FINAL REPORT

UNION COUNTY HOUSING AUTHORTIY
ENERGY EFFICIENT HOUSING PROGRAM
DESIGN CHARRETTE

June 18, 2009 Bucknell University, Langone Center Room 256

Charrette *(shar-ette) n. An intensely focused activity intended to build consensus among participants, develop specific design goals and solutions for a project, and motivate participants and stakeholders to be committed to reaching those goals. Participants represent all those who can influence the project design decisions.*

Layout Goals **Define Objectives** **Determine Criteria**

NEW CONSTRUCTION – DUPLEX HOUSE
1308 / 1310 MARKET STREET, LEWISBURG, PENNSYLVANIA

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UNION COUNTY HOUSING AUTHORTIY
ENERGY EFFICIENT HOUSING PROGRAM
JUNE 18 CHARRETTE

Summary of Results

Charrette Intent:
Address issues of "green building" and high-performance design specific to Union County Housing Authority Energy Efficient Housing Program. This intensely focused discussion and design session evaluated building construction techniques, materials and high performance design strategies appropriate for the new duplex housing at 1308-1310 Market Street Lewisburg, PA. The Charrette provided an opportunity for community leaders and the design team to discuss basic design moves with the intention of developing an early consensus on the project design priorities. At the end of the workshop project design goals and perimeters were prioritized to establish design parameters that the team can use to inform project design decisions. The object of this charrette was to:

- Confirm the vision for the project and the basic design moves
- Develop a consensus of the design goals and strategies
- Re-enforce a strong, all inclusive project team

Abbreviated Agenda:
This initial project charrette took place from 3:30 – 7:00 pm on June 18, 2009. The afternoon began with introductions and an overview of the project intentions, site, and constraints. Initial design intentions and project "Core Values" were outlined. Following a dinner break, specific design strategies were discussed and prioritized.

- Arrival and Welcome, introduction of participants, expectations and goals
- Project Overview
- Project Goals and Vision statement, description of current status
- Presentation of Project Goals and "Core Values"
- Collaborative discussion about design Strategies
- Prioritization of Key Issues and Goals
- Reporting and Conclusion

Participant Introductions:

Union County Housing Authority
Jere Engle – UCHA Executive Director
Greg Walter, UCHA Project Manager
Lori Staggert, Homebuyer Coordinator
Tammy Crawford, Accountant
Sam Wood, UCHA Board Vice Chairman
Larry Shipton, UCHA Chairman

Energy Rater
Peter Vargo, Nu-Tech Energy Solutions, Co

Architecture
Bruce Quigley, Principal, OPA
Todd Alwine, Project Administrator, OPA
Lisa D. Iulo, Sustainable Design Consultant

Advisory Group Participants: Provide wealth of experience to meet constraints and project expectations.

Dean Bohurts, CVC Mechanical Contractors, Inc
Greg Burhill, CVC Mechanical Contractors,Inc
Bill Metzger, Owner CVC Mechanical Contractors, Inc.
Scott Houtz, Air Management Technologies
Brad Haubert, Fogerty Homes
Shawn McLaughlin, Director Union Co. Planning
J.D. Stauffer, Design Homes
Rich Kisner, Columbia County Redevelopment Authority
Stacy Richards, SEDA-COG
Tom Sauers, Central Keystone COG
Eric Winslow, Citizens' Electric Company
Stan Solwocki, PHFA Architect
Jeff Sheaffer, Stahl Sheaffer Engineering
Pat Mrkebrad, Cumberland County Housing Authority
Mike Terns, PA House/ Resource Center
Barbara Woodson, Hometown Energy Systems
Nate Seigel, Mifflinburg Lumber Supply
Dave Sheridan, GBACPA
Antonia Hyde, GBACPA

Project Overview & Background: Jere Engle, UCHA
Background of the Union County Housing Authority – The goal of the Housing Authority is to provide sustainable, affordable housing. The Energy Efficient Housing Program will provide a thread to long-term affordability of housing by accounting for the ongoing cost of energy. UCHA goal for the project is to create a model project for making housing affordable, especially in-fill housing.

Project Financing: UCHA received a grant of $500,000 HOME grant from the PA Department of Community and Economic Development to replace an existing duplex house that stood on the site prior to a structure fire that completely destroyed the existing home.

