

# Comprehensive monitoring system – essential tool to show the results of the energy audit and voluntary agreement programmes

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## Abstract

Without visible results political support to an energy efficiency programme will dissolve in a few years. Therefore high-quality monitoring and reporting systems are essential to maintain a long-term commitment.

Both in Finnish Energy Audit Programme (EAP), began in 1992, and in Voluntary Agreement Scheme (VA), began in 1997, bottom-up monitoring systems have been in place almost since the beginning. These policy measures and their monitoring systems are integrated.

For the EAP monitoring system data is collected in three phases:

- subsidies granted → the energy auditing volumes in different sectors
- submitted EA reports → proposed measures and saving potentials
- VA annual reporting → status of implementation of the proposed measures in EA reports © implementing rate for saving potentials

In VA scheme the companies and communities report annually on their energy consumption and on energy efficiency measures they have implemented or have decided to implement. Information on energy savings in energy units and energy costs as well as the required investment is reported in connection to the presented measures.

The collected data is based on engineering calculations by the energy auditors. Since the companies have no incentives to submit exaggerated savings, the reported savings are equal to those figures the companies have used as criteria when deciding on the implementation of the measures.

By 2005 these two policy measures have generated about 7 TWh annual savings, representing over 2 % of Finland's total energy end-use. In relation to the magnitude of savings brought in daylight, the investment on monitoring has really paid back.

## Introduction

### ENERGY AUDIT AND VOLUNTARY ENERGY AGREEMENT PROGRAMMES IN FINLAND

Voluntary agreements (VA) and energy audits (EA) play a crucial role in implementing energy efficiency under the Climate Strategy (2001) and the associated Energy Conservation Programme (2003–2006). Also in the new National Energy and Climate Strategy (2005) agreements and energy audits are seen as important tools when reaching the climate targets.

Voluntary agreements contain action programmes agreed between ministries and sector associations, aiming at improving energy efficiency in the sectors covered by the agreements.

Sector associations promote energy efficiency and participation in the voluntary agreement scheme among its members. Companies and communities joining the agreement undertake to carry out energy audits in their premises and production plants, to draw up an energy efficiency plan, and to implement cost-effective energy efficiency measures. The government provides subsidies for energy audits and energy efficiency invest-

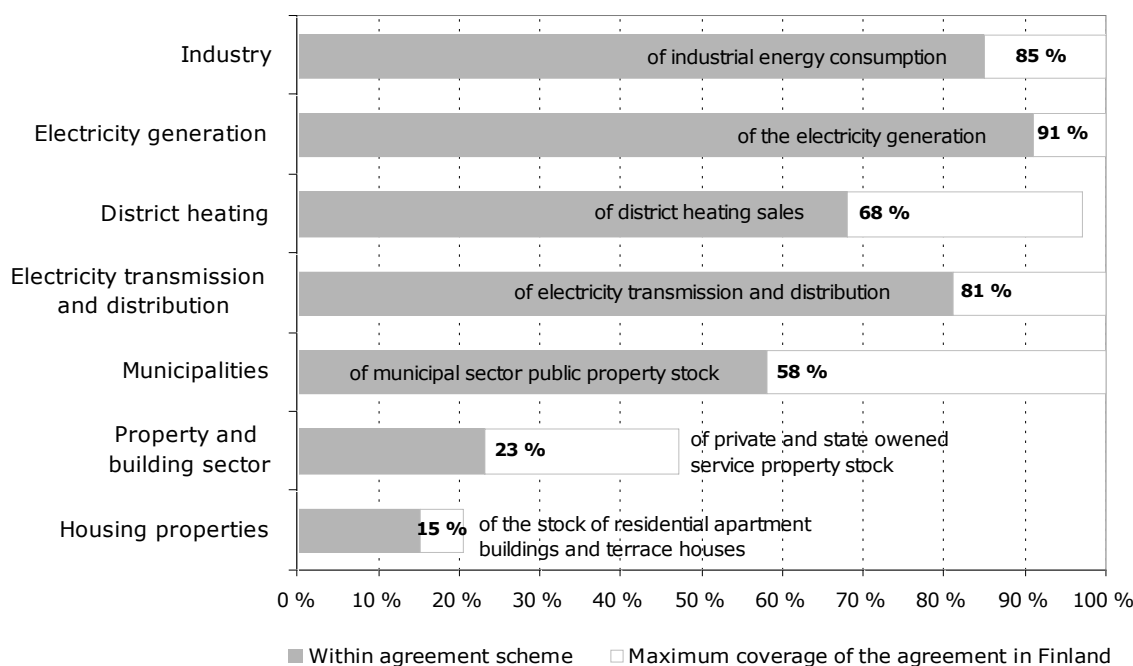


Figure 1. Voluntary agreement coverage in different sectors at the end of 2006.

ments. Motiva Oy (Energy Agency of Finland) is responsible for the monitoring system for energy efficiency measures and other reported data as well as for preparing the Annual Reports on Voluntary Agreements, which are based on the annual reporting from the joined companies and communities.

