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The framework of indicators for monitoring the implementation of EU directives promoting renewable energy sources, energy efficiency and GHG mitigation

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The article deals with the requirements of the main European Union (EU) directives and other policy documents relating to energy sector. The main EU directives on sustainable energy development are those promoting energy efficiency and use of renewable energy sources, GHG mitigation policies and other documents and strategies targeted at the energy sector. Promotion of use of renewable energy sources and energy efficiency improvement are among priorities of the EU energy policy, because they exert positive effects on energy security and climate change mitigation. The framework of indicators can be developed to establish the main targets of the EU energy and environmental policies allowing to connect indicators via a chain of mutual impacts and to define policies and measures necessary to achieve the established targets, to track the impact of measures on the trends of targeted indicators and to assess the interaction of different market-based policy measures (EU emission trading scheme, flexible Kyoto mechanisms, tradable green certificates for electricity, heat, fuels in transport produced from RES, green tradable certificates for electricity produced from CHP, white tradable certificates for energy savings, etc.).

Key words: EU directives, energy efficiency, renewable energy sources, indicators for monitoring

1. INTRODUCTION

The main EU directives that have an impact on sustainable energy development are those promoting energy efficiency and the use of renewable energy sources, GHG mitigation policies and other documents and strategies relating to the energy sector. Promotion of the use of renewable energy sources and energy efficiency improvements are among the priorities of EU energy policy to ensure energy security and climate change mitigation. These directives indicate the EU energy policy priorities: reduction of energy impact on the environment, improvements in energy generation and energy use efficiency, increase in the reliability and security of energy supply, promotion of renewable energy sources (RES) and climate change mitigation.

The impact of implementation of EU environmental directives on the reduction of GHG emissions was assessed seeking to identify and compare the impacts of directives covering different issues relevant to the energy sector and different policies. The impact on GHG emission reduction was assessed to address the different impacts of the implemented directives which in some cases showed conflicting results, though the aim was the same: to reduce the negative impact on the environment. The aim of the article is to analyze the requirements of the main EU directives targeted at the energy sector and the challenges and implications of their implementation on GHG emission reduction on the example of Lithuania.

2. EU DIRECTIVES TARGETED AT ENERGY EFFICIENCY, RES AND GHG MITIGATION

The White Paper on energy policy, White Paper for the Community Strategy and Action Plan COM(97)599 final [1] set the broad principles of energy policy design in the EU. Energy policy must form part of general aims of the Union's economic policy based on market integration, deregulation, limiting public intervention to what is strictly necessary in order to safeguard the public interests and welfare, sustainable development, consumer protection and economic and social cohesion. The EU Green Paper on European Strategy for Sustainable,

Competitive and Secure Energy (SEC (2006) 317) [2] sets the main priorities for the EU energy strategy. The general EU policy objectives considered most relevant to the design of energy policy are: competitiveness of the EU economy, security of supply and environmental protection. These objectives should help to address central policy concerns such as job creation, boosting overall productivity of the EU economy, protection of the environment and climate change. The overall liberalization of the EU electricity and gas markets and the restructuring of the energy sector pursue the competition of economy. For fostering the competitiveness of the EU economy and concomitant income and added value creation, the promotion of one internal market at the Union level is considered essential. Cross-border trade on level playing-field terms would foster competition.

Security of supply is the priority concern of the EU energy policy. The Green Paper on energy supply security (COM (2000) 769 final) [3] states that the EU will become increasingly dependent on external energy sources. It is stressed in this paper that the EU has a very limited scope to influence energy supply conditions, but it can intervene on the demand side, mainly by promoting energy saving in buildings and transport. The EU is not in position to respond to the challenges of climate change and to meet its Kyoto protocol commitments. The Green Paper identifies two main policy priorities: controlling the growth of demand and managing supply dependency. For controlling the growth of demand, the fiscal and financial instruments should be used. Fiscal interventions in energy prices should remove distortions among alternative energy carriers and among the member states and make energy prices reflect the real costs, including environmental damage costs. The reduction of energy demand growth should be achieved by the transportation sector and buildings through stimulation of energy-efficient technologies (regulation, certification, fiscal measures, R&D funding).

The Commission's new Green Paper on energy efficiency, COM (2005) 265, stresses the importance of energy efficiency improvement for controlling the growth of demand and security of supply. According to estimates, the economic potential for improving energy efficiency in 2010 for all sectors is 20% of the total annual primary energy consumption of the current level. The lack of information for consumers and manufacturers, technical barriers and financial obstacles also hamper investment in energy efficiency. In general terms, efforts must be made to promote energy efficiency in other policies, notably in regional, transport, fiscal, research and development and international cooperation policies. More specifically, the following areas for action are proposed as priorities for a short and medium terms:

- Energy-efficient buildings
- Energy-efficient household appliances and other end-use equipment
- Wider use of negotiated and long-term agreements on minimum efficiency requirements
- Better dissemination of information
- Third-party financing, guarantee of results and other creative financing schemes
- Energy efficiency in the electricity and gas sectors and combined heat and power (CHP)
- Energy management and public and cooperative technology procurement.

For managing the supply dependence, the Green Paper on security of supply suggests the stimulation of renewables by internalisation of social costs in energy prices and strengthening the supply infrastructure networks with due regard to environmental impacts. The Green Paper on energy security emphasizes the role of technology development. Technology may contribute to a higher energy efficiency, security of supply and reduction of GHG emissions, in particular by improving access to indigenous energy resources, renewable energy resources. The state aid is foreseen for promoting the use of RES and combined heat and power production through tax exemptions or reductions in particular.

