Consiglio Nazionale delle Ricerche
Dipartimento Terra e Ambiente
La ricerca per la gestione dei rifiuti secondo gli standard europei
Roma, 15 aprile 2009

Aspetti economici del ciclo dei rifiuti

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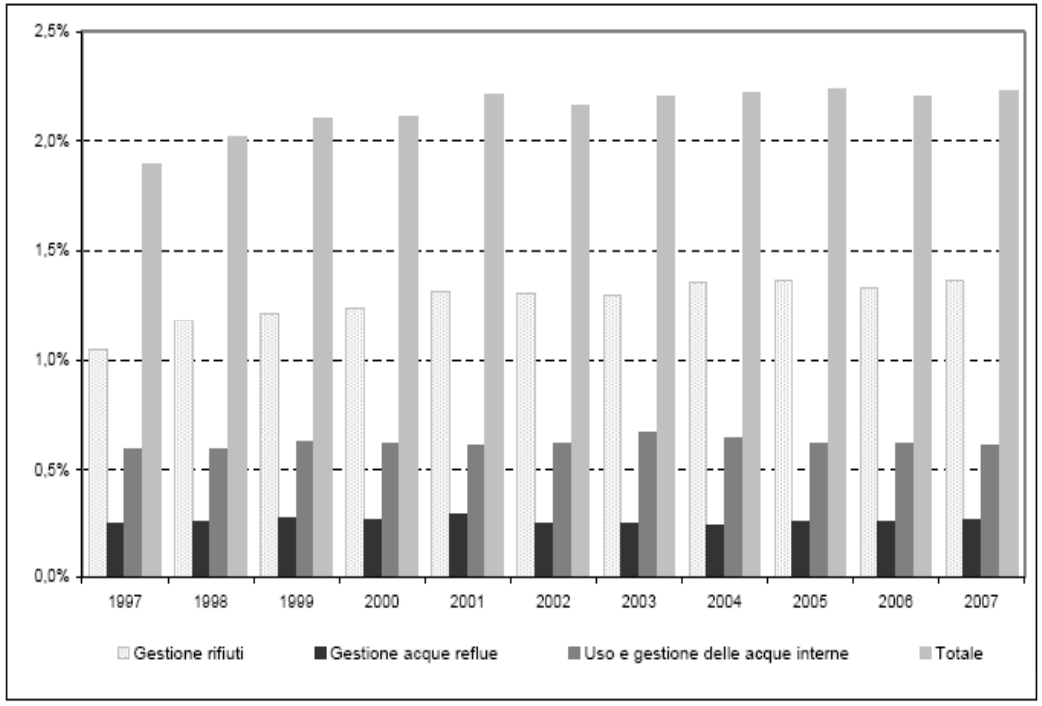
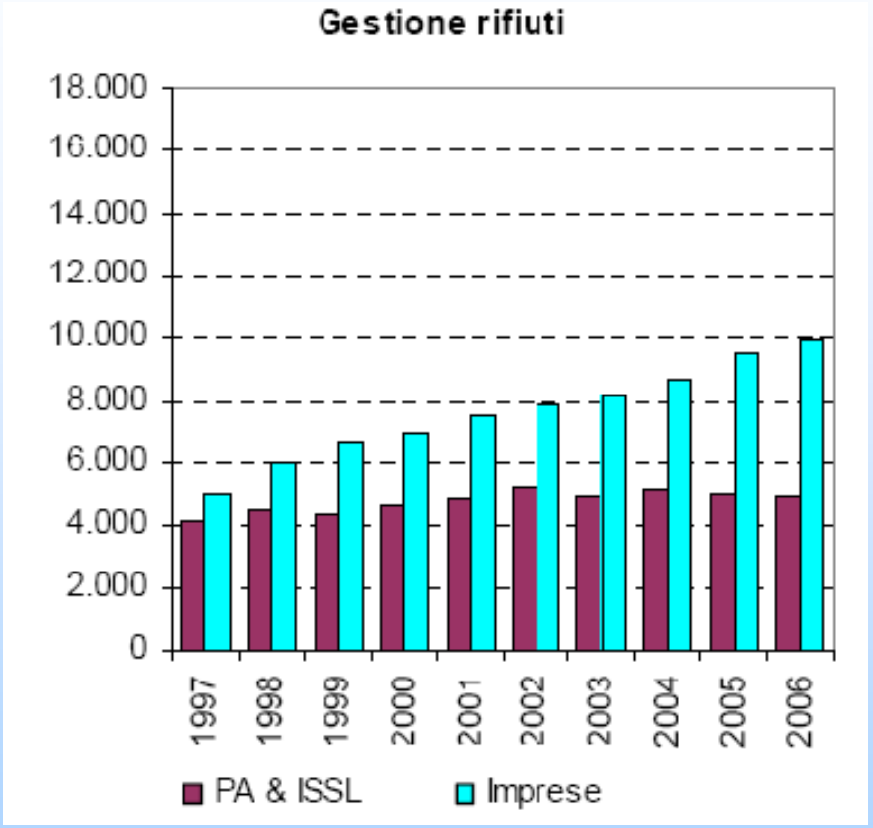
La dimensione economica del sistema rifiuti

Spesa per la 'gestione' 2007
21 miliardi di € (1,4% del PIL)
(ISTAT, 2008)

Incidenza della spesa nazionale per la gestione dei rifiuti, delle acque reflue e delle risorse idriche sul Prodotto Interno Lordo ai prezzi di mercato - Anni 1997-2007 (*valori percentuali*)





Valore della produzione dei produttori specializzati di servizi di gestione dei rifiuti, Anni 1997-2006 (milioni di euro a prezzi correnti)

Occupati settore 'rifiuti' (dati ISFOL): 101.000 nel 2007

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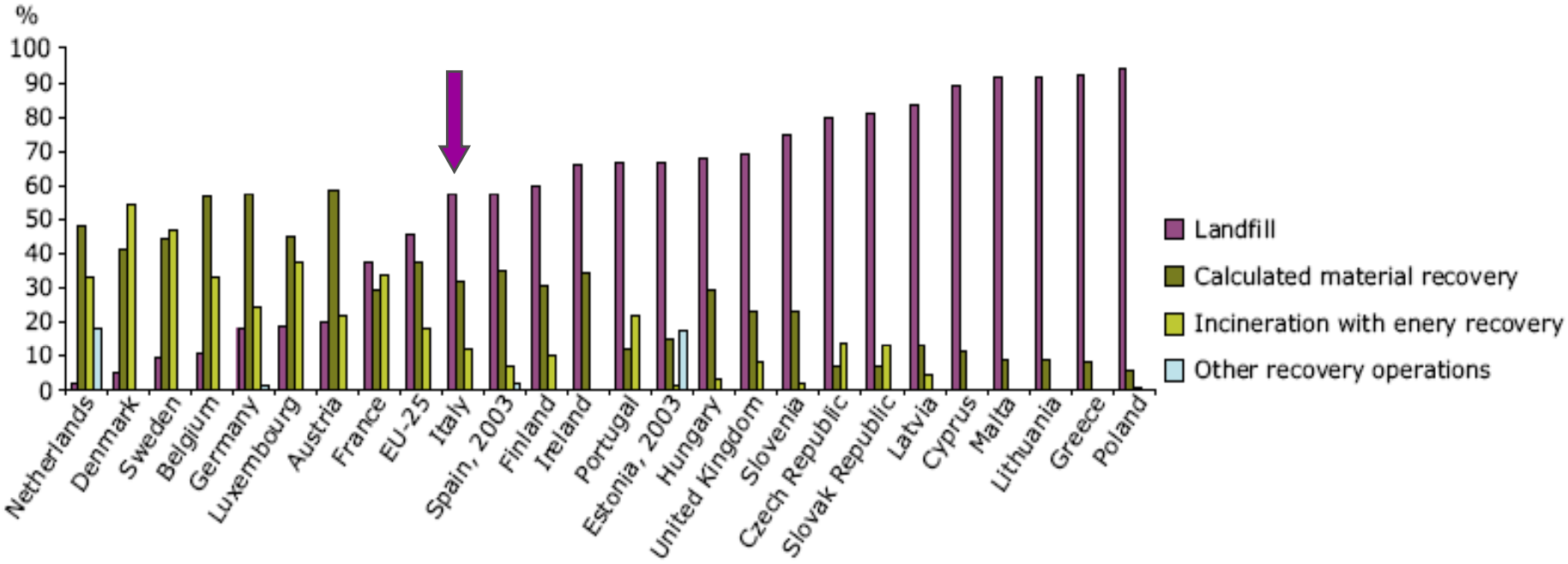
La varietà socio-economica-organizzativa del sistema rifiuti