The energy audit programme has been active in Finland since 1992 and increase of the energy audit volumes have been one of the targets in different sectors in voluntary agreements since 1997. The energy audit programme is officially administered by the Ministry of Trade and Industry. Motiva is however responsible for the development and implementation of practical measures related to the programme.

The energy audits cover the assessment of the current situation in energy and water consumption, possibilities to utilize renewables, proposals for energy efficiency measures and estimates of savings from energy efficiency measures and related reporting. Energy audits are performed by energy auditors trained and authorised by Motiva.

#### ENERGY SUBSIDIES FOR ENERGY AUDITS AND ENERGY EFFICIENCY INVESTMENTS

The subsidy the Ministry of Trade and Industry grants for energy audits is 40–50 %. The higher subsidy applies to all municipalities and federations of municipalities that have involved voluntary agreement. In total, government has granted energy audit subsidies 21.8 million euros during the 1992–2006 period. During the voluntary agreement scheme in 1998–2006, on average approx. 90 % of the audit subsidies have been granted to the projects of companies and communities participating in the voluntary agreements. The number of sites where energy audit subsidy has been granted from 1992 to 2006 has been in total over 6,500, of which the number of industrial sites is approx. 1,100, public service sector buildings nearly 3,800, private service sector buildings over 1,600 and energy sector sites almost 150.

The main focus of the government energy subsidies granted to energy conservation investments is in commissioning of new technology promoting energy-savings. However, under certain conditions, companies and communities participating in voluntary agreements may also receive investment subsidies for customary energy-saving technology projects, within the scope of the government's available funds. In order to qualify for the subsidy, the investments must be quantified in energy audit reports, analyses or other comparable investigations. From 1998 to 2006 the investment subsidies for these projects granted by the government where in total 23.1 million euros of which the share of industry is over 60 %. The total number of subsidised energy investments projects has been approx. 250 of which the share of industrial projects has been over 60 %, public service sector projects almost 25 % and energy sector projects approx. 10 %.

Since 2002 also so-called ESCO projects have received investment subsidies. In 2002–2006, the share of ESCO projects, measured in terms of subsidy volume was about one third. The number of subsidised ESCO-projects was 39, where of the share of industrial projects was almost 70 % and the rest of the projects, except one energy sector project, were implemented in public service sector.

#### COVERAGE OF PROGRAMMES

##### Voluntary agreements cover approx. 60 % of Finland's total energy consumption

By the end of 2006, eight voluntary agreements (see the Figure 1 and in addition public transport) signed by ministries and various associations were in force. In addition there are two ongoing energy efficiency programmes (for truck and van sector and for oil heated buildings), to which companies or other individual parties do not actually sign up.

More than half of the energy consumption of the agreement participants is from the industrial sector, and a good third from the energy sector. The share of the agreement participants from the municipal sector, property and building sector (private and government service building stock) and the residential sector (domestic apartment block and terrace housing stock) totals well under 10 % and transport sector a little over 5 % of that.

Figure 1 shows the coverage of various agreement sectors at the end of 2006. The coverage of all the agreement sectors is presented as the percentage of total volumes of the respective sectors in Finland, to render them directly more comparable. In the property and building sector, housing property sector, and the district heating sector the current voluntary agreement scheme does not cover the entire sector. For these sectors, maximum coverage of the agreements in the respective sectors in Finland is also shown.

In addition to those agreement sectors shown in Figure 1 there are

- **public transport energy efficient agreement**, which covers 45 % of bus and coach stock and all national railways local services, tram services and the metro
- **energy efficiency programme for truck and van transport**, which covers almost 70 % of actual truck and van transport services
- **Höylä II energy efficiency programme of oil-heated properties**, which covers more than 15 % of heating energy consumption of residential, service and agricultural buildings

#### Coverage of the energy audit programme

By the end of the year 2005 approximately 65–70 % (110 TWh/a) of the total energy usage in the industrial sector was covered by the energy audit activity. Consistently energy audits covered approximately 54 % of the municipal building volume (3,700 buildings, 62.5 milj. m<sup>3</sup>) and in private service sector the coverage was over 28 % (1,600 buildings, 70 milj. m<sup>3</sup>) of the sectors building volume by the end of 2005.

