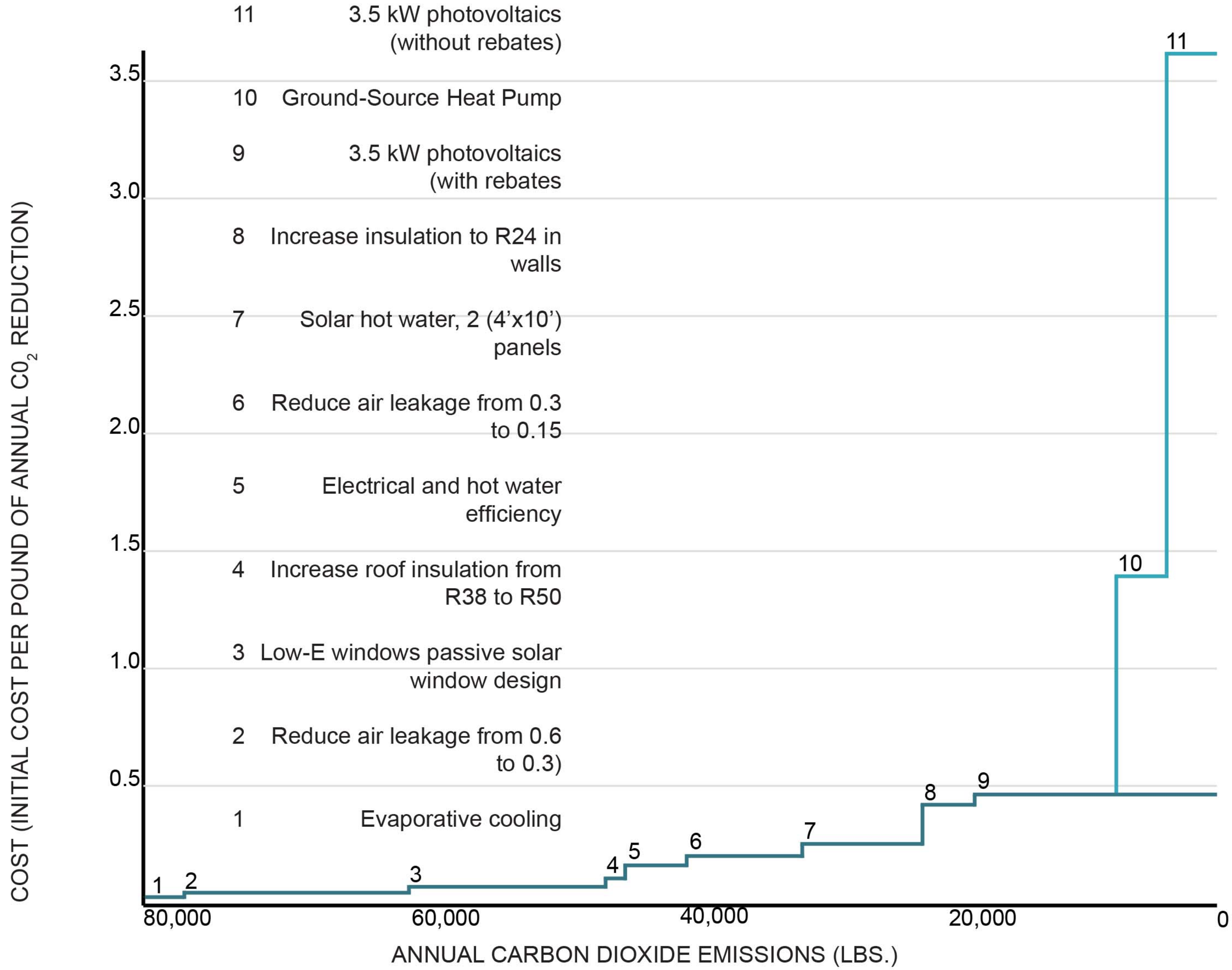
CO_2 EMISSIONS REDUCTION STEPS

Electric heat and hot water

Improvements to reduce carbon dioxide emissions, ranked in order of cost effectiveness

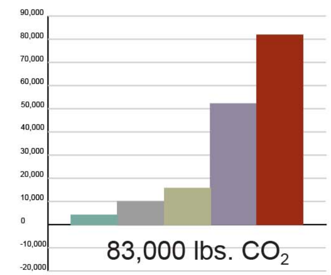


STEPS TO LOWER CARBON EMISSIONS

Fuel Type: Electric Heating and Hot Water
Location: Boulder, CO

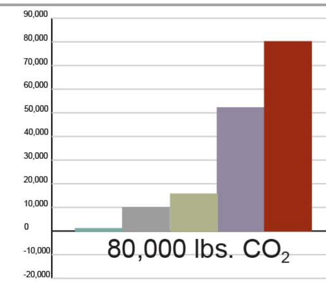
KEY

- Hot Water
- Cooling
- Heating
- Electricity
- Total



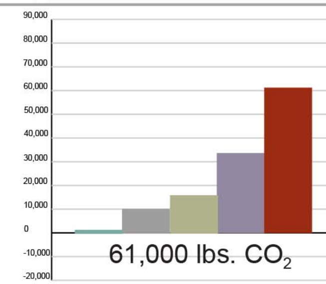
Code-Minimum House: The base design for analysis is a 2400 sq. ft. house with a full walkout basement and air conditioning. The base is the minimum that would pass the 2003 IECC code and Boulder Green Points program.