The White Paper on renewable sources (White Paper for the Community Strategy and Action Plan on renewable energy sources COM(97) 599 final) [4] states that the member states should formulate indicative targets to contribute to the ambitious indicative target of doubling the overall share of RES in the EU by 2010. It sets an indicative target of 12% for the contribution by RES to the total primary energy consumption within EU by 2010 and contains a strategy and action plan to achieve this target. Pursuant to the White Paper on Renewables, the Directive 2001/77/EC on the promotion of electricity produced from RES in the internal electricity market was passed in 2001. It adds the indicative target contribution of 22.1% by renewables-based electricity to the total EU electricity consumption in year 2010. The Lithuanian national energy strategy adopted in 2002 sets the target to reach 12% of renewables in primary energy supply up to 2010. The 2001/77/EC Directive on the promotion of electricity produced from RES in the internal electricity market was implemented in Lithuania by adopting on 13 January 2004 the Decision No 25 of the Government of the Republic of Lithuania (GRL) on Procedure for promotion of production and purchase of electricity produced from RES and by-product energy which foresees that the share of electricity produced from RES would exceed 7% up to 2010.

The 2003/30/EC Directive on the promotion of the use of biofuels or other renewable fuels in transport (*RF Directive*) sets that Member States must ensure by the end of 2005 a 2% minimum proportion of biofuels of all gasoline and diesel fuels sold on their market. In a longer term, the target is to achieve a share of 5.75% of biofuels for transport in the total amount of fuels in Europe by 2010 and 20% by 2020.

The 2002/91/EC Directive on the energy performance of buildings sets a target to realize a savings potential of around 22% by 2010 for energy used in heating, air-conditioning, hot water and lighting. This directive

was implemented in Lithuania by passing on 16 January 2004 the Order of Minister of Economy and Minister of Environment No D1-29/4-12 on adoption of the plan of action for the implementation of European Parliament and Council Directive 2002/91/EC on the energy performance of buildings.

The 2004/8/EC Directive on the promotion of cogeneration based on a useful heat demand in the internal energy market aims to increase energy efficiency and improve the security of supply by creating a framework for promotion and development of high efficiency cogeneration of heat and power based on useful heat demand and primary energy savings, taking into account the specific national circumstances, especially climate and economic conditions. The strategic goal of EU-15 is to double the share of electricity produced by CHP by 2010. The Lithuanian national energy strategy adopted in 2002 establishes a target to achieve 35% of electricity produced from CHP up to 2020.

All these directives have a positive impact on GHG emission reduction and on achieving the Kyoto target. The EU has ratified the Kyoto Protocol, committing itself to 8% GHG emission reduction in the period 2008–2012 from 1990. Equally, the New Member States are determined to meet their individual targets under the Kyoto Protocol. Therefore, GHG emission reduction in the energy sector is the priority issue in the EU energy policy. In March 2000, the Commission launched the European Climate Change Programme (ECCP). The ECCP led to the adoption of a range of new policies and measures, among which the EU emissions trading scheme which started operating on 1 January 2005 will play a key role. As a result of the EU and individual Member States actions, the latest monitoring data indicate that the European Union has delivered on its long-standing commitment to stabilize CO_2emissions at the level of 1990 in the year 2000. The EU-15 is committed to deliver the collective 8% cut in emissions by 2008–2012 to which it signed under the Kyoto Protocol. The monitoring mechanism and its review, as well as the EU emissions trading scheme and the link with the Kyoto flexible mechanisms (JI and CDM) are the key elements of the EU climate change strategy. The Green Paper on greenhouse gas emissions trading within the European Union COM (2000) 87 sets the main blueprints for the introduction of the GHG emission trading scheme in the EU. In January 2005, the European Union Greenhouse Gas Emission Trading Scheme (EU ETS) commenced operation as the largest multi-country, multi-sector greenhouse gas emission trading scheme worldwide. The scheme is based on Directive 2003/87/EC which came into force on 25 October 2003.

During the first phase of the ECCP1 (European Climate Change Programme concluded in June 2001), the idea of the Directive promoting the use of heat from renewable energy sources was put forward. This legislation would complement other types of actions mentioned in the Commission 1997 White Paper on renewable sources of energy, and it would be modeled on the format of the RES-E directive, i. e. covering targets, support schemes, certification, easier administrative procedures, etc. for heat from biomass (e. g., local space-/hot water heating, CHP and distributed heat, district heating), active solar systems (e. g., local space-/hot water heating), geothermal sources (including heat pumps).

Therefore, the main targets of the EU energy policy, which can be addressed by selecting the appropriate indicators, are to increase the security of energy supply, the opening of energy markets, promotion of renewables and cogeneration, increase of energy efficiency and reduction of the impact on the environment. All these policies have a positive impact on GHG emission reduction.

3. INDICATORS FOR MONITORING IMPLEMENTATION OF THE EU DIRECTIVES TARGETING EE, RES AND GHG MITIGATION

As mentioned above, the implementation of EU directives targeting EE and RES has a positive impact on GHG emission reduction. Implementation of these directives requires a regular monitoring of impacts of selected policies and strategies to see if they are furthering EE, RES and GHG emission reductions or if they should be adjusted. In this sense, it is important to measure a country's state of implementation of EU directives targeted at EE, RES and GHG reduction, and to monitor the progress achieved by a country towards the main targets set by these directives. As the first step, it is necessary to evaluate the country's current status concerning the established targets, the items that should be improved and how these improvements can be achieved. In the next step, policy makers should understand the implications of selected directives, energy, environmental and economic programmes, policies and plans and their impacts on achieving the main targets and goals set by these documents. For this purpose, a simple policy tool – energy indicators establishing the aforementioned targets – can be used. There are several frameworks of indicators developed by various international organizations. The most appropriate tool in this case would be the indicators for sustainable energy development (EISD) framework developed by IAEA, UNDECA, IEA, EEA and EUROSTAT [5].