- **Market Demographic:** For-Sale duplex units for income-eligible (approximately $33,800 singles; $38,650 couples) Prime-Time Buyers (head of household age 55 +) UCHA has identified a need for affordable housing for this age-group. Homes will be modest (1,000 +/- sf homes) for efficiency. Buyers will be identified who have bought-into the idea of energy efficient "green" housing and are willing to participate in the proper operation, maintenance and monitoring of the homes. The mortgage and other contractual documents will require proper operation and monitoring of the home for several years after the purchase.

Goals –To provide a model for other energy-efficient affordable housing in the region. Ongoing monitoring will be performed to see what energy savings can actually be achieved and to continually improve upon the model. The DCED $500,000 grant includes money to purchase and renovate two existing houses for energy-efficiency.

MODEL Process

The characteristics of this project, including project constraints that are reasonably typical, in combination with its performance goals make it a prototypical model for development of energy-efficient affordable housing in Union County.

Overview of Benchmark or Model for the Region: Presented by Pete Vargo.

The Duplex Housing at 1308/1310 Market Street in Lewisburg, PA provides an opportunity to define and showcase "energy efficient green building" that is marketable and can be reasonably achieved. "Energy Efficient Green Building" for the sake of this project is defined as low in energy and water consumption. The building will be well sealed and well constructed. The limited budget of $125.00 / square foot is a unique and fun constraint that will allow the project to prove the goals and show others how the goal CAN be achieved. The design will prioritize where money is spent, investing in a high-performance envelope and windows ("Lean, Mean & Green") and balancing give & take to minimize trade-offs and achieving project goals.

PROJECT CONSTRAINTS AND OPPORTUNITIES

Aerial Photograph of Project site and adjacent context, "A" indicates the project site location.

Project Site: 1308 / 1310 Market Street, Lewisburg, PA
The site is a 50' wide x 150' long vacant building lot, which is owned by the Union County Housing Authority. It is a double lot (comprised of two adjacent street addresses that are deeded separately). The project site is an infill lot nested within established town fabric (see aerial photograph above) and the project must be sensitive to this context. As a model, the new duplex construction should represent responsible development and be emblematic of "green" energy-efficient housing.

- 50' x 150' vacant lot; double lot deeded separately.
- Building setbacks are Front (25'); Side (10'); and Rear (30')
- Based on he setbacks, the maximum total building footprint (two homes) is 30' wide x 95' long.
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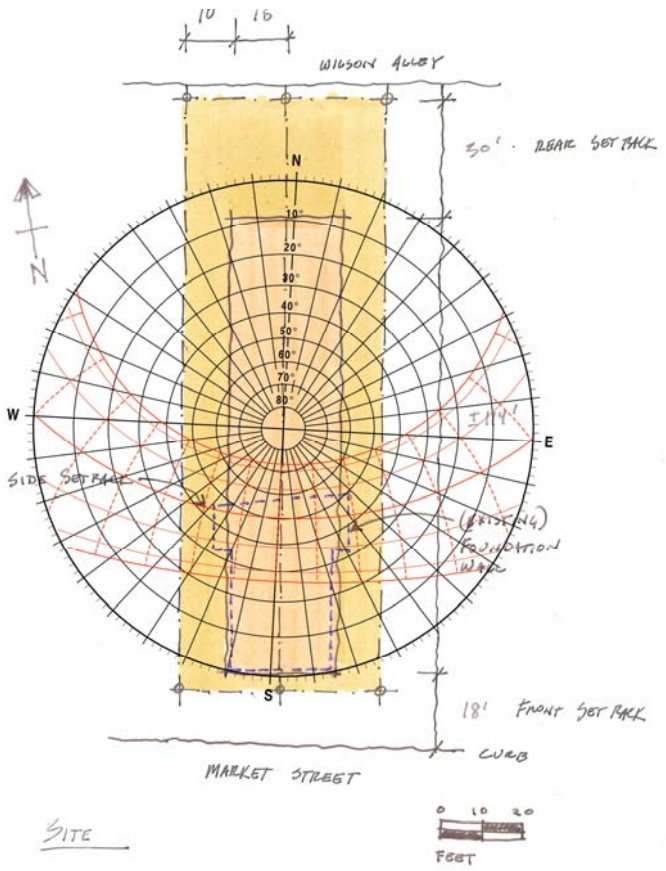
Challenges:

- Very narrow and possibly long homes.
- Orientation not ideal for passive or active solar (see diagrams)
- Homes should be designed for "aging in place" with all living areas located on the first floor level.

