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Analysis of the Energy Consumption of Manufacturing Industry in Türkiye* (2003-2014)

Aynur YILMAZ ATAMAN**

Abstract

In this study, the driving forces of energy demand in Türkiye's manufacturing industry and their contribution to the decoupling between energy consumption and production increase are analysed via LMDI-I and the Tapio decoupling index between 2003 and 2014. It was seen that while the increase in production was the main driver of the rise in energy consumption, changes in the shares and energy intensities of sub-sectors also influenced energy consumption significantly. In that regard, despite the increase in most sub-sectoral shares, net structural impact contributed to reducing the energy demand. As for the intensity effect, it is seen that in most manufacturing industries, there were improvements at varying levels, and the final impact of these improvements on total energy demand was different for each sector. In this regard, the first six sectors in which changes in their sectoral shares and energy intensities had the most impact on total energy demand were found to be basic metals, chemicals and chemical products, textiles, other non-metallic mineral products, food, and rubber. Decoupling analyses showed that the fabricated metal products sector was the only sub-sector in which there was a strong decoupling. It was also found that decoupling occurred temporarily and was very limited in the manufacturing industry. However, in three years (2005, 2008 and 2013), there was a strong decoupling, with improvements in energy efficiency and changes in sectoral distribution being the main contributors.

JEL Codes: C43, Q43, Q48

Keywords: index decomposition analysis, decoupling analysis, LMDI, Tapio decoupling index, manufacturing, energy consumption, WIOD

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** PhD in Economics, Marmara University Economics Department (English), (aynrylmz01@gmail.com) https://orcid.org/0000-0001-6678-7908

Türkiye İmalat Sanayiinde Enerji Tüketiminin Bir Analizi (2003-2014)

Öz

Bu çalışmada, Türkiye imalat sanayinde enerji talebindeki değişimin itici faktörleri ve bu faktörlerin enerji tüketimi ile üretim artışı arasındaki ayrışmaya katkıları 2003-2014 dönemi için LMDI-I ve Tapio ayrıştırma endeksi ile analiz edilmektedir. Çalışmada, üretim artışı ile ölçülen aktivite etkisinin, enerji tüketimindeki artışın temel itici gücü olduğu bulunurken, enerji yoğun sektörlerin sektörel payları ve enerji yoğunluklarındaki değişimlerin de enerji talebini önemli ölçüde etkileyebildiği görülmüştür. Bu bağlamda, alt sektörlerin çoğunun payı artmış olmasına karşın, net yapısal etki, enerji talebini azaltıcı yönde olmuştur. Yoğunluk etkisine bakıldığında ise çoğu imalat sanayinde farklı düzeylerde iyileşmeler olduğu ve enerji verimliliğindeki bu iyileşmelerin toplam enerji talebi üzerindeki nihai etkisinin her sektör için farklı olduğu görülmektedir. Bu doğrultuda, sektörel payları ve enerji yoğunluklarındaki değişimlerin toplam enerji talebini en fazla etkilediği ilk altı sektör ana metaller, kimyasallar ve kimyasal ürünler, tekstil, diğer metalik olmayan mineral ürünler, gıda ve kauçuk olmuştur. Ayrışma analizinde ise, güçlü ayrışmanın olduğu tek alt sektörün fabrikasyon metal ürünleri olduğu görülmektedir. Ayrıca imalat sanayinde ayrışmanın geçici ve çok sınırlı olduğu tespit edilmiştir. Ancak üç yılda (2005, 2008 ve 2013), tam bir ayrışma gerçekleşmiş olup, enerji verimliliğindeki iyileşmeler ve sektörel dağılımdaki değişiklikler buna ana katkı sağlamıştır.

JEL Kodları: C43, Q43, Q48

Anahtar Kelimeler: indeks ayrıştırma analizi, ayrışma analizi, LMDI, Tapio ayrışma endeksi, imalat sanayi, enerji tüketimi, WIOD

1. Introduction

Amid the climate crisis we live in, it is widely recognised that economic policies should be sustainable concerning climate impacts, material footprint and all other ecological outcomes. In that regard, the necessity to make a shift to more renewable and environmentally friendly energy resources from fossil fuels in pursuing economic activities has already been acknowledged by countries and has given a place in the mid- and long-term targets of many national and international energy and economic policies.

Given the high reliance on fossil fuels in energy consumption and import dependency, meeting and securing energy demand has always been critical for Türkiye. In 2022, the total share of coal, oil and gas in the primary energy supply was 82.7%, up from 81.7% in 1990, and the domestic rate in primary energy sources declined from 47.9% to 32.2% in the same period. This is mainly due to the increasing weight of natural gas replacing coal, biomass, and waste in the energy supply and the higher import rates in the coal supply. The share of natural gas in the primary energy supply increased from 5.4% to 27.4%, and as of 2022, the import rate of natural gas was 99.3%. Similarly, in coal supply, the import share increased from 27.2% to 54.7% in the same period, and this was mainly due to the increase in hard coal, of which the import share rose to 96.5% in 2022 from 68.1% in 1990 (MENR, 2024).

However, it is especially after the solid economic growth with a growing population since the 2000s that Türkiye focused on increasing its domestic energy resources, diversifying its oil and gas supply countries, and expanding its upstream oil and gas activities to meet the increasing energy demand (IEA, 2021; Karagöl et al., 2017; Taştan, 2022). As these supply-side policies have been implemented, demand-side measures promoting energy savings in both consumption and production activities have also become increasingly important to manage energy consumption within the supply constraints and slow down the growth in energy demand.

As the manufacturing industry accounts for over one-third of the total final energy consumption in Türkiye (MENR, 2024), this study aims to identify the main factors driving changes in energy consumption within this industry and analyse the decoupling performance in each sub-sector in the beginning of 2000s in which Türkiye experienced high growth rates due to favourable internal and external economic conditions. New financial reforms implemented following the banking crisis in 2001 were backed by the favourable international conjuncture and Türkiye's official candidacy status to the EU, leading to the increase in capital inflows resulting in decreasing interest and exchange rates and increasing imports (Akcay & Güngen, 2019; Orhangazi & Yeldan, 2021, 2023; Taymaz & Voyvoda, 2023). This period also witnessed the emergence of sectoral incentives in policy documents after 2009 for high-value-added products and strategic sectors in the manufacturing industry (Atiyas & Bakis, 2015; Canbaz, 2019). In addition, the regulatory framework and policy strategies for energy efficiency were strengthened only after 2007 when the Energy Efficiency Law (Official Gazette, 2007) was passed to ensure efficiency in energy use, prevent energy waste, decrease the burden of energy costs on the economy and preserve the environment. On the other hand, the following period, after 2013, was slightly different in terms of weakening political stability and increasing interest and exchange rates, thus having a limiting effect on the production activities in the industry. For this reason, in the examination of production-related energy demand, focusing on this period where there were favourable conditions for production activities such as having access to funds with low cost and imports with low exchange rates and policy strategies to increase energy efficiency and high value-added production has just started is considered valuable in terms of providing an opportunity to make a comparison with the following periods in which these conditions have changed to varying extents. In that regard, an index decomposition analysis will be used together with a decoupling analysis to examine the driving factors behind the change in energy demand of the manufacturing industry and their contribution to the decoupling between energy consumption and value-added growth covering the period between 2003 and 2014.

Despite the widespread use of index decomposition analysis in energy-related studies, it has recently become popular in Türkiye for energy and emission analyses, and relatively few studies have concentrated on energy consumption. Additionally, combining index decomposition and decoupling is rare, and only two studies use them together to analyse the driving factors of the changes in related aggregate and their contribution to the decoupling process. To the best of the author's knowledge, (Karakaya & Özçağ, 2003) is the first to use index decomposition to analyse changes in Türkiye's carbon emissions between 1973 and 1999. A similar study focusing on the manufacturing sector was conducted by Yılmaz et al. (2016) covering 1980-2011. It is found that the activity effect always contributed to the increase in energy consumption apart from the economic crisis years 1994, 2001 and 2009. Similarly, energy intensity contributed to the increase in the energy demand in 2000-2011, contrary to the previous periods, due to the increase in energy intensity in cement, chemical-petrochemical, iron and steel sectors as well as the contraction in production due to global economic crisis and lack of strong energy efficiency. Structural effect is also found to have an increasing effect on energy demand, albeit to a limited extent, due to the increase in the sectoral shares of chemical-petrochemicals and cement sector. Amongst recent studies, Akyürek (2020) examines the manufacturing industry, including ten sub-sectors from 2005 to 2014. The study finds few structural changes, with increasing production and energy intensity changes being the dominant factors affecting manufacturing energy consumption. Türköz (2021) analysed changes in national energy consumption across three sub-sector details from 1970 to 2018. During this period, energy consumption increased due to higher production but was offset by reductions in structural changes and intensity changes. Özşahin (2019) focuses on energy intensity changes in industry, services, agriculture and industrial sub-sectors between 1960-2017 and finds that the biggest contribution to the increase in energy efficiency comes from the services and the industry, whereas agriculture has a negative impact on energy efficiency. Moreover, in the industry sector, basic metals and other manufacturing sectors which are energy intensive are found to make the highest contributions to the changes in energy intensity of the sector. In a study focusing on the methodological aspects regarding IDA, Yilmaz Ataman (2022) analyses the change in energy consumption in production-related activities for 2000-2014 as an illustrative example. It is found that the increase in energy consumption is mainly caused by the activity effect, while the primary source of energy saving is the energy intensity, which is mainly due to a significant reduction of 38% in the manufacturing sector's energy intensity during the examined period. Among studies focusing on the changes in energy-related carbon emissions in Türkiye, Karakaya et al., (2019) applies the index decomposition analysis together with Tapio decoupling index to examine the decompositions of CO2 emissions and decoupling performance between emissions and growth from 1990-2016, finding that output and population increase are the main driving forces throughout the whole period and there is either no decoupling or weak decoupling indicating that Türkiye’s economic growth is not sustainable. Ozdemir (2023) focuses on the carbon dioxide emission in electricity generation and uses index decomposition and decoupling analysis together to analyse the CO2 emissions of the electricity generation from fossil fuels from 1990-2020 and find that the main contribution to the increase in emissions come from the activity effect and the weak decoupling was the most frequent decoupling state in the analysed period.

In this regard, this study contributes to the literature by combining index decomposition and decoupling analysis in analysing changes in energy consumption in Türkiye's manufacturing industry. Additionally, in almost all studies, national energy balance tables are the main source of energy data. This study will use the energy accounts in the World Input Output Database (WIOD) as it sets a linkage between energy data and economic activities.

In this sense, the first part of this study focuses on explaining the WIOD in detail as this is the main data source of this study and the required improvements to overcome some constraints to conduct the analysis. The second part explains the methodology, and the following part shares the main findings. The last part is reserved for the summary and further discussion of the findings.

2. Data

Decomposition and decoupling analysis of energy consumption in Türkiye between 2003 and 2014 was performed mainly based on the 2016 Release of the WIOD (Timmer et al., 2015) because of the unique sectoral classification alignment between energy consumption and value-added data. In addition, to overcome certain restrictions arising from the data construction in WIOD, TURKSTAT data (TURKSTAT, 2014, 2021) was used for complementary purposes.

WIOD started as a project in 2009 to analyse global production networks and their environmental linkages through the world input-output tables (WIOTs), which consist of national input-output tables connected by bilateral international trade flows. The second and the last version of the WIOD was released in 2016 and covers the period from 2000 to 2014 for 28 EU countries and 15 other major countries (Genty et al. 2012; Timmer et al. 2015, 2016).

Timmer et al. (2016) summarise the construction of WIOTs in three stages: Firstly, times series of national supply and use tables (SUTs) are constructed based on national accounts. WIOD 2016 release is solely based on the national accounts generated by the 2008 System of National Accounts and follows the ISIC Rev.4 sector classification for 2000-2014. In the next stage, imports are broken down by country of origin and use category using bilateral trade statistics to create international SUTs. In the final stage, full WIOTs are produced by integrating all countries and the rest of the world. In the database, in addition to WIOTs, two different satellite accounts are also created: Socio-economic accounts (SEA) consist of data for production factors, and environment accounts (EA) cover data associated with the environmental effects of production activities.

SEA in the WIOD 2016 Release provides industry-level data on employment, capital stocks, gross output, and value-added in millions of local currencies, both at current and constant prices. However, Timmer et al. (2016) explain that since SUTs at basic prices for 2002 were used for Türkiye, and these tables were in SNA1993 and ISIC Rev.3, required products and industries were later mapped to products/industries in ISIC Rev.4. In the construction of external times series for Türkiye's value-added data for 2000-2014; firstly, national accounts data by one-digit sectors (A to T) was retrieved from TURKSTAT in SNA 2008, ISIC Rev. 4. However, in order to obtain value-added data with two-digits sectors as in the 2002 SUT, shares from the 2002 use tables were applied to the value-added data set for the entire period 2000-2014, leading to constant shares of manufacturing sub-sectors in nominal data. Additionally, Gouma et al. (2016) explain that when information on prices was limited, price deflators in WIOD 2016 release were estimated based on the information in WIOD 2013 release, and for the period beyond 2009, they were extrapolated using GDP deflators from the UN National Accounts statistics by seven broad sectors. Therefore, in the real value-added data, constant sub-sectoral shares in the manufacturing industry are seen only between 2009-2014. It is further stated that some industries (in manufacturing, C20 to C21 and C31 to C33) were not further disaggregated due to the lack of required data at the time of data construction. For this reason, in sub-sectoral disaggregation, "21-manufacture of basic pharmaceutical products and pharmaceutical preparations" is embedded into 20-Manufacture of chemicals and chemical products, and "33-Manufacture of repair and installation of machinery and equipment" is embedded into 31_32 Manufacture of furniture, other manufacturing.

In order to overcome the issue of constant sub-sectoral share in the manufacturing sector value-added data, the annual industry and services statistics of TURKSTAT were applied as value-added at factor costs are produced in NACE Rev. 2 classification since 2009 (TURKSTAT, 2021) and time series produced according to NACE Rev.1.1. were backcasted according to NACE Rev.2 for 2003-2009 (TURKSTAT, 2014). It should also be noted that some data are kept hidden in the value-added at factor cost tables of TURKSTAT for confidentiality reasons. This was the case for one sub-sector in manufacturing for 2009-2013. However, since there is only one hidden sub-sector data at a two-digit level and it is embedded in the sum of sectors at a one-digit level, this hidden data could be obtained by subtracting the sum of value-added data of all other sub-sectors at two-digit levels in the manufacturing industry from the value-added of the manufacturing sector at one-digit in each year between 2009-2013. For this reason, the data set of value-added of manufacturing industries at factor costs covering the period 2003-2014 could be used in improving the WIOD national tables regarding sub-sectoral shares.

In the following step, these calculated shares were applied to the value-added data of the manufacturing sector in WIOD. As these values were at current prices, afterwards, nominal value-added in manufacturing sub-sectors were deflated with the value-added price index, VA_PI (2010=100), provided in SEA in WIOD. By applying the sub-sectoral value-added shares to the total manufacturing value-added in WIOD, rather than directly using the TURKSTAT data, consistency between the socio-economic and energy data classification in WIOD was maintained.

On the other hand, the EA of the WIOD 2016 Release (Corsatea et al. 2019) covered data on energy and carbon dioxide emissions by industry and country for 2000-2016 in a consistent way with the data classification of the SEA in WIOD 2016 Release.

EAs are created using extended energy balances produced by the International Energy Agency (IEA), based on national energy balances reported yearly to the IEA. However, there are some differences between these energy balances and the WIOD energy accounts that have arisen from two main transformations. It is explained by Corsatea et al. (2019) that energy balances are based on territory principles. In contrast, national accounts, according to which WIOD energy accounts are established, are based on residential principles. Thus, the first transformation includes adding activities of residents who operate abroad and reducing those of foreign entities.

Additionally, data in energy balances is redistributed into related sectors based on ISIC Rev.4/NACE Rev.2 classifications used in national accounts to establish a relationship between energy and economic activity. For instance, energy used in road transport is broadly categorised under this title in energy balance tables, regardless of the agent that performs it, whereas in the WIOD energy accounts, the “road transport” item is distributed among relevant economic agents, such as households and transportation companies. By identifying and reconciling the differences between energy balances and SNAs, WIOD energy accounts aim to provide energy resources as given in energy balances, but with the same definitions and classifications used in SNAs, allowing a coherence and direct comparison between economic activity and energy information. For these transformations, a program called GAMS was used, whose steps are described in detail in (Corsatea et al. 2019; Genty et al. 2012).

Additionally, the energy data in WIOD energy accounts is provided in two categories: gross energy use (in TJ) and emission-relevant energy use (in TJ). Gross energy use includes the intermediate energy consumption by industries and equals the sum of the intermediate consumption, final uses and exports. Different from gross energy use, emission-relevant energy use does not cover the non-energy use of energy commodities (such as asphalt used for road building) as well as the input of energy commodities that are used for transformation (such as coal that is transformed into coke and coke oven gas) to provide the direct link between energy use and energy-related emissions (Genty et al., 2012). In this regard, energy data used in transformation from one energy resource to another, such as coal used for power generation or crude oil used in refineries in the production of petroleum products such as gasoline, diesel, etc., are classified in relevant NACE Rev.2 sectors, such as electricity, gas, steam and air conditioning supply or coke and refined petroleum products, in gross energy use data in WIOD. On the other hand, in energy balance tables, these activities are not included in total energy consumption and are reported separately. In this regard, as a consequence of ensuring coherency between energy accounts and sectoral classification of economic activities, there is a double counting of energy consumption in WIOD however, as the analysis conducted in this study focuses on changes in total consumption of all energy sources gross energy use (in TJ) is used in decomposition and decoupling analysis.

3. Methodology

In addition to looking at the descriptive analyses to examine the changes in manufacturing energy consumption during this period, this study used the index decomposition analysis (IDA) together with decoupling analysis to analyse the driving factors of this change and explored the contribution of these factors to the decoupling relationship between value-added growth and energy consumption in the manufacturing industry.

