372-1
X 375-4

From: Mark Bigland-Pritchard <City.Council@Saskatoon.ca>
Sent: Tuesday, August 06, 2019 9:07 PM
To: City Council
Subject: Form submission from: Write a Letter to Council
Attachments: saskatoonclimateplanlettermbp_a.pdf

Submitted on Tuesday, August 6, 2019 - 21:07
Submitted by anonymous user: 207.47.175.16
Submitted values are:

Date: Tuesday, August 06, 2019
To: His Worship the Mayor and Members of City Council
First Name: Mark
Last Name: Bigland-Pritchard
Email: [redacted]
Address: [redacted] 5th St E
City: Saskatoon
Province: Saskatchewan
Postal Code: [redacted]
Name of the organization or agency you are representing (if applicable):
Subject: Climate Change mitigation plan
Meeting (if known):
Comments: This is part 1 of the letter which I attempted to send with my message last night
Attachments:
saskatoonclimateplanlettermbp_a.pdf:
https://www.saskatoon.ca/sites/default/files/webform/saskatoonclimateplanlettermbp_a.pdf

The results of this submission may be viewed at:
https://www.saskatoon.ca/node/398/submission/329265

372-1
X 375-4

from **Mark Bigland-Pritchard**
812 5th St E, Saskatoon SK, S7H 1G9
mark@lowenergydesign.com

2019-08-05

To: Councillor Cynthia Block
Cc: members of the Environment, Utilities & Corporate Services Committee

Dear Cynthia

I write regarding the set of actions set out in the city's recently-published Low Emissions Community Plan, on which I understand Council will be required to vote this month. As you are aware, action to address the climate emergency is a matter of particular concern to me. As you are also aware, I bring to this area a certain expertise, having been involved in research, planning, consultancy and education around sustainable energy paths in various professional capacities since the mid-1980s. I am no longer regularly active as an energy consultant – instead now working to support refugees, many of whom are in that position in large part because of the social, political and economic pressures created by the impacts of climate change on their native lands. However, I maintain a close interest in developments in understanding of climate and energy provision, including regular reading of recent peer-reviewed literature both on climate science and on energy options in all sectors.

I consider the new Plan as a very welcome development, which contains all the elements necessary to achieve the transformation of our energy systems. I therefore urge its endorsement and rapid implementation by City Council.

However, I have a number of concerns which I feel must be expressed:

1. In previous discussions with Councillors (several years ago), I received a request to come up with a short list of measures to address emissions reduction – as if just doing a few of the many things which are necessary will somehow enable us to do our share in address the climate emergency. This Plan rightly takes a different approach – it sets out a comprehensive programme consisting of a diverse collection of measures, all of which are needed to achieve the reductions necessary. I therefore strongly urge that Council accept this as an integrated Plan, not as a menu from which to pick and choose.
2. The report appears to accept 2°C of global average warming as an acceptable aim. In this – and in the City Council's current targets – it falls short of the requirements of the Paris Agreement, which includes a commitment to "pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels".[1] The IPCC Special Report of 2018:Oct demonstrated the importance of a 1.5°C target: I attach its key findings on the differences the authors found between the two options as Annex 1. That report also reached conclusions as to the rate of global emissions reductions necessary to achieve the target. As you will see in Annex 2, they recommend net-zero emissions by about 2050 (as contrasted with the City's current 80% reduction target). While in the past I have held back from calling on the City to adopt a more scientifically realistic target for a date which is, after all, about 8 electoral cycles away, this is nevertheless a matter which also impacts on the degree of urgency of plans implemented in the short term. So, while I consider this report to be a

[1] United Nations Framework Convention on Climate Change (2015), The Paris Agreement, para 2.1.(a). Available at https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf

massive step forward, for which City staff and their consultants deserve considerable congratulations, it needs to be recognised as insufficient unless expedited further.

3. In this context, why such small initial steps in Action 6 (municipal energy step code for domestic energy consumption)? I view a step code as absolutely the right way to go, and the ultimate Step 4 specification of the Passivhaus basic requirement is very welcome – but by failing to move much earlier to high-performance dwellings as the norm, the City will be leaving itself with a much greater future challenge. The technologies already exist to satisfy Passivhaus criteria, and a pool of skills – both professional and craft – exists in the city to do so. With the political will and municipally-endorsed training programmes, a much more rapid transition than is anticipated in the Plan would be possible.

4. Certain measures make sense only in the context of other measures. Unfortunately, this does not appear to be considered in the report's methodology. For example, transition to heat pumps (Actions 5, 14 and 15) makes sense in a context of low-emissions electricity, which unfortunately is not the case in the short-term given SaskPower's current plans, its delayed schedule for exit from coal, and the current Plan's limited penetration of city-based renewables in the next decade. Heat pumps can also make sense for buildings already constructed to Passivhaus or similar standards, as the energy required is minimal even if largely fossil-derived: but in existing buildings, and in new buildings until Passivhaus-compliance becomes the norm, there will be minimal savings and quite possibly emissions increases given the continued high carbon-intensity of our electricity. Hence, plan scheduling should ensure that the shift to heat pumps follows, rather than anticipating, a shift to low-emissions electricity - and that it accompanies, rather than anticipating, a shift to high-performance building envelopes. Pursuing this point more generally, Council should encourage an integrated approach not only in its own policy but in the upgrading and construction policies of all parties responsible for construction or upgrading of buildings. My experience in conducting energy audits is that the savings (whether of energy, emissions or money) from a package of measures is never the sum of the savings from each measure; the same is true of the financial costs if the package can enable additional equipment savings. Appropriate action therefore consists in finding the best package, not necessarily a sequential application based on generalised marginal abatement cost figures.

