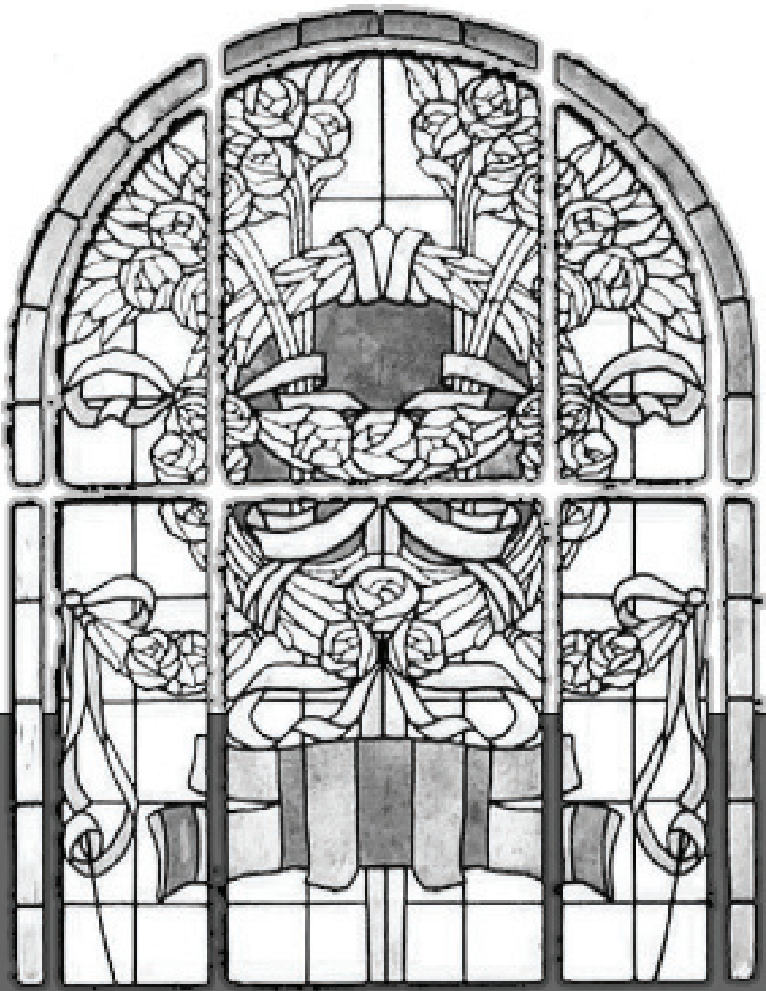

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POTENTIAL IMPACT ON THE REDUCTION OF GREENHOUSE GAS EMISSIONS

ASSESSMENT OF INTERVENTIONS FINANCED BY THE 2007-2013 ERDF OPERATIONAL PROGRAMMES

Ministero dello Sviluppo Economico
Dipartimento per le Politiche di Sviluppo
Unità di Valutazione degli investimenti Pubblici

The Public Investment Evaluation Unit (UVAL – *Unità di valutazione degli investimenti pubblici*) provides technical support to government bodies by preparing and disseminating methods for evaluating public investment programs and projects before, during and after the projects themselves, in part to optimize the use of EU Structural Funds. The unit is a part of the network of central and regional evaluation teams.

UVAL operates within the Department for Development Policies of the Ministry for Economic Development, to which it was transferred by decree of the Prime Minister on 28 June 2007, as published in the *Gazzetta Ufficiale* on 19 September 2007. The unit received its current structure in 1998 as part of the reorganization of the development promotion functions, which were previously assigned to the Ministry for the Economy and Finance.

The unit determines whether investment programs and projects comply with economic policy guidelines, assesses the financial and economic feasibility of the initiatives, and determines whether they are compatible and appropriate as compared with other solutions, while also evaluating their social and economic impact in the areas concerned.

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Editorial Director: Laura Raimondo
Editorial team: materialiuval.redazione@tesoro.it
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Potential impact on the reduction of greenhouse gas emissions
Assessment of interventions financed by the 2007-2013 ERDF Operational Programmes

Abstract

The report on the *Potential Impact on the reduction of greenhouse gas emissions – Assessment of interventions financed by the 2007-2013 ERDF Operational Programmes* summarises a broad methodological and applied research effort promoted by the Evaluation Unit of the Department for Economic Development and Cohesion of the Ministry for Economic Development in cooperation with the Italian National Energy Agency (ENEA). The report provides an estimate of the impact of interventions co-financed by the European Regional Development Fund (ERDF) under the 2007-2013 National Strategic Reference Framework (NSRF) in the sectors of energy, transport and waste management in terms of potential gross total reduction in greenhouse gas emissions in thousands of tonnes of CO_2 equivalent per year. The estimate was produced using a complex methodology which required the calculation of the total amount of public resources planned under national and additional policies and an evaluation of the multilevel governance framework involved. The estimates regard three scenarios: business-as-usual; with the interventions programmed or recently introduced within the current national policy framework; with the 2007-2013 NSRF interventions added to the measures recently planned or recently introduced. The method applied and the results obtained, in addition to offering an significant quantification of emissions with regard to national compliance with the Kyoto Protocol and further issues in the international debate (the post-Kyoto period) are in line with the standards set out in the United Nations Framework Convention on Climate Change (UNFCCC). The final estimate of the impact of the interventions planned under the 2007-2013 ERDF Operational Programmes shows a reduction of about 10 Mt CO_2 eq. at 2020 due to the substantial contribution of the measures for renewable energy and energy efficiency initiatives.

Impatto potenziale sulla riduzione delle emissioni di gas a effetto serra
Valutazione del contributo dei Programmi Operativi FESR 2007-2013

Sommario

Il rapporto sull'*Impatto potenziale sulla riduzione delle emissioni di gas ad effetto serra - Valutazione del contributo dei Programmi Operativi FESR 2007-2013*, elaborato dall'Unità di valutazione degli investimenti pubblici del Dipartimento per lo sviluppo e la coesione economica (DPS) del Ministero dello Sviluppo Economico in collaborazione con l'ENEA, costituisce la sintesi di un ampio lavoro metodologico e di ricerca. Contiene una stima dell'impatto degli interventi cofinanziati dal Fondo Europeo per lo Sviluppo Regionale (FESR) nell'ambito del Quadro Strategico Nazionale (QSN) nei settori dell'energia, dei trasporti e della gestione dei rifiuti in termini di riduzioni potenziali delle emissioni totali lorde di gas serra in CO_2 equivalenti per anno. La stima è il risultato di un esercizio complesso dal punto di vista metodologico che ha richiesto una ricostruzione del quadro complessivo delle politiche ordinarie e aggiuntive e la considerazione dei diversi livelli decisionali che incidono sugli interventi programmati ed è stata quindi elaborata costruendo diversi scenari di riferimento: in assenza di politiche specifiche (*Business-As-Usual*); con gli interventi in attuazione e programmati dalle politiche ordinarie; con le politiche aggiuntive regionali delineate attraverso gli interventi previsti nei PO FESR 2007-2013, in aggiunta allo scenario programmatico ordinario. Il metodo utilizzato ed i risultati ottenuti, oltre ad offrire una prima quantificazione rilevante nell'ambito degli scenari nazionali per il raggiungimento degli obiettivi fissati dal Protocollo di Kyoto e oggetto del dibattito internazionale in corso (cd. Post Kyoto), sono in linea con gli standard stabiliti nell'ambito della Convenzione Quadro sui cambiamenti climatici delle Nazioni Unite. Complessivamente, la stima dell'impatto degli interventi previsti dai Programmi Operativi FESR del QSN 2007-2013 consente di evitare l'emissione di circa 10 Mt CO_2 eq. al 2020, grazie al significativo impegno previsto per lo sviluppo delle fonti rinnovabili e del risparmio energetico.

This study was prepared as part of the agreement regarding the assessment of impact on greenhouse gas emissions of regional development policies within the 2007-2013 National Strategy Framework, signed by the Ministry for Economic Development – Department for Economic Development and Cohesion (DPS-MISE), with the technical support of the Public Investment Evaluation Unit and ENEA.

The following people have worked on preparing the report on the potential impact on the reduction of greenhouse gas emissions of the 2007-2013 ERDF Operational Programmes:
Oriana Cuccu, member of the Public Investment Evaluation Unit, DPS-MISE, officer responsible for the agreement with ENEA
Simona De Luca, member of the Public Investment Evaluation Unit, DPS-MISE

Natale Massimo Caminiti, ENEA, officer responsible for the agreement with DPS-MISE
Andrea Forni, technical coordinator
Antonio Colangelo, Gaetano Coletta, Vito Iaboni, Stefano La Malfa, Sergio La Motta, Maria Lelli, Erika Mancuso, Gabriella Messina, Silvia Orchi, Daniela Palma, Marco Stefanoni and Maria Pia Valentini.

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CONTENTS

I. Methodology for assessing the impact of greenhouse gas emissions

Italy's 2007-2013 National Strategic Reference Framework (NSRF) sets out the strategic guidelines for regional development policy to be implemented using additional EU funds (i.e. the Structural Funds) and domestic funds (i.e. the Fund for Under-Utilized Areas - FAS). The NSRF states that central and regional governments in Italy have decided to pursue the reform of EU cohesion policy – which strengthens the policy's strategic focus on competitiveness, the Lisbon objectives, and the instruments supporting this strategy – unifying EU regional policy planning with Italy's regional policy planning (the FAS). thus, it establishes the objectives, priorities and rules of regional development policy in a unified manner.

The 2007-2013 NSRF establishes ten strategic priorities, involves all of Italy and is being implemented by way of distinct regional, inter-regional and national Operational Programmes that drawn on various EU and Italian funds for the areas regarding Convergence Objective areas and Regional Competitiveness and Employment Objective areas.1

The NSRF specifically addresses climate change issues. With the priority *Energy and the environment: sustainable and efficient use of environmental resources for development*, it gives broad attention to the issue of renewable energy and energy efficiency and envisages the allocation (particularly for regions in southern Italy) of significant funding for the management of urban waste. Within the scope of the priority for *Transport networks and links*, substantial funding is being focused on supporting sustainable mobility (e.g. rail and sea transport). It also underscores the importance of the effective integration of environmental issues within the other priorities (mainly those that concern production systems and urban transport).

Although Italy's commitments at the European level and those established in the Kyoto Protocol are necessarily pursued primarily through ordinary national policy, implementation of projects under regional policy for 2007-2013 (in particular the European Regional Development Fund – ERDF) makes an important contribution to achieving the objectives for both the reduction of greenhouse gas emissions (as well as other atmospheric pollutants) and the creation of a process to counter the impact of current energy consumption on the climate, promoting renewable energy resources, energy savings, and greater energy efficiency in all production processes.

In order to estimate the potential contribution of the implementation of the unified 2007-2013 regional policy measures to reducing emissions, the exercise must be conducted in line with the official greenhouse gas emission estimates for Italy within the framework of the Kyoto Protocol and EU commitments for 2020, so as to be able to measure the differential. This is a complex operation from a methodological standpoint, requiring the

[1] For the 2007-2013 programming cycle, the EU objective areas are classified as Convergence Objective areas (Sicily, Calabria, Puglia and Campania, as well as Basilicata on a phasing out basis) and Regional Competitiveness and Employment Objective areas (all other regions, with Sardinia on a phasing in basis).

reconstruction the overall framework of ordinary and additional policy, given that multiple decision-making levels are involved in implementation, there are potential synergies and overlaps and numerous exogenous factors are also at play.

Assessing the impact on greenhouse gas (GHG) emissions of various implementation scenarios for regional policy will make it possible to:

a) understand the potential contribution of the 2007-2013 National Strategic Reference Framework to reducing greenhouse gas emissions;

b) establish guidelines for the effective implementation of the various Operational Programmes that are consequently undertaken.

The estimates presented in this *Report on the Assessment of the Potential Impact of the 2007-2013 NSRF on Greenhouse Gas Emissions* focuses solely on actions co-financed by the European Regional Development Fund (ERDF) under the 2007-2013 NSRF with a direct, significant impact on emissions.

The assessment of the impact of the 2007-2013 NSRF was conducted by developing a bottom-up regional estimation method of GHG reduction based on the overall framework of investments, policies and instruments within the Operational Programmes co-financed by the ERDF.

Assessing the relationship between funding envisaged in the Operational Programmes implementing the 2007-2013 NSRF and the reduction of greenhouse gases using a regional-level bottom-up approach has the merit of using relatively specific and disaggregated data on the type and characteristics of the various initiatives, and the related policy appropriations, that the central and regional government departments responsible for implementing the programmes intend to promote.

The estimation was performed for each area of intervention with a potentially significant impact on greenhouse gas emissions, following these general steps:

1. analysis of all Operational Programmes co-financed by the ERDF[2] in order to identify measures and instruments and corresponding funding appropriations, based on the expenditure categories defined in accordance with Article 9(3) of Regulation (EC) 1083/2006 (Annex IV);

2. formulation of possible combinations of initiatives and of technologies to quantify specific and total greenhouse gas emissions;

3. comparison, where relevant, with other national operational intervention measures to assess the potential crowding-out effects of initiatives planned under the ERDF and, at the same time, to avoid double counting;

4. comparison of planned sectoral appropriations and objectives to be

[2] This does not include the Operational Programmes funded under the ERDF related to the European Territorial Cooperation Objective.

achieved in order to calibrate the estimate of what can actually be implemented given the average cost of projects.

