RAMEA User Manual
Application - Case studies in Emilia-Romagna

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Summary

1. Context

Linking environmental and economic indicators encourages and facilitates the involvement of the decision makers, who are likely to be more familiar with socio-economic concepts (such as Gross Domestic Product - GDP), but who are having to pay an increasing amount of attention to the effects of economic activities on the environment.

RAMEA is an environmental accounting system useful to evaluate the economic and environmental performance of regions and to inform regional policies/strategies about sustainable development (production of economic activities, consumption of households, level of employment, emissions in air). RAMEA is based on an international accepted methodology (UN, Eurostat), reliable data (official statistical accounts) and standardized systems (SNA 1993[1], SEEA 2003[2], ESA 1995[3]). These conditions assure its coherency with similar tools at national level (NAMEA - National Accounting Matrix including Environmental Accounts).

2. Objectives

The first pilot project of RAMEA in Emilia-Romagna is realized by Arpa Emilia-Romagna, the Regional Environment Agency, in close collaboration with IRPET[4] and ISTAT[5]. The main objectives of the study are:

- to link the economic knowledge on production and consumption activities to the emissions in air exerted on the environment;
- to build a tool useful for reports (in particular environmental reports of Strategic Environmental Assessment - SEA), studies, regional planning;

Two matrices were produced, for year 1995 and 2000, using:

- regional economic data supplied by IRPET for 30 economic branches plus 3 types of household consumptions, using a multi-sector and multiregional econometric model which gives the possibility to produce economic accounting matrices, coherent with national accounting ones, for all Italian regions (Casini Benvenuti & Paniccià, 2003);
- official database of 21 pollutant emission in air at provincial level by National Environment Agency (APAT, 2004)

[1] The System of National Accounts (SNA) consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules. Together, these principles provide a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for purposes of economic analysis, decision-taking and policy-making. The 1993 SNA has been prepared under the joint responsibility of the United Nations, the International Monetary Fund, the Commission of the European Communities, the OECD and the World Bank (OECD 2007).

[2] The Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003 referred to as SEEA 2003, is a satellite system of the System of National Accounts. It brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. It provides policy-makers with indicators and descriptive statistics to monitor these interactions as well as a database for strategic planning and policy analysis to identify more sustainable paths of development (United Nations *et al* 2005).

[3] The European System of National and Regional Accounts (1995 ESA, or simply: ESA) is an internationally compatible accounting framework for a systematic and detailed description of a total economy (that is a region, country or group of countries), its components and its relations with other total economies (OECD 2007).

[4] IRPET, Regional Institute for Economic Planning in Tuscany (www.irpet.it).

[5] ISTAT, Italian National Institute of Statistics (www.istat.it).

The methodology to link the two sets of data was studied in close collaboration with IRPET and it is partially based on previous experiences of regional NAMEA for two Italian regions - Toscana and Lazio (Bertini et al. 2007, ISTAT 2006a-b)[6]

3. Application of RAMEA

We will use RAMEA 2000 for three different kinds of analyses, to explore some of the possibilities that this type of tool offers to the regional planning/reporting:

- monitoring regional air emissions and eco-efficiency
- comparing regional and national eco-efficiency
- understanding the indirect effects/responsibilities of electricity sector

RAMEA 2000 is illustrated in a very simplified version in Table 1, with values for each macro-sector (economic and environmental) calculated as percent to total.

Table 1 - RAMEA 2000 for Emilia-Romagna Region (%). Source: Arpa Emilia-Romagna

		Current Prices			GHG emissions	Acidification	Local air quality		
NACE (COICOP)	**Sectors**	**Output**	**Gross Value Added**	**Final Consumption**	**CO2 eq**	**H+ eq**	**PM**	**NMVOC**	**CO**
A, B	Agriculture, hunting and forestry, fishing	2,8	4,0	-	12,2	47,0	24,2	4,6	9,8
C	Mining and quarrying	0,1	0,1	-	0,1	0,1	0,2	0,2	0,0
D	Manufacturing activities	41,2	27,4	-	31,5	21,2	31,3	30,7	2,4
E	Electricity, gas and water supply	1,3	1,3	-	14,3	10,2	4,6	3,2	0,5
F	Construction	5,5	5,0	-	0,2	0,1	2,2	3,9	0,1
G, H	Wholesale and retail trade, hotels and restaurants	14,4	17,8	-	2,0	0,7	0,9	1,7	0,5
I	Transport, storage and communication	6,4	7,1	-	7,0	7,5	13,2	6,9	5,6
J-Q	Other services	28,2	37,1	-	6,2	1,9	2,1	1,3	2,1
07	Private traffic	-	-	3,4	12,3	9,1	13,3	34,1	70,3
04	Heating, cooking, air cond	-	-	2,1	14,1	2,1	8,0	1,9	8,0
-	Other consumptions	-	-	94,6	0,1	0,0	-	11,4	0,7
	Economic activities	**100,0**	**100,0**	**-**	**73,5**	**88,8**	**78,7**	**52,6**	**21,0**
	Households	**-**	**-**	**100,0**	**26,5**	**11,2**	**21,3**	**47,4**	**79,0**
	Total	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**

As a monitoring and descriptive system RAMEA allows analyzing the pressures placed on the environment by the economic sectors and households: in this report we will highlight the key sectors for Green House Gas (GHG) emissions, acidification and local air quality, establishing a direct link with their economic performances (in terms of production and value added) and developing eco-efficiency indexes (i.e. tons of pollutants emitted per millions of euros of production/value added).

The eco-efficiency of Emilia-Romagna can be easily compared with the same indicators for Italy and a more detailed analysis (Shift-Share analysis) will be carried on to better understand the reasons of different GHG emission intensities of regional economic sectors in comparison with the national level[7].

[6] The methodology mainly deals with the activities carried out to shift from the CORINAIR process-oriented source nomenclature (SNAP 97 codes) to the RAMEA socio-economic nomenclature (which includes economic activities described by NACE codes plus household consumption), and in particular: (i) the analysis of the qualitative link between each SNAP 97 process and RAMEA economic activities and (ii) the quantitative allocation of the emissions of each SNAP 97 process to the related RAMEA activities. Since there is no standard connection between SNAP and NACE categories, the attribution of SNAP-based emission data to NACE-based accounts depends on the economic structure of the region. In addition to that, only emission whose source is anthropic is taken into account, excluding all emissions related to natural phenomena.

[7] Thanks to Shift-Share analysis we will isolate and quantify the role of the productive structure as a cause for the average gap between regional and national efficiency obtaining also, in a complementary way, a measure of the role of the specific efficiency of emissions of productive sectors. The choice of this methodology derives from the search of

Because RAMEA in its complete version comprises an input-output (I/O) table, it is possible to perform inter-sectoral input-output analyses, to highlight the role of intermediate consumption, to identify indirect responsibilities and to forecast and quantify the potential effects of different development policies: in this report we will use the I/O table to understand the indirect effects of electricity consumed within the region.

4. Findings/Output

The simplified version of RAMEA 2000 showed in Table 1 highlights the different contribution of sectors and households to economy (output, value added and final consumption) and the environment (GHG[8], acidification[9], local air quality). This allows simple but interesting analysis of data:

- Manufacturing is the sector with the higher contribution to the output (41.2%) but also with a high pressure on the environment (GHG 31.5%, acidification 21.2% and PM[10] 31.3%);
- Electricity sector has a very little contribution to output and value added (1.3% each) but an important pressure in terms of GHG (14.3%) and acidification (10.2%);
- Agriculture has a little contribution to output (2.8%) and value added (4.0%), but a relevant importance in relation to GHG (12.2%), the highest for acidification (47%) and a strong contribution in terms of PM (24.2%);
- Households have a weight on environment that can not be overlooked, in particular for some pollutants like CO2 (31%), NOX (29%), NMVOC (47%) and CO (79%) (see Figure 1).