The EISD is a comprehensive analytical tool helping energy policy-makers at all levels to incorporate the concept of sustainable development into energy policy. The aim of the present paper is to show how the EISD approach can be used in analyzing trends in terms of energy sustainability, setting goals for sustainable energy development according to national and EU priorities, assessing progress made towards sustainable development and identifying new policy actions necessary to achieve these goals. The EISD set is used to present energy, economic, environmental and social data for policymakers in a coherent and consistent form, showing

their linkages and usefulness for making comparisons, trend analyses and policy assessments. Some indicators from the EISD set can be selected and applied for the analysis of the EU energy policies in Member States and for assessing their success in the implementation of the main targets set by directives and other policies establishing goals for energy efficiency improvements, use of RES and GHG reduction. Therefore, indicators relevant to the EU and Lithuanian energy policies will be selected from the EISD core list, and additional indicators will be developed to address the missing targets in the EISD core set.

The EISD core set is organized following the conceptual framework used by the United Nations Commission on Sustainable Development (CSD). There are 30 indicators classified into three dimensions: social, economic and environmental. These are further classified into seven themes and 19 sub-themes. Some indicators can be classified in more than one dimension, theme or sub-theme, given the numerous interlinkages among these categories. Also, each indicator might represent a group of related indicators needed to assess particular issues. There are four social dimension indicators, three of them representing equity (accessibility, affordability, disparities) and one – the health aspect (safety).

The set of energy indicators of economic dimension consists of 16 indicators, of them 14 represent the use and production theme and are divided according to subthemes into overall use, overall productivity, supply efficiency, production, end use, diversification and price. Two indicators (net energy import dependency and fuel stocks) define the security theme. In our analysis, almost all economic indicators will be used, because they represent very clearly the priorities of the EU energy policy. There are nine environmental indicators in the EISD core list. They are divided into the atmosphere, water and land themes. For the atmosphere, two subthemes (climate change and air quality) were defined. The air quality sub-theme includes ambient concentrations of pollutants in the atmosphere, which indicate air pollutant emissions into atmosphere from the energy sector (direct driving force indicator). The scheme of core EISD is presented in Fig. 1.

Trends in overall energy use, including overall energy productivity, supply efficiency, end-use productivity, fuel mix and energy security, will be analysed using the economic dimension indicators. Environmental dimension indicators will address climate change mitigation issues.

The appropriate EISD were selected to address the requirements of EU directives targeting energy efficiency improvements and promotion of RES. Four priority areas established by the EU energy policy group the selected indicators: increase of energy efficiency (EE), use of renewable energy sources (RES), increase of energy security (ES) and GHG mitigation (GHG). Additional (to EISD) indicators were developed to address the targets of the EU and national policy documents relevant to EE and RES. The indicator framework for the EU energy policy analysis and monitoring of targets by the EU directives are presented in Table. All these indicators can be connected to each other via a chain of mutual impacts seeking to develop a comprehensive policy framework for monitoring the implementation of EU directives and policy measures targeting the relevant indicators. The last in the EU energy policy framework is the GHG emission indicator as all other EU policies (targeting energy efficiency improvements, promotion of RES, and increase in energy supply security)

