

# Northeast Asian Supergrid: Awareness and Support in South Korea for International HVDC Connections

Lizhi Shen

Seoul International School, Republic of Korea

## ABSTRACT

Since 2015, China, South Korea, and Japan have joined 194 countries in ratifying the United Nations' Paris Climate Agreement. Transnational cooperation to develop renewable energy sources and transfer them across borders has intensified rapidly. However, geopolitical tensions have stymied plans to lay high-voltage direct current (HVDC) cables on the seafloor between Weihai in China's northeast region to Incheon in South Korea's northwest region, and Busan in South Korea's southeast region to Kyushu in Japan's southwest region. The successful completion of the plan would provide access to abundant solar and wind energy from the Gobi Desert. This paper explores whether increased public awareness of the projects in South Korea would increase support and whether economic benefits or transnational trust are significant factors that influence support. I used a Likert Scale survey including four sections, which I distributed to one hundred participants. The first section measured project awareness and whether participants supported them. The second section provided a one-page fact sheet, which the participants were asked to read. The third section measured attitudes toward economic benefits and trust. Finally, participants were asked to rate how strongly they support the project's immediate commencement. Descriptive statistics and linear regression were used for analysis. The results showed that no participants were aware of the project or its benefits, but once made aware, a majority expressed support for the project's completion. Significant relationships were found between valuing the economics of the projects and transnational trust support for the projects, with trust showing more significant results.

## Introduction

Despite China being the world's largest emitter of fossil fuels, it is making significant progress in rapidly increasing its renewable energy capacity. It is expected to have created 1,000 gigawatts of solar power capacity by 2026, which is nearly 10% of the world's 11,000 gigawatt commitment in the Paris Agreement (Hilton, 2024). The Gobi Desert is the source of China's renewable energy strength, offering perfect conditions for consistent wind and solar energy production. The renewable energy capacity of the western desert is already half of the total renewable energy capacity of the United States (Chen, 2024).

The geographical variation of renewable energy capacity has encouraged regional transnational cooperation with the creation of renewable energy supergrids. One of the largest is the Africa-EU Renewable Energy Supergrid. The benefits of supergrids have been outlined and established in the European context. Research shows that there are four key benefits to creating energy supergrid connections between countries and regions:

- Resilience through shared sources of power, as disruption in one location can be offset by resilience in another.
- Profit-making from excess energy production through larger potential markets opened by the supergrid.
- Establishment of political security as each country or region becomes mutually reliant on the other.

- Bi-directional power flow, as “interconnectors allow for energy transfer on an ad hoc basis from countries with excess production to those with excess demand” (Balasubramanian, 2022).

Several existing and planned HVDC cables will connect European countries, North Africa, and eventually Asia. The Viking Link is the world’s longest at 765 kilometers long, connecting the European mainland from Denmark to the UK (VikingLink). ELMED (Mediterranean Electricity) is a 200-kilometer HVDC that is being constructed to connect southern Italy to Tunisia (Skopljak, 2024). The Great Sea Interconnector (GSI) is planned to connect Cyprus to Israel (Kambas, 2024).

The European example shows what is possible, but plans to lay HVDC cables between China, South Korea, and Japan have stalled. Research shows that the cost of laying HVDC connections between China and South Korea would be far outweighed by the long-term reduced costs associated with the benefits outlined above in the European context (Chang et al., 2024). Research from Japan also shows the significant social and economic benefits that would result from laying an HVDC cable between Japan and South Korea, creating an interconnected power grid that spans from the Gobi Desert to Hokkaido (Renewable Energy Institute, 2018).

Even though the economic, environmental, and social benefits of connecting China, South Korea, and Japan by HVDC cable are well established, there seems to be very little awareness among the general public in South Korea of the potential projects and their benefits. A keyword search on South Korea’s native search engine, Naver, returned very little information on HVDC cables and the potential of a Northeast Asian renewable energy supergrid. Research intended for an academic audience assesses the plans, but this information does not seem to have percolated into mainstream consciousness.

