

Economics for Energy Workshop

Economic Challenges for Energy

Energy Demand and Energy Intensity

Analysis of recent energy intensities in Spain

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Energy Intensity (EI) is a good indicator of the energy efficiency of a country

EI has 2 components:

ENERGY INTENSITY

Energy Consumption

GDP

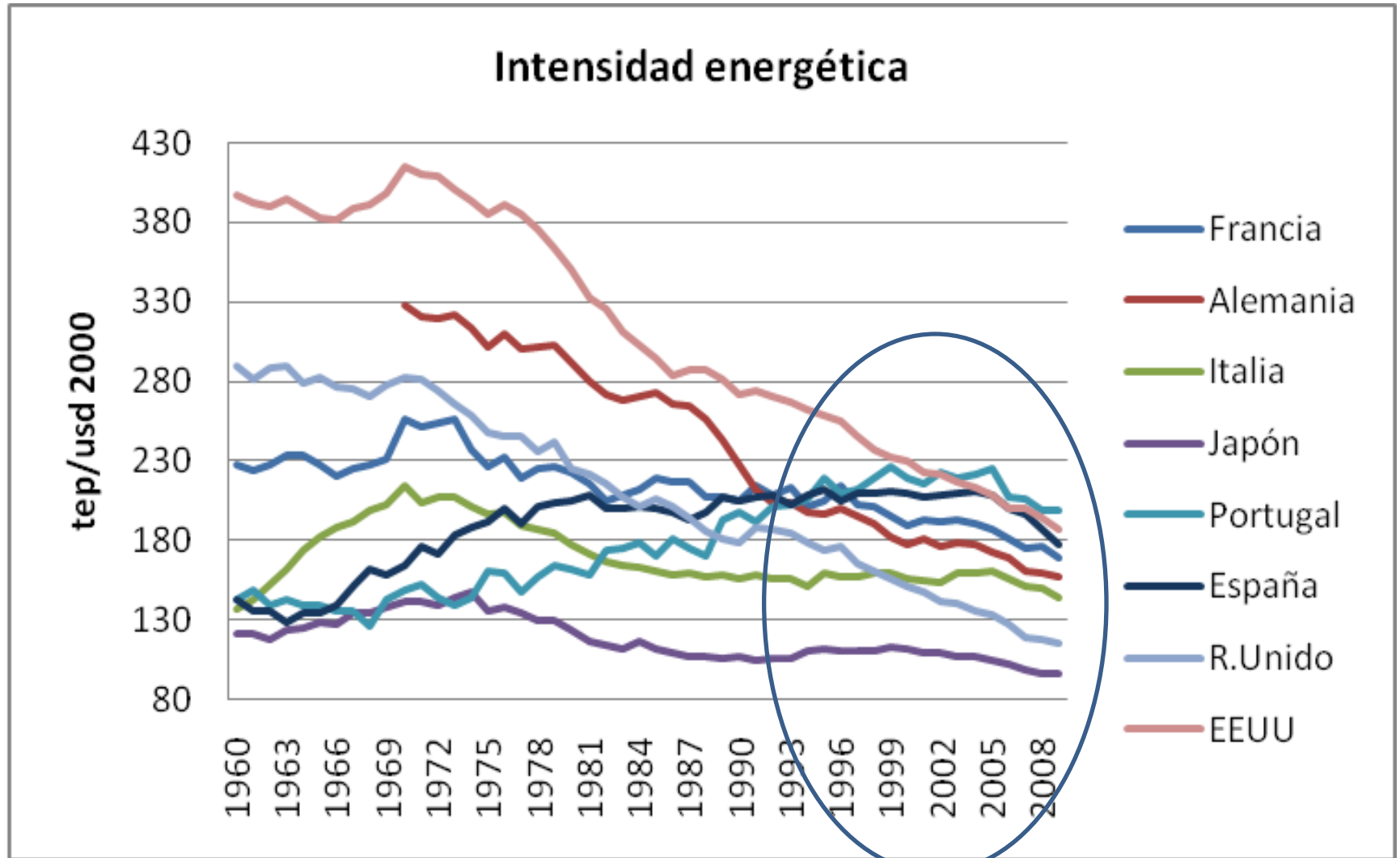
Improved energy efficiency is equal to a reduction of energy intensity

A reduction of energy intensity improves the country competitiveness, creating added value in goods and services with less energy

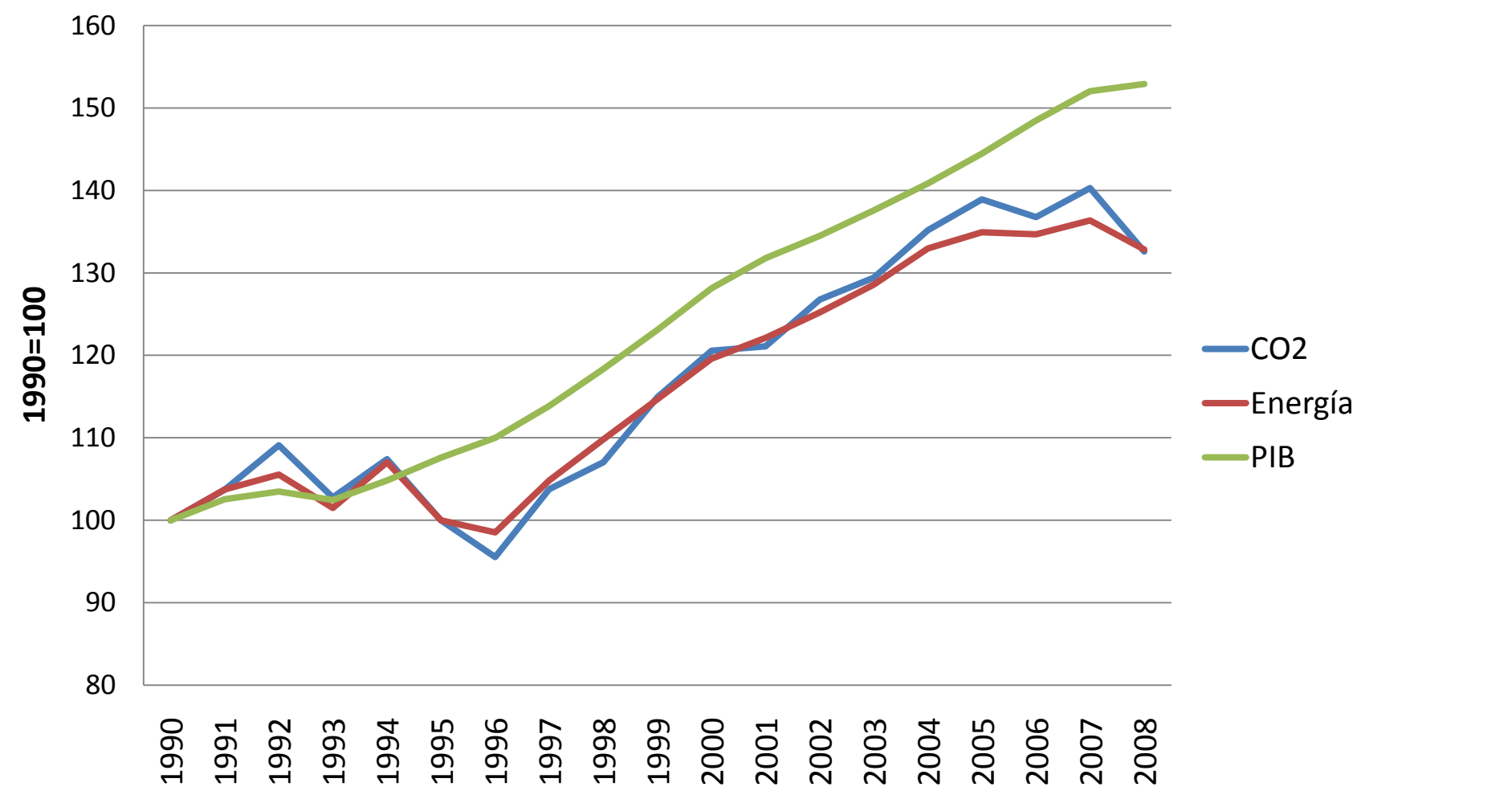
Structure: depends on the economic structure (percentage of energy intensive sectors in GDP total). Also known as activity effect

