DEVELOPMENT OF A CONCEPT FOR A ZERO FOSSIL ENERGY GREENHOUSE

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Abstract
Dutch government and greenhouse horticultural practice aim for reduction of fossil energy use and of environmental loads by increased use of sustainable energy in 2010 and by producing energy neutral greenhouses in 2020. In this framework transition from current fossil energy based heating systems to concepts for energy neutral greenhouses are explored. This research aims to design a greenhouse concept with minimal use of fossil energy. The concept was named fossil-zero-greenhouse. Current energy technology and sustainable energy are used as basis for this concept. Boundary conditions for the design are that Dutch energy and environment objectives are realised and that the concept is not dependent of conventional greenhouses nearby to close the energy balance. Methodical design methods were used to come to a successful design. Literature research was conducted to find appropriate technologies on climate functions with emphasis on technologies capable of controlling crop growth in a closed greenhouse setting. These technologies were displayed in a morphologic chart and experts composed in total nine design concepts for the fossil-zero-greenhouse. These concepts were evaluated against criteria resulting from the brief of requirements. A first quick scan expert evaluation followed but did not point out a unanimous best solution, mainly caused by different viewpoints of the experts. The on-average best concept uses an aquifer for long term heat and cold storage.

Geothermal heat and a heat pump connected to the warm pit of the aquifer were used to heat of the greenhouse. Electricity need is generated in a sustainable way. Cooling and dehumidification of the greenhouse is done by a heat pump and with help of cold pit of an aquifer. This concept was evaluated in depth with help of model calculations. Different scenarios were evaluated that focused on minimizing heat demand, closed or ventilated greenhouse concepts and available capacity of geothermal heat. From the simulations it was concluded that a combination of geothermal heat and a heat pump/aquifer can fill in 90% of the heat demand of the greenhouse, however to work completely without a central boiler is difficult. Also a fully closed greenhouse concept is hard to manage in the summer season. For this season the chosen concept was not able to cool and dehumidify the greenhouse air to target temperature and humidity with given technologies. A semi closed fossil-zero-greenhouse could solve this problem.