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Energy Efficiency and Policy Mix in the European Countries

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Abstract

Although countries have had concerns about energy security and energy supply for a long time, global warming and other environmental problems have led to increased interest in renewable energy use and energy efficiency only in the last decades. On the one hand, energy efficiency is important for cost-effective use of resources, overcoming environmental problems, and improving energy security. On the other hand, it is important for increasing living standards and life quality of inhabitants. Therefore, many countries have developed energy efficiency policies since 1970s. Among them, the EU countries appear as in a very good shape in policy design and innovation policies. Energy efficiency policies and their instruments are inherently complex due to the sectoral diversity, a variety of audience and uses. However, the success of a policy could largely depend on the process of policy making with regard to the characteristics of the policy, instruments and measures used, stakeholders involved and its targets. This paper aims to examine the effect of policy packages on the impact level of policies and to search if there is any efficient combination of policy instruments, based on the data of the MURE project which is a unique database on energy efficiency policy measures in 28 EU countries and Norway. First, the study provides an insight into the energy efficiency policies in European Countries by their sectoral distribution, targeted end-use and measure types to determine policy mix and policy trend. Later, it analyzes the policy packages to determine if the policy mix with respect to sectors, actors and measures has any effect on semi-quantitative impact levels of policies through cross-tabulations. The main finding of the paper is that the policy mix is crucial for policy success.

Key words

Energy Policy, European Union, Energy Efficiency, MURE Project

1. INTRODUCTION

Energy is one of the most important inputs for economic growth and human development since it provides an essential ingredient for almost all human activities. Efficient energy use,[1] on the other hand, is a cost-effective strategy for building economies without necessarily increasing energy consumption. Improving energy efficiency is an important priority in the policy agenda for all countries not only for economic reasons but also for many other reasons, such as environmental benefits, energy security and creating new jobs. Since energy

[1] Energy efficiency improvements are more prudent use of scarce and polluting resources while simultaneously maintaining a certain level of output.

efficiency represents the cheapest and surest means of curbing carbon emissions and saving money for other productive uses, national energy efficiency policies and measures and monitoring energy efficiency are seen today as the most important component of energy strategies of countries.

Besides, the European Union and its members are seen to be the world champion with respect to policy design, policy innovations and their energy efficiency outcomes despite some member states are among the world's largest energy consumers. As national policies of member states are heavily formed by the EU regulations and policies, the EU provides a roadmap for moving a low-carbon and energy-efficient economy by drawing clear targets on emissions and uses to members states. According to the Europe 2020 strategy approved by the European Council, it is targeted to increase energy efficiency by 20%, to reduce greenhouse gas emissions by 20% and to reach a share of 20% of energy from renewables in 2020 compare to 1990. The Energy Efficiency Directive (EED; 2012/27/EU) further specified that the EU-28 energy consumption for 2020 has to be no more than 1,483 Mtoe of primary energy or no more than 1,086 Mtoe of final energy. On 23 October 2014, the European Council decided on a new 2030 Climate and Energy Policy Framework including a binding EU target of at least 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990, and a share of at least 27% of renewable energy consumed in the EU in 2030 is binding at EU level. There are also sector-specific targets by the EU regulations.

According to Energy Savings 2020 report prepared by Wesselink, Harmsen, and Eichhammer (2010; 6), the EU's 20% energy savings target can be met largely through cost-effective measures but a tripling of policy impact is required. There are wide range of policy design with respect to their targets, actors, measures and other instruments in the EU members. The gap between the estimated opportunities in energy efficiency in sectors and achieved levels require examining energy-efficiency policies design and policy-making process in more detail in order to determine the characteristics of successful policy. In this context, the study's first objective is to examine policy design of the European countries where are seen as the leader in energy efficiency policy and in combating climate change, in order to identify the sector and the measure specific characteristics of energy efficiency policies and the recent trends in the region. The second objective is to determine if policy mix or policy packages with respect to their characteristics on actors, targets and measure types has an effect on the policy's impact on energy efficiency. For these objectives, we use the data of the MURE project which is a unique database that provides an evaluation of energy efficiency policy measures in the EU members, Norway, Croatia and the EU as a whole.

