BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF SOUTH DAKOTA

IN THE MATTER OF TRANSCANADA KEYSTONE PIPELINE, LP FOR ORDER ACCEPTING CERTIFICATION OF PERMIT ISSUED IN DOCKET HP09-001 TO CONSTRUCT THE KEYSTONE XL PIPELINE	))))))	HP14-001 Comments of Dr. James E. Hansen

Members of the Commission:

I offer these Comments in opposition to the proposal before you to accept certification of a 2010 permit that this Commission issued to TransCanada Corporation to enable it to construct the Keystone XL pipeline.

By way of background, I am the Director of the Climate Science, Awareness and Solutions (CSAC) program of Columbia University's Earth Institute. I was formerly Director of the NASA Goddard Institute for Space Studies. My formal training is in physics and astronomy. Much of my scholarly work is in the area of climate science, particularly human-caused disruption of Earth's energy balance through the burning of fossil fuels and alterations in land use. I provide a reasonably complete depiction of my qualifications in Exhibit 1: James E. Hansen C.V., which I incorporate herein by reference.

Intertribal Council on Utility Policy, an Intervenor in these proceedings, sought my participation as an expert rebuttal witness, so that the Commission would consider the full implications of its proposed action with respect to the global climate system and future generations. On May 26, 2015 this Commission granted TransCanada's motion to preclude my testimony. You based your decision on a finding that my testimony would have been "beyond the scope of the certification hearing."[1] With respect, it is unfathomable to me that the law properly can be deemed to blind the Commission to consideration of the most fateful consequences of this project. I submit these Comments with the understanding that the Commission is able to reconsider its finding and, barring that, for the record on review.

My specific concern is that, if constructed and put into operation, Keystone XL will substantially increase greenhouse gas emissions and that, in turn, will increase Earth's energy imbalance, thus further disrupting the global climate system.

[1] South Dakota PUC Order Granting TransCanada's Motion to Preclude Witnesses in HP14-001 (May 28, 2015).

Others have provided or, I believe, will provide the Commission with detailed information on risks that may be imposed by crude oil spills on local natural resources, including the regional aquifer. So as to avoid duplication and to keep this comment letter to a manageable length, I will simply add my considered view that the prospect of such risks must not be discounted.

Critical conditions germane to my central concern in these Comments clearly have changed since 2010, when this Commission issued its permit for the TransCanada Keystone XL project. First, our nation and others to date have failed to constrain carbon dioxide (CO_2) emissions. In part as a consequence of that, the atmospheric concentration of CO_2 has risen well beyond the safe level. Accordingly, it is now clearer than before that there is no room for the additional emissions from the burning of the oil that this pipeline will carry to market. Instead, and indeed, the perpetuation of human civilization and nature as we have come to know it alike require a determined and rapid phase-out of fossil fuel emissions so as to avoid looming climate system tipping points.[2]

Second, it is now more apparent than in 2010 that Keystone XL will result in additional CO_2 emissions.

These changed conditions amplify the concern that the project you are now asked to affirm gravely threatens the environmental, social and economic circumstances of current and future inhabitants in the siting area, as well as that of inhabitants currently or anticipated to be outside the siting area. I believe that final action by this Commission affirming certification of the 2010 permit, and thus allowing TransCanada to complete the Keystone XL pipeline, would violate the fundamental constitutional right of young children and future generations to a habitable climate system on which they must depend for their survival and well being.

I will now briefly consider the additional CO_2 emissions that the Keystone XL project would yield, before turning to discuss the major elements of the climate crisis that, in my view, should comprise the appropriate context for any rational modern deliberation of options relevant to fossil fuel projects like Keystone XL.

---

[2] Support for this point is contained in a 2013-published study that I published in conjunction with 17 colleagues, entitled "Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature" (hereinafter "Dangerous Climate Change"). I have attached *Dangerous Climate Change* as Exhibit 2, and hereby incorporate its information and analysis by reference into these Comments. For convenience of the reader, that study may also be found here: www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0081648.

