SOLARGE: ENLARGING SOLAR THERMAL SYSTEMS IN MULTI-FAMILY HOUSES, HOTELS, PUBLIC AND SOCIAL BUILDINGS IN EUROPE
- SOUND SYSTEM SOLUTIONS FOR MULTI-FAMILY HOUSES -

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Summary

Taking national and European energy and climate protection policies into account, the development and implementation of collective solar thermal systems is gaining importance. One of the promising target markets analysed in 8 EU project countries is the Multi-Family Housing sector. Not only because of the large number of buildings but also due to (new) legislative issues. An initial estimate of the market shows an annual potential of around 820 MWth (ca. 1,2 million m^2) that can be developed in the coming years. Over 40% of this potential (350 MWth) can be found in Spain followed by Germany and France with 150 MWth. The market will be served best if solutions are applied that will deliver solar powered hot water over 20 years without technical problems and minimum maintenance requirement. This means that complexity & reliability is a critical item to consider. So, sound system solutions for solar powered hot water systems are simple and solid configurations, meaning: systems are composed with as few as possible (moving) parts and complex hydraulic solutions are avoided.

Key words: market overview, system configurations, market development

Resumen (Español)

Con la entrada en vigor de nuevas normativas, nacionales y europeas, en el campo del ahorro energético y protección del medio ambiente, el desarrollo e implementación de los sistemas colectivos de energía solar térmica está ganando importancia. Uno de los mercados potenciales más prometedores, una vez analizados 8 países de la UE, son las instalaciones para viviendas multifamiliares. No sólo por la gran cantidad de edificios existentes y proyectados, sino también debido a los nuevos requerimientos normativos. Una estimación inicial del mercado muestra un potencial anual alrededor de 820 MWth (cerca de 1,2 millones de m^2) a desarrollar en los próximos años. Mas del 40% de este potencial (350 MWth) lo encontramos en España, seguido de Alemania y Francia con 150 MWth. El mercado estaría mejor preparado si las soluciones aplicadas proporcionan agua caliente solar durante 20 años sin problemas técnicos y con el mínimo mantenimiento posible. Esto significa que la complejidad y fiabilidad es un punto crítico a considerar. De lo expuesto se deduce que los sistemas térmicos para A.C.S. deben ser simples y sólidos en la configuración, lo que significa diseño de instalaciones con el mínimo de piezas (móviles) posible y descartando complejas soluciones hidráulicas.

Key words: estado del mercado, configuraciones del sistema, desarrollo del mercado

1 INTRODUCTION

1.1 General introduction

Taking national and European energy and climate protection policies into account, the development and implementation of collective solar thermal systems is gaining importance. The European project SOLARGE (enlarging solar thermal systems in multi-family-houses, hotels, public and social buildings in Europe) running till December 2007, incorporates all relevant aspects. One of the promising target markets analysed in 8 EU project countries is the Multi-Family Housing (MFH) sector. Not only because of the large number of buildings but also due to (new) legislative issues. The application of solar thermal systems solutions in this market is

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not uniform and a lot of technical as well as non-technical issues have to be addressed. This paper will give an overview of the MFH market as well as the main different system configurations including an analysis on technical issues: e.g. system performance, complexity and reliability, system heat losses, etc., as well as on non-technical issues like investment costs, ownership, exploitation and invoicing and maintenance.

1.2 MFH Market

The total MFH market segment is large in Europe. From the market study of the SOLARGE project (Sievers, 2005) the following figures were derived from the 8 participating countries. The total number of MFH is around 46 million, representing almost 43% of the total dwellings in these countries. In an absolute sense Germany has the most MFH (13 million), followed by France (over 10 million). Also the latest annual production of MFH was analyzed in the 8 countries (2004). Highest annual production was reported in Spain (400.000), followed by Italy (200.000) and France (130.000). See figure 1 for a total overview of the 8 countries.