5. While the ultimate requirement for roof-top solar (Action 7) is extremely welcome, I see no mention of preparation for this in immediate actions – specifically, requiring that all new buildings are solar-ready in terms of construction, orientation and shading, and that, so far as possible, existing buildings are enabled to become solar-ready.

6. As noted above, the commitment to local introduction of solar photovoltaics lacks ambition. Given that the costs of pv are still dropping rapidly, so that even smallscale rooftop installations will probably be able to comprehensively outcompete fair-priced conventional electricity of all types within a few years, a figure of 75MW by 2030 (or about 100GWh/yr production) seems low compared to the city's current consumption of nearly 2000GWh/yr. Especially so at a time when some European jurisdictions are succeeding in shifting over 5% of their electricity from fossil to renewables each year. Admittedly, the structure of the purchase agreement with SaskPower (low electricity charges, high fixed costs) will delay the crossover in our context – but surely it is the responsibility of a city which wishes to achieve change to actively challenge the terms of that agreement. (And the city will in any case need to do so in order to be able to pursue Action 39: procuring electricity from 3rd-party renewables suppliers.)

7. I note none of the Actions refers to low-cost carbon-negative measures, such as tree-planting, introduction of biochar as part of the composting programme, etc. I claim no particular expertise in these areas, but note them as something which may be worthy of Council's attention.

Meanwhile, I applaud unconditionally the commitments to expand public transit availability and the encouragement of a rapid shift to electric vehicles. Likewise, I applaud council staff and consultants for active pursuit particularly of LICs/PACE and on-utility bill financing as funding options for building energy improvements. (I wish I had had such a scheme available for my own home retrofit a couple of years ago...)

Therefore, I urge that Council do three things:

1. **Fully accept the report's recommendations, as a package.**
2. **Start of implement them within a very short time period.**
3. **Move to bring City targets closer to climate science compliance, accelerate the Plan as a whole, and ensure that the scheduling of different components makes sense in terms of energy and emissions.**

Yours faithfully

Mark Bigland-Pritchard MA MSc PhD

372-1
x 375-4

From: Mark Bigland-Pritchard <City.Council@Saskatoon.ca>
Sent: Tuesday, August 06, 2019 9:09 PM
To: City Council
Subject: Form submission from: Write a Letter to Council
Attachments: saskatoonclimateplanlettermbp_b.pdf

Submitted on Tuesday, August 6, 2019 - 21:08
Submitted by anonymous user: 207.47.175.16
Submitted values are:

Date: Tuesday, August 06, 2019
To: His Worship the Mayor and Members of City Council
First Name: Mark
Last Name: Bigland-Pritchard
Email: mark@lowenergydesign.com
Address: 812 5th St E
City: Saskatoon
Province: Saskatchewan
Postal Code: S7H 1G9
Name of the organization or agency you are representing (if applicable):
Subject: Climate change mitigation plan
Meeting (if known):
Comments: This is part 2 of the communication which I tried to send last night
Attachments:
saskatoonclimateplanlettermbp_b.pdf:
https://www.saskatoon.ca/sites/default/files/webform/saskatoonclimateplanlettermbp_b.pdf

The results of this submission may be viewed at:
https://www.saskatoon.ca/node/398/submission/329266

372-1
X 375-4

Annex 1: Comparison of Predicted Impacts of 1.5°C and 2°C Worlds

from:
Intergovernmental Panel on Climate Change (2018), Special Report: Global Warming of 1.5°C, Chapter 3: Impacts of 1.5°C global warming on natural and human systems. Available online at https://www.ipcc.ch/sr15/

Executive Summary

This chapter builds on findings of the AR5 and assesses new scientific evidence of changes in the climate system and the associated impacts on natural and human systems, with a specific focus on the magnitude and pattern of risks for global warming of 1.5°C above the pre-industrial period. Chapter 3 explores observed impacts and projected risks for a range of natural and human systems with a focus on how risk levels change at 1.5°C and 2°C. The chapter also revisits major categories of risk (Reasons for Concern) based on the assessment of the new knowledge available since the AR5.

1.5°C and 2°C warmer worlds

The global climate has changed relative to the preindustrial period with multiple lines of evidence that these changes have had impacts on organisms and ecosystems, as well as human systems and well-being (*high confidence*). The increase in global mean surface temperature (GMST), which reached 0.87°C in 2006-2015 relative to 1850-1900, has increased the frequency and magnitude of impacts (*high confidence*), strengthening evidence of how increasing GMST to 1.5°C or higher could impact natural and human systems (1.5°C versus 2°C) {3.3.1, 3.3, 3.4, 3.5, 3.6, Cross-Chapter Boxes 6, 7 and 8 in this Chapter}.

