Saving potential of energy labelled taps and showers

Sara Jensen

SP Technical Research Institute of Sweden

Energy Technology

SP Report 2014:3P08445

Contents

Preface

Thanks to Marco van Brink, Åsa Wahlström and Matti Weineland who have contributed with literature and knowledge to the work of this project.

Summary

The purpose of this report is to develop a calculation formula that will make it easy to calculate the amount of energy saving that is possible to achieve by changing to an energy-labelled tap or shower, and by choosing an A-rated tap or shower instead of a B-rated.

In order to make an estimate of how much energy you can save by replacing an old tap with an energy-labelled one, you must first know how much hot water is used in an average household. To find this out, a literature review of previous studies and measurements was conducted. Water use, per person, is usually higher in apartment buildings than in detached houses; this has been found in several studies. In Sweden a person living in an apartment uses in average 22 cubic meter of hot water per year, while a person living in a detached house only uses 15 cubic meter of hot water per year.

If the taps and showers are replaced with energy-labelled taps and thermostatic showers both water and energy for hot water can be saved, especially if you change from old taps and showers with a high flow rate and no energy saving functions at all. Most of the hot water is used in the shower and in the kitchen tap; therefore the biggest savings of energy will be made replacing the shower and the tap by the kitchen sink to energy-labelled ones.

Newer taps and thermostatic showers with a flow rate of 4-5 l/min and maybe some simpler energy saving function could usually fulfil the requirements for class C according to the energy labelling system. Older taps and mechanical shower mixers (from before 2000), with flow rates of more than 12 l/min and no energy saving functions can normally be classified with class E.

The energy saving in percentage, calculated from hot water use in apartments (15 m^3/person and year) and detached houses (22 m^3/person and year), is presented in Table 1 and Table 2.

Table 1 Energy saved when replacing taps and showers from before 2000 (equal to class E) with energy labelled ones

	Class of new taps and showers	Energy for hot water, saved	
		[%]	[kWh/(person, year)]
Apartment (Hot water use: 22 m^3/person, year)	A	60	616
	B	45	462
	C	30	308
Detached house (Hot water use: 15 m^3/person, year)	A	60	420
	B	45	315
	C	30	210

Table 2 Energy saved when replacing newer taps and showers (equal to class C) with energy labelled ones

	Class of new taps and showers	Energy for hot water, saved	
		[%]	[kWh/(person, year)]
Apartment (Hot water use: 22 m^3/person, year)	A	43	441
	B	21	216
Detached house (Hot water use: 15 m^3/person, year)	A	43	301
	B	21	147

1 Background

In just over 10 years, the Swedish Standards Institute Technical Committee TK519 has been working the issue of energy saving via energy efficient faucets. This has now resulted in two Swedish test standards (SS 820 000, SS 820 001) and certification rules for energy rating and labelling of sanitary tapware.

Today there are several energy-labelled kitchen and basin mixers on the market. The first energy labelled thermostatic showers will be launched in the spring 2014.

The purpose of this report is to develop a calculation formula that will make it easy to calculate the amount of energy saving that is possible to achieve by changing to an energy-rated tap or shower. The calculation formula will also make it possible to calculate how much more energy you can save by choosing e.g. an A-rated tap or thermostatic shower instead of a B-rated.

1.1 Certification

Energy labelling is carried out according to Certification rules for energy efficiency classification and labelling of sanitary tapware (SIS TK 519). The certification rules describe the requirements that must be met by a producer before it is entitled to apply energy labelling to its products. The requirements are:

- Approved testing according to SS-EN817 (mechanical basin and sink valves) or SS-EN1111 (thermostatic mixer valves)
- Energy Efficiency tested according to SS 820000 (mechanical basin and sink valves) or SS 820001 (thermostatic mixer valves) supplemented with respective PM document
- Quality system in accordance with SS-EN ISO 9001, including continuous monitoring of the production control.

1.2 The standards

To energy label a tap or thermostatic shower it must be tested according to the Swedish test methods "SS 820000 Sanitary fittings - Method for determining the energy efficiency of mechanical wash basin and kitchen taps" or "SS 820001 Sanitary fittings - Method for determining the energy efficiency of thermostatic shower." In these standards it is measured how much energy taps and thermostatic showers use for a range of test activities where e.g. pressure, flow, and the control setting is varied. The energy consumption is calculated for each activity by measuring flow, temperature and time required to perform the activity. The energy consumption for all activities is summed up, which gives the faucet's total energy use. The total energy use is represented by a class in the energy label.

