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A review of energy efficiency policies for small and medium-sized manufacturing enterprises from around the world

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ABSTRACT

In most countries, small and medium-sized manufacturing (industrial) enterprises (SMEs) represent more than 99% of the number of companies and 60% of employment. Thus, this sector, apart from using energy, is a major driver in the economy with regard to innovations, GDP, investments and export. Despite the importance of SMEs in the economy, they have not received much attention in most countries' energy policy activities.

Energy management in its various forms is regarded as one of the key drivers of industrial energy efficiency. While the term “energy management” is often associated with the ISO 50001 standard, there is a broad variety of different programs and schemes in place that do not strictly abide by the framework of the standard. Especially for SMEs, the standardized protocols of ISO 50001 are often too complex for cost-efficient implementation.

The aim of this paper is to provide an international overview of existing energy efficiency policies with a focus on energy management practices in selected EU member states as well as Norway and Japan. Results indicate that different countries apply a broad variety of policy contexts in which the energy management practices are embedded.

Introduction

In most countries, industrial small and medium-sized enterprises (SMEs) represent more than 99% of the number of companies and 60% of employment. Thus, the sector, apart from using energy, is a major driver in the economy with regard to innovations, GDP, investments and export. Despite the importance of SMEs in the economy, they have not received much attention in most countries' energy policy activities.

Energy management in its various forms is regarded as one of the key drivers of industrial energy efficiency. While the term is often associated with the ISO 50001 standard, there is a broad variety of different programs and schemes in place that do not strictly abide by the framework of the standard. Especially for SMEs, the standardized protocols of ISO 50001 are often too complex for cost-efficient implementation.

The aim of this paper is to provide an international overview of existing energy efficiency policies with a focus on energy management practices in selected EU member states as well as Norway and Japan. First, we will give an overview of energy end-use policies and programs in the participating country including subsidies, administrative polices, energy audits, investment funds, networks, information campaigns and benchmarking methods. In the second part, we will

make some concluding remarks and provide some industrial energy efficiency policy recommendations based on the findings from the different countries. For a North American context, the importance of this study is that is allows for the U.S. and Canada to learn from other nations' policy attempts towards industrial SMEs.

EU Member States

For the EU countries a common energy policy framework applies, set by the various policy instruments. For industry, three major instruments have a direct relation to industry:

- The EU Emission Trading Scheme (EU ETS)
- The Energy Audit Obligation for Large Companies (Art. 8 EED)
- The Minimum Energy Performance Standards (MEPS) for a broad variety of product groups (Ecodesign)

EU ETS

The EU ETS operates in the 28 EU countries as well as Iceland, Liechtenstein and Norway, covering around 45% of the EU's greenhouse gas emissions. It is a highly relevant instrument for industry, as the whole electricity sector as well as industrial installations above 20 MW installed power are included in the scheme. Despite some setbacks due to the economic crisis in the late 2000s, the market – also due to EU interventions – is now recovering and carbon prices are rising again (> €20/t CO_2) from previous lower levels.

Energy Audit Obligation for Large Companies

The Energy Efficiency Directive (EU 2012/27/EU amended by (EU) 2018/2002) is the EU's major piece of legislation specifically targeting energy efficiency. It covers a broad variety of instruments to foster energy efficiency in the EU member states. Several of these instruments target industry. Most prominent among them is the obligation for non-SME organizations to conduct regular energy audits. Non-SMEs are companies that are not SMEs in the definition of the EU (> 250 employees; > €50 million turnover; > €43 million balance sheet total). The energy audit has to comply with several minimum criteria set out in the directive. Enterprises that have implemented or committed to introducing an energy management system, e.g. ISO 50001, are exempt from the obligation.

The implementation of the audit obligation is subject to national legislation of the member states. This leads to a certain variety in implementation, especially regarding the reporting and verification of the audits. The directive does not require the implementation of measures or reporting on the implementation. The policy is too new to have been scientifically evaluated, for which reason no data exists on its effectiveness.

The Minimum Energy Performance Standards of the Ecodesign Directive

For a large variety of products, the EU has established minimum energy performance standards (MEPS) in the context of the Ecodesign Directive. These MEPS use a least life cycle cost approach and are in place for most crosscutting technologies in industry. The major product groups covered include a variety of motors and motor-driven systems as well as lighting, boilers and ovens. These standards apply for all products put on the EU internal market (including the EFTA countries).

Germany

Based on the EU framework, the German policy mix for industry is built on several pillars covering the different instrument types:

- Energy taxes (on fuels and electricity)
- Tax exemptions for energy intensive industries with corresponding requirements (ISO 50 001)
- Federal funding schemes for cross-cutting technologies, process technologies, waste heat, energy audits and energy management systems
- The energy efficiency networks initiative

Energy Taxes and the Corresponding Tax Exemptions

In 1999 the federal government introduced the eco-taxation ("Ökosteuer") in Germany raising fuel taxes and introducing a tax on electricity besides the value added tax (VAT). To ensure industrial competitiveness, exemptions from this taxation are granted for energy-intensive industries as well as industries in strong international competition. To comply with EU competition regulations, industry has to deliver a service in return for the exemption. This is operationalized by a voluntary agreement with industry to reduce the energy intensity by 1.3% per year and a requirement for the individual company to introduce a certified energy management system. This led to a tremendous increase of ISO 50001 certifications in Germany with ~8,300 certifications in 2017 (compared to 77 in the US) (ISO 2018).

