THE DPRK’S INTENDED NATIONALLY DETERMINED CONTRIBUTION TO COMMITMENTS UNDER THE UNFCCC: A CLIMATE CHANGE WINDOW INTO THE DPRK ENERGY SECTOR

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June 7, 2017

I. INTRODUCTION

In this essay, David von Hippel and Peter Hayes suggest that the emissions data reported in the DPRK's *Intended Nationally Determined Contribution of Democratic People's Republic of Korea* submitted to the UN are broadly consistent with previously compiled energy supply-demand balances prepared for the DPRK energy sector. They suggest that "the ROK's plan to resume humanitarian aid with the DPRK could focus on those elements in the plan that focus on provision of energy services that directly improve human welfare, especially small, fast, and relatively low technology that do not depend on large-scale and massive infrastructure, and would endure inevitable cycles of inter-Korean and external conflict with the DPRK."

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Banner Image Credit: Nautilus photograph by Chris Greacen, North Korean tractor, Unhari Village, DPRK

II. POLICY FORUM BY DAVID VON HIPPEL AND PETER HAYES

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1 Introduction and Background: Availability of DPRK Energy Data and its Statement of "INDCs"

The Democratic People's Republic of Korea (the DPRK, or "North Korea") rarely provides direct official information on its energy sector, and the data that are provided often need to be interpreted

with care. In our over 20 years of undertaking analyses of the DPRK energy sector, we have grown accustomed to using indirect data, estimates, and comparisons with other nations using similar technologies to assemble coherent—though doubtless not entirely accurate—quantitative estimates of energy supply and demand in the DPRK.[1] Indeed, one of the authors of this paper (Hayes) conducted the DPRK's first official greenhouse gas inventory project with UN support in 1994, working with local counterparts, and encountered these very same issues at that time.

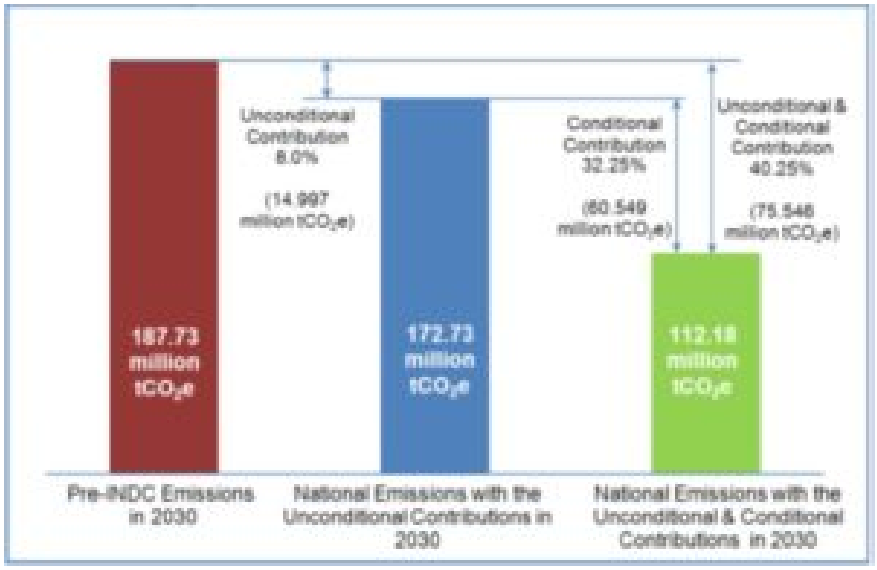
It is thus an unusual and appreciated event when an official document presenting information related to the DPRK's overall energy sector becomes available. The document *Intended Nationally Determined Contribution of Democratic People's Republic of Korea*, dated September 2016, and submitted to the United Nations Framework Convention on Climate Change (UNFCCC) is such a document.[2] Information from the DPRK's "INDC" submission provides insights on topics such as the official policies on climate change and other environmental issues, on the DPRK's intended energy-sector (and more broadly, economic) growth through 2030, and the DPRK's "wish list" of energy-sector and other technologies—at least those with potential to reduce greenhouse gas emissions—for which it would propose to seek international assistance in implementation.

In general, INDCs are commitments that a country makes to reduce emissions of greenhouse gases and/or institute policies to adapt to changing climate. For "non-Annex 1" countries, which are typically countries with lower per-capita income, INDCs are in part a statement of what policies the government of a country intends to implement on its own, namely, "unconditional" INDCs, and those that it would implement with financial and technical assistance from the international community (through various mechanisms. The latter are "conditional" INDCs, and to some extent constitute a wish list of policies and projects that a country nominates as candidates for international assistance.

