Review of solar energy developments in the Netherlands

REVIEW OF THERMAL SOLAR ENERGY DEVELOPMENTS IN THE NETHERLANDS

G.Brouwer (Holland Solar), C.W.J. van Koppen
(Eindhoven University of Technology)
Holland Solar, Korte Elisabethstraat 6,
3511 JG Utrecht (NL)

ABSTRACT

Over a period of about 15 years the Dutch Solar Energy Systems industry has become a major competitor on the market for advanced thermal systems and components with a high performance and relatively low prices. Exploitation of new developments led to highly promising prospects for solar energy technology, the results of which may prove to be valuable in the fight against pollution and the struggle against exhaustion of traditional energy sources. However, a breakthrough of solar energy applications is hampered by competition from low energy prices.
This paper deals with the development of the Dutch Solar market over the past 15 years. Particular consideration is given to solar systems for the preparation of hot water for private use, restaurants and for agricultural applications. In the near future, the cost of investment for solar systems will gradually decrease due to the change in concepts, such as the integrated energy concept (back-up heater included). Also the integration of solar systems into the present building and installation techniques has to be stimulated in order to attune and optimise the use of new technological developments (new materials, durability, etc.)

KEYWORDS

Solar systems, state-of-the-art, market, evolution, potentials.

INTRODUCTION

The adverse climate and the availability of competing energy sources in an extensive infrastructure forced the Dutch solar industry to develop highly efficient low cost solar systems. Even in a country like the Netherlands there is sufficient solar radiation for profitable use in heating. The climate is characterised by typical maritime conditions i.e. mild temperatures, abundant evenly distributed precipitation and reasonable solar radiation levels during summer. Possibilities for the use of solar energy should be looked for in the sectors with a low temperature heat demand predominantly during summer. With 75% of this solar radiation and an average ambient temperature of 14 C during daytime the months of summer offer attractive possibilities for solar energy use.
All over the country fluctuations in all weather data are relatively small (within 5%). (E.C. Solar Radiation Atlas, 1979).

SOLAR ENERGY APPLICATIONS.

Fundamental criteria for solar heat utilisation.

Consumers in different application categories in the Netherlands utilise in a passive or more active way solar heat in a positive or negative sense. Any application requires specific criteria, which, in general, will contribute to optimum results.
The building structure is affected by the outdoor climate and solar heat is absorbed and accumulated. Taking also into account the internal thermal loads the heating installation tries to make a compromise for the consumers.
This results in an optimisation process in which a maximum of solar energy can be used:
a. active systems by means of solar collector installations and
b. passive systems by means of devices or building structures.

The performance criteria for these solar energy systems exist within a context of requirements that depend on the application (e.g. building) for which the system is designed, the site, the region and its climate, or even national energy goals.
The climatic conditions may have a strong influence on designs, components and systems, but also on the selection of materials.
In the Netherlands the performance and the economic feasibility justify realisations in a specific application field. Because of absence of direct solar radiation during summer it would not be worthwhile to install a solar system for cooling. The local climatic conditions, the local heat demand and the government rules and regulations (health, safety, fire resistance) justify a specific solar energy application and they are the first criteria for selecting a system.
The next step involves the selection of a system on technical grounds.

The different application fields with their specific operating temperatures require an adaptation of the construction of the component or the solar system. Solar collectors for swimming pools usually don't have a transparant cover, whereas most other systems ask for more sophisticated solar collectors.
To summarise, even in the Netherlands with a highly developed infra structure and mechanisation there are a lot of application fields in which solar energy can play an important role.

The potential of solar systems for the heating of swimming pools.

The potential use of solar energy for swimming pools in the Netherlands depends on the potential number of swimming pools and on the type whether they are outdoor, indoor or combi pools and on the heat yield per square meter collector area. Table I shows an estimate from some statistical data.

The heat yield per square meter collector area particularly depends on the inlet temperature of the heat transfer medium. When the water of the basin directly passes the solar collector the inlet temperature varies from fresh make up water temperature (about 10 C.) to pooltemperature (25 C.).
If a heat exchanger is used the inlet collector temperature will rise about 5 C. Pool covers can substantially reduce heat losses when the pool is not in use. On the other hand, however, on sunny days we may be confronted with the problem of an overheated pool.

Based on optimised installations the potential of the useful solar energy gained is estimated 0.65 - 1 PJ/year.

