



Boris Selan  
Andreja Urbančič  
"Jožef Stefan" Institute, Energy Efficiency Centre  
Ljubljana, Slovenia

## INCREASED ENERGY EFFICIENCY IN SLOVENIAN INDUSTRY - A CONTRIBUTION TO THE KYOTO TARGET

### Summary

In Slovenia the actual fast growth of greenhouse emissions will require substantial efforts to fulfil the target set in Kyoto. The end-use emissions in the industrial sector represented one third of the total CO<sub>2</sub> emissions in the country in 1996. The cost-effective potential in the sector for CO<sub>2</sub> emission reduction is significant.

In the paper, the most important ongoing energy efficiency activities in the industrial sector are presented: information and awareness building, energy advising to larger industrial consumers, energy auditing programme, demonstration programme of energy efficient technologies, financial incentives for energy efficiency investment and the energy efficiency investment fund. A CO<sub>2</sub> tax has been in force since 1997.

The results of an evaluation of energy efficiency strategies in industry in the frame of the project "Integrated resource planning for the energy efficiency in Slovenia" are discussed from the viewpoint of greenhouse gases reduction targets set by Slovenia, and a brief information on the ongoing and expected post Kyoto activities and studies is given.

The most important points of the future GHG reduction strategy related to industrial sector in Slovenia will be focused on intensified energy efficiency programmes, increased combined heat and power production (CHP), and the effects of incentives through the CO<sub>2</sub> tax.

## POVEĆANA ENERGETSKA EFIKASNOST U SLOVENSKOJ INDUSTRIJI - DOPRINOS KYOTO CILJEVIMA

### Sažetak

U Sloveniji će stvarni brzi rast emisija stakleničkih plinova zahtijevati značajnije napore pri ostvarenju cilja postavljenog u Kyotu. Emisije koje nastaju pri krajnjem korištenju u industrijskom sektoru predstavljaju jednu trećinu ukupnih emisija CO<sub>2</sub> u zemlji 1996. godine. Troškovno učinkoviti potencijal u sektoru za smanjenje emisije CO<sub>2</sub> vrlo je značajan.

U radu su predstavljene trenutno najvažnije aktivnosti vezano uz energetska efikasnost u industrijskom sektoru: informiranje i izgradnja svijesti, savjetovanje većih industrijskih potrošača, praćenje energetskih programa, program demonstracije energetski efikasnih tehnologija, financijske inicijative za ulaganja u energetska efikasnost i investicijski fond za energetska efikasnost. Od 1997. godine na snazi je i porez na CO<sub>2</sub>.

Rezultati ocjene strategije energetske efikasnosti u industriji u okviru projekta "Integrirano planiranje izvora za energetska efikasnost u Sloveniji" obrađuju se sa stajališta smanjenja emisije stakleničkih plinova koje je odredila Slovenija, a dana je i kratka informacija o tekućim i očekivanim studijama i aktivnostima nakon Kyota.

Najvažnije točke za buduću strategiju smanjenja stakleničkih plinova, vezano uz industrijski sektor, u Sloveniji bit će proširenje programa energetske efikasnosti, povećana kombinirana proizvodnja toplinske i električne energije učinak inicijative poreza na CO<sub>2</sub>.

## INTRODUCTION

Slovenia signed and ratified the *UN Framework Convention on Climate Change* (UN FCCC) in September 1995 [Off. J. RS mp59/95], and signed the Kyoto Protocol in December 1997. In Kyoto, Slovenia undertook to reduce the greenhouse gas emissions so that the 2008 to 2012 average shall be 8% lower than in 1986. The First National Communication under the UN FCCC is expected to be prepared for Slovenia in the first half of 1999.

Activities in the field of efficient use of energy were accelerated in 1991, when the Ministry of Energy introduced two new items into the national budget, earmarked for the supporting of energy efficiency and renewable energy sources. From these activities, international cooperation increased as well, especially in the framework of the European Union programmes. To increase efficient use of energy in industry a set of energy efficiency programmes has been designed. They are based on the Resolution on the Strategy of Energy Use and Supply of the Republic of Slovenia [ReSROES] adopted by the National Assembly in January 1996. The resolution sets the goal of increasing energy intensity by 2% a year during the next ten to fifteen years. A package of policy instruments is foreseen in the strategy: price policy, education and awareness building, energy advising, regulations and agreements, subsidies to investments, and research and development of new technologies.