Federal Funding Schemes

For industry in Germany, a broad variety of funding schemes exist on a federal level. The KfW, the German development bank and the federal office for energy efficiency, an authority subordinated to the federal ministry of economy and energy, manages those programs. Although they mainly target SMEs, some of the programs are also open for applications by large companies. The programs cover a broad variety of different subjects:

- cross-cutting technologies
- process technologies
- waste heat
- buildings
- energy audits (only for SMEs)
- energy management systems (only for SMEs)

The technology programs have the common rationale to support technologies that go beyond the minimum standards set out in the ecodesign directive or, in the case of buildings, the national standards. The energy management and energy audit funding schemes only apply to SMEs, as large companies are targeted by (a) the EU energy audit obligation and (b) the incentives set out by the tax exemption mechanism.

For SMEs, the funding schemes for cross-cutting technologies and for energy audits have been extremely successful. Within the funding scheme for energy audits, 2,500 audits were performed in 2018. Those audits are performed by certified energy auditors, which have to prove continuous training to keep their accreditation.

The 500 Networks Initiative

Complementing the regulatory and financial incentive mechanisms, the German federal government and all major industrial and commercial associations signed a voluntary agreement in 2014. The target of this initiative is to establish more than 500 energy efficiency networks in Germany by 2020. These implementation-oriented networks usually consist of 8–12 companies and include energy audits, a common target setting and a monitoring process. The target of the initiative is to achieve primary energy savings of ~75 PJ/year in 2020. By March 2019, 225 networks had been established in the context of the initiative. Those networks are initiated and implemented by different actors such as local energy agencies, chambers of commerce, utilities and consultants. Further information on energy efficiency networks can be found in the paper by Durand (2019).

Italy

There are several tools that incentivise energy efficiency adoptions in Italy, which are presented below.

Energy Efficiency Obligation (EEO) Scheme: White Certificates

The main mechanism to support energy efficiency for industry is the "White Certificates Mechanism." This is an EEO scheme, with a tradable market, and works both as an EEO and as an incentive scheme for voluntary parties. The system rests on the obligation for electricity and gas distributors (DSOs) with more than 50,000 end-users to generate a certain amount of savings each year or, alternatively, to purchase an equivalent amount of certificates.

White certificates (also called "Certificati Bianchi" or "Titoli di Efficienza Energetica," TEE) are used to certify the achievement of energy saving in the final uses of energy, through energy efficiency measures and projects. The economic value of the certificates (originally set at 100 €/TEE) varies depending on the cost of energy and is a function of market trends. The obligation scheme was introduced by the legislative decrees that liberalized the electricity and natural gas markets (Ministerial Decrees –July 20, 2004).

The first review of the scheme was done in the Italian National Energy Strategy of 2013, which assigned white certificates the task of covering about one-third of the new energy savings that needed to be achieved by 2020.

Since the start of the White Certificates mechanism in 2005, overall additional primary energy savings of approximately 1,000 petajoules (PJ) have been certified and more than 47.5 million Energy Efficiency Certificates (Certificati Bianchi) have been issued.

The annual amount of the "Certificati Bianchi" issued in 2017 amounts to approximately 5.8 million white certificates (TEE), a level similar to that of the two-year period 2012–2013, but far from the peak of over 7.5 million observed in 2014. The volume of certified savings in 2017, equal to about 80 PJ, was practically unchanged compared to 2016, but far from the over 125 PJ recorded in the period 2010–2012.

Obligation Scheme: Energy Audits

In line with article 8 in the EED, some types of companies are obliged to perform an energy audit every four years. Apart from the mandatory large companies, Italy also requires energy-intensive manufacturing companies with more than 2.4 GWh of electricity consumption

and an annual cost of energy that is more than 2% of the revenues of the company to also perform energy audits every four years. As with article 8, these kinds of companies are exempt if they have implemented an energy management system according to EMAS, ISO 50001 or EN ISO 14001, as long as it includes an energy audit.

Energy Manager Appointment

According to Art. 19 of Law 10/91, some industrial companies are obliged to appoint an Energy Manager, who is responsible for verifying energy end use and putting measures in place for improvements. The Energy Manager shall be appointed each year by April 30. In particular, the mandatory subjects are:

- Companies, operating in the industrial sector, that, in the previous year, used more than 10 ktoe (primary energy), summing up all energy sources;
- Companies, in civil (residential), tertiary and transport sectors, that in the previous year used more than 1 ktoe (primary energy), summing up all energy sources.