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effects and factors that could explain the relative efficiency of Emilia-Romagna compared to Italy and could be shown in a more exhaustive way than a descriptive statistic analysis. As a matter of fact the latter can give indications on the relative efficiency of Italy with reference to the whole regional economy (Total Emissions/Total Added Value) or to specific fields, but it can not measure two important effects: (i) the different sectorial composition of the regional economy compared to the national one and (ii) the different efficiency of emission of the regional economic sectors compared to the national average. These effects and their combination can be collected and read by a Shift Share analysis that, thanks to the correspondence and coherence between sectorial economic and environmental variables given by RAMEA, allows attributing the whole observable deviations to the combination of the effects mentioned above, and also quantifies them. Therefore the descriptive comparison between efficiency of every field (Emilia-Romagna/Italy) for GHG generates a deviation matrix between the regional and national average: the application of a Shift Share analysis allows carrying out detailed considerations on such differentials.

[8] GHG takes into account the Global Warming Potential (tonnes of CO_2 equivalent) of CO_2, CH_4 and N_2O, with the formula $GHG = CO_2 + 21\ CH_4 + 310\ N_2O$

[9] Acidification takes into account the Potential Acid Equivalent (tonnes of H+ equivalent) of NO_X, SO_X and NH_3, with the formula $H+\ eq = 1/46\ NO_X + 1/32\ SO_2 + 1/17\ NH_3$

[10] Particulate Matter

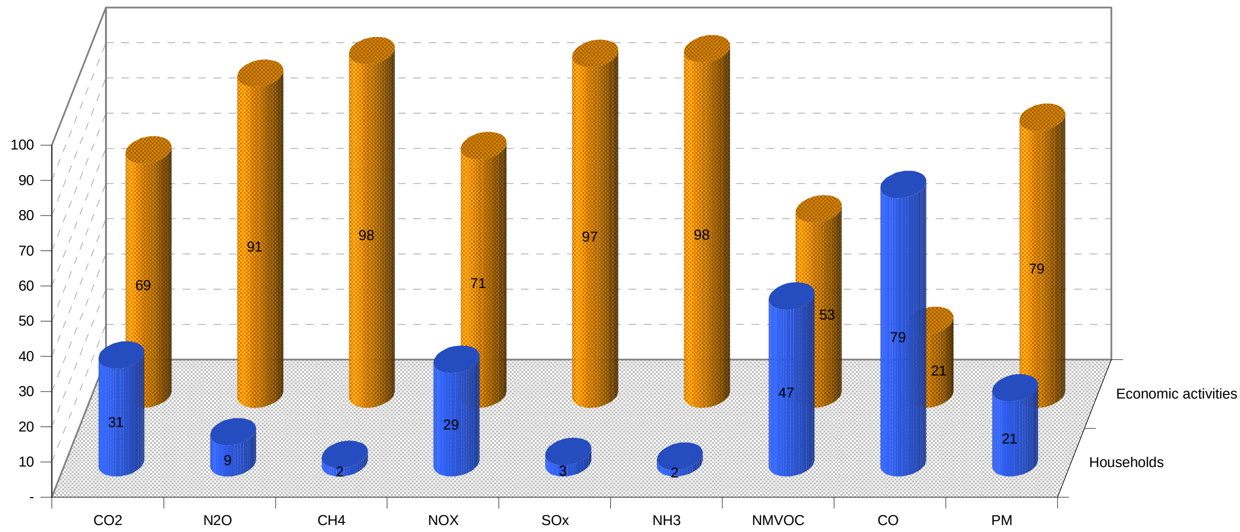

Figure 1 - Economic activities and Households contribution to different emissions (%). Source: RAMEA 2000

4.1. Monitoring regional air emissions and eco-efficiency

If we analyse thoroughly the data of RAMEA 2000, disaggregating the Manufacturing sector D, we can highlight the key sectors for the environmental themes GHG, acidification and local air quality and their related contribution to output.

Figure 2 shows the economic sectors ordered in relation to their contribution to GHG theme: the first three sectors (DI, E and A+B) have a contribution of about 50% to emissions and only 8.4% to output. In particular sector DI “Other non metallic products” (in Emilia-Romagna mainly manufacture of ceramic products) has an overall contribution of 19% to the total of emissions and 4.3% to the output. We can also note that the households’ contribution is about 26.5%, which means that the above three sectors plus households consumption have a weight of 72%. Looking at the green bars (contribution to output) it is interesting to note that they are higher for sectors with little or not so relevant contribution to GHG emissions.

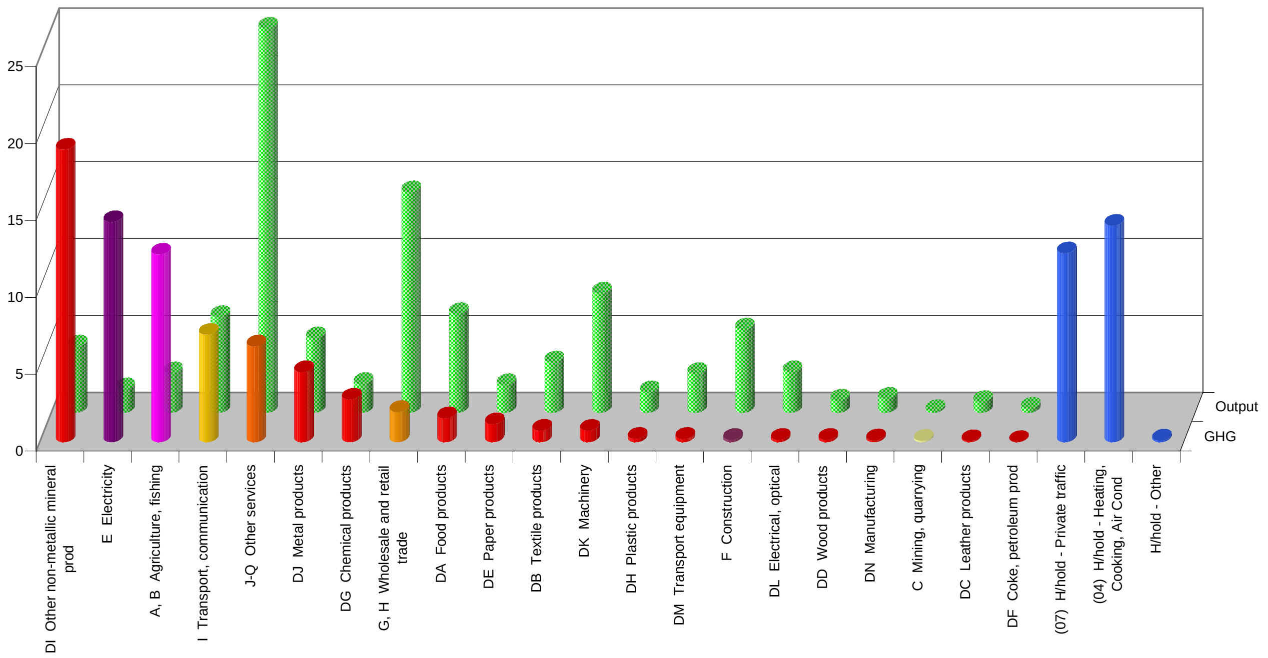

Figure 2 - Contribution of different sectors to Green House Effect and Output (%). Source: RAMEA 2000

If we perform the same analysis for acidification, Agriculture has the major contribution (47%): adding sectors DI, E and households' emission we reach a contribute to the total potential acid equivalent of more than 80%, in comparison to a weight on the total output of about 8% (Figure 3).

