seen-record-june-ice-loss/
[23] https://www.nytimes.com/2019/01/21/climate/greenland-ice.html
[24] https://www.pnas.org/content/pnas/early/2013/12/12/1222460110.full.pdf
[25] https://www.climatecentral.org/news/climate-change-unseen-50-million-years-21312
[26] https://www.ncdc.noaa.gov/billions/events/US/1980-2018
[27] https://www.apnews.com/f5e0d21839dc444dba8d81926b3bf118
[28] https://scripps.ucsd.edu/programs/keelingcurve/2013/12/03/what-does-400-ppm-look-like/
[29] http://www.floodmap.net
[30] https://www.nature.com/articles/d41586-019-01313-4

Some of us here will lose our lives to climate change, some, like myself, have already had life altering near death experiences. To take no action is immoral. To act in half measures, is a false compromise that does not take into account the immutable, unyielding facts of science. We risk the loss not only our cultural heritage and the viability of our species, we risk the genetic legacy and biodiversity of our planet. We demand our elected official to lead, for it is their moral obligation to do so. Call this climate emergency for what it is. Align NYC with 625 local governments in 14 countries.[31] Let people know this is no longer a debate of fact. Declare a climate emergency to give credence to and form a basis for further legal and legislative action.

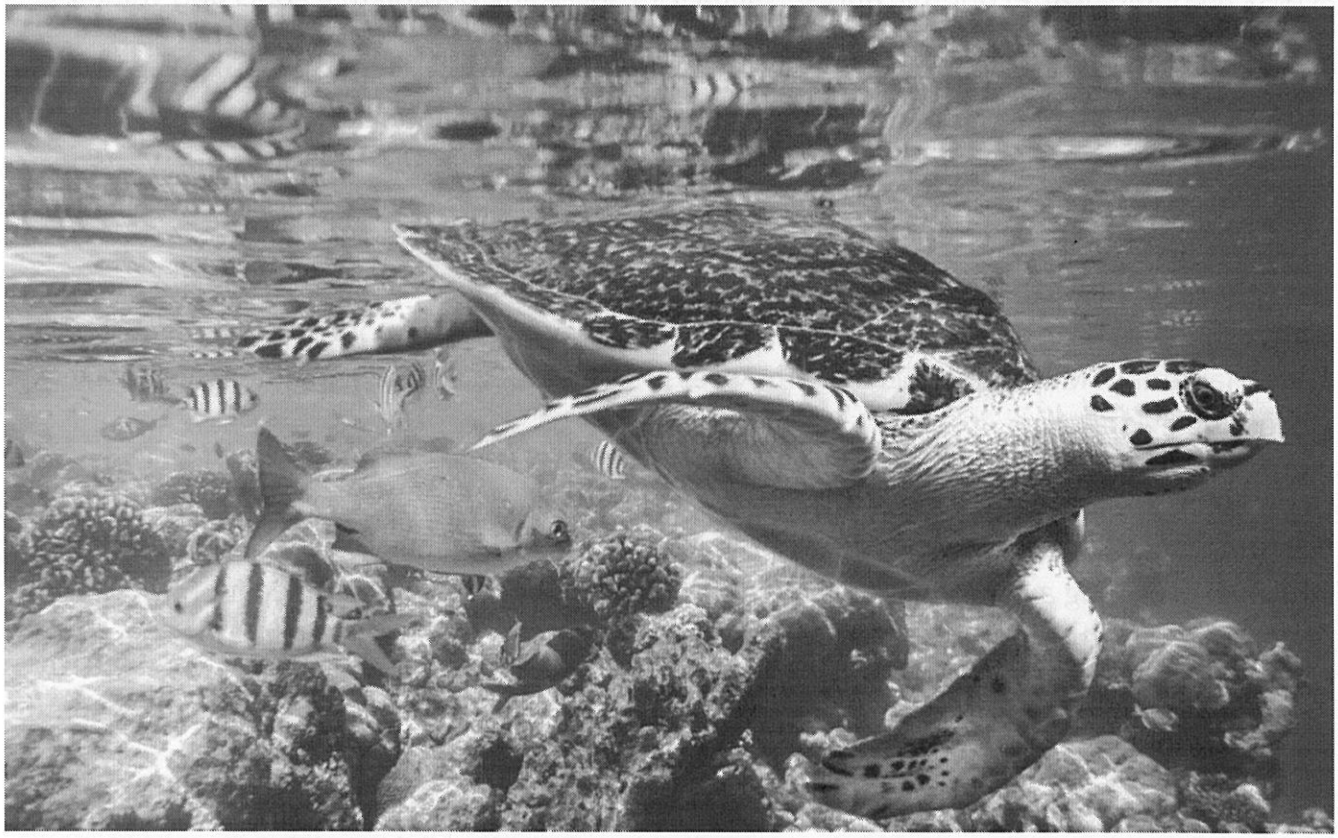
Ken Schles
378 Vanderbilt Avenue
Brooklyn, NY 11238 / (917) 816-3846 / info@kenschles.com

[31] https://www.theclimatemobilization.org/climate-emergency-campaign

UN Report: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'

UN un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report

May 5, 2019



Current global response insufficient;
'Transformative changes' needed to restore and protect nature;
Opposition from vested interests can be overcome for public good
Most comprehensive assessment of its kind;
1,000,000 species threatened with extinction

PARIS, 6 May – Nature is declining globally at rates unprecedented in human history – and the rate of species extinctions is accelerating, with grave impacts on people around the world now likely, warns a landmark new report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the summary of which was approved at the 7th session of the IPBES Plenary, meeting last week (29 April – 4 May) in Paris.

"The overwhelming evidence of the IPBES Global Assessment, from a wide range of different fields of knowledge, presents an ominous picture," said IPBES Chair, Sir Robert Watson. "The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide."

"The Report also tells us that it is not too late to make a difference, but only if we start now at every level from local to global," he said. "Through 'transformative change', nature can still be conserved, restored and used sustainably – this is also key to meeting most other global goals. By transformative change, we mean a fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values."

"The member States of IPBES Plenary have now acknowledged that, by its very nature, transformative change can expect opposition from those with interests vested in the status quo, but also that such opposition can be overcome for the broader public good," Watson said.

The IPBES Global Assessment Report on Biodiversity and Ecosystem Services is the most comprehensive ever completed. It is the first intergovernmental Report of its kind and builds on the landmark Millennium Ecosystem Assessment of 2005, introducing innovative ways of evaluating evidence.

Compiled by 145 expert authors from 50 countries over the past three years, with inputs from another 310 contributing authors, the Report assesses changes over the past five decades, providing a comprehensive picture of the relationship between economic development pathways and their impacts on nature. It also offers a range of possible scenarios for the coming decades.

Based on the systematic review of about 15,000 scientific and government sources, the Report also draws (for the first time ever at this scale) on indigenous and local knowledge, particularly addressing issues relevant to Indigenous Peoples and Local Communities.

"Biodiversity and nature's contributions to people are our common heritage and humanity's most important life-supporting 'safety net'. But our safety net is stretched almost to breaking point," said Prof. Sandra Díaz (Argentina), who co-chaired the Assessment with Prof. Josef Settele (Germany) and Prof. Eduardo S. Brondízio (Brazil and USA).

"The diversity within species, between species and of ecosystems, as well as many fundamental contributions we derive from nature, are declining fast, although we still have the means to ensure a sustainable future for people and the planet."

The Report finds that around 1 million animal and plant species are now threatened with extinction, many within decades, more than ever before in human history.

The average abundance of native species in most major land-based habitats has fallen by at least 20%, mostly since 1900. More than 40% of amphibian species, almost 33% of reef-forming corals and more than a third of all marine mammals are threatened. The picture is less clear for insect species, but available evidence supports a tentative estimate of 10%

being threatened. At least 680 vertebrate species had been driven to extinction since the 16th century and more than 9% of all domesticated breeds of mammals used for food and agriculture had become extinct by 2016, with at least 1,000 more breeds still threatened.

> "Ecosystems, species, wild populations, local varieties and breeds of domesticated plants and animals are shrinking, deteriorating or vanishing. The essential, interconnected web of life on Earth is getting smaller and increasingly frayed," said Prof. Settele. "This loss is a direct result of human activity and constitutes a direct threat to human well-being in all regions of the world."

To increase the policy-relevance of the Report, the assessment's authors have ranked, for the first time at this scale and based on a thorough analysis of the available evidence, the five direct drivers of change in nature with the largest relative global impacts so far. These culprits are, in descending order: (1) changes in land and sea use; (2) direct exploitation of organisms; (3) climate change; (4) pollution and (5) invasive alien species.

The Report notes that, since 1980, greenhouse gas emissions have doubled, raising average global temperatures by at least 0.7 degrees Celsius – with climate change already impacting nature from the level of ecosystems to that of genetics – impacts expected to increase over the coming decades, in some cases surpassing the impact of land and sea use change and other drivers.

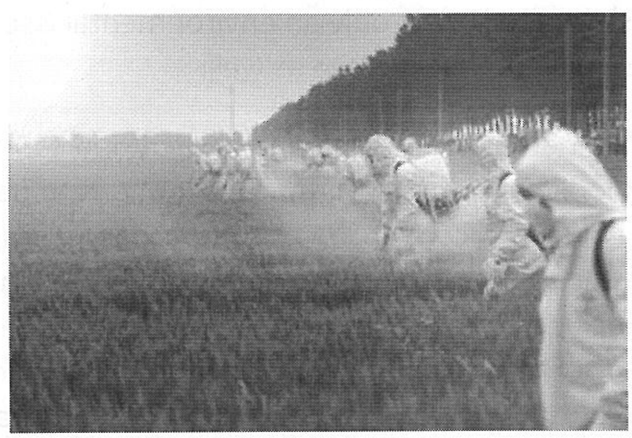
Despite progress to conserve nature and implement policies, the Report also finds that global goals for conserving and sustainably using nature and achieving sustainability cannot be met by current trajectories, and goals for 2030 and beyond may only be achieved through transformative changes across economic, social, political and technological factors. With good progress on components of only four of the 20 Aichi Biodiversity Targets, it is likely that most will be missed by the 2020 deadline. Current negative trends in biodiversity and ecosystems will undermine progress towards 80% (35 out of 44) of the assessed targets of the Sustainable Development Goals, related to poverty, hunger, health, water, cities, climate, oceans and land (SDGs 1, 2, 3, 6, 11, 13, 14 and 15). Loss of biodiversity is therefore shown to be not only an environmental issue, but also a developmental, economic, security, social and moral issue as well.

"To better understand and, more importantly, to address the main causes of damage to biodiversity and nature's contributions to people, we need to understand the history and global interconnection of complex demographic and economic indirect drivers of change, as well as the social values that underpin them," said Prof. Brondízio. "Key indirect drivers include increased population and per capita consumption; technological innovation, which in some cases has lowered and in other cases increased the damage to nature; and, critically, issues of governance and accountability. A pattern that emerges is one of global interconnectivity and 'telecoupling' – with resource extraction and production often occurring in one part of the world to satisfy the needs of distant consumers in other regions."

Other notable findings of the Report include:

- Three-quarters of the land-based environment and about 66% of the marine environment have been significantly altered by human actions. On average these trends have been less severe or avoided in areas held or managed by Indigenous Peoples and Local Communities.
- More than a third of the world's land surface and nearly 75% of freshwater resources are now devoted to crop or livestock production.
- The value of agricultural crop production has increased by about 300% since 1970, raw timber harvest has risen by 45% and approximately 60 billion tons of renewable and nonrenewable resources are now extracted globally every year – having nearly doubled since 1980.
- Land degradation has reduced the productivity of 23% of the global land surface, up to US$577 billion in annual global crops are at risk from pollinator loss and 100-300 million people are at increased risk of floods and hurricanes because of loss of coastal habitats and protection.

- In 2015, 33% of marine fish stocks were being harvested at unsustainable levels; 60% were maximally sustainably fished, with just 7% harvested at levels lower than what can be sustainably fished.
- Urban areas have more than doubled since 1992.
- Plastic pollution has increased tenfold since 1980, 300-400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped annually into the world's waters, and fertilizers entering coastal ecosystems have produced more than 400 ocean 'dead zones', totalling more than 245,000 km2 (591-595) – a combined area greater than that of the United Kingdom.
- Negative trends in nature will continue to 2050 and beyond in all of the policy scenarios explored in the Report, except those that include transformative change – due to the projected impacts of increasing land-use change, exploitation of organisms and climate change, although with significant differences between regions.



The Report also presents a wide range of illustrative actons for sustainability and pathways for achieving them across and between sectors such as agriculture, forestry, marine systems, freshwater systems, urban areas, energy, finance and many others. It highlights the importance of, among others, adopting integrated management and cross-sectoral approaches that take into account the trade-offs of food and energy production, infrastructure, freshwater and coastal management, and biodiversity conservation.

Also identified as a key element of more sustainable future policies is the evolution of global financial and economic systems to build a global sustainable economy, steering away from the current limited paradigm of economic growth.

"IPBES presents the authoritative science, knowledge and the policy options to decision-makers for their consideration," said IPBES Executive Secretary, Dr. Anne Larigauderie. "We thank the hundreds of experts, from around the world, who have volunteered their time and knowledge to help address the loss of species, ecosystems and genetic diversity – a truly global and generational threat to human well-being."

Further Information on Key Issues from the Report

Scale of Loss of Nature

- Gains from societal and policy responses, while important, have not stopped massive losses.
- Since 1970, trends in agricultural production, fish harvest, bioenergy production and harvest of materials have increased, in response to population growth, rising demand and technological development, this has come at a steep price, which has been unequally distributed within and across countries. Many other key indicators of nature's contributions to people however, such as soil organic carbon and pollinator diversity, have declined, indicating that gains in material contributions are often not sustainable .
- The pace of agricultural expansion into intact ecosystems has varied from country to country. Losses of intact ecosystems have occurred primarily in the tropics, home to the highest levels of biodiversity on the planet. For example, 100 million hectares of tropical forest were lost from 1980 to 2000, resulting mainly from cattle ranching in Latin America (about 42 million hectares) and plantations in South-East Asia (about 7.5 million hectares, of which 80% is for palm oil, used mostly in food, cosmetics, cleaning products and fuel) among others.
- Since 1970 the global human population has more than doubled (from 3.7 to 7.6 billion), rising unevenly across countries and regions; and per capita gross domestic product is four times higher – with ever-more distant consumers shifting the environmental burden of consumption and production across regions.
- The average abundance of native species in most major land-based habitats has fallen by at least 20%, mostly since 1900.
- The numbers of invasive alien species per country have risen by about 70% since

1970, across the 21 countries with detailed records.

- The distributions of almost half (47%) of land-based flightless mammals, for example, and almost a quarter of threatened birds, may already have been negatively affected by climate change.

Indigenous Peoples, Local Communities and Nature

- At least a quarter of the global land area is traditionally owned, managed, used or occupied by Indigenous Peoples. These areas include approximately 35% of the area that is formally protected, and approximately 35% of all remaining terrestrial areas with very low human intervention.
- Nature managed by Indigenous Peoples and Local Communities is under increasing pressure but is generally declining less rapidly than in other lands – although 72% of local indicators developed and used by Indigenous Peoples and Local Communities show the deterioration of nature that underpins local livelihoods.
- The areas of the world projected to experience significant negative effects from global changes in climate, biodiversity, ecosystem functions and nature's contributions to people are also areas in which large concentrations of Indigenous Peoples and many of the world's poorest communities reside.
- Regional and global scenarios currently lack and would benefit from an explicit consideration of the views, perspectives and rights of Indigenous Peoples and Local Communities, their knowledge and understanding of large regions and ecosystems, and their desired future development pathways. Recognition of the knowledge, innovations and practices, institutions and values of Indigenous Peoples and Local Communities and their inclusion and participation in environmental governance often enhances their quality of life, as well as nature conservation, restoration and sustainable use. Their positive contributions to sustainability can be facilitated through national recognition of land tenure, access and resource rights in accordance with national legislation, the application of free, prior and informed consent, and improved collaboration, fair and equitable sharing of benefits arising from the use, and co-management arrangements with local communities.

Global Targets and Policy Scenarios

- Past and ongoing rapid declines in biodiversity, ecosystem functions and many of nature's contributions to people mean that most international societal and environmental goals, such as those embodied in the Aichi Biodiversity Targets and the 2030 Agenda for Sustainable Development will not be achieved based on current trajectories.
- The authors of the Report examined six policy scenarios – very different 'baskets' of clustered policy options and approaches, including 'Regional Competition', 'Business as Usual' and 'Global Sustainability' – projecting the likely impacts on biodiversity and

nature's contributions to people of these pathways by 2050. They concluded that, except in scenarios that include transformative change, the negative trends in nature, ecosystem functions and in many of nature's contributions to people will continue to 2050 and beyond due to the projected impacts of increasing land and sea use change, exploitation of organisms and climate change.

Policy Tools, Options and Exemplary Practices

- Policy actions and societal initiatives are helping to raise awareness about the impact of consumption on nature, protecting local environments, promoting sustainable local economies and restoring degraded areas. Together with initiatives at various levels these have contributed to expanding and strengthening the current network of ecologically representative and well-connected protected area networks and other effective area-based conservation measures, the protection of watersheds and incentives and sanctions to reduce pollution .
- The Report presents an illustrative list of possible actions and pathways for achieving them across locations, systems and scales, which will be most likely to support sustainability. Taking an integrated approach:
- In ***agriculture***, the Report emphasizes, among others: promoting good agricultural and agroecological practices; multifunctional landscape planning (which simultaneously provides food security, livelihood opportunities, maintenance of species and ecological functions) and cross-sectoral integrated management. It also points to the importance of deeper engagement of all actors throughout the food system (including producers, the public sector, civil society and consumers) and more integrated landscape and watershed management; conservation of the diversity of genes, varieties, cultivars, breeds, landraces and species; as well as approaches that empower consumers and producers through market transparency, improved distribution and localization (that revitalizes local economies), reformed supply chains and reduced food waste.
- In ***marine systems***, the Report highlights, among others: ecosystem-based approaches to fisheries management; spatial planning; effective quotas; marine protected areas; protecting and managing key marine biodiversity areas; reducing run- off pollution into oceans and working closely with producers and consumers.
- In ***freshwater systems***, policy options and actions include, among others: more inclusive water governance for collaborative water management and greater equity; better integration of water resource management and landscape planning across scales; promoting practices to reduce soil erosion, sedimentation and pollution run-off; increasing water storage; promoting investment in water projects with clear sustainability criteria; as well as addressing the fragmentation of many freshwater policies.
- In ***urban areas***, the Report highlights, among others: promotion of nature-based solutions; increasing access to urban services and a healthy urban environment for

low-income communities; improving access to green spaces; sustainable production and consumption and ecological connectivity within urban spaces, particularly with native species.

- Across all examples, the Report recognises the importance of including different value systems and diverse interests and worldviews in formulating policies and actions. This includes the full and effective participation of Indigenous Peoples and Local Communities in governance, the reform and development of incentive structures and ensuring that biodiversity considerations are prioritised across all key sector planning.
- "We have already seen the first stirrings of actions and initiatives for transformative change, such as innovative policies by many countries, local authorities and businesses, but especially by young people worldwide," said Sir Robert Watson. "From the young global shapers behind the #VoiceforthePlanet movement, to school strikes for climate, there is a groundswell of understanding that urgent action is needed if we are to secure anything approaching a sustainable future. The IPBES Global Assessment Report offers the best available expert evidence to help inform these decisions, policies and actions – and provides the scientific basis for the biodiversity framework and new decadal targets for biodiversity, to be decided in late 2020 in China, under the auspices of the UN Convention on Biological Diversity."

By the Numbers – Key Statistics and Facts from the Report

General

- 75%: terrestrial environment "severely altered" to date by human actions (marine environments 66%)
- 47%: reduction in global indicators of ecosystem extent and condition against their estimated natural baselines, with many continuing to decline by at least 4% per decade
- 28%: global land area held and/or managed by Indigenous Peoples , including >40% of formally protected areas and 37% of all remaining terrestrial areas with very low human intervention
- +/-60 billion: tons of renewable and non-renewable resources extracted globally each year, up nearly 100% since 1980
- 15%: increase in global per capita consumption of materials since 1980
- >85%: of wetlands present in 1700 had been lost by 2000 – loss of wetlands is currently three times faster, in percentage terms, than forest loss.

Species, Populations and Varieties of Plants and Animals

- 8 million: total estimated number of animal and plant species on Earth (including 5.5 million insect species)
- Tens to hundreds of times: the extent to which the current rate of global species

extinction is higher compared to average over the last 10 million years, and the rate is accelerating

- Up to 1 million: species threatened with extinction, many within decades
- >500,000 (+/-9%): share of the world's estimated 5.9 million terrestrial species with insufficient habitat for long term survival without habitat restoration
- >40%: amphibian species threatened with extinction
- Almost 33%: reef forming corals, sharks and shark relatives, and >33% marine mammals threatened with extinction
- 25%: average proportion of species threatened with extinction across terrestrial, freshwater and marine vertebrate, invertebrate and plant groups that have been studied in sufficient detail
- At least 680: vertebrate species driven to extinction by human actions since the 16th century
- +/-10%: tentative estimate of proportion of insect species threatened with extinction
- >20%: decline in average abundance of native species in most major terrestrial biomes, mostly since 1900

  +/-560 (+/-10%): domesticated breeds of mammals were extinct by 2016, with at least 1,000 more threatened
- 3.5%: domesticated breed of birds extinct by 2016
- 70%: increase since 1970 in numbers of invasive alien species across 21 countries with detailed records
- 30%: reduction in global terrestrial habitat integrity caused by habitat loss and deterioration
- 47%: proportion of terrestrial flightless mammals and 23% of threatened birds whose distributions may have been negatively impacted by climate change already
- >6: species of ungulate (hoofed mammals) would likely be extinct or surviving only in captivity today without conservation measures

Food and Agriculture

- 300%: increase in food crop production since 1970
- 23%: land areas that have seen a reduction in productivity due to land degradation
- >75%: global food crop types that rely on animal pollination
- US$235 to US$577 billion: annual value of global crop output at risk due to pollinator loss
- 5.6 gigatons: annual CO2 emissions sequestered in marine and terrestrial ecosystems – equivalent to 60% of global fossil fuel emission
- +/-11%: world population that is undernourished
- 100 million: hectares of agricultural expansion in the tropics from 1980 to 2000, mainly cattle ranching in Latin America (+/-42 million ha), and plantations in Southeast Asia (+/-7.5 million ha, of which 80% is oil palm), half of it at the expense of intact forests

- 3%: increase in land transformation to agriculture between 1992 and 2015, mostly at the expense of orests
- >33%: world's land surface (and +/-75% of freshwater resources) devoted to crop or livestock production
- 12%: world's ice-free land used for crop production
- 25%: world's ice-free land used for grazing (+/-70% of drylands)
- +/-25%: greenhouse gas emissions caused by land clearing, crop production and fertilization, with animal-based food contributing 75% to that figure
- +/-30%: global crop production and global food supply provided by small land holdings (<2 ha), using +/-25% of agricultural land, usually maintaining rich agrobiodiversity
- $100 billion: estimated level of financial support in OECD countries (2015) to agriculture that is potentially harmful to the environment

Oceans and Fishing

- 33%: marine fish stocks in 2015 being harvested at unsustainable levels; 60% are maximally sustainably fished; 7% are underfished
- >55%: ocean area covered by industrial fishing
- 3-10%: projected decrease in ocean net primary production due to climate change alone by the end of the century
- 3-25%: projected decrease in fish biomass by the end of the century in low and high climate warming scenarios, respectively
- >90%: proportion of the global commercial fishers accounted for by small scale fisheries (over 30 million people) – representing nearly 50% of global fish catch
- Up to 33%: estimated share in 2011 of world's reported fish catch that is illegal, unreported or unregulated
- >10%: decrease per decade in the extent of seagrass meadows from 1970-2000
- +/-50%: live coral cover of reefs lost since 1870s
- 100-300 million: people in coastal areas at increased risk due to loss of coastal habitat protection
- 400: low oxygen (hypoxic) coastal ecosystem 'dead zones' caused by fertilizers, affecting >245,000 km2
- 29%: average reduction in the extinction risk for mammals and birds in 109 countries thanks to conservation investments from 1996 to 2008; the extinction risk of birds, mammals and amphibians would have been at least 20% greater without conservation action in recent decade
- >107: highly threatened birds, mammals and reptiles estimated to have benefitted from the eradication of invasive mammals on islands

Forests

- 45%: increase in raw timber production since 1970 (4 billion cubic meters in 2017)

- +/-13 million: forestry industry jobs
- 50%: agricultural expansion that occurred at the expense of forests
- 50%: decrease in net rate of forest loss since the 1990s (excluding those managed for timber or agricultural extraction)
- 68%: global forest area today compared with the estimated pre-industrial level
- 7%: reduction of intact forests (>500 sq. km with no human pressure) from 2000-2013 in developed and developing countries
- 290 million ha (+/-6%): native forest cover lost from 1990-2015 due to clearing and wood harvesting
- 110 million ha: rise in the area of planted forests from 1990-2015
- 10-15%: global timber supplies provided by illegal forestry (up to 50% in some areas)
- >2 billion: people who rely on wood fuel to meet their primary energy needs

Mining and Energy

- <1%: total land used for mining, but the industry has significant negative impacts on biodiversity, emissions, water quality and human health
- +/-17,000: large-scale mining sites (in 171 countries), mostly managed by 616 international corporations
- +/-6,500: offshore oil and gas ocean mining installations ((in 53 countries)
- US$345 billion: global subsidies for fossil fuels resulting in US$5 trillion in overall costs, including nature deterioration externalities; coal accounts for 52% of post-tax subsidies, petroleum for +/-33% and natural gas for +/-10%

Urbanization, Development and Socioeconomic Issues

- >100%: growth of urban areas since 1992
- 25 million km: length of new paved roads foreseen by 2050, with 90% of construction in least developed and developing countries
- +/-50,000: number of large dams (>15m height) ; +/-17 million reservoirs (>0.01 ha)
- 105%: increase in global human population (from 3.7 to 7.6 billion) since 1970 unevenly across countries and regions
- 50 times higher: per capita GDP in developed vs. least developed countries
- >2,500: conflicts over fossil fuels, water, food and land currently occurring worldwide
- >1,000: environmental activists and journalists killed between 2002 and 2013

Health

- 70%: proportion of cancer drugs that are natural or synthetic products inspired by nature
- +/-4 billion: people who rely primarily on natural medicines
- 17%: infectious diseases spread by animal vectors, causing >700,000 annual deaths
- +/-821 million: people face food insecurity in Asia and Africa

- 40%: of the global population lacks access to clean and safe drinking water
- >80%: global wastewater discharged untreated into the environment
- 300-400 million tons: heavy metals, solvents, toxic sludge, and other wastes from industrial facilities dumped annually into the world's waters
- 10 times: increase in plastic pollution since 1980

Climate Change

- 1 degree Celsius: average global temperature difference in 2017 compared to pre-industrial levels, rising +/-0.2 (+/-0.1) degrees Celsius per decade
- >3 mm: annual average global sea level rise over the past two decades
- 16-21 cm: rise in global average sea level since 1900
- 100% increase since 1980 in greenhouse gas emissions, raising average global temperature by at least 0.7 degree
- 40%: rise in carbon footprint of tourism (to 4.5Gt of carbon dioxide) from 2009 to 2013
- 8%: of total greenhouse gas emissions are from transport and food consumption related to tourism
- 5%: estimated fraction of species at risk of extinction from 2°C warming alone, rising to 16% at 4.3°C warming
- Even for global warming of 1.5 to 2 degrees, the majority of terrestrial species ranges are projected to shrink profoundly.

Sustainable Development Goals

- Most: Aichi Biodiversity Targets for 2020 likely to be missed
- 22 of 44: assessed targets under the Sustainable Development Goals related to poverty, hunger, health, water, cities, climate, ocean and land are being undermined by substantial negative trends in nature and its contributions to people
- 72%: of local indicators in nature developed and used by Indigenous Peoples and Local Communities that show negative trends
- 4: number of Aichi Targets where good progress has been made on certain components, with moderate progress on some components of another 7 targets, poor progress on all components of 6 targets, and insufficient information to assess progress on some or all components of the remaining 3 targets

IPBES Partner Comments

"Nature makes human development possible but our relentless demand for the earth's resources is accelerating extinction rates and devastating the world's ecosystems. UN Environment is proud to support the Global Assessment Report produced by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services because it highlights the critical need to integrate biodiversity considerations in global decision-making on any sector or challenge, whether its water or agriculture, infrastructure or

business."
– **Joyce Msuya**, Acting Head, UN Environment

"Across cultures, humans inherently value nature. The magic of seeing fireflies flickering long into the night is immense. We draw energy and nutrients from nature. We find sources of food, medicine, livelihoods and innovation in nature. Our well-being fundamentally depends on nature. Our efforts to conserve biodiversity and ecosystems must be underpinned by the best science that humanity can produce. This is why the scientific evidence compiled in this IPBES Global Assessment is so important. It will help us build a stronger foundation for shaping the post 2020 global biodiversity framework: the 'New Deal for Nature and People'; and for achieving the SDGs."
– **Achim Steiner**, Administrator, United Nations Development Programme

"This essential report reminds each of us of the obvious truth: the present generations have the responsibility to bequeath to future generations a planet that is not irreversibly damaged by human activity. Our local, indigenous and scientific knowledge are proving that we have solutions and so no more excuses: we must live on earth differently. UNESCO is committed to promoting respect of the living and of its diversity, ecological solidarity with other living species, and to establish new, equitable and global links of partnership and intragenerational solidarity, for the perpetuation of humankind."
– **Audrey Azoulay**, Director-General, UNESCO

"The IPBES' 2019 Global Assessment Report on Biodiversity and Ecosystem Services comes at a critical time for the planet and all its peoples. The report's findings – and the years of diligent work by the many scientists who contributed – will offer a comprehensive view of the current conditions of global biodiversity. Healthy biodiversity is the essential infrastructure that supports all forms of life on earth, including human life. It also provides nature-based solutions on many of the most critical environmental, economic, and social challenges that we face as human society, including climate change, sustainable development, health, and water and food security. We are currently in the midst of preparing for the 2020 UN Biodiversity Conference, in China, which will mark the close of the Aichi Biodiversity Targets and set the course for a post 2020 ecologically focused sustainable development pathway to deliver multiple benefits for people, the planet and our global economy. The IPBES report will serve as a fundamental baseline of where we are and where we need to go as a global community to inspire humanity to reach the 2050 Vision of the UN Biodiversity Convention "Living in harmony with nature". I want to extend my thanks and congratulations to the IPBES community for their hard work, immense contributions and continued partnership."
– **Cristiana Pasca Palmer**, Executive Secretary, Convention on Biological Diversity

"The Global Assessment of biodiversity and ecosystem services adds a major element to the body of evidence for the importance of biodiversity to efforts to achieve the Zero Hunger

objective and meet the Sustainable Development Goals. Together, assessments undertaken by IPBES, FAO, CBD and other organizations point to the urgent need for action to better conserve and sustainably use biodiversity and to the importance of cross-sectoral and multidisciplinary collaboration among decision-makers and other stakeholders at all levels."
– Jose Graziano da Silva, Director-General, Food and Agriculture Organization of the United Nations

Notes to editors

IPBES has now released the Summary for Policymakers (SPM) of the Global Assessment report. The SPM presents the key messages and policy options, as approved by the IPBES Plenary. To access the SPM, photos, 'B-roll' and other media resources go to: bit.ly/IPBESReport The full six-chapter Report (including all data) is expected exceed 1,500 pages and will be published later this year.

