SECOND PLACE WINNER

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CONCEPT NARRATIVE

All families deserve a home that is unique and diverse as the families living in them. Our team's approach to the Carbon Challenge was not only to design a home with the smallest carbon footprint, but also to design a home that could become the new inner city prototype home for Habitat for Humanity Providence.

We utilized one of the most efficient home shapes, a cube, keeping a compact footprint and minimizing circulation. With a tight condensed core and a lowered eave line we are able to bring the scale of our home down to the size of a traditional and familiar Cape Cod home. Similar to a saltbox, our unique massing allows our home to have 3 bedrooms on the second floor.

The exterior of the house is clad in continuous clapboard siding and cedar. The natural wood gives a sense of warmth and a welcoming glow to the home. With cellular PVC trim and fiberglass clad windows, the exterior systems are built to last with minimal maintenance.

A covered entry leads you in the front of the home into the living room and dining area. Large picture window with operable awnings above allow for maximum daylighting, natural ventilation, and the living room to feel more open and inviting for the family.

An open stairway allows for the natural light to flood from larger living room windows up the stairwell. A unique feature of the staircase is a built-in storage cabinet that evolves out of the third riser.

The distinct massing of the home allows it to be placed near other adjacent homes of the same design without giving the feeling of repetition. With a simple reiteration or mirroring of the floor plan, or the house becomes a completely different form that complements the next.

In summary we feel a quote by two of the most famous designers for the masses best represents the design of our house, in the words of Charles and Ray Eames “the best for the least in the most.”
PERFORMANCE CRITERIA & OBJECTIVES

Carbon Footprinting
The project seeks to minimize its carbon footprint for both the building and all ongoing operations and maintenance over the life of the home. Materials and system recommendations and selections for the Carbon Challenge House will minimize the overall lifecycle impact of the project by balancing the considerations of first cost, replacement cost, service life, embodied energy and maintainability.

Model for Future High Performance Affordable Homes
This project is intended to exemplify a model affordable high performance home that future Habitat for Humanity projects constructed in the Northeast can reference. The project will incorporate ongoing measurement and verification to determine if actual outcomes meet predicted outcomes to encourage constant improvement on future Habitat for Humanity projects. The project team will hold a lessons learned review at the end of the first year of occupancy to review successes and areas for improvement on future Habitat for Humanity projects.

Keep Things Simple
If the maintenance is complicated and requires a lot of time and additional training, it may be difficult for the owners to keep the systems running properly. This may result in system failure and poor environmental performance. While systems should not be rejected from consideration just because they appear to be complex, ease of maintenance will be considered when recommending what technologies to use.

Maintenance and Longevity
Maintenance cost and time for the resident family will be minimized by selecting materials and equipment with long warranty/service life expectancy, are locally available, and can be repaired easily and inexpensively. The useful life of all products and materials will equal or exceed the standards applicable to the product when compared to industry standards.
SITE FEATURES

Infill Development
The site selected for this project is a previously developed urban infill site in the City of Providence, Rhode Island. The site has no apparent build-out limitations and has sewer, water, electric, natural gas and telephone/internet readily available. The site is located in a neighborhood with sidewalks and is located within walking distance of several essential services and amenities including public transportation.

Landscaping
The project site will be designed to help minimize maintenance and costs associated with landscaping maintenance. The project will accomplish this with the use of native plant species, rainwater harvesting for limited site irrigation and limited use of turf grass which will require no watering after the first year and minimal pruning or maintenance. An area on the project site will also be prepared for use as a garden by the resident family.

Storm Water Management
The project will maximize on-site stormwater infiltration by minimizing impervious surfaces and use of a dry well and rain barrel rainwater collection. The site has an existing topography of approximately 5 feet from north to south. The subsurface topography will be used to retain stormwater runoff on-site and direct it toward the backyard planting areas.

Heat Island Reduction
The project will minimize urban heat island effect by minimizing landscape materials and utilizing strategically located shade trees and plants.
ACCESSIBILITY

The first floor is designed to be fully handicap accessible. An accessible route is provided throughout the entire first floor of the house. All ADA turning radii and floor area clearances are provided in the kitchen, bathroom and bedroom. Walls in the bathroom will have blocking installed to allow for future installation of grab bars. Plumbing fixtures will be provided and mounted at heights required by ADA. An accessible route is provided throughout the entire first floor of the house.