A. Keystone XL Pipeline and Additional CO_2 Emissions

As the U.S. Government and others have pointed out, oil sands crude "has significantly higher lifecycle greenhouse gas emissions than other crudes."[3] The implication of this is that development and exploitation of the tar sands will yield up to an additional 27.4 MMTCO_2-e/year, or 1.37 billion MMT CO_2-e additional emissions for the 50-year lifetime of the pipeline.[4]

In 2014, however, the U.S. State Department's concluded, that although oil sands development and use will lead to increased GHG emissions, the Keystone XL pipeline itself would not increase emissions because, it presumed, the carbon-dense oil sands would be exploited regardless of the pipeline. But the State Department's presumption was based on its expectation that oil prices would stay high.[5] If long-term prices fell to less than $75/barrel, the expense of alternative transport to market, namely rail, would render oil sands exploitation uneconomic. Thus, the implications of the State Department's analysis is that the Keystone XL pipeline is essential to economic exploitation of oil sands crude where long-term market prices are below $75/barrel. In its most recent letter pointing out the State Department's elementary errors, the Environmental Protection Agency noted that "oil was trading at below $50 per barrel."[6]

Accordingly, I think it fair to conclude that the Keystone XL pipeline is essential to oil sands exploitation at reasonably foreseeable crude market prices. It is thus also fair to attribute to the Keystone XL project those additional GHG emissions, as discussed above, that will result from oil sands development and consumption.

Finally, in this brief review, there is the too-little considered interaction with world oil prices and the impact on demand. As the Stockholm Environment Institute recently pointed out, in the event Keystone XL is completed the increase in

---

[3] U.S. State Department, Final Supplemental Environmental Impact Statement for the Keystone XL Project (January 2014) Executive Summary, ES-15. *See also* EPA letter to State (Feb. 2, 2015) at 2. ("The Final SEIS states that lifecycle greenhouse gas emissions from development and use of oil sands crude is about 17% greater than emissions from average crude oil refined in the United States on a wells-to-wheels basis.").

[4] *Id*.

[5] FSEIS Executive Summary, p. ES-12 ("Above approximately $75 per barrel for West Texas Intermediate (WTI)-equivalent oil, revenues to oil sands producers are likely to remain above the long-run supply costs of most projects responsible for expected levels of oil sands production growth.").

[6] Feb. 2, 2015 EPA Letter at 3. At the time of the writing, June 22, 2015, crude was trading at $59 per barrel. It has remained below $75 per barrel since late November 2014. *See* http://www.bloomberg.com/quote/CL1:COM (1Y Time Frame) and http://www.nasdaq.com/markets/crude-oil.aspx?timeframe=1y.

crude oil supply will depress the global market price. That in turn will spur global consumption "by as much as 510,000 barrels per day," resulting in increased emissions from this market effect alone by as much as 93 $MMTCO_2$-e per year.[7] If the Institute's analysis is correct, then the 50-year lifespan of the Keystone XL pipeline will produce additional emissions amounting to as much as 4.65 trillion tCO_2-e, a climate pollution load more than three times the outer limit of that which can be pieced together from the State Department's FSEIS.

Accordingly, we must conclude that, if allowed by the Commission and other authorities, the massive private investment in Keystone XL will accomplish what TransCanada Corporation clearly aims to achieve, namely, additional exploitation of the Alberta oil sands. This will result in increased CO_2 emissions stemming both from the burning of oil extracted from those deposits, and from the increased demand for crude being sold at a depressed global market price.

B. THE CLIMATE CRISIS, AND THE ROAD TO CLIMATE STABILITY

As indicated above, a study that I published along with colleagues in late-2013 provides a detailed treatment of our present predicament and the route that must be taken to sufficiently reduce atmospheric CO_2 to preserve a habitable climate system. In the following, I outline the signal features of the problem and that prescription.

First: Human burning of fossil fuels has disrupted Earth's energy balance, and in response the planet is heating up – with no end in sight, unless we alter our present path. Atmospheric CO_2 concentration, for example, is now at its highest level in 3 million years, and global surface temperatures now have reached the prior maximum of the Holocene era, the period of relatively moderate climate that, over the last 10,000 years, has enabled civilization to develop.

