Bellingham Housing Authority: Green Communities Project (GCP)

The BHA CFRC Green Communities Project began with 3 high rise public housing buildings, containing 396 units all built in the early 1970's and serving a senior and disabled resident population. In total, GCP includes energy and other capital improvements on 3 separate properties to three high-rise multifamily facilities and a total of 5 buildings in the Bellingham Washington area.

The subject BHA owned and operated buildings include:

- Lincoln Square: 198 units
    - Maintenance Shop / Green Roof
    - Rental Management Office
- Washington Square: 97 units
- Chuckanut Square: 101 units

(Note: Lincoln Square, Maintenance Shop and Rental Management buildings are all on the same gas, electrical and water utility)

Grant Requirements

Our first focus was to meet the grant funding requirements. The Bellingham Housing Authority (BHA) "Green Communities Project" (GCP) is funded by a $9.9 million grant from the U.S. Department of Housing and Urban Development (HUD) through the American Recovery and Reinvestment Act (ARRA).

The HUD ARRA Capital Fund Recovery Competition (CFRC) Grant was contingent on the project meeting key requirements identified in the Notice of Funding Availability (NOFA) guidelines provided under Category 4: Creation of an Energy Efficient, Green Community, Option 1: Substantial Rehabilitation or New Construction. Two significant mandatory requirements for this funding path are stated in Section 5.1a of the NOFA-modified Enterprise Green Communities Criteria Checklist, as:

> "Meet Energy Star standards (single family and low rise residential); exceed ASHRAE 90.1-2004 by 15 percent; California-exceed Title 24 by 15 percent; Oregon, Washington, Idaho and Montana—meet Northwest Energy Star."

Additionally, BHA committed to the additional 10 rating points described in Section 5.6a which instructs:

> "Install PV panels, wind turbines or other renewable energy source to provide at least 10 percent of the project's estimated electricity demand."

Mission: Save Energy Water and Waste while creating jobs.

Our general project mantra was to: "Save energy water and waste." We applied this mission to everything we did. The mission was made clear to everyone involved from the architects and general contractors, to the residents and the facility managers.

Procurement: An Integrated Design Team

Our first challenge was to procure a complete integrated design and construction team, with little more than our existing buildings and the NOFA. We used the Part 85 proposal method of procurement and contracted Architects, Engineers and a General Contractor for pre-

development services necessary to assess existing building conditions and identify critical grant and other funding requirements.

Existing Building Analysis, Energy Assessment and Scope of Work Matrix (SOW)
Grant requirements notwithstanding, for a retrofit of this scope it is important to quantify the current energy performance of the existing facility in order to better guide decisions on the most effective upgrade(s).
The existing inventory and energy assessment work was started immediately while the architect developed a Scope of Work (SOW) matrix around the NOFA Green Communities Checklist. checklist. We began exploring various ECM alternatives in the context of the NOFA checklist requirements. Time was of the essence in developing a complete scope of work that could be competitively bid and obligate 100% of the ARRA funding by September 15, 2010.

Calibrated Energy Models
Once initial evaluations of the current building condition and the impact of retrofit measures had been completed and early phases of the retrofit design started it was determined that an in-depth energy analysis using calibrated whole building energy models could ultimately provide much more detail on multiple project phases including:

- characterization of existing building performance,
- in-depth energy conservation measure (ECM) analysis,
- illustration of grant compliance and
- post retrofit measurement and verification of energy savings.

Calibrated energy models of the existing facility were developed using an in-depth audit of the existing facility, including:

- lighting,
- building envelope, and
- HVAC characteristics.

In addition, short-term energy monitoring and other measurements were used to calibrate the models to one year of historical utility data (2009) using the same occupancy dependent loads and schedules developed during the calibration process. The models were then calibrated to predict historic actual energy consumption in 2009, since our resident population was for the most part the same, the calibrated models were now more credibly reliable. We then used the calibrated energy models to estimate the energy savings of various alternative individual energy conservation measures (ECM's), included in the SOW matrix for the proposed retrofit, as well as the impact of all measures combined.

