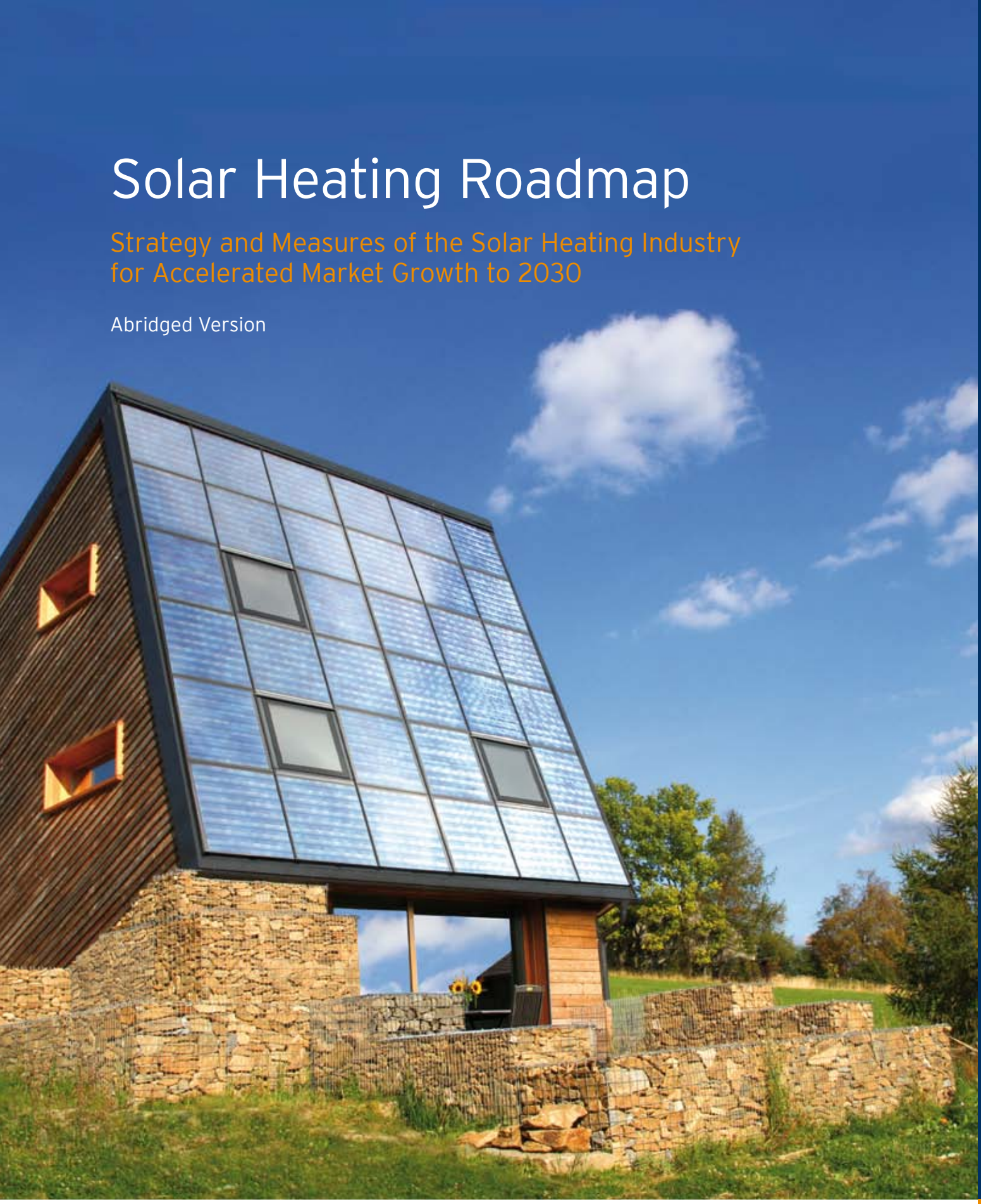
Solar Heating Roadmap

Strategy and Measures of the Solar Heating Industry for Accelerated Market Growth to 2030

Abridged Version



BSW SOLAR

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Strategy and Measures of the Solar Heating Industry for Accelerated Market Growth to 2030

Abridged Version – July 2012

Technomar GmbH

ITW Institute for Thermodynamics and Thermal Engineering at the University of Stuttgart

co2online gGmbH

BSW - German Solar Industry Association

Sponsored by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety based on a German Bundestag decision

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Press date: 31 December 2011

Title page photo: Futuristic vacation house with solar heating façade in Oberwiesenthal, Germany

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1 | Framework

1.1 Current situation and need for action

Heating requirements account for over 50% of total end energy needs in Germany. This means that significantly more kilowatt hours are needed for space heating, hot water production and process heat than for electricity and mobility together. A full energy system transformation with the goal of reducing CO_2 emissions by at least 80% in the year 2050 relative to 1990 levels can therefore only succeed if there is a clear switch to renewable energy sources in the heating sector as well, and additionally, if all savings potentials are fully taken advantage of.

Solar heating is a key driver for this process. Although in the year 2010 it only accounted for around 1% of the heating supply of German households, all the prerequisites for strong growth exist: The technology has reached a high degree of maturity, it has established itself on the market, and there are still enormous potentials for expansion that have yet to be explored.

The years since 2008, however, have shown that further growth does not occur automatically or as a result of rising oil prices alone. Industry and political stakeholders must do their part to ensure that solar heating is given the necessary boost to increase the demand for systems across all market segments, to lower costs and to trigger long term and self-sustaining growth. This is the future of solar heating to the year 2030, which is painted by the "Solar Heating Roadmap". The roadmap examines realistic possibilities of increasing system efficiency, utilizing available surface potential, developing new market segments, strengthening sales and optimizing the framework for support. The cumulative result of the roadmap is the presentation of a comprehensive industry strategy and a bundle of measures aimed at attaining the goal of installing around 70 gigawatts (GW) of solar heating capacity, or around 100 million m^2, of collector surface on German rooftops by the year 2030.

1.1 Vision and objectives

Solar heating is by far the most natural and most sustainable form of heat production, since it does not require fuel and has a high degree of efficiency in utilizing solar radiation. Solar heating should therefore be an integral part of the heat supply system in the majority of residential buildings that are suitable for this purpose. In the area of industrial process heat, solar heating contributes significantly to reducing the energy costs of companies. The solar heating industry thus has a key role to play in reaching the future goal of a climate-neutral housing stock in Germany, with energy requirements that are largely met by renewable energy sources. Further technological advances and cost reductions will give the industry a leading position on the international market, thereby securing growing shares, increased value creation and higher employment in Germany.

The goal of solar heating, as well as of its sister technology photovoltaics, is the attainment of a maximum level of total efficiency. For each industry, there must be optimal concepts and technologies in use. The logical consequence: solar heating for heating applications, solar power for electricity applications.

BSW-Solar pursues 12 measurable objectives intended to drive and accompany the expansion of solar heating. These objectives more than fulfill the energy policy demands placed on solar heat production. They assume a significant level of growth to the year 2020 and forecast a breakthrough by the year 2030.