This general approach was followed sector by sector (energy, transport, waste) based on the level of detail of the basic information contained in the Programmes, on the channels of impact on emissions and the availability of other official sources of information to complete the knowledge on the applicable technologies needed to perform the estimation. The reduction of greenhouse gas emissions measured using this methodology was then compared with the national scenarios and with the effects of the other national policies for reducing greenhouse gases.

However, the relative accuracy of the assessments of the relationship between resources invested in technologies and changes in emissions is not enough to fully meet the objective of assessing the entire economic context in which the expenditure takes place and, therefore, to take account of all of the environmental impacts that follow from such an assessment.3

Accordingly, the assessments discussed below, which have been conducted on the basis of the analyses performed by ENEA within the scope of a specific MISE-DPS/ENEA partnership, should be considered an approximate estimate. Further refinement of these estimates, again based on the analysis of the Operational Programmes, will only be possible after the operational choices and intervention instruments have been established within the implementation process.

[3] In parallel, an assessment method is being developed based on inter-sectoral matrices of the Italian economy (input-output tables) in order to take account of all the feedback effects generated within the production structure once an expenditure impulse is introduced into the economy, thereby resulting in changes in production levels even in sectors not directly affected by the expenditure and, hence, producing a "spillover" environmental impact. In particular, we are experimenting with NAMEA accounting data, which supplements, using European standards, the CORINAIR emissions inventory data in accordance with the SNAP97 classification with those of the national economic accounts, based on which the intersectoral interdependence matrices are prepared.

II. Funding for areas of intervention with a potential impact on greenhouse gas emissions

The reconstruction of funding appropriated for areas of intervention with the greatest potential impact on greenhouse gas emissions is based on the expenditure categories4 listed in the Operational Programmes co-financed by the ERDF and is shown in Table II.1 below.

Table II.1 2007-2013 NSRF – ERDF funding (including national co-financing) by area of intervention with potential impact on greenhouse gas emissions (in millions of euros)

Areas of intervention	ERDF ROPs Convergence	ERDF ROPs Competitiveness	Energy NIOP	Networks and Mobility NOP	Total
Renewable energy	833.0	617.9	780.0	-	**2,230.9**
Energy efficiency	460.2	426.8	763.8	-	**1,650.8**
Total Energy	*1,293.2*	*1,044.7*	*1,543.8*	-	*3,881.7*
Transport	4,679.8	1,119.4	-	2,711.0	**8,510.2**
Waste management	617.2	68.1	-	-	**685.3**
TOTAL	**6,590.2**	**2,302.2**	**1,543.8**	**2,711.0**	**13,097.2**

Source: Based on the expenditure categories of the ERDF ROPs, the Renewable Energy and Energy Savings NIOP, and the Networks and Mobility NOP

Funding that could contribute to the greenhouse gas balance therefore totals €13 billion, out of total ERDF funding, including national co-financing, of about €44 billion for the NSRF as a whole, about €36 billion of which is for the regions of the Convergence Objective.

The transport sector accounts for some €8.5 billion, but significant fund has also gone to renewable energy and energy savings, which, taken together, total about €4 billion. The funding allocated to waste management projects total approximately €0.7 billion.[5]

[4] The expenditure categories considered for each area of intervention are:

- Renewable energy: from expenditure category 39 to 42;
- Energy efficiency: expenditure category 43;
- Transport: from expenditure category 16 to 31, plus expenditure category 52;
- Waste management: expenditure category 44.

[5] In the case of the waste management sector, initiatives are envisaged solely for the Convergence Objective regions and in the transitional regions (i.e. Basilicata for the Convergence Objective and Sardinia for the Regional Competitiveness and Employment Objective).

III. Impact of investments in the energy sector on greenhouse gas emissions

For the energy sector (Table III.1), in addition to the Regional Operational Programmes (ROPs), the Renewable Energy and Energy Savings National Inter-Regional Operational Programme (NIOP),[6] co-financed by the ERDF, was also taken into consideration. The funding has been distributed among energy efficiency projects (42.5 percent) and renewable energy resource projects (57.5 percent).

Table III.1 Energy: ERDF funding (including national co-financing) by expenditure category and Operational Programme (in millions of euros)

Operational Programme	Renewable energy					Energy savings	Total funding
	Wind	Solar	Biomass	Hydroelectric and Geothermal	Total		
Piedmont	25.7	50.1	56.8	56.8	189.4	81.2	270.6
Valle d'Aosta	0.3	0.3	0.3		0.8	3.8	4.5
Lombardy	-	-	-	15.9	15.9	34.0	49.9
Liguria	2.9	6.9	4.5		14.3	14.3	28.7
Trento	0.3	7.3	5.7	1.0	14.3	16.0	30.3
Bolzano	-	8.0	-	6.0	14.0	-	14.0
Veneto	4.8	-	21.1	21.1	46.9	21.1	67.9
Friuli Venezia Giulia	-	-	16.0	8.0	24.0	14.5	38.5
Emilia Romagna	2.2	3.8	-	-	6.0	67.6	73.6
Tuscany	7.9	6.3	6.3	10.9	31.4	22.1	53.5
Umbria	5.6	11.1	2.8	8.4	27.9	24.4	52.2
Marche	1.3	6.5	7.5	1.0	16.3	21.4	37.6
Lazio	6.0	33.0	20.0	-	59.0	16.0	75.0
Abruzzo	-	12.4	12.4	-	24.7	10.5	35.2
Molise	1.4	4.2	4.2	4.2	14.0	12.0	26.0
Campania	40.0	45.0	65.0	50.0	200.0	90.0	290.0
Puglia	-	76.0	36.0	-	112.0	98.0	210.0
Basilicata	-	16.0	7.0	7.0	30.0	25.0	55.0
Calabria	32.4	53.4	32.4	42.8	161.0	53.4	214.4
Sicily	32.0	176.2	80.2	41.6	330.0	193.8	523.8
Sardinia	-	47.6	35.7	35.7	119.1	68.1	187.2
Energy NIOP	-	*140.0*	*400.0*	*240.0*	*780.0*	*763.8*	*1,543.8*
TOTAL	**162.6**	**704.1**	**813.9**	**550.4**	**2,230.9**	**1,650.8**	**3,881.8**

Source: Based on the expenditure categories of the ERDF ROPs and the Renewable Energy and Energy Savings NIOP

The renewable energy resources with the greatest relative significance are biomass and solar, while wind received just €162.6 million, and there are no projects planned for this energy resource under the ERDF ROPs for Basilicata, Puglia, Abruzzo, Bolzano, Friuli, Lombardy or Sardinia or under the Energy NIOP. In the solar power sector, there are no initiatives planned in the regions of Friuli, Lombardy or Veneto, while Sicily has provided €176.2 million in funding. Areas not investing in the biomass sector include Bolzano, Emilia Romagna and Lombardy, while Sicily and Piedmont are investing the most. No funding for the energy savings sector is planned in the autonomous province of Bolzano, whereas Sicily is again the region that has allocated the greatest level of funding.

The methods for calculating the potential impact on greenhouse gases differ renewable energy and energy savings, so they are discussed separately in the sections that follow.

[6] The NIOP for Energy only involves the Convergence Objective regions.

III.1 Impact of investment in the renewable energy sector

III.1.1 Input data

A total of about €2,231 million has been allocated to support the development of renewable energy resources, of which €1,613 million in the Convergence Objective regions, with a further €780 million coming from the Energy National Inter-regional Operational Programme, while about €618 million concerns the regions of the Regional Competitiveness and Employment Objective (Table III.2).

Table III.2 Renewable energy: ERDF funding (including national co-financing) by energy source, expenditure category and Operational Programme (in millions of euros)

Operational Programme	Wind		Solar		Biomass		Hydroelectric/ Geothermal		Total
	€M	% of total	€M	% of total	€M	% of total	€M	% of total	€M
Piedmont	25.7	13.6	50.1	26.4	56.8	30.0	56.8	30.0	**189.4**
Valle d'Aosta	0.3	33.3	0.3	33.3	0.3	33.3	-	0.0	**0.8**
Lombardy	-	0.0	-	0.0	-	0.0	15.9	100.0	**15.9**
Liguria	2.9	20.0	6.9	48.4	4.5	31.6	-	0.0	**14.3**
Trento	0.3	2.3	7.3	51.2	5.7	39.5	1.0	7.0	**14.3**
Bolzano	-	0.0	8.0	57.2	-	0.0	6.0	42.8	**14.0**
Veneto	4.8	10.1	-	0.0	21.1	44.9	21.1	44.9	**46.9**
Friuli Venezia Giulia		0.0		0.0	16.0	66.7	8.0	33.3	**24.0**
Emilia Romagna	2.2	37.1	3.8	62.9	-	0.0	-	0.0	**6.0**
Tuscany	7.9	25.0	6.3	20.1	6.3	20.1	10.9	34.7	**31.4**
Umbria	5.6	20.0	11.1	40.0	2.8	10.0	8.4	30.0	**27.9**
Marche	1.3	7.7	6.5	40.0	7.5	46.2	1.0	6.2	**16.3**
Lazio	6.0	10.2	33.0	55.9	20.0	33.9	-	0.0	**59.0**
Abruzzo	-	0.0	12.4	50.0	12.4	50.0	-	0.0	**24.7**
Molise	1.4	10.0	4.2	30.0	4.2	30.0	4.2	30.0	**14.0**
Campania	40.0	20.0	45.0	22.5	65.0	32.5	50.0	25.0	**200.0**
Puglia	-	-	76.0	67.9	36.0	32.1	-		**112.0**
Basilicata	-	-	16.0	53.3	7.0	23.3	7.0	23.3	**30.0**
Calabria	32.4	20.1	53.4	33.2	32.4	20.1	42.8	26.6	**161.0**
Sicily	32.0	9.7	176.2	53.4	80.2	24.3	41.6	12.6	**330.0**
Sardinia	-	0.0	47.6	40.0	35.7	30.0	35.7	30.0	**119.1**
Energy NIOP	***-***	***-***	***140.0***	***17.9***	***400.0***	***51.3***	***240.0***	***30.8***	***780.0***
TOTAL	**162.6**	**7.3**	**704.1**	**31.6**	**813.9**	**36.5**	**550.4**	**24.7**	**2,230.9**

Source: Based on the expenditure categories of the ERDF ROPs and the Renewable Energy and Energy Savings NIOP

Within the breakdown of funding by energy resource, the funds have been broken down further by technology used, where appropriate. This breakdown was carried out on the basis of the technologies available and taking account of information concerning national objectives, regional energy plans and the potential for development of the individual technologies.

Accordingly, solar energy has been broken down into photovoltaic and thermal technologies. For biomass, on the other hand, an initial distinction concerned "electric only" and "cogeneration", with "electric only" being further broken down into waste-to-energy and the use of landfill biogas. For cogeneration, it was decided to report "short supply chain" separately. Finally, for wind, hydroelectric and geothermal, no further breakdown was found to be necessary. Table III.3 reports this breakdown.

Table III.3 Renewable energy: assumed allocation of funding by energy resource, technology and Operational Programme (in millions of euros)

Operational Programme	Wind	Solar		Biomass				Hydroelectric/ Geothermal		Total
				Electric only		Cogeneration				
		Photovoltaic	Thermal	Waste-to-energy	Landfill biogas	Supply chain	Short supply chain*	Hydroelectric	Geothermal	
Piedmont	25.7	25.0	25.0	11.4	11.4	17.1	17.1	34.1	22.7	**189.4**
Valle d'Aosta	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	**0.8**
Lombardy		0.0	0.0	0.0	0.0	0.0	0.0	9.5	6.4	**15.9**
Liguria	2.9	3.5	3.5	0.9	0.9	1.4	1.4	0.0	0.0	**14.3**
Trento	0.3	3.7	3.7	1.1	1.1	1.7	1.7	0.6	0.4	**14.3**
Bolzano		4.0	4.0	0.0	0.0	0.0	0.0	3.6	2.4	**14.0**
Veneto	4.8	0.0	0.0	4.2	4.2	6.3	6.3	12.6	8.4	**46.9**
Friuli Venezia Giulia		0.0	0.0	3.2	3.2	4.8	4.8	4.8	3.2	**24.0**
Emilia Romagna	2.2	1.9	1.9	0.0	0.0	0.0	0.0	0.0	0.0	**6.0**
Tuscany	7.9	3.2	3.2	1.3	1.3	1.9	1.9	6.5	4.4	**31.4**
Umbria	5.6	5.6	5.6	0.6	0.6	0.9	0.9	5.0	3.3	**27.9**
Marche	1.3	3.3	3.3	1.5	1.5	2.3	2.3	0.6	0.4	**16.3**
Lazio	6.0	16.5	16.5	4.0	4.0	6.0	6.0	0.0	0.0	**59.0**
Abruzzo		6.2	6.2	2.5	2.5	3.7	3.7	0.0	0.0	**24.7**
Molise	1.4	2.1	2.1	0.8	0.8	1.3	1.3	2.5	1.7	**14.0**
Campania	40.0	22.5	22.5	13.0	13.0	19.5	19.5	30.0	20.0	**200.0**
Puglia		38.0	38.0	7.2	7.2	10.8	10.8	0.0	0.0	**112.0**
Basilicata		8.0	8.0	1.4	1.4	2.1	2.1	4.2	2.8	**30.0**
Calabria	32.4	26.7	26.7	6.5	6.5	9.7	9.7	25.7	17.1	**161.0**
Sicily	32.0	88.1	88.1	16.0	16.0	24.1	24.1	25.0	16.6	**330.0**
Sardinia		23.8	23.8	7.1	7.1	10.7	10.7	21.4	14.3	**119.1**
Energy NIOP		*70.0*	*70.0*	*80.0*	*80.0*	*120.0*	*120.0*	*144.0*	*96.0*	*780.0*
TOTAL	**162.6**	**352.1**	**352.1**	**162.8**	**162.8**	**244.2**	**244.2**	**330.2**	**220.1**	**2,230.9**

Note: Short supply chain biomass is defined as the "biodegradable fraction of agricoltural products, waste and residues, including vegetal and animal substances, forestry and related industries, products within the range of 70 km from the power plant. The length of that rage is measured as the distance between the power plant and the administrative municipal boundaries where the biomass is produced

Source: ENEA

III.1.2 Estimation method

In the absence of specific information regarding the procedures for implementing projects, we have assumed that the instruments call for financing on capital account equal to 20 percent or 30 percent of the cost of the investment, with the exception of the photovoltaic sector, which has been assumed to be 20 percent, given that current regulations do not permit granting the subsidized rate to the private sector if the plant receives a capital grant in excess of 20 percent (this ceiling does not apply for systems installed in the public sector).