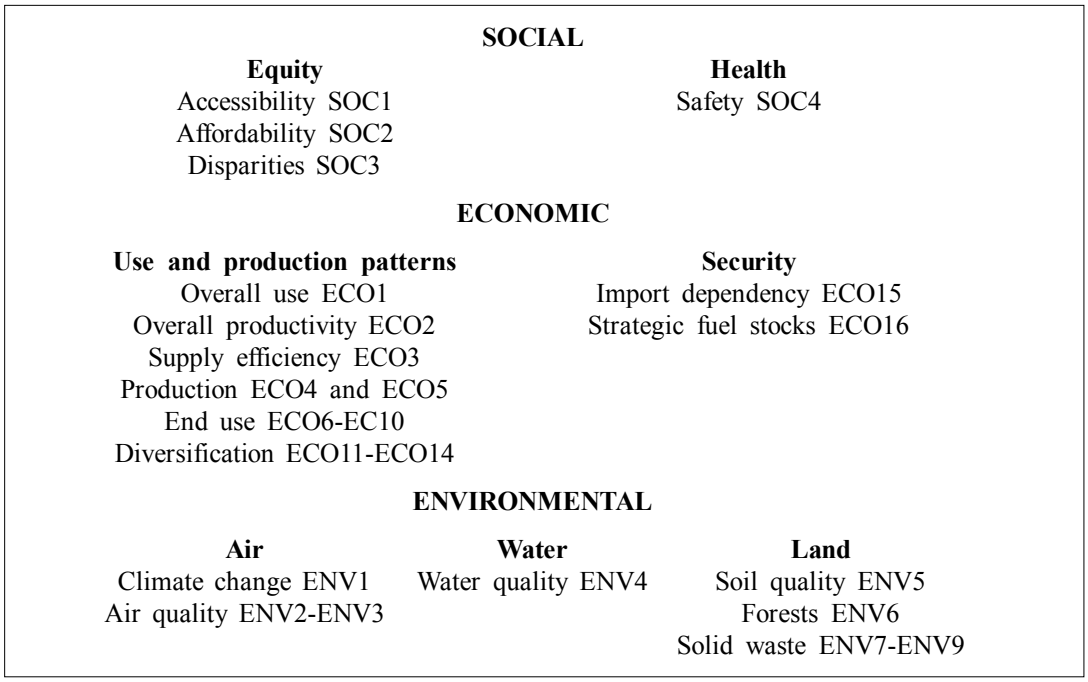

Fig. 1. The core EISD

Table. **Indicators selected for EU energy policy analysis**

Indicators	Acronym	Sub-theme	Directive or policy document	Target	Date for achievement
Energy efficiency (EE)					
Primary energy intensity of GDP	EE 1 (ECO2)	Overall productivity	National sustainable development strategy	To reduce by 50% the current level (2002)	2020
End-use energy intensity of GDP	EE2	Energy efficiency	Directive 2006/32/EC on end-use efficiency and energy services	To reduce by 9% the current level (2006)	2010
Energy saved in buildings	EE3	Energy efficiency	2002/91/EC Directive on the energy performance of buildings	22% of energy used in buildings	2010
Savings of primary energy supply	EE4	Energy efficiency	Green Paper on energy efficiency COM (2005) 265	20% from 2005 year level	2020
Energy supply efficiency	EE5	Supply efficiency	National energy strategy, 2006	To reach the current level of EU-25 or 70%	2025
The share of CHP in electricity production	EE6	Energy efficiency	2004/8/EC Directive on the promotion of cogeneration national energy strategy	Double the current share (13%) 35%	2010 2020
Use of renewable energy sources (RES)					
The share of RES in primary energy supply	RES1 (ECO13)	Renewables	The White Paper on renewable sources Lithuanian national energy strategy	12%	2010
The share of RES in electricity generation	RES2 (ECO 11)	Renewables	Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market	22,1% (7% for Lithuania)	2010
The share of RES in heat production	RES3	Renewables	Proposal for Directive promoting the use of heat from renewable energy sources	Double the current level (11.2%) 22.4%	2010
The share of RES in fuel used in transport	RES4	Renewables	2003/30/EC Directive on the promotion of the use of biofuels or other renewable fuels in transport	2% 5.75% 20%	2005 2010 2020
Energy supply (SS)					
Energy independency	ES1 (ECO15)	Energy security	The EU Green Paper on European Strategy for Sustainable, Competitive and Secure Energy	70%	2030
GHG mitigation (GHG)					
GHG emissions (CO_2 emissions from energy)	GHG1 (ENV1)	Climate change	Kyoto protocol	Reduction by 8% of 1990 level	2008–2012
GHG/GDP	GHG2	Climate change	National sustainable development strategy	Reduction by 50% of current level (2002)	2020

in the end have a positive impact on GHG emission reduction. Some indicators relevant to energy efficiency use of RES, GHG mitigation goals for energy policy analysis reflect the Lithuanian energy policy targets expressed in Lithuanian laws, programmes and strategies.

Therefore the proposed framework integrates all requirements and goals defined in the EU energy policy documents and strategies and Lithuanian national policy goals set by the National energy strategy [6], national sustainable development strategy [7], etc. As goals set for member states for electricity produced from RES is based on negotiations of countries with the EC, the targets presented in Table reflect the targets established for Lithuania. In some cases (2003/30/EC Directive on the promotion of the use of biofuels or other renewable fuels in transport, 2002/91/EC Directive on the energy performance of buildings, Kyoto commitments), the targets for the EU and Lithuania are identical.

The response actions based on the targeted indicators define the possible policy measures and actions to be implemented in order to achieve progress towards primary targets. In our case, market-based policy measures are addressed in the framework seeking to define their interactions and impact on the main sustainable energy development goals.

4. INTERLINKAGES AMONG THE INDICATORS

Figure 2 illustrates linkages among the indicators selected for energy policy analysis. Relevant policy actions based on analysis conducted in the previous sections are based on targeted indicators. The numbers in Fig. 2 refer to the identification numbers of the indicators for monitoring the implementation of the main EU directives on sustainable energy development, listed in Table.

5. MARKET-BASED INSTRUMENTS OF EE, RES AND GHG MITIGATION

Recently a number of market-based instruments (have been introduced to achieve sustainable energy policy goals. The most prominent market-based instruments are tradable permits and certificates introduced to attain CO_2 or other pollutant emission reductions, to enhance security of supply (capacity markets, reliability contracts), to promote market-driven penetration of renewable energy sources (green certificates), and, more recently, to foster energy efficiency improvements (white certificates). These policy instruments often target parts of the same sectors or energy markets (e. g., power generation).