Figure 2 Use of landfilling, incineration and material recovery as treatment options in 2004

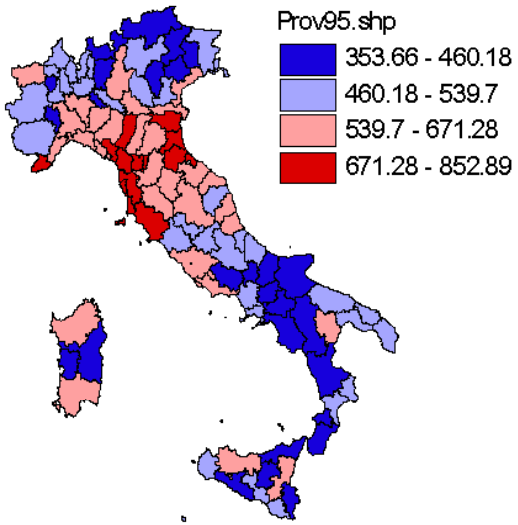


Note: To provide an estimate of material recovery, the above figure uses the residual of municipal waste generated minus municipal waste landfilled and incinerated (with minor adjustments). Thus defined, material recovery covers recycling, composting and other types of recovery operations (except incineration with energy recovery). The category 'other' covers sorting operations for the Netherlands, and differences between Eurostat data and national statistics for Germany, Spain and Estonia.

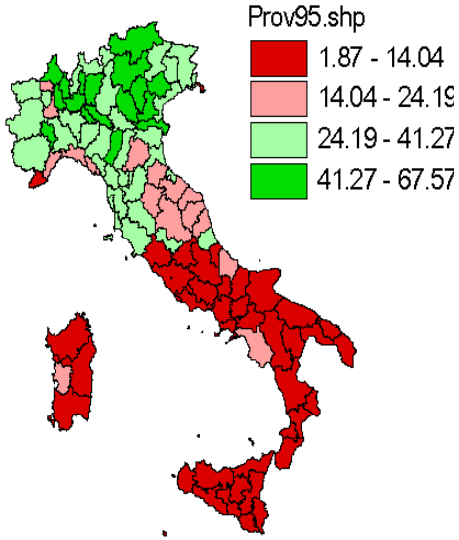
Source: Eurostat Structural Indicators on municipal waste generated, incinerated and landfilled, supplemented with national statistics: Statistisches Bundesamt (2006), Centraal Bureau voor de Statistiek (2007), Ministerio de Medio Ambiente (2005), EEIC (2005).

La varietà socio-economica-organizzativa del sistema rifiuti

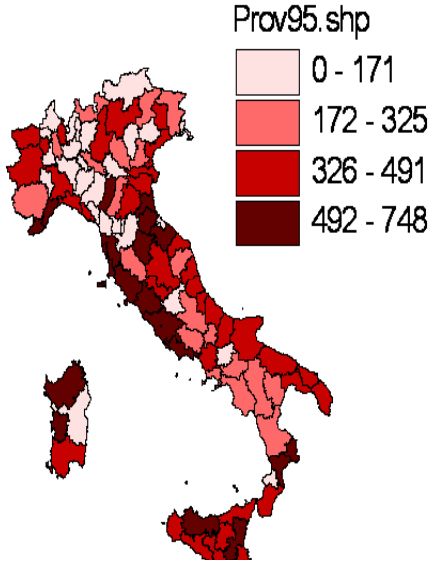
Rifiuti urbani pc 2005 kg

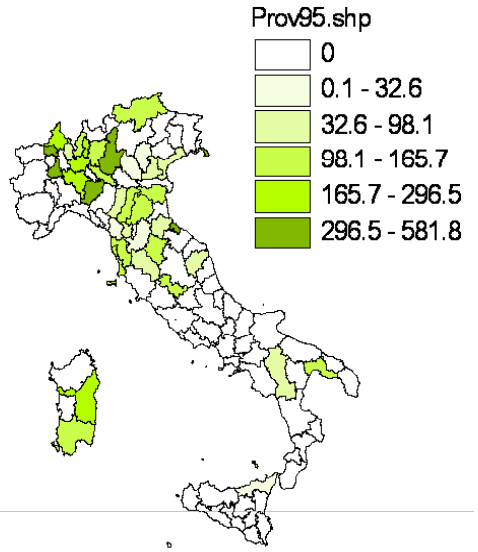


Raccolta differenziata 2005 %

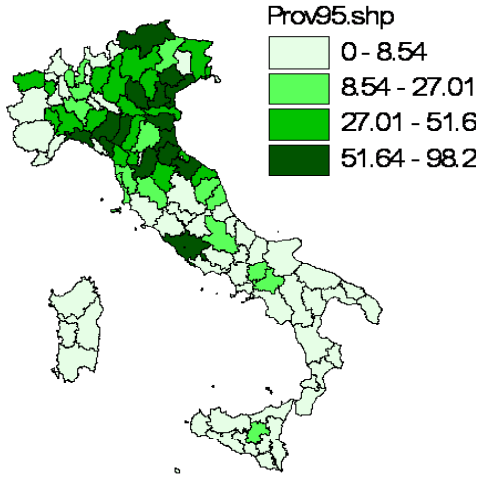


Discarica pc media 1999- 2005 kg

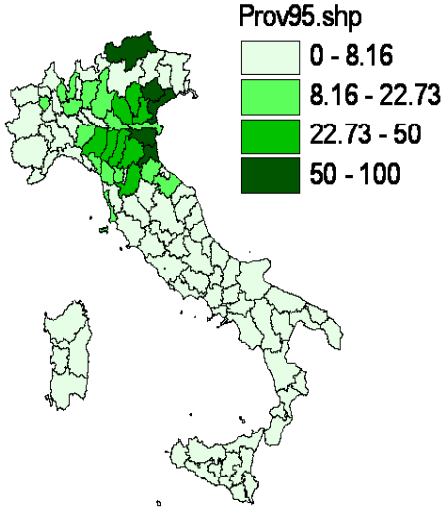




Rifiuti inceneriti pc 2005 kg



Popolazione coperta da tariffa 2005 %



Comuni coperti da tariffa 2005 %

Progetti di ricerca CERIS-CNR (MI) sull'economia dei rifiuti

- **Collaborazione con APAT ai Topic Centre di EEA – European Environment Agency:**
  - **ETC/WMF - European Topic Centre on Waste and Material Flows, 2001-2004**
  - **ETC/RWM - European Topic Centre on Resources and Waste Management, 2005-2008**
- **Partner di ETC/SCP - European Topic Centre on Sustainable Consumption and Production, 2009-2013**
- 'Politiche delle energie rinnovabili e filiere industriali del legno in Italia, per Federlegno-Arredo, Milano. 2005-2006
- Collaborazione con Transcrime, Università Cattolica (trasporti internazionali di rifiuti). 2006
- 'Analisi degli aspetti socio-economici connessi alla discarica di Cerro Maggiore – Rescaldina', per IRSA-CNR e Regione Lombardia. 2005
- "AIRA – Analisi di Impatto della Regolazione Ambientale", in collaborazione con IPA – Istituto per l'Ambiente, Milano 2002-2003
- "International comparison of innovation systems in parts development and parts reuse in the automobile industry", con RWE System Consulting, Mainz, Germania, 2002-2003
- Collaborazione con IPA (Istituto per l'Ambiente), per i rapporti "Il ruolo della termovalorizzazione nella gestione integrata dei rifiuti", per COREPLA, "Prospettive dell'industria di trattamento dei rifiuti in Italia", per Ecosesto; "Evoluzione e prospettive del rapporto tra domanda e offerta di macero in Italia", per COMIECO e ASSOCARTA 2001-2002
- "Regulation and Innovation in the Area of End-of-life Vehicles" per IPTS-JRC. 1998-2000

