UMWELT, INNOVATION, BESCHÄFTIGUNG

01/2015

Estimating Gross Employment Effects of Environmental Protection

- A Combined Demand-Supply Side Approach

Federal Ministry
for the Environment, Nature Conservation,
Building and Nuclear Safety

Umwelt Bundesamt

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UMWELT, INNOVATION, BESCHÄFTIGUNG 01/2015

Environmental Research of the
Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Project No. (FKZ) 3711 14 101
Report No. (UBA-FB) 002094/E

Estimating Gross Employment Effects of Environmental Protection - A Combined Demand-Supply Side Approach

by

Jürgen Blazejczak
Merseburg University of Applied Sciences and German Institute for Economic Research (DIW Berlin), Berlin

Dietmar Edler
German Institute for Economic Research (DIW Berlin), Berlin

On behalf of the Federal Environment Agency (Germany)

Imprint

Publisher:
Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
info@umweltbundesamt.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt

Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit
Stresemannst. 128 – 130
10117 Berlin
service@bmub.bund.de
www.bmub.bund.de

Study performed by:
Deutsches Institut für Wirtschaftsforschung (DIW Berlin)
Mohrenstr. 58 D 10117 Berlin

Study completed in:
January 2015

Edited by:
Section I 1.4 Economic and Social Environmental Issues, Sustainable Consumption
Frauke Eckermann

Publication as pdf:
http://www.umweltbundesamt.de/publikationen/estimating-gross-employment-effects-of

ISSN 1865-0538

Dessau-Roßlau, April 2015

The Project underlying this report was supported with funding from the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear safety under project number FKZ 3711 14 101. The responsibility for the content of this publication lies with the author(s).

Kurzbeschreibung

In der Öffentlichkeit und bei politischen Entscheidungsträgern besteht ein großes Interesse am Thema Umweltschutzbeschäftigung. Die Debatte wird jedoch dadurch erschwert, dass es eine Vielzahl von unterschiedlichen Definitionen und damit von Schätzungen von Umweltschutzbeschäftigung gibt. Aus diesem Grund ist es von großer Bedeutung, für jede Schätzung der Umweltschutzbeschäftigung die verwendeten Abgrenzungen und Methoden sorgfältig zu dokumentieren. Diese Veröffentlichung dokumentiert einen kombinierten angebots- und nachfrageorientierten Schätzansatz für die Bruttoumweltschutzbeschäftigung, also für die Anzahl von Personen, die eine Beschäftigung auf Grund von durchgeführten Umweltschutzaktivitäten haben. Dieser Ansatz wurde in einer Reihe von Untersuchungen für Deutschland angewandt, die vom DIW Berlin durchgeführt wurden.

Diese Veröffentlichung erläutert zuerst die in diesen Studien gewählte Abgrenzung der Umweltschutzbeschäftigung vor dem Hintergrund der von Eurostat entwickelten Klassifikationen CEPA und CReMA. Danach beschreibt sie die verwendeten Schätzansätze für Umweltschutzbeschäftigung. Umweltschutzbeschäftigung, die aus der Produktion von Umweltschutzgütern resultiert, wird mit einem nachfrageorientierten Ansatz geschätzt, der unter Nutzung der Input-Output-Analyse von den Ausgaben für Umweltschutz ausgeht. Umweltschutzbeschäftigung, die auf der Bereitstellung von Dienstleistungen beruht, wird mit einem angebotsorientierten Ansatz quantifiziert, der auf einer Vielzahl von Datenquellen über Beschäftigung in Wirtschaftseinheiten beruht, die für die Umwelt vorteilhafte Dienstleistungen anbieten. Es wird anschließend erläutert, welche Dimensionen der Umweltschutzbeschäftigung in den angesprochenen Studien dargestellt werden. Zum Abschluss werden Überlegungen angestellt, welche zusätzlichen Dimensionen in zukünftigen Studien von Interesse sein könnten.

Abstract

Environmental employment is an issue with high interest to the public and to policy makers. Yet, the debate is blurred by a great number of distinct definitions and hence estimates of environmental employment. Therefore it is essential to carefully document delimitations and methods used in any attempt to quantify environmental employment. This paper presents a combined supply and demand side approach for estimating gross environmental employment, i.e. the number of persons who do have a job due to environmental protection activities. It has been used in a number of studies for Germany by DIW Berlin.

Our paper first outlines the delimitation of environmental employment used in these studies, relating it to Eurostat's CEPA and CReMA classifications. It then describes the approaches used to estimate environmental employment. Environmental employment originating from the production of environmental goods is estimated by a demand side approach based on environmental protection expenditure using Input-Output techniques. Environmental employment stemming from the provision of services is quantified by a supply side approach based on a large number of data sources on employment in establishments offering services which are beneficial for the environment. The paper explains which dimensions of environmental employment are presented in the above mentioned studies and concludes with some reflections on additional dimensions which may be of interest in further studies.

Das Wichtigste in Kürze

Durch den Umweltschutz entstehen Arbeitsplätze und zwar weit mehr Arbeitsplätze als jene, die in der Umwelttechnikbranche direkt angesiedelt sind – zum Beispiel Stellen, die für die Produktion der erforderlichen Vorleistungen und für den Export notwendig sind. Wie viele Arbeitsplätze tatsächlich vom Umweltschutz abhängen, kann nur geschätzt werden, denn Umweltschutz ist eine Querschnittsaufgabe, die in nahezu allen Wirtschaftssektoren Arbeitsplätze schafft.

Die Daten und Informationen, die Grundlage für die Schätzung sind, stammen aus verschiedenen Quellen: amtlichen Erhebungen, Verbandsstatistiken oder auch Expertenschätzungen – etwa, wenn es darum geht, den Anteil des Umweltschutzes an bestimmten Tätigkeiten zu beurteilen.

International etablierte Konventionen und Methoden helfen bei der Abgrenzung der Umweltwirtschaft. Nach den Vorgaben der Organisation für Wirtschaftliche Zusammenarbeit und Entwicklung (OECD) und der europäischen Statistikbehörde Eurostat zählen neben dem klassischen Umweltschutz – Abfallwirtschaft, Gewässerschutz, Lärmbekämpfung und Luftreinhaltung – auch neue umweltschutzorientierte Dienstleistungen zur Umweltwirtschaft, die sich erst in den vergangenen Jahren deutlich herausgebildet haben. Darunter fallen beispielsweise Energie- und Gebäudemanagement, Ökotourismus und umweltschutzorientierte Finanzdienstleistungen. Viele Unternehmen bieten nur teilweise umweltschutzrelevante Aktivitäten an – Beratungsunternehmen etwa, die zum Teil beim Energiesparen beraten, oder Handwerksbetriebe, die auch Gebäude dämmen. In diesen Fällen kommt es darauf an, den Anteil der Umweltschutztätigkeit sachgerecht auszuweisen. Häufig besteht erfolgreicher Umweltschutz auch darin, Produkte und Produktionsprozesse zu wählen, die im Vergleich zu herkömmlichen weniger umweltbelastend sind; hier muss versucht werden, den Mehreinsatz von Arbeitskräften annähernd abzuschätzen.

Die Beschäftigungswirkungen lassen sich am zuverlässigsten mit einer Kombination zweier Ansätze schätzen:

- Angebotsorientierte Schätzungen greifen auf Daten wie Umsatz oder Mitarbeiterzahlen zurück. Dazu liegen in Sparten wie Recycling und anderen Entsorgungsdienstleistungen konventionelle statistische Erhebungen vor, in anderen Fällen werden Unternehmensbefragungen in der Umweltwirtschaft, Panelerhebungen des Instituts für Arbeitsmarkt- und Berufsforschung (IAB) oder Verbandsstatistiken ausgewertet. So lassen sich die Beschäftigungswirkungen der umweltschutzorientierten Dienstleistungen sowie zum Teil bei den erneuerbaren Energien erfassen.
- Nachfrageorientierte Schätzungen nutzen Daten der amtlichen Statistik über die Inlandsnachfrage und den Export von Umweltschutzgütern, um daraus die Beschäftigungswirkung zu berechnen. Mit Modellrechnungen auf Basis der Input-Output-Analyse ermittelt man sowohl die direkten als auch die indirekten Arbeitsplatzeffekte. Die Angaben zu den Beschäftigungseffekten der Investitionen, Sachaufwendungen und Exporte beruhen auf solchen nachfrageorientierten Schätzungen.

Die Verknüpfung der beiden Ansätze verschafft einen fundierten Überblick über die Beschäftigung im Umweltschutz – erfordert allerdings auch eine sorgfältige Analyse und Bereinigung um Doppelzählungen.

Key Points at a Glance

Environmental protection gives rise to far more jobs than just those directly based in the environmental industry itself– for example jobs that are necessary for production of the intermediate inputs and for exports. How many jobs actually depend on environmental protection is something that can only be estimated, because environmental protection is a cross-sectional task that creates jobs in nearly all sectors of the economy.

The facts and figures taken as a basis for the estimates originate from a variety of sources: official surveys, trade association statistics or expert estimates – for example when it comes to assessing the percentage of certain activities that is due to environmental protection.