Taking into account PM emissions for local air quality (Figure 4), Agriculture has again the highest contribution (24.2%), thing that was not so expected, while in this case sector I "Transport, storage and communication", as well as sector DI (17.4%), has a relevant contribution (13.2%). Even in this case the weight of domestic consumption, in comparison with economic activities, is quite important (21.3%).

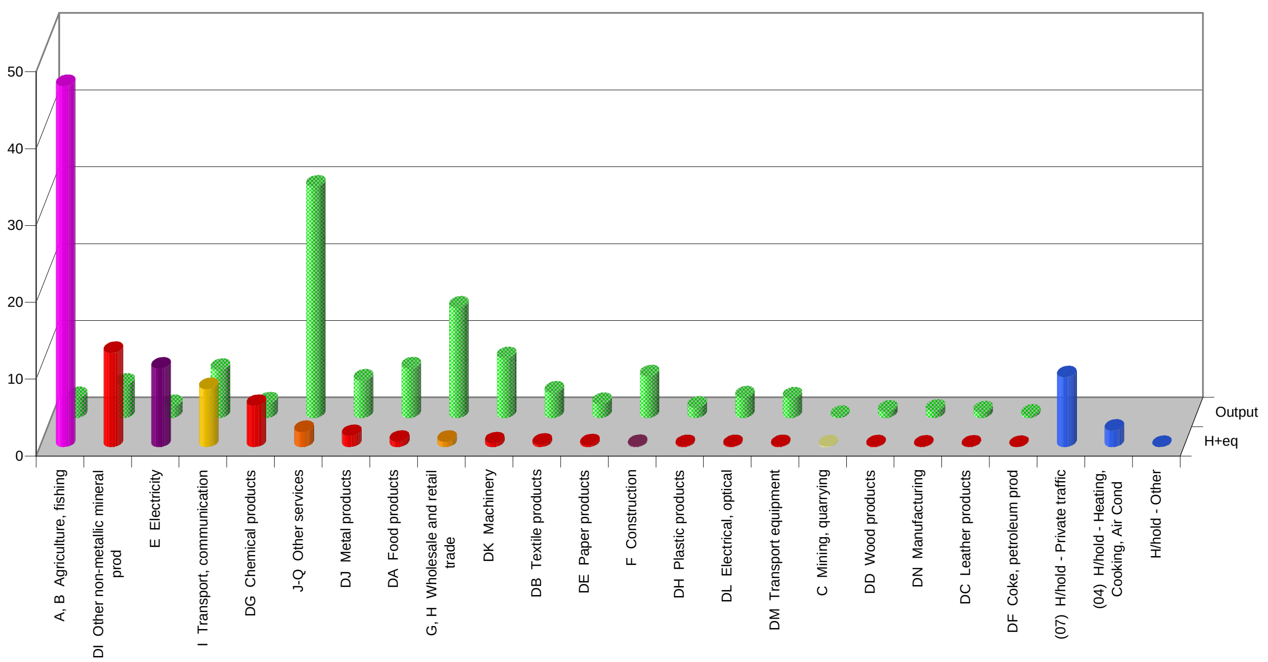

Figure 3 - Contribution of different sectors to Acidification and Output (%). Source: RAMEA 2000

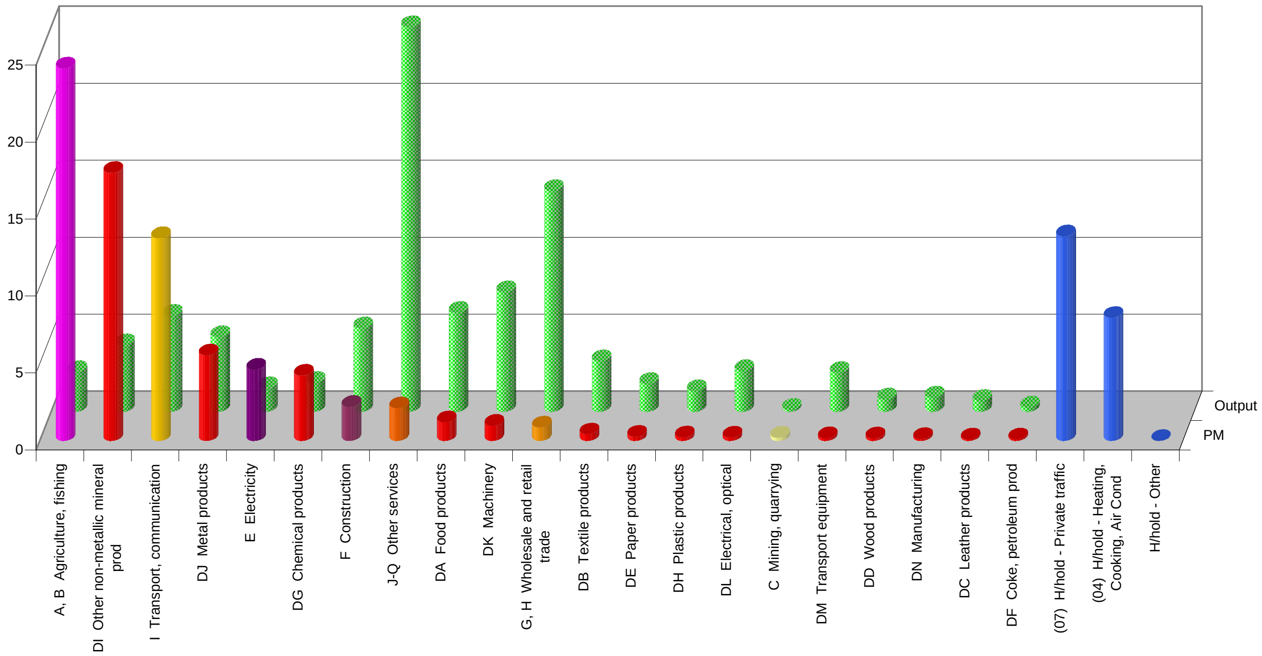

Figure 4 - Contribution of different sectors to PM and Output (%). Source: RAMEA 2000

Starting from RAMEA data it is also possible to calculate indicators called “emission intensity”, expressed as a ratio between emissions and production or value added. As explained in Cervigni *et al* (2005), this ratio can be considered representative, as an inverse index, of the ecological efficiency of a given activity and be the basis for:

- different time period comparisons regarding one economic activity (a reduction in the ratio over time indicates an increase in ecological efficiency and vice versa);
- comparisons between different activities in the same country;
- comparisons amongst different countries.

Figure 5 shows the emission intensity of GHG by production activity in Emilia-Romagna: in this case the sector with the highest ratio (i.e. with the highest emission of GHG per unit of output - about 2000 tons of GHG per millions of euro) is the Electricity sector, and its value is about double related to sectors DI and A+B. These results are linked to the particular approach of the methodology, which is based on the “responsibility of producer”: in fact, in NAMEA/RAMEA framework environmental pressures are allocated to whom directly contributes to them (economic activities and household) and is responsible for generation of emissions. In this case industries with a more polluting productive process (like power generation plants) are, in some way, “damaged” from this approach (Bertini *et al*, 2007:15). In paragraph 4.3 we will give an example, related to Electricity sector, on how it is possible to explore the “responsibility of consumer” by means of an I/O analysis.