4. Index decomposition analysis

IDA is a type of decomposition analysis that breaks down changes in an aggregate indicator from the production perspective into its driving factors using a simple mathematical formula based on index number theory (Ang & Zhang, 2000; de Boer & Rodrigues, 2020). While the majority of the studies have focused on energy consumption and energy related emissions, there have been other areas where IDA have been used. He & Myers (2021) use index decomposition analysis along with material, physical, and monetary flow concepts to identify and examine the factors driving demand for building materials in the UK. Similarly, Z. Wang et al. (2017) use index decomposition to investigate the driving forces of the change in China’s material use. Another field where IDA is being used has been tracking the energy consumption efficiency trends at national and sectoral levels. In Odyssee-Mure project, in which energy consumption and efficiency trends are being monitored, index decomposition analysis is used to track the changes in energy consumption at national and sectoral level in project countries (ODYSSEE-MURE, 2021). In addition to analysing the historical trends, there have also been other studies where IDA is used for prospective analyses and (Ang & Goh, 2019) provides a comprehensive review of 60 studies using IDA in scenario analyses. In addition, there is also a vast literature focusing on its methodological and theoretical aspects. Some of the notable works in this field include (Ang, 2004b; Ang et al., 2009; Ang & Wang, 2015; Ang & Xu, 2013; de Boer & Rodrigues, 2020; Roux & Plank, 2022; Shenning, 2020; Xu & Ang, 2014).

The IDA methods are generally classified into two different methods:[1] decomposition methods based on Laspeyres index and decomposition methods based on the Divisia index (Ang, 2004b). In each method, the relative contributions of the factors to the energy-related aggregate of interest are measured differently. Methods linked to Laspeyres index include Generalized Fisher Index (Ang et al., 2004), Conventional Fisher Ideal Index (Liu & Ang, 2003), Shapley/Sun (Refined Laspeyres) Index (Sun, 1998) and Marshal Edgeworth Index (Reitler et al., 1987) methods whereas methods linked to Divisia index include Average Mean Divisia Index (AMDI) (Boyd G. et al., 1987; Boyd G. et al., 1988), Log Mean Divisia Index (LMDI)-I (Ang et al., 1998; Ang & Liu, 2001) and LMDI-II (Ang et al., 2003; Ang & Choi, 1997). All methods except AMDI can provide perfect decomposition by leaving no residual and dealing with the zero and negative values in the data set. However, the mathematical formula of methods linked to Laspeyres Index gets complicated with the increase in the number of factors, whereas in methods based on Divisia Index, mathematical formula remains the same regardless of the number of factors taken into account in the analysis. For this reason, the LMDI has been a widely preferred method in the majority of the studies in terms of ease of use (Ang, 2004b). On the other hand, LMDI is also divided into two categories: LMDI-I and LMDI-II. LMDI-I provides perfect decomposition at sub-category level (Ang et al., 2009; Ang & Wang, 2015) and ensures consistency in aggregation, meaning that results obtained at higher levels, e.g. country, are equivalent to the aggregation of sub-category level decomposition results, e.g., industry or region (Ang & Liu, 2001). This characteristic makes LMDI-I particularly valuable for conducting multidimensional and multilevel analyses (Ang & Wang, 2015).[2] In this light, the LMDI-I method is preferred over other methods due to its extensive usage, simple

[1] Ang, (2004a) and Ang & Goh (2019a) provides a comprehensive examination for the historical development of different IDA methods.

[2] Multilevel IDA applications and the necessary transformation of formulae are explained in detail in (Xu & Ang, 2014), including its Appendix A-B.

formula, and availability for multilevel analysis.[3] With the aim of facilitating the interpretation of results, the LMDI-I formula was used in its additive form.

The decomposition identity for the change in energy consumption in Türkiye, following (Ang, 2005) is set up as:

$$E = \sum_i^m E_i = \sum_i^m Q \frac{Q_i}{Q}\frac{E_i}{Q_i} = \sum_i^m Q S_i I_i \quad (1)$$

E = Total energy consumption in the economy

Q = Total activity level ($= \sum_i Q_i$)

S_i = Activity share (Q_i/Q) and

I_i = Energy intensity of the related sector (E_i/Q_i)

i represents various sectors, and *m* represents the total number of these sectors. Energy consumption is measured in Joules, and the output level is in national currency units.

The identity above helps in identifying the factors contributing to the changes in total energy consumption (ΔE_{tot}) by dividing them into three categories. Firstly, the changes in total production (ΔE_{act}, activity effect) demonstrate the impact of output changes on energy consumption. Changes in the shares of sectoral output (ΔE_{str}, structural effect) and changes in energy intensity (ΔE_{int}, intensity effect) reflect the role of structural and energy intensity changes in overall energy consumption change.

Following Eq. (1), total energy consumption change in additive analysis is demonstrated as follows:

$$\Delta E_{tot} = E^T - E^0 = \Delta E_{act} + \Delta E_{str} + \Delta E_{int} \quad (2)$$

To identify the contribution of each of these components, the LMDI-I formulas below are used:

$$\triangle E_{ACT} = \sum_i^m L(E_i^T, E_i^0) \ln\left(\frac{Q^T}{Q^0}\right) = \sum_i^m \frac{E_i^T - E_i^0}{\ln E_i^T - \ln E_i^o} \ln\left(\frac{Q^T}{Q^0}\right) \quad (3)$$

$$\triangle E_{STR} = \sum_i^m L(E_i^T, E_i^0) \ln\left(\frac{S_i{}^T}{S_i{}^0}\right) = \sum_i^m \frac{E_i^T - E_i^0}{\ln E_i^T - \ln E_i^o} \ln\left(\frac{S_i{}^T}{S_i{}^0}\right) \quad (4)$$

$$\triangle E_{INT} = \sum_i^m L(E_i^T, E_i^0) \ln\left(\frac{I_i{}^T}{I_i{}^0}\right) = \sum_i^m \frac{E_i^T - E_i^0}{\ln E_i^T - \ln E_i^o} \ln\left(\frac{I_i{}^T}{I_i^O}\right) \quad (5)$$

Looking at the structure of the formula in detail, it can be seen that the activity impact is equivalent to the effect of the change in total production weighted by the sectoral changes in energy consumption. Thus, it shows the impact of changes in total value-added rather than sectoral value-added on total energy demand. Similarly, the structural effect shows the impact of changes in sub-sector shares on the total energy consumption rather than the structural changes in each sub-sector.

[3] (Ang, 2015) offers a comprehensive guide in method selection among 8 different LMDI formulae.

5. Decoupling analysis

While the introduction of the notion of decoupling goes back to the 1970s (Meyer & Rowan, 1977), it was first used in environmental studies by Z. Zhang (2000) and later recognised as an indicator by the OECD in 2002 (OECD, 2002). OECD (2002) defines the term as breaking the link between "environmental bads" and "economic goods", and this target had an essential role in its Green Growth strategy (OECD, 2011). In this period, the linkage between economic growth and environmental outcomes was repeated in different roadmap documents and decoupling economic growth from environmental degradation became a target in the Sustainable Development Goals. The 8th Environmental Action Programme of the European Union covers the period to 2030, and significantly reducing the environmental and climate pressures arising from the economic activities of the Union is among the priority objectives of the programme (EU, 2022).

As a concept, decoupling has many dimensions. Firstly, OECD (2002) divides decoupling into two sub-stages as absolute and relative decoupling; absolute decoupling indicates the stage when the environment-related variable remains constant or decreases while the economic driving factor is increasing, whereas relative decoupling is used to describe a situation where both variables grow, but the growth rate of environment-related variable is lower than that of its economic driving factor. Another dimension of the decoupling relates to environmental variables in the focus of interest. In that regard, a distinguishment is made between resource use and ecological impacts (Förster et al. 2013). Resource decoupling indicates the decoupling of economic activity from the amount of resource used, such as energy, soil, water, or other natural assets. Impact decoupling, however, indicates the decoupling process from environmental impacts, including CO2 and greenhouse gas emissions, waste, pollution or biodiversity loss. Finally, the period of decoupling emerges as an essential factor in the evaluation of the outcome of growth-oriented policies and from the ecological perspective, the required and targeted version of decoupling is the permanent one indicating the continuous decrease in, or at least, decreasing growth rate of the environmental variable while economic activity continues to grow (Parrique et al. 2019).

While various methods are used to calculate decoupling, two main indicators have been widely used: (OECD, 2002) and (Tapio, 2005). Decoupling factor, ε_o, introduced by the OECD (2002), is based on the growth rate of environment-related intensity and is described as:

$$\varepsilon_o = 1 - Decoupling\ Ratio\ \text{(DR)} \tag{6}$$

Where DR equals to:

$$DR = \frac{(EP/DF)_{end\ of\ period}}{(EP/DF)_{start\ of\ period}} \tag{7}$$

in which EP refers to Environmental Pressure and DF refers to the Driving Force.

Decoupling occurs if $\varepsilon_o > 0$ as the EP/DF, environment-related intensity, decreased at the end of the period leading $DR < 1$; on the other hand, $\varepsilon_o \leq 0$ refers to zero or negative decoupling as $DR \geq 1$ since the EP increases with same or higher rates than the DF. Basically, ε_o, indicates that there is decoupling when environment-related intensity decreases and negative decoupling if the intensity increases or does not change. It does not distinguish if there is an absolute or relative decoupling.

Tapio (2005), on the other hand, introduced eight decoupling categories depending on the value of the decoupling index, ε_t. This index was initially developed to analyse the relationship between the output growth and road traffic volumes as well as CO2 emissions from transport in 15 European countries but then found a wide application area in many studies. ε_t shows the economic driving factor elasticity of the environment-related factor. In that regard, following the above notation used in IDA, it can be described as the output elasticity of energy consumption as follows:

$$\varepsilon_t = {}^{\%\Delta E}/_{\%\Delta Q} = \frac{\Delta E/E}{\Delta Q/Q} \tag{8}$$

As seen in Table 1 there are eight "logical possibilities" of decoupling (Tapio, 2005): "Strong decoupling", "weak decoupling", "expansive coupling", "expansive negative decoupling", "recessive decoupling", "recessive coupling", "weak negative decoupling" and "strong negative decoupling". Strong decoupling (SD) refers to an absolute and most ideal decoupling state where energy consumption shows a downward trend despite the increase in economic activity. Weak decoupling (WD), on the other hand, describes a relative decoupling state in which energy consumption increases along with the increase in the economic activity but with a lower growth rate. The third category of decoupling is named as recessive decoupling (RD) as energy consumption decreases at greater rate than output.

Under the state of coupling, energy consumption and output change at the same level; however, to avoid the overinterpretation of slight changes, a +/-20% variation of the elasticity values around 1.00 is still accepted as coupling and depending on the direction of the change; this state is called as expansive or recessive coupling. In other words, if coupling occurs while economic activity is increasing, it is named as expansive coupling (EC), whereas if it is observed in an economic contraction period, it is named as recessive coupling (RC) (Tapio, 2005).

Negative decoupling is also divided into three sub-categories. Being the least preferred state of negative decoupling, strong negative decoupling (SND) refers the increase in energy consumption while economic activity declines. Expansive negative decoupling (END) is the second least preferred scenario in which the energy consumption growth rate is faster than economic growth. Under the weak negative decoupling (WND) state, the decline in economic output is faster than the decline in energy consumption.

Table 1. The criteria for categorizing decoupling

Total output (activity)change ΔQ	***Energy consumption change*** ΔE	***Decoupling elasticity*** (ε_t)	***Decoupling category***
(+)	*(-)*	*(-)*	*Strong Decoupling (SD)*
(+)	*(+)*	*0-0.8*	*Weak Decoupling (WD)*
(+)	*(+)*	*0.8-1.2*	*Expansive Coupling (EC)*
(+)	*(+)*	*>1.2*	*Expansive Negative Decoupling (END)*
(-)	*(-)*	*>1.2*	*Recessive Decoupling (RD)*
(-)	*(-)*	*0.8-1.2*	*Recessive Coupling (RC)*
(-)	*(-)*	*0-0.8*	*Weak Negative Decoupling (WND)*
(-)	*(+)*	*(-)*	*Strong Negative Decoupling (SND)*

Source: Tapio (2005)

In addition to these methods, other methods have been proposed to analyse the decoupling conditions. Amongst them H. Wang et al. (2013), examines the three different (absolute, relative and -non) states for decoupling domestic extraction, energy use and sulphur dioxide emissions from output growth in China and Russia based on a new pair of decoupling indicators introduced by Lu et al. (2011) in a study published in Chinese. Grand (2016) compares these three different decoupling indicators and finds that there are 13 different “logical cases” of decoupling, and each indicator covers only some of them.

Other studies also focused on integrating the IDA with the decoupling method to see the contribution of each driving factor to the decoupling period. While most of these studies apply the Tapio decoupling index, combination of decomposition and decoupling analyses are basically conducted with two different ways. In one group including but not limited to (Diakoulaki & Mandaraka, 2007; Song & Zhang, 2017; W. Wang et al. 2013; M. Zhang & Wang, 2013; Y.-J. Zhang & Da, 2015), the initial decoupling index is revised and decoupling between the energy consumption/carbon emissions arise from the non-economic growth-related reasons and energy consumption/carbon emissions arise from the economic growth-related reasons is analysed. Whereas in another group of studies such as (Engo, 2021; Karakaya et al., 2019; Ozdemir, 2023; M. Zhang & Wang, 2013; Y.-J. Zhang & Da, 2015) Tapio decoupling index is decomposed into driving factors through IDA in order to see the contribution of each of these factors to decoupling.

With the aim to examine the relationship between driving factors of energy consumption with decoupling states, in this study, LMDI-I and Tapio decoupling index, ε_t, will be integrated as below following the second group of studies and in that regard, integrating the Eq.2 to Eq. 8 gives the decomposition of Tapio decoupling index,

$$\varepsilon_t = {}^{\%\Delta E}/_{\%\Delta Q} = \frac{\Delta E/E}{\Delta Q/Q} = \frac{(\Delta E_{act} + \Delta E_{str} + \Delta E_{int})/E}{\Delta Q/Q} = \frac{\Delta E_{act}/E}{\Delta Q/Q} + \frac{\Delta E_{str}/E}{\Delta Q/Q} + \frac{\Delta E_{int}/E}{\Delta Q/Q} \quad (9)$$

$$\varepsilon_t = \varepsilon_{act} + \varepsilon_{str} + \varepsilon_{int} \quad (10)$$

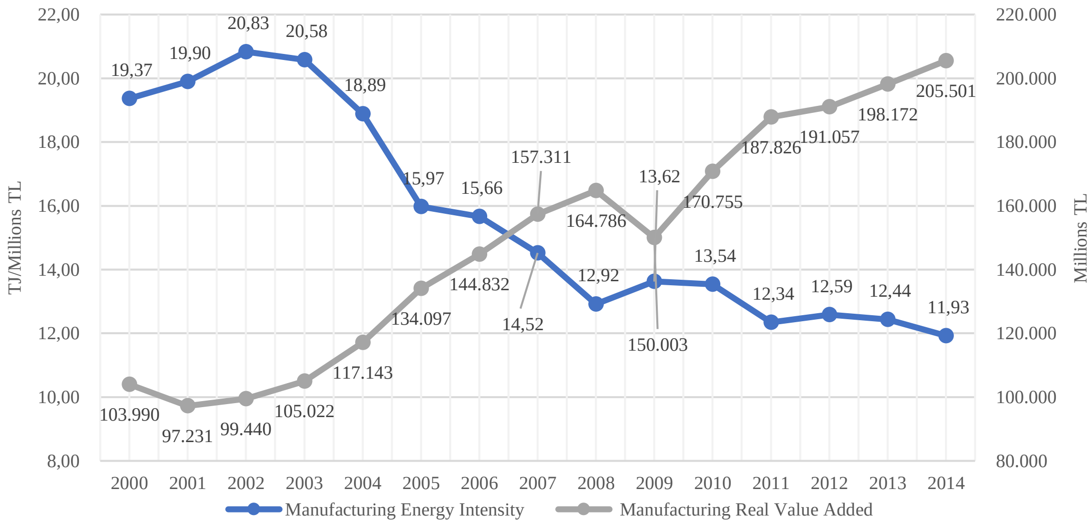
where ε_{act}, ε_{str} ε_{int} illustrates the contribution of each driving factor, namely activity effect, structural effect, and intensity effect, to the Tapio decoupling index. Moreover, when $\Delta Q > 0$, in other words, in times of economic growth, the smaller contribution values indicate a more significant contribution to the decoupling process of energy consumption from economic growth. Whereas if the economic activity is downscaling and $\Delta Q < 0$, the more significant contribution values indicate a greater contribution to decoupling.

6. Analysis results

Before presenting the results of the decomposition and decoupling analyses for the change in energy consumption of the manufacturing sector between 2003 and 2014, some descriptive statistics are provided.[4]

Figure 1 depicts the decreasing energy intensity of the manufacturing sector between 2000-2014. It is seen that while energy intensity increased in the first two years, there was a continuous decline, except for the slight increases that occurred in 2009 and 2012. Consequently, the total increase in sectoral energy demand was limited to 436.5 thousand TJ due to the 38% decrease in sectoral energy intensity in the entire period. The reduction in energy intensity was even higher between 2003 and 2014, equalling 42% and leading to a weak decoupling between energy consumption and production increase as the $\varepsilon_{manufacturing}$ equals 0.14.

Figure 1. Changes in real value-added and energy intensity of the manufacturing sector 2000-2014



Source: Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021)

[4] A scatterplot presenting the relation between energy intensity and value added in manufacturing industry in this period is provided in Appendix A.

Table 2 shows the sub-sectoral energy consumption (in columns A) and their shares (in columns B) in the manufacturing sector in 2003 and 2014 as well as their changes in this period (in column C). In addition, sub-sectoral shares in energy consumption change in the manufacturing sector are given in column D.