Aspetti economici del ciclo dei rifiuti

3 temi di ricerca

1. Valutazione di efficacia delle politiche ('policy') in Europa
2. Determinanti socio-economiche della produzione e gestione dei rifiuti urbani, UE e ITA
3. Economia del riciclo rifiuti industriali (biomassa legno e ELV)

1. Valutazione di efficacia delle policy rifiuti

- Forte intensità di legislazione e policy
- Buoni risultati in alcune politiche (es. packaging)
- Risultati limitati per alcuni obiettivi prioritari (gerarchia UE):
  - **Riduzione alla fonte e ‘prevenzione’**
- Opportunità di studiare effetti delle politiche
  - Questione tecnica (di ‘policy’ e non di ‘politica’)
  - Obiettivo: migliorare le policy
  - Valutazione di efficacia: raggiungimento degli obiettivi (anche ‘non ottimali’ in senso ACB)
  - Valutazione costo-efficacia: gli obiettivi al minor costo possibile

1. Valutazione di efficacia delle policy

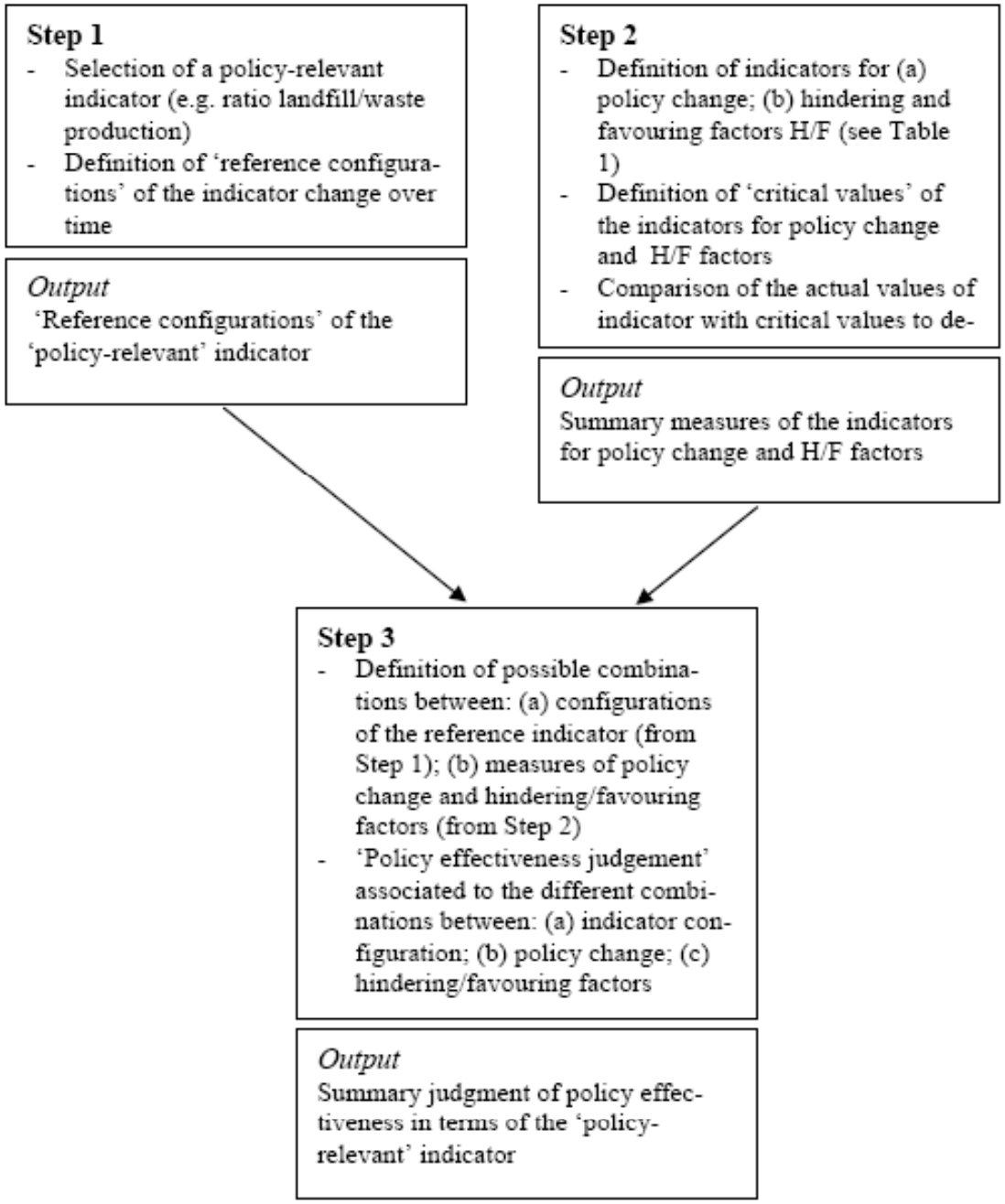
- EEA-ETC/RWM: '**Diverting waste from landfill. Effectiveness of national waste policies related to the Landfill Directive**', 2006-2008 (rifiuti urbani, rapporto EEA in pubblicazione)
- Problemi di co-causazione, sistema altamente interdipendente
  - Diversione RU da discarica dipende da: Politiche dirette su discarica + Politiche di recupero/riciclo che sottraggono/deviano flussi + Cambiamenti comportamento produttori (famiglie)
- Quanto dei cambiamenti osservati uso discariche attribuibile all'attuazione della Direttiva Landfill 1999?

