Material Efficiency & Resource Conservation

Kora Kristof / Peter Hennicke

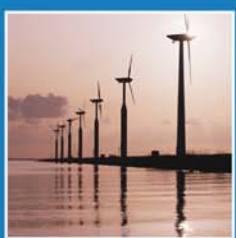
Wuppertal Institute for Climate, Environment and Energy

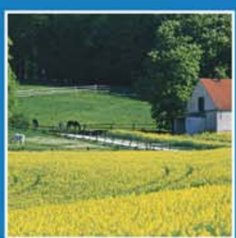
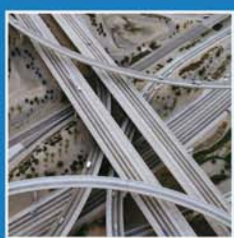
and the project partners of the MaRess - consortium

Final Report on the Material Efficiency and Resource Conservation (MaRess) Project

Core results of the „Material Efficiency and Resource Conservation“ (MaRess) Project

ResourceEfficiency Paper 0.4

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"Material Efficiency and Resource Conservation"
(MaRess) – Project on behalf of BMU I UBA

Project Duration: 07/2007 – 12/2010

Project Coordination:

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More information about the project
"Material Efficiency and Resource Conservation" (MaRess)
you will find on **www.ressourcen.wupperinst.org**

Wuppertal Institute for Climate, Environment and Energy

Wuppertal Institute
in Cooperation with

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Universität Kassel
Universität Lüneburg
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The authors are responsible for the content of the paper.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
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Final Report on the Material Efficiency and Resource Conservation (MaRess) Project

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Material Efficiency & Resource Conservation

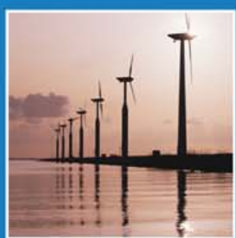
Kora Kristof / Peter Hennicke

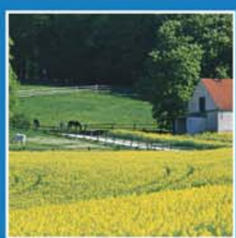
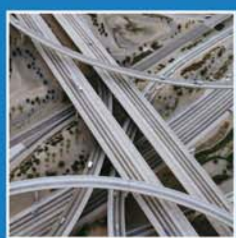
Wuppertal Institute for Climate, Environment and Energy

Brief Overview of the Material Efficiency and Resource Conservation (MaRess) Project and its Outcomes

Brief Overview of the core results of the „Material Efficiency and Resource Conservation“ (MaRess) Project

ResourceEfficiency Paper 0.5

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Brief Overview of the Material Efficiency and Resource Conservation (MaRess) Project and its Outcomes

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Brief Overview of the Material Efficiency and Resource Conservation (MaRess) Project and Its Outcomes

1 Overview of the Project and the Tasks Assigned to It

1.1 The Starting Point

The extraction and exploitation of resources, the associated emissions and the disposal of waste pollute the environment. The increasing scarcity of resources and the high and fluctuating prices of raw materials can lead to major economic and social dislocation in every country on Earth, combined with a growing risk of conflicts over raw materials. Competitive disadvantages arising from the inefficient use of resources endanger the development of businesses and jobs. A strategy for increasing resource efficiency can limit all these problems, which is why this subject is increasingly becoming a key issue in national and international politics. As yet, however, consistent strategies and approaches for a successful resource efficiency policy have been lacking.

Against this background the German Federal Environment Ministry and the Federal Environment Agency commissioned thirty-one project partners, under the direction of the Wuppertal Institute, to carry out the research project Material Efficiency and Resource Conservation (MaRess, project number 3707 93 300, duration 2007 to 2010).

1.2 Project Goal

The project goal was thus to make substantial progress in obtaining knowledge and formulating policy to increase resource efficiency and conserve resources. Addressing four key issues, it

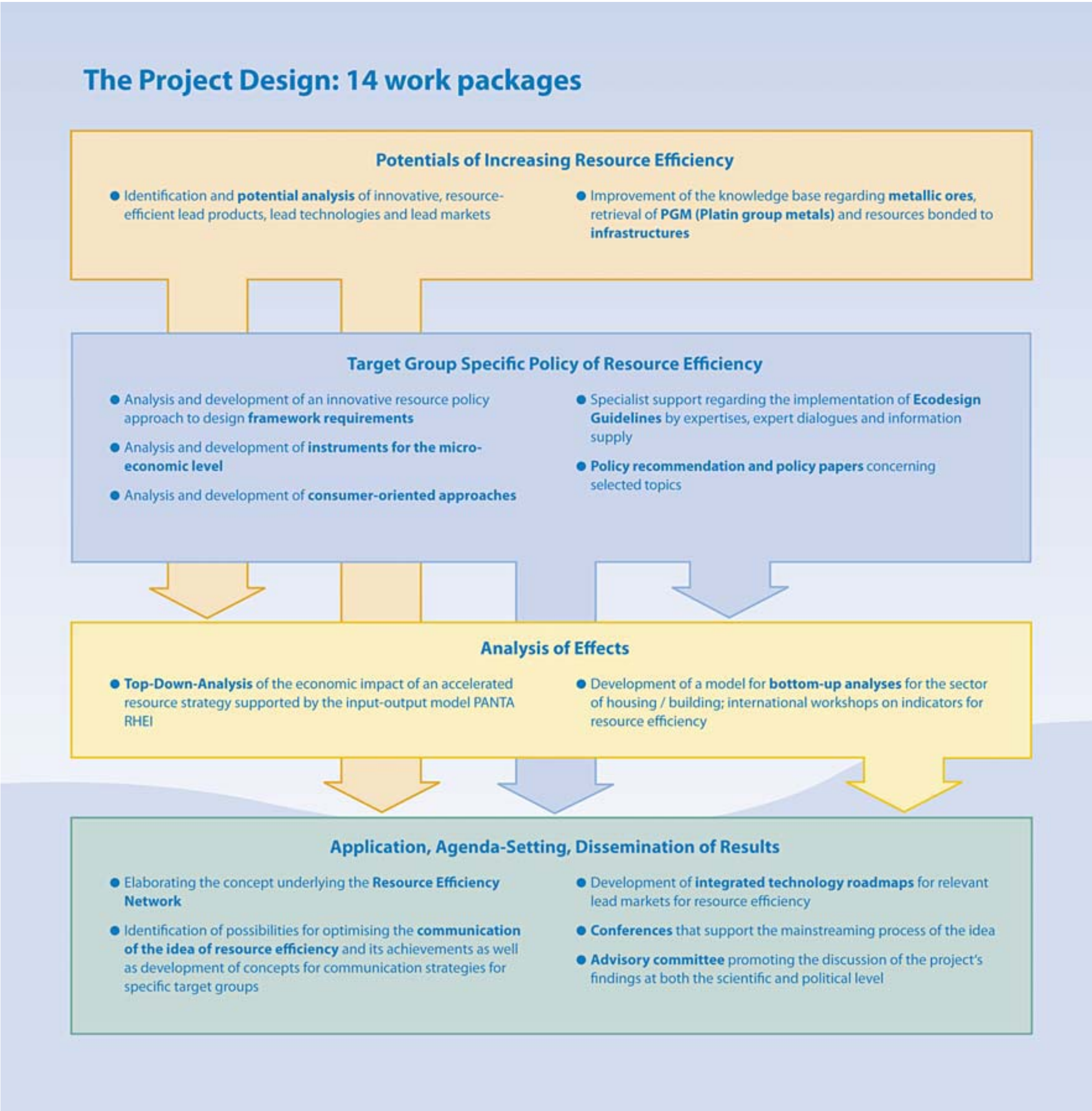
- identified potentials for increasing resource efficiency,
- developed target group-specific resource efficiency policies,
- gained new insights into the effects of policy instruments at the macro- and micro-economic level,
- provided scientific support for implementation activities, engaged in agenda setting and communicated findings to specific target groups.

The MaRess project's target groups are politicians (e.g. the EU, the German government, the German federal states or *Länder*, local authorities), business (e.g. enterprises, employers' associations, trades unions), civil society (e.g. NGOs, foundations, academics and other multipliers), and the media.

1.3 The Project Design

The Tasks assigned to the MaRess project focused on these four key issues. Fig. 1 gives an overview of the 14 Tasks.

Fig. 1: Design of the MaRess Project



1.4 The Project Team

Thirty-one partners from scientific institutions, business and civil society participated in the MaRess project. Tab. 1 gives an overview.

Tab. 1: MaRess Project Team

Non-university research institutions	
Wuppertal Institute (Project Management)	IFEU
Borderstep Institute	IOeW
CSCP (UNEP / Wuppertal Institute Collaborating Centre)	Institut für Verbraucherjournalismus
ECN (Energy research Center of the Netherlands)	IZT
FhG IAO	Oekopol
FhG UMSICHT	Trifolium
GWS (Institute of Economic Structures Research)	ZEW
Universities	
FU Berlin – FFU	TU Darmstadt – PTW
Hochschule Pforzheim – IAF	TU Dresden – ILK
RWTH Aachen – LFA	Universität Kassel – upp
SRH Hochschule Calw	Universität Lüneburg – CSM
TU Berlin – IWF	
Companies	
BASF AG – GUP/CE	
Daimler AG – Society and Technology research group	
Thyssen Krupp Steel AG	
Consulting services	
demea – VDI / VDE-IT	MediaCompany
EFA NRW	Stiftung Warentest
GoYa!	

1.5 The Project Management, the MaRess Steering Group and Professional Monitoring of MaRess

The project was managed by Dr. Kora Kristof and Prof. Dr. Peter Hennicke of the Wuppertal Institute. Coordination between the project and funding agencies took place through the MaRess Steering Group, of which, in addition to the project managers, the following were members at some time during the project:

- on behalf of the Federal Environment Ministry (BMU): Reinhard Kaiser, Udo Paschedag, Uwe Nestle, Dr. Torsten Bischoff, Dr. Ulf Jaeckel, Dr. Stefanie Pfahl and Peter Stutz,

- on behalf of the Federal Environment Agency (UBA): Judit Kanthak, Dr. Michael Angrick, Matthias Koller, Dr. Inge Paulini and Peter Stutz.

In addition, there was close coordination with the UBA and/or BMU staff charged with professional monitoring of the individual Tasks.

Tab. 2 gives an overview of the MaRess consortium partners responsible for the individual Tasks, of the professional monitors from the BMU and the UBA respectively, and of the division of responsibilities for individual Tasks between the project managers.

Tab. 2: Consortium Partners Responsible for Tasks, Division of Responsibilities between Project Managers and Professional Monitors from the BMU and UBA (as of: end of 2010)

Task	MaRess Consortium Partners Responsible for Task	Project Manager Responsible for Task	Professional Monitors (BMU/UBA)
Task 1 “Analyse the Potential for Innovative Lead Products, Lead Technologies and Lead Markets That Increase Resource Efficiency”	Rohn (Trifolium) / Pastewski (FhG IAO)	Kristof	Koch / Müller (UBA)
Task 2 “Metallic Ores, PGM and Infrastructures”	Bringezu (Wuppertal Institut)	Hennicke	Koch (AS2.1), Kohlmeyer (AS2.2), Penn-Bressel / Dickow-Hahn (AS2.3) (UBA)
Task 3 “Innovative Resource Policy Approaches to Designing Framework Requirements”	Bleischwitz (Wuppertal Institut) / Jacob (FU Berlin)	Hennicke	Golde (AS3.1/AS3.2), Kabbe (AS3.3), Kanthak (AS3.4) (UBA)
Task 4 “Innovative Resource Policy Approaches at the Microeconomic Level: Enterprise-Related Instruments and Starting Points”	Liedtke (Wuppertal Institut), für AS4.1: Schmidt (Hochschule Pforzheim) und für AS4.4: Knappe (IFEU)	Kristof	Golde / Peglau (AS4.1/AS4.2), Moser (AS4.3) / Dickow-Hahn (AS4.4) (UBA)
Task 5 “Quantitative and Qualitative Analysis of the Economic Effects of an Accelerated Resource Efficiency Strategy”	Meyer (GWS)	Hennicke	Golde (UBA)
Task 6 “Indicators, Bottom-up Models, and Scenarios”	Fischedick (Wuppertal Institut), für AS6.1: Bringezu (Wuppertal Institut)	Hennicke	Burkhardt (AS6.1), Lorenz (AS6.2) (UBA)
Task 7 “Policy Recommendations and Policy Papers”	Hennicke / Kristof (beide Wuppertal Institut)	Hennicke / Kristof	Kanthak (UBA) bzw. Kaiser / Nestle (BMU)
Task 8 “Conferences”	Sachs (Wuppertal Institut)	Kristof	Kanthak (UBA)
Task 9 “Sector-Oriented Dialogues to Promote the Development of Lead Resource-Efficiency Markets Based on Integrated Technology Roadmaps”	Behrendt (IZT) / Fichter (Borderstep)	Hennicke	Köhn (Roadmap TC) / Leuthold (Roadmap PV) (UBA)

Task	MaRess Consortium Partners Responsible for Task	Project Manager Responsi ble for Task	Professional Monitors (BMU/UBA)
Task 10 "Further Development, Maintenance and Support of the Resource Efficiency Network"	Kristof (Wuppertal Institut)	Kristof	Kanthak (UBA), Kaiser / Nestle (BMU)
Task 11 "Advisory Committee"	Hennicke / Kristof (beide Wuppertal Institut)	Hennicke / Kristof	Kanthak (UBA)
Task 12 "Consumer and Customer-Oriented Approaches to Increasing Resource Efficiency"	Scholl (IÖW) / Stellvertreterin: Baedeker (Wuppertal Institut)	Kristof	Löwe (UBA)
Task 13 "Communicating Resource Efficiency: Success Factors and Approaches"	Liedtke / Kristof (beide Wuppertal Institut)	Kristof	Löwe (UBA)
Task 14 "Ecodesign Directive"	Irrek (Wuppertal Institut), für „Informationsangebot Ökodesign": Jepsen (Ökopol)	Hennicke	Oehme (UBA)

1.6 The Project Advisory Committee

The MaRess project was accompanied by an Advisory Committee whose task was to promote scientific, social and political discussion of the project's findings, including those pertaining to the different fields of actors.

The Advisory Committee comprised people with proven expertise in both the scientific and political aspects of the resource efficiency discussion. Its composition reflects the areas most central to putting material efficiency and resource conservation into practice. This enabled important and broad channels of communication to be utilized for the project and important multipliers to be reached directly and indirectly. The members of the committee represented:

- politics – representing the Federal Environment Ministry, the Federal Environment Agency and any other departments active in the field of resource efficiency,
- science,
- the private sector via a consulting company,
- social actors via a relevant foundation.

Discussion with the Advisory Committee was conducted at the level of the MaRess control group (see chapter 1.5).

Tab. 3 gives an overview of the members of the MaRess Advisory Committee.

Tab. 3: Members of the MaRess Advisory Committee

Dr. Renate Loskill	Federal Ministry of Education and Research (BMBF)	until 31.05.2010
Dr. Lothar Mennicken	Federal Ministry of Education and Research (BMBF)	since 01.06.2010
MinR Thomas Zuleger	Federal Ministry of Economics and Technology (BMWi)	
Dr. Matthias Buchert	Öko-Institut e.V.	
Prof. Dr. Rolf Kümmel	Fraunhofer UMSICHT	
Ralf Baron	Arthur D. Little, Germany	
Klaus Dosch	Aachener Stiftung Kathy Beys / Aachen Foundation	

1.7 Further Information and Downloads

For information and downloads: please visit

… on the MaRess project and its findings: http://ressourcen.wupperinst.org

… on the Resource Efficiency Network: www.netzwerk-ressourceneffizienz.de

1.8 Contacts

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2 The Key Outcomes of the Material Efficiency and Resource Conservation (MaRess)Project

2.1 The Problems to Be Solved

Unsustainable forms of growth and development in the (rich) North have already put global society on a collision course with the elementary boundaries of nature, mainly to the detriment of the (poor) South. If in future nine billion people were to adopt the rich world's patterns of production and consumption, these natural boundaries would be overstepped by far, with disastrous consequences. The way the rich minority of the world's population live and run their economies cannot be generalised, and the problems are becoming increasingly acute. As the global consumption of resources goes on increasing almost unabated, solutions are more and more urgently required. We need to

- prevent or limit resource scarcities that in the case of “critical” resources lead to economic dislocations and that can trigger, or result from, conflicts over resources,
- reduce dependence on imports and the associated economic and political susceptibility to “blackmail” (e.g. restricting the export of critical resources),
- curb the negative macroeconomic and social effects of global price rises and fluctuations in the price of raw materials,
- contain environmental problems that arise from excessive consumption of resources and put excessive strain on sinks,
- prevent the social problems associated with resource extraction and exploitation (e.g. children working in mines, or working conditions harmful to health),
- ensure fairer distribution (e.g. between North and South and between generations).

An increasingly frequent topic of discussion is the extent to which prosperity can be ensured with less growth, with structurally modified growth, or without any growth (Jackson 2009). Some limits to growth have already been overstepped, especially as regards the problem of sinks, but also in the case of certain raw materials (Rockström et al. 2009, Richardson et al. 2009). Natural capital is scarce in both the economic and the secular respect and will doubtlessly become even scarcer as the global economy grows and the world population’s demands increase.

2.2 The Opportunities: Today’s Scarcities Are Tomorrow’s Markets

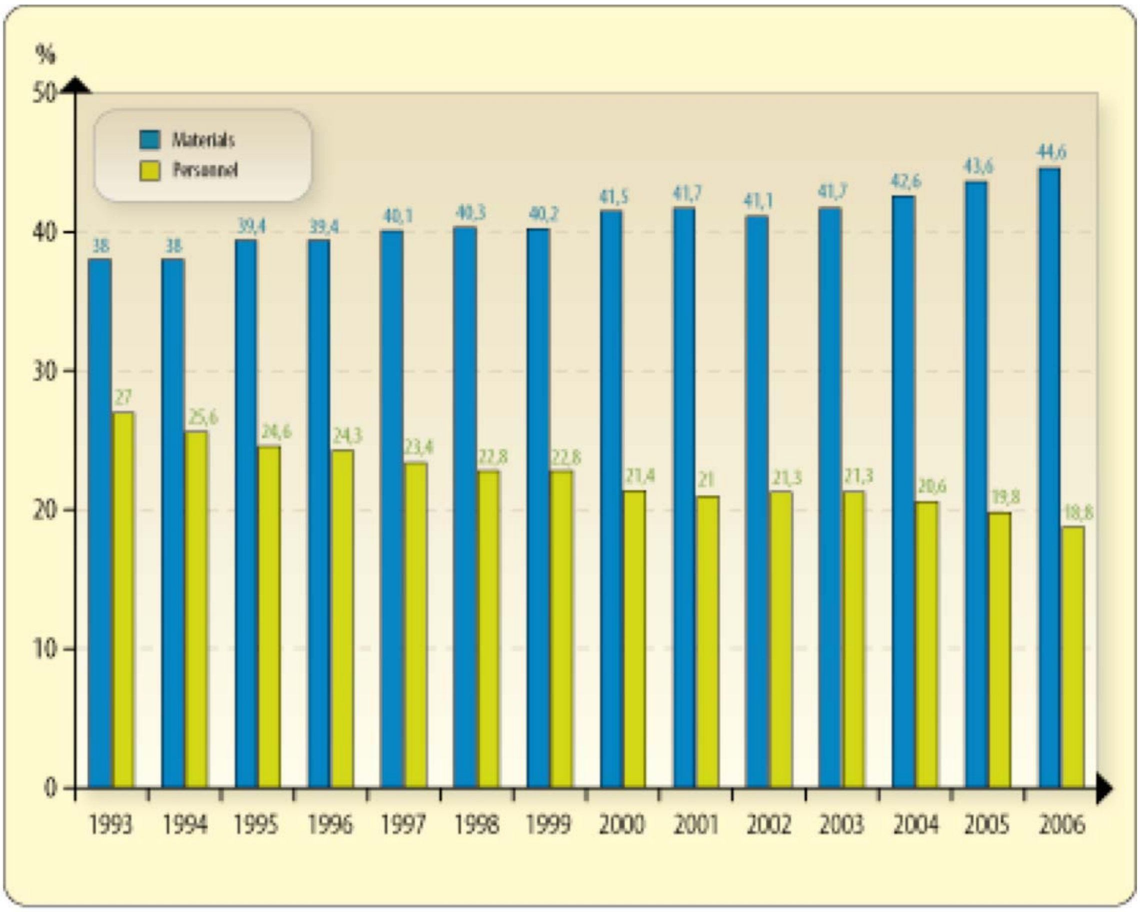
Germany, a country with few natural resources, is to a large extent dependent on imports of resources, apart from a few minerals. At the same time, Germany is an internationally leading exporter of resource efficiency solutions (products and services), so that GreenTech manufacturers in particular are playing an increasingly important role. Moreover, strategic reduction of resource costs in production and products is a growing factor in international competition.

Reducing Production Costs

Many business enterprises still have a blind spot when it comes to the cost of materials. If they need to make economies, their first thought is usually to reduce the cost of personnel. In recent years, many companies have focused increasingly on energy costs, but only a few pioneers are currently spreading cost reductions across all resources. A glance (see Fig. 2) at average cost structures in the manufacturing industry (Federal Statistical Office 2008) shows that businesses have, wrongly, given too little consideration to the issue of resource efficiency. In 2006 personnel costs accounted for 19%, energy costs for roughly 2% and pure material costs for around 43

% of costs. In absolute terms, the total cost of materials in the manufacturing industry in 2007 amounted to EUR 826 billion (Federal Statistical Office 2009). Considering that the potential for economically efficient reduction of energy and material costs is 10 to 20% of resource costs (ADL/Wuppertal Institut/ISI 2005, Kristof/Lemken/Roser/Ott 2008, Thomas et al. 2006), the great as yet dormant cost reduction potential in this area is clear. The success of offers to advise small and medium-sized enterprises (SMEs) on identifying resource efficiency potentials and to support concrete implementation is an impressive indication of the major economic benefits for businesses. According to potential analyses carried out and evaluated by demea, the German Material Efficiency Agency, the average annual cost-saving potential with a short amortisation period is in the order of EUR 200,000. That equates to an average of around 2.4 % of sales revenues and around EUR 3,000 per year per employee (demea 2010). Businesses are making far too little use of this potential.

Fig. 2: Development of the Proportion of Wages and Materials Costs (incl. Energy) in the Manufacturing Industry in Germany in %



Source: Statistisches Bundesamt 2008

GreenTech Markets as Interesting Future Domestic and Export Markets

Resource scarcity will trigger, even compared with earlier innovation cycles, a completely new quality and quantity of basic innovations based on nature-conserving advanced technology (GreenTech). Owing to the worldwide scarcity of resources, technical and social innovations to decouple quality of life from consumption of natural resources will not only be a future megatrend, but also the driver for rapidly growing lead markets for increasing resource efficiency. The Federal Environment Ministry (BMU 2009) has estimated the global market volume for six GreenTech lead markets (energy efficiency, material efficiency, environmentally friendly energies, sustainable water management, sustainable mobility, recycling management) at EUR 1.7 trillion in 2007 and EUR 3.1 trillion in 2020. The more resource-efficient production becomes and the more cutting-edge technology is developed to this end for both national and international markets, the greater the security of raw materials supply to and competitiveness of a business location, and thus the positive effect on employment. Owing to its dual impact as a motor of innovation and as a contribution to resource security, increasing resource efficiency, along with other options, is an integral component of a preventive raw materials policy (German government 2008).

An Integrated Resource and Climate Protection Policy Will Pay Off

For a long time the prevailing view among US economists in particular was that, based on a cost-benefit analysis, ambitious climate protection is expensive and that it is better to wait and see (e.g. Nordhaus/Boyer 2000). Recently, however, a rapidly growing number of national and international studies on climate protection have unanimously come to the opposite conclusion. They found that achieving far-reaching goals for cutting greenhouse gas emissions and accelerating structural change by implementing ambitious climate protection measures was not only technically feasible, but would also bring positive net macro-economic effects (see Stern 2007, McKinsey 2009, WWF/Prognos/Öko-Institut/Ziesing 2009, ADAM 2009, RECIPE 2009). There is an extensive technological overlap between a climate protection strategy and an accelerated resource protection strategy. So what are the consequences of a combined climate protection and resource conservation policy? The answer is that it is a win-win-strategy that strengthens the economic impact of a committed climate protection policy. Initial results of a MaRess simulation combining resource and climate protection policies (Distelkamp/Meyer/Meyer 2010) show that even a limited deployment of resource policy instruments leads to positive effects on business and the environment. Simulation calculations on the Panta Rhei model (Meyer, GWS/Osnabrück University) for the target year 2030 show the following effects, always compared with a reference path of active climate protection that secures a 54% reduction in greenhouse gas emissions by 2030:

- a clear absolute reduction of around -20% in materials consumption,
- a rise of around +14.1% in GDP,

- a 1.9% increase in employment (taking into account demographic factors and productivity-oriented developments in pay),
- a reduction of 33 billion euro in the German government's net borrowing requirement in the federal budget for 2030 (Distelkamp/Meyer/Meyer 2010).

Overall, the simulation calculation showed that "a systematic policy of dematerialisation will strengthen Germany's international competitiveness" (Distelkamp/Meyer/Meyer 2010). This would demonstrate for the first time for a high-tech country that "combining a committed climate protection policy with a policy to increase material efficiency can achieve an absolute decoupling of economic growth from resource consumption" (Distelkamp/Meyer/Meyer 2010). That is a central core finding of the MaRess project.

2.3 The Policy Options: What Can and Should Politicians Do?

To create a successful resource policy, policymakers can use the six core strategies in the MaRess project and the instruments proposed for their effective implementation for orientation. The following core strategies and policy instruments are proposed:

Three instruments are proposed for the **core strategy "Mobilising Institutions – the Key to Successful Diffusion"**. The first and central component is a nationwide resource efficiency stimulus and advisory programme. This is coupled with the second component, which entails setting up and expanding the Resource Efficiency Agency as the hub for all diffusion activities in and for companies and for programme bundling, evaluation and further development. Successful implementation requires "caretakers" and intermediary coordination as an operationally extended and politically independent lever of a cross-departmental and modern resource policy. Third, on-site support for implementation must be increased because the federal resource efficiency agency must have a lean structure and will primarily fulfil an initiation and support function based on the resource efficiency stimulus and advisory programme. The key actors for increasing resource efficiency are the relevant advisors, regional intermediaries and company networks in regions and industries. The expansion and qualification of the existing pool of advisors and the support for regional structures and networks can thus offer the necessary technical and implementation expertise for the companies in a region. The core strategy can build on the existing advisory institutions at federal, state and regional level as well as on the established funding programmes and the Resource Efficiency Network.

The **core strategy "Giving Innovation a Direction – Sustainable Future Markets for Resource Efficiency Solutions"** can be pursued first by systematically setting new resource-efficiency-related focal points in existing funding programmes / funding priorities with the aim of creating a closed-loop innovation and market launch programme for resource efficiency that is more in line with ambitious resource efficiency targets and existing potential. Second, easier access to venture capital should be encouraged because venture capital is a key prerequisite for successful diffusion on the market – closely linked to the innovation and market launch programme. The entire financing chain is thus integrated and the opportunities for real innovation increase. In addition to procuring venture capital, it is also important for companies to be able to professionally implement innovation processes both internally and in cooperation with other companies and research institutions. To achieve this goal, the third component is to encourage innovation agents and the fourth component, resource efficiency-oriented innovation laboratories.

The **core strategy "Resource-Efficient Products and Services"** has four instruments to create resource-saving incentive structures that support the transformation of the market: First, establishing dynamic standards and labelling requirements for resources as part of the amendment to the EU Ecodesign Directive; second, and directly related, supporting resource efficiency-oriented product design; third, introducing a primary construction material tax based on the British model; and fourth, a hybrid governance model that combines self-regulation and knowledge generation in value chains with regulatory approaches that aim to increase the secondary resource percentage of rare metals used in new products. The selected instruments will make it possible to promote particularly resource-efficient products and make them more visible: It will also help increase the resource efficiency of average products on the market and to gradually eliminate the "dirty end".

In the **core strategy "Incentives for Resource Efficiency Solutions via the Financial Sector"**, a Enquete Commission "Resource Efficiency and Sustainability in the Financial Sector" will explore the issue of resource efficiency in the financial sector which scarcely plays a role today. In addition, resource-related Key Performance Indicators (R-KPI) will be developed and the respective data basis created to make the issue of resources more transparent for the decision-making processes in the financial sector (e.g. for risk management and lending rules). The R-KPIs should also be used for financial oversight and corporate reporting.

By virtue of its considerable market volume the government can systematically send signals for market development if it increases demand for resource-efficient products and services and reduces development and marketing risks. The **core strategy "Government as a Consumer and Provider of Infrastructure"** is therefore made up of three elements. First, purchases should only be made on the basis of lifecycle costs as a mandatory procurement criterion. Second, bundling of government demand for innovative and particularly resource-efficient products creates an incentive for companies to come up with new and particularly resource-efficient solutions because the risk is minimised by a minimum guaranteed purchase quantity. The publicly available or controlled infrastructures are often resource-intensive; which is why a third component is necessary: optimising their construction and maintenance with a view to increasing resource efficiency. The question of whether switching infrastructure systems makes sense from the perspective of resource efficiency and costs should also be analysed.

The **core strategy "Changing Attitudes"** first aims to inform (future) decision-makers from the private sector, professional associations, politics and academia about resource efficiency through target group-oriented agenda setting and to motivate them to take action and put it into practice. Second, offering opportunities for additional qualification can create a basis for increasing resource efficiency more successfully and easily. The Resource Efficiency Network formed by the Federal Ministry of the Environment in 2007 is slated to play a key role. In addition, a resource efficiency campaign with the target group “(future) decision-makers” is to be launched for which a market-ready campaign concept was developed under the auspices of the MaRess project (Albrecht / Baum 2009). The issue could then be further addressed in a concerted campaign that brings together leading representatives from politics, business, academia, society and the media with the goal of making it an issue of broad public discussion. The priorities in terms of qualification should initially be on further qualifying advisors, on establishing a “virtual resource university” and on developing course materials for schools. These instruments were selected in view of the awareness that the success of the other core strategies will be limited unless they are accompanied by a change in mentality and visible achievements.

Tab. 4 summarises the core strategies, the proposed instruments allocated to them and the budget impact. It also provides information about priorities and the proposed timeline and sequence. The target groups and resources are also outlined. According to expert projections from the MaRess Consortium and a short expert report for the Federal Ministry of the Environment (Hennicke et al. 2008), the financial volume affecting the budget for these programmes is estimated at roughly EUR 1.3 billion per year. The total volume of approximately EUR 1.3 billion per year could be covered by the proposed primary construction material tax or by self-financing instruments (e.g. reduced costs of public procurement). The macro-economic multiplier effect is considerable and produces additional state revenues. If the primary construction material tax is not implemented, the funding should be made available by re-allocating existing resources. After five years, the implemented instruments should be evaluated. The proposed policy instruments can then be further developed and secured, possibly by passing a framework law on increasing resource efficiency and, if necessary, scaled up.

Tab. 4: Core Strategies, Prioritised Policy Instruments and Estimated Budget Impact

Core strategy	Instruments	Prio-rity	Time-line	Target groups	Target resources	Budget impact
"Mobilising Institutions – the Key to Successful Diffusion"	Resource efficiency agency (including evaluation to optimise funding structures)	1.	Short-term	Company	All	EUR 450 million
	Resource efficiency stimulus and advisory programme	1.	Short-term	Company		
	Expansion of the pool of advisors and regional structures	1.	Short-term	Advisors and intermediaries		

Core strategy	Instruments	Prio-rity	Time-line	Target groups	Target resources	Budget impact
"Giving Innovation a Direction – "Sustainable Future Markets for Resource Efficiency Solutions"	Resource efficiency innovation and market launch programme	1.	Short-term	Producers and users of resource-efficient technologies and suppliers of resource-efficient products / product-service systems	All (focus on TOP 20 from Task 1)	EUR 300 million
	Innovation agents	1.	Short-term			
	Innovation laboratory specialising in resource efficiency	2.	Medium-term	Co-operation between companies and research institutions		
	Venture capital for resource efficiency solutions	2.	Medium-term	Innovative suppliers of resource efficiency-oriented technologies, products and services		Refinancing (EUR 100 million)
"Resource-Efficient Products and Services"	Dynamic standards and labelling requirements (amendment to the EU Ecodesign Directive)	1.	Short-term	Producers of products and services at the end of the service life (e.g. reuse, recycling or disposal)	Abiotic / biotic materials, water	EUR 50 million
	Promoting resource efficiency-orientated product design	1.	Short-term		All	
	Hybrid governance to increase the use of secondary materials of rare metals in new products	2.	Medium-term		Metals	
	Primary construction material tax	1.	Short-term		Materials	Revenues of EUR 1,100 million
"Incentives for Resource Efficiency Solutions through the Financial Sector"	Enquete Commission "Resource Efficiency and Sustainability in the Financial Sector"	1.	Short-term	Policymakers, financial sector and academia	All	EUR 10 million (research programme in particular)
	Resource-related Key Performance Indicators (R-KPI)	1.	Short- and medium-term	Financial sector and academia		
"Government as a Consumer and Provider of Infrastructure"	Procurement based on lifecycle costs as a mandatory procurement criterion	1.	Short-term	Those responsible for public-sector procurement	All	Cost-neutral (EUR 100 million for the initial phase refinanced by lowered costs)
	Demand bundling to minimise risks for innovation processes	2.	Medium-term	Those responsible for public-sector procurement	All (focus on TOP 20 from Task 1)	
	Resource efficiency-optimised infrastructure systems	2.	Medium-term	Public sector as provider of infrastructure		

Core strategy	Instruments	Prio-rity	Time-line	Target groups	Target resources	Budget impact
"Changing Attitudes"	Resource Efficiency Network	1.	Continue	Companies and intermediaries	All	EUR 300 million
	Resource efficiency campaign: Target group of (future) decision-makers	1.	Short-term	(Future) decision-makers		
	Concerted action resource efficiency	2.	Medium-term	Multipliers from politics, business, academia, society, media		
	Qualifying advisors	1.	Short-term	Qualification providers and advisors		
	Establishing a “virtual resource university”	1.	Short-term	Academia		
	Developing course materials for schools	2.	Medium-term	Teacher training		

Source: Kristof / Hennicke 2010

2.4 The Potentials: What Can Business Enterprises Do?

Enterprises can take very different paths towards implementing resource efficiency (Ritthoff/Liedtke/Kaiser 2007, Kristof 2007, Kristof/Türk/Welfens/Walliczek 2006).

Tab. 5: Overview of Options for Increasing Resource Efficiency

Options for Increasing Resource Efficiency		
Starting Point Product Life Cycle	**Starting Point Value Chain**	**Starting Point Change in Attitudes**
Resource efficiency-optimised product design: product design and product service systems	Resource efficiency-oriented design of value chains	Change in production patterns
Choice of raw materials and materials/new materials and renewable raw materials	Resource efficiency-optimised infrastructure solutions	Resource efficiency-oriented integrated management systems (incl. information systems)
Resource efficiency-optimised production systems/cross-sectional technologies		Research & development/research transfer/learning processes
Resource efficiency-optimised product utilisation phase/durable products		Change in patterns of consumption
Continuing use, re-use, conversion, in cascade systems/recycling		

Source: Based on Kristof 2007

If politicians want to support businesses in implementing resource efficiency, they need to know the most effective approaches for doing so. This means knowing where the biggest potential lies dormant. Unlike in the field of energy efficiency there was no substantiated knowledge about resource efficiency potentials. The MaRess project therefore aimed to take the first crucial step towards closing this gap. In a broad-based multi-stage professional process, the most interesting technologies, products and strategies were identified and defined in greater detail. The potential analyses were conducted in the context of a degree programme integrated into a network of experts followed by an expert-assisted analysis process. Overall, potential analyses were carried out for some “top twenty” subject areas where a high resource efficiency potential was to be expected. From these it was also possible to derive recommendations both for action on specific issues and cross-cutting action. (Rohn/Pastewski/Lettenmeier 2010).

Tab. 6: Conclusions Regarding the Key Potentials for Increasing Resource Efficiency

Potentials for Increasing Resource Efficiency – Conclusions
Technologies
• Cross-sectional technologies and enabling technologies to open the door to resource-efficient applications • Regenerative energies will also enable considerable resource savings • The growth market in information and communications technology (ICT) requires careful resource management
Product Level
• Food: Necessary to consider production and consumption • Transport: Greater efficiency potential lies in high-resource infrastructures than in drive systems
Business Strategies
• Align product development specifically to resource efficiency • Gear business models to resource efficiency: product-service systems require rethinking

Source: Rohn / Pastewski / Lettenmeier 2010

2.5 Options for Action: What Can Each Individual Do?

For consumers to be able to consume more efficiently and conserve resources, they must know the options for action and be motivated to gear their behaviour accordingly. In the energy field, there are numerous guides, brochures and websites that provide a host of energy-saving tips. As regards across-the-board resource efficiency, at the start of the MaRess project there was no comparable knowledge and action base at the consumer level. The goal therefore was to identify options for action to increase resource efficiency in everyday consumption. The key strategies are summarised in Tab. 8. In addition, the MaRess project compiled a large number of specific suggestions for individual action.

Tab. 7: Basic Strategies for Resource-Efficient Consumption

Phase	Consumption phase	Basic strategies for increasing resource efficiency
Consumer decisions	**Question needs**	• Reflect on personal needs • Seek, procure and evaluate information • Consumption discourse in social forums
Purchase	**Buyer awareness**	• Resource-saving products (i.e. products with a small ecological rucksack involving minimal use of material, energy, water and land at all stages of production) • Small and/or lightweight products • Multifunctional and/or modularly usable products (adaptable to technical advances or changed needs) • Durable products (timeless design, robust, repairable) • Re-used, passed on or recycled products • Minimise packaging
Use	**Consume economically**	• Save resources during the phase of use (i.e. reducing direct consumption of resources during use) • Avoid waste (e.g. avoid disposable plates etc.)
	Use without owning	• Renting (e.g. tool hire or photocopier leasing), sharing (e.g. car sharing) or pooling (e.g. laundrette) • Private lending, sharing and swapping (e.g. tools, car pools) • Virtualisation (e.g. electronic data instead of products such as music CDs and books)
	Use for longer	• Re-use products • Maintain and repair products yourself (e.g. service or clean) • Use maintenance and repair services
Dispose	**Return**	• Return/pass on recyclable products and those that are still usable

Source: Kristof / Süßbauer 2009

3 Common Theme Running Through the Final Report

We present below the central findings of the fourteen Tasks, in each case in the form of a summary. We also outline concisely the policy recommendations of the MaRess project for a German government resource policy geared to the future – that is, the core strategies of a successful resource policy and the instruments proposed to accelerate its implementation.

For ease of orientation, in this presentation the Tasks have been grouped in terms of the four main focuses of the MaRess project:

- Potentials for increasing resource efficiency
- Policy proposals for conserving resources and increasing resource efficiency
- Impact analysis of instruments for a successful resource policy
- Resource efficiency in practice: implementation, agenda setting and successful communication

Further information on the detailed results can be found in the final report on the individual Tasks and the milestone papers, and in further outputs from the Tasks that are available to download at http://ressourcen.wupperinst.org where further information on the project can also be found.

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Materialeffizienz & Ressourcenschonung

Potentials for Increasing Resource Conservation and Resource Efficiency

Policy Recommendations for Conserving Resources and Increasing Resource Efficiency

Analysis of the Impact of Instruments to Promote a Successful Resources Policy

Resource Efficiency in Practice: Implementation, Agenda Setting and Successful Communication

MaRess-Project-Website
http://ressourcen.wupperinst.org

The project "Material Effciency and Resource Protection" (MaRess) is framed by the environmental research plan (UFOPLAN) launched by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and by the Federal Environment Agency (FKZ: 3707 93 300).

Material Efficiency & Resource Conservation

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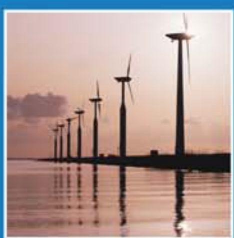
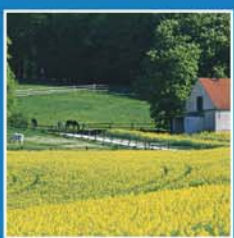
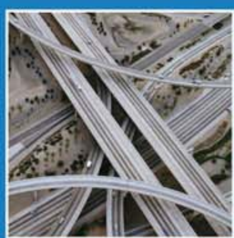
Resource efficiency of selected technologies, products and strategies

Executive Summary

Summary report of Task 1 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) project

ResourceEfficiency Paper 1.7

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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
For our Environment

Resource efficiency of selected technologies, products and strategies: Executive summary

Contents

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Abstract

In order to successfully provide companies with political support in the implementation of resource efficiency, we need to know where to start best, thus, where the highest potentials are to be detected.

Unlike with energy efficiency, only few substantiated data about resource efficiency potentials were available when the MaRess project started. The project took the first necessary steps to fill this gap.

The most interesting technologies, products and strategies for increasing resource efficiency were identified in a broad, multi-staged, expert-driven process. Thereafter, their concrete potential was determined. The potential analyses were carried out in a diploma thesis program in the framework of a network of experts and in an expert-based analytical process. Altogether, potential analyses were carried out with reference to 20 relevant topics (“Top20-topics”) that were expected to carry high resource efficiency potential. After their finalisation, the results of the single potential analyses were analysed in an intense discourse process in the framework of a cross-evaluation and issue-specific as well as overarching recommendations for action were concluded (see Tab. 1).

Tab. 1: Central fields of action with potential for increasing resource efficiency

Central fields of action with potential for increasing resource efficiency
Technologies
Cross-sectional technologies and enabling-technologies: ”Door openers” for resource efficient applications
Renewable energies facilitate substantial resource savings
The growing ICT market needs a careful resource management
Product level
Food – both production and consumption need to be considered
Traffic – Infrastructure bears higher resource efficiency potential than drive systems
Strategies
Integrating resource efficiency into product development
Resource efficiency-oriented business models: product-service systems require rethinking

Source: Own illustration

Foreword and acknowledgements

The contents of this paper are the results of an intensive cooperation process of a number of different persons:

We, as coordinators of this Task in the MaRess project, have been responsible for conceptual and coordinating tasks as well as for the comprehensive evaluations. In cooperation with other MaRess project partners of Task 1, we carried out a broad expert-driven diploma thesis program. The results of the potential analyses were included into the results of Task 1. With regard to several topics, other universities also supported the work by mentoring students’ theses.

We would like to thank all project partners, all other mentors and all students who worked on the variety of different topics for their great commitment. At this point, especially, the many substantive debates and conversations during the different analysis, assessment, evaluation, and diploma student workshops need to be mentioned.

We extend our heartfelt gratitude to the ifu (Institute for Environmental Informatics Hamburg) and to Prof. Mario Schmid (University of Applied Sciences Pforzheim) for the cooperation regarding the software Umberto for Material Flow Analysis. To carry out the potential analyses, the respective licenses were made available to the students free of charge and mentors introduced to the software in a workshop.

We would also like to thank all persons and institutions that participated and supported us in the survey in spring and summer of 2008. This enabled us to integrate many new ideas and aspects into the selection process of the “Top20-topics“ and into general considerations at an early stage of the analysis of the field of investigation.

Our special thanks also goes to the participants of the two expert workshops who intensively discussed and commented on the choice of topics and the contents. Their important suggestions and impulses were included into the overall project results and publications.

We would, furthermore, like to thank Dr. Claus Lang-Koetz (until October 2009) and Dr. Daniel Heubach (until July 2010) for the collaboration and co-chairing of Task 1.

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Holger Rohn und Nico Pastewski

1 Introduction

The need to increase resource efficiency has become a top issue in national and international politics in recent years. In this context, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Environment Agency (UBA) entrusted 31 project partners with the research project “Material efficiency and Resource conservation” (MaRess, see http://ressourcen.wupperinst.org). The project has been coordinated and managed by the Wuppertal Institute for Climate, Environment and Energy. The project aimed at advancing knowledge with respect to central questions of resource conservation, especially the increase of resource efficiency with a focus on material efficiency.

This paper summarises the results of Task 1 regarding the potential analyses of identified technologies, products and strategies. It largely builds upon Resource Efficiency Paper 1.2 (Rohn et al. 2009) and Resource Efficiency Paper 1.4 (Rohn et al. 20101). The results presented in the following were gained in a diploma thesis program in the framework of a network of experts and an expert-based analytical process. Altogether, potential analyses were carried out with reference to 20 relevant topics (“Top20-topics“), which are expected to carry high resource efficiency potential. After their finalisation, the results of the single potential analyses were analysed in an intense discourse process in the framework of a cross-evaluation and issue-specific as well as overarching recommendations for action were concluded. In addition, Resource Efficiency Paper 1.5 (Rohn et al. 2010b) contains the summarised results of the potential analyses (10 pages each).

In a comprehensive form, the acquired results are going to be documented in a final report and central results shall be published in a book. Besides, the results of Task 1 are going to be made use of in other tasks of the MaRess project and in the Network Resource Efficiency.

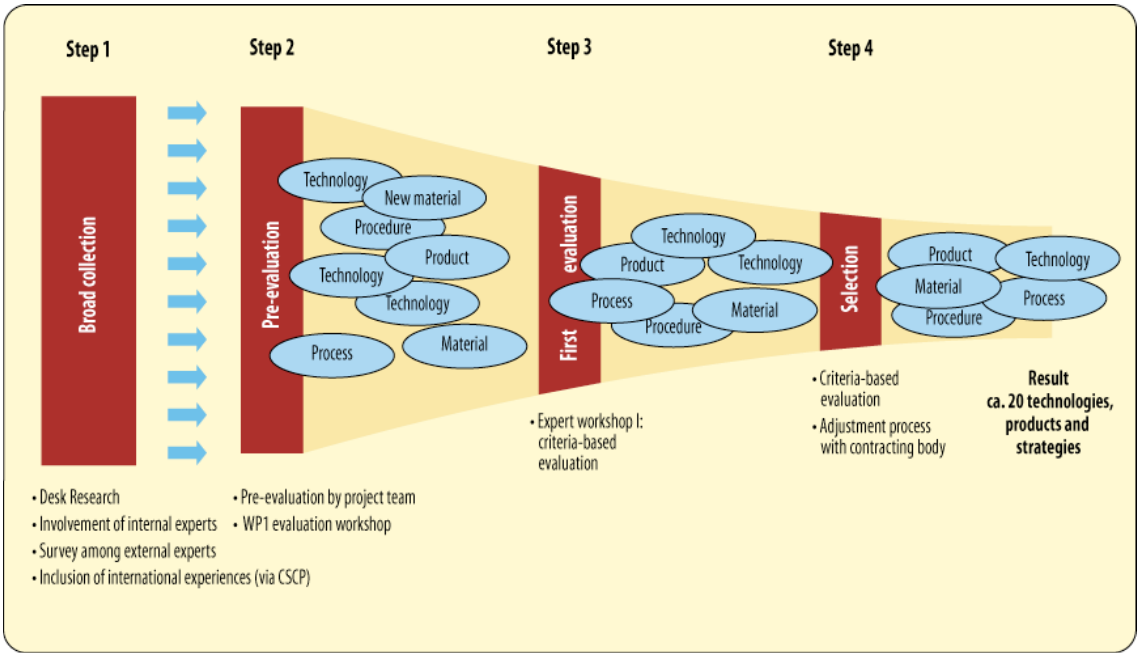
2 Methodology

2.1 Selection of topics

The process of topic selection aimed at the identification of technologies, products and strategies which are expected to carry high resource efficiency potential in Germany. In this respect, a complex expert-based methodology for evaluation and selection was developed including four steps (see Fig. 1). For a detailed explanation of the methodology and proceedings see Rohn et al. 2009.

In a first step, the topics that had been identified via desk research and in a survey were structured in a topic list including about 1000 proposals. The survey was carried out on the basis of desk research results and was aimed at enriching the topic list with the support of experts. The primary addressees of the survey were experts from research institutes, associations, related initiatives and networks (e.g. PIUS-Network, environmental alliances) and enterprises. This way, approximately 15.000 persons were contacted.

Fig. 1: Criteria-based selection of technologies, products and strategies with high resource efficiency potential



Source: Rohn / Lang-Koetz / Pastewski / Lettenmeier 2009

In a second step, the topic list was further elaborated and pre-evaluated. The aim was to evaluate the given 1000 proposals along three criteria: resource input, resource efficiency potential and economic relevance to end up with a focussed topic list of about 250 nominations (“Top250-topics”).

In a third step, an expert evaluation was carried out along seven criteria (presented in Tab. 2) to obtain a ranked topic list. The criteria on resource efficiency were complemented by criteria significant for the implementation. In the course of a workshop with internal and external experts (Expert workshop I) a revised topic list with about 50 proposals (“Top50-topics”) was derived.

On this basis and in a fourth step in cooperation with the Federal Environment Agency, the final selection of the “Top20-topics” took place. In a later stage, these topics were addressed in detailed potential analyses. Thus, the selection of the “Top20-topics” was a result of all previous working steps (see Fig. 1). For details with regard to the “Top20-topics” see Rohn et al. 2009.

Tab. 2: Criteria for the evaluation of technologies, products and strategies

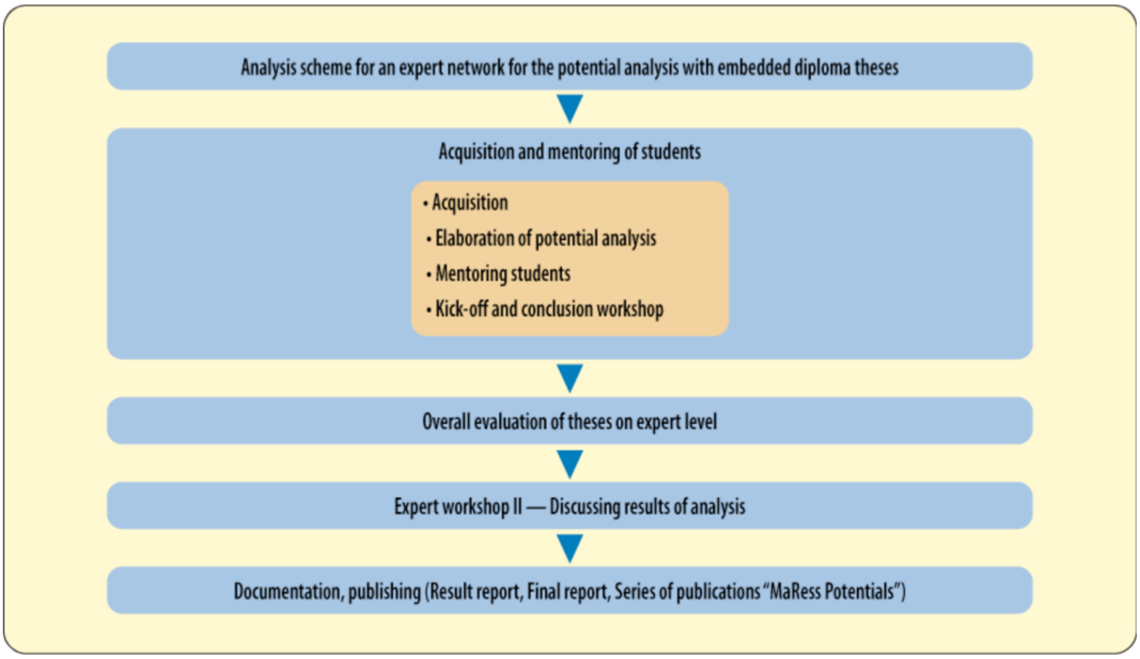
Criteria for the evaluation of technologies, products, strategies
Resource input in terms of mass relevance
Resource efficiency potential of the specific application
Other environmental impacts
Feasibility
Economic relevance
Communicability
Transferability

Source: Own illustration (Details s. Rohn et al. 2009)

2.2 Potential analyses

The potential analyses were carried out in a Diploma Thesis program in the framework of a network of experts along defined consistent guidelines (see Rohn et al. 2010a). The general procedure is illustrated in Fig. 2. Those of the “Top20-topics” were worked on for which qualified interested candidates were found in the given period of time.

Fig. 2: Overview of the potential analysis process



Source: Own illustration

At the beginning of the process, the topic field was analysed and relevant fields of application were identified. The potential resource consumption for the study area was assessed based on at least one case study, assessing and comparing the current status of resource use in the relevant life cycle phases with a possibly more resource efficient alternative.

Methodologically, the resource efficiency potentials were quantified according to the concept “Material Input per unit of Service (MIPS, see Schmidt-Bleek 1994 and Schmidt-Bleek et al. 1998). Therefore, regarding the examined potential analyses, results are largely – depending on data availability – available as life cycle wide resource use in up to five resource categories (abiotic and biotic material, earth movement, air and water, see Ritthoff et al. 2002 and Lettenmeier et al. 2009) as well as the respective concrete potential for increase in resource efficiency.

Where possible, the results were scaled up to the national level to calculate the resource efficiency potential for Germany in the end. Further environmental implications like green house gas emissions were captured in individual cases.

Besides the assessment along quantitative results, a qualitative evaluation was carried out to capture, among other things, possible rebound effects and constraints of a dissemination of the application. To guarantee a uniform and comprehensive assessment, the results were presented according to the outlined criteria (see Tab. 2). These qualitative evaluations are based on publications, statistics and expert opinions.

Beyond intense individual support, interim results were documented, presented, critically discussed and pre-evaluated along consistent guidelines in the framework of four students’ workshops, improvement measures were taken if necessary.

After the finalisation of the potential analyses carried out by the students, the advisors pre-evaluated the theses. Furthermore, an internal evaluation workshop was carried out to assess the pre-evaluated potential analyses of the Task 1 partners according to the seven criteria outlined in Tab. 2 and the guidelines for potential analysis in an overarching frame. The results of each individual thesis were discussed and specific and overarching recommendations for action were concluded. For a further validation of the results the “Expert workshop II” took place on July 1st 2010. Alongside Task 1 partners, further external experts were involved.

2.3 Lessons learned

The selection of essential topic areas with reference to the increase of resource efficiency in the form of technologies, products and strategies is an extremely complex enterprise. This showed in all working steps from the detailed development of the proceedings to the implementation of the individual working steps. One central reason is the broad scope of the investigation which was not restricted to specific products, branches, fields of need or the like beforehand. In addition, quantitative estimates of the deployed resources and resource efficiency potentials are usually not available or difficult to determine which is one of the reasons for the qualitative expert evaluation.

The developed proceedings and the methods to identify the chosen topic areas and “Top20-topics” have, on the whole, proven to be efficient and target-aimed and were validated via the targeted participation of experts in the respective working steps.

Extensive desk research facilitated the identification of central individual topics and topic fields. In the described broad, multi-staged, expert-driven process the most interesting technologies, products and strategies for the increase in resource efficiency were identified. Among these, 20 relevant topics (“Top20-topics”) were chosen which are expected to bear high resource efficiency potential. Due to the response rate of the additional survey and the naturally restricted number of participants of the expert workshops, the choice of relevant topics possibly reveals a certain over- or under-representation of individual topic fields. Integrating experts from a wide range of different professional backgrounds faced this challenge. There are further relevant topics among the „Top250-topics“ that deserve further analysis and evaluation in the future. The “Top20-topics”, thus, are the result of the selection process undertaken with the professional support of the Federal Environmental Agency under the temporal, financial and organisational conditions of Task 1.

Working on the potential analysis one challenge, among others, was to facilitate a uniform assessment of a huge variety of topics. In this context, the described process based on extensive exchange between the participants resulted, all in all, suitable. At the same time, the high number of participants increased the coordination needs. The recruiting process of qualified candidates for the potential analyses in the diploma thesis program was difficult as well in a few cases as the assigned topics were not all in line with the curricula of the participating universities. This is why for a few topics no candidates were found (e.g. micro reactor technology, textile). Furthermore and as expected beforehand, a few of the chosen topics did not end up in the final presentation of results due to a lack of quality or the dropout of the students (nanotechnology, algae, cross-sector technology). The development and use of individual unifying guidelines as well as the systematic scheme of analyses and specific templates for the elaboration of the potential analyses showed to be helpful.

By use of the MIPS-methodology, comprehensive results as life cycle-wide resource use were gained for the majority of topics. This way a quantitative database was built which in many cases allowed to frame possible target-aimed courses of action. One basic problem of quantitative analyses is the availability and validity of the database and the indicators. MIPS is an indicator that allows for life cycle wide analysis with reasonable effort. With reference to the data base and similar to other indicators and methods many analyses faced the problem of unavailable (or only available with unjustifiable effort) upstream-processes of individual materials and intermediate products. This problem needs and has to be resolved on a superior level (e.g. in international committees for ecobalance and in software development), e.g. by the improved integration of life cycle wide resource uses in the advancement and updating of databases. Beyond quantitative analysis and assessment, reflecting on the results in a broader framework and detecting further critical aspects was facilitated by the application of qualitative criteria (see Tab. 2). A correlation of different indicators was found in several cases. In the potential analysis of server-based computing, e.g. external costs correlated with MIPS results.

Alongside this evaluation process, the close monitoring by universities, the Task 1 management as well as by external experts ensured the quality of the acquired results. It showed that this proceeding was very helpful throughout the whole process. Building on the experiences gained, the methodology is to be developed further and reflected on in the light of new insights.

3 Results and recommendations for action

In the following, the central results of the conducted potential analyses are presented in an overview and summarised in seven fields of action. For a more detailed presentation of the results see Resource Efficiency Papers 1.4 and 1.5 (Rohn et al. 2010a und 2010b).

3.1 Overview of results

Seven fields of action were worked out in the course of the criteria-based cross-evaluation in which central results and recommendations for action for the individual potential analyses merge. Each field of action summarises several closely interrelated topics from the potential analyses. The selective assignment of the topics is not always possible and there are complex interdependencies between the individual fields of action. Tab. 3 gives and overview of the fields of action and the potential analyses.

