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ELECTRICITY COGENERATION IN URBAN AREAS

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A. Introduction

Energy price increases and supply uncertainties during the past decade have contributed to a renewed interest in urban living. Cities present many opportunities for energy conservation: in transportation, residential and commercial building design, and improved methods of electricity generation. Full development of these resources is essential if our cities are to continue growing through the next decade. However, efforts to speed the commercial adoption of some conservation technologies have been constrained for several reasons, including public concerns over environmental impacts, social equity, and private sector apprehension over regulatory requirements. Clearly, a balance must be struck, and the interest of the nation's cities lies in speeding this.

This paper examines some of the social and regulatory constraints to increased cogeneration of electricity and thermal energy, a key energy conservation strategy. Environmental regulations, taxation, and potential cost burdens on other utility customers are given particular attention, since urban areas must give especially strong attention to these questions. Other concerns, such as utility rate structures and regulatory treatment of cogeneration are very important but not discussed here for two reasons: first, the NEA gives DOE responsibility for developing guidelines for state regulation of small cogenerators; second, the question is of greater concern to state governments than city administrations.

B. Energy Conservation Through Cogeneration

Cogeneration is a technique for utilizing the heat rejected during the electricity production process.⁽¹⁾ Typically, this heat is used as low-pressure industrial process steam, space heat (or steam-driven absorption chilling) for buildings, or hot water for building or industrial use. By judicious design and planning, cogeneration can offer an overall energy savings of up to forty percent as compared to separate electricity and thermal generation systems. Economic savings can also be substantial due to the fuel savings and reduced capital requirements; however, they are also dependent on technical details of the application, electric utility rate structures, and local tax policies.

Fuel and equipment cost savings were important factors in encouraging cogeneration during the first half of the 20th Century. Cogeneration supplied fifteen percent of the nation's electricity in 1950, but only four percent by 1977.⁽²⁾ This decline was due to scale economies of new power plant construction between 1950 and 1970, a corresponding effort by utilities to increase industrial sales through promotional electricity pricing for large customers, and the large manpower and management costs of operating a private power plant. Only in the past few years has interest in cogeneration been renewed by energy shortages and increased capital costs for new electric utility power plants.

Several prime-mover technologies are currently suitable for cogeneration, including Rankine-cycle steam turbines, diesel engines and gas turbines. Rankine cycle systems can employ a variety of fuels, including coal, municipal and industrial process wastes,

oil, and natural gas. Gas turbines and diesels, however, are almost exclusively fueled by natural gas and distillate oils.* The development of environmentally-acceptable, coal-fired technologies such as fluidized-bed combusters, will eliminate the constraints on fuel use inhibiting some cogeneration applications.

Cogeneration applications are most suited to industries with large low-pressure process steam demands, small industries with large electricity demands in utility service areas with high electricity costs, and selected commercial/institutional settings with carefully matched thermal and electrical energy demands. Several recent studies have identified and analyzed a wide range of potential applications (3&4). These analyses have focussed on a few energy-intensive industries including pulp and paper, chemicals, petroleum refining, and steel. Although important from the overall national perspective, these applications have little direct impact on urban energy use problems. It can, however, serve as a cost-saving opportunity for energy-intensive industries in urban areas (such as iron and steel) that currently suffer economic strains.

Additional cogeneration opportunities are present in commercial buildings, university complexes, hospitals, and numerous industries facing high electricity costs in some cities. This potential presents two important questions to urban officials and planners -- first, how to measure the benefits of cogeneration; second, how to promote its use while safeguarding the environment

* Closed cycle gas turbines are fueled by coal-derived fuels, and used in some applications in Europe and Japan.

and assessing an equitable distribution of the economic savings from cogeneration. These issues have recently been raised over planned cogeneration systems in New York City and Boston, Massachusetts, and deserve greater attention across the nation⁽⁵⁾.

