19TH ANNUAL PACIFIC-RIM REAL ESTATE SOCIETY CONFERENCE

MELBOURNE AUSTRALIA, 13-16 JANUARY 2013

A CONTINGENT VALUATION APPROACH TO THE VALUATION OF HIGH VOLTAGE TRANSMISSION LINES

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ABSTRACT

This paper is to determine the effect High Voltage Transmission Lines (HVOTLs) have on property values, the perception residents have of the effect on value and whether residents are prepared to pay to have an existing HVOTL removed from their neighbourhood.

A case study was undertaken to:

i. Carry out a quantitative analysis to determine the effect of the HVOTL on property values.
ii. Determine the perceptions of property owners to the presence of the HVOTLs, and
iii. *Determine the property owners' 'willingness to pay' to have the HVOTLs removed,*

The results show a disparity between the actual sales data as compared to what residents expect and also how much they would be prepared to pay to remove the HVOTLs. The sales analysis results in a negative effect of 20% to those properties that are adjacent to the HVOTLs. This effect drops to a negligible amount at 100 metres. Owners within the neighbourhood believe there is a 10% effect whether they are adjacent or up to 400m from the HVOTLs. The majority of owners opposed any contribution towards removing the HVOTLs. This paper highlights the need for Valuers to have a better understanding, regarding how to appropriately measure the effect of HVOTLs on property values.

Keywords: Willingness to Pay, High Voltage Transmission Lines, Effect on property value, contingent valuation

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INTRODUCTION

This paper seeks to determine the effect on property sales price and to improve Valuers' understanding of the attitude of residents towards the presence of transmission lines and towers using a case study in Auckland, New Zealand.

The issue of whether the presence of High Voltage Overhead Transmission Lines (HVOTLs) is of importance to existing and potential owners in areas where the lines exist. There is a financial interest by the Power suppliers/operators who own the HVOTLs and may be investigating either adding, removing, or upgrading the lines and need to know the levels of compensation or effect on value of any properties affected. The main interest in this paper is from Property Valuers who are faced with the problem of, how to value the effect. There is no formal methodology for valuing this effect and generally a rule of thumb is applied, which is a guesstimate. This in itself has caused problems with Valuers who are familiar with Valuing properties that are in close proximity applying a lower discount than those that are unfamiliar with the externality (Delaney & Timmons 1992).

The case study area that the HVOTLs traverse consists of heavily populated residential suburbs in Auckland. These lines are part of the National Grid, which is owned and operated by Transpower NZ. They provide for:

- the main electricity supply into Central Auckland,
- support to the electricity supply to West Auckland, North Shore and the balance of the North Island located north of Auckland,
- provision of the electricity supply to the rapidly expanding adjoining suburbs.

At present there are two types of high voltage transmission lines within New Zealand: 110 kV lines are carried on traditional steel lattice towers that are approximately 20 to 33 m high, 220 kV lines are carried on more substantial traditional steel lattice towers that are approximately 33 to 46 m high. Three sets of 110 kV lines and one set of 220 kV lines pass through the case study area.

The following literature review highlights the findings of current literature relating to using a regression and attitudinal surveys which have been the traditional technique for determining any detrimental effect on property values. The literature relating to the Contingent Valuation approach for this paper has predominantly concentrated on the problems with the Willingness to Pay in relation to determining an appropriate bidding starting point and also whether respondents are being 'realistic' in their bids.

This paper looks at three different techniques to enhance the understanding of HVOTLs on property values. An Econometric analysis technique was used to determine a suitable regression equation to quantify any transmission line or tower effects. A survey has also been carried out to determine the attitudes of residents to the high voltage transmission lines and thirdly a Contingent valuation approach using a Willingness to Pay survey to determine whether residents are prepared to have the HVOTLs removed or the numbers reduced.

