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Strategies for Arctic Greenhouse Farming: An Energy and Technology Survey of Greenhouse Farming in the North of Sweden

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Abstract : This article covers a study focusing on a subarctic greenhouse located in Nikkala, Sweden. Through a visit and the creation of a CFD model, the study investigates the differences in energy demand with high pressure sodium (HPS) lights and light emitting diode (LED) lights in combination with an air-carried and water-carried heating system accordingly. Through an IDA ICE model, the impact of insulating the parts of the greenhouse without active cultivation was also investigated. This, with the purpose of comparing the current system in the greenhouse to state-of-the-art alternatives and evaluating if an investment in either a water-carried heating system in combination with LED lights and insulating the non-cultivating parts of the greenhouse could be considered profitable. Operating a greenhouse in the harsh subarctic climate found in the northern parts of Sweden is not an easy task and especially if the operation is year-round. With an average temperature of under -5 °C from November through January, efficient growing techniques are a must to ensure a profitable business. Today the most crucial parts of a greenhouse are the heating system, lighting system, dehumidifying measures, as well as thermal screen, and the impact of a poorly designed system in a sub-arctic could be devastating as the margins are slim. The greenhouse studied uses a pellet burner to power their air- carried heating system which is used. The simulations found the resulting savings amounted to just under 14 800 SEK monthly or 18 % of the total cost of energy by implementing the water-carrying heating system in combination with the LED lamps. Given this, a payback period of 3-9 years could be expected given different scenarios, including specific time periods, financial aids, and the resale price of the current system. The insulation of the non-cultivating parts of the greenhouse was found to have possible savings of 25 300 SEK annually or 46 % of the current heat demand resulting in a payback period of just over 1-2 years. Given the possible energy savings, a reduction in emitted CO_2 equivalents of almost 1,9 tonnes could be achieved annually. It was concluded that relatively inexpensive investments in modern greenhouse equipment could make a significant contribution to reducing the energy consumption of the greenhouse resulting in a more competitive business environment for sub-arctic greenhouse owners. New parts of the greenhouse should be built with the water-carried heating system in combination with state-of-the-art LED lights, and all parts which are not housing active cultivation should be insulated. If the greenhouse in Nikkala is eligible for financial aid or finds a resale value in the current system, an investment should be made in a new water-carried heating system in combination with LED lights.

Keywords : energy efficiency, sub-arctic greenhouses, energy measures, greenhouse climate control, greenhouse technology, CFD
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