Beginning with available funding and the data shown in Table III.3, which breaks funding down by energy resource and technology, and based on specific investment costs, we then calculated the installable capacity. We assumed a life of the investment that differed according to the technology: 20 years for wind and solar; 15 years for biomass and geothermal; 30 years for hydroelectric.

The corresponding annual power output was calculated on the basis of a number of hours/year of operation that varied from 1,234 hours for solar (the average for the south-central regions) to 1,900 hours for wind, 3,500 hours for hydroelectric, 3,000 hours for cogeneration, 7,000 hours for waste-to-energy and landfill biogas and, finally, 7,500 hours for geothermal. Finally, the annual reduction of CO_2 emissions was calculated by taking the average annual power generated and multiplying it by the specific assumed reduction of 0.5 t CO_2/MWh_e.

Table III.4 shows the assumptions made for all energy resources and all technologies.

Table III.4 Renewable energy: assumptions used in calculating annual CO_2 reductions

Breakdown by technology	WIND	SOLAR			BIOMASS				HYDROELECTRIC/ GEOTHERMAL		
		Photovoltaic		Thermal	Electric only		Cogeneration		Hydroelectric		Geothermal
		Ground	Rooftop		Waste-to-energy	Landfill biogas	Supply chain	Short supply chain	Mini hydro	Small hydro	
Size (MWe)	2	2	0.02	---	10	1	1	1	0.3	3	10
Life (years)	20	20	20	20	15	15	15	15	30	30	15
Investment cost (€M/MW)	1.2	4.5	5.5	2.2	5.1	1.6	2,6 - 4,2		1,3 - 5	1,4 - 6	2 - 3,5
Hours/year	1900		1234		7000		3000		3500		7500
Specific reduction (t CO_2/MWh_e)		0.5		0,20[1]				0.5			

Note: [1] Methane gas (tCO_2/MWh_{th})
Source: ENEA

III.1.3 Results

The funding allocated to renewable energy, in the amount of about €2,231 million (Table III.4), can mobilise investments totalling between €8,000 million and €11,150 million, assuming a capital grant of 30 percent and 20 percent of the investment cost, respectively. Table III.5 below shows the estimated annual reductions in greenhouse gas emissions for each Operational Programme, calculated based on the varying leverage effect on the overall investment.

As one would expect, in the case of a capital grant of 20 percent, the amount of the CO_2 reduction is greater than when the capital grant is 30 percent. The potential reduction ranges from more than 9 million tonnes to about 6 million tonnes of CO_2 under the two hypotheses (Table III.5).

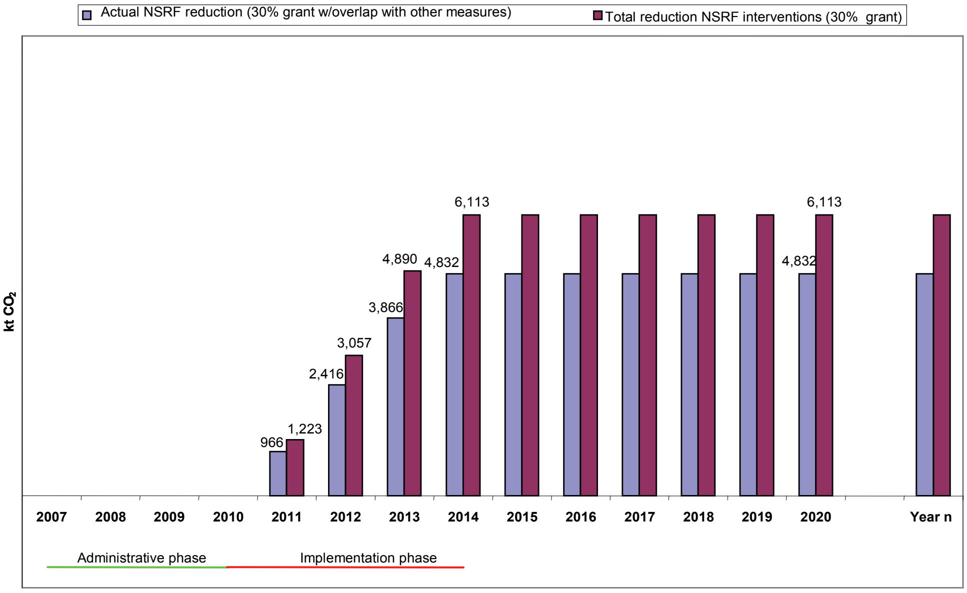
Table III.5 Renewable energy: scenario for annual reduction in greenhouse gas emissions by Operational Programme (t of CO_2)

Operational Programme	*Contribution to total funding*	
	20%	*30%*
Piedmont	829,814	558,512
Valle d'Aosta	2,303	1,562
Lombardy	120,976	80,651
Liguria	36,644	25,164
Trento	39,811	27,317
Bolzano	50,527	34,534
Veneto	277,386	184,924
Friuli Venezia Giulia	135,763	90,508
Emilia Romagna	10,990	7,724
Tuscany	147,408	98,942
Umbria	105,350	71,413
Marche	51,484	35,011
Lazio	136,939	94,788
Abruzzo	65,125	44,725
Molise	59,619	40,190
Campania	869,156	584,203
Puglia	213,962	150,691
Basilicata	95,677	65,480
Calabria	637,308	430,528
Sicily	923,926	634,613
Sardinia	467,842	316,941
Energy NIOP	***3,779,731***	***2,534,649***
TOTAL	**9,057,741**	**6,113,071**

Source: ENEA

Nonetheless, we must take account of possible overlaps with measures other than those of the ERDF Operational Programmes. Starting with a capital grant of 30 percent of the cost of the investment and taking account of potential overlaps, an estimate of the effects on the reduction of CO_2 was performed. It was also assumed that the initial effects occur after completion of the administrative phase, i.e. beginning in 2011 (Figure III.1).

Figure III.1 Renewable energy: scenario for impact of ERDF investments on greenhouse gas emissions assuming a 30 percent grant (t of CO_2 per year)



Source: ENEA

Therefore, assuming a grant of 30 percent of the total cost of the investment, overlaps with other measures reduce the positive impact on emissions from 6.11 million tonnes to 4.83 million tonnes of CO_2 per year.

Analogous calculations assuming a grant of 20 percent of the total investment show a reduction in emissions from 9.06 million tonnes to 6.82 million tonnes of CO_2 per year.

Therefore, the estimated impact of renewable energy projects under ERDF Operational Programmes ranges from a minimum of 4.83 million tonnes to a maximum of 6.82 million tonnes of CO_2 annually.

III.2 Impact of investments in energy efficiency

III.2.1 Input data

The reconstruction of programmed funding allocations by region in the energy efficiency sector, which is based on an analysis of the Regional Operational Programmes and of the Energy National Inter-Regional Operational Program regarding energy efficiency, is reported in Table III.6 below, which also shows the relative weight compared with total funding for energy-sector projects.

Table III.6 **Energy efficiency: ERDF funding (including national co-financing) by Operational Programme (in millions of euros)**

Operational Programme	Energy savings	Share of total funding in the Energy sector
Piedmont	81.2	30.0
Valle d'Aosta	3.8	84.4
Lombardy	34.0	68.1
Liguria	14.3	49.8
Trento	16.0	52.8
Bolzano	-	0.0
Veneto	21.1	31.1
Friuli Venezia Giulia	14.5	37.7
Emilia Romagna	67.6	91.8
Tuscany	22.1	41.3
Umbria	24.4	46.7
Marche	21.4	56.9
Lazio	16.0	21.3
Abruzzo	10.5	29.8
Molise	12.0	46.2
Campania	90.0	31.0
Puglia	98.0	46.7
Basilicata	25.0	45.5
Calabria	53.4	24.9
Sicily	193.8	37.0
Sardinia	68.1	36.4
Energy NIOP	***763.8***	***49.5***
TOTAL	**1,650.8**	**42.5**

Source: Based on the expenditure categories of the ERDF ROPs and the Renewable Energy and Energy Savings NIOP

III.2.2 Estimation method

Each area of intervention in energy efficiency has been studied, taking account of any regional differences due to climate or other local factors, in order to create an indicator that could associate the resultant energy savings (in toe/year for end uses) and GHG reductions (in tCO_2 equivalent/year) with each investment (expressed in euros).

The emission factors used to convert energy savings into tonnes of oil equivalent (toe)/end uses in tonnes of CO_2 regard:

- for the electricity segment, the emissions avoided by the reduced operation of combined-cycle plants in 2005 of 4.19 tCO_2/toe for end uses;
- for the thermal segment, the emissions avoided in relation to the mix of fuels consumed in Italy in 2005, equal to 2.56 tCO_2/toe for end uses.

Two other indicators that take account of different costs of energy savings projects have also been considered, depending on the case, namely:

- total cost to replace "energy-intensive" equipment or infrastructure with new energy-efficient equipment or infrastructure;
- marginal cost alone, i.e. the extra cost that would be incurred for new energy-efficient equipment or infrastructure compared with the cost of conventional equipment.

The difficulty in calculating these figures lies in the need to capture the technological and operational variability of the projects funded by the NSRF in a single indicator. Such variability is found in each sector and specifically concerns: starting consumption; potential savings; the cost of the individual project combined with natural variety of the different types of action that are actually implemented. A sensitivity analysis was therefore conducted to assess the range of potential variation in the indicator based on the variability of the most significant parameters used in each segment.

Based on an analysis of the Operational Programmes, the following types of projects, which show a certain degree of similarity for the purposes of the assessment, were identified:

1. enhancing the energy efficiency of schools, sports facilities, hospitals and other public buildings;
2. enhancing the efficiency of public lighting;
3. renovating and/or constructing public buildings;
4. renovating and/or constructing private-sector buildings; urban development of retired and/or degraded industrial areas; redevelopment of tourism facilities;
5. enhancing the energy efficiency of industry in the thermal segment, within the scope of broader interventions to support business;
6. cogeneration and regeneration;
7. energy networks;
    - electricity, in support of distributed power generation;
    - district heating, in support of cogeneration.

In the absence, again, of specific information on implementation instruments, we have adopted a breakdown of funding in the areas of intervention indicated above, diversified by region, based on information drawn from the individual Operational Programmes (Table III.7).

In order to calculate the overall investment mobilised, we have also assumed the following average percentages for funding on capital account: public sector – 80 percent; private sector – 30 percent. Using these parameters, it was thereby possible to assign a total investment amount to each sector and to each Operational Programme for the initiative, as reported in Table III.8 below.

For each area of intervention, we have prepared a chart that, based on data available in the literature and provided by ENEA, provides an average reference value for the parameter "specific investment per average CO_2 emission unit (euros/(tCO_2/year))", parameterised, where possible and necessary, for the various regional circumstances (Table III.9).

An initial finding of this analysis (Table III.10) provides an average value for the annual reduction of CO_2 emissions as a result of the total funding provided under the ERDF Operational Programmes for energy savings projects of 1.5 tCO_2/year, of which 1.1 tCO_2/year in the Convergence regions.