LITERATURE REVIEW

Econometric Analysis and Attitudinal Studies

A study undertaken by Callanan (1994, 1995 & 2000) on the Newlands suburb of Wellington, New Zealand was the first of its kind published in New Zealand using econometric analysis to estimate the impact of the HVOTLs on property values. The study area had two sets of 110kv lines running through it, with the lines converging at the southern end of the suburb and then splitting out with one line going to the west and the other to the north. The results from this study showed that their was a 27% reduction for properties within 10 metres of the pylon, 5% at 50 metres, 2% at 100 metres and reducing to less than 1% at 200 metres. It is noted that the pylons were located in the backyard of some of the sales within 10 metres of the house. This situation is unique to New Zealand and probably the most extreme case, as most countries provide for a transmission corridor and easements over private property which restricts how close residential properties can be located.

The findings in Pitts & Jackson (2007) are in contradiction with earlier studies by Kinnard et al (1994) and Delaney & Timmons (1992) which conclude that respondents who had no experience in appraising HVOTLs estimated much larger negative price impacts than did designated residential Valuers experienced in valuing such properties. Kinnard (1997) analysed over 700 sales in conjunction with a survey of local Valuers, Real Estate Agents and owners. The results found that opinions of the 'professionals' were a lot more negative than the owners, and both groups were more negative than what the actual sales data indicated. Kinnard (1997) concluded that "the literature of opinion research indicates that respondents commonly do not behave in the way that they say they would, when confronted with an actual purchase or sale decision, instead of a hypothetical choice"

Contingent Valuation

Contingent Valuation is a technique that has been used by natural resource and environmental economists since the 1970s to estimate value. The method requires analysis of a survey to determine how much respondents are willing to pay for a service, utility or resource. The use of this method has been used in such cases as the Exxon Valdez oil spill (Carson et al 1992) to measure the cost to the environment and how much people were prepared to pay to maintain that environment. It has not commonly been used in the measurement of HVOTL impacts or within the traditional Valuation approach; however, in this paper it is used to measure the amount residents are Willing to Pay (WTP) to have the environmental effect, being an existing HVOTL, placed underground or removed. The other measure that is part of the Contingent Valuation is 'Willingness to Accept" (WTA). The WTA was not appropriate in this study as we are looking at removing the HVOTLs. It can be argued that residents have already accepted a discount on their purchase price at the time of buying the property, which is a level of WTA.

Mundy and McLean (1998) list eight common criticisms of the Contingent Valuation method as;

- *"Monopoly money. The reported willingness to pay to improve or protect natural resources is significantly greater than actual willingness to pay.*
- *Extreme hypothetical nature of the questions.*
- *Embedding. The value given for part of a resource was essentially the same as for the entire resource.*
- *So many spills – so little money. Responses to Contingent Valuation (CV) studies seem unrealistically large in view of the many problems for which individuals might be asked to contribute money. Few CV studies remind respondents of the budget constraints under which they must live.*
- *Respondents pre-existing bias.*
- *Funny money. CV studies may improperly determine the extent of the market.*
- *Warm glow. The respondents in the studies may be expressing their public support for (or the "warm glow") associated with charitable giving rather than indicating their willingness to pay for the program in question."*

These criticisms were reinforced in the case study undertaken in this paper, where respondents did not appear to fully weigh up the level of financial benefits against the amount of money they were prepared to pay to achieve that gain.

(Pearce.D & Turner.P, 1990) suggest that to examine the negative effect or damage caused by an environmental project is to measure the total economic value lost. They have used the following rule as to whether a development is acceptable or not as follows:
$(B_D – C_D – B_P) > 0$ To proceed
$(B_D – C_D – B_P) < 0$ Not to proceed

Where B_D refers to the benefits of development.
C_D refers to the costs associated with the development.
B_P refers to the benefits of preserving the status quo of the area.

It is the last variable that is the hardest to measure. Pearce and Turner (1990) carry the equation a step further by trying to measure the 'willingness to pay' of each household. In order to do this, a demand curve is created. This WTP is then extended to see the effect of variation in household income and other household characteristics. For this case study there are limitations in obtaining personal information relating to the individual households, which therefore made it difficult to correlate the amount people were WTP against the household income. However, the average incomes for the area were obtained and were able to be compared in a general sense.