Table I

		number of facilities		surface area (m2)
* swimming facilities		910	municipal 60% private owner 40%	
* swimming pools	outdoor	500	poolsurface area	700000
	indoor	260		100000
	combi	150		350000
* potential collector area swimming pools				400000
* installed collector area as January 1989		80		40000

Note: small private swimming pools for dwellings are not included

Table II

Energy demand per year for hot water production:
(required temperature 40-80 °C)

* dwellings		30 PJ
one family	3,7 mln	
multistore	1,6 mln	
* elderly houses	0,14 mln beds	
* hospitals and nursing homes	0,14 mln beds	4,5 PJ
* restaurants		
* industry		14 PJ
* agriculture		1,5 PJ
	total:	50 PJ

The potential of solar systems for the preparation of hot water.

Domestic hot water solar systems consist of the same components as bigger utility hot water solar systems. However small DHW units have been standardized (collector area about 3m2 and a storage tank of 120 ltr.) whereas the bigger solar systems are specially designed and built. The potential of energy saving and the market development differ considerably. DHW solar systems (with a hot water demand of 100 ltr/day of 60 C. on average) are designed on the basis of a yearly saving of about 50% whereas the bigger systems have to deal with shorter pay-back periods, so smaller systems as well as smaller solar fractions are economically more attractive. In the table II below some important potential applications are shown.
Though industrial processes ask for very high amounts of warm and hot water economic criteria do not easily lead to the realisation of solar systems.

With a solar fraction of 40% and a penetration level of 50% the solar energy potential has been estimated 6-10 PJ/year.

SOLAR ENERGY MARKET IN THE NETHERLANDS.

Market evolution.

Starting around 1975, the solar system market grew rapidly until 1985. Since 1986 however the market has been showing ups and downs (mostly) due to different impacts. The number of collector manufacturers dropped from 20 in the first period to about 3 in the last few years. This was mainly due to the sudden fall of the oil prices and consequently to a drop in the gas and electricity prices in the Netherlands (see fig. 1).
Other influences were improvements in conventional technology competing with solar energy systems, the change of the energy price structure, the change of grants and the decline in demand. Although initially the market for swimming pool collectors had increased due to its real commercial impact, the decline of swimming pool visitors has made exploitation especially for solar systems very unfavourable.
In the sector of agriculture the decrease of cattle fattening led to the same results. At this moment about 35 solar energy projects in different agricultural applications have been realised.
The DHW systems have again been dominating the market for the last 2 years.
In some situations combined systems (including space heating) were developed and are operating very well. Due to important incentives and the interest of local authorities this year the solar energy market is increasing considerably.
Fig. 2 shows the market evolution by application up to January 1989, not including collectors for passive solar use applications.

The yearly gain of solar energy with this collector area can be estimated about 100 TJ.

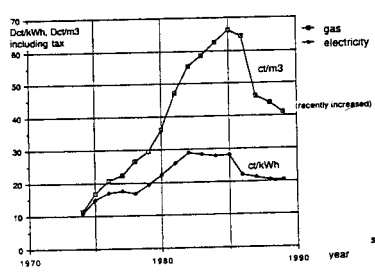

Fig. 1 Evolution of energy prices for domestic consumers

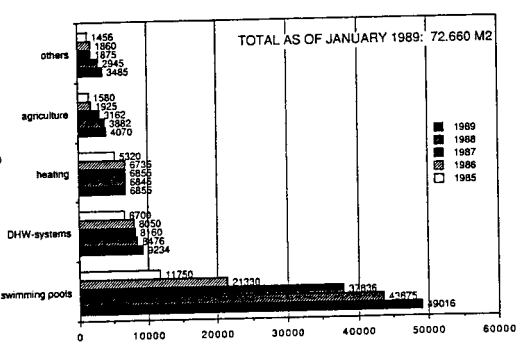

Fig. 2 Installed collector area in the Netherlands (passive solar systems not included)

Changes in solar systems.

In a period of about 15 years the most important innovations of system type, construction etc. have been realised in DHW solar systems due to the prospects of serial production.
In the beginning DHW systems consisted of assembled more conventional components, however, the construction of the collector was the only component on which Research and Development had been concentrated. This resulted in the development of the high efficiency and low cost type of the heat pipe-evacuated tube collector and the very well implemented flat plate collector with spectral selective coated absorber.
More and more DHW systems have been greatly improved and realised. They consist of 2 main components, collector and storage.
The other components have been integrated and directly connected with the storage.

A breakthrough of this tradition may eventually be achieved with the emphasis on a compact system. All functions of the solar system have been incorporated in one component concerning the absorption and the storage of the solar energy.
However considerable development costs and a solar energy market with high economic risks hampered an expected rapid introduction. Very attractive is the extension of the DHW solar system into dimensions of 2 or 3 times the original ones for heating purposes too. These systems have about the same economic feasibility.
In collaboration with the trade association Holland Solar and the Technical Institute of Applied Physics (TNO), guidelines for the certification of liquid and air collectors have been developed and introduced on the basis of the established UEAtc (European Union of Agreement) agreements and under the auspices of a certification body.
In the general background research, much attention was paid to developing and improving computer models for system simulation calculations. Also the System Test Facilities have been used for the fine-tuning of experimental systems or testing systems for pilot projects.