There is a national register of Energy Managers that is kept by FIRE (Italian Federation for the Rational use of Energy). Companies not subject to this requirement can also decide to appoint an Energy Manager, in order to optimize their consumption.

Electricity Discount for Energy-intensive Companies

Companies with high energy intensity, which, however demonstrate a certain level of energy efficiency, are entitled to a discount on some components of system charges in their electricity bills, based on their energy intensity, calculated as the share of electricity costs over the gross value added (GVA). The criteria to access system charge discounts are that companies shall consume at least 1GWh/year of electricity and in addition:

- Belong to a sector listed in Annex 3 of "Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014–2020" (2014/C 200/01);
- Have an energy intensity higher than 20% and belong to a sector listed in Annex 5 of "Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014–2020" (2014/C 200/01);
- Have an energy intensity lower than 20% but for the years 2013–2014 be included on the national list of high energy-intensive industrial companies.

In the first and second case, for companies with energy intensity higher than 20%, the amount of system charges (that are a component of the electricity bill) paid goes from 0.5% of GVA to 2.5% of GVA. Electricity consumption used for energy intensity calculation is however not what is measured, but a "typical" amount for the type of company and product, calculated by the National Energy Agency (ENEA), in order to take into account a certain level of energy efficiency of the plants. Companies listed in Ann. 3 of the above mentioned document, with an energy intensity lower than 20%, or that belong to the third group, get an overall discount on system charges that could be from 25% to 100% of the considered components, increasing with the increase of energy intensity. The use of a standardized electricity consumption measurement, instead of the actual one, is to benefit those companies that have put in place energy efficiency measures and to reduce the proportion of the discount to those that have a high consumption because of the use of aged and inefficient technologies. Moreover, the energy use threshold of 1

GWh, introduced in 2018, instead of 2.4 GWh as it was before, has been done in order to include SMEs in the system.

National Fund for Energy Efficiency

The National Fund for Energy Efficiency ("Fondo nazionale per l'efficienza energetica") is a tool developed by the Ministry of Economic Development in order to support companies and public bodies that invest in energy efficiency. The fund was instituted by Legislative Decree 102/2014, but was effectively put in place with Inter-ministerial Decree 22/12/2017.

It is a rotating fund that foresees two kinds of financial support:

- Concession of guarantees on single investments; 30% of the fund availability is dedicated to this;
- The issue of cut-rate loans; 70% of the fund availability is dedicated to this.

At least 20% of the overall fund availability is dedicated to investments performed by public bodies. The fund is sustained by the Ministry of Environment. In order to get the subsidies, the interested companies shall implement projects in the following fields:

- Energy efficiency in industrial processes;
- District heating network construction or upgrade;
- Energy efficiency for public services and infrastructures, including street lighting;
- Building retrofitting.

Conto Termico

Conto Termico (Thermal Account) is a subsidy, regulated by Ministerial Decree 28/12/2012 and then updated with Ministerial Decree 16/2/2016 and Ministerial Decree 186/2017, the purpose of which is to incentivize the adoption of small thermal energy efficiency measures (EEM) and renewable energy systems. There are different incentivized interventions, depending on the type of subject (public bodies or private companies). For industrial companies, the admissible EEMs are:

- Heat pump installation to replace a pre-existing traditional heating system;
- Biomass boiler and stove installation to replace a pre-existing traditional heating system;
- New installation of solar thermal systems;
- Heat pump water boiler installation to replace a pre-electric boiler;
- Installation of a solar hybrid system with heat pump to replace a pre-existing traditional heating system.

The subsidy can be up to 65% of the investment costs, which is reduced however to a list of recognized expenses for each type of intervention. The subsidy is given in one solution if it is below 5,000 EUR, otherwise, it is split in two to five yearly installments.

For public bodies, more types of energy efficiency measures are incentivized.

Ireland

Ireland Industrial Energy Efficiency Policy

The aggregated final energy use in the Republic of Ireland was approximately 4,960 PJ in 2017, 21% of which was consumed by the industrial sector, 43% by transport, 22% by

residential, and 12% by the commercial sector. Ireland's industrial profile is dominated by light manufacturing operations (ICT, Medical Devices) and food industries (dairy, meat) and has very few energy-intensive industries, e.g. there are no primary iron or steel works in the country. Considering the relative share of transport that may be assigned to industry, in effect, manufacturing industry is responsible for approximately 34% of total final energy consumed (TFEC). Irish manufacturing SMEs, characterized by small and indigenous companies, represent 19% of industrial energy end-use and showed little progress in energy efficiency from 1990–2016, with an average reduction in energy intensity of 3% over the period.

Ireland's goal of 20% energy savings from energy efficiency by 2020 will be missed, with the level of achievement expected to be 16%. Non-ETS emissions are anticipated to be between 0% and 1% below 2005 levels by 2020 compared to the target of 20% below, which was mandated in the EU Effort Sharing Decision (EPA, 2018). The Irish Government Committee on Budgetary Oversight (2017) indicated that the failure to meet EU 2020 and 2030 carbon emissions targets will result in costs to the Exchequer through purchasing compliance or direct fines of between EUR 230 million and 610 million by 2020, and costs of between EUR 3 billion and 6 billion by 2030.