Lesson Learned Design Development
At first we argued that Green Communities section 5.1b for substantial renovation should apply and not new building 5.1a standards of 2004. We had actual utility data on 40 year old buildings and thought measuring actual usage data was more important than modeling abstracts. We were wrong. In hindsight we would have brought energy consultant 360 Analytics in at the very

beginning. The models, once calibrated to predict historic actual utility years was of great value when exploring various alternate scopes of work with various combinations of ECM's.
In the future we plan to use these credible models with our actual future utility usage data to establish energy retrofit improvements. Since our occupant base of senior and disabled residents is for the most part the same, if we can empower occupant behavior to improve energy use and conservation we should be able to statistically account for physical building improvements and separately for resident inspired occupancy changes. Early and careful energy assessment and modeling can help focus scarce dollars where they will do the most good.

NOFA 5.1a: ASHRAE 90.1-2004, Appendix G:
The whole building energy models developed for the ECM analysis were also used to demonstrate the compliance with the energy savings and renewable energy production requirements of the Grant outlined in NOFA Sections 5.1a and 5.6a.
The 5.1a energy savings analysis was performed according to the guidelines outlined in Standard ASHRAE 90.1-2004, Appendix G: Performance Rating Method (90.1 PRM), including Addenda 'a' to the Standard.

Once the retrofit design was finalized, the 90.1 PRM energy models representing the proposed (post-retrofit) and baseline (ASHRAE 90.1-2004 compliant) building designs were generated. Using current utility energy rates, the performance of the proposed building with respect to the 90.1-2004 baseline is calculated using the following formula:

> Percentage Improvement = 100 x [(Baseline Energy Cost – Proposed Energy Cost)/Baseline Energy Cost]

The percentage improvement exceeds the NOFA required 15%,

- Lincoln = 18%
- Washington = 16%
- Chuckanut = 16%
- All buildings combined as one HUD "project" = 17%

The renovations satisfy the CFRC Grant NOFA ASHRAE 90.1-2004, Performance Requirements

NOFA 5.6a Renewable Energy: provide at least 10% of project's peak electricity demand.
Lincoln Square Solar
The average annual peak electrical demand from the three previous three years (pre-retrofit) is 153kW. The proposed retrofit design includes a 20.7 kW solar photovoltaic array, producing an estimated peak electrical output of 17.9 kW, including inverter efficiency and site considerations. Therefore the predicted peak solar PV production is 11.7% of the estimated pre-retrofit peak demand. This facility complies with the renewable energy production requirement of the Capital Fund Recovery Competition Grant.

Washington Square Solar
The average annual peak electrical demand from the three previous three years (pre-retrofit) is 86kW. The proposed retrofit design includes an 18.4kW solar photovoltaic array, producing an estimated peak electrical output of 19.2% of the estimated pre-retrofit peak demand. Therefore this facility complies with the renewable energy production requirement of the Capital Fund Recovery Competition Grant.

Chuckanut Square Solar
The average annual peak electrical demand from the three previous three years (pre-retrofit) is 85kW. The proposed retrofit design includes a 12.4 kW solar photovoltaic array, producing an estimated peak electrical output of 11.2 kW, including inverter efficiency and site considerations. Therefore the predicted peak solar PV production is 13.2% of the estimated pre-retrofit peak demand. Therefore this facility complies with the renewable energy production requirement of the Capital Fund Recovery Competition Grant.

Electricity
Standard electrical improvement included lighting and motion sensors in occupied areas and variable speed fans and motors in mechanical rooms. Our major challenge here was getting retrofit fixtures into our existing, obsolete, can type fixtures embedded in exposed concrete ceilings. The layout, conduit and can light fixture space was too limiting, so a standard ceiling grid and tile system was installed in all corridors where modern energy efficient lighting and controls could be practically placed.