The next section describes and evaluates the main purposes and instruments of energy efficiency policies in sample countries. The third section assesses the energy-efficiency impacts of policy packages by their actors involved, measures used and end-use targeted through the average impact scores calculated from semi-quantitative impact levels. The final section concludes.

2. THE DESIGN OF ENERGY EFFICIENCY POLICIES: PURPOSES AND INSTRUMENTS

There have been implemented numerous energy efficiency policy instruments among countries, the energy gains compared to potential still limited, and the impact of policies varies across policies and countries (Morvaj and Bukarica, 2010) because of components of policies as well as the importance of other drivers in energy saving such as technologic innovations (Huber and Mills, 2005; Hogan and Jorgenson, 1991) and the increase in energy prices (Sutherland, 2003) as argued by some authors. When enforcement can be secured, mandatory and regulatory measures are generally the most cost-effective ways of increasing the energy efficiency on a long-term basis (UNDP, 2009; Erdogdu, Karaca, & Kurultay, 2015).

Taking into account of the energy efficiency gap between the observed level of energy efficiency and the potential of energy efficiency, this gap and therefore the need for policy intervention in energy markets mostly are explained by market and behavioral failures (Gillingham, Newell and Palmer, 2009; Shogren and Taylor, 2008), despite of some critics which argue that all market failures and barriers are not problem that should be overcome or can be overcome cost-effectively (Geller and Attali, 2009). Gillingham, Newell and Palmer (2009) classify potential failures and policy options as energy market failures (policy options are fiscal and new market-based instruments), capital market failures (policy options are financial and loan instruments), innovation market failures (policy options are fiscal and financial instruments), information problems (policy options are information programs) and behavioral failures (policy options are educational and informational instruments and legislative-normative measures as product standards).

In this paper, we examine the European countries which are seen to be having the developed policy designs and to be having enormous energy gains from policies through the MURE database. The first policies that appear in the MURE database are "farm land re-parceling project" of Finland in 1917 and "speed limits and active traffic management" of UK in 1934. Until 1990, there were only 86 policies according to the MURE database. The energy-efficiency policies have mainly began to increase from 1990s, and at mid-2000s, the number of policy

has reached at its highest level, despite of relatively decrease after 2009 (the decrease can be seen to be partly due to data availability in the MURE database). There has been a continuous increase in the number of measures that have come into force every year until 2009. The increase is valid for all sectors, but the least increase was experienced in the industrial sector. The policy number for all years and all sectors is 2382 as of August 2015 when the data was collected for this study. The largest part of policies is those related to energy efficiency in the household sector. Policies without the semi-quantitative impact estimation are about 13% of the total. The largest number of policies consists of measures addressing energy-efficient in the household sector by 28% as share of total policies (663 policies as frequency). The second largest number of policies is those which address transport and tertiary sectors. The share of transport and tertiary sector policies is quite similar and 22% (528 policies for transport and 524 policies for tertiary) with respect to policy numbers. Policies toward the industrial sector and general cross-cutting sector are again same as 14% as a share of total policies (334 policies for general cross-cutting and 333 policies for industrial sector). The MURE database also publishes semi-quantitative impact evaluations of 86 percent of policies (with 2055 at frequency). All sectors have the impact evaluation above 87% except general cross-cutting sector by 76%.

Taking together households and tertiary sector, policies which tackle buildings consist of a half of total policies. EC Directorate-General for Energy (2012) has also recognized that buildings must be central to the EU's energy efficiency policy. Studies have generally indicated that since there is currently a high final energy demand for heating and cooling in the residential and tertiary sector, energy saving potential in the buildings (especially from refurbishment of existing buildings) is rather high compared to other sectors (Eichhammer, et al. 2009; Boßmann et al. 2012).

