FURTHER R & D NEEDS FOR SWEDISH SOLAR HEATING TECHNOLOGY 1990-1993

AN EXPERT GROUP PLAN SPONSORED BY THE SWEDISH COUNCIL FOR BUILDING RESEARCH

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ABSTRACT

In the 1970's when the Swedish development seriously started, experimental plants were built with the primary aim of testing various technologies. The economical aspects were of secondary interest which, in many cases, resulted in high costs and even in poor quality. In the second plant generation during the 1980's, R & D was concentrated upon lowering costs and enhancing performances for the most promising system concepts. Systems are included here for DHW, and for combined DHW and space heating designed for solar heat coverages between 30% and 80% of the annual heat requirement.

In the named plan, the state of the art and the R & D needs are described with the focus upon residential heating. Included are systems for multi-family houses, incorporating roof-integrated solar collectors and short-term heat storage. More developed construction and urban planning methods for roof integration is stressed here, as well as systems flexible for size expansion, e.g. through connection to an external seasonal heat storage.

Also included are district heating systems for solar heat supply of up to a couple of hundred flats. Ground or roof based collectors and seasonal heat storage in water-filled pits or ducts in deep ground are considered here. Emphasis is placed on more efficient high temperature flatplate collectors, more simple piping systems and further development of heat insulation and water-sealing methods for pit storage as well as high temperature practical tests for duct storage.

KEYWORDS

Residential solar heating: state of art; experimental building needs

INTRODUCTION

It is now approximately 10 years since the solar energy technology started to be seriously developed in Sweden. During the 70's, experimental installations were built mainly for testing purposes and without any significant consideration to cost which, in many cases, was extremely high, at the same time as results were poor. In line with results produced from this first generation installation, continued development efforts during the 80's has concentrated on lowering costs as well as improving performances for the most promising types of systems with regard to possible competitive power for the future Swedish heating market. Among these are partly systems for solar heated domestic hot water in multi-family houses, partly solar heating systems even for a minor part of the space heating load, as well as systems with seasonal heat storage which can cover the bulk of the total annual heating demand.

The area of responsibility of the Swedish Council for Building Research (BFR) - the built-up environment - consists mainly of space and domestic hot water heating but even bathing facilities are included. BFR's expert planning group for solar heating technology consists of some 10 experts who have compiled the basis for the BFR's 3-year R & D plan for 1990-1993. This basic report will be published in the summer of 1989.

Solar heating systems to heat buildings and domestic hot water is usually divided into two groups, "individual systems" and "group systems". "Individual systems" usually mean that the solar collectors are placed on the roof and storage is inside the building and used for diurnal storage of solar heat. By "group systems" this often means that solar collectors are placed on the ground and that storage is placed away from the building and used either for seasonal storage or diurnal storage. A group system can, however, also have solar collectors placed on the roof. A group system via an extended network is the simplest way to meet heating demands which serve several buildings, whereas an individual system for one or two buildings is best carried out via a more local network. Larger group systems are sometimes called "district heating systems" but no distinct or well defined boundary exists.

The three-year plan describes the development situation and the background for the Swedish solar heating technology within the mentioned area. With regard to individual systems, this includes systems for multi-family houses, single-family houses and premises such as hospitals. With regard to group systems, this mainly includes smaller systems, such as those which provide heating for up to a few hundred apartment units.

EXPERIENCES AND CONTINUED DEVELOPMENT NEEDS

For the different application areas within Swedish active solar heating technology, the main experiences and continued development needs are given below. The named development needs, in the most cases, are strongly connected to increased field experimental building activities.

Group systems:

Experiences:

Technically seen, well developed principal solutions exist for large solar heating plants with ground-assembled solar collectors and diurnal or seasonal heat storage in water-filled tanks, ground pits or rock caverns. Basic developed design methods exist for systems with solar heating of large groups of buildings which cover the greater part of the annual heating demands, or only the heating demands during the summer months.