Table 2. Energy consumption change in manufacturing sector, 2003-2014

	2003		***2014***		***2003-2014***	
	ETot (A)	**% Shares in ETot (B)**	**ETot (A)**	**% Shares in ETot (B)**	**% ΔE_Tot (C)**	**% Shares in ΔETot (D)**
Manufacturing Energy Consumption	2,161,550		2,450,749		13%	
Coke and refined petroleum products	1,196,229	55.30%	1,027,419	41.90%	-14%	-58%
Basic metals	286,310	13.20%	429,846	17.50%	50%	50%
*Chemicals and chemical products**	165,905	7.70%	167,746	6.80%	1%	1%
Textiles, wearing apparel and leather products	142,761	6.60%	154,792	6.30%	8%	4%
Other non-metallic mineral products	119,551	5.50%	253,043	10.30%	112%	46%
Food products, beverages and tobacco products	68,310	3.20%	94,102	3.80%	38%	9%
Rubber and plastic products	54,240	2.50%	131,644	5.40%	143%	27%
Wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	31,710	1.50%	36,110	1.50%	14%	2%
Paper and paper products	23,050	1.10%	30,050	1.20%	30%	2%
Fabricated metal products, except machinery and equipment	19,596	0.90%	16,392	0.70%	-16%	-1%
Machinery and equipment n.e.c.	15,137	0.70%	26,061	1.10%	72%	4%
Motor vehicles, trailers and semi-trailers	15,026	0.70%	31,405	1.30%	109%	6%
*Furniture; other manufacturing***	9,755	0.50%	26,128	1.10%	168%	6%
Electrical equipment	4,872	0.20%	7,829	0.30%	61%	1%
Printing and reproduction of recorded media	4,150	0.20%	8,570	0.30%	107%	2%
Other transport equipment	2,720	0.10%	5,912	0.20%	117%	1%
Computer, electronic and optical products	2,229	0.10%	3,700	0.20%	66%	1%

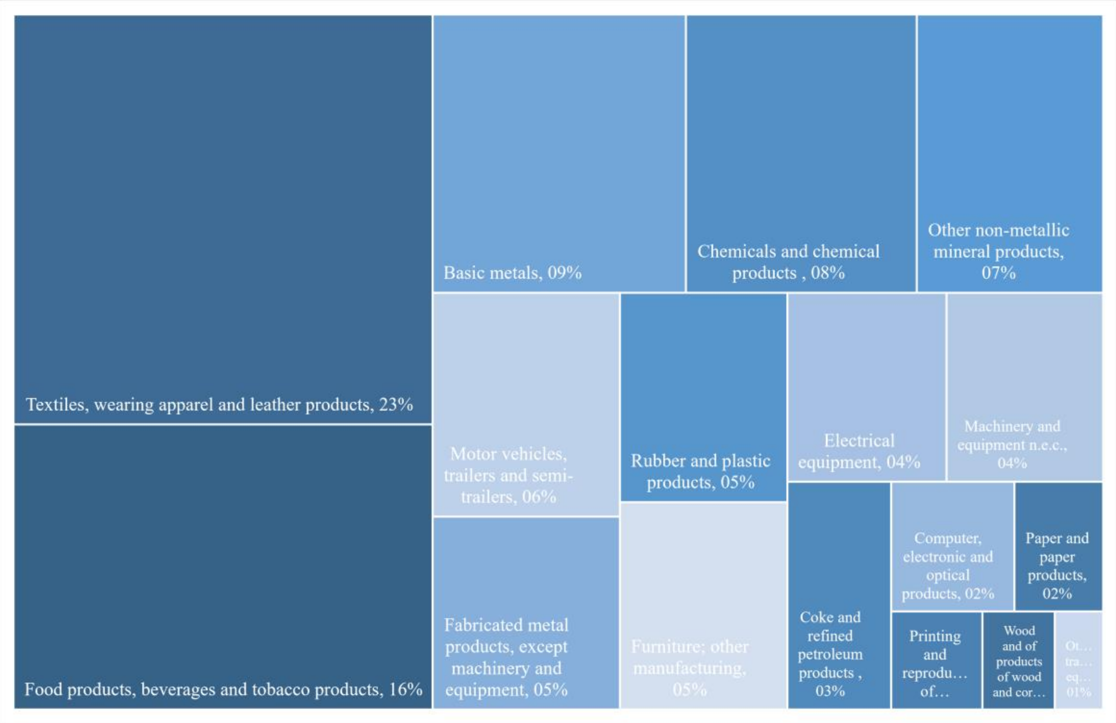
Source: Corsatea et al. (2019)
Notes: The given values for energy consumption are in thousands of TJ.
* Includes also the manufacture of basic pharmaceutical products and pharmaceutical preparations.
** Includes also the repair and installation of machinery and equipment.

It is seen that the five largest energy-consuming sub-sectors that are *coke and refined petroleum products*, *basic metals*, *chemicals*, *textile* and *other non-metallic mineral products*, remained the same in this period; however, their share in total manufacturing energy demand declined from 88.4% in 2003 to 82.9% in 2014. It is also noticeable that the most significant share in total manufacturing energy demand belongs to the manufacture of *coke and refined petroleum products* in both years. However, the energy consumption of this sector decreased by 14%, resulting in a parallel decline in the sectoral energy consumption share from 55.3% to 41.9%. However, the magnitude of the sector's energy consumption led the manufacture of coke and refined petroleum products to have the largest share in the change in total energy demand with -%58.

The second biggest energy-consuming sub-sector was the manufacture of *basic metals* in 2003, having a share of 13.2% in total demand. With a 50% increase in energy consumption, equalling to the most significant increase in absolute terms during this period, its weight rose to 17.5% in 2014. Iron and steel production, the most significant energy-consuming sub-sector in national energy balance tables, falls into this sub-sectoral group. On the other hand, in *chemicals and chemical products*, the increase in energy consumption stayed quite limited, and the sector's share in energy consumption decreased from 7.7% to 6.8%. A similar decrease occurred in *textile production*, and despite the 8% increase in sub-sectoral energy demand, the weight of this sub-sector in manufacturing energy consumption decreased from 6.6% to 6.3%, and it became the fifth largest energy-consuming sector in 2014. At the same time, *the manufacture of other non-metallic mineral products*, including cement production, became the third largest energy-consuming sub-sector in 2014, increasing its share in manufacturing energy consumption to 10.3% as a result of a 112% increase in its energy demand during this period. Additionally, this sector had the third largest share (%46) in total change in the manufacturing energy demand. Aside from these five sectors, *rubber and plastic products* emerged as another important energy-consuming sub-sector, increasing their share from 2.2% in 2000 to 5.4% in 2014.

Similar to the most significant energy-consuming sectors, there has not been a considerable change among the five least energy-consuming sectors except *the manufacturing of furniture and other manufacturing activities* in which the energy consumption almost tripled, increasing from 9.7 thousand TJ in 2000 to 26.1 thousand TJ in 2014 and thus the sector's share in manufacturing energy demand rose to over 1%.

Figure 2. Sub-sectoral distribution of real value-added in the manufacturing sector in 2003



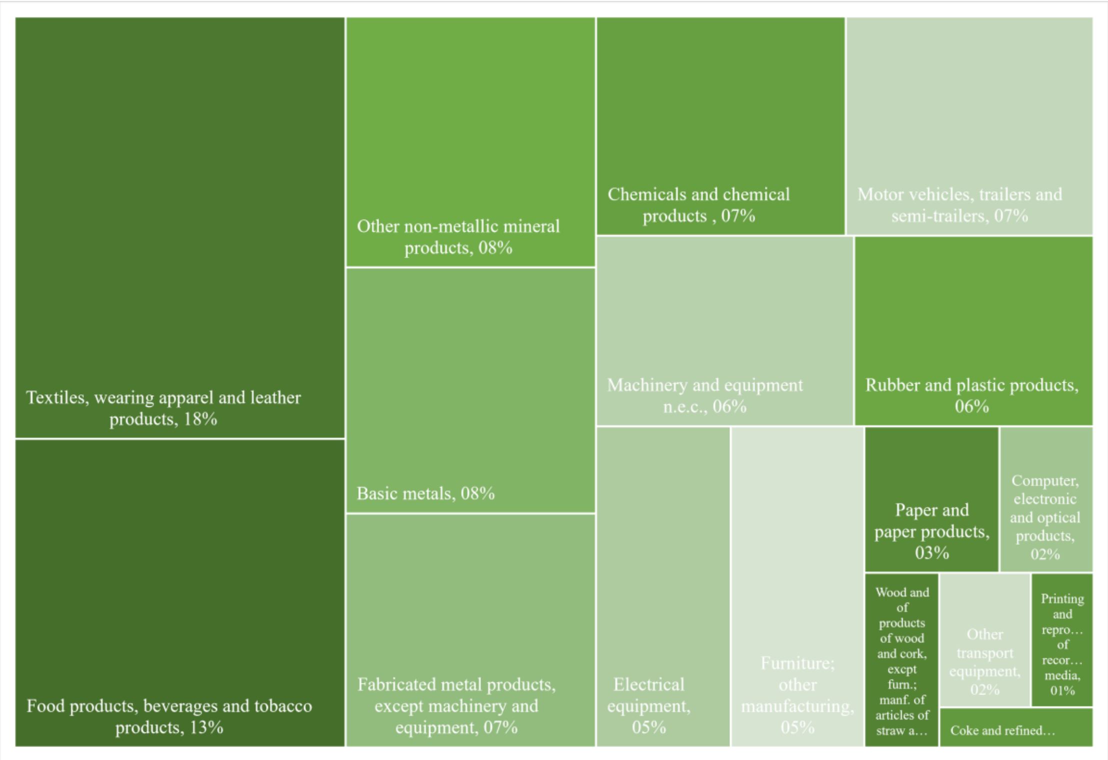
Source: Timmer et al., (2015)

Even though there has not been a considerable change in the sub-sectoral distribution of energy consumption in the manufacturing sector, there seems to be a slight shift in its production structure in this period. Similar to the most significant energy-consuming sectors, there has not been a considerable change among the five least energy-consuming sectors except *the manufacturing of furniture and other manufacturing activities* in which the energy consumption almost tripled, increasing from 9.7 thousand TJ in 2000 to 26.1 thousand TJ in 2014 and thus the sector's share in manufacturing energy demand rose to over 1%.

Figure 2 and Figure 3 demonstrate the sub-sectoral distribution of real value-added produced in the manufacturing sector in 2003 and 2014, respectively. Although the two most prominent industries, *textile* and *food products*, remained the same, their total share in manufacturing value-added decreased from 38,5% to 30,7% in this period. In contrast, the total percentage of these sectors in manufacturing energy demand slightly increased from 9.8% to 10.2%.

On the other hand, value-added in *other non-metallic metal products* increased more than two times, in parallel to the increase in its energy demand. Its share rose from 6.9% to 8%, leading the sub-sector to have the third largest share in the manufacturing sector. A more significant upward shift also occurred in *fabricated metal products* manufacturing as its share increased from 4.8% to 7.4%. The industry became the fourth largest sub-sector in 2014 while its energy consumption decreased. On the other hand, because the increase in the value-added in *basic metals* and *chemicals* stayed limited, their share fell from 9.3% and 8.5% to 7.8% and 6.9%, despite the increase in the energy demand for basic metals during this period. At the same time, there were considerable increases and, thus, changes in both the value-added and composition of other sectors. Amongst them, similar to the rise in its energy demand, the value-added of *rubber and plastic products* almost doubled, and its weight increased from 4.6% to 5.8%. Similarly, value-added produced in *the manufacturing of wood and of wood products* along with *paper and paper products* almost tripled. The total share of these two sub-sectors in manufacturing value-added increased from 2.4% to 4.2%. Value-added in *other transport equipment* also raised more than four times, and its share increased from 0.6% to 1.6% in this period. Aside from this, the weight of *coke and refined petroleum products* considerably decreased from 3.1% in 2000 to 0.8% in 2014, resulting in a higher decrease (51%) than its energy demand (14%). As a result, in contrast to the stagnant structure of energy consumption in the manufacturing sector, its value-added distribution changed.

Figure 3. Sub-sectoral distribution of real value-added in the manufacturing sector in 2014



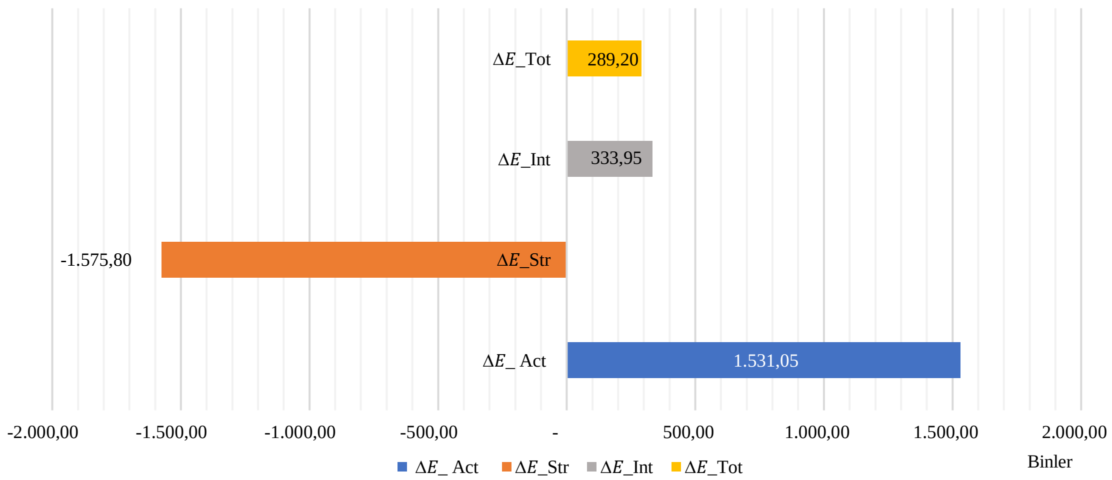
Source: Timmer et al. (2015)

The fact that the change in the sub-sectoral distribution of value-added in the manufacturing sector differs from the change in the sectoral composition of manufacturing energy consumption can be explained by different improvements in the energy intensities of sub-sectors. The impact of changes in sub-sectoral value-added shares and energy intensities, as well as the change in total value-added of the manufacturing on the manufacturing energy demand, is illustrated in Figure 4.

In this period, the total value-added of the sector increased by 96%, and the impact of this increase on the total energy demand of manufacturing equals 1.58 million TJ, more than five times the actual increase. On the other hand, while energy intensity decreased in most of the sub-sectors during this period, the total energy intensity impact had an increasing effect on sectoral energy demand, equalling 333.96 thousand TJ. This impact mainly originated from the increase in the energy intensity of coke and refined petroleum products, as shown in Table 3. A 75.3% increase in sub-sectoral energy intensity led to a 622.9 thousand TJ increase in energy demand, equalling more than two times the manufacturing sector's total increase in energy consumption.

It is also seen that structural impact was the only contributor to the reduction in energy demand. Without any change in the weights of sub-sectors in manufacturing value-added, the total amount of energy consumption increase would be more than five times higher than the actual level. Similarly to the intensity effect, the main components of the structural effect came from the decrease in the sectoral share of coke and refined petroleum products, leading to a reduction of 1.54 million TJ in energy consumption.

Figure 4. Decomposition of the change in the energy consumption of manufacturing sector, 2003-2014



Source: Author’s own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).

Table 3 provides a detailed breakdown of the structural and intensity effects, with the first column (A) showing the percentage change in the sector's value-added and the second column (B) showing the change in the sectoral energy consumption in percentage form. The third column (C) displays the percentage change in sectoral value-added shares for calculating structural effect in index decomposition analysis. The next column (D) shows the structural effect (ΔE_Str) associated with a specific sub-sector, and the sum of these effects gives the overall structural effect. The following column (E) gives the percentage contribution of each sector's structural impact on the total change in manufacturing energy demand, showing how much each sector's share change contributes to the overall change in energy demand for manufacturing. Column (F) displays the percentage change in sectoral energy intensity, while column (G) presents the sectoral contributions to the total intensity effect in the analysis. The last column (H) indicates the percentage contribution of each sector's energy intensity impact on the change in total manufacturing energy demand.

Table 3. Components of structural and intensity effects in manufacturing energy demand change, 2003-2014

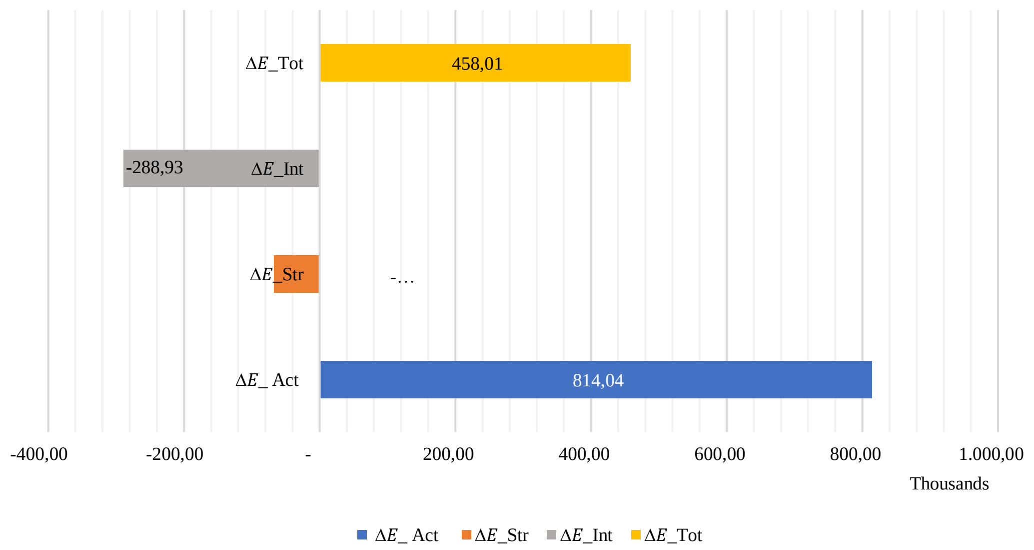
2003-2014	*% Change in VA*	*% ∆E_Tot*	*% Changes in Sectoral VA Shares*	*∆E_Str*	*% Contribution to ∆E_tot through ∆E_Str*	*% Changes in EI*	*∆E_Int*	*% Contribution to ∆E_Tot through ∆E_Int*
	(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**	**(H)**
Food products, beverages and tobacco products	60.7%	37.8%	-17.9%	-15.9	-5.5%	-14.3%	-12.4	-4.3%
Textiles, wearing apparel and leather products	52.9%	8.4%	-21.8%	-36.6	-12.7%	-29.1%	-51.2	-17.7%
Wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	246.4%	13.9%	77.0%	19.3	6.7%	-67.1%	-37.7	-13.0%
Paper and paper products	222.8%	30.4%	64.9%	13.2	4.6%	-59.6%	-23.9	-8.3%
Printing and reproduction of recorded media	78.4%	106.5%	-8.8%	-0.6	-0.2%	15.7%	0.9	0.3%
Coke and refined petroleum products	-51.0%	-14.1%	-75.0%	-1536.6	-531.3%	75.3%	622.9	215.4%
*Chemicals and chemical products**	59.9%	1.1%	-18.3%	-33.7	-11.7%	-36.8%	-76.5	-26.4%
Rubber and plastic products	144.9%	142.7%	25.1%	19.6	6.8%	-0.9%	-0.8	-0.3%
Other non-metallic mineral products	127.7%	111.7%	16.4%	27.0	9.3%	-7.1%	-13.0	-4.5%
Basic metals	64.3%	50.1%	-16.1%	-61.8	-21.4%	-8.6%	-31.8	-11.0%
Fabricated metal products, except machinery and equipment	204.8%	-16.4%	55.8%	8.0	2.7%	-72.6%	-23.2	-8.0%
Computer, electronic and optical products	61.9%	66.0%	-17.3%	-0.6	-0.2%	2.5%	0.1	0.0%
Electrical equipment	170.2%	60.7%	38.1%	2.0	0.7%	-40.5%	-3.2	-1.1%
Machinery and equipment n.e.c.	212.0%	72.2%	59.5%	9.4	3.2%	-44.8%	-12.0	-4.1%
Motor vehicles, trailers and semi-trailers	143.5%	109.0%	24.4%	4.9	1.7%	-14.2%	-3.4	-1.2%
Other transport equipment	390.4%	117.4%	150.6%	3.8	1.3%	-55.7%	-3.4	-1.2%
*Furniture; other manufacturing***	131.6%	167.8%	18.4%	2.8	1.0%	15.6%	2.4	0.8%
Total Effects ((Str.& Int.)				-1575.8			334.0	

Source: Corsatea et al. (2019)
Notes: The given values for energy consumption are in thousands of TJ.
* Includes also the manufacture of basic pharmaceutical products and pharmaceutical preparations.
** Includes also the repair and installation of machinery and equipment.