Second: We are observing impacts of the relatively small amount of warming that has already occurred, and these constitute harbingers of far more dangerous change to come. We can discuss the observable consequences, and their implications. But the key point is that, if unabated, continued carbon emissions will initiate dynamic climate change and effects that spin out of control of future generations as the planet's energy imbalance triggers amplifying feedbacks and the climate system and biological system pass critical tipping points.

Third: There is still time and opportunity to preserve a habitable climate system -- if we pursue a rational course. I will outline the glide path that we think remains feasible, though much further delay in taking effective action will consign that effort to failure. Objectively, then, the situation is urgent and what governments and other decision-makers do, or do not do, today to reduce carbon pollution matters immensely.

---

[7] Stockholm Environment Institute, Working Paper 2013-11 at pp. 4-5.

I. Our Planet is Now Out of Energy Balance

Chart 1 shows global fossil fuel CO_2 emissions on an annual basis from the burning of coal, oil, and natural gas, and from cement production and flaring, along with the total emissions from these major sources. [*See* Appendix 1 to this comment letter for charts.]

Although it is more than twenty years since 170 nations agreed to limit fossil fuel emissions in order to avoid dangerous human-made climate change, the stark reality – as illustrated here – is that global emissions have accelerated. Specifically, the growth rate of fossil fuel emissions increased from 1.5%/year during 1980–2000 to 3%/year in 2000–2013, mainly because of increased use of coal.

Our increased emissions are reflected, at least in part, in the rising concentration of atmospheric CO_2, which is now approximately 400 ppm, over 40 percent more than the preindustrial level.

Moreover, the increase in the atmospheric CO_2 concentration is itself speeding up, as is illustrated in Chart 2. The graphic, by NOAA's Earth System Research Laboratory, shows a doubling, over the last half-century, of the average annual increase in the concentration of atmospheric of CO_2 to 2ppm per year.

This increased concentration of CO_2 and other GHGs in the atmosphere operates to reduce Earth's heat radiation to space, thus causing an energy imbalance – less energy going out than coming in. This imbalance causes Earth to heat-up until it again radiates as much energy to space as it absorbs from the sun.

In point of fact, warming of Earth caused by the increasingly thick CO_2 "blanket" persisted even during the recent five-year solar minimum of 2005-2010. Had changes in insolation been the dominant forcing, the planet would have had a negative energy balance in that period, when solar irradiance was at its lowest level in the period of accurate data, i.e., since the 1970s. Instead, even though much of the greenhouse gas forcing had been expended in causing observed 0.8°C global warming, the residual positive forcing overwhelmed the negative solar forcing.

This illustrates, unequivocally, that it is human activity, and not the sun, that is the dominant driver of recent climate change.

Turning, now to Chart 3, we see the upward march of recent average global surface temperature. Earth has now warmed about 0.8°C above the pre-industrial level. That is now close to, and probably slightly above, the prior maximum of the Holocene era – the period of relatively stable climate over the last 10,000 years that has enabled civilization to develop.

That warming increases Earth's radiation to space, thus reducing Earth's energy imbalance. However, because of the ocean's great thermal inertia, it requires centuries for the climate system to reach a new equilibrium consistent with a changed atmospheric composition. The planet's energy imbalance confirms that substantial additional warming is "in the pipeline". That energy imbalance is now measured by an international fleet of more than 3000 submersible floats that plumb the depths of the world's ocean measuring the increasing heat content.

Earth's energy imbalance now averages about 0.6 Watts/m2 averaged over the entire planet, but I am uncertain whether this conveys to the Commission the scale of what is going on. I can note that the total energy surplus is 300 trillion joules per second, but that large number may still be insufficiently evocative. Accordingly, it may be more useful to observe, and with equal validity, that Earth's energy imbalance is equivalent to exploding more than 400,000 Hiroshima atomic bombs per day, 365 days per year. That is how much extra energy Earth is now gaining each day because of our use of the atmosphere as a waste dump for our carbon pollution.

We can turn now to Chart 4. Here, we summarize the average global surface temperature record of the last 65 million years. This record is based on high-resolution ice core data covering the most recent several hundred thousand years, and ocean cores on time scales of millions of years. That record provides us with insight as to global temperature sensitivity to external forcings such as added CO_2, and sea level sensitivity to global temperature. It also provides quantitative information about so-called "slow" feedback processes – such as melting ice sheets and lessened surface reflectivity attributable to the darker surfaces resulting from the melting ice sheets and reduced area of ice.

