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High-Voltage Electricity Transmission Lines and Property Devaluation in Nigeria: Implications for Compensation

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Abstract High voltage overhead electricity transmission lines (HVOETLs) are very necessary for electric power delivery; hence they are seen crisscrossing towns and villages. Epidemiological studies have been carried out over the years to investigate if there is any link between certain types of cancer and long-term exposure to low-frequency electromagnetic fields (LF-EMFs). Reports of such studies have only succeeded in creating fear of cancer or "cancerphobia" in the minds of people who may be living near transmission lines. Some studies have reported property devaluation occasioned by transmission lines' proximity. This paper reviews literature pieces of evidence of property devaluation by transmission lines, and the recommended minimum setbacks for different categories of transmission lines. It compares spatial dimensions of property devaluation by transmission lines with recommended minimum setbacks. It is herein observed that the negative impacts of transmission lines go beyond the recommended setbacks, negatively impacting properties outside the setbacks. This creates liability for injurious affections to the Transmission Company of Nigeria (TCN). It is herein recommended that compensation for injurious affection be inculcated in Nigerian compensation laws and TCN should embark on "accommodation works" to mitigate transmission structures' externalities.

Keywords Transmission lines, Property value, Injurious affections, Setbacks

1. Introduction

High voltage overhead electricity transmission lines (HVOETLs) are very necessary for electric power delivery; hence they are seen crisscrossing towns and villages. The Nigerian transmission network comprises of about 11,000km of transmission lines (5,000km of 330KV transmission lines and 6,000km of 132KV transmission lines). It also has 23,753km of 330/132KV sub-transmission lines and 91km of 132/33KV sub-station lines [1]. Beginning with the study carried out by Wertheimer & Leeper [2] which made the first attempt to link childhood cancer to the proximity of electricity transmission lines to residences, a good number of epidemiological studies have been carried out to investigate if there is any link between certain types of cancer and long-term exposure to low-frequency electromagnetic fields (LF-EMFs) such as the types generated by HVOETLs. Some of these studies have associated certain types of cancer with long-term exposure to LF-EMFs [3-5]. Some other studies, however, reported no association between cancer and LF-EMFs exposure, and such studies to include The Council of the American Physical Society [6], McBride, Gallagher, Theriault, Armstrong, Tamaro & Spinelli [7], Elliot, Shaddick, Douglass, de Hoogh, Briggs and Toledano [8], Parmer [9]. The foregoing implies that research on the link between EMFs and cancerous diseases is inconclusive.

Though these epidemiological studies are inconclusive, the wide media coverage given to the positive ones among them has instilled in many people, the fear of contracting cancer by living in homes near HVOETLs. In this regard, Bolton and Sick [10] noted that "general fear of EMF exists in the public mind across the board". The question of whether LF-EMF is carcinogenic is not as important as the impact of this fear on property

values. In Criscuola vs. Power Authority of State of New York [11], the New York Supreme Court gave a ruling which allows appraisal evidence to be based on "fear in the marketplace" rather than actual epidemiological evidence of adverse health effects from EMFs. In what follows, property appraisers and researchers have had to occupy themselves with the task of determining whether this fear—or "cancerphobia"—among many people has any depressing effect on property values.

The questions begging for answer in this paper are:

What evidences exist in literature in support of HVOETLs devaluation of property?

What is the spatial extent of possible devaluation?

What is the prescribed safety clearance?

Does the prescribed safety clearance absolve all the negative externalities of HVOETLs so that residents of proximate homes outside the "danger zone" have no genuine claims for compensation for injurious affection?

1.1. Literature Evidence of Hvoetls Property Devaluation

A good number of studies have reported the diminishing effects of HVOETLs on the values of adjacent properties, especially residential properties. Literature reveals a considerable degree of consistency between earlier studies and later studies in terms of results. Earlier studies have found diminution in house values occasioned by HVOETL to be 10.01%— 11.93% [12]; about 10% [13] and 3.3%—7.6% [14]. Colwell and Forley [15], using a more robust methodology, found that property value diminution resulting from HVOETL's proximity has a distance-decay characteristic and varnishes at 61.0m from the HVOETL.