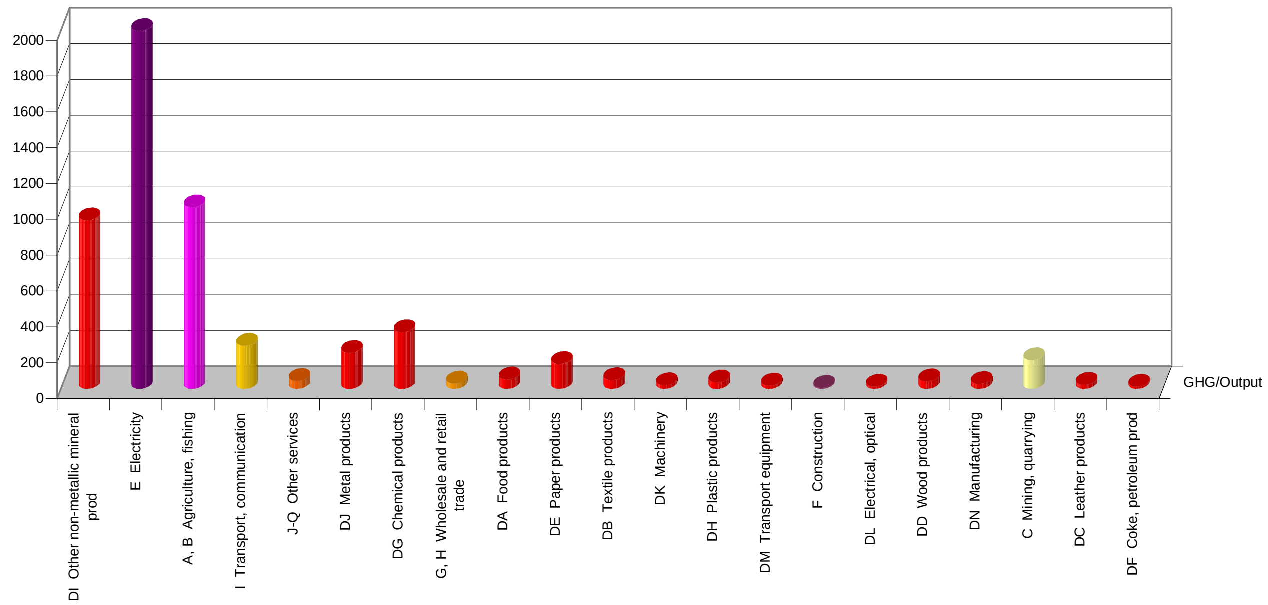

Figure 5 - GHG Intensity of Emissions (Mg CO2eq/Meuro). Source: RAMEA 2000

4.2. Comparing regional and national eco-efficiency

We have developed an analysis of the Intensity of emission of our regional economic system, compared to the national average for the Green House Gas and for all sectors given by RAMEA 2000 and NAMEA 2000 (ISTAT, 2007). This approach was also used in the literature: see e.g. Zaccomer (2005).

Methodological approach

The indicator "intensity of emission", as "Emissions/Added Value", is used in this analysis as a measure of the efficiency in terms of Emissions. The regional average Intensity of emission (X_e) for GHG is the summation of sectorial Intensity of emission, weighted for the ratios of sectors for the Total Added Value (P_e). The national average Intensity (X) is defined in the same way. The region can show a total greater or lower Intensity of emission compared to the national average caused by the combination of the three Shift Share effects:

- Industry mix (or Structural);
- Differential (or National Share);
- Allocative (or Regional Share).

The *Industry mix effect* estimates the part of greater/lower intensity of emissions due to the sector structure of the economic system. It may be that the Intensity of emission is in line with the average national for every field, but the economic industrial mix generates greater/lower Indicators for the whole economic system.

The difference between regional and national average intensity of emission could depend on differences in the specific intensity of emissions of some or all considered fields marking out the *Differential effect*.

Finally, the *Allocative component* adds further analytic information: the covariance between sectorial structure (assuming parity of efficiency) and difference between sectorial intensity of emission (assuming parity of sectorial structure) indicates how much and if the system has a productive specialization in the fields where it carries out a comparative advantage of efficiency.

The total indicator of intensity of emission shown as Total Emissions out of Added Value is defined as X= E/VA for the national average, and as $X_e= E_e/VA_e$ for E-R. Do not forget that the higher is the ratio, the higher is the inefficiency and viceversa.

Let us define:

$X^s_e= E^s_e/VA^s_e$	the indicator of intensity of emission for every economic field in E-R;
$X^s= E^s/VA^s$	the indicator of intensity of emission for every economic field in Italy;
$P^s_e=VA^s_e/ VA_e$	the ratio of sectorial Added Value for E-R;
$P^s=VA^s/ VA$	the ratio of sectorial Added Value for Italy.

Let us consider:

$\sum P^s_e=1$ $\sum P^s=1$ e $X= \sum P^s X^s$ $X_e= \sum P^s_e X^s_e$

We will identify the three effects, provided by the Shift Share model, which explains the Total differential of Intensity of emission between E-R and Italy.

The first effect (structural or *Industry mix*) is given by:

me= $\sum$Xs (Pse - Ps) Hp: Xse – Xs = 0 (parity of Intensity of emission)

m_e takes on positive value (algebraically negative) if the region is specialized in sectors with higher environmental efficiency ($P^s_e - P^s < 0$), as every differential of sectorial Added Value ratio is multiplied by X (as if the region were characterized by the national average efficiency). The effect takes on the minimal value if the region is specialized in more efficient fields on average, compared to the national average.

The second effect (*Differential*) is given by:

$p_e=\sum P^s (X^s_e - X^s)$ Hp: $P^s_e – P^s = 0$ (parity of sectorial structure)

p_e takes on positive value (algebraically negative) if the region is more efficient in terms of emissions (the shift between regional and national efficiency), as if the sectorial ratios of Added Value were the same for the region and for the national average ($X^s_e - X^s <0$).

Finally, the effect of covariance between the two already mentioned, or *Allocative* component, is given by:

$a_e= \sum(X^s_e - X^s) (P^s_e - P^s)$

The effect is negative if the region is specialized, compared to the national average, in the fields with lower Intensity of emission. It takes on the minimal value, in our case, if the region is specialized in the fields in which it records the higher comparative advantage (low Intensity of emission). For this it is an Indicator of covariance between m_e and p_e. Guarini and Tassinari (2000) gave a theoretical explanation of this statistical notion applied to the economic subject.

The total difference between regional and national average Intensity of emission equals the summation of the three effects:

$X_e - X = p_e + m_e + a_e$

Therefore a quantitative measure of the causes of the differentials of Intensity of emission between E-R and the national average is possible. They are reasons deriving from the sectorial structure, and then from “the history of development” of the economic system, or they could be reasons concerning the average state of productive technologies, and then of emissions in the region compared to the national average. For example, it could be that a higher value of regional Intensity of emission is due only to reasons of productive structure in terms of fields on which an energetic-environmental policy cannot have great influence directly; while it could have greater chance of action if the relative total regional inefficiency were due to specific environmental inefficiency of the fields, caused by their technologies or by inefficient public regulation assets.

The more elevated the Indicator the less efficient the considered system or sector. This is reflected in the interpretation of differential between E-R and Italy; so if $X_e - X > 0$, E-R is relatively less efficient (e.g. produces more emissions for unit of Added Value than the national average). The same is true for the signs of the three Shift Share effects: when they are algebraically negative they mark an advantage of efficiency for the region E-R. The same methodology was used for other kind of analysis by Biffignandi and Fabrizi (2006) and by Biffignandi (1993).

Shift-share analysis of the regional economy[11]

First of all it is essential to observe the trend of the Indicator of efficiency (X_e-X) and (X^s_e-X^s) that is the variable object of the Shift Share factorization. The four variables P_e P, that is the relative combination of Added Value, and X_e X, that is the Total Emission for euro million of Total Added Value, are the basis of Shift Share factorization study according to the described approach.

The Figure 6 shows the matrix Sectors/Emissions of the percentage deviation between Indicators X^s_e and X^s, as is $[(X^s_e-X^s)/X^s]$.