The WTP procedure has been applied in this research to analyse whether owners were prepared to contribute to having the HVOTLs removed, and as a spin off we are able to also determine the optimum positioning and route, to produce the least impact on property values. This second step is a further area of research that can be developed for the placement of any NIMBY (Not in My Back Yard) effects on property values, including HVOTLs.

Pearce and Turner (1990) used a hypothetical subdivision for their research, which used a bidding process, where the surveyor sets the first bid, as a starting point. The starting point is then increased or decreased accordingly to a point where the respondent would be WTP, or WTA the development. Bias may be introduced to the survey through the surveyor setting the opening bid. The other source of bias would be if there were a difference between the hypothetical market and the actual market. A third source of bias can arise from the respondents not wishing to reveal the truth in case it in some way disadvantages them. Within this case study the WTA is not applicable as the HVOTLs are already in place, and we are trying to find out how much owners are WTP to have them removed.

An assumption is made that people are prepared to put more weight on any loss of property value, than a similar sized gain.

The hedonic price function is the most commonly used method applied to environmental valuation. "First, a hedonic price function is estimated: second, implicit prices are calculated for the environmental variable of interest: third, a demand curve for this variable may be estimated." (Hanley 1997) Each one of these steps holds problems for the analyst.

Freeman (1982) examines the theory of the Willingness to Pay (WTP) and the Willingness to Accept (WTA) principle. WTP is the amount of money loss that would just offset the gain in utility due to moving to situation B. One of the constraints of this principle is that an owner is going to base their WTP figure on the constraints of their income, rather

than the true value of the utility gained. “the definition of benefits as willingness to pay implies the existence of a demand curve for the effects of the environmental improvement”. (Freeman 1982) Freeman cites a study by Randal et al (1974) that deals with aesthetic impacts of a Power plant including air pollution, effects of landscape and visual impact of the transmission lines. “Respondents indicated an average bid per household of $50 per year to move to a somewhat improved aesthetic state and an additional $85 per year to go beyond that to a substantially improved state”. There is no indication within the paper as to how they were to pay the money, or the options that they were presented with.

METHODOLOGY

Study area and data description

The study is based on a residential area in Auckland, New Zealand. The majority of homes have been built from 1950 onwards and the HVOTLs were already in place at the time of development Housing is predominantly in the low to medium cost range. The topography is relatively flat with a gentle slope throughout the suburbs. The towers and transmission lines are clearly visible throughout the area. Both the lot land size and floor areas are similar to other suburbs in New Zealand that were developed around the same era, with the average land area being 723 square metres and the average floor area being 129 square metres.

As reported by Callanan (2010) the Regression analysis used six years of house sales in order to eliminate large changes the market might have experienced over time, and changing perceptions of transmission line effects on health. Six years data produced 860 sales within 400 metres of the transmission lines that are owner occupied family homes. This number of sales is sufficient to make the regression equation statistically reliable and to give confidence in the results.

For each sale the property specific variables were analysed, in addition to sale price, sale date and location.

The HVOTL distance variable was measured as both the distance from the centre of each lot to the transmission line and also the distance from the centre of the lot to the nearest tower. A ‘View’ variable was not incorporated, as all properties in the suburbs have a view of the HVOTLs, and therefore would not offer any additional clarification.

For the Attitudinal and WTP survey a questionnaire was posted to the registered owner(s) of 887 residential properties within the area. A further 50 properties were visited within close proximity to the HVOTLs to carry out a face to face survey. The combined postal survey and the face to face survey provided a high level of comments and feedback. The questionnaire was based on a Likert scale, including the collection of demographic information and comments. The majority of respondents fully completed the questionnaire including making comments.

Regression Analysis

The sales analysis is based on a quantitative analysis using multiple regression analysis. Calculations were also carried out to pick up any trends and to gain a better understanding of the area and data, including average property sale value according to the distance from HVOTLs. This data showed that the average price was 17 percent lower for property adjacent to the HVOTLs as compared to those over 100 metres away.