Additional videos:

- IPBES Assessment of Land Degradation and Restoration (2018): www.youtube.com/watch?v=KCt7aai17Nk
- IPBES Regional Assessments of Biodiversity and Ecosystem Services (2018): www.youtube.com/watch?v=kR0HeepbWCc
- IPBES Assessment of Pollinators, Pollination and Food Production (2016): www.youtube.com/watch?v=YwkYbeiwK5A
- IPBES Assessment of Scenarios and Models of Biodiversity (2016): www.youtube.com/watch?v=wZfcDmtGa9I

IPBES Partner Comments about the importance of the Report:

- Joyce Msuya, Acting Head, UN Environment
- Audrey Azoulay, Director-General, UNESCO
- José Graziano da Silva, Director-General, Food and Agriculture Organization of the United Nations
- Achim Steiner, Administrator, United Nations Development Programme
- Cristiana Pasca Palmer, Executive Secretary, Convention on Biological Diversity

About IPBES:

Often described as the "IPCC for biodiversity", IPBES is an independent intergovernmental body comprising more than 130 member Governments. Established by Governments in 2012, it provides policymakers with objective scientific assessments about the state of knowledge regarding the planet's biodiversity, ecosystems and the contributions they make to people, as well as the tools and methods to protect and sustainably use these vital natural assets. For more information about IPBES and its assessments visit www.ipbes.net

Follow IPBES on Social Media:

A M Y   L A R K I N

TESTIMONY TO THE NEW YORK CITY COUNCIL
RESOLUTION 864, CLIMATE EMERGENCY DECLARATION
JUNE 24, 2019

My name is Amy Larkin and I have been fighting for climate action for decades. I led the global transformation of refrigeration technology to eliminate HFCs - which will result in a 1.5% decrease in global greenhouse gas emissions, I wrote *Environmental Debt: The Hidden Costs of a Changing Global Economy,* and I was recently Vice Chair of the World Economic Forum's Global Agenda Council on Climate Change. I am currently convening a skunkworks of multinational companies and cities to design and develop re-use standards and protocols for waste infrastructure in order to eliminate large amounts of plastic from consumer goods packaging.

Our 20th century systems, technologies and culture have nearly broken the back of nature. Without a healthy natural world, we suffer and perish. As with everything else, the poor suffer most. Our economic life has been decoupled from nature, and we seem to not notice that we are paying for this folly both financially and environmentally. The first rule of business, the prime directive of government, should be "No Nature, No Business".

I therefore urge you to Pass Resolution #864 and declare a climate emergency in NYC.
Whether you declare it or not, there IS a climate emergency.

Wouldn't it serve all of us to have the wherewithal to address what's coming?....what's already here. Because this emergency will be costly and painful. The state of our climate will only give us difficult choices. As our political leaders, it is your duty to lead the public discourse so we are READY to make these difficult choices, and actually have vetted plans developed and on hand.

Superstorm Sandy cost NYC a minimum of $20 billion and we went ahead and rebuilt most areas almost exactly as they were beforehand. What happens when the National Flood Insurance Program goes bankrupt? Oh, it already is and Congress is unsure how to bail it out.
(continued on reverse)

444 Manhattan Ave., #7J
New York, NY 10026
(646) 522-0291
alarkin@naturemeansbusiness.com
www.environmentaldebt.net

Amy Larkin
City Council Testimony
Page Two

I was raised in Rockaway and was dismayed that my beloved beach community was rebuilt with only tiny improvements. I'd call this stupid money. Where was the smart money to build bicycle and carpool-only highways, distributed energy systems, raised buildings and roads, community gardens, seaway openings, and compost infrastructure? Where were the plans? We still don't have them, yet we are certain that NYC will flood again and another moment for transformative change will be upon us....and wasted.

I urge you to view the City budget differently. Budget items that save greenhouse gas emissions will save money in the future. NYC already does some of this. The tax benefits and financing packages for retrofitting buildings is smart money spent. Congestion pricing on cars is smart money made. Those are the obvious choices though. There are dozens of difficult choices ahead that may have to be taken, from seizing more space from vehicles for transit, pedestrians and bicycles, or taxing takeout containers and toxic and overly packaged foods and goods. And just as taxi drivers are suffering now, parking garage owners and workers will lose big. As I said, no easy choices here!

All of your budgets, capital and infrastructure expenditures, contracts, and transportation planning, must integrate the climate emergency as a first principle and begin to imagine systemic solutions instead of popular and quick fixes. A NYC Chief Science Officer could help convene and cohere the complex and competing narratives as you craft legislation. Please always remember, nature is the boss. We are not stronger than the storms.

Climate change represents an unprecedented danger and we have enough money and enough brains to address it. The only question is do we have the strength of will and the goodwill to protect our children?

Declaring a Climate Emergency for NYC is a first step.

Statement of Benjamin Arana

Business Representative of Local Union #3 I.B.E.W

Hearing of the Committee on Environmental Protection

Regarding Intro 0049-2018: Local Law to amend the administrative code in relation to installation of Utility scale battery storage.

Intro 0269-2018: Local Law to amend the administrative code in relation to a Solar PV pilot program.

Intro 426-2018: Local Law to amend the administrative code in relation to the installation of solar water heating and thermal energy systems on city owned buildings.

Res 0864-2019: Resolution declaring a climate emergency and calling for an immediate emergency mobilization to restore a safe climate.

June 24, 2019

Good afternoon Chair Constantinides and distinguished committee members thank you for the opportunity to testify at today's hearing. My name is Benjamin Arana, I am a Business Representative for Local Union #3 International Brotherhood of Electrical Workers (I.B.E.W) and I am responsible for the Solar PV Program in our industry. I want to start by stating that Local Union #3 is in support of T2019-4470. Local Union #3 and its affiliated electrical contractors are proud of its long history of constructing and maintaining the electrical grid infrastructure that powers New York City's vibrant economy. Our skilled trade's men and women continue to be ready and able to meet the new challenges brought about by technological advances through continued training in the latest renewable energy installation methods at our state of the art training facility. Our trained electricians worked on the installation of the geothermal system at Saint Patrick's Cathedral, as well as the first Net Zero School built on Staten Island. Additionally, they have installed numerous photo Voltaic systems throughout the five boroughs.

Our advanced green-jobs programs in solar, wind turbine and other renewable technologies enable us to continue providing the expert and professional services that our valued customers have grown accustomed to receiving. While we support the objectives outlined today we urge you to include principles that will create good local jobs. It ought to set wage standards that enable new entrants into the industry an opportunity to earn a good living wage, as well as receive safety and training through a qualified pre-apprenticeship and New York State certified apprenticeship programs. I respectfully ask that the NYC Agency Project Labor Agreements be used for future solar installations and all future retrofit work associated with reducing the carbon emissions. P.L.A's already have language for local hire and minority participation in place.

In regards to Intro. 0049-2018, Intro. 0269-2018 and Intro. 0426-2018 we need to move them forward so we can get this work on the way. The clock is ticking and we have an ambitious deadline to meet by 2030. As stated above, as these work opportunities become available to our contractors we can increase our membership from the communities that these projects are in through the programs that are already in place, such as, Construction skills, P2A (pathways into apprenticeships), NYCHA, Non Traditional Employment for Women (NEW), and Helmets to Hardhats.

Local Union #3 supports Res. 0864-2019. Our Business Manager Christopher Erikson addressed the membership of local Union # 3 and expressed the importance of supporting the climate march in 2014. Mr. Erikson was a keynote speaker at the 2014 Climate March where he stated, "We need to leave the planet better than we found it for our children and grandchildren". Climate change is not a hoax but a real and present danger that needs to be addressed with the urgency and action that it merits.

In closing, with the support of the NYC Council and key environmental stakeholders, Local Union #3 will continue to play a pivotal role in advancing a climate change agenda toward a cleaner and more environmentally sustainable planet. Thank you for your time and consideration regarding these important issues.

SPM

Summary for Policymakers

Drafting Authors:
Lisa V. Alexander (Australia), Simon K. Allen (Switzerland/New Zealand), Nathaniel L. Bindoff (Australia), François-Marie Bréon (France), John A. Church (Australia), Ulrich Cubasch (Germany), Seita Emori (Japan), Piers Forster (UK), Pierre Friedlingstein (UK/Belgium), Nathan Gillett (Canada), Jonathan M. Gregory (UK), Dennis L. Hartmann (USA), Eystein Jansen (Norway), Ben Kirtman (USA), Reto Knutti (Switzerland), Krishna Kumar Kanikicharla (India), Peter Lemke (Germany), Jochem Marotzke (Germany), Valérie Masson-Delmotte (France), Gerald A. Meehl (USA), Igor I. Mokhov (Russian Federation), Shilong Piao (China), Gian-Kasper Plattner (Switzerland), Qin Dahe (China), Venkatachalam Ramaswamy (USA), David Randall (USA), Monika Rhein (Germany), Maisa Rojas (Chile), Christopher Sabine (USA), Drew Shindell (USA), Thomas F. Stocker (Switzerland), Lynne D. Talley (USA), David G. Vaughan (UK), Shang-Ping Xie (USA)

Draft Contributing Authors:
Myles R. Allen (UK), Olivier Boucher (France), Don Chambers (USA), Jens Hesselbjerg Christensen (Denmark), Philippe Ciais (France), Peter U. Clark (USA), Matthew Collins (UK), Josefino C. Comiso (USA), Viviane Vasconcellos de Menezes (Australia/Brazil), Richard A. Feely (USA), Thierry Fichefet (Belgium), Arlene M. Fiore (USA), Gregory Flato (Canada), Jan Fuglestvedt (Norway), Gabriele Hegerl (UK/Germany), Paul J. Hezel (Belgium/USA), Gregory C. Johnson (USA), Georg Kaser (Austria/Italy), Vladimir Kattsov (Russian Federation), John Kennedy (UK), Albert M. G. Klein Tank (Netherlands), Corinne Le Quéré (UK), Gunnar Myhre (Norway), Timothy Osborn (UK), Antony J. Payne (UK), Judith Perlwitz (USA), Scott Power (Australia), Michael Prather (USA), Stephen R. Rintoul (Australia), Joeri Rogelj (Switzerland/Belgium), Matilde Rusticucci (Argentina), Michael Schulz (Germany), Jan Sedláček (Switzerland), Peter A. Stott (UK), Rowan Sutton (UK), Peter W. Thorne (USA/Norway/UK), Donald Wuebbles (USA)

This Summary for Policymakers should be cited as:
IPCC, 2013: Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

SPM

A. Introduction

The Working Group I contribution to the IPCC's Fifth Assessment Report (AR5) considers new evidence of climate change based on many independent scientific analyses from observations of the climate system, paleoclimate archives, theoretical studies of climate processes and simulations using climate models. It builds upon the Working Group I contribution to the IPCC's Fourth Assessment Report (AR4), and incorporates subsequent new findings of research. As a component of the fifth assessment cycle, the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) is an important basis for information on changing weather and climate extremes.

This Summary for Policymakers (SPM) follows the structure of the Working Group I report. The narrative is supported by a series of overarching highlighted conclusions which, taken together, provide a concise summary. Main sections are introduced with a brief paragraph in italics which outlines the methodological basis of the assessment.

The degree of certainty in key findings in this assessment is based on the author teams' evaluations of underlying scientific understanding and is expressed as a qualitative level of confidence (from *very low* to *very high*) and, when possible, probabilistically with a quantified likelihood (from *exceptionally unlikely* to *virtually certain*). Confidence in the validity of a finding is based on the type, amount, quality, and consistency of evidence (e.g., data, mechanistic understanding, theory, models, expert judgment) and the degree of agreement[1]. Probabilistic estimates of quantified measures of uncertainty in a finding are based on statistical analysis of observations or model results, or both, and expert judgment[2]. Where appropriate, findings are also formulated as statements of fact without using uncertainty qualifiers. (See Chapter 1 and Box TS.1 for more details about the specific language the IPCC uses to communicate uncertainty).

The basis for substantive paragraphs in this Summary for Policymakers can be found in the chapter sections of the underlying report and in the Technical Summary. These references are given in curly brackets.

B. Observed Changes in the Climate System

Observations of the climate system are based on direct measurements and remote sensing from satellites and other platforms. Global-scale observations from the instrumental era began in the mid-19th century for temperature and other variables, with more comprehensive and diverse sets of observations available for the period 1950 onwards. Paleoclimate reconstructions extend some records back hundreds to millions of years. Together, they provide a comprehensive view of the variability and long-term changes in the atmosphere, the ocean, the cryosphere, and the land surface.

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased (see Figures SPM.1, SPM.2, SPM.3 and SPM.4). {2.2, 2.4, 3.2, 3.7, 4.2–4.7, 5.2, 5.3, 5.5–5.6, 6.2, 13.2}

[1] In this Summary for Policymakers, the following summary terms are used to describe the available evidence: limited, medium, or robust; and for the degree of agreement: low, medium, or high. A level of confidence is expressed using five qualifiers: very low, low, medium, high, and very high, and typeset in italics, e.g., *medium confidence*. For a given evidence and agreement statement, different confidence levels can be assigned, but increasing levels of evidence and degrees of agreement are correlated with increasing confidence (see Chapter 1 and Box TS.1 for more details).

[2] In this Summary for Policymakers, the following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely: 95–100%, more likely than not >50–100%, and extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, e.g., *very likely* (see Chapter 1 and Box TS.1 for more details).

B.1 Atmosphere

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 (see Figure SPM.1). In the Northern Hemisphere, 1983–2012 was *likely* the warmest 30-year period of the last 1400 years (*medium confidence*). {2.4, 5.3}

- The globally averaged combined land and ocean surface temperature data as calculated by a linear trend, show a warming of 0.85 [0.65 to 1.06] °C[3], over the period 1880 to 2012, when multiple independently produced datasets exist. The total increase between the average of the 1850–1900 period and the 2003–2012 period is 0.78 [0.72 to 0.85] °C, based on the single longest dataset available[4] (see Figure SPM.1). {2.4}

- For the longest period when calculation of regional trends is sufficiently complete (1901 to 2012), almost the entire globe has experienced surface warming (see Figure SPM.1). {2.4}

- In addition to robust multi-decadal warming, global mean surface temperature exhibits substantial decadal and interannual variability (see Figure SPM.1). Due to natural variability, trends based on short records are very sensitive to the beginning and end dates and do not in general reflect long-term climate trends. As one example, the rate of warming over the past 15 years (1998–2012; 0.05 [–0.05 to 0.15] °C per decade), which begins with a strong El Niño, is smaller than the rate calculated since 1951 (1951–2012; 0.12 [0.08 to 0.14] °C per decade)[5]. {2.4}

- Continental-scale surface temperature reconstructions show, with *high confidence*, multi-decadal periods during the Medieval Climate Anomaly (year 950 to 1250) that were in some regions as warm as in the late 20th century. These regional warm periods did not occur as coherently across regions as the warming in the late 20th century (*high confidence*). {5.5}

- It is *virtually certain* that globally the troposphere has warmed since the mid-20th century. More complete observations allow greater confidence in estimates of tropospheric temperature changes in the extratropical Northern Hemisphere than elsewhere. There is *medium confidence* in the rate of warming and its vertical structure in the Northern Hemisphere extra-tropical troposphere and *low confidence* elsewhere. {2.4}

- *Confidence* in precipitation change averaged over global land areas since 1901 is *low* prior to 1951 and *medium* afterwards. Averaged over the mid-latitude land areas of the Northern Hemisphere, precipitation has increased since 1901 (*medium confidence* before and *high confidence* after 1951). For other latitudes area-averaged long-term positive or negative trends have *low confidence* (see Figure SPM.2). {TS TFE.1, Figure 2; 2.5}

- Changes in many extreme weather and climate events have been observed since about 1950 (see Table SPM.1 for details). It is *very likely* that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale[6]. It is *likely* that the frequency of heat waves has increased in large parts of Europe, Asia and Australia. There are *likely* more land regions where the number of heavy precipitation events has increased than where it has decreased. The frequency or intensity of heavy precipitation events has *likely* increased in North America and Europe. In other continents, *confidence* in changes in heavy precipitation events is at most *medium*. {2.6}

---

[3] In the WGI contribution to the AR5, uncertainty is quantified using 90% uncertainty intervals unless otherwise stated. The 90% uncertainty interval, reported in square brackets, is expected to have a 90% likelihood of covering the value that is being estimated. Uncertainty intervals are not necessarily symmetric about the corresponding best estimate. A best estimate of that value is also given where available.

[4] Both methods presented in this bullet were also used in AR4. The first calculates the difference using a best fit linear trend of all points between 1880 and 2012. The second calculates the difference between averages for the two periods 1850–1900 and 2003–2012. Therefore, the resulting values and their 90% uncertainty intervals are not directly comparable. {2.4}

[5] Trends for 15-year periods starting in 1995, 1996, and 1997 are 0.13 [0.02 to 0.24] °C per decade, 0.14 [0.03 to 0.24] °C per decade, and, 0.07 [–0.02 to 0.18] °C per decade, respectively.

[6] See the Glossary for the definition of these terms: cold days/cold nights, warm days/warm nights, heat waves.

SPM

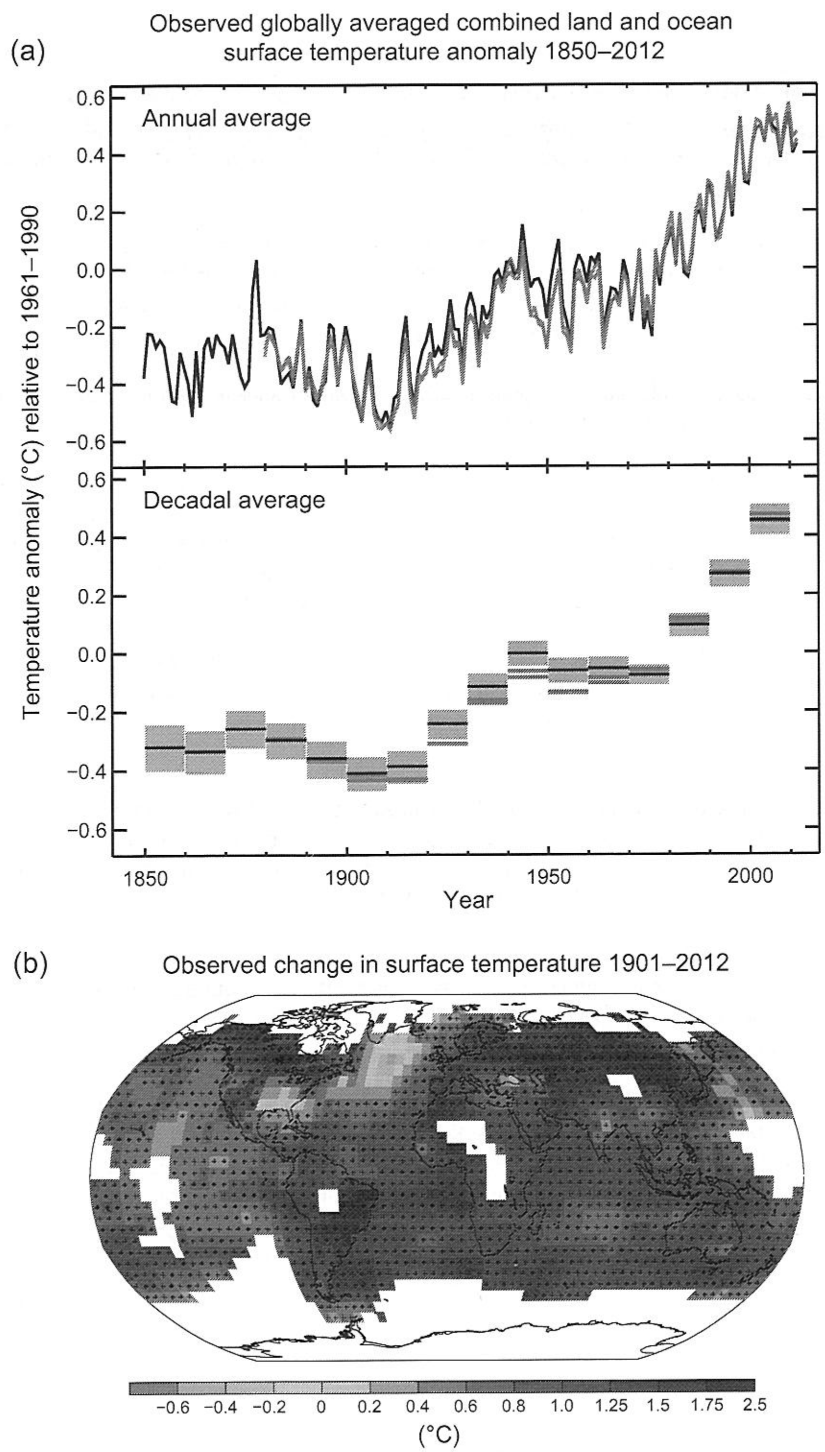


Figure SPM.1 | (a) Observed global mean combined land and ocean surface temperature anomalies, from 1850 to 2012 from three data sets. Top panel: annual mean values. Bottom panel: decadal mean values including the estimate of uncertainty for one dataset (black). Anomalies are relative to the mean of 1961–1990. (b) Map of the observed surface temperature change from 1901 to 2012 derived from temperature trends determined by linear regression from one dataset (orange line in panel a). Trends have been calculated where data availability permits a robust estimate (i.e., only for grid boxes with greater than 70% complete records and more than 20% data availability in the first and last 10% of the time period). Other areas are white. Grid boxes where the trend is significant at the 10% level are indicated by a + sign. For a listing of the datasets and further technical details see the Technical Summary Supplementary Material. {Figures 2.19–2.21; Figure TS.2}

Table SPM.1 | Extreme weather and climate events: Global-scale assessment of recent observed changes, human contribution to the changes, and projected further changes for the early (2016–2035) and late (2081–2100) 21st century. Bold indicates where the AR5 (black) provides a revised* global-scale assessment from the SREX (blue) or AR4 (red). Projections for early 21st century were not provided in previous assessment reports. Projections in the AR5 are relative to the reference period of 1986–2005, and use the new Representative Concentration Pathway (RCP) scenarios (see Box SPM.1) unless otherwise specified. See the Glossary for definitions of extreme weather and climate events.

Phenomenon and direction of trend	Assessment that changes occurred (typically since 1950 unless otherwise indicated)	Assessment of a human contribution to observed changes	Likelihood of further changes	
			Early 21st century	Late 21st century
Warmer and/or fewer cold days and nights over most land areas	*Very likely* {2.6} *Very likely* *Very likely*	***Very likely*** {10.6} *Likely* *Likely*	*Likely* {11.3}	*Virtually certain* {12.4} *Virtually certain* *Virtually certain*
Warmer and/or more frequent hot days and nights over most land areas	*Very likely* {2.6} *Very likely* *Very likely*	***Very likely*** {10.6} *Likely* *Likely* (nights only)	*Likely* {11.3}	*Virtually certain* {12.4} *Virtually certain* *Virtually certain*
Warm spells/heat waves. Frequency and/or duration increases over most land areas	***Medium confidence*** **on a global scale** *Likely* in large parts of Europe, Asia and Australia {2.6} *Medium confidence* in many (but not all) regions *Likely*	***Likely***[a] {10.6} Not formally assessed *More likely than not*	Not formally assessed[b] {11.3}	*Very likely* {12.4} *Very likely* *Very likely*
Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation	*Likely* more land areas with increases than decreases[c] {2.6} *Likely* more land areas with increases than decreases *Likely* over most land areas	***Medium confidence*** {7.6, 10.6} *Medium confidence* *More likely than not*	*Likely* over many land areas {11.3}	***Very likely*** **over most of the mid-latitude land masses and over wet tropical regions** {12.4} *Likely* over many areas *Very likely* over most land areas
Increases in intensity and/or duration of drought	***Low confidence*** **on a global scale** *Likely* changes in some regions[d] {2.6} *Medium confidence* in some regions *Likely* in many regions, since 1970[e]	***Low confidence*** {10.6} *Medium confidence*[f] *More likely than not*	*Low confidence*[g] {11.3}	***Likely (medium confidence)*** **on a regional to global scale**[h] {12.4} *Medium confidence* in some regions *Likely*[e]
Increases in intense tropical cyclone activity	***Low confidence*** **in long term (centennial) changes** *Virtually certain* in North Atlantic since 1970 {2.6} *Low confidence* *Likely* in some regions, since 1970	***Low confidence***[i] {10.6} *Low confidence* *More likely than not*	*Low confidence* {11.3}	***More likely than not*** in the Western North Pacific and North Atlantic[j] {14.6} *More likely than not* in some basins *Likely*
Increased incidence and/or magnitude of extreme high sea level	*Likely* (since 1970) {3.7} *Likely* (late 20th century) *Likely*	***Likely***[k] {3.7} *Likely*[k] *More likely than not*[k]	*Likely*[l] {13.7}	***Very likely***[l] {13.7} *Very likely*[m] *Likely*

* The direct comparison of assessment findings between reports is difficult. For some climate variables, different aspects have been assessed, and the revised guidance note on uncertainties has been used for the SREX and AR5. The availability of new information, improved scientific understanding, continued analyses of data and models, and specific differences in methodologies applied in the assessed studies, all contribute to revised assessment findings.

Notes:

[a] Attribution is based on available case studies. It is *likely* that human influence has more than doubled the probability of occurrence of some observed heat waves in some locations.

[b] Models project near-term increases in the duration, intensity and spatial extent of heat waves and warm spells.

[c] In most continents, *confidence* in trends is not higher than *medium* except in North America and Europe where there have been *likely* increases in either the frequency or intensity of heavy precipitation with some seasonal and/or regional variation. It is *very likely* that there have been increases in central North America.

[d] The frequency and intensity of drought has *likely* increased in the Mediterranean and West Africa, and *likely* decreased in central North America and north-west Australia.

[e] AR4 assessed the area affected by drought.

[f] SREX assessed *medium confidence* that anthropogenic influence had contributed to some changes in the drought patterns observed in the second half of the 20th century, based on its attributed impact on precipitation and temperature changes. SREX assessed *low confidence* in the attribution of changes in droughts at the level of single regions.

[g] There is *low confidence* in projected changes in soil moisture.

[h] Regional to global-scale projected decreases in soil moisture and increased agricultural drought are *likely (medium confidence)* in presently dry regions by the end of this century under the RCP8.5 scenario. Soil moisture drying in the Mediterranean, Southwest US and southern African regions is consistent with projected changes in Hadley circulation and increased surface temperatures, so there is *high confidence* in *likely* surface drying in these regions by the end of this century under the RCP8.5 scenario.

[i] There is *medium confidence* that a reduction in aerosol forcing over the North Atlantic has contributed at least in part to the observed increase in tropical cyclone activity since the 1970s in this region.

[j] Based on expert judgment and assessment of projections which use an SRES A1B (or similar) scenario.

[k] Attribution is based on the close relationship between observed changes in extreme and mean sea level.

[l] There is *high confidence* that this increase in extreme high sea level will primarily be the result of an increase in mean sea level. There is *low confidence* in region-specific projections of storminess and associated storm surges.

[m] SREX assessed it to be *very likely* that mean sea level rise will contribute to future upward trends in extreme coastal high water levels.

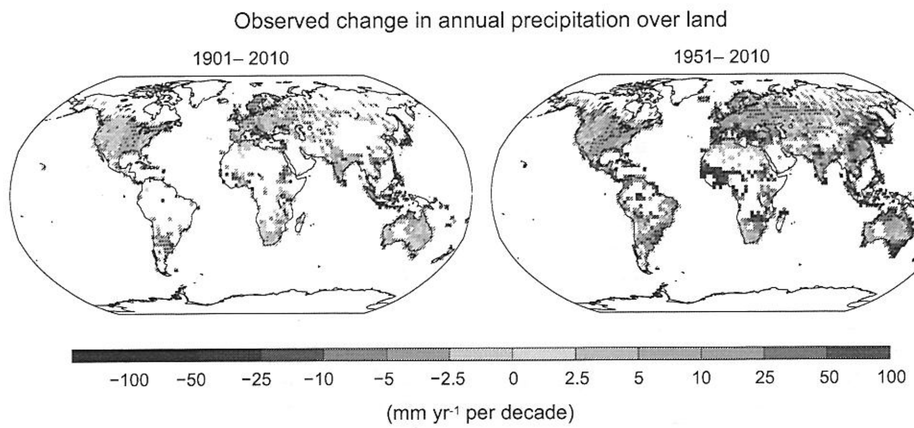


Figure SPM.2 | Maps of observed precipitation change from 1901 to 2010 and from 1951 to 2010 (trends in annual accumulation calculated using the same criteria as in Figure SPM.1) from one data set. For further technical details see the Technical Summary Supplementary Material. {TS TFE.1, Figure 2; Figure 2.29}

B.2 Ocean

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*). It is *virtually certain* that the upper ocean (0–700 m) warmed from 1971 to 2010 (see Figure SPM.3), and it *likely* warmed between the 1870s and 1971. {3.2, Box 3.1}

- On a global scale, the ocean warming is largest near the surface, and the upper 75 m warmed by 0.11 [0.09 to 0.13] °C per decade over the period 1971 to 2010. Since AR4, instrumental biases in upper-ocean temperature records have been identified and reduced, enhancing confidence in the assessment of change. {3.2}

- It is *likely* that the ocean warmed between 700 and 2000 m from 1957 to 2009. Sufficient observations are available for the period 1992 to 2005 for a global assessment of temperature change below 2000 m. There were *likely* no significant observed temperature trends between 2000 and 3000 m for this period. It is *likely* that the ocean warmed from 3000 m to the bottom for this period, with the largest warming observed in the Southern Ocean. {3.2}

- More than 60% of the net energy increase in the climate system is stored in the upper ocean (0–700 m) during the relatively well-sampled 40-year period from 1971 to 2010, and about 30% is stored in the ocean below 700 m. The increase in upper ocean heat content during this time period estimated from a linear trend is *likely* 17 [15 to 19] × 10^{22} J [7] (see Figure SPM.3). {3.2, Box 3.1}

- It is *about as likely as not* that ocean heat content from 0–700 m increased more slowly during 2003 to 2010 than during 1993 to 2002 (see Figure SPM.3). Ocean heat uptake from 700–2000 m, where interannual variability is smaller, *likely* continued unabated from 1993 to 2009. {3.2, Box 9.2}

- It is *very likely* that regions of high salinity where evaporation dominates have become more saline, while regions of low salinity where precipitation dominates have become fresher since the 1950s. These regional trends in ocean salinity provide indirect evidence that evaporation and precipitation over the oceans have changed (*medium confidence*). {2.5, 3.3, 3.5}

- There is no observational evidence of a trend in the Atlantic Meridional Overturning Circulation (AMOC), based on the decade-long record of the complete AMOC and longer records of individual AMOC components. {3.6}

---

[7] A constant supply of heat through the ocean surface at the rate of 1 W m^{-2} for 1 year would increase the ocean heat content by 1.1 × 10^{22} J.