1.3 The energy label

The label is divided into classes from A to G, where A is the best grade a tap can get. A class-A tap or thermostatic shower uses less than 1.6 kWh when tested according to the standard SS 820000 or SS 820001, whereas e.g. an E-rated is using 3.4-4.0 kWh when tested in the same way.

The energy label has been designed to mimic the energy labels used for e.g. refrigerators and other appliances, see Figure 1. It should be easy to recognize and read the label, showing that the tap or shower is energy labelled.

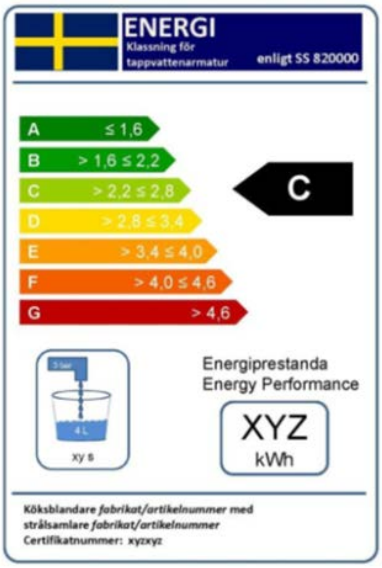


Figure 1 Example of energy label for kitchen and basin taps.

One major difference is that, where it is relatively easy to calculate how much you are saving by switching to more efficient refrigerators, it is much more complicated to work out the savings when purchasing an energy rated tap or shower.

The energy performance on the energy label is the sum of the energy used for the special activities in a standard test. The energy performance on the label cannot easily be used to calculate the energy this tap will use when mounted in a kitchen, on a basin or in a bathroom.

2 Method

Through a literature review of different studies of water consumption in Swedish apartments and detached houses, the use of hot and cold water has been compiled, and also how the consumption is distributed between the bathroom and the kitchen. No measurements have been made in this project.

The classification of older and/or unlabelled taps or thermostatic showers are assumptions based on information from Kiwa Sverige, a test laboratory that performs tests according to Swedish standards SS 820000 and SS 820001.

3 Literature review

In order to make an estimate of how much energy you can save by replacing an old tap with an energy labelled one, you must first know how much hot water is used in an average Swedish household. To find this out, a literature review of previous studies and measurements was conducted.

3.1 Water use

Comparative studies of domestic hot water use that have been performed during recent years are quite few and the statistical data is sometimes limited. The age and type of taps and showers in the apartments and detached houses in these studies are in most cases unknown.

The different designs of the studies with varying area definitions (living area, premises floor space, etc.), hot water temperatures, quantities (volume, energy, etc.) and ratios between these different measurements make it difficult to compare different studies. According to the study by Ek et al. the spread is the least for water use per person and the highest per apartment. This suggests that water use per person is the most reliable key figure, but also that water use per square meter is a better key than water use per apartment. For the latter two variations in housing density matter and the number of people per apartment is likely to vary more than the number of square meters per person. [1]

3.1.1 Apartments

A study of 65 apartments in Gothenburg investigated the change of water use when changing from two-handle taps to single lever taps in kitchen and bathroom. The study shows that hot water use was reduced by 28% when switching from two-handle faucets to single lever faucets, and by an additional 10% when switching from standard single lever faucets to single lever faucets with two water-saving techniques. Hot water use for apartments with standard single lever faucets was 28 m³ per person and year. [2]

Ek et al (2011) have in their study compiled numerous measurements and collected data of hot water usage, to provide a picture of water use in Swedish apartment buildings during the last 60 years and determine how various factors affect the use, see Table 3. Data collection for these studies has been done in various ways, including through individual measurements, estimates of the energy used for water heating, etc. [1]

Table 3 Water use in apartment buildings [1]

	Total water use (m³/person, year)	**Hot water use (m³/person, year)**	**Proportion of hot water (%)**
Mean value	64.0	21.5	34
Mean value 2000-2010	59.6	22.1	37
Min value	35.3	9.5	-
Max value	93.8	35.0	-

Usually, the standard values for hot water consumption is about 30-40% of total water use. In the compilation of Ek et al (2011) just over 52% of these values are within the standard values, 30% are above and are 18% below the standard value. [3]

3.1.2 Detached houses

Water use, per person, is usually higher in apartment buildings than in detached houses; this has been found in several studies. The main reason for these differences is often said to be that detached houses have individual measurement in the billing meter for water, and that their use becomes visible through the water and energy bills. This gives residential houses an incentive to save, unlike in apartment buildings where costs are usually distributed and embedded in the rent. [1] Table 4 shows a compilation of three studies conducted in the 2000s, in which measurements have been made in both apartments and houses.

