Building Simulation and Performance Contracting

James P. Waltz, P.E.
President
Energy Resource Associates

THE LITTLE-KNOWN "DARK SIDE" OF PERFORMANCE CONTRACTING

While it has carried many names over the past few decades, such as "energy services," "demand side management," and "performance contracting," implementing energy conservation and energy cost management programs on a turnkey basis generally including financing and a guarantee, is what we today call performance contracting. It has gained great popularity and seems to be particularly bolstered by the wave of electric utility deregulation which is in the process of sweeping the country.

When done properly, as explained in our Association of Energy Engineers Seminar entitled *"Management, Measurement, and Verification of Performance Contracts"** (and in our upcoming Fairmont Press book on the same subject), performance contracting has the ability to integrate financial, engineering, construction, and operations and maintenance services in a way that often produces spectacular results that could not be achieved by any other means.

Performance contracting, however, does have its dark side. Because the business proposition is so attractive and compelling, it is frequently viewed literally as a "guaranteed free lunch" by numerous building owners. However, in spite of the essential simplicity of the business proposition, the implementation is anything but simple. The soft under-

*Published by The Fairmont Press, 1999, Lilburn, GA belly of performance contracting, is the unfortunate and unavoidable *fact* that *savings cannot be measured.*

Now this would seem to fly in the face of the measurement and verification contingent, but the truth is savings themselves, *cannot in fact be directly measured.* You see, energy savings are the units of energy that are no longer being used. They are things that are no longer there—and you can't measure that which doesn't exist—you can only estimate the space they would have occupied had they existed. That is, it is possible to measure the energy that was being consumed prior to performing the energy retrofit, and it is possible to measure the energy being used after the retrofit is implemented.

One can conclude, then, that the difference between the two measurements is, of course, the "savings." However, and this is a *big* however, the way the building was (the "baseline") no longer exists once the building is retrofitted and what that "baseline" would have been in the future can never be absolutely known.

This is because the list of factors that can affect building energy use is ponderous and includes changes in the size of the building, changes in the building's occupancy and use, failures of existing equipment and control systems, changes in building operations (such as caused by a new operating engineer), etc., etc. etc. It is possible to do an accounting of the cost avoidance produced by an energy retrofit project, but this accounting is the product of a lot of measurements and a whole lot more assumptions and calculations.

Because this demonstration of the results of a performance contract (the counting of the invisible "beans" if you would have it) can be and is very nebulous at times, minor disasters occur when the unwitting or unwary building owner collides with the unscrupulous ESCO. Those not so sure of the problems in this regard should read *Energy & Environmental Management* magazine's article "How to Marry an ESCO," and the State of Arizona Auditor General's report entitled "Energy-Saving Devices and Services Budgeted for by School Districts."

Because "God (and the devil) is in the details" when it comes to performance contracting, we unalterably recommend to our clients that the *entire process* of performance contracting be well-managed—from the beginning to the very end. This is in contrast to what we believe is the biggest and most serious mistake being made in performance contracting in the late 1990's—which is to place too much reliance on measurement and verification, treating it as the first line of defense, and the only portion of the project requiring attentive management. This approach is simply the road to ruin.

Furthermore, since the foundation out of which a performance contract springs is the technical inefficiencies inherent in the existing building's design, construction and operation, we also suggest with great strength that the investment grade energy audit, or detailed engineering feasibility study, be given primary emphasis, care, and attention. This engineering endeavor is much like a Mayo Clinic physical that determines whether the patient's heart will be removed and replaced or whether the patient will be placed on a new diet and exercise regimen.

Because it creates the entire foundation for a performance contract, the investment grade audit is the last place in the entire performance contracting process where shortcuts should be taken or costs cut. Once the importance of the detailed feasibility study is grasped, then the importance of building simulation can likewise be grasped—as it is or should be the key tool of choice for performing the detailed feasibility study.

Computerized building simulation is the key tool for performing detailed feasibility studies for a great number of reasons as will be discussed in detail in this article.

- Confirms the auditor's knowledge of the building
- Provides an energy balance
- Identifies energy conservation opportunities
- Documents the baseline conditions
- Provides a foundation for future adjustments to the contract baseline
- Builds confidence and teamwork, helping the project (and the ESCO's sale) to proceed

BENEFITS FROM BUILDING SIMULATION

Assuming that the computerized building model is a sensible one, a considerable number of benefits accrue from the use of building simulation in performance contracting, as follows:

Confirming the Auditor's Knowledge of the Building

The process of building and calibrating the model causes an interesting thing to take place in the mind of the energy engineer performing the audit. As a by-product of the process, the auditor ultimately winds up confirming his knowledge of the building, i.e., that he knows most every energy-using system and/or equipment that exists in the building and that he knows pretty much what happens in the building with those systems and equipment. The upshot of this is that the auditor may now proceed with developing his project in near-complete possession of the truth and may perform his work without having to guess or speculate—at least not very much at all.

Creating an Energy Balance of the Building

The foundation of the project is technical ways of improving the operation of the building and thereby reduce the use and cost of energy, and thereby producing the cash flow stream which ultimately pays for everything. Now, if the auditor's estimates of potential energy savings are flawed, then the entire project is flawed. This makes the energy engineer's estimates of savings more accurate.