Internationally established conventions and methods help to define the limits of the environmental economy. According to the criteria of the Organisation for Economic Cooperation and Development (OECD) and the European statistics authority Eurostat, the classic environmental protection sectors – waste management, water conservation, noise abatement and air quality control – have been joined by new environmental-oriented services to the environmental economy which have only emerged clearly in recent years. Examples include energy management and facility management, eco tourism and environment-oriented financial services. Many companies offer activities that are only partly relevant to the environment – for examples, consultants who also give advice on energy saving, or construction trades that also insulate buildings. In such cases it is important to make a proper identification of the proportion of environmental protection activities. Often successful environmental protection has the meaning of selecting products and using production processes which are less harmful to the environment than traditional ones; in these cases it is necessary to try to estimate at least approximately the additionally required labor input.

The most reliable way of estimating the impacts on employment is to use a combination of two approaches:

- Supply-oriented estimates make use of data such as sales revenue or employee numbers. Conventional statistical surveys of these exist in branches like recycling and other waste management services, whereas in other cases analyses are made on the basis of company surveys in the environmental economy, panel surveys by the Institute for Employment Research (Institut für Arbeitsmarkt- und Berufsforschung – IAB) or association statistics. This makes it possible to register employment impacts of environment-oriented services and, to some extent, those in the field of renewable energy.
- Demand-oriented estimates take data from the official statistics on domestic demand and on exports of environmental goods as a basis for calculating the employment effects. Model calculations based on input-output analysis are then used to identify the direct and indirect employment effects.

The combination of the two approaches yields a sound overview of employment in the environmental protection sector – though it also requires careful analysis and the elimination of double counting.

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List of Abbreviations and Acronyms

BA	Bundesagentur für Arbeit (Federal Employment Agency)
BAZ	Bundesamt für den Zivildienst (Federal Agency for Civil Service); renamed BAFzA – Bundesamt für Familie und zivilgesellschaftliche Aufgaben since 2011
BfEE	Bundesstelle für Energieeffizienz (Federal Energy Efficiency Center)
BGBl.	Bundesgesetzblatt
BMFSFJ	Bundesministerium für Familie, Senioren, Frauen und Jugend (Federal Ministry for Family Affairs, Senior Citizens, Women, and Youth)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety); renamed BMUB - Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety since 2013
CEPA	Classification of Environment Protection Activities and Expenditure
CReMA	Classification of Resource Management Activities
destatis	Statistisches Bundesamt (Federal Statistical Office)
DIW Berlin	Deutsches Institut für Wirtschaftsforschung (German Institute for Economic Research), Berlin
EGSS	Environmental Goods and Services Sector
EI	Environment Industry
ESE	Environmental Services Employment
Eurostat	Statistical Office of the European Union
FS	Fachserie (specialized publication of destatis)
IAB	Institut für Arbeitsmarkt- und Berufsforschung der Bundesagentur für Arbeit (Institute for Employment Research)
IAB BP	Betriebspanel des Instituts für Arbeitsmarkt- und Berufsforschung (Establishment Survey of the Institute for Employment Research)
ILO	International Labor Organization
ISIC	International Standard Industrial Classification of All Economic Activities
NIW	Niedersächsisches Institut für Wirtschaftsforschung (Lower Saxony Institute for Economic Research)
NGO	Non-governmental organization
OECD	Organization for Economic Cooperation and Development
RE	Renewable Energy
SEEA	System of Integrated Environmental and Economic Accounting
SERIEE	System for the Collection of Economic Data on the Environment
SNA	System of National Accounts
SEE	Share of environmental employment

UBA	Umweltbundesamt (Federal Environment Agency)
UGR	Umweltökonomische Gesamtrechnung (Environmental-economic accounting)
UN	United Nations
UNEP	United Nations Environment Programme
VGR	Volkswirtschaftliche Gesamtrechnung (National Accounts)
WZ 2008	Klassifikation der Wirtschaftszweige, Ausgabe 2008 (German classification of economic activities, edition 2008)

Summary

1. We aim at estimating the gross employment effects of environmental protection, i.e. the number of persons who do have a job due to environmental protection activities, either directly or indirectly, in all sectors of the economy, termed environmental employment.
2. Environmental protection comprises all activities which have as their primary objective the prevention, reduction and elimination of degradations of the environment.
3. For estimating environmental goods production employment, environmental activities are delimited in accordance with the Eurostat classifications CEPA (Classification of Environment Protection Activities and Expenditure) and CReMA (Classification of Resource Management Activities). For the estimates of employment for providing environmental services the OECD/Eurostat EI (Environment Industry) Classification is used. Existing minor differences between these two sets of classifications are neglected.
4. In addition we include activities which are beneficial for the environment, even if their prime objective is to satisfy other needs. In particular we include respective activities in trade, public transportation, and water supply.
5. We include employment related to integrated environmental protection by in production processes or in products which are more environmentally friendly than standard processes or products as far as information is available. Expenditure data include integrated environmental protection investment outlays. Likewise our estimate of environmental services employment includes a share of jobs in industries which are considered to be more environmentally friendly compared to alternatives; the share is chosen as the relation of integrated to all environmental protection investment expenditure. Activities to make products cleaner are captured in a number of industries such as design or architecture.
6. We combine a demand side approach for estimating environmental employment originating from the production of environmental goods and a supply side approach to determine employment stemming from the provision of environmental services.
7. The demand side approach starts from domestically effective expenditure (domestic expenditure plus exports net of imports) on investment goods and inputs for operation and maintenance. Expenditure data are taken from the German Federal Statistical Office (destatis). Current expenditure on personnel is excluded to avoid double counting; corresponding jobs are accounted for as environmental services employment. Exports and imports are own estimates. Domestic expenditure on renewable energy expansion - disaggregated by more than 10 renewable energy technologies - is taken from specialized studies; expenditure includes purchases of biomass and biofuels.
8. From domestic expenditure, related domestic gross output is derived by input-output techniques. Employment is then calculated based on information on labor productivity by industries and renewable energy technologies respectively. We always use the most up to date input-output table, the currently used table for the year 2008 is disaggregated by 73 industries. This approach yields direct employment as well as indirect employment in upstream industries.
9. Environmental services employment is estimated by a supply side approach. Based on lists of environmental protection activities, economic sectors are identified which are engaged in the provision of environmental services, consequently employment in these sectors is determined. A great number of statistical sources are exploited, including official statistical sources, data provided by business associations and NGOs, and research reports and studies.
10. As far as possible, data are immediately quoted from these sources. Otherwise some estimation procedure has to be applied. E.g., if the share of turnover with environmental goods or services is known, it can be applied to total employment, or employment can be inferred from data on turnover and labor coefficients. In some cases it is necessary to project an earlier estimate to the present based on the development of a related variable.

11. If environmental activities are a secondary activity of establishments and/or workers spend only part of their working time on such activities, we count a corresponding share of the workforce as environmental employment. In analogy to the common practice of counting only the extra costs of adapted goods as environmental protection expenditure, we take into account only a corresponding share of the workforce of industries producing cleaner products or using cleaner processes. Environmental activities for own purposes (ancillary activities) of establishments (in order to make its processes more environmentally friendly) are accounted for as far as possible.
12. Using the input-output tables of destatis, the demand side approach yields the number of jobs instead of full time equivalents. Correspondingly, for environmental services employment we count the number of jobs independently of hours worked; an exception is made for seasonal employment.
13. We present our estimates of environmental goods production employment according to expenditure categories, distinguishing domestic demand and exports. Domestic demand is broken down into investment outlays and current expenditure on intermediate goods and services for the operation and maintenance of environmental protection facilities on the one hand and public expenditure, expenditure of manufacturing industries and expenditure of privatized public companies on the other hand. As expenditure for heat insulation in buildings is not included in environmental expenditure data by destatis we include employment related to this activity as a distinct category. For employment due to the exploitation of renewable energy sources we additionally distinguish by energy sources. Environmental services employment is disaggregated by industries according to WZ 2008 (the German classification of economic activities).

1 Introduction

Different questions may be asked when discussing the employment effects of environmental protection:

1. How many people work in the environmental protection industry? (jobs in eco-industry)
2. How many people do have a job due to environmental protection activities? (gross employment for environmental protection)
3. What is the net impact on employment of environmental policy? (net employment of environmental protection)

The first question aims at defining an economic sector (eco-industry) comprising economic units which produce goods and services for environmental protection uses.

The second question addresses the problem of estimating the number of persons working directly or indirectly for environmental protection activities in all sectors of the economy.

The third question goes beyond statistical accounting and can only be answered on the basis of modelling, taking into account secondary economic effects of environmental policy as comprehensively as possible, e.g. to account for possible job losses across the economy due to cost and relocation effects.

This paper presents a combined demand-supply side approach to answering the second type of question, namely estimating the gross employment effects of environmental protection activities in Germany. Although counting the number of individuals being employed due to existing environmental protection activities seems to be quite straightforward, the empirical process of estimation poses a number of challenges. We first discuss problems of the delimitation of environmental protection activities and related environmental employment. Subsequently we deal with data availability and methods of estimation where data are not readily available. Finally we discuss the relevance as well as difficulties of presenting different dimensions of environmental employment.

In April 2012 DIW Berlin on behalf of the Federal Environment Agency (UBA) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) organized an international workshop to discuss this combined approach for the estimation of the gross employment effects of environmental protection. We present the main results of the discussions as “remarks” at the end of each chapter of this report.