B.3 Cryosphere

Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent (*high confidence*) (see Figure SPM.3). {4.2–4.7}

- The average rate of ice loss[8] from glaciers around the world, excluding glaciers on the periphery of the ice sheets[9], was *very likely* 226 [91 to 361] Gt yr^{-1} over the period 1971 to 2009, and *very likely* 275 [140 to 410] Gt yr^{-1} over the period 1993 to 2009[10]. {4.3}

- The average rate of ice loss from the Greenland ice sheet has *very likely* substantially increased from 34 [–6 to 74] Gt yr^{-1} over the period 1992 to 2001 to 215 [157 to 274] Gt yr^{-1} over the period 2002 to 2011. {4.4}

- The average rate of ice loss from the Antarctic ice sheet has *likely* increased from 30 [–37 to 97] Gt yr^{-1} over the period 1992–2001 to 147 [72 to 221] Gt yr^{-1} over the period 2002 to 2011. There is *very high confidence* that these losses are mainly from the northern Antarctic Peninsula and the Amundsen Sea sector of West Antarctica. {4.4}

- The annual mean Arctic sea ice extent decreased over the period 1979 to 2012 with a rate that was *very likely* in the range 3.5 to 4.1% per decade (range of 0.45 to 0.51 million km^2 per decade), and *very likely* in the range 9.4 to 13.6% per decade (range of 0.73 to 1.07 million km^2 per decade) for the summer sea ice minimum (perennial sea ice). The average decrease in decadal mean extent of Arctic sea ice has been most rapid in summer (*high confidence*); the spatial extent has decreased in every season, and in every successive decade since 1979 (*high confidence*) (see Figure SPM.3). There is *medium confidence* from reconstructions that over the past three decades, Arctic summer sea ice retreat was unprecedented and sea surface temperatures were anomalously high in at least the last 1,450 years. {4.2, 5.5}

- It is *very likely* that the annual mean Antarctic sea ice extent increased at a rate in the range of 1.2 to 1.8% per decade (range of 0.13 to 0.20 million km^2 per decade) between 1979 and 2012. There is *high confidence* that there are strong regional differences in this annual rate, with extent increasing in some regions and decreasing in others. {4.2}

- There is *very high confidence* that the extent of Northern Hemisphere snow cover has decreased since the mid-20th century (see Figure SPM.3). Northern Hemisphere snow cover extent decreased 1.6 [0.8 to 2.4] % per decade for March and April, and 11.7 [8.8 to 14.6] % per decade for June, over the 1967 to 2012 period. During this period, snow cover extent in the Northern Hemisphere did not show a statistically significant increase in any month. {4.5}

- There is *high confidence* that permafrost temperatures have increased in most regions since the early 1980s. Observed warming was up to 3°C in parts of Northern Alaska (early 1980s to mid-2000s) and up to 2°C in parts of the Russian European North (1971 to 2010). In the latter region, a considerable reduction in permafrost thickness and areal extent has been observed over the period 1975 to 2005 (*medium confidence*). {4.7}

- Multiple lines of evidence support very substantial Arctic warming since the mid-20th century. {Box 5.1, 10.3}

---

8 All references to 'ice loss' or 'mass loss' refer to net ice loss, i.e., accumulation minus melt and iceberg calving.

9 For methodological reasons, this assessment of ice loss from the Antarctic and Greenland ice sheets includes change in the glaciers on the periphery. These peripheral glaciers are thus excluded from the values given for glaciers.

10 100 Gt yr^{-1} of ice loss is equivalent to about 0.28 mm yr^{-1} of global mean sea level rise.

SPM

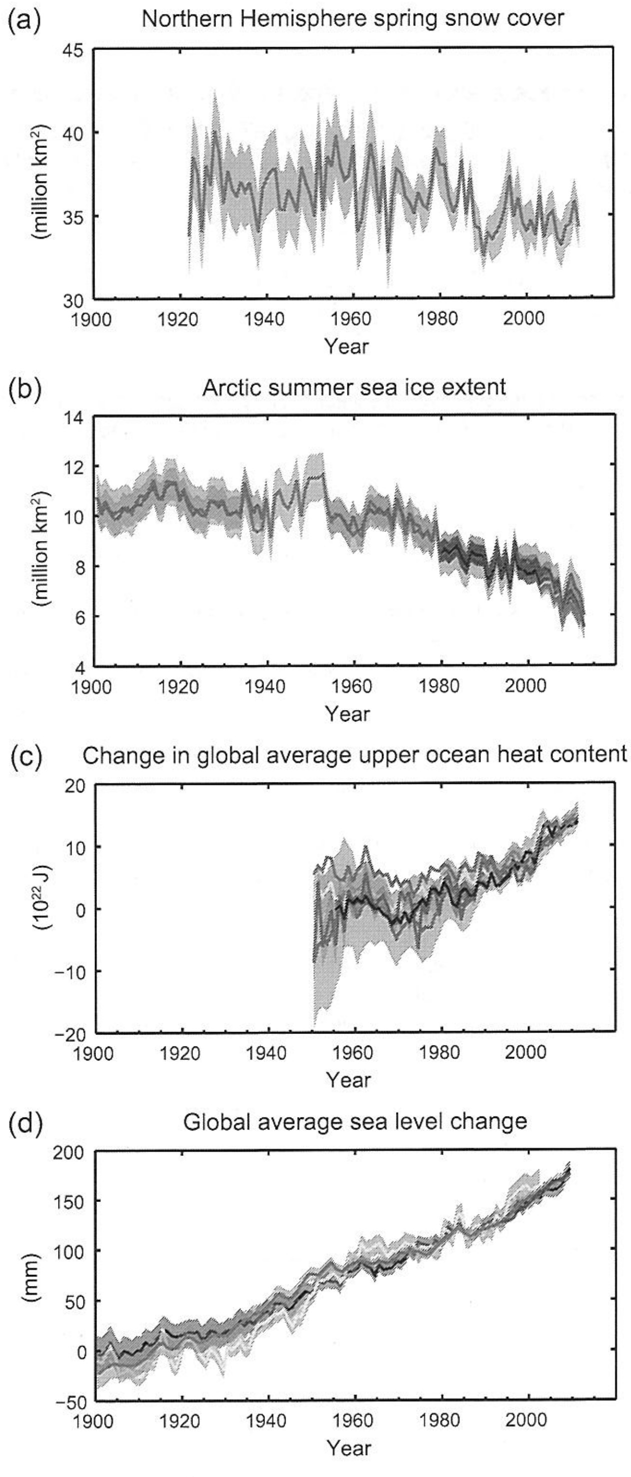


Figure SPM.3 | Multiple observed indicators of a changing global climate: (a) Extent of Northern Hemisphere March-April (spring) average snow cover; (b) extent of Arctic July-August-September (summer) average sea ice; (c) change in global mean upper ocean (0–700 m) heat content aligned to 2006–2010, and relative to the mean of all datasets for 1970; (d) global mean sea level relative to the 1900–1905 mean of the longest running dataset, and with all datasets aligned to have the same value in 1993, the first year of satellite altimetry data. All time-series (coloured lines indicating different data sets) show annual values, and where assessed, uncertainties are indicated by coloured shading. See Technical Summary Supplementary Material for a listing of the datasets. {Figures 3.2, 3.13, 4.19, and 4.3; FAQ 2.1, Figure 2; Figure TS.1}

SPM

B.4 Sea Level

The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (*high confidence*). Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m (see Figure SPM.3). {3.7, 5.6, 13.2}

- Proxy and instrumental sea level data indicate a transition in the late 19th to the early 20th century from relatively low mean rates of rise over the previous two millennia to higher rates of rise (*high confidence*). It is *likely* that the rate of global mean sea level rise has continued to increase since the early 20th century. {3.7, 5.6, 13.2}

- It is *very likely* that the mean rate of global averaged sea level rise was 1.7 [1.5 to 1.9] mm yr^{-1} between 1901 and 2010, 2.0 [1.7 to 2.3] mm yr^{-1} between 1971 and 2010, and 3.2 [2.8 to 3.6] mm yr^{-1} between 1993 and 2010. Tide-gauge and satellite altimeter data are consistent regarding the higher rate of the latter period. It is *likely* that similarly high rates occurred between 1920 and 1950. {3.7}

- Since the early 1970s, glacier mass loss and ocean thermal expansion from warming together explain about 75% of the observed global mean sea level rise (*high confidence*). Over the period 1993 to 2010, global mean sea level rise is, with *high confidence*, consistent with the sum of the observed contributions from ocean thermal expansion due to warming (1.1 [0.8 to 1.4] mm yr^{-1}), from changes in glaciers (0.76 [0.39 to 1.13] mm yr^{-1}), Greenland ice sheet (0.33 [0.25 to 0.41] mm yr^{-1}), Antarctic ice sheet (0.27 [0.16 to 0.38] mm yr^{-1}), and land water storage (0.38 [0.26 to 0.49] mm yr^{-1}). The sum of these contributions is 2.8 [2.3 to 3.4] mm yr^{-1}. {13.3}

- There is *very high confidence* that maximum global mean sea level during the last interglacial period (129,000 to 116,000 years ago) was, for several thousand years, at least 5 m higher than present, and *high confidence* that it did not exceed 10 m above present. During the last interglacial period, the Greenland ice sheet *very likely* contributed between 1.4 and 4.3 m to the higher global mean sea level, implying with *medium confidence* an additional contribution from the Antarctic ice sheet. This change in sea level occurred in the context of different orbital forcing and with high-latitude surface temperature, averaged over several thousand years, at least 2°C warmer than present (*high confidence*). {5.3, 5.6}

B.5 Carbon and Other Biogeochemical Cycles

The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions. The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification (see Figure SPM.4). {2.2, 3.8, 5.2, 6.2, 6.3}

- The atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have all increased since 1750 due to human activity. In 2011 the concentrations of these greenhouse gases were 391 ppm[11], 1803 ppb, and 324 ppb, and exceeded the pre-industrial levels by about 40%, 150%, and 20%, respectively. {2.2, 5.2, 6.1, 6.2}

- Concentrations of CO_2, CH_4, and N_2O now substantially exceed the highest concentrations recorded in ice cores during the past 800,000 years. The mean rates of increase in atmospheric concentrations over the past century are, with *very high confidence*, unprecedented in the last 22,000 years. {5.2, 6.1, 6.2}

[11] ppm (parts per million) or ppb (parts per billion, 1 billion = 1,000 million) is the ratio of the number of gas molecules to the total number of molecules of dry air. For example, 300 ppm means 300 molecules of a gas per million molecules of dry air.

SPM

- Annual CO_2 emissions from fossil fuel combustion and cement production were 8.3 [7.6 to 9.0] GtC[12] yr^{-1} averaged over 2002–2011 (*high confidence*) and were 9.5 [8.7 to 10.3] GtC yr^{-1} in 2011, 54% above the 1990 level. Annual net CO_2 emissions from anthropogenic land use change were 0.9 [0.1 to 1.7] GtC yr^{-1} on average during 2002 to 2011 (*medium confidence*). {6.3}

- From 1750 to 2011, CO_2 emissions from fossil fuel combustion and cement production have released 375 [345 to 405] GtC to the atmosphere, while deforestation and other land use change are estimated to have released 180 [100 to 260] GtC. This results in cumulative anthropogenic emissions of 555 [470 to 640] GtC. {6.3}

- Of these cumulative anthropogenic CO_2 emissions, 240 [230 to 250] GtC have accumulated in the atmosphere, 155 [125 to 185] GtC have been taken up by the ocean and 160 [70 to 250] GtC have accumulated in natural terrestrial ecosystems (i.e., the cumulative residual land sink). {Figure TS.4, 3.8, 6.3}

- Ocean acidification is quantified by decreases in pH[13]. The pH of ocean surface water has decreased by 0.1 since the beginning of the industrial era (*high confidence*), corresponding to a 26% increase in hydrogen ion concentration (see Figure SPM.4). {3.8, Box 3.2}

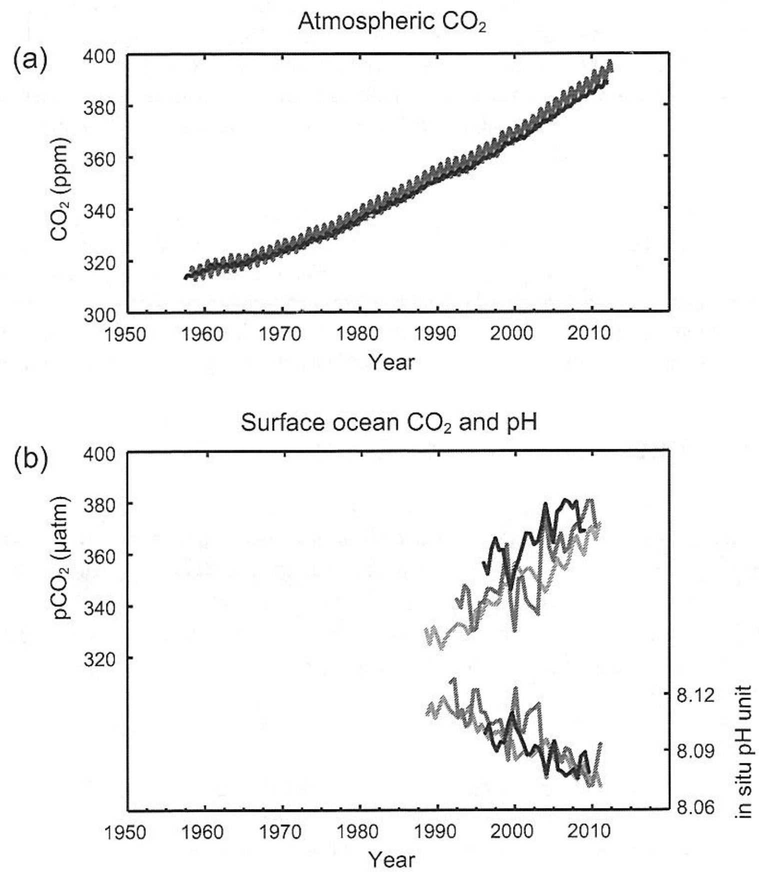


Figure SPM.4 | Multiple observed indicators of a changing global carbon cycle: (a) atmospheric concentrations of carbon dioxide (CO_2) from Mauna Loa (19°32'N, 155°34'W – red) and South Pole (89°59'S, 24°48'W – black) since 1958; (b) partial pressure of dissolved CO_2 at the ocean surface (blue curves) and in situ pH (green curves), a measure of the acidity of ocean water. Measurements are from three stations from the Atlantic (29°10'N, 15°30'W – dark blue/dark green; 31°40'N, 64°10'W – blue/green) and the Pacific Oceans (22°45'N, 158°00'W – light blue/light green). Full details of the datasets shown here are provided in the underlying report and the Technical Summary Supplementary Material. {Figures 2.1 and 3.18; Figure TS.5}

---

12 1 Gigatonne of carbon = 1 GtC = 10^{15} grams of carbon. This corresponds to 3.667 $GtCO_2$.

13 pH is a measure of acidity using a logarithmic scale: a pH decrease of 1 unit corresponds to a 10-fold increase in hydrogen ion concentration, or acidity.

SPM

C. Drivers of Climate Change

Natural and anthropogenic substances and processes that alter the Earth's energy budget are drivers of climate change. Radiative forcing[14] (RF) quantifies the change in energy fluxes caused by changes in these drivers for 2011 relative to 1750, unless otherwise indicated. Positive RF leads to surface warming, negative RF leads to surface cooling. RF is estimated based on in-situ and remote observations, properties of greenhouse gases and aerosols, and calculations using numerical models representing observed processes. Some emitted compounds affect the atmospheric concentration of other substances. The RF can be reported based on the concentration changes of each substance[15]. Alternatively, the emission-based RF of a compound can be reported, which provides a more direct link to human activities. It includes contributions from all substances affected by that emission. The total anthropogenic RF of the two approaches are identical when considering all drivers. Though both approaches are used in this Summary for Policymakers, emission-based RFs are emphasized.

Total radiative forcing is positive, and has led to an uptake of energy by the climate system. The largest contribution to total radiative forcing is caused by the increase in the atmospheric concentration of CO_2 since 1750 (see Figure SPM.5). {3.2, Box 3.1, 8.3, 8.5}

- The total anthropogenic RF for 2011 relative to 1750 is 2.29 [1.13 to 3.33] W m^{-2} (see Figure SPM.5), and it has increased more rapidly since 1970 than during prior decades. The total anthropogenic RF best estimate for 2011 is 43% higher than that reported in AR4 for the year 2005. This is caused by a combination of continued growth in most greenhouse gas concentrations and improved estimates of RF by aerosols indicating a weaker net cooling effect (negative RF). {8.5}

- The RF from emissions of well-mixed greenhouse gases (CO_2, CH_4, N_2O, and Halocarbons) for 2011 relative to 1750 is 3.00 [2.22 to 3.78] W m^{-2} (see Figure SPM.5). The RF from changes in concentrations in these gases is 2.83 [2.26 to 3.40] W m^{-2}. {8.5}

- Emissions of CO_2 alone have caused an RF of 1.68 [1.33 to 2.03] W m^{-2} (see Figure SPM.5). Including emissions of other carbon-containing gases, which also contributed to the increase in CO_2 concentrations, the RF of CO_2 is 1.82 [1.46 to 2.18] W m^{-2}. {8.3, 8.5}

- Emissions of CH_4 alone have caused an RF of 0.97 [0.74 to 1.20] W m^{-2} (see Figure SPM.5). This is much larger than the concentration-based estimate of 0.48 [0.38 to 0.58] W m^{-2} (unchanged from AR4). This difference in estimates is caused by concentration changes in ozone and stratospheric water vapour due to CH_4 emissions and other emissions indirectly affecting CH_4. {8.3, 8.5}

- Emissions of stratospheric ozone-depleting halocarbons have caused a net positive RF of 0.18 [0.01 to 0.35] W m^{-2} (see Figure SPM.5). Their own positive RF has outweighed the negative RF from the ozone depletion that they have induced. The positive RF from all halocarbons is similar to the value in AR4, with a reduced RF from CFCs but increases from many of their substitutes. {8.3, 8.5}

- Emissions of short-lived gases contribute to the total anthropogenic RF. Emissions of carbon monoxide (CO) are *virtually certain* to have induced a positive RF, while emissions of nitrogen oxides (NO_x) are *likely* to have induced a net negative RF (see Figure SPM.5). {8.3, 8.5}

- The RF of the total aerosol effect in the atmosphere, which includes cloud adjustments due to aerosols, is –0.9 [–1.9 to –0.1] W m^{-2} (*medium confidence*), and results from a negative forcing from most aerosols and a positive contribution

---

[14] The strength of drivers is quantified as Radiative Forcing (RF) in units watts per square metre (W m^{-2}) as in previous IPCC assessments. RF is the change in energy flux caused by a driver, and is calculated at the tropopause or at the top of the atmosphere. In the traditional RF concept employed in previous IPCC reports all surface and tropospheric conditions are kept fixed. In calculations of RF for well-mixed greenhouse gases and aerosols in this report, physical variables, except for the ocean and sea ice, are allowed to respond to perturbations with rapid adjustments. The resulting forcing is called Effective Radiative Forcing (ERF) in the underlying report. This change reflects the scientific progress from previous assessments and results in a better indication of the eventual temperature response for these drivers. For all drivers other than well-mixed greenhouse gases and aerosols, rapid adjustments are less well characterized and assumed to be small, and thus the traditional RF is used. {8.1}

[15] This approach was used to report RF in the AR4 Summary for Policymakers.

SPM

from black carbon absorption of solar radiation. There is *high confidence* that aerosols and their interactions with clouds have offset a substantial portion of global mean forcing from well-mixed greenhouse gases. They continue to contribute the largest uncertainty to the total RF estimate. {7.5, 8.3, 8.5}

- The forcing from stratospheric volcanic aerosols can have a large impact on the climate for some years after volcanic eruptions. Several small eruptions have caused an RF of –0.11 [–0.15 to –0.08] W m^{-2} for the years 2008 to 2011, which is approximately twice as strong as during the years 1999 to 2002. {8.4}

- The RF due to changes in solar irradiance is estimated as 0.05 [0.00 to 0.10] W m^{-2} (see Figure SPM.5). Satellite observations of total solar irradiance changes from 1978 to 2011 indicate that the last solar minimum was lower than the previous two. This results in an RF of –0.04 [–0.08 to 0.00] W m^{-2} between the most recent minimum in 2008 and the 1986 minimum. {8.4}

- The total natural RF from solar irradiance changes and stratospheric volcanic aerosols made only a small contribution to the net radiative forcing throughout the last century, except for brief periods after large volcanic eruptions. {8.5}

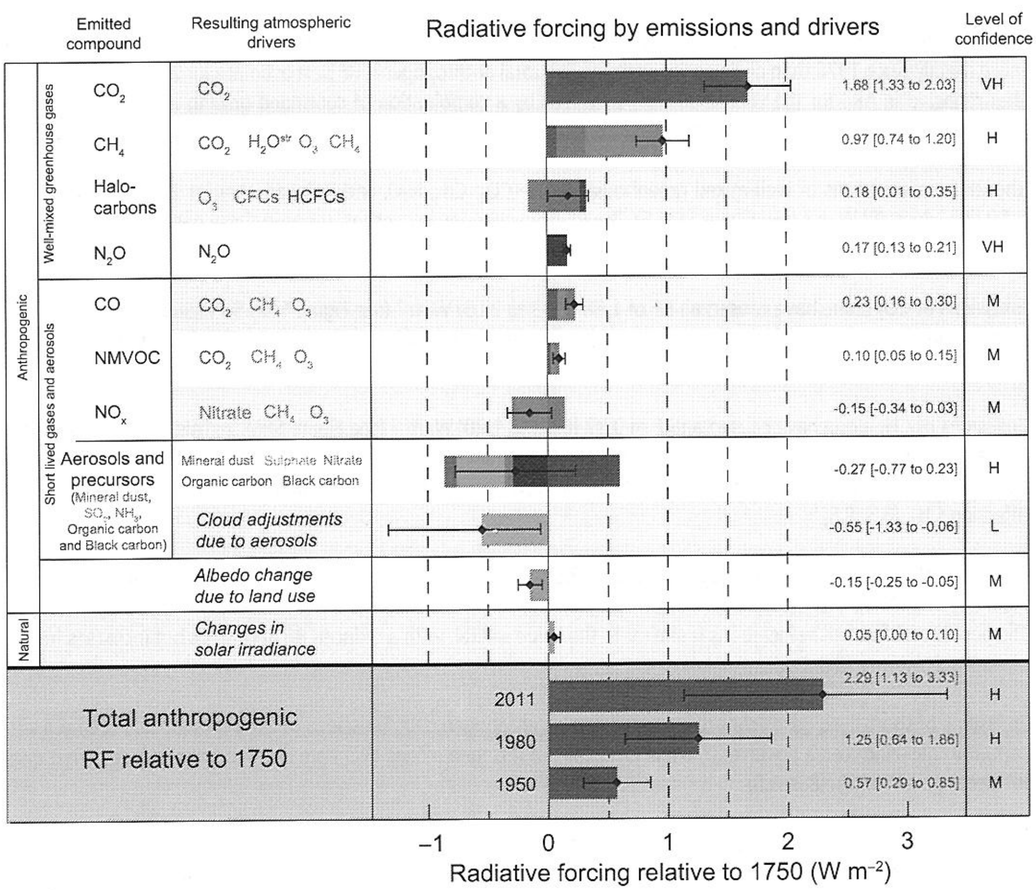


Figure SPM.5 | Radiative forcing estimates in 2011 relative to 1750 and aggregated uncertainties for the main drivers of climate change. Values are global average radiative forcing (RF[14]), partitioned according to the emitted compounds or processes that result in a combination of drivers. The best estimates of the net radiative forcing are shown as black diamonds with corresponding uncertainty intervals; the numerical values are provided on the right of the figure, together with the confidence level in the net forcing (VH – *very high*, H – *high*, M – *medium*, L – *low*, VL – *very low*). Albedo forcing due to black carbon on snow and ice is included in the black carbon aerosol bar. Small forcings due to contrails (0.05 W m^{-2}, including contrail induced cirrus), and HFCs, PFCs and SF_6 (total 0.03 W m^{-2}) are not shown. Concentration-based RFs for gases can be obtained by summing the like-coloured bars. Volcanic forcing is not included as its episodic nature makes is difficult to compare to other forcing mechanisms. Total anthropogenic radiative forcing is provided for three different years relative to 1750. For further technical details, including uncertainty ranges associated with individual components and processes, see the Technical Summary Supplementary Material. {8.5; Figures 8.14–8.18; Figures TS.6 and TS.7}

SPM

D. Understanding the Climate System and its Recent Changes

Understanding recent changes in the climate system results from combining observations, studies of feedback processes, and model simulations. Evaluation of the ability of climate models to simulate recent changes requires consideration of the state of all modelled climate system components at the start of the simulation and the natural and anthropogenic forcing used to drive the models. Compared to AR4, more detailed and longer observations and improved climate models now enable the attribution of a human contribution to detected changes in more climate system components.