Say there is a lot more desktop equipment in a building than the auditor thinks there is and, because he is too lazy to measure the actual connected power draw of the HVAC fans, he allocates this "plug" load to the fans incorrectly. Well, if a variable volume retrofit of the HVAC system is planned, then the estimate of savings generated by the computer simulation model will be much greater than the actual savings produced by this retrofit—unless the auditor makes a convenient (and completely accidental) counterbalancing error in his simulation of the variable volume retrofit.

Unfortunately many, perhaps especially those enamored of measurement and verification, eschew the preparation of an energy balance, saying that they only measure the equipment they intend to retrofit and will perform M&V on that same equipment afterwards. The problem here is that a short term measurement won't capture a major change in building occupancy or operation that occurred just prior to the audit (say the HVAC time clock suddenly dying)—and is one that perhaps the building owner isn't even aware of!

So the auditor monitors 24-hour-a-day operation of the HVAC, bases his savings on this "baseline" (actually a *false* baseline) and is then later surprised when the owner objects to the post-retrofit "invoice" for savings.

Doing an energy balance will catch such "tunnel vision" errors. By doing an energy balance (in essence, calibrating the simulation model), *all* the uses of energy are correctly allocated and the savings projections based thereupon are dramatically more likely to be accurate, and will ultimately result in a successful, rather than an unsuccessful project.

Identifying Energy Conservation Opportunities

One attendee at our performance contracting seminar observed that frequently the reason that the energy balance cannot be completed and/or the model not calibrated, is because there is an as-yet undiscovered energy conservation opportunity! That is, something is operating out of control, unbeknownst to the auditor—say the chillers are being left in operation during cold weather (would you believe a 100 kW chiller load in the middle of the night in the middle of the winter in an Austin Texas college dormitory?).

Now, since the auditor does not know this is happening, his model won't calibrate and sources and uses of energy won't balance. The lazy auditor may just make a "fudge" change to the model and call it a day. However, the earnest auditor will ponder the problem and research the building and the existing documentation to ferret out the reason—and will often be rewarded with a "pot of gold" for his efforts! Yes, it really is this simple (or complex) at times.

Documenting the Baseline Conditions

One of the benefits, particularly for the ESCO, is the fact that a well constructed model, with its supporting documentation, is a detailed statement of the baseline conditions. In one project, we were called back by the ESCO after the project was in operation for a year—and the savings guarantee wasn't being met.

Among other things, we re-took the electrical readings on the power distribution panels on each floor—at the exact same locations the readings were taken during the audit (each was marked with a sticker with the ESCO's logo and a code name). One thing we discovered was that the desktop equipment load (the "plug" load) had increased some 30% since the audit amounting to more than 1,000,000 kWh worth some $100,000 per year! While this was not the only problem with the project, it did save the ESCO a lot of money—and against which he would have been defenseless had the original computer model/energy balance not been performed!

Providing the Foundation for Future Adjustments to the Baseline

The example immediately above leads immediately into adjusting the baseline once a change in the baseline conditions has been identified. In the case above, the increased "plug" load was input to the original model and the contract baseline equitably adjusted—without dispute on the part of the owner. This adjustment, incidentally, took into account interactive effects, such as the added air conditioning load imposed by the increase in desktop equipment, as well.

Building Confidence and Teamwork

While it is hard to put a value on this side-effect of building simulation, once the survey team has been in the building observing and documenting existing conditions, and then this information is converted into a calibrated model of the building, the project team, *including the owner*, arrives at a very high level of confidence in the veracity of the audit process.

Blind faith is great, but faith based on knowledge is unassailable. In our experience we have seen the ESCO's sale made at the exact moment when the building owner realized that the audit and retrofit team, in a very short period of time, had exceeded his own in-house staffs' knowledge of the building—and understood perfectly well how to make the building better!

CONCLUSION

Computerized building simulation offers so many benefits to the business of performance contracting that to fail to use it, even on smaller, simpler buildings (perhaps with a simple spreadsheet model) is a mistake not worth making.

ABOUT THE AUTHOR

James R. Waltz, P.E., C.E.M., President of Energy Resource Associates, Inc., (www.eraenergy. com) is an acknowledged pioneer in the field of energy management. Prior to the Arab oil embargo of 1973, Mr. Waltz made a personal commitment to energy management as a principal focus of his engineering career. Since that time, he has served as energy management program manager for the Air Force Logistics Com-

mand and the University of California's Lawrence Livermore National Laboratory. In addition, he has worked as an energy management engineer for consulting and contracting firms. In 1981, he founded Energy Resource Associates for the purpose of helping to shape the then-emerging energy services industry—and did so through a multi-year assignment to create a successful energy services business unit for a Fortune 500 temperature controls manufacturer. Mr. Waltz holds BSME and MBA degrees and is a founding member of the Association of Energy Engineers (AEE). He also is a member of the Association of Energy Services Professionals, the Energy Services Marketing Society, and the American Society of Heating, Refrigeration and Air Conditioning Engineers. In 1993 he was named International Energy Engineer of the Year by AEE.