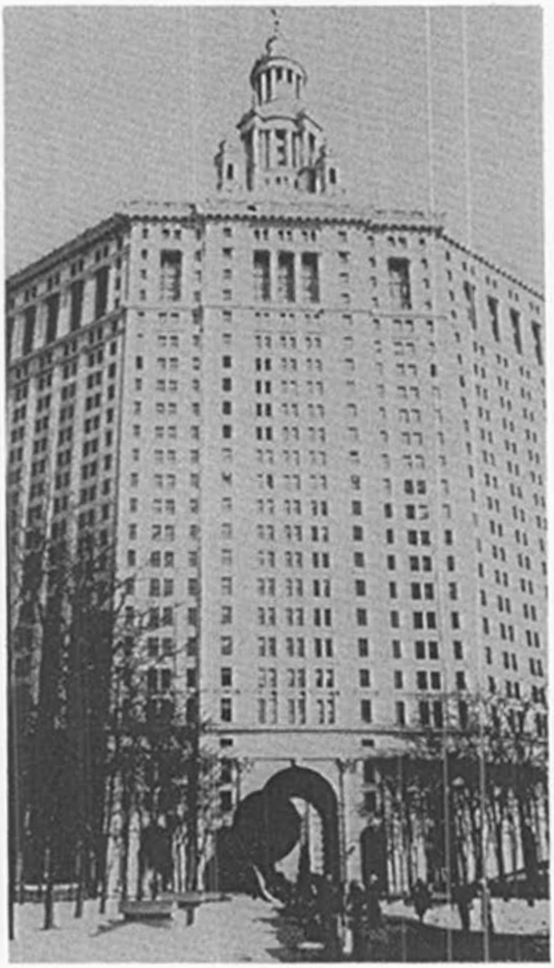
Managing New York City's Energy Conservation Program

New York City established the New York City Energy Conservation Capital Program to identify and implement energy conservation measures in government-owned buildings. Although many problems have arisen from a program of this magnitude, overall the program has been a success.

CHARLES C. COPELAND, P.E.
Member ASHRAE



IN future years, the 1970's may well be remembered as the decade in which energy shortages and escalating costs first made headlines. Neither individuals nor organizations have been immune to the impact of skyrocketing energy costs.

A case in point is the City of New York. By early 1982 total energy expenditures were over $300 million and had climbed from one percent of the city budget in 1978 to two percent. It was projected that without the implementation of widespread conservation measures, energy outlays would soar to over $500 million by 1985.

Charles C. Copeland is a principal in the firm of Goldman Sokolow Copeland, P.C., New York, New York.

The New York City Energy Conservation Capital Program (ECCP) is a budget-conscious city management's response to these escalating energy costs. Conceived during the oil crisis of 1979-80, its purpose is to identify and implement energy conservation measures (ECM's) in government-owned buildings such as museums, libraries, courthouses, office buildings, police precincts, and prisons. Initially, $25 million were set aside for the ECCP, but with the addition of new projects and the incorporation of other ongoing energy conservation projects into the ECCP, projected funding eventually totalled over $60 million. Additional projects are still underway, including a feasibility study of a central steam and chilled water system for municipal buildings in lower Manhattan.

The annual savings were originally projected at $30 million/year which would have produced a 2.5 year payback. Decreases in projected oil prices have reduced projected savings somewhat, but the "oil glut" has not seriously affected the ECCP's viability. It is the largest municipal energy conservation program in the nation.

Under the direction of New York City's Department of General Services (DGS) and its Commissioner, Robert M. Litke, the first step was to hire sixteen architectural/engineering (A/E) firms to conduct audits of buildings and calculate estimated savings for each recommended ECM. These firms, along with seven more added later, have prepared design documents for many of the retrofit measures suggested by their audit reports. In order to be approved for design, these measures had to have a simple payback period of less than five years. The City's Office of Energy Conservation (OEC), a group separate from the ECCP project, set up a plan to monitor retrofitted buildings as well as to track overall energy consumption and savings at the completion of the program. It should be emphasized that this program was developed strictly to save energy dollars as opposed to energy (BTU's).

Soon after selection of the A/E's, an ECCP Project Management (PM) team was engaged by DGS to provide technical reviews and administrative services for the program. Goldman Sokolow Copeland, Consulting Engineers was made responsible for supervising the mechanical/electrical engineering, The Stein Partnership, Architects, for architectural and lighting options, and Vollmer Associates, Engineers and Architects for the general administration and coordination of the program. In some ways, this latter task was the most complex because of the diverse personalities and organizations that had to be responded to.

