The Problem

Especially in winter, much of the food we eat comes from thousands of miles away, often by airplane. The result: energy waste and inferior nutrition. The alternative in cold months is to produce food locally in greenhouses. Unhappily, most conventional greenhouses require large quantities of energy to keep their soil warm, and even then, growth in mid winter is very modest. Thus, oil can be used for flying food over long distances or for keeping inefficient greenhouses from freezing plants. Neither option is sustainable.

This lush growth was achieved over mid winter using only the sun for heat and light when nighttime lows averaged 20F.

SYNERGISTIC
BUILDING TECHNOLOGIES

Feedback is welcome. Please contact:

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Further information on the research greenhouse and others under development is available at:

www.SynergisticBT.com

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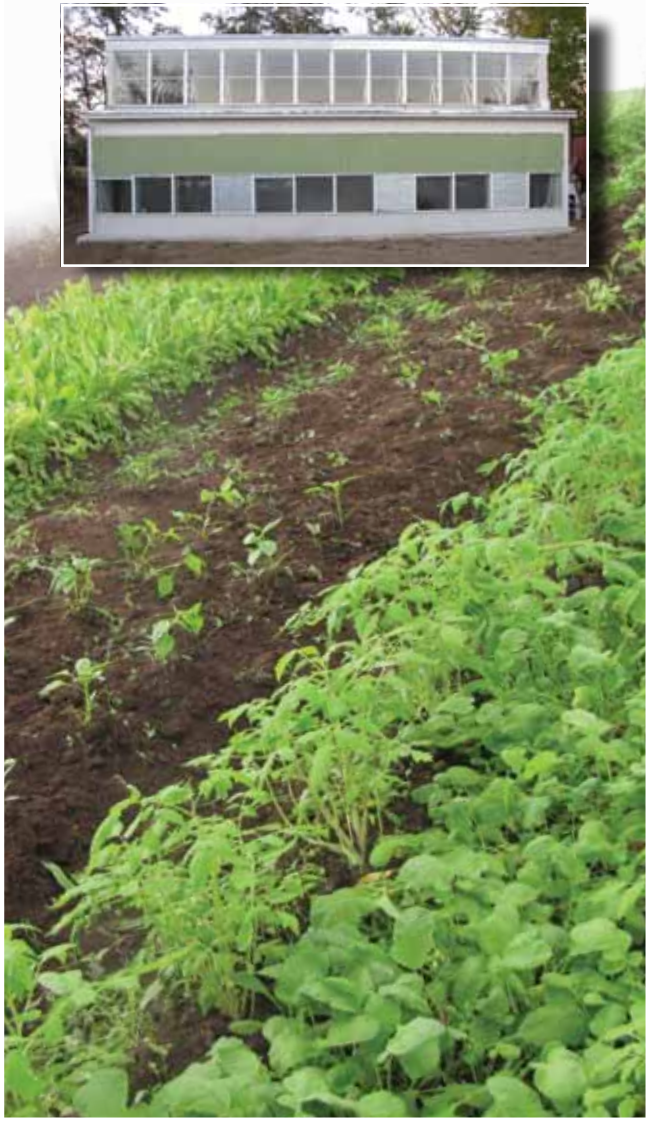
Practical Green
Greenhouse Development

A Joint Research and Development Project of
Synergistic Building Technologies and Cure Organic Farm
Co-sponsored by the Colorado Department of Agriculture



Green Greenhouse Research

Toward seeking a viable solution, this research project involved the design, building, instrumentation, and analysis of a 1000 square foot greenhouse at the Cure Organic Farm in Boulder County, Colorado. It uses a number of principles of building science including heavy perimeter, wall, and roof insulation, automated insulating shutters, high solar heat gain glazing, systems for controlling solar light and heat to maximize growth, plenty of thermal mass, and carefully-controlled ventilation. Only passive solar is used to supply light and heat for the greenhouse—but it's working very well.

Monitoring Energy Performance. Temperature, humidity, and light levels are measured at 15 minute intervals in both the research greenhouse and a nearby "hoop house" greenhouse. The graph gives a snapshot of temperatures during a five-day cold snap in which the thermometer dropped to -18F. Excellent insulation and plenty of thermal mass limit temperature swings and maintain soil and air temperatures in a range that promotes healthy plant growth.

Production greenhouse with apartment

Temperatures have never dropped below 48 F in the research greenhouse. Air temperatures in the greenhouse averaged 64F in December and January; the high was 92F. Soil temperatures 2.5 inches below grade average 62F and vary less than 5F from the average. The hoop house frequently freezes.

Moveable insulation allows for good solar heat gain when the sun is out, but keeps thermal losses at a minimum when it is not. The photo below shows shows one of the 12 "swinging shutters" on the top set of windows in the research greenhouse.

These shutters and others are manipulated by an electronic controller developed for the research project by SBT. It allows for individual control of each shutter or for automatic control to optimize growth.

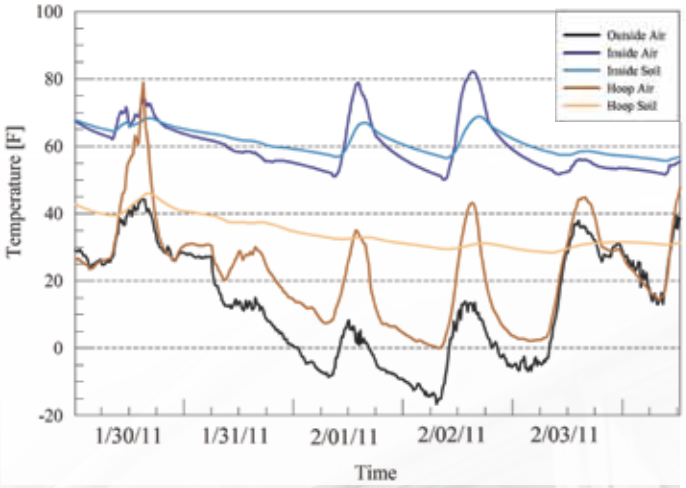
Growth. Robust growth of summer veggies is achieved during the shortest, coldest days of the year using only passive solar energy. Seeds planted on Thanksgiving, 2010, a month shy of the shortest day of the year, are producing twelve varieties of summer veggies faster than under optimal summertime conditions. Tomatoes, whose seeds were planted on Thanksgiving, had vines close to three feet high 62 days later.

The Future. The technology under development can be employed in a range of green greenhouses. These include attached units that supply heat—as well as food a few steps from the kitchen—to large commercial units that produce fresh food all year around for customers of local farmers' markets, restaurants, and grocery stores. All sizes can maintain remarkably tiny carbon footprints even without photovoltaics, net zero or better with them.

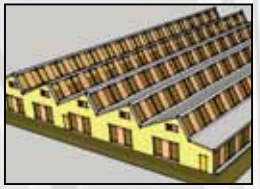
Building on research findings, several conceptual drawings of green greenhouses of the future are shown on the right.

Soil and air temperatures of greenhouse and hoop house during the cold snap of Jan/Feb 2011

Plot of five cold days, high 44F, low -18F. The researchgreenhouse never went below 50F, rising to 82F a few hours after the outside air temperature was 18 below zero. The hoop house air got as low as zero.




Residential configuration


Commercial configuration