Tab. 3: Overview of fields of action and potential analyses

Fields of action and assigned potential analyses
Cross-sectional technologies and enabling technologies: “Door openers“ for resource efficient applications • Assessment of resource efficiency in grey water filtration using membrane technologies • Resource efficient energy storage: comparison of direct and indirect storage for electric vehicles • Resource efficiency potential of energy storage – resource efficient heat storage • Resource efficiency potential of insulation material systems
Renewable energies facilitate substantial resource savings • Resource efficiency potential of wind and biomass power • Resource efficient large-scale energy production: potentials of Desertec • Resource efficient energy production by photovoltaics
The growing ICT market needs a careful resource management • Green IT: Resource efficiency potential of server based computing • Green IT: Resource efficiency increase with ICT – comparison of displays • Resource efficiency potential of recycling small electric and electronic appliances by recoverage from household waste using an RFID labelling of primary products
Food – both production and consumption need to be considered • Resource efficiency potential in food production – Example: Fish • Resource efficiency potential in food production – Example: Fruits

• Resource efficiency potential in food production – Example: Vegetables • Resource efficiency potential of intelligent agricultural technologies with the example of the use of nitrogen sensors for fertilization
Traffic – Infrastructure bears higher resource efficiency potential than drive systems • Assessment of resource efficiency potential in freight traffic • Resource efficiency potential of electric vehicles
Integrating resource efficiency into product development • Consideration of resource efficiency criteria in product development processes • Resource efficiency potential of the implementation of light-weight construction using new materials • Resource efficiency potential of high-strength steel
Resource efficiency-oriented business models: product-service systems require rethinking • Resource efficiency potentials of new forms of “using instead of possessing” in assembly facilities • Resource efficiency potential of production on demand

Source: Own illustration

3.2 Cross-sectional and enabling technologies: “Door openers” for resource efficient applications

Due to the manifold possibilities of application in different branches, cross-sectional technologies in part carry very high resource efficiency potential. Furthermore, in many systems resource efficiency potential can only be (fully) explored with the help of assistive technologies, which, therefore, can be called ‘enabling technologies’. With reference to renewable energies (see Chapter 3.3), e.g. suitable storage media often are the prerequisite to secure energy provision meeting the demands. Even if the individual use of the technology, in part, only generates low saving potential the huge variety of possible applications opens up manifold ways to resource conversation.

Results: The resource efficiency potential of using membrane technologies was analysed with reference to municipal sewage plants of a certain plant size. With respect to the approximately 1.000 existing plants of this type in Germany the potential was estimated to be remarkable, especially for new but also for refit plants. Furthermore, there are 9.000 plants of a different type for which additional resource efficiency potential is to be expected. Additionally, there is number of other fields of application, e.g. drinking water purification (e.g. desalinisation and softening), food production or grey water processing for which product integrated environmental protection is relevant. Membrane technology as well offers great possibilities for export as modern technologies for water treatment are in high demand in countries with rapid economic growth like China and India or with limited existing capacities regarding drinking water purification and supply (e.g. Africa).

To guarantee a better extensive use of central developments like renewable energies and to realise resource efficiency potential, enabling technologies increasing resource efficiency need to be easily available. However, as the comparison of electric vehicles with fuel cell cars shows this potential is only fully revealed by taking into consideration complete life cycles. The production process of the energy storage system for the fuel cell car is notably more resource efficient than that of the “classic“ electric vehicle. This, however, is more than offset during the use phase (due to the extremely energy consuming generation of hydrogen by means of electrolysis). In comparison to conventional drive systems (e.g. diesel car), the efficiency potential of the electric vehicle is only viable by changing the composition of the electricity mix (high percentage of renewable energy).

Minor differences between possible alternatives often have major effects. With reference to the analysed insulation materials made of EPS hard foam, e.g., a minor change of the composition of the insulation material (by adding graphite) resulted in resource savings of about one third. Considerable differences in resource consumption could also be detected with regard to different types of thermal energy storage.

Recommendations for action: The analysis of membrane technologies shows that the resource efficiency potential determined with regard to grey water filtration is transferable. This technology is principally suitable to be broadly applied in this as well as in other branches. Still, obstacles like the reluctance to innovate need to be overcome, as the suitable technology is already available for many uses.

Currently, recharging batteries is the most resource efficient form of temporary electricity storage. Lithium ion cells as marketable commodities are characterised by a higher energy density and few losses compared with other types of accumulators. Long charging times, overheating and continuous losses of capacity, however, are the disadvantages. Additionally, as of today, the geological potential of lithium is restricted to few producing countries with a focus on South America and subjected to competing uses (medicine, pharmaceutics etc.). Besides increasing the efficiency of accumulators, high-quality recycling of lithium ion accumulators needs to play a central role in the process of resource use. For this purpose, research and development in this regard need to be promoted and product responsibility of manufacturers and distributors with reference to recycling needs of lithium ion accumulators need to become legally binding. Currently, disproportionately large and heavy accumulators are necessary to drive vehicles on long-range distances simply by use of electricity. Besides the promotion of Research and Development of electric storage technologies that overcome these disadvantages, alternative concepts of direct electricity storage such as $NaNiCl_2$-(Zebra)-accumulators, Redux-Flow-Batteries and alternative network solutions such as Smart Grids need to be further explored and developed to attain marketability. Generally, the perspective of resource efficiency needs to receive more attention besides climate protection.

Hydrogen being used as indirect electricity storage medium in electric vehicles with fuel cell drive, as of today, can only be generated by means of electrolysis with enormous energy losses. Still, with regard to scope and field of application in the traffic sector (public transport, freight traffic) hydrogen is of considerable advantage as mobile energy source. Based on the results of this analysis, the further optimisation of fuel cell technology and hydrogen production is to be promoted, as well as research and development and the launch of these technologies in the efficient fields relevant to the use of hydrogen.

As all analysed heat accumulator alternatives are potentially resource saving, a further dissemination and promotion is useful. With reference to paraffin latent heat accumulators, it needs to be analysed whether paraffin can be synthetically produced in great quantities as it has merely been a by-product in crude oil processing so far. In addition to the regarded options, additional forms of latent heat accumulators and sorption storage with their diverse storage media and possible uses need to be taken into account and advanced. Generally, the transferability of the technology is to be examined more intensely as heat storage systems are not only relevant to the buildings sector but as well to the transport of heat and cold or to the use of waste heat in industrial processes.

Due to energy saving potentials in existing buildings by measures of insulation, there is going to be great need for remediation throughout the next decades. This is going hand in hand with considerable resource consumption but it is also possibly accompanied by saving potentials depending on the used insulation material and compound system. Corresponding additional analyses ought to be carried out to compare further variants of insulation material resp. systems (e.g. also based on renewable raw materials).

The overall resource conservation potential of cross-sectional technologies is difficult to assess on the base of the analysed case studies as the diversity of the fields of application needs to be specifically calculated.

As enabling technologies support resource efficient overall solutions in resource intensive demand areas, their potential ought to be broadly made use of. Many more fields of application ought to be analysed with reference to their breadth and their limits. As minor changes of enabling technologies can have great effects which was shown in the analysis of insulation material – further research endeavours are useful to, possibly, systematically reveal such potential.

3.3 Renewable energies facilitate substantial resource savings

In this section, the results of the potential analyses carried out in the field of “renewable energies“ are presented.

Results: In comparison to the electricity mix 2008 all explored renewable energies such as wind energy (offshore & onshore), biomass, photovoltaic and solar thermal energy (Desertec concept) offer possible increases in resource efficiency with reference to electricity generation. The specific use of resources of all analysed variants is comparably small, uses of abiotic materials and water make up only a fraction of those necessary for coal-fired power or for the electricity mix 2008. With regard to the consumption of biotic materials and air, biomass in the form of renewable raw materials is the only alternative that shows poorer results than the electricity mix 2008.

The specific use of resources is also determined by the build-up of an appropriate infrastructure. With regard to offshore-wind farms this concerns basically grid connection to the mainland as well as resource consumption for the manufacture of the plants (head mass, tower and foundation) in all analysed resource categories. Regarding other forms of renewable energies (Onshore-Wind farm and biomass), capacities are restricted by a lack of space or in part already exhausted or they compete with other uses such as agriculture or are in conflict with nature conservation. In this respect, the repowering of existing plants/farms is the central option.

As to the examined biogas plant, it shows that especially the nature of the applied substrate, the use of fertilizers as well as the transport distances of the substrate have a relevant influence on the overall resource consumption of the plant. The size of the plant matters as well as the possibilities of using the waste heat of electricity production (e.g. with the help of heat grids).

The Desertec concept is an extraordinary project for the development of a globally applicable solution for the large-scale use of solar thermal power plants. Based on the current results, the technology option of the solar tower offers the highest resource efficiency among the solar thermal plants in comparison to parabolic plants and Fresnel collectors.

By building up new wind farms and solar thermal power plants high resource efficiency potentials can be realised.

Photovoltaic offers a high potential because of its decentralised use (see also the results of Task 9 of the MaRess project, e.g. in Fichter et al. 2010). As the results of the analysis show, the use of thin layer technology offers a considerable resource conservation potential in comparison to multicrystalline silicon thick-film modules. The resource efficiency potential can be significantly increased by the choice of suitable locations and the orientation of the system. The optimal orientation of a photovoltaic system is defined by the available surface (roof area, facade, open land) and its south-facing position.

Recommendations for action: In conclusion, the results reveal that a renewable energy mix carries high resource efficiency potential. With respect to all examined variants, an accelerated expansion of renewable energies can principally be recommended for the shown options even though further integrated analyses regarding resource aspects are necessary. From the point of view of resource consumption per kWh, an increase of wind energy in the provision of electricity is highly recommended. Biogas plants can also contribute to a more efficient provision of electricity even though this is not the case for all kinds of biogas plants. Resource consumption, in this case, needs to be individually evaluated depending on the nature of the used substrates and fertilizers and the interrelated cultivation method, transport distance and plant type and size. The Desertec concept ought to be promoted as resource efficient provider of base load power taking into consideration critical factors such as competition, development policy, dependency on imports, land use or questions concerning its decentralised location. Furthermore, due to the manifold technical uncertainties with regard to environmental impacts and resource efficiency the technical options ought be continuously evaluated. This way, possible problems of the intensive expansion of particularly resource efficient variants of individual technologies can be addressed. Concerning photovoltaic systems resource efficiency of solar laminates ought to be primarily achieved by a lifetime extension and by greater efficiency especially with regard to thin layer technology.

The expansion of renewable energies especially in the field of electricity provision demanded by politics and society involves a general change of our current supply structures which is going to increasingly develop from dominant centralisation to small-scale and local units in combination with large scale industrial renewable electricity generation (e.g. Offshore wind farms). Due to the unsteady availability of renewable energies from sun and wind and due to the focus of political funding on a local or personal use of the energy produced, direct and indirect power and heat storage accumulators are going to become indispensable and have a considerable influence on the resource efficiency of the overall system (see Chapter 3.2). In order to materialise efficiency conservation through the inceased use of renewable energies, further research and development endeavours need to be made. Among others these are:

- Efficiency increases of plants and modules,
- Improvement of transmission networks, e.g. less resource intensive wires and improved transmission rates of wind energy, smart-grids and smart-metering as intelligent interface between power grid and consumers,
- Efficient storage systems for electricity and heat,
- Recycling-possibilities, e.g., for thick-film modules in photovoltaics or for water treatment to clean the mirrors for Desertec-electricity,
- The orientation of the systems to guarantee the optimal use of this infrastructure.

3.4 The growing ICT market needs a careful resource management

In this section the results of the potential analyses carried out in the field of “information and communication technologies“ (ICT) are presented.

Results: Due to rapid growth and the short life span of products on the information and communication market as well as on the electric and electronics market overall, the annual consumption of resources in this sector rises continuously. In comparison to PCs, in server-based computing reduced terminals are used (so called “thin clients“) that being connected to a central server show the same performance. A comparison of the two systems reveals that the server-based variant is considerably more efficient in all resource categories. This is in line with the results from Task 9 of the MaRess project (see Fichter et al. 2010). The potential analysis also showed that the more resource efficient variants according to MIPS are often also the more economical with regard to strategically interesting metals such as silver, gold, palladium, tantalum, copper, nickel, chrome and iron.

With the switch from tubes to LC-displays, the resource efficiency potential of Liquid Crystal Displays (LCD) has been largely exploited. The analysis revealed a high efficiency potential for the extended dissemination of OLED displays (Organic Light Emitting Diode). Resource efficiency in comparison to LC and plasma displays can be increased three- to six fold in different material categories during the use phase.

With respect to mobile phones, design can spare resources. Resource efficiency potentials can be realised with longer life spans or with reduced versions of mobile phones. Forms of zero-energy-mobiles using the human energy harvesting methods (which make use of the human body as primary source of energy) are still in the development stage. The use as smartphone carries high savings potential provided it does completely substitute other appliances and their purchase / manufacture. It depends on the buying and usage patterns whether this potential can be exploited.

The disposal of ICT appliances proves to be the most problematic part of the life cycle with regard to resource efficiency due to several reasons. On the one hand, from an economical perspective, as of today, it is almost impossible to recycle LC and plasma displays. On the other hand, many old smaller electric and electronical appliances are disposed of in the household waste for convenience. This way, they are often energetically recovered instead of being recycled or reused. Marked with passive RFID lables, old electric and electronic appliances could be more easily identified and, therefore, utilised in recycling management, which could save resources.

Recommendations for action: To increase resource efficiency potentials and to counter market instabilities of rare metals, a targeted resource management is necessary – from the design of ICT products factoring in the continued and reuse at the end of the life cycle to totally new utilisation concepts. In this process, questions central to IT like data security need to be taken into account as they are of central importance for the question of acceptance.

Consumer acceptance is a sensitive issue especially on the ICT market and might turn out to be a serious obstacle, e.g., to market penetration with resource conserving mobiles. The analysis of the diverse development opportunities of the mobile shows that a change in mentality of providers and users is necessary which ought to be politically initialised. Currently, the actual life of mobiles declines. Product-service systems can counter this development. However, their market introduction as well requires a new awareness in the fields of production, sales and consumption. Generally, the high relevance of the phase of use needs to be more strongly addressed.

Recycling is a central issue for the realisation of resource efficiency and has dimensions in relation to design, procedures and users. With reference to recycling passive labels facilitate the identification of old electric and electronic appliances and, therefore, its utilisation in recycling management. Additional incentives possibly need to complement the existing legislation in the field of old electric and electronic appliances. Moreover, utilisation possibilities of resource intensive rare metals in IT components need to be improved.

Measures should include communication, funding and legal elements. These serve to promote market penetration, efficiency and technical maturity as well as the integration of resource efficiency in product design and ways of thinking in product life cycles and reflection on the perspective of product use. At the same time, and especially with regard to the short-lived ICT market, rebound effects for all measures need to be separately addressed and analysed.

3.5 Food – both production and consumption need to be considered

In this field of action resource efficiency potentials of food production were analysed with the examples of fish, fruits and vegetables as well as agricultural technologies with the example of the use of nitrogen sensors for fertilization.

Results: On the supply side, resource efficiency potential was identified regarding more sustainable farming and fishing methods as well as more efficient irrigation methods and a safer use of pesticides. This means, e.g., reducing by-catches in fishing, reducing energy consumption in greenhouses or using waste heat from greenhouses. A further interesting approach is the use of nitrogen sensors to save pesticides and to increase yields.

The potential analyses show that different rather small measures in resource efficiency, in sum, can make a substantial contribution. However, the analyses also reveal that even though resource potentials can be realised in food production, there is most probably considerably higher potential on the consumer side. Only by the choice of his/her means of transport on the shopping tour, e.g., the consumer can realise substantial savings. It is known from other studies that savings potential can be increased in waste prevention on production and consumption sides. Furthermore, in consumption, the choice of food and the form of preparation are very relevant to resource use. The analyses also confirmed the finding that seasonal considerations in the choice of vegetables and fruits have a strong influence on resource conservation.

Recommendations for action: The food sector is one of the most resource intensive sectors. Based on the results of the analyses, policy focus ought to be oriented towards the following fields: As to the area of more resource efficient fishing, a central starting point is the implementation of more sustainable fishing methods causing less ground-movement and reducing by-catch. With respect to fruit-growing, water consumption and alternative cultivation techniques are central starting points. Regarding vegetable growing, the reduced consumption of energy and other resources around the greenhouses is a decisive factor apart from water use. As the case study showed, intelligent agricultural technologies and integrated cultivation systems can contribute to a decrease in the use of fertilizers and pesticides.

The consumer side ought to be systematically and broadly analysed with reference to resource efficiency potential, e.g., regarding food choice, preparation of meals and waste. As to overall consumption, the question arises how a long-term change of habits towards more resource saving and sustainable diets can be facilitated and which incentives are needed in this context. A possible starting point for influencing consumer behaviour might be to link the debate about “healthy diets“ with a debate about „diets oriented towards resource efficiency and environmental compatibility”. Public procurement can play an important role in this regard.

3.6 Traffic – Infrastructure bears higher resource efficiency potential than drive systems

This section deals with the results of the potential analyses carried out in the topic field “traffic”.

Results: Due to its high level of resource consumption and its central importance for all social and economical spheres, ‘vehicles and transport’ is an area of focus for endeavours to increase resource efficiency and reduce emissions. The academic discussion not only deals with alternative drive systems but also considers the development of infrastructures (see also the results of Task 2 of the MaRess project, e.g., in Steger et al. 2010).

With regard to a municipal commercial vehicle, the comparison of electric and diesel drive shows that the use of electric vehicles, on the one hand, reduces the emission of GHG emissions and, on the other hand, increases the independence from mineral oil. Still, certain limiting conditions need to be taken into account: The level of resource efficiency is primarily dependent on the electricity mix. This correlation can be transferred to rail traffic as well. Further measures reducing fuel consumption and, therefore, potentially increasing resource efficiency are lightweight construction and an intelligently controlled deployment of vehicles as facilitated by innovative telematics systems. The use of modern traffic telematics possibly contributes to the reduction of infrastructure needed and facilitates the exploitation of further potential.

Construction and maintenance of the infrastructure for the respective carriers are the major sources of resource consumption in rail traffic. Still, infrastructure has often been neglected in resource efficiency or sustainability considerations so far. However, it bears great potential even though the build-up of transportation infrastructure in Germany has been largely completed due to demographic reasons. The reduction of road width is a possible first step to increasing resource efficiency.

Recommendations for action: As infrastructure is a central factor for resource consumption in the traffic sector, solutions to increase resource efficiency not only ought to address energy consumption (resp. the emissions relevant to climate change) but overall resource consumption. Since avoiding the construction and expansion of infrastructure carries a high resource efficiency potential, measures to improve the utilisation of vehicles and infrastructure and maintenance solutions based on optimised resource consumption ought to be prioritised. Furthermore, global demand for resource efficient infrastructure (use) bears export potential.

To meet the so far steady growth in transport services, the development of drive systems needs to be paralleled by the development of more efficient vehicles and infrastructure use. In this process, logistics, traffic telematics and product-service systems (e.g. car sharing) can be useful. Still, in order to increase demand for these systems, offers need to meet target group needs better and demand patterns (of users) need to change. For long term infrastructure projects, changing future user needs ought to be given stronger consideration in planning.

3.7 Integrating resource efficiency into product development

In this field of action, resource efficiency criteria in product development processes were explored and potentials of several materials were analysed.

Results: From a number of previous studies we know that product development processes carry the potential to significantly reduce the environmental impact throughout the entire lifecycle of a product as there are many parameters that can still be influenced. Along the progression of the development process, product parameters are increasingly determined and, correspondingly, future environmental impact becomes more and more manifest. Therefore, attempts to increase resource efficiency throughout the entire lifecycle ought to be addressed at an early stage in the product development process. By integrating the MIPS concept and by defining universal criteria for resource efficiency a design methodology that accompanies the development process could be established which enables the designer to assess and reduce resource consumption of products throughout the entire lifecycle.

The relevance of the integrative lifecycle-oriented product development process was proven in the examination of a lightweight constructed seat shell. Using a textile-reinforced thermoplastic material combined with a consequent material-specific lightweight construction design and adjusted highly productive production processes could significantly reduce the lifecycle-wide resource consumption of the automobile seat shell. The lower mass of the newly developed light weight constructed seat shell contributes to a reduction of fuel consumption in the use phase. Since lightweight construction materials and strategies have a wide range of application, especially in automotive engineering, resource efficiency potential is considered to be high.

Further potential analyses showed that materials advancement is suitable for reducing resource consumption. The analyses of the use of higher- and high-strength steels (hss) for lightweight construction in automobiles reveal that fuel savings of 0.7 l / 100 km can be realised in comparison to conventional steel constructions. Further considerable resource consumption savings can only be realised in combination with innovative casting procedures.

Recommendations for action: Acceptance on several levels is a central prerequisite for adjusting product development to resource efficiency. Along with relevant decision makers in management and construction, suppliers’ and customers’ awareness and motivation with regard to resource-related matters needs to be raised. Expert knowledge, hierarchical potential and personnel networks are necessary to promote the implementation of new directives in design.

The virtual integration of resource efficiency thinking in product development can be achieved in a multi-stage approach. In a first step, targeted communication raises awareness for the need to integrate resource efficiency. Publishing articles in management or construction journals can accomplish this, by integrating the new insights into engineering studies and in further training courses for designers. Furthermore, the means usually used in product development such as CAE programs, can be adapted to the requirements of resource efficient design. In further steps, the consideration of resource efficiency can result in new ways of thinking such as product-service systems, which are explained in the following field of action.

3.8 Resource efficiency-oriented business models: product-service systems require rethinking

This section describes the results of the potential analyses in the topic field “product-service systems“.

Results: An approach to increasing resource efficiency is to understand resource orientation as integral part of the business strategy and to implement it in corresponding business models.

The concept “using instead of possessing“ forces the suppliers to reorganise their sales-oriented business strategy towards service-oriented ways of thinking. This aims at accompanying the customers throughout the product use phase and at re-designing the product after the use phase.

“Production on demand“ is the differentiation of “order-driven“ production that has gone furthest and which, in the ideal case, equals the prevention of overproduction. Quantitative resource efficiency potentials were determined with the example of journals. The concept “production on demand“ starts from the customer side: Customers need to order as early as possible because the quantities produced equal the quantities ordered. This results in longer lead times for customers compared with stocks-based storage. This rethinking can be identified as a chance for the realisation of resource efficiency potentials but, at the same time, as impediment to its concrete implementation.

The potential analysis of a robot according to the principle “using instead of possessing“ revealed that by reusing the robot about half of the resource consumption during production could be saved. Since operating energy makes up the highest consumption share, increasing energy efficiency also bears savings potential.

Recommendations for action: With the example of assembly facilities in the “Business-to-Business“ sector (B2B), it was shown that the principle “using instead of possessing“ can result in saving potential outside already familiar fields like chemical-leasing or working clothes / garment hire services. Against this background, detailed analysis is suggested identifying further fields of application for B2B across the board and assessing possible potentials. In order to save resources, business models based on product-service systems need to be increasingly applied. These can only be realised, however, if actors change their thinking and new configurations of actors emerge – e.g., in addition to the actual user, the facility manufacturer or the equipment supplier can operate a facility as well. The target is to develop an understanding for these business models and to raise awareness for its benefits. E.g., stricter directives for environmentally sound disposal of production facilities could render reuse or further use of facilities more attractive to the respective companies.

For small and medium sized companies concepts for joint use ought to be developed and promoted as this would render the use of facilities more efficient. Innovation and innovation promotion, therefore, ought not only to be understood in terms of production and production technology but it ought to encompass (models of) product use as well.

4 Conclusion and outlook

In the framework of the MaRess project, concrete resource efficiency potentials for twenty selected topics (“Top20”) in the fields of technology, products and strategies were analysed and possible recommendations for action were drawn up. As estimated in the pre-selection process, the analyses provided interesting and resource-relevant starting points. The potential analyses, in part, identified substantial potential for resource conservation. In some cases, these go hand in hand with other aspects of sustainability and open up new perspectives. As a result, in our opinion, so far underrepresented recommendations for action in the sustainability debate were made (e.g. with respect to the relevance of infrastructure, see 3.3 and 3.6, or with regard to resource consumption of electric drives, see 3.2 and 3.6). These could be used for focusing policy measures.

To achieve substantial dematerialisation resp. increase of resource efficiency in our economy and society (keyword factor 10), different measures need to be taken with the participation of key actors to realise the identified potentials and to reveal further potentials. In addition to technologies, resource intensive fields and organisational and institutional innovations, the complete value chain including the use and utilisation phase needs to be integrated to realise actual effects throughout the lifecycle. Against this background, it becomes clear that additional activities beyond Task 1 and MaRess as a whole are necessary.

The topics worked on (“Top20“) ought to be understood as the beginning of a systematic and encompassing analysis of resource efficiency potentials concerning our social and economical activities. Even though representing central and resource intensive sectors, the analysed topics naturally represent only a small selection from the totality of identified topics that were also assessed by the experts during the first expert workshop. Furthermore, with regard to the addressed topics some questions remained open and new questions were raised. Moreover, those topics presented in the expert workshop but not chosen for further analysis (“Top250“, see chapter 2.1) and those chosen in the workshop (“Top50“) promise interesting potentials that ought to be analysed in the future.

There is a need to study focus areas based on further case studies (e.g. central fields such as construction, living or food and nutrition).

The analyses also demonstrate the need to make greater use of or build up suitable ways (such as networks) to involve industrial partners at an early stage. On the one hand, the existing network of the MaRess project needs to be strengthened, on the other hand, further forms and consortia need to be established (e.g. with a stronger focus on individual topics). This is aimed at safeguarding the continuous direct link to the implementation and feasibility of analysed potentials.

Due to the broad range of topics and the possibilities for increasing resource efficiency in diverse sectors, the network of universities integrating the paradigm of resource efficiency in research and training ought to be considerably extended. It would be desirable to extend the circle of participating universities (e.g. all technical universities represented in the group of „TU9“ and, beyond that, schools of design and universities of applied sciences) for the further analysis of the topics identified in the Task 1 of the MaRess project.

So far, in university education, only few departments and specialist areas offer programmes (e.g., lectures, tutorials, projects) in the field of resource efficiency. Therefore, there is much room for a considerable extension of programmes offered that need to be integrated into the existing curricula. To foster the broad integration of resource efficiency into university training and research, activities for the establishment of a „Virtual Resource University“ (from innovation to implementation research) need to be started (see also the results of Task 13 of the MaRess project, e.g. in Kristof et al. 2010).

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Metallic Raw Materials, Worldwide Recovery of PGM and Materials for Infrastructures

Executive Summary

Executive Summary of the results of the Task 2 of the project „Material Efficiency und Resource Conservation“ (MaRess)

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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
For our Environment

Metallic Raw Materials, Worldwide Recovery of PGM and Materials for Infrastructures

Executive Summary

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Introduction

In order to determine the requirements and possibilities of increasing resource efficiency within important, however until today insufficiently researched areas, the knowledge basis towards environmentally relevant metal raw materials, the process for recovering platinum group metals as well as towards those raw materials linked with infrastructures was improved and analysed for possible options of action. The results show that to a considerable extent, there still exists loss of material and environmental pollution along the extraction, processing, utilization and recycling chain which could be decreased by the application of suitable measures. It is particularly necessary to promote return, collection and processing systems in areas where products (new, used or waste) are exported to countries in which, to date no sufficient recycling takes place. Domestically, in turn considerable potentials exist for future use of secondary raw materials, if the type and quantity of the stored materials in infrastructures, their foreseeable durability and the future locality of waste were regularly monitored in the future. Paving the way to „Urban Mining“, which effectively contributes towards the conservation of natural resources.

1 Environmentally Relevant Metallic Raw Materials, Task 2.1

1.1 Objectives and targets of the Task

Metallic raw materials are important for numerous technical applications. Due to the proceeding of technology in many areas, the use of metals increased rapidly within the last decades (more applications and more metals). Accordingly, most of the 60 metals are today used routinely. Thus, numerous metals that are today predominantly applied for specific tasks in small amounts accompany the ferrous metals and base metals that dominate with regard to the amounts of metals used. In this respect, the former metals can be termed as rare. Furthermore, these metals are subject of discussions due to their partly limited availability. For this reason, some of them are also termed as critical metals. Fields of application typical for these metals and with significant growth rates are electric and electronic equipment (including information and telecommunication technology (ICT) and photovoltaics technology, medical technology, and nanotechnology.

As these rare metals have received less attention in technical literature than ferrous and base metals, the availability of knowledge is also relatively limited. This is especially true regarding environmental pressures and material losses along their life cycles and their relevance in the socio-industrial metabolism. The superior aim of the MaRess task “Environmentally relevant metallic raw materials” is the enhancement of the knowledge base on rare metals and thus filling knowledge gaps in order to support the development of appropriate strategies and measures with regard to prevention, substitution, resource efficient production, and circular economy (including international aspects). For this purpose, the following steps have been carried out:

- Screening of potentially environmentally relevant metals: 66 metals (The nonmetals, lanthanides and actinides stayed unconsidered) or metal groups, respectively, were analysed with regard to the criteria reserves, reserve-to-production ratio, annual production, commodity prices, geographic concentration of production and reserves, dissipative use, environmental relevance (by Cumulative Raw Material Demand, Cumulative Energy Demand, and Total Material Requirements) and the application areas. By means of selected criteria, ten metals were identified to be examined in more detail.
- More detailed analyses of ten selected metals with potentially specific relevance. These metals were analysed in more detail with regard to their life cycle material losses and their specific environmental pressures by means of simplified substance flow analyses.
- Options for action: Based on the preceding enhanced analyses, suited measures and strategies were compiled aiming on the reduction of material losses and of the environmental pressures along the life cycle.

1.2 Results

1.2.1 Classification of metals regarding criteria on environmental relevance and rareness

An analysis was carried out on 66 metals with regard to different criteria with the following results:

- Overview of the application areas of the metals including their relative shares in the total use; in addition short descriptions on the applications in the application areas electric and electronic equipment/ICT, medical technology and nanotechnology;
- Annual production, reserves, reserve base and reserve-to-production ratio;
- Geographical concentration of primary production and reserves;
- Determination of dissipative use and other problematic use patterns of the metals;
- Cumulative Raw Material Demand (CRD), Cumulative Energy Demand (CED) and Total Material Requirement (TMR).

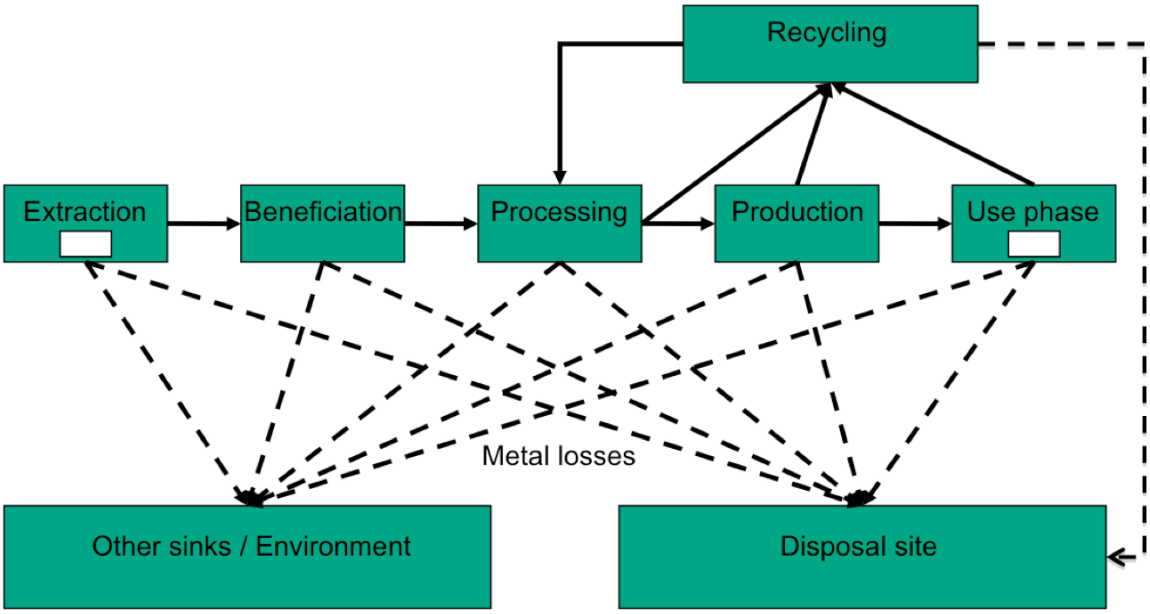
The measures CRD and CED were extracted from so-called environmental profiles, which were developed within the project of the Federal Environment Agency “Indicators for the Use of Raw Materials in the Context of the Discussion of Sustainability”; the determination of the TMR was based on analyses by the Wuppertal Institute. The criteria for the metal selection were the measures CRD, CED and TMR in combination with the reserve-to-production ratio and the dissipative use, while also the expected future development of the production of these metals was considered. Based on the classification of the metals with regard to these criteria, ten metals were selected for a more detailed analysis: the precious metals silver (Ag), gold (Au), palladium (Pd), the steel refiners manganese (Mn) and nickel (Ni), the heavy metals tin (Sn), zinc (Zn) as well as the "specialty metals" gallium (Ga), indium (In) and titanium (Ti).

1.2.2 Analysis on ten selected metals

For each of the ten metals, an analysis of the global substance household was performed along the full life cycle according to a defined scheme, in order to increase the comparability between the metals (Fig. 1.1). For each process of the system, both relevant metal losses and relevant specific environmental pressures were determined along the life cycle; this summary focuses on the metal losses th1at imply an increase in the primary production and the increased environmental pressures that they are generally involved with[1].

[1] A complete description of all environmental pressures that emerge could not be carried out in the course of this study due to the multifaceted processes during the production and use of the metals.

Fig. 1.1: Reference metal system for displaying the metal systems including the metal losses



The undesirable metal flows (losses) are shown dashed. The white boxes are stocks of the corresponding metals.

As expected, the substance flow systems of the single metals vary considerably. With regard to the material losses, the following differentiated pattern was achieved:

- *Relative Material Loss of the Use Phase (RLU)*: This is the annual material loss from use and recycling related to the annual input into the use phase. It varies by factor 8 between the ten metals, ranging from more than 70 % for tin to less than 10 % for gold; it is a question of the “minimal recycling potential” that occurs at the use and recycling phase[2] (it would be increased by further processes residing domestically);
- *Relative Material Loss of the Total Life Cycle (RLT):* This is the total annual material loss along the life cycle related to the annual input into the use phase[3]. They range between ca. 110 % for manganese and ca. 20 % for gold; it is a question of the “maximal recycling potential” on global scale.

[2] Insofar, this potential is generally located in the sphere of influence of national policies, in contrast to the potential of processes, which are located in foreign countries and are additionally covered by the "Relative Total Material Losses".

[3] Due to the reference to the input into the use phase, relations greater than 100 % are possible.

The losses of the other metals are each between the extreme values indicated above. Furthermore, the study reveals, in which life cycle step the relevant material losses occur as shown in Tab. 1.1. Attention should be given to the phenomenon that the environmental relevance of the material losses varies between the metals[4], however, a comparison between the specific environmental pressures, which are associated with the material losses, was not feasible within this study due to data constraints. Therefore, more studies are required to improve the current data.

Tab. 1.1: Overview on the relative losses within the various processes, and on the total annual material loss of the investigated metals[5]

The symbols show the relevance of the losses by the single processes: xxx = share exceeding 25 %, xx = share between 25 and 10 %, x = share falling below 10 %, o = no significant losses, n.s. = not specified.

<table>
<tr><th></th><th>Mn</th><th>Sn</th><th>Pd</th><th>In</th><th>Ni</th><th>Ag</th><th>Zn</th><th>Au</th></tr>
<tr><td>Extraction</td><td>o</td><td>o</td><td>xx</td><td>n.s.</td><td>xxx</td><td>xx</td><td>n.s.</td><td>xxx</td></tr>
<tr><td>Beneficiation</td><td>xxx</td><td>xx</td><td>x</td><td>xxx</td><td>xx</td><td>xx</td><td>xxx</td><td>n.s.</td></tr>
<tr><td>Processing</td><td>xxx</td><td rowspan="2">x</td><td>x</td><td>n.s.</td><td>xx</td><td>n.s.</td><td>n.s.</td><td>n.s.</td></tr>
<tr><td>Production</td><td>x</td><td>x</td><td>x</td><td>x</td><td>n.s.</td><td>xx</td><td>xx</td></tr>
<tr><td>Use phase</td><td>xx</td><td>xxx</td><td>xx</td><td>x</td><td>xxx</td><td>xxx</td><td>X</td><td>x</td></tr>
<tr><td>Recycling[6]</td><td>n.s.</td><td>n.s.</td><td>xxx</td><td>x</td><td>n.s.</td><td>xx</td><td>n.s.</td><td>xxx</td></tr>
</table>

In relation to the input into the use phase, the relative material losses within the total life cycle amount to (figures rounded on 5 %):

RLT [%]	**110**	**80-85**	**65**	**50**	**40-45**	**35**	**30**	**15-20**

4 The environmental pressures are both specific to metals and to processes, as the „ecological rucksack“ grows by progression of the processes.

5 For an assessment of the losses of Gallium and Titan, sufficient results were not available. Therefore, a presentation of these was left out here.

6 Inclusive so-called „downcycling“, by which the metal loses it´s specific functionality. Generally, this is associated with a significant loss in value.

1.3 Options for action

For the last years and with increased intensity during the period of the project, diverse professional articles have been published on substance flows of rare and precious metals. These deal predominantly with the possibilities to improve recycling from technical, logistical and institutional points of view[7]. In combination with the specific recycling potentials[8] determined by means of the ten studies within the scope of this project, the following set of options for action was considered jointly for the diverse metals:

- Increasing the collection volumes of end-of-life products, which contain rare metals in relevant amounts, in Germany and in foreign countries; for example of end-of-life electric and electronic equipment, which contain significant amounts of palladium, gold and silver, as well as used batteries with regard to their manganese content;
- Setting-up or adaptation of existing product-specific collection systems, e.g. for motor vehicles or ICT, in developing countries by governmental or private agendas, in order to allow a subsequent recycling by application of best available techniques on-site or in developed countries[9]; in doing so, protection of efficient collection systems with positive employment effects, and reduction of harmful effects on health and of environmental pressures in the informal recycling sector;
- Setting-up of transnational redistribution systems for scraps of specific product groups, which are relevant for the management of rare metals; for example, the collection performance should be supported within the scope of extending product stewardship for catalytic converters in end-of-live vehicles (ELV) with focus on those countries, where material losses are at the highest. Potential measures are logistical support of collection systems, training courses or agreements to take; potential addressees are manufacturers of vehicles and/or catalytic converters, and specialised recycling companies (via voluntary commitment)(cf. MaRess Task 2.2); long-term security of supply by secondary raw materials could be an incentive for the addressees.
- Support of more detailed manual or automated disassembling respectively, and sorting of old appliances, which contain rare metals in relevant amounts and for which the recovery rate can be increased, e.g. waste of electric and electronic equipment (WEEE) (especially drives, power supply units), or motor vehicles. In future studies, it will be necessary to determine more precisely, which components have the largest potentials;

[7] The articles considered within this study are listed in the final report of task 2.1.

[8] Attention should be given that in this sub-project the material losses are considered as „theoretical“ potential (i.e. maximal potential to be supposed) to prevent losses. Therefore, the diverse technological and institutional possibilities regarding the „practical“ potential to prevent the material losses should be assessed by a further step.

[9] Shipping of dismantled and selected components of scrap to (European) BAT recycling plants is called „best of two worlds approach BAT“. BAT means "best available techniques".

- Monitoring of the flows of old goods and of the recovered amounts of metals for inspecting the achievements of the management of rare metals (effectivity and efficiency of the recycling);
- Monitoring of the interfaces of the recycling chain in order to enhance market transparency, including all stakeholders involved in the processing (collection, treatment, recycling);
- Setting-up of a continentally to regionally adapted supply of product-specific treatment and recycling processes that improves the effectivity of the recovery of rare and precious metals globally by differentiated treatment of the end-of-life products and their delivery to sophisticated recycling plants;
- Periodic accounting of the treatment processes with regard to rare metals aiming at the optimisation of processes for the concentration of rare metals in recycling fractions;
- Comparative analysis and evaluation of re-use and recycling referring to the consumption of raw materials and to environmental pressures with regard to regional distinctions and product group-specific differences between recycling systems;
- Classifying and Certification of recycling technologies by criteria on resource efficiency and resource conservation (reducing the raw material requirements and environmental pressures compared to the primary route);
- Cooperative Governance aiming on binding quality standards regarding the treatment and recycling, including the certification of stakeholders, if need be (cf. MaRess Task 2.2);
- Formulation of a national or international target respectively, to reduce the primary raw material requirements of metals considering the raw materials, which were used along the life cycle, for the production of imported goods, with focus on selected sectors, in which relevant recycling potentials exist (e.g. the recovery of a given share of the gold in WEEE and/or the input of a minimum share of secondary metals in the production);
- Localisation of market failure and formulation of potential framework requirements, which enable the market launch of effective, but currently uneconomical treatment and recycling systems for rare metals.

Besides, the geographic component of the substance flows of rare metals is to be considered: Extraction, production, use and recycling of both old metals and of scrap from production are, in general, spatially heterogeneously distributed. Due to the low amounts of turnover of rare metals and the high investment costs for high-tech recycling plants, only relatively few central recycling plants are cost-effective. Thus, the recirculation of the end-of-life products containing rare metals plays a decisive role. The challenge in this regard is to organise the waste phase of end-of-life products – especially of potential recyclable small electric equipment – in such a way that they are collected as completely as possible.

Beside the collection, the treatment before the actual recycling is vital: Here, the old appliances have to be sorted and separated to route the rare metals to fractions as completely as possible that can be delivered to specialised recycling plants. Thus, from a resource policy point of view, it is required to direct the metal flows, especially the cross-border ones, effectively and efficiently, and to set up collection and treatment systems, which ensure a sufficient collection and treatment performance.

As losses reoccur for each life cycle of the products, besides recycling, also the actual life-time of the products is potentially relevant in order to increase the resource efficiency of the metal systems. However, the prolongation of the life-time of the products competes generally with progress regarding energy efficiency, with progress of the performance of the products, or also with fashion aspects of products. It is suggested to perform scenario analyses for the assessment of recent developments of the life-time of products with regard to their effects on material efficiency.

The knowledge base on the environmentally relevant rare metals could significantly be enhanced and consolidated within MaRess Task 2.1. Nevertheless, the results are intermediate as relevant knowledge gaps and uncertainties still remain that ought to be investigated by more detailed substance flow analyses – based on what has been achieved so far. The largest knowledge gaps with regard to the material losses remain for the metals gallium and titanium regarding the environmental pressures along the life cycle, relevant gaps remain for all metals.

2 Worldwide Recovery of PGM, Task 2.2

2.1 Objectives and targets of the task

Globally the use of platinum group metals (PGM) with its main representatives of platinum, palladium and rhodium in technology-oriented applications continues to increase. The driving factors are the growing demand from industry, particularly in applied fields as autocatalysts and consumer electronics. Simultaneously with these applications the secondary commodity potential grows, which is disposable after the utilisation phase.

From a resource and environmental policy perspective, PGM recycling can make an important contribution to national commodity security, resource conservation and environmental protection.

- Keyword commodity security: as the supply of the primary resources depends on very few countries (mainly Russia and South Africa), any additional ton of recycled PGM could help to reduce the dependency on those countries as well as of price developments in oligopolistic structured markets.
- Keyword resource conservation: PGM raw material reserves are limited. Increasing PGM recycling could preserve primary resources and save them for future generations.
- Keyword environmental and climate protection: PGM recycling is associated with distinctly lower environmental impacts as the extraction of primary resources.

Nevertheless, the economic and environmental benefits of PGM recycling have not yet been sufficiently exploited, mainly due to the export of used cars and used electronic equipment to countries lacking an adequate recycling infrastructure. Because of this PGM material gets lost for a global recycling treatment. At the same time dissipative applications are increasing in the electronics sector; those very small quantities cannot be recovered with conventional recycling technologies.

Against this background, the task "Worldwide Recovery of PGM" develops proposals for an optimisation of an international PGM resource management in selected application fields. For this purpose, the following steps were carried out:

- Identification of potentially problematic export flows and of significant PGM losses in different application fields.
- More detailed actor-related case studies in the fields of autocatalysts and selected consumer electronics (mobile phones and flat screens); deficit analysis relating to logistic collection, dissipative losses and regulatory deficiencies in selected target countries

- Deduction of strategies und measures leading to prevention of PGM losses and substitution of PGM material as well as a more efficient international PGM recycling. Priorisation of the proposed options.

2.2 Results

2.2.1 Conditions and trends in PGM recycling

Nearly 50 percent of the (primary and secondary) production of platinum, palladium and rhodium are used in autocatalysts. Other important applications include electronics, jewellery and process catalysts in the chemical and petroleum refining.[10]

PGM demand is influenced by different market based and technological factors. After the sales declined due to the economic and financial crisis in 2009, a mass related growth of primary production reappeared in 2010, which is in particularly driven by technological application areas. Also the increasing importance of photovoltaics and electro-mobility as application fields should be recognised (see Hagelüken/Buchert 2010). PGM consumption in various demand sectors and their development in the last 3 years is shown in Tab. 2.1.

Tab. 2.1: Development of the global consumption of platinum, palladium and rhodium, based on different application fields (2008 - 2010) in tonnes

Platinum	*2008*	*2009*	*2010*	*Palladium*	*2008*	*2009*	*2010*	*Rhodium*	*2008*	*2009*	*2010*
Auto catalysts	103,6	61,9	84,6	Auto catalysts	126,5	114,8	**146**	Auto catalysts	21,7	17,5	20,6
Electro	6,5	5,3	6,3	Electro	38,8	36,0	**39,8**	Electro	0,08	0,08	0,1
Invest	15,7	18,7	12,3	Invest	11,9	17,7	18,9				
Jewellery	58,4	79,6	68,6	Jewellery	27,9	21,9	17,8				
Glass	8,9	0,2	**10,3**					Glass	0,9	0,5	**1,6**
Medicine	6,9	7,0	7,2	Dental	17,7	18,0	17,5				
Chemistry	11,3	8,2	**12,7**	Chemistry	9,9	9,2	**10,9**	Chemistry	1,9	1,5	1,8
Others	15,0	11,3	12,0	Others	2,1	1,9	2,2	Others	0,6	0,5	0,5
Con-sumption	**226,5**	**192,6**	**214,3**	**Consumption**	**235,0**	**219,7**	**253,4**	**Consumption**	**25,4**	**20,2**	**24,8**
Recycling	51,8	39,8	52,1	Recycling	45,7	40,5	**52,3**	Recycling	6,4	5,3	6,7
Net con-sumption	174,6	152,8	162,1	Net con-sumption	189,2	179,1	201,1	Net con-sumption	18,9	14,9	18,0
Stocks	6,2	18,0	8,2	Stocks	18,0	22,1	1,2				

Source: Own combination and calculation in tonnes on the basis of indications in Johnson Matthey 2010. The values for 2010 are estimated values on the basis of the first 9 months, growth rate in bold.

[10] See also data in Tab. 1.1

The presented data shows that there was a distinct shift during the world economic crisis of 2009 from technology-related applications to value-related uses and that in general the consumption decreased in the crisis year 2009. The area of autocatalysts is for all three metals distinctly the dominant application area. Here it is significant that the proportions between platinum and the lower cost palladium have shifted distinctly[11]. In the field of glass applications for platinum and rhodium there is a significant growth in demand, but also the consumption of platinum and palladium in the chemical industry shows increasing values.

Recycling is increasingly becoming a strategic relevance for commodity security, since there are considerable problems in the expansion of primary production, which in Russia is coupled to the nickel production and in South Africa continually affected by the lack of power.

Despite these constraints, there are still large differences in the cycle of PGM. In industrial applications, for example industrial catalysts reach recycling rates of up to 90 % (see Saurat/ Bringezu 2008 & 2008a). In contrast to this, the recycling rates in the fields of consumer goods are much worse. For example, the contribution of recycling for the supply of palladium in automobile exhaust catalysts is 26 % in 2010 (in 2006 it was 20 %). In the consumer electronics sector the recycling quota is set to rise from 19 % in 2006 to 31 % in 2010 (JM 2010, p. 36). JM expects most of the recycling quotas in open loop systems to improve, due to more effective government incentive schemes. Looking at this it should be considered that due to the decline in prices in 2009 a lot of material was stored, which reached the market with a time lag in 2010. Therefore it should be observed whether the high recycling quota can be stabilised in future.

An important trend is the rising internationalisation of PGM flows. An increasing part of secondary resources is accumulated in the growing product related stocks of the so called emerging nations. Because of this the globally acting smelters/refiners started to establish international redistribution systems providing there „Integrated Smelters“ with input. Those activities are mostly separated from the stateside waste regulation and differ from country to country.

A significant amount of PGM material goes to countries without an adequate recycling infrastructure (like Russia, countries in Middle-Asia, South-East Asia, Middle East and West Africa). Those shifting stocks from Germany to other countries are due to the export of used (and new) consumer goods as cars and consumer electronics.

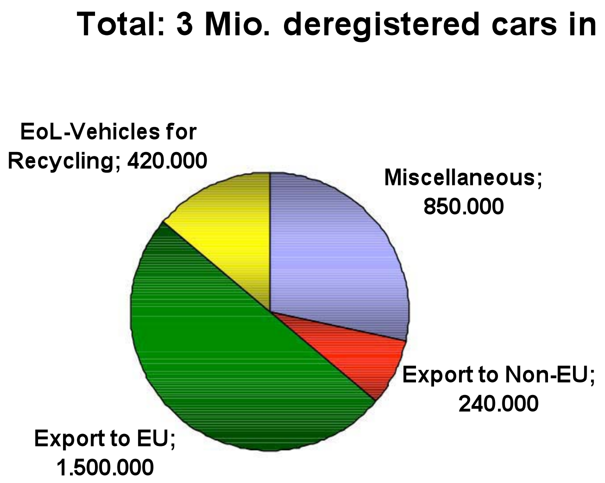
This problematic has been particularly tackled in two case studies: 1. Autocatalysts (see index 2.2.2) and 2. Consumer Electronics (see index 2.2.3).

[11] While palladium is used to large parts in gasoline engines, in diesel vehicles now mainly the much more expensive platinum is used, which is effective even at lower operating temperatures (see Brenscheidt 2001, 24).

2.2.2 Case study „PGM-recovery from autocatalysts“

In 2008 only 15 % of a total of 3 Million deregistered German cars has been brought to waste treatment in Germany, 8 % has been exported as used cars to other EU-countries (mainly the new member states, BMU/UBA 2010). Further on – after a time of using – those cars are exported again to Non-EU-Countries. 23 % of the outflow is statistically unidentified. The following illustration shows an update of the statistical exports:

Fig. 2.1: Destination of the deregistered German cars in 2008



Source: BMU/UBA 2010 related to data of Kraftfahrtbundesamtes (Deregistration,Re-registration) and the Federal Statistic Agency (Waste Statistics, Foreign Trade Statistics)

On the basis of the available statistical sources a reliable assessment is not possible. The registration of exported cars within the foreign trade statistics relating to the intereuropean trade is incomplete due to turnover-related registration duties. Another failure is due to various registration criteria in EU-countries. Last but not least follow-up exports of imported cars are totally intransparent. Against this background it can be very much appreciated that the EU-Commission and Eurostat has launched an instruction how to come to a better and more comparative data base in the case of end-of-life vehicles treatment (European Commission 2010).

As a result of the expert interviews and the country studies it is obvious, that the exports to the GUS-countries and the middle-asian countries (like Kazakhstan) are getting more and more important. Those are countries in which the national car fleets are growing rapidly, but at the same time where there is no effective recycling scheme and awareness of car functionality. Those framing conditions are strongly related to the ability of PGM-recycling.

The country studies also showed the relation between car fleet modernisation and PGM potential. In coming years - for example in the metropol regions of Russia (Moscow, St. Petersburg) – most of the passenger cars will be equipped with a common threeway catalysts converter. For those new cars an additional risk of PGM-losses can be expected if not a stricter technical control of cars will be established. Poor maintenance request in combination with poor condition of streets will lead to more damages of autocatalyst converters and to dissipative losses of the PGM-loadings. In fact, we could indentify only some unsystematic practice of catalyst recycling, mostly in grey markets with unregistered outflows of PGM from country to country.

Bringing some of the discussed problems to a solution a roadmap was created by the project team and presented to different stakeholders at a workshop in Berlin held in 2009 (Lucas/Wilts 2009). The proposed measures for optimising the global PGM-recovery, which were welcomed by the participants of the workshop, are the following:

- A stronger commitment between the actors in the PGM-redistribution-chain addressing common quality standards for dismantling processes, catalytic converters logistics and conditioning.
- Obligation of the car companies and catalyst producers for a recycling quota related to their production and targets for the use of secondary PGM
- Establishing redistribution systems from the target markets of used car exports to the integrated smelters. Strengthening producer’s responsibility by the industrial partners (car industries, converters producers).
- Technical marking by means of RFID: In general this could help to indentify export flows and the final destination of autocatalysts as well as support the redistribution management of private companies. On the other hand the declaration duties of car retailors should be extended.

For all these measures, a time window of 10 to 15 years is needed, because within this time frame most of the cars in the target countries will be equipped with a conventional three way converter. This may differ from country to country.

2.2.3 Case study „PGM-recovery from electrical and electronic equipment” (EEE)

The volume of WEEE in the EU is growing faster than all other fractions of municipal waste (cf. UNU 2008, 3). From a technical point of view recovery rates up to 95% can be achieved by the recycling of printed circuit boards that contain the bulk of the palladium. The relevant deficits are on the one hand the redistribution and the other hand the proper treatment and processing. A major problem is the fact that relevant quantities of used EEE leave the European Economic Area. According to Sander/ Schilling (2010), in 2008 approximately 155,000 t of used EEE exports electrical and electronic equipment have been exported from Germany, including about 2 million monitors. On a global scale one must assume that only about 10% are actually recycled (cf. LaDou et al. 2007 and UNEP 2010). However, an international market for re-use could certainly be established in the medium term based on internationally binding commitments to high quality standards for recycling.

The monitors and mobile phones, the palladium containing products analyzed in detail, are characterized by different circumstances: Mobile phones on the one hand are usually legally exported as a functioning used equipment with a positive market value, monitors on the other hand (especially CRT monitors) are normally illegal exports because of the costs of disposal in Germany exceeding the total export costs. But also domestically deficits result in the circulation result because waste EEE is not collected within the dedicated systems with a high-quality recycling. For both products together, mobile phones and monitors, at the present state of the art recycling an additional theoretical potential for Germany of about 0.75 t PGM was estimated, which would exceed the total European net demand for electronic applications (see JM 2010).

Based on this analysis the developed policy proposals address different spatial levels and aim to improve the coordination of existing initiatives in the field of used and waste EEE. The underlying approach is to strengthen the producer responsibility for the end of life phase of its products, as stated in the WEEE-Directive, but so far undermined by legal and illegal exports (cf. Wilts 2009). Specifical priority should be given to the following measures:

- Approaches of technology and knowledge transfer should be extended to those developing and emerging countries where the use phase of electrical and electronic equipment ends (both imported and domestically generated). These countries are usually characterized by very high collection-rates, but completely lack the necessary recycling infrastructure (cf. Yu et al. 2010). This could open up significant win-win potentials, if the precious metals such as on dismantled circuit boards are supplied to the internationally networked smelters instead of to a backyard recycling causing severe risks to health and environment. The revenues of recovery significantly exceed the additional transportation costs (cf. Hagelüken 2010).
- For mobile phones there is a need to significantly increase the domestic collection rate. Best practice examples for optimized redistribution systems for example with designated recycling fees in combination with intensive public relations (national day of action, teaching materials, etc.) exist e.g. in Switzerland (cf. SWICO 2009). A deposit system for mobile phones could be an additional incentive (cf. MPPI 2009).
- With regard to monitors the illegal export of waste products has to be contained by product-specific regulations for the distinction between waste and used equipment. In addition, the devices should be no longer collected together with bulky waste from the roadside. Direct collection of waste EEE from households could avoid damages and the theft of valuables (Sander / Schilling 2010) as well as increase transparency and security.

2.3 General aspects of an international governance-approach regulating PGM-material flows for recycling

The investigations described here indicate in both action fields that international management of secondary PGM-resources is strongly influenced by international market development and less influenced by national waste regulation. In the near future an international obligatory regulation of this issue within the wto-regime can probably not be expected. Because of this background we propose a cooperative governance approach which should lead the actors in the recycling value chain to a more obligatory understanding of quality standards and environmental targets. For the implementation of those standards the international acting refiners of PGM-material could take a leading role because they will benefit directly by this kind of agreement.

Such cooperative structures could be supported bilateral or mulitilateral by government activities or their subordinated environmental agencies. Also UNEP with its international resource panel could play an important role by co-ordinating the experience exchange about how to improve the efficiency of international acting recycling systems (see UNEP 2010). But at least the key for a new recycling model lies in the hands of the big players in the refining business and their customers in the car industry.

Public authorities could help to optimise the information flow in the PGM-recycling chain by addressing more reporting duties mainly of the retailers. Furthermore, the aimed standards for best available technologies should be considered by laws (Likewise ELV and WEE Regulation). Another field of governmental action should be the different technology and qualification levels between OECD-countries and the target countries, which import used consumer goods. A convenient tool for problem solving could be the promotion of technology and a qualification programme, which would enable the target countries to establish a systematic dismantling, collection and redistribution of PGM containing consumer goods. This programme should be initially designed for new EU-member states and CEEC-countries. As far as we know new refining plants in the emerging economies are not being planned, so the existing redistribution routes will remain in the meantime. It can be expected that upon condition of free trade international material flows of secondary PGM will go ahead.

3 Material Stock and Flows in Infrastructures, Task 2.3

3.1 Objectives and targets of the task

Infrastructure systems can cause severe environmental impacts, as they require large quantities of raw materials for their construction and maintenance. A sustainable resource management should hence aim at decreasing the absolute quantity of primary raw materials while increasing the proportion of secondary raw materials being used. In order to provide the required basic data, task 2.3 of the MaRess-Project analysed relevant on-grid infrastructures in Germany in terms of their material stocks and annual material flows for maintenance and expansion. Four infrastructure systems were considered:

- transport networks,
- drinking water and wastewater infrastructures,
- communication systems,
- electricity, gas and district heating networks.

Analysing the material stocks and annual material flows of relevant infrastructures provides an input to a consistent country-wide data base, in order to identify and discuss potentials for resource conservation in infrastructures. Furthermore, the project provides useful information about which materials are potentially available for recycling purposes when infrastructures are being dismantled and can be useful for assessing the material dimension of certain energetic development goals (e.g. DENA national grid studies).

The part has been divided into four steps:

- Step I: Identify relevant types of infrastructure / reference systems;
- Step II: Determine the present size of infrastructures and amount of the material bound in the reference systems;
- Phase III: Determine the annual material flows of the reference systems;
- Phase IV: Conclusions and further research needs.