2 Contents of the DPRK's INDC Document

The DPRK's 2016 INDC document begins with an introduction that acknowledges the guidance and leadership of Kim Jong Un, then notes the DPRK's progress in the area of environmental protection, including afforestation, setting aside nature reserves, building small, medium, and large hydroelectric capacity, improving efficiency in energy supply and demand, agriculture, "zero-carbon architecture", implementing renewable energy systems, and other accomplishments. The Introduction then notes the DPRK's ratification of UNFCCC agreements over the years, including the Paris agreement of 2016, as well as the DPRK's submission of its First and Second National Communications, in 2002 and 2013, respectively.

In the second section of the DPRK INDC document, the methods used in preparing the INDC greenhouse gas (GHG) emissions reduction estimates are briefly reviewed. The resulting estimated reductions are then presented relative to a "Business as Usual" (BAU) scenario of economic development and GHG emissions running through 2030, with a 2000 base year. Unconditional INDCs are estimated as reducing 2030 BAU emissions by 8% in total, with conditional INDCs contributing a further 32.25% in reductions, as shown in the figure below (taken from the INDC document).



The INDC document notes the DPRK's need for assistance in implementing INDCs, including providing a year-2000 per-capita GDP of USD 462 as evidence of developing-country status. It also lists eight national laws and strategies supporting the reduction of GHG emissions.

Ten different "measures"—actually, a combination of policies and actions—each with its own set of sub-policies or areas of focus, are provided, and constitute a fairly comprehensive suite of potential GHG emissions reduction actions. The ten main categories listed are:

1. Strengthen the national framework on climate change
2. Improve energy use efficiency and reduce energy consumption
3. Improve energy use efficiency and encourage the use of alternative energy in electric power industry
4. Scale up the utilization of renewable energy development
5. Manage and develop forest in a sustainable manner
6. Introduce advanced technologies and methodologies for sustainable agricultural development
7. Introduce sustainable waste management system
8. Raise public awareness and accelerate participatory process for responding climate change
9. Enhance international cooperation for mitigation of climate change
10. Increase financial support for mitigation measures

Following this list, a table offering 19 "Mitigation measures prioritized for conditional contribution" is presented, spanning the ten categories above. These are the key areas where the DPRK is seeking implementation assistance to implement emissions-reducing initiatives. Although independent estimates of emissions reduction from each of these measures are not provided in the INDC document, in some cases enough information is provided that with combined with our previous estimates of energy use in the DPRK, it is possible to make rough estimates of implied emissions reduction, which we attempt below. A similar list of individual "unconditional" measures is not provided.

The final section of the INDC document focuses on climate adaptation, noting that average temperatures in the DPRK increased by 1.9°C over the 20th century, and are projected to rise at a rate above the world average, namely by 2.8 to 4.7°C relative to 1971-2000 average temperatures.

Other projected changes include sea level rise of 0.67m to 0.89m compared to 2000, coastal inundation of nearly 100 meters on the DPRK's East coast and nearly 1 km on the West coast, and changes in precipitation timing and amount. A set of six categories of approaches to adaptation , and a table of adaptation measures by type of measure, are provided, along with a discussion of the DPRK's needs for international assistance to complement its domestic policies to promote climate change adaptation. The DPRK's adaptation strategy as described, though laid out in general terms, seems generally appropriate and consistent with strategies described by other nations.