Advantages:

- Market Street provides an opportunity for high visibility to showcase the homes, however it will be necessary to buffer the living space from street traffic.



Diagramatic site plan showing setbacks and orientation.

Design Considerations:

- Front of lot faces south
- Passive solar will be explored
- New construction techniques and building materials will be encouraged **and** modular housing construction will be considered
- EnergyStar rated appliances must be used
- A basement, crawlspace, or slab-on-grade construction is acceptable
- Air exchangers will be necessary
- Heating and cooling must be provided. Natural gas is available to the site
- Water heating may be high-efficiency solar or DHW heat pumps
- Windows must be triple glazed or equivalent with a .20 U-value or less
- Landscaping issues will relate to energy and natural resource conservation will be considered
- The homes, including energy-efficient systems, must be simple for owners to operate

PROJECT PROGRAM: NEW CONSTRUCTION DUPLEX HOUSE

Goal: The goal for the new construction duplex house is to design and construct a double house on a 50' by 150' vacant lot that will include energy saving construction techniques, building systems, and appliances to make the homes financially affordable for moderate income families to purchase and easy to operate by couples age 55 and older. Emphasis will be on energy efficiency and energy cost savings as a first priority; a second priority will be "green development;" and a third priority will be to minimize construction cost. The house must achieve a HERS rating index score of 50 or better and receive a "Gold" certification under the NAHB Green Home Program scoring system.

Project Program:

The homes at 1308 / 1310 Market Street in Lewisburg will be semi-attached duplex houses sharing a common party wall on the site line between the two units. The duplex homes and properties will be sold individually and fee-simple. The existing lot divisions must be respected with the front of the homes facing Market Street and rear access and parking provided from the alley behind the homes. The massing and design of the homes should generally fit into the context of the adjacent residences.

General Program Considerations:

- The duplex homes should be one and one half stories consisting of ground floor living space and a second story bonus room
- The homes should be approximately 900 to 1,100 square feet of living space on the first floor. A garage is desirable.
- The first floor should include, at a minimum, one bedroom; living room; kitchen; dining area, full bathroom, and laundry facilities. A den or study is desirable. Ground floor should be handicapped adaptable and designed to *visitability* standards
- The second floor "Bonus Room" should be unfinished, but must have utilities stubbed off for future construction of the second floor into living space by owners. The second floor should have sub-flooring and the walls should be dry-walled, taped, and primed for painting

SS Engineering Site Survey Findings
Report by Jeff Shaeffer

On 10 June 2009, SS Engineering surveyed the property at 1308 / 1310 Market Street, Lewisburg, Pennsylvania. The existing foundation was located and borings to test the soil conditions were taken at the fill within the existing foundation walls, at the center of the site, and at the rear of the existing site towards the alley.

- The existing masonry foundation wall was found to be in surprisingly good condition
- The foundation walls are similar in dimension to the adjacent existing home and this home serves as a resource to better understand what the conditions of the duplex that stood on the site were.
- The existing structure at 1308 / 1310 Market Street was destroyed by a fire. After the debris was removed, the existing foundation was back-filled. Fill consists of shale material with some uncontrolled debris near the bottom.
- Fill is good working material, but the foundation should be either below the fill or dealt with through removal and site compaction.
- No water or other concerns were identified. The natural conditions seem to be pretty conducive to building on the site.

PROJECT CORE VALUES

To encourage project input and collaboration while maintaining an efficient project schedule cost-effective building project, and integrated design approach is desirable. To meet this goal project "Core Values" were identified and presented.