Testing of the location and quality factors was performed through the use of dummy variables. The distance to the closest transmission line or tower was firstly measured and then a number of different transformations were used to find the most appropriate measure, which was a reciprocal of the distance.

RESULTS

Regression Analysis

A number of regression models were tested using different variable transformations, in order to obtain the most appropriate specification with the best line of fit. Different methods were used to find the best fit for the distance to the transmission line and tower as well as for the house area and lot size. Regression equations were then run on all the different alternatives. Once the best model was achieved the regression was carried out at varying distances from the line. In all the equations certain variables consistently appeared as significant, including the presence of the HVTOLs (refer Figure 4.1). The goodness of fit statistics generated by the model indicate that it is well specified, with the model error, as a percentage of average sales price being about 10 percent. The effect of the towers and lines on sales price is significant up to 400 metres from the closest tower or line. The level of confidence was set at 95% to determine the final equation which is set out in figure 4.2.

Figure 4.1 Variables used in the Analysis

Property Features:	Land Area, Floor Area, Exterior Construction, Roof Construction
	Condition of Building, Year of Construction
Location:	Based on Quotable Value roll numbers
Market:	Year of Sale
HVOTLs:	Distance from closest transmission line
	Distance from closest tower
	Log of Distance to closest transmission line
	Log of Distance to closest tower
	Reciprocal of Distance to closest transmission line
	Reciprocal of Distance to closest tower
Dependant Variable:	
	Sales Price, adjusted to 31 March 2002 dollars by the NZ Consumer Price Index.

Figure 4.2 Independent Variables: Statistically significant at the 95% confidence level

Constant (Intercept)	$96,369
Floor Area	$625
Roll No 2580	$47,563
Land Area	$59
Built 1990s	$38,897
Roll No 2600	($56,825)
Reciprocal of distance to line	($64,547)
Sold 1997	$17,866
Roll No 35320	$23,097
Sold 1996	$12,136
Built 1940s	($27,027)
Excellent condition	$8,311

Concrete construction	($29,157)
Built 2000s	$52,700

Number of Observations	=	860 sales
Adjusted R-Squared =	.43	
Durbin Watson test	=	1.96

An explanation and discussion of the variables used follows;

All data was obtained from Headway Systems (New Zealand sales database), excluding the distance to the HVOTLs, and views of HVOTLs.

Floor Area

This is the total floor area of the house expressed in square metres. This data will not take into account any additions made to the house since the Government Rating Valuation was carried out. The floor area is rounded to the nearest 10 metres, which may introduce a small degree of error. However this is the most precise measurement available without physically measuring each house.

The model implies an amount of $625 is added per square metre of house size.

Land Area

This is the total land area expressed in square metres. The Model implies an amount of $59 per square metre for each metre of land area.

Year of Construction

This variable shows the decade in which the house was constructed. Houses built in the 1990s proved to be a significant factor with an addition of $38,897. Houses built in the 1940s had a deduction of $27,027 and houses built in the last two years (2000s) an addition of $52,700.

Condition of Exterior Cladding and Roof

The houses were grouped into three categories;

Excellent condition	-	Very good, above average
Average condition	-	Average
Poor condition	-	Poor, Below average
Unknown condition	-	Condition not recorded

The Model indicates that the condition is an important variable and has added $8,311 to properties in excellent condition.

Location

The study area was split up into eight regions which aimed to separate any neighbourhood features. The regions were defined by the government rating rolls.

The model indicates an additional amount of $47,563 for those houses in roll 2580 – the Panmure basin. An addition of $23,097 for properties in roll 35320 – Pakuranga North. A deduction of $56,825 for those properties in roll 2600 - Mount Wellington North (this area is predominantly lower cost housing close to an industrial area).

Year of Sale

A variable was introduced to indicate at which time period over the six years the sale was made.

The model has indicated the following amounts for houses sold in the following time periods;

1996 - +$12,136

1997 - +$17,866

The Auckland housing market has experienced strong growth in the period 1996 and 1997 followed by a period of weakening sales prices to recover again in late 2001, which explains the significance of this variable.