1 | Figure 1 | Key objectives of Solar Heating Roadmap for 2020 and 2030

Scenario	2010	Forced expansion 2020	2030
Increase in collector surface in Germany p.a. (in millions of m^2)	1.15	3.6	8.1
Installed collector surface in Germany (cumulative, in millions of m^2)	14	39	99
Installed solar heating capacity (GW)	9.8	27	69
Solar heating energy production p.a. (TWh)	5	14	36
CO_2 savings p.a. (in millions of t)	>1	3.2	8.0
Share of solar heat in heating requirement of German households (%)	<1	2.7	7.7
Share of solar heat in heating requirement (to 100°C) of German industry (%)	0	0.4	10.2
Installed systems for industrial process heat1 (cumulative)	0	1,500	28,300
Reduction of system price in residential buildings (%)		14	43
Domestic turnover of ST industry (in billions of €)	1.0	2.4	3.0
German value creation rate (%)	75	75	75
Export (in billions of €)	0.5	1.1	1.4

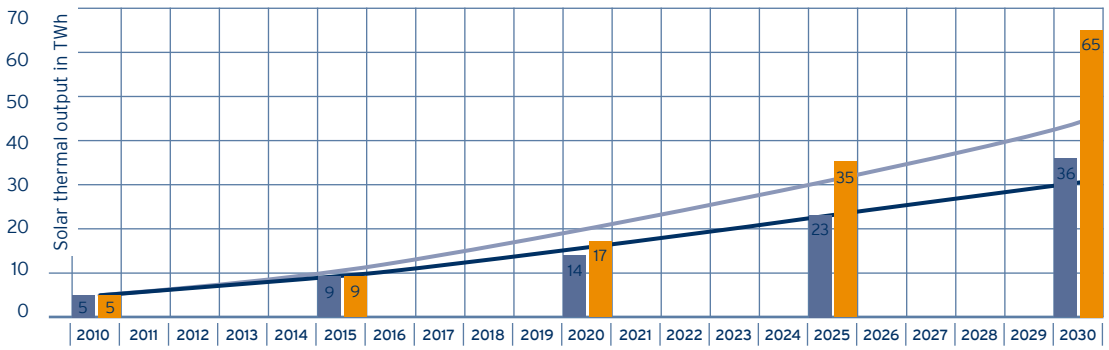
[1] Assumed average system size: 700 m^2

Through the ambitious expansion goals, the portion of solar heating in the heat requirement of German households will increase from around 1% in 2010 to approximately 7.8% in 2030. The portion of solar heating in the heat requirement of German industry to 100°C is to increase from nearly zero today to 10% in 2030.

In terms of solar thermal energy, this means that in the year 2030, solar heating will play a substantial role in the regenerative energy supply of the Federal Republic of Germany, with a volume amounting to 36 terawatt hours/year (TWa/a) (see figure below). Although the expansion goals for local and district heating in Germany will be achieved slightly later than in the base scenario 2010A of the Federal Ministry for the Environment (Bundesministerium für die Umwelt – BMU), the German solar heating industry is able to meet the energy policy goals of the Federal Government nearly in full.

The Federal Association for Renewable Energies (Bundesverband Erneuerbare Energies - BEE) estimates the heating requirement in 2020 to be 1150 TWh; for 2020 the forecast for heat from renewable energy sources is between 270 TWh and 290 TWh [BEE, 2009]. Reaching a level of 14 TWh in 2020, solar heating, according to the roadmap, would account for a share of approximately 5% of the total heat production from renewable energy sources.

1 | Figure 2 | Development of solar heating capacity to 2030



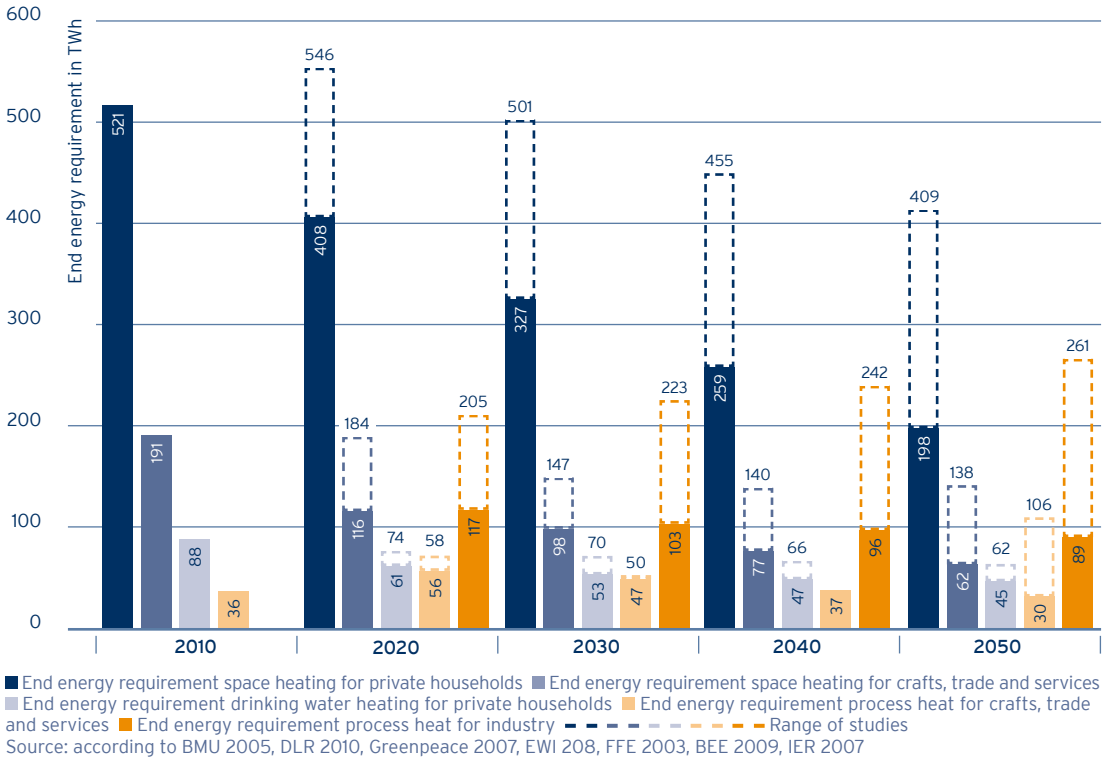
Capacity of installed collector surface in the years up to 2030 according to the Solar Heating Roadmap and the Federal Ministry for the Environment, Lead Study 2020 with and without district heating (N/A: without local and district heating; BMU Base Scenario 2010 A) ■ Forced expansion scenario ■ Global change scenario — BMU 2010 — BMU 2010 N/A

2 | Analysis

2.1 Future heating requirement

All efforts to reduce the end energy requirement must incorporate an in-depth investigation of the heating requirement. Studies assume that by the year 2030 this requirement will be reduced by approx. 30% on account of increases in efficiency, rationalization and improvements in insulation. This means that in 2030, total heating requirement will still be at nearly 10,000 petajoules per year, or 2778 TWh/a, although the structure of the heating requirement will undergo a shift. While space heating requirements are expected to decrease, forecasts suggest that there will be an increased demand for process heat. It is therefore a crucial task for society as a whole to ensure that this immense volume of energy is produced as sustainably and as climate-neutrally as possible. Because it utilizes the sun as an energy source, solar heating is the most natural and most sustainable form of heat production. For this reason, it has a particularly significant role to play within the framework of this task.

2 | Figure 1 | Development of heat requirement to 2050 according to different forecasts



Source: according to BMU 2005, DLR 2010, Greenpeace 2007, EWI 208, FFE 2003, BEE 2009, IER 2007

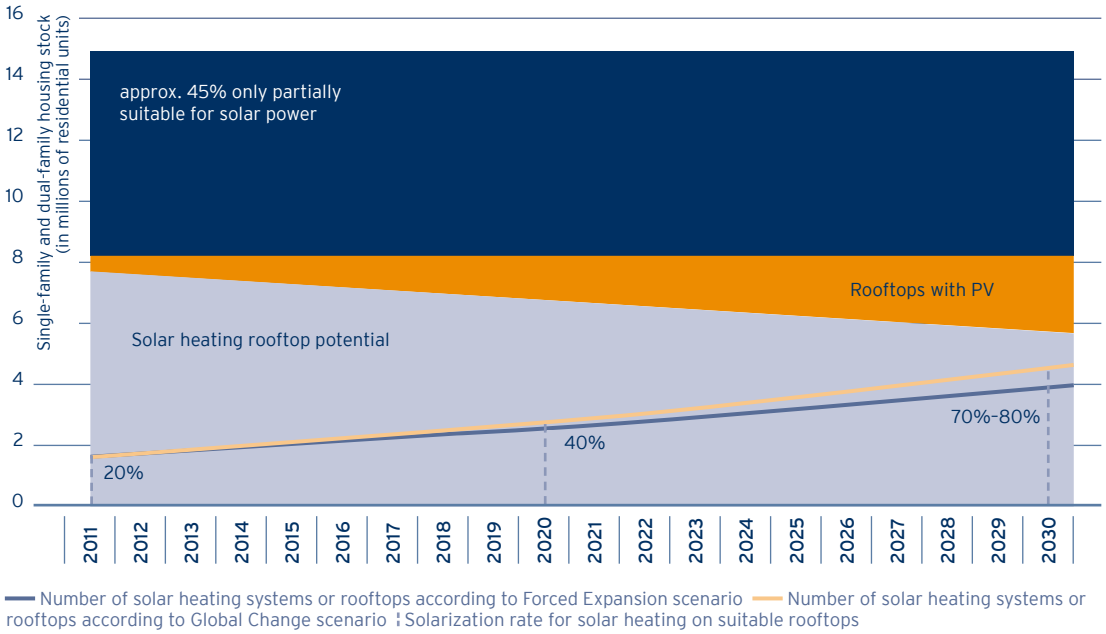
2.2 Surface potential

The so-called technical potential that has been calculated for solar heating in the Federal Republic of Germany is significant. Calculations show that there is a total suitable surface of over 2000 square kilometers (rooftops, façades and open spaces) that can be used for solar heating purposes. The economically viable potential for solar heating, in turn, is dependent on the number of buildings to be heated that have suitable rooftop surfaces. An inventory of the rooftops of single-