Despite the limited weight of coke and refined petroleum products in manufacturing value-added as shown in Similar to the most significant energy-consuming sectors, there has not been a considerable change among the five least energy-consuming sectors except *the manufacturing of furniture and other manufacturing activities* in which the energy consumption almost tripled, increasing from 9.7 thousand TJ in 2000 to 26.1 thousand TJ in 2014 and thus the sector's share in manufacturing energy demand rose to over 1%.

Figure 2 and Figure 3, since it is the most energy-intensive sub-sector and constitutes almost half of the energy demand of manufacturing activities, the changes in its energy intensity and weight in total manufacturing value-added affected all the driving factors of energy change significantly and had a comparatively much more significant impact than the same changes in other sectors. Including coke and refined petroleum products produced by the coke ovens and oil refineries, this sector is one of the main components of double counting of energy resources in WIOD energy accounts. In the national energy balance tables, this sector is given a place in the transformation section where the conversion of primary energy resources into secondary fuels are shown. For this reason, it is considered beneficial to decompose the changes in other manufacturing sub-sectors this time to have a clear understanding of the driving factors of energy consumption change by excluding this sector.

Figure 5. Decomposition of the change in the energy consumption of other manufacturing sector, 2003-2014



Source: Author's own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).

It is seen in Figure 5 that by eliminating the impact of changes in the manufacturing of coke and refined petroleum products, the magnitude of the activity and structural impacts lowered considerably, whereas the intensity impact became the most dominant driving factor contributing to the reduction in the total energy demand of other manufacturing activities. Between 2003 and 2014, the activity impact related to the increase in the value-added of the other manufacturing activities was equalling 814 thousand TJ, almost two times (178%) of the actual change in energy demand. The decreasing impact of structural change on total energy consumption change declined to 67.1 thousand TJ, equalling 15% of the total change in energy consumption. On the other hand, although the decrease in total energy intensity of other manufacturing activities was only 26%, and the decoupling was weaker as the value of the decoupling index $\varepsilon_{other\ manufacturing}$ was higher (0.52) than $\varepsilon_{manufacturing}$ (0.14); the energy intensity had a decreasing impact on total energy demand amounting to 289 thousand TJ, more than half of the total change (63%).

Looking at the other sectors in Table 3, it is observed that a decrease in a sector's weight in total value-added leads to a reduction in total energy consumption. In contrast, increases in the sectoral shares always have an impact of increasing the total energy consumption even if there is a strong decoupling in that sector. However, the magnitude of these impacts (in an increasing or decreasing way) depends on not only the level of changes in sectoral shares but also the weight of this sector in total energy demand and its energy intensity. Aside from the coke and refined petroleum products, the weight of six sub-sectors (*food products, textile, printing and reproduction, chemicals, basic metals and computer, electronic and optical products*) in manufacturing value-added decreased. Even though the decline in the value-added share was similar to each other in some sub-sectors, its impact on manufacturing energy demand varied considerably.

Amongst these sub-sectors, the most significant decline in the sectoral share occurred in textile, equalling 21.8% and leading to a reducing impact on manufacturing energy demand, equalling 36.7 thousand TJ, or -12.7% of total change. Another decline happened in the share of chemicals and chemical products with 18.3%, creating a reducing structural impact of 33.7 thousand TJ, or -11.7% of total change. On the other hand, in sub-sectors of food products, beverages and tobacco products along with the computer, electronic and optical products, sectoral shares declined at a similar rate, 17.9% and 17.3%. Still, their reducing contribution to total change was 15.85 thousand TJ (-5.5%) and 0.6 thousand TJ (-0.2%), respectively. Additionally, the reduction in the sectoral share of printing and reproduction of recorded media was 8.8%, but its impact on the energy demand change was 0.6 thousand TJ, similar to the structural impact caused by the computer, electronic and optical products. In basic metals sectors, the decline in the sectoral value-added share was limited to 16.1%, but its reducing contribution to the energy demand of the manufacturing sector was considerably high, equalling 61.8 thousand TJ, or -21.4%.

Accordingly, the highest increase in the value-added share occurred in the sub-sector of other transport equipment, with 150.6%. Still, the impact of this increase was limited to an increase of 2.8 thousand TJ in energy demand or 1% of total change. The second largest increase occurred in the wood and of wood products with 77%, and the impact of this increase was 19.3 thousand TJ or 6.7% of the total change in energy demand. In paper and paper products, the increase in the sectoral value-added share was 64.9%, and its sub-sectoral structural impact was an increase of 13.2 thousand TJ, equalling 4.6% of total energy demand. The increase in the sectoral value-added shares of machinery and equipment as well as fabricated metal products was similar to each other with 59.5% and 55.8%, and the sub-sectoral structural impact of these increases equalled 3.2% and 2.7% of the total change in energy consumption; equalling 9.4 thousand TJ and 7.9 thousand TJ, respectively. The increase in the weight of electrical equipment in manufacturing value-added was 38.1%, causing an increase of 2 thousand TJ in manufacturing energy demand. While there was a similar increase in the sectoral value-added shares of motor vehicles and rubber and plastic products, the impact of these increases varied and was realised as 4.9 thousand TJ (1.7%) and 19.6 thousand TJ (6.8%), respectively. Similarly, an 18.6% increase in the weight of furniture and other manufacturing activities led to a rise in sub-structural impact on energy demand, equalling 2.8 thousand TJ or 1%. In contrast, a 16.4% increase in the value-added weight of other non-metallic mineral products led to 27 thousand TJ increase in manufacturing energy consumption, equalling 9.3%.

In this regard, while the weight of 10 out of 16 other sub-sectors in manufacturing value-added increased, the total impact of this increase on energy demand change was less than the total impact of the reduction in the weight of six sub-sectors. Thus, the net structural impact of all changes in the sectoral value-added shares was a reduction in the manufacturing energy consumption, equalling 67.1 thousand TJ when excluding the impact of the change in the value-added share of coke and refined petroleum products.

It is also worth noting that in the majority of the sub-sectors in which sectoral value-added shares increased, sectoral energy intensities decreased considerably, and these reductions were more than the reductions in the energy intensities of sub-sectors of which weight in manufacturing value-added decreased. This seems to be the reason behind the limited impact of structural changes on energy demand.

Looking at the changes in sub-sectoral energy intensities in Table 3, it is seen that in 13 out of 17 sub-sectors, energy intensity decreased at varying levels, and the highest decrease occurred in fabricated metal products with 72.6% causing a decreasing impact on energy demand equalling 23.2 thousand TJ, or 8% of total change. However, similar to the structural impact, the level of intensity impact changes among the sub-sectors changed independently from the rate of increase or decrease in energy intensity. In that light, the second most significant decrease in energy intensity was observed in the wood and of wood products with 67.1%, but its decreasing impact was higher than the decrease in the energy intensity of fabricated metal products equalling 37.7 thousand TJ, or -13% of total change. In paper and other transport sectors, the decrease in energy intensity was similar to each other. Still, the sub-sectoral intensity impact realised as 23.4 thousand TJ (-8.3%) and 3.6 thousand TJ (-1.2%), respectively. Similarly, a 44.8%

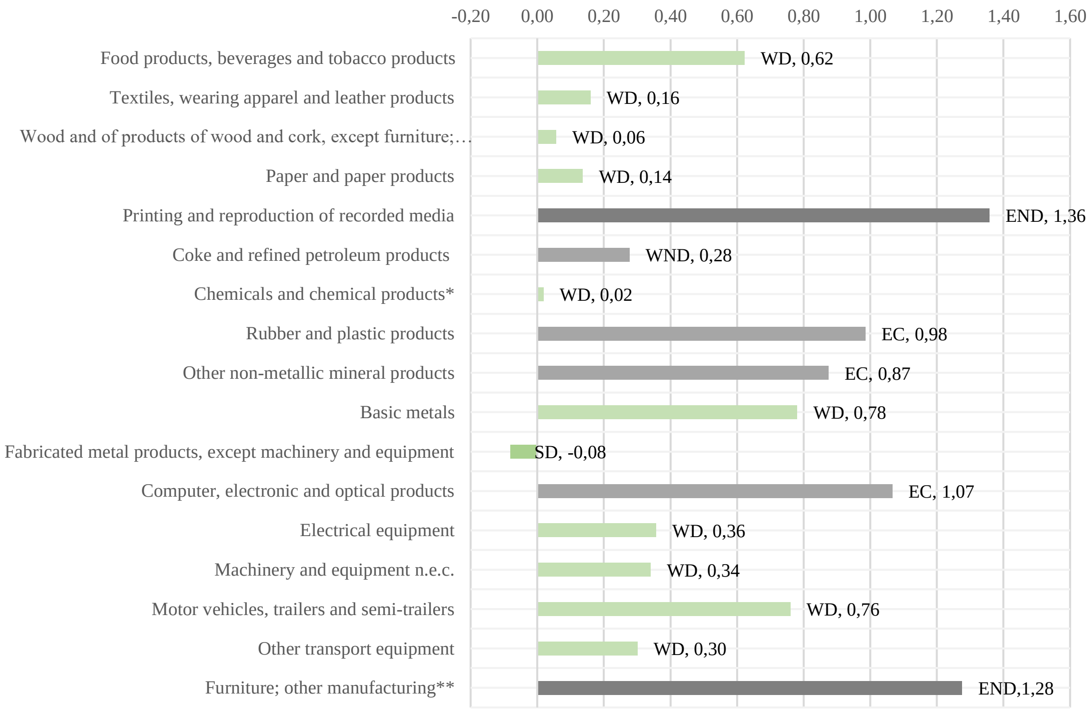
reduction in the energy intensity of the machinery and equipment and a 40.5% reduction in the energy intensity of electrical equipment resulted in intensity impacts accounting for 12.0 thousand TJ (-4.1%) and 3.24 thousand TJ (-1.1%), respectively.

On the other hand, a decrease in energy intensity with a rate of 36.8% in chemicals and chemicals products led to a comparatively higher intensity impact equalling 76.5 thousand TJ, or -26.4% of the total change in energy demand. Likewise, a 29.1% decrease in the energy intensity of the textile industry contributed to the decline in manufacturing energy demand by 17.7%, equalling 51.2 thousand TJ. In food, beverages and tobacco, and motor vehicles, almost the same level of decrease in energy intensity led to the reduction in energy demand by 12.4 thousand TJ (-4.3%) and 3.4 thousand TJ (-1.2%). In the basic metal industry, energy intensity reduction by only 8.6% led to a decrease in energy demand by 31.8 thousand TJ, equalling -11% of the total change in energy consumption. The smallest second decrease in energy intensity occurred in the other non-metallic mineral products with 7.1% and led to decreasing impact on energy consumption by -4.5% of total change, equalling 13.0 thousand TJ. The smallest decrease in the energy intensity occurred in the rubber and plastic products industry with 0.9% and led to a slight decline in manufacturing energy demand of 0.8 thousand TJ, or -0.3% of the total change in energy demand.

Excluding the coke and refined petroleum products, the highest increase in energy intensity was 15.7% and occurred in the printing and reproduction of recorded media leading to a rise in energy consumption by only 0.9 thousand TJ. Almost the same increase in energy intensity realised in furniture and other manufacturing activities, leading to a rise in energy consumption by 0.8%, equalling 2.4 thousand TJ. A relatively small energy intensity increase realised in computer, electronic and optical products by 2.5%, and this led to a neglectable amount of rise in manufacturing energy consumption equalling only 70 TJ.

It is seen that if the coke and refined petroleum products are not taken into consideration, a decrease in energy intensity in the majority of the sub-sectors led to the intensity impact to be the main driving factor contributing to a considerable amount of energy savings in the manufacturing sector in between 2003 and 2014.

Figure 6. Decoupling of value-added growth and energy consumption in manufacturing, 2003-2014

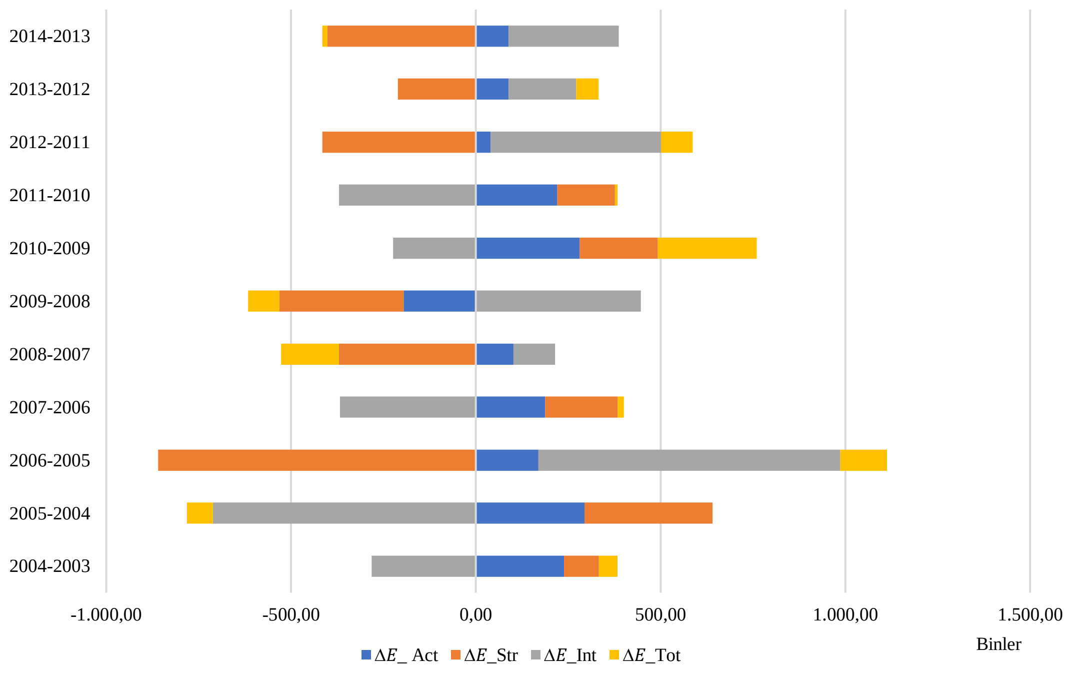


Source: Author's own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).
Notes:
* Also includes the manufacture of basic pharmaceutical products and pharmaceutical preparations.
** Also includes the repair and installation of machinery and equipment.

The decoupling performance of each sub-sector is illustrated in Figure 6. Due to decreases in the energy intensities, the increase in energy consumption was less than the increase in real value-added in 11 out of 17 sub-sectors resulting in weak decoupling between energy consumption and growth. On the other hand, in chemical and chemical products, the value of the decoupling index,$\varepsilon_{chemicals,}$ is close to zero, indicating better decoupling performance among these sub-sectors. Only in fabricated metal products, there was strong decoupling as energy consumption decreased by 16% while the sub-sectoral value-added increased by more than two times. As in two sectors, namely the printing and the reproduction of recorded media as well as the furniture and other manufacturing activities, the increase in energy consumption was higher than the increase in value-added, resulting in expansive negative decoupling. There was weak negative decoupling in the coke and refined petroleum products as the decrease in value-added was higher than the decrease in energy consumption. In three sub-sectors, namely, rubber and plastic products, other non-metallic mineral products and computer, electronic and optical products, there was expansive coupling as the rate of increase in energy demand was almost the same as the increase in value-added.

It is easily notable in Figure 7 that structural and intensity effects were stronger than the activity effect in almost all years except 2010 and the coke and refined petroleum products were the main component behind the large structural and intensity impacts in all years except 2009 and 2010. In these years, changes in the sectoral share and energy intensity of basic metals outweighed the impacts of changes in all other sectors. Also, in the years 2005, 2008, 2009 and 2014, energy consumption decreased, and only in 2009 the downsizing in the economic activity contributed to this decline. In 2005, intensity impact was the main driving factor of this reduction, whereas, in 2008, 2009 and 2014, the structural impact was the main driving factor of the decline in annual energy demand in the manufacturing sector.

