# The Effect of Electric Utility Power Plant Location on Area Property Value

TYPICALLY, estimation of the impact on community welfare of amenity factors such as air pollution, dumps, airports, and water towers has taken two forms: the combined effect of disamenity from all area sources, or the effect of one amenity factor on a "typical" property owner.[1] This paper estimates the total impact on property values of one amenity factor, a power plant. It is found that in a residential community even a relatively small, clean power plant causes measurable damage over two miles away. The total damage is at least $200 thousand and possibly as much as $17 million.

A power plant affects property values because people consider it a nuisance and require compensation for coping with its undesirable effects. Muth explains property values primarily in terms of relative travel savings on trips to the central business district (CBD).[2] Harris, Tolley and Harrell provide an expanded framework which incorporates amenities and which provides a theoretical base for the estimation of power plant disamenities.[3] It implies property value is directly related to amenity and inversely related to travel costs.

### *Winnetka Power Plant*

The Winnetka Power Plant in Winnetka, Illinois, is located in a residential neighborhood with no important disamenity sources adjacent to it. Consequently all changes in property value are assumed to be attributable to the power plant.

The Winnetka power plant is relatively small and burns relatively clean fuel as shown by a comparison of characteristics of the Winnetka plant and the average of all other steam-electric power plants in Illinois. The Winnetka plant had an installed generating capacity of 26 thousand kilowatts while the average is 307 thousand. The amount of coal burned was 23 thousand tons while the average was 667 thousand tons. Of the heat used to fire the steam boilers 57 per cent of the BTUs came from burning coal while the average is 93 per cent.[4] If one accepts the hypothesis (not tested here) that the disamenity increases with plant size, then the Winnetka plant should cause less of a decrease in area property values than the average plant.

Commutation characteristics of the power plant area are fairly uniform. The primary work center is the Loop, Chicago's CBD. The Chicago and Northwestern Railroad provides commuter service from each suburb to the Loop and express train time for the trip ranges from 23 minutes for Wilmette to 37 for Glencoe.[5] The travel savings component of land value will be treated as if it were the same throughout the power plant area.

Studies by Brodsky, Crocker, Pashigian, as well as others, suggest several amenity factors are relevant.[6] In view of these studies and scrutiny of maps of the power plant area, the following variables are proposed as relevant: Winnetka Electric Plant, Lake Michigan, Chicago and Northwestern Railroad tracks, parks, local commercial districts, racial mix, and local political boundaries. Variation in mean property value in the power plant area is hypothesized to be determined by these variables. The change in the property values measures the value of the disamenity associated with the power plant as long as (1) property is the immobile factor which absorbs the decline in value, and (2) everyone in the power plant area has the same demand for amenity.[7] Property immobility is assumed. The similarity of demand in the area is not unlikely, as each village is the same with regard to basic socio-economic characteristics.[8]

### *Data and Statistical Analysis*

All data are taken or derived from the 1970 U.S. Census block statistics.[9] The mean property value (MPV) of each block in the power plant area is the block average of owner's estimates of market sale price of house and lot for all owner-occupied, single-family dwelling units. MPV includes the values of the house and lot as well as location. To reduce the importance of house structure diversity the block average number of rooms per house is added to complement the location-type explanatory variables. Differences due to lot size are not accounted for, but zoning requirements are believed to limit variation.

Distance from the power plant is measured as the distance from the center of the block to the smokestack of the power plant. It is the straightline distance accurate to the nearest 125 feet as measured from the U.S. Census map of the area. Distances to Lake Michigan, to the Chicago and Northwestern Railroad tracks, to the nearest park, and to the nearest local commercial district are measured in a similar manner. Dummy variables are created to distinguish among blocks in Winnetka, Glencoe, Kenilworth and Wilmette.

A sample of 154 blocks was taken as observations from the power plant area. Approximately half of the blocks are in Winnetka. In distance from the power plant the blocks range from 1,500 to 17,500 feet. No block was included if it had an MPV over $50,000 or a percentage of housing units which were single-family less than 75.[10]

The model estimated is the reduced form of the residential market in the power plant area and the variable explained is property value. The parameters of the model are estimated via a regression equation which took the form:

$$(1)\quad MPV = \alpha + \underset{(+)}{\beta_1 ROOM} + \underset{(+)}{\beta_2 DPP} + \underset{(-)}{\beta_3 DLAK} + \underset{(?)}{\beta_4 DRR} + \underset{(?)}{\beta_5 DPK} + \underset{(?)}{\beta_6 DCD} + \underset{(-)}{\beta_7 BLK} + \underset{(-)}{\beta_8 GNCO} + \underset{(-)}{\beta_9 KN} + \underset{(-)}{\beta_{10} WM}$$

where MPV = mean property value, ROOM = average number of rooms per house, DPP = distance to power plant, DLAK = distance to Lake Michigan, DRR = distance to railroad tracks, DPK = distance to park, DCD = distance to local commercial district, BLK = percentage Negro, GNCO = Glencoe dummy, KN = Kenilworth dummy, and WM = Wilmette dummy. The expected sign is shown below each coefficient. The signs of ROOM, DPP, DLAK, and BLK are clear. Rooms add value, the power plant is a disamenity factor, the lake is an amenity factor and blacks in white suburbs break up social homogeneity. (Homogeneity is valuable to many whites.) The signs of DRR, DPK, and DCD are ambiguous in that they are net results of opposed forces, e.g., a park is a pleasant view, but has many noisy ballgames played in it. The signs of GNCO, KN, and WM are negative because Winnetka appears to offer more services for the tax dollar.[11]