Energy audit models developed for the energy sector have been in use for a shorter period – the district heating audit model since 2001 and the energy audit model for power plants since 2003. By the end of 2005 approx 25 % of the electricity generation was under the energy auditing activity. Consistently in the district heating sector about 10 % of the district heating sales is analysed within the energy audit programme, but in addition the sector has reported a number of its own audits without subsidies which covers additionally almost 60 % of the district heating sales.

## Monitoring

### NEEDS FOR MONITORING SYSTEMS – MANY STAGES POSSIBLE

Good monitoring is essential in order to make proper evaluations and modifications to the programmes if needed. It also makes it possible to show the impact of the programmes and is thus crucial for the credibility of the programmes and the commitment to them. However it seems to be rather common in policy programmes that there is lack of monitoring data to reveal the results.

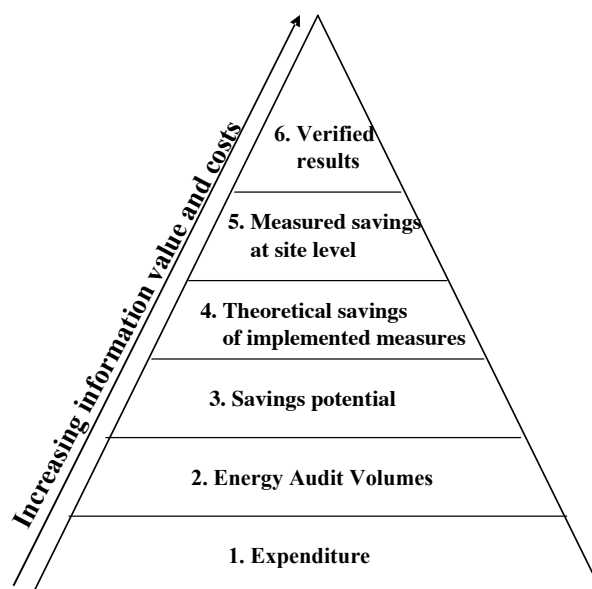


Figure 2. Relations between monitoring, the information value and the costs in energy audit programme.

Compromises have to be made between the monitoring data desired and what is practically possible to gather. As an example in an energy audit programme, at the first monitoring level administration costs are low, if only the amount of subsidies is followed (Figure 2). At the second level administration costs are still quite low but it is also known where the money is spent – for example how the number of audits have been divided on sectors, if the information from the applications is monitored. Anyhow when the data from audit reports is not monitored it leaves the energy efficiency measures and their savings still unknown.

At the third level administrative costs are higher and at least now in this stage a monitoring database to file information for example from the audit reports is needed. Information on proposed energy efficiency measures is now available thus it is possible to calculate the saving potentials. At the fourth level information on implemented measures is gathered from the sites and it is combined with the proposed energy efficiency measures data from the audit reports to get a calculated estimate of the realised savings.

The fifth level needs much more resources because measurements and good energy monitoring systems on the site level are needed. Still the difficulty can be to measure the effect of one implemented energy efficiency measure due to many other changes at the same time for example in the running hours, production, volume etc. At the sixth level physical measures are individually monitored/verified by a third party. Administrative costs are furthermore higher and there will also be other costs e.g. for instruments.

In Finland both in the energy audit and voluntary agreement programmes comprehensive monitoring systems are seen to be highly important. In both programmes monitoring and evaluation are essential parts of the schemes and data collection is based in principal on level four in Figure 2.

The amount of work needed to maintain a monitoring system should not be underestimated. The required resources de-

pend naturally on the volumes but also on how much time is spent to carry out the analysis for various purposes and how actively this type of information service is marketed to various bodies like the media etc.

#### MONITORING IN THE ENERGY AUDIT AND VOLUNTARY AGREEMENT PROGRAMMES IN FINLAND

Monitoring system for the energy audit programme in Finland has been running since 1994. The voluntary agreement scheme was launched for the first sectors at the end of 1997 and the monitoring system for joined companies and municipalities was started in 1999. Monitoring systems for both programmes are Access®-based databases where all relevant data concerning energy audit reports and in case of voluntary agreements companies/municipalities annual reports are filed. The data is used for the annual impact assessment of programmes and to produce the annual reports for schemes and also for other separate analyses.