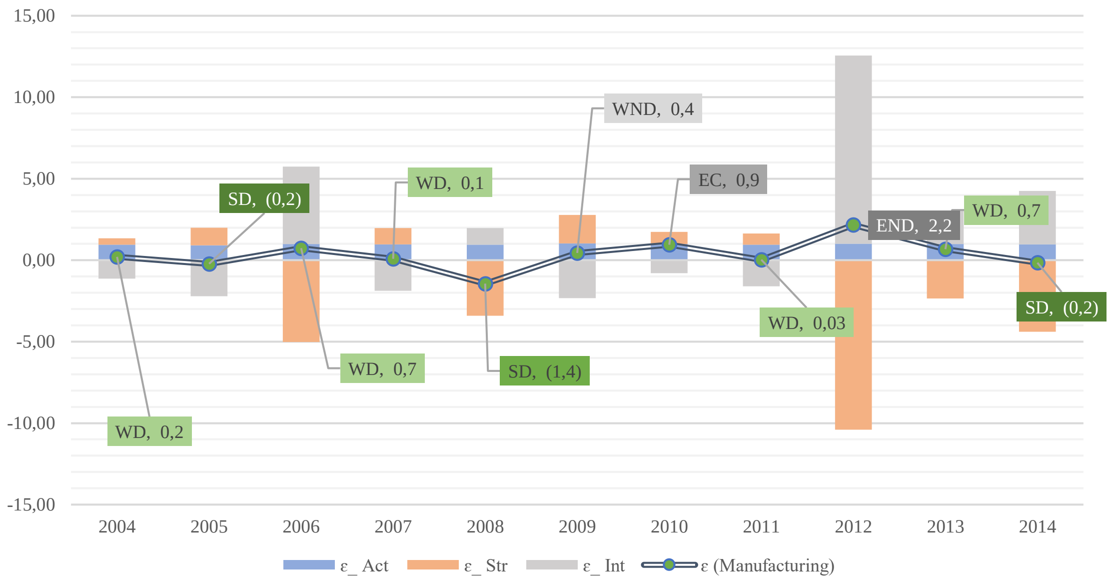
Figure 7. Decomposition of annual changes in the energy consumption of manufacturing sector, 2003-2014



Source: Author's own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).

Figure 8 shows the annual decoupling between energy consumption and value-added growth together with the contributions of the driving factors to the annual decoupling index, $\varepsilon_{manufacturing}$. In 8 out of 11 years, there was decoupling at varying degrees, and in three years, namely in 2005, 2008 and 2014, there was strong decoupling as the energy consumption decreased while real value-added rose. In other years, in 2009, 2010, and 2012 increase in energy consumption was higher than the increase in real value-added. In 2012, the rise in energy intensity, of which the main component was the manufacturing of coke and refined petroleum products, was the main reason behind the high energy demand. Similarly, when a strong decoupling occurred between energy consumption and growth, intensity (2005) and structural (2008 and 2014) effects, of which the main component was the same sub-sector, were the only driving factors.

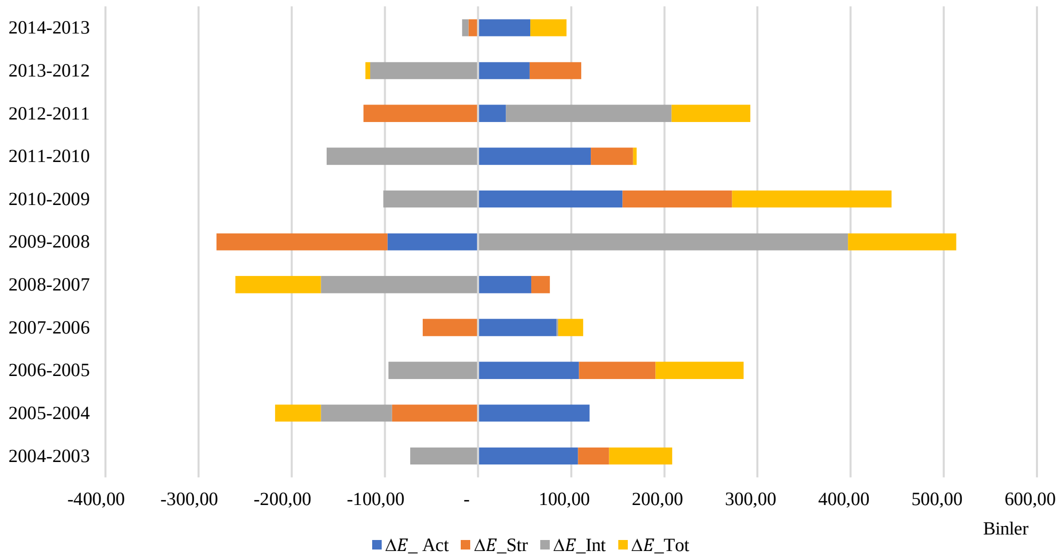
Figure 8. Contribution of driving factors to decoupling in manufacturing sector, 2003-2014



Source: Author's own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).

To eliminate the dominant impact of this sector on the changes in energy demand of manufacturing sector, Figure 9 depicts the decomposition of the annual changes in total energy consumption of other manufacturing activities and the decoupling between energy demand of these activities and the value-added is shown in Figure 10. A detailed analysis of the sub-sectoral components of each driving factor in Appendix (B4) shows that basic metals was the dominant sub-sector among other manufacturing activities and the most significant contributions to structural and intensity effect came from this industry. Additionally, the magnitude of the activity effect increased and became noticeable, however, in neither of the three years energy consumption decreased, namely in 2005, 2008 and 2013; the activity effect contributed to this decline. On the contrary, despite the reduction in real value-added and thus the decreasing activity effect observed in 2009; there was a rise in total energy consumption of other manufacturing activities, and the increase in the energy intensity of basic metals was the main component behind the intensity effect that has an increasing impact. Similarly, in the majority of years, namely 2004, 2006, 2009 and 2010-2013, changes in the sectoral value-added share and energy intensity of this industry were dominant components of structural and intensity effects on the change in energy consumption.

Figure 9. Decomposition of annual changes in the energy consumption of other manufacturing sector, 2003-2014



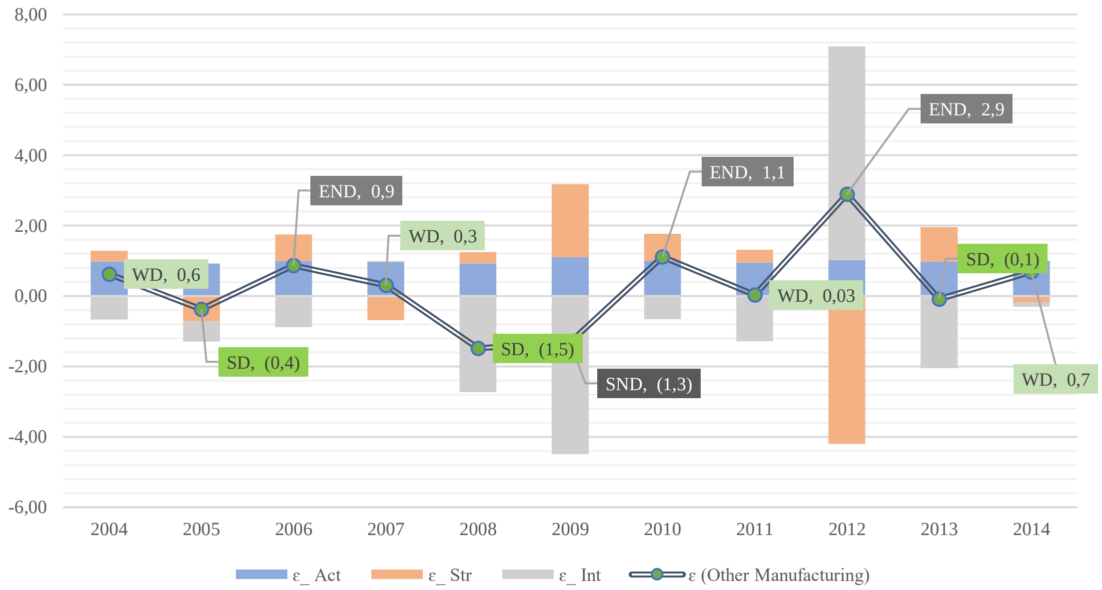
Source: Author's own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).

On the other hand, in 2005 and 2008 and 2013, when the decline in energy consumption was driven by the intensity (2005, 2008 and 2013) and structural effect (2005), the contribution of other industries was equally significant. In 2005, a decrease in the energy intensity of textile and other non-metallic mineral products offset the impact of the increase in energy intensity of basic metals. Similarly, the decreasing impact of structural effect mainly arose from the decline in the sectoral value-added shares of both basic metals and chemical products. In 2008, in addition to basic metals, energy intensity reduction in textile, chemical products, and rubber and plastic sub-sectors were the main components of the intensity. In 2013, chemical products and rubber and plastics were among the main components of intensity effect, along with basic metals.

As stated before, the decoupling performance of other manufacturing industries weakened when coke and refined petroleum products were not taken into consideration. Similarly, the number of years in which decoupling was observed declined to seven. In other years, the degree of negative decoupling increased since, in all these years, there was either expansive or strong negative decoupling. In three out of seven years in which decoupling was observed, namely in 2005, 2008 and 2013, there was strong decoupling. The main contributing factor was the structural effect in 2005, while in other years, it was the energy intensity improvements in different sectors, including basic metals, textile, chemical products, other non-metallic minerals and rubber and plastics.

On the other hand, in other years when decoupling was seen, albeit weak, in 2004, 2007, 2011 and 2014, energy intensity and structural effect contributed to decoupling. The main component of these effects was the value-added and energy intensity changes in the basic metals sector. In 2009, in parallel to the decline in general economic activity due to the global financial crisis, value-added produced by the other manufacturing activities also declined, despite the increase in energy consumption, resulting in a strong negative decoupling. As can be seen both in Figure 9 and Figure 10 the intensity effect was the driving factor of strong negative decoupling, and the increase in the energy intensity of basic metals was the reason behind this effect. In the other three years, where there was negative decoupling, the activity effect (2006 and 2010) and intensity effect (2012) was the main contributing factor to negative decoupling.

Figure 10. Contribution of driving factors to decoupling in other manufacturing sector, 2003-2014



Source: Author's own calculations based on data retrieved from Corsatea et al. (2019), Timmer et al. (2015) and TURKSTAT (2014, 2021).

7. Conclusion

While energy security and ensuring the continuous supply of energy have been at the core of national energy strategies in Türkiye, as a component of demand-side energy policies, analysing the driving factors behind the change in energy consumption either at the national or industrial level also is considered very important in setting up the sectoral energy policies.

In this context, in the index decomposition analysis used in this study to examine these driving factors of the manufacturing energy consumption between 2003-2014 during which Turkish economy presented high growth rates due to the favourable internal and external conditions.

The decomposition analysis shows, in the first place, the importance of coke and refined petroleum products in energy demand. Being the most energy-intensive activity of its own nature, one-unit change in its value-added share or energy intensity outweighs the impacts of corresponding changes in other sub-sectors. For this reason, the decomposition of changes in energy demand of other manufacturing industries, excluding coke and refined petroleum products, was conducted for a better understanding of the energy consumption structure of other manufacturing activities.

Looking at the changes in energy demand of these activities shows that activity effect was the main driving factor behind the increase in energy demand, whereas structural and energy intensity had a decreasing impact on energy consumption. While sectoral dynamics triggering these structural and intensity effects warrant a comprehensive study of their own, two pivotal factors stand out in influencing the overall transformation within the manufacturing industry. One significant factor contributing to the structural shift in manufacturing during this period was the escalating integration with global markets, impacting the production dynamics across the sector. As highlighted in the (SPO, 2007) report, sub-sectors that once enjoyed competitive advantages in trade, such as textiles, experienced limited growth rates. This decline was attributed to the escalating competitive advantages of Asian companies, particularly following China's entry into the World Trade Organization. The second key influence on the production structure of the manufacturing industry was the rapid growth observed in the construction sector. According to the findings of (Gül & Çakaloglu, 2017) sub-sectors like basic metals, other non-metallic mineral products, and fabricated metals underwent changes driven by their backward linkages with the flourishing construction sector. Along with these factors, the promotion of high value-added production began to find a place in development plans and sectoral incentives were implemented in the latter half of the analysed period. However, it remains inconclusive whether these policies had a determining impact on the production structure (Atiyas & Bakis, 2015; Canbaz, 2019).

In this context, while the majority of sub-sectoral shares increased during this period, the net impact stemming from changes in these shares, i.e., the structural impact, contributed to a reduction in energy demand. This reduction can be attributed to two main reasons: Firstly, the impact of a one-unit increase/decrease in sectoral share had varying effects on total energy consumption depending on this sector’s weight in total energy demand and its energy intensity, apart from the magnitude of the change in its sectoral share. In that regard, the first six sectors in which changes in their sectoral shares had the most impact on total energy demand were *basic metals, chemicals and chemical products, textile, other non-metallic mineral products, food, and rubber,* respectively. Another reason for the decreasing impact of structural change is that in the majority of industries in which sectoral shares increased, the reduction in energy intensity was higher than in those where value-added shares decreased.

In terms of the intensity effect, aside from technological dynamics influencing energy efficiencies within each sub-sector, the overall advancements in sub-sectors can be attributed to fundamental shifts in energy policies after the 2000s. There was a notable transition in energy policies, moving away from the goal of increasing energy supply per capita to prioritizing enhanced energy efficiency (SPO, 2000). The combination of elevated energy prices and challenges in energy supply served as inherent drivers for companies to proactively enhance their energy efficiencies, seeking to mitigate energy costs. Decomposition analysis reveals that a majority of manufacturing industries experienced improvements in varying degrees, with the final impact of these enhancements on total energy demand differing across sectors. In that regard, *chemicals, textiles, wood and of products of wood, basic metals, paper and fabricated metal products* were the major contributors to the intensity effect. However, the sectors where a unit change in energy intensity created the highest intensity effect were the same as those that caused the highest structural effect, which are *basic metals, chemicals and chemical products, other non-metallic products, textile, rubber and food*, respectively. Additionally, energy intensity improvements resulted in decoupling, albeit weak, in many of the manufacturing sub-sectors and in one sector, namely fabricated metal products, there was strong decoupling as there was a decrease in energy consumption despite the increase in the value-added.

In terms on decoupling performance, fabricated metal products sector was the only sector in which there was a strong decoupling. On the other hand, among the other sectors where there was weak decoupling, chemical products, wood, paper, textile, other transport equipment, machinery and electrical equipment turned out to have good decoupling performance respectively. However, in motor vehicles and basic metals decoupling performance was weaker, meaning that there was almost a coupling.

It is also seen in the annual analysis that in seven years between 2003 and 2014, there was a decoupling in other manufacturing industries and in three of them, namely 2005, 2008 and 2013, there was strong decoupling and the main contributing factor was the structural effect in 2005, while in other years it was the energy intensity improvements in different sectors including basic metals, textile, chemical products, other non-metallic minerals and rubber and plastics. On the other hand, despite the decrease in total value-added in 2009, energy consumption increased, illustrating a strong negative decoupling which is again led by the energy intensity increase in basic metals. In terms of the frequency of decoupling years, this picture does not change when coke and refined petroleum products are included in the analysis, but only the degree of decoupling and the years when total energy consumption was decreased differentiated.

It is seen that decoupling occurs temporarily and is very limited, resulting in the fact that activity increase remains the main contributing factor to the rise in energy consumption. On the other hand, the opposite is also true: the decrease in energy consumption does not always occur due to the effect of activity but can also result from improvements in energy intensity and even, albeit limited, structural changes. Thus, downsizing economic activity without realising potential improvements in energy intensity may not always be the only and most accurate way to reduce energy consumption. Considering energy-intensive sectors such as basic metals, other non-metallic products and chemicals, reducing production without an improvement in energy intensity of these activities may not be sufficient to reduce energy consumption. Therefore, it seems more feasible to assess industrial policies after integrating technological advances into production and maximising energy efficiency. On the other hand, an energy strategy that aims to reduce energy consumption through changes in the production structure should consider sectors with a high share in energy consumption, as changes in their production shares and energy intensities have a comparatively higher impact on the change in energy consumption.

This study focused on a specific period covering 2003-2014, in which there is a positive conjuncture in terms of accessing finance and importing intermediate goods required to manufacturing production due to the low interest and exchange rates. Additionally, encouragement of high value-added production and energy efficiency were just given a place in official strategy documents in this period. Thus, it might be early to assume that production of high value-added goods and with low energy intensity was triggered by industrial and energy policies. In that regard, it would be helpful to compare these findings with a further study covering the following period where sectoral incentives and promotion of energy efficiency is more concrete. For example, Energy Efficiency Strategy approved in 2012 (HPC, 2012) aimed to reduce sub-sectoral energy intensities in the industry by at least 10% by 2023 through various measures. On the other hand, one of the restrictions of the WIOD is that it covers only this period, and for this reason a further study with the same database depends on the further releases of WIOD covering an updated period. In addition, a multi-level decomposition analysis, which allows the analysis of the effects of the changes in the sub-sectors of the manufacturing industry on total energy demand related with all production activities can also provide a better understanding of the impacts of changes at lower hierarchical level on total energy consumption.