Table 4 Water use in detached houses and apartments

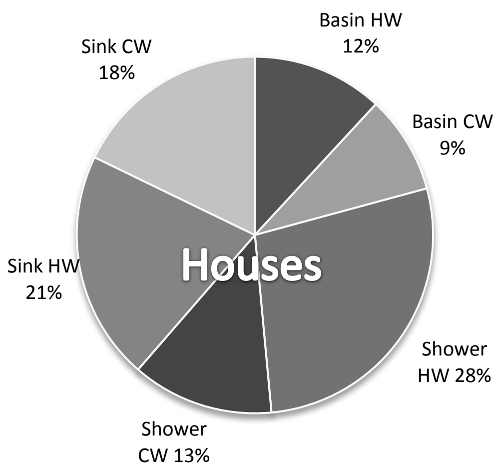
Study	Total water use m³ / (person, year)		Hot water use m³ / (person, year)		Proportion of hot water use (%)	
	Apart ment	House	Apart ment	House	Apart ment	House
Swedish Energy Agency, 2009	67	**48**	21	**15**	32	**33**
Swedish Energy Agency, 2008	43	**36**	17	**12**	39	**32**
Thronell, 2007	68	**48**	-	-	-	-

In one project (Swedish Energy Agency, 2009) the water use in nine apartments and thirty-five houses was measured by SP Sveriges Tekniska Forskningsinstitut. The study's purpose was primarily to describe how much hot water is used and thereby gain knowledge of the proportion of household energy used for heating water. The report by Swedish Energy Agency also references to a study made by Thronell 2007. The total water use of 10,000 people who live in small houses and 25,000 people living in apartment buildings in Halmstad municipality has been measured continuously 1994-2004. These measurements indicate that total water use decreases. Annual water use in 2004 was an average of 48 m^3 per person in detached houses and 68 m^3 per person in apartments. [4]

A preliminary study (Swedish Energy Agency, 2008) was made in Stockholm and Borås 2007-2008. The purpose of this work was to study how much water is used, and where in households (washbasins, kitchen, shower / bath) the water is used in a total of four apartments and six houses. The measurements and following analyses were performed by SP Sveriges Tekniska Forskningsinstitut. [5]

3.2 Distribution between taps

In Energy Agency's 2008 study, measurements were made on how hot and cold water usage is divided between basins, sinks and showers in four apartments and six detached houses – see Figure 2. Water use in laundry room, for washing machine and toilet were not included in the measurement. [5]



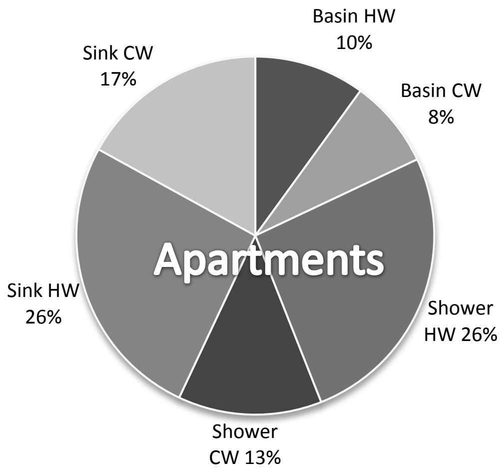


Figure 2 Distribution of water use between different taps, detached houses to the left and apartments to the right.

3.3 Energy for hot water

Ek et al had a large sample size for measurements of water use in apartments to base their figures on and were therefore selected as the most reliable reference for water use, but their report did not present any energy use. Table 5 presents measured and calculated energy use from three other studies.

Table 5 Energy for hot water, mean values

	Energy use, mean value kWh/(person, year)	**Energy use, mean value** kWh/(household, year)
9 apartments [4]	979	1599
4 apartments [5]	885	2228
Apartments* [3]	-	3400
Mean value	**932**	**2409**
35 houses [4]	781	2664
6 houses [5]	717	2350
Detached houses* [3]	-	2800
Mean value	**749**	**2608**

* Calculations based on national data from 2010 [3]

According to calculations based on national data from 2010 8.6 TWh was used for heating hot water in apartment buildings in Sweden. For Swedish detached houses the corresponding figure was 5.3 TWh. [3]

4 Calculating model

The purpose of this report is to develop a calculation model that will make it easier to calculate the amount of energy saving that is possible to achieve by changing to an energy-rated tap or shower. No measurements have been made for this report; the calculations are based solely on a number of previous studies and measures of water and energy consumption. The reported savings in this report depends on the reliability of these earlier investigations.