Human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system. {2–14}

D.1 Evaluation of Climate Models

Climate models have improved since the AR4. Models reproduce observed continental-scale surface temperature patterns and trends over many decades, including the more rapid warming since the mid-20th century and the cooling immediately following large volcanic eruptions (*very high confidence*). {9.4, 9.6, 9.8}

- The long-term climate model simulations show a trend in global-mean surface temperature from 1951 to 2012 that agrees with the observed trend (*very high confidence*). There are, however, differences between simulated and observed trends over periods as short as 10 to 15 years (e.g., 1998 to 2012). {9.4, Box 9.2}

- The observed reduction in surface warming trend over the period 1998 to 2012 as compared to the period 1951 to 2012, is due in roughly equal measure to a reduced trend in radiative forcing and a cooling contribution from natural internal variability, which includes a possible redistribution of heat within the ocean (*medium confidence*). The reduced trend in radiative forcing is primarily due to volcanic eruptions and the timing of the downward phase of the 11-year solar cycle. However, there is *low confidence* in quantifying the role of changes in radiative forcing in causing the reduced warming trend. There is *medium confidence* that natural internal decadal variability causes to a substantial degree the difference between observations and the simulations; the latter are not expected to reproduce the timing of natural internal variability. There may also be a contribution from forcing inadequacies and, in some models, an overestimate of the response to increasing greenhouse gas and other anthropogenic forcing (dominated by the effects of aerosols). {9.4, Box 9.2, 10.3, Box 10.2, 11.3}

- On regional scales, the confidence in model capability to simulate surface temperature is less than for the larger scales. However, there is *high confidence* that regional-scale surface temperature is better simulated than at the time of the AR4. {9.4, 9.6}

- There has been substantial progress in the assessment of extreme weather and climate events since AR4. Simulated global-mean trends in the frequency of extreme warm and cold days and nights over the second half of the 20th century are generally consistent with observations. {9.5}

- There has been some improvement in the simulation of continental-scale patterns of precipitation since the AR4. At regional scales, precipitation is not simulated as well, and the assessment is hampered by observational uncertainties. {9.4, 9.6}

- Some important climate phenomena are now better reproduced by models. There is *high confidence* that the statistics of monsoon and El Niño-Southern Oscillation (ENSO) based on multi-model simulations have improved since AR4. {9.5}

SPM

- Climate models now include more cloud and aerosol processes, and their interactions, than at the time of the AR4, but there remains *low confidence* in the representation and quantification of these processes in models. {7.3, 7.6, 9.4, 9.7}

- There is robust evidence that the downward trend in Arctic summer sea ice extent since 1979 is now reproduced by more models than at the time of the AR4, with about one-quarter of the models showing a trend as large as, or larger than, the trend in the observations. Most models simulate a small downward trend in Antarctic sea ice extent, albeit with large inter-model spread, in contrast to the small upward trend in observations. {9.4}

- Many models reproduce the observed changes in upper-ocean heat content (0–700 m) from 1961 to 2005 (*high confidence*), with the multi-model mean time series falling within the range of the available observational estimates for most of the period. {9.4}

- Climate models that include the carbon cycle (Earth System Models) simulate the global pattern of ocean-atmosphere CO_2 fluxes, with outgassing in the tropics and uptake in the mid and high latitudes. In the majority of these models the sizes of the simulated global land and ocean carbon sinks over the latter part of the 20th century are within the range of observational estimates. {9.4}

D.2 Quantification of Climate System Responses

Observational and model studies of temperature change, climate feedbacks and changes in the Earth's energy budget together provide confidence in the magnitude of global warming in response to past and future forcing. {Box 12.2, Box 13.1}

- The net feedback from the combined effect of changes in water vapour, and differences between atmospheric and surface warming is *extremely likely* positive and therefore amplifies changes in climate. The net radiative feedback due to all cloud types combined is *likely* positive. Uncertainty in the sign and magnitude of the cloud feedback is due primarily to continuing uncertainty in the impact of warming on low clouds. {7.2}

- The equilibrium climate sensitivity quantifies the response of the climate system to constant radiative forcing on multi-century time scales. It is defined as the change in global mean surface temperature at equilibrium that is caused by a doubling of the atmospheric CO_2 concentration. Equilibrium climate sensitivity is *likely* in the range 1.5°C to 4.5°C (*high confidence*), *extremely unlikely* less than 1°C (*high confidence*), and *very unlikely* greater than 6°C (*medium confidence*)[16]. The lower temperature limit of the assessed *likely* range is thus less than the 2°C in the AR4, but the upper limit is the same. This assessment reflects improved understanding, the extended temperature record in the atmosphere and ocean, and new estimates of radiative forcing. {TS TFE.6, Figure 1; Box 12.2}

- The rate and magnitude of global climate change is determined by radiative forcing, climate feedbacks and the storage of energy by the climate system. Estimates of these quantities for recent decades are consistent with the assessed *likely* range of the equilibrium climate sensitivity to within assessed uncertainties, providing strong evidence for our understanding of anthropogenic climate change. {Box 12.2, Box 13.1}

- The transient climate response quantifies the response of the climate system to an increasing radiative forcing on a decadal to century timescale. It is defined as the change in global mean surface temperature at the time when the atmospheric CO_2 concentration has doubled in a scenario of concentration increasing at 1% per year. The transient climate response is *likely* in the range of 1.0°C to 2.5°C (*high confidence*) and *extremely unlikely* greater than 3°C. {Box 12.2}

- A related quantity is the transient climate response to cumulative carbon emissions (TCRE). It quantifies the transient response of the climate system to cumulative carbon emissions (see Section E.8). TCRE is defined as the global mean

16 No best estimate for equilibrium climate sensitivity can now be given because of a lack of agreement on values across assessed lines of evidence and studies.

surface temperature change per 1000 GtC emitted to the atmosphere. TCRE is *likely* in the range of 0.8°C to 2.5°C per 1000 GtC and applies for cumulative emissions up to about 2000 GtC until the time temperatures peak (see Figure SPM.10). {12.5, Box 12.2}

- Various metrics can be used to compare the contributions to climate change of emissions of different substances. The most appropriate metric and time horizon will depend on which aspects of climate change are considered most important to a particular application. No single metric can accurately compare all consequences of different emissions, and all have limitations and uncertainties. The Global Warming Potential is based on the cumulative radiative forcing over a particular time horizon, and the Global Temperature Change Potential is based on the change in global mean surface temperature at a chosen point in time. Updated values are provided in the underlying Report. {8.7}

D.3 Detection and Attribution of Climate Change

Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes (see Figure SPM.6 and Table SPM.1). This evidence for human influence has grown since AR4. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century. {10.3–10.6, 10.9}

- It is *extremely likely* that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. The best estimate of the human-induced contribution to warming is similar to the observed warming over this period. {10.3}

- Greenhouse gases contributed a global mean surface warming *likely* to be in the range of 0.5°C to 1.3°C over the period 1951 to 2010, with the contributions from other anthropogenic forcings, including the cooling effect of aerosols, *likely* to be in the range of –0.6°C to 0.1°C. The contribution from natural forcings is *likely* to be in the range of –0.1°C to 0.1°C, and from natural internal variability is *likely* to be in the range of –0.1°C to 0.1°C. Together these assessed contributions are consistent with the observed warming of approximately 0.6°C to 0.7°C over this period. {10.3}

- Over every continental region except Antarctica, anthropogenic forcings have *likely* made a substantial contribution to surface temperature increases since the mid-20th century (see Figure SPM.6). For Antarctica, large observational uncertainties result in *low confidence* that anthropogenic forcings have contributed to the observed warming averaged over available stations. It is *likely* that there has been an anthropogenic contribution to the very substantial Arctic warming since the mid-20th century. {2.4, 10.3}

- It is *very likely* that anthropogenic influence, particularly greenhouse gases and stratospheric ozone depletion, has led to a detectable observed pattern of tropospheric warming and a corresponding cooling in the lower stratosphere since 1961. {2.4, 9.4, 10.3}

- It is *very likely* that anthropogenic forcings have made a substantial contribution to increases in global upper ocean heat content (0–700 m) observed since the 1970s (see Figure SPM.6). There is evidence for human influence in some individual ocean basins. {3.2, 10.4}

- It is *likely* that anthropogenic influences have affected the global water cycle since 1960. Anthropogenic influences have contributed to observed increases in atmospheric moisture content in the atmosphere (*medium confidence*), to global-scale changes in precipitation patterns over land (*medium confidence*), to intensification of heavy precipitation over land regions where data are sufficient (*medium confidence*), and to changes in surface and sub-surface ocean salinity (*very likely*). {2.5, 2.6, 3.3, 7.6, 10.3, 10.4}

SPM

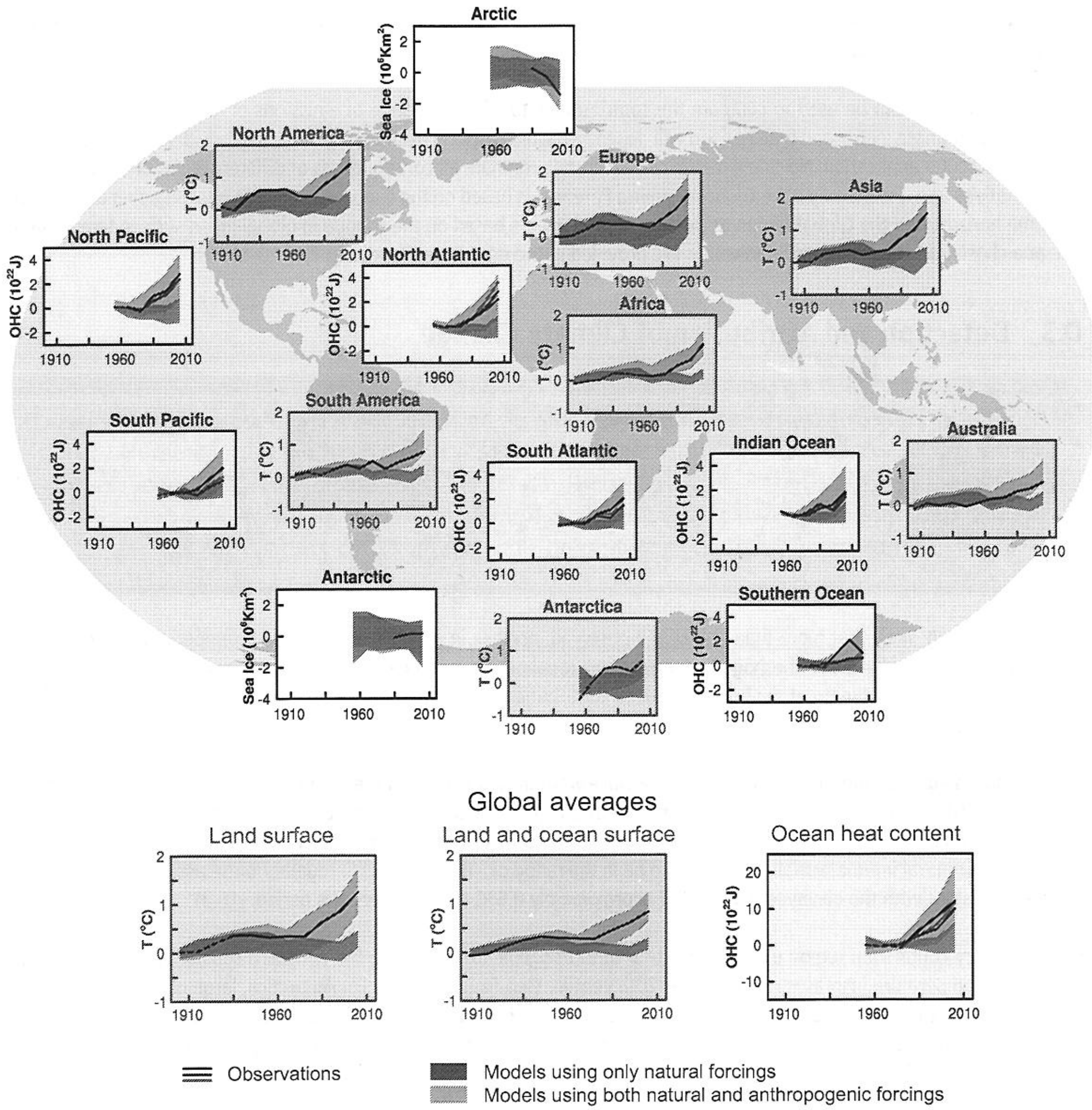


Figure SPM.6 | Comparison of observed and simulated climate change based on three large-scale indicators in the atmosphere, the cryosphere and the ocean: change in continental land surface air temperatures (yellow panels), Arctic and Antarctic September sea ice extent (white panels), and upper ocean heat content in the major ocean basins (blue panels). Global average changes are also given. Anomalies are given relative to 1880–1919 for surface temperatures, 1960–1980 for ocean heat content and 1979–1999 for sea ice. All time-series are decadal averages, plotted at the centre of the decade. For temperature panels, observations are dashed lines if the spatial coverage of areas being examined is below 50%. For ocean heat content and sea ice panels the solid line is where the coverage of data is good and higher in quality, and the dashed line is where the data coverage is only adequate, and thus, uncertainty is larger. Model results shown are Coupled Model Intercomparison Project Phase 5 (CMIP5) multi-model ensemble ranges, with shaded bands indicating the 5 to 95% confidence intervals. For further technical details, including region definitions see the Technical Summary Supplementary Material. {Figure 10.21; Figure TS.12}

- There has been further strengthening of the evidence for human influence on temperature extremes since the SREX. It is now *very likely* that human influence has contributed to observed global scale changes in the frequency and intensity of daily temperature extremes since the mid-20th century, and *likely* that human influence has more than doubled the probability of occurrence of heat waves in some locations (see Table SPM.1). {10.6}

- Anthropogenic influences have *very likely* contributed to Arctic sea ice loss since 1979. There is *low confidence* in the scientific understanding of the small observed increase in Antarctic sea ice extent due to the incomplete and competing scientific explanations for the causes of change and *low confidence* in estimates of natural internal variability in that region (see Figure SPM.6). {10.5}

- Anthropogenic influences *likely* contributed to the retreat of glaciers since the 1960s and to the increased surface mass loss of the Greenland ice sheet since 1993. Due to a low level of scientific understanding there is *low confidence* in attributing the causes of the observed loss of mass from the Antarctic ice sheet over the past two decades. {4.3, 10.5}

- It is *likely* that there has been an anthropogenic contribution to observed reductions in Northern Hemisphere spring snow cover since 1970. {10.5}

- It is *very likely* that there is a substantial anthropogenic contribution to the global mean sea level rise since the 1970s. This is based on the *high confidence* in an anthropogenic influence on the two largest contributions to sea level rise, that is thermal expansion and glacier mass loss. {10.4, 10.5, 13.3}

- There is *high confidence* that changes in total solar irradiance have not contributed to the increase in global mean surface temperature over the period 1986 to 2008, based on direct satellite measurements of total solar irradiance. There is *medium confidence* that the 11-year cycle of solar variability influences decadal climate fluctuations in some regions. No robust association between changes in cosmic rays and cloudiness has been identified. {7.4, 10.3, Box 10.2}

E. Future Global and Regional Climate Change

Projections of changes in the climate system are made using a hierarchy of climate models ranging from simple climate models, to models of intermediate complexity, to comprehensive climate models, and Earth System Models. These models simulate changes based on a set of scenarios of anthropogenic forcings. A new set of scenarios, the Representative Concentration Pathways (RCPs), was used for the new climate model simulations carried out under the framework of the Coupled Model Intercomparison Project Phase 5 (CMIP5) of the World Climate Research Programme. In all RCPs, atmospheric CO_2 concentrations are higher in 2100 relative to present day as a result of a further increase of cumulative emissions of CO_2 to the atmosphere during the 21st century (see Box SPM.1). Projections in this Summary for Policymakers are for the end of the 21st century (2081–2100) given relative to 1986–2005, unless otherwise stated. To place such projections in historical context, it is necessary to consider observed changes between different periods. Based on the longest global surface temperature dataset available, the observed change between the average of the period 1850–1900 and of the AR5 reference period is 0.61 [0.55 to 0.67] °C. However, warming has occurred beyond the average of the AR5 reference period. Hence this is not an estimate of historical warming to present (see Chapter 2) .

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions. {6, 11–14}

- Projections for the next few decades show spatial patterns of climate change similar to those projected for the later 21st century but with smaller magnitude. Natural internal variability will continue to be a major influence on climate, particularly in the near-term and at the regional scale. By the mid-21st century the magnitudes of the projected changes are substantially affected by the choice of emissions scenario (Box SPM.1). {11.3, Box 11.1, Annex I}

SPM

- Projected climate change based on RCPs is similar to AR4 in both patterns and magnitude, after accounting for scenario differences. The overall spread of projections for the high RCPs is narrower than for comparable scenarios used in AR4 because in contrast to the SRES emission scenarios used in AR4, the RCPs used in AR5 are defined as concentration pathways and thus carbon cycle uncertainties affecting atmospheric CO_2 concentrations are not considered in the concentration-driven CMIP5 simulations. Projections of sea level rise are larger than in the AR4, primarily because of improved modelling of land-ice contributions.{11.3, 12.3, 12.4, 13.4, 13.5}

E.1 Atmosphere: Temperature

Global surface temperature change for the end of the 21st century is *likely* to exceed 1.5°C relative to 1850 to 1900 for all RCP scenarios except RCP2.6. It is *likely* to exceed 2°C for RCP6.0 and RCP8.5, and *more likely than not* to exceed 2°C for RCP4.5. Warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Warming will continue to exhibit interannual-to-decadal variability and will not be regionally uniform (see Figures SPM.7 and SPM.8). {11.3, 12.3, 12.4, 14.8}

- The global mean surface temperature change for the period 2016–2035 relative to 1986–2005 will *likely* be in the range of 0.3°C to 0.7°C (*medium confidence*). This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance. Relative to natural internal variability, near-term increases in seasonal mean and annual mean temperatures are expected to be larger in the tropics and subtropics than in mid-latitudes (*high confidence*). {11.3}

- Increase of global mean surface temperatures for 2081–2100 relative to 1986–2005 is projected to *likely* be in the ranges derived from the concentration-driven CMIP5 model simulations, that is, 0.3°C to 1.7°C (RCP2.6), 1.1°C to 2.6°C (RCP4.5), 1.4°C to 3.1°C (RCP6.0), 2.6°C to 4.8°C (RCP8.5). The Arctic region will warm more rapidly than the global mean, and mean warming over land will be larger than over the ocean (*very high confidence*) (see Figures SPM.7 and SPM.8, and Table SPM.2). {12.4, 14.8}

- Relative to the average from year 1850 to 1900, global surface temperature change by the end of the 21st century is projected to *likely* exceed 1.5°C for RCP4.5, RCP6.0 and RCP8.5 (*high confidence*). Warming is *likely* to exceed 2°C for RCP6.0 and RCP8.5 (*high confidence*), *more likely than not* to exceed 2°C for RCP4.5 (*high confidence*), but *unlikely* to exceed 2°C for RCP2.6 (*medium confidence*). Warming is *unlikely* to exceed 4°C for RCP2.6, RCP4.5 and RCP6.0 (*high confidence*) and is *about as likely as not* to exceed 4°C for RCP8.5 (*medium confidence*). {12.4}

- It is *virtually certain* that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales as global mean temperatures increase. It is *very likely* that heat waves will occur with a higher frequency and duration. Occasional cold winter extremes will continue to occur (see Table SPM.1). {12.4}

E.2 Atmosphere: Water Cycle

Changes in the global water cycle in response to the warming over the 21st century will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions (see Figure SPM.8). {12.4, 14.3}

- Projected changes in the water cycle over the next few decades show similar large-scale patterns to those towards the end of the century, but with smaller magnitude. Changes in the near-term, and at the regional scale will be strongly influenced by natural internal variability and may be affected by anthropogenic aerosol emissions. {11.3}

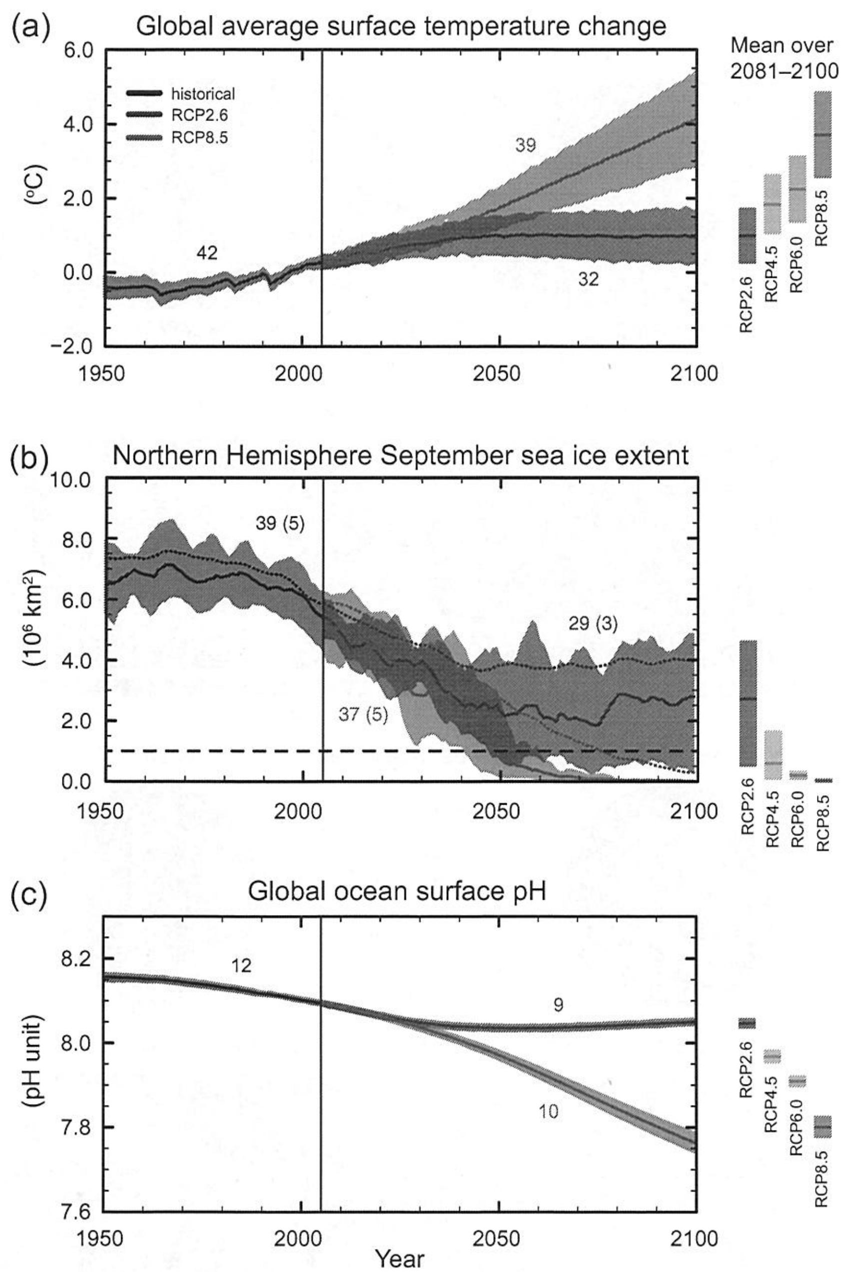


Figure SPM.7 | CMIP5 multi-model simulated time series from 1950 to 2100 for (a) change in global annual mean surface temperature relative to 1986–2005, (b) Northern Hemisphere September sea ice extent (5-year running mean), and (c) global mean ocean surface pH. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). Black (grey shading) is the modelled historical evolution using historical reconstructed forcings. The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as colored vertical bars. The numbers of CMIP5 models used to calculate the multi-model mean is indicated. For sea ice extent (b), the projected mean and uncertainty (minimum-maximum range) of the subset of models that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea ice is given (number of models given in brackets). For completeness, the CMIP5 multi-model mean is also indicated with dotted lines. The dashed line represents nearly ice-free conditions (i.e., when sea ice extent is less than 10^6 km^2 for at least five consecutive years). For further technical details see the Technical Summary Supplementary Material {Figures 6.28, 12.5, and 12.28–12.31; Figures TS.15, TS.17, and TS.20}

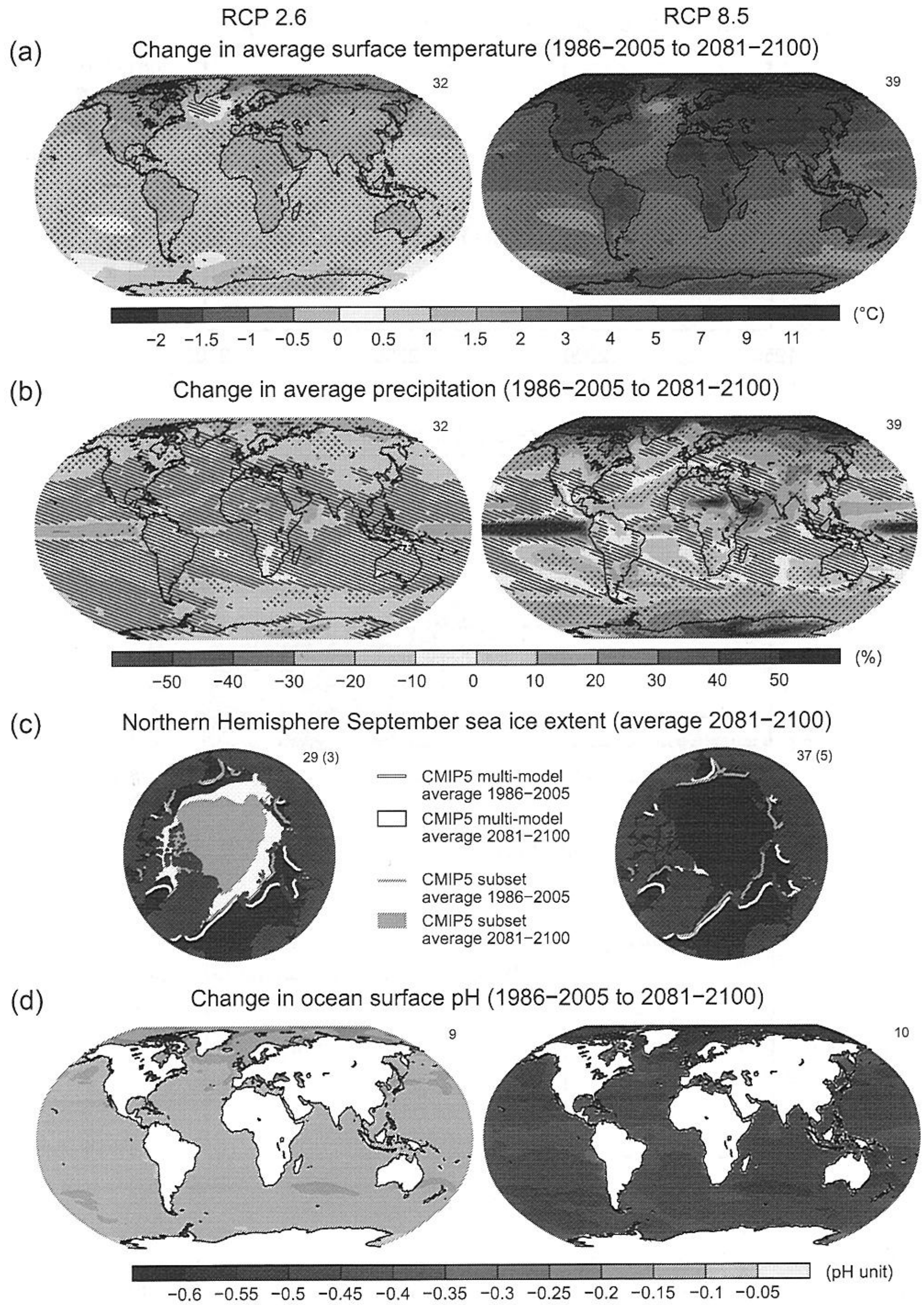


Figure SPM.8 | Maps of CMIP5 multi-model mean results for the scenarios RCP2.6 and RCP8.5 in 2081–2100 of (a) annual mean surface temperature change, (b) average percent change in annual mean precipitation, (c) Northern Hemisphere September sea ice extent, and (d) change in ocean surface pH. Changes in panels (a), (b) and (d) are shown relative to 1986–2005. The number of CMIP5 models used to calculate the multi-model mean is indicated in the upper right corner of each panel. For panels (a) and (b), hatching indicates regions where the multi-model mean is small compared to natural internal variability (i.e., less than one standard deviation of natural internal variability in 20-year means). Stippling indicates regions where the multi-model mean is large compared to natural internal variability (i.e., greater than two standard deviations of natural internal variability in 20-year means) and where at least 90% of models agree on the sign of change (see Box 12.1). In panel (c), the lines are the modelled means for 1986–2005; the filled areas are for the end of the century. The CMIP5 multi-model mean is given in white colour, the projected mean sea ice extent of a subset of models (number of models given in brackets) that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea ice extent is given in light blue colour. For further technical details see the Technical Summary Supplementary Material. {Figures 6.28, 12.11, 12.22, and 12.29; Figures TS.15, TS.16, TS.17, and TS.20}

- The high latitudes and the equatorial Pacific Ocean are *likely* to experience an increase in annual mean precipitation by the end of this century under the RCP8.5 scenario. In many mid-latitude and subtropical dry regions, mean precipitation will *likely* decrease, while in many mid-latitude wet regions, mean precipitation will *likely* increase by the end of this century under the RCP8.5 scenario (see Figure SPM.8). {7.6, 12.4, 14.3}

- Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will *very likely* become more intense and more frequent by the end of this century, as global mean surface temperature increases (see Table SPM.1). {7.6, 12.4}

- Globally, it is *likely* that the area encompassed by monsoon systems will increase over the 21st century. While monsoon winds are *likely* to weaken, monsoon precipitation is *likely* to intensify due to the increase in atmospheric moisture. Monsoon onset dates are *likely* to become earlier or not to change much. Monsoon retreat dates will *likely* be delayed, resulting in lengthening of the monsoon season in many regions. {14.2}

- There is *high confidence* that the El Niño-Southern Oscillation (ENSO) will remain the dominant mode of interannual variability in the tropical Pacific, with global effects in the 21st century. Due to the increase in moisture availability, ENSO-related precipitation variability on regional scales will *likely* intensify. Natural variations of the amplitude and spatial pattern of ENSO are large and thus *confidence* in any specific projected change in ENSO and related regional phenomena for the 21st century remains *low*. {5.4, 14.4}

Table SPM.2 | Projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986–2005. {12.4; Table 12.2, Table 13.5}

		2046–2065		2081–2100	
	Scenario	**Mean**	***Likely* range[c]**	**Mean**	***Likely* range[c]**
Global Mean Surface Temperature Change (°C)[a]	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	1.4	0.9 to 2.0	1.8	1.1 to 2.6
	RCP6.0	1.3	0.8 to 1.8	2.2	1.4 to 3.1
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8
	Scenario	**Mean**	***Likely* range[d]**	**Mean**	***Likely* range[d]**
Global Mean Sea Level Rise (m)[b]	RCP2.6	0.24	0.17 to 0.32	0.40	0.26 to 0.55
	RCP4.5	0.26	0.19 to 0.33	0.47	0.32 to 0.63
	RCP6.0	0.25	0.18 to 0.32	0.48	0.33 to 0.63
	RCP8.5	0.30	0.22 to 0.38	0.63	0.45 to 0.82

Notes:

[a] Based on the CMIP5 ensemble; anomalies calculated with respect to 1986–2005. Using HadCRUT4 and its uncertainty estimate (5–95% confidence interval), the observed warming to the reference period 1986–2005 is 0.61 [0.55 to 0.67] °C from 1850–1900, and 0.11 [0.09 to 0.13] °C from 1980–1999, the reference period for projections used in AR4. *Likely* ranges have not been assessed here with respect to earlier reference periods because methods are not generally available in the literature for combining the uncertainties in models and observations. Adding projected and observed changes does not account for potential effects of model biases compared to observations, and for natural internal variability during the observational reference period {2.4; 11.2; Tables 12.2 and 12.3}

[b] Based on 21 CMIP5 models; anomalies calculated with respect to 1986–2005. Where CMIP5 results were not available for a particular AOGCM and scenario, they were estimated as explained in Chapter 13, Table 13.5. The contributions from ice sheet rapid dynamical change and anthropogenic land water storage are treated as having uniform probability distributions, and as largely independent of scenario. This treatment does not imply that the contributions concerned will not depend on the scenario followed, only that the current state of knowledge does not permit a quantitative assessment of the dependence. Based on current understanding, only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause global mean sea level to rise substantially above the *likely* range during the 21st century. There is *medium confidence* that this additional contribution would not exceed several tenths of a meter of sea level rise during the 21st century.

[c] Calculated from projections as 5–95% model ranges. These ranges are then assessed to be *likely* ranges after accounting for additional uncertainties or different levels of confidence in models. For projections of global mean surface temperature change in 2046–2065 *confidence* is *medium*, because the relative importance of natural internal variability, and uncertainty in non-greenhouse gas forcing and response, are larger than for 2081–2100. The *likely* ranges for 2046–2065 do not take into account the possible influence of factors that lead to the assessed range for near-term (2016–2035) global mean surface temperature change that is lower than the 5–95% model range, because the influence of these factors on longer term projections has not been quantified due to insufficient scientific understanding. {11.3}

[d] Calculated from projections as 5–95% model ranges. These ranges are then assessed to be *likely* ranges after accounting for additional uncertainties or different levels of confidence in models. For projections of global mean sea level rise *confidence* is *medium* for both time horizons.