Construction

A variable for construction type was used which indicates a reduction of $29,157 for those houses constructed of concrete. This would require further investigation of those houses that are categorised as 'concrete' as it appears the majority of these are actually stucco render over timber frame and wrongly classified as concrete.

Transmission Line - Related Variables

A number of different data transformations were assessed to best describe the effect distance from the transmission line and towers have on property values. The best fit was found to be reciprocal of the distance to both the lines and the towers. This indicates a diminishing effect on property values, which disappears around 400 metres.

The different models tested showed a consistent negative result from the transmission lines and towers. The final equation indicates an effect from the lines only, however the correlation is very high between the distance from the towers against the lines and when one is manually removed from the equation the other becomes statistically significant. This indicates a reduction in house price of around 20 percent of the average sale price: for houses very close to a tower or lines, and dropping off to five percent at 50 metres and a negligible amount from 100 metres.

The results outlined in this paper apply to an area consisting of all house sales within 400 metres of the transmission corridor. A separate regression equation was developed as a control measure for the area, of properties within the same suburbs but located 1 kilometre or more from the transmission lines. This equation shows very similar variables as being significant excluding the HVOTLs.

Survey

Attitudinal survey

For the majority of respondents' the increased affordability due to the presence of the transmission lines was not an important feature in their decision to purchase the property they now live in. The most important feature was the house and lot land size, followed by proximity to schools and shops, and the overall Neighbourhood. Table 4.2 illustrates the breakdown of the importance of each feature.

Table 4.2 Important features in the decision to purchase

	Extremely important	Very important	Somewhat important	Not important
The presence of Transpower overhead transmission lines/towers made our purchase affordable	11%	7.6%	27.9%	53.4%
Neighbourhood	25.9%	44.3%	26.6%	3.3%

Close to schools/shops	27.3%	30.5%	24.4%	17.7%
Close to work	19.8%	28.1%	28.4%	23.8%
Close to friends/family	15.5%	18.9%	31.6%	34%
Land area	26%	32.1%	30.4%	11.5%
House size	31.5%	41%	20%	7.5%

Seventy two percent of the respondents believe that the towers and the transmission lines do have an effect on their property values with only 22 percent disagreeing and the majority of these living further than 300 metres from the lines or towers.

The replies in regards to whether Respondents believe that the proximity of the HVOTLs have an effect on property values, has been cross-referenced to the distance from the HVOTLs. The percentage increase indicated by respondents' is between 10 and 19 percent for those respondents within 300 metres. Interestingly of the respondents who live further away 25 percent believe that their property values would increase if the HVOTLs (over 300m from their property) were removed. This can possibly be explained by a change in demographics and higher property values in this neighbouring area.

However, respondents were not as positive when asked, if the multiple sets of transmission lines and towers were reduced to a single set of lines with taller towers, would they expect someone to pay more for their property. Seventy four percent expect that the price would remain the same and 26 percent expect the price would increase, with this increase being less than $10,000 (39 percent), between $10,000 and $20,000 (35 percent).

Willingness to Pay – Contingent Valuation

The second focus of the questionnaire is in regard to whether residents were willing to contribute towards the cost of removing the transmission lines and towers. A range of options where provided and each of the options allowed the respondent to then stipulate how much hey were willing to pay for that option. The options provided were to either pay a one off lump sum amount, or have a pre defined amount added on to a monthly bill (e.g. the utilities account), or pay a percentage of potential capital gains on the sale of the property. This last option provided for a direct correlation of the assumption that the removal of the HVOTLs would result in a capital gain. The exact formula for how this would be calculated was not included, which may have presented a limitation, with respondents not having a clear idea, as to what that was going to cost them. However, in this part of the WTP process we are trying to determine the amount without introducing a bias, by setting the amount.