The ECCP was initially conceived of as a fast-track $25 million program. The City's plan called for a kick-off in the late summer of 1980, the delivery of audit reports in eight weeks, the completion of design work by mid 1981, and the beginning of construction less than a year after commencement of the project.

This schedule proved to be somewhat optimistic. Only one of the sixteen A/E firms hired by the City to conduct the energy audits completed the work on time, reportedly at great expense. Many of the audit reports were not satisfactorily completed until the end of 1981. As a result, the Project Management team realized early that the smooth phasing anticipated by the initial project design had to be modified. Design documents and construction had started on many of the approved retrofits even though final energy conservation reports on those sites remained outstanding. Yet the program proceeded at a much faster pace than any New York City construction project of similar size, and if a more "realistic" set of deadlines had been proposed at the outset, Parkinson's Law suggests that the work would have been completed even later. The tight schedule was a method of minimizing the energy savings lost through delays.

Generic Energy Measures for Public Schools
Total Buildings—420

	No. of Buildings	Percentage of Occurrence
Test Valves	420	N/A
Steam trap replacement	100	N/A
Separate gas DHW heater	100	N/A
Chain operated zone valves—schools	420	N/A
Oil burner low fire lock-in switch—schools	320	N/A

Recommended measures

A large variety of simple low cost energy conservation measures were recommended. The stringent five year payback requirement skewed the recommendations toward less sophisticated measures. Mechanically and electrically, most of the buildings tend to be simple compared to more complex structures in the private and institutional sector; however, they are typical of municipalities.

Examples of the more complex ECM's recommended are those designated for a major refuse incinerator. In this facility the existing heat recovery system will be improved to allow refuse-driven steam to power fans and compressors as well as air condition a city building several blocks away. Steam may be eventually sold to a private dairy along the route. A microcomputer based energy management system will be installed to minimize electrical energy use.

One of the most cost-effective ECM's in the ECCP has been the installation of over twenty energy management systems (EMS) in City-owned buildings. Most of the EMS's are relatively simple carrier-current or hard-wired systems and are used for such purposes as the optimized start/stop of HVAC equipment, night setback, temperature control and light switching. Higher level energy management systems are being installed at colleges where existing computer systems used for primarily non-energy purposes are being upgraded.

A major art museum has had a sophisticated $2.7 million EMS system purchased under the program, which in addition to controlling energy, logs temperatures and humidity in critical art spaces. Since monitoring of post-ECM energy consumption is to be conducted by the Office of Energy Conservation, all EMS specifications require telephone communications capability which allows the OEC to directly dial each EMS system in order to obtain status reports, electrical consumption and demand data. This will also help defeat a frequent problem observed throughout municipal buildings: the unauthorized adjustment of controls.

Options not recommended

Several types of ECM's generally failed to make the five year payback cutoff. Characteristically, these options have involved major cost-intensive building envelope changes. Replacement windows, storm windows, wall and roof insulation all fell outside the program's criteria. Often some of the more cost-intensive mechanical changes such as air-to-air heat recovery or variable air volume system conversions were also not sufficiently cost-effective.

During the audit phase, costly boiler/burner replacements were suggested. However, after reviewing the City of New York's combustion test reports of many boilers as well as conducting new tests, it became apparent that in many instances, little would have been gained from these modifications. Even though many of the boiler/burners are old, the steady state combustion efficiencies were often over 75 percent. Simple and lower capital cost changes such as sealing air infiltration leaks or cleaning the heat transfer surfaces were sufficient.

Similarly, some consultants and agencies argued the value of replacing radiator (thermostatic) steam traps or elements as an effective energy savings measure. From the perspective of sound maintenance, a steam trap or element replacement program makes good sense. It was found however, that for many buildings with boiler plants replacing radiator traps does not have a short payback. Note that this view does not necessarily apply to float and thermostatic traps used on air handling units. For radiator traps, both the calculations and "before and after" test results suggest

Recommendations in Design or Construction as of December 1982
Total Buildings—139—Audits Performed Under Program