Human-induced global warming has already caused multiple observed changes in the climate system (*high confidence*). In particular this includes increases in both land and ocean temperatures, as well as more frequent heatwaves in most land regions (*high confidence*). There is also *high confidence* that it has caused an increase in the frequency and duration of marine heatwaves. Further, there is evidence that global warming has led to an increase in the frequency, intensity and/or amount of heavy precipitation events at global scale (*medium confidence*), as well as having increased the risk of drought in the Mediterranean region (*medium confidence*) {3.3.1, 3.3.2, 3.3.3, 3.3.4}.

Changes in temperature extremes and heavy precipitation indices are detectable in observations for the 1991-2010 period compared with 1960-1979, when a global warming of approximately 0.5°C occurred (*high confidence*). The observed tendencies over that time frame are consistent with attributed changes since the mid-20th century (*high confidence*) {3.3.1, 3.3.2, 3.3.3}.

There is no single '1.5°C warmer world' (*high confidence*). Important aspects to consider (beside that of global temperature) are the possible occurrence of an overshoot and its associated peak warming and duration, how stabilization of global surface temperature at 1.5°C is achieved, how policies might be able to influence the resilience of human and natural systems, and the nature of the regional and sub-regional risks (*high confidence*). Overshooting poses large risks for natural and human systems, especially if the temperature at peak warming is high, because some risks may be long-lasting and irreversible, such as the loss of many ecosystems (*high confidence*). The rate of change for several types of risks may also have relevance with potentially large risks in case of a rapid rise to overshooting temperatures, even if a decrease to 1.5°C may be achieved at the end of the 21st century or later (*medium confidence*). If overshoot is to be minimized, the remaining equivalent CO_2 budget available for emissions is very small, which implies that large, immediate, and unprecedented global efforts to mitigate greenhouse gases are required (*high confidence*) {Cross-Chapter Box 8 in this Chapter; Sections 3.2 and 3.6.2}.

Substantial global differences in temperature and extreme events are expected if GMST reaches 1.5°C versus 2°C above the preindustrial period (*high confidence*). Regional surface temperature means and extremes are higher at 2°C as compared to 1.5°C for oceans in near all locations *(high confidence)*. Temperature means and extremes are higher at 2°C as compared to 1.5°C global warming in near all inhabited land regions, and display in some regions 2-3 times greater warming when compared to the GMST (*high confidence*). There are also substantial increases in temperature means and extremes at 1.5°C versus present (*high confidence*) {3.3.1, 3.3.2}. There are decreases in the occurrence of cold extremes, but substantial increases in their temperature {3.3.1}.

Substantial changes in regional climate occur between 1.5°C and 2°C global warming (*high confidence*), depending on the variable and region in question *(high confidence)*. Particularly large differences are found for temperature extremes *(high confidence)*. Hot extremes display the strongest warming in mid-latitudes in the warm season (with increases of up to 3°C at 1.5°C of warming, i.e. a factor of two) and cold extremes at high-latitudes in the cold season (with increases of up to 4.5°C at 1.5°C of warming, i.e. a factor of three) (*high confidence*). The strongest warming of hot extremes is found in Central and Eastern North America, Central and Southern Europe, the Mediterranean region (including Southern Europe, Northern Africa and the near-East), Western and Central Asia, and Southern Africa (*medium confidence*). The number of highly unusual hot days increase the most in the tropics, where inter-annual temperature variability is lowest; the emergence of extreme heatwaves is thus earliest in these regions, where they become already widespread at 1.5°C global warming (*high confidence*). Limiting global warming to 1.5°C instead of 2°C could result in around 420 million fewer people being frequently exposed to extreme heatwaves, and about 65 million fewer people being exposed to exceptional heatwaves, assuming constant vulnerability (*medium confidence*) {3.3.1, 3.3.2, Cross-Chapter Box 8 in this Chapter}.

Limiting global warming to 1.5°C limits risks of increases in heavy precipitation events in several regions (*high confidence*). The regions with the largest increases in heavy precipitation events for 1.5°C to 2°C global warming include several high-latitude regions such as Alaska/Western Canada, Eastern Canada/Greenland/Iceland, Northern Europe, northern Asia; mountainous regions (e.g. Tibetan Plateau); as well as Eastern Asia (including China and Japan) and in Eastern North America (*medium confidence*). {3.3.3}. Tropical cyclones are projected to increase in intensity (with associated increases in heavy precipitation) although not in frequency (*low confidence, limited evidence*) {3.3.3, 3.3.6}.

Limiting global warming to 1.5°C is expected to substantially reduce the probability of drought and risks associated with water availability (i.e. water stress) in some regions (*medium confidence*). In particular, risks associated with increases in drought frequency and magnitude are substantially larger at 2°C than at 1.5°C in the Mediterranean region (including Southern Europe, Northern Africa, and the Near-East) and Southern Africa (*medium confidence*) {3.3.4, Box 3.1, Box 3.2}.

Risks to natural and human systems are lower at 1.5°C than 2°C *(high confidence)*. This is owing to the smaller rates and magnitudes of climate change, including reduced frequencies and intensities of temperature-related extremes. Reduced rates of change enhance the ability of natural and human systems to adapt, with substantial benefits for a range of terrestrial, wetland, coastal and ocean ecosystems (including coral reefs and wetlands), freshwater systems, as well as food production systems, human health, tourism, energy systems, and transportation {3.3.1, 3.4}.