Efficiency: Includes sectoral efficiency improvements

Spanish EI has followed a different trend than OECD countries



The spanish increase in energy demand and CO2 emissions has been constant, only bellow GDP growth in the last few years



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Some added value to current research

Previous studies

Analysis industrial sector (20% energy consumption)

Analysis least intensive sectors

Input-output analysis of industrial sector & services

Improvements to the methodology

Includes all energy consumption:

- Electricity: 23% consumption
- Transport: 28% consumption
- Households: 12% consumption


Decomposition of EI in 17 +2 sectors:

- Structural effect
- Efficiency effect
- Residencial effect

Analysis EI by sector including indirect energy use

Methodology: LMDI Decomposition

Equation

$$\frac{ET}{YT} = \sum \frac{E_{i,t}}{Y_{i,t}} \frac{Y_{i,t}}{YT} + \frac{ER}{YT}$$


E_t = Total energy consumption in time t.

$E_{i,t}$ = Energy consumption in sector i and time t.

ER= residential energy consumption (households and transport)

Y_t = GDP total in time t.

Y_{it} = Gross Value Added (GVA) sector i in time t.

$S_{it} = Y_{it}/Y_T$

$I_{it} = E_{it}/Y_{it}$

Decomposition model

$$D_{tot} \cong D_{str} + D_{int} + D_{resid} + D_{rsd}$$


Additive decomposition LMDI:

D_{tot} = Variation EI between time t=T & t=0.

D_{str} = Structural effect between time t=T & t=0.

D_{int} = Intrasectoral effect between time t=T & t=0.

D_{resid} = Residential effect between time t=T & t=0.

Methodology: LMDI Decomposition

Decomposition elements

$$D_{\text{tot}} \cong D_{\text{str}} + D_{\text{int}} + D_{\text{resid}}$$



$$D_{\text{str}} = \exp \left[\sum_i W_i' \ln(S_{i,T} / S_{i,0}) \right]$$

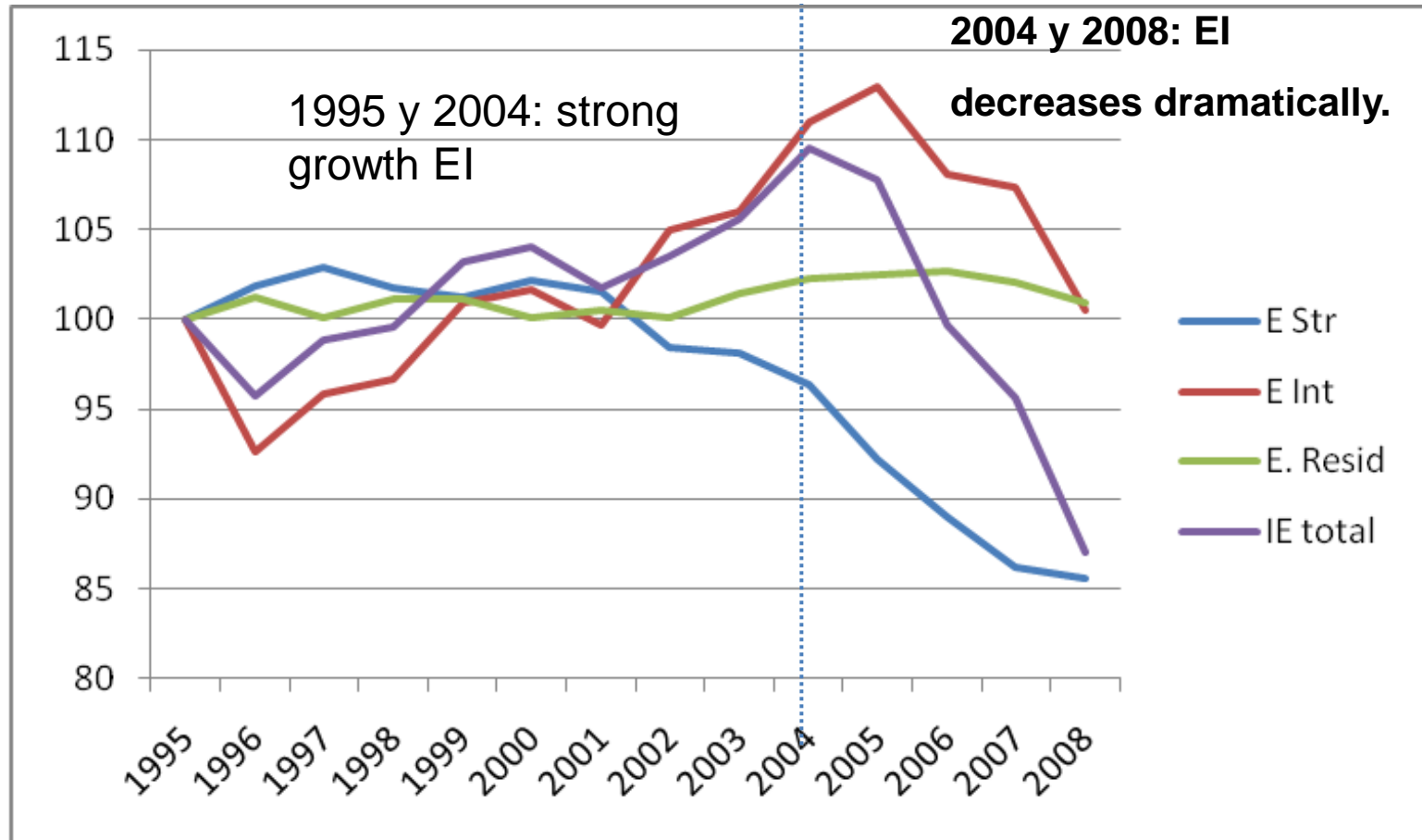
$$D_{\text{int}} = \exp \left[\sum_i W_i' \ln(I_{i,T} / I_{i,0}) \right]$$

$$D_{\text{resid}} = \exp \left[\sum_i W_i' \ln(E_{R,T} / Y_T) / (E_{T,0} / Y_0) \right]$$