Natural Gas
Approximately 80% of the utility consumption is from natural gas. Obsolete domestic hot water and hot water boilers systems were replaced. Early energy models showed us that we were using almost as much boiler heat in the summer as we were in the winter. The obsolete boiler systems, while inefficient, had been well maintained so we looked further to explain this anomaly. We found that while residents were operating their unit temperature controls valves, inside each unit properly, the radiator valves were frozen stuck in many cases. This caused heat to run during the summer even with the control dial turned off. This caused us to replace all unit radiator valves in all units after extensive testing and flushing of the existing boiler loop piping. This ECM alone resulted in a 6% energy savings.
Replacing all the heating boilers in all 3 mechanical rooms with energy efficient variable speed boilers connected to computer sensors was another routine improvement. For example Lincoln Square had 10 individual boilers all firing manually into the same water loop. No system was able to communicate with the others. Now these are replace with 3 smart boilers where each one can service the entire building on all but the coldest days of the year, and all 3 take turns by computer rotation to equally provide the hot water heating needs. In the Northwest we do not have a significant air conditioning need except for all but the hottest days of the year so typically no air conditioning is provided.

Water

Replacing water faucets, showerheads and toilets was an easier ECM to identify, but considerably more difficult to implement in fully occupied high-rise buildings. Existing building water piping stacked vertically servicing clusters of units on all floors. Composite crews were able to complete between 8 and 10 units per day which meant shutting off water services in isolated loops for most of the work day. Residents were informed early at meetings and with notices and free box lunches were provided to impacted residents in the respective community rooms each day. Good general construction and sub-contractor coordination along with resident information, noticing and free lunches helped make this go surprisingly well.

The water savings breakdown is based on 2009 utility consumption of 11,691 ccf costing $63,534.

By comparison:

- New Showerheads saved 1,060 ccf for a cost saving of $5,758
- New Low-flow Faucets save 1,154 ccf for a cost saving of $6,282
- New Water Closets saved 2,016 ccf for a cost saving of $10,952

Total Savings is 4,230 ccf of water for a cost savings of $22,992

Water savings based on actual 2009 usage is estimated at 36%

In the process we learned the term “watergy” which describes the broader energy impact of using water. There is significant energy used to pump excess water through building systems and significant energy needed to process “waste” water at sewage treatment plants. There is also significant natural gas used to heat domestic water that flows down the drain. A gallon of water saved has a ripple effect of saving both electricity and natural gas respectively. We will continue to work on quantifying the extended electrical and gas utility save with efficient water usage. While more complicated to quantify exactly with clear science it is clear that saving water will result in saving some added amount of electricity and natural gas both in the building and in the extended municipal system.

Waste

Bellingham is an area where reuse and recycling of construction waste is well established. Our General Contractor was able to recycle 92% of the construction waste. Our general claim to fame was the invention of “Poticrete.” While we did not invent the idea or practice of recycling old toilets and porcelain products into aggregate for concrete, the project did invent the name “Poticrete” which took off as an local and national interest story. We had full cooperation and creative support from the entire integrated design team, and the City of Bellingham dedicated significant engineering and staff time to establishing Poticrete specification which was later used to pour a bike path restoration project. The Poticrete story was covered by numerous local, regional and national news outlets. We also used the attention to promote a “towards zero waste” resident food waste recycling program. We used the contractors success saving old toilets from the landfill to inspire residents to save food waste from the landfill by participation in the local “Food plus!” recycling program.

Indoor Air Quality

The existing condition in each building caused unit odors from food and other substances to flow from resident units into the common corridors. There were operable windows at the end of each floor wing which were randomly opened by residents to ease the corridor odors and bring in fresh cold air. Since all walls, floors and ceilings were original poured concrete, coring thousands of holes to properly upgrade the indoor air quality was not practical. Instead we used our integrated design team and converted bathroom vents into whole house fans with new computer controlled roof top ventilation equipment. As part of this we closed the windows at the end of each wing and cut fresh air intakes through the walls and installed tempered make up air ventilators. Air from resident unit operable windows can now flow into the unit and up the whole unit fan causing positive pressure in the hallways, supplied with makeup tempered air from the ventilators.