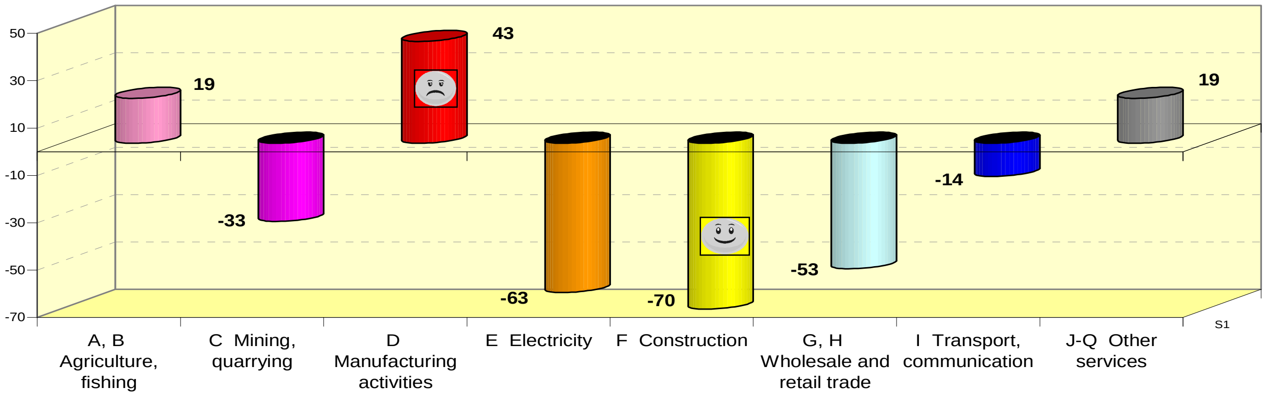

Figure 6 - Difference between Key Performance Indicators $(X^s_e-X^s)/X^s$. Source: RAMEA 2000, NAMEA 2000

However this kind of comprehensive information is insufficient to identify the main drivers of the efficiency gaps and consequently the possible implications for policy makers.

[11] Mazzanti *et al.* (2006) resolved similar analysis for another Italian region (Lazio), still compared to the national average.

The main results of Shift Share analysis are shown in the following chart in terms of effects/components (*m*, *p* and *a*) that contribute to explain the differentials (X_e-X), and are here studied for GHG, according to NAMEA.

Table 2 – Shift Share analysis of the regional economy

Total economic activities	$\sum X_e$	$\sum X$	$\sum (X_e-X)$	$\sum(m_e+p_e+a_e)$	$\sum m_e$	$\sum p_e$	$\sum a_e$
GHG	0,340499	0,412959	-0,0724599	-0,0724599	-0,0248043	-0,0752752	0,0276196
% deviation compared to the national average			-18%				

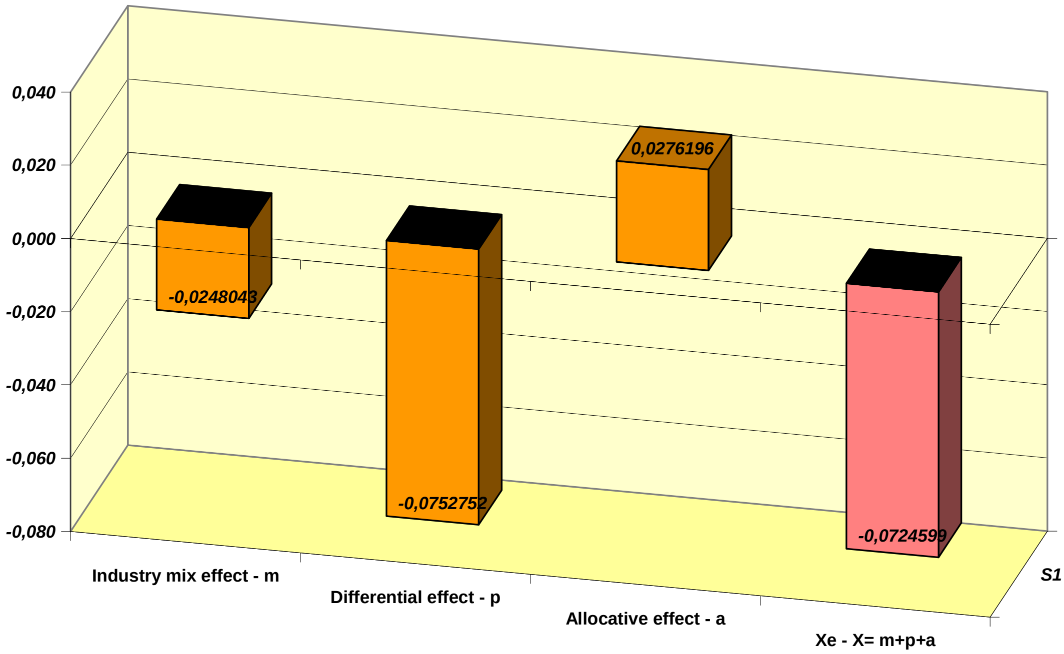

Figure 7 - The three effects of a Shift Share anlaysis of the whole economic system (E-R /Italy): Xe-X= m+p+a. Source: RAMEA 2000 and NAMEA 2000

The results of this first analysis show us that the first two effects identified by Shift Share (m, p) are algebraically negative and highlight the causes of a major efficiency of E-R ($X_e < X$) deriving from an efficient sectorial industry mix and from reasons due to lower Emissions of GHG for unity of Added Value. An algebraically positive sign of the third factor (a) emerges. It tells us the covariance between m and p: it suggests an absence of specialization in E-R in the most efficient sectors, on average. A negative sign of *a* would show us an effective mix of the first two effects. On the whole, the advantage of efficiency of E-R (-18%) seems to be associated to a factor of greater specific environmental efficiency (p= -0,0752752) more than to reasons of sectorial specialization (m=-0,0248043), even if they exist.

Shift Share analysis of regional economic fields (still compared to the national average)

A further analysis of the whole economic sectors allows a reading inside the regional economic system in terms of effects identified by Shift Share. Mazzanti *et al.* (2006) also used this further approach.

First of all let us start our analysis from the efficiency gaps without distinguishing among the three different drivers *(industry mix, national share, allocative components)*, in order to continue with SS analysis and with the possible differences compared to the analysis reported to the whole economic system. We can notice that the analysis of the economic sectors does not confirm a wide spread of E-R about Intensity of emission of GHG, for every sector. We can then verify then if the efficiency in terms of Emission out of Added Value, where it still exists, is lower or higher in the macro-fields compared to the average data (benchmarking between regional and national average economic system). In other words, the analysis of sectorial economy can indicate how much they contribute to the average advantage.

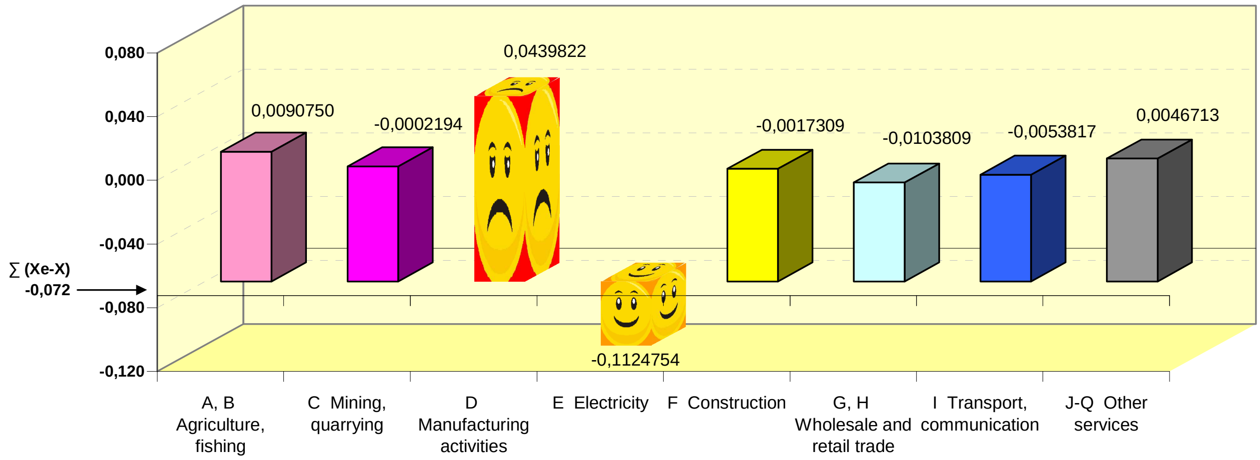

Figure 8 - Benchmarking between the differential for each sector and the average differential for the whole economic system [(Xes-Xs)?(Xe-X)]. Source: RAMEA 2000 and NAMEA 2000