The monitoring systems for the energy audit and voluntary agreement programmes are linked together. Energy audit is a tool for a company or municipality involved to assess the current situation in energy and water consumption, to find out possibilities to utilize renewables, to get proposals for energy efficiency measures and estimates of saving potentials. Thus it is an important tool for a company or municipality part of the voluntary agreement scheme to implement the agreement. On the other hand via voluntary agreements annual reporting implementation data of energy efficiency measures proposed in audits is gathered, so the follow-up data can be returned back to the monitoring system of the energy audits.

#### Data collection in the energy audit programme

The data on an individual energy audit is filed in the database in three phases. The first phase of information on an energy audit is filed when a subsidy is granted by the Employment

and Economic Development Centre (EEDC) (Figure 3, I). By this information Motiva can follow the penetration of energy auditing in different building and client sectors.

The second phase of information on an energy audit is filed when the audit report is submitted to Motiva via the EEDC. At this point the audit has been completed and the report includes information on actual energy and water consumption and costs and a list of all profitable energy efficiency measures with comprehensive numerical data (Figure 3, II). The data is presented in standard tables that are submitted also in digital format in order to simplify the filing of the data. This phase provides information on the average saving potentials in different sectors and in different types of buildings. Based on this information, it is also possible to list e.g. the most common energy efficiency measures.

The third phase of information on an individual energy audit is filed on those buildings/sites where the follow-up data about the implementation of the proposed measures is gathered. First this follow-up data was collected via separate follow-up questionnaires (1995, 1996 and 1999). Since 2000 this data is collected via annual reporting of companies/municipalities (Figure 3, III). The purpose of the follow-up data is to monitor the implementation rate of the suggested energy efficiency measures to estimate realised savings in audit programme.

Data filed in different phases in the monitoring system of the energy audit scheme is described in more details below.

#### Phase I

From the application and subsidy decision documents:

- general data (e.g., volume, year of construction, type of building, involvement in voluntary agreements etc.)
- granted subsidies, auditing costs

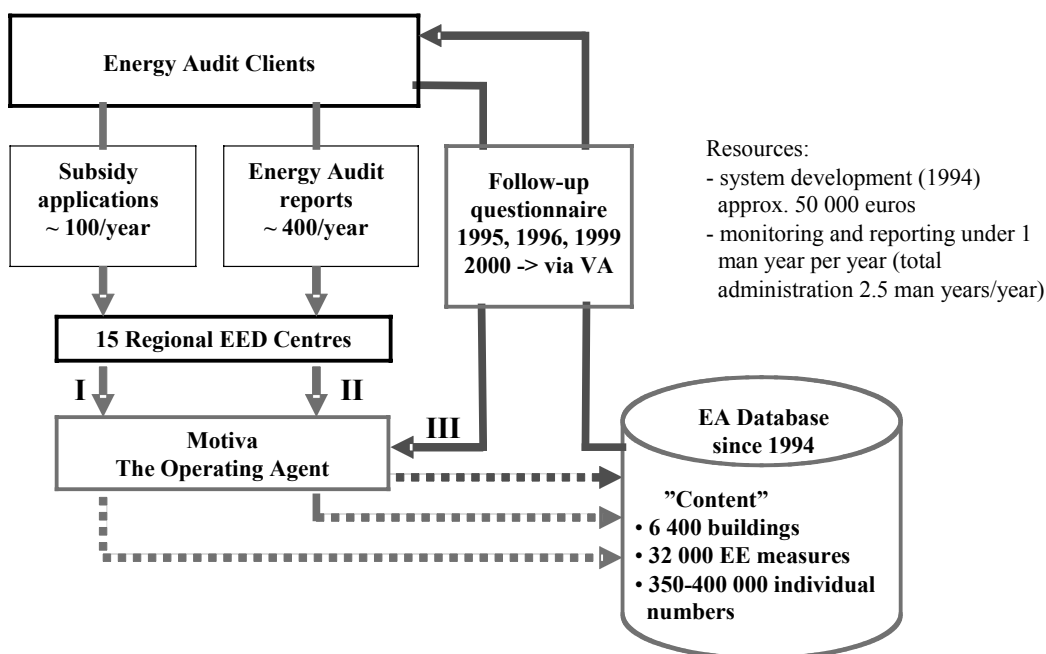


Figure 3. Principle of data collection in the energy audit programme. (EED=Employment and Economy Development, EA= Energy audit, VA=Voluntary agreement))

*Phase II*

From the energy audit report:

- general data (reviewing/updating)
- energy and water consumption data from the year preceding the audit

for each proposed measure:

- short description/name of the measure
- savings in heating, electricity and/or water in energy units (kWh/a)
- savings in heating, electricity and/or water in terms of costs (€/a)
- potential savings in power charges (€/a)
- change in carbon dioxide emissions (tCO<sub>2</sub>/a)
- the estimate of investment and pay-back time of the measure considered (€, a)
- its implementation status (implemented I, decided to be implemented D, under consideration C, not to be implemented N)

*Phase III*

Annual reporting by each company within voluntary agreement scheme provides information on the implementation of measures proposed in the energy audits

- the update to the implementation data of proposed measures (I, D, C, N)

**Data collection in the voluntary agreement programme**

The companies or municipalities who have joined the voluntary agreement scheme report annually to their branch associations, providing information on energy use, energy efficiency measures they have implemented and also some other topics like if they have environmental management system, how they

have organised energy consumption monitoring etc. The energy efficiency measures companies or municipalities report to be implemented can be those found in the energy audits or measures the companies have identified by them selves. Those measures found in the energy audits are reported also through the energy audit monitoring system. This overlapping is taken into account when the total impact of the voluntary agreement scheme and the energy audit program is calculated.

Motiva is responsible for the monitoring system for energy efficiency measures and other reported data as well as for preparing the Annual Report on Voluntary Agreements for different sectors, which are based on the annual reporting from the companies involved, with other agreement parties.

Below is described as an example the data each of the industrial company who have joined the voluntary agreement report annually:

- the general details (e.g., contact information, standard industrial classification, if the company/site is within the emission trading scheme, how the energy audits are carried out etc.)
- detailed data on energy and fuel consumptions
- the main products and production volumes, building data (number, volume, area) etc.

Operating procedures for energy efficiency:

- the monitoring of energy consumption and its frequency (separated for heat, electricity, fuels, specific consumptions, energy costs)
- the questions concerning energy efficiency plans (targets/indicators for energy efficiency etc.)
- type of environmental management system used
- other questions concerning the actions and operational procedures in company/site
- fossil fuels replaced with renewables

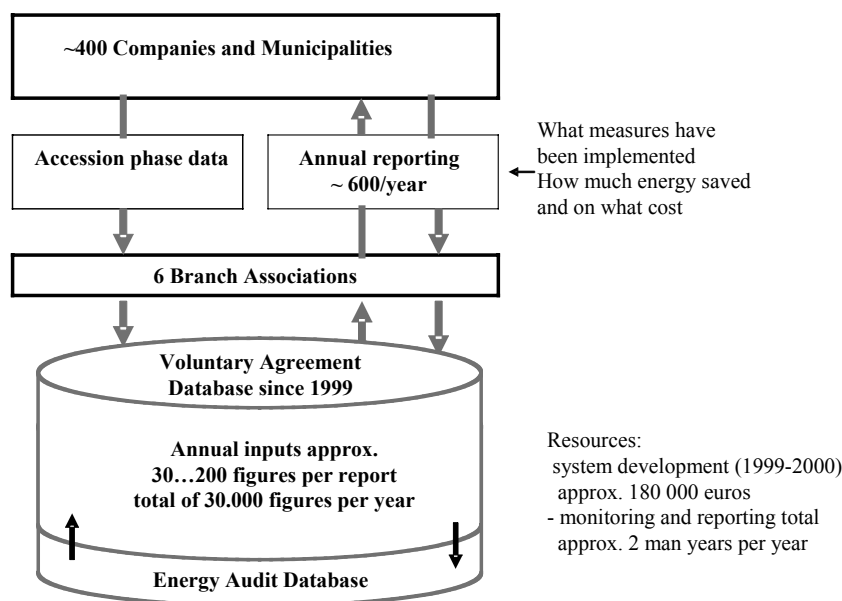


Figure 4. Principle of data collection in the voluntary agreement scheme.

- the guidelines for energy efficiency purchase (EFF1)
- training of employees (ecodriving, environmental etc.)
- participation in the annual Energy Awareness Week
- obligations to subcontractors to join the voluntary agreement (e.g. transport)

The energy efficiency measures proposed in the energy audits and their status of implementation (implemented I, decided to be implemented D, under consideration C, not to be implemented N):

- the data from energy efficiency measures and their implementation is transferred between the energy audit and the voluntary agreement monitoring systems

Other energy efficiency measures than those detected in energy audits and their data:

- the calculated energy savings in electricity, heat and fuels
- investments, implementation year, pay back time

Environmental measures:

- the measures that have effect on energy use (+ or -) and their data (investment, energy impact for electricity, heat or fuels)

E.g. the reporting activity within the industrial voluntary agreement scheme during different years has been 92–100 % based on the number of sites and 97–100 % based on the total energy use within scheme.