Investment Subsidies and Funds

The implementation of renewable energy and energy efficiency across all sectors in Ireland is primarily vested in a state agency called the Sustainable Energy Authority of Ireland (SEAI) which administers most programs, grants and incentives for enterprises seeking to develop energy-saving projects. Funding is made available to engage external resources for services such as baseline quantification, asset assessment, procurement specialists, and project facilitation necessary to develop energy efficiency projects.

SEAI provides a Smart Lighting Grant for SMEs that covers up to 35% of the costs of a full-facility LED lighting upgrade. In 2017, 60 businesses were provided with funding of almost EUR 500,000 towards lighting upgrade projects which resulted in cost savings of over EUR 540,000 for those companies. On average lighting electricity costs were reduced by up to 60%.

In 2018, the strongest performer in terms of Irish export growth was the dairy sector, with export volumes up 5% to a total of EUR 4 billion. In order to improve energy efficiency in this sector, SEAI launched a Pilot Dairy Scheme to support the installation of variable speed drive technology in milking parlors, as well as vacuum pumps and smart meters. Grant aid is available for up to 50% of the total technology and installation costs. Funding of EUR 250,000 was allocated to 47 farm enterprises (SMEs) in 2017 and over EUR 400,000 has been allocated in 2018. Farm enterprises that participated in 2017 reported reduced running costs of vacuum pump/milk pump systems, reduced noise, and improved vacuum.

Energy Audit Programs & Subsidies

SEAI operates a Small and Medium Enterprise (SME) Program, which delivers assessments, advice, mentoring and training services to SMEs to help them reduce energy use and cut costs. Since 2007 the program has supported over 1,470 companies, employing the equivalent of approximately 130,000 full-time staff. In 2017, the average energy bill of companies participating in the program was around EUR 80,000 per year and the average company savings in their first year was 10%. The cost to the business of saving one kWh was 1.8c in comparison to the average cost of a kWh of purchased energy of 8.2c. Overall, if the

program and investment costs are taken in to account, a net benefit to society of EUR 162 million by 2020 is estimated for the scheme when the lifetime of savings measures is included. The value of CO_2 and other emissions abated will reach EUR 40 million by 2020.

The program has clearly established that many investments in energy efficiency improvements save more than they cost as a result of reduced energy usage. It has also been evident that many such investments are not being taken by SMEs despite the opportunity for good (often short-term) economic returns. The reasons suggested for this lack of action are time constraints, financial barriers, lack of knowledge, inadequate human resources, etc.

Sweden

Sweden Industrial Energy Efficiency Policy

In Sweden, improving energy efficiency has been an important issue on the policy agenda, particularly since the oil crisis in the 1970s. Especially conversion from oil to other energy carriers has been very successful. Sweden has reduced its share of oil dependence in the industrial sector, from contributing to nearly half of the energy use in 1970 to only about 7% in 2016 (SEA, 2019). No explicit data are accessible on how much of the Swedish industrial energy use is derived from industrial SMEs. Thollander et al. (2014) stated that it represents approximately 25% of Swedish industrial energy use. Later figures, where data has been collected on how much energy reduction emanates from laws for energy audits for large companies revealed that the actual figure is around 17% of Swedish industrial energy use that comes from industrial SMEs. Based on the EU framework, the Swedish policy mix for industry is built on several pillars covering various public policy instrument types, namely energy taxes, federal funding schemes for cross-cutting technologies and energy audit programs as well as the energy efficiency networks program.

Energy Taxes

In Sweden, energy and environmental taxes are one key part of the policy mix, the most important being an energy tax for electricity of approx. 0.5 EUR/MWh, energy and CO_2 taxes for other energy carriers (SEA, 2019).

Investment Subsidies and Funds

Energy Ladder

Companies that are included under the law for energy audits for large companies, i.e., large companies, can apply for the energy ladder, which includes two parts:

- Support for design of technical installation
- Investment subsidy

The design support includes a subsidy for designing a technical improvement proposal from the energy audit and the investment subsidy includes costs that are seen as additional costs for an energy efficiency investment. No direct investment subsidy exists for industrial SMEs.

The Swedish Environmental Code

The Swedish Environmental Code came into force in 1998 and addresses, among other things, energy efficiency as a key aspect. According to the Code, the best available technology (BAT) should be implemented. This is due to the fact that the European Industrial Emissions Directive (IED) sets requirements for BAT. In the previous European regulations, the Industrial

Pollution and Prevention Control (IPPC) was in force with more than 20 best reference documents (BREF) for a number of industries. Under the new directive, the IED, new documents are designed for different industries.

The impact of the application of the Code is difficult to evaluate since an actual ex-post evaluation is lacking. However, the assessment is that the Code will have an increasingly important role in the future, but its application needs to be balanced against other policies, such as the Act for energy audits for large companies. The Swedish environmental law holds for both SMEs and large companies.

