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Cootner and Löf, Water Demand for Steam Electric Generation

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Water Demand for Steam Electric Generation

by

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This book is the second of a series[1] of Resources for the Future studies on water demands by different sectors of the economy. Both volumes constitute attempts to replace the "requirements" approach to the demand for water with an economic approach. The "requirements" approach involves choosing a single number to represent water demand per unit of output of the industry under consideration. For example, one study[2] has estimated that water intake in the steam-electric power industry was 75 gallons per kilowatt-hour in 1954. By multiplying this "coefficient" or "requirement" by total output of kilowatt-hours, one arrives at an estimate of total water intake. Moreover, the coefficient can be projected to future years by reducing it in accordance with the amount of technological advance that the investigator believes will occur.

An economic approach to water intake attempts to determine which variables influence water intake and the nature of the relationship between these variables and water demand. For example, Cootner and Löf in the present volume show how the amount of water intake varies with the capital and operating costs of cooling towers (the lower these costs, the more likely is recycling of water and, in consequence, the smaller will be water intake), fuel costs (the higher the fuel costs, the greater is the inducement to economize on the amount of fuel used; this implies a smaller amount of heat to be dissipated in the condenser, which, in turn, implies a decrease in water intake) and other such important variables.

The procedure of Cootner and Löf in determining water demand for steam-electric generation is, first, to find the relationship between thermal efficiency (the percentage of total heating value in the fuel necessary to produce one kilowatt-hour which is actually converted to electrcial energy output) and water demand: a high thermal efficiency means that there is less heat to be dissipated in the conden-

1. *See* V. Ruttan, The Economic Demand for Irrigated Acreage (1965), *reviewed,* Hoch, 7 Natural Resources J. 466 (1967).

2. U.S. Senate Select Committee on National Water Resources, Committee Print No. 32, 1960.

ser; correspondingly, the water demand will be lower than for a low thermal efficiency. Second, the level of thermal efficiency in newly constructed plants will have been determined by the demand for and the supply of thermal efficiency. The latter refers to the cost per kilowatt-hour necessary to raise thermal efficiency by 1% (the marginal cost curve of thermal efficiency). On the other hand, the demand curve for thermal efficiency is the saving of fuel and water costs resulting from an increase of thermal efficiency by 1%; thus, the demand curve for thermal efficiency is the marginal benefit curve. The intersection of these curves determines the design thermal efficiency for new plants. The *average* thermal efficiency at any point in time, however, depends not only upon the design efficiency for new plants, but also upon the efficiency of plants already existing. The authors, therefore, derive an expression which enables them to determine average thermal efficiency. As previously mentioned, given thermal efficiency, water demand can be determined. However, this demand can be satisfied in one of two ways: by withdrawing from an external source all the water needed or by recirculating water within the plant. Although water costs are smaller with recirculation, a recirculation system is costly. Thus, the decision to recirculate depends upon a comparison of the savings in water costs with the costs of recirculation. Once this decision is made, one can determine total intake and the amount of water recirculated.

In the last chapter, in order to demonstrate the applicability of their analysis, Cootner and Löf make projections of steam-electric water demands for the West South Central region. There are several difficulties which are involved: first, the analysis of both the demand and supply of thermal efficiency and the decision to recirculate are carried out on the level of an individual firm. Thus, the question arises, to what extent may one generalize from a firm to a region? For example, just as the analysis implies that a firm will either recirculate completely or not recirculate at all, it also implies that within a given region (or a sub-region of a wider region) the "region" (meaning, I suppose, all firms in the region) will either recirculate or not recirculate. Now, for 1954 we observe from the Census of Manufactures that in the Western Gulf region (all of which is contained in the West South Central region) the recirculation rate (gross water applications/water intake) was 2.5. However, according to Cootner and Löf it would be impossible to observe such a rate because there woud be either no recirculation (recirculation rate =1) or there would be complete recirculation (recirculation rate exceeding, say, ten). The discrepancy is due to the fact that the authors have generalized the analysis of a firm to a region.

In addition, the use of the Cootner-Löf model for projections means the rather difficult task of projecting somewhere in the neighborhood of twenty variables in order to project steam-electric water demands. I am left with the feeling that use of this approach for making projections may not be much safer than using the "requirements" approach.

Despite the above limitation, I have no doubt that this book will prove valuable to investigators in the field of water research. Most importantly, it takes a long step toward putting a finger on the factors which influence industrial water use and the nature of relationships between these factors and water demand.

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