$$W_i' = \frac{L(E_{iT} / Y_T, E_{i,0} / Y_0)}{L(E_T / Y_t, E_0 / Y_0)}$$

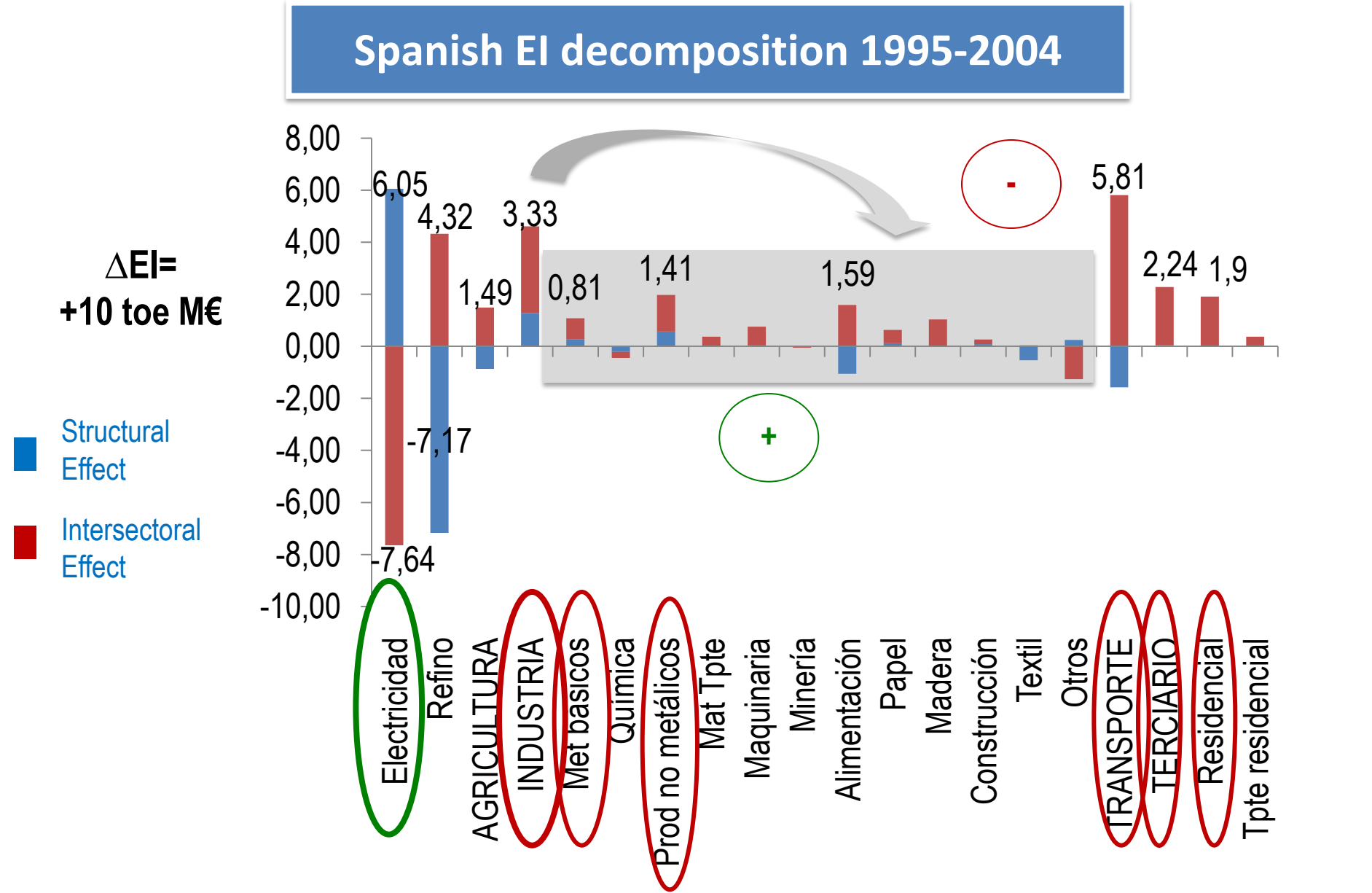
Structural effect is responsible for the decrease of EI