Some regions are projected to experience multiple compound climate-related risks at 1.5°C that will increase with warming of 2°C and higher (*high confidence*). Some regions are projected to be affected by collocated and/or concomitant changes in several types of hazards. Multi-sector risks are projected to overlap spatially and temporally, creating new (and exacerbating current) hazards, exposures, and vulnerabilities that will affect increasing numbers of people and regions with additional warming. Small island states and economically disadvantaged populations are particularly at risk. {Box 3.5, 3.3.1, 3.4.5.3, 3.4.5.6, 3.4.11, 3.5.4.9}.

There is *medium confidence* that a global warming of 2°C would lead to an expansion of areas with significant increases in runoff as well as those affected by flood hazard, as compared to conditions at 1.5°C global warming. A global warming of 1.5°C would also lead to an expansion of the global land area with significant increases in runoff (*medium confidence*) as well as an increase in flood hazard in some regions (*medium confidence*) when compared to present-day conditions {3.3.5}.

There is *high confidence* that the probability of a sea-ice-free Arctic Ocean during summer is substantially higher at 2°C when compared to 1.5°C. It is *very likely* that there will be at least one sea-ice-free Arctic summer out of 10 years for warming at 2°C, with the frequency decreasing to one sea-ice-free Arctic summer every 100 years at 1.5°C. There is also *high confidence* that an intermediate temperature overshoot will have no long-term consequences for Arctic sea-ice coverage and that hysteresis behaviour is not expected {3.3.8, 3.4.4.7}.

Global mean sea level rise will be around 0.1 m less by the end of the century in a 1.5°C world as compared to a 2°C warmer world (*medium confidence*). Reduced sea level rise could mean that up to 10.4 million fewer people (based on the 2010 global population and assuming no adaptation) are exposed to the impacts of sea level globally in 2100 at 1.5°C as compared to 2°C {3.4.5.1}. A slower rate of sea level rise enables greater opportunities for adaptation (*medium confidence*) {3.4.5.7}. There is *high confidence* that sea level rise will continue beyond 2100. Instabilities exist for both the Greenland and Antarctic ice sheets that could result in multi-meter rises in sea level on centennial to millennial timescales. There is medium confidence that these instabilities could be triggered under 1.5° to 2°C of global warming {3.3.9, 3.6.3}.

The ocean has absorbed about 30% of the anthropogenic carbon dioxide, resulting in ocean acidification and changes to carbonate chemistry that are unprecedented in 65 million years at least (*high confidence*). Risks have been identified for the survival, calcification, growth, development, and abundance of a broad range of taxonomic groups (i.e. from algae to fish) with substantial evidence of predictable trait-based sensitivities. Multiple lines of evidence reveal that ocean warming and acidification (corresponding to global warming of 1.5°C of global warming) is expected to impact a wide range of marine organisms, ecosystems, as well as sectors such as aquaculture and fisheries (*high confidence*) {3.3.10, 3.4.4}.

There are larger risks at 1.5°C than today for many regions and systems, with adaptation being required now and up to 1.5°C. There are, however, greater risks and effort needed for adaptation to 2°C *(high confidence)* {3.4, Box 3.4, Box 3.5, Cross-Chapter Box 6 in this Chapter}.

Future risks at 1.5°C will depend on the mitigation pathway and on the possible occurrence of a transient overshoot (*high confidence*). The impacts on natural and human systems would be greater where mitigation pathways temporarily overshoot 1.5°C and return to 1.5°C later in the century, as compared to pathways that stabilizes at 1.5°C without an overshoot. The size and duration of an overshoot will also affect future impacts (e.g. loss of ecosystems, *medium confidence*). Changes in land use resulting from mitigation choices could have impacts on food production and ecosystem diversity {Sections 3.6.1 and 3.6.2, Cross-Chapter boxes 7 and 8 in this Chapter}.

Climate change risks for natural and human systems

Terrestrial and Wetland Ecosystems

Risks of local species losses and, consequently, risks of extinction are much less in a 1.5°C versus a 2°C warmer world (*medium confidence*). The number of species projected to lose over half of their climatically determined geographic range (about 18% of insects, 16% of plants, 8% of vertebrates) is reduced by 50% (plants, vertebrates) or 66% (insects) at 1.5°C versus 2°C of warming (*high confidence*). Risks associated with other biodiversity-related factors such as forest fires, extreme weather events, and the spread of invasive species, pests, and diseases, are also reduced at 1.5°C versus 2°C of warming (*high confidence*), supporting greater persistence of ecosystem services {3.4.3.2, 3.5.2}.

Constraining global warming to 1.5°C rather than 2°C and higher has strong benefits for terrestrial and wetland ecosystems and for the preservation of their services to humans (*high confidence*). Risks for natural and managed ecosystems are higher on drylands compared to humid lands. The terrestrial area affected by ecosystem transformation (13%) at 2°C, which is approximately halved at 1.5°C global warming (*high confidence*). Above 1.5°C, an expansion of desert and arid vegetation would occur in the Mediterranean biome (*medium confidence*), causing changes unparalleled in the last 10,000 years (*medium confidence*) {3.3.2.2, 3.4.3.5, 3.4.6.1., 3.5.5.10, Box 4.2}.