Des Rosiers [16] analyzed 507 sales in Canada using a micro spatial approach and found that house value depreciated by 10%—20% due to visual encumbrance posed by the pylon and by 5% - 10% due to visual encumbrance posed by conductors. Interestingly, Des Rosiers' study suggests that close proximity to HVOETL's easement does not necessarily reduce house value as a house located a lot away from the easement may enjoy a market premium of 7% - 22% due to enhanced visual clearance and increased intimacy. Net visual encumbrance, which the author defined as the difference between drawbacks resulting from visual encumbrance and proximity advantages, reaches its maximum between 50m and 100m from the external boundary of an easement. Furthermore, the author found that orientation of house relative to HVOETL's easement could affect house value as a house having a rear or side view of the easement may benefit from a market premium of 3% - 4%.

Sims and Dent [17] analyzed house sale prices in the UK and found that physical proximity of pylon reduced house value by 6% - 17% for houses located within 100m of a pylon compared with a house at 250m from pylon. Furthermore, house value depreciated by 7.1% due to a view of pylon from the rear of the house and by 14.4% due to a view of the line from the front of the house but a house having a rear view of the line enjoyed a market premium. .

In a study carried out in the Piedmont Region, North-Western Italy, Giaccaria, Frontuto and Dalmazzone [18] used a GIS-backed contingent valuation survey to estimate the marginal impact of a transmission line on human health, landscape and the environment. The authors differentiated the analysis with separate bid designs for households in close proximity to the lines (whose real properties suffer depreciation in value), households subject to intermediate level of impact (i.e. a varying mix of visual encumbrance, perceived health risks, perceived environmental and ecological risks), and households subject to 'ordinary' level of impact (landscape degradation and visual encumbrance). Results of the analysis showed that households subject to ordinary impact of the lines had a mean willingness to pay (WTP) of €189 for getting rid of the lines; households subject to intermediate level of impact had a mean WTP of €576, and households in close proximity to the lines had a mean WTP of €3,753. Willingness to pay, as used in this context, may be conceived as diminution in property value which, as revealed in the hedonic studies discussed above, decays with distance.

Again, the diminishing effect of HVOETL's on house value draws support from the study carried out by May, Corbin, and Hollins [19] which found that house value increased by 0.03% as the distance from the centre line of HVOETL increased by 1%. Three land-use variables were included in the list of variables tested in the study and they were distance to rail lines, distance to a public park, and distance to Welling station (a transport station). The authors found interaction among these three variables and suggested that (1) the positive impact of

the park's proximity on house value disappeared in the presence of railway lines and pylon and (2) any loss of house value caused by pylon's proximity would be partially offset by the availability of transport service.

In one of the very few Nigerian studies on property value impact of HVOETLs, Akinjare, Oluwunmi, and Iroham [20] investigated the impact of transmission lines on residential property rents in Lagos, using multivariate analysis of variance (MANOVA). The study reported that the mean rental value of the impacted properties dropped by ₦786. Furthermore, the 101-150m distance zone (measured from the transmission line) had the highest mean rent, followed by the 51- 100m zone, the 151-200m zone, and lastly, the 0-50m zone. The authors agreed that other factors such as accessibility, flooding, soil condition, and fear of illegality affected the order of mean rental values as stated above. This implies that the model failed to control for intervening factors.

Oluwunmi, Akinjare, and Ayedun [21] compared rental values of residential accommodation units within the HVOETL vicinity (i.e. within 200m perpendicular distance from the line) with rental values of similar units of residential accommodation outside the HVOETL vicinity. The study which was carried out in Surulere and Alimosho areas of Lagos, Nigeria was based on tenement units, a one-bedroom flat, a two-bedroom flat, a three-bedroom flat, a two-bedroom bungalow, a three-bedroom bungalow, and a three-bedroom duplex.

Results show that in both areas, accommodation units outside the HVOETL vicinity commanded higher rents than those within. In Surulere, rents commanded by tenement units and one-bedroom flats outside the HVOETL vicinity were respectively 104% and 31.5% higher than those commanded by counterpart units within. The authors attributed these high figures to "potential threats from HVOETL" and "demolition threat". For the rest accommodation types, rental diminution ranged from 9.73% (for three-bedroom duplex) to 20% (for two-bedroom flat). In Alimosho, rental value diminution ranged from 10.77% (two-bedroom flat) to 25% (for three-bedroom duplex. Perceptual studies carried out so far generally suggest that HVOETLs have negative impact on house values as they reflect what people feel. For this reason, results of earlier studies do not differ from those of recent studies. Even where people bought HVOETL-proximate house without knowledge of the possible adverse health effects, it has been found that they would have negotiated a lower price had they gained such knowledge at the time of purchase [22]. Furthermore, generality of these studies suggest that the causes of the perceived diminution include health concerns, visual pollution, danger of electrocution and the buzzing or humming associated with HVOETLs.