Spanish EI decomposition 1995-2008

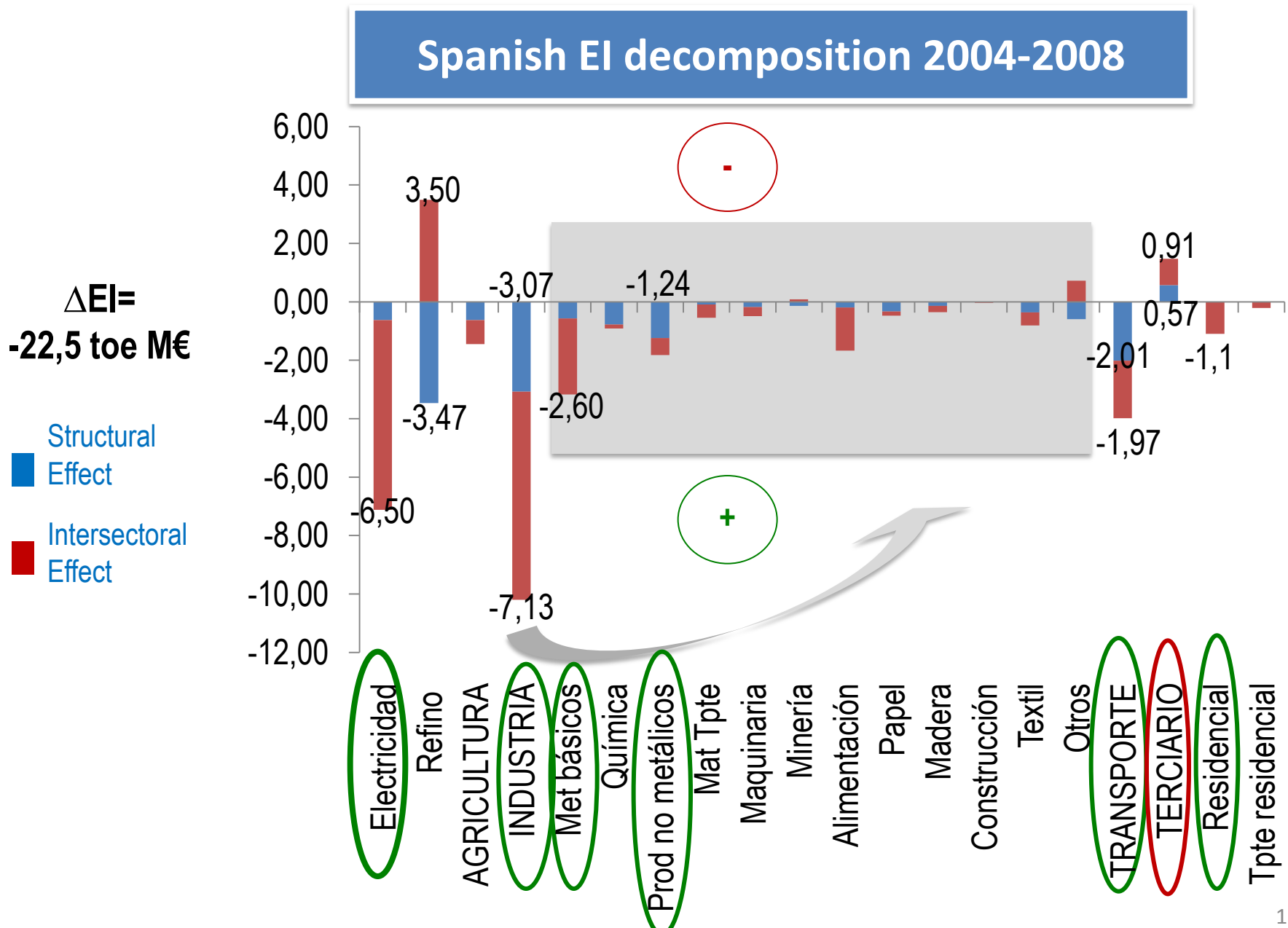


EI shows stages of materialization and dematerialization

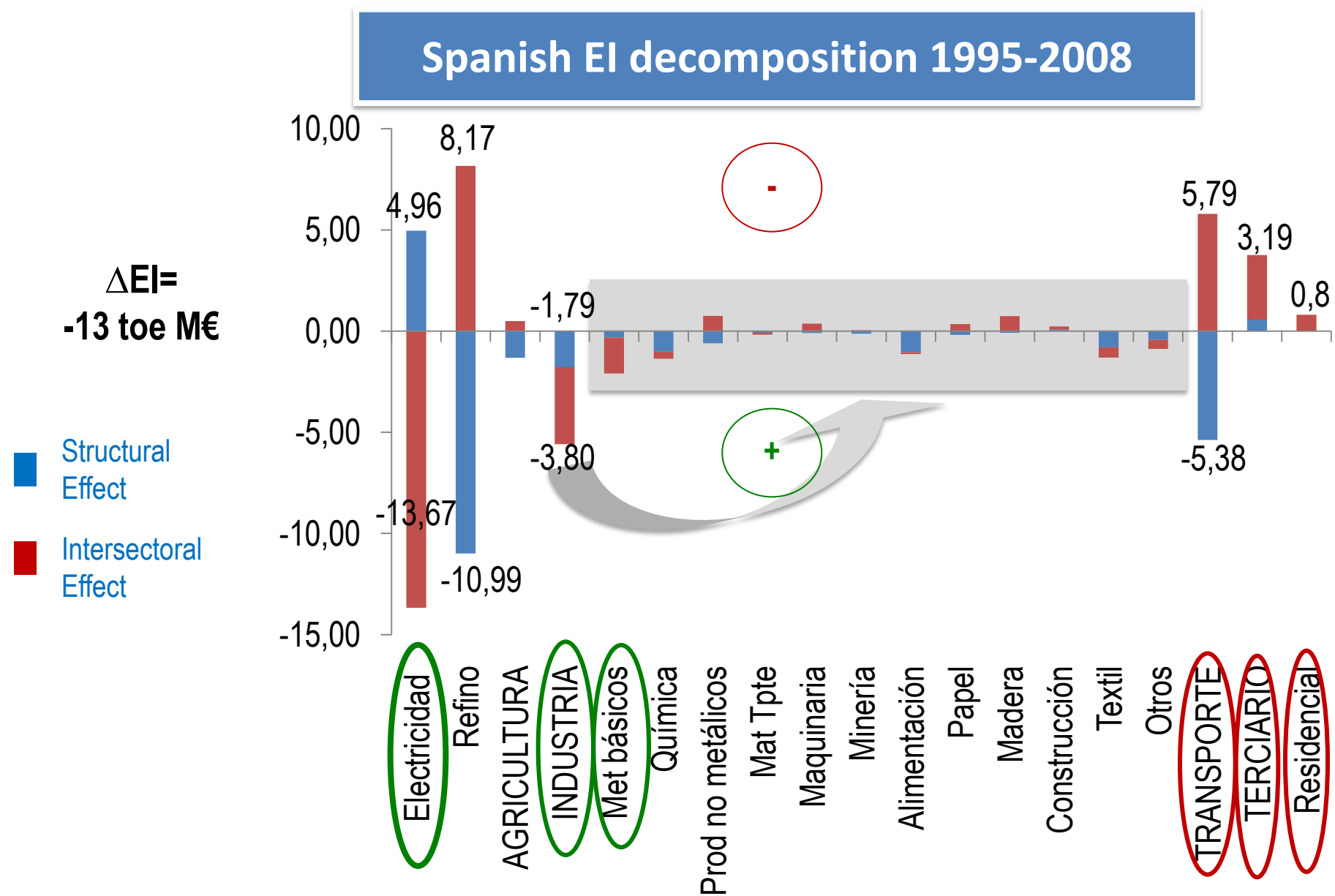
Industry and transport responsible for bad evolution between 1995 and 2004



Power sector and industry drive improvements in EI

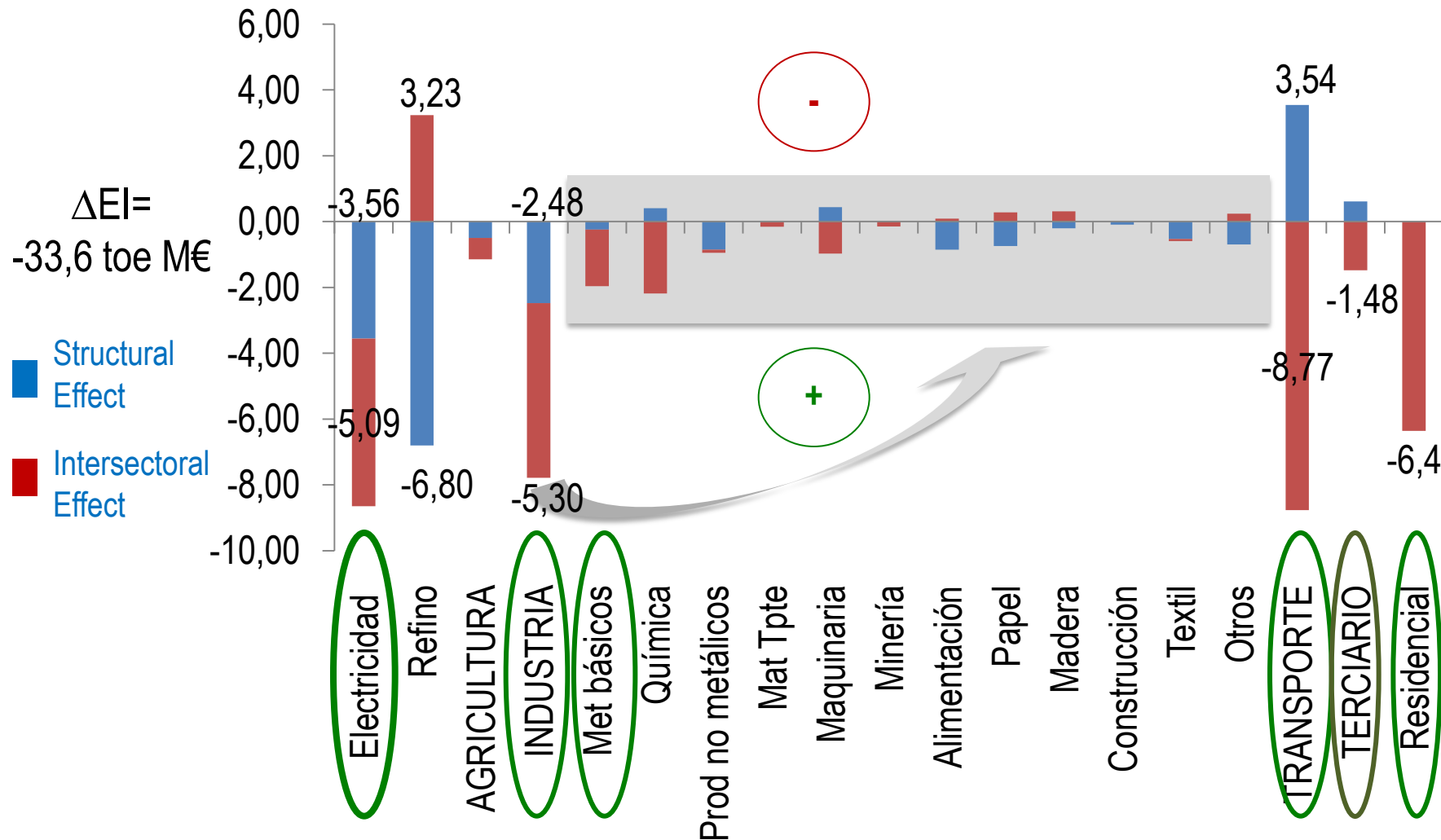


The unfavourable results between 1995 and 2004 are overcome with improvements between 2005 and 2008