family, dual-family and multi-family dwellings shows that between 45% and 55% of all rooftop surfaces are suitable for and thus economically viable to be equipped with collectors. Based on a building stock of approximately 17.9 million residential buildings, this would mean that around 8 to 10 million rooftops are suitable. Minus the rooftops that are already equipped with photovoltaic or solar heating systems, there exists a remaining potential of between 6 and 8 million rooftops in the residential building sector alone.

By the year 2030, depending on growth scenario, between 70% and 80% of the available suitable rooftop potential for solar heating could be utilized without resulting competition for surfaces with photovoltaic systems. This does not take into account potential space from facades and open spaces, or rooftop surfaces available in newly constructed buildings, on non-residential buildings or on buildings in the commercial and industrial sectors.

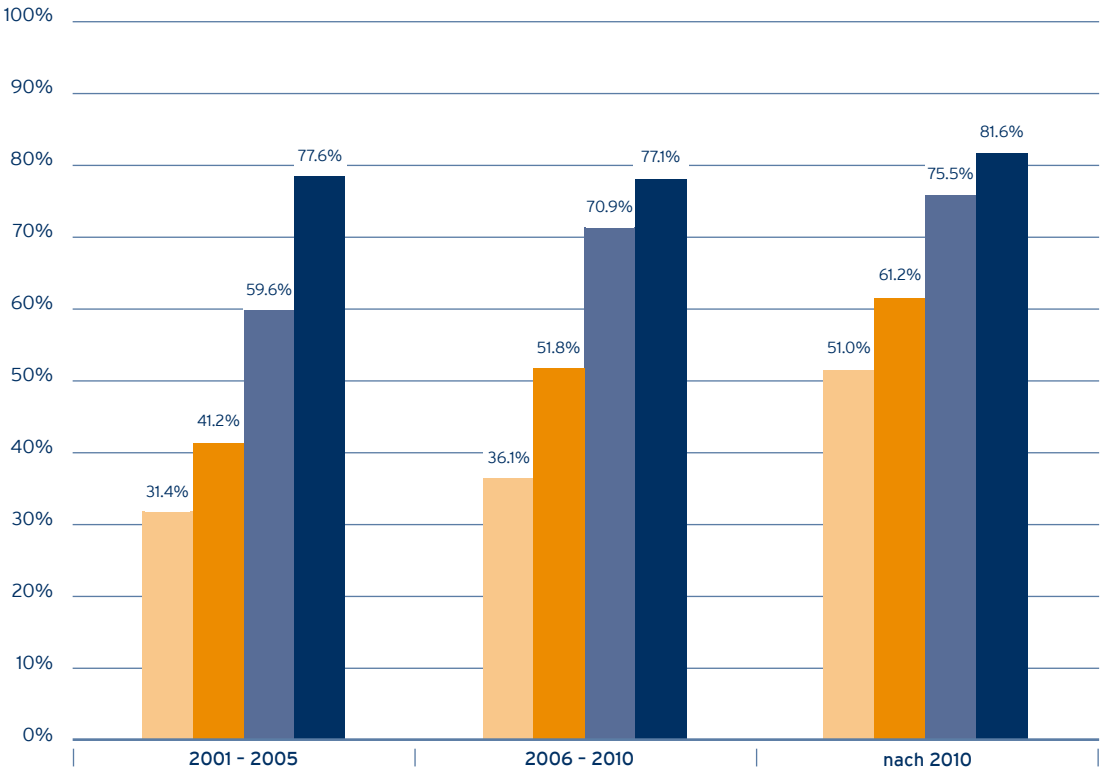
2 | Figure 2 | Utilization of solar rooftop surface potential on single-family and dual-family homes to 2030



2.3 Investment motives

Market research analyses have shown that the vast majority of target groups, in particular the owners of single-family and dual-family homes, have a very positive fundamental attitude toward solar heating (see also fig. 2 | 3). The first argument given for the use of solar heating systems is the environmental aspect, while the second is profitability. Over the last 10 years these two reasons have been given with increasing frequently. Slightly less relevant among motives to invest in solar heating systems, although with a significant upward trend, is the concern about price increases for fossil fuels and the wish to attain greater energy independence.

2 | Figure 3 | Reasons for using solar heating, by year of manufacture of system



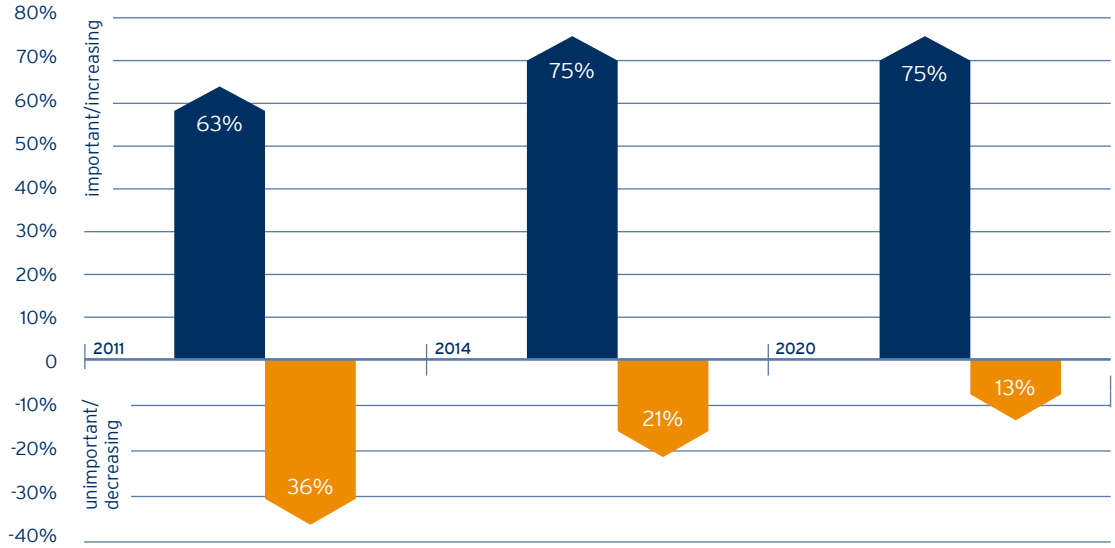
Based on a survey of 1469 solar heating users and interested parties, source: co2online 2011

By far the foremost reason behind the decision not to install a solar system, given by 47% of those surveyed, is the high cost involved. This means that in the short, medium and long term future, the success of solar heating in Germany will hinge upon the absolute level of investment costs for the end customer, as well as the overall profitability of solar power systems.

2.4 Sales partners

The most important factor in the value creation chain, from manufacturer to end customer, is the skilled craft and trade sector. In the mid to long term, skilled crafts and trades will continue to be the most important sales channel for the solar heating industry, in particular in the market segments of single-family and dual-family homes. The skilled craft and trade sector, in turn, has high and rising expectations regarding the business success of the solar heating sector thus has a vested interest as part of the winning community of manufacturers and installers.