Bottemiller and Wolverton [23] analysed home sales data for the period 2005–mid-2007 in Portland, Oregon and Seattle, Washington. Transmission lines involved in that area range from 115 KV to 500 KV. The analysis which is based on multiple regression shows that HVOETL-abutting homes diminish in value by 1.65% in Portland and 2.43% in Seattle. The study is a refinement of an earlier (2003) study by the same authors which found no significant price effects. The authors remarked that the significant value diminution of 2.43% in Seattle owes much to the inclusion of high priced homes in the data set. Sims and Dent [17], in a refinement to their 2005 study, carried out a regression analysis of home sales in Blackwood, Scotland. The sales occurred in the period 1994–2010. About 78% of the samples homes have some view of pylon supporting a 275 KV transmission line transecting the study area. Among variables included in the data set is home with one-quarter of pylon visible from the front, home with a pylon visible from the side, home with half a pylon visible from the front, home with three-quarters of pylon visible from the rear of the home, home with two pylons visible from the rear, and distance of HVOETL from home (measured in 50 m distance bands). Results show that homes within 100 m of HVOETLs sold at a 21% discount compared with homes located 400m away; homes with three-quarter views of the pylon from the rear suffered the greatest value diminution. However, homes with a view of the pylon from the side sold for a premium, presumably because of privacy. All these negative effects diminish with distance.

Han and Elliot [24] analyzed over 5000 sales of detached houses occurring in Brisbane for the period 2001–2010, using both buffering analysis and hedonic modelling. In the former analysis, proximity to HVOETL is measured by five distance bands, while in the later, proximity is measured separately from visual encumbrance by selecting either houses with a good view of, but distant from, HVOETL, or houses close to HVOETL but without a view of it due to vegetation or topography. The buffer analysis reveals that houses within 50m of HVOETL sold for 20 % less than the mean house price for the global sample; houses within 50m–100m and 100m–200m sold for 15 % and 7 % respectively less than the mean house price for the global sample. For sales

occurring beyond 200m away from the line, reduction in price seems to be little. The result of the hedonic modelling shows that the distance and view variables have significant negative impacts on house price, and view of HVOETL is a more important determinant of house price than distance from HVOETL. Using an experimental design based on visual simulations of property to be valued, Seiler (2014) sought to isolate the perceived impacts of noise (humming/buzzing), easement and physical proximity (or mere presence) of HVOETL on house values. The author found that HVOETL in the neighbourhood of a house (though distant from the house) diminished its value by 4.9% compared with a similar house entirely outside the neighbourhood; a house near HVOETL (not subject to noise and easement) diminished in value by 2.5% compared with a house distant from HVOETL. Impact of noise was found to be −2.0%. Although the impact of easement proved to be insignificant, the combined impact of noise and easement was found to be more than the sum of its parts.

Callanan [25] examined the impact of removal of two 110 KV lines on home prices in Wellington, New Zealand. The study reports that, before the removal, home prices within 20 metres of pylons drop by 27 % while those at a distance of 50 metres drop by 5 %. This negative impact becomes negligible at a distance of 100 metres. Homes located directly under the line shows less than 1 % reduction in price, implying that lines *per se* do not have impact on sale price. Post-removal analysis shows that, a few years after the removal of the lines, sale prices increased significantly. Ukpevbo and Egbenta [26] studied how residential land buyers perceive HVOETL's proximity to residential land in Auchi, Nigeria. By means of conjoint analysis, preferences (in terms of utility) for residential land attributes, including HVOETL's proximity, were elicited from prospective buyers of residential land in the study area. Proximity enters the conjoint model as distance between plot boundary and the edge of ROW, and this distance was measured in bands: 30m–150m, 150m–300m and 300m–500m. Result shows that buyers' preference for residential land increases by 40% when distance increases from one band to a higher band. The opinion survey part of the study shows that the average residential land buyer does not perceive any negative impact of HVOETL's proximity beyond 70.12m.

1.2. Injurious Affection

Injurious affection refers to the depreciation in property value which, in many cases, results from compulsory acquisition of land. If the depreciation is as a result of acquisition of a parcel of land which forms part of a claimant's land or "held with" another parcel by the same claimant, it is termed "severance". If the depreciation is as a result of the works carried out on the land taken, it is some other form of injurious affection. So, injurious affection can occur even when no land is compulsorily acquired. In the case of power line infrastructures, injurious affection may arise from visual unattractiveness of the lines, potential health hazards, disturbing sounds, and safety concerns. HVOETL's externalities have been shown, in the foregoing, to have spatial spread and a distance-decay characteristic, thereby depreciating the values of proximate properties. Under some legal systems, injurious affection is well recognized as one of the heads of compensation claims. It is sad to note that in Nigeria, today, the Land Use Act of 1978 does not provide for compensation for injurious affection. The only legislation which attempted to provide for injurious affection was Public Lands Acquisition Act (Cap. 167) of 1917 which, by Section 14, prohibited compulsion of a land owner to sell a part of a building to an acquiring authority when he is willing and able to sell and convey the whole.