Core Values: An Integrated Design Approach: Presented by Todd Alwine

1. **Energy is number 1:** Reduce energy loads by minimizing square footages and conserving energy. Energy efficient lighting and appliances (the basics) will be a "given" during the selection process. Square footage will be optimized without compromising a satisfying home planning and layout.
2. **High Quality Space:** The home will have "good bones." It will be designed to be well built, well lighted, and well loved.
3. **Flexibile Space:** Simple and flexible space should allow for aging in place and perhaps different living paterns of future owners. Relevant concepts include bonus room, open floor plan and outdoor "rooms."
   (Adapted from *Five Principles of Ecological Design* by Sym Van Der Ryn Architects.)
   - The house should adapt and grow (or shrink) with the owner, taking advantage of outside spaces and accommodating accessibility for "aging in place"
   - Neighborhood context should inform the design of the house.
   - "Ecological Accounting" factors that impacts the site, should be considered and demonstrated to others.
   - Natural processes (Nature) should be made visible
   - Represent voices of the project advisory group; think about the future owners
4. **Adaptable:** The building should be constructed with the future in mind, so that future technology can be incorporated to achieve greater energy efficiency. (i.e. Can upfront design allow for future net-zero home or to accommodate future rainwater storage, etc.?) .

Advisory Group
FEEDBACK

Duplex should be considered a 150-200 year structure and materials and details should be selected accordingly.

Bonus Space (potential in basement or 2nd floor) that owner can fit-out as living space / caretaker space.

- Relative comparison of basement vs. non-basement.
  Constraints of Basement as living space
  - lack of light and air
  - Potential moisture and mildew problems. Negative effect on healthy indoor air quality.
- Remember storage! Design for practical storage space, recycling, etc. Consider cheap / operation-free space.

Explore potential for one unit to be entered from the rear to allow for wider units – Constraints:

- Requires re-establishing existing lot-lines
- Requires extra time and expense for zoning approval
- Inconsistent with existing block / lot conditions

- Both homes need rear parking
- Marketability.

UCHA project parameters: Do not want to challenge existing zoning – what can we do from an energy efficiency standpoint within an infill condition to provide a model?

Opportunities - Setbacks and separate units allow light to come in from all sides by maximizes homes exposure to sun – not just 30' south facing area.

Comment: Ask the question – can the site be divided the other way. Should municipalities be looking at alternative strategies for site layout?

Avoid the feel of the shotgun house and long corridors.

Create a common-space – shared space commonly accessed by both owners to allow for light and ventilation, ie – front space along Market Street entries off common space. Could expand to Prime-time and care-giver space.

- What are the legal implications: treat as a condominium ownership model.
- How do you deal with fire separation if inside space.
- Consider the "porch culture" of sitting on an open-air porch

COLLABORATIVE DESIGN DISCUSSION

Design Components: The discussion of design components focus on opportunities for providing a model energy efficient duplex home within the existing and real parameters (including orientation, setbacks, program and market demographics) for 1308-1310 Market Street, Lewisburg PA.

Components:

Sunspace (Isolated Gain Space). A porch at the front of each home may provide the opportunity as a passive solar design "isolated gain" space. A porch is a traditional and desirable design element for homes along Market Street. This space may provide a communal space, as suggested by the Advisory Group, and provides a buffer from the traffic noise on Market Street. This space can be designed to extend the interior living space of the home and provide natural light to the interior spaces and views to the outside.

Clerestories / Daylights: In addition to high-performance vision glass (windows between the height of 2'-6" and 8"-0" above finished floor), windows located high on a wall (8'-0" and above provide day-lighting (ideally diffuse north light) deep into the interior spaces of the home and winter heat gain (south facing). Operable clerestory windows should be located to provide opportunity for natural ventilation, minimizing necessity for mechanical air conditioning, and providing for a comfortable indoor environment and the potential for "night-flushing" to the cool the interior spaces.

Open Flexible Plan: An open flexible floor plan provides efficiency for mechanical systems design and air distribution and allows for a home living environment that can be customized/adapted by the homeowner. The open, flexible floor plan provides optimum conditions for passive solar heating / cooling, views to the outside – expanding the feel and visual appeal of the home, and optimizes day lighting for less use of

electrical lighting fixtures. This spatial organization also eliminates long corridors, eliminating the feel of a "shotgun" home deemed undesirable by the Advisory Group.