Energy Audit Programs & Subsidies

The Act on energy audits for large companies

In line with article 8 in the EED, about 1,100 companies in Sweden are covered by the law. The Swedish law further states that the energy audit shall be carried out by a person with special competence, i.e., a certified energy auditor. The Swedish Energy Agency has produced guides for various industries that show how the energy audit should be carried out.

The energy audit policy program for SMEs

A governmental subsidy for the implementation of energy audits was introduced in 2010. In the first program period of the Swedish energy audit policy program, which ran between 2010 and 2014, approximately 1,000 small and medium-sized enterprises (SMEs) applied for subsidies (Paramonova and Thollander, 2016). In 2015, the Swedish Energy Agency launched a second program period, which runs until 2019. Companies with an energy use exceeding 300 MWh per year can apply for financial support to carry out an energy audit. The support amounts to 50% of the audit cost, but a maximum of EUR 5,000 (Paramonova and Thollander, 2016)

Energy Efficiency Networks for Industrial SMEs

The energy efficiency networks program for SMEs

In 2015, the Swedish Energy Agency initiated a national energy network program for SMEs. The program included between 300 and 400 companies, which have been divided into about 40 unique networks, where groups of about 10 companies work with the support of a network coordinator and an energy expert. The network period begins with the companies conducting an energy audit and then the companies meet regularly for a period of three to four years. The company with an annual energy use of at least 1 GWh/year may participate (Carlén et al., 2016). No energy efficiency networks exist for large companies.

Other Types of Policy Support

Many Swedish municipalities have their own public local authority energy consultant who is supposed to offer support to local SMEs. However, until now the policy has primarily been focused on individuals and very seldom on individual companies. Furthermore, companies that use less than 300 MWh/year can participate in the coaching program where they receive hands-on help at their location with improvement proposals. There are also a number of additional support documents and materials on the Swedish Energy Agency's website, including video tutorials on how to make energy efficiency happen, and guidelines on how to procure an energy service from an ESCO as well as how to procure an energy audit. In addition, a rich range of study guides for energy efficiency exist for different sectors.

Non-EU Countries

Norway

In 2015, energy use in Norway was 213 TWh where manufacturing and transport were the sectors that used the most energy, followed by services and households. Other sectors such as construction, agriculture, forestry and fisheries accounted for only a small proportion of energy use. This pattern has not changed much since 1990, although total energy use has risen by about 23 TWh during this period.

Electricity is the dominant energy carrier, followed by petroleum products. Electricity dominates energy use in manufacturing, the household sector and service industries, while petroleum products account for a large proportion of energy use in sectors that make heavy use of transport and machinery. District heating and natural gas account for only a small share of energy use, but this has been increasing in recent years. Consumption of district heating has risen, particularly in service industries and households, while there has been an increase in the use of gas in manufacturing industries and the transport sector. These energy carriers have been replacing fuel oil for heating and coal, coke and heavier petroleum products in industrial processes.

Half of all energy end use in Norway is electricity. Norwegian electricity production is almost exclusively based on hydropower, which accounted for 96.1% of total power production in 2013. Historically this has made it possible to have relatively low electricity prices and a large energy-intensive industry as well as to use electricity for heating of buildings.

Manufacturing accounts for a larger share of final energy use than any other sector, almost 31% in 2015. This sector includes a wide variety of industries with differing energy needs, but energy use in the sector as a whole generally reflects Norway’s extensive use of electricity. Electricity currently makes up about 66% of energy use in the sector.

Power-intensive manufacturing industry accounted for over three-quarters of total energy use in the manufacturing sector in 2015, or about 51 TWh. Of this, 70% was electricity. One reason for the high electricity share is aluminum production, which is highly energy intensive and almost exclusively electricity-based. Other energy sources, particularly gas, coal and coke, account for a larger share of energy use in the production of other metals, basic chemicals and cement. The pulp and paper industry relies heavily on electricity but also uses some biomass.

About half of Norway's total emissions, and as much as 90% of emissions from the manufacturing industry sector, are now included in the EU ETS, making this a cornerstone in Norwegian climate policy. Most of the big manufacturing companies in Norway are included in the EU ETS.

Energy Taxes

In Norway, energy and environmental taxes are a key part of the policy mix, the most important being a basic tax for electricity of approx. 0.5 EUR/MWh, basic and CO_2 taxes for other energy carriers (NTA, 2019).

Investment Subsidies and Funds

Enova SF is a state enterprise owned by the Ministry of Climate and Environment with a mission to reduce greenhouse gas emissions, develop energy and climate technology, and strengthen the security of supply. Each year, Enova invests more than EUR 0.2 billion of public resources in solutions that help build a green Norway for tomorrow.

The public policy program portfolio has changed over time, but the existing federal programs governed by Enova for industry are presented below.