One possible reason for the lack of public awareness is the increasing geopolitical tension in the region. For several years, the relationships between South Korea, Japan, and China have faced difficulties related to emotive and complex historical disputes. A recent survey showed that 73% of South Koreans view the China-Korea relationship negatively, and 70% of South Koreans view China “very negatively” (Lee, 2024). In contrast, South Koreans’ view of Japan has been improving consistently over recent years, and 42% of South Koreans currently have a favorable view of Japan, which is the highest level on record (Matsuo, 2024).

Furthermore, South Koreans have a strong understanding and sensitivity to environmental issues related to climate change. In 2023, 73% of South Koreans said that they would accept higher levels of income tax to help prevent rapid man-made climate change (Froimovici, 2023). The economic, social, and environmental benefits associated with the laying of HVDC cables between China, South Korea, and Japan are significant, and South Koreans have a high level of awareness about climate change issues as well as a willingness to combat them. Therefore, the lack of public enthusiasm for laying the HVDC cables or even explicit adoption of the policies by any political party is surprising.

In 2023, only 9.64% of South Korea’s energy supply came from renewable sources, far behind the 30.25% world average (Kim, 2024). However, South Korea is particularly vulnerable to the effects of rapid climate change. These threats emerge from heavier rainfall and intensified typhoons, with extreme periods of drought and abnormal temperatures (Moon et al., 2021). The average temperature in South Korea has already risen by 1.5 degrees Celsius over the last hundred years (The Climate Reality Project, 2023). The Korean Peninsula’s low-lying coast is also highly vulnerable to sea level rise, and levels have already risen around the peninsula by about 10 centimeters over 40 years (The Climate Reality Project, 2023). Flooding that would previously have been expected to happen once every one hundred or two hundred years will soon become a regular occurrence according to models of the current rate of climate change (Kim et al., 2023).

In this context, there are currently no immediate plans or timelines to begin the laying of HVDC cables between China and South Korea or South Korea and Japan. Despite widespread support for an increasingly urgent response to rapid man-made climate change, transnational projects in Northeast Asia have stalled. Political momentum and focus have emerged as major obstacles rather than technical, manufacturing, or funding capacity. Awareness in South Korea of the potential creation of HVDC cable connections to China and Japan is limited in the literature and general news sources, which could explain the lack of political momentum for such projects.

No survey of attitudes toward the laying of HVDC cables between South Korea, Japan, and China exists in the current literature. By conducting this research, measuring awareness and attitudes toward the project and using them to inform both environmental campaigns and political decision-making will be possible.

A paper survey was conducted with 100 participants randomly approached in central Seoul. Participants were asked to complete the survey as part of a project to research attitudes toward renewable energy development. No incentive was offered to the participants.

The survey (see Appendix A) consisted of two stages. First, on a scale of 1-5, participants were asked to rate their awareness of the potential for HVDC cable laying between South Korea, Japan, and China. Participants who described themselves as knowing "nothing" or "very little" were then asked to read a small fact sheet on the potential projects (see Appendix B). Participants who self-reported awareness of the projects would have been excluded from the survey, but no participant reported any level of awareness. After reading the fact sheet, the participants were then asked to complete two more sections of the survey with four questions on a scale of 1-5 relating to the economic benefits of the projects and trust in South Korea, Japan, and China to cooperate in their creation. Finally, the participants were asked to rate their support for the immediate commencement of such projects.

The following statement was asked to rate awareness:

1. I am well informed about plans to lay high voltage direct current cables on the seafloor to connect China, South Korea, and Japan and provide access to cheap solar and wind energy from the Gobi Desert.

Scale

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly Disagree

Using the same answer scale, the following statements were used for the economic and trust responses:

Economic Benefit:

1. I believe the HVDC projects will economically benefit South Korea.
2. The HVDC projects will lower energy costs for me.
3. The HVDC projects will lead to lower prices of consumer goods.
4. South Korea's economic potential will be improved by the HVDC projects.