## Evaluation of the achieved savings

### THE ENERGY AUDIT PROGRAMME

#### Calculation of savings in the energy audit programme

Data collected from the energy audit report is verified and/or measured on site by authorised energy auditors, or they are calculations based on these data. The auditor also proposes the sequence of energy efficiency measures in order to take into account the possible overlapping effect of individual measures. The accuracy of the saving calculations corresponds to the accuracy achievable in normal field work. Normally, savings obtained through energy efficiency measures are not verified afterwards through measurements due to practical problems in measuring and additional costs. The estimates of energy savings by energy auditors are realistic because neither the client ordering the energy audit nor the auditors have reason to report excessive savings.

The impact assessment of energy savings (ES) from the energy audits performed in different sectors (industry, municipalities, private service sector) is based on the total saving potential (TSP) in thermal and electrical energy and the related degree of implementation (DI) of the energy efficiency measures proposed in audit reports.

The implementation data of each measure is first obtained from the energy audit report submitted by the auditor on the basis of the information given by the client – this data about implementation of proposed measures in audit is then updated

based on the annual reporting of the voluntary agreements. For each measure proposed in the energy audit report, the annual reporting of the voluntary agreement includes a question whether the measure has been implemented (I), decided to be implemented (D), is under consideration (C) or whether a decision has already been made not to implement it (N). The degree of implementation (DI) of the measures proposed in energy audits is then calculated as following:

$$DI [\%] = I + D + a \cdot C,$$

where according the energy audit follow up data during previous years the implementation rate for the measures under considerations (a) is 1/3 for service sector measures and 0,05 for industrial sector measures.

The total saving potential (TSP) used in the calculations is the reported combined and sliding saving potential of the audited sites/buildings during the previous six year period. Due to the big amount of separate energy efficiency measures it is impossible to assess saving lifetime for each individual measure. Therefore to “play it safe” a sliding period of six years has been used when calculating the total annual saving impact.

The energy savings (GWh/a) to be realised are calculated as follows:

$$ES [GWh/a] = DI(\text{heat}) \cdot TSP(\text{heat}) + DI(\text{electricity}) \cdot TSP(\text{electricity})$$

#### Energy savings by the energy audits

##### *Calculated average realised savings in the different sectors*

The average realised savings in the different sectors are calculated according to the saving potentials found in the energy audit reports combined with the implementation data for proposed measures gathered via voluntary agreement annual reporting. The calculated average realised savings differs according to sectors and are shown below.

**Municipal service sector buildings** (residential buildings not included)

- 9 % in heat and fuels
- 5.5 % in electricity

**Private service sector buildings** (residential buildings not included)

- 12 % in heat and fuels
- 4 % in electricity

**Industry** (energy-intensive process industry not included)

- 6...9 % in heat and fuels
- 3...5 % in electricity

##### *Energy savings by the energy audit programme*

By the end of the year 2005 the estimated annual savings in the energy and water costs achieved by audits in the service and industry sectors (excluding energy-intensive process industry) is estimated to be approx. 30 million Euros. The corresponding savings in the energy use is approximately 1 TWh per year, when calculations are made on the basis of principles described in the previous chapter. From those yearly savings 80 % are from the industrial sector. Due to the use of six year sliding

saving potential described in previous chapter, in practise the yearly energy savings (1 TWh/a) will not increase as long as the yearly audit volumes stay constant. The cumulative savings during the whole period 1992–2005 are over 270 million Euros and approximately 8.5 TWh, of which industry accounts for about 70 %.

The energy audit programme is targeted to all industrial companies but the monitoring of the energy audits in the energy intensive process industry is carried out via the voluntary agreement monitoring system. So this impact assessment covers all other industry but not the above mentioned energy intensive process industry.

## THE VOLUNTARY AGREEMENT PROGRAMME

### Calculation of savings in the voluntary agreement programme

In the voluntary agreements annual reporting companies and municipalities report energy efficiency measures they have implemented. Measures can be those found in the energy audits or measures the companies have identified in other context.

All measures reported in the voluntary agreement annual reports which are based on energy audits have comprehensive initial data in the energy audit report but for “other measures” only energy savings and investment figures are reported. The accuracy of the savings calculations corresponds to the accuracy achievable in normal field work, some of the input data are design data or estimates, because metering is not always possible. As in energy audits also here the reported energy savings are assumed to be realistic because neither the company nor the energy auditor have any reason to report excessive savings. Savings obtained through energy efficiency measures are normally not verified afterwards through measurements, in general only measures implemented by ESCOs can have metered data afterwards.