1. Valutazione di efficacia delle policy

- Informazione limitata: non possibili tecniche classiche di controfattuali (BAU) e campioni di controllo
- Strumento metodologico di tipo 'semi-modellistico', elementi quantitativi (indicatori) e qualitativi:
  - Step 1: Pattern temporali degli indicatori uso discarica (variazione flussi prima/dopo Direttiva)
  - Step 2: Indicatori di: (a) attuazione/cambiamento politica discariche: (b) 'fattori favorevoli' e 'fattori di ostacolo' ('esterni' a discariche); (c) valori critici per definire se forti o deboli
  - Step 3: Incrocio tra indicatori Step 1 e Step 2, giudizio di efficacia

Mazzanti M., Zoboli R., The evaluation of landfill policy effectiveness: A methodology for country studies, ETC/RWM working paper 9/2008

Figure 2. A sketch of the proposed procedure for effectiveness evaluation



Factors influencing effectiveness of a policy of waste diversion from landfill

Positive influence = +; negative influence = -; Italics over grey= landfill policy factors

Favouring/hindering factors	Influence on effectiveness of waste diversion from landfill	Justification of the +/- sign	Possible indicator
Factors related to waste production and collection			
Waste production	-	Need to have many management options	Same as factor
Waste composition	+/-	Depending on materials suitable for recycling	Share of biodegradable or another major stream
Separate collection policy/capacity	+	It favours material recycling	Share of waste production collected separately
'Full cost' collection tariffs/charges	+	Higher capacity to invest in separate collection and incineration/recycling	Share of management cost covered by tariffs
Factors related to landfill sector			
Landfill share in total disposal	+/-	Need to free capacity vs lock-in in dominant technology	Same as factor
Landfill residual capacity	-	Discourage diversion on economic grounds	Same as factor
Landfill geographical concentration	+	High transportation costs from areas with low capacity	Concentration index of capacity
Landfill directive transposed	+	*Favourable legal framework*	*Dummy (1/0)*
Landfill tariffs/gate fees	+	*High cost of landfill*	*Ratio of landfill tariff to incineration tariff*
Landfill tax	+	*High cost of landfill*	*Share of tax over tariff*
Pre-treatment and technical requirements	+	*Discourage landfill*	*Dummy (1/0)*
Selective bans (e.g. biodegradable waste)	+	*Quantity limitation by law*	*Share of the stream(s) banned at a certain date*
Factors related to incineration sector			
Incineration residual capacity (available)	+	Makes diversion easier	Same as factor
Incineration directive transposed	-	Makes incineration more expensive and do not favour diversion from landfill	Dummy (1/0)
Incineration gate fees	-	As above	Ratio of landfill tariff to incineration tariff
Incineration geographical concentration	-	Makes diversion more difficult in areas far from capacity	Concentration index of capacity
Energy prices	+	High prices reduce cost of incineration	Oil price (domestic)
National policies on RES	+	Favour energy recovery from waste and RDF	Electricity price (domestic)
Factors related to material recycling and recovery sector			
Packaging policy in place	+	Stimulates diversion	Distance from policy targets
WEEE policy in place	+	Stimulates diversion	Distance from policy targets
C&D waste policy in place	+	Stimulates diversion	Distance from policy targets
Other specific stream policies (batteries, tyres, etc.)	+	Stimulates diversion	Distance from policy targets/provisions
RDF production capacity	+	Favours diversion	Same as factor
Compost production capacity	+	Favours diversion	Same as factor
Virgin material prices	+	Justify recycling	Same as factor (indexes)

Example

Policy evaluation for Configuration 2 of diversion indicator:
'Trend of diversion from landfills existed before the directive but the trend reinforced itself after the implementation'

Combination	Landfill policy change	Favouring factors +	Hindering factors -	Summary judgement
1	Weak: *Policy was already in line with the directive, or it was far from the directive but changes were small*	Strong	Strong	Ineffective: policy took a passive attitude and the indicator has been driven by the 'game' between strong favourable and hindering factors
2		Weak	Weak	Effective: policy took a passive attitude but it was enough to exploit a situation of 'neutral' favourable and hindering factors and improve the trend
3		Weak	Strong	Effective: policy, albeit weakly changing, has been able to counteract strong hindering factors in presence of weak favouring factors, thus contributing to improve the trend
4		Strong	Weak	Ineffective: policy was too weak to exploit favourable factors in the presence of weak hindering factors, and it cannot be considered as a cause of trend improvement
5	Strong: *The existing policy was far from the directive or was already in line but its change went beyond the directive*	Strong	Strong	Effective: policy has been very active and it was able to exploit/reinforce strong favourable factors to contrast strong hindering factors towards trend improvement
6		Weak	Weak	Effective: policy has been active and it was able to exploit 'neutral' favourable and hindering factors for improving the trend
7		Weak	Strong	Effective: a very active policy has been able to reinforce the positive trend by counteracting strong hindering factors in presence of weak favouring factors
8		Strong	Weak	Ineffective: policy has been very active but favourable factors have probably been the main source of trend improvement in the presence of weak hindering factors

1. Valutazione di efficacia delle policy

- Rapporto EEA 2009: Conclusioni dai 6 casi paese e analisi UE25
- Direttiva efficace per diversione e riduzione discarica, ma:
  - Effetto 'rafforzativo' per paesi con forti politiche già in atto (Germania)
  - Effetto positivo per paesi con forte diversione negli ultimi anni (Italia)
  - Effetto (ancora) limitato in altri paesi (Est)
- In tutti: importanza dei fattori 'favorevoli' o 'di ostacolo' da 'altre' politiche: es. packaging, capacità di trattamento biologico/energetico:
  - **Sinergie/ostacoli 'di sistema'**
- Scarsi effetti della politica landfill (e altre) su 'prevenzione' RU

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Unione Europea:

- **Relazione tra produzione/gestione dei rifiuti (RU) e driver socio-economici e di policy**
- **Formulazione tipo 'curva di Kuznets', per:**
  - **(a) produzione**
  - **(b) discarica**
  - **(c) incenerimento**
    - **(riciclo: dato 'residuale')**
- **Covariate:**
  - ***Economiche:*** **reddito pc/consumi finali**
  - ***Sociali/insediative:*** **densità di popolazione, popolazione urbana, dimensione media della famiglia, indici di vecchiaia**
  - ***Politiche:*** **grado di decentralizzazione, attuazione delle direttive discariche ed incenerimento, indice composito di azione di policy**
- **Tecniche econometriche panel dati Euorstat UE25 (UE15 e UE10), 1995-2005**
  - **In parte utilizzato per analisi EEA/ETC su landfill policy**

Mazzanti, Montini e Zoboli 2008a, 2008b; Mazzanti e Zoboli 2005, 2008, 2009

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Table 1
Descriptive statistics and a summary of research hypotheses

	MIN	MAX	Mean	Acronym	
Dependent variables					
MSW collected/generated (kg per capita)	239,00	753,00	484,70	MSW-GEN	Descriptive stats are calculated for EU 25 over 1995–2005
MSW landfilled (kg per capita)	9,00	659,40	283,95	MSW-LAND	
MSW incinerated (kg per capita)	0,00	396,60	73,47	MSW-INC	
MSW recycled (kg per capita)	8	412	182,89	MSW-REC	

	MIN	MAX	Mean	Acronym	Hypothesised correlation[a]
Independent variables					
1. Economic drivers					
Final consumption expenditure of households (Euro per inhabitant - at 1995 prices and exchange rates)	900,00	21000,00	8103,27	C	+G, eventual inverted U, +I, –L
Gross domestic expenditure on R&D (% of GDP)	0,19	4,25	1,37	RD	+I, –L
2. Structural and socio-economic variables					
Population density	16,70	1276,00	174,80	DENS	+G,
Urban population (% of total)	50,60	97,20	71,36	URBPOP	–L,
Household size	1,9	3,4	2,62	SIZE	?G
Single households (%)	10,12	38,30	25,04	SINGLE	+G
Age index or 'elderly ratio' (population 60 and over to population 20–59 years)	0,3	0,5	0,358	OLDNESS	?G
Value added at factor cost, share of manufacturing	9,10	36,30	18,54	VAMAN	–G
Household expenditure for food and non-alcoholic beverages, clothing and footwear, furnishing, household equipment and routine maintenance at current prices (% of total household consumption expenditure)	18,10	48,90	28,76	COMPC	+G, –R
3. Policy variables					
Decentralised waste management policy drivers (dummy)	0	1	0,24	DECPOLIND	?G, L, I
Incineration Directive (dummy; years/country in which directive is ratified)	0	1	0,24	INCDIR	–G, +I, –L
Landfill Directive (dummy; years/country in which directive is ratified)	0	1	0,27	LANDIR	–G, +I,
Waste strategy policy index (range 0–1)	0,00	0,95	0,34	POLIND	–L
Landfill strategy policy index	0,00	0,25	0,09	LANDPOLIND	

All values in non-log format.