Central Core: A centralized core provides efficiency in the design of the home's systems. A central core will align from roof to basement/ mechanical room, minimizing duct and pipe runs and line losses. The centralized core also minimizes spans for ducts (if necessary) to reach remote rooms. All "wet" appliances and fixtures for the kitchen, bathroom, and laundry facilities should be located adjacent to this core. A vertical core chase will allow for easier access to systems for repairs and upgrades. This centralized core and vertical chase will provide an ideal organization for future systems including upgrades such as solar-thermal advances, or "solar-ready" installation for solar-electric. Heat scavenging from drains, refrigerator, dryer, etc, may be explored.

Large South-facing roof: A pitched roof is contextual with existing homes on Market Street in Lewisburg. A North / South sloping pitched roof provides space for a second – story "Bonus Room" with windows and views possible on three sides (cross-ventilation throughout the home may also be achieved). Optimizing the south-facing slope of the roof provides some benefit for passive-solar (when combined with light-colored roofing) and south-facing sloped roofs provide ideal surfaces for installation of solar panels (solar-thermal and/or solar electric). A slight offset between the north and south roof provides for a clerestory opportunity that will enhances opportunity for natural ventilation (see clerestory description above).

Natural ventilation / convection circulation: Vertical and horizontal alignment of operable windows combined with an open flexible floor plan and the use of reversible ceiling fans optimize opportunity for natural ventilation and convection circulation minimizing the homeowners use of mechanical HVAC systems.

High Performance Envelope: A high-performance envelope, including a very high r-value wall system and high-performance windows is the number one priority of the duplex home design and performance criteria.

Carport / patio instead of enclosed garage: A garage is desirable for marketability, but attached garages (set back from the alley) are not contextual along Market Street. Further, the home should encourage a more sustainable and healthful lifestyle, including walking when possible and use of garden / outdoor spaces. An open carport, rather than an enclosed garage, will still provide for storage and a covered area for vehicle parking, but it will also provide greater views and light from the backyard. The carport can double as a patio, extending the living space of the home to the outdoors. The carport builds on the idea of flexibility, providing a future homeowner the opportunity to weatherproof as an enclosed garage or additional living space if necessary.

Aesthetic and cost-effective storm water control / collection: Effective storm-water control is an important goal for achieving an overall "green" home. Although storm-water infrastructure exists on site, project goals encourage methods that will control storm-water on-site rather than putting unnecessary additional pressure on municipal infrastructure. Aesthetic and cost-effective and proven storm-water control and collection methods such as rain-gardens will add to the overall appeal of the home and landscape as well as serve to promote the "green" mission of the project. Rain-gardens, water-water storage barrels, and other features can assist in defining usable patio spaces and garden areas for the home residents - Research shows that gardens and multiple, defined outdoor spaces are positively associated with allowing prime-timers to "age in place".

Locally produced / procured materials: Whenever possible locally produced and procured materials will be selected to reduce environmental impacts resulting from transportation of goods and to promote local individuals, businesses, and economy.

Efficient systems and construction methods: Design for efficiency of systems will be prioritized during design, specification and installation to minimize energy demand during installation and for future operation. Construction methods, including on-site construction and modular / manufactured components will be designed for efficiency, longevity, energy-efficient performance, and to have a minimal impact on the ecological and home environment.

First Passive, Then Active: Passive, cost-effective measures for an energy-efficient "green" model is paramount. Once this is achieved opportunities may exist for active systems leading to a truly Zero-Energy home. A solid basis for the design taking into account "free" approaches towards energy-efficiency, such as optimizing orientation for passive-solar strategies and providing for alignments for provide for natural ventilations, will be identified. Cost-effective, proven methods for energy-efficient design, as defined by the project goals, NAHB standards, and the expertise of the project team will be the primary focus and objective of the project. Achieving these goals will bring the home close to meeting zero-energy standard, therefore cost-effective or future strategies for solar-thermal, solar-electric and other active strategies should be identified and documented even if they are not implemented.

COLLABORATIVE DESIGN DISCUSSION, continued

Configuration and Opportunities for Improving Building Performance:
The following represents a running list of important concepts and ideas related to the homes' design and performance as identified by the Advisory Group and Charrette Participants during discussion. Key concepts will be prioritized in the next section of this report.