Such a comparison shows the cases in which the gap, favourable to the E-R whole economic system, is greater if it is analyzed specifically for the economic fields. Only one field (E) gives the relative advantage of the region in terms of Emissions for Added Value. As a matter of fact the previous chart shows that the differential of efficiency for field is higher or lower if compared to (X_e - X).

The Shift Share sectorial factorization, shown in the next page, allows to notice other interesting aspects for GHG. These conclusions always refer to the comparison between the efficiency (and the linked drivers) of identified sectors and the national average efficiency.Starting from the result of a lower Intensity of emission in E-R and for the sectors **C, E, F, G+H, I,** compared to correspondents sectors of Italian economic system, we can measure then the rank of lower/greater efficiency of sectorial fields of the region, also referring to the environmental efficiency. About Emissions of GHG, the positive differential (algebraically negative) of E, compared to the efficiency in E-R on average, depends on the greater *industry mix* (m) and *differential* (p) effects, compared to the remaining sectors: consequentially it seems that the structure of Added Value is particularly effective in terms of efficiency of emissions (maximum negative value among the *p*) and of sectorial combination (maximum absolute value among the *m*); positive sign of covariance remains and confirms what has been said; that is the region is not specialized in sub-sectors with greater environmental efficiency in terms of Emission for GHG.

About sector D we can notice an opposite situation: maximum negative differential (algebraically positive) compared to found efficiency for E-R on average and compared to the other sector gaps. The greater relative difference derives from the contributions of the sectorial effect (maximum positive value among the *m*) and of specific emissions (maximum positive value among the *p*). The positive sign of the covariance will suggest us to continue with a Shift Share analysis of the D sub-sectors.

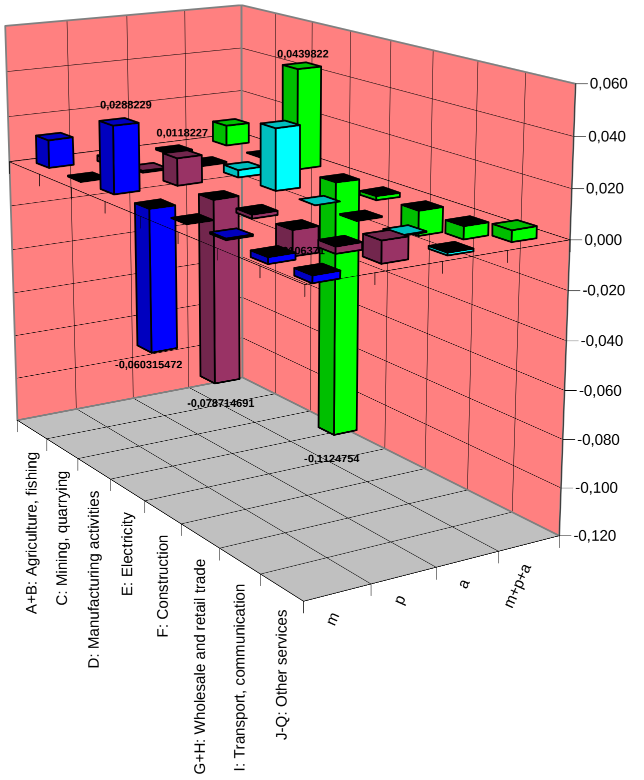

Figure 9 - Shift Share analysis of economic fields: the trend of the coefficients. Source: RAMEA 2000 and NAMEA 2000

Table 2 - Shift Share matrix

Total economic activities	∑Xe	∑X	∑ (Xe-X)	∑(me+pe+ae)	∑me	∑pe	∑ae
GHG	0,3404994	0,4129593	-0,0724599	-0,0724599	-0,0248043	-0,0752752	0,0276196
deviation %			-18%				
A+B: Agriculture, hunting and forestry, fishing	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	1,6036195	1,6925946	0,0090750	0,0090750	0,0122109	-0,0024940	-0,0006419
deviation %			19%				
C: Mining and quarrying	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	0,2843369	0,1346742	-0,0002194	-0,0002194	-0,0004528	0,0007365	-0,0005032
deviation %			-33%				
D: Manufacturing activities	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	0,5483483	0,4914558	0,0439822	0,0439822	0,0288229	0,0118227	0,0033366
deviation %			43%				
E: Electricity, gas and water supply	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	5,0695846	9,0570952	-0,1124754	-0,1124754	-0,0603154	-0,0787146	0,0265547
deviation %			-63%				
F: Construction	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	0,0149001	0,0491699	-0,0017309	-0,0017309	-0,0000421	-0,0017182	0,0000294
deviation %			-70%				
G+H: Wholesale and retail trade, hotels and restaurants	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	0,0531170	0,1169122	-0,0103809	-0,0103809	0,0005637	-0,0106371	-0,0003076
deviation %			-53%				
I: Transport, storage and communication	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	0,4763596	0,5165247	-0,0053817	-0,0053817	-0,0026492	-0,0029385	0,0002060
deviation %			-14%				
J-Q: Other services	**Xse**	**Xs**	**(Xse*Pse) - (Xs*Ps)**	**ms+ps+as**	**ms**	**ps**	**as**
GHG	0,0730957	0,0538107	0,0046713	0,0046713	-0,0029422	0,0086680	-0,0010545
deviation %			19%				

Shift Share analysis of the sub-sectors of Manufacturing D

A Shift Share analysis in the macro-sector D highlights the components that contribute in positive and negative sense to the disadvantage of the field and that confirm a non efficient regional specialization. Such analysis is suggested by the positive covariance of sector D (a= 0,0033366 the region is not specialized in sub-sectors with greater environmental efficiency in terms of emissions of GHG).

Table 3 - Shift Share coefficients of sub-sector DI

DI Fabrication of not metallic products	Xs_e	Xs	(Xs_e*Ps_e) - $(Xs*Ps)$	m_s	p_s	a_s
GHG	2,4742436	2,5881831	**0,1597444**	**0,1749735**	-0,0075262	-0,0077029
deviation %			93%			

The differential is the maximum positive value (0,1597444) and as a consequence the sector is seen as the most negatively impacting. A good specific environmental efficiency is however connected to a non efficient sectorial economic composition (m_s=0,1749735).

Table 4 - Shift Share coefficients of sub-sector DF

DF Coke fabr., industries and treatment of nuclear fuel	XS_e	XS	$(XS_e*PS_e) - (XS*PS)$	m_S	p_S	a_S
GHG	0,1080430	6,6672333	**-0,0718431**	**-0,0555891**	**-0,0709423**	0,0546883
deviation %			-99%			

Industry mix and *differential* effects are shown by maximum negative values (m_s= -0,0555891 and p_s= -0,0709423) and therefore give the maximum positive impact on the differential of sector D (-0,0718431). Between the two effects the specific sub-sectorial efficiency prevails.