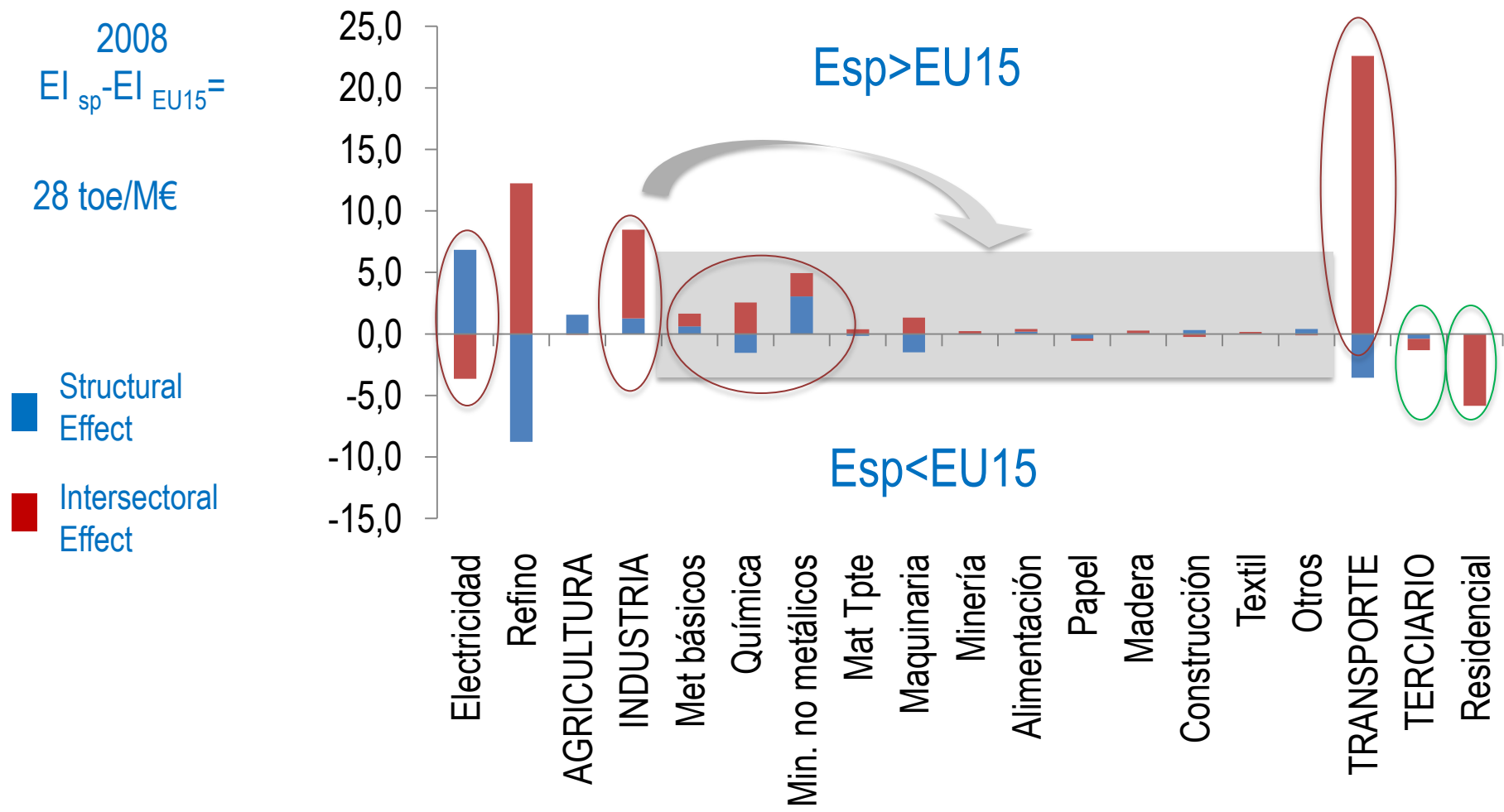
The EU15 shows a continued improvement of EI

EU15 EI decomposition 1995-2008



If Spain had the same EI than the EU15 the country could have saved between 1,5 and 3% of GDP

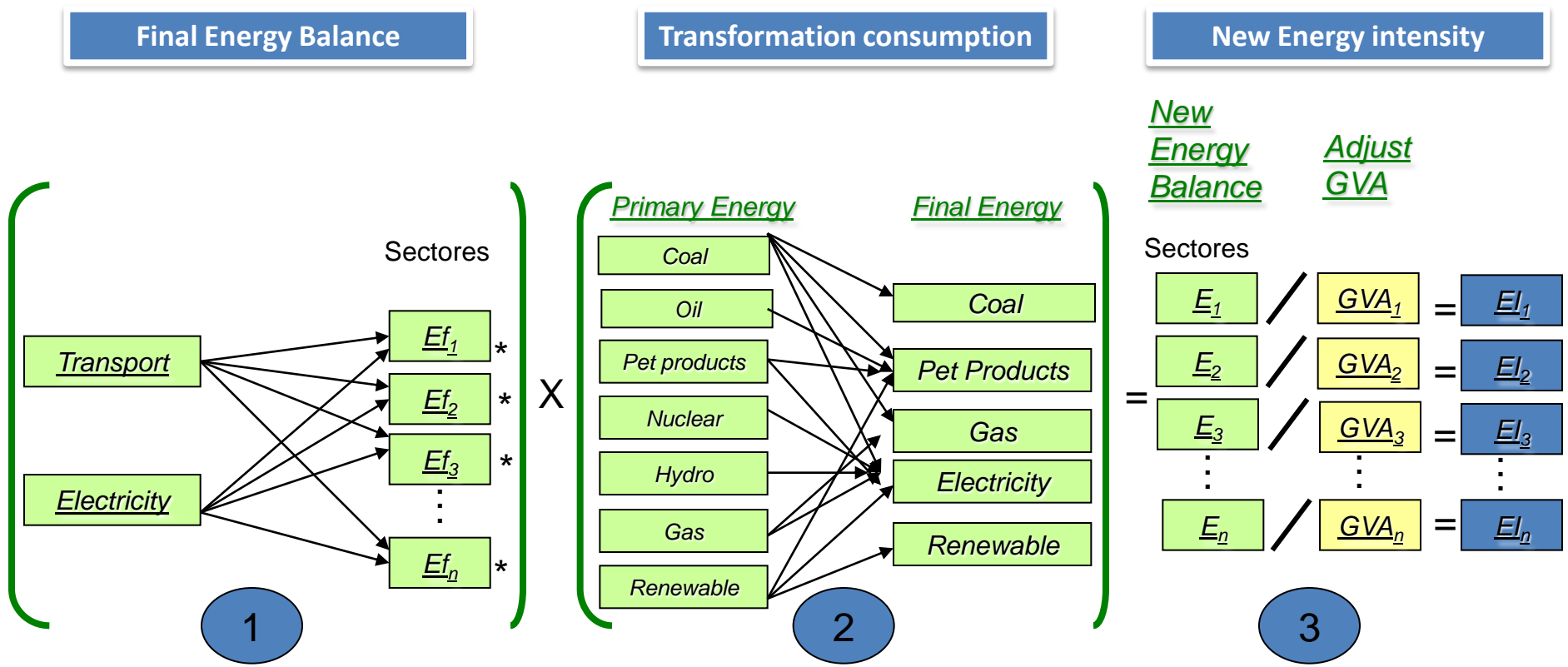
Comparing Spanish and UE15 EI (2008)