Table III.7 **Energy efficiency: assumed funding distribution by type of intervention and Operational Programme (in millions of euros)**

Operational Programme	Renovation of public buildings for energy efficiency	Energy efficiency in public lighting	Upgrading of schools and other public buildings for energy efficiency	Upgrading private/tourism buildings	SME energy efficiency electrical sector	SME energy efficiency thermal sector	Cogeneration	Energy networks	Total
Piedmont	4.1	4.1	12.2	12.2	14.6	14.6	11.4	8.1	**81.2**
Valle d'Aosta	0.2	0.1	0.7	0.7	0.2	0.1	0.9	0.9	**3.8**
Lombardy	5.1	1.7	5.1	1.7	-	-	10.2	10.2	**34.0**
Liguria	2.2	0.3	2.9	1.4	1.4	1.4	3.3	1.4	**14.3**
Trento	1.6	0.8	2.4	2.4	2.4	2.4	2.4	1.6	**16.0**
Bolzano	-	-	-	-	-	-	-	-	**-**
Veneto	2.9	0.4	3.2	3.2	0.4	0.4	5.3	5.3	**21.1**
Friuli Venezia Giulia	0.3	0.3	2.2	5.1	1.5	1.5	2.3	1.5	**14.5**
Emilia Romagna	1.4	1.4	3.4	3.4	13.5	13.5	20.3	10.8	**67.6**
Tuscany	0.4	1.1	1.1	2.2	6.6	6.6	2.2	1.8	**22.1**
Umbria	2.4	0.5	2.9	3.7	4.4	4.4	3.7	2.4	**24.4**
Marche	0.4	0.4	3.8	3.8	3.2	3.2	3.2	3.2	**21.4**
Lazio	1.6	0.3	2.9	3.2	2.4	1.6	2.4	1.6	**16.0**
Abruzzo	1.6	0.5	1.6	1.6	1.6	1.6	1.6	0.5	**10.5**
Molise	1.8	0.6	1.8	1.8	1.8	1.2	1.8	1.2	**12.0**
Campania	13.5	4.5	13.5	9.0	13.5	9.0	13.5	13.5	**90.0**
Puglia	9.8	2.0	14.7	9.8	17.6	14.7	14.7	14.7	**98.0**
Basilicata	3.8	1.3	3.8	3.8	3.8	3.8	3.8	1.3	**25.0**
Calabria	2.7	1.1	13.4	13.4	5.3	2.7	10.7	4.3	**53.4**
Sicily	9.7	3.9	38.8	58.1	29.1	19.4	5.8	29.1	**193.8**
Sardinia	13.6	3.4	20.4	6.8	1.4	1.4	10.9	10.2	**68.1**
Energy NIOP	***152.8***	***38.2***	**-**	***114.6***	***114.6***	***114.6***	***114.6***	***114.6***	*763.8*
TOTAL	**231.8**	**66.7**	**150.5**	**261.7**	**239.2**	**217.9**	**244.8**	**238.1**	**1,650.8**

Source: ENEA

Table III.8 Energy efficiency: total investment by type of intervention and Operational Programme (in millions of euros)

Operational Programme	Renovation of public buildings for energy efficiency	Energy efficiency in public lighting	Upgrading of schools and other public buildings for energy efficiency	Upgrading private/tourism buildings	SME energy efficiency electrical sector	SME energy efficiency thermal sector	Cogeneration	Energy networks	Total
Piedmont	5.07	5.07	15.22	40.59	48.71	48.71	37.89	27.06	**228.33**
Valle d'Aosta	0.23	0.09	0.84	2.25	0.63	0.25	3.13	3.13	**10.55**
Lombardy	6.38	2.13	6.38	5.67	-	-	34.02	34.02	**88.60**
Liguria	2.69	0.36	3.58	4.78	4.78	4.78	10.99	4.78	**36.73**
Trento	2.00	1.00	3.00	8.00	8.00	8.00	8.00	5.33	**43.33**
Bolzano	-	-	-	-	-	-	-	-	**-**
Veneto	3.68	0.53	3.95	10.53	1.40	1.40	17.55	17.55	**56.58**
Friuli Venezia Giulia	0.36	0.36	2.72	16.91	4.83	4.83	7.73	4.83	**42.59**
Emilia Romagna	1.69	1.69	4.23	11.27	45.07	45.07	67.60	36.05	**212.65**
Tuscany	0.55	1.38	1.38	7.35	22.06	22.06	7.35	5.88	**68.03**
Marche	0.53	0.53	4.81	12.82	10.68	10.68	10.68	10.68	**61.41**
Umbria	3.05	0.61	3.66	12.18	14.62	14.62	12.18	8.12	**69.04**
Lazio	2.00	0.40	3.60	10.67	8.00	5.33	8.00	5.33	**43.33**
Abruzzo	1.97	0.66	1.97	5.26	5.26	5.26	5.26	1.76	**27.41**
Molise	2.25	0.75	2.25	6.00	6.00	4.00	6.00	4.00	**31.25**
Campania	16.88	5.63	16.88	30.00	45.00	30.00	45.00	45.00	**234.38**
Puglia	12.25	2.45	18.38	32.67	58.80	49.00	49.00	49.00	**271.54**
Basilicata	4.69	1.56	4.69	12.50	12.50	12.50	12.50	4.17	**65.10**
Calabria	3.34	1.34	16.69	44.50	17.80	8.90	35.60	14.24	**142.40**
Sicily	12.11	4.85	48.45	193.80	96.90	64.60	19.38	96.90	**536.99**
Sardinia	17.02	4.25	25.53	22.69	4.54	4.54	36.30	34.03	**148.90**
Energy NIOP	***190.95***	***47.74***	**-**	***381.90***	***381.90***	***381.90***	***381.90***	***381.90***	***2,148.19***
TOTAL	**289.70**	**83.37**	**188.18**	**872.34**	**797.48**	**726.44**	**816.06**	**793.76**	**4,567.33**

Source: ENEA

Table III.9 **Energy efficiency: estimate of unit investment per annual CO2 emissions avoided by Operational Programme (average reference value – euros/(tCO_2/year))**

Operational Programme	Renovation of public buildings for energy efficiency	Energy efficiency in public lighting	Upgrading of schools and other public buildings for energy efficiency	Upgrading private/tourism buildings	Industrial energy efficiency electrical sector	Industrial energy efficiency thermal sector	Cogeneration
Piedmont	10,811	1,750	2,162	2,162	2,439	1,635	2,958
Valle d'Aosta	10,132	1,750	2,026	2,026	2,439	1,635	2,958
Lombardy	10,811	1,750	2,162	2,162	2,439	1,635	2,958
Liguria	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Trento	10,132	1,750	2,026	2,026	2,439	1,635	2,958
Bolzano	10,132	1,750	2,026	2,026	2,439	1,635	2,958
Veneto	10,811	1,750	2,162	2,162	2,439	1,635	2,958
Friuli Venezia Giulia	10,811	1,750	2,162	2,162	2,439	1,635	2,958
Emilia Romagna	10,811	1,750	2,162	2,162	2,439	1,635	2,958
Tuscany	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Umbria	10,811	1,750	2,162	2,162	2,439	1,635	2,958
Marche	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Lazio	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Abruzzo	11,365	1,750	2,273	2,273	2,439	1,635	2,958
Molise	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Campania	13,062	1,750	2,612	2,612	2,439	1,635	2,958
Puglia	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Basilicata	12,394	1,750	2,479	2,479	2,439	1,635	2,958
Calabria	12,628	1,750	2,526	2,526	2,439	1,635	2,958
Sicily	13,205	1,750	2,641	2,641	2,439	1,635	2,958
Sardinia	13,094	1,750	2,619	2,619	2,439	1,635	2,958
Energy NIOP	***12,737***	***1,750***	***2,547***	***2,547***	***2,439***	***1,635***	***2,958***

Source: ENEA

Table III.10 **Energy efficiency: scenario for average reduction in annual CO_2 emissions by Operational Programme (million tCO_2/year)**

Operational Programme	Renovation of public buildings for energy efficiency	Energy efficiency in public lighting	Upgrading of schools and other public buildings for energy efficiency	Upgrading	SME energy efficiency electrical sector	SME energy efficiency thermal sector	Cogeneration	Energy networks	Total
Piedmont	0.47	2.90	7.04	18.77	19.98	29.79	12.81	-	**91.76**
Valle d'Aosta	0.02	0.05	0.42	1.11	0.26	0.15	1.06	-	**3.07**
Lombardy	0.59	1.22	2.95	2.62	-	-	11.50	-	**18.88**
Liguria	0.22	0.21	1.45	1.93	1.96	2.92	3.72	-	**12.39**
Trento	0.20	0.57	1.48	3.95	3.28	4.89	2.71	-	**17.07**
Bolzano	-	-	-	-	-	-	-	-	**0.00**
Veneto	0.34	0.30	1.83	4.87	0.58	0.86	5.93	-	**14.70**
Friuli Venezia Giulia	0.03	0.21	1.26	7.82	1.98	2.96	2.61	-	**16.87**
Emilia Romagna	0.16	0.97	1.95	5.21	18.48	27.56	22.85	-	**77.18**
Tuscany	0.05	0.79	0.56	2.97	9.05	13.49	2.49	-	**29.38**
Umbria	0.28	0.35	1.69	5.64	6.00	8.94	4.12	-	**27.01**
Marche	0.04	0.31	1.94	5.17	4.38	6.53	3.61	-	**21.98**
Lazio	0.16	0.23	1.45	4.30	3.28	3.26	2.71	-	**15.39**
Abruzzo	0.17	0.38	0.87	2.32	2.16	3.22	1.78		**10.89**
Molise	0.18	0.43	0.91	2.42	2.46	2.45	2.03	-	**10.87**
Campania	1.29	3.21	6.46	11.48	18.45	18.35	15.21	-	**74.46**
Puglia	0.99	1.40	7.41	13.18	24.11	29.97	16.57	-	**93.62**
Basilicata	0.38	0.89	1.89	5.04	5.13	7.64	4.23	-	**25.20**
Calabria	0.26	0.76	6.61	17.62	7.30	5.44	12.04	-	**50.03**
Sicily	0.92	2.77	18.35	73.38	39.74	39.51	6.55	-	**181.21**
Sardinia	1.30	2.43	9.75	8.66	1.86	2.78	12.27	-	**39.05**
Energy NIOP	***14.99***	***27.28***	**-**	***149.92***	***156.60***	***233.55***	***129.11***	**-**	***711.46***
TOTAL	**23.05**	**47.64**	**76.25**	**348.39**	**327.02**	**444.26**	**275.88**	**-**	**1,542.48**

Source: ENEA

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III.2.3 Results

The methodology described above required us to look more closely at the interactions of the initiatives themselves with other possible effects, so as to include and compare the contribution of the 2007-2013 NSRF with the various greenhouse gas scenarios at the national level (see also chapter VI below).

Thus, for each type of energy saving initiative, we analysed the potential perturbation effects of the estimations carried out previously, with particular reference to:

- the free-rider effect, i.e. that generated by parties that would have carried out the project in any case, even without the incentives, in response to market-driven factors alone;[7]
- the effect of double counting with other policies and measures;[8]
- the rebound effect, i.e. the possibility that the energy saving project could increase the demand for the given service compared with the past, thereby actually increasing GHG emissions rather than reducing them;[9]

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[7] The free-rider effect is considered negligible for all types of intervention concerned.

[8] As regards double-counting effects, the following measures included in the various emission scenarios were taken into consideration:

1. 55 percent deduction – Ministerial Decree of 19 February 2007 as amended by the Ministerial Decree of 26 October 2007 and coordinated with the Ministerial Decree of 7 April 2008, implementing the 2008 Finance Act (the "Building Decree") regarding deductions for energy-upgrading expenditure on existing buildings, pursuant to Article 1(349) of Law 296 of 27 December 2006:
    a. Article 10(2), cumulable with other incentives
    b. in force until 2010; not applicable for public property
    c. allocation with respect to the NSRF: proportionate to the share of funding and the period in force.
2. Energy-efficiency credits (white certificates) – decree of 20 July 2004 – New targets for increasing energy efficiency in end uses of energy, pursuant to Article 9(1) of Legislative Decree 79 of 16 March 1999:
    a. Article 5(4), cumulable with other incentives
    b. in force until 2012, subsequently as an adopted/planned measure
    c. allocation with respect to the NSRF: proportionate to the share of funding (related to the EEC values of 2008).
3. Legislative Decree 311/06 – standards regarding new buildings and renovations – It is assumed that public buildings can be renovated in accordance with these new efficiency standards solely through NSRF funding; it was also assumed that only 10 percent of the interventions in the private sector would have been undertaken even without such funding.
4. Directive 2005/32/EC – mandatory energy-efficiency standards for electric motors, inverters, boilers, etc.) – the gradual entry into force after 2012, with exceptions and transition periods, gives a time horizon for the implementation of these measures that extends beyond the NSRF observation period.

[9] For the rebound effect, we have assumed an increase in the demand for the given energy service (e.g. resulting from an increase in spaces heated) of 5 percent in the public and industrial sectors and of 20 percent in the private civil sector (associated with the potential increase in summer air conditioning as a result of renovation and upgrading projects).

- the multiplier effect, i.e. the assumption that the projects funded could set an example for the market and act as a stimulus for other energy savings initiatives outside the scope of the funding.[10]

Although it is difficult to assign an appropriate value to each of these effects, a few initial working assumptions have been made. Table III.11 summarizes the results of this initial analysis, which leads to the direct attribution to the Operational Programmes co-financed by the ERDF of 1.3 million tCO_2 eq., for an overall reduction due to these effects of 14.5 percent.