The most recent application of the methodology described in this paper is an estimate of environmental employment in Germany in 2010 (Edler, Blazejczak 2014).

2 Delimitation of environmental employment[1]

Quite generally, environmental employment can be defined as employment for environmental-protection-related activities. Environmental-protection-related activities are ”activities to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, goods and services that reduce environmental risk and minimise pollution and resource use”.[2]

The general definition given above has been stated more precisely by comprehensive classifications of environmental activities, namely the OECD/Eurostat Environment Industry (EI) Classification[3] as well as the Classification of Environmental Protection Activities (CEPA) and the Classification of Resource Management Activities (CReMA).[4,5]

These classifications aim at identifying the Environmental Goods and Services Sector (EGSS). To be included in the EGSS, environmental protection must be the main purpose of the respective activity according to the technical nature of the activity. This leads to the inclusion of recycling activities but excludes activities that primarily satisfy other needs, even if they are beneficial for the environment, such as the electronic delivery of documents. Also excluded are activities related to the production of intermediate goods and services.

While this delimitation appears sensible in the context of defining an environmental sector of the economy, the question of how many people do have a job due to environmental protection activities requires a somewhat broader definition.

2.1 The combined approach

In addition to the EGSS as delimited by CEPA and CReMA, the combined approach described here includes a number of activities which are beneficial for the environment even though their main purpose is not environmental protection. In particular, employment in

- trade with products which are beneficial for the environment
- public transportation
- water supply

is included.

Also employment for the production of intermediate goods and services is estimated and included as detailed below.

2.1.1 Environmental goods production employment

The employment related to the production of environmental goods is calculated based on a demand side approach. It uses input-output-analysis of environmental expenditure (for details see chapter

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1 Some definitions of green jobs imply as a prerequisite that they are decent jobs (ILO/UNEP 2008). We do not explicitly pay attention to this condition for our estimates for Germany.

2 OECD/Eurostat 1999, p.9.

3 OECD/Eurostat 1999.

4 CEPA is an element of the European System for the Collection of Economic Data on the Environment (SERIEE); SERIEE is compatible with the System of Integrated Environmental and Economic Accounting (SEEA) which has been developed by the United Nations Statistical Office alongside the revision of the System of National Accounts (SNA). CReMA has been developed at the European level for EGSS purposes.

5 CEPA and CReMA can also be used for classifying products and transactions.

3.1.1 on methods of estimation). The delimitation of environmental goods production employment is therefore implicitly determined by the expenditure categories included.

We rely – as far as possible – on official statistical sources provided by the German Federal Statistical Office (destatis). Official environmental statistics in Germany are ruled by Umweltstatistikgesetz (Law on Environmental Statistics).[6] As expenditures for environmental protection activities we consider investment expenditure as well as current expenditure for operation and maintenance.

With respect to the delimitation of environmental protection activities destatis follows CEPA and CReMA (see Annexes 3 and 4). The following environmental domains are covered:

1. Abfallwirtschaft (waste management)
2. Gewässerschutz (waste water management; including protection of groundwater and surface water)
3. Lärmbekämpfung (noise and vibration abatement)
4. Luftreinhaltung (protection of ambient air)
5. Naturschutz und Landschaftspflege (protection of biodiversity and landscapes)
6. Bodensanierung (protection and remediation of soil)
7. Klimaschutz (protection of climate)

The expenditure in manufacturing is collected in specialized detailed surveys. There exists an annual survey for investment in manufacturing (Statistisches Bundesamt 2012a) and a triennial survey for current environmental protection expenditure (Statistisches Bundesamt 2012b). With respect to expenditure for environmental protection activities of government and of privatized public entities[7] it is necessary to rely on results of Umweltökonomische Gesamtrechnung (Environmental-economic accounting; UGR) (Statistisches Bundesamt 2010, Statistisches Bundesamt 2012c). Data for government expenditure and for expenditure of the specified entities are generated by destatis from different statistical sources, e.g. financial statistics of public authorities. Part of current expenditure is calculated by destatis using model-based capital stock data for environmental protection facilities.

As the expansion of renewable energy (RE) is a priority of German environmental policy, the RE related employment is investigated in specialized studies (e.g. Lehr et al. 2011, O´Sullivan et al. 2013). These studies also follow a demand side approach starting from RE related expenditure (investment expenditure, current expenditure for operation and maintenance including renewable fuel supply where applicable). To avoid problems of double-counting we eliminate expenditure for climate protection from destatis data.

Investment expenditure for heat insulation in buildings is included as far as it is subsidized by public funding schemes (IWU, Bremer Energie Institut 2011). To include only subsidized activities for heat insulation in buildings is merely due to the fact that no reliable information exists for other than subsidized activities. It should be noted that only the additional costs related to energy saving and not the full costs of building refurbishment are included as expenditure. Expenditure on energy efficiency measures in other fields than heat insulation in buildings is included as far as these are captured in destatis surveys.

In addition to domestic expenditure for environmental protection, foreign demand for environmental goods effective in Germany is also accounted for. This means that it is required to quantify the ex-

[6] See Umweltstatistikgesetz (2005). The latest change of the law was adopted in 2012.

[7] These privatized public entities are mainly active in the environmental domains of waste management and waste water management. Historically most of these entities belonged to the government sector, but later changed their legal status to become private entities. These entities account for a large percentage of total environmental protection expenditure.

ports of German environmental protection goods. One starting point is an annual survey by destatis on the turnover of goods and services for environmental protections goods (Statistisches Bundesamt 2013a) which collects data for domestic turnover and exports. This information is a starting point for the estimation process of exports that is used in our approach (for methodological details see section 3.1.1). For the exports of goods related to RE we rely on results of the specialized studies cited above (see Lehr et al. 2011, especially chapter 2).

2.1.2 Environmental services employment

The delimitation of environmental services employment (ESE) of the combined approach described here follows the one originally developed by ifo (Sprenger et al. 2002, Sprenger et al. 2003). It corresponds to the OECD/Eurostat Environment Industry (EI) Classification (OECD/Eurostat 1999) (see table 1 and Annex 2).

The parallel reference to the EI classification (for environmental services employment) and to CEPA/CReMA (for environmental goods production employment) does not pose any serious problems as there are only minor differences between the two classifications. The correspondence between the OECD/Eurostat and CEPA and CReMA classifications is presented in the EGSS handbook.[8]

The main differences are:

- Included in the OECD/Eurostat classification but excluded from CEPA/CReMA are
  - Indoor air pollution control
  - Water supply others than minimization of water intake
- Cleaner technologies and processes and cleaner products are a separate category in the OECD/Eurostat classification but form part of all CEPA/CReMA categories.
- Some explicit categories of the OECD/Eurostat classification are captured as implicit parts of several CEPA/CReMA categories (e.g. eco-tourism in the OECD/Eurostat classification) and vice versa (e.g. protection of biodiversity and landscape in the CEPA/CReMA).

Table 2 shows the correspondence between the ESE data of the combined approach (presented according to the German classification of industries (WZ 2008)) and the EI classification. All employment categories we consider can be attributed to specific activities or groups of specific activities listed in the EI classification. Table 3 shows that almost all services items of the EI classification are at least partially covered by our analysis of ESE.

[8] Eurostat 2009, p. 69.

Table 1: OECD/Eurostat Environment Industry (EI) Classification - Overview

(For an annotated list see Annex 2)

I.	The "POLLUTION MANAGEMENT" Group	III.	The "RESOURCE MANAGEMENT" Group[1]
I.A.	**Environmental equipment and specific materials**	**III.A.**	**Environmental equipment**
I.A.1	Air pollution control	III.A.1	Indoor air pollution control
I.A.2	Wastewater management	III.A.2	Water supply
I.A.3	Solid waste management	III.A.3	Recycled materials
I.A.4	Remediation and clean-up of soil, surface water and groundwater	III.A.4	Renewable energy plant
I.A.5	Noise and vibration abatement	III.A.5	Heat /Energy saving and management
I.A.6	Environmental monitoring, analysis and assess-ment	III.A.6	Sustainable agriculture and fisheries
I.A.7	Other	III.A.7	Sustainable forestry
I.B.	**Environmental services**	III.A.8	Natural risk management
I.B.1	Air pollution control	III.A.9	Eco-tourism
I.B.2	Wastewater management	III.A.10	Other
I.B.3	Solid waste management	**III.B.**	**Environmental services and construction**
I.B.4	Remediation and clean-up of soil, surface water and groundwater	III.B.1	Indoor air pollution control
I.B.5	Noise and vibration abatement	III.B.2	Water supply
I.B.6	Environmental R&D	III.B.3	Recycled materials
I.B.7	Environmental contracting and engineering	III.B.4	Renewable energy plant
I.B.8	Analytical services, data collection, analysis and assessment	III.B.5	Heat/energy saving and management
I.B.9	Education, training, information	III.B.6	Sustainable agriculture and fisheries
I.B.10	Other	III.B.7	Sustainable forestry
I.C.	**Construction and installation**	III.B.8	Natural risk management
II.	**The "CLEANER TECHNOLOGY [PROCESSES AND PRODUCTS]" Group**	III.B.9	Eco-tourism
II.1	Cleaner/resource-efficient technologies and processes	III.B.10	Other
II.2	Cleaner/resource-efficient products		

[1] We follow the recommendation in OECD/Eurostat 1999 to present the items in the Resource Management Group under separate headings for equipment and services and construction.