SPM

E.3 Atmosphere: Air Quality

- The range in projections of air quality (ozone and PM2.5[17] in near-surface air) is driven primarily by emissions (including CH_4), rather than by physical climate change (*medium confidence*). There is *high confidence* that globally, warming decreases background surface ozone. High CH_4 levels (as in RCP8.5) can offset this decrease, raising background surface ozone by year 2100 on average by about 8 ppb (25% of current levels) relative to scenarios with small CH_4 changes (as in RCP4.5 and RCP6.0) (*high confidence*). {11.3}

- Observational and modelling evidence indicates that, all else being equal, locally higher surface temperatures in polluted regions will trigger regional feedbacks in chemistry and local emissions that will increase peak levels of ozone and PM2.5 (*medium confidence*). For PM2.5, climate change may alter natural aerosol sources as well as removal by precipitation, but no confidence level is attached to the overall impact of climate change on PM2.5 distributions. {11.3}

E.4 Ocean

The global ocean will continue to warm during the 21st century. Heat will penetrate from the surface to the deep ocean and affect ocean circulation. {11.3, 12.4}

- The strongest ocean warming is projected for the surface in tropical and Northern Hemisphere subtropical regions. At greater depth the warming will be most pronounced in the Southern Ocean (*high confidence*). Best estimates of ocean warming in the top one hundred meters are about 0.6°C (RCP2.6) to 2.0°C (RCP8.5), and about 0.3°C (RCP2.6) to 0.6°C (RCP8.5) at a depth of about 1000 m by the end of the 21st century. {12.4, 14.3}

- It is *very likely* that the Atlantic Meridional Overturning Circulation (AMOC) will weaken over the 21st century. Best estimates and ranges[18] for the reduction are 11% (1 to 24%) in RCP2.6 and 34% (12 to 54%) in RCP8.5. It is *likely* that there will be some decline in the AMOC by about 2050, but there may be some decades when the AMOC increases due to large natural internal variability. {11.3, 12.4}

- It is *very unlikely* that the AMOC will undergo an abrupt transition or collapse in the 21st century for the scenarios considered. There is *low confidence* in assessing the evolution of the AMOC beyond the 21st century because of the limited number of analyses and equivocal results. However, a collapse beyond the 21st century for large sustained warming cannot be excluded. {12.5}

E.5 Cryosphere

It is *very likely* that the Arctic sea ice cover will continue to shrink and thin and that Northern Hemisphere spring snow cover will decrease during the 21st century as global mean surface temperature rises. Global glacier volume will further decrease. {12.4, 13.4}

- Year-round reductions in Arctic sea ice extent are projected by the end of the 21st century from multi-model averages. These reductions range from 43% for RCP2.6 to 94% for RCP8.5 in September and from 8% for RCP2.6 to 34% for RCP8.5 in February (*medium confidence*) (see Figures SPM.7 and SPM.8). {12.4}

---

[17] PM2.5 refers to particulate matter with a diameter of less than 2.5 micrometres, a measure of atmospheric aerosol concentration.

[18] The ranges in this paragraph indicate a CMIP5 model spread.

- Based on an assessment of the subset of models that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea ice extent, a nearly ice-free Arctic Ocean[19] in September before mid-century is *likely* for RCP8.5 (*medium confidence*) (see Figures SPM.7 and SPM.8). A projection of when the Arctic might become nearly ice-free in September in the 21st century cannot be made with confidence for the other scenarios. {11.3, 12.4, 12.5}

- In the Antarctic, a decrease in sea ice extent and volume is projected with *low confidence* for the end of the 21st century as global mean surface temperature rises. {12.4}

- By the end of the 21st century, the global glacier volume, excluding glaciers on the periphery of Antarctica, is projected to decrease by 15 to 55% for RCP2.6, and by 35 to 85% for RCP8.5 (*medium confidence*). {13.4, 13.5}

- The area of Northern Hemisphere spring snow cover is projected to decrease by 7% for RCP2.6 and by 25% in RCP8.5 by the end of the 21st century for the model average (*medium confidence*). {12.4}

- It is *virtually certain* that near-surface permafrost extent at high northern latitudes will be reduced as global mean surface temperature increases. By the end of the 21st century, the area of permafrost near the surface (upper 3.5 m) is projected to decrease by between 37% (RCP2.6) to 81% (RCP8.5) for the model average (*medium confidence*). {12.4}

E.6 Sea Level

Global mean sea level will continue to rise during the 21st century (see Figure SPM.9). Under all RCP scenarios, the rate of sea level rise will *very likely* exceed that observed during 1971 to 2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets. {13.3–13.5}

- Confidence in projections of global mean sea level rise has increased since the AR4 because of the improved physical understanding of the components of sea level, the improved agreement of process-based models with observations, and the inclusion of ice-sheet dynamical changes. {13.3–13.5}

- Global mean sea level rise for 2081–2100 relative to 1986–2005 will *likely* be in the ranges of 0.26 to 0.55 m for RCP2.6, 0.32 to 0.63 m for RCP4.5, 0.33 to 0.63 m for RCP6.0, and 0.45 to 0.82 m for RCP8.5 (*medium confidence*). For RCP8.5, the rise by the year 2100 is 0.52 to 0.98 m, with a rate during 2081 to 2100 of 8 to 16 mm yr^{-1} (*medium confidence*). These ranges are derived from CMIP5 climate projections in combination with process-based models and literature assessment of glacier and ice sheet contributions (see Figure SPM.9, Table SPM.2). {13.5}

- In the RCP projections, thermal expansion accounts for 30 to 55% of 21st century global mean sea level rise, and glaciers for 15 to 35%. The increase in surface melting of the Greenland ice sheet will exceed the increase in snowfall, leading to a positive contribution from changes in surface mass balance to future sea level (*high confidence*). While surface melting will remain small, an increase in snowfall on the Antarctic ice sheet is expected (*medium confidence*), resulting in a negative contribution to future sea level from changes in surface mass balance. Changes in outflow from both ice sheets combined will *likely* make a contribution in the range of 0.03 to 0.20 m by 2081–2100 (*medium confidence*). {13.3–13.5}

- Based on current understanding, only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause global mean sea level to rise substantially above the *likely* range during the 21st century. However, there is *medium confidence* that this additional contribution would not exceed several tenths of a meter of sea level rise during the 21st century. {13.4, 13.5}

[19] Conditions in the Arctic Ocean are referred to as nearly ice-free when the sea ice extent is less than 10^6 km^2 for at least five consecutive years.

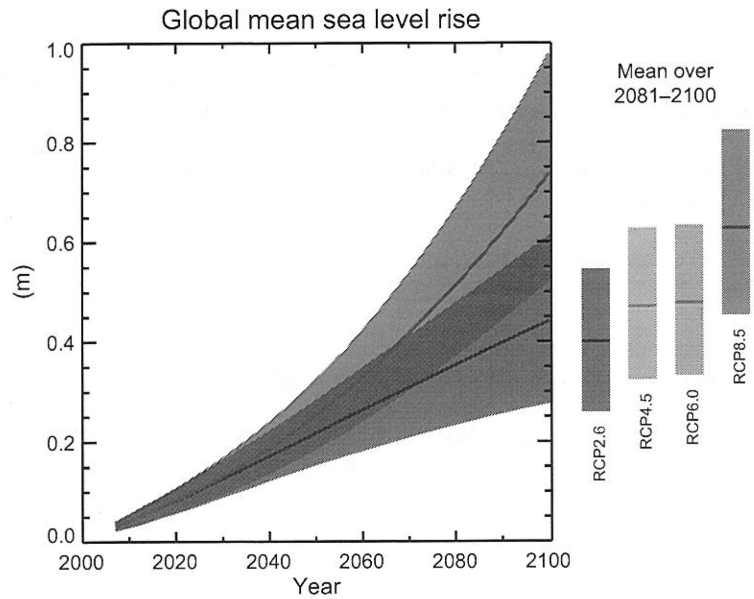


Figure SPM.9 | Projections of global mean sea level rise over the 21st century relative to 1986–2005 from the combination of the CMIP5 ensemble with process-based models, for RCP2.6 and RCP8.5. The assessed *likely* range is shown as a shaded band. The assessed *likely* ranges for the mean over the period 2081–2100 for all RCP scenarios are given as coloured vertical bars, with the corresponding median value given as a horizontal line. For further technical details see the Technical Summary Supplementary Material {Table 13.5, Figures 13.10 and 13.11; Figures TS.21 and TS.22}

- The basis for higher projections of global mean sea level rise in the 21st century has been considered and it has been concluded that there is currently insufficient evidence to evaluate the probability of specific levels above the assessed *likely* range. Many semi-empirical model projections of global mean sea level rise are higher than process-based model projections (up to about twice as large), but there is no consensus in the scientific community about their reliability and there is thus *low confidence* in their projections. {13.5}

- Sea level rise will not be uniform. By the end of the 21st century, it is *very likely* that sea level will rise in more than about 95% of the ocean area. About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change. {13.1, 13.6}

E.7 Carbon and Other Biogeochemical Cycles

Climate change will affect carbon cycle processes in a way that will exacerbate the increase of CO_2 in the atmosphere (*high confidence*). Further uptake of carbon by the ocean will increase ocean acidification. {6.4}

- Ocean uptake of anthropogenic CO_2 will continue under all four RCPs through to 2100, with higher uptake for higher concentration pathways (*very high confidence*). The future evolution of the land carbon uptake is less certain. A majority of models projects a continued land carbon uptake under all RCPs, but some models simulate a land carbon loss due to the combined effect of climate change and land use change. {6.4}

- Based on Earth System Models, there is *high confidence* that the feedback between climate and the carbon cycle is positive in the 21st century; that is, climate change will partially offset increases in land and ocean carbon sinks caused by rising atmospheric CO_2. As a result more of the emitted anthropogenic CO_2 will remain in the atmosphere. A positive feedback between climate and the carbon cycle on century to millennial time scales is supported by paleoclimate observations and modelling. {6.2, 6.4}

SPM

Table SPM.3 | Cumulative CO_2 emissions for the 2012 to 2100 period compatible with the RCP atmospheric concentrations simulated by the CMIP5 Earth System Models. {6.4, Table 6.12, Figure TS.19}

Scenario	Cumulative CO_2 Emissions 2012 to 2100[a]			
	GtC		$GtCO_2$	
	Mean	Range	Mean	Range
RCP2.6	270	140 to 410	990	510 to 1505
RCP4.5	780	595 to 1005	2860	2180 to 3690
RCP6.0	1060	840 to 1250	3885	3080 to 4585
RCP8.5	1685	1415 to 1910	6180	5185 to 7005

Notes:
[a] 1 Gigatonne of carbon = 1 GtC = 10^{15} grams of carbon. This corresponds to 3.667 $GtCO_2$.

- Earth System Models project a global increase in ocean acidification for all RCP scenarios. The corresponding decrease in surface ocean pH by the end of 21st century is in the range[18] of 0.06 to 0.07 for RCP2.6, 0.14 to 0.15 for RCP4.5, 0.20 to 0.21 for RCP6.0, and 0.30 to 0.32 for RCP8.5 (see Figures SPM.7 and SPM.8). {6.4}

- Cumulative CO_2 emissions[20] for the 2012 to 2100 period compatible with the RCP atmospheric CO_2 concentrations, as derived from 15 Earth System Models, range[18] from 140 to 410 GtC for RCP2.6, 595 to 1005 GtC for RCP4.5, 840 to 1250 GtC for RCP6.0, and 1415 to 1910 GtC for RCP8.5 (see Table SPM.3). {6.4}

- By 2050, annual CO_2 emissions derived from Earth System Models following RCP2.6 are smaller than 1990 emissions (by 14 to 96%). By the end of the 21st century, about half of the models infer emissions slightly above zero, while the other half infer a net removal of CO_2 from the atmosphere. {6.4, Figure TS.19}

- The release of CO_2 or CH_4 to the atmosphere from thawing permafrost carbon stocks over the 21st century is assessed to be in the range of 50 to 250 GtC for RCP8.5 (*low confidence*). {6.4}

E.8 Climate Stabilization, Climate Change Commitment and Irreversibility

Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond (see Figure SPM.10). Most aspects of climate change will persist for many centuries even if emissions of CO_2 are stopped. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO_2. {12.5}

- Cumulative total emissions of CO_2 and global mean surface temperature response are approximately linearly related (see Figure SPM.10). Any given level of warming is associated with a range of cumulative CO_2 emissions[21], and therefore, e.g., higher emissions in earlier decades imply lower emissions later. {12.5}

- Limiting the warming caused by anthropogenic CO_2 emissions alone with a probability of >33%, >50%, and >66% to less than 2°C since the period 1861–1880[22], will require cumulative CO_2 emissions from all anthropogenic sources to stay between 0 and about 1570 GtC (5760 $GtCO_2$), 0 and about 1210 GtC (4440 $GtCO_2$), and 0 and about 1000 GtC (3670 $GtCO_2$) since that period, respectively[23]. These upper amounts are reduced to about 900 GtC (3300 $GtCO_2$), 820 GtC (3010 $GtCO_2$), and 790 GtC (2900 $GtCO_2$), respectively, when accounting for non-CO_2 forcings as in RCP2.6. An amount of 515 [445 to 585] GtC (1890 [1630 to 2150] $GtCO_2$), was already emitted by 2011. {12.5}

[20] From fossil fuel, cement, industry, and waste sectors.

[21] Quantification of this range of CO_2 emissions requires taking into account non-CO_2 drivers.

[22] The first 20-year period available from the models.

[23] This is based on the assessment of the transient climate response to cumulative carbon emissions (TCRE, see Section D.2).

SPM

- A lower warming target, or a higher likelihood of remaining below a specific warming target, will require lower cumulative CO_2 emissions. Accounting for warming effects of increases in non-CO_2 greenhouse gases, reductions in aerosols, or the release of greenhouse gases from permafrost will also lower the cumulative CO_2 emissions for a specific warming target (see Figure SPM.10). {12.5}

- A large fraction of anthropogenic climate change resulting from CO_2 emissions is irreversible on a multi-century to millennial time scale, except in the case of a large net removal of CO_2 from the atmosphere over a sustained period. Surface temperatures will remain approximately constant at elevated levels for many centuries after a complete cessation of net anthropogenic CO_2 emissions. Due to the long time scales of heat transfer from the ocean surface to depth, ocean warming will continue for centuries. Depending on the scenario, about 15 to 40% of emitted CO_2 will remain in the atmosphere longer than 1,000 years. {Box 6.1, 12.4, 12.5}

- It is *virtually certain* that global mean sea level rise will continue beyond 2100, with sea level rise due to thermal expansion to continue for many centuries. The few available model results that go beyond 2100 indicate global mean sea level rise above the pre-industrial level by 2300 to be less than 1 m for a radiative forcing that corresponds to CO_2 concentrations that peak and decline and remain below 500 ppm, as in the scenario RCP2.6. For a radiative forcing that corresponds to a CO_2 concentration that is above 700 ppm but below 1500 ppm, as in the scenario RCP8.5, the projected rise is 1 m to more than 3 m (*medium confidence*). {13.5}

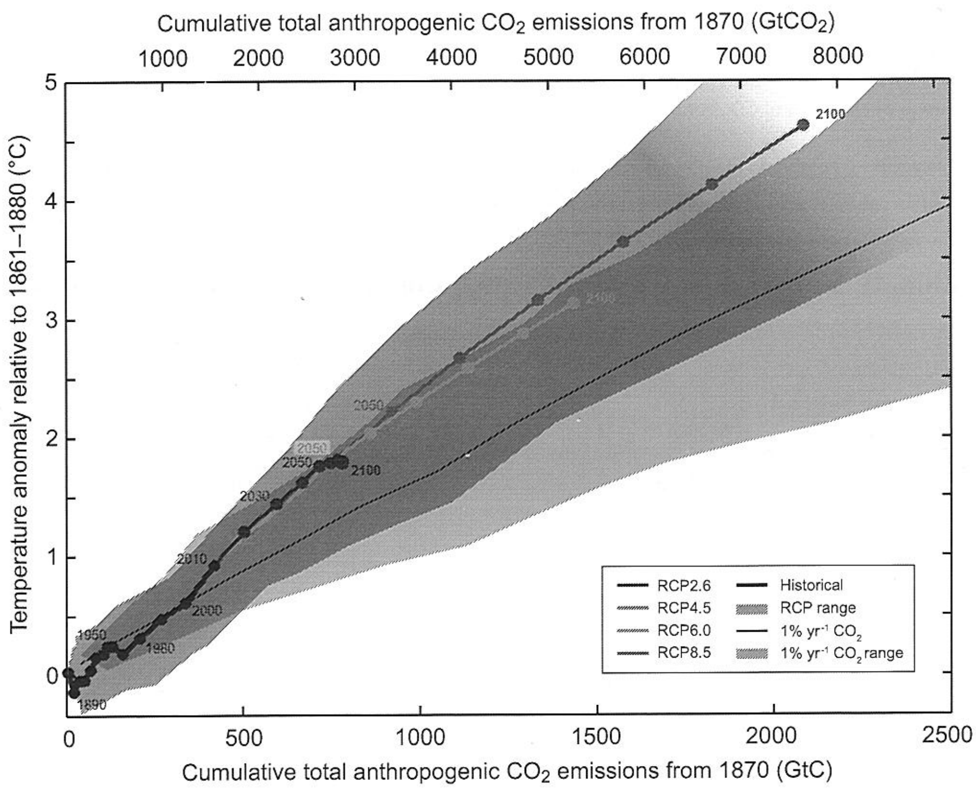


Figure SPM.10 | Global mean surface temperature increase as a function of cumulative total global CO_2 emissions from various lines of evidence. Multi-model results from a hierarchy of climate-carbon cycle models for each RCP until 2100 are shown with coloured lines and decadal means (dots). Some decadal means are labeled for clarity (e.g., 2050 indicating the decade 2040–2049). Model results over the historical period (1860 to 2010) are indicated in black. The coloured plume illustrates the multi-model spread over the four RCP scenarios and fades with the decreasing number of available models in RCP8.5. The multi-model mean and range simulated by CMIP5 models, forced by a CO_2 increase of 1% per year (1% yr^{-1} CO_2 simulations), is given by the thin black line and grey area. For a specific amount of cumulative CO_2 emissions, the 1% per year CO_2 simulations exhibit lower warming than those driven by RCPs, which include additional non-CO_2 forcings. Temperature values are given relative to the 1861–1880 base period, emissions relative to 1870. Decadal averages are connected by straight lines. For further technical details see the Technical Summary Supplementary Material. {Figure 12.45; TS TFE.8, Figure 1}

- Sustained mass loss by ice sheets would cause larger sea level rise, and some part of the mass loss might be irreversible. There is *high confidence* that sustained warming greater than some threshold would lead to the near-complete loss of the Greenland ice sheet over a millennium or more, causing a global mean sea level rise of up to 7 m. Current estimates indicate that the threshold is greater than about 1°C (*low confidence*) but less than about 4°C (*medium confidence*) global mean warming with respect to pre-industrial. Abrupt and irreversible ice loss from a potential instability of marine-based sectors of the Antarctic ice sheet in response to climate forcing is possible, but current evidence and understanding is insufficient to make a quantitative assessment. {5.8, 13.4, 13.5}

- Methods that aim to deliberately alter the climate system to counter climate change, termed geoengineering, have been proposed. Limited evidence precludes a comprehensive quantitative assessment of both Solar Radiation Management (SRM) and Carbon D ioxide Removal (CDR) and their impact on the climate system. CDR methods have biogeochemical and technological limitations to their potential on a global scale. There is insufficient knowledge to quantify how much CO_2 emissions could be partially offset by CDR on a century timescale. Modelling indicates that SRM methods, if realizable, have the potential to substantially offset a global temperature rise, but they would also modify the global water cycle, and would not reduce ocean acidification. If SRM were terminated for any reason, there is *high confidence* that global surface temperatures would rise very rapidly to values consistent with the greenhouse gas forcing. CDR and SRM methods carry side effects and long-term consequences on a global scale. {6.5, 7.7}

Box SPM.1: Representative Concentration Pathways (RCPs)

Climate change projections in IPCC Working Group I require information about future emissions or concentrations of greenhouse gases, aerosols and other climate drivers. This information is often expressed as a scenario of human activities, which are not assessed in this report. Scenarios used in Working Group I have focused on anthropogenic emissions and do not include changes in natural drivers such as solar or volcanic forcing or natural emissions, for example, of CH_4 and N_2O.

For the Fifth Assessment Report of IPCC, the scientific community has defined a set of four new scenarios, denoted Representative Concentration Pathways (RCPs, see Glossary). They are identified by their approximate total radiative forcing in year 2100 relative to 1750: 2.6 W m^{-2} for RCP2.6, 4.5 W m^{-2} for RCP4.5, 6.0 W m^{-2} for RCP6.0, and 8.5 W m^{-2} for RCP8.5. For the Coupled Model Intercomparison Project Phase 5 (CMIP5) results, these values should be understood as indicative only, as the climate forcing resulting from all drivers varies between models due to specific model characteristics and treatment of short-lived climate forcers. These four RCPs include one mitigation scenario leading to a very low forcing level (RCP2.6), two stabilization scenarios (RCP4.5 and RCP6), and one scenario with very high greenhouse gas emissions (RCP8.5). The RCPs can thus represent a range of 21st century climate policies, as compared with the no-climate policy of the Special Report on Emissions Scenarios (SRES) used in the Third Assessment Report and the Fourth Assessment Report. For RCP6.0 and RCP8.5, radiative forcing does not peak by year 2100; for RCP2.6 it peaks and declines; and for RCP4.5 it stabilizes by 2100. Each RCP provides spatially resolved data sets of land use change and sector-based emissions of air pollutants, and it specifies annual greenhouse gas concentrations and anthropogenic emissions up to 2100. RCPs are based on a combination of integrated assessment models, simple climate models, atmospheric chemistry and global carbon cycle models. While the RCPs span a wide range of total forcing values, they do not cover the full range of emissions in the literature, particularly for aerosols.

Most of the CMIP5 and Earth System Model simulations were performed with prescribed CO_2 concentrations reaching 421 ppm (RCP2.6), 538 ppm (RCP4.5), 670 ppm (RCP6.0), and 936 ppm (RCP 8.5) by the year 2100. Including also the prescribed concentrations of CH_4 and N_2O, the combined CO_2-equivalent concentrations are 475 ppm (RCP2.6), 630 ppm (RCP4.5), 800 ppm (RCP6.0), and 1313 ppm (RCP8.5). For RCP8.5, additional CMIP5 Earth System Model simulations are performed with prescribed CO_2 emissions as provided by the integrated assessment models. For all RCPs, additional calculations were made with updated atmospheric chemistry data and models (including the Atmospheric Chemistry and Climate component of CMIP5) using the RCP prescribed emissions of the chemically reactive gases (CH_4, N_2O, HFCs, NO_x, CO, NMVOC). These simulations enable investigation of uncertainties related to carbon cycle feedbacks and atmospheric chemistry.

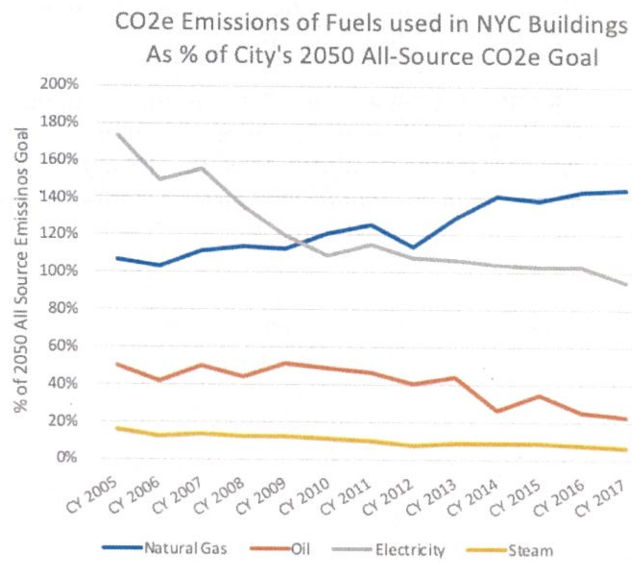
Testimony of Bob Wyman, 24 June 2019

In General: It is essential that New York City accelerate the process of replacing fossil fueled heating systems with non-emitting systems, such as those provided by Geothermal District Heating Systems.

It should be remembered that Local Law 66-2014 established city-wide, all-source limits on Greenhouse Gas Emissions which are expressed in terms of percentage reductions from the City's emissions during 2005 when, according to the New York City Greenhouse Gas Inventory, emissions were 61,062,452 tCO2e/year. The limits established by Local Law 66-2014 are:

- 30x30: 30% reduction by 2030 to, at most, 42,743,716 tCO2e/year
- 80x50: 80% reduction by 2050 to, at most, 12,212,490 tCO2e/year

Since 2005, we've made steady progress towards meeting both the 2030 and the 2050 goals. By 2017, citywide emissions from all sources had already been reduced by almost 17%, a bit over half of the 30x30 goal, and emissions from buildings alone had been reduced even more, by 21%. However, while we're making progress on achieving the City's goal and while there remains much that we can do, emissions from the use of natural gas in buildings have risen steadily and now exceed the maximum amount permitted from all-sources in 2050. **We will not meet the 2050 goal as long as emissions from natural gas use in buildings alone remain greater than the maximum amount permitted from all sources.**



During 2017, the most recent year covered by the City's GHG Inventory, **emissions from natural gas use in buildings were 17,639,988 tCO2e or 41% of the citywide, all-sources 2030 limit and <u>144% of the 2050 limit</u>**. Given that natural gas use in buildings continued to grow after 2017, it is certain that the 2019 Inventory, once published, will show even higher emissions from natural gas use.

As can be seen in the chart to the right, building's emissions from the use of oil, electricity and steam have been falling. Given the high cost of oil and steam, we can anticipate further reductions in their use. Also, given passage last week of the New York State Climate Leadership and Community Protection Act, we can assume that emissions from electricity use will be eliminated after 2040. But these dramatic emissions reductions will not allow us to reach our emissions goals as long as natural gas use continues to grow. In fact, a linear extrapolation of the past growth in gas emissions indicates that by 2050, gas emissions will exceed 250% of the 2050 citywide, all-source emissions limit. Meeting the 2050 goals will require that we immediately begin to reduce emissions from natural gas.

Even though the City's laws and its GHG Inventory are well-known, public information, we still have utilities and others arguing for continued oil-to-gas conversions and for the installation of new gas pipelines, such as the NESE pipeline. These proposals should be rejected. The City should focus on conversion of existing fossil fueled heating systems to Beneficial Electrification technologies such as heat pumps – either individual systems or the District Heating systems which are the subject of the bills being reviewed today.

Int 0051-2018: The definition of "Power Purchase Agreement" in the proposed §3-126(f) is flawed.

- § 3-126(f)(1) requires that *"title to all geothermal system infrastructure located on such an owner's property shall vest in that owner at the conclusion of the term of such agreement."* By creating a property ownership interest in the geothermal system, this requirement ensures that the Federal Internal Revenue Service will consider the "PPA" to be a financing and not, in fact, a PPA. Thus, the owner of the property, not the system, will be considered the system's owner for Federal tax purposes. As a result, any tax benefits (such as Energy Tax Credits or accelerated depreciation) will belong to the property owner, not the developer who installs and pays for the system. In many cases, this will lead to an inefficient use of tax benefits and thus higher costs than would otherwise be the case. If the property owner is a non-taxed non-profit or government agency, then the tax credits would simply be wasted.

  The PPA should provide an option for the property owner to buy-out the installed system, at fair market value, at any time after six years. (i.e. after the benefits of tax incentives have been exhausted.) If the property owner is allowed to assume system ownership at a cost less than fair market value, the PPA will be considered a financing, not a PPA.

- § 3-126(f)(2) requires that *"The duration of a power purchase agreement executed pursuant to this section shall not exceed seven years."* The limitation of the PPA's term to only seven years will ensure that no developer will offer a PPA.

  If we assume, as we should, that savings from the system's installation will be shared between the developer and the property owner, seven years is simply not enough time to ensure a reasonable pay-back for the developer. The term of the PPA should be negotiated, based on project specific conditions. If an arbitrary limit on term is to be created, it should not be less than twenty years.