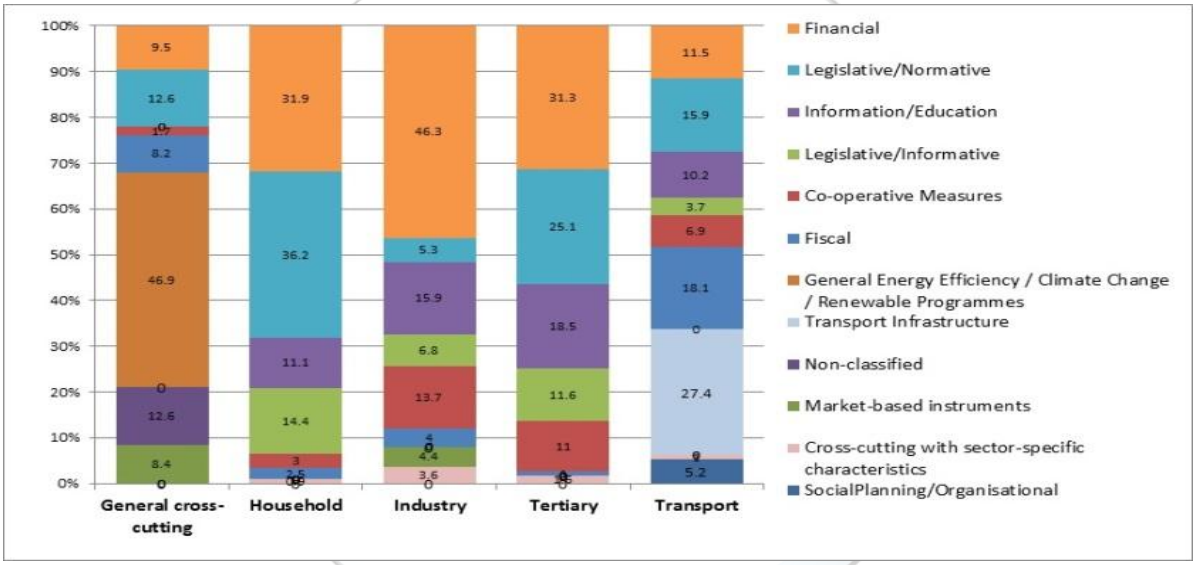

Figure 1. Measures by Sectors

Figure 1 illustrates the distribution of measures by sectors. In the general cross-cutting with sector-specific characteristics which cover mostly all sectors with the same type of instruments, the most commonly used measures are the general programmes on energy efficiency, climate change or renewables. Also, legislative/normative measures such as regulation or mandatory targets become more important, while market-based instruments are on the rise.

In the household sector, legislative/normative (in particular building regulation) and financial measures (addressing mainly existing buildings) are dominant in policies, while the informative policies (legislative informative and information/education) consist of one-fourth of policies and especially legislative/informative measures such as labels have decreased in importance recent years in the consequence of the fact that the very comprehensive labelling policy for the electric appliances has not been renewed. However the Eco-design Directive 2005/32/EC is expected to give a further push to this measure type (ADEME, 2009).

Tertiary sector is similar to household sector in terms of distribution of policies, because both are related to the buildings. However, informative and cooperative measures in tertiary sector play a larger role compared to household sector. Moreover, legislative/informative measures such as labels increase in importance. In industrial sector, the financial measures are in the core of policy mix by 46 percent. The second largest part of measures is informative and cooperative ones such as information/education, cooperative and legislative/informative measures. In transport sector which consumes energy at the highest level with responsibility of inducing one-fifth of CO2 emissions in the EU (AEA, 2012), it is used wide range of measures, as it is not dominated by two

or three measure types. But it can be said that the measures with related to infrastructure, fiscal and legislative measures tend to be more largely employed. Regulation and co-operative measures are on the rise. General cross-cutting measures cover mostly all sectors with the same type of instruments (ADEME, 2009).

Considering how changes the policy mix over time by sectors, it can be said that the financial measures have always dominant in the industrial sector, although the share of financial measures has declined after 2000 compared to before 2000 from 42.5% to 46.3. Another declining instrument is legislative/informative measures from 5.1% to 6.8. On the other hand, the information/education, cooperative and new market-based measures have increased as a share of total policy in the industry. It can be said there is slight tendency toward using informational - cooperative measures and new market-based instruments in the industry. Although most countries have also at least one new market-based instrument, there are a few countries which do not have this kind of measures (ODYSSEE-MURE, 2015).

Financial and legislative measures are dominant in the building sector. However, comparing after-2000 and before-2000, there is a slight increase in legislative/informative measures and fiscal measures for household sector, on the other hand, for tertiary sector, as the financial measures and information/education have increased respectively from 31.3% to 33.4 and from 18.1% to 18.5, legislative normative measures have decreased by 3 percentage points.

