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Assessment of High Voltage Power Transmission Line Right-of-Way Issue: A Case of Bhutan

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ABSTRACT: Power transmission system is a critical component of and plays a vital role in the electric power industry supply chain. However, high voltage power transmission projects (PTPs) are often confronted with multitude of challenges from technical, environmental, and social dimensions. One of the notable issues is the Right-of-Way (RoW), which has become increasingly prominent in recent decades, especially in the developing economies. RoW is defined as strips of land, which is used for safe and reliable transmission of electricity. RoW issue provokes landowner opposition and escalates disputes, resulting in project delay, snowballing into an overall project cost and time overruns. Lately, RoW issue has become a subject of a national discourse in Bhutan. Therefore, an assessment of the impact on private land due to high voltage power transmission line RoWis carried out in the context of Bhutan. The data detailing the impact of RoW corridor on private land was collected from the power transmission company. The results demonstrate highest impact in Thimphu, which is the capital and the fastest developing district, indicating that the impacts on private land due to PTPs are unavoidable in the urban developing cities due to land constraint. Accordingly, countermeasures from various dimensions are discussed, which would provide critical input to the relevant stakeholders during the process of RoW issue mitigation efforts, to ensure that the power sector drives the national economy seamlessly.

KEYWORDS: Right-of-Way issue, high voltage power transmission project, private land, developing economies, Bhutan.

I. INTRODUCTION

Power is the backbone of modern economic development (Pall, et al., 2019) and is necessary for ensuring access to clean energy systems, alleviating poverty, enhancing income level, promoting economic growth, and for achieving global prosperity in a sustainable manner. However, a significant proportion of the global population still do not have access to electricity. In 2014, about 1.06 billion people worldwide lacked access to electricity and this problem is even more prominent in South Asia—with the biggest share of the global population—with about 343 million people without access (World Bank, 2017).

Recognizing the significance of the power sector in meeting the goal of clean, affordable, and reliable electricity supply, the power sector development has gained momentum, especially in South Asia region in recent decades. The region has witnessed dramatic increase in electricity access coverage from 60 % in 2000 to 86 % in 2016 (United Nations, 2018). To achieve 100 % electricity access, there is certainly a need for power transmission system development. The transmission system is the vital link between the generating station and the end-users, and functions as the heart of the entire power industry supply chain. The sector even warrants an accelerated development as universal access to electricity is unlikely to be met by 2030 as per the current progress (United Nations, 2018). This will necessitate expediting PTPs, which will only expand in future to meet the consistently increasing demand resulting from the population and economic growth.

PTPs world-wide, however, faced multitude of challenges from multi-dimensional aspects, such as technical, environmental, social, and regulatory requirements. Amongst these several challenges, RoW issue stands out, which has become increasingly prominent, complex and a critically challenging, especially in developing economies in South Asia. RoW is defined as strips of land, which is used by the transmission company, for transmission of electricity. RoW has been identified as the most critical issue in the PTPs in India (Omer, et al., 2013; Lakhapati, 2014), delaying as

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much as 120 PTPs in 2011 across the country (Singh, 2013). RoW issue provokes significant amount of landowner opposition (Simora, et al., 2020; Neukirch, et al., 2020), resulting in frequent project delays (Rossi, 2021). Similarly, Nepal's transmission sector is plagued by RoW issue due to varied reasons: health and safety impact to the people and agriculture, visual and economic impacts, failures to be adequately compensated including non-acceptability of property as a collateral by banks (Accountability Council, 2019). Nepal Electricity Authority, (2020) noted RoW issue as a common challenge in PTPs in Nepal, instigating disputes due to strong community opposition, and bringing projects into a halt. Several PTPs across seven provinces were halted due to RoW issue (Rijal, 2019). Occasionally, licensees are forced to revise the entire project plan (Upreti, et al., 2019), demanding for route realignment. This is due to diminution of property value (Cain, et al., 2013) and land use restrictions being imposed on the landowners—who are not adequately compensated for the RoW corridor. The protestors have demanded line rerouting at several locations for 132kV Solu corridor PTP (NEA, 2020), stretching the project schedule considerably. The 132kV Middle Marshyangdi PTP, which was granted license for construction in 2002 was commissioned only in 2019, taking almost two decades. The delay causes ripple effect on the project cost, causing significant revenue loss to the authorities and severe financial loss to the contracting companies (Lakhapati, 2014).