Besides the energy strategy a National Energy Programme was prepared in 1997. It elaborates necessary measures in areas of energy efficiency, renewable energy sources, local and central energy supply, and environmental protection.

Policy for greenhouse gas emissions mitigation has not yet been developed in Slovenia, and study has primarily been focused on the economy of CO<sub>2</sub> emission mitigation which does not exist either. The best insight into the future needs in this field is given in the study "Integrated resource planning for the energy efficiency in Slovenia" (IRP) where the analysis was focused on the role of energy efficiency in the future energy system development. The main conclusion of IRP study related to future CO<sub>2</sub> emission mitigation is that a substantial effort will be required in Slovenia to fulfil the targets set by Kyoto.

## CO<sub>2</sub> EMISSIONS IN SLOVENIA

### Present trends of CO<sub>2</sub> emission

In Slovenia the yearly carbon dioxide emissions in 1996 reached again the peak from the base year 1986 or 15,1 million tons of CO<sub>2</sub>. In the decade, the lowest value was reached in 1991 (12,7 million t CO<sub>2</sub>/year) and emissions remained low in the subsequent two years, after that growth has been very fast [HMZ].

The fastest growth is noticed in the transport sector, where emissions have increased by 80% in the last 5 years (90% in the last 10 years). In 1996, the transport sector contributed 29% to the total country CO<sub>2</sub> emissions. The power sector share was about one third of 1996 emissions (33%), emissions from this sector have been increasing by 1% per year in the last five years, while in the last ten year period the emissions have decreased by 17%. The last third

of the emissions originates from the local supply, industry, households and services, mostly from heat production. In the last ten years the trends are the following: a decrease of emissions in industry by 40%, and an increase in households and services by 30%<sup>1</sup>.

## CO<sub>2</sub> emissions in industry

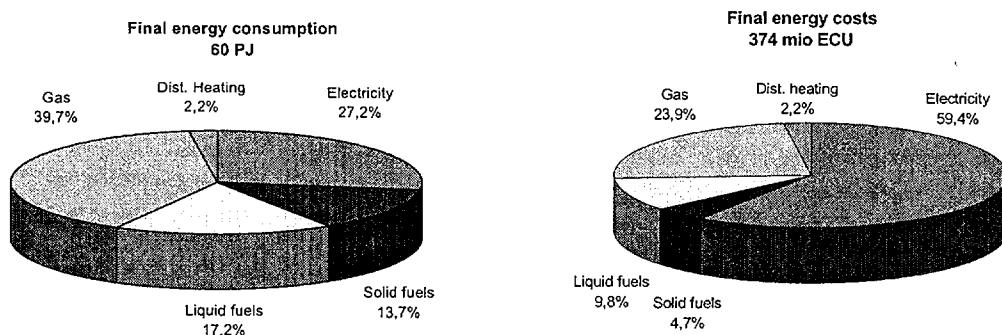
The industrial sector annual energy consumption is 60 PJ, i.e. 27% of the total final energy consumption. The end-use CO<sub>2</sub> emissions (including also indirect emissions from electricity and district heat) amount to 4.8 million tons a year, of which 2.2 million tons arise from direct emission, and 2.6 million tons are the share of the energy industry CO<sub>2</sub> emission attributed to the industrial sector. Thus, the total emission caused by industry, represents 33% of the total CO<sub>2</sub> emission in Slovenia. These data apply for 1996. The estimated industrial sector's annual energy expenditure (including tax) was approximately 374 million ECU.

Main characteristics of the present emissions in industry are:

- in the last ten years CO<sub>2</sub> emissions from industry have decreased by 33%. Emissions from solid fuels have decreased by 45%, from liquid fuels by 40% and natural gas by 17%,
- 32% of direct emissions are from liquid fuels, 49% from natural gas and 19% from solids fuels (half of which from coal),

- average value added in industry is 1260 ECU/t CO<sub>2</sub> considering direct emissions only and 645 ECU/t CO<sub>2</sub> considering all end-use emissions. More than half of industrial emissions are from branches with value added under 98 ECU/t CO<sub>2</sub> of end use emissions.