1.3. Spatial Dimension of Hvoetl's Externalities and the Prescribed Safety Clearance

The foregoing studies which found property devaluation effect of HVOETL's proximity have shown that this devaluation is subject to distance decay, implying that there is a distance from the centre of the transmission line beyond which value diminution ceases to be significant and finally disappears. Spatial extent of value diminution (as this distance may be called) has been reported to be 61m [15], 150 m [16], 250m [17, 27], 200m [21] and 70.12 m [26], 200m ([24] and it depends on the voltage and other characteristics of the line in question.

In view of the dangers of possible electrocution and health concerns associated with transmission lines, governmental authorities in many countries have come up with various regulations on building setback from HVOETL right of way (ROW). For instance, the California Code of Regulations, Title 5 Section 14010(c)

recommends setbacks as measured from the edge of easement of overhead transmission lines to school premises as follows:
30.5 m for 50-133 kV line (interpreted by CDE up to <200kV)
45.7 m for 220-230 kV line
106.7 m for 500-550 kV line
The Government of South Australia [28], through her Electricity General Regulation 2012, provides for setbacks for buildings and structures from the central line of HVOETLs as follows:
15 m for 132 KV (single pole)
20 m for 132 KV (double poles)
25 m for 275 kV line
Safe clearance distances in India are quite long comparatively. The following setbacks exist:
44 m for 110 KV line
54 m for 132 KV line
70 m for 220 kV line
104 m for 440 KV line
Back home in Nigeria, the Nigerian Electricity Regulatory Commission (NERC), by the Nigerian Electricity Supply and Installation Standards Regulation 2014, makes the following provision regarding the right of way (ROW) width for overhead power lines of any voltage:
50m for 330 KV line
30m for 132 KV
11m for 33 KV
11m for 11 KV
The Regulation further stipulates that the Right of Way measurement shall be divided equally from the centre of the line on either side. This translates to the following setbacks:

Table 1: Setback for Abutting Buildings

Voltage Level	Setback (in meters)
330 KV	25
132 KV	15
33 KV	5.5
11 KV	5.5

Source: Nigerian Electricity Regulatory Commission (NERC), 2014

1.4. Setback Regulations in Nigeria: Have they Forestalled Injurious Affection?

A look at the spatial extents or dimensions of the property devaluation characteristic of HVOETLs alongside minimum setbacks recommended by NERC shows that the setbacks are not enough to contain property value diminution. For instance, while the diminution occasioned by the 132 KV power line can extend to 70.12m from the line [26], the minimum setback recommended is only 15m. Thus. property value diminution transcends the recommended setbacks and setbacks have failed to forestall injurious affections occasioned by transmission lines. The implication of this is that the electricity provider (TCN) and the regulatory body (NERC) are liable for compensation for injurious affection suffered by adjacent properties impacted.
However, there seems to be only two cases in which liability for injurious affection lies. They are:

- Properties developed before the transmission line was constructed. It does not matter whether the property lies within the recommended minimum setback or outside it.
- Properties developed outside the recommended setback after the transmission line had been constructed.

If such properties are impacted, TCN and NERC are liable for injurious affection. For properties that were developed within the recommended setbacks after the transmission line had been constructed, the owners have no case to make for compensation.

2. Conclusion

Considering the great opportunity cost of land, the recommended setbacks for power lines are adequate. Asking for greater setbacks would mean the more land is devoted to power line corridors, which would not augur well with thickly populated urban areas where land for development is scarce. However, considering the spatial dimension of property devaluation by power lines, the recommended setbacks have been found to be inadequate. This creates liability for compensation with respect to properties lying outside the recommended setbacks.

3. Recommendations

1. Injurious affection occasioned by power lines should be inculcated in Nigeria's compensation laws.
2. TCN should embark on "accommodation works" in order to mitigate injurious affections occasioned by its transmission line structures. These works include "shielding" of conductors to ameliorate electromagnetic radiations, "line configuration" as well as more aesthetic design of pylons.

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