At first residents were upset that they could no longer operate the corridor windows, but soon with educational and information resources we were able to demonstrate the new system improvements, but the real proof came from the noticeable difference in air quality in the corridors and unit.

Building Performance Dashboard

One of the unique elements included in this project is the Building Performance Dashboards. This is state of the art technology has a two-fold purpose for the Bellingham Housing Authority. Residents are able to see in real time how much energy their building is consuming in a very user friendly format with comparisons to familiar units of measure like gallons of gas and dollars. BHA staff who manage the buildings can also use the Dashboards and data to ensure optimal performance of the buildings.

Data is available for viewing on large flat screens in the lobby of each resident building. The screens are easy to navigate touch screens. The goal is to continue to change and update these panels so residents will continue to have reason to come back to the screens to engage and get new information. We plan to run a competition between residents at a meter level so that residents can beat their own personal best when it comes to saving energy. Our hope is to engage other institutions in the county to install Building Performance Dashboards. This would allow competitions to happen between residents and other groups in the community with the ultimate goal of increasing energy savings.

Resident Empowerment

Resident engagement and empowerment has been an important focus of this grant. Residents control a significant amount of the energy used in each building. Engaging the residents around saving waste, water and energy is a crucial component to ensuring BHA maximize their overall savings. Residents have been engaged throughout the grant period in a variety of ways with the support of Sustainable Connections – a non-profit business membership organization with proven success in motivating change in our local businesses around Think Local First, Eat Local First, saving energy, reducing waste and smart growth. The grant requirements specified an occupant manual. This manual was created and supplied to residents, SC knew a more comprehensive strategy was needed to truly engage residents around saving energy. SC did provide a complete occupant manual to outline new green features of Lincoln Square, Washington Square & Chuckanut Square through the Green Communities Project and additional ways to promote green living in our community. Our approach to resident engagement includes:

- Ongoing in person **Resident Meetings** lead by Sustainable Connections and in partnership with many local businesses in Whatcom County throughout 2011 & 2012. The Community Energy Challenge – a local Whatcom program to drastically reduce energy was highlighted at several meetings as well as other topics such as eating local, Smart Trips, eco rep program, etc.
- Green Communities Project **Website**. This site is created and updated weekly by Sustainable Connections and will post various information such as: press releases & newspaper articles, resident meeting updates, construction schedule updates, and anything else pertinent to the project. The site was created for two main purposes: to engage the residents in the Green Communities Project & to provide a place for BWCHA staff and others in the community to easily access information about the project. The website is the home page for all communal computers in resident buildings. www.projectbellingham.wordpress.com
- **Building Performance Dashboard** in the lobby of Lincoln, Washington & Chuckanut Square. These kiosks will provide residents with information about the energy consumption in their buildings and they will be able to see how they compare to each other. Residents were surveyed in the beginning of 2011 on the energy use and attitudes toward energy conservation. Over 50% of residents responded to the survey and the majority of those surveyed feel that energy conservation is extremely important. A dashboard will give residents real time information about their energy use & tips on how to reduce energy consumption.
- An **Occupant Manual** to highlight new building features through the Green Communities Project. The manual includes information gathered from various sources and experts such as:
    - The contractor on new building features like heating controls and low flow toilets
    - Information and resources from resident meetings – how to eat local, public transportation, energy, waste and water conservation, green cleaning supplies, etc.
    - Already existing community programs such as Smart Trips, Community Energy Challenge, Toward Zero Waste, Eat Local First and City of Bellingham water conservation programs.

Next Steps

Our next steps include monitoring our actual utility usage data and teaching the resident manual to our customers. Building on our Green Team pilot program, at Washington Square we will start Resident Green Teams at Lincoln and Chuckanut square high-rises and begin “Toward Zero Waste” food plus recycling programs. Building on lessons learned we will then apply energy saving and resident empowerment programs to the rest of our housing portfolio where feasible.