Heat Pump Opportunities Using Hybridization and Seasonal Thermal Storage

Jim Thomas

Owner, Thomas Geothermal Engineering

Gaylord Olson

Co-founder, Seasonal Storage Technologies

Dr. Yao Yu

Assistant Professor, North Dakota State University

Better TOGETHER

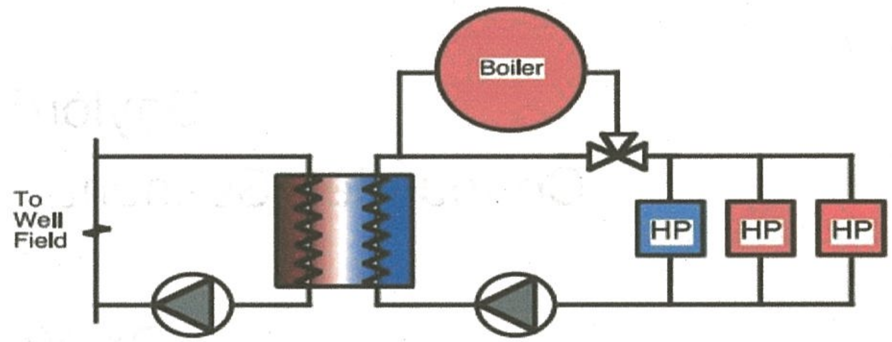
IGSHPA Conference & Expo 2018

IGSHPA

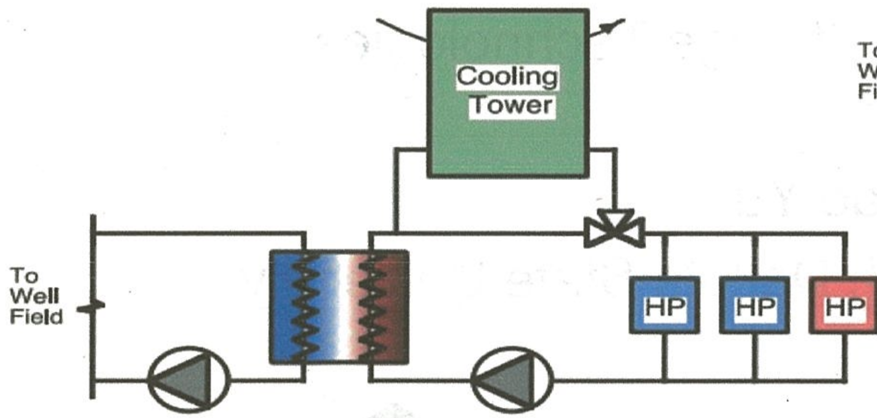
www.globalengineeringconference.com/GEC2012Presentations/Workshops/2012_GEC_ALDERSON_3_23_12.pdf

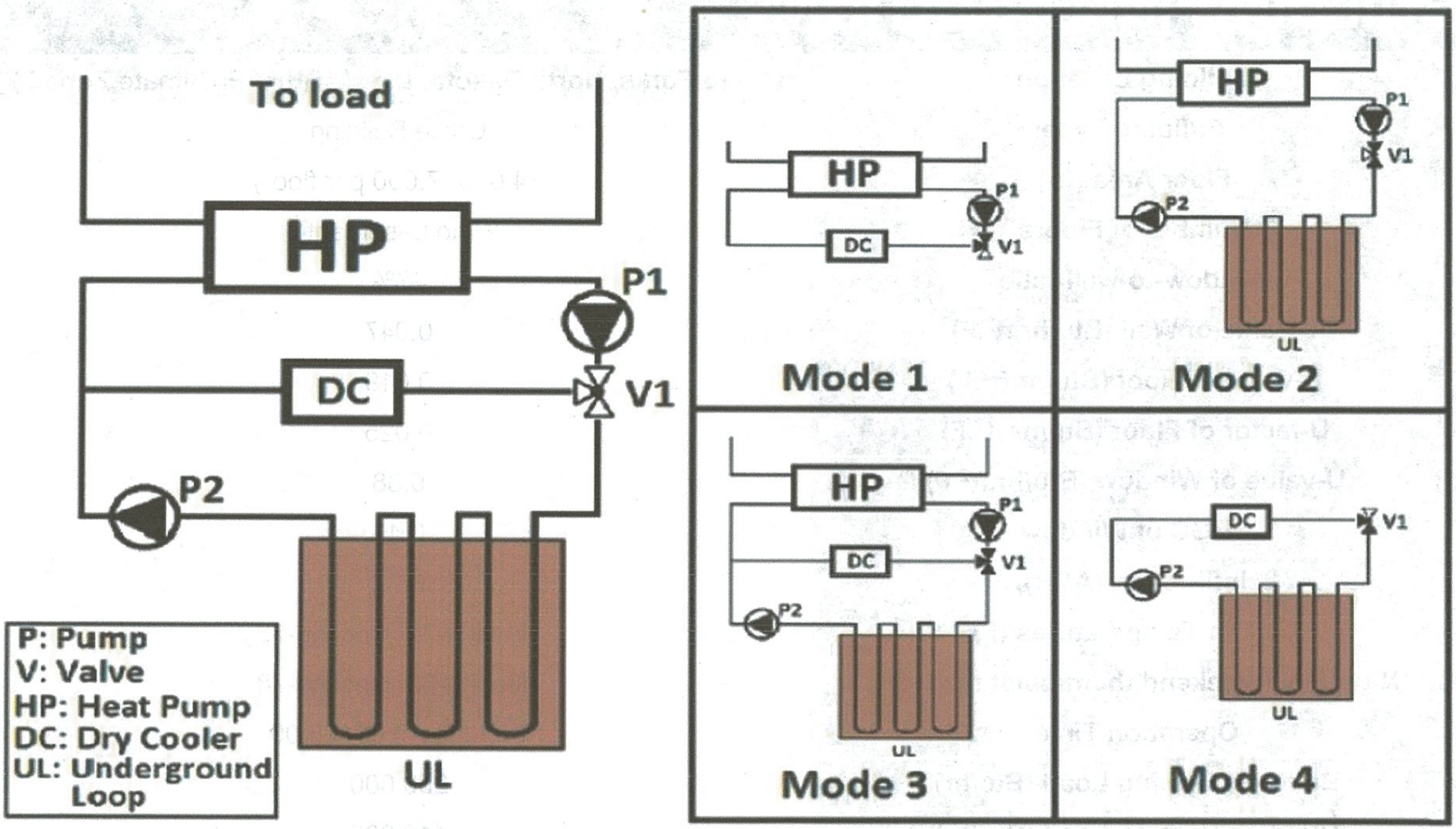
Hybrid Systems

Hybrid System with Boiler



Hybrid System with Cooling Tower





Multi-source system with four operation modes

BUILDING INFORMATION

Building Location	Grand Forks, North Dakota, U.S. (ASHRAE Climate Zone 7)
Building Type	Office Building
Floor Area (ft^2)	14,000 (7,000 per floor)
Number of Floors	2 (no basement)
Window-to-wall ratio	43%
U value of Wall ($Btu/hr.ft^2.F$)	0.047
U-value of Roof ($Btu/hr.ft^2.F$)	0.019
U-factor of Floor ($Btu/hr.ft^2.F$)	0.025
U-value of Window ($Btu/hr.ft^2.F$)	0.38
SHGC of Window	0.45
Infiltration (ACH)	0.72
Design Temperatures (F)	Heating-72 Cooling-72
Nighttime/Weekend thermostat reset (F)	Heating-65 Cooling-78
Operation Time	Workday-7:00~19:00
Building Cooling Load (Btu/hr)	250,000
Building Heating Load (Btu/hr)	412,000
Outdoor Temperature for Heating Design °F)	-24.7 (TMY3 data)
Outdoor Temperature for Cooling Design (F)	95.5 (TMY3 data)
Number of Zones in Simulation	2 (1^{st} and 2^{nd} floors)
Number of People	65
Light Power Density (W/ft^2)	0.8
Equipment Load Density (W/ft^2)	0.35

20 YEAR LOWEST WATER TEMPERATURE COMPARISON

Dry Cooler (100% Capacity = 521.2 MBH with Two BreezeMaster Dry Cooler - Model DC-4-12)	Ground Loop (100% Capacity = 40 boreholes with the depth of 220ft)	20 yrs Lowest Water T from HPs [F] (Case 1 - Without Preconditioning)	20 yrs Lowest Water T from HPs [F] (Case 2 - With Preconditioning)
0% (0 MBH)	100% (40 boreholes)	23.0	23.0
10% (52.12 MBH)	90% (36 boreholes)	20.3	26.6
20% (104.24MBH)	80% (32 boreholes)	18.0	23.0
30% (156.36 MBH)	70% (28 boreholes)	14.5	20.8
40% (208.48 MBH)	60% (24 boreholes)	10.0	17.6
50% (260.6 MBH)	50% (20 boreholes)	4.6	13.1
60% (312.72 MBH)	40% (16 boreholes)		
70% (364.84 MBH)	30% (12 boreholes)		
80% (416.96 MBH)	20% (8boreholes)		
90% (469.08MBH)	10% (4 boreholes)		
100% (521.2 MBH)	0% (0 boreholes)		

Get Colder

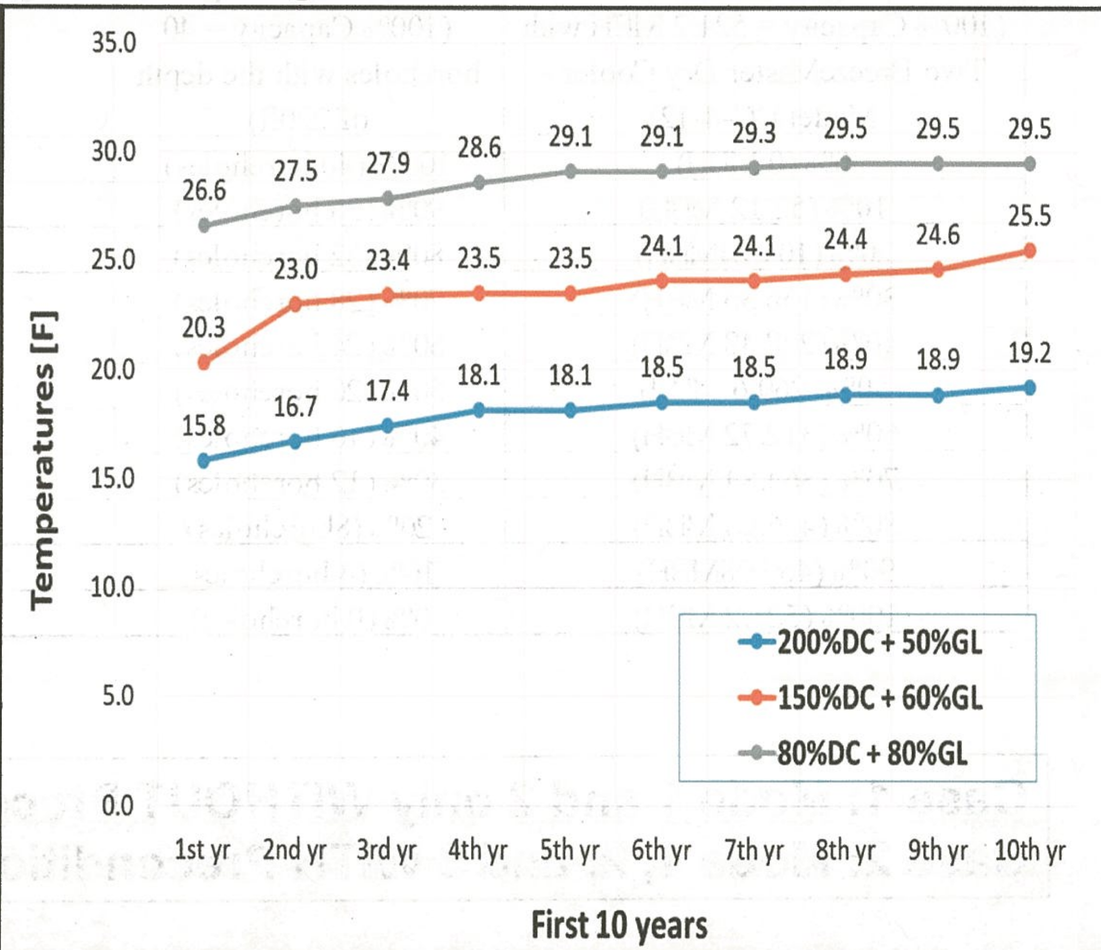
Get Colder

Case 1: Mode 1 and 2 only WITHOUT Preconditioning Mode (Mode 3)
Case 2: Mode 1, 2, and 3 WITH Preconditioning Mode

WHAT IF WE MAXIMIZE THE PRECONDITIONING IN CASE 2?

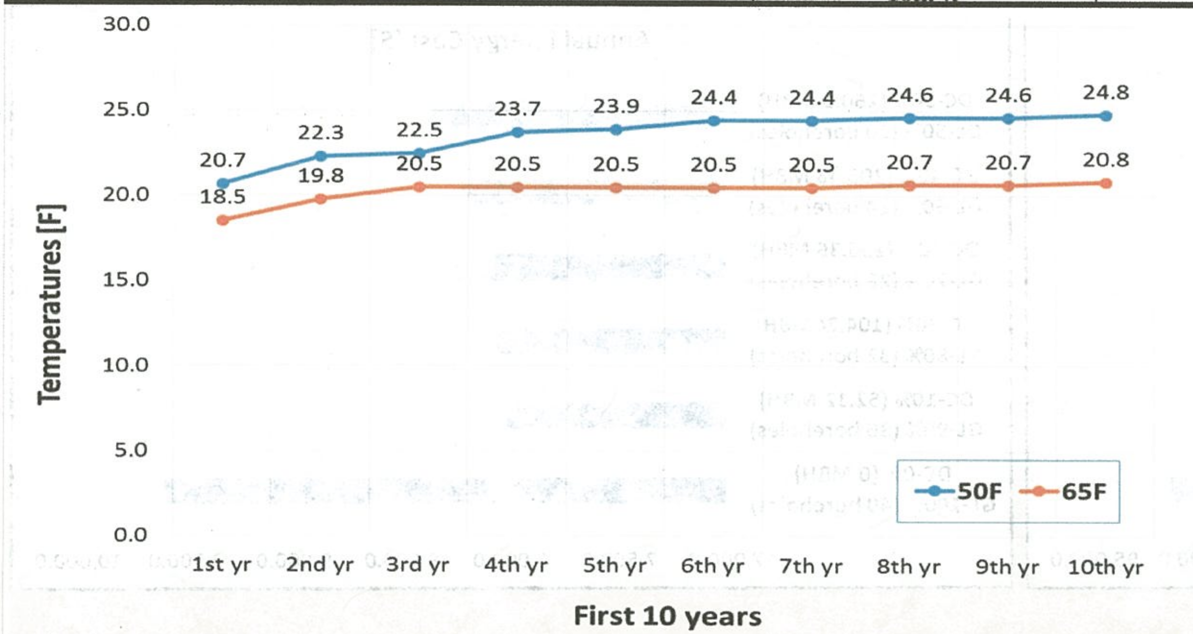
If the nighttime/weekend thermostat reset has been changed to Heating 50F and Cooling 80F, allowing to maximize the preconditioning mode.

Dry Cooler (100% Capacity = 521.2 MBH with Two BreezeMaster Dry Cooler - Model DC-4-12)	Ground Loop (100% Capacity = 40 boreholes with the depth of 220ft)	Lowest Water T from HPs [F] (Case 2 - With Preconditioning)	
200% (1042.4 MBH)	50% (20 boreholes)	1st yr	15.8
		2nd yr	16.7
		3rd yr	17.4
		4th yr	18.1
		5th yr	18.1
		6th yr	18.5
		7th yr	18.5
		8th yr	18.9
		9th yr	18.9
		10th yr	19.2
150% (781.8 MBH)	60% (24 boreholes)	1st yr	20.3
		2nd yr	23.0
		3rd yr	23.4
		4th yr	23.5
		5th yr	23.5
		6th yr	24.1
		7th yr	24.1
		8th yr	24.4
		9th yr	24.6
		10th yr	25.5
80% (416.96 MBH)	80% (32 boreholes)	1st yr	26.6
		2nd yr	27.5
		3rd yr	27.9
		4th yr	28.6
		5th yr	29.1
		6th yr	29.1
		7th yr	29.3
		8th yr	29.5
		9th yr	29.5
		10th yr	29.5



HOW THE NIGHTTIME/WEEKEND THERMOSTAT RESET THE RESULT?

Dry Cooler (100% Capacity = 521.2 MBH with Two BreezeMaster Dry Cooler - Model DC-4-12)	Ground Loop (100% Capacity = 40 boreholes with the depth of 220ft)	Lowest Water T from HPs [F] (Case 2 - With Preconditioning) Nighttime/Weekend Thermostat Reset - Heating 50F and Cooling 78F		Lowest Water T from HPs [F] (Case 2 - With Preconditioning) Nighttime/Weekend Thermostat Reset - Heating 65F and Cooling 78F	
200% (1042.4 MBH)	60% (24 boreholes)	1st yr	20.7	1st yr	18.5
		2nd yr	22.3	2nd yr	19.8
		3rd yr	22.5	3rd yr	20.5
		4th yr	23.7	4th yr	20.5
		5th yr	23.9	5th yr	20.5
		6th yr	24.4	6th yr	20.5
		7th yr	24.4	7th yr	20.5
		8th yr	24.6	8th yr	20.7
		9th yr	24.6	9th yr	20.7
		10th yr	24.8	10th yr	20.8



Hybrid System Cost:

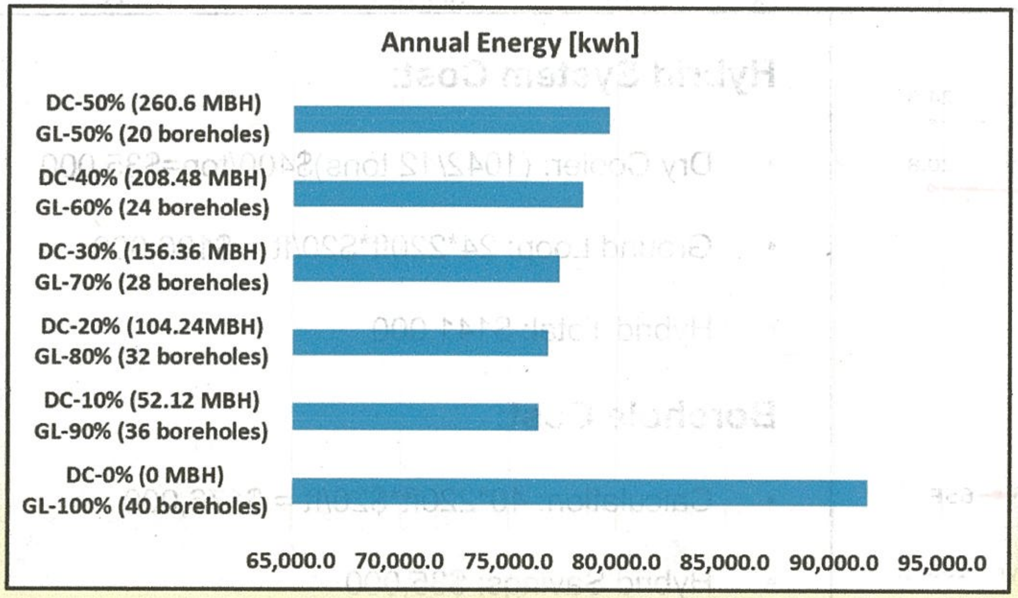
- Dry Cooler: (1042/12 tons)$400/ton=$35,000
- Ground Loop: 24*220ft*$20/ft = $106,000
- Hybrid Total: $141,000

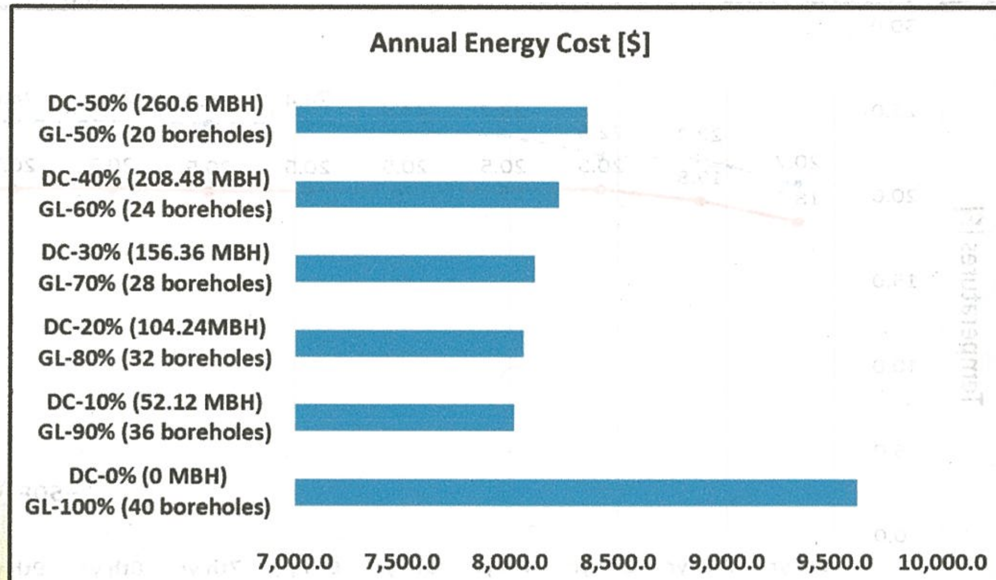
Borehole Cost:

- Calculation: 40*220ft*$20/ft = $176,000
- Hybrid Savings: $35,000

POTENTIAL ENERGY AND ENERGY COST SAVINGS FOR HEAT PUMPS DUE TO MORE DESIRABLE RETURN WATER TEMPERATURES

Dry Cooler (100% Capacity = 521.2 MBH with Two BreezeMaster Dry Cooler - Model DC-4-12)	Ground Loop (100% Capacity = 40 boreholes with the depth of 220ft)	Annual Heat Pump Compressor Energy [kwh]	Annual Heat Pump Compressor Energy Cost ($0.104957/kwh)	Remark
0% (0 MBH)	100% (40 boreholes)	91,509.5	9,604.6	Typical Ground Loop
10% (52.12 MBH)	90% (36 boreholes)	76,369.8	8,015.5	Hybrid - Case 2 With Original Nighttime/Weekend Thermostat Reset (Heating 65F and Cooling 78)
20% (104.24MBH)	80% (32 boreholes)	76,806.0	8,061.3	
30% (156.36 MBH)	70% (28 boreholes)	77,307.6	8,114.0	
40% (208.48 MBH)	60% (24 boreholes)	78,369.1	8,225.4	
50% (260.6 MBH)	50% (20 boreholes)	79,586.3	8,353.1	



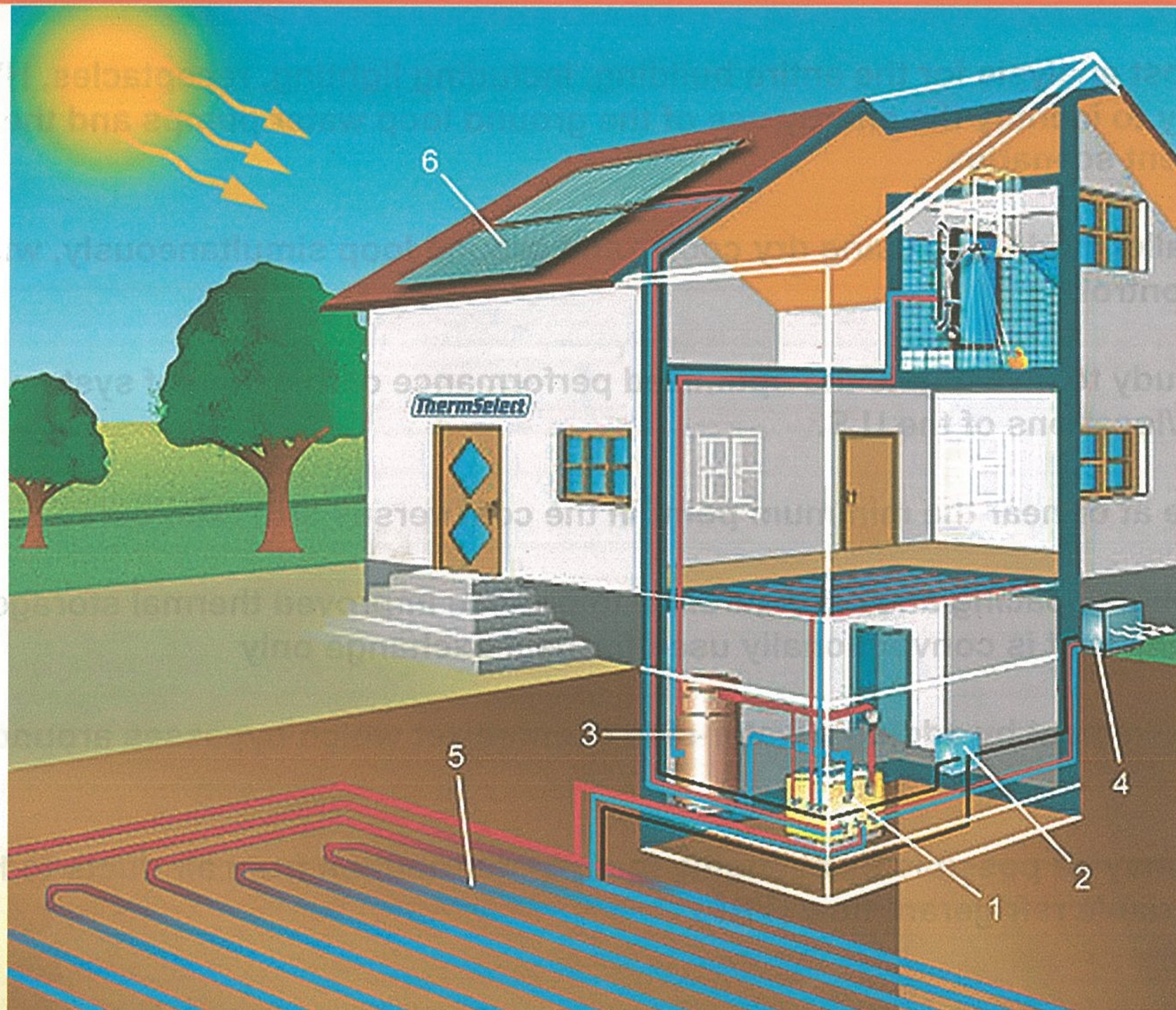


Possible Next Steps

- Energy and cost analysis for the entire building, including lighting, receptacles, HVAC systems, etc., especially to identify the energy use of the ground loop water pumps and the dry cooler fans for different scenarios
- Allow the parallel mode, i.e., using dry cooler and ground loop simultaneously, with an appropriate control
- Expand the study to investigate the optimized performance of this type of system in various climate zones/locations of the U.S.
- May not yet be at or near the minimum point in the cost versus size ratio curve
- Optimize borehole spacing and configuration to provide improved thermal storage rather than the wide spacing that is conventionally used for heat exchange only
- Possible improvement by adding a water-side economizer which bypasses around the heat pump
- Improvement may be possible by changing internal distribution from air ducts to hydronic (radiant) or variable refrigerant flow (VRF)

Thermselect Hybrid System

https://www.thermselect.de/



1/8/2019

To Costa Constantinides

RE: Energy as a service – "EAAS" with a Fisonic thermal energy solution.

Dear Mr. Constantinides
Fisonic Energy is a New York City-based energy & technology company. Fisonic offers resilient, energy savings solutions for the NYC building sector.

Buildings that only use Con Ed steam for heating energy are purchasing more steam then is necessary based on what is now possible with Fisonic technology.

The Con Ed steam system is a "one-way system". A modern district energy system is a two-way "Steam & Condensate Return" system. The reduced fuel cost and water resources savings are huge between a one way and two-way steam system.

Unfortunately, the Con Ed "one-way system" does not allow for the recovery or reuse of the condensate water & thermal energy. A Fisonic system can help buildings bridge this larger efficiency gap.

Buildings that only use the Con Ed steam for heating and domestic hot water are putting additional environmental burdens on our municipal city water and sewer system. Con Ed steam building are typically having to pay higher bills for water and sewer then is necessary and every pound of steam used ends up in our sewer system.

To legally dispose of the hot condensate, building operators will cool the condensate before it enters the NYC sewer system with potable water.

Following Mayor Bill di Blasio's NYC Climate action plan, One City: Built to Last aka '80 X 50'

Fisonic would like to offer a modern, resilient & environmentally sound solution for energy reduction complimented with guaranteed lower operational costs.

It is our understanding that there are currently **52 building in the DCAS portfolio** that are using Con Ed steam at this time and could benefit from our solution.

The Fisonic modern heating method will save millions of dollars in energy & fresh water in NYC and has Zero capital expense for the building owner.

We would like to invite you to see this technology in operation.

Fisonic systems currently operating at the Woolworth Building 233 Broadway (also our testing & energy laboratory)

We have installed Fisonic systems in other DCAS managed buildings & the results have been very positive about energy savings and from the building's engineering staff.

Under direction of Daniel Donovan from DCAS, Fisonic has installed an energy saving system in the Municipal building located at 1 Centre Street.

We would like to meet to discuss how we can help other city-owned buildings reduce energy consumption and cost.

Robert Kremer CEO

www.fisonic.com || Woolworth Building 233 Broadway New York, NY 10007

P: 212 732 3777 | C: 917 806 6230 | F: 917 595 5370

USA VETERAN OWNED BUSINESS

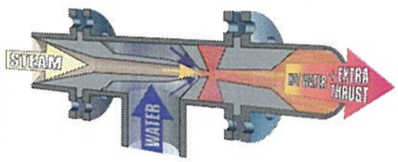
Service Disabled Veteran Owned Small Business SDVOSB CVE

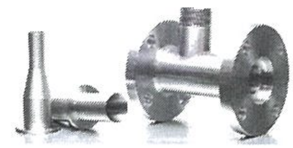
HFC Hudson Fisonic Corp. | 233 Broadway, New York NY | 212 732 3777 | www.fisonic.us

Fisonic Energy is transforming the way we use thermal energy in New York City.

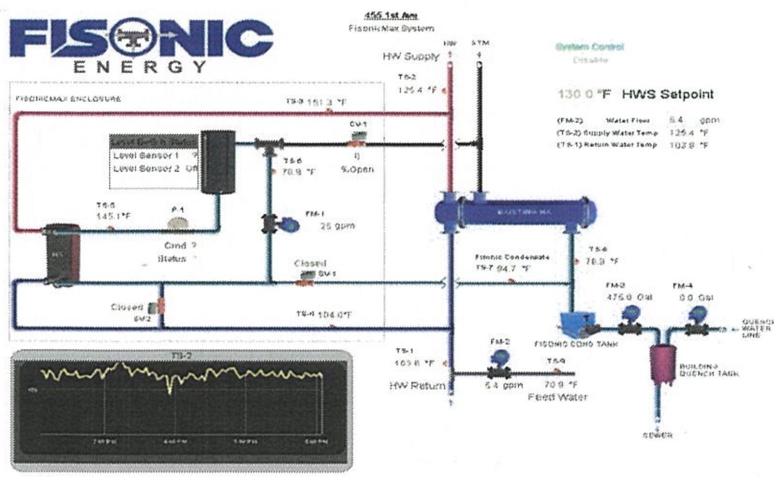
MADE IN NYC

USA VETERAN OWNED BUSINESS





Fisonic Feature	**Building Benefit**
Reducing or eliminating condensate sewer charges	Reduction in building water use for heating
Multiple fuel input choices	Improved building thermal resiliency
Fisonic Nozzles have zero moving parts	No maintenance requirements
Reduced thermal energy use	Lower cost and lowers carbon intensity
24/7/365 open source monitoring	Better access to information for managers
Fisonic Nozzles create 2 phase flow	Allows condensate to be re-purposed
Fisonic systems enable the amplification of heat	Reduces the raw energy use in a building



Green Map System
292 East Third St, #1A
New York, NY 10009 USA
Tel: +1 212 674 1631

Wendy E Brawer
Director
web@greenmap.org

GreenMap.org
Think Global, Map Local!

I support declaration of a Climate Emergency for NYC. June 24, 2019

I'm Wendy Brawer, director of Green Map System and a sustainability and climate change design professional with 30 years of experience. My nonprofit's 2006 energy-themed Green Map of NYC included many of the climate issues we are grappling with now. I've been named a LES Community Hero, a TED Resident and received multiple Service certificates from NYC Mayors. I'm a zero waste advocate and everyday cyclist, and I am co-developer of NYC's first certified Net Zero Passive House building (see R-951.com).

Our City is most vulnerable, not only from climate change, but also from the breakdown in social cohesion that becomes more evident each day. Some of the divisions in our community could be bridged with stewardship, greening and preparedness projects - these would also build capacity, trust and social resilience, and help us both mitigate and adapt to climate change. This is a critical missing link! As we learned in Sandy, a sense of interdependency is key to our common future. Let's include everyone in addressing the Climate Emergency!

I included social resilience in a recent letter to Councilmember Rivera, who has stated the East Side Coastal Resilience project does not need to comply with a State law on Alienation when it comes to adding a flood barrier to East River Park. This means, rather than have professional oversight on this complicated project and the City's antiquated approach, she's recommending a community advisory group do it. While we need to come to a Yes on that emblematic $1.5 billion project and protect local residents, the destruction of natural systems and disregard of State Law should not be considered 'as of right'.

I support Intro 1399, a NYC Department of Sustainability and Climate Change - it goes hand in hand with declaring a Climate Emergency, and will help all future planning include the difficult decisions ahead about the cross-cutting emergency we fear most.