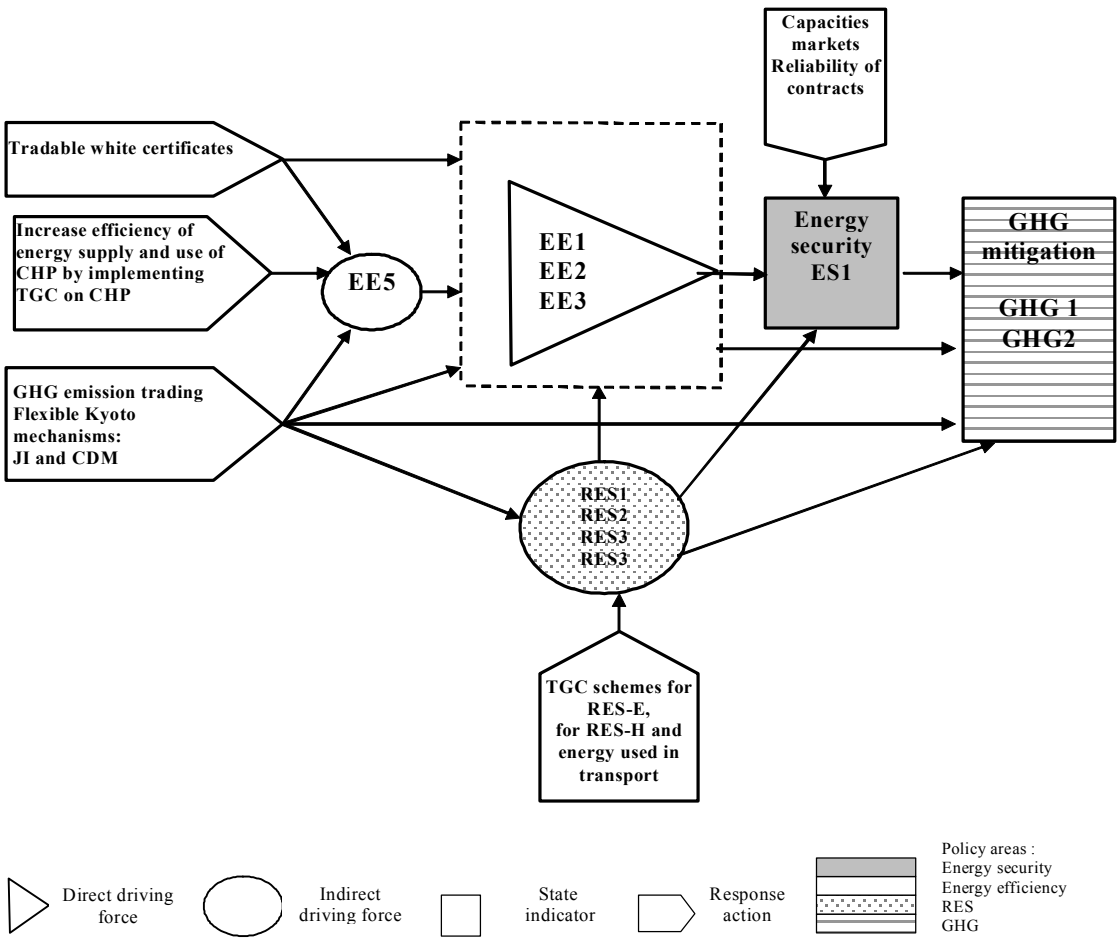

Fig. 2. Linkages among indicators and relevant policy actions based on the targeted indicators

There are a few market-based environmental policy instruments in the energy sector. All the policy instruments have broadly similar objectives: to promote cost-effective energy saving measures and / or to reduce emissions of harmful greenhouse gases. No fundamental conflicts between the objectives of White Certificate schemes and other policy instruments were identified, for example [8–10]:

- The White Certificate scheme would aim to encourage energy saving measures to deliver end-use energy savings reducing energy consumption and CO_2 emissions.
- The EU ETS aims at promoting reductions of greenhouse gas emissions in a cost-effective and economically efficient manner. The flexible Kyoto mechanisms (Joint Implementation and Clean Development Mechanisms) have the same aim on the broader area outside the EU borders.
- Tradable Green Certificates aim to promote renewable electricity generation and reduction in greenhouse gases associated with the generation of electricity from fossil fuels. A similar system can be established for heat generated from RES, or for biofuels used in the transport sector.

However, while greenhouse gas mitigation might be the main driver, it is important to remember other objectives such as security of supply and risk mitigation against fluctuating energy, which also play a role in existing and future policy instruments. All these market-based instruments interact and have a specific impact on GHG emission reduction, RES use, energy efficiency measures and energy security.

5.1. EU GHG emission trading scheme

The EU adopted a directive (2003/ 87/EC) introducing a scheme for greenhouse gas emission (GHG) allowance trading within the Community. Emissions trading (ET) in some sectors started in 2005; the first three-year trading period is limited only to CO_2. The scheme is supposed to cover about 46% of the EU-15 total CO_2 emissions in 2010. Emission reductions from joint implementation (JI) or clean development mechanism (CDM) projects can be used by the companies to reach their emission reduction targets. The details are regulated in the Linking Directive (2004/101/EC) which came into force in November 2004 [11]. Starting from 2005, firms have a direct access through CDM to credits from countries without targets; since 2008, JI credits will be available for countries with targets. The cost of the permits will be accounted for in the price of the products emitters sell: products with a high carbon content will become more expensive and buyers will respond by consuming less or switching to an alternative with less price rise (which presumably is also less carbon-intensive). Hence, this approach only indirectly gives some incentive to energy savings as a means to consume less carbon-intensive products without losing the desired service level. However, price differences among the product alternatives are not only caused by carbon intensity. While it can be argued that carbon content will be internalized in the electricity price and this will create a sufficient price signal to be passed through to consumers, even this short-term impact of the EU ETS on electricity prices will depend on a plethora of factors. The method of allowance allocation, the allowance price, the extent to which additional costs are passed on to consumers rather than to, e. g., shareholders, the carbon intensity of the electricity generation system as a whole, and the elasticity that operate in behavior (in relation to price, substitution, and income), are among these factors. In addition, the demand side of the energy sector is rarely as responsive to price incentives as economic theory predicts. These would probably make negligible the effect on energy efficiency of a possible price increase driven by the EU ETS [12].