In transport sector in which policy efforts intensify on mobility paradigm in transport, using new technologies in vehicles and transport systems, encouraging modal shift toward less energy intensive modes like public transport and improving transport infrastructure systems with regard to energy efficiency and environmental sustainability (ADEME, 2013; EC, 2011; Marcucci, Valeri and Stathopoulos, 2012), it is dominantly implemented infrastructure, fiscal, information/education and legislative/normative measures. Comparing after-2000 and before-2000, the legislative measures (informative and normative) have increased from 19.5% to 22.5% despite of slight decreases in all measure types except of a slight increase in social planning/organization types of measures.

3. POLICY PACKAGES AND THEIR SEMI-QUANTITATIVE IMPACT

One of the most important advantages of the MURE database is that it publishes the impact evaluations of a policy in semi-quantitative categories as having high impact, medium impact and low impact based on quantitative evaluations or expert estimates, with respect to energy savings achieved by the policy. This is quite valuable information to judge the success of a policy.

The information on the impact level could also be used to consider the success of a mix of policy instruments such as actors involved, measures employed and targeted-end-use of policies, when the multiple actors are used in a policy. In this case, an option is to compare how much policy has the highest impact as percentage of total policy or how much of them in the lowest impact level for related categories. Another way is to develop a score on impact levels to compare categories. We prefer the second option by calculating simply the average impact score for comparison purposes. Accordingly, we assign the coefficients for 1 for the low impact, 2 for the medium impact and 3 for high impact in an instrument, and then divide total value by the frequency of the category respective.

In the case that a policy can contain more than one instrument such as actors, measures and targets of the policy, evaluating the policy packages with regard to their impacts could reveal important information to discover successful combinations of instruments. In this section we examine policies by actors, measures and targets to consider the successful combinations of these instruments.

3.1. Policy Packages by Actors and Their Impact Levels

In this section, we consider how often an actor is involved in a policy and what are the actor combinations of policies, taking into account policies mostly contain multiple actors. MURE database classifies actors as central government, energy agencies, financial institutions, industries, local governments, utilities, employers, energy suppliers, manufacturers, professional associations, trade associations, associations, transport companies and vehicle companies. We combine this classification into 7 categories as central government, local authorities, energy agencies, energy suppliers, financial institutions, associations (all types of associations), companies (industries, utilities, employers, manufacturers, transport companies and vehicle companies) by their functions. Considering how often an actor was involved in policies, actor who is used the most commonly in policies is central government, as central government is found in 44 percent of all policies considered. Central government is followed by local governments (15%), energy agencies (14%) and companies (14%). Associations (7%), financial institutions (3%) and energy suppliers (3%) are quite less found in policies.

Table 1. Distribution of Actor Combinations of Policies

Actor	%	Actor	%
Only Central Government	38.8	Government/Companies	8.3
Central and Local Government	7.3	Government/Energy Agencies	7.8
Only Local Government	5.1	Government/Associations/Companies/Energy Agencies	2.7
Only Energy Agencies	4.1	Government/Companies/Energy Agencies	2.7
Only Companies	3.7	Government/Associations	2.2
Only Associations	1.0	Government/Financial Institutions	1.5
Only Energy Suppliers	0.5	Government/Associations/Energy Agencies	1.4
Only Financial Institutions	1.2	Government/Energy Suppliers	1.2
Associations/Companies	1.3	Government/Energy Agencies/Financial Institutions	0.9
Companies/Energy Agencies	0.8	Government/Associations/Energy Suppliers	0.8
Associations/Energy Agencies	0.6	Government/Companies/Energy Agencies/Energy Suppliers	0.7
Associations/Companies/Energy Agencies	0.3	Government/Associations/Companies	0.6
Energy Agencies/Energy Suppliers	0.3	Government/Energy Agencies/Energy Suppliers	0.6
Other	3.2	Government/Associations/Companies/Energy Agencies/Financial Institutions	0.4

Since a policy could be conducted by participation of more than one actor, we also consider actor combinations in policies to avoid double counting of actors. As Table 1 below indicates, the actor contents and combinations of policies, more than half of all policies (54.4%) were conducted by a single actor. Inherently the central government alone is the most active participant of policies by 38.8 percentages. On the other hand, when central government and local government are considered together, 51.2% of the all policies are conducted by only general government. The right column of Table 1 shows collaborations of the general government (central government and/or local government) with any other actor. As could be expected, the government is involved in almost all policies. The most important partner of the government is companies (8.3%) and energy agencies (7.8%).