Introduction of energy management in transport, industry and construction

Support for analyses and establishment of action lists and systematic follow-up of the energy use in industry, construction and transport enterprises that motivate action (terminated in December 2018). More than 800 companies have been supported by this program in the period 2013–2019.

Energy and climate measures in industry and construction

The aim of this policy is to contribute to making efficient energy and climate solutions more accessible in the market, and to be used more quickly and at a larger scope than would otherwise have been the case. In order to realize this, Enova offers support for increasing the efficiency of energy and demand consumption in industry, as well as reduction in emissions not subject to quotas. Areas of current priority are increased utilization of waste heat, and replacing fossil fuels with renewable energy in industry and fish farming.

Pilot-testing of new energy and climate technology

The aim of this policy is to contribute to development of new technology in industry that will, over time, yield reduced greenhouse gas emissions, reduced peak demand or improved energy efficiency and that also leads to expertise development in enterprises and technology environments in Norway. The policy enables planning of, investment in and testing of pilot plants as a basis for further development or as a foundation for utilizing the technology at full-scale later.

Demonstration of new energy and climate technology

The aim of this policy is to contribute to more new technologies that can reduce greenhouse gas emissions, reduce peak demand, improve energy efficiency or increase production of energy from renewable sources in Norway or internationally, being demonstrated under real operating conditions and qualified for the market. The policy provides the opportunity for demonstration under real operating conditions to lower technological, financial and commercial risk associated with utilizing new technology. The program is technology-neutral and is open to projects in all sectors.

Pre-project new energy and climate technology in industry

The aim of this policy is to stimulate increased investments in innovative energy and climate technology in industry through support for pre-projects that are necessary for the applicant to make an investment decision. The support is granted to studies and documentation of concrete and identified investment projects or demonstration projects that qualify for the programs, full-scale innovative energy and climate technology or demonstration of new energy and climate technology.

Full-scale innovative energy and climate technology in industry

The aim of this policy is to increase and accelerate commercial use of new and particularly innovative technology that yields significant reductions in greenhouse gas emissions, peak demand or specific energy consumption or increased production of energy from renewable sources. The program will contribute to developing expertise in Norwegian companies and technology environments and to reducing the costs and risk for enterprises that want to start using innovative technology or innovative system solutions. Technologies must be better than the commercially best available technology and the innovation must entail a significant improvement beyond what is common in the industry.

The program is technology-neutral and covers all technology that contributes to the purpose. The program is open to projects in all sectors. In addition, the company can apply for programs for biogas and biofuel, as well as heating plants.

Energy Efficiency networks

In the period 1990–2000 Energy Efficiency networks were a useful national instrument for promoting energy efficiency within industry in Norway. Especially for the large number of SMEs with limited competence and resources this was an effective way to exchange and share experiences.

Some informal energy management networks still exist, and the web-based benchmark application is still operated by Enova as a part of the mandatory reporting system for companies with national funding. Enova has recently started a process to revitalize the Energy Efficiency network concept with some typical SME sectors.

Japan

Japan is the fifth largest energy user in the world, consuming 13 EJ of final energy in 2016. Although Japanese industrial energy use started to decline in the early 2000s, it still constitutes the largest share at 46% of aggregate domestic energy use. Japan has several energy-intensive industries, such as iron and steel, chemical, cement, and pulp and paper, which consume more than 70% of the nation's industrial energy use.

Because Japan has few domestic energy resources, increasing industrial energy efficiency has been an important policy issue since the 1970s to increase energy independence and economic competitiveness. After the emergence of climate change as a global issue in the 1990s, reducing energy-related CO_2 has become another objective of energy efficiency policy in Japan.

Japanese industrial energy efficiency policy has three major pillars: regulations by Energy Conservation Law, investment subsidies by the central government, and Voluntary Action Plans (VAPs) by industry, each of which is detailed below. Apart from the three pillars, of the Japanese policy, numerous energy audit programs targeting SMEs from various sectors of the Economy are operating

Energy Conservation Law

The Energy Conservation Law was established in 1980 as a response to the oil crisis in the 1970s, and has been amended several times in the 1990s and 2000s to expand its scope and to deepen its obligations. After the amendment in 2008, the law regulates all companies using more than 1,500 kiloliters in crude oil equivalent per year. The number of regulated companies was about 12,000 in 2017, whose energy use covers more than 80% of the industrial energy use in the country.

The Japanese Energy Conservation Law basically requires firms to establish energy management systems on their own. Table 1 shows various requirements of the law. Among them the performance standard to decrease energy intensity by 1% annually is considered to be the most impactful requirement for companies, because they not only need to establish energy management systems, such as assigning energy managers and collecting and analyzing energy data, but also need to make effective investments and/or improvement measures to improve energy intensity (Kimura and Noda, 2014).

Table 1. Major requirements of the Japanese Energy Conservation Law (Thollander et al., 2015).