The issue has been only intensifying in the region. The RoW issue has been identified as the most critical issue in PTPs in Bangladesh. A latest study conducted by Pall, et al. (2019) identified RoW issue as the top-most critical factor in PTPs. The first empirical study, which presents comprehensive delay factors, ranked the RoW issue in the top amongst 63 potential delay factors in both individual and the combined (Employer, Contractor, Consultant) ranking. Thus, RoW is a prime issue and presents a significant challenge to the PTPs in the developing economies in the South Asia region. This is because the PTPs have received little attention (Bergquist, et al., 2020), with priority skewed more towards the power generation projects (Upreti, et al., 2018).

Recently, the issue has become a subject of a national concern. This is because the RoW issue has drawn public attention for the first time in 2019 following the deliberation of the issue in the highest decision-making forum in the parliament. The National Assembly of Bhutan (2019) noted that no policy or guideline could be ascertained concerning the RoW, and recommended instituting appropriate policy and guideline for uniform implementation of provisions related to land substitution and compensation for addressing the RoW issue. The issue has further intensified with recurrent deliberations of the issue in the subsequent parliament sessions. The issue is spiralling with transmission company not able to meet landowner's request of removing transmission towers/lines from their land. Further, power sector is a cornerstone of Bhutan's economy; therefore, transmission system development and grid expansion are indispensable and necessary for Bhutan to "maximize benefits through trading of surplus electricity" (Department of Hydropower and Power Systems, 2021, p.vii), and business as usual development of PTPs would potentially face significant challenge, consequently impeding transmission sector development in future. Therefore, this paper attempts to assess the impact of high voltage power transmission line RoW corridor on private land in Bhutan to comprehend the state of the RoW issue and quantify and qualify the extent of the impact. This will provide valuable insights in understanding the magnitude of the impact, and stimulate appropriate policy interventions.

The next section of the paper expounds the RoW issue concept, followed by explicating the emergence of and deliberations of the RoW issue at a public scope in Bhutan. The subsequent section presents an assessment and analysis of the impact on private land due to RoW corridor, followed by results and discussions. The ensuing section provides conclusions and policy suggestions that may be considered in Bhutan's PTP development, considering the applicability and practicability, and bearing in mind the limitations of the nascent power sector and the national economic conditions. The paper concludes with suggestions for future research using additional data that would help to provide more substantive information to the policy makers for introducing effective intervention measures.

II. UNDERSTANDING ROW ISSUE

RoW is defined as "strips of land used by the electric utilities for safe and reliable transmission of electricity" (Nowak, et al., 1992, p.828). It is the corridor, which the transmission company owns its right to use the land for all categories of land ownership, whether state or private owned, for operation and maintenance of transmission facilities. The transmission company owns the right to access the entire RoW corridor stretch without acquiring the land (except for land occupied by tower base) but imposes certain land use restrictions to the landowners, who owns the land ownership and bears the tax burden. But affected people are not adequately compensated. This is the complex RoW issue, which the new PTPs are facing with an enormous public opposition (Hilen, 2003).

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The common practice in most countries include no compensation for the RoW (Pall, et al, 2019) corridor and one-time cash compensation for the damage caused on fruits/crops/structures. The PTP developers provide one time cash compensation (as per the compensation rates determined by the government) to the landowners during the project implementation; however, the adequacy of the compensation package is perceived to be minimal due to various concerns: occupying space, noise pollution, visually unattractive, health and safety concerns, etc. More importantly, there is a diminution in land value as land cannot be fully utilized (Ministry of Power, 2015) because landowners are not allowed to construct structures, and the banks deny property as a collateral for loans (Accountability Council, 2019). This has intensified landowner opposition, which has exacerbated in recent decades, especially in the developing urban areas with better financial and economic prospects. The following figure shows schematic representation of a typical 400kV transmission system and the RoW corridor:

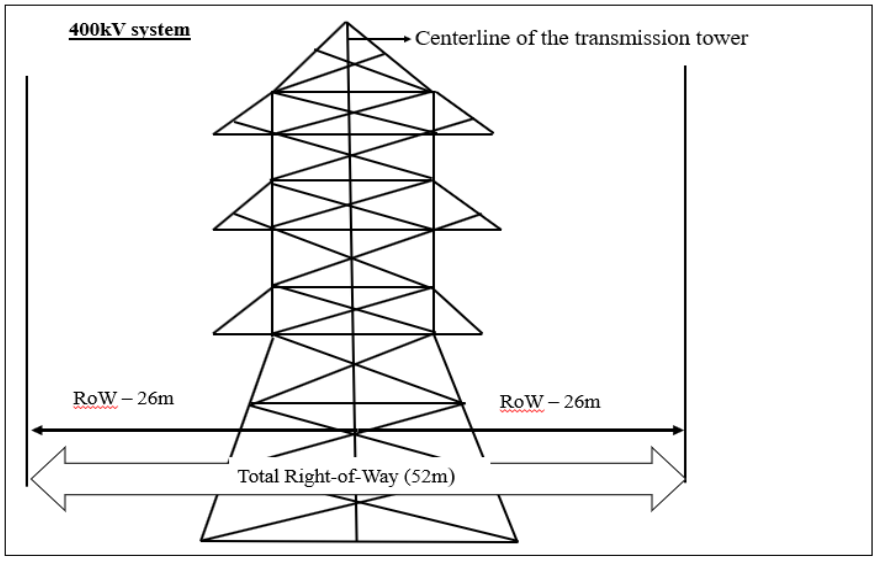

Figure 1 Schematic diagram of a 400kV transmission system

The width of the RoW corridor is same on either side from the centerline of the tower, and it varies depending on the voltage level. As per the National Transmission Grid Master Plan (NTGMP) of Bhutan (2018), the width of the RoW corridor for different operating voltage is defined as follows:

Sl. #	Voltage level (kV)	RoW width (meter)
1	400	52
2	220	35
3	132	27
4	66	18

Table 1 Width of the RoW corridor for high voltage transmission system

Higher the transmission voltage, greater the width of the RoW corridor (bigger the impact) and vice-versa.

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III. RESEARCH METHODS

A. Study Setting

The demand for power is increasing more rapidly in developing economies like Bhutan: facilitating better livelihood and stimulating economic growth. The power sector has significantly contributed to the overall development of the country through spurring and diversification of economic activities besides providing access to clean energy. The following figure shows contribution of the power sector to the overall Gross Domestic Product (GDP) in the past five years:

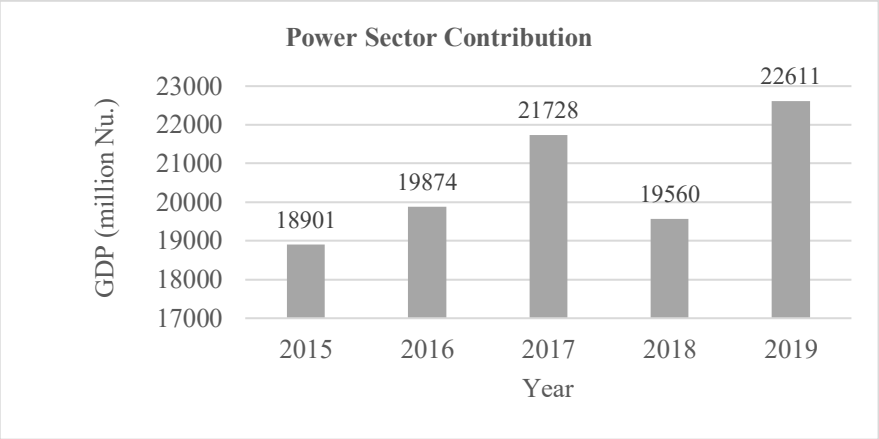

Figure 2 Share of power sector contribution to the overall GDP

Contribution of the power sector to the overall GDP has been consistently on rise; however, it dipped slightly in 2018, and again grew in 2019. Power sector contribution accounts for more than 10% of the total GDP in the past five years.

The power sector needs to cope up with consistently increasing domestic demand resulting from the population growth and industrialization. Accordingly, the NTGMP (2018) estimates dramatic surge in peak demand surpassing 1000MW in the coming decades, representing an increase by three-fold from merely 363MW in 2017; therefore, hydropower is at the forefront of the national development agenda and its priority is emphasized in various national key policies. Its overarching role is expressly accentuated in the 12th five-year plan—national economic development master plan—wherein hydropower is being underscored as the foremost driver of the national economy (Gross National Happiness Commission, 2018). This will necessitate transmission system expansion as it is an integral part of the hydropower development.

The benefit of Bhutan's power sector expands beyond the border, providing clean hydroelectricity to one of the biggest electricity consumers in neighbouring India. Several projects are in pipeline, and implementation of such hydroelectric projects will fortify the drive to "successfully engage in cross border-trade of electricity" (Tortajada, et al., 2018, p.320) amongst the neighbouring countries. This would help in addressing the region's energy security concerns substantially (Srivastava, et al., 2007), while fortifying efforts toward a decarbonized electricity sector (Spath, et al., 2016). This would enable to realize all of the SDGs as the SDG seven: "ensure universal access to affordable, reliable and modern energy services is inextricably linked with all other sixteen SDGs" (World Bank, 2017, p.3). Thus, it presents a win-win situation both for Bhutan and the region in realizing the imminent goal of clean energy access and long-term energy security goal for larger economic benefits. In consonance with these overarching objectives, the NTGMP (2018) presents a scenario of significant capacity addition from potential hydro power projects by 2040 as presented below:

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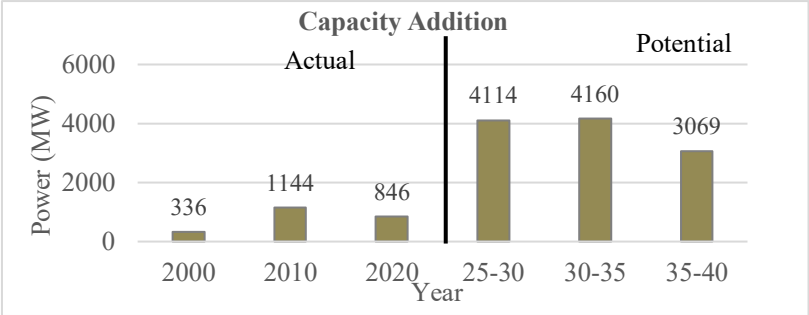

Figure 3 Install capacity addition

It presents potential capacity addition of more than 3000MW every five-year time frame commencing from 2025 until 2040 that could substantially displace fossil fuel-generating sources from the grid in the region wherein transmission system development is an integral part. Therefore, construction of PTPs is apparently discernible and necessary, to support a development that is cleaner and sustainable, both locally and globally.

B. RoW Issue in Public Limelight and Discussion in the Parliament

PTPs are increasingly becoming a ubiquitous issue of a national concern. The RoW issue has recently drawn public attention. The issue for the first time at a national level was deliberated in the parliament in 2019. The parliament recommended formulating RoW related policies/guidelines, specifically stipulating that the private land should be avoided, and if inevitable, land substitution/compensation should be provided for the RoW corridor (National Assembly of Bhutan, 2019). The cases of landowners, soliciting the transmission company for removal of transmission towers and lines from their land has also increased recently, which may have been stirred by the recommendation of the parliament. The issue remained unabated and only heightened recently with repeated deliberation in the recent parliament sessions, and therefore, needs to be addressed as non-resolution of such issues between the transmission company and the landowners would pose serious threat to the power sector development and jeopardize larger national economic ambitions. As such, Bhutan provides timely and appropriate setting upon which to conduct the study to assess the state of the RoW issue and to analyze the magnitude of the impact on the private land.

C. Data Collection and Analysis

The qualitative data concerning the impact on the private land due to high voltage (66kV, 132kV, 220kV and 400kV)) power transmission line RoW corridor was collected from the Bhutan Power Corporation (BPC) Limited—an only licensed state-owned power transmission company—responsible for electricity transmission and distribution systems in the country. The data detailing transmission lines, operating voltage levels, and private land affected across the country is presented in Appendix A: Private land affected by the PTP line RoW corridor. The data regarding power transmission line corridor and their corresponding impact on the private land was analyzed to determine district-wise distribution of the impact and to quantify and qualify the impact degree across the affected districts. The impact degree is defined in terms of number of locations affected by high voltage transmission towers/lines/corridor. The impact distribution has been further segregated into various voltage levels to determine the impact resulting from different operating voltages. In addition, the impact has also been categorized under the two broad thematic areas: tower siting and the RoW corridor as there is varying degree of impact due to tower sitting and RoW corridor.

IV. RESULTS AND DISCUSSIONS

A. District-Wise Impact Distribution

Despite transmission towers and lines widespread across the country, the impact on private land due to existing high voltage power transmission towers and lines is limited to four districts. The following map shows impact distribution across the country with the degree of impact:

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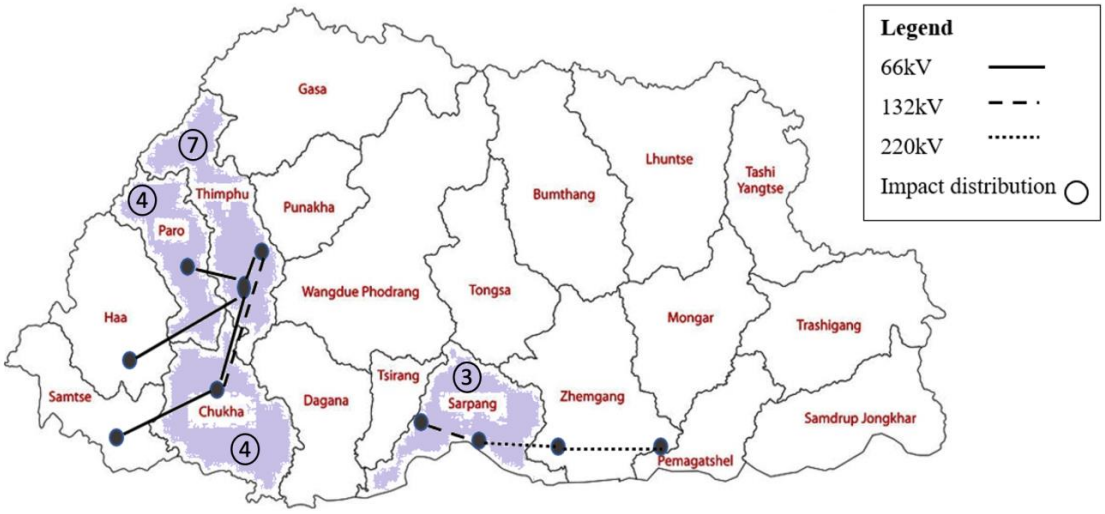

Figure 4 Map reflecting the impact distribution due to RoW issue

The existing high voltage system has affected only four districts: Thimphu, Paro, Chhukha and Sarpang. The private land is affected at eighteen different locations with varying impact degree across four districts. The impact degree is highest in Thimphu district, with private land affected at seven different locations from total of eighteen, followed by Paro and Chhukha districts with impact degree of four, and Sarpang with the lowest impact degree of three. The impact is attributed to high voltage ranging from 66kV to 220kV. 400kV system has no impact so far on the private land.

B. Impact Distribution Across Various Operating Voltages

Different operating voltages have affected private land in four districts. Following figures shows distribution of impact across various operating voltages:

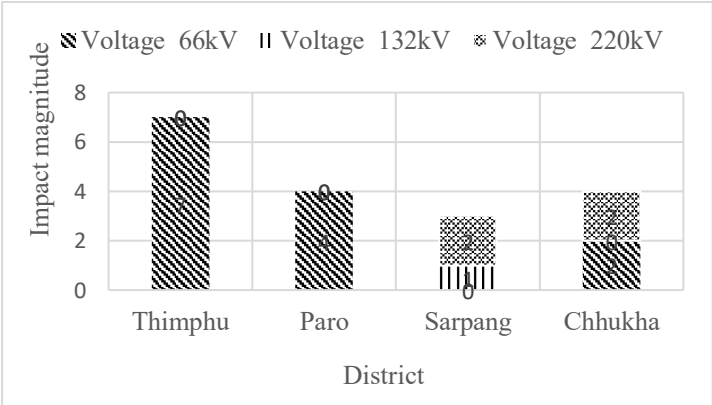

Figure 5 Distribution of impact across different voltage levels

Thimphu and Paro districts are affected solely by 66kV system, while Sarpang has been affected at one location by 132kVand at two locations by 220kV system. Chhukha has an equal impact distribution amongst 66kV and 220kV—each voltage category affecting at two varying locations.

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C. Impact Categorization by Thematic Areas

The impact on the private land by transmission towers and lines is broadly categorized under two thematic areas: (1) land affected by tower siting and (2) RoW corridor. The degree of impact varies between these two attributes in terms of direct physical impact on the land; therefore, have varying compensation entitlements. In case of the former, transmission company can purchase the land and transfer the land ownership, whereas in case of the latter, transmission company has no obligation to purchase the land; therefore, no compensation is provided. The following table shows impact distribution across these two attributes in four affected districts:

Sl No	District	Land Affected By	
		Tower Sitting	RoW Corridor
1.	Thimphu	1	6
2.	Paro		4
3.	Chhukha		4
4.	Sarpang		3
	Total	1	17

Table 2 Impact distribution between two attributes (tower sitting and RoW corridor)

Land affected by tower siting is very negligible comparing to the overall impact. Only one location has been affected by tower siting in Thimphu district. Seventeen locations are affected by RoW corridor.

D. Discussion

Impact by high voltage transmission towers/lines/corridor is limited to four districts despite transmission grid widespread all over the country, suggesting avoidance of private land as far as possible in PTP planning and implementation.

