Shizen Condominiums

Seven-unit residential condominium building in Northeast Portland designed for superior resource efficiency. The Shizen was designed to operate 60% more efficiently than Oregon Energy Code and use renewable energy systems for the remaining building energy demand, making it a "net-zero energy" building. High efficiency fixtures and captured rainwater would have achieved greater than 50% water efficiency and the project was designed to exceed City stormwater requirements by handling stormwater runoff from the street in addition to all on-site runoff. The three-story house that previously occupied the site was to be moved to an infill lot to be reused just blocks away.

"The collapsing market for luxury condominiums coupled with the lack of willing construction lenders effectively and permanently stalled a project that was designed, engineered and one small step away from being permitted."

Project Highlights

Zero-net energy use

On-site stormwater handling

On-site renewable energy production

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Final Report

Treehugger Article (External Link)

Lessons in Sustainable Development:

The Shizen Condominiums

A Sakura Group Project

Executive Summary

In 2007, at the height of the real estate boom, Taka Nakagawa and Timm Ready of the Sakura Group, decided to try to help redefine sustainable multi-family housing with an innovative building, named Shizen (Japanese for nature) in Portland's Irvington Neighborhood. The fact that Shizen was not built is a testimony to how quickly global trends can derail local construction projects. The collapsing market for luxury condominiums coupled with the lack of willing construction lenders effectively and permanently stalled a project that was designed, engineered and one small step away from being permitted.

Shizen was originally designed as a 7-unit, net-zero energy, rain-harvesting model for sustainable housing. Its location, close in on the East side of Portland was an easy walk to bus and light rail lines, shopping and dining opportunities, parks, schools and many other amenities. The building was designed to stay cool during the summer and warm during the winter through a combination of an advanced masonry wall system, the use of a large rainwater cistern under the building (acting both as water storage and heat sink) and an innovative combined heat and power generator which would create hot water for radiant space heating while producing electricity for the building. A very large rooftop solar electric system providing electricity during the summer and a biodiesel-fueled combined heat and power system delivering heat and electricity in the winter would have resulted in annual net zero (grid-supplied) energy for the building.

Many issues contributed to the estimated high construction cost of Shizen. We share the following lessons learned with the hope that they will inform future projects with sustainable goals.

Zoning, Density and Building Size

One of the first challenges for the project was to strike a balance between building scale and massing that would increase density while not overwhelm neighboring single-family homes and yet provide the maximum number of luxury condominiums that would meet market expectations of per unit square footage and off-street parking. The site is located in the R1 zone with an 'a', or 'alternative design' overlay. The R1 zone is a medium density residential zone that would have allowed up to 7 units to be built on the 7,500 sf property. With density bonuses from the 'a' overly, the number of units could have been increased to 10. The minimum number of units allowed by code is 4. With set back and maximum height restrictions, 10 units with off-street parking would have resulted in basically 1000 sf units and 2 layers of underground parking. The first round of design had 7 larger units and one layer of underground parking. The cost of excavation and construction of the underground parking proved prohibitive, and the final design ended up with 5 units and parking under the building at grade level.

Building at this (5-unit) scale allowed a much less expensive structural system. Eliminating the penthouse (of the 7-unit version) with decks allowed more area for the photovoltaic array, and would have resulted in lower operating cost for the life of the building.

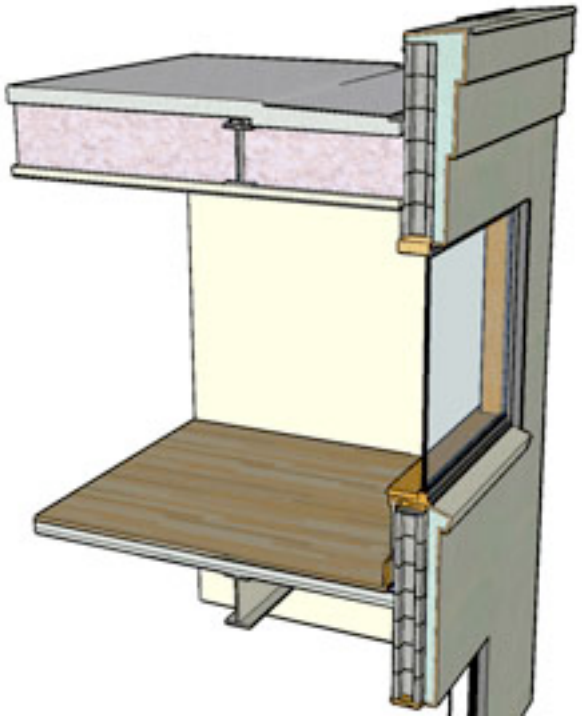
Two distinct paths for 4 or 5 dwelling units on the site were separate townhouse style units, or flats with a common entry and corridors. Townhouses have different accessibility requirements, which can result in lower overall construction costs. The massing of a building with a common entry and an elevator was a better fit with the neighborhood context, more appealing to a near-retirement market segment, and supported the energy efficiency goals of the project with less overall exterior wall. The 5 unit version of Shizen is the one that would have been built absent the rapid melt-down of financial markets at a critical time.

