





# Building Science Corporation

Architecture and Building Science



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**Builder** Prairie Holdings Corporation; Grayslake, IL

**House Plan Name** Lowden (Plan 2230)

## Envelope Characteristics

This is a two story home over a conditioned basement and crawl space, with 2260 ft<sup>2</sup> of conditioned floor area, not including the conditioned basement (3176 ft<sup>2</sup> with basement). The base case, pre-Building America house has the following characteristics: walls=R-13 (both to exterior and to garage); basement walls uninsulated; slab uninsulated; ceiling/roof=R-38; windows are double glazed, vinyl frame units; infiltration rate=8 ACH 50, which is equivalent to 4680 CFM 50.

## Space Heating, Cooling and Domestic Water Heating Systems

Space heat is provided by a gas furnace located in the basement, with an efficiency of 80% AFUE. Cooling is provided by a 10 SEER air conditioner, and sized at 4 tons (48.0 kBtu/hr) nominal. Ductwork is located in the attic and within the conditioned space, insulated at R-4.2. A duct leakage rate of 20% of the high speed air handler flow is used here, which is equal to 320 CFM 25.

A standard gas water with a 40 gallon capacity, an energy factor of 0.56, and a recovery efficiency of 0.76 is located in the basement.

Energy Source	Utility	Price
Electric	Commonwealth Electric	0-400 kWh \$0.1090 per kWh
		400+ kWh \$0.0790 per kWh
Natural gas	North Shore Gas	0-50 therms \$0.5580 per therm
		50+ therms \$0.4480 per therm

## Estimated Annual Energy Use and Costs: before

**Plan 2230 Standard Construction** **Energy Star Score 78.2**

[Mbtu=1,000,000 Btu]

Space Heating	159.8 MBtu	\$749
Space Cooling	12.7 MBtu	\$336
Water Heating	25.6 MBtu	\$131
<b>Total</b>	<b>198.1 MBtu</b>	<b>\$1,216</b>

Design loads: Heating	87.4	\$1,216 Annual heating & cooling cost
(kBtu/hr) Cooling	42.7	
<b>\$101 Monthly heating &amp; cooling cost</b>		

Measure	Estimated Savings	Install Costs	Simple Payback	Useful Life
Switch to advanced framing with R-19 insulation	\$37	-\$250	n/a	60
Replace OSB siding w. R-7 insulating sheathing	\$23	\$0	0	60
Insulate basement with R-13 draped batts	\$103	\$600	5.8	60
Replace windows with low emissivity argon-fill units	\$90	\$1,000	11.1	30
Cut infiltration to 2.5 sq. in. leakage area per 100 sf	\$113	\$100	0.9	60
Change to 90% direct vent furnace	\$37	\$750	20.3	15
Upgrade water heater to power vented model	\$0	\$150	n/a	15
Add setback thermostat	\$18	\$100	5.6	15
Downsize duct distribution system	\$0	-\$300	n/a	60
Place ducts within conditioned space	\$72	\$0	0	60
Downsize air conditioner by 1 ton to 3 tons	\$0	-\$750	n/a	15
Add mechanical ventilation @ 40 CFM continuous	-\$12	\$125	n/a	15
	\$481	\$1,525	3.2	

**Building Envelope:** The framing is changed to the advanced framing system, with 2x6 24" o.c., single top plates, and stacked framing members. This creates a better insulated wall, due to the thicker insulation. Furthermore, it reduces thermal bridging through the studs, as well as reducing the overall amount of wood consumed. The implementation cost is only a small increment, with the increased cost of insulation being offset by reduced labor during framing, and the net lumber cost remaining constant. The OSB siding is exchanged for R-7 1" polyisocyanurate rigid foam sheathing. This insulation board is foil-faced; this surface is taped. Therefore, it acts as an exterior air barrier, as well as the rain drainage plane, eliminating the need for building paper or housewrap.

The basement walls are insulated with R-13 draped batts with a semi-vapor permeable interior facing. As can be seen by the energy savings, losses through the basement walls are a significant load during the heating season.

The double-glazed vinyl windows are exchanged for low-emissivity, argon-filled units. The low-E coating on the glass and the argon fill gas between the panes both increase the insulating value of the windows. The envelope is tightened to a standard of 2.5 square inches of leakage area per 100 square feet of envelope area, equal to 1445 CFM 50 in this house, which is equivalent to an ACH 50 of 3.0.

**Mechanical systems:** The 80% furnace is replaced with a 90% AFUE, sealed combustion condensing gas furnace. In addition to the efficiency upgrade, the furnace is completely sealed from the inside air. Therefore, combustion air is drawn from the outside, and there is a minimal chance of combustion products (such as carbon monoxide) spilling into the conditioned space. In addition, the water heater is upgraded to a power vented model, which is another combustion safety measure. A programmable setback thermostat with a timer is installed, which reduces energy demand.

The leak-free nature of the building envelope, the high-performance window system, and the increased levels of thermal insulation allow a considerable simplification and reduction in size of the duct distribution system for heating and cooling. This downsizing results in further cost savings.

The most important change in mechanical systems is to move the ducts within the conditioned space. This eliminates duct leakage to the exterior, as well as limiting the temperature difference at the ducts. The ducts are run through the conditioned basement and the space created by an engineered wood open-web floor truss system.

The improvements to the ductwork and building envelope resulted in reduced heating and cooling loads; therefore, the air conditioner can be downsized by 1 ton (to a 3 ton unit), with resulting cost

savings.

Controlled mechanical ventilation is provided by a fresh air supply-only system, located in the basement. This system results in a slight energy penalty; however, ventilation is necessary for acceptable indoor air quality.

**Payback periods:** The simple payback in years for each individual measure is shown on the line for that measure. The total payback figured is based on the time of payback of these measures taken as a whole. The numbers shown below reflect the changes listed in the table above.

### Estimated Annual Energy Use and Costs: after

#### Plan 2230 Building America

Energy Star Score 86.6

[Mbtu=1,000,000 Btu]

Space Heating	66.0 MBtu	\$323
Space Cooling	10.3 MBtu	\$277
Water Heating	25.7 MBtu	\$135
<b>Total</b>	<b>102.0 MBtu</b>	<b>\$735</b>

Design loads: Heating	39.9	\$735 Annual heating & cooling cost
(kBtu/hr) Cooling	24.6	<b>\$61 Monthly heating &amp; cooling cost</b>