In most cases, a bottom-up-approach has been used in order to determine the material stocks and flows: Lengths / numbers of the particular reference systems have been linked with specific material coefficients and extrapolated to the total stock (or the annual expansion or renovation). When possible, material flows resulting from the dismantling of infrastructures have been calculated in the same way. We determined the specific material coefficients by analysing relevant databases and literature (Ecoinvent, various life cycle analyses), complemented by extensive own research (technical literature, product catalogues, expert interviews). In order to systematically determine and visualise inputs, outputs and stocks of materials in infrastructures, we used the material flow analysis (MFA). Furthermore, we determined the total material requirement (TMR) of the identified material stocks and flows in order to calculate the specific ecological rucksack and hence illustrate the ecological relevance of the particular reference systems.

3.2 Results

3.2.1 Transport networks

In terms of transport networks, we analysed material stocks and annual flows of streets as well as railways and waterways, including civil engineering structures (bridges, tunnels along railways and motorways, gates and harbours along waterways).

The material stocks of the German road network (more than 7.3 billion tons) were calculated for one square meter reference-road based on technical road construction standards, which define the build-up of different street categories. The results were then extrapolated on the total length of the Germen road network, based on reference profiles. Annual renovation needs have been extrapolated based on the specific operating life.[12] Material stocks include the road space as well as the civil engineering structures along motorways. Food and bicycle paths, noise and beam barriers, which are also parts of the road network, have not been included. In terms of the railway material stocks, we could use data of another recent UBA-project (Schmied/Mottschall 2010) and hence make reliable calculations of the material stock (1.35 billion tons). Extrapolations of the material bound in waterways (more than 200 million tons), including inner harbours, are based on earlier analyses at the Wuppertal Institute (Stiller 1995; Manstein/Stiller 2000).

The quantity of mineral building material bound in the road network is multiple times higher than in other infrastructure systems. Furthermore, the annual material flows in transport networks, in contrast to other infrastructure systems, are mainly induced by maintenance and renovation: Annual material flows for the maintenance of roads and streets (104 million tons) are five time higher than for expansion activities (21 million tons). Due to their length, municipal roads in terms of expansion as well as maintenance induce the majority of material flows. In contrast, motorways are the most material intensive type of road in relation to their length. The railway network, too, induces the better part of its annual material flows for maintenance reasons, as there is nearly no expansion taking place any more. Regarding water ways, the annual material flows induced by maintenance activities could not be reliably calculated due to lack of data. Hence, annual material flows have only been calculated based on expansion and upgrading activities[13].

[12] As far as no detailed information was available, we proceeded the same way for other infrastructures.

[13] Renovation and expansion of sluices often go hand in hand and are hence hard to distinguish.

3.2.2 Drinking water and wastewater infrastructures

The following reference systems in the field of drinking water and wastewater infrastructures were identified and analysed:

- Water supply infrastructures: barrages, water works, cisterns, pipe network
- Wastewater infrastructures: sewer network, inspection chambers, stormwater overflow, wastewater treatment plants

Partly we could use existing material coefficients from other analyses, which merely had to be modified with regard to German conditions. In addition, extensive research in technical literature, product catalogues and expert interviews in most cases lead to a reliable data basis. However, through the project it became clear that particularly concerning annual material flows data needs to be improved.

Water and wastewater infrastructures tie up around 1.8 billion tons of materials. These consist mainly (99%) of mineral construction materials, due to the pipe beddings. In addition, reinforced concrete plays a major role in the construction of wastewater facilities (475 million tons). In contrast, metals (around 20 million tons, mainly steel and iron) and plastics (< 2 million tons) only play a minor role. Furthermore, they are in most cases built in underground pipe networks, hence poorly accessible.

Annual material flows are still caused by mainly expansion rather than (various) maintenance and renovation activities. However, the calculated annual flows are probably underestimated due to insufficient data, particularly with regard to maintenance and renovation. For renovation activities, material input even lies below material output due to the use of new materials (plastics).

However, against the background of expected massive investment needs[14] for renovation in German water and wastewater infrastructures, annual material flows are expected to grow more significant in the future.

3.2.3 Electricity, gas and district heating networks

The analysed energy infrastructures can be differentiated into energy production and energy distribution. In this part we analysed nine types of energy production[15]. We did not include facilities with low relevance for the German energy supply (e.g. geothermal energy) and those serving mainly household self supply (photovoltaic). In terms of energy distribution systems, data for electricity, gas and district heating grids have been calculated.

[14] Projections range from 65 (Reidenbach et al. 2008) to 150 to 250 billion Euro (Kluge et al. 2003) for municipal replacement expenditures in the field of water and wastewater infrastructures.

[15] These are conventional power plants (black coal, lignite), gas power plants, nuclear power plants as well as water and wind power plants (on-shore) and biogas for renewable energy production. In addition, cogeneration and block heat and power plants have been assessed.

The material stocks of the energy distribution grids (650 million tons) are – mainly due to the sandbeds (585 million tons) – more material intensive than the energy production infrastructure (88 million tons). Besides sand, it is mainly concrete (94 million tons) and steel (37 million tons) which dominate the material stocks of energy infrastructures – similar to water and wastewater infrastructures.

Most conventional power plants have reached the end of their life cycle and need to be renovated or replaced by other energy production facilities – e.g. based on decentralised renewable energy sources. This induces relevant material flows. Our analyses show that decentralised facilities are also linked with high material flows for their construction. On the other hand, the construction phase of renewable energy plants is more than compensated by their utilisation phase, when they induce only little material flows for maintenance activities and consume much less fossil resources than conventional power plants. With an expansion of decentralised energy production facilities and a regional shift of the energy supply (offshore wind energy in Northern Germany), expenditures for power line construction on all voltage-levels will rise. Overall, annual material flows in the area of power grids and renewable energy production are still based on expansion and upgrading rather than renovation and maintenance.

3.2.4 Telecommunication systems

Originally, the project scheduled to analyse the communication infrastructure in terms of fixed and mobile networks. However, fixed network infrastructures could not be analysed, as no data with regard to their expansion was accessible. Company data or data from the Federal Network Agency (BNetzA) could not be used due to business secrets confidentiality obligations.

First, material stock and flows of the mobile networks (GSM, UMTS) were assessed, based on information of network operators and life cycle inventory analyses. As data from different sources is not consistent, we worked with ranges. Other studies that worked on the material dimension of information and communication technologies (e.g. Borderstep-study on behalf of the UBA on material stocks of computing centres) have already shown that the particular ICT-components of the mobile network cannot be divided into separate material categories due to aggregated data. More complex modules can in most cases only be calculated with regard to their weight but not divided into different material categories. Due to the dynamic development of network technologies, LCA-studies are often out-dated after only two years.

An essential finding is, that the material stocks (around 137 thousand tons) as well as the annual material flows (around 17.000 tons) in mobile network infrastructures are comparably irrelevant in comparison to the other three infrastructure systems. If material stocks of fixed network infrastructures were included, the significance of the communication systems for the total infrastructure material stock would be much higher (sandbeds of copper cables). Furthermore, the current ICT-infrastructure offers a high recycling-potential, due to the future expectedly net-conversion into glass fibre cables.

3.3 Recommendations and further research needs

Growing Material Stocks generally lead to increasing material flows for maintenance and renovation. Any expansion activities should hence be generally questioned. Limiting the scope of infrastructure systems is necessary in order to get the constantly growing maintenance costs under control and to restrict the increasing consumption of resources.

With regard to road construction, reviewing the construction standards in co-operation with civil engineers and other experts (e.g. road safety) could lead to enormous saving potentials of mineral construction materials (thinking e.g. of reducing the road width when expanding or renovating). Resource aspects should become part of investment decisions of infrastructures as a matter of principle, combined with preferably resource conserving technologies. When renovating infrastructures at the end of their life-cycle (e.g. bridges and tunnels), resource efficient processes should be preferred.

As far as technically possible and ecotoxicologically harmless recycling material should be used for required maintenance and expansion activities. When dismantling infrastructures, the proportion of recycling should be maximised.

For grid-bound infrastructures it makes sense to pursue a strategy of pro-active land management: That means to use existent area reserves (brownfields, empty building lots, vacant areas), in order to prevent or minimise further expansion of pipes and cables. Furthermore, processes of urban consolidation should aim at preserving a structural density, thus sustaining the efficiency of on-grid infrastructures. Hence, a grid deconstruction should take place from the ends instead of running disperse.

Built on the project’s experiences, further research needs focussing on improving the data basis. Many extrapolations are based on assumptions, other infrastructures had to be neglected, as adequate data was not existent or accessible. It would be helpful for future analyses of material stocks and flows (especially regarding their later usability potential), if municipal cadasters would integrate position and type (incl. material) of underground sewers, pipes and cables; or if network operators would inventory and regularly update their material stocks. Furthermore we recommend that the data of the Federal Network Agency, accredited by the net operators, should be made (anonymously) accessible for scientific analyses, in order to make use of them for scientific and statistic purposes.

The annual material flows for renovation and maintenance in particular need to be analysed in more detail. Therefore, it would make sense to co-operate with a utility, in order to analyse the data precisely for their specific service area (rural, urban) and empirically assess the underlying assumptions.

For a potential reduction of maintenance needs, LCAs should be used in order to analyse, how far alternative constructions (e.g. concrete surface replacing asphalt surface in road construction) can reduce maintenance intervals and hence minimise overall environmental impacts.

In order to better forecast future material flows for construction and renovation on the one hand, for solid waste on the other, a dynamisation of the present material flow analysis is required, based on the age structure of the German infrastructure systems. Furthermore it should be analysed, how far infrastructures are being deconstructed at present and if they are being withdrawn from underground.

Based on the provided material inventory, information and management systems for a potential urban mining need to be further developed, in order to foster a sustainable resource management based on an optimised use of secondary raw materials from and into civil engineering.

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Material Efficiency & Resource Conservation

Kora Kristof / Peter Hennicke

Wuppertal Institute for Climate, Environment and Energy

Core Strategies for a Successful Resource Policy and the Instruments Proposed for Their Effective Implementation

Executive Summary of the Policy Recommendations of the MaRess Project

Summary report of Task 7 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project

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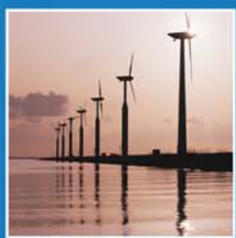


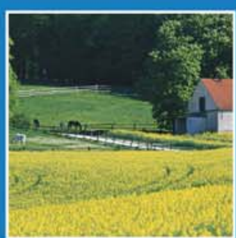
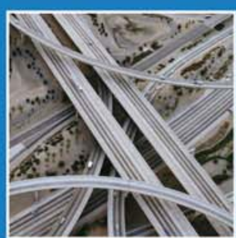

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Core Strategies for a Successful Resource Policy and the Instruments Proposed for Their Effective Implementation

Executive Summary of the Policy Recommendations of the MaRess Project

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1 Overview of Policy Options

To create a successful resource policy, policymakers can use the six core strategies developed in the MaRess project for orientation. The core strategies and the instruments proposed for their effective implementation are discussed in detail in the following. Tab. 1 provides an overview.

Tab. 1: Overview of the Core Strategies and the Policy Instruments Proposed for their Implementation

Core strategy	Instruments
"Mobilising Institutions – the Key to Successful Diffusion"	Resource efficiency agency (including evaluation to optimise funding structures)
	Resource efficiency stimulus and advisory programme
	Expansion of the pool of advisors and regional structures
"Giving Innovation a Direction – “Sustainable Future Markets for Resource Efficiency Solutions"	Resource efficiency innovation and market launch programme
	Innovation agents
	Innovation laboratory specialising in resource efficiency
	Venture capital for resource efficiency solutions
"Resource-Efficient Products and Services"	Dynamic standards and labelling requirements (amendment to the EU Ecodesign Directive)
	Promoting resource efficiency-orientated product design
	Hybrid governance to increase the use of secondary materials of rare metals in new products
	Primary construction material tax
"Incentives for Resource Efficiency Solutions through the Financial Sector"	Enquete Commission "Resource Efficiency and Sustainability in the Financial Sector"
	Resource-related Key Performance Indicators (R-KPI)
"Government as a Consumer and Provider of Infrastructure"	Procurement based on lifecycle costs as a mandatory procurement criterion
	Demand bundling to minimise risks for innovation processes
	Resource efficiency-optimised infrastructure systems
"Changing Attitudes"	Resource Efficiency Network
	Resource efficiency campaign: Target group of (future) decision-makers
	Concerted action resource efficiency
	Qualifying advisors
	Establishing a “virtual resource university”
	Developing course materials for schools

Source: Kristof / Hennicke 2010

2 Core Strategies and Policy Instruments

2.1 Core Strategy: “Mobilising Institutions – the Key to Successful Diffusion”

The core strategy "Mobilising Institutions – the Key to Successful Diffusion" contains the institutional foundation on which the other core strategies are based. For this reason it has been given top priority and recommended for rapid implementation. It also plays an important role in the economy overall because it is largely self-financing and will modernise institutional structures. The idea here is, on the one hand, to scale up existing institutions at the federal or state level (e.g. demea, North Rhine-Westphalia Efficiency Agency) and advisory structures (e.g. pool of advisors) and, on the other, to expand and concentrate existing funding options – e.g. VerMat (for improving material efficiency), NeMat (for promoting networks for material efficiency), FONA (for research on sustainable development). The institutions and the funding programmes are considered to have achieved convincing and robust results (e.g. Kristof / Lemken / Roser / Ott 2008) so that solid reasons exist for a considerable expansion of institutions and funding nationwide.

The core strategy "Mobilising Institutions – the Key to Successful Diffusion" comprises three components that build on and mutually reinforce one another: establishing a federal resource efficiency agency (including independent evaluation to optimise funding structures); launching a resource efficiency stimulus and advisory programme; and expanding the pool of advisors and regional structures. EUR 450 million are proposed annually for implementation of the core strategy. These three components define in more concrete terms the “mobilising institutions” (“caretaker” function) that the state requires as a “guiding and helping hand” at all levels in order to successfully implement resource efficiency policy. For it is only through these institutions that the target group, e.g. small and medium enterprises (SMEs), can really be reached. Designing and implementing strategies that span more than one area of institutional competence and are not limited to one term of political office is a task that exceeds traditional institutional capability and thus needs the support of relatively independent intermediary institutions and networks. Empirical evidence also shows that many theoretically highly profitable micro-economic measures undertaken to conserve resources are not yet automatically being applied comprehensively and rapidly. The core strategy therefore focuses on offering a consolidated package of measures intended to accelerate diffusion and make use of existing economic resource efficiency technologies and solutions to lower the cost of resources. Using a funding programme that combines advice and implementation support with start-up funding (particularly for SMEs) coupled with business advice and local support has proven an effective way of removing obstacles and should thus be scaled up.

Resource Efficiency Agency
(including evaluation to optimise funding structures)

The Resource Efficiency Agency will be formed as a new institution at federal level to bundle public diffusion and financing options for companies, company networks and associations and to play the necessary role of "caretaker" for all core strategies. The resource efficiency agency will coordinate, support and evaluate activities for companies – particularly SMEs – throughout Germany via the resource efficiency stimulus and advisory programme with the aim of rapidly realising the considerable potential that exists for increasing resource efficiency in production processes and product development. It will also be responsible for expanding the pool of advisors and regional structures. The agency will be a lean organisation that will operate nationwide and at all levels. It will create networks for existing actors and structures and develop them further. The main tasks of this core strategy will be to create networks for actors (at all federal levels, with private-sector consultants and existing intermediary institutions such as the Resource Efficiency Network) and to act as a guide for companies (using the principle of a central point of contact). To be able to fulfil its responsibilities as well as possible, the agency will also require a solid international network (e.g. cooperation with international organisations at EU level, initiating new supranational activities, learning from the experiences and achievements of others). The Resource Efficiency Agency's activities are not, however, limited solely to implementing this core strategy but also extend to all other core strategies.

It is also envisaged that the Resource Efficiency Agency will commission independent evaluators to continually analyse the achievements of the resource policy instruments using standard, central criteria and thus to provide a sound basis to further develop the instruments (particularly to optimise the funding structures) and the policy mix. The goal is make funding structures more effective and easier to access. This will also enable the structure of funding programmes with other primary goals to be addressed with a view to integrating the issue of resource efficiency. The funding programmes of the EU and of the German federal and state governments with their broad spectrum of subsidies, low-interest loans and assumption of equity and liabilities serve as an indispensable component in financing innovation and market launch processes, particularly in the SME sector. Yet the programme structures often lack clarity, transparency and flexibility, while for many SMEs the procedures for applying for funding and managing projects are also a major obstacle. Unlike in other countries, funding programmes and the entire research funding system in Germany have so far not been comprehensively evaluated using comparable criteria. This is, however, an important prerequisite for evaluating their success, for using public resources more efficiently and for further optimising the programmes. It is thus important to establish an independent evaluation which, if used intelligently, will also reduce costs in the long run.

Resource Efficiency Stimulus and Advisory Programme

The Resource Efficiency Agency's Resource Efficiency Stimulus and Advisory Programme will provide advice and support for companies and company networks engaged in integrating resource efficiency into their production processes or product design as well as for resource efficiency activities that span the entire value chain. As a side effect of this programme existing efficiency technologies, solutions and services will be able to penetrate the market more quickly (diffusion). Thus in its role as "caretaker" for implementation, the agency could be mobilised not only to help increase resource efficiency in companies and their value chains but also in the area of public and private resource consumption. Here the agency should involve actors already working in the area of resource efficiency – both those with their own economic interests such as advisors but also publicly funded intermediaries such as the North Rhine-Westphalia Efficiency Agency or NGOs active in the field of resource efficiency like the Nature and Biodiversity Conservation Union (NABU). It could also, however, indirectly encourage implementation, e.g. through tenders for innovation competitions.

Expanding the Pool of Advisors and Regional Structures

The regional structures that play an important role in reaching companies should be strengthened across the board, while in some regions, new structures will have to be created. As part of this process, the pool of independent advisors who motivate and support companies in implementation should be drastically increased. An institutionalisation programme called "für die Fläche" (for the region) (based on the example of several states such as North-Rhine Westphalia and Rhineland Palatinate) will be created to help expand the pool of advisors and the regional structures. The regional structures can be supported by various actors (e.g. by state-level institutions, chambers of commerce and industry, chambers of trade, the RKW (German Centre for Productivity and Innovation), the VDI (Association of German Engineers), business and professional associations, business angel networks, existing regional networks) and should be firmly anchored in institutional structures with a clear financing framework so as to be able to work successfully (e.g. efficiency offices affiliated with existing institutions). Expanding the pool of advisors aims to provide advice embracing all kinds of resources and the technical, organisational and business expertise necessary for implementation. It should be accompanied by an extensive qualification programme for (accredited) advisors and the development of an accreditation system (including methods to monitor success and basic data). The existing activities (e.g. demea, KfW, North-Rhine Westphalia Efficiency Agency) should be incorporated here.

2.2 Core strategy: “Giving Innovation a Direction – Sustainable Future Markets for Resource Efficiency Solutions”

Consensus exists that innovation drives economic and technical development. But not everything that is new is truly innovative, useful to society, responsible or conducive to sustainable development. “Giving Innovation a Direction”, however, means exactly this forward-looking orientation aimed at creating sustainable future markets. Innovation should generally be geared towards solving problems and, to this end, should bring together technical and social innovations to successfully contribute more to protecting the climate and conserving resources. This also includes, for example, cooperative innovative processes (such as innovation agents or innovation laboratories specialising in resource efficiency) and systematically promoting creative technical and social experiments.

Of course “Giving Innovation a Direction” does not mean that binding government requirements are imposed on basic and applied research. Nevertheless, the government should exercise the steering prerogative it has over a major portion of its R&D funding (e.g. FONA) to create more incentives for joint projects with innovations and investments to increase resource efficiency. The focus should be on ambitious reduction targets for resource consumption so that R&D activities as well as demo and pilot projects have a reliable long-term standard on which to orient themselves. The innovation programme should also be combined with a market launch programme and venture capital made available to prevent “breakdowns” like the famous “Valley of Death” (e.g. failure of projects for financing reasons after the first phase of funding has ended).

Taking all this into account, the core strategy "Giving Innovation a Direction – Sustainable Future Markets for Resource Efficiency Solutions" is based on four instruments: the resource efficiency innovation and market launch programme, funding for innovation agents, the institutionalisation of innovation laboratories committed to resource efficiency and the availability of venture capital for resource efficiency solutions. The funding requirement for the first three instruments is estimated at EUR 300 million, while venture capital totalling EUR 100 million should be made available in revolving funds. The innovation and market launch programme and support for innovation agents should be pursued as the top priorities and implemented quickly. The other two instruments should then follow. The findings of the MaRess task "Identification and Analysis of the Potential of Innovative Groundbreaking Products, Technologies and Markets to Increase Resource Efficiency" can be used to pinpoint more precisely where funding should be targeted.

Resource Efficiency Innovation and Market Launch Programme

The goal of the resource efficiency innovation and market launch programme is to stimulate the research and development of new and more resource-efficient technologies, materials, products, services and systems solutions from “cradle to grave” and to provide incentives for resource efficiency-oriented process and product design. Target groups of the programme are:

- Producers and users of resource-efficient technologies (e.g. functional materials, surface finishing processes, waste-free production processes, optimised maintenance / service cycles, flexible factory).
- Suppliers of resource-efficient products / product-service systems (e.g. insulation systems, lightweight vehicles, cascaded use systems, resource-optimised packaging systems, modularisation / multifunctional devices, services for resource efficiency-oriented process and product design).

The goal is to systematically focus existing joint R&D programmes more specifically on resource-efficient solutions with solid financial support (in particular KfW, Federal Ministry of the Environment, Federal Ministry of Education and Research) or, to put it another way, to systematically direct the constantly changing focus of research funding towards resource efficiency. The market launch of resource-efficient products and product-service systems must also be given targeted support for groundbreaking technologies, products and services. Pilot and flagship projects are also important to develop product-service systems that increase resource efficiency (e.g. in the area of mobility services).

Innovation Agents

To overcome the dearth of knowledge and expertise in companies, actors with the appropriate qualifications and specialisations play an important role in providing professional and / or financial support for innovation processes in companies from invention through to market launch. In addition to government subsidies, one of the chief sources of funding for innovation projects is private investment capital. This is where innovation agents come in. Innovation agents are, on the one hand, innovation coaches who as advisors on innovation management supply the expertise and knowledge the company lacks and, on the other hand, act as business angels who supply the company with the necessary private capital, expertise and outside contacts. This allows additional synergies for increasing resource efficiency to emerge, particularly in the early phases of innovation. The activities of innovation coaches are supported by a funding programme that can be based on existing federal and state financing programmes. The two target groups are producers and users of resource-efficient technologies and suppliers of resource-efficient products / product-service systems.

Innovation Laboratories Specialising in Resource Efficiency

When it comes to innovation processes, SMEs in particular often have difficulty compensating for the disadvantages of their size compared to large companies. Industrial research on resource efficiency is also not yet sufficiently well-established. The innovation laboratories instrument was conceived to tackle these two issues. Companies work together in innovation laboratories with support from research institutions to promote cross-company innovations in resource efficiency. Timelines and organisation are flexible. Complex or large-scale research projects are set up as joint projects and can make use of the infrastructure provided by the innovation laboratories. Equipment, expertise and personnel resources are shared to overcome the disadvantages SMEs face in terms of size. The different experiences and perspectives of the companies and research institutions involved are the primary driving force in the creation of new types of non-technology-specific solutions.

Venture Capital for Resource Efficiency Solutions

The innovation and market launch programme is closely linked to this instrument to make it easier to procure the venture capital necessary to launch resource-efficient innovations onto the market in a targeted fashion. The basis is a revolving mixed asset fund with basic government funding. Suppliers of innovative, resource-efficient technologies, products and services form the target group of this instrument.

2.3 Core Strategy: “Resource-Efficient Products and Services”

The core strategy "Resource-Efficient Products and Services" aims to incorporate the criterion of resource efficiency into consumer goods, buildings and services. The concept and design of a product determine not just the form, quality, aesthetics and functional characteristics but also the material composition, the consumption of material, energy and water during use and how it can be used at the end of the product lifecycle (e.g. reuse, recycling, conversion). Dynamic standards and labelling requirements are hence very important, e.g. in line with the top-runner principle. They should, to the extent possible, create incentives to keep the entire product lifecycle in mind and to consider when designing a product what can be done during the consumption phase, during reuse and at the end of the product lifecycle in terms of recycling. In addition to product design, it is important to develop special instruments for large material flows, such as construction materials, but also for the material flows of raw materials that are particularly interesting for economic reasons. The metals processed in ICT products are not reused or recycled (e.g. at the end of a product’s life), because the products are kept in households (e.g. mobile phones that are no longer in use) or (illegally) exported (e.g. old vehicles to circumvent laws on old cars). For these reasons the cycle sometimes fails to come full-circle because the incentives to use recycled materials are too weak.

This is precisely where the proposed instruments of this core strategy come in. The dynamic standards and labelling requirements – stipulated in the amended EU Ecodesign Directive – eliminate the “dirty end” and create incentives to improve resource efficiency on the entire market. Promoting resource-efficient product design – combined with these dynamic standards – establishes a resource efficiency orientation more quickly in the day-to-day work of product designers and creates opportunities for more resource efficiency-oriented product-service systems. The hybrid governance for rare metals negotiated between companies in a value chain and government institutions creates new incentives to bring material cycles full-circle by defining minimum percentages of recycled materials that must be used in new products and stipulates their implementation in global value chains by way of information and certification requirements. The primary construction material tax supports a shift to secondary construction materials. The target groups of all four instruments are product manufacturers and the service providers operating at the end of the product lifecycle (e.g. those involved in reuse and recycling).

EUR 50 million are required for the first three instruments. The primary construction material tax will generate roughly EUR 1,200 million and can thus finance the entire policy mix of all core strategies proposed. With the exception of hybrid governance which, as a new instrument, requires a longer leadtime and more intense negotiation, the instruments should implemented in the short term as a matter of priority.

Dynamic Standards and Labelling Requirements (amended EU Ecodesign Directive)

The dynamic standards aim to increase the resource efficiency of products – from production through (re)use all the way to recycling – and to encourage more use of secondary materials and renewable raw materials. The idea behind making the minimum product-specific standards dynamic is to continually take account of technical advances and stimulate innovation. In concrete terms, the specific resource consumption can, for example, be stipulated (e.g. maximum consumption of water in the use phase or in production) and a minimum set for the percentage of specific secondary materials that must be used in new products. Information and certification requirements could be established to make data easier to obtain. To keep pace with technical advancements the minimum standards could be made dynamic – as is the case in the EU Ecodesign Directive – either through dialogue with experts at fixed intervals or by applying the top-runner principle. The latter uses the most resource-efficient devices on the market as a benchmark for imposing stricter standards, and manufacturers are given a certain period of time to bring their products into line. The top-runner principle produces good results if the competitive market is dynamic. Top-runner approaches generally lower the costs of providing information and give the standard more legitimacy because proof of the technical feasibility of the standard already exists.

Pioneers could and should benefit from labelling requirements as the successful example of appliances has clearly shown. But the labelling categories must be continually adjusted to technical advancements, so that Category A is always reserved for the small group of top-performing devices on the market and no new labelling categories (e.g. A++) are created that might be confusing to consumers. To accelerate the extension of the Ecodesign Directive to all resources (i.e. to energy and, in some cases, to water consumption in the use phase) and to the entire value chain (i.e. from resource through to production and even after the use phase), Germany should become more intensively involved in the consultations on the Ecodesign Directive and its further development as well as associated activities at EU level.

Promoting Resource Efficiency-Orientated Product Design

Pilot product design projects should be used to encourage a resource efficiency orientation over a product’s entire lifecycle. In addition, given that prizes and awards are common for design, other possible ideas for furthering resource efficiency would be competitions for sustainable and resource efficiency-oriented product design, a resource efficiency design award or manufacturer prizes for the development and market launch of top-performing devices.

Hybrid Governance to Increase the Use of Secondary Materials for Rare Metals in New Products

The proposed hybrid governance model is based on goals negotiated between companies in a global value chain and government institutions (such as a “minimum percentage of secondary materials” to increase the amount of secondary resources used in new products) coupled with mandatory information and certification requirements related to resource conservation (“no data, no market”). These requirements ensure verification that the agreed minimum quantities have actually been complied with in the final product. The instrument combines self-regulation and knowledge generation approaches with legislative approaches. Hybrid governance is an important way of promoting resource efficiency in global value chains to which national policy has only very limited access. Rare metals are interesting for this new policy form because currently the closure of material cycles involving rare metals is not of a sufficiently high quality and these metals are of great economic and ecological importance. In developing countries in particular, the inefficient and low-tech recovery / extraction of a relatively small number of metals has a considerable environmental impact and also entails health risks and material losses. The instrument should initially be developed and tested in an exemplary manner for mobile phones that contain these rare metals. It could then be extended to other products and material cycles based on the experience with mobile phones.

Primary Construction Material Tax

The use of primary construction materials such as sand, gravel, crushed rock and limestone has a massive direct and indirect environmental impact along the entire value chain. The result of high primary construction material extraction and consumption is extensive destruction of the landscape and a negative impact on ecosystems (e.g. emissions, adversely affected groundwater, habitat fragmentation). Particularly in the production of concrete and cement, high energy consumption causes considerable greenhouse gas emissions. The uninterrupted physical growth of infrastructure in building and road construction also entails extensive land use and surface sealing. The ratio between new construction and maintenance is a decisive factor as well as the percentage of secondary construction materials used. Germany extracts roughly 550 million tons annually to meet its domestic demand and is the third-largest producer of construction minerals after Spain and France (BGS 2009). The percentage of recycled and secondary construction materials, however, is only approx. 10% (compared with 25% in Britain). To encourage more use of recycled and secondary building materials, the German government is proposing to impose a nationwide consumption tax on the extraction and import of primary building materials based on the successful British model. The tax would affect companies that extract and import raw materials and would initially be at least EUR 2 for every ton of sand, gravel, crushed rock and limestone extracted. The revenue from a primary construction material tax would therefore be around EUR 1.1 billion and would be sufficient to finance all the core strategies proposed here. Because the primary construction material tax is designed to encourage a reduction in the consumption of primary construction materials, a quantity tax would be preferable. An annual 5 percent progression announced far in advance would counteract the loss in value of the quantity tax brought about by inflation and create a steadily increasing incentive.

2.4 Core Strategy: “Incentives for Resource Efficiency Solutions via the Financial Sector”

The financial sector can play a key role in ecological modernisation and increasing resource efficiency because it can control financial flows on the basis of various criteria. The financial sector has a hand in deciding whether resource efficiency innovations can be financed in companies and, if so, how financial support can be provided for extensive market launches by companies. Resource efficiency is currently only a peripheral issue in the financial sector, both in the debate about the relevant financial issues as well as in the key decision-making factors, i.e. the key performance indicators. These determine not just the direct financing conditions for companies but also the rating and risk-management processes on the financial markets and the listing conditions for prime market segments on stock exchanges. With this in mind, it is important to establish resource efficiency as a key factor for competitiveness in the financial sector – as a central starting point for lowering costs and as a dynamic growth market for GreenTech. To achieve this goal, a Enquete Commission focusing on “Resource Efficiency and Sustainability in the Financial Sector” should first be set up. Second, resource-related Key Performance Indicators (R-KPI) must be developed because in the financial sector they are a central basis for evaluation and decision-making processes. The R-KPIs translate the idea of resource efficiency into directly usable criteria for the financial sector in its day-to-day work, including rating, risk- management or listing. To generate solid data for their work quickly, the financial authorities should use the R-KPIs to define the legal and supervisory rules for risk management by financial service providers more precisely, and reporting on R-KPIs should be made mandatory in company management reports. When resource efficiency starts to play a more important role in the financial sector and the R-KPIs provide adequate indicators, it will be easier to convince stock exchange operators and the stock exchange council to integrate R-KPIs as a listing condition for prime market segments on stock exchanges.

The instruments should be implemented in the short term and given high priority. Around EUR 10 million is proposed for implementation, primarily for the research programme.

Enquete Commission “Resource Efficiency and Sustainability in the Financial Sector”

An Enquete Commission should be set up that focuses on "resource efficiency and sustainability in the financial sector" to stimulate the debate on the critical role of the financial sector in environmental modernisation and in the implementation of a resource efficiency strategy and to further reinforce the political decisions in this complex field. The mission of the Enquete Commission would be to explore this range of issues for political decisions – supported by a research programme – and to involve the primary stakeholders from both the financial and other sectors. Political strategies could then be developed on this basis. Setting up a Enquete Commission could also help bring back together the financial sector and the real economy, which have drifted away from one another, and to pursue a more forward-thinking development path. Given the central role of the financial sector, establishing a Enquete Commission should be a matter of high priority. The research programme should be interdisciplinary so that concepts ready for implementation can be developed with actors from the financial sector and other stakeholders.

Resource-Related Key Performance Indicators (R-KPI)

Financial service providers do not at present include resource efficiency in their financing and investment decisions because the appropriate indicators and necessary data are still lacking. Because the issue of resources has not yet been established as a risk aspect, the current regulation of risk management among financial service providers does not include the risks of company resource use although the financial authorities could already today exploit the latitude they have for interpreting the applicable regulations – for example to allow rating agencies to change their rating and risk-management processes. The goal is hence to develop a set of widely applicable and relevant resource-related Key Performance Indicators (R-KPI) and to create the necessary data basis quickly and efficiently. The R-KPIs should represent resource consumption at company level in a meaningful way that permits comparison and practical application. The set should also include usable industry-wide and industry-specific indicators for the financial sector for which KPI sets would serve as the basis. The indicators should be gathered by companies independently and it should be possible to reference the data from the Federal Statistical Office for upstream chains. The relevant stakeholders – financial sector, private sector, auditors, Federal Statistical Office, relevant research institutions – should be included in developing the R-KPIs and creating the concept for the data basis. Work should begin soon on developing the R-KPIs and creating a concept for the data structures and should be completed as quickly as possible as part of the discussion already being held on the reform of the financial sector. R-KPIs can be used at various levels in the financial system and offer a simple way to represent resource issues in the day-to-day work of financial service providers. They should also be used by the financial authorities to further refine the legal and supervisory rules for risk management of financial service providers in Germany and could be integrated via the appropriate bodies into the international process of financial market regulation (Basel III ff.). In addition, R-KPIs could be made mandatory in company management reports; this would entail using the R-KPIs to make the commercial requirements for disclosing non-financial performance indicators more precise. The publication of management reports on this basis would then make the information supplied by the R-KPIs relevant for auditing. German stock exchanges impose extensive requirements on capital market companies seeking admission to their prime segments (e.g. Prime Standard). In this context the R-KPIs could be used to provide adequate indicators about resources and could be included as listing conditions. This could be an interesting option for stock exchange operators or the stock exchange council if the issue of resource efficiency started to play a more important role in the financial sector. The stock exchange regulatory authorities of the German federal states could support this process.

Developing the R-KPIs should be given high priority owing to their potential widespread impact; the costs for developing and implementing the R-KPIs are contained in the funding programmes slated for this core strategy.

2.5 Core Strategy: “Government as a Consumer and Provider of Infrastructures”

The government is a central actor both as a consumer of products and services and as a provider of infrastructures. The government has a 24.4% share in the demand for goods and services and a 10% share in construction demand (Federal Statistical Office 2009). The fact that the government could also capitalise on its market power to create sustainable future markets is often forgotten – as is its ability to function as a role model. The government has considerable room to manoeuvre within its own area of activity, and at the federal level could take the lead in lowering costs by increasing resource efficiency in the public arena. On account of its considerable market volume the government can change markets by increasing demand for resource-efficient products and services (e.g. lowering development risks through contractually agreed minimum demand) hence sending signals for innovation and market development. Increasing resource efficiency through the government involves decisive control variables at three levels: lifecycle costs as a mandatory procurement criterion for purchasing products and services; demand bundling to encourage innovation towards more resource-efficient products and solutions through a guaranteed sales volume; and resource efficiency-optimised infrastructure systems. At the request of the task sponsor, public procurement was only addressed in the general analysis phase of the MaRess task “Consumer and Customer-Oriented Approaches to Increasing Resource Efficiency”, which identified the central political approaches.

The three instruments proposed must and can be implemented without incurring costs if the policy is designed accordingly. Experts estimate that approx. EUR 100 million will be needed for the launch phase and the pilot projects, a sum that could be recouped through the potential savings. Making lifecycle costs a mandatory procurement criterion should be given high priority in the short-term, followed by the other two instruments.

Lifecycle Costs as a Mandatory Procurement Criterion

The goal is to change the procurement guideline with the aim of establishing lifecycle cost considerations as a mandatory procurement criterion and thus promote resource efficiency. The ongoing simplification and modernisation of the German public procurement law (legal and administrative regulations in particular) could be used to achieve this goal. Implementation should be vigorous at all political levels (from “the very top”) because resource efficiency reduces the costs of public procurement over the lifecycle of the purchased products; additional costs are usually only generated in the short term when procurement routines are changed.

Demand Bundling to Minimise Risks for Innovation Processes

Bundling of government demand for innovative and particularly resource-efficient products creates an incentive for companies to come up with new solutions because the risk is minimised by a minimum guaranteed purchase quantity. The goal is to develop a concrete implementation concept for demand bundling in the field of resource efficiency. Specifically adapted solutions should be developed, tested and optimised for deployment in other product categories on the basis of pilot projects for two to three selected product categories. The product groups should be selected in terms of their high relevance to the public procurement system and their suitability for demand bundling. The results of the MaRess task “Identification and Analysis Potential of Innovative Groundbreaking Products, Technologies and Markets to Increase Resource Efficiency” should be used in this process. Implementation can start in the short term and be completed in the medium term. Start-up financing is important for the launch phase. Once the instrument becomes established, support will no longer be necessary.

Resource Efficiency-Optimised Infrastructure Systems

The infrastructure provided by the government is resource-intensive. Consequently, in expanding, renewing and maintaining this infrastructure it is important to take resource efficiency into account. Alternative system solutions optimised for resource use (e.g. transport; drinking water and wastewater; telecommunications; and electricity, gas and district heating) must also be considered. The data basis for the infrastructures developed in the “Metal Raw Materials, PGM and Infrastructure” task of the MaRess project offers a data basis for this. The goal is to derive policy recommendations for the individual infrastructure systems and implement them as quickly as possible because infrastructure systems usually have long lifecycles. The focus on cost-saving non-resource-intensive infrastructures will lower costs and hence enable the necessary concept studies, policy analyses and pilot projects to be financed.

2.6 Core Strategy: “Changing Attitudes”

While the significance of climate protection and energy efficiency is generally acknowledged today, this is not yet the case for resource problems, which are really just as urgent. Target group-oriented agenda setting and qualification programmes should thus inform decision-makers from the private sector, professional associations and the political realm as well future decision-makers currently in training or studying at universities about the key issue of resource efficiency and motivate them to take action and put it into practice. Instruments at two levels are recommended for the core strategy “Changing Attitudes” to create a successful resource policy:

- Agenda setting focused on selected target groups: continuation of the Resource Efficiency Network formed by the Federal Ministry of the Environment in 2007; a short resource-efficiency campaign targeted at (future) decision-makers followed by a Concerted action resource efficiency that brings together the top representatives from politics, business and the media.
- Appropriate qualification options for selected target groups. These would serve as the basis for implementing increases in resource efficiency more successfully and easily. Priority should be given at the outset to options for qualifying advisors and establishing a "virtual resource university" followed by the development of course materials for schools.

The instruments were chosen because we realised that the success of the other core strategies would be questionable if they were not accompanied by a general change in awareness (“Changing Attitudes”). The idea here is to raise awareness about the issue, make successes more visible and to raise qualifications. Because the resources for agenda setting and educational activities are limited, the leveraging effect of multipliers must be used and the focus placed on selected target groups open to change (Kristof / Liedtke 2010). The costs for the instrument selected for this core strategy are estimated at approximately EUR 300 million.

Resource Efficiency Network

Continuing the successful activities of the Resource Efficiency Network should be given priority. In addition to the network conferences that take place every six months with multipliers from politics, business and environmental associations, companies, private or public advisory institutions, media, etc., on-site conferences that target companies (SMEs in particular) should also continue to be offered in various regions and industries. An annual international resource conference would also be important because the issue of resource efficiency is increasingly gaining momentum internationally. In support of this, a short English version of the website would also be useful to help advance internal EU discussions. The network should be supplemented, as has been the case until now, by newsletters, the website and, increasingly, also by qualification options for advisors, the financial sector and other intermediaries. Co-operative network activities in which the Resource Efficiency Network supports and assists the activities of the various actors should also continue to be initiated and supported. Here, the experience from the dialogues and roadmaps already incorporated into the Resource Efficiency Network can be built on. Pilot or flagship projects could play an important role in concrete implementation and diffusion. Regular theme-based campaigns or special offers for the younger generation of skilled workers or Web 2.0 users would also be conceivable. The Resource Efficiency Network is designed as a learning network so that it always has the ability to adapt to the current needs of its members in a rapidly changing world. Consequently, further developing the concept of the network design based on a regular evaluation is useful.

Resource-Efficiency Campaign

The resource efficiency campaign is a very important resource policy instrument for winning people over. A market-ready campaign was designed for (future) decision-makers from universities in the MaRess task "Strategies for Successful Marketing" (Albrecht / Baum, 2009). The results of the possible activities for private households discussed in the task “Consumer and Customer-Orientated Approaches to Increasing Resource Efficiency” in the MaRess project could be used to reinforce the content. The resource-efficiency campaign should start as soon as possible. The necessary impact cannot be achieved with a budget of less than approximately EUR 2.5 million for the launch phase; the campaign should be continued and expanded in subsequent years for other target groups.

A Concerted Resource-Efficiency Campaign

Leading representatives from politics, business and media could then be brought together in a concerted campaign to give the message of resource efficiency a more central place in the public debate. The concerted campaign could capitalise on the momentum generated by the resource efficiency campaign. The people involved have an impact as role models and multipliers, they are mouthpieces to the social groups they represent and they convey credibility through their own commitment, – e.g. via flagship projects – which lends this issue the urgency it needs. The issue could take on symbolic power much more quickly this way. The process and the flagship projects will require funding that could be supplied jointly by all the participating actors.

Qualifying Advisors

To truly be able to increase resource efficiency in concrete terms, companies need qualifications and technical, methodological and social expertise. However, this is often lacking. Companies primarily receive support from their environment, i.e. from advisors, qualification facilities, chambers of industry and commerce, chambers of trade and from other publicly and privately financed actors. Evaluations show, however (e.g. Kristof / Lemken / Roser / Ott 2008), that these actors have considerable gaps in knowledge and require further qualification in the areas of technical, social, methodological and implementation expertise when it comes to resource efficiency. As a result, one important goal should be to properly qualify private and intermediary actors who advise and support companies as soon as possible and to create the necessary qualification structures. This would increase companies’ chances of success in their bid to increase resource efficiency. The goal is to gauge the qualification needs of professional training facilities, multipliers and other actors and to jointly develop educational concepts and course materials with relevant active intermediaries and qualification providers.

Establishing a “Virtual Resource University”

The goal of a "virtual resource university" would be to tap into synergies by creating networks for research departments already working on resource efficiency (including energy and energy efficiency) and hence boost research and education in the area of resource efficiency. The university network for resource efficiency should conduct interdisciplinary research, develop joint research projects and apply for funding. To reach this goal, a concept for the network must be developed and joint projects for implementation initiated. Shared research infrastructure and jointly funded innovation campus projects could strengthen network activities but also encourage the exchange of scientists and the diversity of the courses offered. The activities should start soon to further expand the network of universities initiated in the MaRess project through the broadly based involvement of partners from universities and harness the momentum that the resource efficiency campaign is intended to bring to universities.

Developing Course Materials for Schools

Study seminars designed to train future teachers can be used to educate teachers nationwide about resource efficiency. Courses and training could first be developed for the study seminars to familiarise future teachers with the issue. Second, the future teachers could develop course materials for resource efficiency as part of their practical work coached by their trainers. These could then be distributed via an Internet platform to capitalise on additional synergies. The goal of the Internet platform would be to make well-designed course materials about resource efficiency available nationwide. The educational materials would be freely available to teachers but also for professional training and adult education. These activities should take place after the "virtual resource university" has been established.

3 Summary and Outlook

To create a successful resource policy, policymakers can use the six core strategies in the MaRess project and the instruments proposed for their effective implementation for orientation. The following core strategies and policy instruments are proposed:

Three instruments are proposed for the **core strategy “Mobilising Institutions – the Key to Successful Diffusion”**. The first and central component is a nationwide resource efficiency stimulus and advisory programme. This is coupled with the second component, which entails setting up and expanding the Resource Efficiency Agency as the hub for all diffusion activities in and for companies and for programme bundling, evaluation and further development. Successful implementation requires “caretakers” and intermediary coordination as an operationally extended and politically independent lever of a cross-departmental and modern resource policy. Third, on-site support for implementation must be increased because the federal resource efficiency agency must have a lean structure and will primarily fulfil an initiation and support function based on the resource efficiency stimulus and advisory programme. The key actors for increasing resource efficiency are the relevant advisors, regional intermediaries and company networks in regions and industries. The expansion and qualification of the existing pool of advisors and the support for regional structures and networks can thus offer the necessary technical and implementation expertise for the companies in a region. The core strategy can build on the existing advisory institutions at federal, state and regional level as well as on the established funding programmes and the Resource Efficiency Network.

The **core strategy "Giving Innovation a Direction – Sustainable Future Markets for Resource Efficiency Solutions"** can be pursued first by systematically setting new resource-efficiency-related focal points in existing funding programmes / funding priorities with the aim of creating a closed-loop innovation and market launch programme for resource efficiency that is more in line with ambitious resource efficiency targets and existing potential. Second, easier access to venture capital should be encouraged because venture capital is a key prerequisite for successful diffusion on the market – closely linked to the innovation and market launch programme. The entire financing chain is thus integrated and the opportunities for real innovation increase. In addition to procuring venture capital, it is also important for companies to be able to professionally implement innovation processes both internally and in cooperation with other companies and research institutions. To achieve this goal, the third component is to encourage innovation agents and the fourth component, resource efficiency-oriented innovation laboratories.

The **core strategy “Resource-Efficient Products and Services”** has four instruments to create resource-saving incentive structures that support the transformation of the market: First, establishing dynamic standards and labelling requirements for resources as part of the amendment to the EU Ecodesign Directive; second, and directly related, supporting resource efficiency-oriented product design; third, introducing a primary construction material tax based on the British model; and fourth, a hybrid governance model that combines self-regulation and knowledge generation in value chains with regulatory approaches that aim to increase the secondary resource percentage of rare metals used in new products. The selected instruments will make it possible to promote particularly resource-efficient products and make them more visible: It will also help increase the resource efficiency of average products on the market and to gradually eliminate the “dirty end”.

In the **core strategy “Incentives for Resource Efficiency Solutions via the Financial Sector”**, a Enquete Commission “Resource Efficiency and Sustainability in the Financial Sector" will explore the issue of resource efficiency in the financial sector which scarcely plays a role today. In addition, resource-related Key Performance Indicators (R-KPI) will be developed and the respective data basis created to make the issue of resources more transparent for the decision-making processes in the financial sector (e.g. for risk management and lending rules). The R-KPIs should also be used for financial oversight and corporate reporting.

By virtue of its considerable market volume the government can systematically send signals for market development if it increases demand for resource-efficient products and services and reduces development and marketing risks. The **core strategy “Government as a Consumer and Provider of Infrastructure”** is therefore made up of three elements. First, purchases should only be made on the basis of lifecycle costs as a mandatory procurement criterion. Second, bundling of government demand for innovative and particularly resource-efficient products creates an incentive for companies to come up with new and particularly resource-efficient solutions because the risk is minimised by a minimum guaranteed purchase quantity. The publicly available or controlled infrastructures are often resource-intensive; which is why a third component is necessary: optimising their construction and maintenance with a view to increasing resource efficiency. The question of whether switching infrastructure systems makes sense from the perspective of resource efficiency and costs should also be analysed.

The **core strategy “Changing Attitudes”** first aims to inform (future) decision-makers from the private sector, professional associations, politics and academia about resource efficiency through target group-oriented agenda setting and to motivate them to take action and put it into practice. Second, offering opportunities for additional qualification can create a basis for increasing resource efficiency more successfully and easily. The Resource Efficiency Network formed by the Federal Ministry of the Environment in 2007 is slated to play a key role. In addition, a resource efficiency campaign with the target group “(future) decision-makers” is to be launched for which a market-ready campaign concept was developed under the auspices of the MaRess project (Albrecht / Baum 2009). The issue could then be further addressed in a concerted campaign that brings together leading representatives from politics, business, academia, society and the media with the goal of making it an issue of broad public discussion. The priorities in terms of qualification should initially be on further qualifying advisors, on establishing a “virtual resource university” and on developing course materials for schools. These instruments were selected in view of the awareness that the success of the other core strategies will be limited unless they are accompanied by a change in mentality and visible achievements.

Tab. 2 summarises the core strategies, the proposed instruments allocated to them and the budget impact. It also provides information about priorities and the proposed timeline and sequence. The target groups and resources are also outlined. According to expert projections from the MaRess Consortium and a short expert report for the Federal Ministry of the Environment (Hennicke et al. 2008), the financial volume affecting the budget for these programmes is estimated at roughly EUR 1.3 billion per year. The total volume of approximately EUR 1.3 billion per year could be covered by the proposed primary construction material tax or by self-financing instruments (e.g. reduced costs of public procurement). The macro-economic multiplier effect is considerable and produces additional state revenues. If the primary construction material tax is not implemented, the funding should be made available by re-allocating existing resources. After five years, the implemented instruments should be evaluated. The proposed policy instruments can then be further developed and secured, possibly by passing a framework law on increasing resource efficiency and, if necessary, scaled up.

Tab. 2: Core Strategies, Prioritised Policy Instruments and Estimated Budget Impact

Core strategy	Instruments	Priority	Timeline	Target groups	Target resources	Budget impact
"Mobilising Institutions – the Key to Successful Diffusion"	Resource efficiency agency (including evaluation to optimise funding structures)	1.	Short-term	Company	All	EUR 450 million
	Resource efficiency stimulus and advisory programme	1.	Short-term	Company		
	Expansion of the pool of advisors and regional structures	1.	Short-term	Advisors and intermediaries		
"Giving Innovation a Direction – “Sustainable Future Markets for Resource Efficiency Solutions"	Resource efficiency innovation and market launch programme	1.	Short-term	Producers and users of resource-efficient technologies and suppliers of resource-efficient products / product-service systems	All (focus on TOP 20 from Task 1)	EUR 300 million
	Innovation agents	1.	Short-term			
	Innovation laboratory specialising in resource efficiency	2.	Medium-term	Co-operation between companies and research institutions		
	Venture capital for resource efficiency solutions	2.	Medium-term	Innovative suppliers of resource efficiency-oriented technologies, products and services		Refinancing (EUR 100 million)
"Resource-Efficient Products and Services"	Dynamic standards and labelling requirements (amendment to the EU Ecodesign Directive)	1.	Short-term	Producers of products and services at the end of the service life (e.g. reuse, recycling or disposal)	Abiotic / biotic materials, water	EUR 50 million
	Promoting resource efficiency-orientated product design	1.	Short-term		All	
	Hybrid governance to increase the use of secondary materials of rare metals in new products	2.	Medium-term		Metals	
	Primary construction material tax	1.	Short-term		Materials	Revenues of EUR 1,100 million
"Incentives for Resource Efficiency Solutions through the Financial Sector"	Enquete Commission “Resource Efficiency and Sustainability in the Financial Sector"	1.	Short-term	Policymakers, financial sector and academia	All	EUR 10 million (research programme in particular)
	Resource-related Key Performance Indicators (R-KPI)	1.	Short- and medium-term	Financial sector and academia		

Core strategy	Instruments	Prio-rity	Time-line	Target groups	Target resources	Budget impact
"Govern-ment as a Consumer and Pro-vider of Infrastruc-ture"	Procurement based on lifecycle costs as a mandatory procurement criterion	1.	Short-term	Those responsible for public-sector procurement	All	Cost-neutral (EUR 100 million for the initial phase refi-nanced by low-ered costs)
	Demand bundling to minimise risks for innovation processes	2.	Me-dium-term	Those responsible for public-sector procurement	All (focus on TOP 20 from Task 1)	
	Resource efficiency-optimised infrastructure systems	2.	Me-dium-term	Public sector as provider of infra-structure		
"Changing Attitudes"	Resource Efficiency Network	1.	Con-tinue	Companies and intermediaries	All	EUR 300 million
	Resource efficiency campaign: Target group of (future) deci-sion-makers	1.	Short-term	(Future) decision-makers		
	Concerted action resource efficiency	2.	Me-dium-term	Multipliers from poli-tics, business, aca-demia, society, me-dia		
	Qualifying advisors	1.	Short-term	Qualification provid-ers and advisors		
	Establishing a “virtual resource university”	1.	Short-term	Academia		
	Developing course materials for schools	2.	Me-dium-term	Teacher training		

Source: Kristof / Hennicke 2010

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Material Efficiency & Resource Conservation

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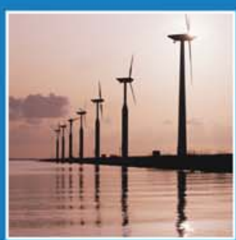
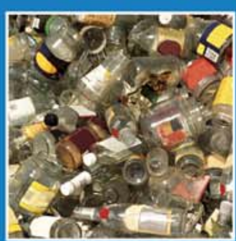
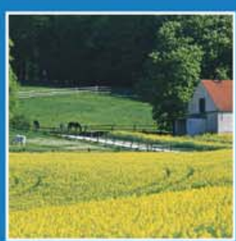
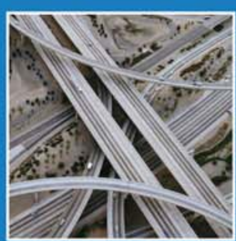
Resource Policy to Design Framework Requirements

Executive Summary

Summary report of Task 3 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project

ResourceEfficiency Paper 3.12

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Federal Ministry for the
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and Nuclear Safety

Umwelt
Bundes
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Resource Policy to Design Framework Requirements: Executive Summary

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1 The Function and Goals of Resource Policy

Natural resources are the foundation of all economic activity. No economy can do without raw materials. The growth of the service economy has created new sources of value creation, but has not led to an absolute reduction of raw material consumption. The sales volume of raw materials has rapidly increased, creating a global network of supply relationships. Companies are becoming dependent on suppliers from sites around the world. These developments have enabled the continuous production of low priced products; concurrently, global market penetration and the volume of goods produced are rising. For the producers of natural resources the exploitation of sources of raw materials and global trade are often associated with a new prosperity.

The current utilization of resources, especially non-renewable ones, is, however, not sustainable. The extraction of metal ores, coal, oil, building materials and other materials often causes devastating environmental impacts. In addition to the increasing consumption of land and nature, transportation and processing of natural resources as well as the use of the resulting products is associated with large emissions of contaminants and greenhouse gases, as well as energy and water consumption. Finally, these material streams also produce enormous amounts of waste.

Current usage of resources is not only facing ecological limits. Economic limits are also becoming noticeable: for example, scarcities of certain metals which currently seem indispensable for use in information and communication technologies are clearly indicating the limits of natural resource reserves. Some other materials have adequate natural resource reserves, but have experienced rapidly rising prices due to skyrocketing demand, strong concentration of natural deposits in individual countries and in the hands of specific resource extraction companies, or their coupling with co-products in extraction. However, notable economic opportunities exist for an efficient use of natural resources: numerous studies demonstrate the considerable growth potential of resource-efficient products and recycling-technologies.

For this reason the Federal Government has stated the goal of doubling natural resource productivity: by 2020 every euro of value creation should be produced with half of the abiotic natural resources used in 1994. Insofar as efforts towards this goal lead to an absolute reduction of natural resource use, it would be associated with formidable environmental load reduction at every stage of the supply chain. The costs associated with the adjustment of products and processes would in many cases be compensated by reduced material consumption. As with energy use there are notable non-realised efficiency potentials in the utilization of natural resources.

Economic theory would suggest that companies have a strong incentive to exploit these efficiency potentials to gain competitive advantages. Scarcity of resources will be reflected in rising prices, triggering innovations for substituting or limiting the use of scarce materials. From this perspective resource policy should be limited to internalising harmful environmental effects into the price of resource use, while enabling market and pricing mechanisms to determine the optimal allocation of goods . The free market is viewed as the most efficient form of regulating the use of scarce resources.

However, research shows that this is not the case. Efficiency potentials have not been maximised, scarce resources not substituted. Moreover, resource extraction and the associated environmental damage (negative externalities) and final resource use are often geographically and temporally distinct. In many cases the necessary knowledge about environmental consequences, about possibilities of avoiding them as well as about appropriate and intelligent incentives are missing.

Sustainable resource use – material efficiency and resource conservation – faces a number of challenges. These include:

- **External effects**: It is possible to externalise the environmental damages from resource utilization, e.g. from resource extraction and environmentally damaging recycling practices. These costs are not born by the beneficiaries of resource use, but by the general public. The failure to internalise environmental costs is proof of market and policy failures.
- **Information deficits:** Company internal information deficits on potential savings as well as uncertainties about future market developments and natural resource prices contribute to the absence of innovations. Moreover, the widespread short-termism of economic actors in the form of reporting years and short production cycles suppresses planning for medium-term foreseeable scarcities for a number of metals and minerals. Furthermore, increasingly complex production chains and shorter product life cycles have led to information deficits on the composition of pre-products, the source of materials and conditions under which resource extraction takes place, and the whereabouts of end-of-life products. The lack of information of market actors is a further source of market failure.
- **Non-utilized innovation potentials:** Many sectors show underutilized innovation potentials for the development and diffusion of resource efficient products. This under-utilization is due, on the one hand, to the inherent incentive structures of innovations (unforeseeable risks, missing capital, spill-over-effects, missing infrastructure, etc.) and, on the other hand, to positive externalities: the benefits of innovations are realized by society as a whole. As a result, there are too few incentives for private actors, especially to induce far reaching system innovations.

The identified barriers allow one to deduce the following key areas for a resource policy.

1. A sustainable **environmentally sound utilization of resources**: requires the avoidance of negative externalities along the value-added chain. This includes the preservation of ecosystem functions and services which are particularly endangered by the extraction of natural resources or the improper disposal of end-of-life equipment. Reducing material intensity and preventing resource

losses by closing material cycles and establishing efficient recycling structures are further points of departure for reducing environmental impacts.