Source: OECD/Eurostat 1999.

Table 2: Correspondence of Environmental Services Employment (ESE) by Industry and the Environment Industry (EI) – Classification

	Environmental Services Employment (ESE) by Industry		Corresponding Position of the Environment Industry (EI) Classification cf. Table 1
1	**Agriculture and forestry**	**Land- und Forstwirtschaft**	
1.1	Ecological agriculture	Ökologischer Landbau	III.B.6/9
1.2	Agricultural services and machinery rentals	Lohnunternehmen, Maschinenringe	III.B.6
1.3	Horticulture, landscaping	Garten- und Landschaftsbau	III.B.6
1.4	Forestry	Forstwirtschaftliche Dienstleistungen	III.B.7
2	**Mining and manufacturing**	**Bergbau und verarbeitendes Gewerbe**	
2.1	Internal environmental services	Interne Umweltschutzdienstleistungen	II.1
2.2	Product related services	Produktbegleitende Dienstleistungen	II.2
3	**Energy and water supply**	**Energie- und Wasserversorgung**	
3.1	Internal environmental services in energy supply	Interne Umweltschutzdienstleistungen der Energieversorgung	II.1
3.2	Energy services for third parties	Energiedienstleistungen	I.B.7 / III.B.4/5
3.3	Water supply	Wasserversorgung	I.B.2 / III.B.2
4	**Construction**	**Baugewerbe**	I.C.
5	**Trade, repair of motor vehicles and personal and household goods**	**Handel, Instandhaltung und Reparatur von Kfz und Gebrauchsgütern**	
5.1	Wholesale and retail trade with clean products	Groß-/Einzelhandel mit umweltfreundlichen Produkten	II.2/ III.B.6
5.2	Wholesale and retail trade with investment goods for environmental protection	Groß-/Einzelhandel mit Investitionsgütern für den Umweltschutz	I.B.1-9 / III.B.1-10
5.3	Wholesale trade with waste materials	Großhandel mit Altmaterialien und Reststoffen	I.B.3 / II.2
5.4	Car repair shops	Kfz-Handwerk	I.B.1 / II.2
6	**Hotels and restaurants**	**Gastgewerbe**	II.1
7	**Transport and communications**	**Verkehr und Nachrichtenübermittlung**	
7.1	Environmentally sound transport services	Umweltverträgliche Verkehrsdienstleistungen	
7.1.1	Deutsche Bahn AG (German Rail)	DB Konzern	II.1
7.1.2	Public passenger transport	Öffentlicher Personenverkehr	II.2
7.1.3	Inland water transport	Binnenschifffahrt	II.2
7.2	New transport services	Neue Mobilitätsdienstleistungen	II.2
8	**Financial Intermediation**	**Kredit- und Versicherungsgewerbe**	III.B.8/10
9	**Real estate, renting, and business activities**	**Grundstücks- und Wohnungswesen, Vermietung von beweglichen Sachen, Dienstleistungen für Unternehmen**	
9.1	Cleaning of buildings	Gebäudereinigung	I.B.3 / III.B.1/10
9.2	Chimney sweeping	Schornsteinreinigung	I.B.1 / III.B.5
9.3	Data management, data banks	DV, Datenbanken	I.B.8
9.4	Research and development	Forschung und Entwicklung	I.B.6

	Environmental Services Employment (ESE) by Industry		Corresponding Position of the Environment Industry (EI) Classification cf. Table 1
9.5	Real estate, renting	Grundstücks- und Wohnungswesen	I.B.7/8/9 / III.B.10
9.6	Architectural and engineering consulting, laboratories	Architektur- und Ingenieurbüros, Laboratorien	I.B.7/8/9 / III.B.10
9.7	Others	Sonstige	I.B.7/8/9 / III.B.10
10	**Public administration**	**Öffentliche Verwaltung**	
10.1	Environmental and nature and landscape protection administration	Umweltschutz-, Natur- und Landschaftsschutzverwaltung	I.B.1-9 / III.B.1-10
10.2	Parks and gardens	Park- und Gartenanlagen	III.B.6/9
10.3	Other environmental protection activities of public administrations	Weitere Umweltschutztätigkeiten der öff. Hand	I.B.1-9 / III.B.1-10
11	**Education**	**Erziehung und Unterricht**	I.B.9 / III.B.10
12	**Other community, social, and personal services**	**Erbringung von sonstigen öffentlichen und persönlichen Dienstleistungen**	
12.1	Waste and wastewater management	Entsorgung	I.B.2/3 / III.B.3
12.2	Services for households	Dienstleistungen für Haushalte	I.B.1-9 / III.B.1-10
12.3	Environmental NGOs and lobby groups	Interessenvertretungen im Umweltschutz	I.B.9/ III.B.10

Source: Compilation by DIW Berlin.

Table 3: Coverage of the Environment Industry (EI) Classification by the DIW Estimate of Environmental Service Employment (ESE)

	Position of the Environment Industry (EI) Classification	Environmental Services Employment (ESE) Estimate cf. Table 2
I.	**The "POLLUTION MANAGEMENT" Group**	
I.A.	**Environmental Goods**	(see chapter 2.1.1)
I.B.	**Environmental Services**	5.2, 10.1, 10.3, 12.2
I.B.1	Air pollution control	5.4, 9.2
I.B.2	Waste water management	3.3, 12.1
I.B.3	Solid waste management	5.3, 9.1, 12.1
I.B.4	Remediation and cleanup of soil, water and groundwater	
I.B.5	Noise and vibration abatement	
I.B.6	Environmental R&D	9.4
I.B.7	Environmental contracting and engineering	3.2, 9.5, 9.6,, 9.7
I.B.8	Analytical services, data collection, analysis and assessment	9.3, 9.5. 9.6, 9.7
I.B.9	Education, training, information	9.5, 9.6, 9.7, 11, 12.3
I.C.	**Construction**	4.
II.	**The "CLEANER TECHNOLOGY [PROCESSES AND PRODUCTS]" Group**	
II.1	Cleaner/efficient processes	2.1, 3.1, 6, 7.1.1
II.2	Cleaner/efficient products	2.2, 5.1, 5.2, 5.3, 7.1.2, 7.1.3, 7.2
III.	**The "RESOURCE MANAGEMENT" Group**	
III.A.	**Environmental Goods**	(see chapter 2.1.1)
III.B.	**Environmental Services and Construction**	5.2, 10.1, 10.3, 12.2
III.B.1	Indoor air pollution control	9.1
III.B.2	Potable water treatment	3.3
III.B.3	Other recycling	12.1
III.B.4	Renewable energy plant	3.2 (see also chapter 2.1.1)
III.B.5	Heat/energy management	3.2, 9.2
III.B.6	Amenity and natural conservation	1.1, 1.2, 1.3, 10.2
III.B.7	Sustainable agriculture and fisheries	1.1, 1.2, 5.1
III.B.8	Sustainable forestry	1.4
III.B.9	Natural risk management	
III.B.10	Eco-tourism	1.4, 10.2
III.B.11	Other	8, 9.1, 9.5, 9.6, 9.7, 11, 12.2

Source: OECD/Eurostat 1999; Compilation by DIW Berlin.

2.2 Remarks

The OECD/Eurostat and CEPA/CReMA classifications form a solid and state-of-the-art basis for deciding which items to include in the estimate of environmental employment. Relying on CEPA/CReMA also ensures that the estimate will correspond to the rules established by Eurostat for assessing the EGSS. Items which are included in our combined approach but are not part of the EGSS shall be presented separately.

Alternative concepts which have been proposed include the concept of Green Future Markets[9] which characterizes technologies with potential for environmental protection and resource efficiency which simultaneously offer important future world market potentials. This concept is not regarded to be suitable for delimiting environmental employment in a comparable way because no established classification exists. Another approach to delimiting environmental employment counts all jobs which depend on an unspoiled environment.[10] While this approach may be suitable for some purposes it is inadequate for answering the question of how many people do have a job due to environmental protection activities.

New developments which are underway at the International Labour Office[11] may lead to improved consistency as well as a stronger emphasis on environmental domains instead of industries. However, these activities will only yield results in the long run.

In some instances environmental employment may have ecologically damaging side effects such as in hydro power generation and in bio-fuels production. Such activities are nevertheless included.

[9] Walz et al. 2008, BMU 2012.

[10] This is proposed i.a. in a study of the links between biodiversity and the labor market. See ICF GHK 2012.

[11] ILO 2013.

3 Methods of data collection and estimation of environmental employment

From the methodological viewpoint a distinction is to be made between a supply side approach and a demand side approach to estimating environmental employment.

The *supply side approach* starts from a list of goods and services relevant for environmental protection and resource management activities (see section 2 above), identifies economic units which produce these goods and services, and determines employment in these establishments. Several methodological and statistical problems are associated with the supply side approach. First, many goods and services can be used for different purposes in different processes and often the producer has no information about the final destination of its product (dual-use).[12] Second, the production of environmental goods and services is combined with non-environmental protection activities in the same establishment (secondary activity). In such cases isolating the labor input into the production of environmental goods and services is difficult. Environmental activities which are produced for the own use of establishments (ancillary activities) may not be easily identified either. Finally, there exists a risk of double counting. If filter cloths and complete fabric filters are both included in a list of potential environmental goods and services the same filter cloths (and therefore the respective labor input) may be counted twice.