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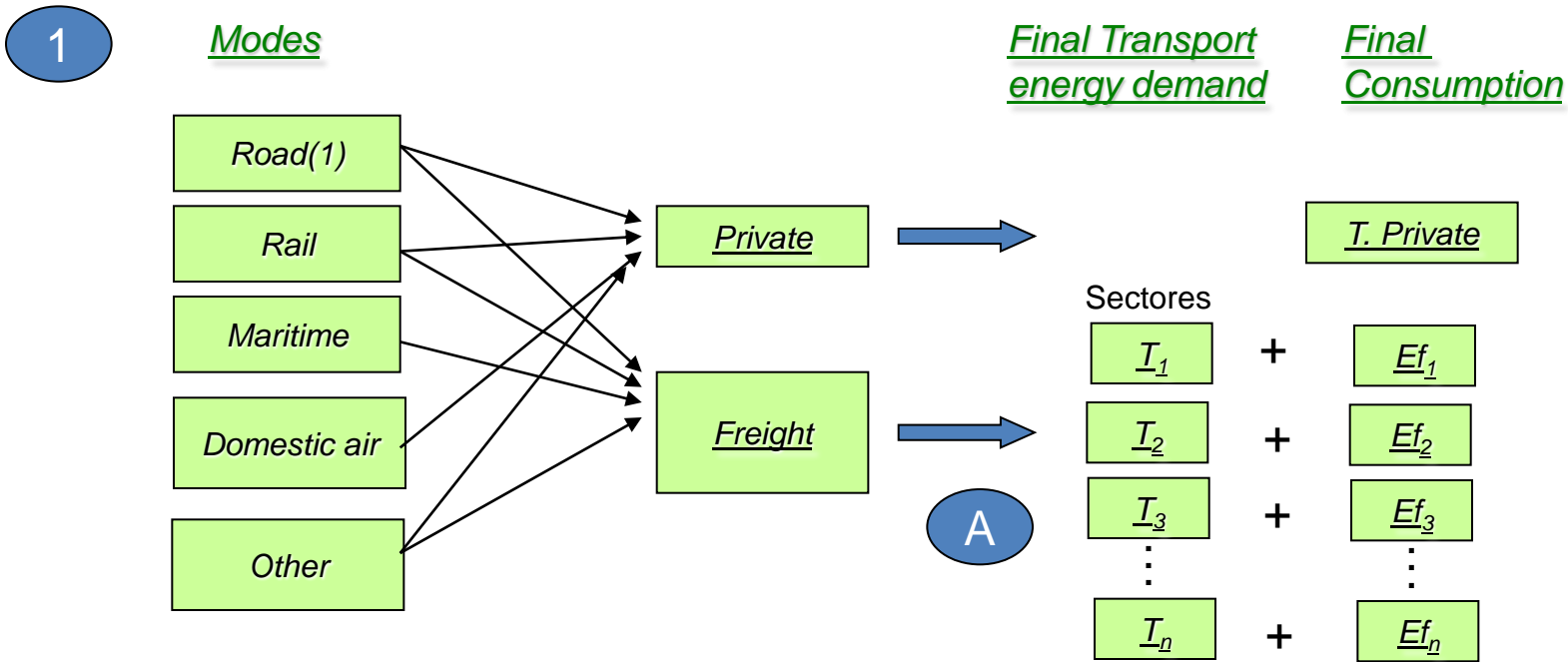
Methodology to allocate indirect consumption to the sectors



Input/output methodology

E_f is the final energy consumed by the sectors (1,2...n); E is the total energy consumed by the sectors (direct & indirect)

Methodology to allocate transport energy consumption to the sectors



(1) Includes light and heavy trucks , buses and cars

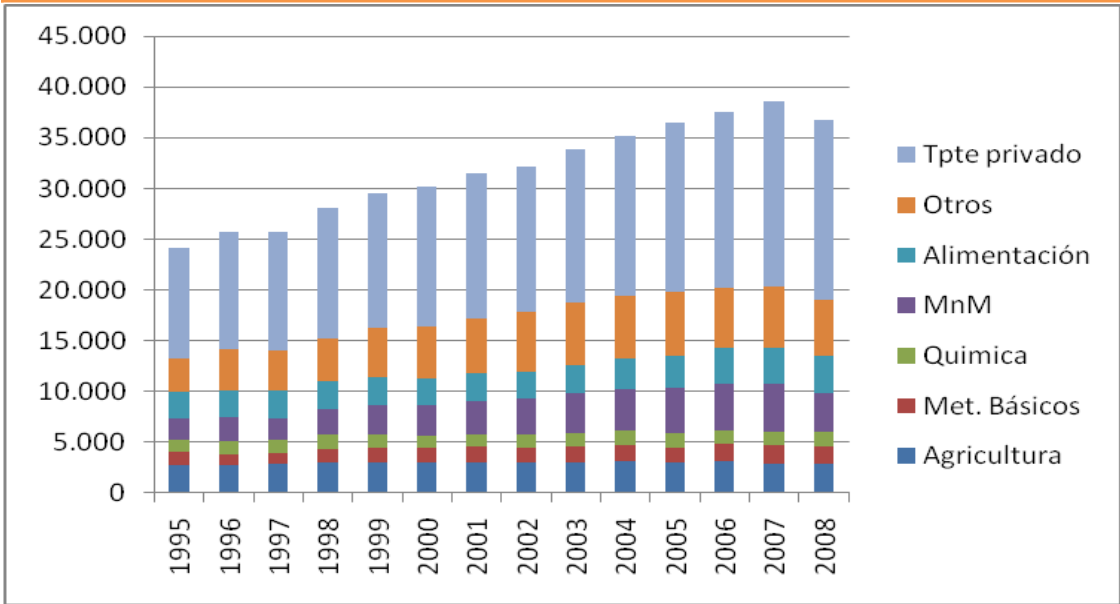
Decrease in the level of sector disaggregation

A

Combining
EPTMC and
Energy Balances

Nuevo	EPTMC	Balances energéticos
Agricultura	0. Productos agrícolas y animales vivos	Agricultura
Alimentación	1. Productos alimenticios y forrajes	Alimentación
Energía	2. Combustibles minerales sólidos 3. Productos petrolíferos	Energía
Metales básicos	4.Minerales y residuos para la fundición 5. Productos metalúrgicos	Metales básicos
Construcción	6. Minerales en bruto o manufacturados y materiales de construcción	Minerales no metálicos Minería Construcción
Química y papel	7. Abonos 8. Productos químicos	Química y plásticos Papel
Otros	9. Máquinas, vehículos y objetos manufacturados	Madera Material de transporte Maquinaria Textil y calzado Otros

Transport
energy
demand



Methodology to allocate transformation energy consumption per final energy (input /output methodology)

2

Spanish Energy Input / Output Table 2006 (ktoe)

	C	R	Oil	N	H	G	P.P	E	Indirect	Direct	Total
Coal(C)	1.743	0	0	0	0	0	0	14.717	16.460	1.412	17.872
Renewables (R)	0	0	0	0	0	0	0	3.476	3.476	3.770	7.246
Oil(O)	0	0	-838	0	0	0	63.117	0	62.279	12	62.291
Nuclear (N)	0	0	0	0	0	0	0	15.669	15.669	0	15.669
Hydro(H)	0	0	0	0	0	0	0	2.198	2.198	0	2.198
Gas (G)	0	0	0	0	0	926	0	13.203	14.129	16.921	31.050
Prod. petrolí (P.P)	0	0	61	0	0	58	5.657	4.493	10.269	51.225	61.494
Electricity (E)	0	0	0	0	0	0	0	3.965	3.965	21.758	25.723