3 Implications of Values Relative to Nautilus Estimates of DPRK Energy Sector Activity

The values stated in the INDC document for GHG emissions offer some insights into DPRK official projections. First, and most basic, the values provided for per-capita and total GHG emissions in 2000 imply a DPRK population in that year of 22.7 million, which is just slightly higher (2-3%) than the value we assume for our analyses. For 2030, the values provided imply a population of nearly 29 million in 2030, which is somewhat higher than the 27 million we use in our projections and future energy scenarios. For the year 2000, the INDC document lists overall GHG emissions of 65,714 $GgCO_2$, presumably in units of carbon dioxide equivalents (CO_2e), and presumably including estimates of all sources of GHGs. This is the same as 65.7 Mt (million tonnes) CO_2e. Our most recent estimate of year 2000 DPRK GHG emissions from the energy sector alone sum to about 40.5 Mt CO_2e. Adding in on the order of 8.7 Mt CO_2e emitted due to in-soil and above-ground biomass lost from deforestation (we estimate loss to have been about 4 million tonnes of growing stock of above-ground biomass per year in the years around 2000), 2.0 Mt CO_2e of methane emitted from rice paddies, as estimated by the United Nations Food and Agriculture Organization (UNFAO),[3] plus 0.9 Mt CO_2e of methane emitted from livestock, 0.4 Mt CO_2e of methane and nitrous oxide from manure management, and 1.1 Mt CO_2e of nitrous oxide emissions from synthetic fertilizer use (all also from UNFAO), plus about 1.4 Mt CO_2 from cement manufacture (our estimate—apart from energy use in coal manufacture), and the sum of our estimate of DPRK GHG emissions for 2000 would be about 55 Mt CO_2e. The difference between our estimate and that included in the DPRK's INDC document—about 10.7 Mt CO_2e–is due in part to additional smaller sources of GHG emissions not included in our total (for example, high global warming potential gases such as chlorofluorocarbons and other compounds from industry, and emissions from human waste management), but we would expect those to be relatively small in total. The implication, therefore, is that our estimate of DPRK fossil energy use is about 20 percent below the DPRK's own estimate for the year 2000.

The DPRK's projections of GHG emissions for 2020—116.36 Mt CO_2e—and projections for 2030 as shown above imply about 5 percent annual growth in emissions between those years, and about 3 percent annually between 2000 and 2020. Our own projections suggest that GHG emissions from industry in the DPRK grew by only about 4 percent between 2000 and 2010, reflecting only modest change in fossil fuel consumption between those years. Assuming that our historical growth rate for the first decade of the century is reasonably accurate, and that emissions from non-energy sources of GHGs don't change much through 2020, the implication is that overall GHG emissions in the DPRK, based on the projections in the INDC document, would also rise by about 5 percent annually between 2010 and 2020. If we assume that growth in emissions since 2010 through 2016 probably hasn't been at the 5 percent per annum level, it means that projected growth through 2020 would be much higher.

To get at what the level of GHG emissions growth indicated above might mean for the DPRK's future fossil energy use, we start by assuming that our/UNFAO's estimate for total non-energy GHGs would not change between 2000 and 2030. This first-order assumption probably masks two countervailing trends. As the DPRK's economy improves, one would expect that deforestation, and related

emissions, to go down, as households and others return from using biomass for fuel to using fossil fuels and electricity as the supplies of the latter improve. On the other hand, as fertilizer use increases, increased building activity calls for more cement, and diets include more meat, we would expect the other non-energy sources of emissions to increase, thus our assumption that the two trends are roughly balanced. With that assumption, the DPRK's estimates of GHG emissions in 2020 and 2030 imply increases in fossil energy (coal and oil) use of over 6 percent annually between 2010 and 2020, and 5.5 percent per year between 2020 and 2030. Interestingly, the overall annual growth rate implied for 2010 to 2030 is not that different from trends in a "Redevelopment Case" projection of GHG emissions from the energy sector that we prepared in 2013. In our scenario, however—in which the DPRK economy opens up rapidly to the international community starting in about 2014—energy use in the DPRK grows rapidly from about 2013 through 2020, followed by lower growth as structural change in the economy takes place, with, for example, inefficient industrial plants retired and more use of electricity and gas in place of coal.

4 Do the DPRK's Estimates for INDCs Add Up?

The DPRK INDC document includes a listing of 19 "Mitigation measures prioritized for conditional contribution". Although these may not be the full list of measures that the authors of the DPRK INDC document estimate sum to 60.5 Mt CO_2e in emissions reduction by 2030, it is interesting to undertake an independent estimate of the amount of emissions reduction these listed measures might add up to. Our very rough estimates are provided in the table below. These estimates could and should, of course, be further refined with additional, more detailed assumptions and parameters, but at this point they serve as points of reference relative to the total estimated emissions provided in the INDC document.