Several relevant conclusions can be drawn. First, the mechanisms that account for the relatively rapid oscillations between cold and warm climates were the same as those operating today. Those past climate oscillations were initiated not by fossil fuel burning, but by slow insolation changes attributable to perturbations of Earth's orbit and spin axis tilt. However, the mechanisms that caused these historical climate changes to be so large were two powerful amplifying feedbacks: the planet's surface albedo (its reflectivity, literally its whiteness) and atmospheric CO_2.

Second, the longer paleoclimate record shows that warming coincident with atmospheric CO_2 concentrations as low as 450-500 ppm may have been enough to melt most of Antarctica. Our emissions have already driven up the CO_2 concentration in the atmosphere to about 400 ppm from 280 ppm of the preindustrial era.

I conclude that the present level of CO_2 and its warming effect, both realized and latent, is already in the dangerous zone. Indeed, we are now in a period of overshoot, with early consequences that are already hazardous and that will rise to severe unless action is taken without delay to restore energy balance at a lower atmospheric CO_2 amount.

All that said, we can turn now to a brief review of these increasingly unacceptable, but still avoidable, consequences.

II. Climate Change May Devastate Life As We Know It, Absent Effective Action

As I earlier noted, global warming to date measures “only” 0.8°C above the pre-industrial period. And yet, that level of warming has already led to a 40 percent reduction of Arctic sea ice cover at the end of the melt season, and an even faster decline in sea ice thickness.

Mountain glaciers, the source of fresh water to major world rivers during dry seasons, already are receding rapidly all around the world. To cite a close-to-home example, glaciers in iconic Glacier National Park appear to be in full retreat: In 1850, according to the Park Service, Glacier had 150 glaciers measuring larger than twenty-five acres. Today, it has just twenty-five.

As well, tropospheric water vapor and heavy precipitation events have increased, as we would expect. A warmer atmosphere holds more moisture, thus enabling precipitation to be heavier and cause more extreme flooding. Higher temperatures, on the other hand, increase evaporation and can intensify droughts when they occur, as can the expansion of the subtropics that occurs as a consequence of global warming.

Coral reef ecosystems, harboring more than 1,000,000 species as the “rainforests” of the ocean, are impacted by a combination of ocean warming, acidification from rising atmospheric CO2, and other human-caused stresses, resulting in a 0.5-2% per year decline in geographic extent.

World health experts have concluded with “very high confidence” that climate change already contributes to the global burden of disease and premature death with expansion of infectious disease vectors. Increasing climate variability is being examined as a possible contributor to the expansion of Ebola.

Subtropical climate belts have expanded, contributing to more intense droughts, summer heat waves, and devastating wildfires. Further, summer mega-heat-waves, such as those in Europe in 2003, the Moscow area in 2010, Texas and Oklahoma in 2011, Greenland in 2012, and Australia in 2013 have become more widespread with the increase demonstrably linked to global warming. The probability of such extreme heat events has increased by several times because of global warming, and the probability will increase even further if global warming continues to increase.

Recent estimates of sea level rise by 2100 have been on the order of 1 meter, which is higher than earlier assessments. However, these estimates still in part assume linear relations between warming and sea level rise. It is likely that continued business-as-usual CO_2 emissions will spur a nonlinear response, with multi-meter sea level rise realized this century. Needless to say, we are not close to being prepared for that. Very recent research that colleagues and I have undertaken serves to underscore this danger and, with the Commission's leave, I will supplement this Comment letter with that detailed study upon its publication and ask that it be included in the record of these proceedings.

Turning, then, to Charts 5 and 6: measurement reveals that both Greenland and Antarctica have been losing mass at rapidly increasing rates during the period of accurate satellite data, i.e., approximately the last 20 years.