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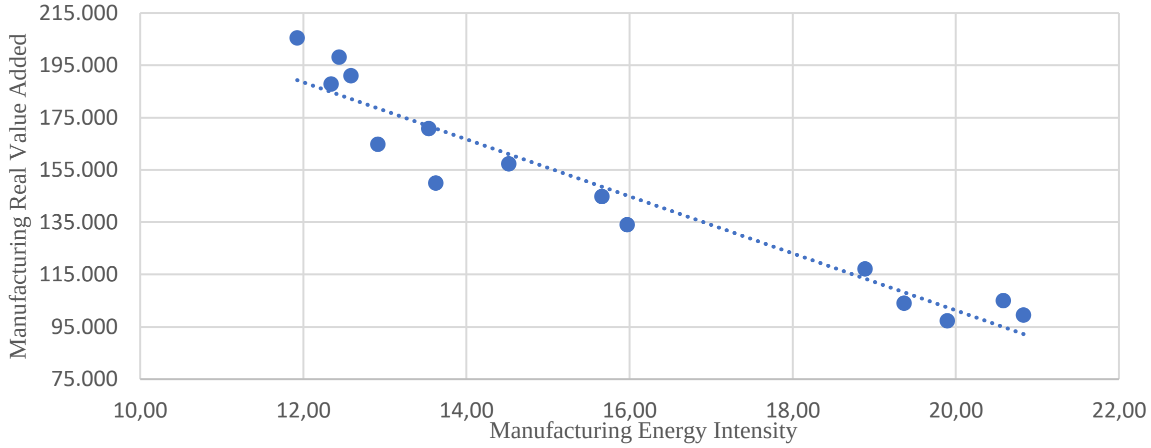
Appendix-A

Figure A-1. **A scatterplot of energy intensity and value added in the manufacturing sector (2000-2014)**



Source: Corsatea et al. (2019)

Figure A-1 shows a negative correlation between energy intensity and real value-added in the manufacturing industry, showing that value-added increases while energy intensity decreases. In other words, an increase in energy efficiency comes with an increase in value added. The positive relationship between the increase in energy efficiency and value-added can be explained by the fact that the same technological developments driven the increase in energy efficiency can result in an increase in productivity. Among many studies exploring the relationship between energy efficiency and productivity and investigating the extent to which energy-related technological improvements lead to productivity increases, Boyd & Pang (2000) focus on the plant-level data in the glass industry and support the linkage between energy efficiency and productivity. Their findings indicate a correlation between higher energy intensity and lower productivity in plants. Additionally, it is noted that while energy costs contribute to total production costs, policies aimed at improving energy efficiency can yield not only productivity gains but also other benefits. One of the recent firm-level research by Montalbano et al. (2022) confirms a positive, albeit varied, relationship between energy efficiency measures and increased productivity, depending on factors such as firm size, industry, and geographical region. Burgaç Çil (2023) focuses on the four energy-intensive subsectors within the cement, textile, weaving, and basic iron and steel industries between 2003 and 2015. In alignment with the presented scatterplot, the study identifies a positive relationship between energy efficiency and total factor productivity, fixed capital stock per employee, and firm size within these subsectors.

Appendix-B: IDA calculations

B-1 IDA for manufacturing activities 2003-2014 (period-wise analysis)

	CALCULATIONS				
	2003-2014	**2003-2014**	**2003-2014**	**2003-2014**	**2003-2014**
	E(t) -E (t-14)	**ln E(t)- ln E(t-14)**	**ln (Qt/Qt-14)**	**ln (St/St-14)**	**ln (It/It-14)**
Manufacturing Total	289,199.13	0.13	0.67		
C10_12	25,792.12	0.32	0.47	-0.20	-0.15
C13_15	12,030.64	0.08	0.42	-0.25	-0.34
C16	4,400.50	0.13	1.24	0.57	-1.11
C17	7,000.25	0.27	1.17	0.50	-0.91
C18	4,420.42	0.73	0.58	-0.09	0.15
C19	(168,810.17)	(0.15)	-0.71	-1.38	0.56
C20_21	1,841.00	0.01	0.47	-0.20	-0.46
C22	77,404.58	0.89	0.90	0.22	-0.01
C23	133,492.42	0.75	0.82	0.15	-0.07
C24	143,535.77	0.41	0.50	-0.18	-0.09
C25	(3,204.27)	(0.18)	1.11	0.44	-1.29
C26	1,470.87	0.51	0.48	-0.19	0.02
C27	2,957.35	0.47	0.99	0.32	-0.52
C28	10,923.77	0.54	1.14	0.47	-0.59
C29	16,379.06	0.74	0.89	0.22	-0.15
C30	3,192.22	0.78	1.59	0.92	-0.81
C31_33	16,372.59	0.99	0.84	0.17	0.15

	DRIVING FACTORS (Tera Joule) 2000-2014			
TOTAL EFFECT (Tera Joule) 2000-2014	ΔE_ Act	ΔE_Str	ΔE_Int	ΔE_Tot
C10_12	54,050.76	- 15,849.99	- 12,408.65	25,792.12
C13_15	99,817.12	- 36,632.81	- 51,153.67	12,030.64
C16	22,731.28	19,336.80	- 37,667.57	4,400.50
C17	17,718.74	13,209.85	- 23,928.34	7,000.25
C18	4,091.72	- 561.88	890.59	4,420.42
C19	744,915.31	- 1,536,606.40	622,880.92	(168,810.17)
C20_21	111,986.39	- 33,695.35	- 76,450.04	1,841.00
C22	58,600.67	19,582.39	- 778.47	77,404.58
C23	119,510.79	26,998.82	- 13,017.19	133,492.42
C24	237,118.55	- 61,818.69	- 31,764.09	143,535.77
C25	12,047.35	7,952.82	- 23,204.44	(3,204.27)
C26	1,948.47	- 550.01	72.42	1,470.87
C27	4,184.85	2,012.76	- 3,240.27	2,957.35
C28	13,497.62	9,384.12	- 11,957.96	10,923.77
C29	14,914.57	4,855.76	- 3,391.27	16,379.06
C30	2,759.92	3,777.64	- 3,345.34	3,192.22
C31_33	11,155.93	2,801.12	2,415.54	16,372.59
	TOTAL EFFECT (Tera Joule) 2000-2014			
	ΔE_ Act	**ΔE_Str**	**ΔE_Int**	**ΔE_Tot**
Contributions of Driving Factors to Total Effect (Tera Joule)	1,531,050.02	- 1,575,803.05	333,952.17	289,199.13
% Shares of Driving Factors in Total Effect (%)	5.29	(5.45)	1.15	1.00

B-2 IDA for manufacturing activities 2003-2014 (annual analysis)

	CALCULATIONS										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	E(t) -E (t-1)	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**
Manufacturing Total (C10_33)	50,918.7	(70,622.0)	126,367.4	16,317.6	(156,103.6)	(84,659.7)	268,077.0	6,643.8	86,092.9	60,430.4	(14,263.5)
C10_12	(8,756.6)	124.7	3,679.3	6,561.6	(10,357.0)	38,121.1	34,092.8	(33,326.4)	(1,972.0)	(8,854.7)	6,479.4
C13_15	(12,981.8)	(25,754.8)	9,427.9	39,200.8	(59,934.6)	13,696.6	13,027.2	(6,561.1)	16,443.5	10,498.9	14,968.0
C16	(2,640.0)	(4,527.0)	697.7	2,649.8	(8,070.0)	4,714.7	(237.0)	(9,589.6)	7,843.7	13,201.9	356.4
C17	(3,423.9)	(1,736.7)	2,151.0	183.2	(1,272.7)	(426.0)	41.1	2,221.7	1,862.2	2,692.7	4,707.7
C18	(332.0)	635.3	653.5	513.4	76.2	(94.0)	495.4	15.7	282.5	1,114.6	1,059.8
C19	(16,999.0)	(21,519.1)	31,936.7	(10,485.3)	(64,444.0)	(200,998.2)	97,054.5	2,866.0	1,418.5	65,501.5	(53,141.8)
C20_21	43,505.8	(17,088.5)	11,676.2	(35,578.7)	(54,221.1)	65,771.8	17,383.3	(10,164.7)	26,042.8	(37,531.5)	(7,954.4)
C22	3,252.4	2,588.5	13,578.4	(7,440.7)	(18,963.2)	28,787.8	48,179.0	10,516.5	12,176.8	(9,837.1)	(5,434.0)
C23	28,388.0	(20,293.5)	9,657.0	21,680.8	45,236.3	(22,275.2)	5,245.5	11,309.0	13,700.8	28,350.4	12,493.2
C24	19,426.7	12,274.4	31,764.2	1,088.5	20,887.8	(9,334.4)	39,387.0	28,880.1	(1,523.3)	1,753.5	(1,068.7)
C25	(1,778.2)	(248.2)	2,974.0	(602.9)	(6,940.5)	(535.1)	2,129.2	(1,532.4)	2,648.2	(1,857.1)	2,538.8
C26	(155.6)	281.6	414.2	267.3	(48.3)	(422.6)	483.8	50.0	25.3	354.6	220.6
C27	(616.3)	460.7	587.7	194.0	301.0	(605.4)	935.4	129.0	283.7	402.6	884.9
C28	(1,125.5)	1,552.4	2,064.2	620.3	1,458.6	(1,833.9)	3,062.3	62.7	1,519.0	(234.1)	3,777.7
C29	3,799.3	1,498.8	2,502.6	(1,673.2)	993.0	(2,888.4)	285.1	9,138.3	(452.8)	325.2	2,851.2
C30	762.6	381.8	399.3	(317.1)	227.4	(738.4)	148.2	1,714.4	(155.6)	339.5	430.1
C31_33	592.7	747.6	2,203.6	(544.4)	(1,032.4)	4,399.8	6,364.1	914.6	5,949.6	(5,790.4)	2,567.7
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln E(t)- ln E(t-1)	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**	**ln E(t)- ln E(t-1)**
Manufacturing Total (C10_33)	0.02	- 0.03	0.06	0.01	- 0.07	- 0.04	0.12	0.00	0.04	0.02	- 0.01
C10_12	- 0.14	0.00	0.06	0.10	- 0.16	0.49	0.30	- 0.29	- 0.02	- 0.10	0.07
C13_15	- 0.10	- 0.22	0.09	0.30	- 0.50	0.14	0.12	- 0.06	0.14	0.08	0.10
C16	- 0.09	- 0.17	0.03	0.10	- 0.34	0.21	- 0.01	- 0.50	0.43	0.46	0.01
C17	- 0.16	- 0.09	0.11	0.01	- 0.07	- 0.02	0.00	0.11	0.09	0.11	0.17
C18	- 0.08	0.15	0.14	0.10	0.01	- 0.02	0.08	0.00	0.05	0.16	0.13
C19	- 0.01	- 0.02	0.03	- 0.01	- 0.06	- 0.20	0.10	0.00	0.00	0.06	- 0.05
C20_21	0.23	- 0.09	0.06	- 0.19	- 0.39	0.45	0.09	- 0.05	0.13	- 0.19	- 0.05
C22	0.06	0.04	0.20	- 0.11	- 0.34	0.48	0.49	0.08	0.09	- 0.07	- 0.04
C23	0.21	- 0.15	0.07	0.15	0.25	- 0.12	0.03	0.06	0.07	0.13	0.05
C24	0.07	0.04	0.10	0.00	0.06	- 0.03	0.10	0.07	- 0.00	0.00	- 0.00
C25	- 0.10	- 0.01	0.16	- 0.03	- 0.43	- 0.04	0.16	- 0.11	0.18	- 0.13	0.17
C26	- 0.07	0.13	0.16	0.09	- 0.02	- 0.15	0.17	0.02	0.01	0.11	0.06
C27	- 0.14	0.10	0.12	0.04	0.05	- 0.11	0.17	0.02	0.04	0.06	0.12
C28	- 0.08	0.11	0.12	0.03	0.08	- 0.10	0.16	0.00	0.07	- 0.01	0.16
C29	0.23	0.08	0.12	- 0.08	0.05	- 0.14	0.01	0.38	- 0.02	0.01	0.10
C30	0.25	0.10	0.10	- 0.08	0.06	- 0.19	0.04	0.39	- 0.03	0.06	0.08
C31_33	0.06	0.07	0.18	- 0.04	- 0.08	0.32	0.33	0.04	0.23	- 0.22	0.10
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln (Qt/Qt-1)	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**
Manufacturing Total (C10_33)	0.11	0.14	0.08	0.08	0.05	- 0.09	0.13	0.10	0.02	0.04	0.04
C10_12	- 0.06	0.25	- 0.05	0.12	0.05	0.02	0.01	0.01	0.10	- 0.03	0.05
C13_15	0.02	0.07	0.09	- 0.03	- 0.04	- 0.09	0.14	0.11	0.04	0.08	0.03
C16	0.12	0.52	- 0.06	0.34	- 0.07	- 0.03	0.21	0.05	0.22	- 0.13	0.07
C17	0.24	0.29	0.15	0.04	- 0.09	0.14	0.11	0.11	0.08	- 0.02	0.14
C18	0.09	0.55	- 0.24	0.06	0.09	- 0.02	0.08	- 0.04	0.08	- 0.03	- 0.04
C19	0.16	0.52	- 0.75	0.30	- 0.30	- 0.25	0.23	0.21	- 0.28	- 0.22	- 0.34

C20_21	0.08	-0.10	0.15	0.01	0.05	0.11	0.18	-0.02	0.01	-0.03	0.04
C22	0.18	0.10	0.16	-0.00	0.17	-0.01	0.07	0.13	0.06	0.02	0.03
C23	0.27	0.22	0.21	0.04	-0.13	-0.12	0.17	0.01	0.03	0.08	0.04
C24	0.20	-0.14	0.33	-0.05	0.23	-0.71	0.44	0.30	-0.31	0.21	0.01
C25	0.10	0.35	-0.00	0.08	-0.02	0.16	0.13	0.12	0.11	0.04	0.06
C26	0.11	0.15	0.09	-0.32	0.15	0.04	-0.01	0.09	0.07	0.04	0.06
C27	0.27	0.24	0.19	0.10	0.14	-0.11	-0.00	0.09	-0.01	0.13	-0.04
C28	0.20	0.28	0.14	0.13	0.00	-0.06	0.18	0.16	0.06	0.02	0.03
C29	0.32	-0.16	0.07	0.54	0.15	-0.28	0.15	0.12	-0.02	0.01	0.01
C30	0.25	0.06	0.02	0.68	0.55	-0.21	-0.02	0.05	0.00	-0.07	0.27
C31_33	-0.04	0.09	0.09	0.19	0.02	0.12	0.09	0.08	0.08	0.01	0.11
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln (St/St-1)	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**
Manufacturing Total (C10_33)											
C10_12	-0.16	0.12	-0.13	0.03	0.01	0.11	-0.12	-0.09	0.08	-0.07	0.01
C13_15	-0.09	-0.07	0.01	-0.11	-0.09	0.01	0.01	0.02	0.02	0.04	-0.00
C16	0.01	0.39	-0.13	0.26	-0.11	0.06	0.08	-0.05	0.21	-0.17	0.03
C17	0.13	0.15	0.07	-0.05	-0.14	0.23	-0.02	0.02	0.06	-0.06	0.10
C18	-0.02	0.42	-0.32	-0.03	0.04	0.07	-0.05	-0.14	0.06	-0.06	-0.08
C19	0.05	0.39	-0.83	0.22	-0.35	-0.15	0.10	0.11	-0.29	-0.26	-0.38
C20_21	-0.03	-0.23	0.07	-0.07	-0.00	0.20	0.05	-0.11	-0.01	-0.07	0.01
C22	0.07	-0.03	0.08	-0.09	0.12	0.08	-0.06	0.04	0.04	-0.02	-0.01
C23	0.16	0.09	0.13	-0.04	-0.17	-0.03	0.04	-0.09	0.01	0.04	0.01
C24	0.09	-0.28	0.25	-0.13	0.18	-0.62	0.31	0.20	-0.33	0.18	-0.03
C25	-0.01	0.21	-0.08	-0.01	-0.06	0.25	0.00	0.02	0.09	-0.00	0.02
C26	0.00	0.02	0.02	-0.40	0.10	0.14	-0.14	-0.01	0.05	0.00	0.03
C27	0.17	0.10	0.11	0.02	0.10	-0.02	-0.13	-0.01	-0.03	0.09	-0.08
C28	0.09	0.14	0.06	0.04	-0.04	0.03	0.05	0.07	0.05	-0.01	-0.01
C29	0.21	-0.30	-0.01	0.45	0.11	-0.19	0.02	0.02	-0.04	-0.03	-0.03
C30	0.14	-0.08	-0.05	0.60	0.51	-0.12	-0.15	-0.04	-0.02	-0.11	0.24
C31_33	-0.15	-0.04	0.01	0.11	-0.03	0.21	-0.04	-0.01	0.06	-0.03	0.07
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)	ln (It/It-1)
Manufacturing Total (C10_33)											
C10_12	-0.08	-0.25	0.11	-0.02	-0.21	0.48	0.29	-0.30	-0.12	-0.07	0.02
C13_15	-0.12	-0.29	-0.00	0.32	-0.46	0.23	-0.03	-0.17	0.10	0.00	0.07
C16	-0.20	-0.69	0.08	-0.24	-0.27	0.24	-0.22	-0.55	0.20	0.59	-0.06
C17	-0.40	-0.38	-0.04	-0.03	0.03	-0.16	-0.10	0.00	0.01	0.13	0.03
C18	-0.18	-0.40	0.38	0.04	-0.07	0.01	0.00	0.04	-0.03	0.19	0.17
C19	-0.18	-0.54	0.78	-0.31	0.25	0.05	-0.13	-0.20	0.28	0.29	0.29
C20_21	0.16	0.01	-0.09	-0.20	-0.43	0.35	-0.08	-0.03	0.12	-0.16	-0.09
C22	-0.12	-0.06	0.05	-0.10	-0.50	0.49	0.42	-0.05	0.03	-0.09	-0.07
C23	-0.05	-0.37	-0.14	0.10	0.38	0.01	-0.14	0.05	0.04	0.05	0.01
C24	-0.14	0.18	-0.24	0.05	-0.17	0.69	-0.33	-0.23	0.31	-0.21	-0.01
C25	-0.19	-0.36	0.16	-0.11	-0.41	-0.20	0.03	-0.23	0.08	-0.16	0.11
C26	-0.19	-0.03	0.07	0.41	-0.17	-0.20	0.19	-0.07	-0.06	0.07	-0.00
C27	-0.41	-0.13	-0.07	-0.06	-0.09	-0.00	0.17	-0.07	0.06	-0.07	0.16
C28	-0.28	-0.17	-0.01	-0.09	0.07	-0.04	-0.02	-0.16	0.01	-0.03	0.13
C29	-0.09	0.24	0.05	-0.61	-0.11	0.14	-0.14	0.27	0.01	0.00	0.09
C30	-0.00	0.04	0.08	-0.76	-0.50	0.01	0.06	0.34	-0.03	0.13	-0.20
C31_33	0.10	-0.02	0.09	-0.23	-0.10	0.20	0.24	-0.04	0.14	-0.23	-0.00
	ACTIVITY EFFECT (E act)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
C10_12	6,972.1	8,058.3	4,735.9	5,503.5	2,998.9	(7,242.6)	14,755.4	10,892.1	1,661.9	3,363.1	3,298.5
C13_15	14,873.2	15,737.7	8,368.4	10,917.5	5,580.1	(9,343.6)	14,615.9	11,066.3	2,061.9	4,918.0	5,345.2