Option Number	Description as Provided in INDC document	Authors' Estimate of Annual GHG emissions reduction by 2030 (Mt CO2e per year)	Notes/Assumptions
1	To reduce power transmission and distribution losses to 6%	3.0	Assumes reduction in losses from our 2010 estimate results in less operation by (mostly new or updated) coal-fired power plants
2	To build 2 000MW nuclear power station	13.4	Assumes 80% capacity factor, nuclear displaces mostly new (or updated) coal-fired power plants
3	To install a total of 1000 MW grid connected solar PV systems	1.1	Assumes 1200 annual kWh/kW capacity, solar displacing new or updated coal-fired power
4	To build a total of 500MW West Sea off –shore wind farms at the Korean West Sea	1.5	Assumes average capacity factor of 35%, wind displacing new or updated coal-fired power

Option Number	Description as Provided in INDC document	Authors' Estimate of Annual GHG emissions reduction by 2030 (Mt CO2e per year)	Notes/Assumptions
5	To build a total of 500MW on-shore wind farms	1.2	Assumes average capacity factor of 28%, wind displacing new or updated coal-fired power
6	To use energy-efficient air conditioners and heat pumps instead of coal-fired space heating at households and offices	3.5	Assumes demand for coal heat about 3 times 2010 levels by 2030, 50% of coal-fired boilers or furnaces displaced by heat pumps using coal-fired electricity.
7	To use biogas from livestock manure and domestic sewage instead of coal or firewood for cooking	0.7	Rough estimate--assumes equivalent of most livestock manure CH_4 and N_2O emissions will be displaced.
8	To replace coal use for hot water with solar hot water system at households	2.7	Assumes demand for coal water heat is about 3 times 2010 levels by 2030, 50% of coal-fired water heat displaced by solar water heat by 2030.
9	To replace conventional wood stoves for cooking with efficient wood stoves at rural households	0.1	Placeholder value. Modest decrease in non-CO_2 GHG emissions, with any decrease in CO_2 emissions overlapping with reduction in deforestation, below.
10	To build the rice husk cogeneration plants	0.5	Assumes 50% increase in rice production 2010-2030, and 50% of rice husks are used to displace coal as a fuel.
11	To building centralized compositing facilities to collect and treat municipal solid waste	0.1	Placeholder value. Current average treatment of municipal solid waste is not known. Much of the existing solid waste may be used as fuel already.
12	To replace the old subcritical coal power stations with ultra-supercritical coal power stations	3.7	Assumes old plants would be used about 25% more in 2030 than in 2010, and would be replaced under measure by new plants with average efficiency of 36%.
13	To increase additives (blast furnace slag or fly ash) from 15% to 50% in blended cement	1.8	Assumes cement production will rise to # times 2010 estimate by 2030. Reduction to 50% seems ambitious.

Option Number	Description as Provided in INDC document	Authors' Estimate of Annual GHG emissions reduction by 2030 (Mt CO2e per year)	Notes/Assumptions
14	To build biogas plants treating municipal solid waste	0.1	Presumably this should be targeted at municipal sewage. Current methods of sewage treatment are unclear. Value shown is a placeholder.
15	To replace conventional coal stoves for cooking with efficient electric cookers at the households	1.2	It is not entirely clear that this would save much coal if coal-fired power was used to power electric cookers. Estimate here assumes a mixture of microwave and resistance cookers.
16	To reduce 25% of energy consumption in industry through technical modernization by 2030	13.4	Assumes growth in fuel and electricity use in industry tracks overall baseline growth in GHG emissions
17	To replace tunnel brick kilns with vertical shaft brick kilns	1.6	Assumes 50% reduction in coal use as a result of technology upgrade.
18	To introduce the Bus Rapid Transit systems in large cities	0.1	Placeholder estimate. Savings will likely be modest, particularly if a lack of transportation services continues.
19	To scale up agroforestry and sustainable forest management	8.7	Assumes deforestation essentially halted, on average, relative to our estimates for 2000.
Sum of Measures Listed Above		**58.3**	**Mt CO_2e**

The sum of the initial estimates of emissions reductions from the options above, at 58.3 Mt CO2e per year, is remarkably close to the "contingent contribution" total provided in the DPRK's INDC document. Of course there are many ways that the calculations of emissions reduction for each of these measures can be carried out, and it is difficult to judge emissions reductions without the full context of a "baseline" or "business as usual" scenario for the development of the DPRK economy. Still, the sum of these contingent contributions is quite close to the difference in emissions that we found in our own modeling of the future of the DPRK energy sector when we compared a "Redevelopment" scenario analogous to a baseline projection with a "sustainable development" case that includes the types of energy efficiency and renewable energy measures listed above, though not exactly the same measures included in the list in the INDC document.[4] In our work, however, aggregate 2030 emissions were significantly lower in the Redevelopment case than are reported in the INDC document, though our work focused only on energy sector emissions.