STEP 1 EVAPORATIVE COOLING



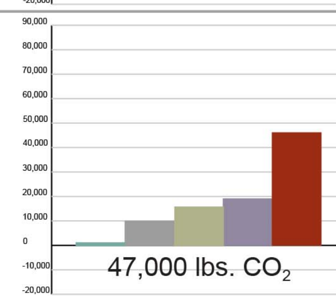
Evaporative cooling uses one-fourth the energy of typical air-source air conditioning, with a lower initial cost.

STEP 2 REDUCE AIR LEAKAGE



Blower door testing with caulking and sealing of the building can reduce the air leakage -- the amount of outside air to be heated and cooled. Spray insulations, such as wet-blown cellulose and icynene, reduce air leakage by filling gaps in the framing. An initial reduction from 0.6 air changes per hour to 0.3 is easily attainable in both new and existing buildings.

STEP 3 LOW E WINDOWS, PASSIVE SOLAR TEMPERED



Changing the glass to double low-E reduces both heating and cooling loads. In this step, we have increased the South glazing to 8% of the floor area. The South glass has a high solar heat gain coefficient (0.6) -- allowing 60% of the heat from the sun into the building during winter months and reducing our heating load.

STEPS TO LOWER CARBON EMISSIONS

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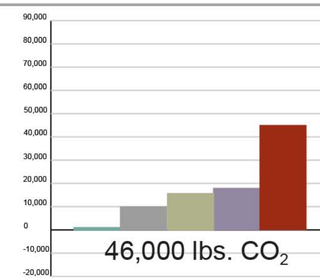
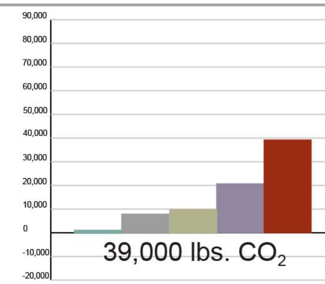
STEP 4 INCREASE ROOF INSULATION TO R-50

Typical roof construction often has a large enough cavity to allow increasing the amount of insulation from the R-38 typically required by code to R-50.



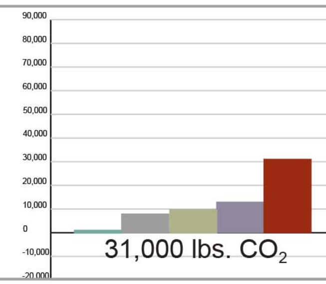
STEP 5 ELECTRICAL AND HOT WATER EFFICIENCY

Use Energy Star labeled appliances and electronically ballasted fluorescent lighting. Hot water use can be minimized with low-flow fixtures and efficient delivery systems.



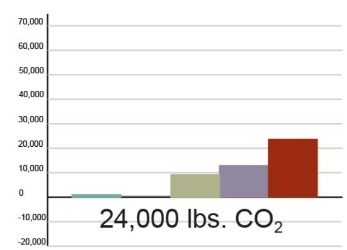
STEP 6 REDUCE AIR LEAKAGE TO 0.15 ACH

Further caulking and sealing in new construction can lower the air leakage to 0.15 air changes per hour. At these low levels of leakage, an air-to-air heat recovery ventilator is typically added to ensure good indoor air quality.



STEP 7 SOLAR THERMAL DOMESTIC HOT WATER

Solar hot water panels are cost-effective in reducing CO_2 emissions. A two-panel system will provide almost all of the domestic hot water needed for a typical family.



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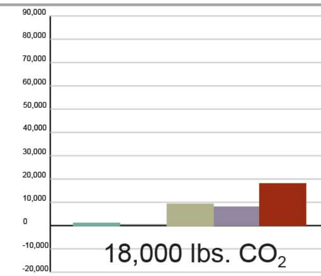
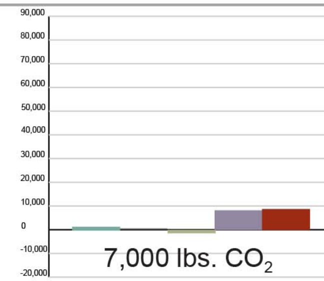
STEP 8 R-24 IN THE WALLS

Specialized closed-cell foams, such as polyisocyanurate and polyurethane, can bring a 2x6 wall to R-24 (as opposed to R-19 for open-cell foams and wet-blown cellulose). Structural insulated panels (SIPs), filled with these foams, minimize thermal bridging to achieve R-24 or above.



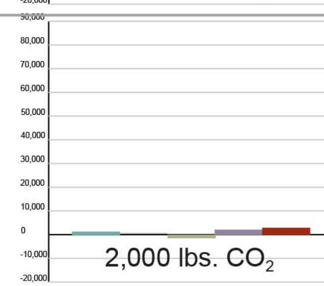
STEP 9 PHOTOVOLTAIC PANELS

With the Xcel rebates, photovoltaic energy supply is more cost-effective in terms of reducing CO_2 emissions than super-insulation or efficiency measures. At this point, the strategy switches from load reduction to renewable supply.



STEP 10 GROUND SOURCE HEAT PUMP

A ground-source heat pump exploits a refrigeration cycle to import heat from the ground in the winter and export it to the ground in the summer. It increases the efficiency of the electric system to which it is linked: of heating by a factor of 4 and of cooling by a factor of 6.



STEP 11 PHOTOVOLTAIC PANELS WITHOUT REBATES

At current market costs, photovoltiac energy is still less expensive than extreme load reduction measures such as triple low-E windows or R-50 walls. We also find it to be a better value in most cases than using solar thermal panels for building heat. Finally, we expect the cost of PV energy to decline in the future relative to fossil fuels as the technology becomes widespread and demand for fossil fuels outstrips supply.