2 | Figure 4 | Economic significance of solar heating for skilled craft and trade sector – currently and outlook to 2020



Based on a survey of 500 people; difference to 100%: no answers provided, Source: Technomar Stakeholder Analysis 2011

The business fields in the skilled craft and trade sector that are relevant to solar heating – solar heating systems, bathroom installation, air-conditioning and climate control, building technology and electrical installation – will continue to expand in scope in the future. The number of those employed in this sector, however, will remain largely constant in the medium term as well, with a slightly declining tendency. It is therefore crucial to maintain and continue to build upon the attractiveness of solar heating for the skilled craft and trade sector. Occasional installers of solar heating systems have a particular role to play in this context. Efforts should be made to bring them from a passive sales approach based on customer demand to a more active marketing role. Important factors in this process are the intensification of support for this group by manufacturers of solar heating systems, but also the amount and continuity of government funding.

2.5 Competing technologies

It is safe to assume that the majority of heat generating technologies, whether they operate on a conventional basis using fossil energy or on the basis of regenerative energy sources, will in the future have a very high level of competitiveness. The central question is how economical a heating system with support of solar heating technologies is compared to a heating system without the support of solar heating technologies. In order to become competitive even without support measures, the industry must make substantial improvements regarding the production costs of systems supported by solar heating technology. Solar power systems that support hot water generation will continue to have slight advantages in terms of cost effectiveness over combined systems for hot water generation and heating support. Their disadvantage is that they supply a smaller share of solar heat to the overall heating of a household.

Compared to the existing market standard, the oil or gas-fired condensing boiler, the competitive position of solar heating is strong both in the short and in the long term. The reason for this is that from an economical standpoint, such heating systems can easily supplement this existing technology, in particular when it comes to modernization and in newly constructed buildings. Solar heating systems are also just as easily combined with heating systems based on biomass technologies.

2 | Figure 5 | Distribution of heat producing technology in heating system modernization

Turnover	2010	2015	2020	2030	Significance for solar heating
Oil/Gas-fired condensing	66%	67%	66%	66%	++
Low temperature oil/gas	23%	19%	12%	5%	+
Electric heat pump	6%	8%	10%	12%	-
Gas heat pump	0%	0%	3%	6%	-
Biomass	4%	5%	7%	9%	+
(Micro) CHP	1%	1%	2%	2%	-
Electric direct heat	0	0	0	0	0

++ very helpful + helpful 0 neutral - hindering -- very hindering, Source: Technomar 2011

2.6 Cost reduction

Already today, the components of a solar heating system have a very high technical standard. There is very little room for improvement when it comes to the collectors, storage technologies and materials used in the current systems. There is, however, still potential that can be taken advantage of in terms of accelerating the assembly and installation process. Experts forecast that the greatest impact, however, will be achieved through major leaps in technology in the areas of collectors and storage. This applies both to the use of new materials and production processes for flat plate collectors as well as to the development of thermo-chemical storage technologies. A further key success factor is the cost-side optimization of integrated systems for heat production that include solar heating. The effect on systems would range from optimized coordination of all components to the simplification of assembly and installation through pre-configured and possibly standardized construction components.

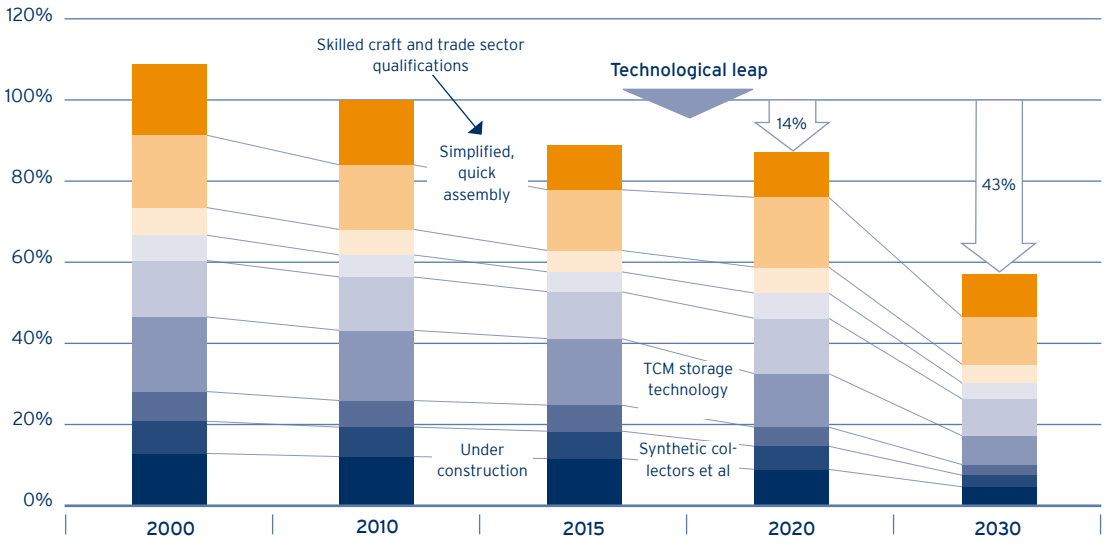
2 | Table 1 | Technology-based cost reduction potential of solar heating

A) Cost reduction collector	B) Simplified underbody construction	C) Simplified, quick assembly	D) Synthetic collectors or comparable technology	E) Thermochemical storage technology (TCM)
Substitution of costly materials e.g. through use of plated substances	e.g. different choice of materials and greater pre-fabrication	Standardization and optimization regarding error avoidance	Testing and development of alternative manufacturing processes	Testing and development of alternative long-range storage systems (see DSTTP)*

'DSTTP=Deutsche Solarthermie Technologie Plattform (German Solar Heating Technology Platform)

The roadmap shows how various bundles of measures can reduce the costs of a solar heating system for the end customer by a total of 43% by the year 2030. The steps leading to that goal can be found in the areas of simplification of assembly, optimizing complete systems including heat generators as well as the previously mentioned leaps in technology for collectors and storage systems. Since new technologies often bring about initial price increases, the goal is a cost reduction for the end customer of approximately 14% by 2020; the full extent of the cost reduction will only be reached in the course of the twenty-year period. This cost reduction will not only by achieved by the manufacturers alone, but instead it will apply across the entire value creation chain all the way to the end customer.

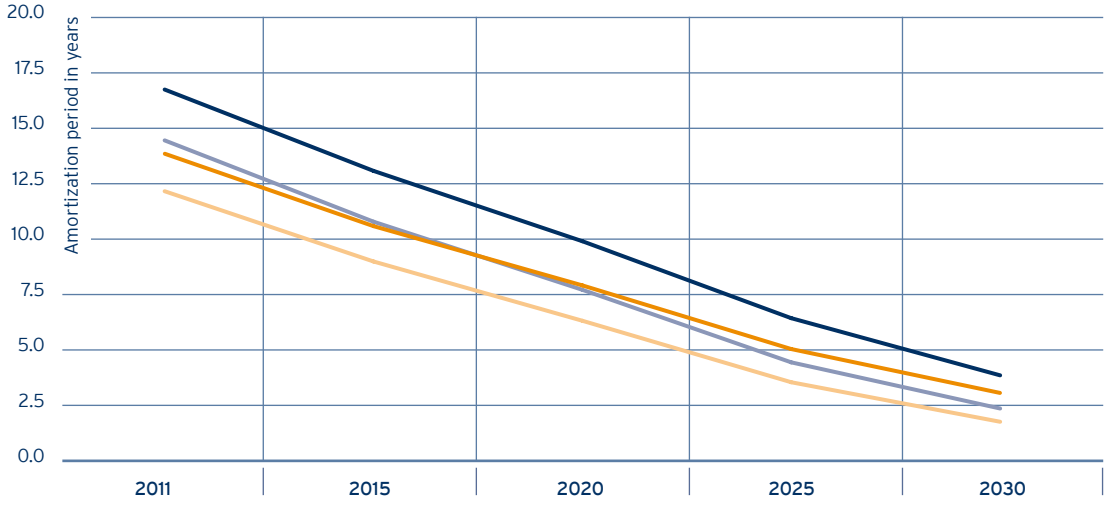
2 | Figure 6 | Development of end customer system costs of a solar heating system to 2030



HW= skilled craft and trade sector, Mo= Modernization, SK= other costs, EBITDA= earnings before interest, taxes, deductions and amortization, SP= storage, FGH= specialized wholesale trade, HST= manufacturers, KO= collectors

Thanks to the assumed cost reductions, the amortization period of the systems in the single-family and dual-family housing market drops significantly from an average of 16 years (2011, 15 m²) to 3 three years in 2030. The amortization period for larger systems is only slightly above these figures.