How can the opportunities for and benefits of cogeneration be determined by a city? Prime candidates for cogeneration include medical complexes, universities, and commercial buildings. Shopping centers, apartment complexes, and commercial offices have operated "total energy systems" (with varying degrees of success) since the 1950s⁽⁶⁾. HEW and DOE-funded feasibility studies for building complex cogeneration systems indicate that up to a thirty percent overall reduction in fuel use can be achieved⁽⁷⁾. Technologies and fuels can vary widely---coal, natural gas, wood and municipal wastes have been identified as likely fuels at different sites across the nation. The technical potential for cogeneration in buildings is very large in the nation's cities and the economic feasibility of cogeneration is primarily dependent upon commercial electricity prices. Four major U.S. cities---New York, Newark, Boston, and Salt Lake City---currently have commercial electricity costs averaging six cents per kilowatt-hour (KWH) or above⁽⁸⁾. Chicago, Cleveland, Philadelphia, St. Louis, Hartford, Miami, and Washington, D.C., are only a few of the cities with rates currently standing at five cents per KWH or above. The future promises continued rate increases ranging from five to fifteen percent annually, and the response of many electricity customers will be to turn to cogeneration for lower costs through improved fuel-use efficiency.

C. Key Issues for Cities

City governments have a critical role in determining the taxation and regulatory posture to be taken towards potential cogenerators. Electric utilities are subject to numerous and sometimes overwhelming regulatory constraints on site selection for generating plants, allowable air and water pollutant emissions, tax liability, and rates and conditions of service to customers. Privately-owned electric generating systems must share the same responsibilities---particularly regarding environmental safeguards, constraints on oil and gas use, and equitably sharing the urban tax burden. At the same time though, they should receive strong incentives to conserve energy. The regulatory burden on cogenerators may be the most effective deterrent to widespread use of the technology simply because small firms cannot afford the expertise and manpower required for compliance with complex regulations.

Key urban concerns over cogeneration should focus on four areas:

1. Environmental Suitability;
2. Shifts in Local Fuel Needs;
3. Tax Policies for Cogeneration vs. Electric Utilities; and,
4. Cost Burden on Other Utility Customers.

Environmental suitability is primarily dependent upon air quality impacts. With the exception of larger coal-fired systems, water impacts are minimal. Land use, visual, and noise problems must be addressed on a site-specific basis, but generally sound

engineering and planning can minimize their severity. Air quality is invariably an issue when cogeneration entails increased combustion of fossil fuels in an urban location. Coal-fired systems may present problems with sulfur dioxide (SO₂) and particulate emissions, although a wide range of control technology is available for those willing to pay the price. Diesel engines generally have higher nitrogen oxide (NO_x) emission levels than conventional electric generating technologies, although SO₂ can be controlled through low-sulfur coal use.

Considerable controversy has arisen over the precise environmental impact of diesel engine systems proposed for use in New York City. Conclusive analysis is made difficult by widely differing claims made over fundamental engineering facts and assumptions. Resolution of this dispute will hopefully come from the City and State, but the entire episode has nevertheless exposed several basic problems with the existing structure of environmental regulation.

The art of environmental regulation is still imperfect, but is constantly evolving in response to new legislation and reconsideration of existing laws. Enforcement of Federal air standards is being placed completely in the hands of the states as individual State Implementation Plans (SIPs) are developed and approved by the EPA. A proposed cogeneration facility will generally have to pass several hurdles: first, it must not create a violation of local ambient air quality standards: second, its net emissions impact must either be offset by emissions reductions elsewhere or

else be compared to the economic benefits it creates; and third, emissions levels must fall below a level prescribed by Federal New Source Performance Standards (NSPS) or stricter state standards. Major U.S. cities, especially some of those with the most promising cogeneration potential, generally establish standards stricter than those required by the U.S. EPA.

Although the intent of this three-step regulatory test is clearly beneficial, its implementation fails to create energy conservation incentives. Existing NSPS and proposed revisions are based upon the energy value of fuel input. This gives no incentive for more efficient fuel use, whether through cogeneration or other capital improvements. Furthermore, NSPS can place a high cost of regulatory compliance on the potential facility operator, giving him additional incentive to build nothing and continue to purchase electricity. The EPA recognizes this shortcoming in the present NSPS formulation, but revising the standards presents a long and arduous task. Environmental planners in the nation's cities must first press EPA for better energy conservation incentives in NSPS, and then work to establish a fair, comprehensive regulatory scheme.