Figure 1: Final energy consumption and costs in 1996 (tax included)



## Tax on CO<sub>2</sub> emissions

The present CO<sub>2</sub> tax in Slovenia, after the latest changes, truly considers the CO<sub>2</sub> mitigation goals. It was introduced two years ago as a more or less fiscal instrument, and was increased to 16 ECU/t CO<sub>2</sub> in March 98. At this level the CO<sub>2</sub> tax represented 16% and 13% of price for industry for light fuel oil and natural gas respectively, which was a heavy financial burden for many industrial users.

<sup>1</sup> Official reports on GHG inventories are in preparation. The assessment given is based on Statistical yearbook for energy and emission factors as documented in [JS 98].

In August 1998 the decree on the CO<sub>2</sub> tax was revised, so that 67% of quantity<sup>2</sup> of the fuel used in base year<sup>3</sup> is free of tax, the rest is taxed at the level as before (16 ECU/t CO<sub>2</sub>).  
\*\*By this, the financial burden for end user is considerably reduced but the motivation for CO<sub>2</sub> reduction remains the same as before, since the tax level has not changed. Additional tax free fuel quantities can be approved for electricity produced in combined heat and power systems (0.44 kg CO<sub>2</sub> per kWh) and for energy savings (1 kg CO<sub>2</sub> per 1 kg CO<sub>2</sub> of fossil fuels saved and 0.44 kg CO<sub>2</sub> per 1 kWh of electricity saved).

## ENERGY EFFICIENCY PROGRAMMES IN INDUSTRY

With the process of privatisation approaching its completion, the Slovenian economy is facing a new development cycle, aiming at the increase of productivity, increase of the value added per employee, and decrease of operation costs. These efforts may also draw advantages from the potentials available in the area of energy efficiency. The analyses completed in recent years, confirm potential savings in excess of 20% of energy bills arising from economically attractive investments (with pay-back periods under 3 years), and capable, in this manner, to increase competitiveness while also contributing to the environmental protection.

Experience abroad and analyses of barriers, carried out in Slovenia in the recent years, indicate that even the energy prices which in industry have already reached the EU level in the recent period do not provide by themselves a strong enough incentive towards the promotion of energy efficiency. Slovenia is experiencing a series of information, economic, managerial and other barriers to implementation of energy efficiency measures.

To overcome these barriers, a series of energy efficiency programmes have been conceived, based on the Resolution on the Strategy of Energy Use and Supply of the Republic of Slovenia [ReSROES] adopted by the National Assembly in January 1996. The resolution set the goal of increasing energy efficiency by 2% a year during the period of the next ten to fifteen years. A package of policy instruments is foreseen: price policy, education and awareness building, energy advising, regulations and agreements, subsidies to investments, and research and development of new technologies. One of the significant steps forward was also the establishment of the Agency for Efficient Use of Energy within the Ministry of Economic Affairs, early in 1995. The Agency's principle task is the implementation of the national energy strategy, by developing and implementing of national programmes of energy efficiency.

Below, the main programmes for promotion of energy efficiency in the industrial sector are presented. The international co-operation within the framework of the European Union programmes (PHARE, SYNERGY, THERMIE, SAVE) has played an important role in design and implementation of the programmes.

### Information and awareness building

Information, education and promotion activities are carried out by means of publications, seminars, workshops, exhibitions and similar events. These activities are significant for the increase of the level of information, awareness and qualification, both of energy consumers and those co-operating with them.

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2 Different shares of tax free fuels are considered: for industry 67 %, for local heat supply 50 % and for power sector 92 %.

3 A base year is selected by industrial enterprise

The energy efficiency newsletter plays an important role. It is a central informational and promotional periodical published by the Agency for Efficient Use of Energy. In the domain of industry, a number of seminars, workshops and training courses have been organised in the last five years, dealing with: energy auditing, energy management, energy efficiency in SMEs, safe and economic boilers operation, efficient compressed air systems, reducing energy costs of electric motors and drives, and financing of energy efficiency and cogeneration projects. In addition, a series of brochures for the promotion of horizontal energy efficient technologies has started. The booklets on efficient use and production of compressed air and on efficient electric motor drives have been published.

A very important step to a more intensive promotion of energy efficiency technologies presents the entering of Slovenia into OPET Network of the European Union (OPET - Organisation for Promotion of Energy Technologies) through the project FEMOPET Slovenia. The aim of the project is to foster market penetration of successful new and innovative energy technologies and to improve international co-operation.