2 | Figure 7 | Decrease in solar heating amortization period, linked to cost reductions and energy price increases (not including storage and fresh water station)

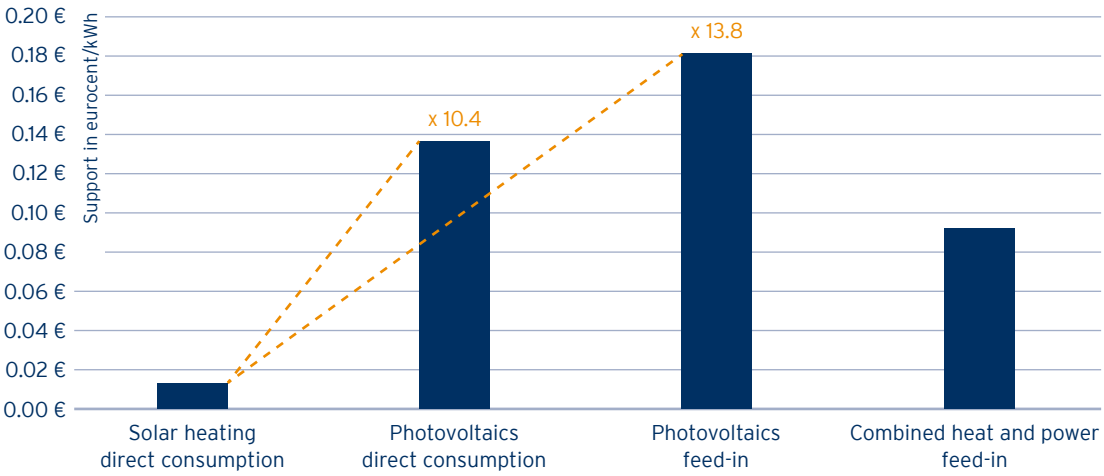


Combined system with 10 m² collector surface, 8% p.a. energy price increase — Combined system with 15m² collector surface, 8% p.a. energy price increase — Combined system with 10 m² collector surface, 11% p.a. energy price increase — Combined system with 15 m² collector surface, 11% p.a. energy price increase, Source: ITW, Technomar

2.7 Political framework

Compared to the support mechanisms for photovoltaics and power-heat cogeneration, the roadmap shows that the heating potential of solar heating systems has so far been at a significantly disadvantage when it comes to government funding. Given a level playing field, i.e. if solar heating were to have access to the same conditions as equal these technologies, the use of solar heating could increase significantly, possibly tripling in volume to reach the level of Austria, the leading country in terms of solar heating capacity.

2 | Figure 8 | Comparison of support measures of photovoltaics, combined heat and power and solar heating



Parameters for calculation based on Solar Heating Roadmap, base year 2011, fig. 3|58, Source: Technomar 2011

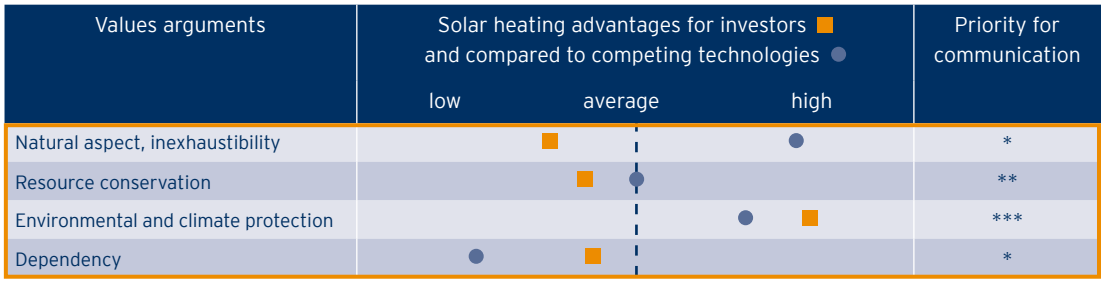
A support model that is capable of supporting the goals of the roadmap should fulfill the following criteria:

- Degressive support rates
- Budget-independent funding
- Strong stimulus effect
- Simple implementation
- Technology that is differentiated and user-oriented
- Increasing level of technological efficiency

2.8 Communication

In the future, the solar heating industry should build its communication around arguments concerning both immaterial and material benefits. The main arguments here are environmental and climate protection, resource conservation and cost savings. Efficiency certifications and financial returns should serve more as secondary information than as persuasive arguments. Once the amortization period of solar systems as been significantly improved, as is provided for the in the roadmap, the profitability of systems can also be highlighted in the communication strategy.

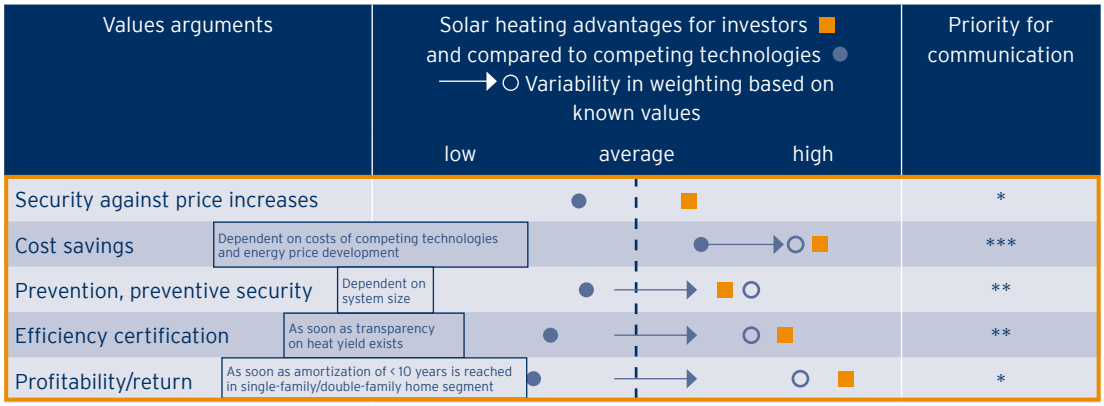
2 | Figure 9 | Positioning of immaterial values arguments for solar heating in communication



Tendency toward argumentation based on immaterial values

Source: BSW-Solar

2 | Figure 10 | Positioning of materiel values arguments for solar heating in communication



Tendency toward material value arguments

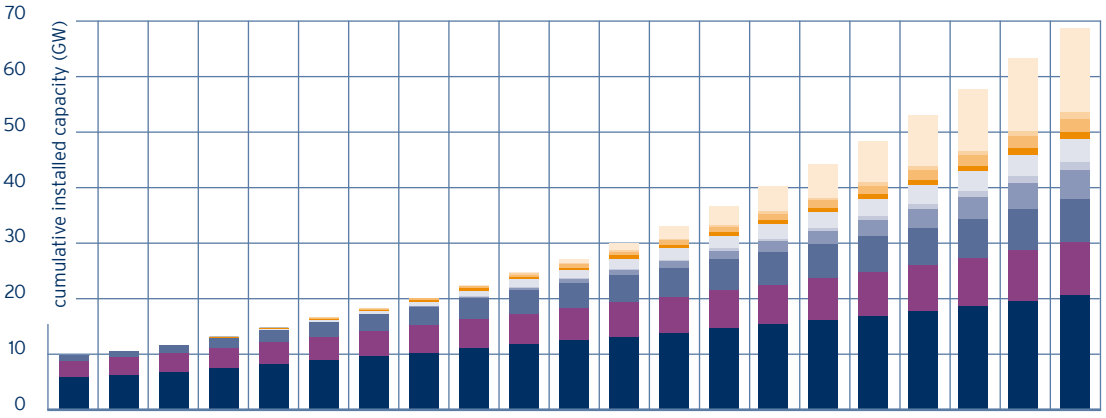
Source: BSW-Solar

3 | Scenarios

Based on in-depth analyses in the areas of technology, business, society, and politics, three expansion scenarios have been drawn up to represent the development of solar heating through the year 2030. The scenario "Business as Usual" assumes no significant progress with regard to sales, cost reduction and innovation. Fossil fuel prices increase moderately by approximately 3-5% per year. This scenario also foresees government funding for solar heating at a level comparable to current levels.