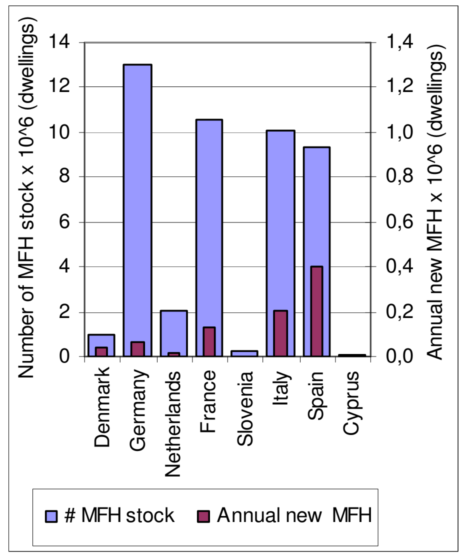

Figure 1: MFH stock and annual production of MFH

1.3 MFH solar thermal market

The capacity installed worldwide of solar thermal collectors was around 100 GWth at the end of 2004 and is estimated to be 115 GWth at the end of 2005. This is almost 2 times more then the total worldwide installed wind power capacity (Weiss et al, 2006).

Based on the market figures of the SOLARGE project (Sievers, 2005) and some expert guesses an initial estimation of the MFH solar thermal market was made for the 8 participating countries. The estimated potential is plotted against the total installed capacity of solar thermal glazed collectors at the end of 2004, see figure 2. Total estimated annual potential is 820 MWth, this is 15% of the total accumulated installed capacity in these countries. The annual energy production of this potential is 475 GWh, which will reduce 210 Mtons of CO_2 on a yearly base. The potential is roughly divided in 60% existing and 40% new build MFH. Currently Spain has the highest annual potential, around 350 MWth, followed by Germany and France with 150 MWth. The overall potential in Spain is mainly focused on newly build MFH. The reason for this is that from 29th September 2006 onwards, it will be obliged to apply solar thermal systems in all new buildings and major renovation projects, in combination with a remaining high building volume. However the projection of the high new MFH volume can be tempered by the increase of the interest rate.

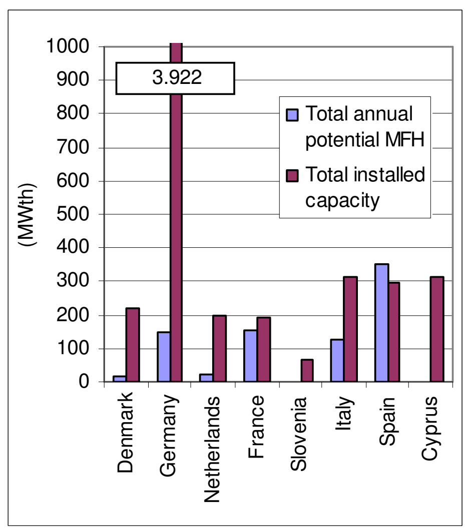

Figure 2: Total estimated annual potential MFH market versus the total accumulated capacity of glazed solar collectors, end 2004 (source: ESTIF, 2005).

2 SYSTEM CONFIGURATIONS

2.1 Solar powered hot tap water installation

Solar thermal installations are mainly used for the production of hot, sanitary water. In this paper this main application is considered. The main 2 components of a solar powered hot tap water installation are: the solar thermal system and the back-up heater. The solar system itself is normally formed by 2 main components: the solar collectors, transferring the solar irradiation into useful solar heat and a storage tank to store the solar heat for later use. Some systems combine the solar/hot water storage and the back-up heater in one device and some systems combine collector and solar storage in one device (so called Integrated Collector Storage). Because the working fluid of solar powered hot tap water installations is liquid (water based) the components are connected by tubes to transport the energy from one component to another. We distinguish 3 main circuits: primary circuit, between collector and solar storage, secondary circuit, between solar storage and back-up heater and a third circuit between back-up heater and demand (taps). For the final savings these circuits have to be taken into account because of heat losses, especially if recirculation circuits are applied.

2.2 Different system configurations

For solar powered hot water systems several basic system configurations exist. The main distinction is between central versus de-central components (collector, solar storage and back-up heater). On this basis we can describe 4 main configurations (see table 1 and figure 3). The gray-shaded areas are not applicable.