Thimphu, which is the capital, and the fastest developing district is affected severely by the RoW issue. This is because of power system expansion to meet the increasing energy needs resulting from the population growth and economic activity in the capital city. The following figure shows population growth trend in Thimphu:

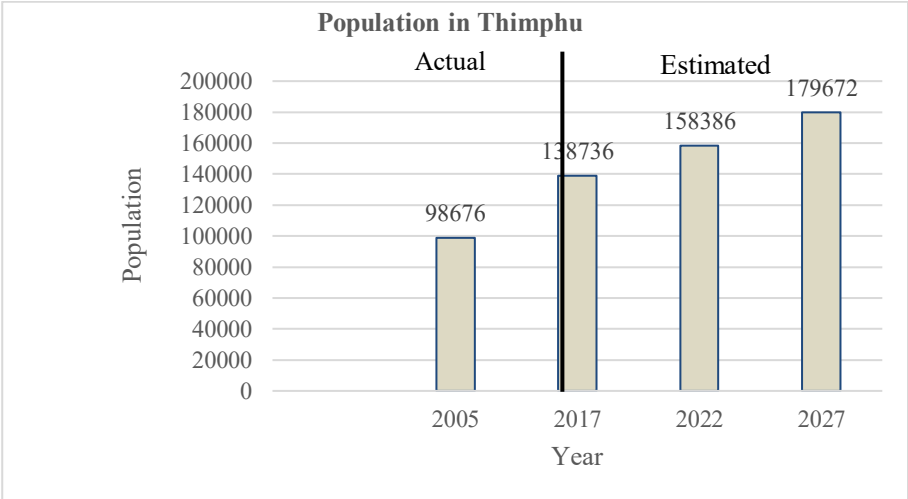

Figure 6 Population growth trend in Thimphu

The population in Thimphu has increased considerably and is estimated to increase by 29.5% in 2027 from 2017 level. Of the total, 82.5% of the district's population were residing in the city in the same year (Sangay Chophel, 2019),

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propelling massive residential building construction, which are often seen as an attractive option for economic reasons. This may be the primary reason why landowners in the capital city vehemently requested the transmission company to remove the power infrastructures from their private land to construct buildings. The RoW issue is expected to exacerbate due to population growth in future.
66kV system has dominated the overall impact. It is because the power will have to ultimately reach to the consumers. As the voltage is stepped down from 400kV—which can be located far from the settlement as it is typically use for long distance power transmission—to 66kV system, the infrastructures approach closer to the human settlement for supplying power to the end-users; therefore, the possibility of avoiding private land in 66kV system would be extremely difficult, especially in developed urban areas like in Thimphu and Paro due to space constraint. This is evident as the impact in Thimphu and Paro are solely due to 66kV system.

PTPs in Bhutan appears to have appropriately considered the RoW issue in project planning and implementation by the very fact that there have been very minimal instances of impact on private land in the last two decades of massive power system expansion period. In fact, more than 400 kms of high voltage transmission lines commissioned recently in 2018 and 2019 (Jigmeling-Alipurduar (4.75km), Jigmeling to PHP-II porthead yard (64.98km), PHP-II porthead yard to Lhamoizingkha (80.81km), Mangdechhu to Jigmeling line A (85.11km), Mangdechhu to Jigmeling line B (84.65km), Kanglung to Phuntshothang (52km), and Motanga to Nganglam (35km) (NSB, 2020)) had averted impact on the private land in any form, indicating considerations of the RoW issue.

It appears that the transmission company has attempted avoiding tower sitting in private land—because only one location is affected by tower sitting from total of eighteen—as it entails compensation/land substitutions; Majority of the impact is associated with the RoW corridor, where landowners are not compensated for the land apart from the compensation on damage of crops/structures, etc. That is why the government of India initiated compensation regime for the RoW corridor to overcome the opposition (Ministry of Power, 2015; Ministry of Power, 2020). Therefore, drawing lessons from the region, Bhutan should equally focus to address the issue surrounding the RoW corridor in addition to the tower sitting.

The issue has become ubiquitous in the wake of the discussion in the parliament, and landowners are closely following up on the discussions and decisions. The second session of the third parliament of Bhutan recommended relevant agency to formulate guideline/policy concerning RoW and specifically stipulated that private registered land in rural areas should be avoided and compensated for the RoW, if unavoidable (National Assembly of Bhutan, 2019). This recommendation may have provided impetus to the affected people as the land owners requesting transmission company to remove towers and lines from the private have increasingly become prominent recently after the deliberation of issuein the parliament in 2019. The issue is only heightening with recurrent deliberations in the recent parliament session, exerting more thrust on the relevant agency. It is likely that the PTPs in Bhutan are soon going to face a challenge from a new dimension—landowner opposition. Providing fair compensation to the affected landowners would largely help in addressing the issue that may unfold sooner, as non-compensation for the RoW corridor is the primary reason extending delays in many countries (Pall, et al., 2019). Therefore, it is crucial for making a paradigm shift in transmission project planning and development, especially in terms of compensation norms, which has remained status quo thus far.