ROOM KEY

1. LIVING ROOM (12' x 11'4"
2. DINING ROOM (9'4" x 12'6"
3. KITCHEN (10'4" x 9'2"
4. BEDROOM (12'4" x 11'2"
5. BATHROOM (7' x 6'4"

ENTRY #114
FIRST FLOOR PLAN
SCALE: 1/4" = 1'-0"
DATE: 2013.06.04
Bedroom Closets
Closet doors and front walls have been omitted in bedrooms eliminating 28 L.F. of interior non-structural wall and four closet doors resulting in a savings of 149.3 kilograms of CO2e.

Plumbing Stacking
The second floor bathroom has been located above the kitchen on the first floor to minimize the amount of plumbing required. Stacking of plumbing also minimizes the distance and heat loss from domestic hot water systems.

Compact Footprint
The first floor is designed to be compact and efficient by utilizing all spaces available. This compact helps reduce carbon footprint by requiring less material to be built and less energy to operate on an annual basis.

Advanced Framing
Use Advanced Framing will reduce framing material use by approximately 10% compared to a house framed with studs at 16” o.c.

Source Energy
HVAC systems have been designed to be highly efficient. Fuel sources have been selected to minimize source energy and CO2e.

Renewable Energy
The house has been designed to be “Solar Ready” with a pathway to approximately 532 s.f. of south facing roof for the future installation of solar photovoltaic or solar thermal systems.

ROOM KEY

<table>
<thead>
<tr>
<th>Room</th>
<th>Description</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>MASTER BED (10’6&quot; x 14’10&quot;)</td>
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<tr>
<td>7</td>
<td>BEDROOM 2 (10’3&quot; x 10’12&quot;)</td>
<td></td>
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<tr>
<td>8</td>
<td>BEDROOM 3 (10’12&quot; x 10’4&quot;)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>BATHROOM (5’4&quot; x 9’4&quot;)</td>
<td></td>
</tr>
</tbody>
</table>
ENERGY EFFICIENCY INCENTIVES

Energy Star Appliances
All appliances will be Energy Star appliances. The use of Energy Star appliances is estimated to save approximately 350 kWh of electricity per year which equals 350 lbs of source energy CO2e.

Utility Rebates
The Carbon Challenge House will maximize local utility rebate opportunities available at the time of construction. Prescriptive and custom rebate and assistance programs are currently available through National Grid which could result in thousands of dollars worth of energy incentives and rebates. Prescriptive utility rebates are currently available for installation of the following components:

- High efficiency furnaces
- Programmable thermostats
- LED light bulbs
- Energy recovery ventilators
- Energy Star appliances

There are also state and federal tax credit programs that the homeowner may be able to take advantage of during their first year of occupancy.
Cementious clapboard siding
Cellular PVC trim
Shiplap siding
ALUM, HALF ROUND GUTTER & DOWNSPOUT
Double hung window
Rain barrel

**WATER USE REDUCTION**

WaterSense
The project will use flow fixtures that meet or exceed the EPA’s WaterSense program. Flow fixtures will be selected for the following which will result in an approximate #.#/year reduction in water use.

- Toilets = 0.8/1.6 gpf
- Sinks = 0.5 gpm
- Showers = 1.5 gpm

**No Potable Water Use for Irrigation**
The project will not include any permanent irrigation systems. Local drought resistant plant species will be used in site landscaping and rain barrels will be used to capture rainwater from the roof for select watering needs.
VERIFIED OUTCOMES & LESSONS LEARNED

Measurement & Verification
The Carbon Challenge House will be commissioned to verify actual outcomes against predicted outcomes. Prior to occupancy, the thermal enclosure will be blower door tested to measure air leakage. The project seeks to achieve an air infiltration rate of 1.5 ACH @ 50Pa. Ductblaster testing will also be performed on all ductwork located in the basement to verify all leakage of <5 CFM/100 SF. An infrared study will be performed during occupancy to verify the as-built thermal performance of the building enclosure. Site electrical, natural gas and water use will be metered and benchmarked during the first year of occupancy. The electrical system will be designed to allow for lighting, plug and HVAC loads to be separately sub-metered.

