Proposed Carbon Finance Methodology for Energy Efficiency Improvements in Buildings

Joe Huang
White Box Technologies
Moraga CA

International Workshop
Mainstreaming Building Energy Efficiency Codes
In Developing Countries
organized by the ESMAP and Carbon Finance Unit of the World Bank

November 20, 2009
Washington DC

Key features of proposed methodological approach

1. Uses whole-building computer simulations to estimate carbon reductions.
2. Utilizes many of the same techniques developed to verify building energy code compliance using whole-building energy simulations.
3. Differs from energy code compliance simulations in that benchmark building needs to be calibrated to actual energy consumption within a local building sector.

Why use computer simulations?

1. In addition to the “intrinsic” thermal efficiency of the building shell and equipment, a building’s energy use is also highly dependent on the climate and how it is used and operated (hours of operation, setpoint temperatures, internal loads, etc.)
2. Determining carbon reductions from actual measurements is not only time-consuming, but also problematic due to the need to adjust for differences in the above-mentioned conditions.
3. Computer simulations can hold all variables constant except for the energy efficiency measures, and provide a theoretical answer of the carbon reductions due to those measures, but how reliable are computer simulations?
4. To assure that the simulations replicate typical energy usage, the models must be calibrated against measured data.

Relationship to building energy codes

1. In countries where building energy codes are rigorously enforced, they provide a ready-made baseline for evaluating the energy savings and carbon reductions of the candidate building. In countries where they are not, building energy codes can still serve as a reference in creating the baseline.
2. Many building energy codes, e.g., ASHRAE, have a performance option requiring computer simulations of the candidate building as compared to a code-compliant reference building. The method for doing compliance simulations have been refined for over 20 years.
3. The main differences between a compliance simulation and the proposed methodology is that for compliance it is a pass-fail, while here it's the amount of carbon reductions.
4. The methodology will focus on how to insure that the simulated carbon reductions are conservative.

Proposed simulation tool

1. Will be based on eQUEST/DOE-2.2, probably the most widely used building energy simulation software in the world.
2. DOE-2.2 is the latest version of DOE-2, an engineering program first developed in the early 1980's and used to develop building energy codes in many countries around the world.
3. eQUEST is a user-interface that makes DOE-2 easier to use, and is now the primary method by which consultants now do DOE-2 simulations. eQUEST is probably used for at least 80% of the USGBC's LEED applications.

eQUEST

*the **QU**ick **E**nergy **S**imulation **T**ool*

4. eQUEST can be downloaded without charge. Discussions are still ongoing with the developer of eQUEST whether the proposed tool will be a separate product or a feature within the eQUEST program.

Proposed simulation tool

1. in the course of drafting the methodology, we will develop the modeling rules, which will then be integrated into the eQUEST program that will be an integral part of the methodology annex.
2. The World Bank has selected Tianjin Eco-City in China as the candidate project for developing and testing the methodology.
3. These rules will be refined by calibration against available measured data for the relevant building stock, here being residential buildings in China, so that they will produce energy use estimates that are consistent with measured data.
4. These rules will be imported into the modified version of eQUEST, as well as the definition of the baseline buildings .
5. The project will test out the implementation using the candidate residential project.
6. Other users wishing to apply this methodology will need to model their buildings using the modified version of eQUEST, which will show them the energy savings and carbon reductions.

Caveats to proposed simulation tool

1. Although the methodology is generic, the modeling rules defined in our project is based only on residential and commercial (public) buildings in China, and will be provided as an annex to the methodology.
2. The applicability of these modeling rules to other countries is not known, and should be tested as the need arises, such as by comparing the energy use intensities against measured data, and comparing the local energy code requirements. For countries with no energy codes, the baseline should be typical construction practices.
3. for any project for which the modeling rules in the annex are not applicable, the methodology would need to be revised to include additional annexes containing appropriate modeling rules and benchmarks that can be added to eQUEST.
4. Weather data should not be a problem, since White Box Technologies is now producing for ASHRAE typical-year weather files for 3000 international locations.