### **Energy advising to larger industrial energy consumers**

The aim of the project is to increase information and awareness of larger industrial consumers on how to implement energy management and energy efficiency measures in an organisation. The energy advising launched in 1997 is focused on industrial enterprises with yearly energy bills between 0.5 and 5 million ECU.

The advising includes a walk-through-audit of the company, a senior management event and an awareness event for employees. One of the project outputs is also an analysis of energy consumption and costs, suggestions for immediate actions and proposals for further activities. Under two projects 26 industrial enterprises and 4 organisations from commercial and public sector have been advised. Very positive comments from general managers have confirmed the project approach.

### **Energy auditing programme**

The energy auditing programme is aimed at introducing energy management and promoting energy efficiency investment in the industrial, commercial and public sector, and in the apartment block buildings. An energy audit results in a list of proposals of organisational measures and investment proposals. It presents a basis for developing a strategy to reduce energy consumption and increase energy efficiency.

To date, the Ministry, respectively the Agency, has supported 58 energy audits in several industrial branches. Additional 9 energy audits were performed in 1997 under the auspices of the PHARE programme. The audits have to be performed according to the common methodology. The audits are subsidised by up to 50% of the total costs.

The evaluation of the energy auditing programme shows that the measures proposed enable an average reduction of energy bill by 15%. The energy costs were reduced by 2% in the first year after performing the energy audit.

Closely connected with the energy auditing programme is also the energy monitoring & targeting programme. The energy monitoring and targeting represents an effective tool for the reduction of energy consumption with major energy users. The programme has been designed and a promotional brochure has been drafted. The programme will be launched in 1999.

## **Demonstration programme of energy efficient technologies**

The purpose of the programme is to demonstrate the technical, economic, environmental and organisational adequacy of new and innovative energy technologies. Demonstration projects upgrade technology level of the energy user, and offer new business opportunities to the equipment suppliers.

In conceiving the programme of demonstration projects, we shall apply the results and experience gained in the PHARE project "Demonstration projects for energy efficiency investments in the buildings and industry sector", which was completed in 1997. Six demonstration projects were carried out, one half of them in industry, and the rest in building construction. In industry, the following technologies were implemented: in an ironworks, a variable speed drive on a combustion fan at a pusher type furnace; in a textile company, refurbishment of the compressed air system, and, in a cardboard factory, oxygen trim control on a large industrial boiler. The pay-back periods of the industrial demonstration projects range from one to two years.

Within a follow-up project, monitoring, evaluation of effects, and promotional leaflets of the demonstration projects were elaborated. Beside that, an extensive promotion of the project results is being carried out, by means of a presentation event for all the projects, leaflets, site visits, presentation at the courses and workshops, and similar actions.

## **Financial incentives for energy efficiency investments**

To overcome one of the principal barriers to the energy efficiency investment, i.e. poor accessibility and high cost of the investment capital, the Ministry, respectively the Agency, promoted the realisation of a number of projects in the period from 1990 to 1995, both in the industrial sector and in the commercial and public sectors. A variety of financial instruments were applied: soft loans, subsidised interest rates, and subsidies. In all, 53 investment projects were supported, of which, 30 in the industrial sector. In the period, energy efficient investments in the industrial sector in an amount of 16 million ECU were realised within the programme. The investments were supported by the national budget through soft loans and subsidies in an amount of 4.5 million ECU. The average pay-back period of the investments was estimated to 2.3 years.

## **Fund for energy efficiency investments**

The financial sources, available for the energy efficiency investments out of the national budget, are not sufficient for the realisation of the goals of the national energy strategy. Therefore, an energy efficiency investment fund was established in January 1998. The fund goal is to provide industrial enterprises, institutions and building managers with financial resources under attractive interest rates, and thereby, to decrease energy costs in the long term.

The fund is managed by Bank Austria, which was selected in a public competition. In this manner, a rational granting of loans will be secured.

The fund is supplied from a mix of financial sources. The commercial part of the fund will be provided by the fund manager. An attractive all-in interest rate on the level of 60% of the commercial interest rate is achieved by a grant from the national budget of the Republic of Slovenia and by a zero-interest loan granted by the European Union PHARE Programme. The initial fund balance of 12 million ECU is planned. The fund will operate on a revolving principle.