4.1 Classification of unlabelled taps

The first kitchen and basin taps with a Swedish energy label were launched in 2012, and the first labelled thermostatic showers will be launched in 2014. The calculations in this report are based on measurements and statistics from before 2011. The water and energy use calculated from the literature study is therefore assumed to correspond to water and energy use when no energy labelled taps is used.

Classifications in the Swedish energy label system are shown in Table 6.

Table 6 Classifications in the Swedish energy label

Class	**Energy use per test according to SS 820000/SS 820001** [kWh]
A	≤ 1.6
B	$>1.6 \leq 2.2$
C	$>2.2 \leq 2.8$
D	$>2.8 \leq 3.4$
E	$>3.4 \leq 4.0$
F	$>4.0 \leq 4.6$
G	>4.6

No tests according to standards SS 820000 and SS 820001 have been made on old and/or unlabelled taps or thermostatic showers. The classification of older and/or unlabelled taps or thermostatic showers in this report are assumptions based on information from Kiwa Sverige, a test laboratory with experience of performing tests according to Swedish standards SS 820000 and SS 820001.

Newer taps with a flow rate of 4-5 l/min and maybe some simpler energy saving function could usually fulfil the requirements for class C according to the energy labelling system. The class C will be used as a reference, and the potential savings when a C classed tap is replaced by a tap with B or A class is calculated with the figures in Table 6 as a percentage of this reference, see Table 7.

Table 7 Energy saving potential when replacing a new unlabelled tap/shower (equal to class C)

Classification	Energy saving potential
Existing tap ≈ C	0 %
New tap = B	21 %
New tap = A	43 %

Older taps with flow rates of 12 l/min and no energy saving functions can normally be classified with class E. The class E will be used as a reference, and the potential savings when an E classed tap is replaced by a tap with A, B or C class is calculated as a percentage of this reference, see Table 8.

Table 8 Energy saving potential when replacing an old unlabelled tap/shower (equal to class E)

Classification	Energy saving potential
Existing tap ≈ E	0 %
New tap = C	30 %
New tap = B	45 %
New tap = A	60 %

4.2 Hot water and energy use

According to the study by the Swedish Energy Agency from 2009, the mean value of hot water use in detached houses is 15 m^3/person and year. [4] The mean value of hot water use in apartments is according to the literature study made by Ek et al 22 m^3/person and year. [1] The energy used for heating water is calculated with Equation 1.

Equation 1

$$Q = \frac{hw \cdot \rho \cdot C_p \cdot (T_{hw} - T_{cw})}{3600}$$

Q = energy for heating water (kWh)
hw = hot water use (m^3)
ρ = density of water (1000 kg/m^3)
C_p = Heat capacity for water (4.2 kJ/ (kg, K))
T_{hw} = temperature of hot water (50°C)[1]

---

[1] Boverkets Building regulations says that installations for domestic hot water shall be designed so that a water temperature of not less than 50°C can be achieved after the tap. (6. Boverket, *Regelsamling för byggande, BBR 2012*. 2011: Boverket.)

T_{cw} = temperature of cold water (10°C)

Hot water use and calculated energy used to heat water in detached houses and apartments is presented in Table 9, which also shows the distribution between different taps. The distribution of water use between different taps (sink, basin and shower) is based on the percentages in Figure 2.

Table 9 Hot water use and energy for hot water

	HW use [m³/person, year]	**Energy for HW** [kWh/(person, year)]	HW use in Kitchen sink [%]	HW use in Wash basin [%]	HW use in Shower [%]
Apartments [1]	22	1027	42	16	42
Houses [4]	15	700	34	20	46

Energy use presented in Table 9 differs a bit from the calculations in Table 5 which shows energy calculations from three other studies. Ek et al had a large sample size for measurements of water to base their figures of water use on and was therefore selected as the most reliable reference, but they had no energy calculations or measurements presented in their study so this was calculated with Equation 1. For houses the figures calculated in Table 9 is a bit lower than calculations from previous studies because the energy use was calculated with Equation 1 that differs a bit from the equation used in the other studies. Recalculation was made to ensure a harmonized approach in energy use for apartments and houses.