Table III.11 Energy efficiency: scenario for reduction in annual CO_2 emissions by type of intervention with overlap with national intervention measures (million tCO_2/year)

	Renovation of public buildings for energy efficiency	Energy efficiency in public lighting	Upgrading of schools and other public buildings for energy efficiency	Upgrading private/tourism buildings	SME energy efficiency electrical sector	SME energy efficiency thermal sector	Cogeneration	Total
Free-rider effect	negligible							
Double-counting effects								
55% deduction	0%	0%	0%	-11%	-11%			
White certificates	-2%	-16%	-2%	-2%	-26%	-14%	-17%	
Equipment standards	0%		0%	0%				
Directive 2005/32/EC	Implementation after NSRF							
Rebound effect	-5%	-5%	-5%	-5%	-5%	-5%	-5%	
Multiplier effect	5%	5%	5%	20%	20%	20%	10%	
Total effects	-3%	-16%	-3%	-25%	-25%	-2%	13%	**14.5%**
CO_2 emissions avoided after interventions (Mt CO_2/year)	0.02	0.05	0.08	0.35	0.33	0.44	0.28	**1.54**
Total attributable to NSRF (Mt CO2/year)	**0.02**	**0.04**	**0.07**	**0.26**	**0.25**	**0.44**	**0.24**	**1.32**

Source: ENEA

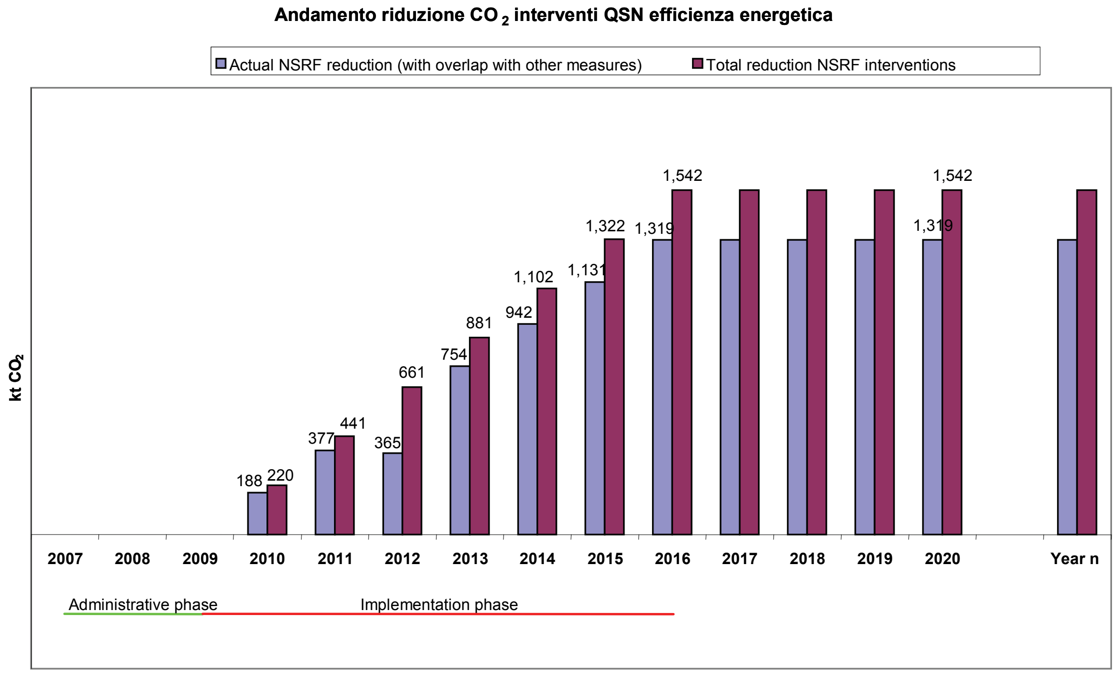
In order to ensure the comparability of the results of this analysis with national scenarios, we have assumed a linear trend over time of the effects of the reduction in GHG attributable to the NSRF for the period 2009-2016. The following additional assumptions were also necessary:

- a period of two years from approval of the Operational Programmes to the operational start of the measures;
- an average of about one year to execute the projects and begin operations;
- a constant level of annual funding disbursed for the period 2009-2015.

Based on these assumptions, there was a constant annual increase in interventions resulting in a reduction of 0.188 or 0.220 million tCO_2 eq./year, depending on whether we consider the direct contribution of the NSRF or the total of all interventions (Figure III.2).

[10] The multiplier effect assigned varies by sector: plus 5 percent for the public sector; plus 20 percent for the private sector, where the example of good energy efficiency could partially unleash market potential.

Figure III.2 Energy efficiency: scenarios for impact of ERDF investments on greenhouse gas emissions (thousands of t of CO_2 per year)



Source: ENEA

IV. Impact of investments in the transport sector on greenhouse gas emissions

The reduction in greenhouse gas emissions resulting from investments in the transport sector was estimated on the basis of highly incomplete information concerning the characteristics of the infrastructure concerned, the location and the expected impact of the projects. We therefore often had to turn to data drawn from official sources other than the Operational Programmes for our analyses.[11]

A very rough estimate was made of the reduction of CO_2 emissions as a result of the infrastructure investments indicated as "possible" in the Regional Operational Programmes (ROPs), both in the Convergence Objective regions and the Regional Competitiveness and Employment Objective regions, and the initiatives planned under the Networks and Mobility National Operational Programme (NOP).

IV.1 Input data

The total funding allocated to the transport sector under the ERDF Operational Programmes comes to €8,510.2 million, of which €2,711.0 million through the Networks and Mobility NOP for the regions of Campania, Calabria, Puglia and Sicily.

Our analysis considered all expenditure categories and all types of infrastructure projects with a potential impact on reducing CO_2 emissions (initiatives regarding the rail network, interchange parking area, upgrading/expansion of ports and interports, improvement of related road and railway access, metropolitan rail transport, etc.). The road projects did not always have a positive impact on reducing CO_2 emissions and therefore require further study, which was not possible to pursue on the basis of the data currently available.

However, the funding not considered accounts for just 14 percent of the total resources allocated to the Convergence Objective regions and just 8 percent of the Competitiveness Objective regions.

Table IV.1 below reports the planned funding for the transport sector within the ERDF ROPs and the Network and Mobility NOP. The expenditure categories that account for the greatest amount of funding are rail transport (30.5 percent), trans-European railways (13.3 percent), and ports (13.9 percent).

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[11] For the regions of Abruzzo, Friuli, Marche, Molise, Umbria and Veneto, we were unable to obtain the data needed, so they have been excluded from the analysis.

Table IV.1 Transport: ERDF funding (including national co-financing) by expenditure category and Operational Programme (in millions of euros)

Region	Rail transport	Railways (TEN-T)	Mobile rail infrastructure	Motorways	Motorways (TEN-T)	National highways	Regional/local roads	Bicycle paths	Urban transport	Multi-modal transport	Multi-modal transport (TEN-T)	Intelligent transport systems	Airports	Ports	Internal waterways (regional and local)	Promotion of clean urban transport	Total
Piedmont	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Valle d'Aosta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.0	**4.0**
Lombardy	22.9	-	-	-	-	3.0	37.0	2.5	-	10.1	-	-	-	4.0	8.1	59.0	**146.7**
Liguria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.7	**32.7**
Trento	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bolzano	2.0	-	-	-	-	-	-	-	-	2.0		2.0	-	-	-	5.0	**11.1**
Veneto	9.5	-	-	-	-	-	-	19.0	-	9.5	-	9.5	-	9.5	-	-	**56.9**
Friuli Venezia Giulia		6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	**8.5**
Emilia Romagna	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Tuscany	84.9	-	-	-	-	-	-	-	-	-	-	-	-	-	24.3	190.2	**299.4**
Umbria	1.7	-	-	-	-	-	10.4	2.1		1.7	-	7.7		-	-	16.7	**40.4**
Marche	-	-	-	-	-	-	-	-	-	18.0	-	6.0	2.1	5.0	-	9.5	**40.7**
Lazio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	226.0	**226.0**
Molise	-	-	-	-	-	36.6	-	-	-	-	-	-	-	-	-	-	**36.6**
Abruzzo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.3	**12.3**
Campania	615.0	160.0	-	55.0	-	-	75.0	-	-	60.0	-	-	70.0	150.0	-	-	**1,185.0**
Puglia	680.0	-	90.0	-	-	-	20.0	2.0	20.0	100.0	-	8.0	-	210.0	-	-	**1,130.0**
Basilicata	45.5	-	-	-	-	-	58.0	1.0	15.0	15.0	-	9.0	-	-	-	2.5	**146.0**
Calabria	104.9	-	-	-	-	60.0	66.0	-	45.0	94.7	-	1.2	45.0	45.0	21.0	0.0	**482.7**
Sicily	431.6	14.4	-	143.9	-	28.8	172.6	22.6	287.7	86.3	14.4	14.4	86.3	339.6	-	93.5	**1,736.1**
Sardinia	-	-	-	-	-	-	-	-	30.6	61.3	-	61.3	-	40.8	-	10.2	**204.2**
Transport NOP	***593.9***	***954.1***	-	***19.2***	***68.7***	***470.2***	-	-	-	***63.2***	-	***82.5***	***82.5***	***376.7***	-	-	***2,711.0***
TOTAL	**2,592.0**	**1,134.5**	**90.0**	**218.1**	**68.7**	**598.5**	**439.1**	**49.1**	**398.3**	**521.9**	**14.4**	**201.5**	**285.9**	**1,180.6**	**53.4**	**664.2**	**8,510.2**

Source: Based on the expenditure categories of the ERDF ROPs and the Networks and Mobility NOP

IV.2 Estimation method

The information contained in the Operational Programmes is not consistent from region to region. In most cases, the projects to be executed are not described, and only the areas of intervention are indicated, associated with one or more outcome indicators and one or more implementation indicators, that often only correspond to the number of projects to be carried out.

For the Convergence Objective regions, which are allocated the greatest amount of funding, a list is provided of the potential "major projects", even though no details are available regarding the infrastructure characteristics, expected impacts and estimated execution times. For the Competitiveness Objective regions, where the available resources are much more limited, only small-scale projects tend to be implemented, so no reference is made to "major projects".

The analysis was conducted for each region and for each operational objective, assessing individual areas of intervention when possible.

The methodology adopted in producing the broad estimate of CO_2 emission reductions resulting from the projects envisaged for the Operational Programmes involved the following steps:

- analysing the ROPs/NOP and related policy and implementation documentation;
- selecting the types of intervention with an impact on reducing CO_2;
- estimating the potential traffic on the new/upgraded infrastructure;
- estimating the change in CO_2 emissions as a result of shifting traffic from one mode of transport to another;
- calculating the estimated reduction in CO_2 as a proportion of regional emissions in the transport sector (APAT 2005).

The reduction in emissions was quantified on the basis of the estimated value of the shift in traffic from roadways (unless specified otherwise) to other modes of transport (e.g. from car to tram or from car to train) in terms of passengers per km and tonnes per km, multiplied by the difference in specific emissions of the two modes of transport concerned.

In an effort to adopt, as far as possible, a single methodological approach to calculating the change in traffic volume generated by the new infrastructure, the analysis began with the expected values for the outcome indicators or, in their absence, with the implementation indicators provided by the regions for each operational objective (which aggregates multiple areas of intervention), obviously considering only those indicators relevant to estimating CO_2 emissions. The outcome indicators are generally expressed as a percentage change between the reference year (2013 or 2015) and the most recent available data (2004-2005). It was therefore necessary to estimate the absolute values using data published by primary official sources, namely ISTAT and the Transport Ministry, for the various modes of transport and, where possible, the regional and/or traffic data for the urban areas involved.

In the absence of evidence to the contrary, we have assumed that the outcome indicators used to calculate the reduction in CO_2 emissions were only related to the corresponding project or set of projects, even when these were a part of a broader initiative with a time horizon for implementation extending beyond the period considered here.

Where the ROPs had not established any value for the outcome indicator or the indicator was not significant to the CO_2 analysis, the increase in traffic and/or shift in mode of transport that the infrastructure project is expected to generate was estimated parametrically based on the values of the implementation indicator, where specified, and/or the characteristics of the projects as determined on the basis of the documentation published by the regions, assuming that total demand for transport would remain constant over time.

The specific emissions (gCO_2/passenger-km and gCO_2/tonne-km) have been estimated on the basis of data from the Transport Ministry, the 2006 National Energy Report, the 2007 APAT Yearbook, and the 2005 APAT regional inventory of consumption and emissions for roadway transport, resulting in values that vary depending on the segment of transport demand.

IV.3 Results

As noted, resources allocated to the transport segment total about €8.5 billion. Given that it was not possible to estimate the CO_2 avoided for all of the projects envisaged in the ROPs due to a lack of data, the study actually evaluated projects totalling €6.64 billion. The interventions excluded include all of those called for under the six Operational Programmes of Abruzzo, Mache, Molise, Umbria, Friuli Venezia Giulia and Veneto, given that the information on projects was not sufficient even to make an approximate estimate.

Based on the estimations performed, the overall reduction obtainable as a result of the infrastructure projects considered is about 0.73 million t/year for the Convergence Objective regions and around 0.22 million t/year for the Competitiveness Objective regions, whereas the estimated reduction for the initiatives under Networks and Mobility NOP is about 0.33 million t/year. Therefore, assuming execution of all of the planned areas of intervention planned and the achievement of all of the expected results as indicated in the Operational Programmes, we would have a total reduction of 1.28 million t/year of CO_2.

Table IV.2 shows the estimated annual reduction in CO_2 for each Operational Programme, as well as the total funding for all of the expenditure categories of the transport sector, and the portion of funding corresponding to the areas of intervention assessed. The table also shows a comparison of the estimated reduction in CO_2 emissions for each region and the corresponding emissions for the transport sector[12] based on the 2005 APAT regional inventory.

[12] The calculation of the emissions from the inventory specific to the transport sector exclude emissions for international air and sea transport.

The reduction in CO_2 emissions varies from region to region almost proportionately with the level of funding and, therefore, with the size of the projects to be executed. Accordingly, we see greater reductions for the Convergence Objective regions, with a high of about 0.25 million t/year of CO_2 for Sicily against funding of €1,297 million.

In addition, CO_2 emissions avoided as a result of execution of the ROP projects are equal to about 1.7 percent of the total emissions for the transport sector in the regions considered or, more specifically, more than 2 percent for the Convergence Objective regions and just 0.47 percent for the Regional Competitiveness and Employment Objective regions. The initiatives planned under the NOP, which received funding equal to about half that of the ROPs of the Convergence regions, would produce a reduction in CO_2 emissions of around 1.2 percent. The greatest percentage reduction was seen in Puglia, at around 3 percent.

Indeed, despite the fact that the infrastructure projects in the transport sector called for under the Operational Programmes focus mainly on achieving development and modernization objectives, rather than on reducing greenhouse gas emissions, the reduction in emissions achieved is significant.