[a] The sign on the hypothesised correlation is shown, as well as the level at which this is most relevant (G for generation, L for landfilling, R for recycling, I for incineration). The element (?) means that the hypothesis is ambiguous either because opposing forces may be influencing the link or because economic theory and other scientific fields do not provide clear insights.

Mazzanti M., Zoboli R. (2008). Waste generation, waste disposal and policy effectiveness: Evidence on decoupling from the European Union, Resource Conservation and Recycling, vol. 52(10), pp. 1221-1234.

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

'Policy proxies'

1. *Implementation in the member states of the European Landfill and Incinerations Directives: dummy variables with value 1 in a given year between 1995 and 2005 if the country has transposed directives into national law*

2. Country specific policy proxies:

- 'Decentralised waste management index': degree of waste policy decentralisation across the country

- Proxy for national waste related policies: captures all possible information regarding policies on MSW, biodegradable solid waste, packaging waste, end of life vehicles, other. Country studies available on EIONET as information source

Mazzanti M., Zoboli R. (2008). Waste generation, waste disposal and policy effectiveness: Evidence on decoupling from the European Union, Resource Conservation and Recycling, vol. 52(10), pp. 1221-1234.

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Risultati 'produzione RU'

- **Avvio di 'disaccoppiamento relativo' tra consumi finali e produzione RU (differenze tra EU15 e EU10):**
  - ***Rifiuti crescono meno dei driver economici*** **(elasticità rifiuti-consumi circa 0,72 in EU15)**
- **Quota di pop urbana ha effetto significativo (+)**
- **Variabili di policy poco significative sulla produzione RU**

Table 2a
MSW generation (EU25)

Model	FEM	FEM	FEM	FEM	REM	FEM	FEM	FEM
C	0,230***	0,163***	0,117**	0,158***	0,188***	0,114*	0,118**	0,164***
Dens	0,629***	…	…	…	…	…	…	…
Urbpop	…	4,263***	1,760***	42,582***	0,290	1,760***	1,761***	1,777***
Vaman	…	…	−0,284***	…	−0,319***	−0,284***	−0,285***	−0,291***
Size	…	…	…	0,117	…	…	…	…
Oldness	…	…	…	0,120	…	…	…	…
Decpolind	…	…	…	…	−0,015	…	…	…
Polind	…	…	…	…	…	0,002	…	…
Landdir	…	…	…	…	…	…	−0,0005	…
Incdir	…	…	…	…	…	…	…	−0,022
TP	–	–	–	–	–	–	–	–
N	275	275	264	275	264	264	264	264

(…) means not included. Significance at 90%, 95% and 99% is denoted by *, ** and ***; TP (€, consumption per capita); *F* test show overall significance for all regressions at 1%, *R* squared present reasonably high value for panel settings.

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Risultati gestione in discarica:

- **Statisticamente significativo e forte 'disaccoppiamento assoluto' rispetto ai consumi finali**
- **Effetto significativo di altri fattori:**
  - **Quota di popolazione urbana (-)**
  - **Importante effetto delle politiche (-)**
  - **Decentralizzazione politiche limita diversione (+)**
  - **'Punti di svolta' a consumi finali bassi**

Table 5a
Landfilled MSW (EU25)

Model	FEM	FEM	REM	REM	REM
C	3,382**	3,658***	4,156***	3,390***	3,666***
C^2	−0,242***	−0,248***	−0,260***	−0,236***	−0,224***
Urbpop°	−3,694**	−1,554**	−1,714**	−1,340**	−2,679***
Decpolind	…	0,576**	…	…	…
Landdir	…	…	−0,324***	…	…
Polind°	…	…	…	−0,632***	…
Incdir	…	…	…	…	−0,312***
TP	1083	1595	3610	3951	3532
N	275	275	275	275	275

(…) means not included; °DENS is less significant; °if a specific index only related to landfill policy is included results do not change. The correlation between the two is 0,81. Significance at 90%, 95% and 99% is denoted by *, ** and ***; TP (€, consumption per capita); *F* test show overall significance for all regressions T 1%, *R* squared present reasonably high value for panel settings.

Incenerimento: **Risultati analoghi con segno rovesciato, cresce con il reddito in modo statisticamente significativo. Politiche contano**

Table 3
Incinerated MSW (EU15°)

Model	REM	REM§	FEM	FEM	REM	FEM	FEM	FEM
C	20,293***	1,676***	22,450***	24,287***	19,328**	…	…	19,34
C^2	−1,014**	…	−1,143***	−1,269***	−0,965**	…	…	−0,994
Urbpop	0,651	…	0,111	0,252	1,157	4,451***	1,192***	0,145
RD	…	…	…	…	…	1,414***	3,623***	…
Decpolind	…	…	…	…	−0,868***	…	…	…
Incdir	…	…	0,076*	…	…	…	…	…
Polind	…	…	…	0,380***	…	…	0,151*	…
Landdir	…	…	…	…	…	…	…	0,143***
TP	22168	–	18409	14319	22348	–	–	16787
N	137	126	137	137	137	137	137	137

(…) means not included; significance at 90%, 95% and 99% is denoted by *, ** and ***; TP (€, consumption per capita). Greece and Ireland are discarded since they show only 0 values over the period, the panel is unbalanced for some years where Portugal also shows 0 values; §excluded Luxem; *F* test show overall significance for all regressions at 1%, *R* squared present reasonably high value for panel settings.

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

In sintesi:

- **Parziale 'disaccoppiamento' (relativo) produzione rifiuti-reddito in media UE**
- **Politiche nei paesi UE efficaci nel modificare scelte di gestione (discarica), ma effetti non significativi su 'prevenzione' (produzione) che è priorità in 'gerarchia' UE**
- **<u>Sviluppi</u>:**
  - **Utilizzo parametri stimati per scenari di produzione rifiuti EU ed emissioni GHG da rifiuti (ETC/SCP, '*Waste projection study*', 2009)**
  - **Utilizzo di modelli SUR (Seemingly Unrelated Regression) per identificate elasticità rifiuti-reddito dei singoli paesi**

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Italia:

- Relazione produzione rifiuti (urbani) e variabili socio-economiche
- Panel di dati regionali (20, anni 1996-2004) e provinciali (103, anni 2000-2004) costruiti su dati pubblici APAT-ONR
- Covariate livello provinciale:
  - Valore aggiunto pc
  - Densità di popolazione
  - Quota di raccolta differenziata
  - Quota di popolazione in comuni con tariffa rifiuti
  - Quota di comuni con tariffa rifiuti
  - Gettito tassa/tariffa come quota costi variabili del servizio (2003)
  - Presenze turistiche pro-capite

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Table 1. descriptive statistics: dependant and independent variables

acronym	Variable description	mean	min	max
Provinces				
WASTE	MSW generated in tons per capita	517.13	289.61	893.23
VA	Provincial value added per capita (€2000)	17742.52	9704	28796
DENS	Population/surface (inhabitants/km2)	243.73	36.55	2640.91
COLLEC	% Share of separated collection	18.52	0.4	64.9
TARIFF	Share of population living in municipalities that introduced a waste tariff substituting the former waste tax (%)	8.42	0	99.72
TARIFF2	Share of municipalities that introduced a waste tariff substituting the former waste tax (%)		0	
COST-REC	Cost recovery of waste management services (tax/tariff revenues on variable service costs, only one data for 2003) (%)	84.05	0	105
TOURIST	TOURIST yearly Attendance (per capita)	7,.27	0.43	58.3
Regions				
WASTE	MSW generated in tons per capita	491.11	335.60	692.55
GDP	GDP per capita (€1995)	17141	9885.3	24091.33
C	Household consumption per capita (€1995)	735.18	412.47	1030.03
DENS	Population/surface (km2)	175.8	36.42	426.54
COLLEC	% Share of separated collection	12.31%	0.6%	44%