Recently published data indicate that, in the most recent 3-year period, the combined volume loss for Greenland and Antarctica is approximately 500 km3/yr. Greenland has contributed nearly 75% of that loss. Red areas in Charts 5 and 6 mark locations of ice sheet loss over the period, while blue areas mark ice gains as a result of increased snowfall associated with higher amounts of atmospheric water vapor. As noted, the two ice sheets together appear now to be thinning at a rate of 500 cubic kilometers per year – the highest rate of ice thinning that has been observed.

A word about the atmospheric residence time of CO_2 is in order, and we can do that with the aid of Chart 7.

A pulse of CO_2 injected into the air decays by half in about 25 years, as CO_2 is taken up by the ocean, biosphere and soil, but nearly one-fifth remains in the atmosphere after 500 years. Indeed, that estimate is likely optimistic, in light of the well-known nonlinearity in ocean chemistry and saturation of carbon sinks, implying that the airborne fraction probably will remain larger for a century and more. It requires hundreds of millennia for the chemical weathering of rocks to eventually deposit all of this initial CO_2 pulse on the ocean floor as carbonate sediments.

The critical point here is that carbon from fossil fuel burning remains in the climate system, with much of it in the atmosphere, and thus continues to affect the climate system for many millennia, ensuring that over time sea level rise of many meters will occur – tens of meters if most of the fossil fuels are burned.

That order of sea level rise would result in the loss of hundreds of historical coastal cities worldwide, with incalculable economic consequences. It would also create hundreds of millions of global warming refugees from highly populated low-lying areas, and thus likely cause or exacerbate major international conflicts.

We have seen, in the past decade, that sea level increased about 3cm—a rate of about one foot per century, nearly twice as fast as the rate of increase during the preceding century. This rise in the sea has resulted in losses of coastal wetland areas and greater levels of damage from coastal flooding. For example, in Louisiana, increased sea level and regional land subsidence have led to the loss of 1900 square miles of coastal wetland, which in turn exacerbates the area's vulnerability to storm surges as occurred during Hurricane Katrina.

Other impacts abound. Acidification stemming from ocean uptake of a portion of increased atmospheric CO_2 will increasingly disrupt coral reef ecosystem health, with potentially devastating impacts to certain nations and communities. Inland, fresh water security will be compromised, due to the effects of receding mountain glaciers and snowpack on seasonal freshwater availability of major rivers.

As to human health: increasing concentrations of CO_2 and associated increased global temperatures will deepen impacts, with children being especially vulnerable. Climate threats to health move through various pathways, including by placing additional stress on the availability of food, clean air, and clean water. Accordingly, unabated climate change will increase malnutrition and consequent disorders, including those related to child growth and development, increased death, disease and injuries from heat waves, floods, storms, fires and droughts, and increased cardio-respiratory morbidity and mortality associated with increased ground-level ozone.

With regard to other species, we see that climate zones are already shifting at rates that exceed natural rates of change; this trend will continue as long as the planet is out of energy balance. As the shift of climate zones becomes comparable to the range of some species, the less mobile species will be driven to extinction. According to the UN Panel on Climate Change, with global warming of 1.6°C or more relative to pre-industrial levels, 9-31 percent of species are anticipated to be driven to extinction, while with global warming of 2.9°C, an estimated 21-52 percent of species will be driven to extinction. These temperature/extinction thresholds will not be avoided absent concerted, rational action on carbon emissions.

At present, we remain on track to burn a significant fraction of readily available fossil fuels, including coal and tar sands, and so to raise average surface temperature, over time, to far above pre-industrial levels.

High global surface temperatures have been recorded previously, in the age of mammals, with some successful adaptation through evolution of higher surface-area-to-mass ratio body types -- for example transient dwarfing of mammals and even soil fauna. However, human-made warming is occurring rapidly and will be fully realized in only centuries, as opposed to millennia, thus providing little opportunity for evolutionary dwarfism to alleviate impacts of global warming. Along with several colleagues, I have been forced to conclude that the large climate change that will result from burning all or most fossil fuels threatens the survival of humanity.

Which brings me to my third and last point.

III. Restoration of Our Climate System, and so Protection of Our Future, Is Still Possible, But We Must Act With Reason, Courage, and No Further Delay.