Trust

1. I believe South Korea, Japan, and China can overcome geopolitical challenges and share a power grid.
2. Current political tensions will not be an obstacle to the construction of the HVDC cable projects.
3. South Korea will not be vulnerable if it shares renewable energy sources with China and Japan.
4. South Korea, Japan, and China can effectively work together in the long term to create mutual benefit through a shared renewable power grid.

Finally, the same answer scale, along with the following statement, was used to assess support for the projects after viewing the fact sheet:

I support the immediate laying of HVDC cables between South Korea, China, and Japan to create access to cheap renewable energy sources from the Gobi Desert.

Descriptive statistics and linear regression were used to analyze the results.

## Methods

The survey (see Appendix A) consisted of three sections. The first asked participants to rate their awareness of the HVDC cable projects on a scale of 1-5. Initially, it was thought that any potential participant reporting high levels of pre-existing knowledge about the projects would be excluded in order to focus on the impact that raising awareness of the projects has on individual support of them. However, no potential participants reported confidence in their pre-existing knowledge of such projects. In the second section, a fact sheet on the HVDC projects was given to the participants (see Appendix B). In the third, a Likert Scale survey was used to collect responses on two major themes: economic benefits and trust in transnational cooperation. Four items were created for both themes. Finally, participants were asked to rate their support for the immediate commencement of the HVDC projects.

One hundred participants took the survey. They were randomly selected by being approached in public and asked to participate in a survey to measure awareness and attitudes toward a new renewable energy project. Forty-nine women and fifty-one men participated in the survey. The mean age of the participants was 36.5, 35.22 for women and 37.25 for men. The age range was 19-74.

The results were first analyzed with descriptive statistics then linear regression analysis. The Likert Scales for economic value and trust were the independent variables and support for the project was the dependent variable. The null hypothesis (H1) was that there is no significant difference between valuing the economics of the projects, trusting South Korea, Japan, and China to successfully cooperate on such projects, and reporting support for the projects. The alternative hypothesis was that there is a significant difference.

Ethical considerations such as approaching individuals on the street and the collection of anonymous data were taken into account.

## Results

Before viewing the fact sheet, the mean self-rating of awareness of the HVDC projects was 1.06, with no significant difference between genders or age groups.

The mean responses to the economics and trust items including standard deviations are as follows:

**Table 1.** Likert Scale Items: Economics

Statement	Mean Response
I believe the HVDC projects will economically benefit South Korea.	3.7
The HVDC projects will lower energy costs for me.	3.66
The HVDC projects will lead to lower prices of consumer goods.	3.76
South Korea's economic potential will be improved by the HVDC projects.	3.64

**Table 2.** Likert Scale Items: Trust

Statement	Mean Response
I believe South Korea, Japan, and China can overcome geopolitical challenges and share a power grid.	2.99
Current political tensions will not be an obstacle to the construction of the HVDC cable projects.	2.97
South Korea will not be vulnerable if it shares renewable energy sources with China and Japan.	2.93
South Korea, Japan, and China can effectively work together in the long term to create mutual benefit through a shared renewable power grid.	2.59

**Table 3.** Mean Responses for Economics, Trust, and Support

	Economic	Trust	Support
Mean Response	3.7 (SD 0.97)	2.87 (SD 1.09)	3.4 (SD 1.25)

A linear regression test was run on the dataset with the following results:

Model Fit Measures

Model	R	R <sup>2</sup>
1	0.858	0.737

*Note.* Models estimated using sample size of N=100

Model Coefficients - Support

Predictor	Estimate	SE	t	p
Intercept	-0.249	0.2605	-0.958	0.341
Economics	0.421	0.0806	5.222	<.001
Trust	0.729	0.0716	10.173	<.001

**Figure 1.** Linear Regression Test Results

For the model fit measures,  $R=0.858$  shows a strong correlation between the variables. The analysis also shows that there is a significant relationship at  $<.001$  between believing the projects have economic value and supporting the projects, trust in the three parties to work together, and strength of support for the project. Trust in the parties to work together was a more significant factor in the final strength of support.