Mean, min and max are calculated across provinces and over time

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Risultati Italia - province:

- **Significativa evidenza di 'disaccoppiamento relativo' tra produzione di rifiuti e reddito (VA pc)**
- **Tuttavia 'punto di svolta' a livelli molto alti di reddito pc (23.000-26.000€), solo poche aree del Nord**
- **Dinamica del reddito non sufficiente per migliorare il rapporto reddito-rifiuti ('efficienza')**
- **Necessarie politiche ma:**
  - **sistematicamente più sviluppate nelle aree più ricche**
  - **alta correlazione tra produzione RU pc e quota raccolta differenziata (endogenità)**
  - **diffusione del regime tariffario e capacità di recupero costi del servizio non sembrano impattare la produzione di rifiuti (per ora)**
  - **'prevenzione' (minor produzione) richiede politiche esplicite e creative**

2. Determinanti socio-economiche di produzione/gestione e ruolo politiche

Table 2. Provincial level: base estimations and additional specifications

€	1	2	3	4	5	6	7	8
Cons	*	*	*	/	***	**		**
VA	0.032***	0.0335***	0.047***	0.0425***				
VA^2	-0.000000627**	-0.000000659***	-0.00000103***	-0.00000091**				
logVA					0.3627***	8.17**	0.283***	8.29**
$(logVA)^2$						-0.402**		-0.409**
DENS		0.20	0.25	-0.211			-0.0003	0.000044
COLLEC				1.304***			0.002***	0.00073
Turning point	25917€	25417€	22815€	23351€		25311€		25196€
FEM/REM	REM	REM	REM (AR1)	FEM (AR1)	REM	REM (AR1)	FEM	REM(AR1)
$adjR^2$				0.938				
F test and Chi-sq prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
N	515	515	515	515	515	515	515	515

Coefficients are shown in cells: *10% significance, **5%, ***1%.

Table 4. The effect of waste policy instruments

	1	2	3
Cons	Not sign	Not sign	Not sign
VA	0.0472***	0.0464***	
VA^2	-0.00000104***	-0.00000102***	
logVA			9.045**
$(logVA)^2$			-0.4478**
DENS	0.025	0.026	0.000048
TARIFF	0.321**		0.00053*
COST-REC		0.275	0.00016
Turning point	22692€	22549€	24427€.
FEM/REM	REM(AR1)	REM(AR1)	REM(AR1)
F test and Chi-sq prob.	0.000	0.000	0.000
N	515	515	515

Coefficients are shown in cells: *10% significance, **5%, ***1%.

3. Economia del riciclo

3.A. Biomassa e rifiuti legnosi: uso energetico vs riciclo

- Politiche FER in EU e Italia: 'spiazzamento' degli usi industriali della biomassa *(scarti, residui, assortimenti minori)* in industria dei pannelli di particelle (= riciclo legno)

  $\Rightarrow$ +Δ produzione di energia da biomassa legnosa (centrali)

  $\Rightarrow$ No offerta addizionale da agro-foresta

  $\Rightarrow$ Eccesso di domanda per input legnosi

  $\Rightarrow$ + Δ prezzi

  $\Rightarrow$ + Δ competizione con industria dei pannelli

  $\Rightarrow$ + Δ auto-produzione energia da legno (scarti) altre industrie di filiere legno-arredo

CERIS-CNR per Federlegno-Arredo: analisi problema e possibili soluzioni

3. Economia del riciclo

Energy from wood: Trends in Italy

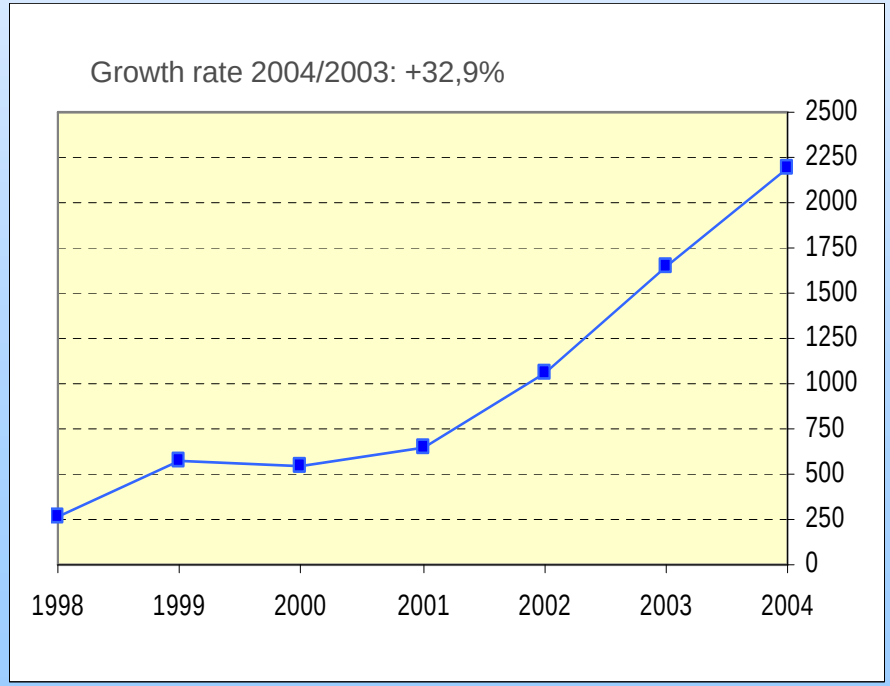
- Wood the second most important RES in Italy (20% of total) after hydro-power
- General increase of wood/biomass consumption for energy

Italy: Energy from wood and other biomass in fossil fuel equivalent (ktoe)

Source: calculation on ENEA data

- Incremental E-RES largely based on wood biomass (quota and green certificates system)
- Still distant from policy targets: bound to increase more

Italy: Electricity from wood and biomass (GWh)



Source: calculation on ENEA data

3. Economia del riciclo

Italy: estimated sources and uses of wood biomass, 2003/2004, million/m3

	Input wood-biomass in panel, paper, and biomass energy		Sources of wood-biomass for industry/energy	
	Total million/m3	*of which: 'virgin wood'* *	Total million/m3	
Input in industrial processing (panels and wood pulp)	7,7	*4,7*	5,0	**Residues of wood industries: equivalent rough wood (incl. forest)** (CERIS on various sources)
WB Panels, PB and MDF (CERIS on FLA data)	*6,5*	*3,5*	1,1	**Import Wood Residues** (FAO)
Wood pulp (Assocarta)	*1,2*	*1,2*	1,5	**Import Chips and Particles** (FAO)
Wood input in biomass energy production plants (CERIS on various sources)	3,3	*3,0*	0,9	**Import Pulpwood** (Assocarta)
Energy use in Woodworking Industries (CERIS on various sources)	1,5	*1,5*	0,3	**Domestic prod. Pulpwood** (Assocarta)
Pellets production (CERIS on various sources)	0,3	*0,3*		
Total inputs	**12,8**	***9,5***	***8,8***	***Total virgin wood***
			2,1	**Post consumer packaging** (Rilegno)
* From forestry and woodworking residues			**10,9**	**Total estimated sources**

Estimated imbalance in wood-biomass market: around 2 million/m3 (or more)

Other 'guessed' sources of input (in use but not recorded): Other flows of post consumer wood; Wood residues from agriculture (e.g. vineyards); Other forest residues.