Transformation



Final
consumption

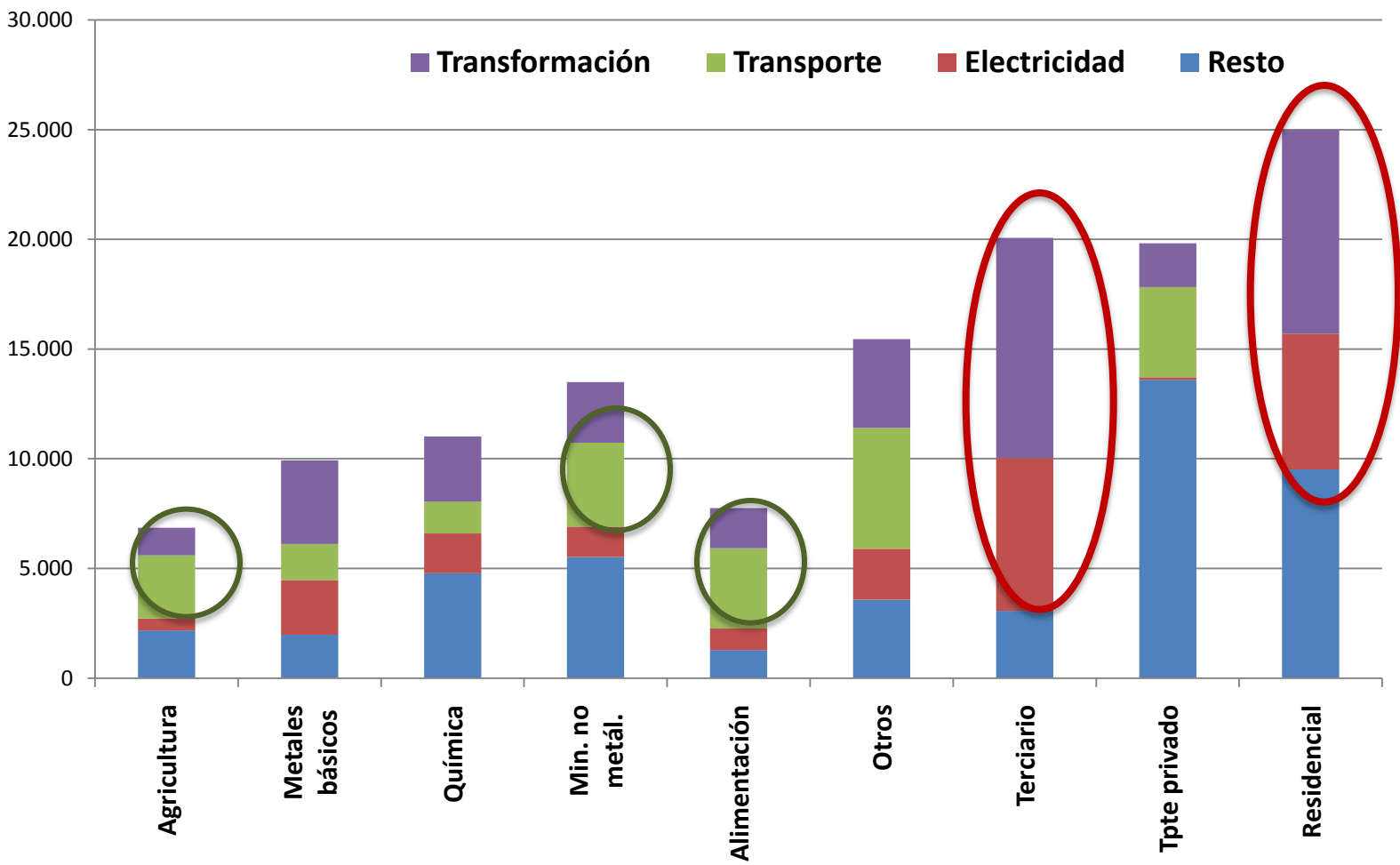


Energy coefficients
(transf. energy per
final consumption)

The residential and tertiary sector are the largest energy consumers

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Energy balance (direct and indirect)

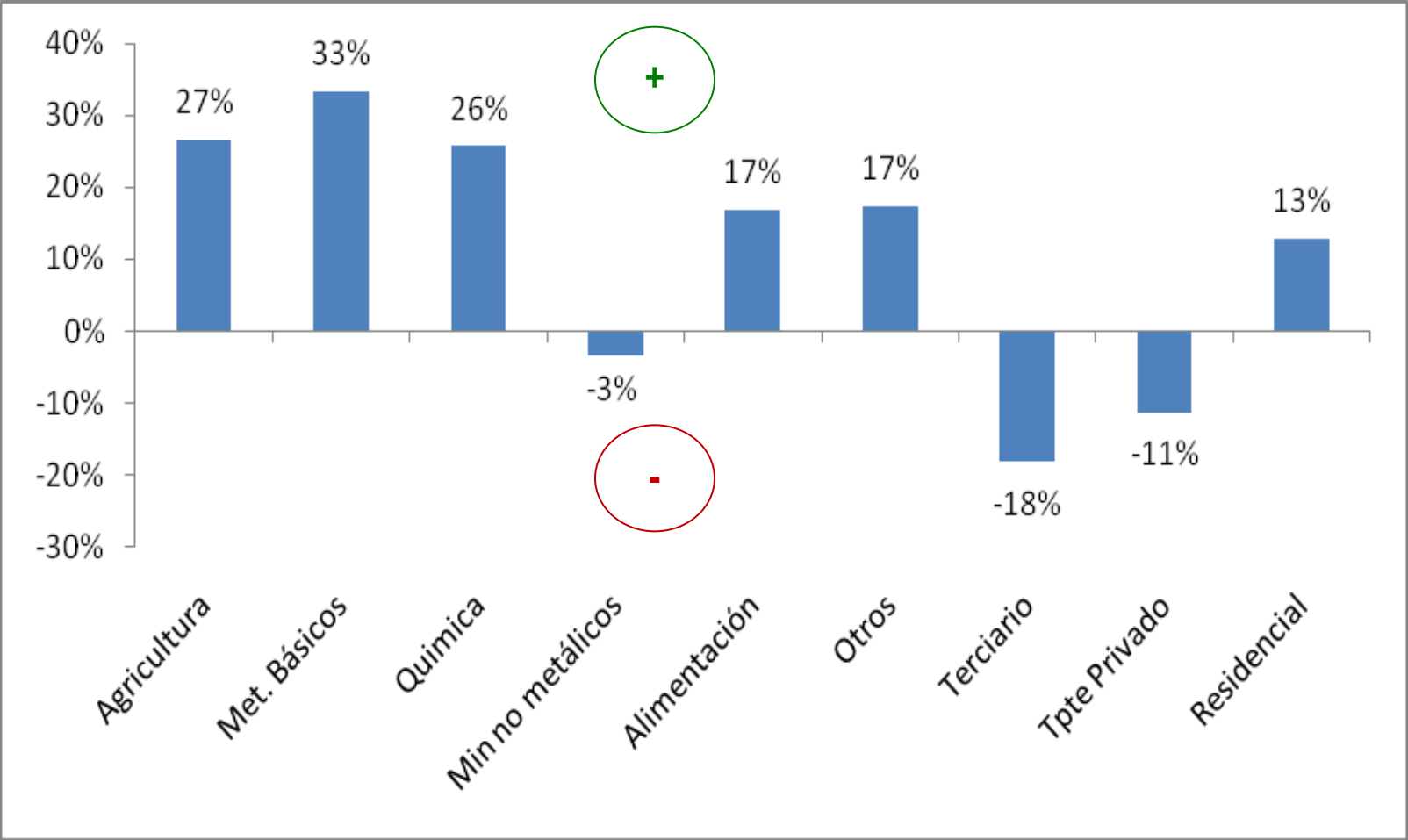


Improvements in electricity generation benefit EI evolution of some sectors

New energy intensity decomposition 1995-2008

$\Delta IE =$
-13 tep M€

■
% sector
contribution
(str+intr)



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Analysing EI requires getting to the largest decomposition level

Electricity sector is the sector that most improve EI in Spain due to increase in gas and renewable generation



More generation (+87%) with less energy (+25%).

