Private Purchases of Solar Photovoltaic Panels in the DPRK: Signs of Green Growth on the Way?

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I. Introduction

In the following Policy Forum, David von Hippel and Peter Hayes examine the growth of solar panel purchases in North Korea. They write, "The DPRK's growing markets for solar PV systems suggest two things. First, it suggests that that there is likely a high level of suppressed demand for electricity in the in both rural and urban areas. Second, the evident willingness on the part of DPRK citizens to pay high costs per unit of electricity delivered by use of PV/battery systems reflects the very high "opportunity cost" of foregoing the use of electricity when it is needed."

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II. Policy Forum by David von Hippel and Peter Hayes

A combination of lack of investment due to international economic sanctions and limited foreign exchange earnings, coupled with multiple chronic and ongoing problems with energy supply infrastructure, have left per-capita electricity consumption in the Democratic Peoples' Republic of Korea (DPRK) far below that of its Southern neighbor. On average, the DPRK consumes an estimated 420 kWh (kilowatt-hours) of grid electricity per capita annually, while the Republic of Korea (ROK) consumes 9300 kWh per capita/year, more than 20 times as much.[1] Faced with frequent electricity blackouts and brownouts, average DPRK residents, as well as members of a growing middle class, elite families, and wealthier traders, are turning to Chinese-made solar photovoltaic (PV) systems to power entertainment electronics, lights, and other devices, the *Daily NK* reports.[2] Although it is unclear how widespread the adoption of PVs by North Koreans is at this time, the interest in this technology in the DPRK underscores the value that North Koreans place on the services provided by electricity. In addition, however, the uptake of renewable energy systems by the DPRK together with the success of the aggressive program of renewable energy adoption in Germany, suggests that the DPRK officials and members of the international community who will be involved in the eventual rebuilding of the DPRK's energy system might do well to plan to "leapfrog" the fossil-based energy system used in the ROK, and fully implement the concept of "low carbon green growth"—nominally adopted in the ROK in 2008—with a focus on renewable energy.

DPRK citizens in many cities are reportedly spending the equivalent of several months of household income to buy solar PV systems to power small electronics (the most common being combination DVD/CD/media players with 9 inch screens) as well as, probably, some light-emitting diode (LED) lighting and other small electric devices. The most common system purchased includes a PV panel with a rated capacity of 30 Watts (W), and a sealed lead-acid automotive-type battery with a capacity of 28 Amp-hours. Wealthier households purchase larger panels and batteries, and larger electronic devices. Households purchase the systems because electricity supplies from the DPRK central grid are in many places unreliable at best, and at worst, rarely available. Although these systems provide households with consistent access to entertainment and (probably) some lighting and other services, and do so without pollutant emissions, the cost of providing electricity via the solar PV systems is relatively high. The reason for this is not so much the cost of the PV panel in the DPRK—PV costs have been declining rapidly for years, and the in-DPRK retail cost quoted by *Daily NK*, about $1.30 on a per-Watt-capacity basis, is similar to the high end of current bulk pricing for 30 W PV panel kits as quoted in Alibaba (the dominant Chinese internet market). Taking just the cost of the panel into account, and assuming a lifetime of 20 years, the cost per kWh of delivered electricity in the system comes to about $0.22 per kWh.[3] The system cost becomes much more expensive, however, when the cost of batteries is included. The reason here is that the batteries used in the system, 12-volt lead-acid batteries of the type used in small vehicles (for example, electric scooters), have a finite lifetime (perhaps 5 or 6 years) even under the best of circumstances, but when continuously discharged to a low level, as they likely would be when used as North Korean households are likely to use them, the battery lifetime could be much shorter, even though some of the batteries sold with PV systems may be nominally designed for deep-cycle use. As a result, the batteries needed to accompany PV panels must be replaced many times over the life of the panels. Factoring in battery lifetimes of 5 years (a best case scenario), the cost of usable energy from the PV/battery systems rises to $0.49 per kWh. If the batteries last only an average of 2 years, the cost per unit of energy rises to $0.78 per kWh. By way of comparison, the residential retail price of electricity in the ROK was about $0.13 (130 ROK Won) per kWh as of July 2014.[4]

The actual cost of electricity from PV systems underscores the high value that DPRK households place on access to even small amounts of electricity, and probably even significantly understates it. Based on UN Comtrade (customs trade statistics) data, the DPRK imported from China on the order of 6 million flashlights and 60 million small batteries (likely for electronics) in each of 2012 and 2013 alone. The effective cost of electricity from these small batteries is on the order of $20 per kWh. Although the categories used for Comtrade statistics make it difficult to determine for certain, recorded trades (as opposed to trades in goods that do not appear on the Customs ledgers) in PV systems could be on the order of several (perhaps 3 to 5) megawatts annually, meaning that perhaps 100,000 or more DPRK households have adopted them to date.