### *Power Plant Property Value Gradient and Disamenity Margin*

The power plant property value gradient is the rise in value with increases in distance from the plant. It is estimated by the coefficient of DPP in equation (1). The disamenity margin is that distance from the power plant where the pollution and other characteristics of the power plant cease to have a noticeable effect on property value. The disamenity margin is analogous to the travel margin of the household utility maximization mentioned earlier where the travel margin is that distance from the CBD where travel savings cease to have a noticeable effect on land value.

It was found that the power plant property value gradient and the disamenity margin could not be estimated simultaneously using equation (1). Several changes in equation (1) proved fruitful.[12] DPP is replaced by a variable, effective distance (EDPP), which is characterized as follows: for a given DPP, say $DPP_i$, each EDPP less than $DPP_i$ equals the respective DPP, but EDPP equals $DPP_i$ for all DPP greater than $DPP_i$. The intercept, $\alpha$ in equation (1), is fixed at predetermined level of the value of an average property near the power plant. The level of $40,600 was determined by taking the average of property values of six blocks which as a group had an average of 7.3 rooms per house and were an average of 2,771 feet from the power plant. MPV, ROOM, and EDPP were normalized about 40,600, 7.3, and 2,771 respectively. Regressions were accomplished for a wide range of EDPP values. The maximum distance from the power plant, $DPP_i$ was increased by 500-foot increments from 3,500 to 15,500 feet. Standard error of estimate were compared and the "best" estimate chosen. The standard errors of estimate fell consistently from 37.78 at 3,500 feet to 35.80 at 11,500 feet. It rose consistently from that level to 36.81 at 15,500 feet. The disamenity margin, i.e., the distance beyond which the power plant is no longer a relevant amenity factor, is 11,500 feet from the power plant. The regression results obtained are:

$$(2)\quad MPV = 40{,}600 + \underset{(9.1)}{3{,}952\ ROOM} + \underset{(4.8)}{0.6166\ EDPP} - \underset{(3.1)}{0.3955\ DLAK} + \underset{(5.1)}{0.8364\ DCD} - \underset{(6.0)}{145.6\ BLK} - \underset{(3.2)}{2{,}855\ WM}$$

$$R^2 = 0.556 \quad SEE = 35.80 \quad DF = 148$$

where EDPP is effective distance from the power plant where the maximum is 11,500 feet, SEE is standard error of estimate, DF is degrees of freedom, and the t value of each coefficient is shown in parentheses.

The signs of the coefficients are much as expected. ROOM has a positive coefficient which indicates that in general a property is more valuable the more rooms the house has. EDPP has a positive coefficient which is the power plant property value gradient. It shows that it is good to live away from the pollution source.[13] The sign of the DLAK coefficient is negative. It means that it is good to live near Lake Michigan. The positive sign of the DCD coefficient was not fully anticipated. However, it indicates that the desirability of living away from the bustle of activity of the local business districts outweighs the lack of quick access to them. The negative coefficient of BLK appears to indicate a preference of whites to live next to whites and that the presence of blacks decreases amenity. The negative coefficient of WM probably shows that Winnetka offers more desirable levels of public services and taxes than Wilmette. DRR, DPK, GN and KN were deleted inasmuch as their t values were less than 1.0.

### *Disamenity Value of Power Plant*

An indication of the per property change in property value is given by the elasticity of property value with respect to distance from the power plant computed at the mean values of the observations. This elasticity is 0.09. It can be interpreted as follows: within 11,500 feet of the power plant a typical property value increases in value 0.9 per cent as it "moves" away from the power plant by ten per cent.

The total change in property value due to the disamenity can be calculated by determining the change in average land value in a ring of a certain distance from the power plant, multiplying by the number of residential properties within the ring and summing over the rings from the power plant to the margin. If 500-foot rings are used then the total decrease in property value due to the power plant is:

$$(3)\quad \sum_{i=1}^{23} N_i b_2 (D_M - DPP_i)$$

where $N_i$ is the number of residential properties within ring i (including those excluded from the estimation sample); $b_2$ is the coefficient of EDPP, 0.6166; and $D_M$ is distance to the margin, 11,500 feet; and $DPP_i$ is the distance from the power plant to the center of ring i. Equation (3) yields a total decrease in property value of $202,-804. This estimate is a lower bound on damage in that $N_i$ includes only residential property. An upper bound may be obtained by assuming the entire area within the disamenity margin is in residential use or that non-residential property is evaluated equally as is reasonable if land is allocated competitively. The total decrease in property value is one-half of:

$$(4)\quad \int_0^{D_M} \frac{2\pi r b_2 (D_M - r)}{WL}\, dr$$

where $D_M$ and $b_2$ are the same as in (3), r is distance from the power plant, W is the average width of a property and L is its average length. (The total is one-half because the Winnetka area is approximately a semi-circle due to Lake Michigan.) The total decrease in property value calculated by this method is $17,708,000. In other words, if ten per cent is the relevant interest rate, inhabitants of the power plant area incur disamenity worth between $20,280 and $1,770,800 per year.