Table IV.2 Transport: annual reduction of CO_2 emissions by Operational Programme (Mt CO_2/year)

Operational Programme	ERDF funding and co-financing (€M)	Funding considered (€M)	CO_2 reduction (Mt/year)	2005 transport emissions (Mt)	CO_2 reduction/ CO_2 transport (%)
Piedmont	-	-	-	-	-
Valle d'Aosta	4	4	**0.001**	*0.66*	*0.08*
Lombardy	147	145	**0.050**	*16.91*	*0.30*
Liguria	33	33	**0.021**	*4.78*	*0.43*
Trento	-	-	-	-	-
Bolzano	11	11	**0.005**	*1.39*	*0.37*
(Veneto)	*(57)*	-	-	-	-
(Friuli Venezia Giulia)	*(8)*	-	-	-	-
Emilia Romagna	-	-	-	-	-
Tuscany	299	275	**0.043**	*8.07*	*0.53*
(Umbria)	*(40)*	-	-	-	-
(Marche)	*(41)*	-	-	-	-
Lazio	226	226	**0.075**	*10.2*	*0.73*
(Molise)	*(37)*	-	-	-	-
(Abruzzo)	*(12)*	-	**-**	-	-
Campania	1,185	925	**0.208**	*10.49*	*1.98*
Puglia	1,130	1,110	**0.183**	*7.53*	*2.43*
Basilicata	146	88	**0.022**	*1.04*	*2.11*
Calabria	483	311	**0.072**	*4.74*	*1.52*
Sicily	1,736	1,391	**0.236**	*10.69*	*2.25*
Sardinia	204	133	**0.028**	*2.86*	*0.96*
Networks and Mobility NOP	***2,711***	***1,988***	***0.331***	***33.44***	***0.99***
TOTAL	**8,510** *(8,317)*	**6,640**	**1,278.00**	**79.35**	***1.61***

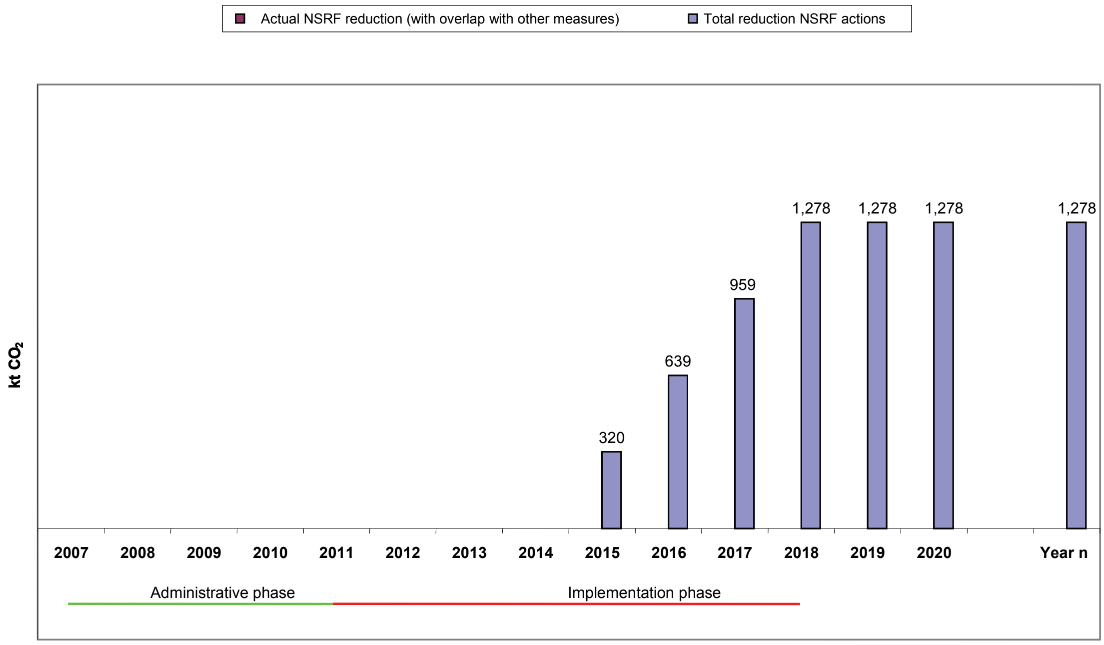
Source: ENEA

Note: For the regions shown in parentheses, no funding amount was considered, given that it was not possible to calculate even an approximate estimate of the impact on CO_2 emissions of the projects indicated in the respective ROPs.

We should reiterate that the results are merely indicative, given that a more precise estimate of CO_2 emission reductions can only be obtained by analysing each individual project based on definite implementation data. Furthermore, the assumptions used need to be verified on the basis of any revisions of the outcome indicators that underlie the calculation of the CO_2 emission reductions.

Figure IV.1 below shows the trend over time in the annual reduction in CO_2, assuming that the 2007-2010 period is dedicated to administrative activities (e.g. calls for tender, award of contracts, etc.) and the planned projects are implemented from 2010 to 2018, with the actual use of some works to begin in 2015. The trend in CO_2 reduction from 2015 to 2018 is then assumed to be linear.

Figure IV.1 Transport: scenarios for impact of ERDF investments on greenhouse gas emissions (t of CO_2 per year)



Source: ENEA

V. Impact of investments in the waste management sector on greenhouse gas emissions

V.1 Input data

Projects to improve waste management have been planned in all of the Convergence Objective regions and in Sardinia.

The funding for the waste management sector allocated under the Regional Operational Programmes totals €685.2 million (Table V.1).

Table V.1 Waste management: ERDF funding (including national co-financing) by Operational Programme (in millions of euros)

Operational Programme	Millions of euros
Campania	270.0
Puglia	100.0
Basilicata	27.0
Calabria	60.0
Sicily	160.2
Sardinia	68.1
TOTAL	**685.2**

Source: Based on ERDF ROP expenditure category data

V.2 Estimation method

For the purpose of calculating the greenhouse gas emission impact of investments to improve urban waste management, we have drawn on the "greenhouse gas balances" of the various plant alternatives. Specifically, the following forms of waste collection and disposal have been considered:

a) recycling;

b) composting of organic waste;

c) landfill disposal.

a) recycling

Estimate were made of the equivalent value of greenhouse gas emissions generated by waste collected separately for recycling (paper and cardboard, glass, iron, aluminium, textiles, electrical and electronic equipment, etc.).[13] The values for climate-change gases have been calculated based on:[14]

[13] See European Environment Agency – Technology 2001 – *Waste management option of climate change* – 2001; Ambiente Italia – *Il riciclo ecoefficiente – Potenzialità ambientali, economiche ed energetiche* (2006) and *Il riciclo ecoefficiente – Performance e scenari economici, ambientali ed energetici* (2008)

[14] These figures do not include emissions generated by plant construction. However, it should be noted that,

- energy and corresponding greenhouse gases in waste collection, transport and treatment;
- energy and emissions avoided by using recycled materials rather than new materials;
- energy and emissions avoided by not transporting new materials and using recycled materials.

In Table V.2, we see that recycling is also an important way to save on raw materials and boost energy efficiency, given that it produces an objectively measurable reduction in energy use compared with production from raw materials. Furthermore, products made using recycled materials are functionally equivalent to those that are made using raw materials.

Table V.2 **Waste management: greenhouse gas balance from recycling ($kgCO_2$ eq/t of waste recovered)**

Material recycled	Collection, transport and treatment	Energy and materials replaced	Total emissions
Paper and cardboard	34	-634	-600
HDPE	39	-530	-491
PET	39	-1,800	-1,791
Glass	34	-287	-253
Ferrous metals	34	-1,521	-1,487
Aluminium	34	-9,108	-9,074
Textiles	34	-3,203	-3,169

Source: ENEA based on 2001 EEA data and 2006 and 2008 Ambiente Italia data

b) composting of organic waste

The composting process is used to recycle the organic waste. The term composting refers to the biological processes that occur in the conversion of complex organic matter into simpler substances. The bacteria involved in the process break down the complex organic matter as they feed on it, and the by-products of their metabolism are absorbed by the earth, thereby recycling the organic waste collected.

In this typically aerobic process, part of the degradable organic carbon contained in organic fraction is converted into CO_2. However, it is also possible for methane (CH_4) to be synthesised if, during the composting process, pockets of organic matter in anaerobic conditions should form, as well as nitrous oxide (N_2O) generated from the organic nitrogen (Table V.3).

by also taking energy consumption and additional emissions generated by waste collection and treatment, there is a significant reduction in greenhouse gas emissions.

Table V.3 **Waste management: methane (CH_4) and nitrous oxide (N_2O) emissions from the composting process**

CH_4 emission factor kg CH_4/t $_{(OF)}$		N_2O emission factor kg N_2O/t $_{(OF)}$	
Dry fraction	**As is**	**Dry fraction**	**As is**
10	4	0.6	0.3
(0.08 - 20)	(0.03 - 8)	(0.2 – 1.6)	(0.06 – 0.6)

Note: It is assumed that the dry fraction is made up of 25-30 percent degradable organic carbon and 2 percent nitrogen. The emission factors have been calculated assuming a moisture content of 60 percent in the organic matter to be treated.

Source: Intergovernmental Panel on Climate Change - IPCC 2006

Energetically and environmentally, the process entails an average consumption of electricity of 32 kWh/$t_{(OF)}$ and emissions of gaseous CO_2 that are not taken into consideration given that they are of biogenic origin (Table V.4).

According to calculations found in the literature[15], the organic carbon contained in compost corresponds to avoided CO_2 emissions of around 80 kg $CO_2/t_{(COMPOST)}$, plus 200 kg $CO_2/t_{(COMPOST)}$ of emissions avoided through use in replacing peat and fertilizer. However, for the purposes of these estimates, we have conservatively assumed a carbon sink[16] and use of peat and fertilizer that corresponds to 183 kg $CO_2/t_{(OM)}$ of emissions avoided.

Table V.4 **Waste management: energy consumption, CO_2 emissions and carbon stock from the composting process**

Energy consumption	CO2 eq. emissions from energy consumption	Carbon sink and unused peat and fertilizer
kWh/t $_{(OF)}$	**kg CO_2 eq/t $_{(OF)}$**	**kg CO_2 eq /t $_{(OF)}$**
32 (9-60)	13.2	-183

Source: Ambiente Italia, 2008, and US Environmental Protection Agency (EPA), 2006

c) landfill disposal

Landfills operate under anaerobic conditions in which the organic carbon found in residual urban waste (RMW) is converted, by way of biochemical reactions, into biogas (mainly CH_4 and CO_2), the formation of which depends on the actual composition of the waste.

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[15] See Ambiente Italia 2008, op. cit. and US EPA- *Solid Waste Management and Greenhouse Gases - A Life-Cycle Assessment of Emissions and Sinks* – 2006

[16] Taking account of the mass balances and net of discarded materials, the recycling of biogenic materials results in the permanent storage of CO_2 credits in biomass. Among the targets for reducing atmospheric greenhouse gas emissions, the Kyoto Protocol allows the industrialized countries to use CO_2 absorption by forests and agricultural land (carbon sinks).

The development of separate waste collection has also had an impact on the characteristics of residual urban waste, particularly with regard to the composition of the materials of which it is made up, which has had a consequent effect on both the lower heating value, which is tending to increase, and the biogenic carbon content, which is tending to decrease. The latter of these parameters influences the formation of biogas.

Landfill biogas is generated from the anaerobic decomposition of the organic matter found in residual urban waste. It is estimated that 33 percent of landfills reach the methanogenic phase within 2.5 years from when the waste is deposited, 73 percent after 4 years, and 93 percent after 10 years. Under optimal conditions, most of the biogas from waste is produced within twenty years of disposal. Thus, the composition of biogas is strictly correlated with a number of distinct phases in the waste degradation process.[17]

It should also be underscored that the production of biogas from residual urban waste is extremely variable and depends on a variety of environmental factors (moisture content, the presence of nutrients, size of waste, etc.). There are various biokinetic models for calculating the production of biogas, but it is clear that the extreme variability due to the factors described above, and the consequent difficulty in obtaining accurate starting data, means that these models can only produce an approximation.

The methodology used here in calculating the biogas emissions from residual urban waste is based solely on a mass balance and does not take any time factor into account. All of the biogas is assumed to be emitted in the same year in which the residual urban waste is deposited in the landfill.

Drawing on the data available in the literature, the total production of biogas is between 100-250 $Nm^3/t_{(RMW)}$ (54-135 $Nm^3/t_{(RMW)}$ of CH_4), not all of this gas can be captured, and most of it is dispersed into the atmosphere.[18]

Therefore, given the material composition of the residual urban waste deposited in the landfill, and adopting the methodology used in EEA (2001), we have calculated the production of biogas emitted and the carbon sink.[19]

The results show a production of 209.7 $Nm^3/t_{(RMW)}$ of biogas with the following composition (in volume and mass):

- 104.5 $Nm^3/t_{(RMW)}$ of CH_4 (74.9 $kg/t_{(RMW)}$ of CH_4);

[17] The residual urban waste deposited in landfills produces biogas in ways that change significantly over time, but which essentially entail the following basic phases: the first phase is aerobic (using the oxygen available within the mass of waste) and produces CO_2; the second phase features a sharp decline in available oxygen, producing CO_2 and resulting in an anaerobic environment; in the third (anaerobic) phase, CH_4 begins to be formed, while the production of CO_2 declines. Therefore, CO_2 content is initially high (first phase) before declining rapidly (second and third phase) and then becoming nearly stationary in the composition of biogas.

[18] The biogas capture system is an integral part of a landfill. It is good practice to capture biogas right from the start of operation of a landfill (after six months to a year). To that end, it is advisable to take all possible steps in landfill design (extraction by rapid-exhaustion lots, temporary horizontal and vertical capture systems) and operation in order to accelerate the activation of the capture system.

