

**HYBRID ALL ELECTRICAL RADIANT FLOOR/FORCED AIR with DIRECT
EXPANSION GSHP IN A NORTHERN GREENHOUSE**

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ABSTRACT

This paper presents the conception and the results of a 12-month field experiment of an original, hybrid, all electrical, radiant floor/forced air system including a direct expansion ground-source heat pump for heating a northern greenhouse. In Canada, the majority of greenhouses is traditionally heated by fossil combustibles (natural gas, oil) and their annual energy costs are object of the energy prize fluctuations. A recent, sudden rise of the market natural gas prizes has pushed the greenhouses owners to consider other alternatives for heating in order to reduce their annual operating costs. Between several alternatives, the use of a ground-source, direct expansion heat pump was considered and then field tested in an experimental greenhouse sited in a very cold climate region. The first prototype, aiming to fully eliminate the natural gas as primary source and to replace it by an all electrical energy source system, includes a concrete radiant floor, a refrigerant-to-air de-superheating heat exchanger and an electrical back-up coil. Among the original contributions of the system development it can be mentioned the optimum design of the direct expansion ground heat exchanger, buried at only three feet in a very cold climate, and the efficient control of the total heating capacity, floor surface temperature and the compressor's discharge superheating upon the outdoor temperature conditions and the actual heating demands. A 15-ton heat pump equipped with an horizontal ground heat exchanger and three identical hermetic compressors allowed to reduce the annual energy cost by about 40 % compared with a conventional greenhouse, and to assure the same or better internal conditions for an efficient production.