The *demand side approach* starts from data about expenditure for environmental protection activities and derives a model based estimate of environmental employment by applying input-output techniques.[13] Although this approach circumvents the dual-use and secondary activity problems as well as the risk of double-counting, the interpretation of the results is restricted through various assumptions implicit in the input-output methodology. In a first step expenditure has to be transformed into domestically effective final demand which requires calculations of imports and exports for environmental goods which may pose considerable empirical difficulties (see the next section for more detailed information). In a second step domestically effective final demand has to be transformed into gross output by applying input-output techniques (static open input-output model). In a third step gross output has to be linked to employment using labor coefficients.[14] This step requires information on labor coefficients in an industry disaggregation compatible with the input-output tables used. Moreover, average productivity in an industry may only be a poor approximation for the productivity of the specialized production of environmental goods and services.

3.1 The combined approach

We use a combination of supply side and demand side approaches. The estimation of environmental goods production employment is based on a demand side approach using input-output analyses whereas the estimation of environmental services employment is mostly based on the supply side approach. Bringing the estimates together requires attention to the risk of double counting.

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[12] Therefore, more appropriately, the term „potential environmental goods and services“ or „goods and services relevant for environmental protection“ is used. The dual-use problem might be more severe for the producers of goods as providers of services often have a closer connection to their customers.

[13] See Miller, Blair 2009 or Stäglin, Edler, Schintke 1992.

[14] A labor coefficient measures how much labor input is required to produce one unit of gross output in a specific economic sector. Labor productivity measures the inverse relation and is usually based on value added. Labor coefficients and labor productivity can be based on hours worked or persons employed. We use persons employed; thus labor coefficients implicitly reflect the average working time per person for each industry.

Environmental employment is presented as persons employed regardless of whether they are working full time. In other words, we do not transform employment to full time equivalents. An exception is made for non-permanent employment (seasonal employment) in ecological agriculture and in machinery rentals: of these persons one quarter and one half respectively are taken into account.

That many workers spent only a part or their working time on environmental protection is captured by the imputed shares of environmental protection employment. E.g. that 65% of chimney sweepers are accounted for as environmental employment can thus be interpreted as all chimney sweepers spending 65% of their working time on environmental protection activities.

3.1.1 Environmental goods production employment

The estimation of employment in environmental goods production follows a demand oriented approach: We start from data on demand for environmental goods and estimate employment necessary to produce these goods. Demand is defined as expenditure for environmental protection activities. Expenditure considered includes investment expenditure for new or existing facilities for environmental protection and current expenditure for the operation and maintenance of existing domestic facilities for environmental protection. Current expenditure for personnel (labor costs) is excluded, as the persons providing environmental services for internal purposes (e.g. operating or maintaining own environmental protection facilities) are accounted for as a part of environmental service employment.

In both categories, investment expenditure and current expenditure, only demand effective in Germany is taken into account. That is, we exclude the fraction of final demand which is satisfied by imported goods. To quantify the amount of imported goods for final demand[15] we take into account "tradability" of environmental protection goods. Using the concept of tradability coefficients[16] disaggregated by industry we estimate the amount of imported environmental protection goods for final demand use. If this amount is deducted from expenditure we obtain effective final demand for environmental protection from domestic sources. In addition we include foreign demand for environmental goods being effective in Germany (exports). Exports of environmental goods are estimated based on the relation between domestic production and exports disaggregated by sectors. This method uses results from an annual official survey on turnover of products and services for environmental protection (Statistisches Bundesamt 2013a) and ratios of exports to domestic turnover in manufacturing industries (Statistisches Bundesamt 2013c).[17] Summing up final demand from domestic sources and from exports gives the total final demand for environmental protection goods and services effective in Germany which is the starting point for calculating environmental goods production employment.

We apply input-output analysis to estimate employment for environmental goods production. Currently we use the official input-output-table for Germany for the year 2008 which covers 73 industries (Statistisches Bundesamt 2012d).[18] Therefore environmental expenditure data have to be disaggregated to 73 supplying sectors. Applying the static open input-output model, expenditures for environmental protection activities are transformed into induced gross output, a method usually called imputation analysis in input-output literature. In a further step the employment requirements to pro-

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15 Not only goods and services for final demand but also for intermediate use in production processes are imported. To account for intermediate imports in the production of environmental goods and services, averages for each industry´s gross output are applied.

16 Tradability coefficients are estimated jointly with Niedersächsisches Institut für Wirtschaftsforschung (NIW). For details see Edler et al. 2009, chapter 15.

17 Export ratios are estimated jointly with Niedersächsisches Institut für Wirtschaftsforschung (NIW). For details see Edler et al. 2009, chapter 15.

18 The most recent input-output-table for Germany covers the year 2009; see Statistisches Bundesamt 2013b.

duce this gross output are calculated using labor coefficients by industry. It should be noted that by applying input-output techniques not only the direct labor content for the production of environmental goods is calculated but in addition also the indirect labor content of all products and services which enter the production process as intermediate goods (employment in supporting industries).[19]

As we estimate environmental service employment separately (see next section) we exclude from the demand oriented estimate of environmental employment all direct employment in service sectors to avoid the risk of double counting. For example, architectural and engineering services in planning and building of waste water treatment plants are excluded as they may be performed in specialized units whose employment is already accounted for in the supply oriented estimate of environmental service employment. In contrast, indirect employment in service sectors resulting from demand for environmental goods is included as such services are mostly unspecific in the sense that their relation to environmental protection cannot be recognized form any characteristics of the particular jobs and therefore cannot be identified as part of environmental services employment by the supply side approach. For example, indirect service employment for transporting concrete to a new waste water treatment site is included as the transport operator is not specialized on environmental activities.

It should be noted that due to the importance of expansion of RE as the focal point of environmental and climate policy in the last decade in Germany, the employment related to RE is calculated with some detail using the same methodological approach. Environmental expenditure in the domain of RE includes:

- investment expenditure for new RE facilities including exports of RE facilities and parts of it,
- operating and maintenance expenditure of existing RE facilities (as far as it can be identified, to avoid double counting these services are excluded from the calculation of environmental services employment),
- expenditure for purchases of biomass and biofuel.

To achieve a better degree of homogeneity of the underlying production processes we distinguish more than ten RE sources (or technologies). In line with the concept of demand effective in Germany, we do not include expenditure if it is satisfied by imports and we include foreign demand (exports) for new RE facilities and components of facilities. For methodological details see Lehr et al. 2011.

3.1.2 Environmental services employment

Employment related to the provision of environmental services is estimated by a supply side approach. That is, we collect data on employment in establishments providing environmental services as delimited in chapter 2. In many fields, however, figures on employment are not readily available and various methods to estimate employment from related information have to be applied.

A detailed description of the methods we use to estimate environmental services employment organized by economic sectors is given in Edler, Blazejczak 2014. An overview can be found in Annex 1.

We use the following main sources of information to estimate environmental services employment:

1. Official statistical sources, regularly available

   a) Personalstandsstatistik (Public Sector Employment Report)

[19] The ILO Proposal for the statistical definition and measurement of green jobs in accordance with Eurostat 2009, p. 132 suggests that the suppliers of non-exclusively environmental components and the distributers of environmental technologies and products shall be excluded from the environmental goods and services sector. (see ILO 2013, p. 24). However, ILO acknowledges the high relevance of information on indirect (and induced) effects for policy-makers.

   b) Statistik der laufenden Aufwendungen für den Umweltschutz (Current Environmental Expenditure Statistics)
   c) Verkehrsstatistik (Transport Statistics)
   d) Volkswirtschaftliche Gesamtrechnung (National Accounts)
   e) Jahreserhebung im Handel (Annual Trade Survey)
   f) Beschäftigungsstatistik (Employment Survey)
   g) Handwerkszählung (Craft and Trades Survey)
   h) Statistik des Personals an Hochschulen (Survey of Personnel in Higher Education)
   i) Konjunkturstatistik im Dienstleistungsbereich (Business Cycle Statistics in Service Sectors)

2. Official statistical sources, special evaluation

   a) Agrarstrukturberichterstattung (Report on Agriculture)
   b) Betriebspanel des Instituts für Arbeitsmarkt und Berufsforschung der Bundesagentur für Arbeit (IAB) (IAB Establishment Survey)

3. Information from business associations
4. Studies, reports

The IAB Establishment Survey is an annual representative survey of some 16.000 establishments of all sectors of the economy (Bellmann et al 2002). In 1999, 2005, and 2012 establishments were asked to self declare if they produce goods or services for environmental protection and, if so, to indicate the (primary) environmental domain to which their activities relate. They were also asked to indicate their shares of turnover with environmental goods or services of total turnover. Using the latter information and total employment, environmental employment can be estimated.[20] Employment through environmental goods production and services provision can be distinguished, and be attributed to one of some 40 industries. Results for individual industries and a comparison of results between 1999 and 2005 suggest that respondents may find it difficult to determine if they produce for environmental markets; this may be due to the dual use problem or unfamiliarity with classifications of environmental protection activities.