Many impacts are projected to be larger at higher latitudes due to mean and cold-season warming rates above the global average (*medium confidence*). High-latitude tundra and boreal forest are particularly at risk, and woody shrubs are already encroaching into tundra (*high confidence*). Further warming is projected to cause greater effects in a 2°C world than a 1.5°C world, for example, constraining warming to 1.5°C would prevent the melting of an estimated permafrost area of 2 million km^2 over centuries compared to 2°C (*high confidence*) {3.3.2, 3.4.3, 3.4.4}.

Ocean ecosystems

Ocean ecosystems are experiencing large-scale changes, with critical thresholds expected to be reached at 1.5°C and above (*high confidence*). In the transition to 1.5°C, changes to water temperatures will drive some species (e.g. plankton, fish) to relocate to higher latitudes and for novel ecosystems to appear *(high confidence)*. Other ecosystems (e.g. kelp forests, coral reefs) are relatively less able to move, however, and will experience high rates of mortality and loss (*very high confidence*). For example, multiple lines of evidence indicate that the majority of warmer water coral reefs that exist today (70-90%) will largely disappear when global warming exceeds 1.5°C (*very high confidence*) {3.4.4, Box 3.4}.

Current ecosystem services from the ocean will be reduced at 1.5°C, with losses being greater at 2°C (*high confidence*). The risks of declining ocean productivity, shifts of species to higher latitudes, damage to ecosystems (e.g. coral reefs, as well as from mangroves, seagrass and other wetland ecosystems), loss of fisheries productivity (at low latitudes), and changing ocean chemistry (e.g., acidification, hypoxia, dead zones), however, are projected to be substantially lower when global warming is limited to 1.5°C (*high confidence*) {3.4.4, Box 3.4}.

Water Resources

The projected frequency and magnitude of floods and droughts in some regions are smaller under a 1.5°C versus 2°C of warming (*medium confidence*). Human exposure to increased flooding is projected to be substantially lower at 1.5°C as compared to 2°C of global warming, although projected changes create regionally differentiated risks (*medium confidence*). The differences in the risks among regions are strongly influenced by local socio-economic conditions (*medium confidence*) {3.3.4, 3.3.5, 3.4.2}.

Risks to water scarcity are greater at 2°C than at 1.5°C of global warming in some regions (*medium confidence*). Limiting global warming to 1.5°C would approximately halve the fraction of world population expected to suffer water scarcity as compared to 2°C, although there is considerable variability between regions (*medium confidence*). Socioeconomic drivers, however, are expected to have a greater influence on these risks than the changes in climate (*medium confidence*) {3.3.5, 3.4.2, Box 3.5}.

Land Use, Food Security and Food Production Systems

Global warming of 1.5°C (as opposed to 2°C) is projected to reduce climate induced impacts on crop yield and nutritional content in some regions (*high confidence*). Affected areas include Sub-Saharan Africa (West Africa, Southern Africa), South-East Asia, and Central and South America. A loss of 7-10% of rangeland livestock globally is projected for approximately 2°C of warming with considerable economic consequences for many communities and regions {3.6, 3.4.6, Box 3.1, Cross-Chapter Box 6 in this Chapter}.

Risks of food shortages are lower in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon at 1.5°C of global warming when compared to 2°C (*medium confidence*). This suggests a transition from medium to high risk of regionally differentiated impacts between 1.5 and 2°C for food security (*medium confidence*). International food trade is *likely* to be a potential adaptation response for alleviating hunger in low- and middle-income countries {Cross-Chapter Box 6 in this Chapter}.

Fisheries and aquaculture are important to global food security but are already facing increasing risks from ocean warming and acidification (*medium confidence*), which will increase at 1.5°C global warming. Risks are increasing for marine aquaculture and many fisheries at warming and acidification at 1.5°C (e.g., many bivalves such as oysters, and fin fish; *medium confidence*), especially at low latitudes (*medium confidence*). Small-scale fisheries in tropical regions, which are very dependent on habitat provided by coastal ecosystems such as coral reefs, mangroves, seagrass and kelp forests, are at a high risk at 1.5°C due to loss of habitat (*medium confidence*). Risks of impacts and decreasing food security become greater as warming and acidification increase, with substantial losses likely for coastal livelihoods and industries (e.g. fisheries, aquaculture) as temperatures increase beyond 1.5°C (*medium to high confidence*). {3.4.4, 3.4.5, 3.4.6, Box 3.1, Box 3.4, Box 3.5, Cross-Chapter Box 6 in this Chapter}

Land use and land-use change emerge as a critical feature of virtually all mitigation pathways that seek to limit global warming to 1.5°C (*robust evidence, high agreement*). Most least-cost mitigation pathways to limit peak or end-of-century warming to 1.5°C make use of Carbon Dioxide Removal (CDR), predominantly employing significant levels of Bioenergy with Carbon Capture and Storage (BECCS) and/or Afforestation and Reforestation (AR) in their portfolio of mitigation measures (*robust evidence, high agreement*) {Cross-Chapter Box 7 in this Chapter}.