2. Security of supply: Medium-term scarcities are foreseeable for a multitude of natural resources. This includes several critical metals which are relevant for the production of technologies of the future. Even metals with adequate reserves have experienced rapidly rising or highly volatile prices on commodity markets. Resource policy, therefore, also aims to reduce natural resource use by exploiting efficiency potentials, thereby contributing to security of supply. Again the before mentioned closing of material cycles and optimization of recycling are important points of departure.
3. The competitiveness of domestic industries is to be secured in the future by stimulating **economic modernization effects**. These effects require political, legal and economic incentives towards a self-supporting development and the diffusion of green future technologies for material efficiency and resource conservation. These include the promotion of product innovations and more encompassing system innovations as well as support of the diffusion of innovations into the mass market. Overall, visions for sustainable resource consumption can be devised and realized through eco-innovations (Bringezu 2009). Material and resource efficiency innovation potentials exist that have not yet been fully realized.

There is no single policy tool that would be equally suited for all problem structures, goals, actor types, kinds of resources, etc. Instead a policy-mix is required that overcomes a variety of barriers, is mindful of separate innovation stages, and effectively addresses future global challenges. The suggested policy instruments can be grouped into the following categories:

- **Regulation**: States use regulatory measures to directly influence product design or production processes (e.g. in the form of prohibitions or product requirements). They aim at reducing or preventing negative environmental impacts or, where appropriate, to hold polluters responsible for environmental damage. Main disadvantages of this approach are the high information and legitimacy demands. Therefore, binding regulation needs to be linked with instruments of self-regulation (hybrid governance arrangements, Hey et al. 2007). The proposed instrument „Dynamic Standard Setting/Resource Top-Runner“ in MaRess Task 3 belongs to this group. A different form of regulation is the linking of reporting requirements for producers with market access for their products. Due to the complex nature of product life cycles and non-transparent supply chains, information on the natural resources found in products and their origin is often unavailable or only available in a limited form. Such information is, however, imperative for effective regulation. On the one hand, information generating instruments form a necessary basis for regulation (e.g.. material bans or substitution requirements) and, on the other hand, they can influence the behaviour of producers and consumers.

- **Economic incentives**: Taxes and duties can be used to induce short-term price changes for certain resources, thereby sending price signals to producers and consumers. Rising resource prices can induce innovation leading to positive economic developments in the medium-term. Fiscal tools can be used to make these incentives calculable and stable. They can help resource conserving innovations achieve higher demand and market penetration. Moreover, they serve as instruments for the internalization of negative externalities. MaRess Task 3 illustrates the effects of fiscal tools with the example of a building materials tax.
- Economic incentives can also be directly targeted at promoting innovation and the diffusion of innovations into the mass market. The state can use the entire spectrum of innovation policy tools, such as the direct support of R&D projects, the provision of risk capital or the promotion and funding of networks or clusters. In addition to supply side innovation policy it is also sensible to support the diffusion of innovation policy into the mass market. Export promotion is a potential instrument to support demand for innovate products. The MaRess Task 3, therefore, also studies the German export promotion initiatives in the area of recycling and efficiency technologies.
- **Private regulation** and the negotiation of standards: considering the limited (territorial) reach of state intervention contracts between state and private actors (so called covenants) present an opportunity to govern trans-boundary material streams and to involve a large number of actors along the product life cycle. The instrument aims at an improved assignment of responsibilities for materials used (material responsibility). Such an approach is introduced using the example of end-of-life vehicle recycling. The covenant is supposed to contribute to the closing of material cycles and to the avoidance of resource losses.

The aim of a resource policy is to design framework conditions for economic activity that provide incentives for efficient and sustainable, utilization of resources and that initiate search processes for more resource efficient technologies. Key areas of a resource policy are „avoiding negative environmental impacts“, „security of supply“, and „realizing competitive advantages“. Under increasingly globalized production chains and product life cycles, the conception of a role for the state necessarily goes beyond the national context and must acknowledge the framework requirements established by the single European market and international agreements. These include both challenges and opportunities. On the one hand many relevant policies, including environmental policy, but also trade, economic and innovation policy are Europeanized, making unilateral national action increasingly difficult. Moreover, the environmental impacts of resource use (such as those resulting from resource extraction and the disposal of end-of-life equipment) are primarily felt in jurisdictions outside those where the end products of the natural resources are consumed. On the other hand, internationalization provides an opportunity for innovations to create further international markets. If environmental concerns can be integrated into the mechanisms of world trade and the standardization of products and services, a potential for mutual amplification could develop (Oberthür / Gehring 2006, Gehring 2007, Bleischwitz et al. 2009). Furthermore, environmental technologies that have demonstrated their technical and economic feasibility often experience high demand in important emerging economies (Walz 2010).

Accordingly, the MaRess Task 3 developed resource policy tools which aim to create dynamic framework requirements. The Task used a case study approach in which various modes of governance, policy and problem areas were examined in detail. Environmental, economic and innovation policy tools that use economic incentives, regulatory approaches, self-regulation and information based governance mechanisms were analyzed. The selected tools were subjected to a comprehensive impact assessment taking into consideration ecological, economic and social aspects as well as their legal and political feasibility. To conduct the impact assessment the tools were applied to concrete material streams and industries. The goal was to demonstrate the effectiveness and necessity of resource governance and provide exemplary an impact assessment.

2 An Overview of Suggestions for Resource Policy Tools to Design Framework Requirements

2.1 Resource Information and Certification Obligations in Supply Chains (RICOS) for the ICT Sector

Missing information on environmental impacts along global value-added chains is a central barrier to effective resource policy. To limit this problem a knowledge generating policy instrument named „Resource Information and Certification Obligations in Supply Chains" (RICOS) is suggested and illustrated with the example of mobile telephones and the critical metals they contain. RICOS combines self-regulatory and knowledge generating approaches with legal instruments. The goal is knowledge generation and the limiting, or rather, reduction of environmental impacts that appear along global material streams, especially in developing countries. By providing basic information, RICOS also serves as point of departure for other tools.

The fulfilment of reporting obligations by producers is the precondition for gaining market access („No data no market").Reporting requirements directly concern the materials used in products, as well as their environmental impacts. These responsibilities would start with resource extraction and, therefore, at the beginning of the supply chain. However, information would also be gathered on the share of recycled materials utilized. All resource related information would be presented in a product data sheet. In the case of Information and Communications Technology (ICT), the input of „critical metals" is of particular importance due to their environmental impacts and scarcity.

The information obligations could be supplemented by obligations for substitution and certification. With help of the producers, it is to be determined for the various relevant product groups whether the „especially problematic“ materials can be substituted by a less environmentally harmful material. Products that contain problematic materials for which substitutes exist would no longer gain market access. An agency would maintain a register of especially problematic materials. This register would be developed step-by-step on the basis of knowledge generated by the reporting requirements of producers. For those metals classified as especially problematic, but not substitutable, there would be an obligation to reduce their environmental impacts. The goal is to promote resource extraction with comparatively low environmental impacts and to continuously reduce such impacts. The effectiveness of the corresponding impact reduction measures is to be ensured through a certification system.

The application of RICOS for product and material streams must take place incrementally and in a dialogue with stakeholders. RICOS will further allow companies to a) take action on their own to provide solutions that might make regulation unnecessary, e.g. by voluntary substitution of certain materials, or b) to prepare for the requirements of the instrument.

2.2 Instruments for Product Input Regulation: The Example of Dynamic Standards / Resources Top Runner

This tool formulates a requirement for the use of secondary material in new ICT products. It contains a minimum input quota for recycled critical metals. The adherence to this standard is a precondition for market access and must be fashioned as a European ordinance. The aim of the regulation is to increase recycling rates as a means of reducing the use of primary materials for especially environmentally intensive metals such as gold, silver or platinum group metals. By creating incentives to introduce end-of-life equipment into the recycling process (generation of demand for secondary materials) it complements the provisions of waste legislation for electronic appliances (European Directive on Waste Electrical and Electronic Equipment (WEEE) and the German Electrical and Electronic Equipment Act). Furthermore, the approach more generally creates an incentive for steering global material intensity for valuable metals.

Concretely, producers must present a product data sheet for each product line that indicates the amount of specific materials used (cf., Chapter 2.1) . As it is not possible to determine whether a metal originates from recycled materials or natural ores, material streams along the production chain have so far not been traceable. In order to circumvent this problem certificates for recycled materials are to be distributed. For every model, producers must prove that they or their suppliers, have met requirements for secondary use of specific materials (ex. gold, palladium, indium, etc.). The certificates are distributed by accredited recycling companies and passed on along the production chain.

The standard can be determined using a top-runner-approach. In this approach the minimum quota is defined taking the best performers in a product category as benchmark. The level of recycled materials achieved in this group becomes a binding minimum standard for all products of this product group. Such approaches have the advantage of initiating an efficiency race between producers, while doubtlessly proving the technical feasibility of the minimum standard. This approach has been demonstrated to be effective with energy using products, e.g. in the Japanese Top-Runner Program. However, an autonomous trend towards more efficient products that results from the expected operating costs and influences consumers’ purchasing decisions already existed in this case. Since such operating costs do not derive from the use of materials, incentives towards more material efficient products must be established exogenously (e.g. by announcing the intention of introducing a top-runner approach). The motivation for producers, then, is to exclude competitors from the market by setting benchmarks. The approach should be complemented with incentives for placing material responsibility at the intersection with the Waste Sector (e.g. standards for „Design for Recycling“).

2.3 Differentiated Value-Added Tax Rates for Promoting Resource Efficient Consumption

The aim of a transformation of the value-added tax (VAT) system oriented towards enhancing material efficiency and resource conservation criteria is to provide a signal that stimulates the demand for environmentally friendly products and services through price privileges in the short-term and, in the medium to long-term, aims at promoting innovation and market development. The intention is both a macroeconomic and consumer-level reorientation. This approach should generally produce incentives to make resource efficient and less environmentally damaging products and services relatively less costly, thereby also easing purchasing decisions for less wealthy consumers (e.g. organic products, energy efficient white goods, or energy consulting and energy-saving renovation).

Next to product and product group specific sectoral reductions or increases of VAT-rates, revisions of existing distortions and inconsistencies should contribute to a tax revenue neutral financing of VAT reductions in other areas in the sense of an ecological finance reform.

In the context of the German tax system, the project proposes a repeal of the VAT-waiver for international flights, a reduced VAT-rate for conventionally produced foods (at a reduced tax rate for organically produced foods) or alternatively a repeal of the reduced VAT-rates for resource intensive foods, such as meat and milk products, and the introduction of a reduced VAT-rate for inner-community and international rail traffic, as well as the introduction of a reduced VAT-rate for resource efficient and service intensive business (KOM(2008) 428).

On the European level, MaRess Task 3 proposes an expansion of the directive which allows the introduction of reduced VAT-rates for approved labelled products (such as the environmental label „ “Blauer Engel“ / “Resource Angel“),or for energy/water/material efficient household technological equipments (A++). How a reduced tax rate for secondary resources or products using secondary material can sensibly be achieved requires further discussion.

2.4 Introducing a Building Materials Tax to Increase Recource Efficiency in the Building Sector

A federal consumption tax on the extraction and import of primary building materials is proposed. A primary building materials tax is a fiscal policy tool which serves to increase state revenues. At the same time, it is a steering tax that, like the mineral oil tax, aims at creating an incentive to reduce the overall consumption. The tax revenues flow into the federal budget. They are not tied to a particular purpose and can be freely used. The tax would be applied to resource extracting companies which will pass on their increased burden along the supply chain. From the point of introduction the tax should amount to at least €2.00 per ton of extracted sand, gravel, rock, or limestone. As the primary building materials tax should send a clear signal for reduced physical consumption, a quantity tax will be used. For this reason a long-term tax increases with a progression of 5% per year should be planned to counter the immanent actual reduction of the quantity tax.

Outsourcing of the extraction and the subsequent production stages due to the materials tax are not to be expected. This could be further insured if a federal harmonization of the existing Länder and district specific regulations could be achieved. However, an increasing use of recycled and secondary resources in the construction sector can be expected. Outsourcing of operating sites is also unlikely due to high transportation costs. Simultaneously, a compensation for the extraction regions should be planned to internalize the environmental impact costs and achieve regional innovation potentials.

2.5 A Covenant for Closing Material Cycles in the Recycling of End-of-life Vehicles

End-of-life vehicles contain a number of materials whose recycling saves a substantial amount of resources in comparison with the primary route of acquisition, e.g. steel, copper, but also platinum group metals (PGM). The German end-of-life Vehicle Ordinance therefore mandates producers to achieve 85% recycling rates – and 95% by 2015. However, only about one-sixth of all vehicles are actually scrapped in Germany. Most vehicles are exported in advance as used cars and end up as waste in countries outside of the EU in which these recycling mandates no longer apply and where only the main mass stream (especially steel), if at all, is salvaged.

The central approach of the examined incentive mechanism is the negotiation of a legal contract – a covenant – between motor vehicle manufacturers and suppliers, recycling industries and relevant public administrations in exporting and importing countries. This covenant should determine long-term targets for increasing resource efficiency through high quality recycling of end-of-life vehicles. The contracting parties, producers (or their associations), commit themselves to ambitious resource protection targets, while states guarantee stable and supportive framework requirements for the contract period. In contrast to voluntary agreements the covenant should in principle also be enforceable in a court of law, while at the same time the contract should contain possibilities for dispute settlement and sanctions if a contracting party does not fulfil its responsibilities. Germany could take the initiative for introducing such a covenant at the EU-level.

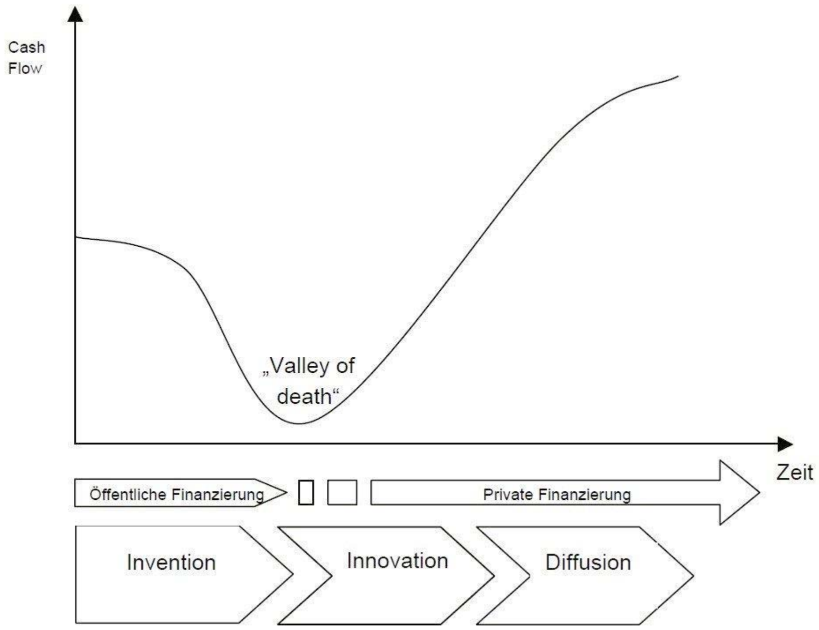
With such a covenant it would be possible to establish a framework for closing material cycles at the international level. The distribution of the resulting costs and benefits along the value-added chain could flexibly be determined in the contract. The expanded responsibility of producers for the physical and financial effects of their products at the end of their utilization phase would no longer be undermined by exports. This would above all create real incentives for introducing “design for recycling”.

2.6 Innovation Policy Tools: A Green Tech Fund for Lighthouse Projects

Innovation policy tools offer a means of supporting the introduction of resource efficient products and processes. Eco-innovations more generally and innovations for increasing resource efficiency in particular are impacted by a „double externality“: imitators profit as free riders from the innovative activities of other companies, preventing first-mover advantages from being realized (spill-over effects). Moreover, improvements of the quality of the environment not only benefit the innovator. They are a public good. Therefore, investments in eco-innovations fail to achieve, or rather, remain below economically desired levels. State interventions for the promotion of eco-innovations are, therefore, necessary to overcome this market failure.

An analysis of national support programs for innovation promotion found that resource efficiency has so far not been addressed as an independent issue area. Furthermore, it was shown that innovation policy tools are mainly aimed at the first of the three innovation phases (invention) in the form of direct project funding. The following phases of commercial launch and diffusion, on the other hand, do not receive much attention. This lack of support leads to financing gaps in the transition from public to private financing („valley of death“). Thus, many innovations are never realised (Fig. 1).

Fig. 1: Valley of Death



Source: Murphy / Edwards 2003

Therefore, in MaRess Task 3 tools were examined for bridging this „valley of death". The short-term provision of risk capital by the state is of particular importance. A strengthened promotion of material efficiency could be achieved through the creation of a specific „Green Tech Fund" for material efficiency innovations, but also through the establishment of material efficiency as a sustainability criterion in public technology funds.

A further tool for supporting the diffusion of material efficiency innovations is the promotion of so called lighthouse projects. The establishment of lighthouse projects using a national strategy similar to „transition management" in the Netherlands (i.e. the planned transition to sustainable economy in several core areas-). Such projects would not least help to encourage emulation and promote acceptance. Points of departure already exist with the Hightech Strategy as well as the Masterplan Environmental Technologies. Further innovation policy tools could also be used, such as project financing, cluster-promotion, innovation workshops (Lemken et.al 2009) or incentives for research institutes.

2.7 Export Promotion of Recycling and Efficiency Technology

The export of recycling and waste disposal technologies offers substantial economic potentials for German companies. Achieving these potentials will require commensurate institutional framework requirements that effectively support German companies in their export activities.

According to the work of the „Export Initiative Recycling and Efficiency Technology“ (RETech), five fields of action (capacity building, information about and for target countries, networking, marketing support as well as financing and risk hedging) involving different life cycle phases and tools were identified. These fields of action were among other things examined by conducting surveys of companies, associations as well as researchers concerning their acceptance and effectiveness. Overall the assessments and the discussions of tools for export promotion in the recycling and efficiency technology sector show that the instruments identified by the RETech-Initiative would be of great importance for making use of export opportunities and were generally viewed very positively. Nonetheless, weaknesses could also be identified from which a need for action could be deduced (cp. Fig. 2).

Fig. 2: An overview by field of action of the recommended actions for the further development of export promotion

Source: MaRess Task 3.2

- **1. Capacity Building**
  - Increase operations directly on site under local conditions
  - Link capacity building activities with online career platforms

- **2. Information about Target Countries**
  - Strengthen conferences and workshops directly in the target country
  - Strengthen intercultural training
  - Increase the ease of use and accessibility of online offerings
- **3. Information for Target Countries**
  - Make branch-leading, trade and information publications available online
  - Support the provision of accessible and specialized newsletters
  - Take advantage of increased internet use in target countries
- **4. Networking**
  - Increase the effectiveness of cooperation forums by comparing interests with expectations
  - Open the innovation processes of „grassroots innovators“ for select technologies in target countries through open-source online platforms
- **5. Marketing Support**
  - Reduce the complexity of grant opportunities
  - Support an increased focus on specific topic areas for business trips
  - Increase transparency for the support of lighthouse projects
- **6. Financing and Risk Hedging**
  - Support the ease-of-use of existing instruments by reducing complexity
  - Improve consulting services for the selection of appropriate tools for exporters and importers

3 Summary

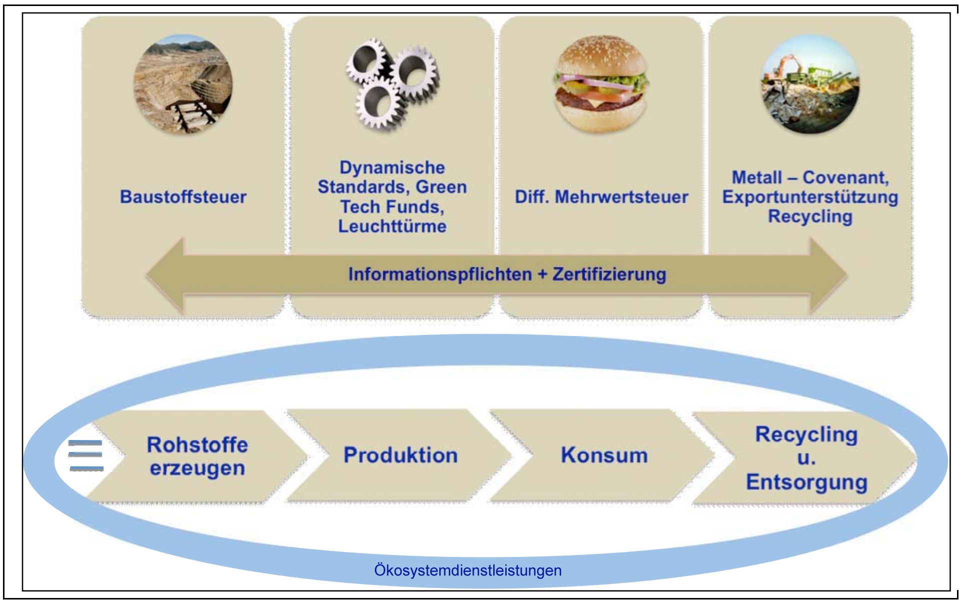
MaRess Task 3 examines the effectiveness of various steering mechanisms for a comprehensive resource policy. The point of departure is an analysis of the barriers and mechanisms of market failures with regard to sustainable resource utilization. The work is based on considerations on the configuration of a ‘resource policy’ field and about functions and key areas of a resource policy. This analysis concluded that a resource policy must especially aim towards environmentally friendly resource utilization, but also make contributions to security of supply and ecological modernization. Based on these premises concrete options for a policy mix to enhance framework conditions were identified and analyzed in detail.

The condensed version at hand outlined a policy mix for designing framework conditions based on regulation, economic incentives and a private law approach. The development of instruments was related to specific resources and sectors – the latter of which are to be understood as exemplary and served to demonstrate the technical, economic and institutional feasibility as well as to demonstrate the difficulties and limits of steering opportunities.

Parallel to the work in MaRess Task 4 (Resource Policy at the Business Level), Task 12 (Consumer and Customer Oriented Resource Policy) and Task 7 (Policy Recommendations and Policy Papers), this work is to serve as a contribution to real developments in resource policy, thereby contributing to a sustainable resource utilization in Germany and Europe.

Fig. 3 illustrates the assignment of the tools developed in MaRess to stages of the value-added chain.

Fig. 3: Assignment of Resource Policy Tools in MaRess Task 3 to stages of the value-added chain



Source: MaRess Task 3.2

The figure demonstrates that all stages of the value-added chain are covered. Overall, the policy mix developed in MaRess Task 3 holds the potential to make significant contributions to a sustainable resource use, increased security of supply and ecological modernization.

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Material Efficiency & Resource Conservation

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Resource Policy in the Area of Enterprise-Related Instruments

Executive Summary

Summary report of Task 4 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project

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Resource Policy in the Area of Enterprise-Related Instruments Executive Summary

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1 Introduction

1.1 Present situation

Improving resource efficiency is becoming a high-priority political issue both in Germany and internationally. The cost of materials in the manufacturing industry in Germany rose from EUR 577 billion to EUR 754 billion between 2002 and 2006 (German Federal Statistical Office 2008). In the goods production sector, material costs accounted for nearly 45% of total costs in 2006, while personnel costs incurred by companies accounted for just 19% (Federal Statistical Office 2008). The German Agency for Material Efficiency (demea) estimates that the German economy could realise total savings of up to EUR 100 billion in this area (demea 2009).

In a 2005 study into how SMEs in selected sectors could reduce expenditure on materials, Arthur D. Little GmbH, the Wuppertal Institute and the Fraunhofer Institute for Systems and Innovation Research (ISI) found that within seven years these enterprises could cost-effectively tap a material savings potential of between EUR 5 billion and EUR 11 billion per annum. Reducing resource consumption is an especially important consideration for SMEs. Optimised process flows and efficient use of resources lead to cost reductions, thereby improving competitiveness. Moreover, the quest for resource-saving possibilities encourages more innovative business management. Current studies also show that innovations in the area of resource efficiency contribute to job security and help to create new jobs.

Making the improvement of resource efficiency a factor in the micro-economic decision-making process also leads to a win-win situation for business enterprises as far as the aforementioned cost savings potential is concerned. In addition, cutting resource consumption reduces the business risk of price rises in raw materials on the one hand and rising price volatility on the other. It may also help to alleviate any shortages in the supply of scarce raw materials. By systematically improving resource efficiency, companies can often enhance their competitiveness, especially as economising on resources often triggers or encourages in-house innovation processes.

Task 4, “Resources Policy at the Enterprise Level”, addresses these aspects, along with obstacles, in selected areas of corporate activity, focusing on enterprise-oriented policy instruments and measures affecting both the enterprise and the value chain. The goal is to optimise the impact and diffusion of policy instruments so that business enterprises are better placed to improve resource efficiency. This refers back to the core strategies for a successful resource efficiency policy described in Step 7.2.

The measures proposed in Task 4 begin by stimulating individual enterprises with the aim of supporting their implementation of measures to improve resource efficiency in the desired way. Decision-making and creative scope will remain the purview of actors in the individual enterprises.(see Görlach et al. 2009).

1.2 Task 4 Steps

With the results of Task 4 of the MaRess project we have succeeded in assembling and singling out instruments and measures conducive to a successful resource-efficiency policy for business enterprises and their market activity in global value networks and chains. The Task 4 policy mix, focusing on enterprise-related aspects, is embedded in the wider context of MaRess project instruments. Thus the proposals for measures and instruments developed in Task 4 are supplemented by macro-economic policy measures (Task 3) and proposals for consumer policy (Task 12).

The core strategies described in Step 7.2 form the basis for the portfolios of instruments in Task 3, Task 4 and Task 12. The relevant core strategies are:

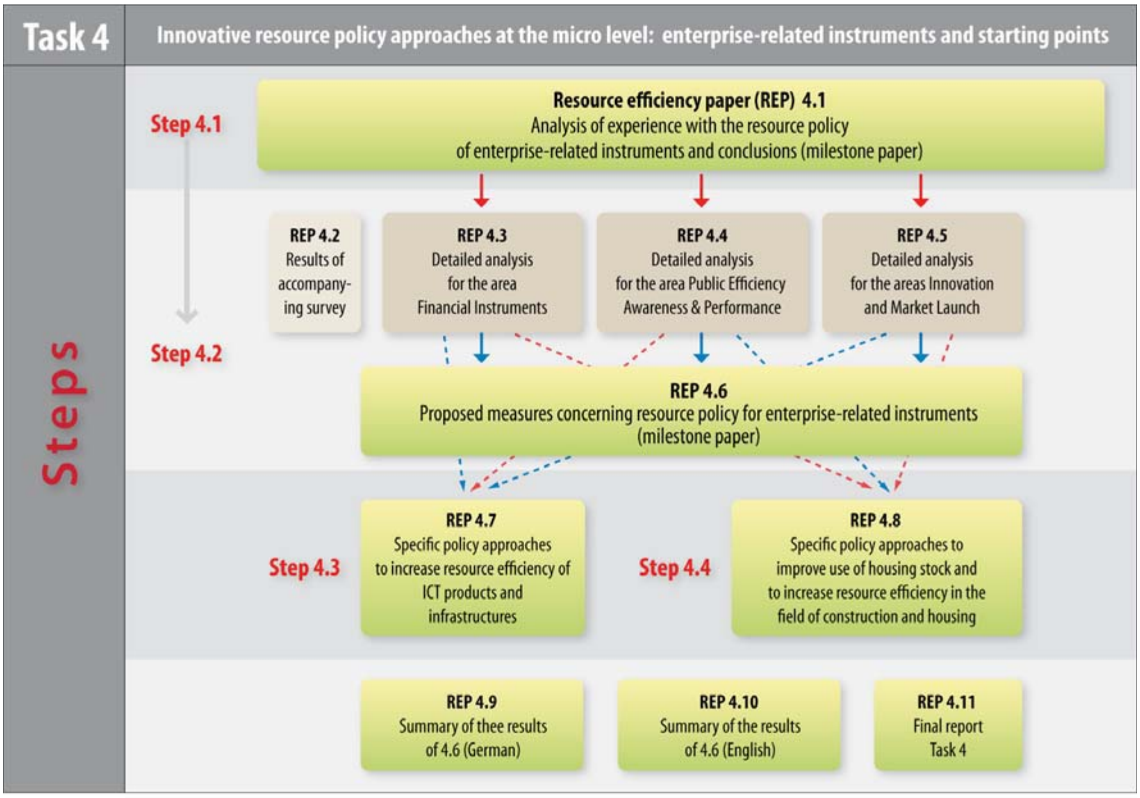
- “Giving Innovation a Direction – Sustainable Future Markets for Resource Efficiency Solutions” in the areas of promotional programmes, corporate reporting, financial instruments, research and development, innovation and market launch of product service systems
- “Mobilising Institutions – the Key to Successful Diffusion” in the areas of advisory services, funding institutions, forging networks
- “Resource-Efficient Products and Services” in the areas of invention and of market launch and diffusion processes
- “Changing Attitudes” in the areas of enterprise-level communication and education strategies and training and continuing education.

Eleven papers were produced for Task 4, all of which can be downloaded at http://ressourcen.wupperinst.org/downloads/index.html (see Fig. 1). Step 1, “Analysis of Resource Policy Options in the Area of Enterprise-Related Instruments” (Görlach et al. 2009), involved selecting the instrument areas to be analysed, focusing especially on the criterion “high potential impact on resource efficiency”. Resource Efficiency Paper (REP) 4.1 outlines the results together with the methodological background and the procedure.

Resource Efficiency Paper (REP) 4.6 (Liedtke et al. 2010) is a milestone paper summarising the central findings of different studies in the three areas of activity for which detailed analyses were produced at Step 2 (Onischka et al. 2010, Görlach/Schmidt 2010, Lemken et al. 2010 – REP4.3, REP4.4, REP4.5), along with the findings of the interview paper (Görlach/Zvezdov 2010 – REP4.2). REP4.6 contains an overview of the integrated policy mix of enterprise-oriented instruments. REP4.9 gives a summary of the policy mix developed (Liedtke et al. 2010). The policy mix or selected elements thereof were made more concrete in the context of two case studies, “Construction and Housing” (REP4.7) (Knappe/Lasche/Büttgen 2010) and “Value Chains of Information and Communication Technology Products” (REP4.8) (Bienge et al. 2010).

In devising the Task 4 policy mix, we took expert legal advice in order to take account of legal pitfalls and the latest jurisdiction in a two-stage process.

Fig. 1: Task 4 Results Papers – Overview and Interaction



Source: Compiled by the authors

1.3 Areas of Activity Analysed in Detail

For each of the three areas of activity on which we focused, we explain below the interdependencies on which the individual measures derived are based. Initially, the main focus was on describing the status quo – the starting point for identifying specific obstacles that were then addressed by the policy mix developed.

1.3.1 Financial Sector

The financial sector can assume an important role as an initiator and multiplier in improving resource efficiency in companies and can play a formative role. Moreover, in its role as an intermediary the financial sector also influences the development of a collective policy framework. However, the protection of resources has not been a consideration in the financial sector so far, though structurally this would be justified. This can be attributed to the following main obstacles:

- The lack of awareness of resource efficiency issues among finance market-related institutions and intermediaries
- The incomplete and inconsistent data basis on resource efficiency;

- Shortcomings in the supervision-relevant risk management of banks.

1.3.2 Public Efficiency Awareness & Performance

For a resource-efficient style of operation to be implemented in business enterprises, agents must be sensitised to the issue. Intermediaries play an important role in raising "efficiency awareness" (Görlach et al. 2009) in enterprises and often have greater success in influencing enterprises than state actors. This is because of their relative proximity to enterprises and hence closer communicative relations. If state actors communicate "indirectly," i.e., by strategically integrating the (leading) actors at the intermediary level into the communication process, it is not only possible to address individual behaviour better but also to shape these regulatory systems themselves. Insufficient awareness can be attributed inter alia to the following main obstacles:

- Complexity: the lack of a systemic understanding of resource efficiency among enterprise-related actors from both a technical and a social point of view
- Communication: language and communication problems owing to different professional and group-related backgrounds;
- Support structures: there is no guarantee that promotional, advice and training offers will fit their purpose exactly

1.3.3 Innovation and Market Launch

The decision on how many resources will be used throughout the life cycle of a product or service is definitively taken in the early stages of the innovation process when it is being developed (see Pfriem 2006). Moreover, these early stages provide the best opportunity to influence product features, production processes and resulting cost structures. Yet the topic of resource efficiency currently plays little part in the early stages of innovation processes. This can be attributed inter alia to the following obstacles:

- The innovation culture: here, especially, management and employees are inadequately qualified, which leads to a lack of market information and defined responsibilities
- Deficiencies in external framework conditions: this applies to structures and dynamics on the capital markets, to innovation advice services and to funding structures
- The effectiveness of promotional programmes in resource efficiency and capacity for innovation is often inadequately implemented in promotional systems

2 Enterprise-Related Instruments – the Policy Mix

2.1 Task 4 Innovation: A Policy Mix to Stimulate Enterprises

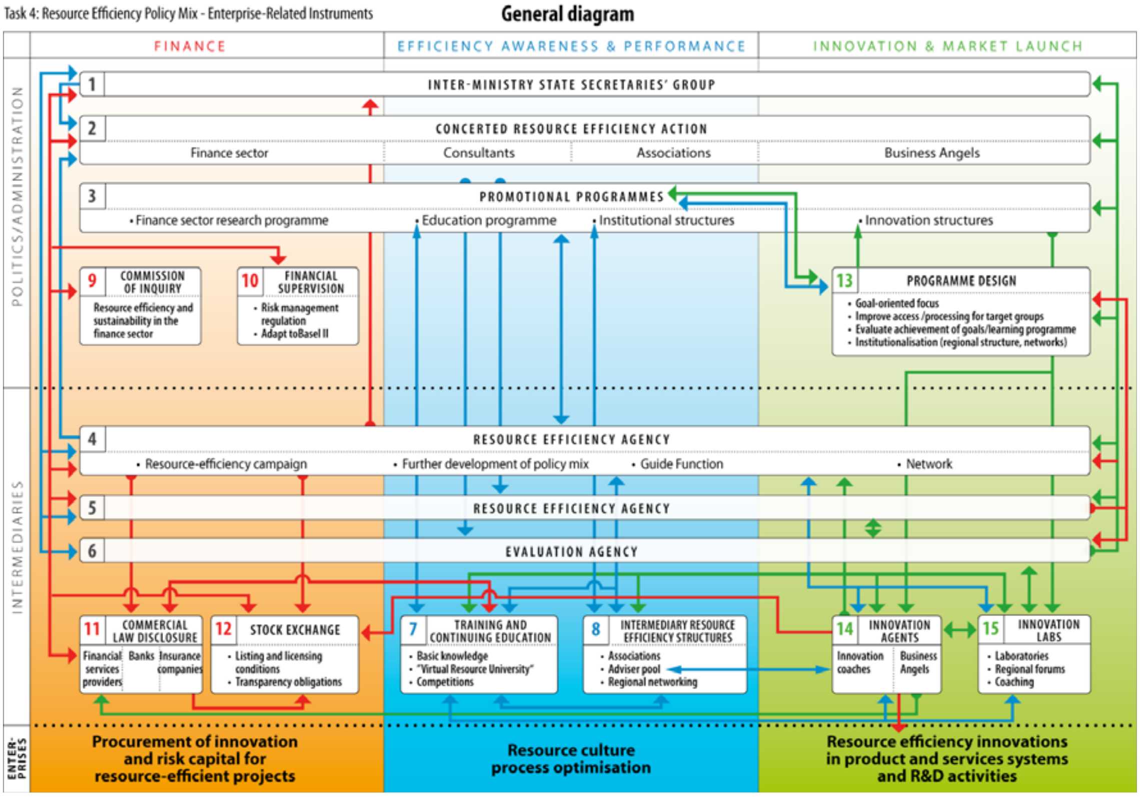
The basic idea behind most of the individual measures proposed in Task 4 is to encourage efficient behaviour in a way that is compatible with incentive while leaving the details of individual measures open and not making them mandatory. In this way existing market mechanisms would hardly be affected.

Since entrepreneurial (decision-making) freedom is to be restricted as little as possible, the issue of resource efficiency must be disseminated by raising awareness and be integrated into actors’ competency and qualification profiles. In addition, ecological and/or resource-saving technologies must be promoted in enterprise-oriented innovation and research processes.

Since the necessary advances in resource efficiency can only be realised by means of radical system innovations, further measures using existing policy instruments will be required. These would aim to accelerate the spread of resource-efficient products, technologies and processes and innovation activity. In other words, application of the policy mix would begin at several points simultaneously.

Individual instruments may be chosen from the portfolio of enterprise-related instruments in Task 4 (comprising fifteen individual measures) to enable an easier start to the ambitious programme of action. Together with the measures resulting from the other tasks, especially Tasks 3 and 12, Task 4 measures must be merged with the policy mix from Task 7 (see Hennicke/Kristof/Dorner 2009, Kristof/Hennicke 2008). In the long term, however, it would be preferable and expedient to implement the individual Task 4 measures as a package because they build on one other and have been coordinated and hence promise more lasting success – i.e. advances in resource efficiency across different sectors. Fig. 2 shows cross-links and complex interdependencies. For further explanations see in-depth analysis papers REP4.3, REP4.4, REP4.5 and REP 4.6.

Fig. 2: Schematic Overview of Interdependencies between Individual Instruments in the Task 4 Policy Mix



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2.2 Overview of Individual Measures in the Task 4 Policy Mix

Starting from the policy instruments proposed in the three areas of activity (see detailed analysis papers REP4.3, REP4.4 and REP4.5), a consistent policy mix was developed. All instruments serve to support enterprises in developing resource-efficient technologies, products and services and in aligning their corporate culture and their management accordingly. The individual instruments are co-ordinated, which leads to system-oriented reinforcement of the impact of individual measures. Tab. 1 gives an overview of the policy instruments developed and categorises them in the resource-policy context. The policy mix comprises a total of fifteen policy instruments, of which six, instruments (1) to (6), are designed for application across different areas of activity. This means they impact on all three areas of activity. However, each area of activity also has specific instruments tailored to its particular area: (9) to (12) are for finance, (7) and (8) for public efficiency awareness & performance, and (13) to (15) for innovation and market launch. The instruments shown in Tab. 1 are described in detail.

Tab. 1: Overview of Task 4 Policy Instruments by Resource Policy Category

	Administrative law instruments	Financial policy instruments	Agreed objectives	Information-related instruments	Institutional instruments	Qualification instruments	Research and development policy
Cross-area policy instruments							
(1) Set up inter-ministry state secretaries' group					X		
(2) Concerted resource-efficiency campaign			X		X		
(3) Set up promotional programmes		X					X
(4) Establish resource-efficiency agency		X	X	X	X	X	X
(5) Create resource-efficiency data basis				X			
(6) Establish evaluation agency			X	X	X		X
Policy instruments in the public efficiency awareness & performance area of activity							
(7) Step up training and continuing education				X		X	
(8) Create intermediary resource-efficiency structures					X	X	
Policy instruments in the financial instruments area of activity							
(9) Commission of inquiry into resource efficiency and sustainability in the financial sector				X	X		
(10) Financial supervision, statutory and supervisory regulations	X	X					
(11) Commercial law disclosure	X						
(12) Stock exchanges: integrate ecological aspects			X				
Policy instruments in the market launch and innovation area of activity							
(13) Programme design (promotional programmes)							X
(14) In-company innovation agents					X	X	
(15) Create innovation laboratories					X		

Source: Compiled by the authors

However, the impact and diffusion of the existing measures will be facilitated if the core measures below (Tab. 2) are implemented first. These core measures were selected on the basis of a detailed analysis of the interactions and synergies between individual measures in the Task 4 mix.

Tab. 2: Essential Core Measures in the Task 4 Policy Mix

Essential core measures for increasing resource efficiency
(3) Establish promotional programmes
(4) Resource Efficiency Agency: promote communication and information
(5) Resource efficiency data basis: develop enterprise-related key performance indicators relating to resources
(6) Evaluation agency: analyse effect of funding programmes and the entire research funding system
(7) Training and continuing education: qualification and education concepts
(11) Commercial law disclosure: publish key performance indicators for resources in company reports

Source: Compiled by the authors

2.3 Characterisation of Policy Measures in the Task 4 Policy Mix

There follows a brief description of the individual policy instruments, focusing on the central objectives and mode of action. A detailed description of their conception and interactions with other policy instruments, along with more detailed statements of costs, can be found in the detailed analysis papers (Onischka et al. 2010, Görlach/Schmidt 2010, Lemken et al. 2010).

2.3.1 Inter-Ministry State Secretaries’ Group: Develop and Manage Cross-Departmental Innovation Policy Measures (1)

Idea: To create a group of state secretaries facilitated by the Federal Chancellor’s Office to discuss strategies and policy measures for increasing resource efficiency and coordinate them across departments.

Organisation: Since policy measures in the area of resource efficiency and sustainable finance affect a variety of policy areas, they can only be realised effectively if cross-departmental strategies are adopted. An inter-ministry state secretaries’ group is to be created in the near future and become established in the long term, and its membership must reflect the areas of activity focussed on in the overall context of the MaRess project and its policy Tasks. It will draw on the experience of similar bodies in the past (e.g. the “Green Cabinet”).

Among other things, it should mobilise and co-ordinate the top ten priorities for action in the field of sustainable finance:

- The future of financial market regulation (Basel III)
- Guidance for the research programme “Sustainable Finance”
- The main emphases of financial products to promote exports
- The main tasks of state-run business development banks
- Corporate reporting
- Transparency responsibilities on the capital market
- Fiscal support for sustainable financial investments
- (Financial market-compatible) data collection and provision
- The role of the financial supervisory authorities
- An alliance for long-term efficiency and sustainability in the financial sector.

2.3.2 Concerted Resource-Efficiency Campaign: Create Awareness (2)

Idea: Along with political commitment to resource efficiency issues, there is a need for private-sector willingness and/or involvement and co-ordinated campaigns by politicians and the private sector. “Concerted” involvement of leading private-sector and political representatives will give the issue of resource efficiency symbolic significance. Leading representatives of consulting firms, industry associations or financial institutions will act as mouthpieces to spread the message among their own target group.

Organisation: Ten to twenty leading political and private-sector actors will act jointly to agree specific packages of measures for their target groups and actively support a national strategy for the private sector. They will support and facilitate implementation in their own target groups. Bodies that could be involved are the Federal Chancellor’s Office, the Federal Environment Ministry and the Federal Environment Agency, the Federal Ministry of Economics and Technology, the Federal Ministry of Finance and the Federal Ministry of Education and Research. In addition, industry associations, banks and consulting companies should be brought in.

The inter-ministry state secretaries’ group (1) will entrust the Resource Efficiency Agency (2) with the organisational implementation. In this connection, we recommend developing and undertaking strategic flagship projects of a highly symbolic nature to develop resource efficiency into a well-known and accepted “brand”. One or two consultancies should be recruited to implement them in co-operation with prominent companies, including manufacturing sector enterprises.

2.3.3 Resource Efficiency Agency: Successfully Promote Diffusion and Innovation (4)

Idea: As a lean organisation, the Resource Efficiency Agency will link actors into networks and will be directly involved in developing appropriate structures (e.g. concerted campaigns at the regional level, networking advisory competencies). The objective of the Resource Efficiency Agency will be to effect noticeable progress with inventions designed to increase resource efficiency and their diffusion. Thus the main emphases of its work will be to

- Network and support actors
- Serve as a guide
- Step up a resource-efficiency campaign
- Initiate educational concepts
- Co-develop and assist promotional programmes and
- Further develop the policy mix.

Organisation: The resource efficiency agency will act as a guide in the corporate landscape. It will act as the first point of contact for information, mediation and distribution in support of implementation (coordinating rather than intervening). It will work with authorities and newly developed intermediary structures (e.g. associations, chambers of industry and commerce and chambers of trade at the federal state and regional level). It will offer companies initial subject- and region-specific information online and by telephone. In addition it will be able to make suggestions for (new) promotional priorities for companies in cooperation with enterprise-related partners and resource efficiency networks, and in individual cases participate in their actual development and implementation.

It will simultaneously engage in a resource efficiency campaign to push agenda setting for the resource efficiency idea. This campaign will include, for example, information on specific economic measures and instruments (e.g. promotional programmes).

2.3.4 Resource Efficiency Data Basis: Develop Indicators and Data Sets (5)

Idea: Currently resource efficiency indicators are often either absent or inadequate. To overcome this problem a set of resource-related key performance indicators (R-KPI) will be developed so that resource consumption at company level can be mapped in a meaningful way that permits comparison and practical application. This will cater to the need for enterprises and financial services providers to have sufficiently robust and comparable data to be able to include resource efficiency in their financing and investment decisions.

Organisation: A set of resource-related R-KPIs of this kind will include both cross-sector and sector-specific indicators that can be used for analysis and evaluation processes by financial services providers and by companies themselves. It will be developed on the basis of the first existing KPI sets (see Onischka et al. 2010). The goal is for the indicators to be fundamentally suiTab. for companies to capture data independently. The development process will be facilitated with the involvement of relevant stakeholders from the financial sector, by the private sector and by Federal Environment Ministry and Federal Environment Agency auditors. The results can also be used within twelve months for further legislation.

Under the aegis of a data centre that should be attached to the Federal Statistical Office, resource-relevant information at the enterprise level made available via reporting obligations, from annual reports or general statistics could be gathered together and processed. In the long term, this should lead to systematic company reporting. The provision of data for politicians, associations and especially for financial service providers should also be supported by national and international harmonisation, for example in development and standardisation bodies. After a pilot phase of two to three years, the data centre should be fully functional and could in the medium term provide the necessary data for financial service providers’ risk management. This could also satisfy the need to develop resource-related key performance indicators in the Task 4 areas Efficiency Awareness & Performance and Innovation & Market Launch.

2.3.5 Intermediary Resource-Efficiency Structures: Mediation and Promotional Structures (8)

Idea: At the regional level, existing mediation and promotional programmes aimed at increasing resource efficiency should be expanded and linked.

Organisation: The central measures are:

- To build and/or expand actor structures to increase the resource efficiency of sectors, regional intermediaries and private-sector associations in the form of financial support and by establishing efficiency offices
- To optimise existing pools of advisers at the regional level. For example, advisers who are competent both professionally and in terms of process could be supported by “efficiency angel” networks in the company context. Adviser tandems can offer specialist technical skills combined with implementation competence and will be deployed regionally, inter alia by way of integration into existing structures (associations, networks, etc.)
- To push regional networks in the direction of resource efficiency.

To build up intermediary resource-efficiency structures, an appropriate promotional programme for institutional structures (3) will either be integrated into existing promotional structures or newly launched (see in greater detail Görlach/Schmidt 2010).

2.3.6 Training and Continuing Education: Qualification and Educational Concepts (7)

Idea: A heterogeneous but balanced mix of concepts and strategies for training and continuing education in companies and universities to address the subject of resource efficiency.

Organisation: The lack of resource competency (inter alia life-cycle thinking or innovation competence) calls for targeted (training and) education measures. Since existing educational infrastructures and corresponding promotional programmes are hardly geared to these subjects and target groups (including intermediaries), (state) qualification programmes must be adapted or offered additionally. Individual measures can be assigned to the following areas:

Building up basic knowledge with:

- An Internet platform for resource efficiency
- Research seminars for teaching staff
- Co-ordination of further professional training and teaching
- Training advisers/tandem coaching (technical and implementation skills).

Develop a "Virtual Resource University" (see also Task 13.2; http://ressourcen.wupperinst.org/downloads/index.html):

- "Virtual Resource University"
- Integrated courses of study/dual courses of study
- Innovation camp.

Hold competitions (see also Task 13.2):

- Young researchers/entrepreneurs (resource efficiency as a prize category)
- Excellence competitions for academic training and further education.

2.3.7 Commission of Inquiry: Set Up a Commission of Inquiry into Resource Efficiency and Sustainability in the Financial Sector (9)

Idea: As part of the sustainable increase in resource efficiency, a Bundestag commission of inquiry to answer fundamental questions relating to the role of the financial sector taking into account necessary structural changes.

Organisation: Within one electoral term, political positions will be developed and a long-term strategy will be worked out concerning how the finance industry should contribute to sustainable development of financial products. Equipped with a focused assignment, the commission would analyse and assess the present role of the financial industry in terms of sustainable development and the goal of increasing energy and resource efficiency and identify perspectives for making appropriate structural changes in the financial sector.

The inquiry commission findings could be the starting point for specific projects in the context of the intended research programme. They could also serve as a guide for a long-term strategy and as orientation for financial supervision.

2.3.8 Financial Supervision: Define Legal and Supervisory Provisions for Risk Management by Financial Services Providers (10)

Idea: The current regulation of risk management by financial services providers effectively prohibits the inclusion of risks resulting from business enterprises’ use of resources (see Onischka et al. 2010 on this). Steps should therefore be taken to define the regulatory framework more precisely in this respect.

Organisation: The first “instant measure” that can be realised at short notice should be to make full use of the interpretative scope of financial supervision within the framework of current regulations. This would enable changes in rating and risk management processes in rating agencies, for example. Within the next few years adjustments could also be made to financial market regulation (Basel II/III). This could be prompted by appropriate initiatives by the German supervisory authorities in the development bodies (e.g. the Basel Committee).

2.3.9 Commercial Law Disclosure: Publication of Key Performance Indicators for Disclosure in Company Reports (11)

Idea: The requirements under commercial law to disclose non-financial performance indicators should be legally supplemented by resource-related aspects. In addition, this information should be integrated into the annual management report and financial statement.

Organisation: With reference to the resource-related key performance indicators developed (5), the commercial law provisions concerning the disclosure of non-financial performance indicators should be supplemented by resource- and climate-related aspects. Since publication in management reports will make this information relevant for audit (Section 289 (1) of the German Commercial Code [HGB]), resource efficiency would have to be included in the professional audit and accounting standards.

2.3.10 Stock Exchanges: Include Ecological Aspects in the Listing Conditions for High-End Market Segments (12)

Idea: German stock exchanges should supplement the wide-ranging conditions for the admission of capital market enterprises to their high-end segments (e.g. Prime Standard) with resource efficiency and climate aspects (on this, see Onischka et al. 2010).

Organisation: The first step would be to oblige listed companies to publish an annual audited environment and sustainability report in accordance with GRI guidelines and to participate fully in the Carbon Disclosure Project. The disclosure of resource aspects could be added at a later date, with reference to the resource-related key performance indicators developed (5). Along with the Federal Environment Ministry and the Federal Environment Agency, the momentum for this should be generated in particular by the stock exchange supervisory authorities in Germany's federal states.

2.3.11 Innovation Agents: Know-How and Capital for Business Enterprises (14)

Idea: The new concept of innovation agents links innovation coaches (advisers on innovation management in business enterprises) with business angels who bring private capital, know-how and external contacts into companies. This will generate new synergies for increasing resource efficiency, especially at the early stages of innovation.

Organisation: To counter their lack of in-house knowledge and know-how, companies need actors who lend specialist professional support to their corporate product and service innovation processes, from invention to market launch. Along with government grants, innovation projects are financed largely by private share capital. The new aspect here is the interaction between in-house innovation advice (innovation coaches) and private share capital (business angels). The deployment of specially trained innovation coaches would professionalise innovation management in companies and spur on product, structure and process innovations in SMEs. Business angels, in contrast, bring private capital, commercial know-how and external contacts into companies. The networking of these two actors, who have functioned separately hitherto, could activate and generate considerable synergy potential. The basis for the work of the innovation coaches will be a promotional programme set up to supplement existing promotional programmes in individual federal states (3).

2.3.12 Innovation Laboratories: Improve Resource Competence and Capacity for Innovation (15)

Idea: Innovation laboratories would provide a temporally and organisationally flexible co-operation opportunity for a cross-company innovation process in complex or large-scale research projects in the field of resource efficiency. Innovation laboratories would not only be a form of cooperation between companies and various company-related actors, but would offer the necessary equipment, know-how and human resources for complex innovation projects. This would enable SMEs to address their innovation needs directly and to overcome size-related disadvantages in relation to other business enterprises.

Organisation: Depending on their detailed conception, innovation laboratories could address the following sub-goals:

- Training of creative milieus
- Focusing on problem-solving strategies in the innovation process
- Cross-company spread of innovation risks
- Improving resource efficiency at the product and company level.

The innovation laboratories should be conceived as collaborative projects by business enterprises in which scientific institutions and other intermediaries could play a creative role as neutral partners. The innovation laboratories would have a co-operative basic understanding. They should make a crucial contribution to accelerating the innovation process and place emphasis on the joint realisation of research findings.

For implementation, we propose an "Innovation Laboratory to Increase Resource Efficiency" promotional programme (see Chapter 2.3.13).

2.3.13 Set Up Promotional Programmes (3)

Idea: Set up targeted promotional programmes to implement and finance the individual instruments and integrate these into promotional structures as necessary.

Organisation: The proposed promotional programmes would include:

- *A sustainable financial sector research programme* to deal with specific methodological issues in the area of linking sustainability-relevant aspects with the financial sector (8) (see Onischka et al. 2010).
- *An educational programme*: funding and support for an educational infrastructure in the area of resource efficiency (Instrument 7) (see Görlach/Schmidt 2010).
- *An "Institutional Structures" promotional programme:* this reflects the need for a structure to promote the institutional resource-efficiency structures instrument (8) (see Görlach/Schmidt 2010).
- *"Innovation Laboratories to Support Resource Efficiency" promotional programme:* a non-technology- and non-sector-specific nationwide promotional programme in collaboration with business-oriented research institutes and other actors (15) (see Lemken et al. 2010).
- *An "Innovation Coaches" promotional programme:* this programme would offer companies the opportunity to strengthen collaboration with external cooperation partners for innovative projects (14) (see Lemken et al. 2010).

2.3.14 Programme Design: Optimising Promotional Structures (13)

Idea: Build on complementary individual suggestions for optimising the design of and access to promotional programmes in order to interlink areas of activity and promotional structures better and more closely (see Lemken et al. 2010). The aim is not only to make promotional structures effective and efficient, but also to cater better to the needs of SMEs.

Organisation: EU, German government and federal state promotional programmes with their wide range of grants, low-interest loans, equity instruments and assumption of liability are an indispensable cornerstone for financing the innovative SME sector. However, programme structures often lack clarity, transparency and flexibility. In addition, procedures for applying for and executing projects represent a major obstacle for many SMEs.

It is proposed that the design of the relevant promotional programmes be optimised continuously with a view to integrating the subject of resource efficiency. At the promotional organisation level, target systems and corresponding performance indicators will be devised for the entire range of support activity. In addition, access to promotional programmes will be made simpler. Selected individual measures are:

Structuring promotional programmes:

- Bundle, streamline, standardise and interlink promotional programmes
- Enable promotional programmes to be combined and funding to be cumulative
- Actively address companies, coaching.

Optimising promotional programmes:

- Integrate quantitative targets into programme guidelines, project applications, etc.
- Include resource efficiency as a goal in non-technology-specific promotional programmes
- Boost incentives for borrowers’ banks to arrange Kreditbank für Wiederaubau (KfW) loans
- More target-group-specific incentive systems (e.g. resource bonus).

Managing promotional programmes:

- Regular, cross-programme evaluation of comparable criteria.

2.3.15 Evaluation Agency: System Evaluation and Quality Assurance (6)

Idea: In Germany, unlike in the European context, promotional programmes and research promotion guidelines have not been evaluated across programmes and using comparable criteria. Yet this is a fundamental prerequisite for monitoring the success of programmes, for using public funds even more efficiently and for being able to optimise programmes. An independent evaluation agency would evaluate all measures (in this case, all policy tasks) of relevance to resource-efficiency policy, but also the research promotion system. Evaluation would include how effectively and efficiently funds are spent and further quality criteria still to be developed. The goal of the evaluation agency’s work should be to analyse research promotion and funding in terms of their effectiveness and to identify action required to improve them, including with respect to resource efficiency.

Organisation: The evaluation agency would also analyse the way in which research promotion instruments work, along with the extent to which they are designed and used efficiently. The work of the agency would include portfolio analysis, bundling and setting priorities at the programme level, as well as evaluating research projects and individual plans in the context of innovation and resource efficiency.

The inter-ministry group (1) and the Resource Efficiency Agency (4) would use the evaluation agency’s findings to optimise measures and make them more focused. Accordingly, these findings would be incorporated directly into a future programme design (13) and into further development of the policy mix by the inter-ministry group (1) and the Resource Efficiency Agency (4).

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Material Efficiency & Resource Conservation

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Consumer-Oriented Approaches to Foster Resource Efficiency

Executive Summary

Summary of the results of Task 12 of the project „Material Efficiency and Resource Conservation“ (MaRess)

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For our Environment

Consumer-Oriented Approaches to Foster Resource Efficiency: Executive Summary

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1 Background, Objectives and Approach

In 2004, the resource consumption per capita in Germany reached 74 tons (Bringezu et al. 2004). This figure does not only cover direct resource demand, but also the ecological rucksack, that is all resources consumed along the lifecycle of the goods and services consumed – from production, over use to final disposal.

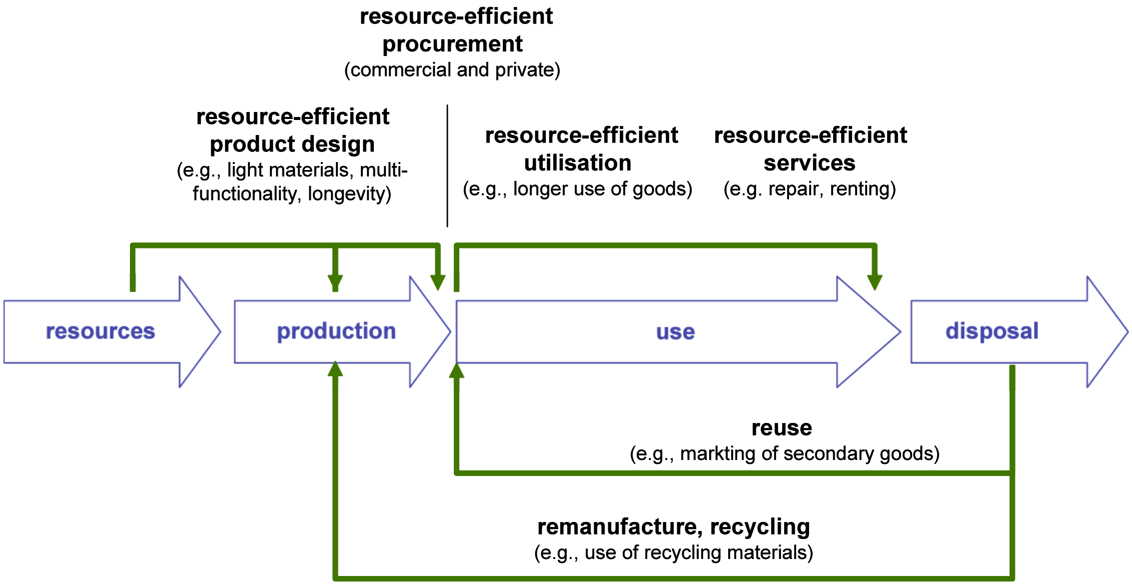
At the global level, resource consumption is unevenly distributed. If developing countries were to catch up and achieve similar consumption levels, by 2050 we would haveseven times the resource consumption of today – based on the current projections of population growth. This would exceed the earth’s carrying capacity by far. Hence, an absolute decoupling of wealth development and resource demand needs to be realized very soon (Schmidt-Bleek 2007).