5 Conclusions

Although our estimate of potential greenhouse gas emissions reductions from the contingent contributions listed in the DPRK's INDC document is admittedly "quick-and-dirty", that is, quite approximate, the fact that they are reasonably consistent with the sum of measures that the authors of the DPRK INDC document come to suggests that the DPRK's estimates have indeed been prepared in line with established international methodologies. The fact that the estimates are similar, and that the DPRK has seen fit to publish its INDC document in the first place, also suggests a potential opening for engagement with the DPRK on climate-related matters. With the Trump administration's recent withdrawal of the United States from the Paris climate accord,[5] it may well be up to other nations to work with the DPRK on climate issues, but the opening to do so does appear to exist.[6]

Perhaps the ROK's plan to resume humanitarian aid with the DPRK[7] could focus on those elements in the plan that focus on provision of energy services that directly improve human welfare, especially small, fast, and relatively low technology that do not depend on large-scale and massive infrastructure, and would endure inevitable cycles of inter-Korean and external conflict with the DPRK.

III. ENDNOTES

[1] See, for example, David von Hippel and Peter Hayes (2012), *Foundations of Energy Security for the DPRK: 1990 – 2009 Energy Balances, Engagement Options, and Future Paths For Energy and Economic Development*, dated September 13, 2012, and available as

https://nautilus.org/wp-content/uploads/2012/12/1990-2009-DPRK-ENERGY-BAL-NCES-ENGAGEMENT-OPTIONS-UPDATED-2012_changes_accepted_dvh_typos_fixed.pdf; David F. von Hippel and Peter Hayes (2014), *Strategies for the Rehabilitation of the DPRK Energy Sector*, NAPSNet Special Reports, June 22, 2014, available as https://nautilus.org/napsnet/napsnet-specia--reports/strategies-for-the-rehabilitation-of-the-dprk-energy-sector/; and David von Hippel and Peter Hayes (2014), *An Updated Summary of Energy Supply and Demand in the Democratic People's Republic of Korea (DPRK)*", NAPSNet Special Reports, April 15, 2014, available as https://nautilus.org/napsnet/napsnet-special-reports/an-updated-summary-of--nergy-supply-and-demand-in-the-democratic-peoples-republic-of-korea-dprk/.

[2] This document is available from the UNFCCC website as http://www4.unfccc.int/ndcregistry/PublishedDocuments/Democratic%20People%27s%20Republic%20of%20Korea%20First/DPRK-INDC%20by%202030.pdf.

[3] Estimates Downloaded from UN Food and Agriculture Organization Statistics website, http://www.fao.org/faostat/en/#data.

[4] See, for example, David von Hippel and Peter Hayes (2014), *Assessment of Energy Policy Options for the DPRK Using a Comprehensive Energy Security Framework*, NAPSNet Special Reports, January 30, 2014, available as https://nautilus.org/napsnet/napsnet-special-reports/assessment-of-energy-policy-options-for-the-dprk-using-a-comprehensive-energy-security-framework/.

[5] See, for example, Michael D. Shear (2017), "Trump Will Withdraw U.S. From Paris Climate Agreement", *New York Times*, June 1, 2017, available as https://www.nytimes.com/2017/06/01/climate/trump-paris-climate-agreement.html?_r=0.

[6] Options for engagement with the DPRK on related energy efficiency and renewable energy activities, and for larger energy-sector projects with the DPRK, have been the topics of a number of

publications by the authors, including, for example, David von Hippel and Peter Hayes (2015), *Energy sector cooperation with the DPRK in support of a regional Nuclear Weapons Free Zone*, NAPSnet Special Report, available as https://nautilus.org/napsnet/napsnet-special-reports/energy-sector-cooperation-with-the-dprk-in-support-of-a-regional-nuclear-weapons-free-zone/, and the short article by David Von Hippel (2016), "Bright idea? Engaging North Korea through energy: Offering to assist the DPRK with energy infrastructure could bring it to the negotiating table", *NK News.org*, dated October 11th, 2016, and available as https://www.nknews.org/2016/10/bright-idea-engaging-north-korea-through-energy-incentives/.

[7] "S. Korea likely to resume humanitarian aid, civilian exchanges with N. K," *Yonhap*, May 22, 2017,
at http://english.yonhapnews.co.kr/news/2017/05/22/0200000000AEN20170522002600315.html

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