The project team will meet after one year of occupancy to review the infrared thermography study and metering data and determine lessons learned to help improve future habitat for Humanity projects.

It is assumed that a measurement & verification program and infrared thermography study will be funded by National Grid as part of a custom rebate program.
There is no practical or cost effective way to make the Carbon Challenge House net-zero site energy within the project budget. The project would require a minimum of 20kW of roof photovoltaics plus a solar thermal system for domestic hot water to offset predicted site energy use. An 8kW PV system would require the entire south facing roof surface. A future 4kW PV system would offset the general electrical use of the household and eliminate over 10,000lbs of CO2e per year. The project has been designed to be solar ready with conduit stubs at the underside of the south facing roof.
HVAC System
The proposed HVAC system for the project is a gas fired, forced hot air furnace with an energy recovery ventilator. The system has been selected to fit the energy use as well as source energy use and carbon footprint. A ducted high efficiency Variable Refrigerant Volume heat pump system was considered but ultimately not chosen due to the increased source energy and carbon footprint of an all electrical system utilizing grid provided electricity.

Domestic Hot Water System
The proposed domestic hot water system is a gas fired on-demand hot water system with an AFUE of 98%. The house is designed to be solar ready to accommodate the installation of a solar thermal system in the future.

Lighting
All permanently installed light fixtures will be provided with LED lamps with a color temperature of 2700K - 3500K and a Color Rendering Index of 80 or better. LED lamps have an expected lamp life of 50,000 hours and use approximately 10% of the energy of incandescent lamps and 40% compared to compact fluorescent lamps (CFLs).

Natural Gas:

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>kWh</th>
<th>Efficiency</th>
<th>Usage Cost</th>
<th>Energy Cost</th>
<th>Total Cost</th>
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</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>600</td>
<td>0.65</td>
<td>396</td>
<td>396</td>
<td>396</td>
</tr>
<tr>
<td>Electric</td>
<td>600</td>
<td>0.65</td>
<td>396</td>
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<td>396</td>
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Grid Supplied Electricity:

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<th>kWh</th>
<th>Efficiency</th>
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<th>Energy Cost</th>
<th>Total Cost</th>
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<tbody>
<tr>
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<td>396</td>
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<tr>
<td>Electric</td>
<td>600</td>
<td>0.65</td>
<td>396</td>
<td>396</td>
<td>396</td>
</tr>
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INDOOR AIR QUALITY

HVAC System
Whole house mechanical ventilation will be provided in conformance with ASHRAE 62.2 via an energy recovery ventilator (ERV). The ERV will provide ventilation air on a year-round basis at a rate of 60CFM/7.5 CFM/occupant + 0.01CFM/ft²). Operable windows will also be provided to provide additional occupant controllability and satisfaction. The house will be equipped with carbon monoxide sensors per NFA 720.

Dedicated Exhaust
Dedicated local exhaust will be provided at the kitchen and bathrooms sized for 100CFM with local "on-demand" control. Exhaust air outlets will be located on the opposite side of the house from fresh air intakes used for ventilation.

Materials
All materials will be selected to be low or no VOC content. In general, adhesives, paints, coatings, etc., will have VOC content of <50 g/L. Materials will also be selected to minimize use of Red List materials as defined by the Living Building Challenge.
The Carbon Challenge House will reduce its carbon footprint and cost by minimizing its use of materials with the use of advanced framing techniques. Advanced framing can reduce overall framing material use by approximately 10% and the number of pieces by 30% when compared to a house framed at 16" o.c. Advanced Framing techniques will also improve the thermal performance of the thermal envelope by approximately 15% due to reduced thermal bridging and increased stud cavity depth for insulation. Project specific framing plans along with typical advanced framing details will be provided to ensure the volunteer labor understands advanced framing concepts and optimum outcomes are achieved.
GLOBAL WARMING POTENTIAL SUMMARY MEASURE TABLE BY LIFE CYCLE STAGES