Those measures reported in the audits are prefilled in company's or municipality's annual report form. In the voluntary agreement annual reporting, the company or municipal reports the status of implementation (I, D, C, N) of each energy efficiency measures.

The energy saving (ES) impact assessment is based on the energy efficiency measures the companies have, in their annual reporting, reported to be implemented (I) during the previous year. The amount of energy saving, which is reported in connection to each measure, is used as such without any correction factors. The agreement scheme has been in force since 1997 and majority of the measures have a technical lifetime of 15 to 25 years. Typical reported measures are e.g. measures concerning heat recovery, process equipment, air conditioning, heating system, lightning etc. Therefore the energy savings from all reported measures are expected still be effective in year 2006. The only assumptions taken are that the companies have implemented all those measures they have reported to be implemented and that the presented savings are in range. For those measures reported in the energy audits, the energy audit quality control system does check the level of presented savings in relation to the realistic level typical for the measure in concern.

The formula used to calculate the total savings (GWh/a) from the voluntary agreement scheme:

$$ES [GWh/a] = ES(\text{heat+fuel}) + ES(\text{electricity})$$

### Energy savings by the voluntary agreements

Based on sector-specific annual report data for 2005, the impact of energy efficiency measures implemented in the companies and municipalities in industrial, energy, municipal, real estate and building sectors participating in the agreements by the end of 2005 totalled approx. 7.1 TWh/a (electricity 1.5 TWh/a, heating + fuels 5.6 TWh/a), which is equivalent to the annual electricity and thermal energy consumption over 350,000 single family houses, calculated on the customary house consumption of 20,000 kWh/a.

82 % (5.85 TWh/a) of the energy conservation effect of implemented energy efficiency measures is reported under the industrial voluntary agreement which represents the savings collected from about 350 industrial sites. The proportion of the power plant sector of the conservation impact of the implemented measures is 14 % (0.96 TWh/a). The remainder, about four percent, of the conservation impact of implemented measures was reported in the district heating sector (0.09 TWh/a), the municipal sector (0.07 TWh/a), the power transmission and distribution sector (0.07 TWh/a) and the property and building sector (0.05 TWh/a).

The annual saving in energy costs achieved through implemented energy efficiency measures across the agreement sectors is approx. 135 million Euros, estimated using the average heating and fuel price of € 15/MWh and the average electricity price of € 35/MWh. In order to implement the energy efficiency measures, corresponding investments of more than 250 million Euros have been made in the industry, and approx. 60 million Euros in the power plant sector. As well as the savings achieved, the voluntary agreement report includes measures where the decision to implement had been made, with the total savings potential across the various agreement sectors of approx. 1.2 TWh/a. The bulk of this saving potential, over 90 %, is reported in the industrial and power plant sector agreements, the share of industry being clearly more than a half. The saving potential of these decided measures increased a bit from the previous year, but it has varied only a little over the years.

In addition to the implemented and decided measures companies and communities have reported measures classified as being under consideration, with a total saving potential of 5.5 TWh/a. The proportion of these measures under consideration has grown annually throughout the whole agreement term. Converting this saving potential, equivalent to almost 80% of savings of measures already implemented, into real savings is a great opportunity, and at the same time also a challenge to all parties.

### AVOIDING DOUBLE-COUNTING WITHIN THE DIFFERENT INSTRUMENT PACKAGES

In voluntary agreement reporting those measures found in the energy audits are reported also through the energy audit monitoring system. This overlapping is taken into account when the total effects from the voluntary agreement scheme, the energy audit program and the energy subsidy scheme is calculated. This needs a lot of knowledge of the programmes to separate the overlapping of the programmes. Figure 6 illustrates the problem for one year.

As seen in the Figure 6 the total saving impact of three instruments is approx. 6.6 TWh/a in 2004 and not 8.1 TWh/a as