	No. of Buildings	Percentage of Occurrence
Reduce outside air and/or supply air	57	41%
Self-contained thermostatic radiator valves	46	33%
Disconnecting ballasts of delamped fixtures	44	32%
Timecolcks (generally to control a single piece of equipment or load)	39	28%
Flow restrictors (often implemented as an 0 + M)	38	28%
Flue dampers	37	27%
Weatherstripping	36	26%
Replace incandescent fixtures with fluorescent	23	17%
Energy management system	22	16%
Gas-fired separate DHW heater	22	16%
Relamp fluorescent fixtures with lower wattage bulbs	18	13%
Relamp fluorescent fixtures with "phantom tubes"	18	13%
Delamp fluorescents	17	12%
Night setback (also included in most EMS)	16	12%
Install "Heat timer" or modulating steam/hot water valve controlled by outdoor temperature	13	9%
Dual fuel burners	12	9%
Oil-fired separate DHW heater	12	9%
Air side economizer	10	7%
Chilled water/condenser water reset controls	10	7%
CO sensors to control exhaust fans	10	7%
Replace steam traps	9	6%
Zoned heating	9	6%
Pipe insulation	8	6%
Boiler controls (0_2, pressure reset, etc.)	7	5%
Preheat DHW with condensate	8	6%
Ceiling/wall/door insulation	7	5%
New thermostats (recessed or with guard covers)	9	6%
Two speed motors for AHUs	5	4%
Incandescents to MV/HPS	5	4%
DHW tempering tank	5	4%
Insulated DHW or condensate tank	4	3%
Heat recovery	4	3%
Photocell control of lighting	4	3%
New chillers	4	3%
Relamp incandescents with lower wattage bulbs	4	3%
Isolation of air zones	3	2%
New boilers	3	2%
Storm windows/insulated panels	3	2%
Separate DHW heater (electric)	3	2%
Rehab. existing pneumatic radiator valves	3	2%
Aquastat to control DHW circ. pump	3	2%
Optional start/stop or warm-up cycle	2	1%
Insulate boiler	2	1%
New oil burners	2	1%
Fire-tube turbulators	2	1%
Solar domestic hot water heater	1	1%

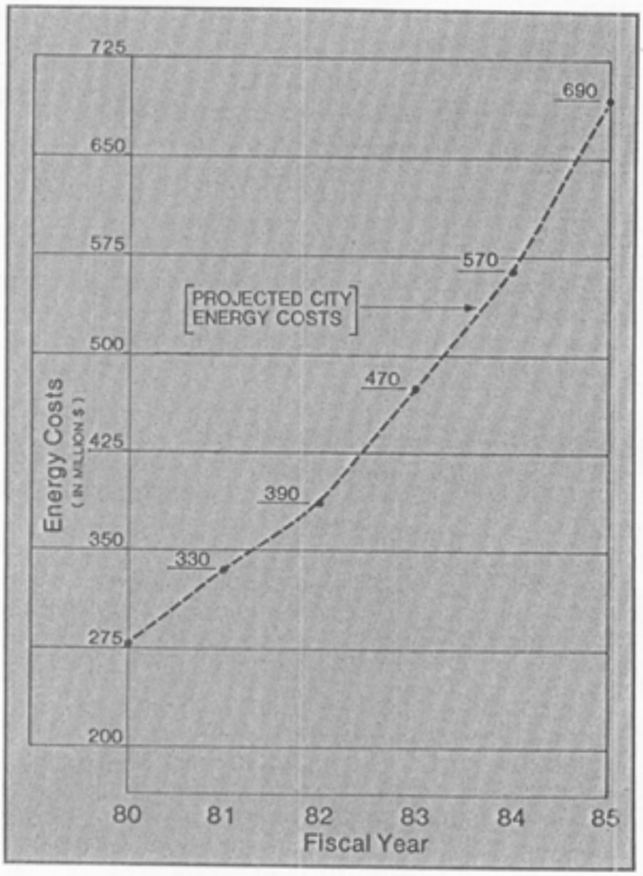


Figure 1 The projected rate of increase of energy costs for all New York City government buildings in 1980 when the ECCP was begun.

low energy savings per dollar invested. In the buildings reviewed, most of the steam bypassing the faulty radiator traps returns either to the boiler or is released by the return piping to the building. Additionally, the contractor labor cost to replace individual radiator traps is frequently quite high.

Audit phase

The report stage of the program ran into a few problems. As expected, the A/E's experienced problems in gaining access to buildings or finding the right personnel to show them around. In addition, design drawings for many buildings were either incomplete or unavailable, and the large number of buildings in the program made it difficult to undertake extensive document searches. Some of the buildings are so old that drawings no longer exist.

To standardize the actual audit report format, a detailed model audit report for a mythical "Big Apple College" was distributed. As the project developed, informal instructional support was also provided. A number of A/E's prepared excellent reports despite the compressed time schedule. Nevertheless, because of the pressure of deadlines and inexperience in energy work, some of the A/E's overlooked ECM's as well as incorrectly estimated ECM cost savings. The latter mistake was potentially a major problem because of the unique way New York City plans to control energy use once ECM's are implemented. That is, once an ECM is installed, the calculated savings in energy will automatically be subtracted from the budget of the agency. Because of this, some large City institutions understandably protected their interests by engaging their own consultants to check the projected savings. Listed are examples of some of the more common analysis problems that developed in some of the draft reports by A/E's which the Project Management corrected in the development of final reports.