C16	3,317.3	3,614.8	1,916.7	2,193.9	1,096.7	(2,076.6)	3,163.6	1,820.4	312.9	1,047.5	1,304.9
C17	2,325.6	2,533.6	1,458.8	1,664.0	908.9	(1,761.1)	2,402.9	1,873.0	370.1	876.5	1,003.4
C18	434.9	557.9	367.5	443.0	262.7	(531.0)	757.5	581.8	106.6	253.7	291.6
C19	129,730.2	157,939.4	90,376.1	97,896.8	53,228.4	(95,014.2)	124,572.3	96,454.2	17,296.7	38,299.1	38,270.0
C20_21	20,405.2	27,135.0	15,255.4	15,344.2	6,478.5	(13,591.0)	24,427.6	18,317.5	3,409.2	7,088.2	6,235.4
C22	6,100.4	7,945.0	5,131.7	5,775.4	2,609.1	(5,687.6)	12,719.9	12,331.5	2,399.9	5,189.8	4,879.0
C23	14,553.5	18,591.8	10,196.9	12,222.9	8,386.4	(18,127.7)	23,912.7	18,371.1	3,500.3	8,266.2	8,961.1
C24	32,322.2	42,151.0	25,692.7	28,955.7	16,767.7	(34,500.6)	49,466.1	39,648.4	7,331.0	15,723.6	15,630.3
C25	2,041.8	2,391.7	1,464.5	1,673.0	753.2	(1,196.6)	1,749.5	1,316.4	244.6	539.8	547.9
C26	234.9	298.9	196.9	239.8	139.8	(260.5)	362.9	293.0	53.1	120.6	130.3
C27	497.7	605.8	385.4	446.4	262.2	(516.1)	731.9	590.2	109.1	246.5	267.9
C28	1,591.2	1,997.1	1,276.4	1,482.6	880.6	(1,764.7)	2,509.0	1,998.0	370.9	819.0	876.1
C29	1,840.9	2,644.6	1,659.6	1,816.7	1,004.8	(1,942.6)	2,513.6	2,269.9	485.2	1,038.1	1,087.9
C30	337.0	496.1	312.7	339.1	188.4	(356.5)	454.7	417.9	89.0	194.2	206.8
C31_33	1,097.6	1,448.7	936.7	1,076.6	567.8	(1,297.6)	2,478.5	2,186.1	447.8	963.4	901.5
	STRUCTURAL EFFECT (E str)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
C10_12	(10,506.6)	7,064.2	(7,903.7)	2,166.6	495.0	8,711.8	(13,746.6)	(10,012.0)	8,218.5	(6,038.5)	1,284.2
C13_15	(11,933.5)	(7,708.7)	1,300.4	(14,560.8)	(10,482.2)	654.7	1,497.6	1,766.1	2,453.2	5,478.3	(460.0)
C16	185.1	10,305.2	(3,301.2)	6,932.5	(2,672.9)	1,413.8	1,865.5	(916.7)	3,808.5	(4,765.7)	1,099.7
C17	2,723.2	2,891.8	1,401.8	(926.5)	(2,764.0)	4,342.3	(455.3)	336.8	1,315.1	(1,367.0)	2,861.9
C18	(65.2)	1,718.8	(1,508.7)	(143.1)	229.3	390.5	(280.2)	(825.2)	394.7	(429.0)	(620.4)
C19	62,380.0	455,354.9	(970,908.7)	261,469.8	(398,749.6)	(155,575.8)	94,701.2	113,735.2	(298,726.6)	(271,461.4)	(396,196.9)
C20_21	(5,942.1)	(46,549.7)	14,045.4	(13,609.2)	(165.0)	29,000.3	8,980.0	(21,836.7)	(1,236.6)	(13,382.9)	1,018.3
C22	3,937.2	(1,847.4)	5,314.1	(6,033.0)	6,759.0	4,905.5	(5,683.6)	4,767.0	5,520.3	(2,818.6)	(1,044.6)
C23	21,016.7	11,728.3	17,419.4	(5,587.6)	(31,373.7)	(5,929.7)	7,983.8	(16,615.3)	2,946.6	9,572.8	1,360.6
C24	27,963.6	(86,278.1)	84,835.2	(46,872.1)	65,055.8	(226,707.3)	116,726.4	84,132.0	(142,221.1)	75,688.9	(12,453.0)
C25	(196.4)	3,789.5	(1,557.4)	(133.8)	(1,013.1)	3,190.8	30.2	337.4	1,315.2	(19.3)	343.4
C26	8.5	40.3	46.0	(1,162.3)	315.7	381.2	(404.5)	(28.8)	170.9	2.1	96.5
C27	752.6	459.8	554.5	93.3	547.6	(86.6)	(755.8)	(31.2)	(198.4)	638.2	(583.1)
C28	1,356.8	2,100.5	1,021.1	792.7	(805.3)	592.5	923.3	1,406.3	980.5	(284.3)	(256.7)
C29	3,475.4	(5,781.3)	(252.2)	9,983.6	2,296.3	(3,855.8)	409.3	480.6	(1,169.2)	(775.2)	(811.9)
C30	426.6	(277.9)	(220.6)	2,446.6	2,053.1	(437.4)	(527.9)	(181.6)	(86.3)	(563.9)	1,357.3
C31_33	(1,514.7)	(466.9)	145.7	1,432.3	(320.9)	2,928.6	(747.8)	(333.4)	1,706.6	(710.3)	1,752.9
	INTENSITY EFFECT (E int)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
C10_12	(5,222.2)	(14,997.7)	6,847.1	(1,108.5)	(13,850.9)	36,651.9	33,084.1	(34,206.5)	(11,852.4)	(6,179.3)	1,896.7
C13_15	(15,921.5)	(33,783.8)	(240.9)	42,844.1	(55,032.5)	22,385.5	(3,086.4)	(19,393.4)	11,928.4	102.5	10,082.7
C16	(6,142.4)	(18,447.0)	2,082.2	(6,476.6)	(6,493.9)	5,377.4	(5,266.1)	(10,493.2)	3,722.3	16,920.2	(2,048.2)
C17	(8,472.8)	(7,162.1)	(709.6)	(554.2)	582.4	(3,007.2)	(1,906.4)	11.8	177.0	3,183.2	842.4
C18	(701.7)	(1,641.5)	1,794.7	213.6	(415.8)	46.5	18.1	259.1	(218.8)	1,289.9	1,388.6
C19	(209,109.2)	(634,813.4)	912,469.2	(369,851.8)	281,077.2	49,591.8	(122,219.0)	(207,323.4)	282,848.4	298,663.8	304,785.1
C20_21	29,042.7	2,326.1	(17,624.6)	(37,313.8)	(60,534.6)	50,362.5	(16,024.3)	(6,645.5)	23,870.1	(31,236.9)	(15,208.1)
C22	(6,785.2)	(3,509.1)	3,132.6	(7,183.0)	(28,331.4)	29,569.9	41,142.8	(6,582.0)	4,256.6	(12,208.3)	(9,268.4)
C23	(7,182.2)	(50,613.6)	(17,959.3)	15,045.5	68,223.6	1,782.2	(26,650.9)	9,553.3	7,253.8	10,511.3	2,171.5
C24	(40,859.1)	56,401.5	(78,763.8)	19,004.8	(60,935.7)	251,873.5	(126,805.5)	(94,900.3)	133,366.8	(89,659.0)	(4,245.9)
C25	(3,623.6)	(6,429.4)	3,066.9	(2,142.1)	(6,680.5)	(2,529.3)	349.5	(3,186.2)	1,088.3	(2,377.6)	1,647.5
C26	(399.0)	(57.6)	171.3	1,189.8	(503.8)	(543.3)	525.5	(214.2)	(198.7)	231.9	(6.3)
C27	(1,866.6)	(604.9)	(352.2)	(345.7)	(508.7)	(2.8)	959.2	(430.0)	373.0	(482.1)	1,200.0
C28	(4,073.5)	(2,545.2)	(233.3)	(1,655.0)	1,383.4	(661.6)	(370.0)	(3,341.5)	167.6	(768.9)	3,158.3
C29	(1,517.0)	4,635.5	1,095.3	(13,473.5)	(2,308.1)	2,910.0	(2,637.8)	6,387.8	231.2	62.3	2,575.1
C30	(1.0)	163.6	307.2	(3,102.8)	(2,014.1)	55.5	221.5	1,478.0	(158.4)	709.2	(1,134.0)
C31_33	1,009.8	(234.2)	1,121.2	(3,053.3)	(1,279.3)	2,768.8	4,633.4	(938.0)	3,795.1	(6,043.5)	(86.7)
	CONTRIBUTIONS OF DRIVING FACTORS TO TOTAL EFFECT (Tera Joule)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**

ΔE_ Act	238,675.73	294,147.53	169,732.36	187,991.11	102,114.13	- 195,210.55	281,593.71	220,427.56	40,250.33	88,947.17	89,237.96
ΔE_Str	94,067.50	346,543.21	- 859,569.05	196,288.95	- 370,594.98	- 336,080.57	210,515.66	156,180.48	- 414,807.93	- 211,235.51	- 401,251.78
ΔE_Int	- 281,824.50	- 711,312.77	816,204.10	- 367,962.42	112,377.29	446,631.44	- 224,032.40	- **369,964.22**	460,650.53	182,718.76	297,750.32
ΔE_Tot	50,918.73	- 70,622.03	126,367.41	16,317.64	- 156,103.56	- 84,659.69	268,076.96	6,643.82	86,092.93	60,430.42	- 14,263.50
	% SHARES OF DRIVING FACTORS IN TOTAL EFFECT (%)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
ΔE_ Act	4.69	(4.17)	1.34	11.52	(0.65)	2.31	1.05	33.18	0.47	1.47	(6.26)
ΔE_Str	1.85	(4.91)	(6.80)	12.03	2.37	3.97	0.79	23.51	(4.82)	(3.50)	28.13
ΔE_Int	(5.53)	10.07	6.46	(22.55)	(0.72)	(5.28)	(0.84)	(55.69)	5.35	3.02	(20.87)
ΔE_Tot	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

B-3 IDA for manufacturing activities 2003-2014 (period-wise analysis) - excluding coke and refined petroleum products

	CALCULATIONS				
	2003-2014	**2003-2014**	**2003-2014**	**2003-2014**	**2003-2014**
	E(t) -E (t-14)	**ln E(t)- ln E(t-14)**	**ln (Qt/Qt-14)**	**ln (St/St-14)**	**ln (It/It-14)**
Manufacturing Total	458,020.30	0.39	0.70		
C10_12	25,792.12	0.32	0.47	-0.22	-0.15
C13_15	12,030.64	0.08	0.42	-0.27	-0.34
C16	4,400.50	0.13	1.24	0.55	-1.11
C17	7,000.25	0.27	1.17	0.48	-0.91
C18	4,420.42	0.73	0.58	-0.12	0.15
C19	-				
C20_21	1,841.00	0.01	0.47	-0.23	-0.46
C22	77,404.58	0.89	0.90	0.20	-0.01
C23	133,492.42	0.75	0.82	0.13	-0.07
C24	143,535.77	0.41	0.50	-0.20	-0.09
C25	(3,204.27)	(0.18)	1.11	0.42	-1.29
C26	1,470.87	0.51	0.48	-0.21	0.02
C27	2,957.35	0.47	0.99	0.30	-0.52
C28	10,923.77	0.54	1.14	0.44	-0.59
C29	16,379.06	0.74	0.89	0.19	-0.15
C30	3,192.22	0.78	1.59	0.89	-0.81
C31_33	16,372.59	0.99	0.84	0.14	0.15

	DRIVING FACTORS (Tera Joule) 2000-2014			
TOTAL EFFECT (Tera Joule) 2000-2014	**ΔE_ Act**	**ΔE_Str**	**ΔE_Int**	**ΔE_Tot**
C10_12	55,969.70	- 17,768.94	- 12,408.65	25,792.12
C13_15	103,360.88	- 40,176.57	- 51,153.67	12,030.64
C16	23,538.30	18,529.78	- 37,667.57	4,400.50
C17	18,347.80	12,580.79	- 23,928.34	7,000.25
C18	4,236.98	- 707.15	890.59	4,420.42
C19				
C20_21	115,962.20	- 37,671.16	- 76,450.04	1,841.00
C22	60,681.14	17,501.91	- 778.47	77,404.58
C23	123,753.73	22,755.88	- 13,017.19	133,492.42
C24	245,536.86	- 70,237.00	- 31,764.09	143,535.77
C25	12,475.06	7,525.11	- 23,204.44	(3,204.27)
C26	2,017.64	- 619.19	72.42	1,470.87
C27	4,333.43	1,864.19	- 3,240.27	2,957.35
C28	13,976.82	8,904.92	- 11,957.96	10,923.77
C29	15,444.08	4,326.25	- 3,391.27	16,379.06
C30	2,857.91	3,679.66	- 3,345.34	3,192.22
C31_33	11,551.99	2,405.06	2,415.54	16,372.59

	TOTAL EFFECT (Tera Joule) 2000-2014			
	ΔE_ Act	ΔE_Str	ΔE_Int	ΔE_Tot
Contributions of Driving Factors to Total Effect (Tera Joule)	814,044.51	- 67,106.45	- 288,928.75	458,009.30
% Shares of Driving Factors in Total Effect (%)	1.78	(0.15)	(0.63)	1.00

B-4 IDA for manufacturing activities 2003-2014 (annual analysis) -excluding coke and refined petroleum products

	CALCULATIONS										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	E(t) -E (t-1)	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**	**E(t) -E (t-1)**
Manufacturing Total (C10_33)	67,917.8	(49,102.9)	94,430.7	26,802.9	(91,659.6)	116,338.5	171,022.5	3,777.8	84,674.5	(5,071.1)	38,878.3
C10_12	(8,756.6)	124.7	3,679.3	6,561.6	(10,357.0)	38,121.1	34,092.8	(33,326.4)	(1,972.0)	(8,854.7)	6,479.4
C13_15	(12,981.8)	(25,754.8)	9,427.9	39,200.8	(59,934.6)	13,696.6	13,027.2	(6,561.1)	16,443.5	10,498.9	14,968.0
C16	(2,640.0)	(4,527.0)	697.7	2,649.8	(8,070.0)	4,714.7	(237.0)	(9,589.6)	7,843.7	13,201.9	356.4
C17	(3,423.9)	(1,736.7)	2,151.0	183.2	(1,272.7)	(426.0)	41.1	2,221.7	1,862.2	2,692.7	4,707.7
C18	(332.0)	635.3	653.5	513.4	76.2	(94.0)	495.4	15.7	282.5	1,114.6	1,059.8
C19	-	-	-	-	-	-	-	-	-	-	-
C20_21	43,505.8	(17,088.5)	11,676.2	(35,578.7)	(54,221.1)	65,771.8	17,383.3	(10,164.7)	26,042.8	(37,531.5)	(7,954.4)
C22	3,252.4	2,588.5	13,578.4	(7,440.7)	(18,963.2)	28,787.8	48,179.0	10,516.5	12,176.8	(9,837.1)	(5,434.0)
C23	28,388.0	(20,293.5)	9,657.0	21,680.8	45,236.3	(22,275.2)	5,245.5	11,309.0	13,700.8	28,350.4	12,493.2
C24	19,426.7	12,274.4	31,764.2	1,088.5	20,887.8	(9,334.4)	39,387.0	28,880.1	(1,523.3)	1,753.5	(1,068.7)
C25	(1,778.2)	(248.2)	2,974.0	(602.9)	(6,940.5)	(535.1)	2,129.2	(1,532.4)	2,648.2	(1,857.1)	2,538.8
C26	(155.6)	281.6	414.2	267.3	(48.3)	(422.6)	483.8	50.0	25.3	354.6	220.6
C27	(616.3)	460.7	587.7	194.0	301.0	(605.4)	935.4	129.0	283.7	402.6	884.9
C28	(1,125.5)	1,552.4	2,064.2	620.3	1,458.6	(1,833.9)	3,062.3	62.7	1,519.0	(234.1)	3,777.7
C29	3,799.3	1,498.8	2,502.6	(1,673.2)	993.0	(2,888.4)	285.1	9,138.3	(452.8)	325.2	2,851.2
C30	762.6	381.8	399.3	(317.1)	227.4	(738.4)	148.2	1,714.4	(155.6)	339.5	430.1
C31_33	592.7	747.6	2,203.6	(544.4)	(1,032.4)	4,399.8	6,364.1	914.6	5,949.6	(5,790.4)	2,567.7
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln E(t)-ln E(t-1)	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**	**ln E(t)-ln E(t-1)**
Manufacturing Total (C10_33)	0.07	- 0.05	0.09	0.02	- 0.09	0.11	0.14	0.00	0.06	- 0.00	0.03
C10_12	- 0.14	0.00	0.06	0.10	- 0.16	0.49	0.30	- 0.29	- 0.02	- 0.10	0.07
C13_15	- 0.10	- 0.22	0.09	0.30	- 0.50	0.14	0.12	- 0.06	0.14	0.08	0.10
C16	- 0.09	- 0.17	0.03	0.10	- 0.34	0.21	- 0.01	- 0.50	0.43	0.46	0.01
C17	- 0.16	- 0.09	0.11	0.01	- 0.07	- 0.02	0.00	0.11	0.09	0.11	0.17
C18	- 0.08	0.15	0.14	0.10	0.01	- 0.02	0.08	0.00	0.05	0.16	0.13
C19											
C20_21	0.23	- 0.09	0.06	- 0.19	- 0.39	0.45	0.09	- 0.05	0.13	- 0.19	- 0.05
C22	0.06	0.04	0.20	- 0.11	- 0.34	0.48	0.49	0.08	0.09	- 0.07	- 0.04
C23	0.21	- 0.15	0.07	0.15	0.25	- 0.12	0.03	0.06	0.07	0.13	0.05
C24	0.07	0.04	0.10	0.00	0.06	- 0.03	0.10	0.07	- 0.00	0.00	- 0.00
C25	- 0.10	- 0.01	0.16	- 0.03	- 0.43	- 0.04	0.16	- 0.11	0.18	- 0.13	0.17
C26	- 0.07	0.13	0.16	0.09	- 0.02	- 0.15	0.17	0.02	0.01	0.11	0.06
C27	- 0.14	0.10	0.12	0.04	0.05	- 0.11	0.17	0.02	0.04	0.06	0.12
C28	- 0.08	0.11	0.12	0.03	0.08	- 0.10	0.16	0.00	0.07	- 0.01	0.16
C29	0.23	0.08	0.12	- 0.08	0.05	- 0.14	0.01	0.38	- 0.02	0.01	0.10
C30	0.25	0.10	0.10	- 0.08	0.06	- 0.19	0.04	0.39	- 0.03	0.06	0.08