Table 1: Basic system configurations

Collector	Solar storage		Back-up heater		Number	Remark
	Central	De-central	Central	De-central		
De-central*		X		X	1	Single family houses, apartments buildings up to 2 or 3 storeys
Central*	X		X		2	Large central systems (e.g. hotels)
	X			X	3	Large systems for multi-family buildings
		X		X	4	Large systems for multi-family buildings

*) de-central is on dwelling level, central is on string or building level

For the MFH sector all main configurations can be applied, however configuration 1 (a standard solar water heater system for single family houses) is restricted by the number of storeys regarding a meaningful use. Totally centralised systems (2) are essentially the same as configuration 1, although all components are larger. If this configuration is applied for MFH normally a hot tap recirculation circuit is incorporated in the installation design for comfort reasons (less waiting time). System configurations 3 and 4 are specially developed for multi-family buildings. The systems have a central collector, a de-central back-up heater and a central or de-central solar storage. The applied back-up heater can be a flow through combination boiler (for heating and hot tap water), or a hot tap water storage heated by electricity or a conventional boiler/fuel. Configuration 4 can be divided in different sub-configurations (see figure 3):

4.1) Solar storages connected in parallel (per string of building) with 1 central solar control unit and pump

4.2) Solar storages connected in parallel (per string) with de-central (1 per dwelling) solar control units and pumps

4.3) Solar storages connected in series (per string) with 1 central solar control unit and pump.

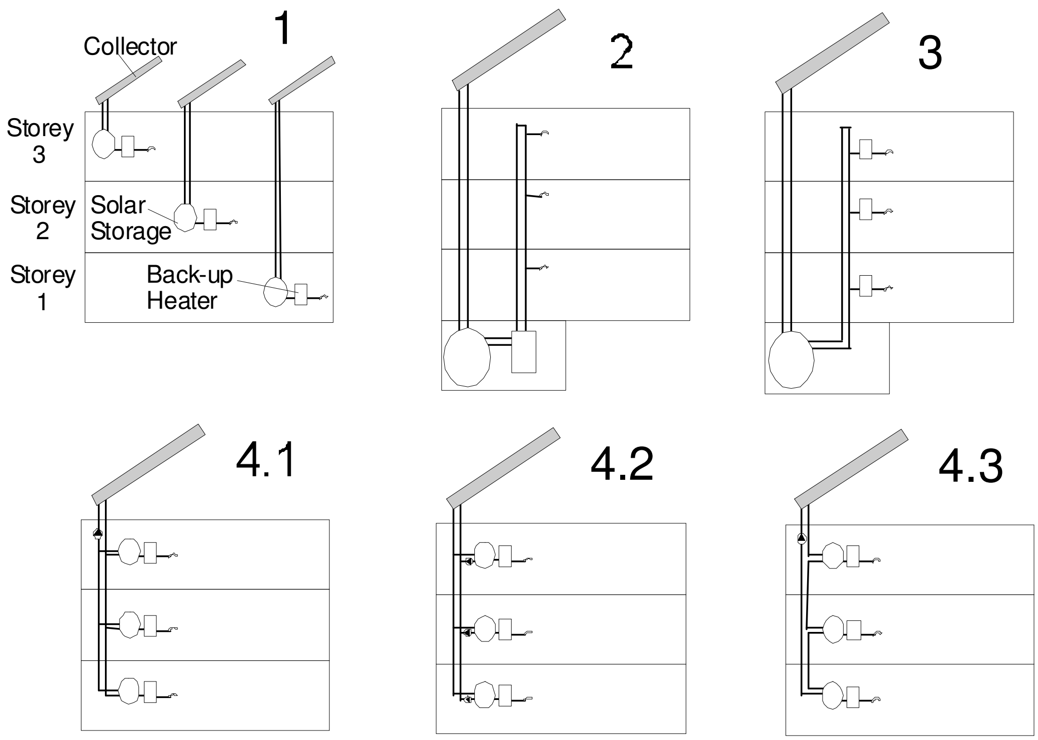

Figure 3: Overview of analysed system configurations for MFH

2.3 Analyses

In table 2 the considered system configuration are analysed on main technical issues: suitability, system performance, system heat losses and complexity and reliability, as well as on non-technical issues: like investment costs, exploitation and invoicing and maintenance.