1. Instead of using accepted published estimating methods such as the bin analysis technique (Chapter 28, 1981 *ASHRAE Handbook of Fundamentals*) to determine savings for energy conservation measures, design day loads were determined and "adjusted" for the season using arbitrary procedures.
2. Blanket assumptions about savings were applied to common ECM's such as weatherstripping, thermostat rehabilitation, and boiler upgrades, without sufficient regard to the unique circumstances of the building being audited.
3. Erroneous savings were projected for upgrading the efficiency of HVAC equipment. If upgrading of an existing boiler/burner suggested an improvement of from 60 percent to 80 percent efficiency, some auditors determined a 20 percent savings (80-60) while others calculated a 33 percent savings, 100 times (80-60) divided by 60. The correct answer is 100 times (80-60) divided by 80 or 25 percent.
4. The loss in savings potential of a given ECM as impacted by other ECM's was not always recognized in the first drafts submitted by some AE's. This interaction of ECM's, which we call "cascading," was most common with combinations of architectural and mechanical ECM's. For example, improvements in the thermal integrity of the structure (storm windows, weatherstripping, etc.) reduce the potential fuel savings from upgrading the heating plant because less total fuel is burned.
5. Consumption estimates were determined from *Handbook* tables without comparing them to available metered data. For example, savings calculations for flow restricting showerheads and separate domestic hot water heaters often made use of ASHRAE average consumption values for hot water consumption. The overlooked hot water heater fuel bills reflected only a fraction of this consumption. Estimates of potential savings by not comparing these two values sometimes exceeded total fuel consumed!
6. Electrical demand and consumption charges were not separated in some draft reports. Despite instructions to the contrary, some A/E's occasionally used combination demand/energy charges that were fixed at $0.085 kWh, actual electricity rates were $0.03 kWh and $16 per kW demand in 1980-81. Any single standard rate applied to a separate demand and consumption rate structure is bound to be inaccurate. As an example, ECM's which involve turning off electrical equipment during off-hours do not save demand charges.

Apparently, the most time consuming aspect of the project manager's engineering effort was checking calculations, which were understandably complicated and lengthy. One consultant used over 40 pages of documentation to determine the viability of a costly ECM which interacted with a series of others. This analysis was so involved and the assumptions so numerous that it was more cost-effective for the management team to construct a DOE-2 hourly computer model to independently check the calculations. After cascading all the measures, the model indicated that this ECM would not meet the expections of a less than five year payback.

One of the successes of the ECCP was that although some A/E's produced flawed draft reports, the program's review process assisted them in correcting the shortcomings—resulting in improved final reports.

Design and construction phases

As in the report stage, the design and construction phases of the project presented challenges for all of those managing the project. In some buildings, A/E's found that by the time they were ready to begin design or construction, conditions had changed or were in the process of being revised. Even more awkward were those instances where the design group within the A/E's office found the ECM impossible to implement. Sometimes it was found, after careful investigation, that an excessive amount of remedial or maintenance work was required to implement the ECM.

Lighting ECM's proved to be so cost effective that in some cases building operating staffs took the initiative in performing delamping after learning of the projected savings. When the A/E's showed up for their design survey, they found the work completed.

Alternatively, on several occasions employees in ECCP buildings complained about the reduced lighting even though the levels met good practice and codes. In most cases, the problem eventually resolved itself as people adjusted to the new lighting conditions. In other circumstances, the lighting had to be readjusted to a higher level.

A number of bid packages exceeded the consultant's budget when finally issued for contract. This was particularly troublesome if the low bid pushed the project over the five year payback criteria. On the one hand, a substantial amount of cost and effort had been expended designing the energy conservation measures and issuing them for bidding. On the other hand, the traditional cost cutting technique used to pare down budgets once bid is not appropriate for energy conservation measures. That technique, although often not in a client's long range interest, consists of downgrading the equipment quality at the expense of energy efficiency. Obviously reducing energy performance is counterproductive. On this program, excessive costs were generally resolved by analyzing each measure within a bid package. The least cost-effective options were eliminated and the package rebid.

Another difficulty experienced was caused by the public bid process. On a few of the larger bid packages, the low bid contractor dropped out after the public opening claiming mistakes in their calculations. This is a typical experience for NYC agencies. Although New York City could theoretically force a low bidder to execute a job, as a practical matter the contractors were generally relased from their obligations. In a few cases the other bids were too high to accept, and, therefore, the whole package had to be modified and rebid—a very time consuming and costly process.