Note: The wood fuel market is 'separated' from industrial biomass energy. Official estimate of consumption: 6,2 million/m3; unofficial estimates (direct inquiries) up to 29 million m3 !!

3. Economia del riciclo

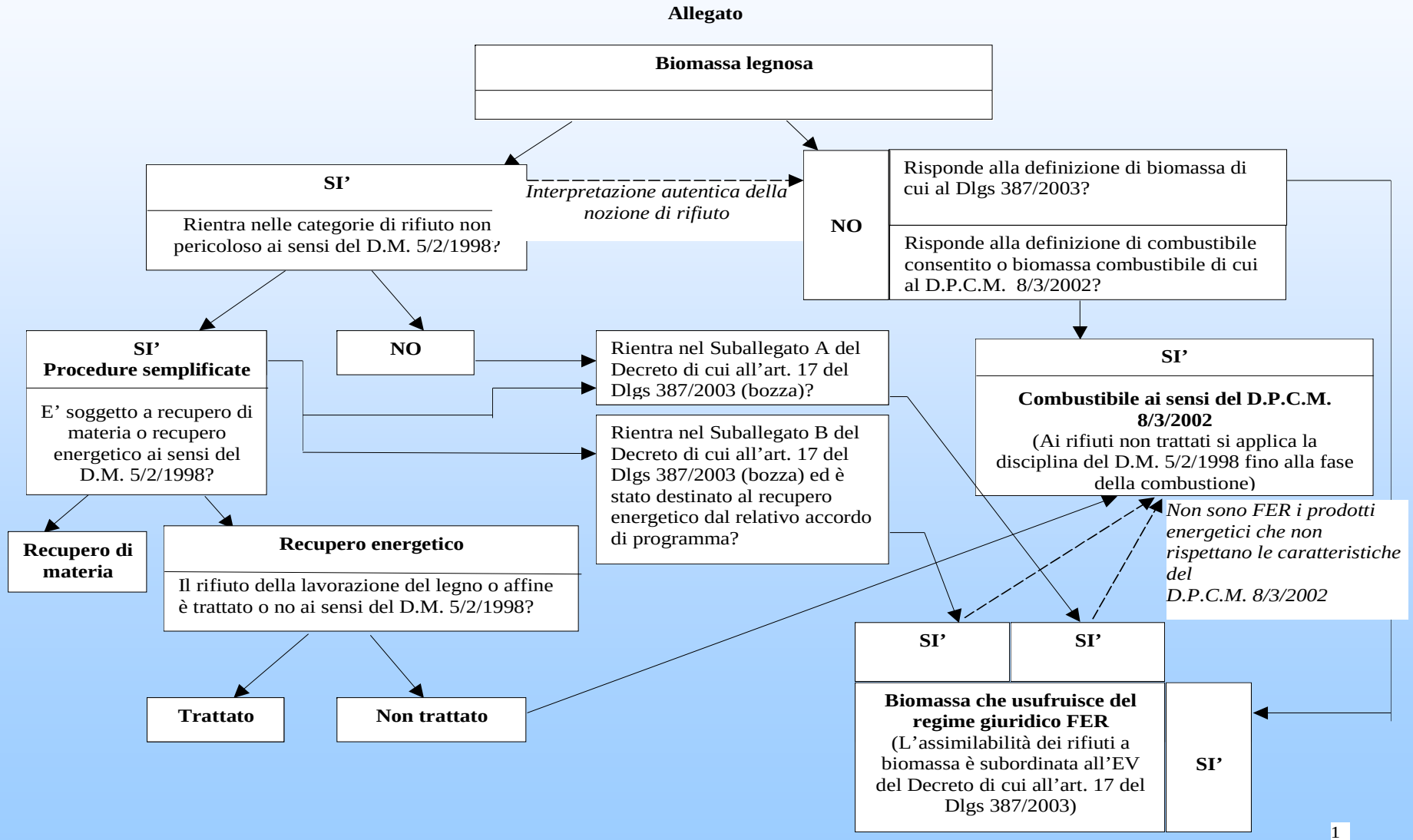
Un problema multidimensionale

- ***Potenziale di offerta agro-forestale (scarti) e industriale (residui):*** Alto, ma a quali condizioni economiche e logistiche?
- ***Potenziale da raccolta e riciclo RILEGNO-CONAI:*** Già decisivo per industria pannelli: Raggiunta la saturazione? A quali costi andare oltre (es. piattaforme a Sud)? Politica di 'discarica zero' per il legno?
- ***Problemi definizione legislativa 'rifiuti'/'biomassa rinnovabile':*** Un puzzle molto problematico (inoltre: più rifiuti a recupero energetico, meno tensione su biomassa legno)
- ***Potenziale da politiche clima:*** Prodotti in legno come 'carbon stock': riciclo del legno meglio dell'uso energetico per GHG: come riconoscere in contabilizzazione IPCC?

Risultato: **Programma di iniziative per l'industria del legno-arredo** ***(ancora di più dopo 'Pacchetto 20-20-20 ' ....)***

Gargiulo T., Zoboli R. (a cura di), Una nuova economia del legno tra industria, energia e cambiamento climatico, Franco Angeli, Milano, 2007

Un puzzle legislativo per distinguere tra 'rifiuto' e 'biomassa rinnovabile'



3. Economia del riciclo

3.B. 'Responsabilità del produttore' e innovazione: da rifiuto-riciclo a 'product making'

- **Legislazione / politica dei rifiuti induce la risposta innovativa industriale necessaria? Se sì, a quali condizioni e meccanismi?**
- Questione critica per flussi specifici di rifiuti ('speciali'): packaging, auto a fine vita, rifiuti elettrici ed elettronici:
  - **'Politica del rifiuto' comincia nel 'fare il prodotto'** (IPP)

CERIS: Studi su politiche delle auto a fine vita per IPTS e RWE:

- Zoboli R., Barbiroli G., Leoncini R., Mazzanti M., Montresor S., 2000, *Regulation and Innovation in the Area of End-of-Life Vehicles,* edited by Fabio Leone, IPTS-JRC, EUR 19598 EN, March, Seville.
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3. Economia del riciclo

Veicoli a fine vita

- 10 anni (e più) di dibattito tra industria auto europea e policy makers della Commissione prima delle Direttiva 2000/53 che comprende:
  - (a) target vincolanti su riciclo/recupero/riuso;
  - (b) criteri di riciclabilità per i nuovi modelli;
  - (c) 'responsabilità del produttore': meccanismo di free-take back combinato con 'accordi volontari' dimostrabili;
  - (d) regime autorizzativo rigoroso per smantellatori;
  - (e) limitazione per alcuni materiali nella fabbricazione.
- Caratteristiche del problema:
  - (i) innovazione tecnologica (fare auto) e organizzativa (gestione post-consumo) è unica via per raggiungere target;
  - (ii) innovazione ha carattere sistemico e multi-industriale, dati molti settori coinvolti (auto, componentistica, smantellatori, riciclatori, ecc.)
  - (iii) strumenti economici (free-take back) e 'accordi volontari' presentano costi/benefici ed incentivi per industrie che possono ostacolare il raggiungimento dei target di policy

3. Economia del riciclo

Tutti i produttori cercano soluzioni per 'fine vita' che coprono:

- **(a) 'design for dismantling'; 'design for recycling'; semplificazione regime materiali;**
- **(b) accordi con smantellatori e riciclatori/recuperatori (post-consumo)**