Figure 2 compares the average impacts of actor combinations on energy efficiency through a simple impact score. The single-actor policies are shown in Figure 2 with regardless their frequency. However, the categories which have less than 1% of frequency are counted in the category "other".

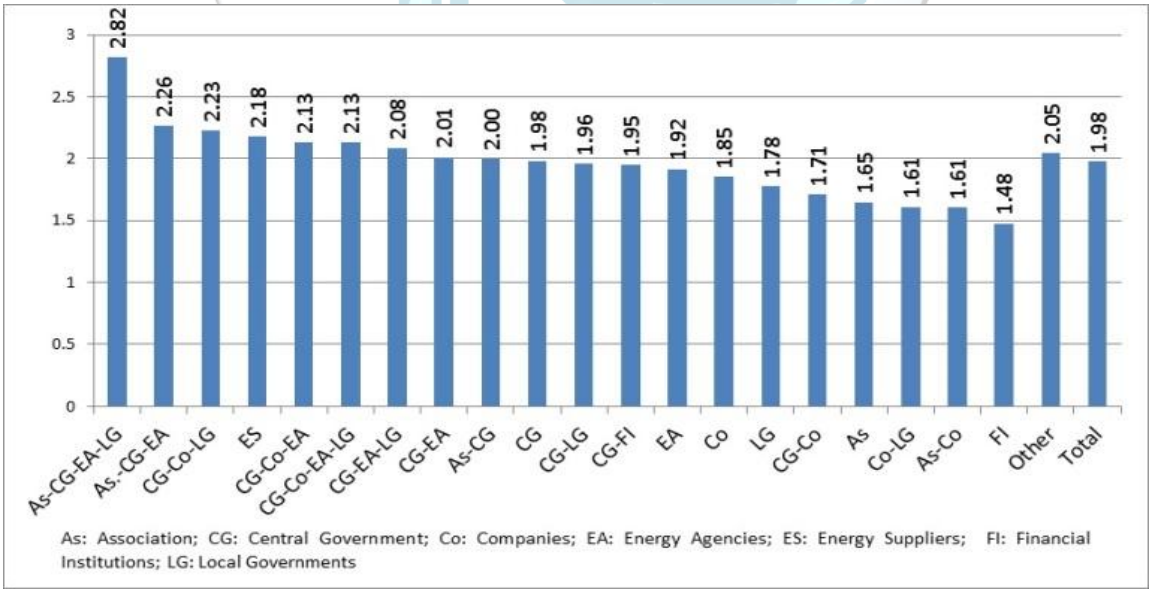

Figure 2. Impact Scores of Policies by Actors

As can be seen from Figure 2, the most successful actor collaboration is clearly those which among associations, central government, energy agencies and local governments with regard to impact score. While policies which conducted by the central government alone produce 1.96 of the impact score, the cooperation of the central government with other actors generally produces higher impact except of the collaboration of central government with corporations. Central government-corporations cooperation produces the higher impact if only

there is another actor in the policy such as central government-corporations-local government, central government-corporations-energy agencies and government-corporations-energy agencies-local governments. Among the policies with single-actor, the most successful one is seen to be the policies which conducted by energy suppliers. But it should be kept in mind that the assessment was made only with 11 frequencies.

In general, it can be said that policies which is conducted by associations, energy agencies and/or companies in addition to the central government and/or local government are more successful rather than policies implemented by the single-actor. Policies without central government generally produce lower impact score with exception of the cooperation central government and companies.

3.2. Policy Packages by Measure Types and Their Impact Levels

Next, we assess the distribution of measure types among policies, their combinations and their impacts on energy efficiency. The MURE database classifies measures into eleven categories as cooperative, cross-cutting measures with sector-specific characteristics, financial, fiscal, information/education, legislative/informative, legislative/normative, market-based measures for only ındustry sector, and two measure types as infrastructure and social planning/organization for only transport sector.