Offsetting reductions in region-wide emissions may be required for new pollutant sources under some SIP's. Under current EPA interpretation, offset credits are granted only if a specific pollution source is closed permanently. Cogeneration facilities will generally not meet this requirement since utilities will reduce the generation output of one or more plants instead of

closing a single facility. Furthermore, secondary emissions sources must also be considered in determining the impact of a new facility. These can include vehicular emissions necessitated by plant operations as well as emissions attributed to electricity consumption in the plant. However, EPA specifically excludes secondary emissions if they are "non-quantifiable", and provides the example of electricity purchased from a multi-state utility grid.⁽⁹⁾ The combined effect of these two interpretations is to officially ignore the largest environmental benefit of cogeneration. By not attributing air emissions reductions at utility plants to a cogenerator, an important opportunity for overall environmental improvement may be missed.

A final constraint to cogeneration is the regulatory and licensing process itself. New York State, for example, requires a construction permit and operating certificate for any owner of an emissions source consuming more than one million Btu's of fuel per hour (approximately 15 to 20 times the size of a typical Northeastern suburban home's furnace). The State may require the applicant to conduct testing, data analysis, and preparation of a report at his own expense. The Massachusetts Energy Office has estimated these expenses to range from about \$5,000 to over \$100,000 for small cogeneration operations, depending upon the requirements for pollutant monitoring⁽¹⁰⁾. For small cogeneration candidates whose equipment costs are less than \$500,000, the time and cost uncertainties of site-specific review may create a de facto prohibition in themselves.

Several alternatives to this regulatory burden should be considered in states and cities where the cogeneration potential is large. Standards could be set for manufacturers of diesel and gas turbine systems, since each system comes as an integrated package. This would be analogous to automotive emissions standards, since clearly the equipment user is ill-equipped to model, monitor, and improve the emissions level of his vehicle. By placing the burden of proof on the manufacturer and setting a reasonable standard for pollutant levels, an incentive for design improvement is created and the cost of regulation is more readily borne. Concurrent with this sort of initiative should be increased testing of the emissions characteristics of cogeneration technologies, particularly stationary diesel engines. Currently accepted EPA "emissions factors" for diesel cogeneration systems are given a "C" ranking for accuracy and applicability by EPA (out of an "A" to "E" range) and are noted by EPA as inferior to specific data for engine design and application⁽¹¹⁾.

Fuel Shifts. Are oil-fired cogeneration systems consistent with national objectives to reduce imported oil use? The answer is yes, sometimes. Oil use can be reduced by several strategies, including renewable energy use, shifts to coal and nuclear-generated electricity, and increased fuel-use efficiency. The cogeneration technologies best suited for urban use often rely on petroleum fuels; consequently, the increased efficiency of cogeneration must be weighed against the possibility of "locking out" future shifts to solar, nuclear, or coal fuels.

New York City provides an illustration of these tradeoffs. Much-maligned Con Ed currently derives two-thirds of its electrical generation from residual and distillate petroleum fuels. The next decade appears to hold limited demand growth (about two percent annually), possible shifts to low-sulfur coal in two of its oil-fired baseload plants (but only after further negotiation with State environmental officials) and minimal increases in nuclear capacity (although the utility is publicly optimistic). Capacity expansion will be limited during the 1980's: perhaps a coal/refuse plant can be built in the metropolitan region but additional plant construction is doubtful. By 1990, Con Ed will be at least one-third oil dependent and likely will be forty to sixty percent of its energy requirements.

Under these circumstances cogeneration will probably save oil, so long as installed capacity is limited to about five to ten percent of the utility's peak demand. Building and community applications will primarily reduce peak and intermediate utility loads, especially if thermal energy is used to drive absorption chillers for summer air-conditioning. Industrial applications will have varying impacts on utility load profiles: around-the-clock operation will cut into utility baseload demands while one or two eight-hour shift operations will help reduce the daily peak. A large number of cogeneration opportunities can thus help reduce utility oil use, since oil will remain Con Ed's peak and intermediate fuel through the 1980s.

Other regions with a heavy dependence upon oil or natural gas-fired generation include New England, the Gulf Coast, and

California. In each case regional energy planners must examine the present and future utility generating options and the impact of cogeneration on their use.

Taxation has become a key concern in New York City, since the city's utilities have long served as surrogate tax collectors. Con Ed's tax burden is about 2.3 cents per kilowatt-hour, far higher than electricity taxes in other cities and states. Even so, cogeneration's potential effect on tax revenues due to reduced electricity sales should be carefully considered.