In the scenario "Forced Expansion", all of the objectives and measures laid out in the framework of the roadmap are implemented. These include, in the mid term, a significant cost reduction for systems, the use of new technologies, the systematic development of new market segments for solar heating and the entry into the segment industrial process heat to 100°C. The sales sector is strengthened significantly and the manufacturers close ranks to proactively meet structural change in the market. This scenario is based on a continuing increase in energy prices, as occurred in the first decade of the 21st century (approx. 8% p.a.) as well as on increased levels of funding leading up to the attainment of the profitability threshold without support measures, which is expected to set in shortly after 2020. This scenario was selected as the basis for the quantitative and qualitative development of the roadmap. Additionally, a third scenario entitled "Global Change" (GC) was calculated, which is based on the same attainment of objectives for the solar heating industry as the scenario "Forced Expansion". The differences are that, in this scenario, significantly more emphasis is placed on ecology, energy prices rise even more drastically than has been the case so far (approx. 11% p.a.) and solar heating receives the same level of support as do the other regenerative technologies.

3 | Figure 1 | Total installed solar heating capacity in Germany to 2030



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.7	1.4	2.3	3.4	4.6	6.0	7.6	9.3	11.1	13.2	15.3
	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2
	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.7	1.9	2.2	2.4
	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.2
	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.7	1.0	1.3	1.5	1.8	2.1	2.3	2.6	2.8	3.1	3.4	3.6	3.9	4.2
	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6	0.9	1.2	1.5	1.9	2.4	2.9	3.4	4.0	4.7	5.3
	1.0	1.2	1.5	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.5	4.9	5.2	5.6	5.9	6.2	6.5	6.8	7.1	7.5	7.8
	2.9	3.1	3.4	3.6	4.0	4.3	4.6	4.9	5.3	5.6	5.9	6.2	6.5	6.9	7.2	7.5	7.9	8.3	8.7	9.1	9.6
	5.9	6.3	6.8	7.5	8.2	8.9	9.6	10.3	11.1	11.8	12.5	13.2	13.9	14.7	15.4	16.2	17.0	17.8	18.7	19.7	20.7
= FE	9.80	10.66	11.77	13.18	14.81	16.55	18.40	20.35	22.45	24.75	27.32	30.19	33.32	36.73	40.41	44.37	48.64	53.22	58.14	63.42	69.1

Industrial process heat to 100°C Local and district heat Non-residential buildings Newly constructed multi-family dwellings Heating modernization and supplementation in existing multi-family dwellings Sun house single-family & dual-family homes (cf. D. ≥ 50%) Renewal of existing solar heating systems Newly constructed single-family & dual-family homes Heating supplementation in existing single-family & dual-family homes Heating modernization in existing single-family & dual-family homes, total research and development, MFH = Mehrfamilienhaus (multi-family home), EFH= Einfamilienhaus (single-family home), ZFH= Zweifamilienhaus (dual-family home)

Roadmap scenario "Forced Expansion"

The scenario "Forced Expansion" represents the central expansion trajectory of the solar heating roadmap. This scenario lays out a total of six strategic thematic priorities, which, while not necessarily applicable to the individual situation of every company in the solar heating industry, point in a general direction of overall success in the industry. The priorities are the accelerated expansion of solar heating in the established market segments of single-family and dual-family homes, the development of further market segments through the gaining of additional qualifications as well as the assertive move into the future-oriented solar heating market of "industrial process heat to 100°C". For these measures to succeed, it is necessary to continue to increase the competitiveness of solar heating through cost-effective system solutions and an active steering of structural change. In order to protect the established areas and to ensure rapid success in the new areas as well, research must in the future be more geared to the development of more cost-effective solutions in established areas as well as in the area of industrial process heat. In the process, a greater effort than before must be put into collaborative research and a greater bundling of activities. Another requirement for the future is an active communicative shaping of the necessary framework conditions for the growth of the solar heating sector – in particular in the political arena.

3 | Table 1 | Strategic focus areas

Strategic focus areas within the framework of "Forced Expansion"	
Strategic focus area I:	All efforts toward expansion of established segments in single-family/dual-family homes
Strategic focus area II:	Development of additional market segments by gaining new expertise
Strategic focus area III:	Entschlossener Eintritt in den Solarwärme-Zukunftsmarkt Industrielle Prozesswärme bis 100°C
Strategic focus area IV:	Enhanced competitiveness through cost-effective system solutions and active development of structural change
Strategic focus area V:	Prioritizing of research toward development of inexpensive solutions in established segments and in the area of industrial process heat
Strategic focus area VI:	Active communicative shaping of necessary framework conditions for growth of solar heating sector

The roadmap examines a total of eleven market segments with regard to their current and future significance in terms of sales potential for solar heating products. It differentiates between segments in which suppliers of solar heating are already established, i.e. that already have customer-friendly products, market access, sales channels etc., and in which there is already an existing customer demand, but in which the those characteristics must be further developed and intensified, and those segments which are new for suppliers of solar heating systems, which still have to be explored from the ground up.

The scenario "Forced Expansion" (FE) was the scenario assumed as the background for assessing the respective market segments. From the standpoint of the solar heating industry, each of the market segments has a different strategic significance, which pertains primarily to the level of sales that can be achieved in the particular segment.

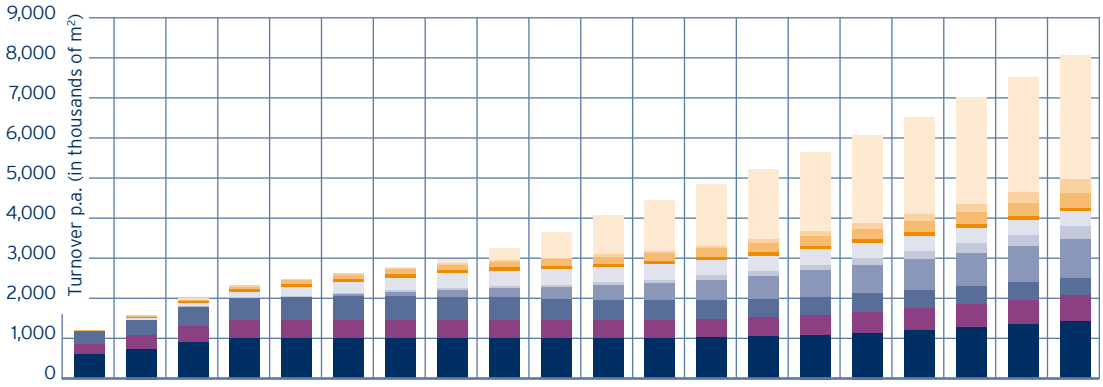
3 | Figure 2 | Strategic significance of segments over time

	Segment	Strategic significance		
		2015	2020	2030
1	Heating modernization single-family & dual-family homes	***	***	***
2	Solar heating supplementation single-family & dual-family homes	**	**	**
3	Newly constructed single-family & dual-family homes	**	**	**
4	Renewal of existing single-family & dual-family homes	–	**	**
5	Sun house single-family & dual-family homes	*	*	**
6	Heating modernization and supplementation multi-family dwellings	*	**	**
7	Newly constructed multi-family dwellings	*	*	*
8	Non-residential buildings	–	*	**
9	Local and district heating	–	*	*
10	Industrial process heat to 100°C	–	**	****
11	Industrial cooling and air conditioning	Strategic significance within the framework of export and Global Change scenario		

Assessment: * less than 300 T m² collector surface p.a.: ** more than 500 T m² collector surface p.a.: more than 2m m² collector surface p.a.: **** stars, Source: ITW. Technomar

Based on the scenario "Forced Expansion", the roadmap foresees an increase in turnover from a current figure of 1,15 million m² of collector surface (2010) to approx. 3.6 million m² of collector surface per year by 2020. By 2030, a further expansion to 8.1 m² of collector surface is envisioned. The main sales drivers continue to be the established segments in the single-family and dual-family homes sector, supplemented by the growing market for retrofitting existing systems and – in particular in the period 2020-2030 – by the sector "industrial process heat" to 100°C.