Table 2. Distribution of Measure Combinations of Policies

Measure	%	Measure	%
Only Financial	23.81	Other	5.91
Only Legislative/Normative	19.04	Financial-Fiscal	2.23
Only Information/Education	10.86	Leg/Informative - Leg/Normative	1.95
Only Co-operative	6.91	Financial - Information/Education	1.50
Only Legislative/Informative	6.86	Financial - Leg/Normative	0.10
Only General Programmes	6.18	Cooperative- Information/Education	0.07
Only Fiscal	5.09	Fiscal - Leg/Normative	0.05
Only Infrastructure	3.82	Information/Education - Leg/Informative	0.05
Only Market-based	1.64		
Only Cross-cutting	1.27		
Only Social Plann/Org.	0.41		

Considering how often a measure type is used in policies at the expense of the risk of double counting policies, the measure types which are used the most frequently are financial measures (29%), legislative/normative measures (23%) and information/education measures (15%). Market-based, infrastructure and social planning/organization measures which are specific to particular sectors (the first is to industry sector and the other two are to transport sector) are inherently used the less frequently.

Table 2 considers the distribution of measure combinations to find out how often measures are used alone or together with other specific measure type. As policies which have lower frequency than 10 were combined in the category “Other”, this category consists of a variety of the measure combinations. As can be seen, the vast majority of policies contain the single-measure type (86%). Policies which use a combination of several measure types are 14% of total policies. The most widely used measures are only-financial measures (24%), legislative/normative measures (19%) and information/education measures (11%). The most frequently used measure combinations are financial-fiscal measures (2.23% and 49 of frequency), legislative/informative-legislative normative measures (1.95% and 43 of frequency) and financial-information/education measures (1.15% and 33 of frequency).

For examining the impact levels of measures combinations, we again calculate a simple impact score following the method used for actor combinations. Figure 3 shows comparative impact scores of policies by measure types used in. Accordingly, the most successful measure combinations are fiscal-legislative/normative, financial-legislative normative and legislative informative-legislative/normative measures, however they have low frequency. Successful measure combinations are generally those which supported by "legal / normative" measures. Only-legislative/normative measures also have the impact score above average. The most unsuccessful combinations are cooperative-information/education and information/education-legislative/informative. In general informative (legislative or not) and cooperative measures associated with lower impact with except of the combination of legislative/informative measures with legislative/normative measures.

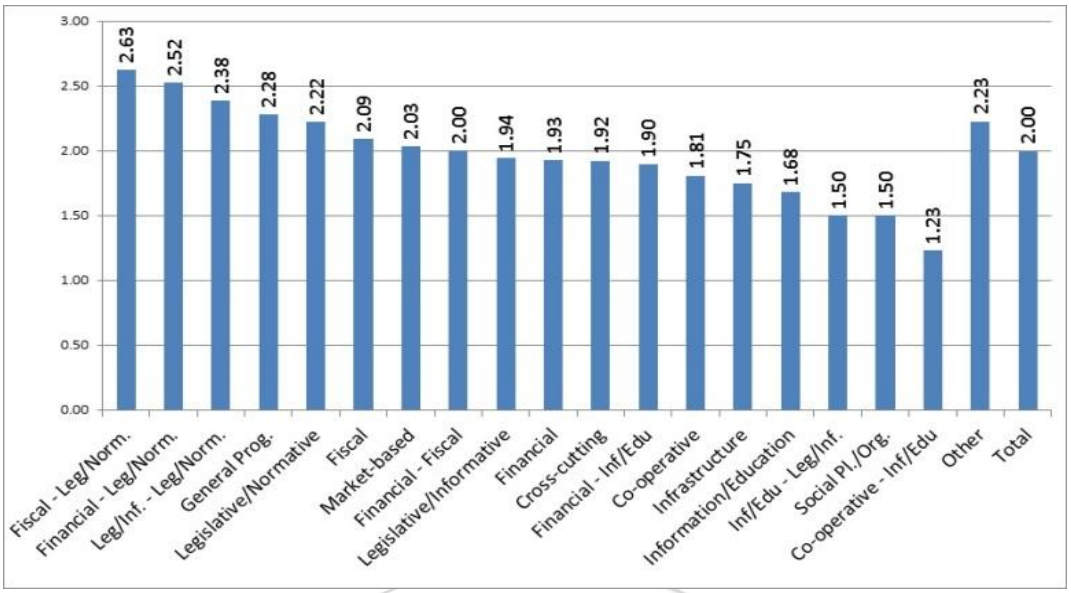

Figure 3. The Impact Scores of Measure Combinations

The financial measures which are used the most frequently in policies shows the impact below average when they are used alone. Financial measures are more successful when it is used together with legislative/normative measures and relatively fiscal measures. It should be remembered that besides their impact on energy efficiency, financial and fiscal measures are also criticized to be regressive their effect on income distribution (Brookes, 2000; Sutherland, 2003).