[19] Based on the methodology used by the European Environment Agency – Technology 2001 – Waste management options and climate change – 2001

- 104.2 $Nm^3/t_{(RMW)}$ of CO_2 (206 $kg/Nm^3/t_{(RMW)}$ of CO_2) not counted because of biogenic origin.

Assuming, for the purposes of this analysis, a 20 percent capture rate of the biogas, then:

- the combustion of 20 percent of CH_4 (20.9 $Nm^3/t_{(RMW)}$) generates 41.3 $kg/t_{(RMW)}$ of (biogenic) CO_2;
- the remaining 83.6 $Nm^3/t_{(RMW)}$ of CH_4 corresponds to 1,258 $kg/t_{(RMW)}$ of CO_2 equivalent in terms of greenhouse gases.

Finally, we calculated that the carbon sequestered amounts to 430 $kg/t_{(RMW)}$ of CO_2 equivalent.[20]

V.3 Results

The parameters described above were then compared with the planned plant technologies of the Regional Operational Programmes and with the indicated targets for separate waste collection.[21]

As an effect of the reuse of materials and the consequent substitution of production cycles based on raw materials, recycling provides environmental benefits in terms of both energy savings and greenhouse gas emissions. The estimates for greenhouse gas emissions are shown in Table V.5 below.

However, achieving the targets set out in the Operational Programmes depends on executing a given amount of investments in plant and in organising separate waste collection services. Therefore, in order refine the estimate, we conducted an analysis of the consistency between the amount of funding allocated under the ERDF Operational Programmes and the plant needed to achieve the targets. This has shown that the planned funding does not always appear to be sufficient to meet the plant requirements to achieve the targets. For this reason, and in the absence of further information on appropriations from other sources of funding (ordinary or additional), we have constructed a conservative scenario based on average investment costs available in the literature (Table V.6).

[20] ENEA based on 2001 EEA data.

[21] The reference values for the existing situation (inhabitants, production of municipal waste, percentage of separate waste collection) were taken from the more recent 2007 data from the ISPRA, rather than the data from the 2007-2013 ROPs (regarding 2004 and 2005). Based on this assumption, we then calculated the data regarding the quantity of separate waste collection once fully implemented.

Table V.5 **Waste management: scenario for reduction of annual CO_2 emissions from separate waste collection based on Operational Programme targets (t of CO_2/year)**

Operational Programme	Quantity of waste handled through separate waste collection		Greenhouse gas emissions			
			Not deposited in landfill	Composting organic fraction [2]	Recycling dry fraction	Total
	t/total	kg/inhab	teq(CO_2)	teq(CO_2)	teq(CO_2)	teq(CO_2)
Campania	128,373	22.1	-106,293	690	-2,120	-107,723
Puglia	668,130	163.9	-553,212	3,089	-35,032	-585,155
Basilicata	78,045	132.1	-64,621	351	-5,041	-69,153
Calabria	291,450	145.2	-241,321	1,203	-23,199	-263,317
Sicily [1]	520,173	103.4	-430,703	3,745	--	-426,958
Sardinia	105,416	63.3	-87,285	291	-10,886	-97,879
TOTAL (avg)	**1,791,588**	**-93.4**	**-1,483,435**	**9,369**	**-75,572**	**-1,550,185**

Note: [1] In Sicily, no value is specified for the dry fraction of separate waste collection given that, in the related ROP, no increase is required.
[2] In the composting process, the values for greenhouse gas emissions are positive given that account is not taken of the waste not deposited in the landfill.

Source: ENEA

Table V.6 **Waste management: scenario for reduction of annual CO_2 emissions from separate waste collection based on planned investments indicated in the Operational Programmes (t CO_2/year)**

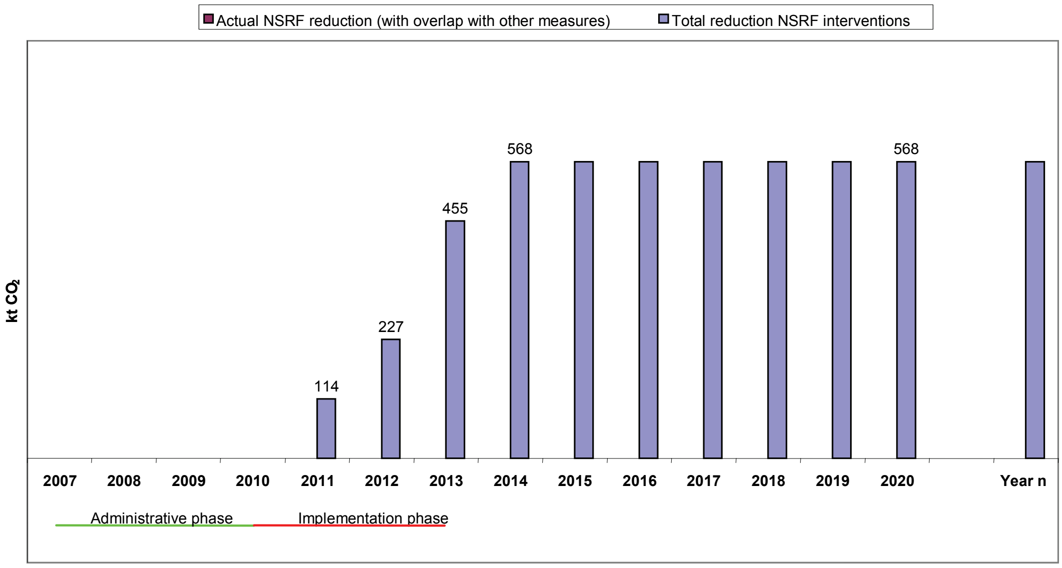
Operational Programme	Quantity of waste handled through separate waste collection		Greenhouse gas emissions			
			Not deposited in landfill	Composting organic fraction [2]	Recycling dry fraction	Total
	t/total	kg/inhab	teq(CO_2)	teq(CO_2)	teq(CO_2)	teq(CO_2)
Campania	128,373	22.1	-106,293	690	-2,120	-107,723
Puglia	107,416	26.3	-88,941	635	-2,822	-91,128
Basilicata	34,252	58	-28,360	193	-1,102	-29,269
Calabria	66,024	32.9	-54,668	392	-2,165	-56,441
Sicily [1]	226,397	45	-187,456	1,630	--	-185,826
Sardinia	105,416	63.3	-87,285	291	-10,886	-97,879
TOTAL (medio)	**667,878**	**-34.8**	**-553,003**	**3,831**	**-19,095**	**-568,267**

Note: [1] In Sicily, no value is specified for the dry fraction of separate waste collection given that, in the related ROP, no increase is required.
[2] In the composting process, the values for greenhouse gas emissions are positive given that account is not taken of the waste not deposited in the landfill.

Source: ENEA

In order to compare the results of this analysis with the national scenarios, we have assumed a rising trend over time in the effects of the reduction in GHG attributable to the projects called for under the Operational Programmes for the period 2011-2014. We have also assumed a period of three years between the start of the program and the start of investments, and a three-year implementation phase for the projects to become operational. Finally, the amount of funding dispersed annually is assumed to be constant for the period 2009-2015. Figure V.1 incorporates these assumptions, with an annual reduction once fully operational of 568 kg CO_2/year, with no overlapping national measures.

Figure V.1 Waste management: scenarios for impact of ERDF investments on greenhouse gas emissions (kg CO_2/year)



Source: ENEA

VI. Scenarios for overall impact of investments on greenhouse gas emissions

In this final chapter, we quantify the overall trends in greenhouse gas emissions until 2020 based on two scenarios:

- in the first (benchmark) scenario, we consider all policies and measures specifically designed to reduce or limit emissions at the national level, not including the interventions called for under the ERDF Operational Programmes of the 2007-2013 NSRF;
- in the second scenario (with additional measures), the developments in emissions also include the effects of actions funded under the NSRF.

The impact on emissions of the actions called for under the NSRF are, generally speaking, therefore considered to be additional to the package of policies and measures currently being implemented in Italy in order to comply with the Kyoto Protocol and any post-Kyoto obligations. However, there may be some overlap between current policies and the actions of the NSRF, in the sense that the NSRF initiatives could be implementations of actions already planned at the macro level, but not at the operational level. This makes it possible to assess the NSRF initiatives and, in particular, their impact on emissions within the more general context of national greenhouse gas emissions.

VI.1 Benchmark scenario and impact on greenhouse gas emissions

In order to specify the benchmark scenario to which the actions of the 2007-2013 NSRF are to be added, we have used the scenarios prepared by ENEA using the Markal-GAINS models.[22] The policies and measures considered have been divided into the following categories:

- approved and operational policies and measures, for which there are detailed legislative measures;
- approved but not yet operational policies and measures for which there are general legislative measures that require further implementation;
- policies and measures under study for which there are no legislative measures at this time.

Table VI.1 shows the approved and operational measures; Table VI.2, those that have been approved, but are not yet operational; Table VI.3, those that are still under study.

[22] This scenario is in line with the one transmitted to the European Commission in March 2009 by the Ministry for the Environment, in agreement with the Ministry for Economic Development, in compliance with Decision 280/2004/EC.

Table VI.1 Benchmark scenario: approved and operational policies and measures and impact on emissions in 2020

Policy or measure	Objective or activity	Total GHG reduction (Mt CO_2 eq.) by 2020
ENERGY SECTORS		
ENERGY SUPPLY		
Renewables		
Photovoltaic net metering account (Min. Dec. 20 July 2005 as amended by Min. Dec. 8 February 2006)	To promote photovoltaic power generation via feed-in tariffs until the cumulative nominal capacity of all beneficiary plants reaches 500 MW	Measures already included in the emission trend scenario
Photovoltaic net metering account (Min. Dec. 19 February 2007)	To promote photovoltaic power generation via subsidised tariffs until the cumulative nominal capacity of all beneficiary plants reaches 1200 MW	
Photovoltaic power (2007 Finance Act)	To promote the installation of photovoltaic systems in new buildings. The measure has not been analysed separately as it only regards 2007, and so was considered as an enhancement to the existing system	
Renewable energy excluding photovoltaic	To promote power generation from renewable sources via a new incentive system. To raise the annual increase in the minimum share of renewable energy from 0.35% to 0.75% over the period 2007-2012	
Cogeneration		
White certificates (Min. Dec. December 2007)	To promote energy savings by promoting cogeneration	Measures already included in the emission trend scenario
INDUSTRY		
White certificates (Min. Dec. December 2007)	To promote energy savings	2.02
CIVIL (residential and service sector)		
Energy efficiency of buildings (2007 Finance Act). The measures have not been analyzed separately, but as enhancing the existing system	To promote energy renovations on existing buildings To promote thermal insulation projects in existing buildings To promote the use of condensing boilers To promote energy savings in existing buildings	0.26
White certificates (Min. Dec. December 2007)	To promote energy savings in buildings	3.47
TRANSPORT		
Infrastructure measures	To complete the high-capacity/high-speed network and upgrade	5.70
Operational measures	To improve local urban public transport	1.00
Biofuels	To promote the use of biofuels	Measures already included in the emission trend scenario
WASTE MANAGEMENT		
Separate waste collection	To achieve separate waste collection goals and reduce biodegradable waste in landfills	Measures already included in the emission trend scenario
TOTAL MEASURES APPROVED AND OPERATIONAL		**15.15**

Source: ENEA

Table VI.2 Benchmark scenario: approved but not operational policies and measures and impact on emissions in 2020

Policy or measure	Objective or activity	Total GHG reduction (Mt CO_2 eq.) by 2020
ENERGY SECTORS		
ENERGY SUPPLY		
Renewables		
New incentives for renewable energy (2008 Finance Act). The 2007-2013 NSRF has not been analysed separately, but considered as a supporting measure	To promote power generation from all renewable sources, with a particular emphasis on less competitive sources	7.44
Renewable thermal energy		
Building (Leg. Dec. 192/2005, as amended by Leg. Dec. 311/2006) implementing decrees pending (annex 1, point 13)	To promote thermal solar, biomass for thermal uses (fireplaces, boilers), low-temperature geothermal and ground-heat exchange	2.91
Energy efficiency of buildings (2008 Finance Act).		
2007 Action Plan		
Cogeneration		
Action Plan July 2007 (white certificates – new 2015 targets)	To promote energy savings	2.47
INDUSTRY		
Action Plan July 2007 (white certificates – new 2015 targets)	To promote energy savings	2.76
CIVIL (residential and service sector)		
Building (Min. Dec. 27 July 2005)	To promote energy savings in new and existing buildings	3.48
Building (Leg. Dec. 192/2005, as amended by Leg. Dec. 311/2006)	To increase the energy performance of new and existing buildings	
Action Plan July 2007 (white certificates – new 2015 targets). 2008 Finance Act and 2007-2013 NSRF have not been analysed separately, but considered as supporting measures	To promote energy savings	3.61
TRANSPORT		
Biofuels	To promote the use of biofuels	3.65
Intermodal measures	To shift passenger traffic from cars to road-based public transport. To shift goods transport from road to sea	1.20
Operational measures	Efficient truck transport. To improve road traffic circulation in urban areas	2.3
TOTAL APPROVED BUT NOT OPERATIONAL		**29.82**

Source: ENEA

Table VI.3 Benchmark scenario: policies and measures under study and impact on emissions in 2020