V. CONCLUSIONS AND POLICY IMPLICATIONS

Due to the criticality of the RoW issue in power transmission system, and deliberation of the issue in the highest decision-making forum in Bhutan, this paper has assessed the impact of high voltage power transmission RoW corridor on the private land in Bhutan. The result showed that impact is limited to four districts despite transmission grid widespread across the country, suggesting consideration of the RoW issue in PTP planning and implementation; however, it also suggests that the impact will be difficult to avoid when the voltage is stepped down further to 66kV as the power infrastructure approaches closer to the human settlement for supplying the power for final consumption, and it would be inevitable, especially in a densely populated and developed urban cities due to space constraint. The attribution of 70% of the total impact to 66kV system explains this phenomenon, with most populated district like Thimphu affected solely by 66kV system.

Thimphu, the capital district has the highest impact degree with private land affected at seven different locations, followed by Paro and Chhukha with four, and Sarpang the least with three. The developmental activities and dramatic population growth necessitates transmission system strengthening, putting more thrust on the limited land resources in

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the developed cities. Therefore, underground transmission technology would play a significant role in addressing the issue, especially in land-constrained developed urban areas. Embracing technology and innovation in transmission design and construction would by and large help to minimize the RoW corridor, thereby lessening the RoW issue. From total of eighteen impact, only one location has been affected by tower sitting, while rest of the impact is attributed to RoW corridor. Since, the majority of the impact is attributed to the RoW corridor, the relevant agency(s) should equally address the concerns associated with RoW corridor as it limits the land use potential and affects the landowners.

The RoW is a recent phenomenon in Bhutan as it first came into public limelight in 2019; however, the issue has become alarming with recurrent deliberation in recent parliament sessions. The landowners seeking the transmission company to relocate transmission towers and lines are on rise. The concerned agency (s) needs to prioritize on the issue as non-resolution of such issue between the landowners and the transmission company would pose significant challenge in power system development. Comprehensive strategic plan aimed at addressing the RoW issue need to be formulated, particularly considering compensation for land along the RoW corridor. The possibilities of purchasing land within the RoW corridor (in addition to the tower sitting) may be explored as it would help to avoid future compensation related issues as transmission infrastructures can last for a longer period. These countermeasures would certainly bring financial implications to the PTP developers and the relevant authority, but it is apparently inevitable if the RoW issue is to be mitigated for smooth power system expansion. Therefore, the policy needs to strike a balance between the national and the individual interests.

RoW issue concerns both the policy makers and the landowners. Therefore, it is a common issue and needs to be addressed through consensus. This requires engagement of an affected parties. This will help avoid decision barriers and legal conflicts, (Anna, et al., 2016) due to landowner participation (Mueller, 2020). Thus, providing valuable insights in addressing the common issue in pursuit of a larger national interest as “open, fair, participatory process is associated with greater trust and better policy outcomes” (Cain, et al., 2013, p. 209).
To better understand the magnitude of the impact, both from the policy makers and the landowners’ perspectives, future study could be carried out using detailed data such as plot size, urban/rural location, etc. to assess and quantify financial implications to the landowners and the relevant authority. This would aid in providing substantive information to the policy makers for appropriate policy intervention in the effort to overcome the underlying RoW issue.