The methods we apply for estimating environmental services employment can be classified as follows; in some instances they are applied in combination:

1. Quote
   Employment data are directly taken from any of the above sources. This is the preferred method if applicable. In some cases data are unavailable on employment, but we can find data from which employment can be inferred like turnover and labor coefficients. In particular, the IAB employment survey gives information on total employment and the share of turnover with environmental goods or services of an establishment. The latter is applied to the establishment´s total employment in order to estimate environmental employment.
2. Analogous projection
   A base figure for an earlier year is projected (now-casted) by applying the rate of change of a related variable (see table 4).
3. Imputation of a share of environmental protection employment (see table 5)
   A share of total employment in an industry is counted as environmental protection. This method is applied when environmental activities are a secondary activity of establishments in an industry

[20] The results of the IAB Establishment Survey for 2005 were evaluated by Horbach 2012 for estimating environmental employment in 2010, see Edler, Blazejczak 2013.

and/or workers spend only part of their working time on environmental protection. It is also applied in case of cleaner processes and products in analogy to the common practice of counting only the extra costs of adapted goods as environmental protection expenditure.[21]

For method 2 "Analogous projection" table 4 gives the sources of base figures and related variables:

Table 4: Base figures and related variables for analogous projections

	Industry (see table 2)	Base figures	Related variables
2.2	Product related services	IAB BP 2005	Employment survey
(3.2)	Renewable and CH Power	Sprenger et al. 2002:166	Share of renewables in gross power consumption
4	Construction	IAB BP 2005	Employment survey
5.4	Car repair shops	IAB BP 2005	Employment survey
6	Hotels and restaurants	IAB BP 2005	Employment survey
9.1	Cleaning of buildings	Industry association report 2005	Employment survey, crafts and trades survey
9.4	Research and development	IAB BP 2005	Employment survey
9.5	Real estate, renting	IAB BP 2005	Employment survey
9.6	Architectural and engineering consulting, laboratories	IAB BP 2005	Employment survey
9.7	Others	IAB BP 2005	Employment survey
10.1	Environmental and nature and landscape protection administration	Public sector employment report 2005	Public sector employment report (larger aggregate)
10.2	Parks and gardens	Public sector employment report 2005	Public sector employment report (larger aggregate)
12.2	Services for household	IAB BP 2005	Employment survey
12.3	Environmental NGOs and lobby groups	IAB BP 2005	Employment survey

Source: Compilation of DIW Berlin.

For method 3 "Imputation of a share of environmental protection employment" table 5 gives the shares:

[21] SERIEE recommends to include only an 'environmental share' of economic aggregates related to adapted goods (comprising cleaner goods and resource efficient goods); the share is to be determined by the extra cost of the adapted goods. See Eurostat 2009, page 36.

Table 5: Imputed shares of environmental protection employment

	Industry (see table 2)	Imputed share	Source
(1.2)	Agricultural services	40%	Industry association estimate
(1.2)	Machinery rentals	12%	Industry association estimate
1.3	Horticulture, landscaping	0 to 100% in 17 activities	DIW estimate
1.4	Forestry services	35%	DIW estimate
7.1.1.	Deutsche Bahn AG (German Rail)	20%	Share of integrated environmental protection investment in selected industries (Sprenger et al. 2002, S. 74
7.1.2	Public passenger transport	20%	
7.1.3	Inland water transport	20%	
9.1	Cleaning of buildings	10%	Sprenger et al. 2002, S. 80
9.2	Chimney sweeping	65%	Industry association estimate
10.1	Environmental and nature and landscape protection administration	33% of employment in environment, sports and recreation excl. parks and gardens departments	DIW estimate
10.3	Other environmental protection activities of public administrations	10% of employment in housing, urban planning and community services departments 50% of employment in energy, water, trade and services departments	DIW estimate

Source: Compilation of DIW Berlin.

3.2 Remarks

Given the broad coverage of environmental protection activities and the variety of data sources to be exploited, a combined supply and demand side estimation process seems appropriate. The supply side approach and the demand side approach as single sided estimation methods each have their merits and weaknesses but neither can replace the combined approach. For selected activities for which overlapping data exist both the demand- and the supply side method could be applied for cross-checking the results of both estimation processes. The complexity of the approach poses the risk of inconsistencies, requiring careful and well-balanced steps of reconciliation of estimated figures. Special attention is needed to avoid double-counting.

Although there is a preference for the use of official statistical data, there is a clear need to supplement them with data from other sources. There exist some blank spaces in official statistics which have to be filled by data from other sources. In addition official statistics is slow in adjusting to new developments in environmental protection. Being slow in adaption to new problem settings has the advantage of having a better comparability and consistency over time, but also calls for the use of additional information in order to give advice for evolving new topics.

The DIW approach uses a variety of data from different sources. This is unavoidable but nevertheless creates some problems. Some of the data are produced primarily for purposes other than to estimate environmental protection employment. The heterogeneity of data implies that the reliability of data from different sources may differ.

Given different reliability of data (and methods), a core (narrow) definition and a wider definition of environmental protection employment may be employed, reflecting more or less reliable data sources. But there is no clear concept or consensus where to draw the line between a core and a wider

concept. A division according to data derived by the supply side approach versus estimates resulting from the demand side approach does not seem appropriate.

There are some items missing in our combined approach. Although they can be well identified (e.g. noise management and natural risk management) they cannot be easily complemented without quite extensive specialized studies.

For some problems of estimation there exist no unanimous solutions in international studies e.g. how to deal with public transport. In general, the issue of how to account for cleaner processes remains controversial.[22] Arguments can be raised in favor of including all employment associated with cleaner processes such as rail transport; this would avoid arbitrariness with respect to determining a share. On the other hand, this would lead to a very wide and possibly meaningless concept of environmental employment. Even the problem of how to identify cleaner processes and products is an unsolved methodological issue as cleaner processes and products constitute moving targets. Sometimes labeling may offer a solution, but criteria as well as confirmation procedures are sometimes unclear. Having a moving target also poses a problem for the consistency and comparability of results over time. To make estimates comparable over time revisions of earlier estimates can be performed. Usually it seems sufficient to apply revisions only for one period backwards (overlapping consistency).

[22] The EGSS handbook suggests to include the total employment figures generated by the production of adapted goods. See Eurostat 2009, page 36.

4 Dimensions of environmental employment

Depending on the specific policy questions for which information is needed, various dimensions of environmental employment may be of interest. Thus environmental employment may be disaggregated by:

- type of green technology,
  - elimination, reduction, prevention of environmental degradation - cleaner products, processes, goods,
  - connected or adapted goods - end-of-pipe or integrated technologies - environmental specific or connected services,
  - external - internal environmental services,
- industry,
- environmental domain,
- qualification (level of education and skills, specialized skills),
- quality of jobs,
- quality of data and estimation methods.

4.1 The combined approach

We present our estimates of environmental goods production employment according to the expenditure categories of official statistical sources. One distinction is between employment due to domestic demand effective in Germany from domestic sources on the one hand and employment due to foreign demand (exports) on the other hand. In domestic demand we distinguish between employment attributable to investment for environmental protection facilities and employment attributable to current expenditure on goods and services for the operation and maintenance of environmental protection facilities. For each of the demand components the employment impacts can be separated into direct and indirect employment.

For each of the two domestic components of expenditure and the corresponding employment figures we can distinguish between three different sectors of the economy from which the expenditure originates. We separate public expenditure, expenditure of manufacturing industries and expenditure of privatized public companies. In Germany privatized public companies play a dominant role in waste management and in waste water management and are responsible for more than 50% of non-RE environmental expenditure.

Concerning the expenditure for RE, we report the results by the dimensions domestic investment expenditure, exports and expenditure for maintenance and operation. In addition we distinguish RE-related employment by sources like wind, water, solar, biomass and geothermal.

In addition, we present employment generated by investment in insulation of buildings as a distinct category as the expenditure for this purpose is not included in destatis data.

Internationally, a presentation of environmental employment by industries as in our approach is more common. It seems adequate to also present indirect employment through environmental goods production in this way. In future work a presentation of environmental employment according to both environmental domains and industries seems desirable.

Environmental services employment is disaggregated by industries according to WZ 2008 as shown in table 2 above. As additional information we present employment through environmental activities in public work and other public programs but we do not include these persons in the overall estimate of environmental employment.

4.2 Remarks

In principle, overall environmental employment might be broken down by qualification levels. It seems difficult, however, to assess specific "green" knowledge which is a small element in most jobs anyway. In addition, if the intention is to steer future supply, future qualification needs are more relevant than ex-post structures.

A rather crude approach to assessing qualification levels would be to exploit information on qualification profiles across sectors of the economy. Instead, the IAB establishment survey may be evaluated for qualification levels; this analysis would of course underlie the usual restrictions of supply side approaches in general and of the specific survey in particular. Indirect employment cannot be assessed in this way. The IAB establishment survey could also be exploited for information on characteristics of the employing firm such as its innovativeness.