Large-scale, deployment of BECCS and/or AR would have a far-reaching land and water footprint (*medium evidence, high agreement*). Whether this footprint results in adverse impacts, for example on biodiversity or food production, depends on the existence and effectiveness of measures to conserve land carbon stocks, measures to limit agricultural expansion so as to protect natural ecosystems, and the potential to increase agricultural productivity (*high agreement, medium evidence*). In addition, BECCS and/or AR would also have substantial direct effects on regional climate through biophysical feedbacks, which are generally not included in Integrated Assessments Models (*high confidence*). {Cross-Chapter Boxes 7 and 8 in this Chapter, Section 3.6.2}

The impacts of large-scale CDR deployment can be greatly reduced if a wider portfolio of CDR options is deployed, a holistic policy for sustainable land management is adopted and if increased mitigation effort strongly limits demand for land, energy and material resources, including through lifestyle and dietary change (*medium agreement, medium evidence*). In particular, reforestation may be associated with significant co-benefits if implemented so as to restore natural ecosystems *(high confidence)* {Cross-Chapter Box 7 in this Chapter}

Human Systems: Human Health, Well-Being, Cities, and Poverty

Any increase in global warming (e.g., +0.5°C) will affect human health (*high confidence*). Risks will be lower at 1.5°C than at 2°C for heat-related morbidity and mortality (*very high confidence*), particularly in urban areas because of urban heat islands (*high confidence*). Risks also will be greater for ozone-related mortality if the emissions needed for the formation of ozone remain the same (*high confidence*), and for undernutrition (*medium confidence*). Risks are projected to change for some vector-borne diseases such as malaria and dengue fever (*high confidence*), with positive or negative trends depending on the disease, region, and extent of change (*high confidence*). Incorporating estimates of adaptation into projections reduces the magnitude of risks (*high confidence*) {3.4.7, 3.4.7.1}.

Global warming of 2°C is expected to pose greater risks to urban areas than global warming of 1.5°C (*medium confidence*). The extent of risk depends on human vulnerability and the effectiveness of adaptation for regions (coastal and non-coastal), informal settlements, and infrastructure sectors (energy, water, and transport) (*high confidence*) {3.4.5, 3.4.8}.

Poverty and disadvantage have increased with recent warming (about 1°C) and are expected to increase in many populations as average global temperatures increase from 1°C to 1.5°C and beyond (*medium confidence*). Outmigration in agricultural-dependent communities is positively and statistically significantly associated with global temperature (*medium confidence*). Our understanding of the linkages of 1.5°C and 2°C on human migration are limited and represent an important knowledge gap {3.4.10, 3.4.11, 5.2.2, Table 3.5}.

Key Economic Sectors and Services

Globally, the projected impacts on economic growth in a 1.5°C warmer world are larger than those of the present-day (about 1°C), with the largest impacts expected in the tropics and the Southern Hemisphere subtropics (*limited evidence, low confidence*). At 2°C substantially lower economic growth is projected for many developed and developing countries *(limited evidence, medium confidence)*, with the potential to also limit economic damages at 1.5°C of global warming. {3.5.2, 3.5.3}.

The largest reductions in growth at 2°C compared to 1.5 °C of warming are projected for low- and middle-income countries and regions (the African continent, southeast Asia, India, Brazil and Mexico) (*limited evidence, medium confidence*) {3.5}.

Global warming has affected tourism and increased risks are projected for specific geographic regions and the seasonality of sun, beach, and snow sports tourism under warming of 1.5°C (*very high confidence*). Risks will be lower for tourism markets that are less climate sensitive, such as non-environmental (e.g., gaming) or large hotel-based activities (*high confidence*) {3.4.9.1}. Risks for coastal tourism, particularly in sub-tropical and tropical regions, will increase with temperature-related degradation (e.g. heat extremes, storms) or loss of beach and coral reef assets (*high confidence*) {3.4.9.1, 3.4.4.12; 3.3.6, Box 3.4}.

Small islands, and coastal and low-lying areas

Small islands are projected to experience multiple inter-related risks at 1.5°C that will increase with warming of 2°C and higher (*high confidence*). Climate hazards at 1.5°C are lower compared to 2°C (*high confidence*). Long term risks of coastal flooding and impacts on population, infrastructure and assets (*high confidence*), freshwater stress (*medium confidence*), and risks across marine ecosystems (*high confidence*), and critical sectors (*medium confidence)* increase at 1.5°C as compared to present and further increase at 2°C, limiting adaptation opportunities and increasing loss and damage (*medium confidence*). Migration in small islands (internally and internationally) occurs due to multiple causes and for multiple purposes, mostly for better livelihood opportunities (*high confidence*) and increasingly due to sea level rise (*medium confidence).* {3.3.2.2, 3.3.6-9, 3.4.3.2, 3.4.4.2, 3.4.4.5, 3.4.4.12, 3.4.5.3, 3.4.7.1, 3.4.9.1, 3.5.4.9, Box 3.4, Box 3.5}.

Impacts associated with sea level rise and changes to the salinity of coastal groundwater, increased flooding and damage to infrastructure, are critically important in sensitive environments such as small islands, low lying coasts and deltas at global warming of 1.5°C and 2°C (*high confidence*). Localised subsidence and changes to river discharge can potentially exacerbate these effects {3.4.5.4}. Adaptation is happening today (*high confidence*) and remains important over multi-centennial timescales {3.4.5.3, 3.4.5.7, Box 3.5, 5.4.5.4}.