Against this background, the issue of sustainable consumption has recieved increasing attention in the last years. This includes, for instance, during the Marrakech Process of the United Nations (Cf. http://esa.un.org/marrakechprocess/index.shtml), the European Commission’s “Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP) Action Plan“ (European Commission 2008) or the National Dialogue Process for the Promotion of Sustainable Consumption and Production (Cf. www.dialogprozess-konsum.de). In spite of these ongoing activities, the policy mix implemented in different countries to foster sustainable consumption patterns is not highly developed (e.g., OECD 2002, UNEP 2002, OECD 2008). This applies especially to measures dedicated to improve the resource efficiency of consumption.

Task 12 of the project “Material Efficiency and Resource Conservation (MaRess)” addresses this topic. It is dedicated to approaches that improve the resource efficiency of consumption patterns and it aims to develop policy instruments capable of enhancing material efficiency and resource conservation in consumption. By doing so, Task 12 refers to the “Strategy Resource Efficiency” of the German Federal Environmental Ministry that aims to assess the potentials for resource efficiency in lifestyles and consumption habits and to stimulate innovations in these areas (BMU 2007).

Consumer-oriented approaches to foster the resource efficiency are defined as policy measures that achieve a more sustainable use of natural resources. This is achieved through changing the demand and utilisation of goods by private households or by commercial customers. Fig. 1 illustrates possible strategies for improving resource efficiency along the product lifecycle.

Fig. 1: Strategic levers to enhance material efficiency and resource conservation along the product lifecycle



Source: own elaboration

Resource-efficient product design encompasses the use of efficient materials, the development of multi-functional products, and the supply of particularly long-lasting goods. *Resource-efficient procurement* addresses all activities of private or commercial customers increasing the sale of eco-efficient goods and services. The "use phase" covers, on the one hand, *resource-efficient usage* of products, for example through extended individual use, and, on the other hand, the sale of *resource-efficient services*, such as repair services or renting and sharing services. Finally, strategies of *reuse and recycling* address the end of the product lifecycle and aim to extend the use period of products or single components or materials.

In order to accomplish the objective of Task 12, numerous innovative policy instruments were first screened. Promising approaches were selected along criteria such as the potential for resource efficiency, novelty, and ease of implementation. Development options were sketched for each selected instrument (Scholl et al. 2009a, Scholl et al. 2009b). In the second step, single instruments were further elaborated and proposals for their implementation formulated. The areas addressed were the following the findings of which are presented in the next chapters:

- options for improving resource efficiency in everyday consumption,
- perspectives of resource-efficient services („consumption without ownership")
- resource-efficiency prospects of the German eco label „Blue Angel",
- resource-efficiency consulting of low-income households,
- internet-based consumer information and consumer advice on resource-efficiency.

2 Options for Improving Resource Efficiency in Everyday Consumption

Within private consumption, the biggest resource rucksack is borne by building and housing (45% for housing and household goods), leisure time and mobility (28% for traffic, accommodation and leisure time), and food (26%) (cf. Tab. 1). As a result, policy needs to especially address these areas.

Tab. 1: Resource consumption incl. rucksack of different consumption domains

Consumption domains	Resource consumption	
	1,000 tons	**%**
Food and drinks (incl. alcoholic drinks)	12.644.777	26
Home, water, electricity, gas, and other fuels	9.223.308	19
Traffic	9.140.765	19
Furniture, appliances, devices, and equipment for the household, incl. Maintenance	7.696.969	16
Accomodation and gastronomy	4.473.912	9
Leisure time, entertainment, cultural events	1.555.107	3
Clothing and shoes	1.177.867	2
Health care	1.028.759	2
Other goods and services	1.028.420	2
Tabacco	187.666	<1
Information	181.925	<1
Education	100.102	<1

Source: own elaboration based on Acosta-Fernández 2009; Acosta-Fernández 2007

Individuals will only be able to consume less resources when they know how this can be done in everyday life and when they are motivated to do this,. In energy consumption, there is a plethora of guidelines, brochures and internet information sites offering recommendations on how to save energy in the different domains. For resource efficiency, there is only little information available so far. Moreover, a target group and lifestyle specific presentation and communication of the existing advice are lacking.

The objective of studying the options for resource efficiency in everyday consumption was to identify concrete options for private households and to target them to different societal groups with different consumption styles (Kristof / Süßbauer 2009). At first, several options for everyday action were identified and grouped into basic strategies. Criteria for differentiating the options for action were developed then. There are two groups of criteria, one for characterising the options and their individual impacts and another one for distinguishing different target groups. Characterising options for action according to impact, socio-demographic, and psycho-graphic variables allows for clustering them with regard to the most suitable target groups.

For two groups, such sets of different everyday options were elaborated on: low income households and heavy users of advanced internet media (web 2.0). Such target group specific sets are key for designing successful consumption-oriented policies. Hence, they build the basis for the policy instruments developed in Task 12.

3 Consumption Without Ownership: Potentials of Resource-Efficient Services

The resource efficiency of consumption can be improved by using products rather than owning them. For instance, by renting rarely needed products rather than buying them (e.g. car sharing or renting of leisure time equipment) or by leasing high-value consumer goods and returning them to the supplier after final use (e.g., furniture rental). However, what is the potential for this kind of consumption without ownership? Answers to this question were developed in a short study within Task 12 comprising a literature review, an analysis of good-practice cases, expert interviews and an expert workshop (cf. Scholl et al. 2010). The study provides the following results for policy-makers.

Focus on selected product and service domains

Replacing products by services bears big potential for, but does not automatically improve the resource efficiency of consumption. Therefore, when communicating consumption without ownership it is important

- to focus on such consumption areas where the replacement of products by services provides obvious ecological improvement and,
- in all other cases, to convey the conditions (e.g. avoiding additional transportation with the rental and return of shared goods) under which sharing, renting and the like can be the more resource efficient alternative to individual ownership.

Distinguish commercial, non-commercial, and public services

Resource-efficient services can be supplied in different institutional settings. They can be market-based, commercial services and as such provide a business-case for consumption without ownership. Examples are Daimler’s mobility service “car2go” and the internet platform www.erento.com promoting rental services. Besides that, consumption without ownership is part of individual consumption practices, e.g. when lending or borrowing goods in the neighbourhood. An internet platform such as www.teilo.de provides an institutional frame for such private activities increasing the transparency and fostering the demand for collective use. Eventually, resource-efficient services can be supplied as public services. Examples are rent-a-bike systems such as “Vélib“ in Paris, “Bicing” in Barcelona or “City Bike” in Stockholm which are supplied as an integral parts of the public transport system. The recent expansion of the Paris system to cars (“Autolib”) shows the potential for development of such approaches.

In Tab. 2 the three different types of resource-efficient services, their focus, examples and possible leverages for their proliferation are summarised.

Tab. 2: Overview of resource-efficient services („Ownership without consumption“) and supporting measures

Type	Focus	Examples	Supported by …
Commercial services	Economic viability	Car rental, car sharing, renting of toys, leasing of furniture	Wirtschaftsförderung / Existenzgründung Sustainable development policies: increasing the transparency of available services
Non-commercial services	Social benefit (e.g., Nachbarschaftsfhilfe)	LETS, neighbourhood Verleihbörsen, internet platforms for brokerage	Sustainable development policies: Awarenes-building (e.g., information, campaigning), Incentives for behavioural change
Public services	Social benefit (Daseinsvorsorge)	Bike rental as part of public transport	Municipal measures; strengthening communal economies

Link with current environmental policies

In the context of the recent amendment of the **EU Waste Framework Directive** and the amendment of the **German Act for Promoting Closed Substance Cycle Waste Management**, resource-efficient services can be regarded as waste prevention strategies: by using the current stock of products more intensively the amount of waste per unit of service gained from a product is diminished. The new European Waste Framework Directive calls upon the Member States to set up Waste Prevention Programmes by 2013. Consumption without ownership can be featured here as well, for example by stipulating a certain level of collective use in selected consumption domains in the formulation of waste prevention objectives or by covering all existing supporting measures for resource-efficient services in the assessment of the waste prevention policies in place.

Apart from waste management policies, the environmentally friendly design can be another leverage for fostering resource-efficient services. Through the amended Directive 2009/125/EC, the European **Eco Design** Directive has been extended from energy-consuming to energy-relevant products. In 2012, the European Commission will assess the impact of the Directive. The assessment shall reveal whether there is good reason for further extending the Directive’s scope to non-energy-relevant products and a broader range of (material) resources. In this context, it should be analysed if and in what way the extension of the Eco Design Directive to services and, in particular, to resource-efficient services is beneficial and feasible.

A further important topic with respect to sustainability is the **product-based CO_2-footprint**. Possibilities for expanding the Memorandum Product Carbon Footprint (BMU et al. 2009) to include the service sector should therefore be explored.

At the initiation of the German Federal Environment Agency (UBA) a concept for a **Blue Angel Award** is presently being drawn up. If resource-efficient services were to be specifically included, this new and effective publicity instrument could in turn foster the concept of consumption without ownership among manufacturers, businesses, and consumers.

Additionally, the topic of consumption without ownership could be incorporated into the regularly conducted **survey Environmental Awareness** in Germany, in order to acquire a more precise estimate of the extent and acceptance of resource-efficient service providers.

Creating an innovative and easily communicable vision statement

In order to most effectively communicate these ideas – both in sustainability policy statements as well as in the end consumer target group, these concepts should be augmented by **innovative vision statements**, for example, “Live lightly, live resourcefully” or “Enlighten Your Life” (drawing on the motto “Simplify Your Life”). The intent is to communicate not only reduced resource consumption but also the relief from the obligations of property ownership. Ultimately, the goal is to establish a **new usership culture**.

Building strategic alliances

The fostering of resource-efficient services will require strategic alliances among the players involved; the specific nature of these will vary, depending on the sector, i.e., commercial, non-commercial, or public. Inasmuch as implementation of the consumption without ownership concept often involves a combination of technical and social innovations, a broad network of agents for change is important. The selection of the specific players to be brought in will depend upon the actual product or service sector involved.

4 Perspectives for a “Resource Angel” ecolabel

The current 88 Blue Angel award criteria address various protection goals: protection of water resources, climate, health, and other resources. Currently there are 16 product categories listed under protection of resources, e.g., paper recycling, reusable packaging, reconditioned toner cartridges, and rechargeable batteries. Strengthening the brand image of the Blue Angel in the area of resource protection is a worthwhile idea in several respects:

- In order to achieve the goal formulated in the National Sustainability Strategy of significantly increasing raw materials productivity, the ‘soft’ instruments of governmental environmental policy must also be directed toward this objective.

- The Blue Angel still enjoys a very high level of brandname recognition. A greater emphasis in the Blue Angel certification on aspects of resource protection would be an important contribution to building public awareness.

For the purpose of developing a "resource angel" various strategic options were identified in Task 12:

Products utilising resource-efficient materials

Metals such as gold, platinum, tin, and silver show a very high level of resource consumption (incl. the ecological backpack). Furthermore, important resources, such as indium, for example, which are utilized in the manufacture of LCD displays, flat-screen monitors and mobile telephones, are very scarce worldwide (e.g. Behrendt et al. 2007).

The resource angel could be used to single out those products demonstrating a very low level of resource consumption, as well as those avoiding the use of extremely scarce raw materials. For this purpose, a ranking of mineral and metallic raw materials, reflecting not only resource consumption (incl. the ecological backpack) but also the scarcity of the material, should be drawn up.

Products utilising secondary raw materials

Re-utilisation of materials is a central maxim of closed-loop recycling management in Germany. Utilising secondary raw materials in place of primary ones provides not only for a more efficient use of resources and waste reduction over the course of the entire life cycle, it also can reduce greenhouse gas emissions (e.g., Fraunhofer UMSICHT / Interseroh 2008).

The utilisation of secondary raw materials is already being promoted by various Blue Angel award criteria. It is recommended that further product areas be ascertained in which the utilisation of secondary raw materials is ecologically advantageous and economically viable; it then remains to be determined whether certification criteria for these products can be developed.

Products utilising renewable raw materials

To date, Blue Angel certification has not focussed on the use of renewable raw materials. An exception to this would be compostable containers for gardening and moulded parts consisting only of biodegradable substances, such as straw, cork, wood dust, or cornstarch (RAL-UZ 17). Greater attention to this topic for product groups such as paints and coatings, cements/adhesives, simple packaging (e.g., covers, carrying bags, sacks, and wrappers) or catering products (cups, plates, and cutlery) is conceivable. However, only sustainable options should be supported, as the ecological advantages of renewable materials is not always conclusive and often is only assessable in specific cases (e.g., Nova Institut 2010).

Products with an extended life cycle

The strategy behind **long-life products** is the generation of additional units of service from the environmental resources invested in a product and thus increased resource efficiency. This is particularly effective with consumer goods, where the resulting environmental impact derives almost entirely from the manufacturing process; examples include goods such as furniture, clothing, shoes, etc. So far, Blue Angel certification has only addressed product durability indirectly, in the sense of reparability and product quality. It is thus recommended that further product categories be ascertained for which a Blue Angel for above-average product lifespan might be appropriate – something along the lines of the Austrian seal of sustainability for repair-friendly and durable consumer goods (Pirkner et al. 2008).

The strategy of **re-utilisation** refers to products or goods that are re-used for the same original purpose (e.g., refillable glass containers, cloth shopping bags). **Remanufacturing**, on the other hand, involves bringing a used product into a quasi-new (refurbished) condition. Examples of remanufactured or refurbished capital goods include medical equipment, machine tools, and photocopiers. In the case of consumer goods, examples of remanufactured products include toner cartridges, automotive parts, automobile tyres, bicycles, furniture, and computers. Re-utilisation is, to some extent, already addressed in the Blue Angel criteria. Remanufacturing, however, presently does not play a large role with the Blue Angel. Although the perspectives for further development in the area of re-use are relatively minimal, expanding application of the remanufacturing principle in product groups such as furniture, compressors, and copiers is worthy of review; for this, the experiences of other countries, such as the United Kingdom, should be evaluated.

Resource-efficient services

The Blue Angel presently offers only a few certification criteria addressing service sector businesses, e.g., wet cleaning services, carbon dioxide cleaning, car sharing, and eco-friendly ships. Behrendt et al. (2001) report that opportunities for development in these areas do exist, but due to methodological problems with the criteria for certification and verification (among other things), they are limited. A look at other ecolabel systems (see Tab. 3) shows, however, that even beyond tourism and other leisure activity services, further opportunities for the Blue Angel ecolabeling of other services do exist. These should be systematically explored in a new feasibility study.

Tab. 3: Services addressed by selected ecolabeling systems

Country, Ecolabel	Service-related certification criteria for ...
European Union, the EU Ecolabel	hospitality industry, hotels, campgrounds
Austria, the Austrian Ecolabel	eco tickets for public transport, energy contracting, green investment funds, travel offerings, the hospitality industry, campgrounds, gastronomy, schools, and educational institutions
Scandinavia, the Nordic Swan	cleaning services, hotels/hostels, laundry services, printers, restaurants, groceries, car wash facilities
Sweden, “Good Environmental Choice”	energy providers, groceries, transportation service providers
Czech Republic, “Environmentally Friendly Product”	hospitality industry, hotels, campgrounds, schools, educational institutions
Canada, the EcoLogo	car wash facilities, hospitality industry, hotels, climate-neutral air travel, investment funds for electrical energy from renewable resources
USA, the Green Seal	cleaning services (commercial and retail), fleet vehicle maintenance, hospitality industry, restaurants/catering

Source: Data compiled by authors

5 Resource-efficiency counselling for socially disadvantaged households

In Task 12, the promotion of community-oriented resource efficiency counselling for special target groups was identified as an important policy option (see Scholl et al. 2009a). Using the example of providing energy efficiency counselling to socially disadvantaged households, the goal of the subsequent steps was to determine what possibilities there might be for the integration of resource efficiency topics. This method of consumer affairs counselling was chosen because it represents an outreach approach and places resource efficiency counselling under the primacy of economic advantageousness.

Contact was established with two agencies providing advice and counselling services to socially disadvantaged households: the Cariteam-Energiesparservice (Cariteam Energy Conservation Services) in Frankfurt, and the EnergieSparProjekt (ESP), an energy conservation project that is a part of the energy debt prevention services provided by the Nuremberg department of social services.

In the course of two meetings with the management of Cariteam, initial insights were obtained regarding the potential for integration of a resource efficiency module into the range of currently offered services. Following an initial meeting with the managers and staff of ESP in Nuremberg, a workshop was arranged at which specific options for action were discussed. This led to the preparation of talking points or discussion aids, which are being used with success locally by the Nuremberg counsellors; currently an informational pamphlet for distribution to the client households is also being drawn up.

With this difficult-to-reach target group in particular, it is extremely helpful in overcoming the most common challenges (lack of information, expertise, motivation, or ability to act and, to some extent, language barriers) to have in place an already well-established and trusted advisory relationship.

Previously, such outreach counselling approaches had focussed only on the conservation of water and energy and on the specific target group, socially disadvantaged households. Further resource efficiency measures, e.g., the measures for saving energy in everyday life addressed in the talking points (rechargeable batteries instead of disposables, showering instead of bathing, tap water rather than mineral water, rinsing in the basin rather than with running water, fresh rather than frozen produce) can also be easily integrated into local advising and counselling measures suitable to the intended target group.

In conjunction with the newly reworked energy efficiency counselling services, incorporation of resource efficiency would also be quite a worthwhile idea. The services offered must remain free of charge; the counselling must be personalised and on-site and should incorporate examples from the various resource areas.

The counsellor thus needs to be well-versed in the most important resource efficiency topics. In support of this, suitable training and qualification materials for the counsellors should be prepared by the BMU / UBA and made available in the local counselling offices. Important here is that specific and clear recommendations for action are given. For this purpose, the options for action developed in Task 12 (see above) could serve as a point of departure.

Households with mid- to upper-level incomes are presumably somewhat less concerned about the need for cost savings; in such cases there may be other applicable recommendations that would be largely irrelevant to the socially disadvantaged household. There is a need here for further research, as other attributes, such as image and attitude towards environmental concerns, are likely to come to bear.

6 Internet-based consumer information and counselling on resource efficiency affairs

In the first work phase of Task 12, the development of possibilities for cooperation between Internet-based consumer counselling concerns and consumer-related environmental policy in the area of resource efficiency was identified as an important policy option. This option was further explored in the course of a workshop at the BMU attended by various experts and other interested parties in the area of consumer counselling, as well as Web 2.0 players, and BMU/UBA participants. The following topics were addressed in three blocks: opportunities for cooperation in the area of online communities, in the area of online resources or calculators, and in the area of Web-based service and product testing. These three avenues differ with respect to the objectivity of the information, the possibilities for interactivity with users, and in the potential influence of commercial interests; each offers a different point of access to the environmental players in the area of consumer information and counselling in Web 2.0.

Web 2.0 makes possible the merging together of the production and consumption of information. This is reflected in the transformation of communication from a one-sided model (information provider/expert advises information recipient/lay person) to an interactive Web 2.0 model, in which all parties may participate as both providers and recipients – with each of us, essentially, having the opportunity to become a “consumer expert”. New forms of both independent and commercial counselling are continually being developed in Web 2.0. Thus online merchants in Second Life are able to successfully offer “face-to-face” product consulting, with one consumer advising another.

Internet communities tend to be characterised more by a subjective information quality and a high level of interaction. The degree of commercial orientation varies. Internet-based product tests, in comparison, tend to deliver information of a more objective nature and mid-level interaction. Here, too, there may be commercial aspects or elements. The many online information calculators likewise tend to be more objective in nature; the possibilities for interaction so far generally have been minimal and they are for the most part not commercially oriented.

With respect to the question of how consumer awareness can be influenced by means of environmental policy measures and transformed into more resource-efficient consumer behaviour by means of appropriate incentives, a distinction must be made between a general consciousness-raising – an awareness of material efficiency and resource conservation issues – and more specific approaches that actually foster the use of resource-efficient products and behaviour. In the process, the intent should not be to address resource efficiency as a special issue, but rather to integrate it into everyday consumer decision-making and behaviour. Internet-based consumer affairs counselling can only be effective when the use of such instruments and tools (online calculators, forums, guides, etc.) by the target group for various consumer matters becomes repeat behaviour – at the point where a certain “stickiness” develops.

Web 2.0 offers the possibility of mobilising so-called **participatory consumers** for responding to resource queries. This can be defined as the intersection of the LOHAS and the Web 2.0 user: average age of 46, a well-educated, intensive media user, and well-informed (Zucker Kommunikation / SKOPOS 2009). This consumer group can provide a certain multiplier and opinion-maker function for the topics of material efficiency and resource efficiency. Particularly within the context of peer-to-peer consumer counselling and user-generated content, the participatory consumer can serve as a useful source of information on resource efficiency. Peer-to-peer communication is one of the most important information sources for consumers today, and with respect to perceived credibility and authenticity, it enjoys a clear advantage over “official” Web sites. Furthermore, Web 2.0 offers the possibility to strengthen the direct dialog between business and consumer.

So far, however, there has been a lack of conceptual as well as empirical work that could provide **a measure of the behavioural relevance of Internet-based consumer**

information and counselling. In the case of material and resource efficiency, this is made more difficult by the lack of agreement on a single indicator or dependant variable.

The workshop “Promoting resource efficiency in the context of consumer counselling in Web 2.0” has made clear the interest in an exchange of ideas among the players. Thus the following recommendations are made:

The dialogue and exchange of ideas between BMU / UBA and the relevant players should be continued and expanded, for example, as a part of the **National Dialogue Process** – with content materials prepared, accompanied and documented by a project team.

Furthermore, an in-depth analysis of the topic of resource policy in Web 2.0 and newer communication forms for various target groups (e.g., use of social networks for communication) would be beneficial; likewise, the preparation of a **strategy paper – “Resource policy in Web 2.0”** as a conceptual further development of the results obtained from the workshop is also recommended.

BMU/UBA can serve here in the role of data provider in making available suitable information to the various Internet service offerings. Questions thus arise as to the need for data and data availability and, above all, the most suitable interface between date provider and data user (data format, usage rights, etc.). This is an issue – **the interface issue** – that should be addressed in future projects. A first step towards a solution could possibly be found in cooperation with the Blue Angel ecolabel, which represents an important platform for product-related environmental data.

In the area of **online calculators**, the Web portal “One Did It” represents a good starting point for further development. The portal is the only resource-oriented online calculator in Germany. In further conceptual development and expansion of content to come, it would be worthwhile to include the courses of action for resource efficiency in consumer daily life that were developed in Task 12.

7 Outlook

7.1 General recommendations for action

Develop multi-impulse approaches

Drawing on the British 4-E model (*enable, encourage, engage, exemplify;* SDC / NCC 2006), we need to:

- **enable and facilitate** consumer- and customer-relevant approaches to increasing resource efficiency, e.g., through appropriate offerings of information and counselling,
- **provide incentives**, e.g., through financial measures,

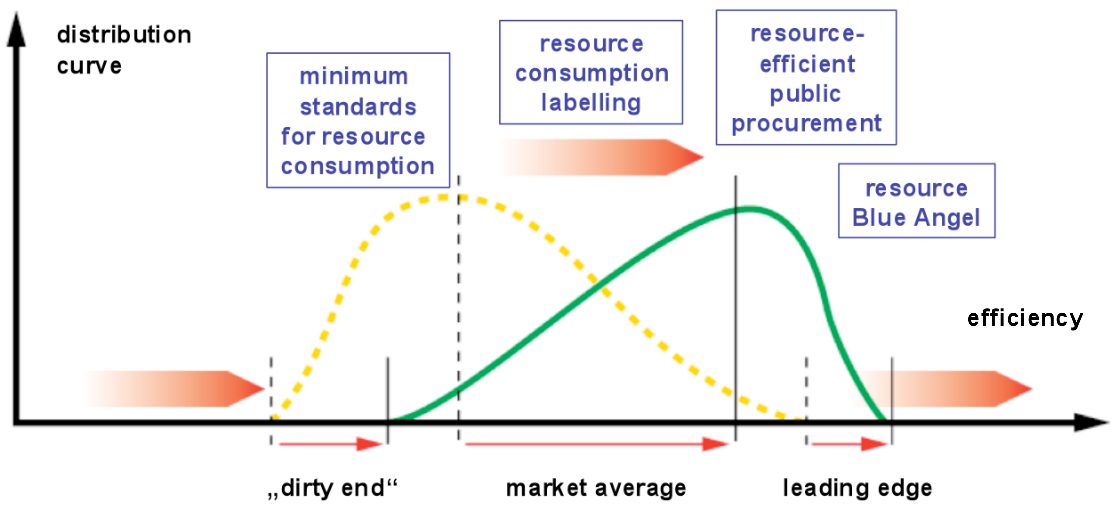
- **engage and mobilise**, e.g., by making available a suitable infrastructure for collective action and
- **provide good examples** for the feasibility of resource-efficient consumption.

The consumer- and customer-oriented approaches for increasing resource efficiency in Task 12 represent just one aspect of such a **multi-impulse approach**. Informative approaches are a priority in the Task, and thus the aspect of “enable & facilitate” is fully engaged. Furthermore, the action points for increasing resource efficiency in everyday consumption, in particular, as well as the Internet-based communication of “resource-efficient consumption,” provide excellent opportunities for demonstrating good examples of feasibility. The dimension of “engage & mobilise” is also targeted by Internet-based resource efficiency counselling measures as well as approaches in the area of consumption without ownership. Instruments such as the resource angel certification or resource efficiency outreach services for socially disadvantaged homes, in contrast, offer (relatively weak) incentives for resource efficient behaviour.

Develop resource-efficient product policy

The “classic” product policy instruments need to be further developed with respect to resource efficiency (see Fig. 2).

Fig. 2: The product policy instruments for fostering resource efficiency



Source: Developed from Kristof / Hennicke 2008

While the Blue Angel and in part government procurement procedures, too, can play a vanguard role in matters of resource efficiency, a mandatory resource consumption label could aim to gradually increase average efficiency in the marketplace. Minimal standards with respect to resource efficiency could eventually lead to the disappearance of non-resource-efficient products from the marketplace.

Expand base strategies

The courses of action and base strategies for resource-efficient consumption developed in Task 12 (see Tab. 4) should be augmented by further development of the policy field.

Tab. 4: Base strategies for resource-efficient consumption

Consumption phase	Approach	Base strategy for increasing resource efficiency
Consumption decisions	**Scrutinizing needs**	• Reflection on personal needs • Information searches and acquisition as well as assessment • Discussions about consumption in social arenas
Shopping	**Informed shopping**	• Resource-light products (i.e., products with a light-weight ecological backpack, with minimised material, energy, water, and land use at all stages of manufacture) • Small and/or light-weight products • Multifunctional and/or modularly utilisable products (technologically upgradable or expandable as needed) • Long-life products (timeless design, robust manufacture, easily repairable) • Re-used, re-manufactured, and recycled products • Packaging minimisation
Use	**Reduced consumption**	• Reduced consumption in the utilisation phase (i.e., reduction of direct resource consumption during utilisation) • Waste prevention (e.g., avoiding disposable tableware)
	Using, not owning	• Renting (e.g., tool leasing or photocopier leasing), sharing (e.g., car-sharing) or pooling (e.g., laundry service) • Private lending, sharing and exchange (e.g., equipment, carpools) • Virtualisation (e.g., electronic data rather than physical products such as CDs, books)
	Longer use	• Product re-use • Self-maintenance, cleaning, and repair of products • Using maintenance and repair services
Disposal	**Return**	• Returning or recirculating recyclable and still usable products

Source: Kristof / Süßbauer 2009

7.2 Area-specific recommendations for action

In Task 12 various options for consumer- and customer-relevant resource policy were identified (see above). For each of these options there are various recommendations for action, and these are summarised in tab 5.

Task 12 also furthermore recognised the need for the following **additional research**:

- Preparation of solid fundamental base data for consumer and lifestyle-specific resource consumption (incl. the ecological backpack) as part of the further development of current work (e.g., Acosta-Fernández 2007, Kotakorpi et al. 2008, Global 2000 / SERI 2009).

Tab. 5: Opportunities for implementing selected policy options

Policy option	Recommendation for action
Using, not owning	• Concentration on product and service fields offering a clear resource efficiency yield • Distinguishing between commercial, non-commercial, and public services • Tie-ins to current environmental policy developments (e.g., waste prevention programmes, ecodesign guidelines, product carbon footprint) • Development of vision statements as an element of a new utilisation culture (e.g., “Lighten your carbon footprint and *en*lighten your life”). • Formation of sector-specific strategic implementation alliances.
Ecolabel for resource efficiency	• Products from resource-efficient materials • Products from secondary raw materials • Products with an extended life cycle (long-life, re-usable, remanufacturable) • Resource-efficient services • (Products from renewable raw materials)
Resource efficiency counselling for socially disadvantaged households	• Outlining the financial advantages of resource-efficient consumption • Further development of the talking points on resource-efficient consumption for use in existing (energy-conservation) counselling service programmes. • Model trials with the talking points (e.g., as part of the EnergieSpar-Projekt in Nuremberg).
Internet-based resource efficiency counselling	• Continuation of the dialogue between the relevant players, e.g., as an aspect of the National Dialogue Process • Preparation of a strategy paper: “Resource policy in Web 2.0” • Improvement of the interface between existing product-oriented environmental information systems (e.g., the Blue Angel) and Internet-based information offerings • Further development and promotion of online resource calculators

Source: Kristof / Süßbauer 2009

- Systematic treatment of the options for action and good practice for resource efficiency in everyday consumption (particularly in the area of “using, not owning”) on the basis of the overview developed in Task 12 and as a possible contribution to a meta-portal for sustainable consumption.
- Development of packages of integrated measures for increasing resource efficiency in selected areas of consumption, e.g., nutrition, home and living, or mobility.

- More extensive investigation and development of innovative approaches to increasing resource efficiency that focus primarily on informing and mobilising consumers (such as Internet-based peer-to-peer dissemination). Specification of the potential roles for environmental players beyond the “classic” product policy instrument.

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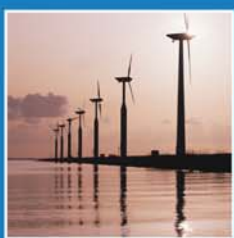
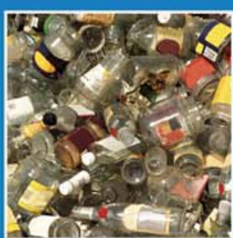
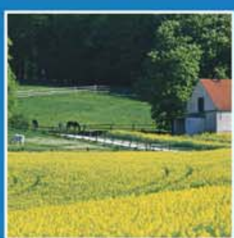
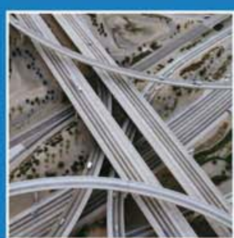
Ecodesign Directive

Executive Summary

Summary report on Task 14 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project

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Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

Umwelt
Bundes
Amt
For our Environment

Ecodesign Directive:
Executive Summary

Contents

Tables

1 Background

In 2005, the European Union released the Energy using Products (EuP) Directive, focusing on environmental standards for energy using products (Directive 2005/32/EC of the European Parliament and Council of 06 July 2005, revised by Directive 2009/125/EC of the European Parliament and the Council of 21 October 2009). This directive, also called Ecodesign Directive, establishes a framework for defining concrete requirements for individual products through so-called implementing measures. As a framework directive, it requires definition of regulations on the European and implementation on the national level. It includes both options to determine measures and regulations as well as self-regulating alternatives for the industry. In order to prepare **implementing measures,** the European Commission

- contracts **preparatory studies** on selected product groups and on cross-product group topics,
- prepares a **working programme**, which has to be revised after three years, determining the product groups to be covered (firstly for the years 2009-2011). In its interim working programme, the Commission had already determined 18 product groups and one cross-cutting issue and commissioned the respective preparatory studies for the implementing measures, serving as a basis for the discussion on proposals regarding the implementing measures during the project progression,
- involves already designated representatives of the Member States and interested parties (industry and business, trade, trade unions, wholesalers and retailers, importers, environmental protection and consumer organisations) via a **consultation forum** and
- is assisted by representatives of the Member States in a **regulatory committee**.

The example which gave rise to the highest publicity regarding an implementing measure within the Ecodesign Directive is the regulation on household lamps, leading to the phasing-out of incandescent lamps and which has evoked numerous discussions in 2009. Besides, this regulation was the subject of one out of nine short expertises within this Task 14 of the MaRess project. In addition, the European Commission has already implemented minimum requirements for other products like refrigerators and freezers, television sets and electric motors, which manufacturers and importers have to comply with when placing products on the European common market. Suggestions regarding implementing measures for further products are currently being discussed and preliminary studies are being prepared.

2 Objectives and Tasks

Against this background, the main tasks of the “MaRess” Task 14 regarding the Ecodesign Directive have been:

- a **critical examination of the working programmes 2009-2011 presented by the European Commission** for the further work process regarding the implementation of the EU Ecodesign Directive **as well as of the drafts for the implementing measures** regarding selected product groups,
- the scientific **support for a German positioning** within the consultation process for the Ecodesign Directive on the EU level, and,
- the **support for the practical application of future-oriented Ecodesign approaches**.

These tasks have been accomplished in close co-operation with the donors and in dialogue with the relevant groups of actors in Germany.

The overall objective has been to reach comprehensive and, at the same time, practice-oriented consideration of ecodesign aspects by making proposals for the design of measures for the implementation of the EU Ecodesign Directive on the EU level.

Additionally, more attention for the importance and practical implementation approaches of future-oriented Ecodesign approaches should be generated.

3 Approach

The demonstrated tasks have each been adjusted in close co-operation with the donors on behalf of the German Federal Environment Ministry (Bundesumweltministerium) and the German Federal Environment Agency (Umweltbundesamt) within the consultation process for the Ecodesign Directive and the communication and information processes with national stakeholders. In doing so, the objectives of the Task could be fully achieved. Especially the following results have been presented:

- **Nine short expertises** regarding different Ecodesign topics: In each case the basis have been specifications by the Federal Environment Agency including the research questions to be answered. For the acquirement of answers, analyses, evaluations, comments and information (e.g. preliminary studies, working documents, Excel tools), all relevant materials from the European Ecodesign Directive process have been used, but also other studies of third parties, data from producers and from the Federal Environment Agency as well as expertises, data and models available from the contractors. Some of these short expertises served exclusively as internal working papers for the preparation of a German positioning within the European consultation process, others are also publicly available at the following internet address (partly in English, partly in German only):

  http://ressourcen.wupperinst.org/downloads/index.html.

- **Further compilations** for the Federal Environment Agency: These included the preparation of data sheets for selected product groups and the supplement of a potential analysis of the Federal Environment Agency regarding Ecodesign Directive implementation measures.

- **Four expert dialogues** were planned, prepared, moderated and evaluated. Besides, the concept for a further expert dialogue was developed. The preparation of the expert discussions partly included the drafting of background and positioning papers. A total of 140 persons participated in the four expert dialogues from 2008 to 2010. Programmes, contributions and protocols of the dialogues are available on the following websites:

  http://www.umweltbundesamt.de/produkte/oekodesign/EbP-Fachgespraeche.htm and http://ressourcen.wupperinst.org/downloads/index.html.

- An **information pool** on the Ecodesign Directive, which was initiated in a previous project (project no. 206 93 300 / 02), was continued on demand of the donors until the beginning of August 2008, including the website www.eup-netzwerk.de, a monthly newsletter, a helpdesk, as well as presentations and discussions concerning the Ecodesign Directive on the occasion of conferences. Since mid of August 2008, the Federal Institute for Materials Research and Testing (BAM), now in charge of this matter, publishes its own newsletter in cooperation with the Federal Environment Agency. However, Ökopol continues with the information activities independently from the MaRess project in a different context.

The milestones and products of the Task 14 regarding the Ecodesign Directive are summarised in the following table.

4 Milestones and Products

Tab. 1: Overview of Task 14 results

Task 14 Ecodesign Directive	
AS14.1 **Short expertises within the European consultation process**	Short expertises on the following subjects: • Analysis of and comments on the **working programme** of the European Commission regarding the Ecodesign Directive for the years 2009-2011 • Statistical analysis of manufacturer data for **lamps*** • Ecodesign requirements for **heating systems and hot water supply boilers**: analysis of devices labelled with the “Blue Angel”* • Analysis of and comments on the Ecodesign preparatory studies on **home ventilating and air conditioners*** • Information on several questions regarding an EU regulation proposal for Ecodesign requirements for **ventilators** • Analysis of and comments on a proposal of the European Commission for Ecodesign requirements on **commercial refrigerators and freezers** • Analysis of and comments on a suggestion by the European manufacturer association CECIMO for a self-regulation initiative by the manufacturers of **machine tools** within the Ecodesign Directive framework • Analysis of the environmental impacts of **light-emitting diodes (LEDs)*** • Preparation of conclusions from the expert discussion **„Waste prevention and design for recycling“** Further compilations for the Federal Environment Agency: • **Data sheets** for selected product groups • Contribution to the Federal Environment Agency’s analysis of **energy savings potentials** of the Ecodesign Directive implementation measures
AS14.2 **Expert discussion on national level**	Expert discussions (concept, preparation, implementation, minutes, partly background and position papers) regarding the following topics:** • **Ecodesign Directive & Blue Angel**, 25.06.2008, Berlin (with the jury for the environmental label) • Ecodesign for **building technology**, 29.10.2008, Berlin • Ecodesign for **solid fuel small combustion plants**, 01.04.2009, Berlin • **Waste prevention and design for recycling** – operationability for the Ecodesign Directive, 02.03.2010, Berlin Concept for another expert discussion: • Ecodesign and the interests of **consumers**
AS14.3 **Information on Ecodesign**	Information provided until the beginning of August 2008, in particular: • **Website** www.eup-netzwerk.de • Monthly published **newsletter** • **Helpdesk** • **Presentations and discussions** about the Ecodesign directive on events Since mid-August 2008, the now responsible Federal Institute for Materials Research and Testing (BAM) publishes a newsletter in co-operation with the Federal Environment Agency (see also http://www.ebpg.bam.de).

* see http://ressourcen.wupperinst.org/downloads/index.html

** see http://www.umweltbundesamt.de/produkte/oekodesign/EbP-Fachgespraeche.htm

5 Essential Results

5.1 Essential Results of the Short Expertises

The following summary presents the essential results of the short expertises:

- The European Commission had issued a **working programme for the Ecodesign Directive process for 2009-2011**. The analysis of this programme **demonstrated**, that substantial energy savings are attainable through ecodesign requirements for energy-using products specified in the working programme. Ambitious, dynamic and technology-independent standards are necessary. The experiences of the interim working programme have demonstrated the need for stronger quality assurance of preparatory studies.
- Ideally, energy efficiency requirements for **non-directional household lamps** should put the service provided by a lamp (and its ballast) to the end-user in the centre of attention. Hence, regulatory measures are proposed as a function of light quantity and additional lamp features provided by the lamp (i.e. colour temperature, colour rendering or shatter protection), yielding a certain maximum rated power consumption as a function of these variables. A statistical analysis based on catalogue data from manufacturers could not deliver robust and funded parameters and coefficients for such a function in practice.
- The recent proposals of the European Commission for Ecodesign requirements for **heating systems and hot water supply** were analysed. The requirements and methodology for measuring energy efficiency of these appliances developed within the EU ecodesign process were exemplarily applied to selected heating systems and hot water boilers with the voluntary eco-label “Blue Angel”. The results of the calculations and further analyses showed that the implementation measures proposed by the European Commission would lead to significant changes in the market of heating technology: Market share of low-temperature heaters, which will be banned from the EU-market in 2013 due to efficiency requirements, is currently about 25%. Additionally, some combustion boilers of inferior quality will be banned. And finally, promoting programmes of both product ranges in Germany had to be adjusted.
- The analyses of the Ecodesign preparatory studies for **room air conditioning** found them seemingly consistent to a large extent. However, they revealed some improvement potential. For example, the influence of control technology on efficiency is not considered. Additionally, power limits and measurement standards applied in residential air conditioning are not clear.
- Some comments collected by producers and experts on the proposal by the European Commission for the regulation of **fans** seemed to stress the strong impact on Small and Medium Enterprises (SME) in comparison to the impact on larger com-

panies. For some smaller producers, the change in production and marketing structures will be costly whilst some European (and especially German) producers will benefit from regulation, as they will find it easier to place their more efficient products on the market. Exact estimation of the effects and conclusions were not possible due to lacking data. Experts, however, considered the proposed requirements to be feasible for the reduction of product life-cycle costs.

- The analysis of the Commission proposal on requirements for **commercial refrigerators and freezers** showed the necessity of alignment of the three EU Ecodesign Directive lots ENER 12, 13 and ENTR 1 for different product groups in the field of refrigeration and freezing. In addition to energy efficiency requirements, regulation should stimulate a more efficient lighting and the use of more climate-friendly refrigerants. A mandatory labelling of the appliances is generally regarded as positive.
- The producers association of **machine tools**, CECIMO, has proposed a self-regulatory initiative for ecodesign of their products. It seems to be a plausible proposal to first initiate a streamlined and coherent process of data generation before using this improved data to analyse the possibility of minimum energy efficiency standards. In parallel, possible energy efficiency potentials through minimum requirements for certain components should be analysed.
- The study on **light emitting diodes** (LED) analysed potential toxic or environmentally relevant materials in the production and use phase of LED, which of the materials might be scarce and recycling potentials. Special emphasis was put towards the semiconductor metals indium and gallium as they are produced as by-products in the production process of other metals in relatively small quantities. No significant negative environmental impacts have been encountered, but there are optimisation potentials in the production process and there is no data yet on recycling potentials and quota, as well as on long-term effects of LED-based lightening. A complete shift to LED technology in many countries might lead to resource scarcity problems and price increases.
- Some recommendations have been elaborated following the experts dialogue on **waste prevention and design for recycling**, especially with regard to the broadening of the applicability of the Ecodesign Directive and the consequent demand for a review of the EuP methodology.

5.2 Conclusions on experts dialogues

With the expansion of instruments for environmental protection using the means of product regulation by the European Commission and the German Federal Government, the coordination of these instruments and its material requirements has become crucial. It is essential for realising synergies and for combining instruments effectively.

The first experts dialogue on 25 June 2008 in Berlin and the subsequent strategy paper „**Ecodesign & Blue Angel**“[1] discussed the strategic positioning of the voluntary eco-label within the array of instruments of product-related environmental protection measures. Its focus lay especially on the energy-using products regulated by the Ecodesign Directive 2009/125/EG, i.e. the then effective Directive 2005/32/EG. The essential contribution by the “Blue Angel” label is to represent a certain additional value in terms of environmental and health-related issues in comparison to existing minimum requirements and energy-efficiency labels, such that customers accept the ecolabel. Therefore, the criteria of the “Blue Angel” might have to be adjusted following EU-wide Ecodesign requirements in different product groups.

The second experts dialogue on 29 October 2008 discussed ecodesign requirements for **technical building equipment**, respectively for the ten relevant product groups regulated within the framework of the Ecodesign Directive. Special emphasis was laid on the relation between the EU Ecodesign Directive and the European Buildings Directive and its national implementation in Germany, on uniformly applied norms across product groups, on a standardised proceeding within the Ecodesign regulations demanded by participants, especially concerning different product groups relevant for heating, and finally on the consequences of technical building equipments for customers and the responsibilities of the overall optimisation.

As well in the field of heating, technical state of the art and future developments of **solid fuel small combustion installations**, emissions of particulate matters from these appliances, and standardisation processes within Europe, energy efficiency and testing procedures have been analysed in a meeting on 1 April 2009 in Berlin. Additionally, interactions between the EU Ecodesign Directive and the German emissions ordinance 1.BlmSchV and the (already above) observed systematical deviations in the development of Ecodesign requirements for heating equipment were discussed in this meeting. As it took place at a relatively early point in time concerning the regulation process, the numerous experts’ proposals could be used in the further elaboration of preparatory studies before the European Commission will issue the first draft regulation. This opened possibilities for detecting and indicating undesired developments in the regulation process.

Within the framework of the preparatory studies for the EU Ecodesign implementing measures, the analysis of the amounts of waste of the considered product groups is part of a simplified life-cycle assessment. However, requirements for the mitigation of waste-related environmental impacts or supporting the utilisation of recycled materials have not been integrated yet into the regulatory measures in the context of the Ecodesign Directive. Exceptions are information requirements for recycling and demounting for certain product groups (see e.g. lamps, pumps and motors). The reasons for this exclusion and the question if an inclusion of this topic into the ecodesign process might open up new potentials for environmental relief have been discussed at an

[1] Original German title: Ökodesign & Blauer Engel.

experts’ meeting on **waste prevention and design for recycling** on 3 February 2010 in Berlin. First of all, technical, economic and political obstacles for the realisation of a waste-reducing and recycling-appropriate construction within the existing legal framework were analysed. On this basis, requirements for recovering and recycling were elaborated in two directions: towards the product design by producers and towards co-ordination and regulation of policy instruments and measures. Finally, possibilities and limits for further operationalisations of requirements for sustainable product design and recycling economy within the Ecodesign Directive have been discussed.

5.3 Main results of the information offered

Central elements of information materials provided have been the website www.eup-netzwerk.de which has been visited by about 3,000 users per month and the 6 email newsletters disseminated to about 300 recipients (relevant stakeholders, especially producers, government institutions and associations). These offers were completed by presentations and discussions on the Ecodesign Directive at events and conferences as well as by a helpdesk.

Actors regarded these information as useful, as feedback indicated: At this time, it was the only informational source in Germany comprising the entire Ecodesign Directive process in a clear-presented way and providing all relevant documents as fast as possible, usually within few days after issuing. This was especially important as many actors (especially small and medium enterprises) were not well-informed about the process.

6 Ecodesign Directive: Preliminary Conclusions

First rough estimations by Wuppertal Institute which have not been published yet estimated possible reductions of about 320 to 600 TWh/year of heat/fuels and about 500 to 600 TWh/year electricity, if the European Union (EU-27) realised **ambitious, but practice-oriented ecodesign requirements** for the about 40 product groups currently focused on. This induces a possible reduction of 210 to 270 million t CO_2 equivalents per year in relation to business-as-usual development. The expected increase in electricity consumption in the EU-27 may thus be mitigated and the already expected reductions of heating and fuel consumption may be enhanced.

There is no end in sight towards ongoing selection of product groups, the elaboration of preparatory studies and executive measures for ecodesign requirements for products in the European internal market. The Commission amplified the scope of the Ecodesign Directive with its 2009 revision: Now, not only energy-using products but all energy-related products shall be included. Consequently, in addition to energy efficiency issues, other ecodesign aspects (such as **material efficiency**) will gain higher importance. The question rises, which chances and challenges may be derived from the experiences with the current regulations and which aspects will have to be included with this broadening of the field of application.

As well, the **shortcomings** of the enacted ecodesign regulations have become clear:

- The **quality and methodology of preparatory studies** is not always sufficient for the deduction and justification of effective and practice-oriented implementing measures. Consequently, the European Commission should improve the requirements for the contractors of preparatory studies, for the methodological framework and tools to be applied by them, and for a common design for the presentation of results from preparatory studies.
- **Consumers** and their possible reactions to changing products and their information necessities are often not sufficiently acknowledged.
- **Aspects other than energy use** are insufficiently addressed. Apart from several information requirements, there are no measures e.g. for promoting recyclability. Other environmental or health-related aspects such as noise, toxic emissions, emissions of refrigerants in cooling appliances or use of scarce materials are not satisfactorily taken into account. Material efficiency is of no matter for the elaboration of ecodesign requirements.
- The analysis of products for technical building equipment such as heating boilers or air conditioning yields: the Ecodesign Directive only allows for a **product-specific perspective**. Interaction effects between different components (“products”) are analysed only partly by this framework. Synergy effects for additional energy savings can be realised by optimising component usage, adequate dimensioning and regulated operation within a **systemic context**. On the other hand, certain energy-efficient appliances exist, which, in certain systemic contexts, will lead to an increase in energy consumption. Many product groups thus require not only implementing measures for the market access of the special product group but an optimisation of the entire **policy package** they are embedded in, and to coordinate the single measures within the package. For instance, requirements to technical building equipment within the Ecodesign-Directive should be aligned with the EU-Energy Performance of Buildings Directive and its national implementation, with requirements regarding EU energy labelling and with any national support measures.
- Finally, the **largest part of energy savings potentials** of technology with high energy consumption and a sales minimum of 200,000 per year (criteria formulated by the Ecodesign Directive) **will be exhausted soon** by the implementing measures realised or proposed so far. Implementing measures for the remaining more complex and less standardised products with sufficient sales quantities will be increasingly difficult to realise.

Despite these limits, the Ecodesign Directive induces a **change towards more environmentally compatible products** and, in some product groups, leads to ecological innovations. Additionally, consumers are released from some information problems: they can place confidence in the market banning of the most inefficient and, in terms of **life-cycle costs,** most expensive products and in the setting up of market conditions to guide them towards more sustainable consumption.

The widened applicability of the Ecodesign Directive with its recast in 2009 to **energy-related products** creates a demand for the revaluation of numerous aspects if not only energy consumption shall be focused on. The restructuring of the ecodesign methodology required to be applied by preparatory study contractors will be especially challenging: to analyse the entire product life-cycle with all relevant environmental effects, material efficiencies and resource consumptions, to estimate consequences to certain possible policy measures and to balance the trade-offs of conflicting goals.

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- All presenting experts and participants of the four experts dialogues.

Materialeffizienz & Ressourcenschonung

Potentials for Increasing Resource Conservation and Resource Efficiency

Policy Recommendations for Conserving Resources and Increasing Resource Efficiency

Analysis of the Impact of Instruments to Promote a Successful Resources Policy

Resource Efficiency in Practice: Implementation, Agenda Setting and Successful Communication

MaRess-Project-Website
http://ressourcen.wupperinst.org

The project "Material Effciency and Resource Protection" (MaRess) is framed by the environmental research plan (UFOPLAN) launched by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and by the Federal Environment Agency (FKZ: 3707 93 300).

Material Efficiency & Resource Conservation

Martin Distelkamp
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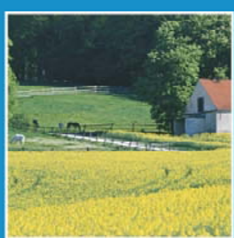
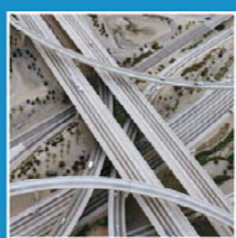
Quantitative and qualitative Effects of a forced Resource Efficiency Strategy

Executive Summary

Summary report of Task 5 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project





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Questions

What are the economic effects of a forced policy to raise resource efficiency? Which interrelations have to be considered in the macroeconomic context concerning the impacts of different policy instruments? Is a decoupling of economic growth and resource consumption possible in the long run? These are the questions that Task 5 has to answer.

Methodology

The methodology is to run simulations with a sectorally deep disaggregated economic environmental model that depicts the relations between economic development, resource consumption and emissions. A comparison is drawn between a model forecast that includes one or more policy activities and a reference forecast, in which these policy activities are not implemented. The comparison between both forecasts allows for the identification of all direct and indirect effects that are induced by the policy instruments.

To obtain empirically substantiated results, it is useful to work with a model whose parameters are estimated using econometric methods. The model PANTA RHEI fulfils this requirement. It has been used in many applications answering economic environmental questions. During the project it has been completed by a material module. The data base of the material module is a data set of the Wuppertal-Institute that links the different categories of material consumption with the economy in deep sectoral disaggregation.

The Reference

The reference is a forecast which in our case depicts the economy, resource consumption and emissions for each year till 2030. The preparation of the forecast requires assumptions about the development of variables that are not calculated by the model. In our case the further development of the world economy and the policy variables, especially the instruments of environmental policy, have to be fixed. The study discusses these questions in detail running scenarios with different assumptions. Two main results could be achieved: At first, it could be shown that the dynamic of material consumption, which could be observed in Germany during the last ten years, was driven by metals which are linked to the strong export development. Germany is exporting with big success investment goods as machinery and cars which consist preponderant of metals. Secondly, material consumption is also dependent from climate policy, which reduces the use of fossil fuels, coal, gas, and oil. Insofar the level of resource consumption in Germany in the reference is strongly depending on the assumptions about the further development of the world economy and the decisions on climate policy in Germany.

We assumed a moderate long run growth for the world economy which induces an average growth rate for German exports of about 3.2% p.a. With regard to climate policy we assume an engaged strategy that achieves a reduction of CO_2-emissions of 80% (compared to the historic value of the year 1990). For the last year of our simulation this means a reduction of 54%. Of course there is no specific decision about the chosen instruments for the whole time period. So we assumed that the already established policy instruments with the aim to enforce renewable energies and energy productivity in firms and households will be further developed so that the set targets will be reached. The selection of this reference scenario is supported by the fact that the government and the opposition in Germany conclude regarding the targets even though there is no consensus yet about the policy mix.

The Discussed Instruments

Analyzing all groups of instruments – economic instruments, information and consultation instruments and regulation by technical standards - the study covers a broad range. But it is not the aim of the study to discuss all instruments that play a role in the other Tasks of the MaRess project. This is not possible since many of the possible measures cannot be quantified. The idea is to include at least one instrument of each group that plays an important role in the other Tasks of the project as well.

From the group of **economic instruments** changes in value added taxes for transport services and the introduction of a resource tax for building materials have been elected.

The change of the rates of value added taxes concerns rail road transportation and air transport services. The tax rate for rail road transportation is lowered from the regular rate of 19% to the reduced rate of 7%. Contrastingly, the tax rate for air transport services is raised from 7% to 19%.

The effects of resource taxes are analysed for the extraction and import of building materials. It is assumed that in 2012 a tax of 2 € per ton of extracted and imported building material is introduced. The tax rate rises by 5% p.a. and reaches 4.80 € in 2030.

Information instruments are of a very different nature. An analysis of specific characteristics of such instruments is nearly impossible because the empirical information about its direct impacts is missing. Therefore, it is not possible to model these instruments. The alternative approach is to ask what are the differences between a situation in which the agents have perfect information compared to the situation of the reference scenario where, for example, many producers do not use the best practice technology concerning resource consumption because they do not know all alternatives that they have. So we ask for the potential of an information policy as a whole without relating it to a specific information instrument. For the firms there is empirical information for this potential based on the experience of consulting firms. Furthermore, the German Efficiency Agency DEMEA and the Efficiency Agency for North-Rhine-Westphalia have a lot of information about the impact of consulting: What is the impact of the introduction of the “best practice” technology for resource consumption on material costs, capital costs and costs for consulting services? The consulting firms come to the result that in manufacturing on average 20% of material costs can be saved. To realize this potential additional costs arise which equal the savings of one year. One third of these costs are consulting services, two thirds are investments in equipment. We assume that it might be possible to introduce the best practice technology in 5% of all manufacturing firms per year so that in 2030 the potential of all manufacturing firms is exhausted.

As a **regulation instrument** we discuss the introduction of rules for the use of recycling in the production of non-ferrous metals. Here it is assumed that in final products a certain percentage of non-ferrous metals has to be of recycled material. The share of recycled non-ferrous metals rises linearly from the actual level so that it reaches factor three in relation to that level in 2030.

One can imagine that here intelligent forms of regulation come into practice which may be based on voluntary agreements or the top runner concept. Since all final products have to fulfill the standards, all imported products are included. This means that we have either branch-oriented international agreements about the production of non-ferrous metals or the importing firms have to prove that the imported products are in line with the standards.

This scenario is calculated in two variants. The econometrically estimated elasticity of substitution of non-ferrous metals by secondary products is about -0.4. This means that the substitution will cause costs. In the second variant it is assumed that in a world with permanently rising world market prices for metals there will be incentives to improve the recycling technology. Furthermore, with rising activities there will be learning effects. To catch the potential of these cost reducing factors we run the model in the second variant with an elasticity of substitution of -1 for non-ferrous metals versus secondary products.

The Results

The impact of **economic instruments** is analysed for a change in consumer taxation of traffic services and the introduction of a resource tax on building materials. The additional tax revenue will be compensated by a reduction of income taxes so that the total tax revenue is not affected. The rise of the taxes for goods itself has negative economic effects which are completely compensated by the positive effects of the reduction of income tax. The change in the rates of the value added taxes for traffic services (higher taxation of air services, lower rates for railway service) reduces energy consumption but not material consumption. The reduction of air transport of course reduces consumption of oil, but on the other side the higher demand for electricity induces also the consumption of coal and gas. The introduction of the taxation of building materials has severe impacts on material consumption. Domestic extraction of materials reduces the consumption of non-metallic minerals by 15.6% and the total domestic extraction of materials by 9.7%. The total material requirement indicator TMR, which measures the sum of domestic extraction, imported resources and the contents of materials given directly and indirectly with the imported goods, reduces by 1.5% compared with the reference scenario in the year 2030.

Tab. 1 summarizes the results for the change of value added taxes for traffic services, the introduction of the tax on building materials and the compensation of income taxes.

Tab. 1: The impact of the analysed economic instruments on macro indicators in the year 2030

Deviations from the reference scenario

	real gdp	disposable income	employment	final energy demand	TMR
in percent	-0,06	0,07	-0,01	-0,3	-1,5
absolute	-1.5 bill. €	+1.5 bill. €	-5,400 Pers.	-25,784 TJ	-81.9 Mio t

Which results can be expected if all firms of the manufacturing sector will participate within the next 20 years till 2030 in an **information and consulting program** and achieve the "best practice" in respect to material consumption? The direct effects are clear: Those firms that use materials will enjoy a reduction of production costs, on the other side the producers of materials will lose shares in sales and production. Since markets are not perfect, the winners will reduce their prices but not to the same extent as the reduction of unit costs. This means that value added will rise in these firms. The extensive effect induced by the winners dominates by far: Rising value added pushes income and consumption, falling prices raise real income and improve international competitiveness with rising exports and falling imports. A further reduction of imports is given with the lower imports of resources. The total effect on real GDP is +14.2% in 2030 in comparison with the reference scenario.