<table>
<thead>
<tr>
<th>Summary Measures</th>
<th>Emissions</th>
<th>Operational Energy</th>
<th>Operational Energy</th>
<th>Operational Energy</th>
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</thead>
<tbody>
<tr>
<td>Material</td>
<td>Transportation</td>
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<td></td>
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<tr>
<td>Energy</td>
<td></td>
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<tr>
<td>Total</td>
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GLOBAL WARMING POTENTIAL SUMMARY MEASURE TABLE BY ASSEMBLY GROUPS

<table>
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<th>Summary Measures</th>
<th>Emissions</th>
<th>Operational Energy</th>
<th>Operational Energy</th>
<th>Operational Energy</th>
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<tr>
<td>Total</td>
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GLOBAL WARMING POTENTIAL SUMMARY MEASURE CHART BY LIFE CYCLE STAGES

GLOBAL WARMING POTENTIAL SUMMARY MEASURE CHART BY ASSEMBLY GROUPS

BILL OF MATERIALS REPORT

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity</th>
<th>Unit</th>
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<tbody>
<tr>
<td>603 Organic Fall</td>
<td>80.993</td>
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</tr>
<tr>
<td>930 Organic Fall</td>
<td>29.385</td>
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<tr>
<td>1/2&quot; Regular Gypro Board</td>
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<tr>
<td>6mm Polyethylene</td>
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<td>kg</td>
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<tr>
<td>Air Blower</td>
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<tr>
<td>Acrylate</td>
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<tr>
<td>Glass Reinforced</td>
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<td>ft</td>
</tr>
<tr>
<td>Cedar Wood Shingles</td>
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<td>ft</td>
</tr>
<tr>
<td>Cedar Wood Tongue and Groove</td>
<td>0.400</td>
<td>ft</td>
</tr>
<tr>
<td>Cold Rolled Steel</td>
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<td>ft</td>
</tr>
<tr>
<td>Corrugated 20-gauge (6x6)</td>
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<td>yd</td>
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<td>yd</td>
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<tr>
<td>EPDM Membrane (black)</td>
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<td>in</td>
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<tr>
<td>Expanded Polystyrene</td>
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<tr>
<td>Insulated Plywood</td>
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</tr>
<tr>
<td>RG-100/15</td>
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<td>ft</td>
</tr>
<tr>
<td>Roof Cement</td>
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<tr>
<td>Insulated Sheer</td>
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<td>ft</td>
</tr>
<tr>
<td>Hollow Structural Panel</td>
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<td>ft</td>
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<tr>
<td>Joint Compound</td>
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<td>lb</td>
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<tr>
<td>Insulated Foil Insulation</td>
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<td>ft</td>
</tr>
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<td>0.080</td>
<td>ft</td>
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<td>0.080</td>
<td>ft</td>
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CARBON FOOTPRINT ESTIMATING LIMITATIONS

The Athena Institute Impact Estimator does not include or allow for controlled input for the following items:
- HVAC ductwork and equipment
- Plumbing supply and waste piping
- Permanent fixtures (cabinets, built-in casework, etc.)
- Finishes (carpet, wall covering, tile, wood, wall covering, tile, etc.)
- Interior stairs
- Shingle roofing with >30 year life
- Windows do not include fiberglass frame options
- Doors do not include an insulated core option
- Insulable to control floor and roof framing depths
- Spray foam insulation (i.e.,., IPE)

Operational Energy Type and Use are not Considered

The submission criteria of this competition does not include the carbon footprint of the annual operational energy use of the house. The ongoing annual operational carbon footprint of a home (heating, cooling, lighting, etc.) can greatly exceed the CO2e of the materials used to construct it. Operational CO2e is determined by the carbon emissions associated with the source energy use of a project. The submission has a predicted annual operational source carbon footprint of 15.029 lbs CO2e per year. Over a 60 service life this equals over 4,500 tons of operational CO2e. The CO2e of the primary materials used to construct the house as calculated by the Athena Impact Estimator equal#.# of tons of CO2e.