Existing and restored natural coastal ecosystems may be effective in reducing the adverse impacts of rising sea levels and intensifying storms by protecting coastal and deltaic regions. Natural sedimentation rates are expected to be able to offset the effect of rising sea levels given the slower rates of sea-level rise associated with 1.5°C of warming (*medium confidence*). Other feedbacks, such as landward migration of wetlands and the adaptation of infrastructure, remain important (*medium confidence*) {3.4.4.12, 3.4.5.4, 3.4.5.7}

Increased reasons for concern

There are multiple lines of evidence that there has been a substantial increase since AR5 in the levels of risk associated with four of the five Reasons for Concern (RFCs) for global warming levels of up to 2°C (*high confidence*). Constraining warming to 1.5°C rather than 2°C avoids risk reaching a 'very high' level in RFC1 (Unique and Threatened Systems) (*high confidence*), and avoids risk reaching a 'high' level in RFC3 (Distribution of Impacts) (*high confidence*) and RFC4 (Global Aggregate Impacts) (*medium confidence*). It also reduces risks associated with RFC2 (Extreme Weather Events) and RFC5 (Large scale singular events) (*high confidence*) {3.5.2}.

In "Unique and Threatened Systems" (RFC1) the transition from high to very high risk is located between 1.5°C and 2°C global warming as opposed to at 2.6°C global warming in AR5, owing to new and multiple lines of evidence for changing risks for coral reefs, the Arctic, and biodiversity in general (*high confidence*) {3.5}.

1. **In "Extreme Weather Events" (RFC2) the transition from moderate to high risk is located between 1.0°C and 1.5°C global warming,** which is very similar to the AR5 assessment but there is greater confidence in the assessment (*medium confidence*). The impact literature contains little

information about the potential for human society to adapt to extreme weather events and hence it has not been possible to locate the transition from 'high' (red) to 'very high' risk within the context of assessing impacts at 1.5°C versus 2°C global warming. There is thus *low confidence* in the level at which global warming could lead to very high risks associated with extreme weather events in the context of this report {3.5}.

2. **In "Distribution of impacts" (RFC3) a transition from moderate to high risk is now located between 1.5°C and 2°C global warming as compared with between 1.6°C and 2.6°C global warming in AR5**, due to new evidence about regionally differentiated risks to food security, water resources, drought, heat exposure, and coastal submergence *(high confidence)* {3.5}.

3. **In "Global aggregate impacts" (RFC4) a transition from moderate to high levels of risk now occurs between 1.5°C and 2.5°C global warming** as opposed to at 3°C warming in AR5, owing to new evidence about global aggregate economic impacts and risks to the earth's biodiversity *(medium confidence)* {3.5}.

4. **In "Large scale singular events" (RFC5), moderate risk is located at 1°C global warming and high risks are located at 2.5°C global warming**, as opposed to 1.9°C (moderate) and 4°C global warming (high) risk in AR5 because of new observations and models of the West Antarctic ice sheet (*medium confidence*) {3.3.9, 3.5.2, 3.6.3}

372-1
x 375-4

From: Mark Bigland-Pritchard <City.Council@Saskatoon.ca>
Sent: Tuesday, August 06, 2019 9:11 PM
To: City Council
Subject: Form submission from: Write a Letter to Council
Attachments: saskatoonclimateplanlettermbp_c.pdf

RECEIVED
AUG 06 2019
CITY CLERK'S OFFICE
SASKATOON

Submitted on Tuesday, August 6, 2019 - 21:10
Submitted by anonymous user: 207.47.175.16
Submitted values are:

Date: Tuesday, August 06, 2019
To: His Worship the Mayor and Members of City Council
First Name: Mark
Last Name: Bigland-Pritchard
Email: mark@lowenergydesign.com
Address: 812 5th St E
City: Saskatoon
Province: Saskatchewan
Postal Code: S7H 1G9
Name of the organization or agency you are representing (if applicable):
Subject: Climate change mitigation plan
Meeting (if known):
Comments: This is part 3 (of 3) of the communication which I attempted to send to councillors last night
Attachments:
saskatoonclimateplanlettermbp_c.pdf:
https://www.saskatoon.ca/sites/default/files/webform/saskatoonclimateplanlettermbp_c.pdf

The results of this submission may be viewed at:
https://www.saskatoon.ca/node/398/submission/329270

372-1
x 375-4

Annex 2: Emissions pathways compatible with 1.5 °C

from:
Intergovernmental Panel on Climate Change (2018), Special Report: Global Warming of 1.5°C, Summary for Policymakers. Available online at https://www.ipcc.ch/sr15/

N.B. The graphs shown on this page are for scenarios for worldwide emissions reductions. Clauses 2.2 and 4.4 of the Paris Agreement set out a commitment that wealthy industrialised jurisdictions (such as Canada) should decarbonise rather faster than the global average.

Global emissions pathway characteristics

General characteristics of the evolution of anthropogenic net emissions of CO_2, and total emissions of methane, black carbon, and nitrous oxide in model pathways that limit global warming to 1.5°C with no or limited overshoot. Net emissions are defined as anthropogenic emissions reduced by anthropogenic removals. Reductions in net emissions can be achieved through different portfolios of mitigation measures illustrated in Figure SPM3B.