Summarising we may say that, despite new developments with promising prospects, the Dutch solar energy market as always delivers quality products based on a long experience.

Changes in investment costs.

Decrease of investment costs of solar systems are attributed to the following main factors:
. research & development activities resulting in improved components and systems.
. improved production methods
. experience and education of designers and installers
. increased production
However, also increases of investment costs occur due to:
. lack of strong competition between manufacturers
. general improvement of the economic situation
. the stronger requirements for standardisation, durability and quality
. the marketing and dealer costs (indirect sales)
The new government aid of 40 % of the investment costs on solar systems from 1988 up to now strongly affects this market. Apart from this aid the investment costs for DHW systems decreased by a factor of 2 from 1977 to 1987 but increased with about 15% since then.
Both consumer and industry profit by this measure, but nevertheless no stable market can be expected under the current circumstances.
With grants however DHW solar systems are economic feasible at this moment, especially compared with electricity boilers.
The investment costs of these traditional solar energy systems can decrease by 25% due to e.g. serial production effects; a maximum improvement of heat gain of 10-15% can be expected. The conclusion is justified: without grants and with to-day energy prices new system concepts have to be introduced, especially if solar energy has to compete with natural gas (gas-fired uxiliary heaters).

New developments.

In the near future the investment costs of solar systems will gradually decrease due to changes in concepts, systems, components and materials. The past developments and realisations prove that prospects for the application of solar energy systems are promising. However, the breakthrough, hampered by competition from low energy prices, still needs some time.
A new integrated energy concept existing of one or two componentsat most, continuously supplies heat for hot water production in dwellings. Solar radiation should automaically be included as a building component; it replaces part of the roof incorporated in the architectural design of the dwelling.
The second component, the back-up heater including heat storage, can be integrated in the solar collector circuit as one compact system for especially small systems or can be separately installed directly connected with the solar collector circuit.
The two components can be considered a combination of a building component which faces no freezing problems and an installation component; both components having their own standard requirements and specifications. In this way integration of solar systems into the existing building and installation techniques has to be stimulated in order to attune and optimise the use of new technological developments (new materials, durability, etc.).
The research on new materials and the improvements of properties of existing materials eg. durability do also arise promising possibilities for a new generation of solar systems.
The application of special plastics as construction material, the high performance of heat insulation combined with a high solar transparancy and the control of the system operation can be expanded into new solar systems. Manufacturers would be greatly helped in their research efforts by government grants. This would permit a minimum of overhead costs on production. The same conclusion applies to the existence of information data bases on realised projects, test- and measuring results, materials etc.
All efforts should be directed to encouraging solar business and reducing the costs of solar systems. Then we may eventually find an important commercial answer to energy conservation and environmental problems.

CONCLUSIONS AND RECOMMENDATIONS.

-With a percentage far below 1% of the economically feasible potential of the solar collector area at this moment the solar energy market in the Netherlands is still at an early stage.
-Experiences from solar energy projects already realised during the past 15 years in the Netherlands prove that prospects for solar energy use in swimming pools, in DHW systems and other hotwater demand applications are indeed promising.
-Without grants and with today's energy price levels conventional solar systems for private use cannot financially compete with the traditional energy sources.
-New developments and concepts in solar systems have to be stimulated in order to satisfy consumer needs, which more and more require one integrated energy system (including auxiliary heater) consisting of one or two components. In that case our position in the competition with traditional energy systems would be strengthened.
-The use of renewable energy from the (solar) environment, e.q. less pollution, by application of solar systems has to be expressed in the cost-profit comparison of solar systems.

The application categories of thermal solar systems are only a part of the fields covered by Holland Solar(the Dutch Association for the Application of Solar Energy Systems). Its 50 member companies are active in manufacturing, architectural and installation design, consultancy, research and development for photo-voltaic applications and for solar thermal applications in the Netherlands as well as abroad.

REFERENCES.

1. E.C. Solar Radiation Atlas, Brussels 1979.
2. Solar Heating and Cooling Programmes in IEA Countries 1988, March 1989 (IEA/SHC/NP88). Int. Planning Associates, Beltsville MD 20705 USA.
3. Solar heated Swimming Pools, Energy demonstration Programme, EUR 11434 EN, 1988. Proceedings of an EC Conference; Berlin 1987, ISBN 92-825-8136-5. Editor:W. Kaut.