Very good technical and economical development possibilities are judged to exist for group systems of various sizes.

Development needs:

- More effective and rationally manufactured high temperature solar collectors
- Complete systems with a very simplified piping connection
- Direct ground seasonal storage of heat with high temperatures.
- Heat insulation and water-sealing methods with high durability for pits.

Individual systems for multi-family houses:

Experiences:

Technically, relatively well developed solutions exist for solar heating installations in private multi-family houses with roof-mounted solar collectors and diurnal storage in water-filled tanks. Practically developed design methods exist for systems which supply solar heating for buildings with up to one-third of the annual heating demand

Economically, systems which supply heating below a coverage of 20% are preferred. Systems for only domestic hot water heating in newly built houses are the most interesting.

Development needs:

- More effective and rational roof-mounted high temperature solar collectors.
- Architectually suited roof-mounted collectors which fit into newly built areas.
- Effective combinations with supplementary heating systems
- Methods for expansion of individual systems to group systems

Individual Systems for single-family houses:

Experiences:

Technically, relatively simple package solutions for installations in both new and older houses exist. Similar supply options as in multi-family houses exist and the solar heat coverage can, for suitably utilized small housing systems, be equally as good as in multi-family houses.

From an economical point of view, a relatively strong development is needed in order to make these systems competitive. An assessment is that systems installed in a newly built houses has the best development possibilities.

Development needs:

- More effective and simple integrated systems for newly built standard houses

SUGGESTION FOR SUBSTANTIAL CONTRIBUTION WITHIN EXPERIMENTAL BUILDING ACTIVITIES

According to this plan, in the majority of the solar heating installations it most interesting to use high temperature solar collectors which are efficient at a temperature of between 60 to 100°C. Such solar collectors are assumed to be incorporated in all the below mentioned cases. There are applications where lower or higher temperature demands can be met and where other types of solar collectors can be of interest when cost and performance are considered jointly. Firstly, however, more extensive system-related studies are needed before experimental building projects can be considered.

Within the group of experimental building projects suitable for quick application are the following specific examples:

Group systems:

- Building of two to three heating plants in new building areas with heating loads of approx. 1,500 - 2,000 MWh/year which corresponds to approximately 200 - 300 apartments in multi-family houses. One of the plants should have ground heat storage in clay and the other, storage in a water-filled ground pit. The pit should be constructed according to the principle which is most suitable in the on-going prototype investigations. The ground heat storage should eventually be tested, partly in connection to heating systems with very low temperature demands, i.e. floor heating systems or via heating in cavity walls, and partly in connection to more normal low temperature systems, i.e. overdimensioned radiator systems. Coverage by solar heating should in all areas be at least 60%.

- Building of a plant in a building area with a heating demand of approx. 10,000 MWh/year - which in a newly built area corresponds to approx. 1,400 apartments in multi-family houses. For heat storage

water-filled rock caverns with temperatures of up to approx. 100°C should be used. Solar heating coverage should be at least 60%. An alternative is the expansion of the already existing Lyckebo plant which includes 100,000 m^3 of rock caverns, where large ground areas are available, with approx. 22,000 m2 of solar collectors.

Individual systems in multi-family houses

- Building of two to three plants in new building areas which consist of at least 100 apartments. The solar heating system should be of a combined type, and supplementary heating should be provided via local group distribution networks where diurnal storage can be utilized advantageous for all heating supply.

One area can be provisionally planned for successive expansion of the number of houses and one for direct expansion but with a later connection to some kind of seasonal heat storage. The third area can be planned as a cross between the other two, but provisionally differentiated from them with respect to some important factor, i.e. number of storeys, degree of exploitation, etc.

The degree of solar heating coverage should be about 30% in all areas.

Individual systems in single-family houses

- In some standard house areas, 10-20 houses should be equipped with combined systems or domestic hot water systems. A detailed follow-up of the solar heating results and heating loads should continue for the next few years.