5.2. Tradable green certificate schemes

In October 2001, the renewable electricity Directive (2001/77/EC) was adopted, aiming to increase the share of green electricity from 14% to 22% of gross electricity consumption by 2010. It establishes non-mandatory national targets for the portion of electricity consumption to be met by RES. Tradable green certificate (TGC) schemes work as follows: a quantified obligation is imposed on one category of electricity system "operators" (generators, producers, distributors, retailers, or consumers) to cover a certain percentage of electricity from RES. On a settlement date, the operators must submit the required number of certificates to show compliance. Certificates can be obtained in one of the following ways: (a) operators can own their own RE generation, and each defined amount of energy produced by these would represent a certificate; (b) operators can purchase electricity and associated certificates from eligible RES-E generators, or (c) operators can purchase certificates without purchasing the actual power from a generator or trader or via a broker. Under perfect market conditions, supply-side competition leads to minimal generation costs for RES, if there is surplus RES generation beyond the demand for certificates. Renewable quota obligations coupled with tradable green certificates have been established in a number of EU member states, including Italy, Belgium, Sweden and the UK.

5.3. Tradable certificate schemes for energy savings

A tradable white certificate for energy savings (TWC) portfolio involves four key elements [10, 12]: (a) the creation and framing of the demand, (b) the tradable property right and the rules for trading, (c) the cost recovery mechanism and (d) institutional infrastructure and processes (such as measurement and verification) to support the scheme. Variations of this policy mix have been recently introduced in Italy and the UK; in France, a similar scheme is under preparation. In Italy, energy-saving targets for electricity and gas distributors in terms of savings in primary energy consumption are combined with tradable energy saving certificates issued to distributors and ESCOs, as well as with elements of

tariff regulation (cost recovery mechanism via electricity and gas tariffs and multiple driver tariff schemes to avoid profit losses) or dedicated funds. At least half of the target set for each single year has to be achieved via reduction of electricity and gas end-use.

The TWC can be understood in terms of a market for EE measures, where the supply of EE measures depends on the technologically available means of achieving energy savings. Existing schemes focus on household energy use and include, among eligible measures, activities such as building insulation or switching to more energy-efficient appliances. It is in principle possible to allow non-household energy consumers to generate certificates as well; for example, industrial EE measures such as the installation of combined heat and power (CHP) generation could be made eligible. Consumers would generally be prepared to pay more to reduce their energy use if the cost savings were greater, and thus there would be a greater demand for EE if the price of energy were higher. White certificate targets are often denominated as a requirement to achieve additional energy savings, beyond the amount that would be undertaken in a baseline scenario without the TWC scheme. In practice, it may be very difficult to define 'energy savings' as a commodity in this fashion. Consumers without any specific policy intervention will undertake some EE improvements, and the counterfactual baseline therefore may not be easy to verify.

5.4. Interaction between market-based schemes

It is possible to combine domestic TGC and TWC in a single common scheme in which both RES and end-use energy efficiency measures contribute to meeting a specific obligation. Energy savings may contribute to meeting an overall RES target by reducing the overall consumption. In effect, Directive 2001/77/EC on the promotion of RES-E encourages such integration by establishing the RES-E target as a share of final consumption. The key common characteristic of green and white certificates is that both allow for the separation of the physical flow of electricity from, respectively, the "greenness" of electricity and the energy savings. The same rationale holds for integrating renewable heat and end-use energy efficiency [10].

Both end-use EE and RES projects result in CO_2 emission reductions, and these can be calculated. The carbon value from end-use EE and RES could be calculated and included in the certificate. The carbon value of EE and RES projects varies in accordance with factors such as the local electricity mix and the time of the day when energy is saved. Calculating the exact value of the carbon displaced is a technically solvable issue: in the NO_x set-asides in the United States there are software programs that calculate the real time power generation displaced by savings, taking into account factors such as time of the day and exact generation mix. The total value of certificates (both white and green) may be viewed as constituted of two items: an energy benefit and a carbon benefit. The energy value is limited to a certain country or region and hence purely domestic and unsuitable for trade in an international carbon scheme; conversely, the benefits from carbon mitigation are global, i. e. internationally valid. There are two ways in which white and green certificates may interact with carbon credits represented by Option 2 "One-way fungibility" (with two possible roots) and Option 3 "Two-way fungibility" in Fig. 3. Two-way (full) fungibility among the three schemes may compromise the environmental soundness, especially of green certificate systems: while RES-E and end-use energy efficiency have a carbon component / value, not all carbon projects have an energy component / value (e. g., reducing CO_2 without reducing the primary energy consumption). For this reason, we focus mostly on the possibilities of one-way fungibility; its two interaction roots (2A and 2B) differ in whether both values are simultaneously utilized or whether only one of them is utilized [10].