4.3 Energy saving potential

If the taps in kitchen and bathrooms are replaced with energy labelled taps and thermostatic showers a lot of energy for hot water can be saved, especially if you change from an old tap with a high flow rate and no energy saving functions at all.

The calculated energy use from Table 9 is used as a reference in following calculations for both reference level C and E.

If you compare the hot water use in apartment buildings and detached houses, the water use is higher in apartments. Therefore this report separates the calculations of energy saving potential into two categories; apartments in Table 10 and houses in Table 11.

4.3.1 Apartments

Table 10 Energy saved in APARTMENTS when taps and/or showers are replaced with energy labelled ones.

	Energy saved [%]	Total energy saved [kWh/(person, year)]	Energy saved Kitchen sink [kWh/(person, year)]	Energy saved Wash basin [kWh/(person, year)]	Energy saved Shower [kWh/(person, year)]
C to A	43	441	185	71	185
C to B	21	216	91	34	91
E to A	60	616	259	99	259
E to B	45	462	194	74	194
E to C	30	308	129	49	129

4.3.2 Detached houses

Table 11 Energy saved in detached HOUSES where all taps and the shower is replaced with energy labelled ones.

Tap/shower changed from	Energy saved [%]	Total energy saved [kWh/(person, year)]	Energy saved Kitchen sink [kWh/(person, year)]	Energy saved Wash basin [kWh/(person, year)]	Energy saved Shower [kWh/(person, year)]
C to A	43	301	102	60	138
C to B	21	147	50	29	68
E to A	60	420	143	84	193
E to B	45	315	107	63	145
E to C	30	210	71	42	97

4.4 Examples of savings

To show what the saving in energy means in money, three examples have been made. Energy prices in the calculations are only examples, and to get an exact figure of how much money can be saved in a house or apartment, the actual energy price must be used.

In order to compare the energy use for hot water with the total energy use for hot water and space heating the energy saving is presented in the unit kWh/m² A_{temp}, year.

4.4.1 Example 1

This example shows how much energy and money a rental owner could save if all the twenty year old taps and showers (equal to class E) in 40 apartments with 100 residents, in a building heated with district heating, are replaced with A-classed taps and showers.

2.5 residents per apartment * 616 kWh/ (person, year) = 1540 kWh/ (apartment, year)
With a heated floor space of 100 m²/ apartment the energy saving is 15.4 kWh/ (m² A_{temp}, year).

District heating, price per kWh (incl. tax and VAT): 0.85 SEK/kWh
100 persons * 616 kWh/ (person, year) * 0.85 SEK/kWh = 52360 SEK/year

4.4.2 Example 2

A family of four persons, living in a detached house with direct electricity heating, is replacing their 15 year old taps and showers (equal to class E) to B-classed taps and showers.

4 persons * 315 kWh/ (person, year) = 1260 kWh/ year
With a heated floor space of 100 m²/ apartment the energy saving is 12.6 kWh/ (m² A_{temp}, year).

Electricity price (incl. VAT), 0.60 SEK/kWh
Variable cost (incl. VAT), 0.21 SEK/kWh
Energy tax (incl. VAT), 0.37 SEK/kWh
Total electricity cost: 0.60 + 0.21 + 0.37 = 1.18 SEK/kWh
4 persons * 315 kWh/ (person, year) * 1.18 SEK/kWh = 1487 SEK/year

4.4.3 Example 3

A family of four persons, living in a detached house with ground source heat pump, is replacing their 15 year old taps and showers (equal to class E) to A-classed taps and showers.

4 persons * 420 kWh/ (person, year) = 1680 kWh/ year
With a heated floor space of 100 m²/ apartment the energy saving is 16.8 kWh/ (m² A_{temp}, year).

Total electricity cost (as calculated in example 2): 1.18 SEK/kWh
Heat factor of heat pump: 4
Energy price (ground source heat pump): 1.18 / 4 = 0.29 SEK/kWh
4 persons * 420 kWh/ (person, year) * 0.29 SEK/kWh = 487 SEK/year