Industry improves efficiency but not as much as in Europe:



Key is the bad evolution between 1995 y 2004, far from the european trend

Tertiary and residential sectors worsen EI trends, whereas EU15 presents important improvements

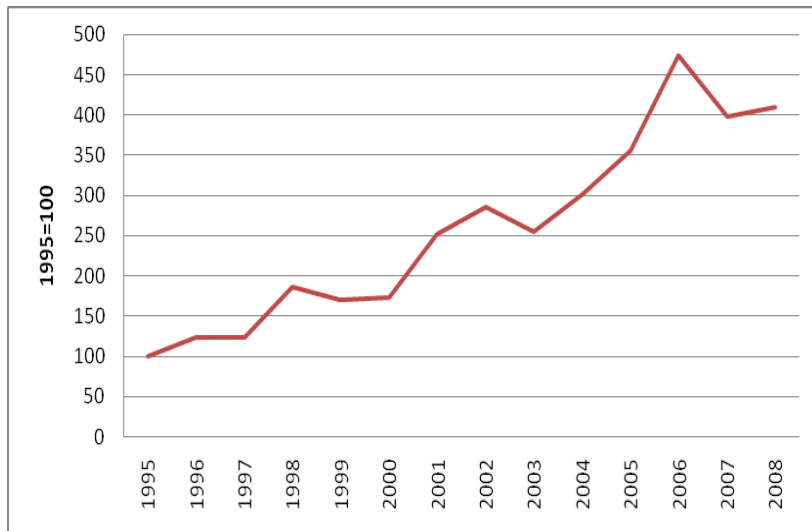
Residential sector is the largest energy consumer (34% total) and drives EI behaviour thorough consumption in households and private transport

Construction is the key driver of the bad evolution of EI in Spain and the differences with EU evolution

Economic Structure

+ Construction
+ Turism

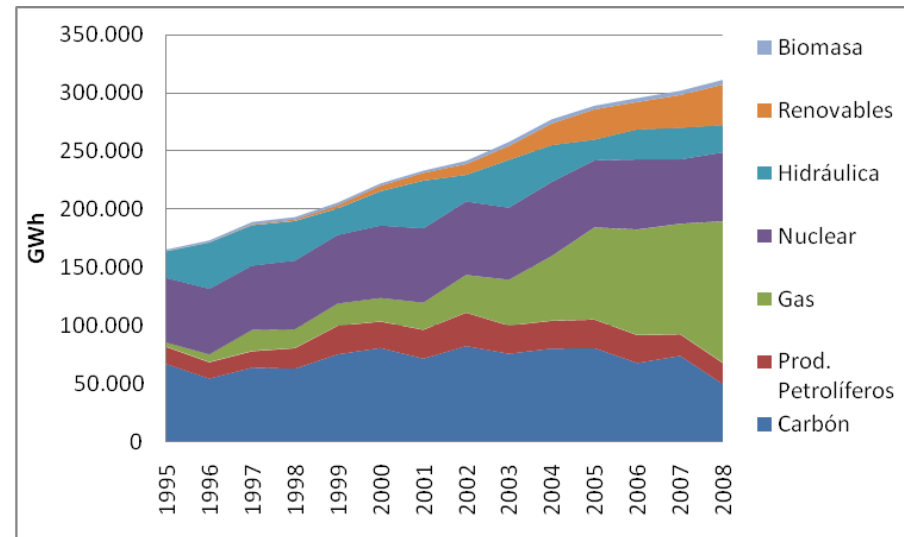
Public investment in infraestructures and in the stock of dwellings



Efficient generation

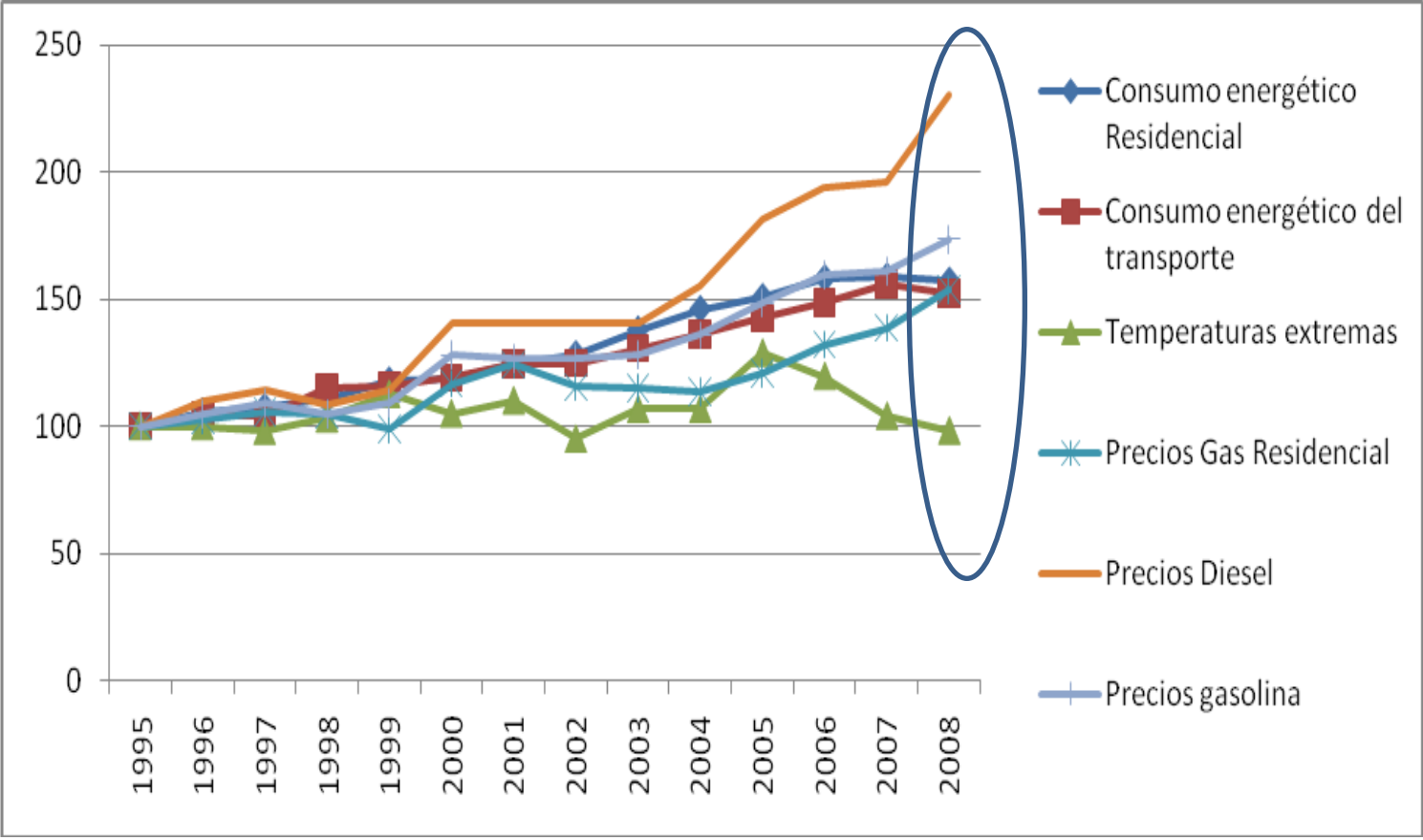
+ Renewables
+ Gas

Power Generation in Spain



...Efficient electricity generation is driving improvements

Clima and energy prices have influenced recent residential energy consumption



General conclusions

- To improve energy efficiency Spain should:
 - Drive its economic activity to high value added activities that tend to be low energy consuming
 - Focus its energy savings and efficiency measures in the residential and transport sector , given their strong influence in the spanish EI
 - Continue with the current trend of increasing renewables and gas, substituting coal electricity production
 - Use energy prices as a policy instrument to control demand