1. Assignment of qualified "Energy Manager" (mandatory), both from working- and executive-levels
2. Development of responsible organization (mandatory)
3. Reporting (mandatory), including: - Energy use, flow, related equipments, CO2 emissions - Actions taken and plans for energy conservation - Compliance status with standards
4. Management standards (mandatory): - Develop firms' own "Standards for Energy Management" for major energy-using equipments (boilers, furnaces, motor-systems, etc)
5. Performance standard (voluntary): 1% decrease in energy intensity annually (in five-year average)

While the Energy Conservation Law is considered to be the vital basis of the Japanese energy efficiency policy for the industrial and commercial sectors, there has been only little evidence showing its effectiveness (Thollander et al., 2015). The energy intensity of companies regulated by the law shows declining trends in sectoral average (Figure 1), which might be the result of regulation by the law but should reflect autonomous technological change at least partly. An econometric analysis by Arimura and Iwata (2007) estimated that tightening of the regulation in the 2000s decreased fuel consumption and fuel intensity by 2.8% and by 2.4% respectively in the hotel sector.

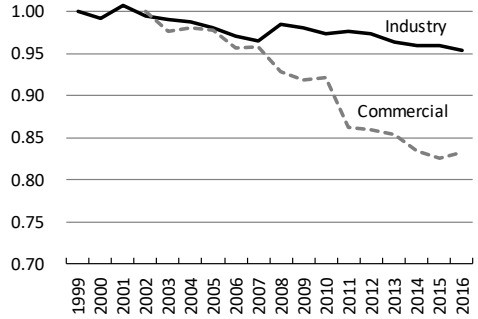

Figure 1. Trends of sectoral average of energy intensity of companies regulated by the Energy Conservation Law (METI, 2018).

Investment subsidies

In Japan, subsidies for energy efficient investments have been implemented since the late 1990s. The total budget for energy efficiency investment subsidies is approximately USD 2 billion in recent years (Kimura, 2017). Among them, the biggest program for industrial and commercial sectors is called "Support program for enhancing energy efficiency investments." This is a long-standing program started in 1998, and its budget in recent years is about 400 to USD 500 million. The program subsidizes energy efficiency projects which install new or improve existing industrial equipment and systems, such as boilers, furnaces, co-generation systems, and energy management systems. Eligible projects are subsidized by one-third up to one-half of their investments, while they are required to achieve energy savings of more than 1% of the firm's energy consumption or more than 10.8 GWh (i.e., 1,000 kiloliters in crude oil equivalent) compared to the baseline.

Voluntary Action Plans (VAPs) by Industry

In Japan, voluntary agreements between the government and industry have a long history, dating back to the 1960s, in the field of pollution control (Matsuno, 2007). Since the 1990s, several voluntary actions have been led by industry associations that are considered to be successful in increasing energy efficiency and reducing greenhouse gas emissions. An example includes the standby power reduction by the Japan Electronics and Information Technology Industries Association, which successfully reduced standby power consumption of major appliances to 1W or less by 2003 (Wakabayashi, 2013).

Among voluntary action programs for energy efficiency and climate change mitigation by industry in Japan, the biggest ones are the VAPs by various industry associations. Coordinated by Keidanren[1], the Japan Business Federation, the VAPs were established in 1997. With 114 associations participating from 34 industries, they covered approximately 80% of greenhouse gas emissions from the industrial and energy conversion sectors in Japan (Wakabayashi, 2013). In VAPs, each industry association established either CO_2 emission reduction or energy conservation targets, whose content is communicated with and outcome is evaluated by the government. Despite the term "voluntary," participating companies were somewhat compelled to comply with the plan due to the strict evaluation by the government and pressure from society (Wakabayashi and Sugiyama, 2007; Wakabayashi, 2013). Thirty-four industries successfully met the uniform target to reduce CO_2 emissions from the industrial and energy conversion sectors between 2008 and 2012 to below the 1990 level (Thollander et al., 2015).

Conclusions

The aim of this paper has been to provide an international overview of existing energy efficiency policies with a focus on energy management practices in selected EU member states as well as Norway and Japan. The diverse policy initiatives for the countries considered differ but have similarities. All studied countries apply some form of investment subsidy to promote uptake of industrial EEMs that form a backbone of industrial energy policy. One studied country, Italy, also relies on a "white certificate" scheme and Japan relies on both the Energy Conservation Law as well as the VAP Keidanren. All countries apply stand-alone energy audit policy schemes for industrial SMEs and two countries, Germany and Sweden, also apply energy efficiency implementation networks as key policy programs for the sector. Notably, energy efficiency networks as a form of energy management support for industrial SMEs seem to only be present in two countries, Germany and Sweden (Durand et al., 2018; Carlén et al., 2016). If results of the energy efficient networks as an energy efficiency policy program initiatives are as good as the current research states, i.e., about twice as high a degree of improved energy efficiency compared with a stand-alone energy audit program, such a policy initiative is suggested to also be used as an argument for undertaking pilot studies in other parts of the world as well.