## Discussion

Despite all participants reporting little or no awareness of the HVDC cable projects and their potential benefits and risks before participating in the survey, the majority of participants reported support for the projects after viewing the fact sheet, with most reporting that they believed the projects would be economically beneficial. However, reported trust in the ability of South Korea, Japan, and China to work together on such projects was lower than belief in the economic benefits. Even though the reported trust was lower than belief in the economic benefits, most participants reported support for the immediate commencement of the laying of HVDC cables to share in the benefits of a renewable supergrid project for Northeast Asia.

Although both valuing the economic benefits and trust in the parties were significantly related to the strength of final support for the projects, trust in the parties was more significant. The results imply that environmental groups and policymakers who hope to build support for the laying of the HVDC cables need to not only focus on building general awareness of the benefits but specifically address the issue of trust. If South Koreans trust their own government and the governments of China and Japan to cooperate on the creation and maintenance of the projects, they will be significantly more likely to support the immediate commencement of the projects. Conversely, if this type of transnational trust decreases, it will become increasingly difficult to build political momentum for the completion of the projects.

This paper aimed to show that increased awareness of plans to lay HVDC cables between South Korea, Japan, and China would lead to significant support for the immediate commencement of the projects. Specifically, awareness of the economic benefits and levels of trust in transitional cooperation were shown to be significantly related to the strength of support for such projects. Environmental campaigners and policymakers should therefore base any effort to start and complete these projects on the foundations of raising awareness about the economic benefits, but more importantly improving the levels of trust, among the general population that South Korea, Japan, and China can effectively work together on these projects. Despite the strong support found for the projects once awareness was raised, if levels of trust fall, support for the projects will also fall, regardless of the potential economic benefits. Given the current rise in regional tensions, building South Korean public support for the HVDC projects may prove challenging.

Further research is required on the level of awareness among the South Korean public regarding environmental projects. This paper shows that raised awareness of economic benefits leads to strong support even with the negative influence of regional geopolitical tensions. It is likely that domestic environmental projects, which do not suffer from the challenges of transnational trust, would benefit from increased support if awareness of the economic benefits of such projects was increased.

Despite the robust findings of the research, some limitations could be addressed to improve the reliability and generalizability of the results. Participants were randomly approached on the street, which means there is some influence of self-selection, as many potential participants rejected participation. A further limitation is the time given to participants to familiarize themselves with the HVDC projects. Given more information and time to think about their position, the participants' views may change. The survey was conducted in central Seoul, in a relatively wealthy neighborhood. To make the findings generalizable to the wider South Korean population, a broader survey would be required.

## Acknowledgments

I would like to thank my advisor for the valuable insight provided to me on this topic.