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Annex 1: Sources and Methods for Estimating Environmental Services Employment (ESE)

	Industry	Source, Method
1	**Agriculture and forestry**	
1.1	Ecological agriculture	Report on agriculture 2010; 20% of seasonal workers included
1.2	Agricultural services and machinery rentals	
	Agricultural services	Business association information: persons employed 2006, adjusted for short term employment; SEE 40%
	Machinery rentals	Business association information: persons employed 2010; SEE 12%
1.3	Horticulture, landscaping	Business association information: persons employed by main occupation 2010; own estimate of SEEs by main occupation
1.4	Forestry services	Public services: public sector employment report 2010: public enterprises: projection of employment figures of the public sector employment report 2005; SEE from previous studies 35%
2	**Mining and manufacturing**	
2.1	Internal environmental services	Current environmental expenditure statistics 2010, outlays for personnel, adjusted for energy and water supply; national accounts 2010, compensation per employee
2.2	**Product related services**	IAB establishment survey 2005; projection with employment survey figures for manufacturing 2005 and 2010
3	**Energy and water supply**	
3.1	Internal environmental services	Analogue to 2.1
3.2	Energy services for third parties	
	Contracting	Survey 2008: see Prognos 2010; BfEE information
	Renewable and CH Power	Figure for 1988 from Sprenger et al. 2002, p. 166; projection with the share of renewable energies in gross power consumption
	Energy consulting, Energy agencies	Figure for 1988 from Sprenger et al. 2002, p. 166; projection with media and industry association information
3.3	Water supply	Employment survey 2010
4	**Construction**	IAB establishment survey 2005; projection with employment survey figures
5	**Trade, repair of motor vehicles and personal and household goods**	
5.1	Wholesale and retail trade with clean products	
	Organic food	
	Shops specialized on organic food	Industry association information: trade turnover with organic food by specialized shops and food retailing; annual trade survey: turnover per employee in food retailing 2009 projected for 2010
	Food retailing	Analogue to shops specialized on organic food
	Other distribution channels	Analogue to shops specialized on organic food
	Catering, canteens	Analogue to shops specialized on organic food

	Industry	Source, Method
	Non-food environmentally friendly products	Identification of non-food trade sectors with significant share of environmentally friendly products base on the Blauer-Engel label; SEE 10%
5.2	Wholesale and retail trade with investment goods for environmental protection	Demand oriented approach
5.3	Wholesale trade with waste materials	Annual trade survey 2010
5.4	Car repair shops	IAB establishment survey 2005; projection with employment survey figures
6	**Hotels and restaurants**	Figure for 1999 from Sprenger 2003; projection with employment survey figures
7	**Transport and communications**	
7.1	Environmentally sound transport services	
7.1.1.	Deutsche Bahn AG (German Rail)	Number of employees: company report of German Rail; share of services of business section according to previous studies; projection of environmental services employment with rate of change of total services employment
7.1.2	Public passenger transport	Destatis specialized statistics (FS8, R3.1) for end of 2009; SEE 20%; projection for 2010 with distance travelled in line traffic
7.1.3	Inland water transport	Destatis specialized statistics (FS8, R4) for 2008; SEE 20%; projection for 2010 with information of business cycle statistics in service sectors
7.2	New transport services	
	Car-sharing	Industry association information on the number of suppliers; estimate of average number of employees based on numbers of cars and users
	Bicycle messengers	Study on behalf of the federal network agency (MRU 2009)
	Call-a-bike	Estimate based on company information on call-a-bike services
8	**Financial Intermediation**	
	Banking	Employment survey 2010; SEE 0.8% based on industry association information on sustainable financial products
	Insurance	Analogous to banking
	Connected activities	Analogous to banking
9	**Real estate, renting, and business activities**	
9.1	Cleaning of buildings	Figure for 2005 from an industry study (Grömling 2007); projection to 2008 with employment survey figures; to 2010 with crafts and trades survey; SEE 10% from previous studies
9.2	Chimney sweeping	Crafts and trades survey; SEE 65% from industry association information
9.3	Data management, data banks	IAB establishment survey 2005; projection with employment survey figures
9.4	Research and development	IAB establishment survey 2005; projection with employment survey figures
9.5	Real estate, renting	IAB establishment survey 2005; projection with employment survey figures
9.6	Architectural and engineering consulting, laboratories	IAB establishment survey 2005; projection with employment survey figures

	Industry	Source, Method
9.7	Others	IAB establishment survey 2005; projection with employment survey figures
10	**Public administration**	
10.1	Environmental and and nature and landscape protection administration	Projection of estimate for 2008 with public sector employment report figures for 2008 and 2010 for the federal and Länder level; for the communal level: assumption of no change
10.2	Parks and gardens	IAB establishment survey 2005; projection with employment survey figures (for a wider sector)
10.3	Other environmental protection activities of public administrations	Public sector employment report 2010; SEE for housing etc. 10%, for energy and water 50%
11	**Education**	
	Universities	Number of sustainability oriented study programs (BUB 2012); estimate of scientific and non-scientific personnel per study program based on survey of personnel in higher education 2010
	Non-school environmental education	Information in Giesel et al. 2002 and Rhode et al. 2011.
12	**Other community, social, and personal services**	
12.1	Waste and wastewater management	Employment survey 2010
12.2	Services for households	IAB establishment survey 2005; projection with employment survey figures
12.3	Environmental NGOs and lobby groups	IAB establishment survey 2005; projection with employment survey figures
13	**Others**	(For information only because of risk of double counting)
13.1	Environmental employment promotion	
13.1.1	Job creation scheme (ABM)	Federal employment agency (BA); SEE from IAB (2002)
13.1.2	Job support scheme (Arbeitsgelegenheiten)	Federal employment agency (BA); no calculation of SEE
13.2	Civilian services	Federal agency for civil service (BAZ); SEE of 2008 (by places); incl. occupations in agriculture and horticulture
13.3	Voluntary ecological year	Press release of BMFSFJ of 2007; number of starts of service until 2009

For sources quoted see Edler, Blazejczak 2014.

Source: Compilation of DIW Berlin.

Annex 2: OECD/Eurostat Environment Industry (EI) Classification

(I) The "POLLUTION MANAGEMENT" group

(I.A.) Environmental equipment and specific materials

(I.A.1) Air pollution control

This class includes any activity that produces equipment or specific materials for the treatment and/or removal of exhaust gases and particulate matter from both stationary and mobile sources. It includes air-handling equipment, dust collectors, precipitators, filters, catalytic converters, chemical treatment and recovery systems, specialised stacks, incinerators, scrubbers, odour control equipment, environmentally less-damaging specialised fuels.

(I.A.2) Wastewater management

This class includes any activity that produces equipment or specific materials for collection, treatment and transport of waste water and cooling water. It includes pipes, pumps, valves, aeration equipment; gravity sedimentation equipment, chemical treatment and recovery equipment; biological recovery systems, oil/water separation systems, screens/strainers, sewage treatment equipment, waste water reuse equipment, water purification equipment and other water handling systems.

(I.A.3) Solid waste management

This class includes any activity that produces equipment or specific materials for collection, treatment, disposal and recovery of hazardous and non-hazardous solid waste. It includes waste storage and treatment equipment (thermal, biological, chemical), waste collection equipment, waste disposal equipment, waste handling equipment, waste separation and sorting equipment, recovery equipment, recycling equipment. It also includes equipment for outdoor sweeping and watering of streets, paths, parking lots, etc. It includes equipment, technology or specific materials for the treatment of low-level nuclear waste. It excludes materials for the treatment of high level nuclear waste. Recycling activities exclude production or equipment or specific materials for the manufacture or production of new material or products from waste or scrap and subsequent use of these materials or products.

(I.A.4) Remediation and clean-up of soil, surface water and groundwater

This class includes any activity that produces equipment or specific materials to reduce the quantity of polluting materials in soil and water, including surface water, groundwater and sea water. It includes absorbents, chemicals and bioremediators for cleaning up, as well as cleaning-up systems either in situ or in appropriate installations.

(I.A.5) Noise and vibration abatement

This class includes any activity that produces equipment or specific materials to reduce or eliminate the emission and propagation of noise and vibration, both at source and dispersed. It includes mufflers/silencers, noise deadening material, noise control equipment and systems vibration control equipment and systems.

(I.A.6) Environmental monitoring, analysis and assessment

This class includes any activity that produces equipment or specific materials for the sampling, measurement, and subsequent recording, analysis and assessment of various characteristics of environmental media. It includes measuring and monitoring equipment, sampling systems, data acquisition equipment, other instruments or machines for measurement. Environmental information systems, analytical software, specific safety and personal protection for environmental purposes are included.

(I.A.7) Other

This class includes any activity that produces equipment or specific materials to measure, prevent, limit or correct environmental damage to air, water and soil, as well as problems related to waste, noise and eco-systems, not included in any other class. These activities should be separately specified and listed.

(I.B.) Environmental services

(I.B.1) Air pollution control

This class includes any activity that designs, manages systems or provides other services for treatment and/or removal of exhaust gases and particulate matter from both stationary and mobile sources.

(I.B.2) Wastewater management

This class includes any activity that designs, operates systems or provides other services for the collection, treatment and transport of wastewater and cooling water. It includes design, management or other services for sewage treatment systems, wastewater reuse systems, and water handling systems.

(I.B.3) Solid waste management

This class includes any activity that designs, operates systems or provides other services for the collection, treatment, management, transport, storage and recovery of hazardous and non-hazardous solid waste. It includes design, management or other services for waste handling (collection, transport, separation, sorting and disposal), operation of sites, recycling (including collection of waste and scrap), operation of recycling plants. It includes services for outdoor sweeping and watering of streets, paths, parking lots, etc. Services for treatment of low-level nuclear waste are included. It excludes services for the treatment of high-level nuclear waste. It excludes services for manufacture of new materials or products from waste and scrap and the subsequent use of these materials or products.