Shift Share analysis outputs

On the whole, therefore, the relative efficiency of E-R compared to Italy is mainly explained by an effective lower Intensity of emissions for unity of Added Value, more than by an efficient sectorial composition of the economic system in terms of produced emissions.
The covariance between the two effects (a), that of sectorial mix and of specific efficiency, is positive, that means that E-R is not characterized particularly by a specialization in sectors in which its differential in terms of emissions is greater than the national average. The most efficient sectors are not the ones have more weight on the economic system.

Carrying on the Shift Share analysis of single economic sectors we can get some further elements. The total differentials of efficiency for GHG do not remain in favour of E-R for every sector. As far as the observed differential for the regional average is concerned, we can notice that the ranking of macrofields in contributing to regional relatively advantage is **(1) E (2) G+H (3) I**, (4) F, (5) C. As far as the fields with a disadvantageous impact on the regional average, in increasing order we have **6)J-Q 7) A+B, 8) D.**

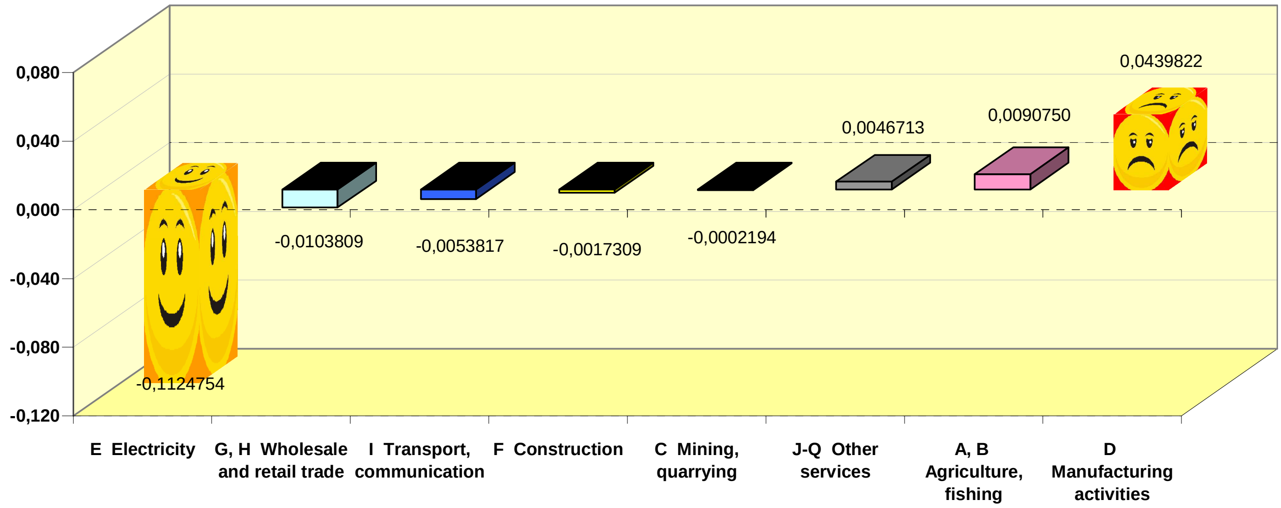

Figure 10 - Shift Share analysis of economic fields (E-R/Italy): from the most positive sector to the least one. Source: RAMEA 2000 and NAMEA 2000

We can observe that the **sector E** contributes positively to the positive differential of efficiency of E-R compared to Italy, more than the other sectors. The sector E seems to be the main sectorial driver of the relative efficiency of E-R in terms of Emission of GHG (-0,1124754).

The same sectors itself turns out to be also more than the others efficient from the point of view of environmental specific efficiency (p maximum relative value) and from the point of view of industry mix effect (m maximum value); instead D is the sector that contributes more the others with a negative turning out on the average differential of economic system (0,0439822): particularly all the three effects are >0, unlike all the other cases, with maximum values both for the effect *m* and for *p*. We could think that the policy strategy could be a combined mix of regional development and environmental policy, in the sector. The positive covariance indicates a non specialization of the macrofield of activities with a greater comparative advantage (low Intensity of emission), that is in the most efficient sectors (positive mix of m and p: m and p<0). Consequently we have carried out a further analysis in sub-sectors: *Ceramics* sector has become determinant on the disadvantageous differential. Here is a ranking of the sub-sectors D:

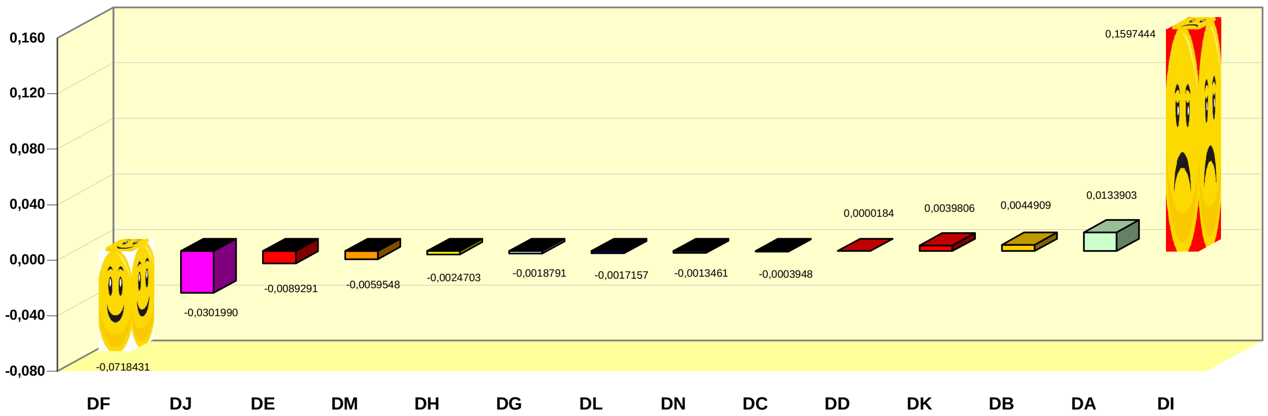

Figure 11 - Shift Share analysis of the sector D (Emilia-Romagna / Italy) from the most positive subsector to the least one: (Xde*Pde-Xd*Pd). Source: RAMEA 2000 and NAMEA 2000

Considering the **sector A+B,** the second for the disadvantage brought to the whole differential of the economic system (0,0090750), industry mix effect denotes that inside this sector the Added Value composition is not effective in terms of efficiency of emission, even if the negative sign of the effect p remains. A negative covariance could lead regional policy to boost to develop those sub-sectors that have a lower Intensity of emission, in order to take the most of the comparative advantage.

In no sectors do we have the positive combination of the three effects (m, p, a<0), but more sectors are characterized by an environmental specific efficiency (in decreasing order G+H, I, A+B, F): a general approach how to derive and analyze the Shift Share signs is explained in Foderà *et al.* (2005). In these sectors where, as a result of an analysis on the whole polluting emissions for sector, we should verify a covariance <0 in correspondence to an effect m<0 we could give strategies for a less impacting sectorial technology: besides increasing the positive effect on the economic system average, it could connect the weight due to the sectorial specialization (m<0) with a greater efficiency in terms of emission of GHG (our case: C, J-Q).