Since resource productivity rises stronger than GDP, the level of TMR falls by 9.2% in 2030 compared with the reference scenario. The reduction of material consumption raises energy productivity indirectly by 13.8%. So final energy demand will in spite of the strong positive effect on GDP only be slightly above the low level of the reference scenario. The economic prosperity raises also the tax revenue. On the expenditure side of the budget of the government there will be reductions for social security payments following the higher employment. Furthermore, public consumption will grow less than the tax revenue because public services like defence, security, administration, education etc. will not rise that much as a consequence of dematerialization of the economy. These savings year by year reduce public debt. In 2030 it will be 10.2% lower than in the reference scenario. Tab. 2 summarizes the results of the impacts of the information and consulting program.

Tab. 2: The impact of the information and consulting program on macro indicators in 2030

Deviations from the reference scenario

	real gdp	public debt	employment	final energy demand	TMR
in percent	+14.2	-10.2	+1.9	+0.42	-9.2
absolute	+374.7 bill. €	- 226.0 bill. €	+696,100 Pers	+33,147 TJ	-506.4 Mio t

In both variants of the **recycling** scenario the economic effects on GDP and employment are positive because expenditures for imported resources are substituted by domestic value added. In the following section we discuss only the further results for the variant with a elasticity of substitution of -1.

GDP rises by 0.04% or 1 bill. € and employment in 2030 is by 10,600 persons higher than in the reference scenario. Public debt falls by 2.5 bill. €.

TMR is 8.9% lower in 2030 compared with the reference scenario. In this scenario the impact is concentrating on the consumption of metals. Their TMR reduces by 23.5%. A central role is given to the huge rucksacks which lie on the indirect imports of non-ferrous metals being part of the goods imports.

Tab. 3 summarizes the impact of the recycling scenario on important indicators.

Tab. 3: The impact of the recycling of non-ferrous metals on important indicators in 2030

Deviations from the reference scenario

	real gdp	public debt	employment	final energy demand	TMR
in percent	+0.04	-0,1	+0.03	+0.01	-8.9
absolute	+1.0 bill. €	-2.5 bill €	+10,600 Pers.	+916.0 TJ	-489.8 Mio t

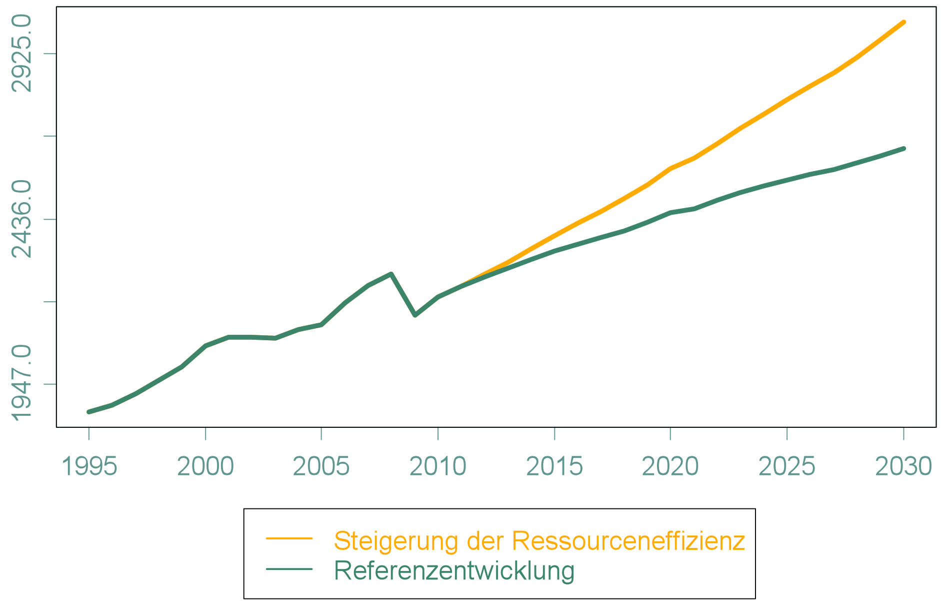
The Potential of a forced Strategy for the Improvement of Resource Efficiency

So far it could be shown which impacts the different instruments have. The study did not ask for completeness, but it intends to give examples for the groups of instruments and their effects. Insofar the aim of the following chapter is not to present a concrete policy proposal. The idea is to give an estimate for the potential that a forced strategy for the improvement of resource efficiency can have. In this respect the chapter has more the character of a sensitivity study. All discussed policy instruments could be implemented and be part of a policy proposal. Therefore, it makes sense to ask for the impacts, if all instruments are integrated in one total scenario.

The analysis of the single instruments has shown that especially the information and consulting program has a high potential for an economic expansion induced by the rebound effect of dematerialization. As already said: Rising material efficiency reduces production costs and prices, and this development improves international competitiveness and value added in Germany. The aggregated price index of gross production falls by 4.3%. The nominal wage rate remains more or less constant because the influences of falling prices and rising productivity compensate each other in their effect on wage bargaining. Therefore, the real wage rate rises with the absolute rate of price changes. The expansive effects on demand are much stronger than the contractive effects coming from the firms which produce materials. In this context the reduction of resource imports coming also from other scenarios plays an important role.

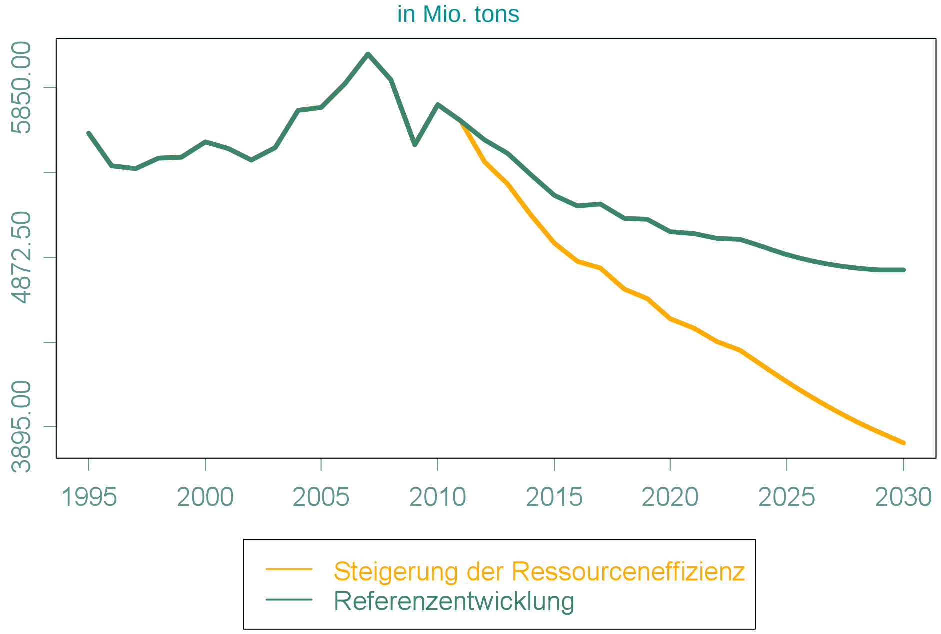
The other instruments have a smaller effect on value added, income and GDP. Tax changes are on average neutral because the rise of good taxes is completely compensated by a reduction of income taxes. The regulation of recycling of non-ferrous metals has little positive effects on GDP because imports of resources are substituted by domestic value added.

Fig. 1: GDP in billion € and constant prices



The results of the simulation studies can be summarized as follows: An engaged climate policy in Germany will be able to combine a permanent economic growth with a reduction of CO_2 -emissions by 54% in relation to the historic values of the year 1990 and an absolute decoupling of resource consumption from GDP can be reached in the long run. Based on this reference scenario the following **potential** for a forced resource policy consisting of economic instruments, information and consulting instruments, and regulation can be estimated in relation to the reference scenario for 2030: A rise of GDP in constant prices of 14% (+372 bill. €) will be possible (Fig. 1), employment will be 1.9% higher (+680,000 persons), public debts will shrink by 11% (-251 bill. €), total material consumption will be reduced by 20% (-993 Mill. t) (Fig. 2) and CO_2-emissions remain at the low level of the reference in spite of the strong rebound effect. Resource productivity will be doubling from 2010 to 2030.

Fig. 2: Total Material Consumption (TMC) in Germany



The information instruments which realise the efficiency potentials of the given technologies in manufacturing sectors have the advantage that they prevail easier in the policy process than other instruments. Their potential is mighty. In our simulations the positive economic effects and about half of the environmental impact are related to them. Whether this potential can be fully exhausted depends on the number of firms that can be reached by the program.

In the long run the "low-hanging fruit" will not be enough. A resource-saving technical progress has to be generated. Here recycling gives an interesting perspective especially for Germany. For the example of non-ferrous metals it could be shown that the potential for dematerialization is rather high because compared to other countries Germany has a very large sector that produces investment goods mainly for the world economy. Therefore, the consumption of metals is very high in Germany and follows the economic dynamic of the world economy. Combining this situation in Germany with the scarcity of metals and the rising world market prices, recycling is also a major topic from an economic viewpoint. But there is also a high potential for the recycling of building materials.

The use of economic instruments has the advantage that price effects induce a lot of substitution effects over all stages of production and also in the sphere of consumption. But if international competitiveness is affected negatively, it is problematic to prevail it in the policy process. For the three tax instruments, which we discussed in the project, the changes of value added, tax rates for air transport and railway transport this is not the case.

Material Efficiency & Resource Conservation

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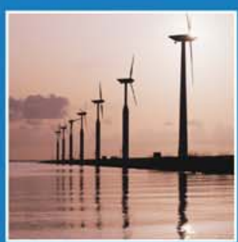
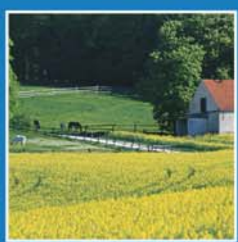
Indicators / Bottom-Up Models and Scenarios

Executive Summary

Executive Summary of Task 6 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project

Resource Efficiency Paper 6.6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Indicators / Bottom-Up Models and Scenarios

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Preface

This report is divided into two parts:

Part I: Material Use Indicators for Measuring Resource Productivity and Environmental Impacts

Part I outlines the results of Task 6.1.

Part II: Bottom-Up Impact Analysis Model

Part II outlines the results of Task 6.2.

PART I – Summary report of Task 6.1

Material Use Indicators for Measuring Resource Productivity and Environmental Impacts

Authors: Stefan Bringezu, Helmut Schütz

Executive Summary

The German government intended to assess the applicability of macro indicators measuring the use of resources by the German economy and requested suggestions for further use and development. In a broader context, this relates to the development of a national programme for sustainable resource management, which is, for instance, requested by the EU´s Thematic Strategy for Sustainable Use of Natural Resources. More specifically, the existing monitoring of progress towards sustainability in pursuit of the national strategy for sustainable development should be improved, through widening the scope of the raw material productivity indicator used so far.

The material flow accounting concepts of ESTAT and OECD provide a stepwise extension of indicators for resource use and resource productivity. Direct Material Input (DMI) and Domestic Material Consumption (DMC) build the basis; however, they do not account for indirect flows of imports and exports, nor consider unused extraction, thus missing the foreign dimension and the full extent of primary resource extraction. DMI and DMC can be accounted as raw material equivalents (RME) that accounts for indirect flows of used extraction thus leaving out unused extraction. The most comprehensive indicators accounting for the total global primary material requirements for production and consumption, i.e. including both used and unused extraction, account for Total Material Requirement (TMR) and Total Material Consumption (TMC).

Furthermore, the European Commission aims at developing indicators to account for environmental impacts associated with resource use, so as to be able to monitor progress towards double-decoupling which is a central issue in the Thematic Strategy on the Sustainable Use of Natural Resources.

The workshop brought experts and representatives of data users, data providers from research, and statistical offices together. Different approaches and positions were highlighted and discussed regarding basic methodological issues and interpretability of derived indicators. A mind map exercise worked out basic requirements of an ideal resource use indicator as seen by users, providers or statisticians. An interactive session on requirements for German official reporting and need for improvement put the focus further on the interest of the German government how to proceed with monitoring resource use and resource productivity.

Among the users of data and indicators there was a general tendency to go for RME first and then for TMR/TMC which was regarded as most comprehensive indicator.

Also impact related indicators received some attention of users. However, there was no clear attitude towards changing the current headline indicator in the short term.

Providers from research institutes confirmed their background for indicators work, with a general tendency – like users - to go for RME in the short term and for TMR/TMC in the longer run by following a modular approach and add up unused extraction to RME, while being open towards further research on resource use impact indicators.

Statisticians were in favour of the RME indicator and showed interest for TMR/TMC as well as for an impact related resource use indicator.

Apart from that, some critical open issues concerning the conceptual foundation of the different indicators were identified which require further discussion and harmonisation.

PART II – Summary report of Task 6.2

Bottom-Up Impact Analysis Model

Authors: Thomas Hanke, Ole Soukup, Peter Viebahn, Manfred Fischedick

1 Concept of the Model

1.1 Goals and remit

The aim of Task 6.2 was to analyse how policy approaches for increasing resource efficiency affect the resource balance, using the example of a chosen category of need, and to find out how successfully these approaches have been implemented. This study contains three levels of investigation:

- By developing and using an exemplary *bottom-up impact analysis model,* we seek to determine the direct and indirect effects of a policy mix identified by Task 3 (Innovative resource policy approaches to design framework conditions), 4 (Innovative resource policy approaches at the microscopic level: instruments and approaches close to companies) and 12 (Consumer and customer-oriented approaches to increase resource efficiency). In other words, our aim is to perform a “net” assessment of the resource flows resulting from various policy approaches. This method enables us to identify not only direct interactions, but also trade-offs and synergistic effects between measures under consideration.
- In addition to the impact on the resource area, interactions with other socio-political objectives (in particular, climate protection targets) should also be analysed simultaneously. In view of climate policy regulations in Germany and the European Union, for instance, we must ask ourselves whether measures to reduce resource flows are consistent with the reduction targets for greenhouse gas emissions. Other environmental impact areas on the emissions side include summer smog, the acidification of soils and bodies of water, and fine dust pollution, which can be determined using a *life cycle assessment model*.
- By applying and transferring the scenario analysis established in the energy sector, it was also possible to model the impact of various resource policy approaches in the same category of need, and to compare their impacts and how they differ. By modelling not only the actual situation, but also the development on a time line up to 2050, we were simultaneously able to analyse *long-term effects*. These effects are particularly relevant when the impact of resource efficiency measures apply to a period of several decades.

The ultimate aim was, then, to analyse whether the experiences gained in modelling the chosen category of need and the devised method can be applied to other categories of need. This part of the analysis is explored in Paper 6.1 “*Applicability of the bot-*

tom-up impact analysis model to other categories of need.” This paper shows that the model developed here is applicable to other categories of need under two conditions: first, measurable indicators must be available to enable the impact of policy instruments to be portrayed; second, a technical model for calculating changes to the chosen indicators with regard to the scenario over a specific time period must be operational for the respective category of need. In the category of need “mobility and transport”, for instance, this condition is met by the TREMOD model, developed by ifeu Heidelberg for the German Federal Environment Agency (see ifeu 2010).

1.2 The category of need “warm living space” as an element of the category of need “building and living”

The sub-category of need “warm living space” within the category of need “building and living” was chosen. In accordance with the definition adopted here, this category of need comprises the demand for “warm living space” in Germany. “Warm living space” can be achieved using heating systems based on fossil fuels and renewable energies, using electric heating based on fossil fuel-fired electricity or renewables, or by optimising the energy situation of buildings (for example, heat insulation). In addition to the housing stock, new constructions and demolitions by 2050 will also be considered.

This category of need was selected for a number of reasons:

- The category of need “building and living” is a hot spot area with regard to the direct and indirect overall material expenditure involved in domestic sectoral production (Acosta-Fernandez et al. 2009). If, in addition, the consumption of energetic resources is analysed, the crucial importance of the category of need “warm living space” becomes apparent.
- Despite the considerable importance of the area of buildings to the question of resources, efficiency strategies have so far been explored only rather rudimentarily. In this paper, therefore, energy saving strategies and the resulting demand for insulating materials will be compared for the first time.
- Until now, measures taken to save energy and emissions in the area of buildings implicitly assume that there will be no negative trade-offs. Whether, for example, the impact of energy saving measures will perhaps be cancelled out by the energy required to produce the insulating materials can be assessed relatively easily by making a rough estimate. Less obvious, however, are the interactions ultimately resulting from energy- and process-related emissions with regard to various environmental impacts, which often depend primarily on the design of the process chains under consideration. This will be specifically investigated for the first time here by coupling a building energy model to a material flow model.
- In particular, due to the high expenditure of non-energetic resources required in the category of need “warm living space”, it is also interesting to analyse the trade-offs

between energy- and emission-driven strategies and more resource efficiency-driven strategies.

- Last but not least, Wuppertal Institute has developed a bottom-up method for the energy flows relevant to this area, implemented in the stock-exchange building model *HEAT*.

1.3 The bottom-up impact analysis model “warm living space”

The bottom-up impact analysis model “warm living space” described below was developed to meet the targets outlined above. Fig. 1 shows the various modules contained in the model.

Module 1: Modelling the category of need “warm living space” using *HEAT*

The purpose of the EDP system *HEAT* (Household Energy and Appliances modelling Tool) is to balance and monitor energy and emissions in the household sector. In addition to a differentiated household appliances side to determine power requirements, the system also contains a structural element-specific modelling of the building stock in Germany on the heat side. The system can be adjusted to regional and data requirements, and is able to differentiate between a maximum of 64 types of building.

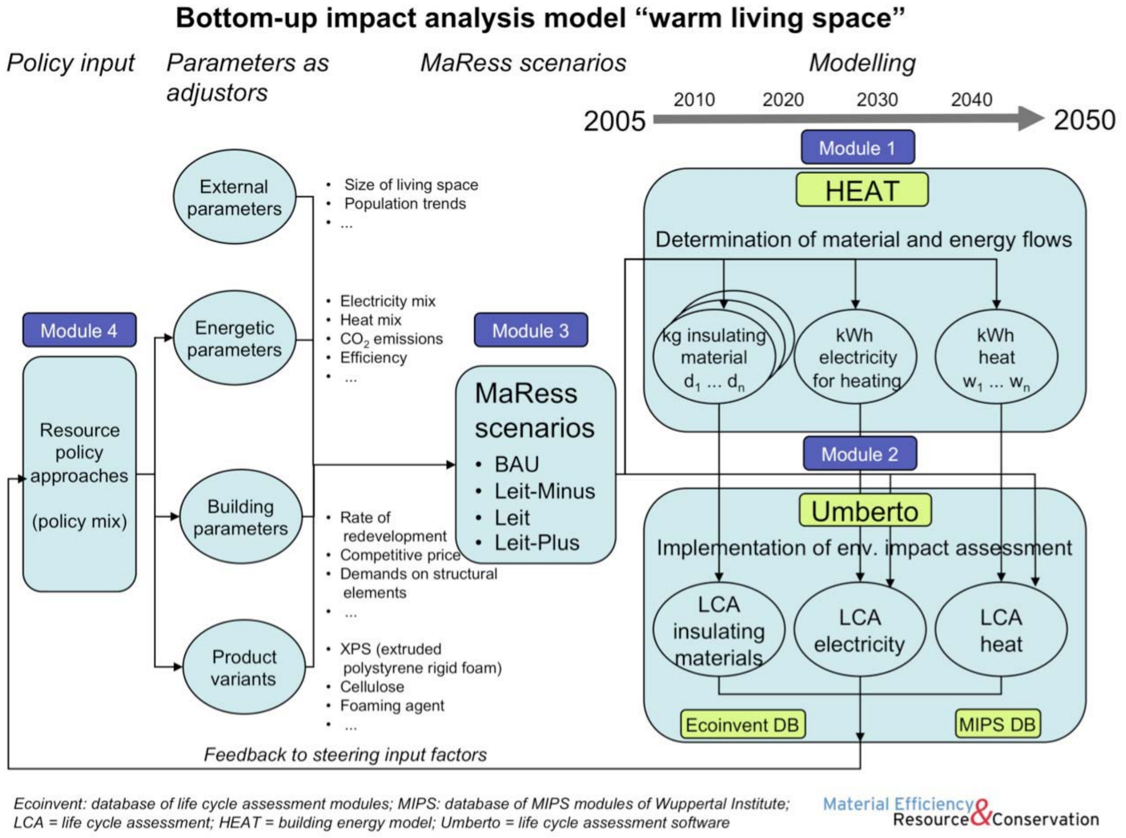
Within this technology model, the development of the final energy demand for the housing sector, divided into energy types, will be modelled for a long-term period up to 2050 for various scenarios, derived from resource policy regulations. At the same time, the direct demand for insulating materials will be determined, whereby the predicted requirements of heat transfer coefficients of building envelopes, for example, are assessed in the calculation of insulating material quantities. The whole building stock in Germany, including new constructions and demolitions, is considered for the years 2005, 2010, 2020, 2030, 2040 and 2050.

Module 2: Environmental impact analysis

The annual quantities of insulating materials used and the annual use of final energy in heating systems in the total building stock computed by *HEAT* are then entered into material and energy flow models, created using the software Umberto. To determine their environmental impacts, life cycle assessments are created in line with (DIN 2006a,b).

The results of these assessments finally undergo an environmental impact assessment, enabling an ecological overall assessment of materials and quantities of energy used to be made with the help of various environmental impact indicators, taking the respective upstream supply chains into consideration. We use the CML method (Guinée et al. 2002: 63ff), applied by a wide range of international users, which is characterised by its coverage of a multitude of impacts of various environmental media. These include impact categories on the emissions side and the input side.

Fig. 1: Model concept for the category of need “warm living space”



Source: Author’s design

On the emissions side, the following impact categories are assessed: eutrophication, acidification, stratospheric ozone depletion, freshwater sediment ecotoxicity, sedimentary marine water ecotoxicity, freshwater aquatic ecotoxicity, marine aquatic ecotoxicity, terrestrial ecotoxicity, photo-oxidant formation, climate change, ionising radiation and human toxicity.

On the resource side, the following impact categories are assessed: *depletion of abiotic resources* and *land use.* The resource indicator captures the extraction of mineral raw materials and fossil fuels. On the basis of its relation between annual extraction and resource potential (“ultimate reserves”), its depletion potential is determined and converted to the reference resource antimony during characterisation.

These two indicators on the resource side provide information on the strain placed on energy, material and land resources by the product system, whereby 284 elementary flows of the “resource” category are assessed. The depletion potential, however, does not take into account the total quantity of abiotic and biotic resources used. To this end, we must also capture the “ecological rucksack” via indicators MIPS or TMR (one of the main categories of MIPS which is to be captured long-term at the economic level, too, as a key indicator of OECD, ESTAT and DESTATIS). Since, however, it is not possible at present to carry out a consistent assessment including both life cycle assessment indicators and MIPS indicators (see need for research in Section 4), the life cycle assessment indicators are used here for the time being. In a sensitivity analysis, material intensities are additionally computed using MIPS in one case.

Module 3: MaRess scenarios

Modelling within HEAT and Umberto is based on the definition and design of various “MaRess scenarios”. In the long-term perspective, these describe potential development paths to reduce energy demand (and hence energetic resources) in the private building sector. The scenarios cover a range from low to very high depths of (policy) intervention. Initially, they are oriented towards the instrument of energy modelling, since we have decades of experience and specific policy regulations or memorandums of understanding on this (see Section 2).

Module 4: Policy mix and influence parameters

Drivers for the various scenarios are relevant influence parameters resulting from the policy mix of a resource policy. These variables, also called “adjustors”, determine the range of scenarios, showing a spectrum of potential developments up to 2050. These include

- *External parameters*: Framework indicators which reflect a general economic or social development, and are equally applicable to all scenarios, are combined under the general non-energetic drivers. They also include demographic trends and the associated development of living space, the development of structural element standards (since the quality of the respective standards within the scenarios are not varied, only their market shares), as well as the impact of accompanying measures on redevelopment rates.
- *Energetic parameters:* Assumptions were made on the development of the electricity mix and the heat mix in the benchmark years for all MaRess scenarios. In the material flow model, the respective electricity mix is taken as a basis for the direct power requirements for manufacturing insulating materials and the use of electricity for heating purposes. The heat mix is incorporated into the assessment of heat and hot water generation in households.
- *Building parameters*: In addition to the assumptions directly concerning energy scenarios, further assumptions were made for each scenario with regard to modelling the respective energy consumptions in the housing sector. These assumptions included the expected rate of redevelopment in the housing stock, the demands on the quality of structural elements and competitive prices related to the costs of redevelopment measures.
- *Product variants*: As sensitivity analyses, a variation of the insulating material and the composition of the foaming agents required for manufacturing the insulating material XPS was modelled. With the product variants, it will generally be possible in future to take into account expected changes in production processes (resulting,

for example, from technical innovations, the reduction of materials and energy used or the replacement of individual products by substitute materials).

Throughout the course of various impact indicators, the policy mix Module 4 is finally fed information about the degree to which the targets of original policy approaches have been achieved. It is then possible to adjust and optimise policy approaches if the targets are not met, and to adapt the MaRess scenarios accordingly.

2 Definition and Implementation of the MaRess scenarios

2.1 Starting point: policy mix

Basic idea of the planned modelling

The original aim of modelling the scenarios was to build on one of the policy mixes identified by Task 3, 4 and 12 and, in particular, to integrate resource policy measures into the scenarios or to develop our own specific resource scenarios. The best practice of creating scenarios known from energy modelling served here as the methodical basis. The key elements are:

- *Target orientation*: Definition of a long-term objective consisting of one or more target values – prominent examples are the energy scenarios that have been generated for years and which, in variant E1 of the Lead Scenario 2008 (BMU 2008), for example, focus on the target of achieving an 80% reduction in energy-related CO_2 emissions by 2050;
- *Scenario arrays*: Development of a large number of long-term scenarios which create development paths to achieve the target values set or which show how, and the extent to which, targets have not been met. Such scenarios usually range from little intervention (business-as-usual path) to deep intervention (with consequences to the point of changing the system).

To develop policy instruments, several coordination meetings and joint workshops took place between Modelling Task 5 (Quantitative and qualitative analysis of the economic effects of an accelerated resource efficiency strategy) and 6, as well as Policy Task 3, 4 and 12. In a nutshell, however, none of the resource policy approaches identified by the Policy Task can be directly applied to the modelled area concerning the redevelopment of residential buildings. The only two instruments identified as relevant would have been the taxation of construction materials (Task 3) and the resource certificate for buildings (Task 12). The former, however, takes only primary building materials into account, whilst insulating materials are modelled in Task 6.2; the latter was discarded due to major uncertainties regarding the values to be applied. It became evident that there is still need for further research concerning the connection of the scenario development to material flow modelling with the specification of housing-related instruments.

Even if quantifiable instruments were available, however, the challenge, from a technical point of view, is to be able to model them in material flow models. As mentioned above, integrating resource indicators into life cycle assessments constitutes another important research approach.

Alternative modelling approach chosen

Due to the difficulties in defining specific resource targets, and the instruments to achieve them, existing climate policy targets and scenarios were reverted to. In established scenarios from this sector, such as variant E1 of the Lead Scenario 2008 (BMU 2008), a limitation of energy-related CO_2 emissions in Germany to 40% by 2020 compared to 1990 and to 80% by 2050 is generally modelled. These targets are often even more ambitious in more recent scenarios. For instance, a figure of -91% by 2050 is given in the innovation scenario according to the Öko-Institut and Prognos (2009). Even if these scenarios do not include specific resource targets, they are nevertheless of great relevance to the targets pursued in MaRess:

- Due to the energy demand in the power, heat and transport sectors, a large quantity of finite energetic resources (primary energy) is used. It therefore appears to be extremely relevant to consider these sectors, not only for climate policy, but also for resource policy (and security policy) reasons;
- until now, no assessments had been made of possible trade-offs between energy savings and the total consumption of raw materials. By coupling a building energy model to a material flow model, we now have the opportunity to analyse this specifically for the first time.

Against this background, the MaRess scenarios for the category of need “warm living space”, based on the respective energy scenarios, will be described in the following section.

2.2 Narrative description of the MaRess scenarios

The *Lead Study 2008* by the German Federal Ministry for the Environment, Nature Conversation and Nuclear Safety served as a basis for creating the scenarios. The Lead Study is based on the target-oriented *Lead Scenario 2008,* which shows how energy-related CO_2 emissions in Germany can be reduced by approximately 20% by 2050 compared to the 1990 value (BMU 2008). It specifies the interim targets set by the German government for 2020, laid down in the resolutions of the German government, applicable laws and the regulations of the EU Commission. They concern stipulations on the reduction of CO_2 emissions, the increase of energy productivity and the contribution of renewable energies, triggering a structural change in energy supply. The heat mix in the household sector and the national average electricity mix from the energy scenarios are used for modelling purposes in Task 6.2.

The economic data and other underlying data (for example, population trends, household sizes) upon which all scenarios of the Lead Study are based were slightly adjusted. In particular, the economic data was revised downwards due to the economic crisis. Modelling in *HEAT* and top-down modelling in Task 5 are both based on the same adjusted data.

The *MaRess BAU* scenario

To show how the *Lead Scenario 2008* contributes to climate protection and resource targets, it is advisable to model a reference development first. Since in the *Lead Study 2008* target-oriented scenarios were devised that were not compared to such a reference development, we first had to devise our own business-as-usual scenario (BAU). To achieve this, we used the reference scenarios from the World Energy Outlook (IER et al. 2009) and the WWF study “Modell Deutschland” (Öko-Institut and Prognos 2009).

The *MaRess Leit-Minus* scenario

The *MaRess Leit-Minus* scenario corresponds to the *Defizitszenario D1* contained in the *Lead Study 2008*. On the one hand, it is assumed here that use of renewable energies will be expanded as intended, that is, that the quantity of power and heat generated in absolute quantities remains the same as in the *Lead Scenario 2008*. On the other hand, however, it is assumed that the package of measures to increase efficiency and to expand combined heat and power will have a lower impact. Consequently, the demand for energy increases, which is why the share of renewable energies declines in relative terms.

The MaRess Leit scenario

The *MaRess Leit* scenario corresponds to the Lead Scenario 2008, described above.

The *MaRess Leit-Plus* scenario

MaRess Leit-Plus differs to *MaRess Leit* in that the efforts to improve efficiency in the category of need “warm living space” have been *heightened* by further reducing the demand for heat energy. The simplified heat mix composition was kept constant, meaning that both fossil and renewable heat transfer media decrease in absolute terms.

2.3 Details of scenario interventions on the demand side and their drivers in *HEAT*

Complementary to the basic assumptions on the energetic side, further influence factors or drivers (see Module 4) were set in the MaRess scenarios to implement efficiency measures in the housing sector. These were used to model the demand side in *HEAT,* and are outlined in Tab. 1.

Tab. 1: Scenario-specific summary of influence factors in the area of buildings

Scenarios				
Influence factors	***MaRess BAU***	***MaRess Leit-Minus***	***MaRess Leit***	***MaRess Leit-Plus***
Objectives **• Lead Study 2008** **• Other**	a. Final energy b. Renewables	a. Final energy b. Renewables	a. Final energy b. Renewables	--- --- Result-oriented complete redevelopment whilst tapping the full potential of renewable energies from the Lead Scenario
Lead indicators at the effective energy level (building efficiency)				
Redevelopment rate	Residuum up to < 0.7% p.a. Current rate of redevelopment in the implementation of thermo-technical measures to the building envelope	Residuum up to < 0.7% p.a.	Residuum < 1.5% p.a. Promotion of accompanying measures (energy consulting, energy performance certificate, Reconstruction Loan Corporation (KfW))	< 2.5% p.a. Maximum implementation (complete redevelopment)
Competitive price		Residuum up to < 4.4 ct/kWh	Residuum up to < 6.7 ct/kWh	8.8 ct/kWh Oriented to future price trend of energy sources
Amortisation expectation		< 4 years Expected profit from household investments	< 10 years Average expectation of profit (banking practice)	< 15-20 years Oriented to life cycles of structural element renewals
Demands on structural elements (old buildings)	EnEV 2009 (Energy Saving Ordinance)	EnEV 2009	-15% HT’ (average heating heat requirements) (based on EnEV 2009)	Gradual tightening from 2020 to 2050 to passive house
New buildings **up to 2020** **2020-2050**		Residuum -15% HT’	Residuum -80% HT’	-80% HT’ Passive house
Lead indicator(s) at the final energy level (heating system mix/efficiency)				
Potential renewable energies	SPECIFICATION of reference development	SPECIFICATION from the Lead Scenario (D1 reduced efficiency)	14.8% of the demand for heat in 2020 (excluding heat flow)	Absolute values from the Lead Scenario
Technical progress (specifically degree of utilisation)	BAU	BAU	BAU	BAU

Source: Author’s compilation

3 Modelling Results and Conclusions

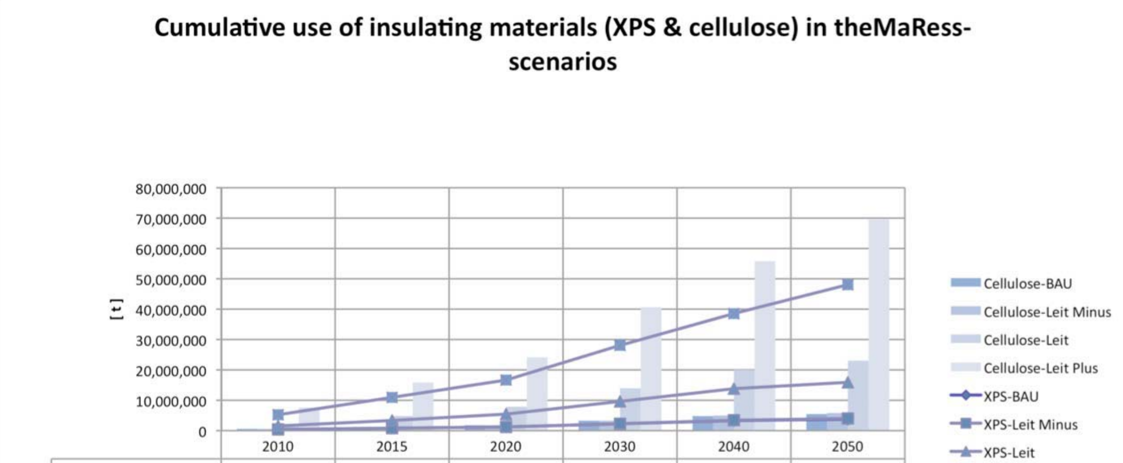
Modelling in Task 6.2 revealed a plethora of new findings. The three key results on the methodological side are

- the development of the bottom-up impact analysis model and its exemplary application to the category of need “warm living space”,
- a trade-off analysis, conducted for the first time, between increasing efficiency, resource consumption and emission impacts, and
- the expansion of “pure” energy scenarios by resource policy analyses, made possible by this analysis.

The key result of the model analysis is that the additional expenditure for insulating materials is overcompensated in almost all environmental impact categories due to considerable savings on building heating only both the resource and the emissions side. Essentially, no trade-offs are perceptible, and the percentage contribution of insulating materials to the environmental impact indicators is low.

Fig. 2 shows the development of the cumulative use of insulating material in the four MaRess scenarios (in the base case, we used the insulating material XPS, portrayed as a line). The increasing demand for insulating materials associated with ever deeper intervention based on policy stipulations is clearly visible, particularly in the *MaRess Plus* scenario.

Fig. 2: Cumulative use of insulating materials (XPS and cellulose) in the MaRess scenarios *MaRess BAU, MaRess Leit-Minus, MaRess Leit* and *MaRess Leit-Plus*

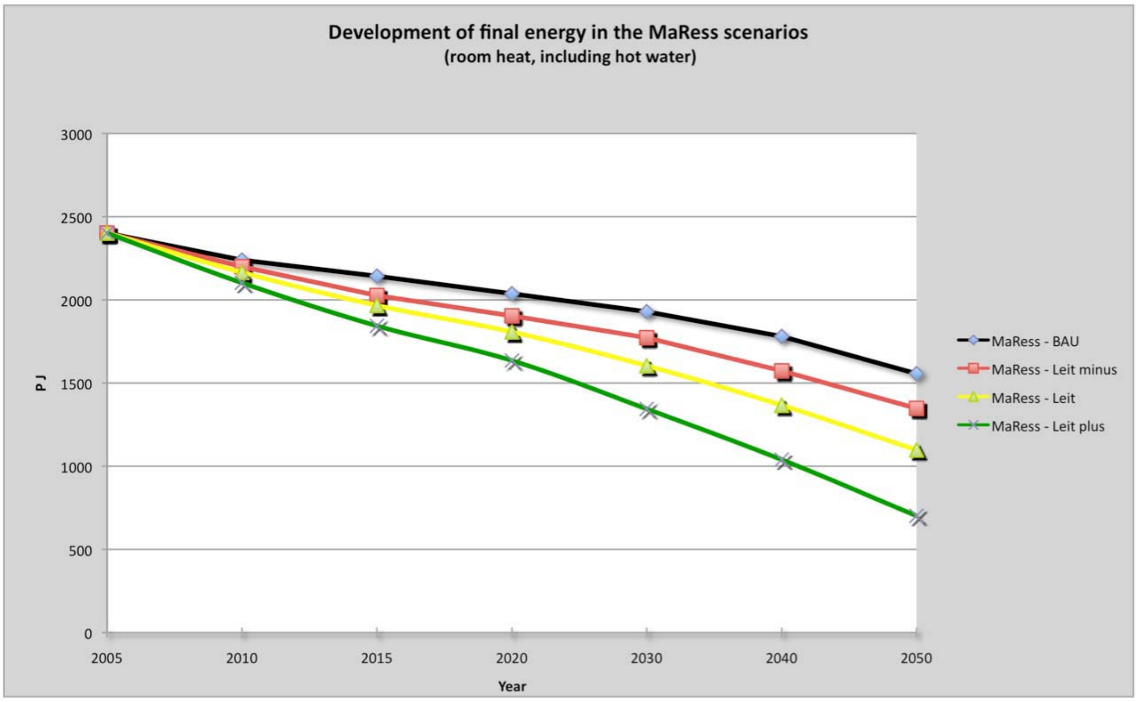


	2010	2015	2020	2030	2040	2050
Cellulose-BAU	589,690	1,179,380	1,769,070	3,285,415	4,801,760	5,468,529
Cellulose-Leit Minus	589,690	1,179,380	1,769,070	3,285,415	4,970,243	5,805,495
Cellulose-Leit	2,223,041	4,850,272	7,881,692	13,944,532	20,007,372	23,041,920
Cellulose-Leit Plus	7,580,105	15,849,310	24,118,515	40,656,925	55,817,134	69,599,143
XPS-BAU	407,128	814,256	1,221,383	2,268,283	3,315,183	3,775,527
XPS-Leit Minus	407,128	814,256	1,221,383	2,268,283	3,431,505	4,008,171
XPS-Leit	1,534,810	3,348,676	5,441,599	9,627,444	13,813,289	15,908,371
XPS-Leit Plus	5,233,380	10,942,521	16,651,662	28,069,945	38,536,705	48,051,940

Source: Author’s model calculations

Fig. 3 shows the reduction in final energy (room heat, including hot water) resulting from the use of insulating materials. In the business-as-usual path (*MaRess BAU*), a 35% reduction by 2050 is possible. In the *MaRess Leit-Plus* scenario, the quality of redevelopment measures (gradual intensification of the redevelopment of old buildings to passive house standard) has a particular impact on the demand for effective energy, leading to consistent reductions in effective energy, final energy and emissions in connection with the use of renewable energies. The enforced saving strategy leads to effective energy savings of 1,250 PJ and final energy savings of approximately 1,700 PJ, or 70%.

Fig. 3: Comparison of the demand for final energy in the MaRess scenarios *BAU*, *Leit-Minus*, *Leit* and *Leit-Plus* for room heat and hot water up to 2050

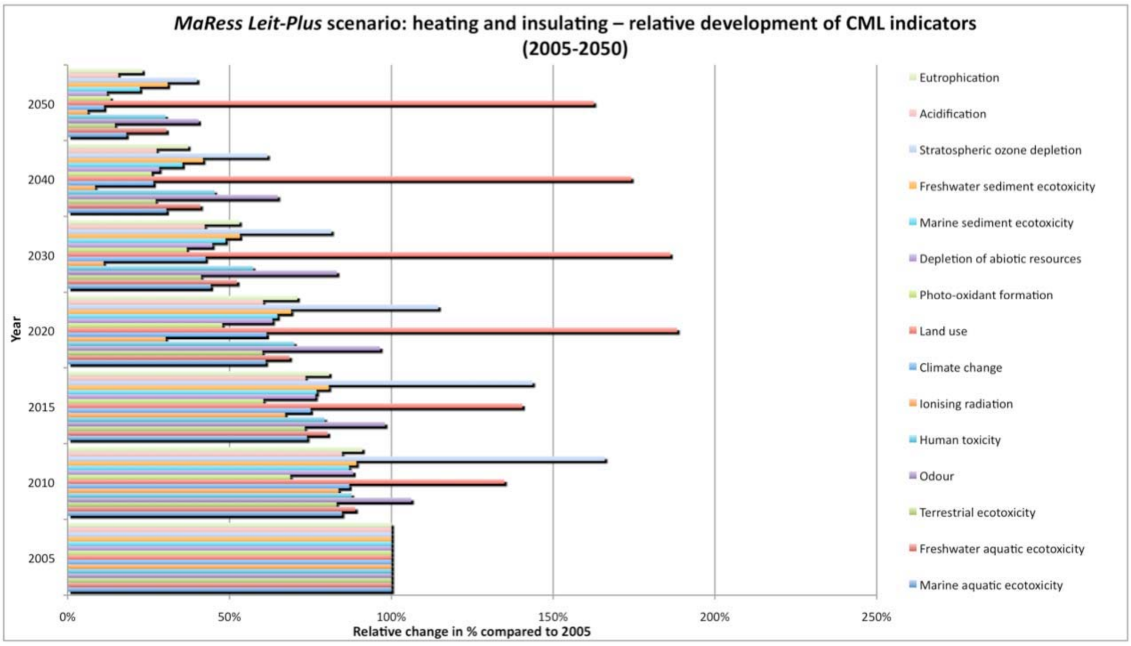


Source: Author’s model calculations

If we compare the development of environmental impacts along the four scenarios, it becomes evident that, even in the reference case – the *MaRess BAU* scenario – a continuous, but moderate net decline of 30-50% by 2050 compared to 2005 can be observed in all of the impact category indicators considered. As expected, this decline increases steadily the more resource and climate policy is accelerated, and reaches a net reduction of 70-90% in the same period in the *MaRess Leit-Plus* scenario (see Fig. 4).

Here, however, (and also in the *MaRess Leit* scenario not shown here) initially opposing developments can be observed in three environmental impact categories: the two impact categories “*odour”* and “*stratospheric ozone depletion”* increase up to 2010, and only then decrease analogously to the other categories. The impact category “*land use”* increases up to 2020, and only then drops (slightly).

Fig. 4: Relative development of environmental impact indicators in the *MaRess Leit-Plus* scenario



Source: Author’s model calculations

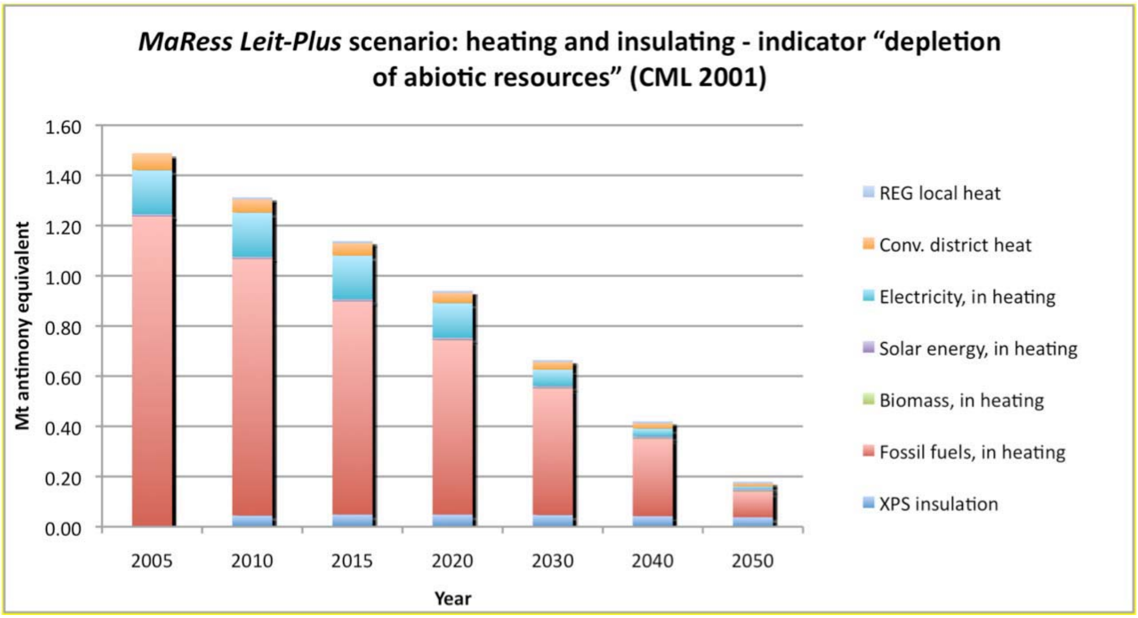
This is due to the following developments:

- The indicator “odour”, dominated by fossil fuels, initially exceeds the value of the base year due to increasing proportions of biomass in the electricity mix and regenerative local heat, but falls below it by 2050, as a result of savings in fossil fuel heat energy. The increased use of biomass can also impact on the particulate air pollution which is not captured separately here, but is included in the indicator “human toxicity”.
- The indicator “stratospheric ozone depletion”, dominated essentially by the use of fossil fuel-fired heating, also increases initially by over 50% of the value of the base year 2005, due to additional process-related emissions in the manufacture of XPS insulating materials. This effect is compensated as early as from 2030 due to savings in fossil heat energy caused by insulation. In the further course of time, the impact drops considerably by around 60% of the reference value by 2050.
- The rise in the indicator “land use” is also a result of the increased use of biomass heating in the heat mix. Due to the increased use of biomass in pellet and firewood heating, this is the only indicator that is higher in 2050 than the base value of 2005. However, this development must be seen independently from efficiency measures, since it is based on scenario assumptions on covering the remaining need for heat by renewable energies. Since, in the event of the growing need for forest biomass

and restricted domestic potential, increased competitive usages can be expected with material uses and increasing import dependencies, the Lead Scenario of the BMU should be reviewed on the basis of a comprehensive biomass concept, taking domestic and foreign land use into consideration.

It can also be seen from Fig. 4 that the impact indicator “depletion of abiotic resources” will drop continually, despite the extensive use of insulating materials. In a detailed analysis, Fig. 5 shows which processes contribute to the depletion of natural resources, in turn using the example of the *MaRess Leit-Plus* scenario. According to this, the share of XPS insulating material is very low: 3% in 2010 and 10% in 2050. The impact results primarily from the use of fossil sources of energy for heating purposes.

Fig. 5: Absolute development of the environmental impact indicator “depletion of abiotic resources” in the *MaRess Leit-Plus* scenario

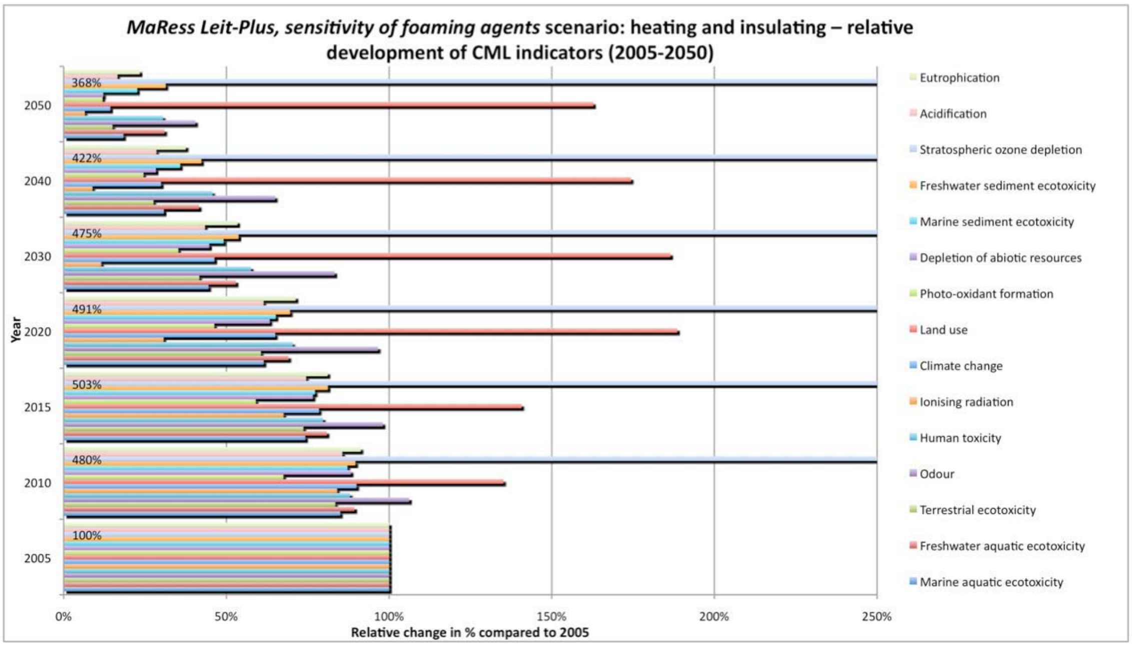


Source: Author’s model calculations

The choice of foaming agent in the foamed XPS insulating materials is important (see Fig. 6): it was assumed for the base analysis that 90-96% of the XPS used in Germany was foamed using CO_2, whilst the remainder was foamed in equal parts by the fluorocarbons HFC-134a and HFC-152a. Since this proportion may differ considerably in other countries, in a sensitivity analysis a foaming agent composition of 50% CO_2 and 25% each of HFC-134a and HFC-152a was assumed. In the final result, this leads to a considerable trade-off with regard to the impact category “stratospheric ozone depletion” (the impact of insulation exceeds the relief caused by the 500% energy savings in 2015, and decreases to 368% in 2050) and to a perceptible, yet not very considerable impact on the greenhouse potential.

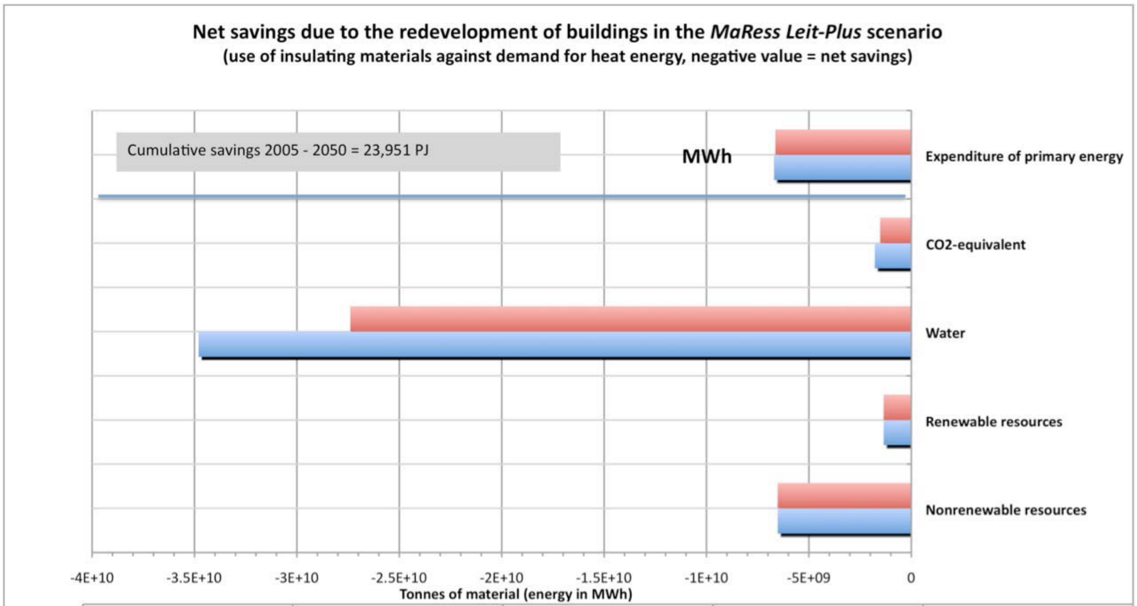
In the second sensitivity analysis, the alternative insulating material cellulose (made of recovered paper) was used. As seen above in Fig. 2, there is a considerable additional consumption of cellulose compared with XPS – with the same heat insulating standard. This is because XPS has a substantially lower density than cellulose. The results of the life cycle assessment show, however, that even the already small proportions of insulating materials in the impact indicators decrease yet further.

Fig. 6: Relative development of CML indicators in the *MaRess Leit-Plus (sensitivity of foaming agents)* scenario – values between 250 and 500% are cut off



Source: Author’s model calculations

Fig. 7: Results of the trade-off analysis (use of resources versus savings) of the insulating material variants XPS and cellulose



	Nonrenewable resources	Renewable resources	Water	CO2-equivalent	Expenditure of primary energy
XPS	-6522521333	-1350429185	-27389684153	-1521791597	-6,637,855,394
Cellulose	-6524117169	-1350429185	-34803888107	-1782416129	-6,704,123,783

Source: Author’s model calculations

If, in addition to the impact indicators from the life cycle assessment, the resource indicator set MIPS is taken into consideration, it becomes evident that XPS and cellulose insulation have a comparative impact on the material intensity. The cumulative net impact from the use of insulating materials compared with the savings from heat energy is portrayed in Fig. 7. They include an estimate of the balances of primary energy expenditure, greenhouse gas emissions and the need for water, biotic and abiotic raw materials. The negative indicator values show that, due to the impact of insulating materials and the associated considerable reduction in heat energy, the additional consumption of material is overcompensated by savings in both cases. In summary, ambitious insulating material strategies using not only XPS, but also cellulose, make a considerable contribution to both material efficiency and emission reduction targets with regard to all of the factors analysed in this Task.

In general, competitive situations can arise in the use of wood-based insulating materials. According to Fig. 2, in the case of cellulose, however, even with a complete redevelopment by 2050 exclusively on the basis of this insulating material, an average annual expenditure of around 1.2 million tonnes of recovered paper must be assumed. This value equates to approximately 8% of the quantity of domestic recovered paper in 2007, which amounted to 15.4 million tonnes (VDP 2010). In a realistic insulating material mix, competitive usages with the manufacture of recycled paper and indirect competition for space for forest resources are therefore assessed as low, but should nevertheless be investigated when devising an insulating material strategy.

Since energy resources make up a considerable share in the environmental impact of the category of need “warm living space”, it was nevertheless possible in the first step to model in detail energy and climate policy approaches in connection with resource policy (in particular with regard to building insulation). This constitutes a considerable expansion of previous “pure” energy scenarios, which do not focus on the resource side, and generally consider only greenhouse gas emissions on the emissions side.

4 Policy Recommendations and Need for Research

The results presented here lead to the following policy recommendations:

- The energy savings and efficiency strategies modelled in the MaRess scenarios, based on the BMU Lead Scenario 2008, should be implemented promptly. Relevant policy guidelines would have a positive effect on virtually all environmental impact categories, in particular the consumption of material resources and almost all emissions indicators.
- The increased consumption of land arising (indirectly) from the increase in biomass heating plants should be taken into consideration when implementing a renewable energy strategy. To this end, a comprehensive biomass strategy is required that takes into account the use for food, materials and energy, and the domestic and foreign use of space.
- Due to the considerable trade-off arising when XPS insulating material is not foamed using CO_2, but using fluorocarbons (HFC), a further reduction of HFC in insulating materials should be supported in industrial policy. Whilst in Germany, CO_2 is already predominantly used (a proportion of 90-96% was assumed), this concerns insulating materials manufactured, in particular, in other EU Member States.
- The impact on resources in the manufacture of insulating materials and building materials in general should be analysed in depth, and included in industrial policy instruments.
- Efforts should be made to develop a standardisable assessment approach that couples life cycle assessment methods currently being developed to comprehensive material resource indicators. In addition, current, harmonised, reviewed and continuable datasets should be made available.

In addition, a series of research aspects was derived following the analysis of the unanswered questions that arose during the implementation of the project. These aspects ought to be explored in a possible follow-up project with adequate resources.

Technology model *HEAT*

- *Modelling building stock*: In addition to our examination of insulating materials in the framework of energy-saving redevelopment measures, a change in the actual building stock should be modelled. This includes the options of demolition, new construction or recycling. Other materials besides insulation, such as replacing windows, should be taken into consideration. Such a work step necessitates the assessment of the material flows used to build the 44 different house types, as well as an assessment of future material flows arising from new constructions and demolitions. In this Task, we can build on the work from MaRess Task 4.4, in which considerations were made for three exemplary house types.

- *Expansion of HEAT*: Expansion of the MaRess building type model by the estate type approach to enable renewable energies to be included more effectively (consideration of many decentralised plants, including local grids and hot water storage tanks).
- *Consideration of climate change*: In future, assumptions should be made on the extent to which climate change will impact on the need for heat and air conditioning in buildings, which, if possible, should be included in the model calculations.

Bottom-up modelling

- *Quantification*: Political scientists should methodically quantify policy approaches or more advanced instruments. The aim should be to have the ability to assess the short-, medium- and long-term effects of identified policy measures on a time line up to 2050. At the same time, one or more target indicators should be developed that can be modelled into long-term scenarios.
- *Other categories of need*: The devised approach could be transferred to other categories of need (for example, mobility, nutrition or consumption). To this end, relevant “technology models”, such as that available for the category of need “warm living space” in the form of the *HEAT* model, would have to be used or developed. For the category of need “mobility”, it would make sense, for instance, to couple it to ifeu’s TREMOD model.
- *Renewables and consumption of resources*: Trade-offs between raising efficiency, consumption of resources and the impact of emissions were calculated in Task 6.2. Building on the model approach developed, the expansion of renewable energies in accordance with the *Lead Study,* and its impact on the consumption of resources should be computed. In particular, the scenarios of the *Lead Study* with regard to total demand for land for all biomass consumptions in Germany should be reviewed.
- *Scenario update*: The MaRess scenarios are based on scenarios from the Lead Study 2008. Following the publication of the new *Lead Study 2010,* the MaRess scenarios should be updated accordingly.