5 Suggestions for further work

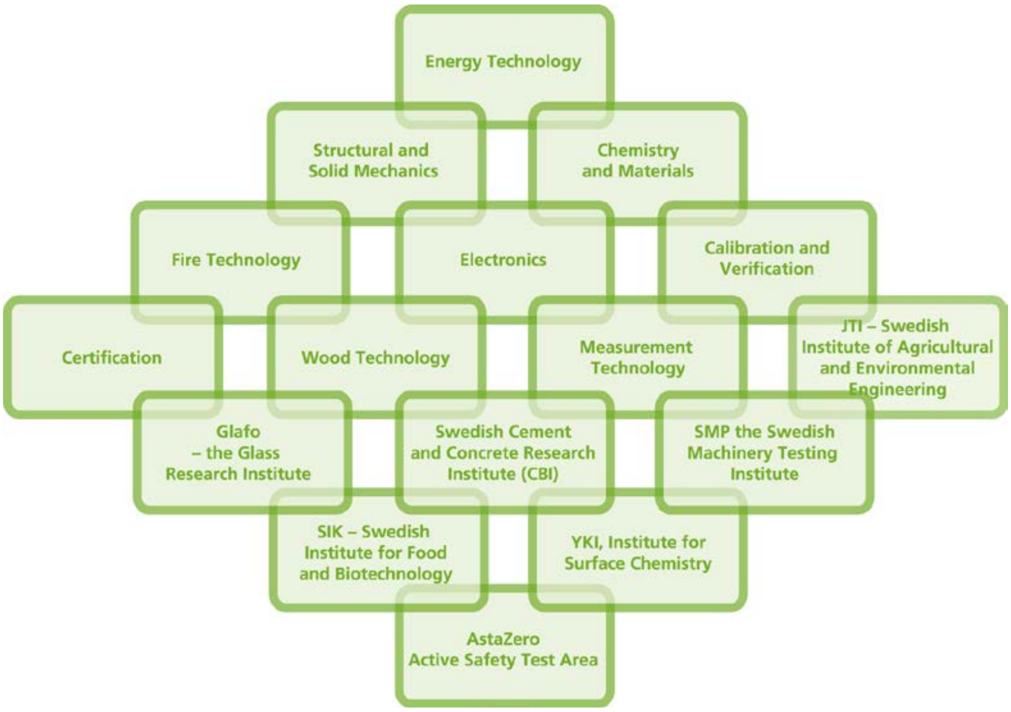
- Perform energy efficiency tests according to SS 820000/SS 820001 of unlabelled taps/showers on the market and of older taps/showers commonly installed in apartment buildings, in order to get a better reference of energy use for unlabelled taps and showers.

- The energy-labelled taps and showers have functions that are supposed to decrease the hot water use by complicating mechanistic use of hot water when it's not needed e.g. cold start functions. Other functions are supposed to change the user's behaviour to be more energy efficient and water saving. It would be interesting to measure hot water and energy use in apartments and houses before and after old taps and showers have been replaced with energy-labelled ones, to find out if energy savings will remain over time, or if users tend to circumvent the impeding functions after learning how their new taps work, which could make the energy savings decrease over time.

1. Ek, C. and D. Nilsson, *Varmvatten i Flerbostadshus: Erfarenhet, Kunskap och Mätning för en Klokare Användning*. 2011.
2. Wahlström, Å., *Vatten- och energibesparing vid byte av tappvattenarmatur*. 2000: Gustavsberg Vårgårda Armatur AB.
3. Ossman, L. and e. al.;, *Nulägesanalys av byggnaders energianvändning inför satsning på näranollenergibyggnader*. 2013: SP Sveriges Tekniska Forskningsinstitut.
4. Björkman, J., *Mätning av kall- och varmvattenanvändning i 44 hushåll*. 2009: Energimyndigheten.
5. Wahlström, Å., R. Nordman, and U. Pettersson, *Mätning av kall- och varmvatten i tio hushåll*. 2008: Energimyndigheten.
6. Boverket, *Regelsamling för byggande*, *BBR 2012*. 2011: Boverket.

SP Technical Research Institute of Sweden

Our work is concentrated on innovation and the development of value-adding technology. Using Sweden's most extensive and advanced resources for technical evaluation, measurement technology, research and development, we make an important contribution to the competitiveness and sustainable development of industry. Research is carried out in close conjunction with universities and institutes of technology, to the benefit of a customer base of about 10000 organisations, ranging from start-up companies developing new technologies or new ideas to international groups.



SP Technical Research Institute of Sweden
Box 857, SE-501 15 BORÅS, SWEDEN
Telephone: +46 10 516 50 00, Telefax: +46 33 13 55 02
E-mail: info@sp.se, Internet: www.sp.se
www.sp.se

Energy Technology
SP Report 2014:3P08445
ISBN
ISSN 0284-5172

More information about publications published by SP: **www.sp.se/publ**