Tell the Truth is the Extinction Rebellion's #1 point. The City must be forthright and start engaging with us on a daily basis, using all means to help citizens, businesses, agencies and schools all see ourselves as part of the solution. Call out the true cost of flying, motor vehicles and over consumption, and keep all us in the loop.

I support Intro Bill 0140-2018 for Community Choice Aggregation, and recommend the following for a NYC CCA bill:
1- must be an opt-out program
2- must be for 100% renewable energy
3- include a pilot program for willing communities that meet defined criteria

NYC City Council! Let's move on this, while we still can

Wendy Brawer

Green Map System
292 East Third St, #1A
New York, NY 10009 USA
Tel: +1 212 674 1631

Wendy E Brawer
Director
web@greenmap.org

GreenMap.org
Think Global, Map Local!

I support declaration of a Climate Emergency for NYC. June 24, 2019

I'm Wendy Brawer, director of Green Map System and a sustainability and climate change design professional with 30 years of experience. My nonprofit's 2006 energy-themed Green Map of NYC included many of the climate issues we are grappling with now. I've been named a LES Community Hero, a TED Resident and received multiple Service certificates from NYC Mayors. I'm a zero waste advocate and everyday cyclist, and I am co-developer of NYC's first certified Net Zero Passive House building (see R-951.com).

Our City is most vulnerable, not only from climate change, but also from the breakdown in social cohesion that becomes more evident each day. Some of the divisions in our community could be bridged with stewardship, greening and preparedness projects - these would also build capacity, trust and social resilience, and help us both mitigate and adapt to climate change. This is a critical missing link! As we learned in Sandy, a sense of interdependency is key to our common future. Let's include everyone in addressing the Climate Emergency!

I included social resilience in a recent letter to Councilmember Rivera, who has stated the East Side Coastal Resilience project does not need to comply with a State law on Alienation when it comes to adding a flood barrier to East River Park. This means, rather than have professional oversight on this complicated project and the City's antiquated approach, she's recommending a community advisory group do it. While we need to come to a Yes on that emblematic $1.5 billion project and protect local residents, the destruction of natural systems and disregard of State Law should not be considered 'as of right'.

I support Intro 1399, a NYC Department of Sustainability and Climate Change - it goes hand in hand with declaring a Climate Emergency, and will help all future planning include the difficult decisions ahead about the cross cutting emergency we fear most.

Tell the Truth is the Extinction Rebellion's #1 point. The City must be forthright and start engaging with us on a daily basis, using all means to help citizens, businesses, agencies and schools all see ourselves as part of the solution. Call out the true cost of flying, motor vehicles and over consumption, and keep all us in the loop.

I support Intro Bill 0140-2018 for Community Choice Aggregation, and recommend the following for a NYC CCA bill:
1- must be an opt-out program
2- must be for 100% renewable energy
3- include a pilot program for willing communities that meet defined criteria

NYC City Council! Let's move on this, while we still can

Wendy Brawer

Green Building Worldwide
110 Wall Street, Suite 6-053
New York, New York 10005
Telephone: 212.500.1160
www.greenbuildingww.com

Testimony of
Michael Gersho, Green Building Worldwide Research Fellow
Before the
New York City Council Committee on Environmental Protection
on
0140-2018; 0269-2018 SUPPORT
June 24, 2018

I. Intro

Thank you members of the Council for giving me the opportunity to speak today. My name is Michael Gersho, I am a fellow at Green Building Worldwide, an organization dedicated to promoting sustainable practices in development. GBW is known for its ability to unite Minority and Women owned Business Enterprises with the City's largest players to ensure that all are aware and have equal understanding of development, sustainability and resiliency initiatives.

II. Community Choice Aggregators

I would like to comment on initiative 0140-2018- Community Choice Aggregation Programs, abbreviated as CCAs. CCAs are an essential tool for the modernization of the energy economy and promotion of clean energy sources. By allowing the government or a government entity to purchase energy for communities, a mix of energy can be provided to consumers that comes from a broad range of sources, including renewables. This can encourage the adoption of renewable energy, which is a necessity in a world where greenhouse gas emissions are causing the existential threat of climate change. Promoting renewables in any capacity will help the state meet its targets for Reforming the Energy Vision: fifty percent renewable energy and forty percent reduction in 1990 emissions levels by 2030.[1]

Existing Community Choice Aggregation Programs have been a resounding success in eight states thus far, and a similar program in New York City would likely be no exception. In 2017, over 750 CCAs provided 42 million megawatt hours of energy to an estimated five million consumers.[2] CCAs are required to meet the same renewable energy mandates that apply to traditional utilities, so a CCA in New York would be bound by the Clean Energy Standard to procure a certain portion of its portfolio from renewables. But many CCAs choose to go above and beyond this minimum renewable portfolio requirement. Over 100 CCAs procured a combined 8.9 million megawatt hours of voluntary renewable energy in 2017.[3] CCAs are already a proven concept in New York State. Over half the energy supplied by the Westchester Power CCA is voluntary, and the program has saved over 10 million dollars for over 100,000 county residents and businesses.[45] With around 8 million people in New York City compared to slightly under 1 million in Westchester County, there is massive potential for increased renewable energy consumption.[6]

Community Choice Aggregators in New York City could also help the city comply with the newly minted Climate Mobilization Act. The Climate Mobilization Act sets emissions

---

[1] "DPS Reforming the Energy Vision." New York State. Accessed June 24, 2019. http://www3.dps.ny.gov/W/PSCWeb.nsf/All/CC4F2EFA3A23551585257DEA007DCFE2?OpenDocument.

[2] O'Shaughnessy, Eric, Jenny Heeter, Julien Gattaciecca, Jenny Sauer, Kelly Trumbull, and Emily Chen. 2019. *Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-72195. https://www.nrel.gov/docs/fy19osti/72195.pdf.

[3] Ibid.

[4] "Frequently Asked Questions." Westchester Power. Accessed June 24, 2019. https://www.westchesterpower.org/frequently-asked-questions/.

[5] "New York." LEAN Energy US. Accessed June 24, 2019. http://leanenergyus.org/cca-by-state/new-york/.

[6] "Current and Projected Populations." NYC.gov. Accessed June 24, 2019. https://www1.nyc.gov/site/planning/data-maps/nyc-population/current-future-populations.page.

intensity limits for buildings over 25,000 square feet.[7] Under the Act, property owners have the ability to deduct from their annual emissions through the purchase of renewable energy credits. However any RECs used for deductions need to be generated in or directly deliverable to the Zone J Load Zone of New York City. Currently little to no energy sources that meet this set of criteria exist, however this will likely change in the near future, as two projects are being planned to directly deliver renewables to the city via direct HVDC cables.[8] Community Choice Aggregators can choose where the energy mix they supply comes from, giving them the potential to acquire renewable energy certificates from sources deliverable to New York City. If these new energy transmission projects comes to fruition, then CCAs could help building owners meet emissions reduction targets mandated under bill 1253-c of the Climate Mobilization Act

However the fact that the proposed program is opt-out means certain precautions need to be taken. Having an opt-out program allows people and businesses to choose not to participate in such a program, rather than choosing to participate in the program. Opt-out programs typically get significantly more participation than opt-in programs, due to the simple fact that customers have to take an action to leave the program, rather than having to take action to join the program.[9] This does raise some concerns of taking advantage of the misinformed, as some people may not understand the implications of a Community Choice Aggregation, or they may

---

[7] "The Climate Mobilization Act Overview." Building Energy Exchange. Accessed June 24, 2019. https://be-exchange.org/insight/the-climate-mobilization-act-int-1253/.

[8] "New York City Passes GHG Emissions Cap for Buildings - Local Law 97." EnergyWatch. June 10, 2019. Accessed June 24, 2019. https://energywatch-inc.com/breaking-new-york-city-council-passes-first-of-its-kind-ghg-emissions-cap-for-buildings/.

[9] O'Shaughnessy, Eric, Jenny Heeter, Julien Gattaciecca, Jenny Sauer, Kelly Trumbull, and Emily Chen. 2019. *Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-72195. https://www.nrel.gov/docs/fy19osti/72195.pdf.

be too busy with the goings on of their daily lives to fully understand what they are being signed up for. Extensive interviews with participants in CCAs have shown that many people are completely unaware that a change in their electricity supplier has occurred after the CCA is implemented. This is significant because there is a very real possibility that CCA energy rates could sometimes be higher than standard utility rates.[10] People should not have to bear the costs of higher rates without being informed of these possibilities.

The proposed feasibility study should take care to examine the best ways to make sure participants understand what aggregation is, and what its potential implications are for their energy bills. Additionally, the city should make sure any program that could result from this study gives participants ample time and warnings for consumers to opt out. Because Community Choice Aggregations are focussed on community, the feasibility study should hold stakeholder meetings to address concerns and take into account the needs of communities that may be participating in the new programs.

III. Solar Power Pilot Program

I would also like to take this opportunity to speak on initiative 0269-2018. The Solar Power Pilot Program will undoubtedly help aid the transition to a healthier planet, as well as establishing a more robust and modern energy grid. By using only solar thermal and photovoltaic systems to power a community, this measure takes advantage of distributed energy sources. These energy sources provide two distinct benefits: 1) They provide the obvious benefit of providing energy without directly producing emissions; 2)They make the community less dependent on the power grid at large.

This second benefit is just as important as the first. The grid is large, inefficient, and often unstable. When power is transmitted over long distances, much of it is lost or wasted due

[10] Ibid.

to the nature of transmission technology.[11] Sending power from centralized power plants to consumers long distances away is inherently wasteful, and outdated. Producing power close to the point of consumption eliminates these inefficiencies, which makes distributed resources like solar thermal and photovoltaic especially appealing. Additionally traditional energy infrastructure like power lines and substations are vulnerable to extreme weather events like Hurricane Sandy in 2012 ("Superstorm Sandy").[12] Localized energy sources are more resilient, and can get back up and running much faster after a disaster (Greentech Media).[13] This is especially important in the coming years, as climate change promises to make these disasters more frequent and intense. By working to lower emissions and modernizing the grid, this initiative will make a real difference for New Yorkers statewide. Thank you for the opportunity to provide testimony today.

---

[11] Wirfs-Brock, Jordan. "Lost In Transmission: How Much Electricity Disappears Between A Power Plant And Your Plug?" Inside Energy. November 6, 2015. Accessed June 24, 2019. http://insideenergy.org/2015/11/06/lost-in-transmission-how-much-electricity-disappears-between-a-power-plant-and-your-plug/.

[12] Lacey, Stephen. "Resiliency: How Superstorm Sandy Changed America's Grid." Greentech Media. June 11, 2014. Accessed June 24, 2019. https://www.greentechmedia.com/articles/featured/resiliency-how-superstorm-sandy-changed-americas-grid#gs.hrflkb.

[13] Merchant, Emma Foehringer. "One Year After Maria, Puerto Rico's Energy Future Still in Limbo." Greentech Media. September 20, 2018. Accessed June 24, 2019. https://www.greentechmedia.com/articles/read/one-year-after-maria-puerto-ricos-energy-future-still-in-limbo#gs.hredpp.

Testimony of Philip Chen
Research Fellow, Green Building Worldwide

Before the Committee on Environmental Protection
Of the New York City Council

June 24th, 2019

Supporting Intro 0049-2018 and 0051-2018

Intro 0049-2018

Overview

The first bill in the packet intro 0049-2018, a local law to amend the administrative code of the city of New York, in relation to installation of utility-scale battery storage systems on city buildings and conducting a feasibility study on installation of such systems throughout the city. If passed, it amends an administrative code for New York City to require city owned buildings to add batteries if they pass a feasibility test. In conjunction, the Climate Mobilization Act requires buildings to reduce their emissions by a percentage on a set timeline. Both the cities initiative and the CMA are assisting each other with their goals while providing a green innovative solution.

Case Study

This is an interesting way to be environmentally friendly. Assuming that each building will get their very own battery as stated in the bill, this is a good start but not a great solution. When placed in individual buildings, like in a case study pilot program done by NYSERDA in the Marcus Garvey Apartments in Brooklyn, tenants were able to be connected to a more reliable and cheaper electrical grid by reducing its peak demand electricity usage by 25% allowing for a more sustainable property, have 12 hours of emergency backup power for necessities, and the owner saved money by lowered operating costs. Additionally, the microgrid also reduced Con Edison's peak demand in the area by 207 kW (NYSERDA) (NYSolarMap).

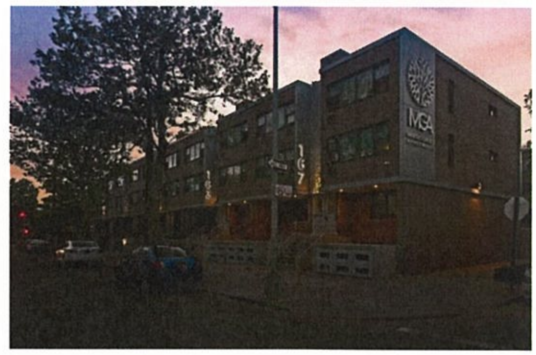


Figure 1: Marvin Garvey Apartments in Brooklyn, NY

This was the first Solar+Storage system in New York City and was a huge success, garnering the Marcus Garvey Apartments a Building Brooklyn award in July 2017. However, these benefits were only experienced by one building. I believe that more can be done so that everyone can experience this greener energy. One way to approach this to have the batteries on the buildings as well as having a setup like a pilot program that Sweden conducted. In their scenario, Volvo electric bus batteries were placed in their second life battery refurbishing program where they still had 80% of their original battery capacity. Then grouped into 200 kWh systems of 14 individual battery packs connected together, they were placed in "power" warehouse buildings around

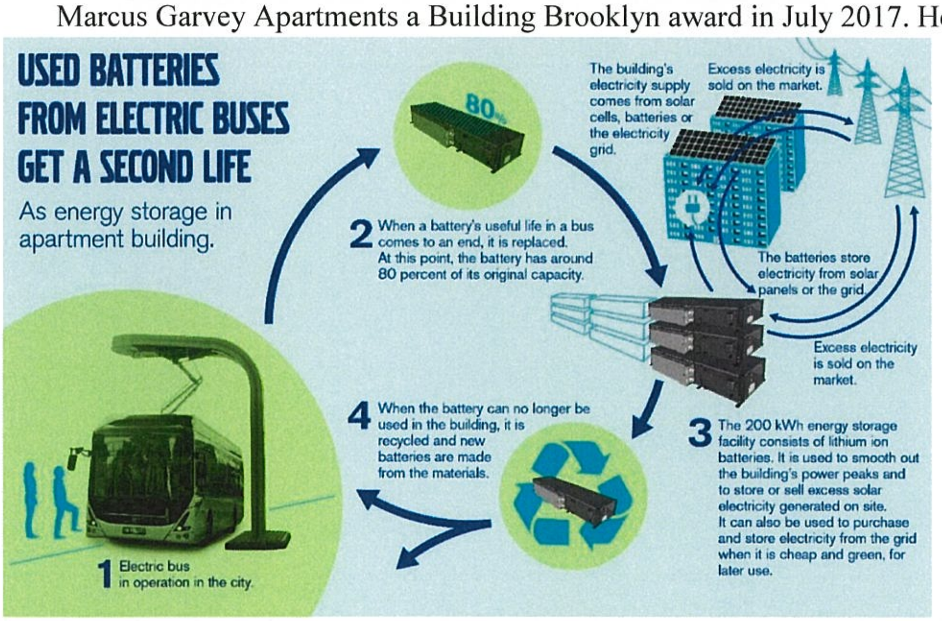


Figure 2: Cycle of Electric Bus Battery

Philip Chen, Research Fellow
Green Building Worldwide
June 24, 2019

Gothenburg, Sweden. Charged by solar panels and extra electricity that the grid produced, the system was turned on during peak demand times to assist with electricity distribution (MDPI).

After conducting a detailed study, there were nothing but amazing results. It was shown that the battery packs improved the energy and electricity quality of the system by balance generation and demand. Just like the Marvin Garvey Apartments, the batteries benefit the host(s) connected. By putting the batteries at the source of the electricity, many more can benefit from cheaper prices and more consistent electricity (MDPI).

Conclusion

Using the same model as Sweeden is with its busses is a great addition to this bill. New York City is currently turning our diesel and compressed natural gas busses to 100% electric. With the current count of 1,700 hybrid and 10 electric busses in NYC, and plans for all 5,700 of the fleet to become electrified by 2040, those batteries will eventually be spent at some point (Inside Climate News). This will leave the city with thousands of bus batteries that still have value once repurposed for building use. Repurposing these batteries gives them a second life, helping NYC become even greener without any negative economic effects.

Intro 0051-2019

Overview

Second, we have intro 0051-2018, mandating the implementation of geothermal and electrical systems on city owned buildings. This is a promising green energy source that functions through an underground pipe system that is either heated or cooled by the earth's natural temperature, then fed to a compressor that handles the compressing and the distribution throughout the building. In California, geothermal powers up to 60% of the upper northern coast. And if we utilized all geothermal areas in the United States, it could power as much as 10% of the nation; and for a source of energy that produces almost no byproducts, of which can be recycled and used in other industries, it is a sustainable source of clean electricity (Energy.gov). Additionally, it is more reliable, with geothermal power available 90% of the time, 365 days a year, whereas coal is only available 75% of the time (Energy.gov).

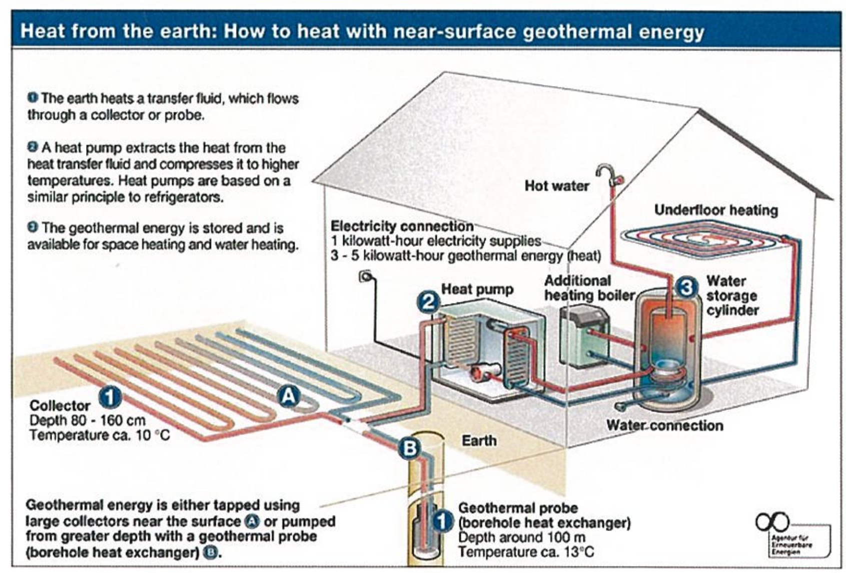


Figure 3: How Geothermal Systems Work; this is the same system in buildings but larger

Cities

Creating a districtwide geothermal system is a great source of green energy and many cities are already utilizing it, powering as much as 90% of the city Reykjavik in Iceland. For a place in the United States, Reno, Nevada has the largest installed geothermal energy capacity on a per person basis. The city is completely self-sufficient, with power plants creating +100 megawatts of power from geothermal energy.

Homeowners

Within individual homes, geothermal systems are able to reduce electricity costs between 50% and 70% and pay for themselves between five and ten years (Mashable) (Energy News). Implemented in residential areas, and proven to be very effective, residents are benefiting from this clean energy. A resident in Ronkonkoma, New York was spending $1,600 just on oil to heat her house. After spending $50,000 for the system and installation, her bill was reduced to $300 for all heating, cooling, and electricity needs. Installed in 2007, she was able to recuperate the cost in seven years (Newsday). Now after many years, geothermal systems have improved in efficiently by 46%, the time it would take to recuperate startup costs would only be reduced as more electricity is available to its host to use (MDPI). Additionally, with the start of many financing programs, tax credits, and grants by energy companies and the government to help people acquire these systems, the time is even further minimized.

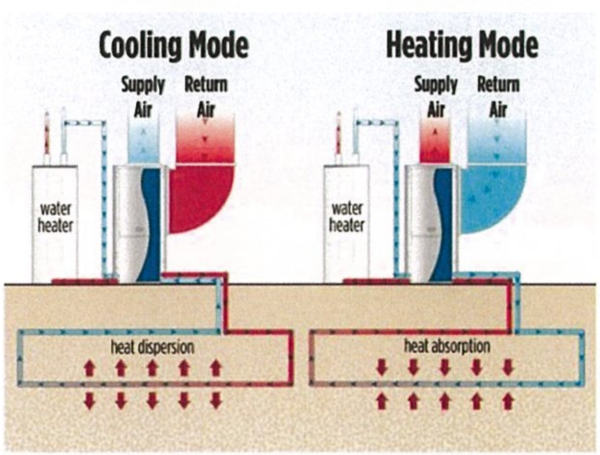


Figure 4: Geothermal Pump

Commercial

The largest commercial system in New York, is the St. Patrick's Cathedral. Completed in 2017, it heats and cools the 76,000 square foot cathedral and the neighboring campus completely from the system. Estimated to be 30% more efficient than the previous system, it saves over 200,000 thousand pounds of carbon dioxide from being released into the atmosphere, which is equivalent to the CO2 emissions of burning 293 barrels of oil. It was praised so highly, in 2018 St. Patrick's Cathedral received an honor from the American Council of Engineering Companies (Clean Technica). Another impressive feat of this technology was exploited in Cornell's Technology Campus on Roosevelt Island. Completely powered by clean renewable energy, their geothermal system contributes to much of this feat. Being called the Ground Source Heat Pump (GSHP), it is expected to save the 2 million square feet campus from producing 500 million pounds of CO_2 emissions a year, or more than 300,000 barrels of oil a year (PRweb).

Conclusion

Both bills focus on reducing carbon emissions and an overall greener New York City. This aligns with the Climate Mobilization Act, also known as the CMA, which is a packet of bills that make NYC reduces its emissions by in different ways. Many of which relate to the bills that I previously mentioned. Intro 1253-C does exactly this by mandating the highest emitting buildings reduce their emissions by a certain year. Installing batteries on buildings as well as geothermal systems will assist in this endeavor, making it easier to reach the lowered emission limits. However, these systems are very costly, and that is where intro 1252-A, a bill that establishes the Property Assessed Clean Energy program (also known as PACE), comes in. This aims to incentivize building owners to install such systems by providing them with enticing financing options that allow them to put little to no money down to receive these renewable energies. These two groups of bills working together ensures that a cleaner NYC is reachable in the future, and with the apparently aggressive timelines set, there should be no problems achieving our goals.

Sources:

https://www.navigantresearch.com/news-and-views/retired-bus-batteries-to-power-buildings-emerging-second-life-battery-market
https://www.weforum.org/agenda/2017/11/battery-batteries-electric-cars-carbon-sustainable-power-energy/
NYSERDA: Enhancing resiliency, reducing energy costs, and increasing tenant comfort with energy storage
https://nysolarmap.com/media/1844/marcus-garvey_casestudy_917.pdf
https://insideclimatenews.org/news/26042018/nyc-air-pollution-electric-bus-public-transportation-mta-clean-technology
https://www.energy.gov/eere/videos/energy-101-geothermal-energy
https://mashable.com/2011/11/23/geothermal-technology/
https://www.energy.gov/eere/geothermal/geothermal-faqs
https://energynews.us/2018/10/15/midwest/geothermal-and-the-city-utilities-and-industry-push-installations-in-chicago/
https://www.newsday.com/lifestyle/home-and-garden/geothermal-air-conditioning-and-heating-can-cut-energy-costs-1.13796182
https://www.mdpi.com/2313-0105/3/1/10
MDPI: A Study on the Efficiency Improvement of Multi-Geothermal Heat Pump Systems in Korea Using Coefficient of Performance By Young-Ju Jung 1 , Hyo-Jun Kim 2 , Bo-Eun Choi 2 , Jae-Hun Jo 3 and Young-Hum Cho 4,*
https://cleantechnica.com/2018/03/19/st-patricks-cathedral-new-york-city-goes-green-35-million-geothermal-installation/
https://www.prweb.com/releases/2017/11/prweb14890311.htm

Green Building Worldwide
110 Wall Street, Suite 6-053
New York, New York 10005
Telephone: 212.500.1160
www.greenbuildingww.com

Testimony of
Michael Gersho, Green Building Worldwide Research Fellow
Before the
New York City Council Committee on Environmental Protection
on
0140-2018; 0269-2018 SUPPORT
June 24, 2018

I. Intro

Thank you members of the Council for giving me the opportunity to speak today. My name is Michael Gersho, I am a fellow at Green Building Worldwide, an organization dedicated to promoting sustainable practices in development. GBW is known for its ability to unite Minority and Women owned Business Enterprises with the City's largest players to ensure that all are aware and have equal understanding of development, sustainability and resiliency initiatives.

II. Community Choice Aggregators

I would like to comment on initiative 0140-2018- Community Choice Aggregation Programs, abbreviated as CCAs. CCAs are an essential tool for the modernization of the energy economy and promotion of clean energy sources. By allowing the government or a government entity to purchase energy for communities, a mix of energy can be provided to consumers that comes from a broad range of sources, including renewables. This can encourage the adoption of renewable energy, which is a necessity in a world where greenhouse gas emissions are causing the existential threat of climate change. Promoting renewables in any capacity will help the state meet its targets for Reforming the Energy Vision: fifty percent renewable energy and forty percent reduction in 1990 emissions levels by 2030.[1]

Existing Community Choice Aggregation Programs have been a resounding success in eight states thus far, and a similar program in New York City would likely be no exception. In 2017, over 750 CCAs provided 42 million megawatt hours of energy to an estimated five million consumers.[2] CCAs are required to meet the same renewable energy mandates that apply to traditional utilities, so a CCA in New York would be bound by the Clean Energy Standard to procure a certain portion of its portfolio from renewables. But many CCAs choose to go above and beyond this minimum renewable portfolio requirement. Over 100 CCAs procured a combined 8.9 million megawatt hours of voluntary renewable energy in 2017.[3] CCAs are already a proven concept in New York State. Over half the energy supplied by the Westchester Power CCA is voluntary, and the program has saved over 10 million dollars for over 100,000 county residents and businesses.[45] With around 8 million people in New York City compared to slightly under 1 million in Westchester County, there is massive potential for increased renewable energy consumption.[6]

Community Choice Aggregators in New York City could also help the city comply with the newly minted Climate Mobilization Act. The Climate Mobilization Act sets emissions

---

[1] "DPS Reforming the Energy Vision." New York State. Accessed June 24, 2019. http://www3.dps.ny.gov/W/PSCWeb.nsf/All/CC4F2EFA3A23551585257DEA007DCFE2?OpenDocument.

[2] O'Shaughnessy, Eric, Jenny Heeter, Julien Gattaciecca, Jenny Sauer, Kelly Trumbull, and Emily Chen. 2019. *Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-72195. https://www.nrel.gov/docs/fy19osti/72195.pdf.

[3] Ibid.

[4] "Frequently Asked Questions." Westchester Power. Accessed June 24, 2019. https://www.westchesterpower.org/frequently-asked-questions/.

[5] "New York." LEAN Energy US. Accessed June 24, 2019. http://leanenergyus.org/cca-by-state/new-york/.

[6] "Current and Projected Populations." NYC.gov. Accessed June 24, 2019. https://www1.nyc.gov/site/planning/data-maps/nyc-population/current-future-populations.page.

intensity limits for buildings over 25,000 square feet.[7] Under the Act, property owners have the ability to deduct from their annual emissions through the purchase of renewable energy credits. However any RECs used for deductions need to be generated in or directly deliverable to the Zone J Load Zone of New York City. Currently little to no energy sources that meet this set of criteria exist, however this will likely change in the near future, as two projects are being planned to directly deliver renewables to the city via direct HVDC cables.[8] Community Choice Aggregators can choose where the energy mix they supply comes from, giving them the potential to acquire renewable energy certificates from sources deliverable to New York City. If these new energy transmission projects comes to fruition, then CCAs could help building owners meet emissions reduction targets mandated under bill 1253-c of the Climate Mobilization Act

However the fact that the proposed program is opt-out means certain precautions need to be taken. Having an opt-out program allows people and businesses to choose not to participate in such a program, rather than choosing to participate in the program. Opt-out programs typically get significantly more participation than opt-in programs, due to the simple fact that customers have to take an action to leave the program, rather than having to take action to join the program.[9] This does raise some concerns of taking advantage of the misinformed, as some people may not understand the implications of a Community Choice Aggregation, or they may

---

[7] "The Climate Mobilization Act Overview." Building Energy Exchange. Accessed June 24, 2019. https://be-exchange.org/insight/the-climate-mobilization-act-int-1253/.

[8] "New York City Passes GHG Emissions Cap for Buildings - Local Law 97." EnergyWatch. June 10, 2019. Accessed June 24, 2019. https://energywatch-inc.com/breaking-new-york-city-council-passes-first-of-its-kind-ghg-emissions-cap-for-buildings/.

[9] O'Shaughnessy, Eric, Jenny Heeter, Julien Gattaciecca, Jenny Sauer, Kelly Trumbull, and Emily Chen. 2019. *Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-72195. https://www.nrel.gov/docs/fy19osti/72195.pdf.

be too busy with the goings on of their daily lives to fully understand what they are being signed up for. Extensive interviews with participants in CCAs have shown that many people are completely unaware that a change in their electricity supplier has occurred after the CCA is implemented. This is significant because there is a very real possibility that CCA energy rates could sometimes be higher than standard utility rates.[10] People should not have to bear the costs of higher rates without being informed of these possibilities.

The proposed feasibility study should take care to examine the best ways to make sure participants understand what aggregation is, and what its potential implications are for their energy bills. Additionally, the city should make sure any program that could result from this study gives participants ample time and warnings for consumers to opt out. Because Community Choice Aggregations are focussed on community, the feasibility study should hold stakeholder meetings to address concerns and take into account the needs of communities that may be participating in the new programs.

III. Solar Power Pilot Program

I would also like to take this opportunity to speak on initiative 0269-2018. The Solar Power Pilot Program will undoubtedly help aid the transition to a healthier planet, as well as establishing a more robust and modern energy grid. By using only solar thermal and photovoltaic systems to power a community, this measure takes advantage of distributed energy sources. These energy sources provide two distinct benefits: 1) They provide the obvious benefit of providing energy without directly producing emissions; 2)They make the community less dependent on the power grid at large.