Bottom-up versus top-down modelling

- The model results from bottom-up modelling should be aligned with the results of the top-down computation carried out in parallel by modellers in Task 5. This step could no longer be carried out in Task 6.2, due to time limitations. Using an example (such as the *MaRess Leit* scenario), it should be investigated whether appreciable deviations exist between the two model approaches and, if so, what causes them. It should be explored whether the results could be optimised using a hybrid model. Data from the top-down model could then be applied to the bottom-up model if it does not contain its own life cycle assessment data, or if the quality of such data is inadequate.

Life cycle assessments and resource indicators

- *Coupling life cycle assessments to MIPS*: The life cycle assessment (LCA) method has not yet been fully developed. For one, there is no capture and assessment of the abiotic and biotic use of resources. For this purpose, the MIPS method, for instance, was developed. This method is a variant of the LCA that focuses on the input side and comprehensively captures the use of primary material. One of the main indicators of the MIPS concept – the TMR – is also used at the macroeconomic level and, following improvements to data availability, is to be used long-term as the headline indicator (ESTAT, OECD).

  The system boundaries and allocation rules of LCA and MIPS are very similar. Nonetheless, several deviations should be harmonised in future. On the one hand, various international databases with life cycle assessment modules have been developed over a number of years (such as the ecoinvent database used here). According to the life cycle assessment method, these are oriented to emissions caused by products or services, and partially capture selected substance flows on the input side, up to the extraction of raw materials (with the indicator “depletion of abiotic resources”). On the other hand, the method used in MIPS focuses on considering the whole resource flows of a product. Both approaches have already been combined in a plethora of single studies (including in MaRess 1), whereby key indicators, such as greenhouse gas emissions, are combined with MI categories such as land use. However, there is no harmonisation in the area of previous standard life cycle assessment software packages.

  For this reason, the two approaches must be coupled and the resource categories considered in the MIPS concept should, ideally, be added to the life cycle assessment instrument. This requires an input in the LCA discussion at international and national level, for example, via the UNEP/SETAC International Life Cycle Initiative or the German Life Cycle Inventory network.

- *Expansion of existing life cycle assessment* software: In line with the first point, the MIPS method must also be harmonised with life cycle assessments with regard to software technology. Here, it would make sense to add the MIPS approach to existing software products and databases, with the assistance of software developers (for example, ifu Hamburg for the software Umberto). Discussions have already been held with the providers.

- *Further development of resource indicators*: There is still a need for methodological research in many of the established environmental impact categories. For instance, with regard to the impact category "use of raw materials", discussions on a suitable raw material indicator have not yet been concluded. Indicator sets such as MIPS to capture the extraction of primary material from the natural environment across the life cycle is a possible solution in this case. The suitability and security of direction of such solutions should be discussed and enhanced within a differentiation process. To this end, an international workshop under the leadership of the Wuppertal Institute has already been held within the scope of the MaRess project.
- *Expansion of data inventories*:
    - Data inventories on the use of raw materials should be updated and harmonised (alignment of assumptions, data and system boundaries) and dynamised (projection to 2025 and 2050).
    - Equally, a series of life cycle assessment data inventories (for example, geothermal power plants, fossil fuel-fired combined heat and power plants) should be updated and harmonised; resource indicators should be integrated into new and updated datasets; collaboration with the German Life Cycle Inventory network would also be of interest here.
    - The stock-taking of resource-intensive infrastructures should be advanced further; the expansion of stock and recycling options ("urban mining") should be examined using different long-term scenarios.
    - Process chain modelling within life cycle assessments should be further advanced to be able to take dynamic changes in the process chain into consideration more easily and comprehensively (for example, changed material compositions or energy demands in all stages of production).

5 Literature

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Materialeffizienz & Ressourcenschonung

Potentials for Increasing Resource Conservation and Resource Efficiency

Policy Recommendations for Conserving Resources and Increasing Resource Efficiency

Analysis of the Impact of Instruments to Promote a Successful Resources Policy

Resource Efficiency in Practice: Implementation, Agenda Setting and Successful Communication

MaRess-Project-Website
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The project "Material Effciency and Resource Protection" (MaRess) is framed by the environmental research plan (UFOPLAN) launched by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and by the Federal Environment Agency (FKZ: 3707 93 300).

Material Efficiency & Resource Conservation

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Resource Efficiency Network

Executive Summary

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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
For our Environment

Resource Efficiency Network

Executive Summary

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1 Resource Efficiency Network: Generating Momentum for a Resource-Saving Future in Germany

Both the German government’s national sustainability strategy, “Perspectives for Germany”, and the Resource Efficiency Network’s founding document stress that ecologically, economically and socially sustainable development in the twenty-first century requires a rapid increase in resource efficiency, an ecological New Deal. At the same time, the development and application of innovative, ecologically efficient processes and products and resource-saving services that make intelligent and sparing use of resources presents tremendous economic opportunities. The globally increasing need for resource-efficient products, technologies, processes and services holds great potential for business and employment, especially for Germany as a high tech country of business start-ups. “The markets of the future are green.” (Federal Environment Ministry, 2006, 10).

To develop these future markets and utilise them in the interest of sustainable development in Germany, it is essential to transcend the resource-intensive patterns of thinking and acting of the twentieth century and to replace them gradually by resource-saving patterns of production and consumption on a national and international scale. The Resource Efficiency Network was set up in March 2007 to intensify this process in Germany. The impetus to do so was provided by the following objective set out by the Federal Ministry for Environment, Nature Protection and Nuclear Safety: *“By 2020 our country will be the world’s most resource-efficient economy, a pioneer in careful and environmentally friendly treatment of energy and raw materials. Those are the markets of tomorrow” (Sigmar Gabriel in his speech to the conference launching the Resource Efficiency Network, 2007).*

Designed as a cross-sector, open and “learning” platform, the Resource Efficiency Network aims in the short to medium term to bring together existing know-how on more economical treatment of resources; to intensify communication and cooperation between actors from enterprises, industry associations, advisory and educational institutions, academia, politics and the media; and to mobilise their central competencies to create a broad awareness of the issue.

The Resource Efficiency Network has four central tasks:

- to promote more efficient use of resources for products and services in manufacturing, trade and consumption,
- to bring together actors from politics, business enterprises, industry associations, trade unions, academia and civil society and to coordinate their activities,
- to initiate the exchange of experience gained with promising approaches to efficient use of resources,
- to develop proposals for the design of framework conditions that provide incentives to use resources more efficiently and to remove obstacles that impede this.

The goal of Task 10 was to further develop, maintain and support the Resource Efficiency Network set up in 2007 with respect to concept, content and organisation. Here, the Wuppertal Institute as the coordinating institution collaborates with the North Rhine-Westphalia Efficiency Agency (EFA NRW) and the German Material Efficiency Agency (demea). Cooperation between these very differently positioned institutions is close and works well and hence represents a special, unique feature of the process and a key to its success.

In addition to further developing the Network’s design and orientation (see Chapter 2), joint tasks were to initiate and support activities and Network outputs that generate momentum, multipliers and dialogue (see Chapter 3) for the two target groups Enterprises and Multipliers. The activities initiated and carried out by the Resource Efficiency Network during the project yielded valuable experience in a broad range of areas. The lessons thus learnt about individual activities and target groups provide further input for the future work of the Network. The project also “evolved” structures that can be built on. As one of the central actors working to increase resource efficiency in Germany, the Resource Efficiency Network has helped to establish and strengthen communications and cooperation as well as interdisciplinary and of course personnel structures between business and industry, academia and politicians. The task now is to extend these strategically. In view of changing external circumstances (e.g., the global financial crisis) and new scientific findings and social developments, it makes sense to further develop the Network’s activities. An overview of proposals agreed between the partner institutions for future work is given in Chapter 4.

2 Direction and Definition of the Network Design

The main milestones in Task 10 were to further develop the Network design concept (i.e., the direction the Network’s strategy and programme should take), develop and implement various target-group activities and construct an Internet-based information platform. Agreement was reached at the start of the project on the direction Network strategy should take and what its activities should be, and target groups’ needs were identified. In consultation with the Federal Environment Ministry and the Federal Environment Agency the following preliminary steps were proposed:

- Draft a background paper entitled “Recommendations for Work in Heterogeneous Networks and the Implications for the Resource Efficiency Network” (Wuppertal Institute 2007). This document is available (in German) in the ::to JOIN section of the website under the heading *Netzwerkkonferenzen* at www.netzwerk-ressourceneffizienz.de/to_join/netzwerkkonferenzen/zweite_konferenz.
- Design, carry out and evaluate a survey of all Network members using a questionnaire on further development of the Network design (Wuppertal Institute 2008). This document (in German) can also be downloaded from the website under the heading *Netzwerkkonferenzen* at www.netzwerk-ressourceneffizienz.de/to_join/netzwerkkonferenzen/zweite_konferenz.

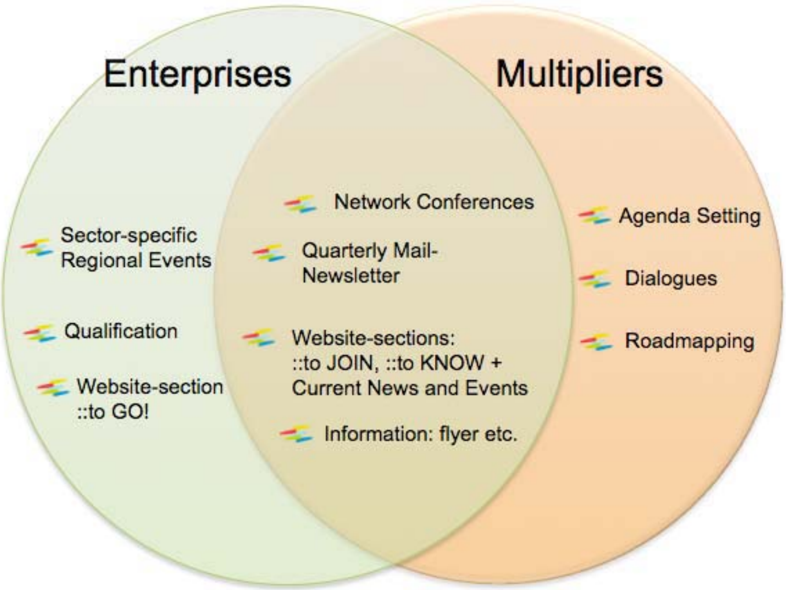
- Draft a paper entitled “Further Development of Proposals for the Network Design Based on an Evaluation of the Questionnaire” (Wuppertal Institute / EFA NRW / demea 2008). The paper and the detailed results of the questionnaire evaluation are available (in German) in the ::to JOIN section of the website under the heading “*Ziele und Angebote”* at www.netzwerk-ressourceneffizienz.de/to_join/ziel_amp_angebote.

In developing the Network design we identified two principal target groups for Network activities that need to be addressed quite specifically:

- **Enterprises** as direct implementers of resource efficiency. In particular, it is essential to empower and support SMEs in achieving a rapid increase in resource efficiency nationwide.
- **Multipliers** from the fields of politics, administration, industry associations, large corporations, academia, NGOs, media, advisory and educational institutions as promoters of implementation. These must all work together to make resource-efficient thinking and action the new social norm. Collaborating with actors that have their own structures and means of disseminating the idea of resource efficiency is therefore crucial.

In addition to those that are target group-specific, we also offer some network activities to all members. These are of equal interest to both member segments and will improve cooperation between the two target groups. Fig. 1 gives an overview of the Network’s activities.

Fig. 1: Overview of Network Activities 2007-2010



Source: Wuppertal Institute

It is important to involve Network members in designing activities by means of subject-specific surveys and also to evaluate actual implementation:

- Thus the above-mentioned survey of members supplied important indicators for further development of the Network design which were incorporated in 2008.
- In addition, the Wuppertal Institute in July 2009 carried out a statistical evaluation of website use in order to analyse the trend in user numbers and content accessed and to identify any need for improvement (see Chapter 3.5, Lessons Learnt). In the 04/2009 issue of our newsletter we asked all members for ideas about to make the design of the ::to GO! section more user-friendly. The ::to GO! section was then restructured in spring 2010 and re-launched in May 2010. A better-focused and clearer page and subject structure made it easier to navigate and more user-friendly.

Lessons learnt

Taking stock of the three-and-a-half years’ experience gained and using that experience to continually improve the Network design is important for the future development and definition process and hence a factor determining its success. Major lessons learnt are:

- Both target groups – Multipliers and Enterprises – should come from a broad range of institutions and should participate actively. The longstanding experience-based and structural knowledge offered by different actors and sectors and the regular exchanges taking place between them under the umbrella of the Resource Efficiency Network are fundamental to the success of the Network.
- A further key requirement is to involve all network members in identifying information and activity needs and thematic “hot spots”. This can be achieved via Network and regional conferences, but also by having an open Network design (“learning network”). Important conclusions can thus be drawn about how to tailor measures to address specific target groups while at the same time enhancing transparency and confidence in the Network. The impact of this approach is also manifest in the wide range of Network Resource Efficiency topics.
- Regular progress reports on ongoing processes and the attractive presentation of the results give members an overview of what has been achieved so far. This also allows their continuous active participation, facilitates diffusion of the messages and enhances the Network’s public profile.
- Another important success factor is maintaining a close link between the Resource Efficiency Network and academic research on resource efficiency conducted in the context of the MaRess project coupled with support for the Network by significant actors who are already established in the resource efficiency field. This has made it possible to communicate the latest developments and findings from all fields speedily via the Network and to initiate specific processes along widely differing and broadly based target lines (e.g. road mapping processes, more in Chapter 3.4).

Network Design, Follow-up Activities: Thematic Campaigns, Internationalisation of Activities and Young NeRess

The success factors outlined above provide a basis for a number of follow-up activities that might be used to further develop the Network design:

- **Focused thematic campaigns**: Development and design of thematic campaigns on leading technologies, products and strategies with high resource-efficiency potential, as identified in Task 1 of the MaRess project. Information on Task 1 and the results thereof can be downloaded from http://ressourcen.wupperinst.org/info/entwd/index.html?beitrag_id=935&bid=9.
- **Internationalisation of activities**: It is also important to adopt an international outlook and to build international cooperation. Examples of how this might be done include:
  - international management of value chains,
  - exchange of ideas on successful national political strategies, innovative approaches and entrepreneurial good practice.
- **Young NeRess**: Another meaningful follow-up activity would be to integrate young economists, scientists and politicians in the conception of Network Resource Efficiency offerings and activities. Possible starting points are described in detail in Chapter 3.

3 Network Activities and Their Results

In this chapter we describe the network activities for the Multipliers and Enterprises target groups and their outputs.

3.1 Network Conferences: A Concerted Effort to Achieve Greater Resource Efficiency

Six Network conferences have been successfully held in Berlin. The main target groups were multipliers and large business enterprises. SMEs were addressed specifically by regional events. In each case the Wuppertal Institute developed the content and organisational concept, and the Institute’s Berlin office was in charge of managing the event. Network conferences allow members to exchange ideas and to network and to communicate needs or obstacles regarding implementation of resource efficiency; they also provide an opportunity to agree on and initiate new activities. Each Network conference was designed for 100 participants and aroused a corresponding level of interest. The conference structure detailed in the Further Development of the Network Design Concept milestone included the following elements, which became established as a fixed sequence of events that received a positive rating from participants.

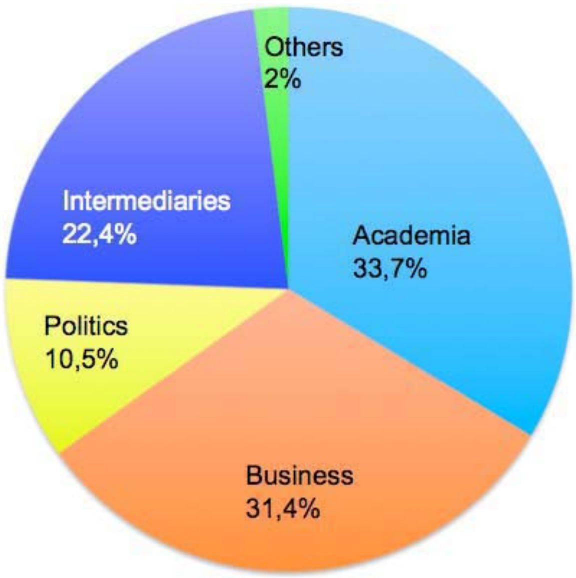
- **Welcoming remarks**: By way of introduction one or two new developments in resource efficiency and the Resource Efficiency Network were mentioned. At the conferences held so far, the welcoming remarks were delivered by the Parliamentary Secretary of State at the Federal Environment Ministry. In addition, the launch conference was addressed by the then Federal Environment Minister Sigmar Gabriel.
- **Good practice**: A round-table discussion of examples of good practice proved to be a good way of generating momentum. Successful examples from business enterprises were described and discussed in informal exchanges.
- **Present some Resource Efficiency Network activities**: A key success factor for developing the Network is to present the results and successes achieved by the Network, to exchange experiences and thus to initiate joint learning processes.
- **Spotlight:** After the launch conference establishing the Network in March 2007, each of the following five conferences focused on headline topics chosen to be of interest to as broad a section of members as possible:
  - The focus of the second conference (17 June 2008) was the Resource Efficiency Network one year on and financing resource efficiency activities. The Network’s past and future work was summarised and discussed and various funding possibilities were presented.
  - The third conference (29 January 2009) focused on successful networks and learning from the experience of other networks.
  - The fourth conference (26 June 2009) focused on qualification as a success factor for implementing resource efficiency. Approaches to qualification and successful examples were presented.
  - The fifth conference (15 April 2010) focused on leaps in innovation, the fast track to resource efficiency. Innovative approaches to increasing resource efficiency were presented and discussed.
  - The sixth conference (03 December 2010) will focus on successful implementation of resource efficiency and on which success factors are helpful.
- **Dialogue rounds**: The first survey of Network members found that intensive exchange and joint development of ideas was an important element. The rounds of dialogue on specific topics and strategic developments were held either as part of a plenary session or in different working groups whose findings were made available to all members for discussion.
- **Looking ahead**: Finally, representatives of the bodies responsible for the Network – i.e., the Wuppertal Institute and the Federal Environment Ministry – summarised the conference results and outlined what was to be done next.

Summaries of proceedings of the individual conferences, their programmatic content and the talks delivered are available in the ::to JOIN section of the Resource Efficiency Network website under the heading *Netzwerkkonferenzen*.

Lessons Learnt

The conference structure worked well and feedback from participants was extremely positive. The second to sixth Network conferences (see Fig. 2) were attended by a diverse group of interested parties that well reflects the Network’s two target groups.

Fig. 2: Composition of Participants at the Second to Sixth Network Conferences



Source: Wuppertal Institute

Many participants attended more than one conference. The Network conferences thus fulfilled their central objective as a platform for cross-sector information exchange and networking in the resource efficiency field. Many participants said they would like a longer time slot for informal exchange of information and ideas.

Network conference follow-up activities: International conference, better integration of the younger generation, and support for PR campaign

The positive response and the large number of people accessing and downloading the documentation from the website is evidence of the broad interest in the Network conferences. The following modifications are recommended for future conferences:

- **International conference**: One meaningful follow-up activity would be to organise an annual international conference to build cooperation with international actors. Possible topics could be exchange of information on successful national political strategies, entrepreneurial approaches and good entrepreneurial practice.
- **Better integration of the younger generation**: So far, young scientists, politicians and intermediaries have been underrepresented at Network conferences. In future, special conference elements or special events could address this target group specifically. This will primarily involve building well-targeted cooperative

partnerships with universities and staging joint activities. The positive experience of collaborating with five universities in Task 1 of the MaRess project (Technical University Berlin, Technical University Darmstadt, Technical University Dresden, University of Kassel, RWTH Aachen University) may serve as a reference point. One proposal for future conferences is to get students to report on Network conferences from their own point of view (possibly also in blogs). Here the World Resource Youth Group, a student blog initiated by the Mercator Foundation of Switzerland to report on the World Resources Forum 2009 in Davos, might be a potential partner for the Resource Efficiency Network. The group still exists and is now run by students. For further information on the blog, please visit: www.worldresourcesforum.org/wrfyg-blog.

- **Present conference material and results more attractively and creatively, thereby enhancing their publicity value**: Here one might consider closer cooperation with (communications) design departments (e.g. Bergische Universität Wuppertal, Folkwang University Department of Industrial Design) or agencies.

3.2 Regional Events: Resource Efficiency for Local Enterprises

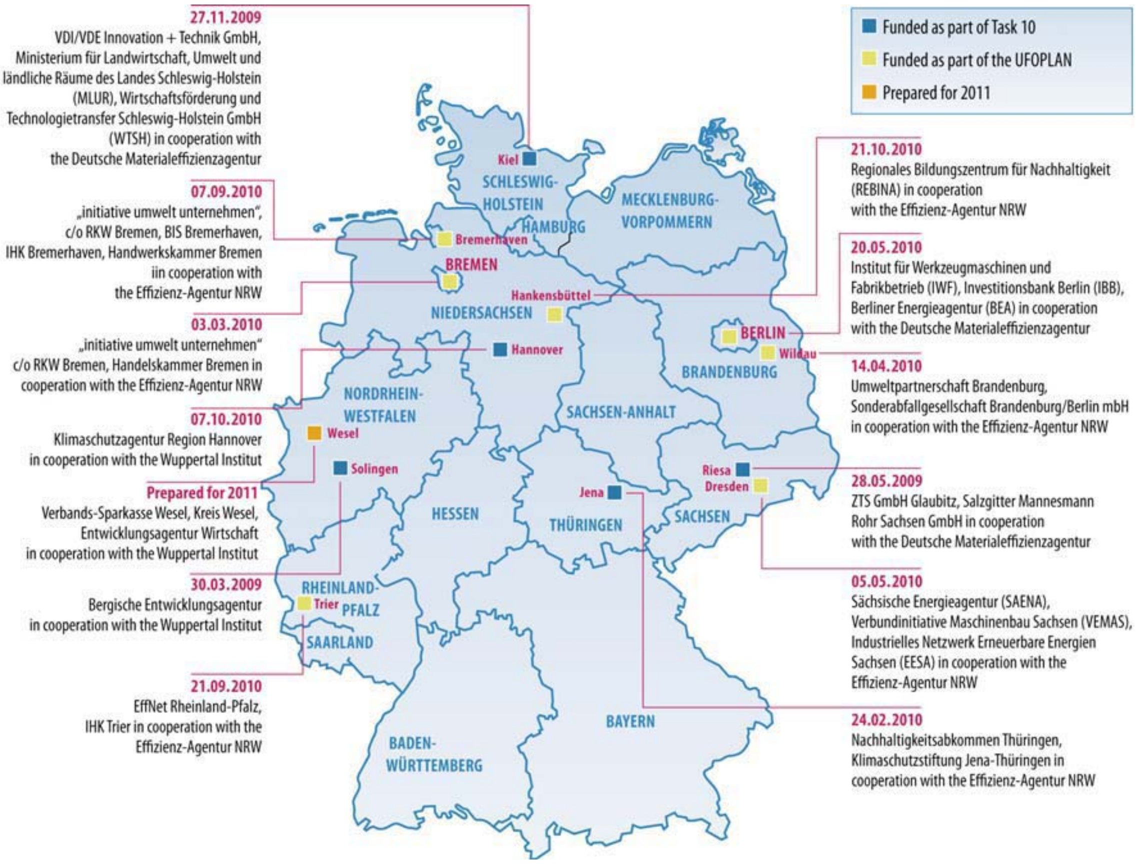
Twelve regional events in the series "Ressourceneffizienz für Unternehmen vor Ort" (Resource efficiency for local enterprises) especially for SMEs were held during the project and one additional was prepared for 2011 (see Fig. 3). Owing to the success of the first regional events and the importance of addressing people locally, in addition to six events supported by the Federal Environment Agency as part of Task 10, another seven regional events were funded as part of the Federal Environment Ministry's environmental research plan (UFOPLAN) and run along identical lines.

Run under the motto "Tread new paths, save material and raw materials, spare resources and reduce costs at the same time," these events

- provide information about the specific use of resources,
- present various successful examples from regional or sectoral business enterprises,
- offer help with implementation in business enterprises,
- provide information about the options for financing innovative technologies,
- provide stimuli for networking locally or in sectors.

The events were organised and run in close cooperation between initiators from the Network support bodies (Wuppertal Institute, EFA NRW and demea) and regional partners such as public or private intermediaries, industry associations, the German Chamber of Industry and Commerce (DIHK), the Federation of German Chambers of Trade (HWK), etc.

Fig. 3: Overview of Regional Events



Source: Wuppertal Institute / EFA NRW / demea

Lessons Learnt

Both participants and organisers see regional events as important drivers of regional communication processes and activity structures on the subject of resource efficiency. The local resource efficiency programme structure was well received by participants and regional partners. The concept for organising regional events aimed to continue existing initiatives and include regional players already involved. This proved to be a sensible approach because it allows the Network to take advantage of its extensive experience and evolved contacts, thereby enhancing participants' identification with and trust in the event's co-providers. This is also a good way of coordinating the activities of different players and offerings, because it provides the necessary clarity for enterprises. Moreover, the integration of regional structures into Resource Efficiency Network activities aimed at intermediaries encourages synergy effects.

Nonetheless, the initiators' experience of staging these events differed widely from region to region. Where actor structures and activities concerning resource efficiency are already well established, it is possible to reach more enterprises successfully. The main industrial focus in a particular region played a role here, because resource-intensive sectors recognised the relevance of the issue sooner. Great interest has been shown in the subject in regions such as Brandenburg and Dresden that are still "structurally weak" in terms of resource efficiency. However, additional efforts are needed here to recruit regional actors as long-term drivers of resource efficiency. This should be pursued more extensively as part of the follow-up activities.

Follow-up activities, regional events: Establish better networked regional structures for resource efficiency

Participants and organisers repeatedly stressed their interest in and need for these regional events, so it would seem to make sense to continue holding them. However, on the basis of experience so far we recommend the following modifications:

- **Establish better networked regional structures for resource efficiency** in the "blank spots" of the resource efficiency landscape. To achieve this the Resource Efficiency Network should co-operate with relevant regional and sector-specific intermediaries in order to sound out what kind of support might be necessary and to utilise existing engagement (such as with chambers of industry and commerce, chambers of trade, or RKW rationalisation and innovation centres).

3.3 Dialogues: Initiating and Promulgating Resource Efficiency Jointly

As a rule, it takes many parties to make specific economic processes more economical with resources: management and producers, the supply and demand sides, research and development, and policy-makers. Dialogue can set such processes in motion. Two dialogue processes were initiated as part of Task 10:

- **Industry dialogue between social partners on the resource efficiency of aluminium products:** The Resource Efficiency Network dialogue process – consisting of workshops, surveys and interviews – brought together representatives of the IG Metall engineering trade union and the German Aluminium Industry Federation (GDA), associated enterprises, works councils, the Federal Environment Ministry and the Network support in order to discuss the significance of resource efficiency of aluminium products along the value chain and throughout their life cycle. The aim of this two-stage process (conception, implementation) was to develop innovative approaches to promoting the resource efficiency of aluminium products in production and consumption. The project partners were the GDA, IG Metall and the Federal Environment Ministry. The dialogue process was organised by the UNEP/ Wuppertal Institute Collaborating Centre on Sustainable Consumption and Production (project management), Sustain Consult (conduct and analysis of interviews and questionnaires) and the Wuppertal Institute (cooperation with the Resource Efficiency Network). The project was supported via MaRess and the Hans Böckler Foundation. Detailed documentation and all the results can be found on the project website: www.aluminium-ressourceneffizienz.de.

- **IG Metall specialist dialogues in mechanical engineering and in the field of cross-sectional technologies, with works councils as the target group**: Resource efficiency – giving direction to progress and securing employment was the topic of the Resource Efficiency Network's dialogue workshop with works councils, run jointly by IG Metall, the Federal Environment Ministry and the Resource Efficiency Network in April 2009. The workshop was preceded by numerous expert interviews with works council chairpersons, who contributed their experience to the discussion. Specialist support for the entire dialogue process was provided by the Wuppertal Institute and the IG Metall executive's technology and environment section.
  The central outcome of the dialogue process is a guide for works councils that is available as a printed document or a PDF file. It brings together scientific findings and the knowledge works councils have gained from experience and can help them take advantage of their rights to information and participation in the interest of a sustainable corporate policy. The guide can be downloaded from the Resource Efficiency Network website at www.netzwerk-ressourceneffizienz.de/to_join/detail/entwd/index.html.
- **Resource Efficiency-"Society" / Competence Pool Resource Efficiency:** Since summer 2010 different national institutions in the workfield of resource efficiency have been meeting on their own initiative on a quarter-annual basis with the superior goal of jointly foster resource efficiency in Germany and to promulgate the topic efficiently and effectively to relevant target groups. Besides the Resource Efficiency Network the following institutions participate on an operative level (status: november 2010): the RKW Kompetenzzentrum, the Effizienz-Agentur NRW, the Deutsche Materialeffizienzagentur, the Wuppertal Institute, the VDI/VDE Zentrum für Ressourceneffizienz, the DIHK and i.con innovations (ReMake). As a result of regular exchanges, improved inter-institutional coordination and a concerted development of joint activities synergies can be achieved and duplication of work can be avoided.

Lessons Learnt

The participants' positive response and the highly publicised results have made it clear that dialogue processes are an effective instrument for initiating examination of resource efficiency in other relevant fields, too. The keen personal engagement of various participants was supported by the Resource Efficiency Network. This helped to develop synergy effects.

Follow-up activities, dialogue: initiate further dialogues in resource-intensive sectors, continue joint activities within the resource efficiency-"society" / competence pool resource efficiency

The Resource Efficiency Network offers a good framework for further dialogue in other areas where there is great potential for increasing resource efficiency. Other promising areas are those where good contacts with possible participants already exist or there is scope to follow up on existing activities. The Network support is currently exploring possible dialogue in the areas of Green IT, resource efficient design and communication, though these have yet to be finalised. Additionally, the joint activities developed within the resource efficiency-“society” / competence pool resource efficiency pose an innovative and promising approach to achieve synergy effects. To successfully and efficiently promulgate the topic of resource efficiency in Germany, the cooperation should be continued based on a “Memorandum of Understanding”. Furthermore, if required, it should be institutionally strengthened by a systematic expansion of member institutions. The establishment of a national resource efficiency agency should be aimed at in the long run, combining existing competences under the umbrella of a single institution and hereby enhancing efficiency, effectivity and transparency of institutions in the field of resource efficiency.

3.4 Roadmapping: maps for opening up lead markets for resource efficiency

Roadmaps are an instrument for the active design of technological developments and future markets. This type of map brings together many individual themes, identifies options for action and names priorities. Starting from the current state of technology, roadmaps supply information about the type, speed and direction of possible technological developments in enterprises and industries and visualise target-group-specific transfer activities. The goal of Task 9 of the MaRess project was to develop – jointly with industry and industry associations – integrated technology roadmaps for two Resource Efficiency Network road-mapping processes, with the aim of identifying lead markets with a high resource efficiency potential.

Dr. Siegfried Behrendt of the Institute for Futures Studies and Technology Assessment (IZT) gGmbH and Prof. Dr. Klaus Fichter of the Borderstep Institute for Innovation and Sustainability were in charge of the two roadmapping processes forming part of MaRess Task 9.

- The **Thin Client & Server-Based Computing** roadmap centres on the development of lead markets for energy- and material-efficient use of ICT. Server-based computing means that application programmes do not run on a terminal but on powerful central servers, and that the thin client (a small, compact terminal for computer work stations) accesses them from there.
- The **Resource-Efficient Photovoltaics** roadmap aims to open up lead markets for photovoltaic products, focusing on early recognition of raw material requirements and shortages, reducing production costs, and recycling.

The final report on Task 9 can be downloaded from http://ressourcen.wupperinst.org/downloads/index.html.

3.5 Website: News and Information at a Click

Another central milestone in Task 10 was designing and setting up the Resource Efficiency Network website. The goals set out in the application included providing information on the Network’s activities (including dates), agenda setting and finding ways to publicize resource efficiency as effectively as possible, presenting examples of good practice, and providing lists of thematic links (including links to funding options, advisory institutions, implementation tools, etc.).

The Wuppertal Institute developed and realised the concept for the website structure, provided scientific support and drafted text in coordination with the Federal Environment Ministry and the Federal Environment Agency. The communications consultancy Martin Feldmann in Wuppertal was responsible for conceptual support and website design, while the technical realisation was done by the oundmdesign – maikranz ohnesorge gbr design agency. The Wuppertal Institute maintained the website using the Typo 3 content management system.

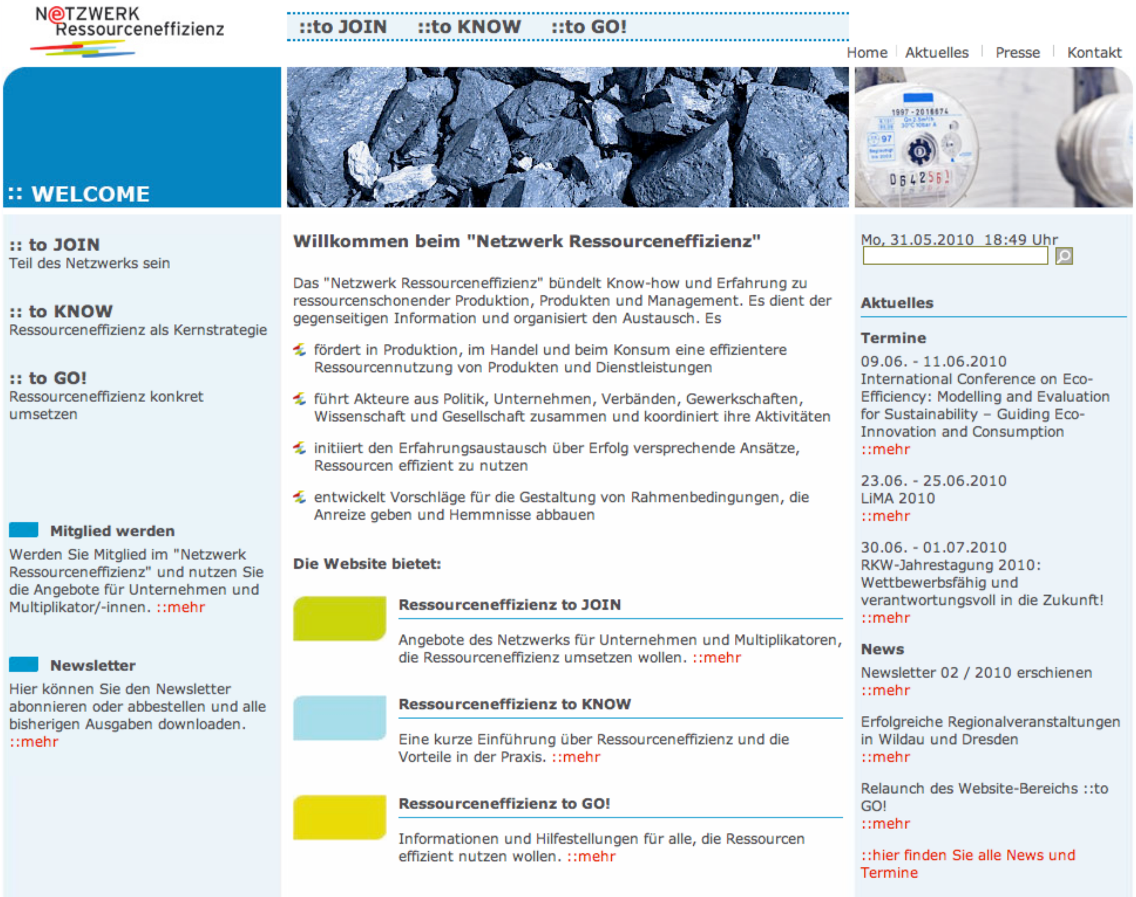
The website is divided into three main content sections with subpages. It also includes an overview of current events and news along the right-hand margin (see Fig. 4):

- **::to Join – being part of the Network:** This area has information, documentation, downloads and links relating to the goals, offerings and activities of the Resource Efficiency Network (Network conferences, regional events, dialogues, qualification, newsletters, etc.).
- **::to KNOW – resource efficiency as a core strategy:** This section contains extensive information, facts and figures as well as resource efficiency links. *Politikoptionen* provides an overview of political measures and strategies to promote resource efficiency. *Unternehmensoptionen* gives an overview of crucial starting points for implementing resource efficiency in business enterprises.
- **::to GO! –I mplementation of resource efficiency in practice:** This area is the real heart of the website, where under the headings *Informationen & Tools*, *Bildungsangebote* (Training), *Förderangebote* (Funding) and *Auszeichnungen* (Awards), users can access all approaches, offerings and examples to enable them to start implementing resource efficiency in their own context straight away.

Lessons Learnt

The creative and attractive layout of the website won praise in many quarters, and counter showed a continuous increase in user numbers and in the intensity of use of the website. The ::to JOIN area and the current news and events were visited especially frequently, followed by the ::to KNOW and ::to GO! areas. In spring 2010 the ::to GO! area was restructured to make it easier to navigate and more user-friendly.

Fig. 4: The Resource Efficiency Network Website



Source: Wuppertal Institute

Website follow-up activities: English short version, Web 2.0, Wikipedia

- **English short version:** The core areas and information of the website should be translated into English for international users. This is also relevant regarding the internationalisation of activities.
- **Web 2.0:** Podcast (interactive good practice area), activities in social networks (Facebook, XING, etc.).
- **Wikipedia:** Write an article on resource efficiency, identify where there is a need to augment existing subject areas, close gaps.

3.6 Qualification: No Implementation without Sufficient Know-How

Qualification plays a crucial role in achieving resource efficiency aims and was therefore explicitly included on the agenda of the second and fourth Network conferences. Enabling (future) employees and managers to anchor resource efficiency firmly in their thinking and behaviour in their specific contexts is very important. Since learning processes do not take place overnight and rarely lead to immediate changes in behaviour, it is all the more important to build and expand opportunities for people to obtain additional qualifications in resource efficiency as quickly as possible.

At the second Network conference, the dialogue round on qualification and tools discussed three Resource Efficiency Network activities in detail and identified specific strategies for putting these into practice:

- Design a Resource Efficiency course of study,
- Develop partnerships with SMEs,
- Conduct research project on qualification and personnel development concepts.

The details of each dialogue round can be downloaded from the ::to JOIN area of the website under the heading *Netzwerkkonferenzen* (Network conferences). They are to be found on the second conference page in the document marked *Protokoll* (minutes).

The main topic of the **fourth conference** was qualification as a factor in successfully implementing resource efficiency. A number of researchers and practitioners talked about the need for qualifications and about existing approaches. For example, one contributor presented a simplified overview of qualification options focusing on resource efficiency (Knowledge roadmap, “Qualification Options for Resource Efficiency”), including the energy efficiency ambassador model as an approach that might be applied to resource efficiency. Also presented were the findings of a project at the Industrial Design Department of Folkwang University that took resource efficiency as a starting point for a course on product design. The conference proceedings can be downloaded from the ::to JOIN section of the website, under the heading *Netzwerkkonferenzen*, where they are on the page for the fourth conference. A detailed description of other MaRess activities on the subject of qualification and resource-efficient design can be found in the results of MaRess Steps 13.2 and 13.3 at http://ressourcen.wupperinst.org/downloads/index.html.

The training project Resource Efficiency at Work developed by the German trades union federation DGB, its educational section DGB Bildungswerk e.V. and the Federal Environment Ministry in May 2008 is to be the Resource Efficiency Network’s core qualification project, its goal being to elaborate a continuing education concept for material and energy efficiency in companies. For further information, please visit: www.einblick.dgb.de/hintergrund/2008/09/intro_ressourcen.htm/.

Lessons Learnt

There should also be a continued focus on stimulating, developing and disseminating training, further education and continuing education programmes in resource efficiency in a wide range of professions and at a wide range of levels.

Follow-up activities, qualification: qualification for consultants, financial managers and other intermediaries, summer schools

- Draw up and launch **qualification programmes for consultants, the banking sector and other intermediaries**: SMEs in particular often have financial difficulty with investing in resource-efficient technology and need competent advice and useful support. To be able to provide this advisory agencies such as financial institutions must pay more attention to educating their employees about resource-efficiency potential, instruments and technologies. There is an urgent need for action in this area. This topic could easily be incorporated into regional events.
- **Summer Schools**: The model here is two international summer schools on Industrial Design. The first took place in 2009 under the heading 1st Sustainable Summer School and the second, held in 2010, was devoted to the topic Society, Systems and Swarms. Running summer schools on resource efficiency themes is an important educational component, especially with Young NeRess in mind. Further information about the above summer schools is available at www.designwalks.org.

3.7 Agenda Setting: Communicating Trends and Providing Motivation

With the aim of disseminating knowledge about and specific approaches to resource efficiency more widely and increasing accessibility both to target groups and to the general public, various agenda-setting activities were implemented as part of Task 10:

- Website,
- Communications campaign as outlined in MaRess Task 13 on resource efficiency,
- Qualification.

Lessons Learnt

Our positive experience with the website and with our qualification programmes suggest that these should now be expanded. The next organisational step in the resource efficiency campaign will be to establish the idea and put it into practice.

Follow-up activities, agenda setting: build media partnerships

- Develop media partnerships and general press and media work to support the resource efficiency campaign.

3.8 Information: Arouse Curiosity and Raise Awareness

A wide range of information in different formats was prepared as part of Task 10. Central elements, in addition to the website, are the quarterly **Mail Newsletter**, subject-specific **Special Newsletters** and separate bulletins on important news and events. The newsletter is composed on the basis of regular online research and of new, relevant information obtained from the MaRess consortium and other actors in the resource efficiency field. The newsletters are sent, using the Typo 3 content management system and with the Resource Efficiency Network as the sender (newsletter@netzwerk-ressourceneffizienz), to all members of the Resource Efficiency Network in business, academia, politics, civil society and the media. All newsletters and special newsletters can also be downloaded as PDF files from the website. The Wuppertal Institute is responsible for editorials and graphics and for posting the individual articles on the website. Between January 2009 and December 2010, nine regular newsletters and two special newsletters were published. Following the structure of Network conferences, the newsletter comprises the following subject areas:

- **From the Network**: News about the work of the Resource Efficiency Network.
- **Local resource efficiency**: News about regional resource efficiency activities (e.g. good practice, reports on regional events).
- **National resource efficiency**: News and developments in business and industry, politics and research concerning all aspects of resource efficiency at the national level.
- **International resource efficiency**: News and developments in business and industry, politics and research concerning all aspects of resource efficiency at the international level.
- **Successful implementation**: News and good practice examples from business enterprises, politics and research that generate special momentum or open up innovative approaches and perspectives.
- **Service**: This category includes the headings *Termine* (dates), *Im WWW* (on the Web) and *Gedruckt* (printed material), each with current information and new publications).

The first special newsletter on Green IT was published to coincide with CeBIT 2009. The second, published after the big MaRess conference “Resource Efficiency – Motor for Green Growth”, was devoted to films on resource efficiency that use creative visual approaches to bring the message of resource efficiency home to a broad general public. In addition, a panel discussion held at **“Natural Resources Day”** – an event organised by the Federal Environment Agency on 16 September 2009 alongside the World Resources Forum in Davos – introduced the Resource Efficiency Network and explained its added value from the point of view of initiators and partners. Further information is available at www.umweltbundesamt.de/ressourcen/faktor-x/tag.htm.

Information on the goals and offerings of the Resource Efficiency Network is also provided in **flyers** produced in German and English for the two target groups, Business Enterprises and Multipliers. In addition, invitation and programme flyers were produced for each of the six Network conferences and fourteen regional conferences. The Wuppertal Institute designed the content of the flyers and the Institute’s VisLab was responsible for the graphics. A large quantity of flyers was printed for display at events. The flyers can also be downloaded from the website as PDF files.

In addition, the Wuppertal Institute in cooperation with VisLab produced a **poster** for the fifth Network conference with the heading **“The Resource Efficiency Network Three Years On: Activities for a Resource-saving Future”** giving an overview of the Network’s work.

To enable interested parties to register as members on the spot at Resource Efficiency Network events or those of its partners, and to offer a non-web option, the Wuppertal Institute produced **membership application to GO! postcards,** which were also sent to Resource Efficiency Network partner institutions to display.

The Resource Efficiency Network also offers **telephone and e-mail support for members** via the account info@netzwerk-ressourceneffizienz.de.

Lessons Learnt

While there is certainly a demand for information, this must be actively promoted and disseminated.

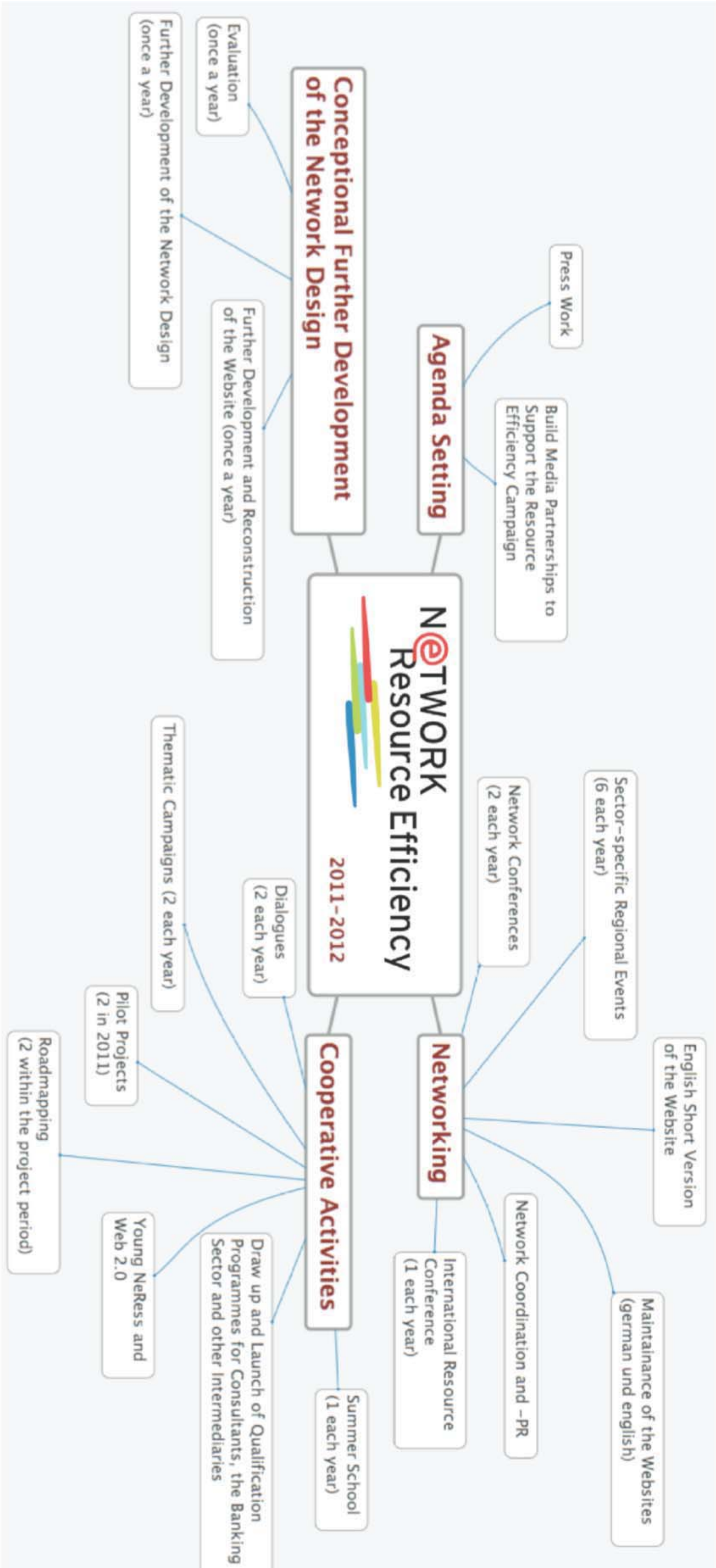
Follow-up activities, information: continue approaches that have proven successful

The kinds of information currently provided have proven effective and are well established, so we should continue to work with them.

4 Summary of Proposals for Follow-up Activities

Fig. 5 summarises the follow-up activities considered useful for the period 2011–2012.

Fig. 5: Overview of Follow-up Activities for the Period 2011–2012



Source: Wuppertal Institute

Material Efficiency & Resource Conservation

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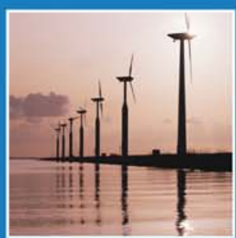
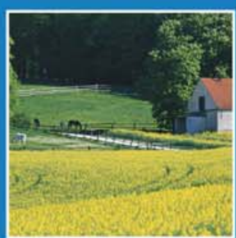
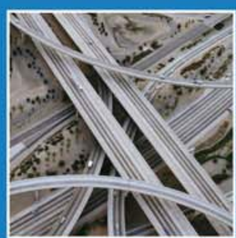
Cooperative Roadmapping as a Tool for Innovation-Orientied Resource Policy

Early Detection and Development of Resource Efficiency Potentials, using the examples of Roadmapping Initiatives in Photovoltaics and Green IT

Executive Summary

Summary report of Task 9 within the framework of the Project „Material Efficiency and Resource Conservation“ (MaRess)

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"Material Efficiency and Resource Conservation"
(MaRess) – Project on behalf of BMU I UBA

Project Duration: 07/2007 – 12/2010

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you will find on **www.ressourcen.wupperinst.org**

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Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Umwelt Bundes Amt
For our Environment

Cooperative Roadmapping as a Tool for Innovation-Orientied Resource Policy

Executive Summary

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1 Occasion and Background

With regard to material efficiency and resource conservation, the early detection of innovation opportunities and risks, new businesses and markets has great importance for the success of innovations. While the German Federal Environment Ministry (BMU) and the Federal Environment Agency (UBA) have already made some estimates of potentials, further substantiated and clarified in the UFOPLAN project “Innovative environmental policy in key areas of action (future markets)” (FKZ 206 14 132 / 05), the next logical step within the framework of the BMU-funded project “Material Efficiency and Resource Conservation” (MaRess) is to derive specific technological and market-based challenges, and to feed these results into state funding policy, activities of business associations, and into the innovation management of key players in the industry.

With view to this task, the Institute for Futures Studies and Technology Assessment (IZT) and the Borderstep Institute for Innovation and Sustainability have initiated dialogue processes with industry, consumer and academia representatives. In this context, so-called “Roadmaps” were developed collaboratively from summer 2008 to summer 2010 (cf. Behrendt 2010). The term “Roadmap” is understood here as a representation of a path of development along a timeline. Based on trend analysis, interviews and dialogue workshops, material efficiency and resource conservation potentials were determined, and objectives, milestones and concrete measures by which the identified potentials can successfully be developed were outlined subsequently. This systematic process of developing a roadmap is called “Roadmapping”. Roadmaps were developed exemplarily for two important resource-related fields: firstly, for photovoltaics as a young, dynamic field of technology, and secondly, for information and communication technology (ICT) as a particularly significant cross-sectional technology. Within the ICT roadmap, the main focus was on the most important and rapidly growing area of workplace computer solutions. Analysis has shown that ICT as a cross-section technology holds major, as yet undeveloped, resource efficiency potentials.

Roadmapping allows for the formulation of a “map” that bundles various individual issues, identifies courses of action and names priorities. Early detection of resource efficiency potentials, as well as development of future markets including the associated challenges of market development, is based on the analysis of trends and the identification of driving forces. The examination is directed not only towards the dynamics of technological and market developments, but also on efficient life cycle and system observations. The roadmap creates the necessary framework by facilitating intelligent networks and communications between important innovation protagonists and by integrating knowledge.

While the roadmapping method has already been used in the past for the development of “master plans” for federal institutions at the level of individual companies or industries, the systematic cooperation of stakeholders from business, politics, administration, and science does present a new form and quality of "cooperative roadmapping", duly tested within the Task 9 of the MaRess project for the technology fields mentioned above. From a methodological point of view, one main question was how collaborative roadmapping processes need to be designed in order to support innovation-oriented environmental policy effectively in unlocking resource efficiency potentials.

2 Roadmap: Resource-efficient Photovoltaics

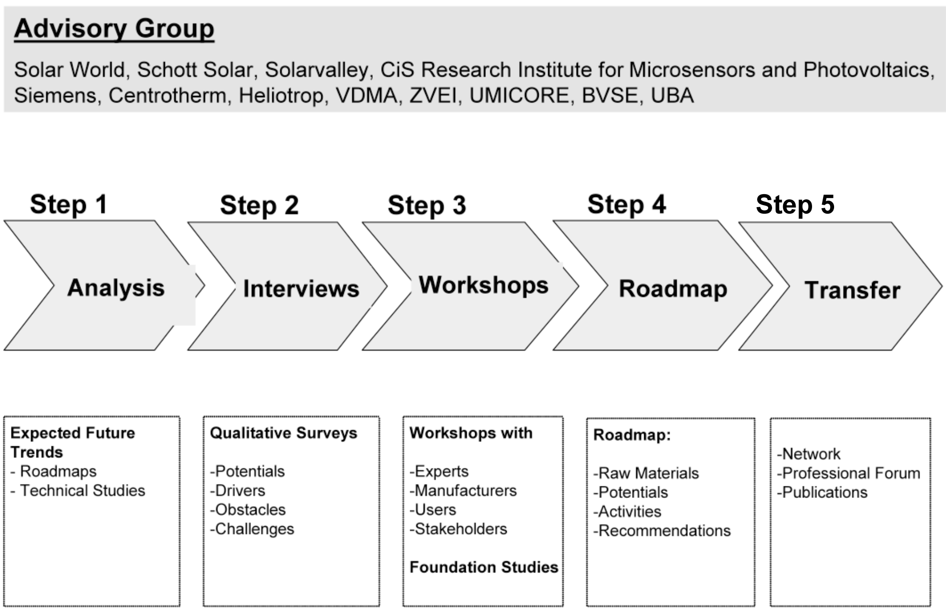
2.1 Initial Situation

Photovoltaics is a relatively young industry. It has in recent years been developed into a profitable, rapidly growing lead market. This is particularly true for Germany, the largest and most profitable photovoltaics market even ahead of the U.S. and Japan. The photovoltaic market has been growing faster than expected in the last years, and a worldwide total of 8.5 Gigawatt of newly installed capacity is expected for 2010. For photovoltaics to assume a globally significant position as future energy supplier, sustained high growth of the market is necessary in the decades to come. This does not only require a long-term, reliable political framework, but also continuous enhancement of solar technology, solar systems, and production technology. Important tasks are improving material efficiency, securing raw material availability and conservation of resources. Material efficiency is a main development objective in the photovoltaic industry, and the subject of numerous research and development activities, with the aim of improving the cost-performance ratio of solar cells, thus strengthening and securing the photovoltaic industry's competitive position. The main challenge lies in increasing the degree of efficiency of solar cells, improving production yields and in optimizing their economic life-time and system reliability. Despite recent increases in efficiency, there are still significant untapped potentials and new challenges regarding material efficiency and resource conservation lying ahead. This makes process innovations targeting material and energy savings even more important. Furthermore, the solar industry is facing the challenge that in the near future, it will be necessary to recycle growing amounts of waste from of discharged solar modules and products in an economically viable and ecologically sound manner. In the relevant roadmaps that serve as strategic innovation routes for the solar industry, these challenges have only been touched upon so far. This is why the roadmap for resource-efficient photovoltaics was developed within the "Material efficiency and resource conservation" project MaRess, funded by the Federal Environment Ministry BMU and the Federal Environment Agency UBA. This was achieved in cooperation with key industries, organizations and academics from different areas of the solar industry, from mechanical and plant engineering, automation technology and the recycling industry.

2.2 The Dialogue Process

The creation of the roadmap is based on a broad dialogue with important stakeholders from the photovoltaics industry and their professional environment. Together with companies, associations and academics, main challenges were identified, assessments of potential made, and plans of action that consider material efficiency and resource conservation were reviewed.

Fig. 1: Dialogue process



Altogether, more than 60 experts from the photovoltaic industry participated in the process in two moderated workshops:

- Material Efficiency and Resource Conservation in Manufacturing, November 03, 2009, in Berlin
- End of Life Recycling, December 11, 2009, in Berlin

The workshops were supplemented by interviews with relevant experts from the photovoltaics industry, R & D institutions as well as business associations. The development of the roadmap was supported by an advisory group of representatives from different levels of the value chain: from photovoltaics companies (Solar World, centrotherm GmbH, Heliotop GmbH, Solar Valley Central Germany eV, Schott Solar, Umicore Precious Metals Refining), research institutions (CiS Research Institute for Microsensors and Photovoltaics, Borderstep Institute for Innovation and Sustainability), associations (the German association of machinery and plant manufacturers VDMA, the German association of the electrical engineering and electronics industry ZVEI, the German federal association of secondary raw materials and waste disposal BVSE), as well as the German Federal Environment Agency UBA.

2.3 Results and Outlook

Key results of the roadmap are:

New material-saving technologies and processes provide a way of meeting increasing cost pressure in the years to come. The solar cells’ base materials make up the greatest cost pool. Progress in resource efficiency and the availability of low-cost raw materials is therefore particularly relevant to the competitive environment of the solar industry and its further development. By utilizing the material efficiency potentials identified in the roadmap, costs could be halved in the medium term[1].

With the photovoltaic market growing, it is becoming more relevant to material flow. Currently, the output from photovoltaics is still significantly below the amounts of other products such as electronics, and so far does not represent a large material flow by comparison. However, the market penetration of photovoltaics will change this. In 2008, the global material flow for photovoltaic electricity was around 593 000 tonnes. This could be doubled in five years, and quadrupled by 2020. By 2030, it could increase globally by a factor of nine, growing to around 5.3 million tonnes.

Shortages are possible, and may become evident in delivery problems and high prices. Numerous future technologies are already competing for silver. The supply of silver cannot easily be expanded in the short term, mainly because silver is a by-product of less dynamically sought-after core products. In the case of tellurium for cadmium telluride (CdTe) solar cells, and indium for copper indium gallium selenide (CIGS) solar cells, a surge in demand is to be expected in the medium term that will exceed current production. Due to the relatively low amounts of the respective materials in the product, incentives for material-efficient economic activities are only to be expected with high prices for tellurium and indium. Potentials of increasing supplies lie mainly in the increased exploitation of bypasses of copper and zinc smelting, and in the subsequent treatment of residues. Whether there is an absolute scarcity of high-quality quartz for the production of metallurgical silicon cannot be assessed reliably at present, due to the lack of systematic surveys of pure quartz deposits. However, shortages of raw materials can always arise temporarily if the supply does not keep pace with the dynamic developments of demand. Apart from photovoltaics, the semiconductor industry is primarily decisive here.