Policies with single measure are higher impact in the case of the general programmes and legislative/normative, while they fail in the case of social planning/organization, infrastructure, cross-cutting with sector-specific characteristics and financial.

3.3. Policy Packages by Targeted End-Uses and Their Impact Levels

Finally, in this section we examine the distribution of targeted end-use of policies, target combinations and their impacts on energy efficiency. The MURE Project publishes detailed information on targeted end-uses of policies. Some targets are only related to sector-specific characteristics. For the household and the tertiary sectors, it is mostly targeted energy efficiency in buildings such as targets which is aimed to appliances, heating, cooling, lighting etc. While the sector industry contains process-related targets such as electric motors, process heating cooling as well as space heating, cooling etc., in the transport sector, a series of sector-specific targets are used such as those aimed at driver behaviors, mobility, modal shift, technical and non-technical ones. On the other hand, all sectors share the categories of general targets as total electric consumption, total final consumptions and total fuel consumptions.

Examining the percentage of being included of a target in policies, the most frequently targeted end-uses are total final consumption among these general targets (32.5%). Other general targets are also used commonly in policies. Following these targets, the categories of space heating/cooling (13.5%), the appliances/cooking/hot water (7.9%) and the lighting (5%) are common across policies. However, as can be recalled from the other section, these general figures may be misleading because of double counting of policies if they include more than one target. Therefore, we examine target combinations by eliminating double count problem in Table 3.

The left column of Table 3 presents the single-target policies as a share of total policies, while the right column sorts target combinations for the multiple-targeted policies. Policies which have lower frequency than 10 were combined in the category “Other”. Accordingly, the majority of policies contain the single-measure type (67%), while the majority of the multiple-targeted policies have the less frequency within the category “other”. Among the single-targeted policies, total final consumption is clearly one that is used the most frequently. Following the target of total final consumption, the 7.5 percentage of policies targets the total fuel consumption and the 6.7 percentage of policies targets space heating/cooling. The most common combinations are the combination of the appliances/cooking/hot water and the space heating/cooling (3.6%), the combination of the space heating/cooling and the total final consumption (2.3%) and the combination of the appliances/cooking/hot water, the space heating/cooling and the total final consumption (1.3%). Targets related to transport such as technical and behavioral are generally together with total fuel consumption.

Table 3. Distribution of Target Combinations

Target Combination	%	Target Combination	%
TFinalC	37.48	Other	22.24
TFuelC	7.52	ACH & SHC	3.57
SHC	6.68	SHC & TFinalC	2.33
TElecC	3.96	ACH & SHC & TFinalC	1.3
TecTRA	2.92	TecTRA & TFuelC	1.17
Lighting	2.27	TElecC & TFinalC & TFuelC	1.17
ACH	1.75	BehTRA & TFuelC	1.1
OTU	1.75		
BehTRA	1.1		
MsTRA	0.84		
Process	0.84		
ACH: Appliances/cooking/hot water		SHC: Space heating/cooling	
BehTRA: Behavior -in Transport		TecTRA: Technical in Transport	
MobTRA: Mobility in Transport		TElecC: Total Elec. Cons.	
MsTRA: Modal shift in Transport		TFinalC: Total Final Cons.	
OTU: Other Targeted Uses		TFuelC: Total Fuel Cons.	
Process: Process heating, cooling, el. gen.			

For examining the associations between the impact levels and the target combinations, we again calculate a simple impact score following the method used for actor and measure combinations. Figure 4 shows comparative impact scores of policies by targets used in. As can be seen from Figure 5, the highest impact score is for the combination of appliances/cooking/hot water, the space heating/cooling and the total final consumption. Among the single-target policies, ones which aimed at lighting are the most successful. In general, targets related to building sector such as lighting, total electric consumption, space heating/cooling have the higher impact levels, while policies with transport-specific targets are unsuccessful with regard to their impact scores. Among transport-specific targets, the most successful one is behavioral targets, but it has higher impact if it is used with total fuel consumption target.