## EVALUATION OF THE FUTURE ENERGY EFFICIENCY STRATEGIES

### Integrated resource planning studies

In Slovenia, a study primarily focused on the economy of CO<sub>2</sub> emissions mitigation does not exist yet. The best insight is given by energy studies "*Integrated resource planning for the energy efficiency in Slovenia*" (IRP) [IJS 95-97] and an assessment "*Technical Options for CO<sub>2</sub> Reductions to Reach the Kyoto Target for Slovenia*" [IJS 98].

In the studies "Integrated resource planning for the rational energy use in Slovenia" aiming to provide strategic decision support, effects of different intensities of energy efficiency activities were quantified. The studies considered all sectors of the energy system while special emphasis was given to detailed evaluation of the energy efficiency potential in industry and households, and also to the development of local supply systems.

The evaluation of energy efficiency strategies followed the objectives set by the Resolution on Energy Use and Supply for Slovenia. The analysis was a *multi-criteria* evaluation of energy policy economic, energy, environmental and social impacts. The climate change was addressed by an assessment of CO<sub>2</sub> emissions.

The three evaluated strategies differed in the intensities of energy efficiency measures. The reference strategy denoted business as usual development, moderate strategy considered moderate introduction of measures, in the intensive strategy energy efficiency was included in its full economic potential. The strategies varied also in the penetration rate of combined heat and power production in local supply and in industry, and in the level of coal driven thermal power production. The strategies were analysed in circumstances of fast and slow economic growth, together with other external parameters linked to two scenarios named: Plus and Minus. The study base year was 1994.

In the model, the following energy efficiency measures were considered for industry and similarly for households: financial incentives (the level considered in reference, moderate and intensive strategy was 0%, 5% and 10% of investment value respectively), additional energy taxes (levels for industry considered: 0%, 3% and 6% in reference, moderate and intensive strategy respectively), and promotional activities. The effects of those incentives to penetration of improved technologies in areas of electric motors, wood and fossil fuel boilers, thermal processes in paper industry and electric arc furnaces were evaluated. The assumed governmental activities and estimated costs for industry up to 2020 are presented in the Table 1. For details see also [IRP 94-97, Tomšič 98]

Table 1. Assumed governmental activities in the area of energy efficiency in industry and estimated costs up to 2020

	REFERENCE		MODERATE		INTENSIVE	
		million ECU <sub>94</sub>		million ECU <sub>94</sub>		million ECU <sub>94</sub>
1. Information programs	few	0,158	more	0,316	more	0,474
2. Demonstration projects	some	1,708	more	3,415	even more	5,123
3. Agreements	few, late	0	soon, more branches	0	very soon, all branches	0
4. Financial incentives: - soft loans	some	0	more	12,445	more and immediately	16,798
Costs for budget* (1+2+3+4)		1,865		16,176		22,395
B. Energy tax**	0	0	3 %	-326,910	6 %	-630,999
5. Investment in technologies		56,790		248,760		335,797
C. Costs for industry		56,790		236,314		319,001
The total costs (A+C)		58,656		252,490		341,395

\* Financed from the budget

\*\* Revenue from energy tax is presented with negative sign since it is an inflow to budget (assumed energy tax of equal level for all fuels but graduated by strategies as shown)

\*\*\* Exchange rate in 1994 was 152,36 SIT/ECU

The IRP study shows that the CO<sub>2</sub> emissions will rise under all three strategies. In the case of the intensive strategy, the CO<sub>2</sub> emissions will increase by 15% till 2010 in high economic growth (energy intensity improvement 4% per year) and will be stable in the case of slow economic growth (energy intensity improvement 2.5% per year). The reference and moderate strategies show higher increase of CO<sub>2</sub> emissions. So all strategies fail to meet the Kyoto target. One can also conclude that the target set in the resolution on energy strategy for improvement of energy intensity by 2 % p.a. is not sufficient to meet the Kyoto target.

Intensive strategy, in comparison to reference and moderate strategy, implies also lower total energy system costs, lower sulphur dioxide and nitrous oxides emissions, lower primary energy use and import dependency. Significantly lower are fuel related costs.