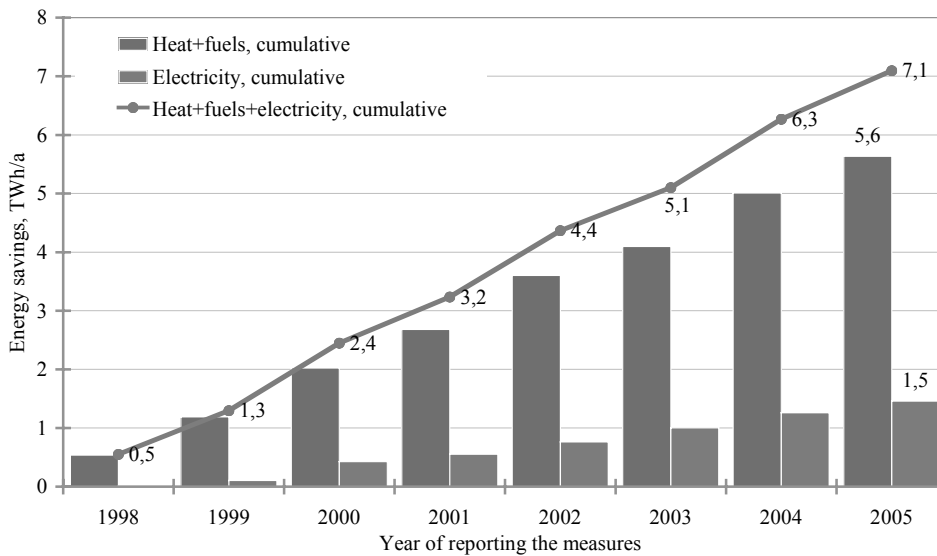


Figure 5. Cumulative energy saving impact of energy efficiency measures reported as implemented. (Results from the industrial, energy, municipal and property and building sector voluntary agreements)

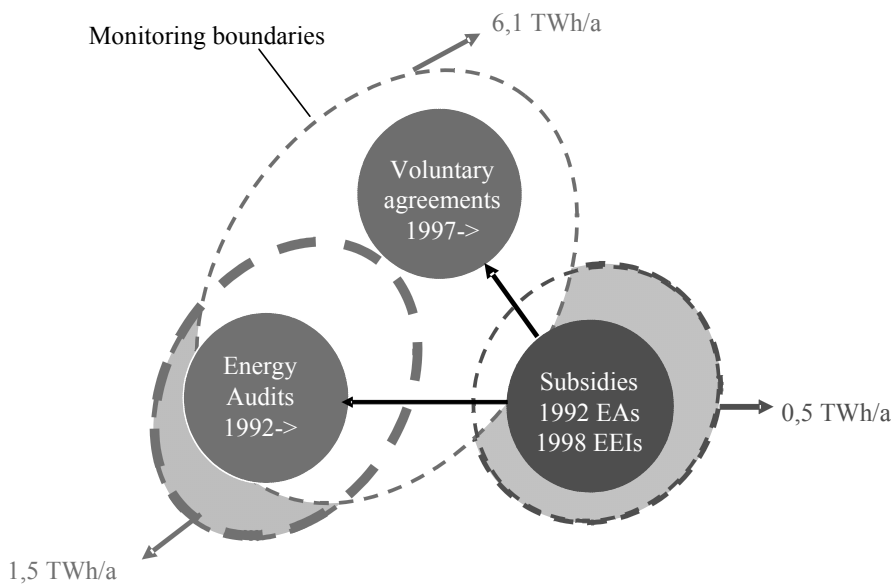


Figure 6. Avoiding double counting within the different instruments. (Three instruments: The energy audit programme, The voluntary agreement programme, The energy subsidy scheme; EA=Energy audit, EEI=Energy efficiency investment)

if all separate savings from different instruments were added up together.

Within the programmes no priority has been given to the monitoring or evaluation of the free rider effect. The programmes essentially aim is at having energy efficiency measures actually carried out. As long as this has been the case, it is not seen as an important priority to determine the extent of the free riders effect.

## Success factors and future plans

### COMPREHENSIVE MONITORING AS A SUCCESS FACTOR

A successful programme needs several success factors. Reliable assessment of productivity and impacts of programmes demands both sufficiently comprehensive and high-quality monitoring and reporting. Consequently, a great deal of effort was invested in developing a monitoring method and system in the early stages of the Finnish energy audit and voluntary agreement programmes.



Monitoring systems for both the energy audit and the voluntary agreement programmes have been in the key position to maintain the continuous top-level commitment. The energy audits have been mentioned in all national energy policy and strategy documents since 1992 and also voluntary agreements since they were launched in 1997. This has guaranteed the programmes adequate resources, both on subsidies and administration. On the other hand, this government support would not exist without the good results the programmes have continuously provided. Therefore also the decisions in 1994 and 1998 to invest on a high-quality monitoring systems have paid off.

#### **THE AGREEMENT SCHEME CONTINUES**

The majority of the voluntary agreements signed mainly in 1997 were due to expire at the end of 2005. Based on evaluation of the agreement scheme and feedback received from the field, it was decided that the agreements would be extended by two years. During that time drafting of next generation new agreements (2008-2016) is expected to progress at a good pace. The updated National Energy and Climate Strategy approved by the Government in November 2005 also refers to energy efficiency agreements and energy audits as important means of reaching the climate targets.

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