C31_33	0.06	0.07	0.18	- 0.04	- 0.08	0.32	0.33	0.04	0.23	- 0.22	0.10
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln (Qt/Qt-1)	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**	**ln (Qt/Qt-1)**
Manufacturing Total (C10_33)	0.11	0.12	0.11	0.08	0.05	- 0.09	0.13	0.09	0.02	0.04	0.04
C10_12	- 0.06	0.25	- 0.05	0.12	0.05	0.02	0.01	0.01	0.10	- 0.03	0.05
C13_15	0.02	0.07	0.09	- 0.03	- 0.04	- 0.09	0.14	0.11	0.04	0.08	0.03
C16	0.12	0.52	- 0.06	0.34	- 0.07	- 0.03	0.21	0.05	0.22	- 0.13	0.07
C17	0.24	0.29	0.15	0.04	- 0.09	0.14	0.11	0.11	0.08	- 0.02	0.14
C18	0.09	0.55	- 0.24	0.06	0.09	- 0.02	0.08	- 0.04	0.08	- 0.03	- 0.04
C19											
C20_21	0.08	- 0.10	0.15	0.01	0.05	0.11	0.18	- 0.02	0.01	- 0.03	0.04
C22	0.18	0.10	0.16	- 0.00	0.17	- 0.01	0.07	0.13	0.06	0.02	0.03
C23	0.27	0.22	0.21	0.04	- 0.13	- 0.12	0.17	0.01	0.03	0.08	0.04
C24	0.20	- 0.14	0.33	- 0.05	0.23	- 0.71	0.44	0.30	- 0.31	0.21	0.01
C25	0.10	0.35	- 0.00	0.08	- 0.02	0.16	0.13	0.12	0.11	0.04	0.06
C26	0.11	0.15	0.09	- 0.32	0.15	0.04	- 0.01	0.09	0.07	0.04	0.06
C27	0.27	0.24	0.19	0.10	0.14	- 0.11	- 0.00	0.09	- 0.01	0.13	- 0.04
C28	0.20	0.28	0.14	0.13	0.00	- 0.06	0.18	0.16	0.06	0.02	0.03
C29	0.32	- 0.16	0.07	0.54	0.15	- 0.28	0.15	0.12	- 0.02	0.01	0.01
C30	0.25	0.06	0.02	0.68	0.55	- 0.21	- 0.02	0.05	0.00	- 0.07	0.27
C31_33	- 0.04	0.09	0.09	0.19	0.02	0.12	0.09	0.08	0.08	0.01	0.11
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln (St/St-1)	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**	**ln (St/St-1)**
Manufacturing Total (C10_33)											
C10_12	- 0.16	0.13	- 0.16	0.04	- 0.00	0.11	- 0.12	- 0.09	0.08	- 0.07	0.01
C13_15	- 0.09	- 0.05	- 0.02	- 0.10	- 0.10	0.00	0.01	0.02	0.02	0.04	- 0.01
C16	0.01	0.40	- 0.16	0.27	- 0.12	0.06	0.08	- 0.05	0.20	- 0.17	0.03
C17	0.13	0.17	0.05	- 0.04	- 0.15	0.23	- 0.02	0.02	0.06	- 0.06	0.10
C18	- 0.01	0.43	- 0.34	- 0.02	0.03	0.07	- 0.05	- 0.13	0.06	- 0.07	- 0.08
C19											
C20_21	- 0.03	- 0.22	0.04	- 0.07	- 0.01	0.20	0.05	- 0.11	- 0.01	- 0.07	0.00
C22	0.07	- 0.02	0.05	- 0.08	0.11	0.08	- 0.06	0.04	0.03	- 0.02	- 0.01
C23	0.16	0.10	0.10	- 0.03	- 0.18	- 0.03	0.04	- 0.08	0.01	0.04	0.00
C24	0.10	- 0.26	0.23	- 0.13	0.17	- 0.62	0.31	0.20	- 0.34	0.17	- 0.03
C25	- 0.01	0.23	- 0.11	- 0.00	- 0.07	0.25	0.00	0.03	0.09	- 0.00	0.02
C26	0.01	0.03	- 0.01	- 0.40	0.10	0.13	- 0.14	- 0.01	0.05	- 0.00	0.02
C27	0.17	0.12	0.08	0.02	0.09	- 0.02	- 0.13	- 0.00	- 0.04	0.09	- 0.08
C28	0.09	0.16	0.03	0.05	- 0.05	0.03	0.05	0.07	0.04	- 0.02	- 0.01
C29	0.21	- 0.28	- 0.04	0.46	0.10	- 0.19	0.02	0.02	- 0.05	- 0.03	- 0.03
C30	0.14	- 0.06	- 0.08	0.60	0.50	- 0.12	- 0.15	- 0.04	- 0.02	- 0.11	0.23
C31_33	- 0.15	- 0.03	- 0.02	0.12	- 0.03	0.21	- 0.04	- 0.01	0.06	- 0.03	0.07
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
	ln (It/It-1)	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**	**ln (It/It-1)**
Manufacturing Total (C10_33)											
C10_12	- 0.08	- 0.25	0.11	- 0.02	- 0.21	0.48	0.29	- 0.30	- 0.12	- 0.07	0.02
C13_15	- 0.12	- 0.29	- 0.00	0.32	- 0.46	0.23	- 0.03	- 0.17	0.10	0.00	0.07
C16	- 0.20	- 0.69	0.08	- 0.24	- 0.27	0.24	- 0.22	- 0.55	0.20	0.59	- 0.06
C17	- 0.40	- 0.38	- 0.04	- 0.03	0.03	- 0.16	- 0.10	0.00	0.01	0.13	0.03
C18	- 0.18	- 0.40	0.38	0.04	- 0.07	0.01	0.00	0.04	- 0.03	0.19	0.17
C19											
C20_21	0.16	0.01	- 0.09	- 0.20	- 0.43	0.35	- 0.08	- 0.03	0.12	- 0.16	- 0.09
C22	- 0.12	- 0.06	0.05	- 0.10	- 0.50	0.49	0.42	- 0.05	0.03	- 0.09	- 0.07
C23	- 0.05	- 0.37	- 0.14	0.10	0.38	0.01	- 0.14	0.05	0.04	0.05	0.01

C24	-0.14	0.18	-0.24	0.05	-0.17	0.69	-0.33	-0.23	0.31	-0.21	-0.01
C25	-0.19	-0.36	0.16	-0.11	-0.41	-0.20	0.03	-0.23	0.08	-0.16	0.11
C26	-0.19	-0.03	0.07	0.41	-0.17	-0.20	0.19	-0.07	-0.06	0.07	-0.00
C27	-0.41	-0.13	-0.07	-0.06	-0.09	-0.00	0.17	-0.07	0.06	-0.07	0.16
C28	-0.28	-0.17	-0.01	-0.09	0.07	-0.04	-0.02	-0.16	0.01	-0.03	0.13
C29	-0.09	0.24	0.05	-0.61	-0.11	0.14	-0.14	0.27	0.01	0.00	0.09
C30	-0.00	0.04	0.08	-0.76	-0.50	0.01	0.06	0.34	-0.03	0.13	-0.20
C31_33	0.10	-0.02	0.09	-0.23	-0.10	0.20	0.24	-0.04	0.14	-0.23	-0.00
	ACTIVITY EFFECT (E act)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
C10_12	6,861.3	7,085.3	6,475.5	5,146.1	3,512.4	(7,033.7)	14,563.3	10,647.3	2,162.2	3,676.5	3,625.2
C13_15	14,636.7	13,837.5	11,442.4	10,208.6	6,535.6	(9,074.0)	14,425.7	10,817.5	2,682.6	5,376.3	5,874.6
C16	3,264.6	3,178.4	2,620.8	2,051.5	1,284.5	(2,016.7)	3,122.4	1,779.5	407.1	1,145.1	1,434.2
C17	2,288.7	2,227.7	1,994.7	1,555.9	1,064.6	(1,710.3)	2,371.6	1,830.9	481.5	958.1	1,102.8
C18	428.0	490.6	502.5	414.2	307.6	(515.7)	747.7	568.7	138.7	277.3	320.5
C19											
C20_21	20,080.8	23,858.8	20,859.2	14,347.8	7,587.7	(13,198.9)	24,109.7	17,905.8	4,435.5	7,748.8	6,853.0
C22	6,003.4	6,985.7	7,016.8	5,400.3	3,055.8	(5,523.5)	12,554.3	12,054.4	3,122.3	5,673.5	5,362.2
C23	14,322.2	16,347.1	13,942.6	11,429.2	9,822.3	(17,604.7)	23,601.4	17,958.1	4,554.0	9,036.6	9,848.6
C24	31,808.3	37,061.7	35,130.6	27,075.5	19,638.7	(33,505.2)	48,822.3	38,757.2	9,537.9	17,189.0	17,178.3
C25	2,009.4	2,102.9	2,002.5	1,564.4	882.1	(1,162.1)	1,726.7	1,286.8	318.3	590.1	602.2
C26	231.1	262.8	269.2	224.2	163.8	(253.0)	358.1	286.4	69.0	131.9	143.2
C27	489.8	532.7	526.9	417.4	307.0	(501.2)	722.3	576.9	142.0	269.4	294.5
C28	1,565.9	1,756.0	1,745.3	1,386.3	1,031.3	(1,713.8)	2,476.4	1,953.1	482.5	895.4	962.9
C29	1,811.6	2,325.3	2,269.2	1,698.7	1,176.9	(1,886.6)	2,480.9	2,218.9	631.3	1,134.8	1,195.7
C30	331.7	436.2	427.6	317.1	220.7	(346.2)	448.8	408.5	115.8	212.3	227.3
C31_33	1,080.2	1,273.8	1,280.8	1,006.7	665.0	(1,260.2)	2,446.2	2,136.9	582.7	1,053.2	990.8
	STRUCTURAL EFFECT (E str)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
C10_12	(10,395.7)	8,037.1	(9,643.4)	2,524.0	(18.5)	8,502.9	(13,554.6)	(9,767.2)	7,718.3	(6,351.9)	957.5
C13_15	(11,697.0)	(5,808.5)	(1,773.6)	(13,851.9)	(11,437.7)	385.1	1,687.8	2,014.8	1,832.5	5,020.0	(989.4)
C16	237.9	10,741.7	(4,005.3)	7,074.9	(2,860.7)	1,353.9	1,906.7	(875.8)	3,714.2	(4,863.3)	970.4
C17	2,760.2	3,197.7	865.9	(818.5)	(2,919.6)	4,291.5	(424.0)	378.9	1,203.6	(1,448.6)	2,762.5
C18	(58.3)	1,786.2	(1,643.7)	(114.3)	184.3	375.2	(270.3)	(812.2)	362.6	(452.6)	(649.3)
C19											
C20_21	(5,617.7)	(43,273.4)	8,441.6	(12,612.8)	(1,274.2)	28,608.2	9,297.9	(21,424.9)	(2,262.8)	(14,043.4)	400.7
C22	4,034.2	(888.1)	3,429.0	(5,658.0)	6,312.3	4,741.4	(5,518.1)	5,044.2	4,797.9	(3,302.3)	(1,527.8)
C23	21,248.0	13,973.0	13,673.8	(4,793.9)	(32,809.6)	(6,452.7)	8,295.0	(16,202.4)	1,892.9	8,802.5	473.1
C24	28,477.5	(81,188.8)	75,397.4	(44,991.8)	62,184.8	(227,702.7)	117,370.2	85,023.2	(144,428.0)	74,223.5	(14,001.1)
C25	(163.9)	4,078.2	(2,095.4)	(25.2)	(1,142.1)	3,156.3	53.0	367.0	1,241.6	(69.6)	289.1
C26	12.3	76.4	(26.3)	(1,146.7)	291.8	373.7	(399.8)	(22.2)	154.9	(9.2)	83.6
C27	760.6	532.9	413.0	122.3	502.7	(101.4)	(746.2)	(17.9)	(231.2)	615.3	(609.6)
C28	1,382.1	2,341.6	552.2	889.0	(956.1)	541.6	955.9	1,451.2	868.9	(360.6)	(343.5)
C29	3,504.7	(5,462.0)	(861.8)	10,101.6	2,124.2	(3,911.9)	442.0	531.7	(1,315.2)	(871.9)	(919.6)
C30	432.0	(218.0)	(335.5)	2,468.7	2,020.9	(447.7)	(522.0)	(172.2)	(113.1)	(582.0)	1,336.8
C31_33	(1,497.3)	(292.0)	(198.4)	1,502.2	(418.1)	2,891.2	(715.5)	(284.2)	1,571.8	(800.1)	1,663.6
	INTENSITY EFFECT (E int)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
C10_12	(5,222.2)	(14,997.7)	6,847.1	(1,108.5)	(13,850.9)	36,651.9	33,084.1	(34,206.5)	(11,852.4)	(6,179.3)	1,896.7
C13_15	(15,921.5)	(33,783.8)	(240.9)	42,844.1	(55,032.5)	22,385.5	(3,086.4)	(19,393.4)	11,928.4	102.5	10,082.7
C16	(6,142.4)	(18,447.0)	2,082.2	(6,476.6)	(6,493.9)	5,377.4	(5,266.1)	(10,493.2)	3,722.3	16,920.2	(2,048.2)
C17	(8,472.8)	(7,162.1)	(709.6)	(554.2)	582.4	(3,007.2)	(1,906.4)	11.8	177.0	3,183.2	842.4
C18	(701.7)	(1,641.5)	1,794.7	213.6	(415.8)	46.5	18.1	259.1	(218.8)	1,289.9	1,388.6
C19											
C20_21	29,042.7	2,326.1	(17,624.6)	(37,313.8)	(60,534.6)	50,362.5	(16,024.3)	(6,645.5)	23,870.1	(31,236.9)	(15,208.1)

C22	(6,785.2)	(3,509.1)	3,132.6	(7,183.0)	(28,331.4)	29,569.9	41,142.8	(6,582.0)	4,256.6	(12,208.3)	(9,268.4)
C23	(7,182.2)	(50,613.6)	(17,959.3)	15,045.5	68,223.6	1,782.2	(26,650.9)	9,553.3	7,253.8	10,511.3	2,171.5
C24	(40,859.1)	56,401.5	(78,763.8)	19,004.8	(60,935.7)	251,873.5	(126,805.5)	(94,900.3)	133,366.8	(89,659.0)	(4,245.9)
C25	(3,623.6)	(6,429.4)	3,066.9	(2,142.1)	(6,680.5)	(2,529.3)	349.5	(3,186.2)	1,088.3	(2,377.6)	1,647.5
C26	(399.0)	(57.6)	171.3	1,189.8	(503.8)	(543.3)	525.5	(214.2)	(198.7)	231.9	(6.3)
C27	(1,866.6)	(604.9)	(352.2)	(345.7)	(508.7)	(2.8)	959.2	(430.0)	373.0	(482.1)	1,200.0
C28	(4,073.5)	(2,545.2)	(233.3)	(1,655.0)	1,383.4	(661.6)	(370.0)	(3,341.5)	167.6	(768.9)	3,158.3
C29	(1,517.0)	4,635.5	1,095.3	(13,473.5)	(2,308.1)	2,910.0	(2,637.8)	6,387.8	231.2	62.3	2,575.1
C30	(1.0)	163.6	307.2	(3,102.8)	(2,014.1)	55.5	221.5	1,478.0	(158.4)	709.2	(1,134.0)
C31_33	1,009.8	(234.2)	1,121.2	(3,053.3)	(1,279.3)	2,768.8	4,633.4	(938.0)	3,795.1	(6,043.5)	(86.7)
	CONTRIBUTIONS OF DRIVING FACTORS TO TOTAL EFFECT (Tera Joule)										
	2004-2003	2005-2004	2006-2005	2007-2006	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
ΔE_ Act	107,213.46	119,762.34	108,506.41	84,243.95	57,256.00	- 97,305.67	154,977.88	121,186.78	29,863.40	55,368.22	56,015.92
ΔE_Str	33,419.56	- 92,365.90	82,189.47	- 59,330.42	19,784.35	- 183,395.44	117,857.97	45,231.85	- 122,991.09	55,505.77	- 10,102.84
ΔE_Int	- 72,715.26	- 76,499.38	- 96,265.15	1,889.37	- 168,699.95	397,039.61	- 101,813.37	- 162,640.84	177,802.15	- 115,945.08	- 7,034.79
ΔE_Tot	67,917.77	- 49,102.94	94,430.74	26,802.91	- 91,659.61	116,338.50	171,022.48	3,777.79	84,674.46	- 5,071.08	38,878.29
	% SHARES OF DRIVING FACTORS IN TOTAL EFFECT (%)										
	2004-2003	**2005-2004**	**2006-2005**	**2007-2006**	**2008-2007**	**2009-2008**	**2010-2009**	**2011-2010**	**2012-2011**	**2013-2012**	**2014-2013**
ΔE_ Act	1.58	(2.44)	1.15	3.14	(0.62)	(0.84)	0.91	32.08	0.35	(10.92)	1.44
ΔE_Str	0.49	1.88	0.87	(2.21)	(0.22)	(1.58)	0.69	11.97	(1.45)	(10.95)	(0.26)
ΔE_Int	(1.07)	1.56	(1.02)	0.07	1.84	3.41	(0.60)	(43.05)	2.10	22.86	(0.18)
ΔE_Tot	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00