Renault SA.	• ELV collection, spare-parts recovery, material recycling, energy recovery, car recyclability • R&D efforts on plastic recycling • Dismantlers contracted by Renault in 1997 were 270 • An average reuse/recovery/recycling of 82.9% in the Renault system is calculated
PSA - Peugeot Citroen	• Design of vehicles to be 90%-recyclable from 2002 • Recycling of end-of-life parts and re-use of certain parts • DFR: reduction of the diversity of materials • Increasing use of recycled materials in new cars
Adam Opel AG	• ELV recovery and car design. • Network of 234 dismantlers in 1998 • DFR manuals for internal use • Recyclability coefficients calculated for internal use • Life Cycle Assessment (LCA) for materials and components
BMW	• ELV recovery and car recycling • Network of 90 associated dismantlers • DFR/DFD: "Dismantling parts charts" containing guidelines and recommendations • Recycling coefficients and indexes of "suitability for recycling" of components and parts
Daimler-Chrysler	• DFD/DFR guidelines for internal use • Simplification of material regime by reducing the number of plastics • LCA is made for evaluating material alternatives
Ford Motor Company	• Restrictions on hazardous substances DFR guidelines • Parts marking and material coding standards • Targets for recyclability of new models and use of recycled materials • Network of 170-180 dismantlers in Germany • LCA is used for material and component selection
FIAT	• FARE system on dismantling, the reuse of recycled materials and ASR energy recovery • Network of 312 associated dismantlers in 1998 • Recovery rate is calculated at 82% of car weight • Recyclability coefficients for internal use • LCA applied to materials and components
Volvo Car Corporation	• DFD/DFR together with car recycling and ASR energy recovery • Guidelines on design to be applied to the parts and components of new models • Cooperation on recyclability with component and material suppliers • Network of 70 dismantlers in Sweden

Source: adapted from Zoboli et al. (2000), direct interviews and information from companies.

Fig. 2. Examples of innovative activities on ELV by selected European carmakers.

3. Economia del riciclo

Percorsi innovativi ancora aperti e incerti:

(a) Creazioni di mercati per materiali ora non recuperati/riciclati (plastiche)

(b) Maggiore recupero di energia (vincolato)

(c) Innovazioni nel regime dei materiali nel fare auto (problema peso e consumi)

Tutte comportano meccanismi di filiera, possibilmente cooperativi e sinergici

Un ruolo critico per i mercati della componentistica di seconda mano ('reuse')

	Material market creation	*Energy market creation*	*Radical substitution*
Implications in terms of policy objectives	Increase RRR rates, especially material recycling and parts reuse Reduce ASR landfilling by preventing its production or by ASR-material recovery	Increase RRR rates, especially energy recovery and parts reuse Reduce ASR landfilling by developing its alternative use *Can be either substitute for or complement to "material market creation"*	Increase RRR rates, especially recycling. by changing car material mix towards material easily (i.e. economically) recyclable Reduce ASR by reducing the share of materials difficult to recycle *Can be substitute for both "material" and "energy" market creation" if they prove to be difficult to implement*
Specific innovations involved	ELV collection/dismantling networks Dismantling techniques Selective DFD, DFR, and LCA in carmaking Material-regime simplification in carmaking Innovations in plastic recycling Innovations in recycling of other car materials Innovative outlets for recycled car materials Innovations in material recovery of ASR Cooperative research	Energy recovery technologies for ASR Innovative energy uses in different industries Cooperative research	Change car material mix against (composite) polymeric materials or other materials difficult to recycle at present conditions Adaptations of other aspects of car design and making
Industrial actors most directly involved	Dismantlers Shredders Recyclers Material producers Components producers Carmakers	Shredders Industries using fuel from ASR	Material producers Components producers Some material recyclers Carmakers
ELV actors possibly having positive preference	Policy makers Carmakers Dismantlers Material recyclers Some material producers	Carmakers Plastics producers Shredders	Various non-plastic materials producers and recyclers
Trade-off with other car innovation trajectories	No trade-off with car lightness and energy/emission saving	No trade-off with car lightness and energy/emission saving	Trade-off with car lightness and energy/emission saving

Keys: DFD: design for dismantling; DFR: design for recycling; ASR: automobile shredding residue.

Fig. 3. Innovation paths.

3. Economia del riciclo

Che ruolo possono avere strumenti economici di 'responsabilità del produttore' (free take-back) che assegnano costo a industria auto?*

Incerti:

(a) se si generano 'nuovi mercati' per i materiali, vi è esito innovativo nel fare auto e nelle filiere del 'fine vita';

(b) se <u>non</u> si generano 'nuovi mercati' per i materiali dal fine vita, industria può: (i) 'passare' costo ai consumatori; (ii) prendere controllo del settore smantellamento per ridurre costo; (iii) cambiare design verso 'vecchi' materiali

Starting impact (by assumption)	Carmakers pay for FTB and dismantlers receive the corresponding flow of economic resources through last car-owners. FTB-related incentive is transmitted to recycling activities through reduced costs and increased economic quality of materials from incremental dismantling. New recycling markets are incentive-based, and innovations in material recycling and car recyclability are necessary to have self-sustained markets. Two alternative outcomes are possible:			
First-round transmission	A Recycling innovations do occur downstream Selective innovations in DFR and DFD occur upstream to help recycling	B Innovations in material recycling are not enough to create self-sustained markets for recycled materials. FTB-based incentives become subsidies to dismantling and recycling activities According to levels of FTB and their technological capabilities, carmakers (i.e. the payer) can:		
Other-rounds transmission	A.1. Creation of a closed material loop, i.e. increased use of recycled materials in car making and other industries Carmakers can pay decreasing amounts of FTB due to the value of additional recycled materials Carmakers can pay decreasing amount of FTB by making only selective adaptations in car design and material mix	B.1 Preserve the advantages of unchanged material mix and pay high FTB costs FTB is likely to be passed to consumers in new-car prices	B.2 Downstream integration by the car industry may occur to control FTB costs	B.3 Make radical design/material adaptations in favour of easily-recycled traditional materials thus reducing FTB costs
Prevailing innovation path	Innovation may go along "material market creation path"	Incentive dissipation: innovation chain interrupted at the recycling level New recycling steadily subsidised by consumers	Innovation may go along "material market creation path" with a change in the structure of the ELV system	Innovation may go along the "radical substitution path"

Source: elaboration from Zoboli et al., 2000.

Fig. 5. Alternative expected effects of "EPR-FTB" in terms of innovation paths.

* Art 5(4) Directive 2000/53/EC: "Member States shall take the necessary measures to ensure that the delivery of the vehicle to an authorised treatment facility in accordance with paragraph 3 occurs without any cost for the final holder and/or owner as a result of the vehicle's having no or a negative market value. Member States shall take the necessary measures to ensure that producers meet all, or a significant part of, the costs of the implementation of this measure and/or take back end-of-life vehicles under the same conditions as referred to in the first subparagraph."

3. Economia del riciclo

In sintesi

- 'Strumenti economici' per innovazione su rifiuti/riciclo in filiere industriali complesse (ELV, WEE), con implicazioni su design e fabbricazione, richiedono attenzione a possibilità tecnologico-organizzative e costi/benefici delle industrie, che possono attuare risposte non sinergiche ad obiettivi di policy
- Necessario collocare politica rifiuti/riciclo in prospettiva più ampia di Integrated Product Policy e Sustainable Consumption and Production
- Necessaria più ricerca: es. 14 delle 31 Technology Platform europee sono connesse ad energia, risorse, ambiente, ma pochissimo a riciclo e rifiuti

Prospettive di ricerca

- **Comportamenti di consumo/produzione e Prevenzione rifiuti *(Sustainable Consumption and Production)***
- **Sindrome NIMBY e localizzazioni impiantistiche**
- **'Disaccoppiamento' packaging**
- **Scenari di produzione/gestione rifiuti e politiche del clima**
- **Riciclo del legno e politiche del clima**

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