Overall, the take-away lesson for zoning and density was that projects with more, smaller units (and few off-street parking spaces) or projects with a lower number of easily constructed units pencil out better than projects that try to strike a middle ground. Off-street parking greatly increases per unit cost, but even at a location where multiple modes of public transportation are available, market information indicates a parking stall is an expected amenity. As car sharing strategies become more widely accepted, this expectation of the condo market may shift in a way that improves the economic model of low-rise urban density.

Building Envelope

The first round of design included masonry walls, which need to be thermally coupled to conditioned space to provide the benefit of stabilizing indoor temperatures. That implies all insulation must be on the outside of the masonry wall, and that means the skin has to be on the outside of the insulation. Exterior Insulation Finishing System (industry acronym EISF) is theoretically the solution to this problem, but massive lawsuits for badly installed and catastrophically failed skin systems make this an unacceptable choice to both local building officials and to the insurance industry. We will skip the long, tortuous path of exploring structural and wall systems and get to the punch line.

The wall system for low rise construction that seems to have the best cost to (energy efficiency) benefit ratio uses 2x8 plates with offset 2x4 studs filled with spray-in closed cell (R-7 per inch) foam. The outer weather skin has solid support; the inner wall finish has solid support; the thermal bridging is limited to plates and window/door framing; the foam does the lion's share of air sealing; and you eliminate the need for a vapor barrier. What you don't have is the thermal and hygroscopic benefit of exposed mass. Some of the benefit can be recouped if the design includes some interior mass walls, which can be particularly effective if they are near wood stoves or other sources of interior heat gain.



The original masonry wall (above) was found to be too expensive to implement

Central vs. Decentralized Systems

During the economic evaluation of Shizen and several subsequent projects, it was determined that centralized systems were more expensive than the sum of decentralized systems. This was true especially for rainwater disinfection, hot water heating and mechanical space heating. As technologies evolve, this kind of evaluation might have a different result, but the lesson learned is to evaluate both approaches. An added benefit of having individual systems and monitoring is that there is a maximum benefit, and therefore maximum incentive, to each owner for his/her effort toward energy efficiency.

For solar hot water it would be especially important not to have batch storage and individual water heaters. The first person to use hot water would get all the benefit and pay a disproportionately small share of the common storage.

Centralized rainwater harvesting for indoor use had particularly expensive implications. The issues are maintenance and liability for water quality. A single unit owner of a single unit system has direct custody of these issues for the water he or she consumes, and consequently building officials have much more stringent requirements for situations where this direct custody relationship does not hold. The one place where it makes sense to have centralized rainwater collection is for the irrigation of collectively owned landscaping. There is no requirement for disinfection of rainwater for irrigation, and it is customary to have maintenance contracts for this type of landscaping. Single family disinfection systems are much less costly than multi-family ones.

The centralized vs. individual systems choice has implications for how mechanical space is apportioned within the building and for solar access on the roof. From a marketing perspective, it is easier to sell an extra 100 sf of space inside a condo even if is occupied with mechanical equipment than it is to sell 100 sf of apportioned common area. Pre-wiring or running extra chases for future solar systems makes sense anywhere there is a solar resource. When a project does not have a budget for solar technology in the initial construction, it is even more important to have these raceways in place so that future owners can make individual decisions.

Combined Heat and Power

The appeal of on-site combined heat and power is being able to make use of the heat by-product of electric generation from a combustion process and thereby minimizing the source fuel. If the fuel is renewable, we consider this an acceptable way to get to the definition of net zero energy (at least in an urban setting). Solar electricity in the summer and combined heat and power from a renewable fuel in the heating season seem a good fit for our Pacific NW climate. There are several issues which make this difficult at the scale of Shizen. The first is that once the building envelope is really energy efficient, the heating demand is so small that there are few choices of CHP equipment. The second is getting a reliable of supply of a renewable fuel. Third is using valuable space in the building for storing the fuel, and finally, the equipment must be maintained regularly. A condominium association with only 5 or 7 members has little resource for maintenance staff. If the equipment is unconventional, finding experienced maintenance contractors is difficult.

The conclusion, several projects later, is that until the market offers more and different CHP choices, a better path to net zero is to use a combination of heat pump (electric), heat recovery ventilator, wood stove back up (with adequate mass to even out the temperatures), and as much solar PV as you have room for. The energy efficient envelope, including very low (tested) infiltration is fundamental.

Summary

The key, for now, is to think of this kind of project as an aggregation of small individual units as compared to a scaled down version of a big building with centralized systems. One of the significant advantages of development at the scale of Shizen is that it fits into existing urban neighborhoods. Individual dwelling units at this density are by nature smaller than the national average, and if thoughtfully designed and constructed can use significantly less energy per dwelling while maintaining the many benefits of living in a residential neighborhood. Technologies are developing (becoming available) in a way that will improve the economics of projects like Shizen. Car sharing is gaining popularity. The knowledge and skill base for energy efficient design and construction is growing. As the economy improves, there are reasons to be very optimistic about future and better versions of Shizen.