*Conclusion*

The findings of this study are based on a rather special instance where the power plant is physically isolated as the sole disamenity factor and where the community is composed of primarily single-family residences. The former allows all decline in property value to be attributed to the power plant. The latter permits use of MPV from the U.S. Census to reflect the decline. Nonetheless, the effect of a power plant on area property value has been identified and measured. Within 11,500 feet of the power plant a typical property loses 0.9 per cent of its value for each 10 per cent move closer to the plant. The total disamenity value of the power plant is somewhere between $202,804, the estimate if no damage to non-residential property is assumed, and $17,-708,000, the estimate if it is assumed that all area property is evaluated and damaged as residential property. The range of estimate is wide, but the assumptions are extreme. If an electric utility company or government makes an estimate of the effect of the power plant on non-residential activity, then it will arrive at an estimate within the range. In this manner, the location of the power plant can be selected so as to consider the social cost of the site, i.e., the cost on nearby property owners. Even if no compensation is actually paid the site decision making will be more efficient if the decision makers act as if they will have to pay. With due consideration given to the external costs, the final site will more closely approximate a socially optimal location.

GLENN BLOMQUIST
*The Center for Urban Studies,*
*University of Chicago*

FOOTNOTES

[1] Ronald G. Ridker, *Economic Costs of Air Pollution* (New York, New York: and London, England: F. A. Praeger, 1967), pp. 115–140, for the combined effect; and Joseph Havlicek, Jr., Robert Richardson and Lloyd Davies, "Measuring the Impacts of Solid Waste Disposal Site Location on Property Values," University of Chicago Urban Economics Report No. 65, November 1971, for the effect of a single factor.

[2] Richard F. Muth, *Cities and Housing* (Chicago, Illinois: University of Chicago Press, 1969).

[3] R. N. S. Harris, G. S. Tolley and C. Harrell, "The Residence Site Choice," *Review of Economics and Statistics*, May 1968, pp. 241–247.

[4] National Coal Association, *Steam-Electric Plant Factors, 1966* (Washington, D.C.: National Coal Association, 1967), pp. 11–12.

[5] Gerald C. Canine, ed., *Chicagoland's Community Guide* (Chicago, Illinois: Law Bulletin Publishing Co., 1972), pp. 76, 82, 104, 106.

[6] Harold Brodsky, "Residential Land and Improvement Values in Central City," *Land Economics*, August 1970, pp. 229–247; Thomas D. Crocker, *Urban Air Pollution Damage Functions: Theory and Measurement*, National Technical Information Service Report PB 197668, 1970; also, Peter B. Pashigian, "Local Public School Expenditures and their Effects on House Values," University of Chicago Center for Mathematical Studies in Business and Economics Report No. 7238.

[7] A. Myrick Freeman III, "Air Pollution and Property Values: A Methodological Comment," *Review of Economics and Statistics*, November 1971, pp. 415–416.

[8] Canine, *loc. cit.*, pp. 9–10.

[9] U.S. Bureau of Census, *Census of Housing: 1970 Block Statistics*, Final Report HC (3)—68 Chicago, Ill. and Northwestern Ind. Urbanized Area (Washington D.C.: U.S. Government Printing Office, 1972), Table 2 and Maps 13–15.,

[10] The Census reported the top interval for property value as "$50,000 and above" and the value assigned to it when MPV is calculated is $60,000. The exclusion of blocks with MPV greater than $50,000 diminishes the open interval problem. Exclusion of blocks with less than 75 per cent single-family dwelling units reduces the error due to the Census not reporting MPV for multi-family units.

[11] Canine, *loc. cit.*, pp. 76, 82, 104, 106.

[12] Log-linear models were tried, but the ordinary linear model yielded better results.

[13] Havlicek, Richardson and Davies, *op. cit.*, get the same coefficient, 0.61, for the property value gradient due to solid waste disposal sites.

# Economic Determinants of the Regional Allocation of Federal R & D Expenditures†

IN THE POST-WORLD WAR II period, the federal government has played an increasingly major role in financing research and development activities (R & D) in the United States. Federal R & D expenditures increased to $17.5 billion in fiscal 1972 from $691 million in fiscal 1947, representing 7.1% and 2.4% of total federal budget outlays, respectively. In terms of total R & D spending, federal government agencies in 1972 funded roughly 54% of all national R & D effort in contrast to a 40% contribu-