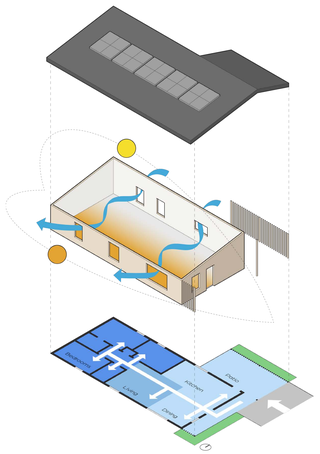
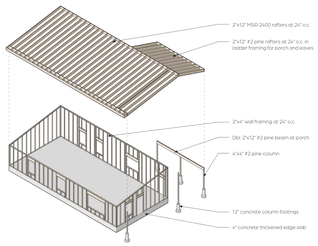
HARMONY

JoBeth Hancock | Net Positive Studio | Professor Michael Gibson | Fall 2021

The home must exist in perfect sync with its environment and its occupants. These three harmonious elements can ebb and flow but will always remain in tune with one another. The design relies on a simple rectangular volume with interlocking public and private zones. One enters between the kitchen and dining areas and progresses through the living area to the bedrooms. A covered entry and patio extend from the eastern facade and the kitchen to expand community-focused interior spaces outward beyond the home. This fosters constant connection between the home's occupants, the community, and the environment. The northwest patio can double as a carport as well. Plus, passive thermal heating and cross ventilation are used to create more comfortable spaces throughout the year in response to the surrounding Emporia climate. Southern windows provide ample daylight in addition to passive heating. Overall, the home relies on a gradient of program and passive strategies to create a welcoming, functional home that fosters affordable and sustainable living for an entire community.



Program, Circulation, and Passive Strategies



Structure

		Material	Labor	Subtotal Cost
	Existing Conditions	$0.00	$0.00	$0.00
1	Site Work	$0.00	$0.00	$5,630.64
2	Foundations	$7,907.14	$5,447.76	$13,643.54
3	Framing	$6,467.95	$8,160.83	$14,628.78
4	Exterior Walls	$13,963.25	$7,202.50	$21,164.76
5	Roofing	$7,170.96	$5,350.40	$12,521.36
6	Interiors	$6,113.78	$9,349.68	$15,463.46
7	Specialties	$6,801.10	$1,594.95	$11,846.05
8	Mechanical (Plumbing and HVAC)	$6,489.00	$0.00	$27,978.00
9	Electrical	$2,337.72	$3,775.20	$6,112.92
			Total Subcontractor Costs:	**$130,989.53**
			Subcontractor Costs (from above)	$130,989.53
			General Conditions (Div. 1) Allowance	$6,549.48
			Sales Tax (mat'ls & equip) @ 8.6%	$11,828.35
			GC Overhead	$13,098.95
			GC Profit	$6,549.48
			Contingency	$13,098.95
			Misc Fees	$0.00
			Design Fees	$0.00
			Grid-Tied Photovoltaic System	$9,056.00
			Lot Costs	$0
			Financing Costs	$7,000
			Project Cost for Conventional Build	**$191,170.74**

Cost Analysis

The 1200 square-foot Harmony home is designed with the Spring Green Street corner lot in mind, though it serves as a prototype that could easily be built on any site in Emporia. Careful analysis of the site conditions and Emporia's climate results in a net positive home that responds to and interacts with its environment. The bioclimatic chart depicts the wide range of temperature and humidity conditions that occur throughout the year. Emporia experiences both extreme cold and scorching heat, leaving little time during the year to fall in the comfort zone. The home mediates these varied temperatures through passive solar heating during the underheated months and cross ventilation during the overheated months. Since much of the desired winds for cooling originate from the north and northwest, an east-west orientation best captures these winds and provides ample southern exposure for solar heating. Thus, the home provides both fixed and operable windows along the northern and southern facades to take full advantage of available sunlight and wind.

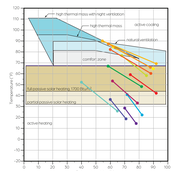
These passive strategies in combination with a tight, continuously insulated envelope allow for thermal performance that far exceeds that of a typical Midwestern home. Harmony is estimated to use only 6,117 kWh of energy per year, which is 78% less than the 27,542 kWh used by a typical home. This number is also under the estimated 6,408 kWh produced by a 12 module photovoltaic array, meaning the home will be net positive. Similarly, the EUI is 17 kBTU/ft², also significantly less than the 41.4 kBTU/ft² of a typical home. This value represents the home's annual energy usage divided by the building area, allowing for easy comparison between homes. As seen in the energy use chart below, much of the energy consumed is from equipment, though the heating and cooling fluctuate throughout the year, especially when passive systems are less available.

Daylight plays an important role in an occupant's physical and visual comfort while helping to conserve energy. Illuminance indicates the amount of light falling on a surface, and the illuminance provided by daylight changes throughout each day and throughout the year. The daylight factor indicates the illumination available inside relative to outside, and a home should be around 2%. Harmony has an average daylight factor of 2.8%, meaning plenty of daylight is provided to adequately serve the occupants.

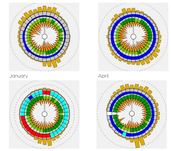
Site EUI: 17 kBTU/ft²
70% reduction from typical home at 41.4 kBTU/ft²

Total energy use: 6,117 kWh
78% reduction from typical home at 27,542 kWh

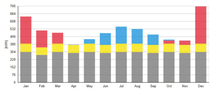
Heating energy: 993 kWh
Cooling energy: 993 kWh
Lighting energy: 977 kWh
Equipment energy: 3,555 kWh



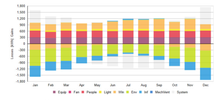
Bioclimatic Chart for Emporia, KS



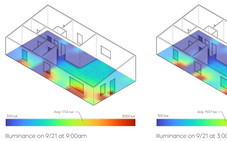
Wind Patterns



Energy Use Chart



Energy Flow Chart



Illuminance on 9/21 at 9:00am

Illuminance on 9/21 at 3:00pm

Daylight Factor

Floor Plan