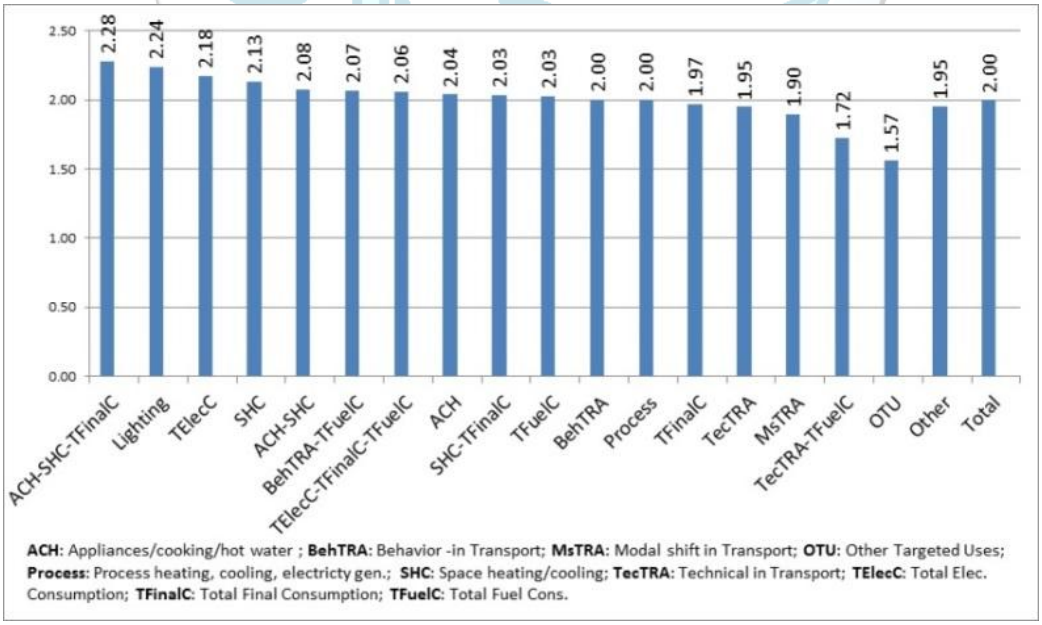

Figure 4. The Impact Scores of Targeted End-Use Packages

Among targets aimed at general energy efficiency (total final consumption, total electric consumption and total fuel consumption), total electric consumption is the most successful, while total final consumption is the less successful one, when they are used alone. Total final consumption has higher impact if it is used together with targets the appliances/cooking/hot water and the space heating/cooling instead of using alone, while the fuel consumption has higher impact if it is used together with behavioral targets for transport instead of using alone.

4. CONCLUSION

We have evaluated the policy contents with respect to their impacts on energy efficiency by actors, measure types and targets. The most successful actor collaboration clearly appears as those which among associations, central government, energy agencies and local governments. The cooperation of the central government with other actors generally produces the higher impact except the collaboration of central government with corporations. Policies without central government generally produce lower impact score with the exception of the cooperation central government and companies.

For measure types employed in policies, the most successful measure combinations are fiscal-legislative/normative, financial-legislative normative and legislative informative-legislative/normative measures. Successful measure combinations are generally those which supported by "legislative/normative" measures. Only-legislative/normative measures also have the impact score above average. When enforcement can be secured, mandatory and regulatory measures are generally the most cost-effective ways of increasing the energy efficiency. The most unsuccessful combinations are cooperative-information/education and information/education-legislative/informative. In general informative (legislative or not) and cooperative measures associated with lower impact with except of the combination of legislative/informative measures with legislative/normative measures. The financial measures which are used the most frequently in policies shows the impact below average when they are used alone. Financial measures are more successful when it is used together with legislative/normative measures and relatively fiscal measures.

With regard to target packages of policies, the highest impact score is for the combination of appliances/cooking/hot water, the space heating/cooling and the total final consumption. Among the single-target policies, ones which aimed at lighting are the most successful. In general, targets related to building sector such as lighting, total electric consumption, space heating/cooling have the higher impact levels, while policies with transport-specific targets are unsuccessful with regard to their impact scores. Among transport-specific targets, the most successful one is behavioral targets, but it has higher impact if it is used with total fuel consumption target.

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