In a way, and perhaps not entirely intentionally, the DPRK seems to be approaching the same renewable energy path that German policies have been emphasizing for some years. A recent article in *Foreign Policy* describes the trend, under a policy called *Energiewende*, in which the orchestrated use of mostly local renewable energy sources has been replacing power from central stations: [5] “In just a dozen years, industrial-powerhouse Germany has replaced around 31 percent of its nuclear and fossil fuel generated electricity with green power, produced overwhelmingly from moderately sized onshore wind, solar PV, hydro, and bio-energy installations – an achievement no one predicted when the Energiewende commenced in 2000.” One of the features of the German approach has been an emphasis on increasing the use of renewable energy starting at the local and regional levels, a “citizen-led energy boom” in which local projects increasingly use smart grids to manage local demand and supply and, increasingly, to trade power with other cities and regions. Such an approach, if not necessarily consistent with how the DPRK government has typically managed its energy sector, is certainly consistent with both the North Korean philosophy of *juche*, or self-

reliance, as well as with DPRK government exhortations, in recent years, to local areas to provide their own energy sources to augment central supplies. Consistent with this direction is the recent announcement of the organization of a "natural energy institute" in Pyongyang "with various rooms for researches into wind energy, geotherm, solar heat and other natural energies, e-library, laboratories, a pilot plant, etc."[6] Setting up such an institute was actually a topic that Nautilus Institute talked about with DPRK counterparts as early as 2000. The DPRK government's longstanding interest in renewable energy, coupled with the widespread grassroots adoption of solar PV and other renewable technologies, mean that cooperation in renewable energy systems will likely serve as an attractive (to both sides) and helpful approach to engagement between the DPRK and the international community.

The DPRK's growing markets for solar PV systems suggest two things. First, it suggests that that there is likely a high level of suppressed demand for electricity in the in both rural and urban areas. Second, the evident willingness on the part of DPRK citizens to pay high costs per unit of electricity delivered by use of PV/battery systems reflects the very high "opportunity cost" of foregoing the use of electricity when it is needed.

In South Korea, on the other hand, in contrast with German policies, and also in contrast, for example, to the strong growth in installation of solar power in Japan (driven in part by the post-Fukushima anxiety about reliance on nuclear power, as well as by the high prices of electricity in Japan and Japanese Feed-in Tariff policies), the ROK government's commitment to promoting the domestic use of solar PV power appears to have waned.[7] In the DPRK, the need to rehabilitate virtually the entire power sector may, paradoxically, coupled with the demonstrated interest by individual DPRK citizens in harvesting the benefits of renewable energy (and thereby receiving at least some of the energy services they have been missing), make it easier, not harder, for the DPRK to follow the German model of growth of local and even household renewable energy systems into local, then regional, then national renewables-dominated smart grids. Achieving such a future rapidly will of course require investment, as well as technical and other assistance, from outside the DPRK, assistance that can only come via cooperation and engagement with the international community. It is even possible that a DPRK focused on using renewables for green growth will help to spur the ROK to take more meaningful steps in the same direction, thus moving South Korea more rapidly toward the goals implied by its government's stated, as of 2008, intent to undertake a green energy path.

III. References and Notes

[1] Both per-capita figures include electricity consumed in all sectors of the economies. DPRK figure are derived from Nautilus DPRK energy analysis; 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 Redevelopment*, dated 18 December 2012, and available as https://nautilus.org/napsnet/napsnet-special-reports/foundatio-s-of-energy-security-for-the-dprk-1990-2009-energy-balances-engagement-options-a-d-future-paths-for-energy-and-economic-redevelopment/; and David F. von Hippel and Peter Hayes, *An Updated Summary of Energy Supply and Demand in The Democratic People's Republic Of Korea (DPRK)*, published as Hanyang University Center for Energy Governance and Security Working Paper 2014-2, and available from http://www.egskorea.org/sub/sub2_2.asp and as https://nautilus.org/napsnet/napsnet-special-reports/an-updated-summary-of--nergy-supply-and-demand-in-the-democratic-peoples-republic-of-korea-dprk/. ROK figure is for 2012, and is derived from data in Korea Energy Economics Institute (2013), *Yearbook of Energy*

Statistics, 2013, available as http://www.keei.re.kr/keei/download/YES2013.pdf.

[2] Seol Song Ah (2014), "Solar Panels Shine New Light on NK", *Daily NK*, dated 2014-10-24, and available as http://www.dailynk.com/english/read.php?cataId=nk01500&num=12465/.

[3] Calculated using a real (not including inflation) discount rate of 15%/year, which is probably appropriate, if not low, for household consumers, an assumed output of 1200 W-hours per W of PV capacity, and an average charge/discharge efficiency of 80 percent for the PV/battery system.

[4] Korea Energy Economics Institute (2014), *Monthly Energy Statistics, Volume 30-10* (October, 2014), available as http://www.keei.re.kr/keei/download/MES1410.pdf.

[5] Paul Hockenos (2014), Germany's Revolution in Small Batch, Artisanal Energy", *Foreign Policy.com*, dated October 31, 2014, and available as http://www.foreignpolicy.com/articles/2014/10/31/german_green_energy_revolution_backyard_windmills_solar_gas.

[6] Korean Central News Agency (KCNA, 2014), "Natural Energy Institute Established in DPRK", dated November 4, 2014, and available as http://www.kcna.co.jp/item/2014/201411/news04/20141104-10ee.html.

[7] BusinessKorea (2014), "Dark Outlook: Domestic Solar Power Demand Expected to Plummet", dated October 15, 2014, and available as http://www.businesskorea.co.kr/article/6812/dark-outlook-domestic-solar-power-demand-expected-plummet.