The interaction between the EU ETS and TGC can be analyzed in the following way. Implementation of the GHG emission trading scheme would create incentives to increase efficiency and to switch to the fuels with less carbon content and implement RES. Tradable allowances allocated on the grandfathering principle would stimulate enterprises to gain additional revenues by selling the surplus allowances generated by efficiency improvements and switching from HFO to gas, especially to biomass. We assume that no GHG credits are attached to certificates. This means that the development of renewables will add to GHG reductions only in

Option 1. No interaction: only energy value for EE and RES projects in certificates. No conversion to CO_2 and not included in EU ETS	
Option 2. One-way fungibility: separate carbon and energy values for EE and RES	
2A. If both values are utilised Carbon benefit ———— EU ETS Energy benefit———TGC/TCES	2B. If either one or other are utilised: Carbon benefit————EU ETS but not TGC/TCES Energy benefit ———— TGC/TCES but not EU ETS
Option 3. Two-way fungibility, but feasible only for carbon projects which have energy value. Risk of double counting: if a new wind mill is built, the generator gets reduced GHG emissions but is also eligible for GTC	

Fig. 3. Interaction of TWC, GTC and EU ETS

the countries where the plants are established, no matter what kind of tradable allowance scheme is adopted. Changes in the spot market price of electricity are reflected immediately and totally in the TGC price. The implementation of RES and other GHG mitigation measures would decrease the burden of GHG emission restriction on the price of conventional electricity. The reduction of electricity price leads to an increase of TGC price (because the TGC price is the difference between the marginal costs of producing electricity from RES minus the price of electricity at the quota level). This will stimulate RES deployment and the further GHG emission reduction.

A direct interaction between TWC and the EU ETS is limited by the fact that the obligations introduced by the two directives concern separate sectors (power producers and energy-intensive industries vs. energy distributors). However, the electricity supply companies are often directly linked in ownership terms with power generators or possess their own electricity generation capacities and therefore can participate in both schemes simultaneously. The implementation of the EU ETS will affect energy end-use efficiency and the operation of a possible TWC scheme in a number of ways, e.g. [12]:

- An increase in energy prices due to the implementation of the EU ETS might trigger energy efficiency measures and / or increase the demand for TWCs. Furthermore, if the retail price for energy goes up, the TWC price goes down and hence the obligated parties may get more interested in TWC eligible projects.
- TWC could lead to a reduction in the overall consumption of electricity in the EU. Assuming that, in the main, fossil fuel capacity is switched off; this in turn will lead to reductions of CO_2 emissions by power generators and reduce the allowance needs of power generators and would therefore help to control the price of allowances and power generators could meet their targets at a lower cost.
- Electricity prices could also be affected depending on the degree of competitiveness and the shape of the marginal cost curve of power production. In addition, there are many examples of vertical integration in the energy sector with an energy supplier owned by a power generation company. In this case, while their EU ETS compliance costs may be reduced through a reduction in electricity supplied as a result of a TWC scheme, overall costs may increase, as the cost of measures stimulated by the TWC scheme may be higher than meeting targets in other ways.

There is an interaction between GCT and GHG credits under Kyoto flexible mechanisms [13]. In general, it would be attractive for firms to deploy electricity from RES in CDM / JI up to the point where an additional kWh of RES-E costs more than the price of allowances. In the case of absence of GCT, implementation of the linking directive allowing transfer of CERs and ERUs to allowances will reduce the price of allowance and this will also drive down the price of electricity. A lower electricity price will result in a lower deployment of renewables. Producers of RES-E do not benefit from the reduction in allowance price, because neither they are allocated free allowances nor they will have to buy allowances in the market: their costs remain the same, but their revenues will be lower. The effect on total GHG emissions is neutral [14]. More GHG emissions would take place in the country, but more GHG emissions will be reduced in host country. In the case of GCT, implementation of the linking directive (allowing transfer of GHG credits generated during CDM and JI) will cause a different effect: the reduction of electricity price leads to an increase of TGC price (because this price is the difference between the marginal costs producing RES-E minus the price of electricity at the quota level). This will stimulate RES deployment and GHG emission reduction [15, 16].

There is a potential overlap between TWCs and the issuing of ERUs (Emission Reduction Units) from JI (Joint Implementation) project activities in installations in Member States and particularly the new Member States and accession countries soon to join the EU. At present, however, the incentives provided by the Kyoto mechanisms, including the possible use in the EU ETS of credits generated through JI or CDM project activities are not sufficient to support energy efficiency projects. This is particularly the case for small-scale energy efficiency projects where the transaction costs are too high to use the JI. This means that in practice this is not likely to be a big issue.

6. CONCLUSIONS

1. The main EU energy policy documents and directives on implementing sustainable energy policies or priorities for the energy sector development in the EU target at energy efficiency improvements, promotion of the use of RES, increase of security of supply, and GHG mitigation can be addressed by the framework of indicators establishing the concrete targets for monitoring the progress towards implementation of the main EU directives promoting sustainable energy development.

2. The framework of indicators for addressing EE, RES and GHG targets establishes the interlinkages among the indicators and allows to develop policy actions or response actions on targeted indicators and to define the interaction between the policies and measures aiming at different goals established by the EU and Lithuanian legal acts and programmes.

3. The main indicator and the last one in the framework for monitoring the implementation of the main EU directives targeting sustainable energy development is the GHG emission indicator, as all other EU policies (energy efficiency improvements, promotion of RES, and increase in energy supply security) in the end have a positive impact on GHG emission reduction.

4. There are a few market-based policy tools aiming at different goals of the EU policies that interact with

each other and with energy prices: the EU emission trading scheme (EU ETS), flexible Kyoto mechanisms (JI, CDM), tradable green certificates for electricity, heat, fuels in transport produced from RES (TGC), green tradable certificates for electricity produced from CHP, white tradable certificates for energy savings (TWC), etc.