Future CO<sub>2</sub> emissions from industry, including also industrial combined heat and power production, will rise by 25%, 18% and 7% in reference, moderate and intensive strategy in the case of high economic growth until 2010. The CO<sub>2</sub> emissions in 2010 in the moderate strategy are 6% lower than in the reference strategy. The difference between intensive and reference strategy is 14%. Considering only electricity related indirect emissions, the difference between intensive and reference strategy is 20%, a part of reduction (5%) is a consequence of lower electricity use in the intensive strategy, the rest of the difference (15%) comes from lower electricity production emissions, achieved by increased CHP production and lower use of coal in power sector.



## POST KYOTO ACTIVITIES

As a first step, a short study "*Technical Options for CO<sub>2</sub> Reductions to Reach the Kyoto Target for Slovenia*" was elaborated in 1998. In the study the technical potential to reach the Kyoto target was investigated without considering financial, economic and political feasibility of the proposed measures. The assessment was based on the model developed in the IRP study. In difference to the IRP study, instead of economic potentials technical potentials for energy efficiency were considered. Restructuring of economy has been considered, like in the IRP study, according to the national strategy of economic development. The technological improvements correspond to best available technologies, in some cases also a future development was accounted (e.g. emissions from cars in range according to EU directives under discussion: 5 L/100 km for average car sold after 2005).

This analysis shows that the total CO<sub>2</sub> emissions can be reduced by 3.5% till 2008-2012 compared to the base year 1986. The study confirms previous conclusions that it will require substantial efforts for Slovenia to reach Kyoto targets.

A first national communication to the UN FCCC is in preparation including emission inventory of greenhouse gases and projections of future emissions. It is organised in several sub-projects. In this framework, greenhouse gases reduction potential is classified according to their costs and will represent a very important input for the design of possible national GHG reduction strategies. Beside that, a separate study is carried out to assess the implication and possible responses to the needs of power sector.

The national greenhouse reduction programme will require decision support, in its first step focused on the following questions:

- to define the least cost strategy to reach the Kyoto target, considering also other environmental, social and strategic criteria
- to assess cost and benefits of GHG mitigation
- to assess marginal costs of greenhouse gases reduction, relevant for further discussion of burden sharing between sectors, future use of flexible mechanisms, and future level of CO<sub>2</sub> tax
- to assess the role of energy efficiency, renewable energy and combined heat and power production and fuel switching in GHG reduction strategy and appropriate level of incentives required for their stimulation
- to define more ambitious national targets for energy efficiency
- to assess the implications of different levels of domestic coal use.

A supporting analysis has been tendered to evaluate strategies in the energy sector and provide methodological background for the overall methodology.

Based on the Kyoto targets, the Resolution on Strategy of Energy Use and Supply of the Republic of Slovenia should be revised in terms of goals concerning improvements of energy efficiency. Energy efficiency programmes for individual sectors should be intensified.

For industrial companies with yearly energy bills over one million ECU a special energy efficiency programme is being prepared. This group of companies consume more than 80% of energy in industry. It is expected that the main programme elements will be focused on information and awareness building supporting the introduction of energy management in those companies. The execution of the programme will be based on long term agreements between the Ministry of Economic Affairs and the group of companies.

## CONCLUSIONS

The Kyoto obligations present a new challenge for strategic energy planning and implementation of energy efficiency programmes in Slovenia. The Strategy of Energy Use and Supply of the Republic of Slovenia and National Energy Programme should be revised according to the Kyoto target. Substantial efforts will be required to reach the targets. It will be very difficult to slow down the present fast growth of CO<sub>2</sub> emissions, especially in the transport sector.

A considerable economically viable potential exists for the improving of energy efficiency in the Slovenian industry, which can be exploited to reduce energy bills and to reduce CO<sub>2</sub> emissions. To overcome particular barriers, a series of programmes is under way, for the promotion of energy efficiency to stimulate industrial companies towards energy efficiency measures. These programmes also support the development of the market of energy services, supply of energy efficient equipment, and financial engineering. The current programmes present a good basis for improvement in the future.

In order to meet the Kyoto target, the present energy efficiency activities in industry will have to be significantly intensified in the near future. The present target of energy intensity yearly improvements of 2% will require substantial changes, at least a level of 4% of yearly improvements should be considered. For the success of the Kyoto protocol implementation, the most important points in industry will be intensified and focused energy efficiency programmes for larger and smaller enterprises, increased combined heat and power production and the effects of incentives through the CO<sub>2</sub> tax.

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