## References

- Balasubramanian, K. (2022, May 27). *Supergrids, a miracle solution?* Illuminem. Retrieved November 2, 2024, from <https://illuminem.com/illuminemvoices/supergrids-a-miracle-solution>
- Chang, H., Chun, Y., Heo, E., & Her, Y. (2024). Economic and environmental impacts from the China-Korea power grid interconnection. *The Electricity Journal*, 37(6), 107416. <https://doi.org/10.1016/j.tej.2024.107416>
- Chen, S. (2024, February 20). *China builds up electric power in Gobi and western deserts equal to half US capacity*. South China Morning Post. <https://www.scmp.com/news/china/science/article/3252564/china-builds-electric-power-gobi-and-western-deserts-equal-half-us-capacity>
- Froimovici, T. (2023, November 24). *South Koreans look forward to the benefits of a green economy and are ready to support those with lower incomes to ensure a just transition, EIB survey finds*. European Investment Bank. Retrieved November 3, 2024, from <https://www.eib.org/en/press/all/2023-455-south-koreans-look-forward-to-the-benefits-of-a-green-economy-and-are-ready-to-support-those-with-lower-incomes-to-ensure-a-just-transition-eib-survey-finds>
- Hilton, I. (2024, March 13). *How China Became The World's Leader On Renewable Energy*. Yale E360. Retrieved January 2, 2024, from <https://e360.yale.edu/features/china-renewable-energy#>
- Kambas, M. (2024, September 17). *Cyprus backs multi-billion electric cable link from Europe to Mideast*. Reuters. Retrieved November 3, 2024, from <https://www.reuters.com/technology/cyprus-says-progress-seen-talks-with-greece-multi-billion-electric-cable-link-2024-09-17/>
- Kim, M. (2024, August 14). *South Korea's economy risks missing out on global transition to renewables | IEEFA*. Institute for Energy Economics and Financial Analysis. Retrieved November 5, 2024, from [https://ieefa.org/resources/south-koreas-economy-risks-missing-out-global-transition-renewables#:~:text=Executive%20Summary-,Despite%20a%20pledge%20to%20achieve%20net%2Dzero%20by%202050%2C%20South,and%20even%20Asia%20\(26.73%25\).](https://ieefa.org/resources/south-koreas-economy-risks-missing-out-global-transition-renewables#:~:text=Executive%20Summary-,Despite%20a%20pledge%20to%20achieve%20net%2Dzero%20by%202050%2C%20South,and%20even%20Asia%20(26.73%25).)
- Kim, S., Kwon, J., Om, J., & Lee, T. (2023). Increasing Extreme Flooding Risk Under Future Climate Change Scenarios in South Korea. *Weather and Climate Extremes*, 39, 1–12. <https://www.sciencedirect.com/science/article/pii/S2212094723000051?via%3Dihub>
- Lee, S. (2024, February 16). *[2024 Public Perception Survey] Korea and China, which country has greater capabilities?* Korean Research Public Survey Division. Retrieved November 2, 2024, from <https://hrcopinion.co.kr/en/archives/29045>
- Matsuo, T. (2024, February 23). *Public Opinion Surveys and Diplomatic Dynamics in Korea-Japan relations - Korea Economic Institute of America*. Korea Economic Institute of America. Retrieved November 2, 2024, from <https://keia.org/the-peninsula/public-opinion-surveys-an>
- Moon, T. H., Chae, Y., Lee, D., Kim, D., & Kim, H. (2021). Analyzing climate change impacts on health, energy, water resources, and biodiversity sectors for effective climate change policy in South Korea. *Nature*, 11(1). <https://doi.org/10.1038/s41598-021-97108-7>
- Renewable Energy Institute. (2018). Asia International Grid Connection Study Group: Second Report Summary. In [www.renewable-ei.org](http://www.renewable-ei.org). Retrieved November 3, 2024, from [https://www.renewable-ei.org/pdfdownload/activities/REI\\_ASG\\_SecondReportSummary\\_EN.pdf](https://www.renewable-ei.org/pdfdownload/activities/REI_ASG_SecondReportSummary_EN.pdf)
- Skopljak, N., & Skopljak, N. (2024, January 4). *First DC connection between Europe and North Africa gets €45 million from EIB*. Offshore Energy. Retrieved October 30, 2024, from <https://www.offshore-energy.biz/first-dc-connection-between-europe-and-north-africa-gets-e45-million-from-eib/>
- The Climate Reality Project. (2023, April 10). *How the Climate Crisis is Impacting South Korea*. Retrieved November 2, 2024, from <https://www.climateRealityProject.org/blog/how-climate-crisis-impacting-south-korea#:~:text=South%20Korea%20is%20one%20of,and%20changes%20in%20agricultural%20yield>
- Viking Link. (2024). *About Viking Link*. Retrieved November 1, 2024, from <https://www.viking-link.com/>