5. These market-based instruments need to be integrated to reduce the uncertainties in their implications. Harmonization of the commodities traded within each scheme and establishment of agreed baselines are essential to allow conversion among different types of certificates. This can be achieved only if a common way of estimating the climate benefit is determined and an accurate conversion of the embodied CO_2 of a TWC and GTC is possible.

6. The eligibility for TGC and TWC should be strictly separated. EE measures should only be eligible for TWC, and RES measures should be only eligible for TGC. In this way, there would be no interactions between both systems due to the measures. However, there are some reasons for making certain RE measures eligible for both TWC and TGC. In this case, an individual measure should either receive a TGC or a TWC to avoid double counting. Still, the extra benefit for RES operators to have the possibility to get awarded TWC instead of TGC is admittedly small. Usually, the income from TGC marketing will be higher than from TWC marketing, so there will be no reason to switch over to the TWC. So far, no experiments have been made in integrating the TWC and TGC markets. These markets have been kept entirely separated. The TWC and TGC systems address different technologies. Integration of markets would dilute the aspired targets. Particularly, less RES projects would be supported if TWC were allowed to be traded into the TGC market. Cost savings by introducing TWCs into TGC markets will be realized at the expense of fewer RES deployment. Therefore the EC recommends keeping the TGC and the TWC markets entirely separated.

7. However TGC and TWC schemes can be successfully integrated in EU ETS by applying one way fungibility approach and distinguishing between carbon and energy values, the energy value will be used in TGC or TWC schemes and the carbon value will be used in EU ETS.

8. Integrating a market for TWC and TGC with EU ETS has the potential to establish one homogeneous good, to increase compliance options, to boost the liquidity of the carbon market and bring market stability. The set-aside quota approach as in the case of converting carbon credits generated by Flexible Mechanisms into EU tradable allowances can be applied.

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ES DIREKTYVŲ DĖL ENERGIJOS EFEKTYVUMO IR ATSINAUJINANČIŲJŲ ENERGIJOS IŠTEKLIŲ VARTOJIMO DIDINIMO BEI KLIMATO KAITOS ŠVELNINIMO ĮGYVENDINIMO RODIKLIŲ SISTEMA

Santrauka

Nagrinėjami pagrindinių ES direktyvų reikalavimai bei kiti dokumentai, susiję su energetikos sektoriumi. Pagrindinės ES direktyvos, kurios daro poveikį energetikos plėtrai, skatina energijos efektyvumo didinimą ir atsinaujinančių energijos šaltinių naudojimą, taip pat direktyvos, įgyvendinančios šiltnamio dujų mažinimo priemones, bei kiti dokumentai ir strategijos, susiję su energetikos sektoriumi. Atsinaujinančių energijos šaltinių naudojimo ir energijos efektyvumo didinimo skatinimas yra tarp ES energetikos politikos prioritetų, nes atsinaujinančių energijos šaltinių naudojimas ir energijos efektyvumo didinimas daro teigiamą poveikį energetikos patikimumui ir klimato kaitos švelninimui. Rodiklių sistema gali būti sukurta, atsižvelgiant į pagrindinius tikslus, nustatytus pagal ES energetikos ir aplinkos politikos nuostatas, leidžiančias sujungti rodiklius per abipusio poveikio grandinę ir apibūdinti politikos priemones, būtinas pasiekti nustatytus tikslus ir stebėti nustatytų rodiklių poveikio tendencijas bei įvertinti skirtingų rinka paremtų politikos priemonių sąveiką (ES prekybos emisijomis schema, lankstieji Kyoto mechanizmai, prekyba žaliaisiais sertifikatais ir kt.).

Raktažodžiai: ES direktyvos; atsinaujinantys energijos šaltiniai; rodikliai, skirti monitoringui

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СИСТЕМА ИНДИКАТОРОВ ДЛЯ МОНИТОРИНГА ВНЕДРЕНИЯ ДИРЕКТИВ ЕВРОПЕЙСКОГО СОЮЗА, СВЯЗАННЫХ С ПОВЫШЕНИЕМ ЭФФЕКТИВНОСТИ ЭНЕРГОПОТРЕБЛЕНИЯ, ВНЕДРЕНИЕМ ВОЗОБНОВЛЯЮЩИХСЯ ИСТОЧНИКОВ И СО СМЯГЧЕНИЕМ ИЗМЕНЕНИЯ КЛИМАТА

Резюме

Анализируются требования главных директив Европейского Союза (ЕС) и другие документы, связанные с энергетическим сектором. Основные директивы, регулирующие энергетический сектор, связаны с повышением эффективности энергопотребления, поощрением использования возобновляющихся источников и со снижением выбросов парниковых газов.

Поощрение использования возобновляющихся источников и повышение эффективности энергопотребления являются среди приоритетов в энергетической политике ЕС потому, что внедрение возобновляющихся источников и использование эффективности энергопотребления положительно влияют на надежность энергетики и на смягчение изменения климата.

Система индикаторов может быть создана на основе приоритетов энергетической политики ЕС. Система индикаторов позволяет соединить индикаторы, отражающие цели энергетической политики ЕС, через цепь обоюдного влияния и установить политические меры, направленные на достижение поставленных целей. Эти меры устанавливаются на отдельные индикаторы, но через цепь взаимосвязи они оказывают влияние и на другие индикаторы системы. Поэтому такая система является очень полезным инструментом для установления и координирования гармоничности энергетической политики, где основные цели устанавливаются и внедряются систематически.

Ключевые слова: директивы ЕС, возобновляющиеся источники, индикаторы для мониторинга