Which configuration is the best solution will be determined by various conditions and sometimes dictated by the building and/or existing installation. Also the various actors will have different needs. End users want to have a reliable hot water supply, low energy bills and no maintenance. Property developers will normally look for the cheapest solution which complies with the minimum requirements. Also occupied floor area by a solar system (= loosing money) is an issue for them. However, in general the total market and all actors are served best if systems will be applied that will deliver solar powered hot water over 20 years without technical problems and a minimum requirement of maintenances. This is especially true for solar powered hot water systems because of the classic problem that in the case the solar system fails this will not (directly) be noticed by the user; the back-up heater will serve the demand. Taking this into account, the most critical item to be considered is “complexity and reliability”.

Based on this, sound system solutions for solar powered hot water systems should be simple and solid system configurations, meaning: systems are composed with as few as possible (moving) parts and complex hydraulic solutions are avoided. This will also decrease installation costs and mistakes. The optimal/desirable configuration in this case is a system without electronic control unit(s), and pump(s) and a few additional valves.

Table 2: Analyses of different solar powered hot water system configuration for multi-family-houses

Item	1: standard solar water heater	2: total centralized system	3: centralized solar system with de-central back-up	4.1 de-centralized solar system, parallel, central control	4.2 de-centralized solar system, parallel, de-central control	4.3: de-centralized solar system, series, central control
Suitability	Only applicable to the 2 to 3 top storeys in MF building. Additional space needed in dwelling for solar storage (1m^2).	Sufficient space needed for large solar storage and back-up heater in community area. No additional space needed in dwelling for solar storage and back-up. Specially interested for replacement of existing central hot tap water installation. Normally separate systems for space heating and hot water back-up heating.	Sufficient space needed for large solar storage in community area. No additional space needed in dwelling for solar storage. In the case a combination boiler is used, only one device is needed for space heating and hot tap water back-up heating.	Additional space needed in dwelling for solar storage (1m^2). In the case a combination boiler is used, only one device is needed for space heating and hot tap water back-up heating.	Additional space needed in dwelling for solar storage (1m^2). Can only applied in strings, so normally several strings needed per building. In the case a combination boiler is used, only one device is needed for space heating and hot tap water back-up heating.	Additional space needed in dwelling for solar storage (1m^2). Can only applied in strings, so normally several strings needed per building. In the case a combination boiler is used, only one device is needed for space heating and hot tap water back-up heating.
System performance	Standard, it is not possible to make use of simultaneousness advantages.	It is possible to make use of simultaneousness advantages, so less m^2 of collectors.	It is possible to make use of simultaneousness advantages, so less m^2 of collectors.	It is possible to make use of simultaneousness advantages, so less m^2 of collectors. Central control with de-central solar storages results normally in a non-optimal system performance.	It is possible to make use of simultaneousness advantages. Optimal system performance, due to de-central control. Each dwelling can use the whole collector array.	It is party possible to make use of simultaneousness advantages. Overall system performance the same of higher as de-central parallel (4.2). Due to higher collector circuit resistance, higher pump capacity needed.
Heat losses	Only collector circuit heat losses; depending on the number of storey. High heat losses of solar storages; 2 to 3 times higher than central storage.	High. If solar storage is placed in basement large collector piping needed. Recirculation circuit needed between back-up and taps. High losses (circulation 60º water 24 h/day). Also back-up efficiency has to be taken into account. Low heat losses of solar storage.	High. If solar storage is placed in basement large collector piping needed. If recirculation circuit is applied between solar storage and back-up heaters medium high losses but less than centralised system (2), lower average temperature.	High collector circuit heat losses. Normally a large quantity of piping per dwelling is needed for collector circuit. High heat losses of solar storages; 2 to 3 times higher than central storage.	Medium collector circuit heat losses. Less quantity of piping per dwelling compared to 4.1. High heat losses of solar storages; 2 to 3 times higher than central storage.	Low-medium collector circuit heat losses. Less quantity of piping per dwelling compared to 4.2. High heat losses of solar storages; 2 to 3 times higher than central storage.