[1] Japan Business Federation

References

Arimura, T., Iwata, K., 2007. CO2 emission reduction under the law concerning the rational use of energy: an empirical study of energy management in the Japanese hotel industry. *Review of Environmental Economics and Policy Studies* 1: 79-89. [in Japanese]

Audit.gov.ie, 2018. Annual Report – Energy Efficiency National Fund. Available online at: https://www.audit.gov.ie/en/Find-Report/Publications/2018/2017-Annual-Report-Chapter-09-The-Energy-Efficiency-National-Fund.pdf

Backlund, S., Broberg, S., Ottosson, M., Thollander, P., 2012. Energy efficiency potentials and energy management practices in Swedish firms. In *Proceedings of the ECEEE Industry Summer Study*, 1 METI, 20181-14 September, 2012.

Carlén, A., Rosenqvist, M., Paramonova, S., Thollander, P., Municio, S., 2016. Energy efficiency networks for small and medium sized enterprises-boosting the energy efficiency potential by joining forces. In *ECEEE Industry Summer Study*, Berlin, 12-14th of September.

CBO, 2017. Committee on Budgetary Oversight (CBO), 2017. Report of the Committee Pre-Budget 2018. Available at http://www.oireachtas.ie/parliament/media/committees/budgetaryoversight/Budget-Report-2018-Final-Report-laid.pdf

CCAC, 2018. Irish Climate Change Advisory Council (CCAC), Annual Review 2018 (July), Available at: http://www.climatecouncil.ie/media/CCAC_AnnualReview2018.pdf

Cosgrove, John, John Littlewood and Paul Wilgeroth, 2017. Development of a Framework of Key Performance Indicators (KPIs) to Identify Reductions in Energy Consumption in a Medical Devices Production Facility. *International Journal of Ambient Energy* (IJAE). doi:10.1080/01430750.2017.1278718.

DCCAE, 2018. Department of Communications Climate Action & Environment Annual Report 2017. Published 23/10/2018. Available online at: https://www.dccae.gov.ie/en-ie/news-and-media/publications/Pages/2017-Annual-Report.aspx

Durand, A, Jochem, E., Joest, S., Quezada, A., Roser, A., Chassein, E., 2018. Energy efficiency networks: lessons learned from Germany. In *ECEEE Industry Summer Study*, Berlin, 10–13 June.

Harrington, J., Cosgrove, J. and Ryan, R., 2014. A Strategic Review of Energy Management Systems in Significant Industrial Sites in Ireland. Conference on Energy Efficiency in Industry, European Council for an Energy Efficient Economy (ECEEE). Arnhem, NL. 2-5 June 2014.

ISO (2018): ISO survey 2017 http://www.iso.org/iso/iso-survey

Kimura, O., 2017. Database for monitoring and evaluating government energy efficiency programs: a Japanese case. *ECEEE 2017 Summer Study Proceedings*, Online version: 1917–1927.

Kimura, O., Noda, F., 2014. Does regulation of energy management systems work? A case study of the Energy Conservation Law in Japan. *ECEEE 2014 Industrial Summer Study*, 2-5 June 2014, Arnhem, the Netherlands.

Matsuno, Y., 2007. Pollution control agreement in Japan: conditions for their success. *Environmental Economics and Policy Studies* 8: 103-141.

METI (Ministry of Economy, Trade and Industry, Japan), 2018. Survey on enforcement status of regulated companies and cargo owners. Report prepared for METI by Energy Conservation Center, Japan. www.meti.go.jp/meti_lib/report/H29FY/000398.pdf.[in Japanese]

NTA (Norwegian Tax Agency), 2019. Download at: https://www.skatteetaten.no (2019-03-18)

Paramonova, S., Thollander, P., 2016. Ex-post impact and process evaluation of the Swedish energy audit policy programme for small and medium-sized enterprises. *Journal of Cleaner Production* 135: 932–949.

SEA (Swedish Energy Agency), 2019. Energy in Sweden – facts and figures. Download at: www.energimyndigheten.se (2019-03-18)

STA (Swedish Tax Agency), 2019. Download at: https://www.skatteverket.se (2019-03-18)

Thollander, P., Palm, J., 2012. Improving energy efficiency in industrial energy systems - an interdisciplinary perspective on barriers, energy audits, energy management, policies & programs. Springer. ISBN 978-1-4471-4161-7.

Thollander, P., Kimura, O., Wakabayashi, M., Rohdin, P., 2015. A review of industrial energy and climate policies in Japan and Sweden with emphasis towards SMEs. *Renewable and Sustainable Energy Reviews* 50: 504-512.

Wakabayashi, M. 2013. Voluntary business activities to mitigate climate change: Case studies in Japan. *Energy Policy* 63: 1086-1090.

Wakabayashi, M., Sugiyama, T. 2007. Japan's Keidanren Voluntary Action Plan on the Environment. In: Morgenstern, R.D., Pizer, W.A. (Eds.), *Reality Check—The Nature and Performance of Voluntary Environmental Programs in the United States, Europe, and Japan*. Washington DC: Resources for the Future: 43–63.