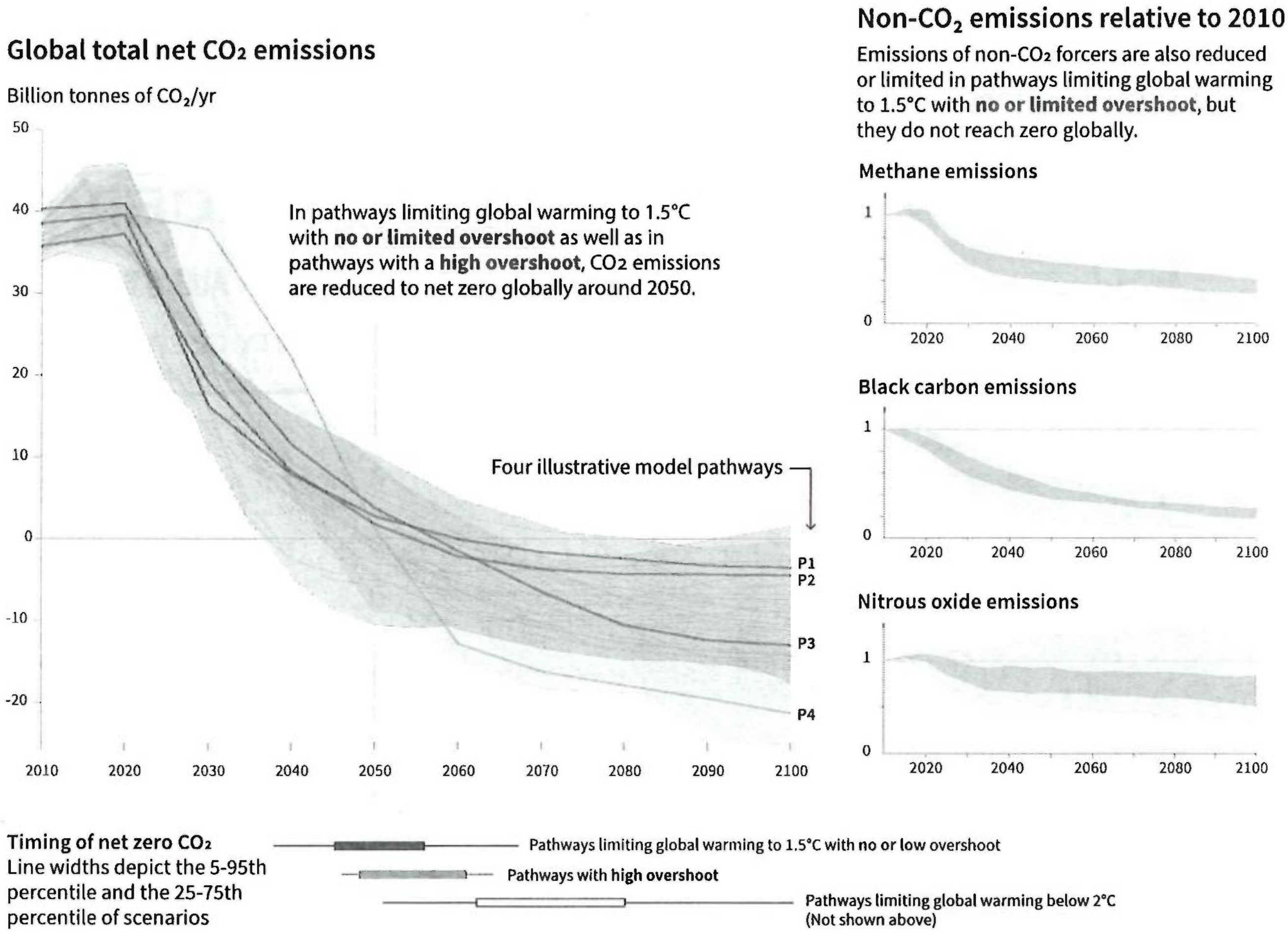

Figure SPM.3a: Global emissions pathway characteristics. The main panel shows global net anthropogenic CO_2 emissions in pathways limiting global warming to 1.5°C with no or limited (less than 0.1°C) overshoot and pathways with higher overshoot. The shaded area shows the full range for pathways analysed in this report. The panels on the right show non-CO_2 emissions ranges for three compounds with large historical forcing and a substantial portion of emissions coming from sources distinct from those central to CO_2 mitigation. Shaded areas in these panels show the 5–95% (light shading) and interquartile (dark shading) ranges of pathways limiting global warming to 1.5°C with no or limited overshoot. Box and whiskers at the bottom of the figure show the timing of pathways reaching global net zero CO_2 emission levels, and a comparison with pathways limiting global warming to 2°C with at least 66% probability. Four illustrative model pathways are highlighted in the main panel and are labelled P1, P2, P3 and P4, corresponding to the LED, S1, S2, and S5 pathways assessed in Chapter 2. Descriptions and characteristics of these pathways are available in Figure SPM3b. {2.1, 2.2, 2.3, Figure 2.5, Figure 2.10, Figure 2.11}