Policy or measure	Objective or activity	Total GHG reduction ($Mt\ CO_2$ eq.) by 2020
	ENERGY SECTORS	
ENERGY SUPPLY		
Renewable thermal energy		
Position Paper 2007 – renewable energy	To promote thermal solar, biomass for thermal uses (fireplaces, boilers), low-temperature geothermal and ground-heat exchange	2.91
Cogeneration		
White certificates – increase after 2015	To further promote cogeneration	0.55
District heating and other integrated territorial energy systems – AIRU proposal	Operating grants for district heating delivered to users	
Increase infrastructure efficiency		
CESI document	To reduce electricity losses	0.19
CESI document	To reduce electricity losses by modernizing the national transmission and distribution grids (lines and substations)	0.76
INDUSTRY		
White certificates – increase after 2015	To further extend the energy savings targets to 2020	1.75
Energy efficiency standards for equipment used	Eco-design and introduction of mandatory machinery efficiency standards (Directive 2005/32/EC) for electric motors, inverters, boilers, etc.	3.05
CESI document	To reduce greenhouse gas emissions by significantly increasing aluminium recycling	0.8
CESI document	Mechanical steam compression, energy savings in the chemical, glass and paper industries	2.56
CESI document	To reduce CO_2 emissions by replacing fossil fuels used in cement production with waste-derived fuels	1.2
CIVIL (residential and service sector)		
White certificates – increase after 2015	To further extend the energy savings targets to 2020	1.95
Additional incentives	Incentives (financial, local, etc.) to support the introduction of new equipment	9.27
Energy efficiency standards for equipment used	Eco-design and introduction of mandatory machinery efficiency standards (Directive 2005/32/EC) for electric motors, inverters, boilers, etc.	
New energy efficiency standards for buildings	To further reduce energy consumption in buildings and promote the use of renewable energy	8.35
TRANSPORT		
Vehicle fleets	Further aid in replacing old vehicles with new ones with average emissions of 120g CO_2/km	2.80
Rail transport	Adoption of systems to assist train drivers (e.g. energy-efficient driving). Assumption: average energy savings of 10% in the rail segment	0.95
Technical measures regarding vehicles	Efficient air conditioners; gear-change indicator; low rolling resistance tires and systems to monitor tire pressure; low-viscosity lubricants	2.90
Measures focusing on demand and on conduct	Eco-driving; taxation based on consumption	3.30
TOTAL MEASURES UNDER STUDY		**43.3**
	NON-ENERGY SECTORS	
INDUSTRIAL PROCESSES		
Nitric acid	Reduce N_2O emissions by acid production plants	1.57
AGRICULTURE		
Fertilizers	To optimize the use of fertilizers	0.98
Storage of animal waste	Recovery of biogas from the stores of animal waste	
WASTE MANAGEMENT		
Stabilizing exploitation of organic matter	Treatment of all biodegradable waste before dumping in landfills	4.40
TOTAL MEASURES UNDER STUDY		**50.25**

Source: ENEA

The set of approved measures, both operational and non-operational, generate a reduction of about 45 Mt CO_2 eq. If account is also taken of reduction measures currently under study, equal to about 50 Mt CO_2 eq., the total reduction comes to around 95 Mt CO_2 eq.

Table VI.4 shows the potential reduction in greenhouse gas emissions of all three categories of policies and measures.

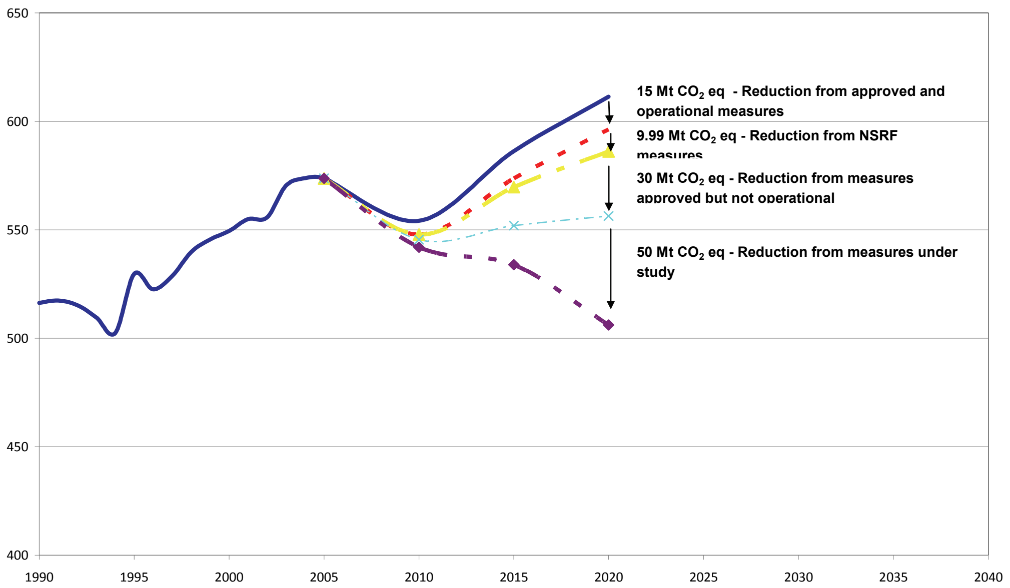
Table VI.4 Benchmark scenario: impact on greenhouse gas emissions of all measures in 2020

Policy or measure	Total GHG Reduction by 2020 (Mt CO2 eq.)
Approved and operational	15.15
Approved but not operational	29.82
Under study	50.25
TOTAL	**95.22**

Source: ENEA

Figure VI.2 shows the impact of these measures in the benchmark scenario. The dark blue line (at the top) represents the current greenhouse gas emission trend. The dashed red line shows emissions after the effects of approved and operational policies, which result in a total reduction as at 2020 of about 15 Mt CO_2 equivalent; the yellow line with the triangles shows emissions considering both the above effects and those of the policies and measures that have been approved but are not yet operational; finally, the dashed blue line represents the effect of all three packages of policies and measures.

Figure VI.1 Benchmark scenario: trend of greenhouse gas emissions net of actions under the ERDF Operational Programmes of the 2007-2013 NSRF (Mt CO_2)



Source: ENEA

VI.2 Impact of the NSRF actions in reducing greenhouse gas emissions

This section discusses the trend over time in expected reductions in GHG emissions as a result of the NSRF initiatives.

Table VI.5 shows the effects on emissions of measures funded under the NSRF in the renewable energy, energy efficiency, waste management and transport sectors.

Table VI.5 Scenario with additional measures: potential impact on greenhouse gas emissions of the measures envisaged under the ERDF Operational Programmes of the 2007-2013 NSRF

Type of intervention	NSRF funding (€M)	Emissions avoided (Mt CO_2/year)
Renewable resources (Energy NIOP and ERDF ROPs - Convergence and Competitiveness Objectives)	2,231	4,83 - 6,82 [2]
Energy savings (Energy NIOP and ERDF ROPs - Convergence and Competitiveness Objectives)	1,721	1,32 [2]
Waste management (ERDF ROPs – Convergence Objective and Sardinia)	685	0.57
Transport (Networks and Mobility NOP and ERDF ROPs - Convergence and Competitiveness Objectives)	8.512 [1]	1.28
TOTAL	**13,149**	**8,00 - 9,99**

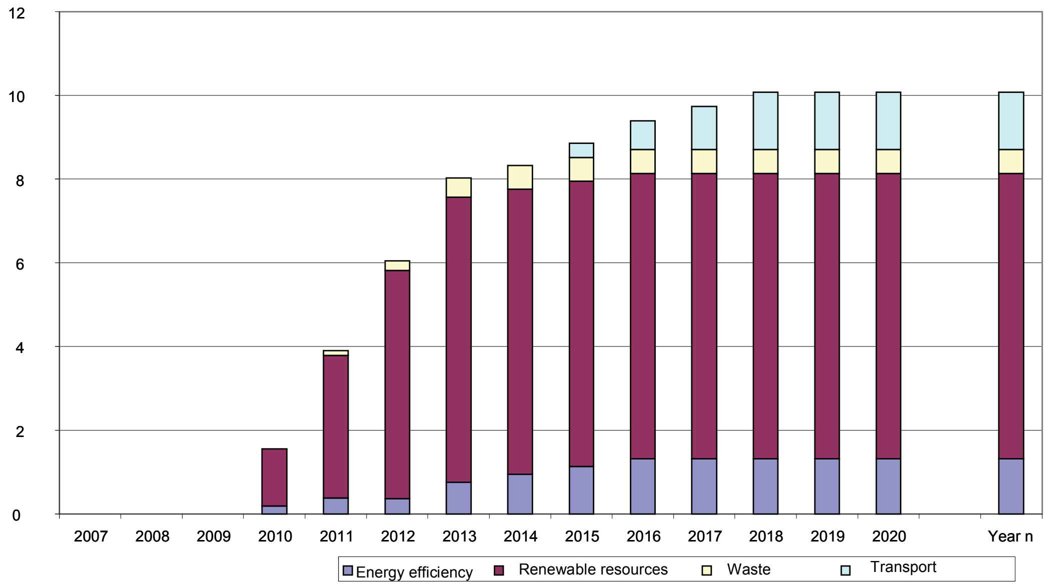
Note: [1] The amount of funding used in calculating the reduction in CO_2 emissions was €6,640 million, due to the lack of information on the specific type of initiatives in a number regions within the transport sector.
[2] The amount of CO_2 emissions avoided has been calculated taking account of the overlap with other measures.

Source: ENEA

Based on these figures, we see that the maximum estimated potential of the actions funded under the NSRF is about 10 Mt CO_2 eq. The greatest potential reductions come from initiatives in the area of renewable energy, while those in transport, energy efficiency and waste management have a lesser impact.

A possible trend in the reduction of greenhouse gas emissions is shown in Figure VI.2, which also shows that the total potential reduction in emissions is reached by 2020, when it has been assumed that all of the NSRF actions will have been implemented. Figure VI.3 also underscores the fact that the impact on emissions will continue beyond the period considered.

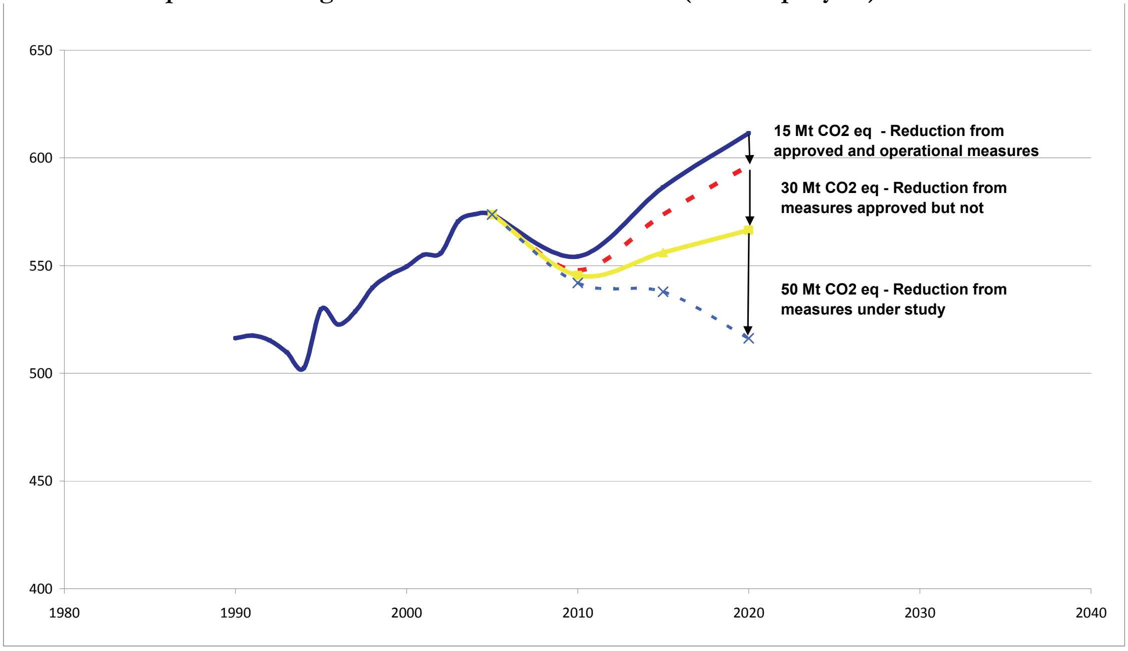
Figure VI.2 **Scenario with additional measures: trend in greenhouse gas emissions with the actions of the ERDF Operational Programmes of the 2007-2013 NSRF, by sector (Mt CO_2 per year)**



Source: ENEA

The reduction in emissions due to the actions funded under the NSRF is shown in Figure VI.3, together with the reductions resulting from the policies and measures other than those of the NSRF.

Figure VI.3 Scenario with additional measures: trend of greenhouse gas emissions with the actions of the ERDF Operational Programmes of the 2007-2013 NSRF (Mt CO_2 per year)



Source: ENEA

In particular, compared with the trend line for greenhouse gas emissions (dark blue at the top), the line at the bottom (dashed purple with diamonds) shows the trend including both the policies and measures of the benchmark scenario (operational, approved and under study) and the actions of the ERDF Operational Programmes of the 2007-2013 NSRF.

The chart tracks reductions attributable to the various types of measures:

- approved and operational policies and measures: a reduction of 15 Mt of CO_2 eq. by 2020 (dashed red line);
- approved but not yet operational policies and measures: a further reduction of about 30 Mt CO_2 eq. (dashed blue line);
- policies and measures that are still under study: reduction of 50 Mt of CO_2 eq. by 2020 (dashed purple line with diamonds);
- actions funded under the ERDF Operational Programmes of the NSRF, which provide a further reduction of about 10 Mt CO_2 eq. (dashed yellow line with triangles).

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