Complexity & reliability	Standard, reliable systems. Each dwelling has his own complete system. If one control or pump fails, this will only affect the dwelling of the event.	Not complex system, limited amount of standard components needed. If control or pump fails, this will affect all the dwelling connected.	Not complex system, limited standard components needed. If control or pump fails, this will affect all the dwelling connected.	Complex system, especially the collector circuit. Various types of valves needed per dwelling. Difficult to adjust flows and control. Specialized solar installers required. If control or pump fails, this will affect all the dwelling connected.	Quite complex since each dwelling has his own control and pump. Additional valves needed. Less problems to adjust flows and control compared with 4.1. Specialized solar installers required. If one control or pump fails, this will only affect the dwelling of the event.	Not complex system, limited amount of standard components needed. If control or pump fails, this will affect all the dwelling.
Investment costs	As standard single family dwelling with additional piping costs depending on the storey.	Investments costs solar system low. Investment cost for recirculation circuit can be considerable.	Investments costs solar system low. Investment cost for recirculation circuit can be considerable. Investment costs for back-up higher as central back-up (2).	Investment costs high, mainly due to complex and large collector circuit, additional valves and a number of small solar storages. Costs for de-central solar storage up to 2 times higher than central storage.	Investment costs high, mainly due to separate control units pumps and a number of small solar storages. Costs for de-central solar storage up to 2 times higher than central storage.	Investment cost solar system lower than de-central parallel systems (4.1 & 4.2) mainly because of less components needed, but higher than 2 and 3 due to a number of small solar storages. Costs for de-central solar storage up to 2 times higher than central storage.
Exploitation & invoicing	Each dwelling has his own complete system. No separate invoicing is required.	Have to be taken care of by the association of tenants. Invoicing of hot tap water and back-up energy. Not possible for exact invoicing per dwelling if no additional water meters are installed (per dwelling).	Have to be taken care of by the association of tenants. Invoicing of hot tap water. Not possible for exact invoicing per dwelling if no additional water meters are installed (per dwelling).	No separate invoicing is required.	No separate invoicing is required.	No separate invoicing is required.
Maintenance	Normal, each tenant will take care of his own system	Have to be taken care of by the association of tenants for the solar system and back-up.	Have to be taken care of by the association of tenants for the solar system. Back-up heater by tenant.	Have to be taken care of by the association of tenants for the solar collector part. Solar storage and back-up heater by tenant.	Have to be taken care of by the association of tenants for the solar collector part. Solar storage and back-up heater by tenant.	Have to be taken care of by the association of tenants for the solar collector part. Solar storage and back-up heater by tenant.

3 CONCLUSIONS

- One of the promising target markets for the application of large scale solar thermal systems is the Multi-Family Housing (MFH) sector. In the 8 analyzed countries the total amount of MFH (46 million) accounts for 43% of the total housing sector in these countries.
- An initial estimation of the MFH market shows an annual potential of around 820 MWth (ca. 1,2 million m^2) that can be developed in the coming years.
- Over 40% of this potential (350 MWth) can be found in Spain followed by Germany and France with 150 MWth. The annual potential in Spain exceeds the total accumulated installed capacity in 2004. The main market in Spain will be the newly build MFH due to the fact it is obliged by law as from the end of September 2006 onwards.
- For the application of solar powered hot water installation in MFH different system configurations can be applied which all have there pros and cons concerning technical and non-technical issues. In general the total market and actors are served best if solutions are applied that will deliver solar powered hot water over 20 years without technical problems and a minimum maintenance requirement.
- So, sound system solutions for solar powered hot water systems are simple and solid system configurations, meaning: systems are composed with as few as possible (moving) parts and complex hydraulic solutions are avoided. The optimal/desired solution is a system without electronic control unit(s), and pump(s) and a few additional valves.

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