Offsetting this reduction will be increased tax revenues from property, sales and income taxes. Using a small industry in New York City as an example, about 0.6 cents per KWH is recovered from local taxes on plant operation, city general corporation tax, and state franchise tax. An additional 0.9 cents per KWH is taxed as Federal income tax if all of the system's savings become profit. A more likely case would be for most of this increased revenue to be used for capital investment, higher wages, or debt payment--in turn creating a better business climate in the city, creating or retaining jobs, and increasing the tax revenue from personal income taxes.

Regardless of the precise tax impact calculated under an existing tax structure is a more fundamental question. Can any city afford to not encourage local businesses to remain and expand by allowing them to lower their operating costs? Clearly, cogeneration can prove cost-effective without being a tax shelter. Relying on high levels of energy consumption for critical tax revenues is a poor strategy to couple with energy conservation. A high tax

burden on energy use will encourage increased conservation, be it cogeneration or numerous other options. The argument that decreased tax revenues justify refusal to permit cogeneration is simply not true in many cases; where it is the problem can be remedied with Btu-equivalent taxes on all energy consumed.

The cost burden on other utility customers is a final question of concern, particularly for urban electric utilities anticipating low future growth rates. Most of the nation's utilities do not face this problem---for them, cogeneration is an attractive means of decreasing the need for additional nuclear and coal generating plants. This view is based upon greatly increased costs for new construction, and heightened by the uncertainties over the legal and regulatory feasibility of new plant construction. However, cities with stable or declining populations and a shrinking industrial base should be concerned if cogeneration threatens to eliminate a large block of customers with low costs of service. Historically, most utilities have found commercial and industrial customers the most profitable. Thus, an erosion of this base could result in higher rates for residential customers.

Other efforts to reduce energy use have encountered a similar paradox, since effective conservation of electricity and natural gas has directly contributed to rate increases. Utility regulators across the United States have tried to resolve the paradox through various approaches. California, for example, has proposed pegging the utility rate-of-return to its effectiveness in reducing energy use. Cogeneration is yet an additional illustration of a problem that deserves a general solution.

Even without significant changes in utility rate determination, the fixed-cost question will not be serious in most cases. First, it is only important for cities where high electricity costs contribute to low growth in electricity demand. These cities---New York, Boston, and Newark, to name several---rely on oil-fired electricity for a sizable fraction of their overall generating mix. These facilities are not used whenever possible due to daily and seasonal electric demand variations, shifts to coal and nuclear plants, or reduced electricity demands. The operating costs of these plants are high---older, less efficient plants, for example, have a variable cost of five cents per kilowatt hour if oil is purchased for \$20 per barrel. In New York this means that fixed costs account for just over thirty percent of utility revenue lost due to cogeneration, assuming that the utility can indeed minimize operation of its most expensive non-peak load capacity. By contrast, the overall fixed cost burden for Con Ed is about sixty percent of its revenues* due to the much higher ratio of fixed-to-variable costs for nuclear and hydro. Over the course of several years this fixed-cost "deficit", attributable to cogeneration, should decrease if long-range utility planning takes cogeneration into account.

D. Summary

Although cogeneration presents significant advantages to electricity users, utilities and the general populace it remains for the nation's cities to address the remaining regulatory issues

* Based on Con Ed operating year, 1978. For 1979, this figure will decrease due to imported oil price increases.

surrounding its use. Environmental concerns over diesel engines and coal-fired systems are important, but regulations should not be allowed to operate by placing a crushing burden on the potential cogenerator. The Federal EPA and DOE share much of the responsibility for improving the implementation and effectiveness of regulations, but cities must act to ensure attention to their unique interests. Fuel use is an important question over oil-fired cogeneration systems, but at least in several cases the efficiency benefits will not cost the nation additional oil imports. Social equity through taxation and utility cost distribution must be examined on an individual basis, but the adverse impacts of either appear small and amenable to resolution by city and state governments. New York City appears to be the worst case for either concern, but even there the magnitude of the problem appears far smaller than alleged by either Con Edison or The New York Times (5&12).

The real issues of cogeneration concern utility rates and regulation assurance of adequate operation and maintenance, and development of improved technologies. The principal players in resolving these are the U.S. DOE, manufacturers of cogeneration equipment, and private and government-supported researchers. Cities must now take the opportunity to examine the benefits and constraints of cogeneration in order to take advantage of the continuing transition to wiser use of our energy resources.

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