Table 5 - Synthesis of the Shift-Share analysis for sectors D, E, A+B

Sector	Impact	Comments	Notes
D	the most negative impacting (Xs_e – Xs = 0439822)	All the three effects are >0. The factors *m* and *p* are the highest. The *Industry mix* effect quantifies the higher part of Intensity of emission given by the weight of the sector D on the regional economy, compared to the national average	Shift Share analysis of the sub-sectors

Sector	Impact	Comments	Notes
E	the most positive impacting (Xs_e – Xs = -0,1124754)	ms and ps are <0 and are relatively higher. More sector efficiency compared to the national average deriving both from the economy sectorial composition and from reasons connected to the lower emissions of GHG for unit of Added Value	
A+B	the second sector for the disadvantage brought to the whole differential of the economic system: Xs_e – Xs = 0,0090750	Effect p<0, good environmental efficiency of emissions of GHG Effect m>0, shows that inside this sector the Added Value structure is not effective in terms of efficiency of emissions compared to the national average, even if the p sign is algebraically negative.	Covariance <0

4.3. Understanding the indirect effects/responsibilities of electricity sector

As stated above (par. 4.1) RAMEA (and NAMEA) approach considers the direct responsibility of the producer for the allocation of environmental pressures. The availability of an I/O table allows analysis and calculation to the interface between economy and environment, which is based on the model proposed by W. Leontief in the 1970. In this case, we can identify not only who directly contributes to production and related pollution ("responsibility of the producer"), but, by means of the I/O table, it is possible to understand the indirect contribution of intermediate consumption ("responsibility of the consumer"). In particular:

"*the more an industry uses products of which the production is intensive in terms of pollution the higher is the pollution indirectly caused by the production necessary to satisfy the final demand of its product*" (Eurostat 2004:71).

With the I/O table available in RAMEA, it is possible to highlight the role played by sectors and households who demand for electricity (Figure) and thus understand who is indirectly responsible for the high weight of this sector on air emissions. The chart shows the different contribution to the total purchase from sector E, i.e. who and how much demand for electricity. We can see that a part of the electricity produced is used to satisfy needs of sectors DI (10.3%), E itself (9.9%), Services and Commerce together (15.8%); nevertheless it is immediately clear that the higher request comes from households, which could be claimed indirectly responsible for the 34% of the emissions by sector E.

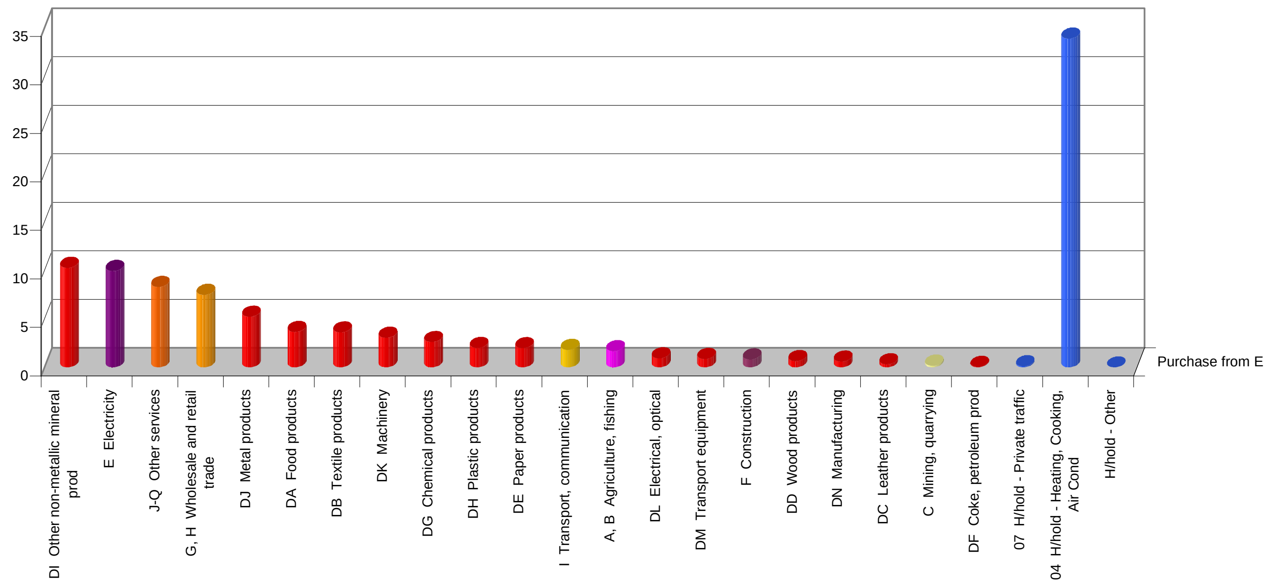

Figure 10 - Purchase from Electricity sector (E) by other sectors and households (%). Source: RAMEA 2000

5. Use of findings (policy, intervention, fiscal)

The main proposal is to use the possibility of forging a clear link between economy and environment that RAMEA gives in SEA's Environmental Report, to assess the potential effects of plans and programmes and suggest decision makers how to develop the territory economically and socially without causing environmental harm. In particular RAMEA can be useful in the:

- determination of the environmental issues, objectives and indicators that should be considered within SEA;
- evaluation of the potential effects of plans and programmes on the environment (together with scenario analysis);
- evaluation of the monitoring system for the programming document;
- decision making and information on the decision.

In Emilia-Romagna Region, RAMEA could be useful to assess regional plans and programmes prepared both for the development of the whole territory and for the different sectors (Energy, Agriculture, Industry…). Taking into account the results of the Shift-Share analysis (Table 5), we have built a prototype of Decision Support Matrix, to support policy makers: after showing the possible scenarios, depending on the possible combination of Shift Share effects, we have identified strategies for sectorial policy.

It could also help to inform the public about the decision making process and chosen strategies, with the help of the integrated economic-environmental indicators already available or through the developing of a single score indicator, like ecological footprint or carbon footprint.

Table 6 - Effects of Shift Share analysis & possible scenarios (Decision Support Matrix)

m: Industry mix	p: Differential	a: Allocative (covariance)	How may Policy Makers react ?
-	-	-	
+	+	+	A joined action of environmental and sectorial development Policy is advisable
+	-	-	Sectorial development Policy to boost environmentally efficient sectors
+	+	-	
-	-	+	Double advantages of the effects m and p. A further Shift Share analysis of the sub-sectors allows us to look into their relative impacts, not being the mix of the effects m e p yet advantageous e.g. Ramea E-R sector D (manufacturing)
-	+	+	A further Shift Share an. can give us information on the situations of the sub-sectors (a>0). An action aiming at the improvement and reduction of the Intensity of emission of sector would be useful.
-	+	-	An effective environmental Policy can contribute to a technological development of sector. Besides improving the positive effect on the average economic system, it could combine the weight given by the sectorial specialization (m<0) with a greater efficiency in terms of emissions of GHG.

The availability of a more extended set of RAMEA together with analysis on the totality of polluting emissions, could allow deepening this kind of analysis. Particularly, they would characterize the trend of the three effects identified by Shift Share analysis, separating the trend of productive structure factors, objects of development regional policy, from the trend of specific pure efficiency, connected to the state of technologies and of the regulations and therefore objects of the environmental policy.

6. Monitoring and upgrading proposal

RAMEA for Emilia-Romagna Region was built for years 1995 and 2000. An upgrade of the 2000 version for the year 2003 was developed for the benchmarking between RAMEA partners: while 1995 and 2000 version are based on robust data, the 2003 version, despite its suitability for the above purpose, should be considered of a lower level of reliability.

A first step should consist in upgrading the 2003 version to the same level of reliability of the others, in order to have a more recent year and consistent time series. This will need an effort to gather robust environmental data on air emissions which, in comparison to economic data, are usually updated with a lower frequency: on the other hand environmental data are more and more important for planners and strictly related to the economic ones, in particular for reduction of GHG emissions through trading schemes and Kyoto project-based mechanisms[12]. Others potential steps could be the development of new environmental themes (emission in water and eutrophication, production of waste, direct and indirect effects of energy …) and the inclusion of social dimension.

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[12] see in particular Directive 2003/87/EC "Emission Trading" and Directive 2004/101/EC "Linking"

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