As I indicated above, the energy imbalance of Earth is about 0.6 W/m2. In the light of that imbalance, colleagues and I have calculated the level to which atmospheric CO_2 must be drawn down in order to increase Earth's heat radiation to space by the same amount and thus restore energy balance -- the fundamental requirement to stabilize climate and avoid further dangerous warming.

The measured energy imbalance indicates that CO_2 must be reduced to a level below 350 ppm, assuming that the net of other human-made climate forcings remains at today's level. Specification now of a CO_2 target more precise than <350 ppm is difficult due to uncertain future changes of radiative forcing from other gases, aerosols and surface albedo, but greater precision should be feasible during the time that it takes to turn around CO_2 growth and approach the initial 350 ppm target.

Let us return, for a moment, to Chart 7, so as to consider again the question of delay. On the left side of the chart, the long-residence time for atmospheric CO_2 is illustrated. It is reflected in the length of time it would take to return CO_2 to lower concentrations even if, as indicated on the right side of the chart, fossil fuel emissions were to cease entirely.

Of course, an abrupt cessation of all CO_2 emissions, whether in 2015 or 2030, is unrealistic. Industry, other business, and consumers all need time to retool and reinvest in emission-free options to fossil fuels.

Accordingly, we have evaluated emissions reduction scenarios to devise the path that is both technically and economically feasible, while being sufficiently rigorous to constrain the period of "carbon overshoot" and avoid calamitous consequences (greatly accelerating warming, ecosystem collapse, and widespread species extermination). See Chart 8. Our analysis constitutes the best science available on the subject, and prescribes a glide path towards achieving energy balance by the end of the century. It is characterized by large, long-term emissions reductions (of approximately 6 percent annually), coupled with programs to limit and reverse land use emissions via reforestation and improved agricultural and forestry practices (drawing down approximately 100 GtC by the year 2100).

These actions could achieve the goal of restoring the atmosphere to approximately 350 ppm within this century if the plan were commenced without delay, and then adhered to. As I have indicated, such action is minimally needed to restore earth's energy balance, preserve the planet's climate system, and avert irretrievable damage to human and natural systems – including agriculture, ocean fisheries, and fresh water supply -- on which civilization depends. However, consistent with the abrupt phase out scenarios discussed in the prior paragraph supra, if rapid annual emission reductions are delayed until 2030, then the global temperature will remain more than 1°C higher than preindustrial levels for about 400 years. Were the emissions cessation only to commence after 40 years, then the atmosphere would not return to 350 ppm CO_2 for nearly 1000 years. Overshooting the safe level of atmospheric CO_2 and the safe range of global ambient temperature for anything approaching these periods will consign succeeding generations to a vastly different, less hospitable planet.

Considered another way, the required rate of emissions reduction would have been about 3.5% per year if reductions had started in 2005 and continued annually thereafter, while the required rate of reduction, if commenced in 2020, will be approximately 15% per year. Accordingly, the dominant factor is the date at which fossil fuel emission phase out begins, again presuming the rate of annual emissions reductions thereafter are sustained.

C. CONCLUSION

Based on the above, I think it is clear that a decision by this Commission to certify the Keystone XL pipeline permit will shove the planet hard towards, and perhaps beyond, climate tipping points of no return. Moreover, I think there is no question but that, once approved and operational, the TransCanada Corporation will fight tooth and nail to keep KXL open and pumping, notwithstanding the increasingly overwhelming evidence that burning the crude that it will bring to market threatens our children, the unborn, future generations, and the natural world as we have known it.

My colleagues and I have outlined a fundamentally different course, one that, if vigorously pursued, could restore Earth's energy balance and preserve a habitable climate system. Delay in its adoption will defeat those prospects.

TransCanada's ringing demand for certification, on the other hand, constitutes a death knell for the planet. Reject it to help secure a viable future for our children.

Thank you for your consideration.

Dated this 22 Day of June, 2015.

James E Hansen

Dr. James E. Hansen

Respectfully Submitted on behalf of
Dr. James E. Hansen by:
/s/Daniel M. Galpern

Daniel M. Galpern
Oregon Bar #061950
1641 Oak St.
Eugene, OR 97401
Telephone: 541.968.7164
Email: dan.galpern@gmail.com
Attorney for James E. Hansen