3 | Figure 3 | Forecast for annual solar heating expansion according to "Forced Expansion" scenario

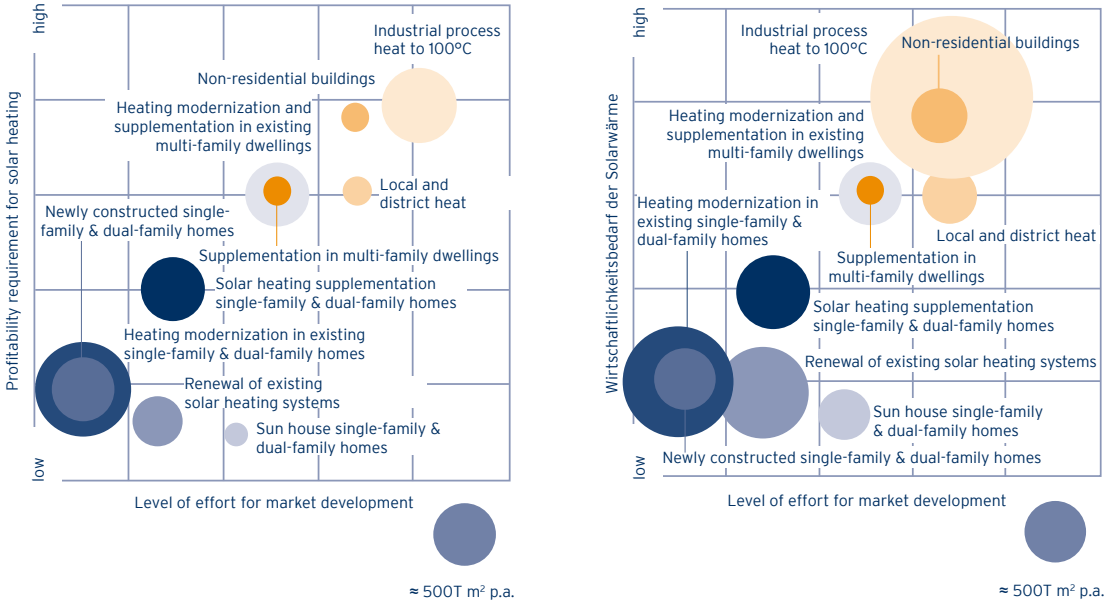


	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0	1	1	1	2	5	7	105	315	630	998	1,260	1,544	1,764	1,985	2,205	2,426	2,657	2,888	3,119
	4	14	20	26	31	34	38	40	42	45	50	60	70	85	100	130	160	200	260	350
	16	29	45	62	76	91	107	122	139	155	173	190	209	228	247	267	288	309	331	353
	6	23	43	65	85	92	95	95	95	96	96	96	97	97	97	97	98	98	98	98
	3	46	75	134	214	268	322	375	375	375	375	375	375	375	375	375	375	375	375	375
	9	14	19	24	28	33	39	46	54	63	74	87	102	120	141	166	195	229	270	317
	0	0	0	0	0	52	114	170	231	289	361	427	503	584	660	722	784	846	908	970
	309	370	486	551	569	581	581	569	551	524	498	482	468	463	459	454	450	445	441	436
	263	339	408	455	459	459	459	459	459	459	459	459	467	475	495	519	547	579	611	647
	613	757	911	1,015	1,024	1,024	1,024	1,024	1,024	1,024	1,024	1,024	1,042	1,060	1,104	1,158	1,220	1,292	1,363	1,443

Industrial process heat to 100°C Local and district heat Non-residential buildings Newly constructed multi-family dwellings Heating modernization and supplementation in existing multi-family dwellings Sun house single-family & dual-family homes (cf. average ≥ 50%) Renewal of existing solar heating systems Newly constructed single-family & dual-family homes Heating supplementation in existing single-family & dual-family homes Heating modernization in existing single-family & dual-family homes, MFH = Mehrfamilienhaus (multi-family home), EFH= Einfamilienhaus (single-family home), ZFH= Zweifamilienhaus (dual-family home)

All relevant solar heating segments can be classified according to the relative effort they require to develop the market and the level of profitability demanded by the customer, i.e. the amortization period of solar heating systems. The portfolio serves as an orientation aid for manufacturers of solar heating systems who were previously exclusively active in the established segments of single-family and dual-family homes, and who are interested in expanding their field of activity. It is apparent that there is a relatively high level of effort necessary to successfully develop many of the so-called developing segments. For this reason the question should be examined whether an alternative or additional entry into the segment industrial process heat should be treated as the more promising alternative. This should be answered on a case-by-case basis from the point of view of the individual solar heating companies.

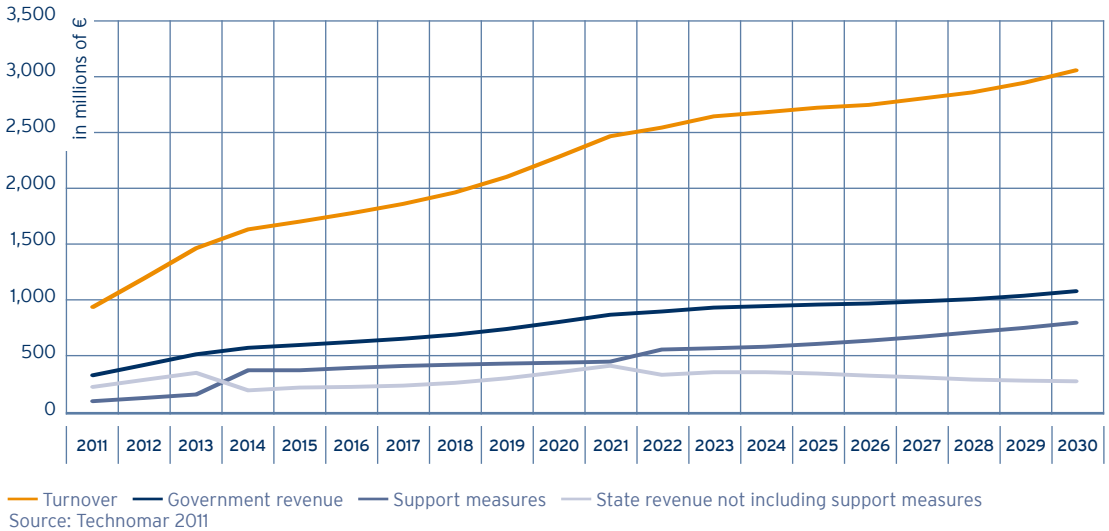
3 | Figure 4 | Development of market segments 2020 and 2030 based on "Forced Expansion" scenario



4 | Economic effects

The economic significance of the solar heating industry is constantly growing. Across all stages of value creation, government revenue is steadily increasing. By 2030, solar heating will have generated a cumulative turnover of over € 44bn, which translates into more than € 15.7bn of public revenue. Minus the cumulative support measures totaling € 9.7bn, this amounts to public revenue totaling € 6bn.

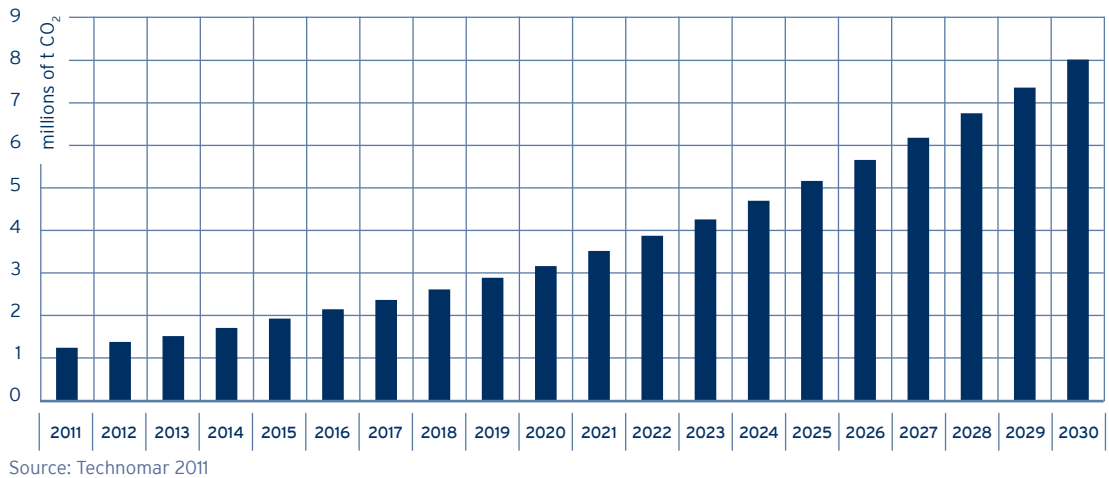
4 | Figure 1 | Developments of turnover, support measures and government revenue according to the "Forced Expansion" scenario



Source: Technomar 2011

By the year 2015, solar heating will be able to achieve CO_2 equivalent savings totaling nearly 2m t. As a result of the continual expansion of solar heating in the development segments, and supported by the government support measures for solar heating, this value will have already reached 3m t of CO_2 equivalent savings by the year 2020. In the third decade, the continuing rise in energy prices combined with reductions in cost for solar heating systems will lead to a virtual tripling of this value to 8m t by 2030.