The following is a summary of the overall response:

- Lump sum contribution 80.5 percent oppose
- Monthly bill payment 73.8 percent oppose
- Capital gains percentage 67.7 percent oppose

Of those respondents that approved a lump sum payment, the amount they were prepared to pay varied from $50 to $5000. The monthly bill sum supported was between $5 and $200 per month. A flaw in the questionnaire arose with this question as some respondents indicated a time frame had not been stipulated and the dollar amount would depend on how long they had to pay for. The capital gains percentage that respondents were prepared to pay varied from 1% through to 100% of the capital gain portion of the sale price.

These dollar amounts have to be read with the knowledge that only a very small number of respondents were prepared to indicate any percentage or dollar amounts they would be prepared to pay.

DISCUSSION

The attitude of buyers to the presence of a transmission line will vary over time. Changes may be due to new information regarding the health effects of the electromagnetic field produced by the transmission lines. If a buyer is convinced that transmission lines have a negative health or safety effect, it would be expected that their perception of what the property is worth will be altered. Alternatively if a conclusive paper was to be issued stating there was no health risk, a whole new set of buyers would enter the market for those properties near the HVOTLs and thereby affect the value. Changes in the consumer attitude to new technology or the acceptance of the visual impact of the transmission corridor may also impact on the value. Therefore the impact of the transmission corridor on property value is subject to change either positive or negative according to changing attitudes.

A general limitation on carrying out any Regression analysis is the lack of properties sold within close proximity of the HVOTL as compared to the proportionately larger number of sales further away. This causes a problem in obtaining a statistically significant equation without going back over a number of years to obtain sufficient sales. Therefore a suitable methodology has to be developed to provide a mechanism to isolate the 'proximity to the HVOTL' variable within the Regression analysis. This paper builds on the premise that the Reciprocal of the Distance is the most suitable transformation to identify this variable.

The primary limitation in carrying out a survey in this area is the high number of non English speaking new immigrant residents. Of the residents approached for the face to face survey within close proximity to the HVOTLs, approximately a third had very little English comprehension. As the survey was asking for the owner occupier to complete the questionnaire a further limitation occurred in the large number of rental properties which are either under or adjacent to the HVOTLs.

The Willingness to Pay, Contingent valuation is an additional method to build on the understanding of what owners perception is of the effect on value, and also to understand if the owners are prepared to contribute towards the removal of an externality that they believe will subsequently increase the value of their property. There is a lack of literature in the use of CV in relationship to property values and it is envisaged that his paper will be the beginning of further research to determine whether it is an appropriate method to use in this application.

CONCLUSION

This study uses 3 different methods on 1 case study area to endeavour to provide a better understanding of the effects of HVOTLs on property values. The results from using the different methods have provided 3 different answers:

- The sales analysis shows a negative effect of 20 percent for those properties within close proximity (up to 10 metres). This effect drops to 5 percent at 50 metres and to a negligible 1 percent at 100 metres.
- The majority (70%) of owners perceive that the HVOTLs have an effect on their property value, and 60% believe the removal of all the towers and lines would increase their property value by around 10 percent of what they consider to be the current market value. 74% of respondents did not feel that reducing the multiple sets of lines to a single set would increase their property value.
- The contingent valuation WTP, shows the majority of people oppose any payment contribution to be made, and of those that were prepared to pay, it was at a minimal amount, but inconclusive as there was insufficient response as to how much they would pay.

These results are unique to these areas, as each area has its own distinguishing features: however, the results do coincide with similar HVOTL studies undertaken by Kinnard (1997), Sims (2005), and Callanan (1995) and therefore build on the literature. These studies have been a mixture of quantitative and qualitative studies, but do not include any Contingent Valuation analysis. The CV approach has limitations as described by Mundy and McLean (1998) with the main criticism within this study being the lack of connection by respondents between the potential financial benefit in the removal of the externality, and how much they are prepared to pay to have that benefit. A further hypothesis that was not tested within the study was that the nature of the purchase process, means that only people who are prepared to live near the HVOTLs will purchase, and therefore they will not feel the same desire to have them removed, This was highlighted by

the results showing the few people that were prepared to pay lived in the control area, which was further than 300 metres from the HVOTLs.

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