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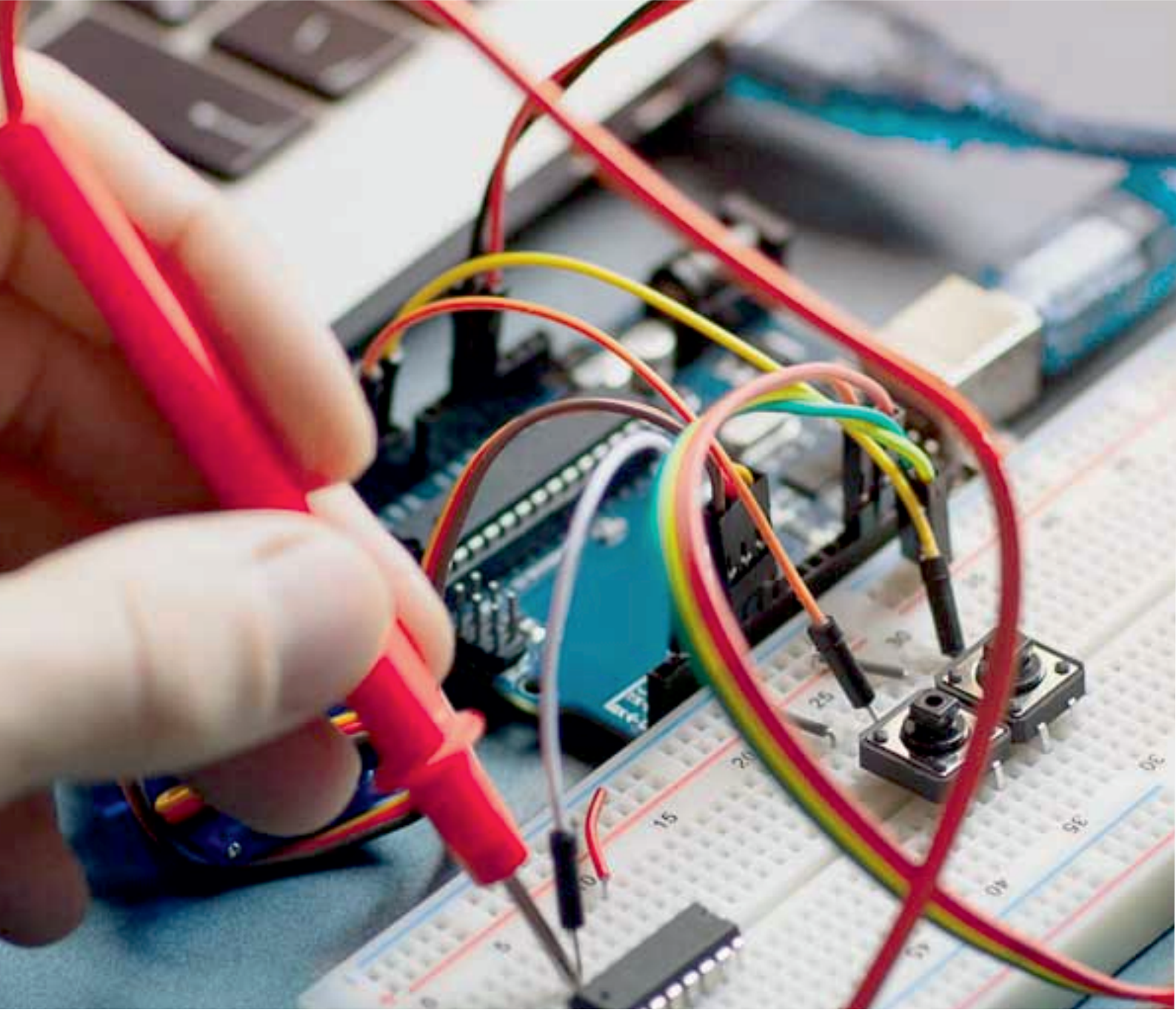
APPENDIX A

Table A1. Private Land Affected by the Power Transmission RoW Corridor

Sl. #	Transmission Line &Tower Number	Affected District	Land Affected by
1	66 kV Chukha-Thimphu (tower nos. 143 & 144)	Chhukha	RoW corridor
2	66kV Chukha-Thimphu (tower nos. 185 and 186)	Thimphu	RoW corridor
3	66kV Chukha-Thimphu (tower no. 169)	Thimphu	RoW corridor
4	66kV Chukha-Thimphu (tower nos. 185 & 186)	Thimphu	RoW corridor
5	66kV Chukha-Thimphu (tower nos. 172 & 173)	Thimphu	RoW corridor
6	66kV Chukha-Thimphu (tower nos.157 & 158)	Thimphu	RoW corridor
7	66kV Chukha-Thimphu (tower no. 162)	Thimphu	Tower sitting
8	66kV Chumdo-Haa (tower nos. 57, 58, & 59)	Thimphu	RoW corridor
9	220kV Chukha-Singhigoan (tower nos. 40 to 43)	Chhukha	RoW corridor
10	220kV Chhukha-Singhigaon (tower nos. 5 & 6)	Chhukha	RoW corridor
11	66kV Chumdo-Paro (tower nos. 82, 83, & 84)	Paro	RoW corridor
12	66kV Chumdo-Paro (tower no. 62)	Paro	RoW corridor
13	66kV Chumdo-Paro (tower no. 49)	Paro	RoW corridor
14	66kV CP 75 & 76 (Chumdo-Paro)	Paro	RoW corridor
15	220kV Jigmeling -Lodrai (tower no. 28)	Sarpang	RoW corridor
16	132kV Gelephu-Tintibi (tower no. 13)	Sarpang	RoW corridor
17	66kV Phuntsholing-Pugli (tower no. 9)	Chhukha	RoW corridor
18	220kV Tsirang- Jigmeling (tower nos. 62 & 63)	Sarpang	RoW corridor



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