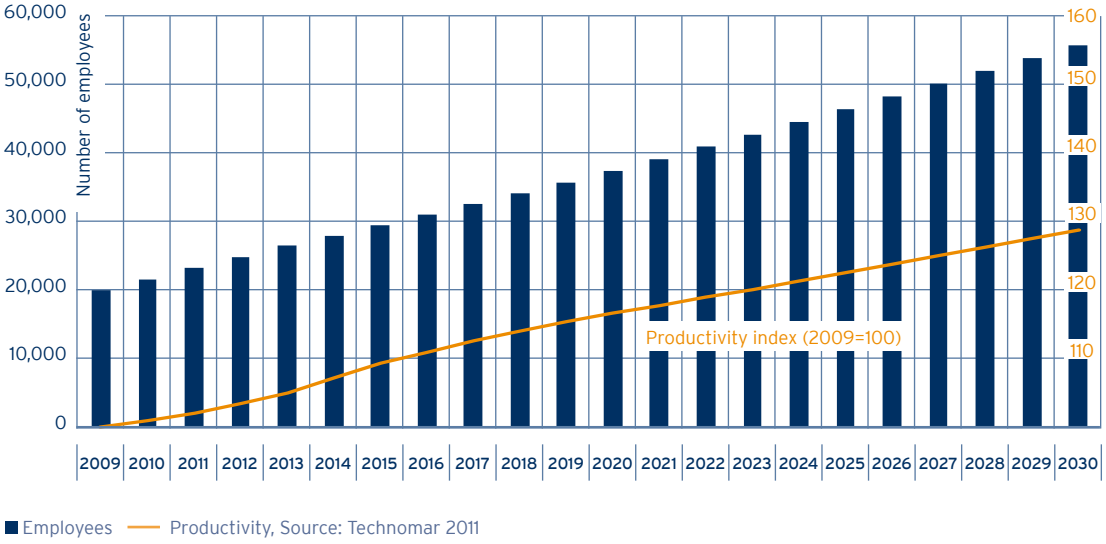
4 | Figure 2 | CO_2 equivalent savings per year according to the "Forced Expansion" scenario



Source: Technomar 2011

Regarding the employment outlook in the German solar heating industry, the revenue trend in the "Forced Expansion" scenario will bring about a doubling of the number of employees by 2020 to around 40,000, while by 2030 employment in the sector will have nearly tripled to 55,000. This is assuming an increase in productivity within the timespan of the roadmap of a total of 30% for manufacturers and the skilled craft and trade sector. The significant increase in productivity between 2013 and 2015 is in particular attributed to advances in simplified assembly. The reason for the constant level of productivity increase from 2020 to 2030 is that manufacturers will be perfecting the production technologies as a result of technological advances in collectors and storage systems.

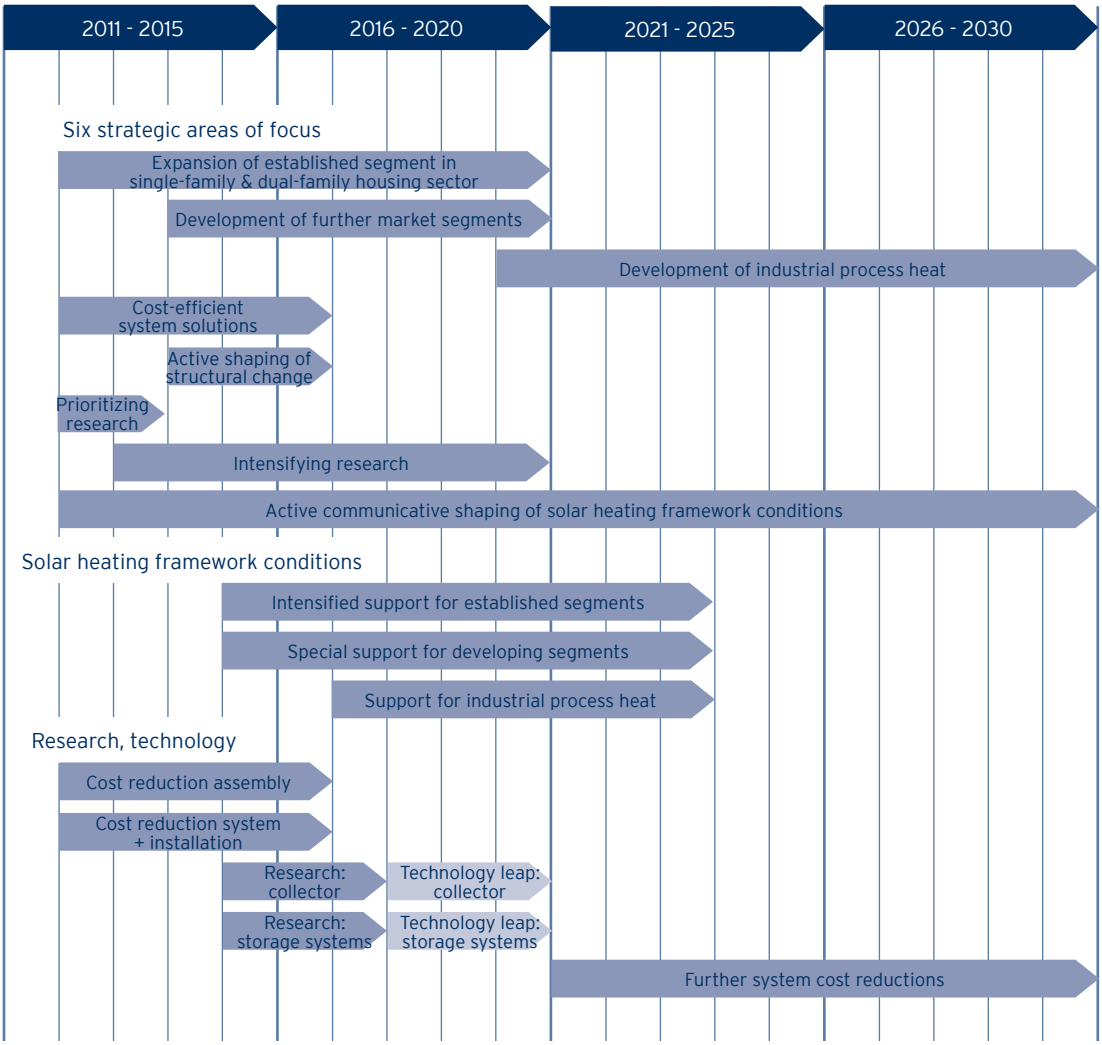
4 | Figure 3 | Development of employee numbers and employee productivity in the solar heating industry



5 | Fields of activity

The measures set out within the framework of the roadmap can be categorized into the following thematic blocks: Short-term market stimulus in the segments modernization and solar heating retrofitting, cost reduction, entry into the industrial process heat sector, communication and political framework. Approximately 70 individual measures in total are laid out within the framework of the project, which cover all of these thematic blocks. The measures described in the roadmap are activities that are best tackled at association or industry level. The successful expansion of solar heating naturally requires individual measures at company level as well, but this strategy was not the subject of this study.

5 | Figure 1 | Fields of activity in the solar heating roadmap to 2030



Gefördert durch:

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Status: July 2012