Site Strategies:

1) Context Sensitive
   - Fits with character of other homes
   - Enhances Streetscape
   - "Front Porch Community": Provide porch to sit and watch the cars go by and to interact with neighbors and passer-byers, etc. If we glass-up and isolate the front in attempt to create that solar space would we completely lose this feature? We may want to consider this from the buyers' perspective. This "front porch community" is a common theme for retirees and semi-retirees in the region.

2) Showcase Homes
   - Sustainable strategies visible but not "foreign." Home should be comfortable and manageable and *loved* by the owners and neighbors.
   - Don't disregard storm water & water use (rainwater capture).
   - Accessible and Visit-able: design for 0-steps to interior or ramp with an accessible entry.

3) General Strategies
   - Active solar for domestic hot water ("cost-effective renewable", visible and fosters idea of energy efficiency)
   - Don't over-estimate orientation and passive. Focus on thermal envelope: start with thermal envelope and then see what other opportunities there are.
   - Multiple south facing roofs for solar and storm water collection.
   - Develop strategies for water use (captured rain water / vs. gray water (PA frowns on gray water reuse in the home)- rain water use may be acceptable for gardening and flushing toilets.
   - Storage (if we build on a slab and have a carport we don't have any storage). Home will need some storage for bulk and recreational items. If forced to go with basement then not an issue. If slab then we have to integrate some type of indoor or outdoor storage (min. of 50 sq ft of designated storage space) to be integrated with carport, with outside access and ability to lock it.

High Performance Design Strategies

- High u-value Windows, Low-e. Design for appropriate solar coefficient
- Super-insulated house. How can we make a thin but super-insulated wall?
- Is spray foam an affordable option? It will be a foam based insulation not fiberglass batt insulation.
- Focus effort and money on envelope and plan for upgrades
- What would be the perfect thermal envelope? Design to the point of declining return – 5" foam insulation. (dense-packed cellulose?)
- Small scale thermal mass (rainscreen detail) as inexpensive way to get break
- General duct-less system

Space conditioning strategies (also see Appendix A)

- ERV / HRV, tie into heat salvaging as space heating preheat. This is appropriate with split-system? It will minimize over-all heat load and therefore the overall systems size.
- Heating zones: Put heating and cooling where you need it, when you need it.
- Upgradable home- does it make sense to put money into controls & wiring rather than efficient equipment? – Find the right balance.
- Consider radiant heat using solar thermal system.
- Use air directly and design for temperate air recovery and use

Sustainable Construction Systems and methods

- Unconventional framing – staggered studs to **avoid thermal bridging**. Dual wall with airspace in between.
- Use recyclable products – is steel a better choice? Probably not.

- Modular – “you can do just about anything that you can think of with modular”. All material is reused in the facility (drywall, wood) scraps recycled or sent to agriculture uses. Construction inside to out (better sealing); impact on site minimized.
- Basement as plenum – basement open to first floor to use ground temperature to condition living space – ambient air temperature.
- Creatively use of conventional / affordable products as a model

Domestic Water Heating

- Instantaneous hot water? Wouldn't recommend instantaneous water heaters on this project in consideration of the high electrical peak demand, which could limit "0-energy" in the future with photovoltaic. It also wouldn't lend its self to using active solar water heating due to no storage.
- Place active solar water heater on the project for recognition. This will get more attention than any sign and will be noticed long after the project is complete.
- Consider using the domestic water heater as a dual purpose to provide space heating now and also in the future depending on what modeling provides for heat loads. This concept could be incorporated into the ERV or HVAC unit depending on how design plays out. Glycolic mixture and a intermediate HX may be necessary depending on design for winter operation.

Other Comments:

- No basement, crawl space. Why? Decide whether excavation/compaction is cost effective and low enough risk (settling aspects) or do we just go with full basement. Crawl space or basement have major impacts and considerations on project. We simply cannot move ahead until we make this decision.
- Buyer education and marketing : pick the right people and prepare them for how to live in the home. Need more than one training session and be available to answer questions. Provide for open communication with buyers.
- Geothermal? Rebate would not apply for builder, geared towards homeowner (split-system a better option).

MODEL
Affordable Efficiency

This Duplex will be an example for what is do-able today and affordable today and for the future residents. Think about and approach the project differently by tweaking the conventional.