This second benefit is just as important as the first. The grid is large, inefficient, and often unstable. When power is transmitted over long distances, much of it is lost or wasted due

[10] Ibid.

to the nature of transmission technology.[11] Sending power from centralized power plants to consumers long distances away is inherently wasteful, and outdated. Producing power close to the point of consumption eliminates these inefficiencies, which makes distributed resources like solar thermal and photovoltaic especially appealing. Additionally traditional energy infrastructure like power lines and substations are vulnerable to extreme weather events like Hurricane Sandy in 2012 ("Superstorm Sandy").[12] Localized energy sources are more resilient, and can get back up and running much faster after a disaster (Greentech Media).[13] This is especially important in the coming years, as climate change promises to make these disasters more frequent and intense. By working to lower emissions and modernizing the grid, this initiative will make a real difference for New Yorkers statewide. Thank you for the opportunity to provide testimony today.

---

[11] Wirfs-Brock, Jordan. "Lost In Transmission: How Much Electricity Disappears Between A Power Plant And Your Plug?" Inside Energy. November 6, 2015. Accessed June 24, 2019. http://insideenergy.org/2015/11/06/lost-in-transmission-how-much-electricity-disappears-between-a-power-plant-and-your-plug/.

[12] Lacey, Stephen. "Resiliency: How Superstorm Sandy Changed America's Grid." Greentech Media. June 11, 2014. Accessed June 24, 2019. https://www.greentechmedia.com/articles/featured/resiliency-how-superstorm-sandy-changed-americas-grid#gs.hrflkb.

[13] Merchant, Emma Foehringer. "One Year After Maria, Puerto Rico's Energy Future Still in Limbo." Greentech Media. September 20, 2018. Accessed June 24, 2019. https://www.greentechmedia.com/articles/read/one-year-after-maria-puerto-ricos-energy-future-still-in-limbo#gs.hredpp.

I testified in person two weeks ago on your groundbreaking methane emissions legislation and was sincerely delighted to hear about Int. No. 0051-2018 and Int. No. 1076-2018 promoting district geothermal heating and cooling for New York. Methane emissions reduction from our aging gas system and promotion of geothermal districts are linked, and I would like to briefly share with you one way we are approaching the challenge of renewable heat in MA.

I believe you all already understand that we need to transition to a world Beyond Gas rapidly, even as we triage the aging and leaking gas system. My understanding is that the NY City GHG Inventory today shows emissions for the NY gas system at over 144% of the citywide, all sources emissions limits for 2050. So even if the gas system was the ONLY fossil fuel left in all of NY in 2050, we would STILL need it to be at least 1/3 the size it is today.

Yet today, NY is putting new gas pipe into the ground. We are doing it too, in MA, at an average utility reported cost of $1.7 million/mile. A NY City estimate came out at multiple times higher and the gas pipe going in is currently expected to last and be depreciated over, 85 yrs. New Yorkers don't seem like a naïve bunch, and I suspect the idea of paying for pipe through 2100 when it can't be used past 2050 isn't going to fly. We are at a serious decision point on the gas system we have. So what to do?

My organization, HEET, has a plan. We would like to redirect gas distribution company infrastructure investments into what we are calling GeoMicroDistricts. As old pipe comes out of the ground, we install new shared geothermal loops into the ground in place of gas pipe. The modular design of the geomicrodistrict allows for the gas system to evolve into a renewable thermal system, interconnected microdistricts as it grows. This essentially collapses the gas system without excessive burden on the low income, without gas workers losing their jobs, and without a fight.

The GeoMicroDistrict system design is also a unique combination of distributed generation, thermal network optimization, and centralized management and backup. The distributed generation is through geothermal boreholes in the existing gas corridor, where feasible, but could also be conceived of in parking lots or parks, in the pilings of new large buildings, etc.

The creation of a thermal network allows for load balancing, load cancelling, and the management of peaks through distributed storage. There is wasted temperature all around us and capturing and redistributing this energy provides enormous efficiency gains. Furthermore, the earth is the largest long term energy storage on earth and this kind of system can be used for seasonal energy storage. This storage potential, together with significant peak cutting, can support a more rapid transition of our electric grid to renewable energy.

HEET will be announcing the results of our feasibility study on July 1st, together with the engineering firm, BuroHappold - the same firm that did New York's 80x50 plan. While our feasibility study focused on Massachusetts, the results are relevant to New York and show an enormous amount of promise in this approach.

Constraining the model to 500' depth vertical closed loop boreholes every 20' in the gas companies right of way and without ANY weatherization or other optimization, the GeoMicroDistrict can meet the heating and cooling needs of the majority of Massachusetts gas customers. As long as the system is interconnected and managed thermally – which in many locations up here means that some cooling will need to be dumped or sold over time if we are to maintain the ground temperature as it is today over coming decades.

This is enormously hopeful news. It gives me hope as we face the largest challenge of our lives in the next decade and I hope it convinces you that the proposed legislation is opening a path forward that just might get us to where we need to go.

ACEC New York

American Council of Engineering Companies of New York

Testimony for the Record

Committee on Environmental Protection – June 24, 2019
"Oversight – Renewable Energy" and Intro. 49

The American Council of Engineering Companies of New York's (ACEC New York) thanks Chair Constantinides and the Committee for the opportunity to submit testimony for this hearing on renewable energy bills.

ACEC New York represents close to 300 consulting engineering and affiliate firms throughout New York, with a concentrated presence in the City. Our members plan and design the structural, mechanical, electrical, plumbing, civil, environmental, fire protection and technology systems for the City's buildings and infrastructure.

Last year, our Association adopted "Principles for Reviewing New York City energy legislation." Our Principles state; "New York City should strive to be a leader in sustainability, green building, energy efficiency and carbon emissions reduction." With this principle in mind, we generally support the intent and goals of the bills to advance renewable energy technologies.

The legislation was reviewed by Professional Engineers who serve as volunteers on our Electrical, Mechanical, Plumbing and Energy Code Committees. Our Committees provided the specific feedback and recommendations below:

Intro. 49, in relation to installation of utility-scale battery storage systems on city buildings and conducting a feasibility study on installation of such systems throughout the city

Recommendations

- The feasibility study should identify regulatory barriers that impede the permitting of battery storage systems and opportunities to improve the regulatory process.
- The study should specifically examine FDNY's rules and permitting process which are an impediment to battery storage system installations.
- The study should recommend possible legislative and/or rulemaking actions that can be taken to improve FDNY's regulatory process to make it streamlined and less restrictive for both indoor and outdoor installations.
- The bill defines "cost effective" as a system with a payback period of 25 years or less. Batteries and related equipment often have a lifecycle less than 25 years. Calculation of the payback period must take into account the typical lifecycle of batteries and equipment (including replacement cost).
- Local Law 6 of 2016 (Intro. 609-A) set criteria to be used in evaluating the cost-effectiveness of geothermal systems. We recommend similar criteria be set by Intro. 29 to evaluate the cost-effectiveness of battery storage systems.
- We recommend the feasibility study be conducted on a building-by-building basis because each building has unique characteristics that determine whether a battery storage

system is appropriate for installation, what the system's specifications, costs and benefits would be, as well as what modifications would be required to an existing building's infrastructure to make use of the battery system.

- We recommend a third party(s) be consulted to perform the feasibility study to ensure it is completed by the most objective, experienced professionals available.
- Clarify whether the feasibility study covers existing buildings, new construction, or both.
- For non-City buildings, we recommend the City establish a program making resources available to large-building owners to complete feasibility studies specific to their buildings.

For further information please contact:

Hannah O'Grady
Vice President, ACEC New York
8 West 38 Street, Ste 1101, New York, NY 10018
P: 212-682-6336
hannah@acecny.org

Bill Murray
NYC Director of Government Relations, ACEC New York
bill@acecny.org

6/24/2019

Testimony submitted by
Marion Yuen
901 Ave H #1N, Brooklyn, NY
11230
E: myuen@pipeline.com
C: 917-609-5402

Mr. Kallos, Mr. Constantinides and Members of the Committee on Environmental Protection.

I want to speak in support of **Res. 0864-2019** in essence.

Because words have power, I want to offer you alternative language to the current text: "Resolved, The City Council declares a climate emergency and calls for an immediate emergency mobilization to restore a safe climate."

Please consider the following alternative language:

> *Resolved, The City Council recognizes the severe environmental degradation and global climate crisis impacting New York City, and commits itself to immediately and earnestly:*
>
> > *a) Enact legislation for crisis mitigation and adaptation as well restoring a healthier, more balanced and livable environment in NYC;*
> >
> > *b) Enact legislation to educate, activate and engage City residents in the restoration of a healthier, more balanced and livable environment – with attention to specific needs of the most vulnerable sectors and expanding meaningful democratic participation of all City residents.*
> >
> > *c) Engage the Mayoral Administration and Executive Departments to lead by example and fully support the implementation of a) and b.*

Words have power.

History has shown that emergency declarations and emergency mobilizations could lead to draconian laws and measures as well as serious, hurtful violations of civil rights and liberties – from the War World II internment of Japanese Americans to the Trump administration's recent declaration of "border emergency" to the current fearful looming of massive ICE raids in New York City and other sanctuary cities.

In **Res. 0864-2019**, I urge you to employ words that the City Council and New York City will be proud to live by for years to come.

Testimony on Resolution 864-2019, to declare a climate emergency in NYC.

Hi, my name is Ken Schles. I'm a father of two, a photographer and a writer who has lived in NYC for nearly all of my 58 years. In October of 2016 I had a heart attack while cycling in Prospect Park, Brooklyn. I'm fit, don't smoke, have low cholesterol, exercise regularly and live a vegan lifestyle. It's well documented that burning fossil fuel creates small particulate matter that infiltrates vascular walls and causes plaque formation.[1],[2] It damages lung tissue and exacerbates asthma, which kills 11 people a day in the US.[3] Increasing heat waves magnify both the frequency and severity of heart disease, stroke and asthma leading to higher morbidity and mortality rates.[4],[5] According to the World Health Organization 4.2 million people die prematurely from ambient air pollution per year—or 7.6% of all annual deaths.[6],[7]

But we're just beginning to feel the effects of climate change. It will take thousands of years for the effects of increased atmospheric carbon to fully materialize.[8] They call the climate crisis a hyper object because its magnitude is impossible to conceptualize. True, but because of my health scare, I recognize the climate crisis as something that affects individuals intimately as lost potential, diminished lives and broken families. New Yorkers are hobbled with increased healthcare costs and lost wages, increased tax burdens to fund hospitals, increased costs to harden infrastructure and provide storm damage remediation.

Climate change risks not only life and limb, but also destroys our cultural heritage. I have photographic work in the collections of Metropolitan Museum of Art, The Museum of Modern Art and the Museum of the City of NY as well as in cultural institutions throughout the world. Last year work of mine in a collection bound for

---

[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4740122/
[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6202600/
[3] https://www.asthmamd.org/asthma-statistics/
[4] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4155032/
[5] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4687168/
[6] https://www.who.int/airpollution/en/
[7] https://www.who.int/gho/phe/outdoor_air_pollution/burden/en/
[8] https://scripps.ucsd.edu/programs/keelingcurve/2013/12/03/what-does-400-ppm-look-like/

the Museum of Fine Arts in Houston was destroyed, along with 36,000 other objects in the Woolsey fire that ravaged Malibu, California.[9] Nearly 300,000 people were evacuated.[10] The fire caused $1.6 billon dollars in damages. Another piece of mine, in the collection of the US State Department, was destroyed in the US Embassy in Yemen, a minor casualty of a war that precipitated one of the greatest humanitarian disasters of this century[11] and is the result, arguably, like the war in Syria, a war initiated by water scarcity due to climate change.[12]

A 2018 study by the World Wildlife Fund notes the world's wildlife population is down by 60% on average since 1970.[13] We are living through what the NY Times dubbed the insect apocalypse.[14] The Pulitzer Prize winning author Elizabeth Kolbert described our era as "the sixth extinction,"[15] a time when species demise is between 1,000 and 10,000 times the normal background rate.[16]

Last year the IPPC report gave us 12 years to reduce our greenhouse gas output, but even in the few months since the report's publication scientists have made some surprising findings: the oceans are warming faster than previously thought,[17] they are becoming hypoxic, rife with dead zones.[18] According to NASA, the West Antarctic ice sheet is contributing to sea level rise at a faster pace while it signals a "rapid decay."[19],[20] The Greenland ice sheet, which contains enough water to raise global sea levels by 23 feet is melting at rate 44% faster than in the 20th century.[21] Since that report was published Greenland is experiencing record ice melts that are

---

9 https://www.bjp-online.com/2018/11/heiting-collection-destroyed/
10 https://en.wikipedia.org/wiki/Woolsey_Fire
11 https://www.nytimes.com/interactive/2018/10/31/magazine/yemen-war-saudi-arabia.html
12 https://climateandsecurity.org/2016/08/03/a-storm-without-rain-yemen-water-climate-change-and-conflict/
13 https://www.worldwildlife.org/pages/living-planet-report-2018
14 https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html
15 https://en.wikipedia.org/wiki/The_Sixth_Extinction:_An_Unnatural_History
16 http://wwf.panda.org/our_work/biodiversity/biodiversity/
17 http://science.sciencemag.org/content/363/6423/128.summary
18 https://oceanservice.noaa.gov/podcast/feb18/nop13-hypoxia.html
19 https://www.pnas.org/content/116/4/1095
20 https://sealevel.nasa.gov/news/152/huge-cavity-in-antarctic-glacier-signals-rapid-decay
21 https://www.pnas.org/content/116/6/1934

further disrupting weather patterns.[22] It is expected that 80 million people will be put at risk due to coastal flooding by 2040,[23] (include NYC residents in that number) and a significant fraction of the world's population will experience chronic or absolute water scarcity.[24] At our present trajectory climate modeling shows by 2050 a climate equivalent to the Eocene, last experienced 50 million years ago. Extend that out another two hundred years and we see a planet uninhabitable by humans.[25]

According to NOAA, damages from Hurricane Sandy cost over $72 billion. It shut down the NY Stock exchange for two consecutive days and caused the disruption of critical electric and water services and took 159 lives. This was just one storm. It was the most costly weather event in US history up until that point in time. That was 2012. In the years since, thousands have lost their lives and there has been trillions of dollars more in damages. Hurricane Maria alone cost $91.8 billion and took over 3,000 lives.[26] Cyclones Idai and Kenneth in Mozambique displaced over 1,000,000 children.[27] Storms, floods, fires and the damages they cause, the lives they take are growing apace.

During the Pliocene CO2 levels were as high as they are now. The earth on average was 5.5 to over 7 degrees F warmer, the poles were 18 degrees F warmer and the seas up to 131 feet higher than they are today—it is only because it takes time for the heat in the atmosphere to build up and the ice caps to melt that NYC is not currently hotter or underwater.[28],[29] Permafrost is melting much faster than anticipated creating feedback loops that may eventually triple the amount of carbon currently in the atmosphere.[30]

---

22 https://www.washingtonpost.com/weather/2019/06/14/arctic-ocean-greenland-ice-sheet-have-seen-record-june-ice-loss/
23 https://www.nytimes.com/2019/01/21/climate/greenland-ice.html
24 https://www.pnas.org/content/pnas/early/2013/12/12/1222460110.full.pdf
25 https://www.climatecentral.org/news/climate-change-unseen-50-million-years-21312
26 https://www.ncdc.noaa.gov/billions/events/US/1980-2018
27 https://www.apnews.com/f5e0d21839dc444dba8d81926b3bf118
28 https://scripps.ucsd.edu/programs/keelingcurve/2013/12/03/what-does-400-ppm-look-like/
29 http://www.floodmap.net
30 https://www.nature.com/articles/d41586-019-01313-4

Some of us here will lose our lives to climate change, some, like myself, already life altering near death experiences. To take no action is immoral. To act in half measures, is a false compromise that does not take into account the immutable, unyielding facts of science. We risk the loss not only our cultural heritage and the viability of our species, we risk the genetic legacy and biodiversity of our planet. We demand our elected official to lead, for it is their moral obligation to do so. Call this climate emergency for what it is. Align NYC with 625 local governments in 14 countries.[31] Let people know this is no longer a debate of fact. Declare a climate emergency to give credence to and form a basis for further legal and legislative action.

Ken Schles
378 Vanderbilt Avenue
Brooklyn, NY 11238 / (917) 816-3846 / info@kenschles.com

[31] https://www.theclimatemobilization.org/climate-emergency-campaign

Statement of Samantha Wilt
Senior Energy Policy Analyst, Climate and Clean Energy Program
Natural Resources Defense Council

Before the New York City Council
June 24, 2019

In support of Intro. No. 49

Good afternoon, my name is Samantha Wilt. I am a senior policy analyst at the Natural Resources Defense Council. Thank you Chairman Constantinides and committee members for the opportunity to testify today in support of Intro 49. As stated in Resolution 864, we are facing a climate emergency, and we must all be part of the mobilization to restore a safe climate. NRDC has been working to that end for nearly 50 years, here in this great city where we are headquartered, and around the world.

Thanks again to the Chairman and the Committee members for their tireless efforts to take on the myriad opportunities to reduce climate pollution in New York City; in just the last few months you have tackled so many issues, encompassing everything from buses to buildings, and now on to batteries.

As we move rapidly toward a clean energy future, energy storage is essential to integrating the soon to be meteoric growth of renewables in and around New York City. The Climate Leadership and Community Protection act that was passed last week in the state legislature mandates a 70 percent renewable powered grid by 2030, and fully zero carbon electric sector in New York State by 2040. To reach these awesome numbers we will need significant amounts of energy storage; the state goal is 3,000 MW by 2030, and (as you know) the New York City goal is 100 MWh by next year. To help catalyze and foster the storage market in New York City it is important to focus on making the regulatory processes as efficient as possible, and to continue to lead by example as New York City has done so frequently on climate. Exploring deployment of large scale energy storage on city-owned properties can provide useful illustrative data and analysis about the storage market, and demonstrate where attention should be directed to accelerate development.

In addition to energy storage, Intro 51 creating a district geothermal system pilot is an important boost for a technology that will be critical to getting our built environment off of fossil fuels. The U.S. Department of Energy recently published a report on geothermal potential across the country, showing that New York has the greatest potential for ground source heat pumps in the nation (see graphic on next page).

Along with the multiple bills being discussed today covering energy storage, solar thermal, and geothermal technologies, we would also recommend looking at opportunities to expand the deployment and demonstrate the benefits of electrification of heat and hot water in city owned buildings, which will also be an important part of implementing local law 97. As you know from your long years of work to reduce emissions from buildings, we need to electrify heating and hot water on a vast scale in the city, and the more the city can show the way, the better it will be for all of us.

Thank you.

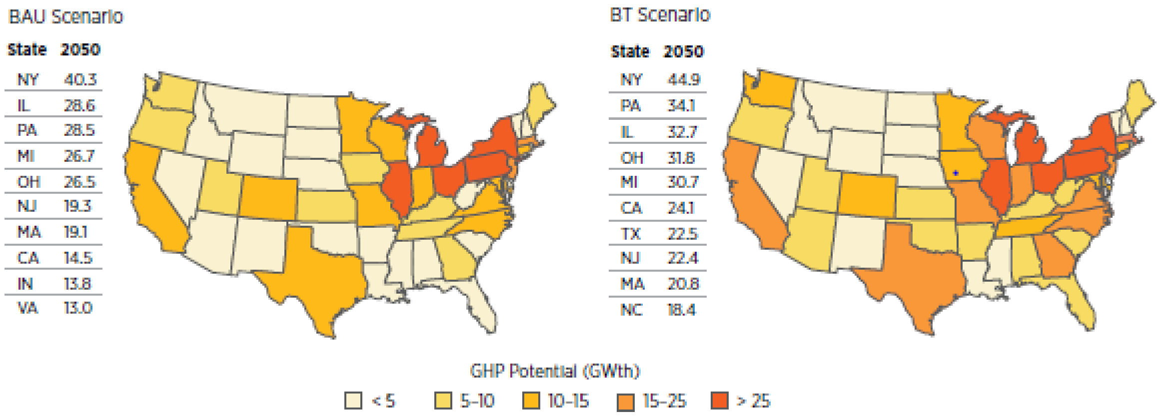


Figure 4-8. Economic potential for geothermal heat-pump systems by state in 2050 under the Business-as-Usual (left) and Breakthrough (right) scenarios, with the top 10 states listed separately

GeoVision: Harnessing the Heat Beneath Our Feet, U.S. Department of Energy, May 2019, p. 73 at https://www.energy.gov/eere/geothermal/downloads/geovision-harnessing-heat-beneath-our-feet

Hearing on Res 0864-2019 sponsored by NYC Councilmember Ben Kallos

June 24, 2019

City Hall, New York City

My name is Kyle Jeremiah and I am the Communications and Community Engagement Manager at Energy Vision, a New York City-based national environmental 501(c)(3) organization. Since our founding in 2007, we have been working to advance commercial and cost-effective options for a carbon-free economy through research, education and partnerships. I'd like to thank Councilmembers Constantinides and Kallos for the opportunity to testify on this important resolution.

More than 650 local governments in 15 countries around the world have already declared a climate emergency since the release of the UN's Intergovernmental Panel on Climate Change's (IPCC) Special Report that found we have 12 years left to significantly reduce greenhouse gas emissions in order to ensure that we at least have a chance to keep global warming below 1.5° C. Major cities in Europe, Canada, Australia, and even in here the United States have already made emergency declarations and committed to acting to drive down climate warming emissions. Given NYC's ambitious climate goal of slashing emissions 80% by 2050, but the current slow pace of progress, Energy Vision fully supports the resolution to declare a climate emergency and call for an immediate emergency mobilization to restore a safe climate.

Innovative strategies and technologies already exist as part of a growing suite of options we'll need to make the *immediate* transition to a low-carbon future. That's why Energy Vision is particularly focused on here and now solutions that can be implemented today. One such option with great potential in NYC is the use of anaerobic digestion technology, which could help our city address both its waste disposal and clean energy goals. In fact, according to the DEP, one hundred percent of NYC's food scraps—4,000 tons per day—most of which end up in distant landfills where they emit potent methane gas, could be processed in existing anaerobic digesters at the City's 14 wastewater treatment plants, with the appropriate investments and infrastructure upgrades.

The biogases captured from these decomposing organic wastes—sewage and food waste—could then be refined into net-carbon-neutral biomethane, and used to power these same facilities, fuel vehicles, or heat/cool NYC buildings. This strategy provides an opportunity for the City to deal with the climate emergency, as it both captures potent methane gases from organic waste that would otherwise escape into the atmosphere *and* creates a flexible source of clean, local, baseload renewable energy.

If we are to stave off the worst effects of climate change in vulnerable coastal cities like New York, we cannot afford to wait any longer. The emergency exists whether or not it is formally declared by the City Council, and swift, aggressive action must be taken. A decade of research makes it clear that the organic waste-to-clean energy strategy is a proven, scalable approach to decarbonize various sectors, while simultaneously improving air, water and soil quality, public health, and the economy. We encourage the City to pass this resolution.

Thank you for your time and consideration.

Kyle Jeremiah
Communications and Community Engagement
Energy Vision
Tel: 212.228.0225 Email: jeremiah@energy-vision.org

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

864

I intend to appear and speak on Int. No. ________ Res. No. ________

☑ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Becca Trabin

Address: 535 Graham Ave. 2R Brooklyn NY

I represent: life on Earth

Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. 864

☑ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: XIYE BASTIDA PATRICK

Address: 70 La Salle St.

I represent: Fridays For Future / People's Climate Movement

Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. 849

☑ in favor ☐ in opposition

Date: 24 June 2019

(PLEASE PRINT)

Name: Guy R. McPherson

Address: 36 Hobby Street

I represent: myself / XR

Address: ________

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☒ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: RORY VARRATO

Address: 155 CLAREMONT AVE NEW YORK, NY 10027

I represent: EXTINCTION REBELLION NYC

Address: N/A

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 51 1076 Res. No. ______
☐ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Gaylord Olson

Address: 273 Jefferson Rd. Princeton, NJ

I represent: self & www.sstusa.com

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 51 eyc Res. No. ______
☑ in favor ☐ in opposition

Date: 24 June 2019

(PLEASE PRINT)

Name: Bob Wyman

Address: 203 W 85th Street PH2, NY/NY 10024

I represent: ~~[illegible]~~ Self

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 0149 ~~0049~~ Res. No. ________
☑ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Annel Hernandez

Address: 166a 22nd Street

I represent: NYC-Environmental Justice Alliance

Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 0140 Res. No. ________
☐ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Richard Berkley

Address: 25 Broadway, 5th Flr NYC

I represent: Public Utility Law Project of NY

Address: 90 S. Swan St, Suite 305, Albany NY

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. 864
☑ in favor ☐ in opposition

Date: ~~April~~ June 24 2019

(PLEASE PRINT)

Name: Dr Susan Rubin

Address: 22 Pond Hill Rd Chappaqua NY

I represent: Extinction Rebellion NYC

Address: ________

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864

☑ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: Elliana Pfeffer

Address: 275 Central Park West #11C NY, NY 10024

I represent: ______

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 0140-2018 Res. No. ______

☑ in favor ☐ in opposition

Date: 6/24/2019

(PLEASE PRINT)

Name: Michael Gersho

Address: 3889 North Road Poughkeepsie NY

I represent: Green Building Worldwide

Address: 110 Wallstreet Suite 6-053

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______

☐ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Susan Shapiro

Address: 75 N. Middletown Rd. Nanuet

I represent: IPSEC, Clearwater, RPHP, PHASE, LEAF, Grassroots Environmental Education

Address: ______

susan@[illegible]law.com

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☐ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: Gregory Schwedock

Address: 141 East 13th St.

I represent: Extinction Rebellion

Address:

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 0049, 0051 Res. No. ______
☑ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: Philip Chen

Address: 79 Gilmar Lane Roslyn Heights 11577

I represent: Green Building Worldwide

Address: 110 Wall Street

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☑ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: MARGARET KLEIN SOLOMAN

Address:

I represent:

Address:

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864

☑ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: Ted Bojin

Address: 425 E 80th St

I represent: Sunrise NYC

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864

☒ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: Jilly Edgar

Address: 202 East 13th Street

I represent: Sunrise Movement

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______

☒ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: Rio Hao

Address: ~~[illegible]~~ 75 3rd Ave

I represent: ______

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864

☒ in favor ☐ in opposition

CLIMATE Emergency

Date: ______

(PLEASE PRINT)

Name: KEN SCHLES

Address: 378 VANDERBILT AVE

I represent: SZF, 350 BK, SUNRISE

Address: 378 VANDERBILT AVE

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864

☑ in favor ☐ in opposition

Date: 6/24

(PLEASE PRINT)

Name: Margaret Klein Salamon

Address: 409 2nd St Brooklyn 11215

I represent: The Climate Mobilization

Address: ~~[illegible]~~ 150324 9th St Brooklyn 11215

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______

☑ in favor ☐ in opposition

Date: 24 June 2019

(PLEASE PRINT)

Name: ROBERT KRAMER

Address: 233 BROADWAY

I represent: FISONIC ENERGY

Address: 233 BROADWAY NYC.

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☒ in favor ☐ in opposition

Date: 6/24/19

(PLEASE PRINT)

Name: LINDA NOVENSKI

Address: 505 W 37th #3206

I represent: XR

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. 864
☑ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Richard McLachlan

Address: 1415 Dorchester Road

I represent: Self

Address: ______

*9 YEAR OLD BOY

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☑ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Zayne Cowie

Address: 1163 Prospect Avenue

I represent: Fridays for Future

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______
☑ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Jonathan Minard
Address: 239 Banker St. #30 Brooklyn
I represent: Extinction Rebellion
Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______
☑ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: John Breitbart
Address: 255 West 95th St. Apt. 1A
I represent: myself
Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______
☒ in favor ☐ in opposition

Date: 6-24-19

(PLEASE PRINT)

Name: Ben Arana
Address: 65-25 160th Street #3A
I represent: Local 3 IBEW.
Address: 158-11 Harry Van Arsdale JR AVE

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☒ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: William Beckler

Address: 1834 Caton Ave #4L Brooklyn, NY 11226

I represent: Extinction Rebellion

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______
☒ in favor ☐ in opposition

Date: 2/24/19

(PLEASE PRINT)

Name: WENDY BRAWER

Address: 175 Rivington #1D 10002

I represent: Green MAP System

Address: 292 E 3rd 10009

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. 864
☒ in favor ☐ in opposition

Date: 8/24/19

(PLEASE PRINT)

Name: CHRISTINA SEE

Address: 41-21 28th ST #7G LIC NY 10001

I represent: ______

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. 864

☑ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Olive Raymond

Address: 98 Roebling St. Brooklyn NY 11211

I represent: self

Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. 864

☒ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Lisa Bloodgood

Address: 98 Roebling St.

I represent: Newtown Creek Alliance / North Brooklyn Neighbors

Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. 864

☑ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: AMY LARKIN

Address: 444 Manhattan Ave, #7J, NY 10026

I represent: Myself

Address: ________

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______

☑ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Greg Waltman

Address: ______

I represent: G-One-Quantum

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______

☒ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Matthew Ketschke

Address: 864

I represent: Con Edison

Address: ______

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 864 Res. No. ______

☒ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Kyle Kimball

Address: ______

I represent: Con Edison

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 1040 Res. No. ________
☐ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Mike Gordon
Address: Bedford Hills NY
I represent: Int 1040
Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 1040 Res. No. ________
☐ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Charlotte Binns
Address: 68 Skillman Ave Brooklyn NY 11211
I represent: INTRO 1040 - 2018
Address: ________

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 1040 Res. No. ________
☒ in favor ☐ in opposition

Date: ________

(PLEASE PRINT)

Name: Jasmine Graham
Address: 223 Himrod St Brooklyn, NY
I represent: Sustainable Westchester
Address: 55 Maple Ave Mt Kisco NY 10549

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. 49, 269, 426, 1076, 1375 Res. No. ______

☐ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Christopher Cavanagh

Address: ______

I represent: National Grid

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ______ Res. No. ______

☐ in favor ☐ in opposition

Date: ______

(PLEASE PRINT)

Name: Anthony Fiore

Address: DCAS

I represent: ______

Address: ______

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. ________
☐ in favor ☐ in opposition

Date: ____________

(PLEASE PRINT)

Name: Christopher Diamond
Address: 30-30 Thomson Ave
I represent: NYC DDC
Address: ____________

Please complete this card and return to the Sergeant-at-Arms

THE COUNCIL
THE CITY OF NEW YORK

Appearance Card

I intend to appear and speak on Int. No. ________ Res. No. ________
☐ in favor ☐ in opposition

Date: 9/24/

(PLEASE PRINT)

Name: Susanne DesRoches
Address: Mayor's Office of Sustainability
I represent: ____________
Address: ____________

Please complete this card and return to the Sergeant-at-Arms