(I.B.4) Remediation and clean-up of soil, surface water and groundwater

This class includes any activity that designs, manages systems or provides other services to reduce the quantity of polluting materials in soil and water, including surface water, groundwater and sea water. It includes cleaning-up systems either in situ or in appropriate installations, emergency response and spills clean-up systems. Treatment of water and dredging residues are included.

(I.B.5) Noise and vibration abatement

This class includes any activity that designs, manages systems or provides other services to reduce or eliminate the emission of noise and vibration, both at source and dispersed. It includes design, management or other services for acoustic and soundproof screens and street covering.

(I.B.6) Environmental R&D

This class includes any systematic and creative activity which is concerned with the generation, advancement, dissemination and application of scientific and technological knowledge to reduce or eliminate emissions in all environmental media and to improve environmental quality. It includes non-technological research to improve knowledge on ecosystems and the impact of human activities on the environment.

(I.B.7) Environmental contracting and engineering

This class includes any activity that investigates feasibility, designs and manages environmental projects not included elsewhere. It includes multidisciplinary environmental contracting and engineering. Environmental management consulting, other environmental consulting services and environmental audit services are included.

(I.B.8) Analytical services, data collection, analysis and assessment

This class includes any activity that designs, manages systems or provides other services to sample, measure, and record various characteristics of environmental media. It includes monitoring sites, operating both singly and in networks, and covering one or more environmental medium. Health, safety, toxicology studies and analytical laboratory services are included. Weather stations are excluded.

(I.B.9) Education, training, information

This class includes any activity that provides environmental education or training or disseminates environmental information and which is executed by specialised institutions or other specialised suppliers. It includes education, training and information management for the general public, and specific environmental workplace education and training. The activities of the general educational system are excluded.

(I.B.10) Other

This class includes any activity that provides services to measure, prevent, limit or correct environmental damage to air, water and soil, as well as problems related to waste, noise and eco-systems, not included in any other class (e.g. general public administration, if it provides specific environmental services not elsewhere classified). These activities should be separately specified and listed.

(I.C.) Construction and installation

This class includes any activity for the construction and installation of facilities for: air pollution control; wastewater management; solid waste management; remediation and clean-up of soil, surface water and groundwater; noise and vibration abatement; environmental monitoring, analysis and assessment; other environmental facilities.

(II.) The "CLEANER TECHNOLOGY [processes and products]" group

This group includes any activity which continuously improves, reduces, or eliminates the environmental impact of technologies, processes and products.

(II.1) Cleaner/resource-efficient technologies and processes

Cleaner and resource-efficient technologies which decrease material inputs, reduce energy consumption, recover valuable by-products, reduce emissions, minimise waste disposal problems, or some combination of these.

(II.2) Cleaner/resource-efficient products

Cleaner products decrease material inputs, improve product quality, reduce energy consumption, minimise waste disposal problems, reduce emissions during use or some combination of these.

(III.) The "RESOURCES MANAGEMENT" group

Note: In the case of the "Resource management" group, activities aimed at the production of environmental goods and services and related construction are grouped together for convenience. However, it is suggested that, wherever possible, information on these items be separately collected and presented under separate headings for equipment, services and construction.

(III.A.1/III.B.1) Indoor air pollution control

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services for the treatment and renewal of indoor air to remove pollutants. It excludes air-conditioning.

(III.A.2/III.B.2) Water supply

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services for water supply and delivery systems, both publicly and privately owned. It includes activities aiming to collect, purify and distribute potable water to household, industrial, commercial or other users.

(III.A.3/III.B.3) Recycled materials

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services for manufacturing new materials or products separately identified as recycled, from waste and scrap.

(III.A.4/III.B.4) Renewable energy plant

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services for the generation, collection or transmission of energy from renewable sources including solar, wind, tidal, geothermal or biomass sources.

(III.A.5/III.B.5) Heat /energy saving and management

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services to reduce heat and energy use or minimise heat and energy loss (i.e. co-generation). It includes equipment, technology or specific materials to reduce climate change.

(III.A.6/III.B.6) Sustainable agriculture and fisheries

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services which reduce the negative environmental impact of agriculture and fishery activities. It includes biotechnology applied to agricultural and fishery activities.

(III.A.7/III.B.7) Sustainable forestry

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services for programmes and projects for reforestation and forest management on long-term sustainable basis.

(III.A.8/III.B.8) Natural risk management

This class includes any activity that produces equipment, technology or specific materials, designs, constructs or installs, manages or provides other services to prevent or reduce the impact of natural disasters (storm, floods, volcanic eruption, etc.).

(III.A.9/III.B.9) Eco-tourism

This class includes any activity that designs, constructs or installs, manages or provides other services for tourism that involves protection and management of natural and cultural heritage, or education and interpretation of the natural environment, and that does not damage or degrade the natural environment.

(III.A.10/III.B.10) Other

This class includes any activity that measures, prevents, limits or corrects environmental damage to air, water and soil, as well as problems related to waste, noise and eco-systems, which is not included in any other class (e.g. nature conservation, habitats and biodiversity). These activities should be separately specified and listed.

Numeration is our own; it corresponds to Table 1.

Source: OECD/Eurostat 1999.

Annex 3: Classification of Environmental Protection Activities and Expenditure (CEPA)

1 Protection of ambient air and climate

1.1 Prevention of pollution through in-process modifications

1.1.1 for the protection of ambient air

1.1.2 for the protection of climate and ozone layer

1.2 Treatment of exhaust gases and ventilation air

1.2.1 for the protection of ambient air

1.2.2 for the protection of climate and ozone layer

1.3 Measurement, control, laboratories and the like

1.4 Other activities

2 Wastewater management

2.1 Prevention of pollution through in-process modifications

2.2 Sewerage networks

2.3 Wastewater treatment

2.4 Treatment of cooling water

2.5 Measurement, control, laboratories and the like

2.6 Other activities

3 Waste management

3.1 Prevention of pollution through in-process modifications

3.2 Collection and transport

3.3 Treatment and disposal of hazardous waste

3.3.1 Thermal treatment

3.3.2 Landfill

3.3.3 Other treatment and disposal

3.4 Treatment and disposal of non-hazardous waste

3.4.1 Incineration

3.4.2 Landfill

3.4.3 Other treatment and disposal

3.5 Measurement, control, laboratories and the like

3.6 Other activities

4 Protection and remediation of soil, groundwater and surface water

4.1 Prevention of pollutant infiltration

4.2 Cleaning up of soil and water bodies

- 4.3 Protection of soil from erosion and other physical degradation
- 4.4 Prevention and remediation of soil salinity
- 4.5 Measurement, control, laboratories and the like
- 4.6 Other activities

5 Noise and vibration abatement (excluding workplace protection)

- 5.1 Preventive in-process modifications at the source
  - 5.1.1 Road and rail traffic
  - 5.1.2 Air traffic
  - 5.1.3 Industrial and other noise
- 5.2 Construction of anti noise/vibration facilities
  - 5.2.1 Road and rail traffic
  - 5.2.2 Air traffic
  - 5.2.3 Industrial and other noise
- 5.3 Measurement, control, laboratories and the like
- 5.4 Other activities

6 Protection of biodiversity and landscapes

- 6.1 Protection and rehabilitation of species and habitats
- 6.2 Protection of natural and semi-natural landscapes
- 6.3 Measurement, control, laboratories and the like
- 6.4 Other activities

7 Protection against radiation (excluding external safety)

- 7.1 Protection of ambient media
- 7.2 Transport and treatment of high level radioactive waste
- 7.3 Measurement, control, laboratories and the like
- 7.4 Other activities

8 Research and development

- 8.1 Protection of ambient air and climate
  - 8.1.1 Protection of ambient air
  - 8.1.2 Protection of atmosphere and climate
- 8.2 Protection of water
- 8.3 Waste
- 8.4 Protection of soil and groundwater
- 8.5 Abatement of noise and vibration
- 8.6 Protection of species and habitats
- 8.7 Protection against radiation

8.8 Other research on the environment

9 Other environmental protection activities

9.1 General environmental administration and management

9.1.1 General administration, regulation and the like

9.1.2 Environmental management

9.2 Education, training and information

9.3 Activities leading to indivisible expenditure

9.4 Activities not elsewhere classified

Source: Eurostat.
http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL_LINEAR&StrNom=CEPA_2000&StrLanguageCode=EN (29.11.2013)

Annex 4: Classification of resource management activities (CReMA)

10 – Management of water

11 – Management of forest resources, of which:

- 11A – Management of forest areas
- 11B – Minimization of the intake of forest resources

12 – Management of wild flora and fauna

13 – Management of energy resources

- 13A – Production of energy from renewable resources
- 13B – Heat/energy saving and management
- 13C – Minimization of the use of fossil energy as raw materials

14 – Management of minerals

15 – Research and development activities for resource management, of which:

16 – Other resource management activities

Source: Eurostat.
http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Environmental_goods_and_services_sector#Methodology_.2F_Metadata (29.11.2013)