PRIORITIZED LIST OF ISSUES (bullets listed from most to least important)

1) **Thermal Envelope**
   - **Insulation: Price Vs. Thickness**
   - **High-Performance Windows**
   - **Continuous Insulation; Thermal Breaks not bridges**
   - **Innovative**

2) **Heat / Cool**
   - **Ductless**
   - **ERV / HRV**
   - **Provide the "right" systems:** including dehumidification, natural ventilation, use of ambient temperate for preheat.
   - **Zones**
   - **Controls**

3) **Site**
   - **Water** should be a **High Priority**
   - **Accessible**

4) **Model**
   - **AFFORDABLE EFFICIENCY**

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- **Provide user education**

Appendix A: Additional Notes on HVAC From Scott Houtz

1. Energy Recovery Ventilator (ERV) will probably be required for wintertime operation to maintain humidity levels with "tight construction". The requirement for this device is dictated by the amount of moisture permeation and active generation in home which impart can be controlled by exhaust fans (showers, cooking, people, etc.). Humidity levels for good IAQ should be from 30-60% (ASHRAE). The ventilation requirement ASHRAE Standard 62-2007 is about 60CFM for 1000 ft2. Unit should incorporate an enthalpy based exchange to control summer humidity, a concern that Pete mentioned is real. Such a system would help to minimize impact.

2. In regards to using ductless vs. ducted units I have provided summary below:

Consideration to which alternative will depend on the final heat load analysis and ventilation summary.

A Ductless systems offer similar efficiencies to split systems and have an advantage on no ducting although several issues should be considered that may be a disadvantage.

Unit sizing is limited; the smallest single evaporator size I'm aware of being 9,000 BTU. This may be fine for the main living area but would not try to place such an oversized unit in the bedroom. Over sizing isn't a good thing with tight construction as Pete indicated there is a real humidity concern and with over sizing you can find the space smelling like a locker room (humidity's above 60%) if you are not careful. Even with variable speed as discussed it helps increase the amount of moisture removal by about 10% but it isn't a dehumidification control. The thermostat still controls on-off function.

- Most ductless split evaporators don't have sufficient auxiliary heat to handle the space load so supplemental baseboard electric may be required.

- Cleaning and maintenance can be an issue as coils that are hanging on the living room wall may need to be cleaned (not like cleaning inside an AHU). Filtration on these systems is also limited and increase the requirements for cleaning compared to split system. In addition with aging people increased filtration due to allergies may be a concern and with ductless you are limited.

http://www.mrslim.com/Products/itemDetail.asp?ProductSubCategoryID=140&ProductCategoryID=24&ProductID=1488

B. Split systems (York, Trane) have disadvantage in your application (1,000 ft2) of size with ultra high efficiency units starting at 24,000 BTUH in capacity and high efficiency at 18,000 which is to large for your home. You also have ducting issues which cost energy and space.

- System can be designed to provide the right amount of airflow to meet the space requirements and also operate with variable speed humidity control functions.

Appendix A, continued.

- ERV can directly connect into the system and potential to provide medium air filtration as a standard for IAQ.

- Supplemental electric heat is built into the unit and it allows flexibility for a future hot water coil for solar heating.

- Little more maintenance friendly when it comes to cleaning and maintaining evaporator.

System preliminary design thoughts based on last nights meeting (subject to change once when envelope design is finalized).

- Ductless HE heat pump large open area.

- Electric baseboard heaters supplemental with own thermostats (large area/bedroom). Interlock heat pump and living room T-stat to make sure HP is first stage.

- Bedroom ceiling fan and or potential transfer air from open space (cooling room).

- Energy recovery ventilator (exhaust toilet room/supply main living area).

- Solar active domestic hot water system with electric water heater. Size heater large enough for storage.

- Would recommend trend logger to record space temperature and humidity. This can be provided for less than $200 and data can be retrieved every 6-months.

- Need to make sure that moisture permeation is addressed whether slab, basement, or craw space to avoid dehumidification requirements.

I would still discourage any use of the HVAC system to circulate air thru the basement due to various factors in respect to IAQ and also control that would be required for cooling/heating changeover. In addition with a basement there may be a tendency for the people to want to use this as a living space which would require some environmental control (potential dehumidifier) and wall insulation measures that would raise energy costs.