Conclusion

The difficulties that this program encountered, though numerous, are inevitable in a project of this magnitude. Overall, the ECCP's track record has been good. Although New York City's early goal of two years completion for the $25 million project will not be met, the bulk of the work of the $64 million program will be executed within four years. This is much faster than the same dollar volume of construction work conducted within the normal administrative process for non-energy projects. The indications are that the energy savings and payback period goals will meet the projections.

Aside from the program goals, the ECCP has proved to be a valuable learning experience. Many of the A/E consultants, who had not executed much energy work prior to this program, can now use this experience and knowledge with their private clients. Those at the project management level have learned a great deal about running a major program of this scale.

If we were to advise a client on managing another large energy program, what would we suggest? The enormous size of the ECCP makes comparisons diffcult, but a few observations stand out with the benefit of experience and hindsight.

1. *Involvement of the PM team from the inception of the program provides more planning time and may result in reducing the bottlenecks.* For the ECCP, a period of only two weeks was available between the time the PM was hired and the program began.

2. *It must be strongly emphasized to the A/E auditors that*

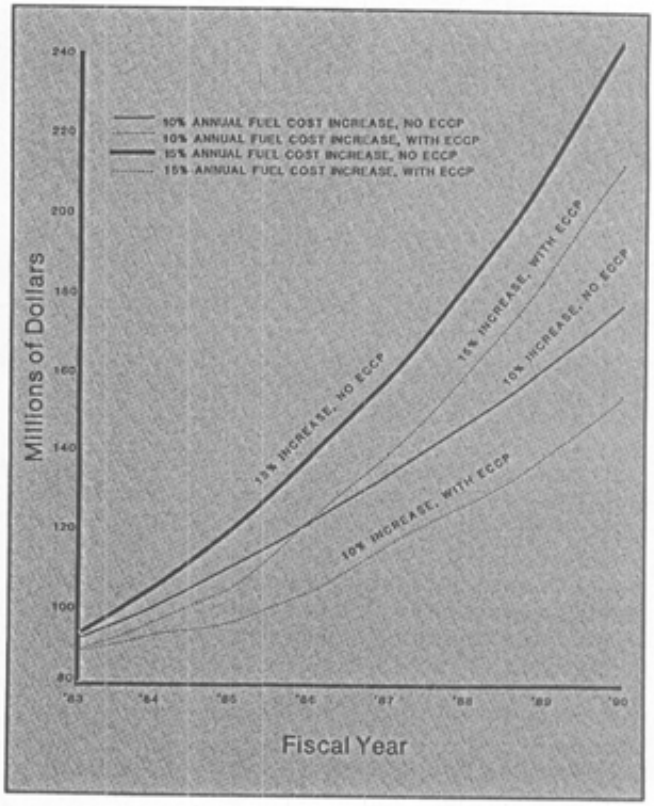


Figure 2 Effect of the ECCP measures on the increasing energy costs for the buildings included in the program. Separate plots assuming 10 percent and 15 percent energy price escalation rates illustrate the effect and uncertainty of prices.

the City expects high quality energy analyses. Although most of the A/E's presented adequate work and a few expended exceptional effort, there were also several who never grasped the program requirements. We required savings analyses considerably more sophisticated than estimates based on arbitrary percentages.

3. *The need for good communication between user agencies, their personnel, and the A/E's can not be overemphasized.* Often different operating or management personnel possess contradictory operations information. The correct basis for the conservation measure assumptions must be established.

It is not entirely clear how manageable some of the problems are in a project of the ECCP's size. When three dozen auditing firms and City agencies are involved with structures ranging from office buildings to zoos located all over a major city, organizational perfection becomes an elusive goal. From the City's point of view there is also the ever present tradeoff between spending time fine tuning savings calculations and getting a project constructed to obtain those savings as soon as possible.

In the final analysis, the value of this program can only be measured by comparing it to the other options that exist to make energy available. The principal alternatives to energy efficiency are the construction of coal-fired or nuclear power plants. The cost to replace oil by energy conservation at the municipal level via a program like ECCP ranges from $0.68 to $1.00 a gallon, depending on the term and interest rate of the financing bond. It is now estimated, by contrast, that it will cost over $2.20 for the new Shoreham Nuclear Plant on Long Island to displace a gallon of #6 oil. New coal fired plans are also not far from this high cost. Thus, in addition to any other advantages that energy conservation may offer over new power plant construction, it is clearly more cost-effective. ■