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[1] Surveys and Evaluations by the authors, based on: Wim C. Sinke, Wijnand van Hooff, Gianluca Coletti, Boukje Ehlen, Giso Hahn, Stefan Reber, Joachim John, Guy Beaucarne, Emmanuel van Kerschaver, Mariska de Wild-Scholten, and Axel Metz: Wafer-based crystalline Silicon Modules at 1 €/Wp: Final Results from the crystal clear integrates project. 24th European Photovoltaic Solar Energy Conference and Exhibition, 21-25 September 2009

Tab. 1: Possible structural supply bottlenecks for the Development of Photovoltaics

Production Lines	Begrenzende Materialien	Research Needs
Silicon-PV (c-Si, Poly-Si)	Silver (n-Electrode)	Partial and complete substitution of silver, Minimizing the amounts of silver in products
	Indium (TCO)	Avoiding ITO, e.g. by using ZnO or ATO
Thin film PV		
CdTe	Tellurium (Cell material)	Minimizing layer thickness, increasing product yield, recycling of production waste
CIGS	Indium (Cell material)	Minimizing layer thickness, increasing product yield, recycling of production waste
Farbstoff	Indium (TCO)	Avoiding ITO, e.g. by using ZnO or ATO
	Tin, Platinum (TCO)	Increasing Material Efficiency
III-V PV (Heterojunction)		
MJC III-V	Germanium (Substrate)	Alternative Substrates
	Gallium (GaAs Substrate)	Lift-off, III-V/Si
MJC III-V, lift-off	Indium (Cell material)	In-free Heterojunction Cells
	Gold (Electrode)	Alternative Electrodes

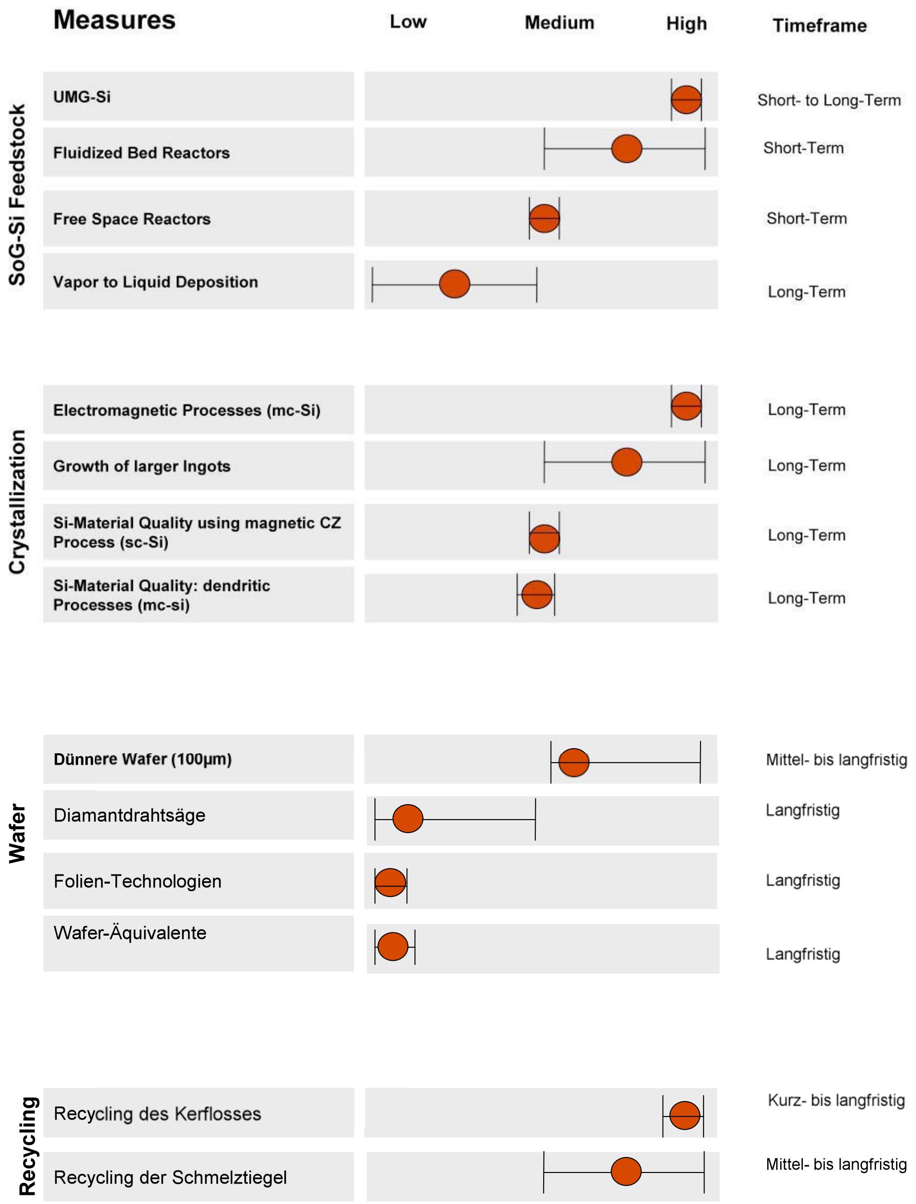
TCO – Transparent Conductive Oxides; ITO – Indium-Tin Oxide, ATO – Antimony-Tin Oxide; MJC – Multi-Junction Cells; Tin and Platinum are only potentially limiting factors for the development of Dye-PV if the Indium problem in TCOs can be alleviated.

Source: Evaluation of the IZT authors, based on: Andersson 2000, DoE 2005, Feltrin, Freundlich 2008, and Feltrin 2009, Hagelüken 2008, ISI / IZT 2009, Ökoinstitut 2009, Ökopol et al. 2007, Wadia et al. 2009, Wäger 2008.

In the course of the dynamic development of the photovoltaics market in recent years, significant improvements in material efficiency have already been achieved. The “low hanging fruits” in manufacturing have in fact largely been picked. But the possibilities of production with less material and resources are by no means fully exploited. The remaining short-term potentials for the crystalline silicon technology mainly lie in the production of solar grade silicon (SoG-Si) from metallurgical grade silicon (MG-Si), as well as the use of fluidized bed reactors and free-space reactors for the production of SoG-Si. Frameless modules can be realized in the short term, the reduction of glass thickness in the short to mid term, whereas electromagnetic methods of manufacturing silicon in sufficient quality and at acceptable costs are more relevant in the long term. In thin-film technology, the optimization of plasma-enhanced chemical vapour deposition (PECVD) for the production of amorphous silicon (a-Si) absorber layers and the reduction of absorber layers in copper indium selenide (CIS) technology are particularly promising. Entirely novel cell and module concepts that efficiently combine material efficiency demands with the requirements of industrial production are only to be expected in the long-term perspective.

The analysis of raw material requirements has shown that the most effective material efficiency strategies today are minimizing the gross amounts of material in products, and improving process yield and production waste recycling. In the short and medium term, concrete measures in production waste recycling and material efficiency, for instance by increasing production yield or reducing the amount of raw materials, are especially effective. Nevertheless, the foundations for the recycling of discharged modules need to be laid today as the waste flows are of high latency (“Design for Recycling”). In the long term, the recovery of raw materials from recycled modules will also prove effective (“Urban Mining”). As soon as material efficiency is increasingly implemented in manufacturing, the amount of production waste and module recycling will decrease.

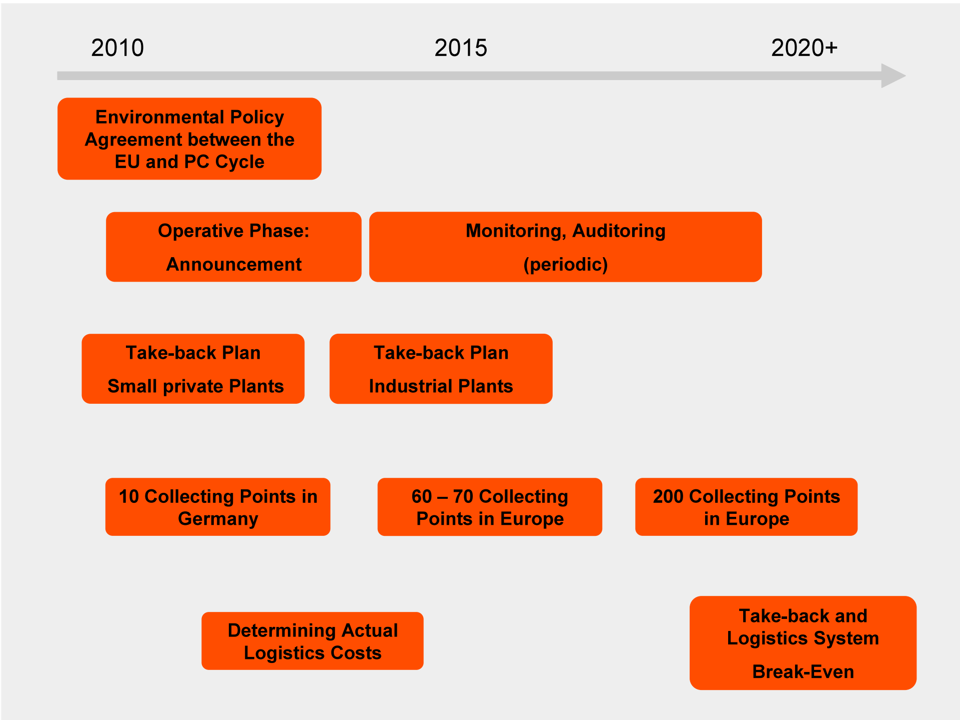
Fig. 2: Relevant Measures and Timeframe for the Manufacturing of c-Si Modules



Source: Workshop "Material Efficiency and Resource Conservation in PV Production", IZT, Nov. 03, 2009.

In future, there are adequate structures to be set up for end-of-life recycling, as well as bulk procedures for joint recycling of faulty modules to be developed. After further examination it may be required to concentrate on specific materials, e.g. glass, steel, aluminum, or copper, with special regard to the decreasing amounts of raw materials actually used in photovoltaics products. Further questions to be addressed include an ecologically sound recycling which not only covers mass materials, but also ensures that rare and special metals essential to future technologies are recovered. Quantity-based recycling ratios, as laid out in the European Union's Waste Electrical and Electronic Equipment (WEEE) Directive, are not sufficient because they do not account for those functional materials used solely in small amounts.

Fig. 3: Milestones for a Comprehensive Take-Back and Logistics System



Source: Workshop End-of-Life Recycling, Berlin, Dec. 11, 2009.

The unlocking of resource efficiency potential involves overcoming a number of hurdles. Refashioning production units makes higher investment costs necessary, and there are questions regarding the technological complexity of certain processes and quality issues (such as the purity of solar-grade silicon) still to be resolved. Although the potential for recycling production waste is notably high, the assessment of this aspect remains the most uncertain and, accordingly, the most demanding to implement. There is no "silver bullet" for resource-efficient photovoltaics in the foreseeable future. In fact, it is rather more important to individually test singular cases in order to balance differing expectations. This involves specific systemic innovations through interdisciplinary R & D that includes product developers as well as plant, construction and process engineers. Several areas in which further improvements are most pressing and fit to be targeted with appropriate R & D activities have been identified in the roadmap for different areas of solar technology. These include standardized analytical methods for measuring contamination and for the quantification of key material figures; development of flexible wafers to simplify the very fragile wafers’ handling; hydro-metallurgical and chemical procedures for recycling production waste from thin film technologies; and the development of alternatives to silver as contact materials.

Benchmarking: A broad informational base is required to encourage the development of resource efficiency potentials, for instance in the shape of a classification figure system for material and energy efficiency. These types of reference numbers can be used to condense large amounts of data into a manageable form of meaningful information. One particular benefit of these figures is that they highlight weaknesses and optimization potentials at the same time. Direct comparisons may help in disclosing opportunities for improved material efficiency. Various companies in the photovoltaics industry already use such figures as part of their environmental management, to regularly record waste, water use or energy consumption at the enterprise level, for example. But so far, they have rarely been systematically employed at the process level or used to uncover optimization potentials.

Initiating beacon projects for “Smart Integrated Manufacturing”: Resource efficiency would be greatly facilitated if there was clear progress in integration, automation and upscaling of production units. New automatic manufacturing concepts are becoming more and more important for increasing operational capacities and improving overall quality. While production was restricted to “custom-made” unique pieces made with considerable amounts of manual labor a few years back, today there are fully automated, ready-made production lines for manufacturing of ingots, solar cells and modules available. Vertically integrated automatic production facilities may be state of the art, but have nevertheless hardly been practically realized so far. Automation can benefit yield, cost reduction, high quality and standardization of manufacturing. The demand is high enough to render efficient and consistently automated manufacturing and testing procedures for solar cells appealing. By using intelligent systems controls, the rejection rate can be reduced, process quality increased, and error sources eliminated or at least compensated. Automated processes in which the possibilities of control are nevertheless transparent provide some leverage to resource-efficient and therefore economic mass production of solar cells. Here, a lot can be drawn from concepts like the “gigawatt factory” or “grid parity factory”. The German photovoltaics company centrotherm AG has presented some of these ideas under the heading “grid parity factory” and shown how the integrated production of ingots, cells and modules provides opportunities for saving energy and resources. These concepts focus on the integration of production under one roof. One the one hand, this saves in transport, packaging, and the margins of intermediate levels. Wear, aging and fracturing of materials can be reduced by direct processing. On the other hand, by optimization of the production process and recycling, the amount of water used, the process chemicals required, and the energy consumed can significantly be reduced. Hence, the larger the production plant, the easier – and more economic – its water recycling will become. Possible savings in water consumption could be up to 60 percent. In addition, the company M + W Zander has calculated that the scale benefits that these one-gigawatt plants offer for wafer manufacturing can reduce capital investments by 25 percent, while investments could be reduced even further in thin film manufacturing. However, the industrial manageability of solar factories of this size has not yet been satisfactorily established. Altogether, concepts of scaling and vertical integration have been very successful in comparable industries such as semiconductor or flat panel display production, and have significantly contributed to cost reduction. For these concepts to be applicable to photovoltaics, landmark projects for “Smart Integrated Solar Factories” are required that have a similarly high signalling effect and multiplicator function in order to facilitate and accelerate a similar wave of innovation in the photovoltaics sector.

With regard to utilizing potentials for material efficiency and resource conservation in the solar photovoltaic industry, trade associations are especially important. They are crucial to providing a platform for moderated, structured search procedures, and for exchanging experience and business results (best practice, benchmarking, etc.). In addition to those initiatives and associations of the solar industry already in place (Glottertal forum, EPIA, BSW), the German engineering federation VDMA offers an independent trade platform called “Means of production for photovoltaics” (Produktionsmittel für die Fotovoltaik) that draws on the results of the roadmap and uses it to develop strategies for further resource efficiency challenges. For the automation technology sector, the German association of electrical and electronics industries ZVEI was brought on board. This kind of cooperation results in opportunities for more effective exchange relationships that go far beyond strictly business-oriented market signals and technology forecasts and help identifying opportunities and risks.

3 Roadmap Workplace Computing Solutions 2020: Development of a Lead Market for Green Office Computing

3.1 Initial Situation

In our contemporary information and knowledge-based society, information and communication technology (ICT) forms the technical base and as a dynamic field of innovation, significantly contributes to economic development. ICT can make an important contribution to saving natural resources in various economic and social contexts, for example through intelligent control of power grids and buildings, or through facilitating telephone and video conferences. However, environmental relief potential aside, the production of ICT equipment (personal computers, laptops, televisions, etc.) and infrastructure (data centers, mobile networks, etc.) and of course their use is generally associated with high energy and resource consumption rates that have in the past been rising steadily. For example, the ICT-generated power consumption in Germany has risen from about 38 TWh in 2001 to approximately 55 TWh in 2007 (Cremer et al. 2003), currently representing approximately 10.5 percent of the total power consumption in Germany. The strongest growth is being recorded in the infrastructure segment, i.e. servers, data centers, mobile and telephone networks. Even so, at present consumer devices still account for the greatest part of ICT-related power consumption. The approximately 26.5 million desktop computers currently in use in German business, government, and educational institutions (schools and universities) make up the largest fraction of this with an annual consumption of about 6.5 TWh (Fichter / Clausen / Hintemann 2010, P. 10) – more electricity than two medium coal power plants produce in a year. Currently, the inventory consists of 50 percent PCs, 41 percent notebooks, 8 percent “Thin Clients” and 1 percent “Mini” or “Compact PCs”, a new generation of computers that has only been available on the market just over two years (Ibid., p. 17). In terms of energy and material consumption, notebooks, Thin Client and server-based computering as well as Mini-PCs perform a lot better than PCs. While an average office PC requires 698 kWh of primary energy per year (not including the monitor), notebooks, Mini PCs and Thin Clients (including server share) need only around half of that. Averaged over the different types of devices, the average workplace computer has a primary energy consumption of currently around 500 kWh. As the following table shows, the amounts of materials used in different devices also reveal a similar picture. Given the growing importance of the service sector, the increasing computerization of industries with little computer equipment so far (trades and crafts, for instance), as well as the national policy of improving computer access in schools and universities, current forecasts estimate that the number of workplace computers will increase to around 37 million devices in 2020 (Fichter, Clausen, Hintemann 2010, p. 18). Despite all improvements in energy efficiency, the ongoing high use of computers means that the total energy consumed by desktop computers in Germany is likely to continue to grow in the years to come. Using more devices from energy-saving device groups like notebooks, thin clients and mini-PCs – their performance generally being quite sufficient for regular office applications – could significantly contribute to saving energy and material. Therefore, the objective should be the advancement of sustainable structural changes to workplace-related computer solutions in Germany till 2020 and the development of a lead market for "Green Office Computing".

Tab. 2: Different Types of Workplace Computers in Comparison

	Workplace Computers in Germany 2010				
	PC	Mini PC	Notebook	Thin Client	Total
Terminal Devices					
Number of Devices	13.000.000	300.000	11.000.000	2.200.000	26.500.000
Furnishing structure, in percent	49,1	1,1	41,5	8,3	100,0
Energy Consumption					
Annual Energy Consumption per Device (without monitor etc.) p.a. (in kWh)	201	74	65	43	
Cumulative Energy Demand (CED) of Devices (in kWh)	549	202	177	117	
Production Energy (CED) for Devices (in kWh)	584	285[2]	340	141	
Service life (in years)	5	5	4	8	
Production and Operation Energy (CED) per Device p.a. (in kWh)	666	259	262	135	
Total Cumulative Energy Demand (CED) divided by Use of central IT resources per Workplace Computer p.a. (in kWh)	32	32	32	249	
Production and Operation Energy (CED) per Workplace Computer p.a. (in kWh)	698	291	294	384	499
Materials Used					
Total Weight in kg	8	2	2,4	1,5	
Pro-Rata Weight of Terminal Server (25 kg) per Workplace Computer (in kg)[3]	0,07	0,07	0,07	0,55	
Weight of Device and Terminal Server shares per Workplace (in kg)[4]	8,07	2,07	2,47	2,05	5,18
Environmental Effects					
Greenhouse Gas Potentials through Energy Consumption in CO2-equivalent p.a. per Workplace Computer (in kg)	122,9	49,4	44,1	75,4	85,4

Source: Calculation and compilation of data by the Borderstep Institute, 2010.

2 For the calculation of the Cumulative Energy Demand (CED) of Mini PCs, corresponding data was used from notebooks without Monitor, as notebook parts are generally used in Mini PCs.

3 As a Terminal Server serves several workplaces, the weight is allotted proportionately.

4 This refers to the weight of the devices needed for one single workplace. Not only does this include the weight of the end devices, but the proportionate weight of the terminal server utilized as well.

3.2 The Dialogue Process

Based on the Borderstep Institute's initial scientific analysis from 2008, and the resource savings potentials for ICT and for workplace computing in particular determined therein, the area "Thin Client & Server Based Computing" (TC & SBC) was chosen as the primary field of examination for the roadmapping process, in agreement with the funding authorities, the Federal Environment Ministry and the Federal Environment Agency UBA. In order to continuously incorporate different perspectives and interests surrounding the value chain of workplace-related IT solutions into the roadmapping project and involve those stakeholders crucial to subsequent implementation of the roadmap at an early stage, a control group was set up that met every two months from September 2008 to September 2010. This steering committee has supported and professionally accompanied the Borderstep Institute's analytical work. Additionally, the steering committee designed and adopted the roadmap. Members of the roadmapping control group were:

- IT manufacturers and software producers: Fujitsu Technology Solutions, Igel Technology, Sun Microsystems Inc., Citrix Systems
- System houses and IT consultants: Accentrix IT Consulting, Computacenter
- IT users: Finanz Informatik (Financial Computer Science), the German savings bank Sparkasse's IT service provider, and Federal Environment Agency UBA
- Associations: German Federal Association of Information Technology, Telecommunication and New Media BITKOM
- Science: Borderstep Institute, Fraunhofer Umsicht
- Monitoring: UBA

The two-year roadmapping process consisted of the following steps:

- Ecological evaluation of different workplace computing solutions
- Selection and analysis of the industries and sectors relevant to the development of resource efficiency in office computing
- Analysis of the selected priority sectors (small service providers, federal authorities, schools, home offices)
- Case studies and identification of best-practice applications of resource-efficient workplace computing (TC & SBC, etc.)
- User surveys, including all federal agencies and a number of system houses and retailers, regarding the constraints in using TC & SBC
- Technological, market-based and social trend analysis
- Realization of four Delphi surveys for the evaluation of future trends
- Developing the business-as-usual scenario "Workplace computing solutions 2020"

- Developing the "Resource-efficient workplace computing solutions 2020" roadmap, adopted by the steering committee in July 2010
- Deriving a Green IT scenario based on the roadmap, and determining the resource saving potentials outlined in the roadmap
- Editing the results for publication (Roadmap, best practice, etc.), and organizing transfer workshops.

3.3 Results and Outlook

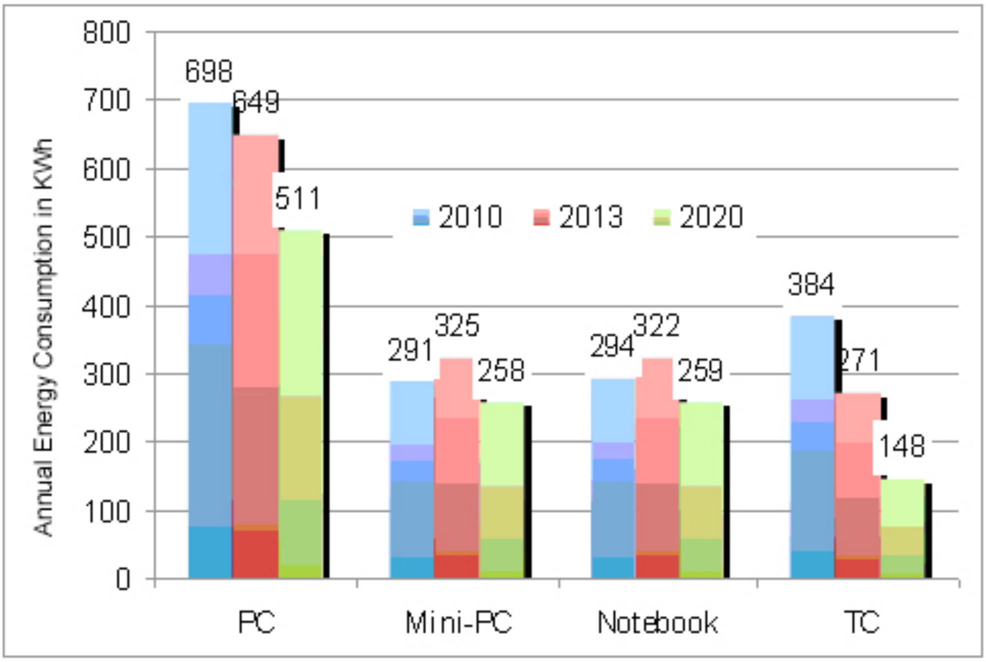
Based on the analysis carried out as part of the roadmapping process (trends and existing obstacles for the implementation of energy and material-efficient computing solutions like TC & SBC, case studies on best practice applications, etc.), and on the Delphi surveys, the roadmap "Workplace computer solutions 2020" was first developed using the basic "business as usual" scenario (BAU scenario). In this basic scenario, current trends are continued and extrapolated (increasing energy efficiency of devices, growing number of mobile devices, etc.), thus representing the future impacts of an undisturbed "business as usual". The BAU scenario also shows where there is most need for action in future in order to tap material efficiency and resource savings potentials in workplace computing. This was the foundation for determining the objectives of the roadmap and for articulating concrete measures for resource saving potentials to be realized. The "Green IT" scenario developed subsequently picks up the measures from the roadmap and shows what happens when it has been completely implemented. So the difference between the "BAU" scenario and the "Green IT" scenario is that, in the latter, the roadmap has already been implemented.

In both scenarios, the number of computer workstations has been equalized, but the additional energy and material efficiency measures from the roadmap account for the differences in the "Green IT" model, i.e. shifting ratios of computer device groups (more TC & SBC, compact PCs, etc. in comparison to regular desktop PCs), an accelerated improvement of energy and material efficiency, as well as a greater life expectancy of equipment.

Selected results of the BAU scenario

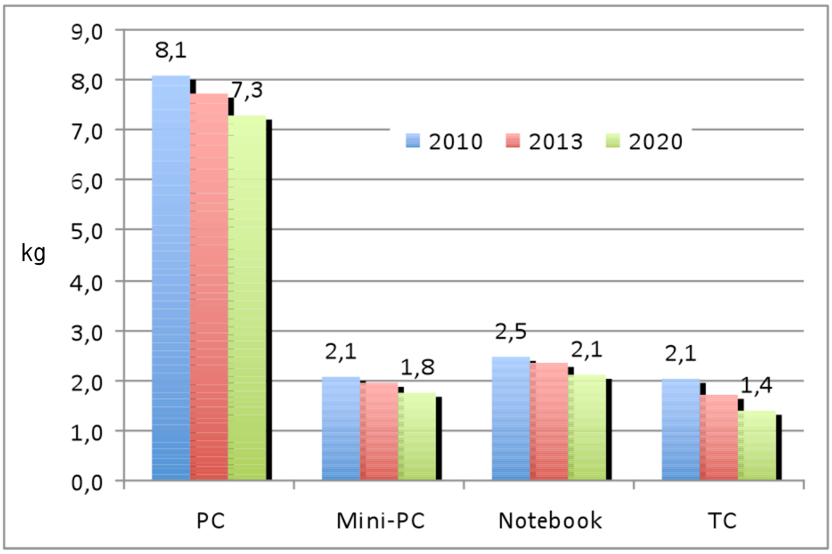
As the two following charts show, despite substantial increases in the efficiency of desktop computers, Mini PCs, notebook and TC& SBC will still have distinct advantages regarding energy and material consumption in future. The figures also show that as of today, Mini PCs, notebooks, and thin clients (including their terminal server shares) are more or less equally resource-efficient. But Thin Client & Server-based Computing will play the lead role from no later than 2013 onwards from an ecological point of view. The reason is that when using Thin Clients, the application software runs exclusively on terminal servers, and the efficiency of servers, data centres and required software is increasing much faster than that of end devices.

Fig. 4: Development of Annual Energy Consumption per Workplace Computer in kWh in Germany (including production and terminal server share, not including monitor) in the BAU Scenario



Source: Calculation by the authors, Fichter/Clausen/Hintemann (2010).

Fig. 5: Development of Material Use per Workplace Computer in kg in Germany (including terminal server share, not including monitor) in the BAU Scenario



Source: Calculation by the authors, Fichter/Clausen/Hintemann (2010).

Advantages of Thin Client & Server-Based Computing

As the BAU scenario illustrates, a resource-saving strategy for desktop computers mainly needs to address two points: Firstly, the respective devices need to become distinctly more energy- and material-efficient, and secondly, "structural changes" regarding the types of devices used are necessary. The desktop PC as an "allrounder" will still be important in the future for some individual applications; for the largest part of office and desktop applications however, Mini PCs, notebooks, and especially Thin Client & Server-Based Computing will clearly be better alternatives from an ecological point of view.[5] Apart from energy efficiency, TC & SBC has other benefits as well, such as reduced administration, greater security, and lower total costs of ownership.

Obstacles regarding Thin Client & Server-Based Computing

Against this background, the question is why TC & SBC is that slow to spread. This is primarily due to the fact that the transition from a desktop PC to a server-based computing system constitutes a fundamental shift in IT, with major impacts on work flow and the workplace in general. The significance of such a system change already indicates that it may be connected with a variety of barriers. That being said, there are also numerous prejudices about server-based computing, originating mostly from experiences with the first generation of Thin Clients, but influencing the formation of opinions even today. As the case analysis and barrier analysis within the roadmapping project have shown, the following obstacles regarding the use of TC & SBC play an important role:

In many cases, decision-makers in business, administration and organizations are not well informed. This is not only due to the fact that the information provided by manufacturers and suppliers of TC & SBC leaves room for improvement, but also because the marketing for traditional PC solutions often promotes prejudices towards TC & SBC. The amount of misinformation with decision makers regarding possible cost reduction effects is particularly crucial.

5 Clear environmental benefits can be found throughout the entire product life cycle, in energy consumption, avoidance of pollutants and the use of material (weight) in the end product. As extensive research within the roadmapping project has shown, the available data regarding the (cumulative) raw material use throughout the product life cycle of computer terminals and servers is fragmentary at best. There is a notable lack of detailed and scientifically sound data about electronics components, the consumption of raw materials in the manufacturing process, and the younger generation of devices such as Mini PCs in particular. Assessing the resources used in the devices examined with the indicator "Cumulative raw material Usage" would have been desirable, because it is undoubtedly more meaningful to examine than material weight and material composition in terms of prioritizing prospective ecological benefits. However, due to the lack reliable data this could not be accomplished. Therefore the idea was dropped, in consultation with the Federal Environment Agency UBA expert panel, so the analysis concentrates on identifying the material weight of end devices (weight in kg) and their respective composition (proportion of electronic components, metal, plastic and power supplies, in kg). The Roadmapping project has revealed some considerable research needs with respect to (cumulative) raw material usage.

The complexity of a TC & SBC project is often perceived as high, leading to a certain degree of uncertainty with the responsible staff. Also, in many larger organizations and authorities, IT management responsibilities are split up into central IT maintenance (data centers, key central services, etc.) and decentralized IT tasks (responsibility for end devices, applications for individual departments, etc.). This further complicates the implementation of integrated TC & SBC solutions, since there are issues of losing responsibilities and decision-making power.

TC & SBC is also associated with a number of changes to the workplace itself. Employees usually do not know anything of the benefits or downsides beforehand. Hence, there is also a certain degree of resistance to the implementation of TC & SBC on the part of the employees themselves. Probably the most widespread bias against TC & SBC is that graphics and media services are estimated as poor. The reason for this is that the first generation of Thin Clients in parts indeed did not have sound cards, making them unsuitable for applications such as language teaching in schools for example, even though there is excellent and widespread software on offer for exactly these purposes.

But for specialist software with low sales figures in particular, terminal server-capable applications are still largely missing. So many companies, including scientific users, cannot make the transit to server-based computing just yet. These kinds of barriers may be overcome by so-called "Desktop Virtualization" in future.

However, the interplay of terminal, terminal server and network infrastructure that TC & SBC requires not only challenges and sometimes overburdens many users, but system houses that are not yet that familiar or often lack knowledge, experience and qualified personnel for TC & SBC as well. This significantly increases decision-makers' uncertainty on the corporate side, as they often rely on long-standing, stable and good relations to their system houses. Mostly they want to perform important and risky system changes with a partner who knows their business well. So ultimately, it is the expertise of system houses that presents one of the main obstacles.

Roadmap "Workplace computing solutions 2020" - Development of a lead market for Green Office Computing

The aim of the roadmap is the advancement of sustainable structural change for work-related computer solutions in Germany by 2020. With the roadmap, a leading market for "Green Office Computing" shall be developed, contributing to the following economic and environmental goals:

1. Increasing the fraction of energy- and material-efficient desktop computer solutions from 50 percent today to 60 percent in 2013 and 85 percent in 2020.[6]
2. Reducing the cumulated energy demands (CED) of workplace computers in Germany from 500 kWh per year today (including production and terminal server shares, but not including the monitors) to 400 kWh by 2013 and 200 kWh by 2020.
3. Reducing the average product weight per workplace computer (including server share) from 5.2 kg today (without monitor) by 20 percent by 2013 and at least 50 percent by 2020.

The 39 practical measures listed in the roadmap are intended to achieve those objectives. The implementation of the roadmap by 2020 would lead to savings of 29.4 TWh of primary energy, which translates to savings in electricity costs of around 2.75 billion Euros, a reduction of carbon dioxide emissions of 5.5 million tonnes, and savings of around 245,000 tonnes of material. Furthermore, with the implementation of the roadmap, the rapidly growing market for "green" future technologies can successfully be developed, and Germany can be positioned as a Green IT pioneer in the international competition environment.

The wide range of measures and the resources necessary to implement them make it clear that the implementation of the roadmap can only be accomplished in a concerted action of ICT producers and users, politics and science. Therefore, the formation of a "Green Office Computing" initiative in the form of a public-private partnership has been proposed for the execution of the roadmap. As a network of partners that advances and promotes resource-efficient computing solutions in business, government and education institutions, the initiative serves as an institutional platform devoted to the development of strategic partnerships and the coordination of measures to be implemented from the roadmap. The initiative should be supported by the federal governments, ICT services and users (Council of IT officers, the German CIO Colloquium, etc.), industry associations such as BITKOM, and scientific institutions.

[6] „Energy- and material efficient" computing solutions are understood here as devices that use at least 20 percent less energy, or are at least 20 percent lighter in total, than an average workplace computer in the year 2010.

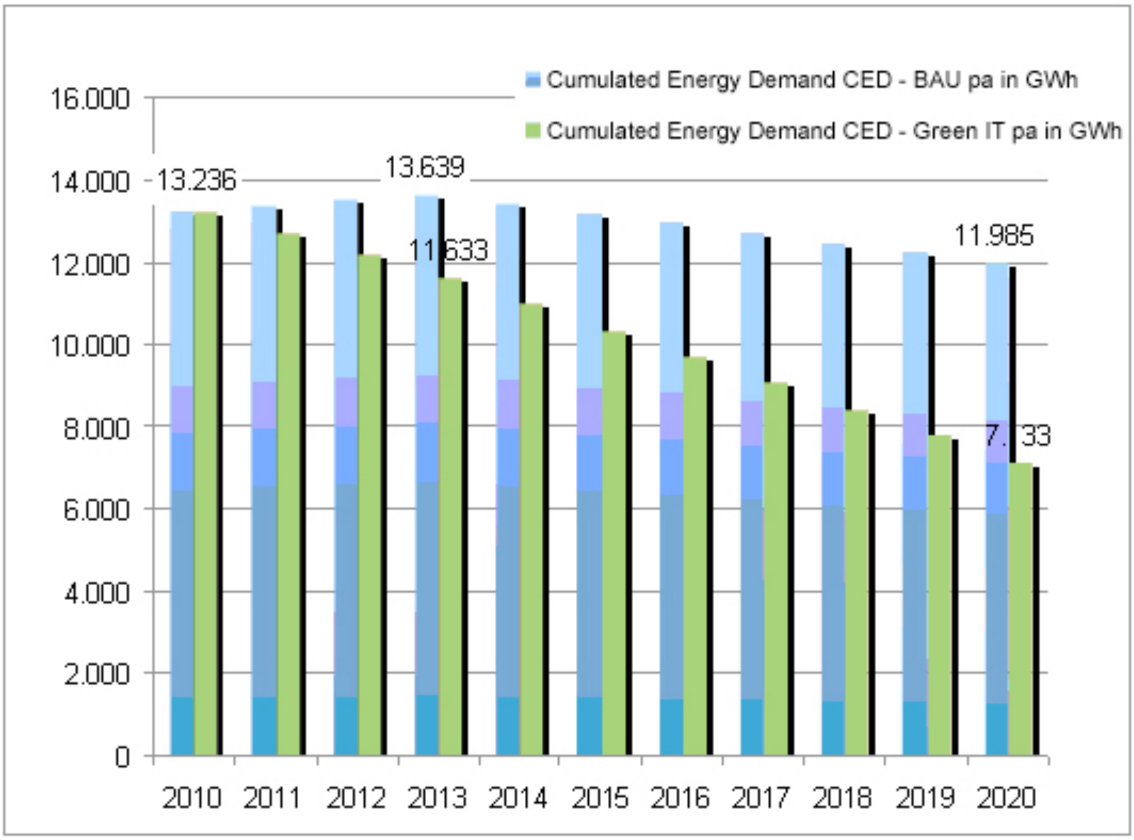
Tab. 3: Selected Measures from the Roadmap "Workplace Computer Solutions 2020"

Roadmapping Measures	**Timetable**
"Green Office Computing" Initiative	
Founding of a "Green Office Computing" Initiative as a Public-Private Partnership	Foundation 2010 - 2011, Continuation 2011 - 2020
"Green Office Computing" Information Campaign	
Best-Practice Information Packs for different target groups (SME, administration, etc.)	2010 - 2012; Regular Updates
"Green Office Computing" Information Campaign in cooperation with business media (Target group: Senior management, not IT specialists)	Main phase: 2010 - 2013, Continuation 2014 - 2020
"Green Office Computing" Information Campaign in cooperation with IT specialist media (Target group: IT decision-makers and experts in enterprises)	2010 - 2013
"Green IT Truck" for local presentation of innovative Green IT solutions	2012 - 2015
Showroom "Green Office Computing" in Berlin	From 2012
Beacon Projects "Thin Client & Green Cloud Computing"	
Beacon Project **–** Small service providers, Medical Practices, Crafts, etc.	2011 – 2015
Beacon Project **–** Engineering Jobs	2011 – 2015
Beacon Project – Estate Housing	2011 – 2015
Business Models	
Development of Software as a Service (SaaS) and Desktop as a Service Applications; attractive Margins for System Houses; Hardware and Service Bundles (similar to mobile phone flat rates); offers for private households and small companies on a monthly basis; Thin Client-compatible software licensing (and possibly data licensing, e.g. e-books)	2010 – 2015
Education and Qualification	
Information and training for system houses and resellers: "Future Market Green Office Computing"	2010 - 2011 planning, 2011 - 2013 implementation
Including TC&SBC and Green Computing in higher education curricula (Computer Science, etc.)	Pilot project 2011– 2014, Transfer 2014 – 2020
Endowment Chairs "Server-based Computing" and "Green Office Home Computing"	Exploration 2011 – 2012, Appointments from 2013
Including TC&SBC and Green Computing in school education curricula (Computer Science lessons, etc.)	Pilot project 2011 – 2014, Transfer 2014 – 2020
Trade Unions, Staff Associations and HR	
Survey on effects and acceptance of server-based workplace computing	2011
Developing a model company agreement on server-based workplace computing, and dissemination of the survey's results	2011
Dialogues with trade unions, technology consultants, staff associations and councils	From 2012
Technology Development and Standards	
R&D for increasing energy and material efficiency of Thin Clients	From 2010
High-performance servers and high-performance bandwidth for engineering and graphics users	From 2011
Development of software solutions for increasing the client per server ratio in server-based computing and SaaS	From 2011
Facilitating the diffusion of Mini PCs	From 2010
Measures to increase the average energy efficiency (PUE or power usage-effectiveness) of data centre infrastructure in Germany from 1.9 (present) to 1.6 in 2013 and 1.3 in 2020	From 2010
The Government as a patron and IT user	
"Green Office Computing" as part of the German goverment's ICT Strategy, as well as integration into the government's Green IT action plan	2010
Innovation Alliance "Energy-Saving Application Software"	Realization: 2012 - 2015
Adaptation of directives and framework agreements in public procurement	2010 - 2012
Establishing an eco-label ("Blauer Engel") for Thin Clients and Mini PCs	2011 - 2012
"Green Office Computing" as a funding priority in the BMU project "IT goes green"	2010 - 2020

Savings Potentials through Implementation of the Roadmap: Green IT Scenario

The Green IT scenario differs from the BAU scenario in that it assumes that the roadmap measures presented above have already been implemented.[7] The effect of the roadmap is therefore immediately represented in the difference between the BAU scenario and the Green IT scenario. Not all of the effects of the roadmap can be quantified, so only those actions were taken into account whose impact could be plausibly estimated on the grounds of expert judgments and workshops. The implementation of the roadmap is represented in the "Green IT" scenario and would lead to the following effects:

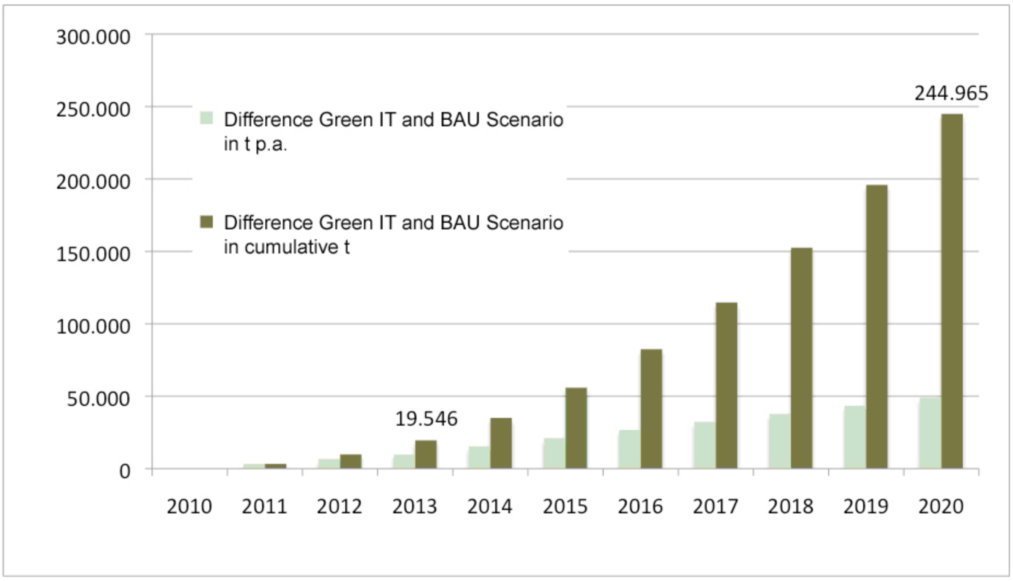
Fig. 6: BAU and Green IT Scenario in Comparison: Energy Consumption of Workplace Computers in Germany (including production and terminal server share, not including monitor)



Source: Calculations by the authors, Fichter/Clausen/Hintemann (2010).

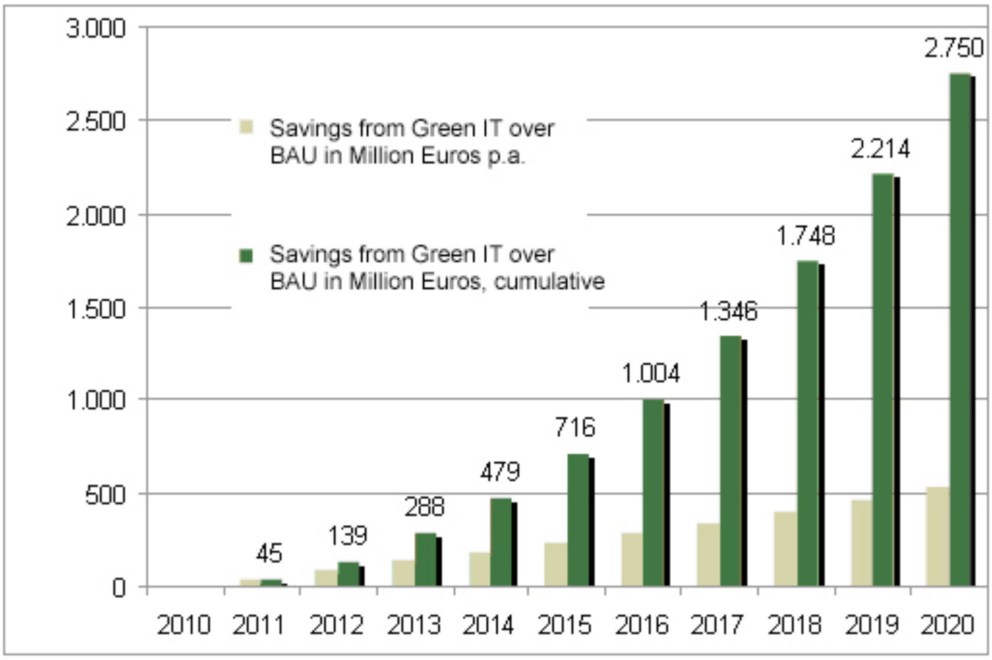
7 While a "Scenario" refers to the situation at a specific time in the future (e.g., for the year 2020), the "Roadmap" shows the path of development towards that point.

Fig. 7: Material Savings[8] in Workplace Computers in Germany (including terminal server share, not including monitor) through the Implementation of the Roadmap (Green IT Scenario)



Source: Borderstep Institut 2010.

Fig. 8: Power Costs Saved[9] in Operation of Workplace Computers in Germany through the Implementation of the Roadmap (Green IT Scenario, Source: Calculations by the authors, Fichter/Clausen/Hintemann, 2010)



8 Here, only the weight reduction of the end devices was considered. If the associated shifts in usage of materials and raw materials throughout the product life cycle had been considered additionally, the figures would be much higher.

9 Calculations of future power costs were based on average electricity costs of 0,18 € per kWh for commercial customers in 2010 and an increase of prices of 5 percent p.a..

4 Lessons learnt: What can cooperative Roadmapping accomplish?

Co-operative roadmapping can achieve the following:

- *Long-term perspective*: Early identification of opportunities and risks (e.g. raw material shortages in photovoltaics, environmental and economic opportunities for the development of a lead market for Green Office Computing).
- *Assessment of potentials*: Identifying material efficiency and resource conservation potentials (e.g., through increased use of “lean” devices like Thin Clients in workplace computing, or in photovoltaics, adaptations in manufacturing and recovery of PV products)
- *Accelerating and facilitating the dissemination of existing efficient technologies*: Better understanding of existing obstacles preventing the implementation of resource-efficient future solutions (e.g. replacement of IT systems), and clarifying how to best tap material efficiency and resource conservation potentials in the short, medium and long term (e.g. in the production of photovoltaic products).
- *Integration of different stakeholder perspectives*: Resource efficiency from the point of view of different protagonists involved. In the photovoltaics field (e.g., photovoltaics industry, mechanical engineering and plant engineering, automation technologies, recycling companies and related business and trade associations), this is achieved for instance by determining how new production concepts in mechanical and plant engineering or automation technology can support the development of efficiency within the value chain. In the workplace computing field, this applies to groups like IT manufacturers, software vendors, system houses, IT users (e.g., SMEs, large companies, government agencies or schools), and scientific institutions.
- *Innovation Timetable*: Development of concrete measures for material efficiency and resource conservation potentials (as presented in the Roadmap “Workplace Computer Solutions 2020”) with specific objectives, milestones and responsibilities.
- *Supporting and establishing the “Ecological Industrial Policy” of the German Federal Environment Ministry*, particularly the initiative for material and energy efficiency and the development of future “green markets” through industry-oriented roadmapping procedures.
- *Identifying technology requirements, standardization needs and areas requiring further research*: Qualification requirements, user demands and other conditions for developing relevant future resource efficiency markets.
- *Combining skills and knowledge*: The roadmapping process bundles specific know-how from research institutions, companies, associations and social forces, something that cannot be achieved by individual firms, SMEs in particular, alone.

Participants are given access to interdisciplinary knowledge and professional know-how.

- *Involvement of business associations*: Sensitization, activation and integration of pertinent industries and professional associations into a platform for the development of coordinated innovation roadmaps for resource efficiency, as potential disseminators for the transfer of results into companies’ innovation management (pilot scheme).
- *Market opportunities*: Identifying opportunities and strategies to create and expand markets for efficient technologies, as well as identifying pilot projects for German companies in key future markets for efficiency technologies.
- *Innovation incentives for companies*: Impulses for linking the roadmap with operational activities in innovation policy and management for the development of resource efficiency potentials.

The experience from the roadmapping projects can also be transferred to other areas of technology and used as an essential element of innovation-oriented environmental policy. For future use of the cooperative roadmapping method, there are however a number of important aspects to be noted to help design the process efficiently and activate high resource savings potentials:

- Involving independent, market- and technology-neutral process moderators with technical expertise and methodological skills
- Selecting areas of examination with high potential for resource savings and “hidden” opportunities (e.g., cross-sectional technologies)
- A certain extent of political will within government ministries and authorities to follow the roadmap in cooperation with industry and science
- Government representatives actively involved in the process of drafting the roadmap
- Involving committed industry experts and senior decision-makers
- Expanding technological perspectives, user and operator integration
- Generating knowledge from different perspectives (e.g., with the Delphi method)
- Not suppressing possible side effects and risks (e.g., rebound effects)
- Involving social stakeholders
- Target group-geared and active transfer of results
- Securing continuity, for example by institutionalizing alliances.

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6 Glossary

ATO: Antimony-Tin Oxide

CdTe: Cadmium telluride is one of several semiconductor materials that are used to produce thin film photovoltaics modules.

CIGS: Solar Cells based on Copper indium gallium selenide

CIS: Copper indium selenide

c-Si: Monocrystalline solar cells

Dendritic Processing (mc-Si): Dendritic growth is a form of crystal production based on precise knowledge of crystal growth mechanisms for controlling micro-structure and defects of the crystal.

Electromagnetic Processing: Silicon is melted by a magnetic field produced by induction coils. The electromagnetic forces keep the material in the heart of the reactor, so that a crucible is no longer required, and the inclusion of oxygen is mostly largely avoided.

EoL: End-of-life Recycling

Fluidized bed Reactors: E.g., for Silicon Production.

Free-Space Reactor: This technology allows the production of silicon powder out of monosilane. Impurities in the silicon resulting from contact with the walls of the reactor can be avoided with this method.

Ingots: Blocks of semiconductor material such as silicon. The growth of larger Ingots can potentially increase throughput and reduce specific energy consumption.

ITO: Indium-Tin Oxide

Kerf Loss: There is high saving potential associated with minimizing kerf loss, material wasted by saw cuts.

Lift-off process: A microstructuring procedure using adhesive layers that are washed out later on.

Magnetic CZ Process: With the magnetic Czochralski process, oxygen can be kept away from the silicon when growing crystals.

MG-Si: Metallurgical grade silicon,

MJC: Multi-Junction Cells

PECVD Process: Plasma-Enhanced Chemical Vapor Deposition

Poly-Si: Poly- or Multicrystalline Cells (mc-Si)

Slurry: A slurry made of fluid glycol or oil and silicon carbide is used to separate bars of silicon with wire saw technology.

SoG-Si: Solar grade silicon.

TCO: Transparent conductive oxide.

UMG–Si: Upgraded metallurgical grade silicon.

Vapor-to-Liquid Deposition: Similiar to the Siemens process, except in that the tubular reactor precipitates silicon as fluid using induction heating.

Material Efficiency & Resource Conservation

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Wuppertal Institute for Climate, Environment and Energy

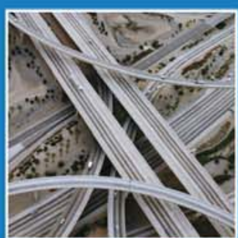
Communicating the Idea of Resource Efficiency: Success Factors and Approaches

Executive Summary

Summary report of Task 13 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project





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and Nuclear Safety

Umwelt
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For our Environment

Communicating the Idea of Resource Efficiency: Success Factors and Approaches

Executive Summary

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1 Communicating the Idea of Resource Efficiency: Success Factors and Approaches – the Nature of the Task

Underlying the development of a communications strategy is a single vision: in five to ten years’ time actors in industry, politics and society will have the principle of using resources efficiently so firmly anchored in their minds that it will automatically guide their behaviour. There are, after all, a number of pertinent facts pressuring people to change the way they use resources: A growing world population and steady economic advancement, particularly in the threshold countries and most especially in the populous states of China and India, is leading to a sharp increase in global resource consumption. The major economic, ecological, social and security implications of this trend make the efficient use of resources an economic, ecological and social imperative that has already been translated into policy. These facts in themselves already offer a number of central messages and ideas that could provide part of the input for a successful communications strategy.

As we know, however, objective arguments are not always what motivates people to act in pursuit of a common goal; nor are they necessarily sufficient to change existing modes of production and consumption habits among people whose interests and views not only differ but in some cases are diametrically opposed. This is where a long-term, systematic communications strategy with clearly defined goals comes in. The first task of such a strategy will be to identify central target groups, to define tactical elements and to establish the roles that lobbying and public relations will play. It will also seek to win the commitment of other like-minded groups and to find out where the interests of different target groups overlap as a basis for further communications work.

The goal of Task 13 was therefore to use the key competencies and realms of practical experience at the participating institutions – the Wuppertal Institute (education, communication of scientific concepts, policy concepts), the Institute for Consumer Journalism (mass media), the advertising agency GoYa! (concepts and brand marketing for sustainability and environmental communication) and MediaCompany (theme branding, PR concepts) as well as the comments offered by Lucia Reisch from the SRH University of Applied Sciences Calw (sustainability communication) – to sound out the potential for communicating the idea of resource efficiency in the most successful way possible. Step 13.1 was devoted to an “Analysis of the Success Factors for Communicating the Idea of Resource Efficiency”. Step 13.2 evolved “Concepts for How to Market the Idea Successfully”. These comprised a two-pronged communications strategy aimed at particular target groups. Specifically it:

- developed a campaign and PR concept as far as the commissioning stage
- formulated policy approaches for communicating resource efficiency in education

Educational pilot projects implemented in Step 13.2 as part of the Innovation Campus devoted to resource-efficient design included a seminar on sustainable households and a summer school devoted to resource efficiency-oriented industrial design. It was explicitly stated that realising the communications concept beyond the pilot phase was not part of the remit of Task 13.

The findings of Step 13.1 “Analysis of the Success Factors for Communicating the Idea of Resource Efficiency” can be found in Resource Efficiency Paper 13.1 (Liedtke / Kristof / Parlow / Fasel / Reinermann / Austermann / Reisch / Baum / Albrecht 2009). The concepts for target-group-specific communications strategies developed by Step13.2 were presented to the state secretary of the Federal Ministry of the Environment on 20 April and 8 July 2009. The PowerPoint transparencies used for this presentation are documented in Resource Efficiency Paper 13.2 (on education; Kristof / Liedtke 2009) and in Resource Efficiency Paper 13.3 (on campaign & PR strategy; Albrecht / Baum 2009). The seminar on resource-efficient design Nachhaltige Haushalte/Sustainable Households was held in the winter semester of 2008/09 at the Folkwang University in cooperation with the Department of Industrial Design. The 1st Sustainable Summer School: design walks_value through less” took place from 27 September to 4 October 2009 at the Nikolauskloster in Jüchen. The findings of the summer school were summarised in a brochure produced in cooperation with the participating design departments (Resource Efficiency Paper 13.4; Wolf / Liedtke 2010). All the findings of Task 13 and the other MaRess tasks can be downloaded at:
http://ressourcen.wupperinst.org.

Task 12 “Consumer- and Client-Focused Approaches to Increasing Resource Efficiency” formulated schemes for getting consumers to use resources more efficiently in their daily lives (Kristof / Süßbauer 2009). These could serve as a basis for the communications strategy developed in Step 13.2.

2 Analysis of the Success Factors for Communicating the Idea of Resource Efficiency

Increasing resource efficiency will require a broad social “resource movement” with a vision of a new resource-efficient way of living and running the economy that strives to make this the new status quo. But how should one go about translating the idea of resource efficiency – for many people a rather abstract concept – into a fundamental premise for behaviour at all levels of society? How can the idea of resource efficiency be successfully communicated? To whom should a communications campaign be addressed? And what instruments should it use? With these questions in mind Step 13.1 analysed the relevant theoretical perspectives, looking for suitable communications instruments and evaluating selected public information campaigns in terms of their potential success and impact (Liedtke / Kristof / Parlow / Fasel / Reinermann / Austermann / Reisch / Baum / Albrecht 2009). It identified the following as key factors for a successful communications strategy:

A successful communications campaign must attract attention and heighten awareness by highlighting the causes of and possible solutions to the efficiency problem – ideally via an emotionally charged or entertaining communications strategy. Most crucially it should communicate the direct benefits to the consumer of resource efficiency, portray alternative forms of behaviour convincingly and convey its message in an attractive, emotionally appealing and positively entertaining form. The message should be directly relevant to everyday life and as simple as possible. It should challenge generally accepted notions of what constitutes normal or desirable behaviour by presenting conventional lifestyles and modes of production as outdated, while resource-efficient lifestyles and modes of production are depicted as modern.

This strategy would serve to legitimise and enhance the status of desirable alternative modes of behaviour at a *theoretical* level. The message is: resource efficiency is not only imperative but represents a modern, intelligent new standard, while resource *in*-efficiency is out-of-date and passé. Showing attractive groups or well-known personalities already engaging in resource-efficient behaviour would enhance the status of such behaviour at a practical level and set new standards. Such groups should be clearly identifiable as belonging to the social mainstream, while using household names to exemplify resource-efficient behaviour would endow the campaign with authenticity, charisma and credibility, thus encouraging the individual to follow their example. By taking personalities with whom the public can identify, the campaign would convey a sense of togetherness, making those it targets feel part of a community that acts in accordance with reality-based standards.

Clear and simple messages that avoid any possibility of confusion are the most effective recipe for winning people over. Moreover, a successful public information campaign must always operate at an emotional level, playing on people’s sense of humour, pride, fears and hopes, or alternatively using the element of surprise to get its message across. Visual clarity, reduction to the essentials and clever ideas are other important ingredients. Branding in the form of a logo or symbol running through the whole campaign creates a basis for recognition and is a good way of conveying a sense of a common goal and a shared acceptance or interpretation of the issue. A single slogan may come to stand for a whole set of emotions, convey a vision and provide a sense of purpose.

A communications strategy also creates a new interpretative frame of reference for re-evaluating the costs and benefits of conventional versus new, more desirable forms of behaviour. Before it can become socially institutionalised, however, this new frame of reference must be communicated many times (repetition factor) using a variety of instruments. A campaign that peters out after a short time will not succeed in establishing a new standard and will fail to achieve the desired results. For this reason any campaign of this kind requires strategic planning based on an integrated communications concept that ensures optimal timing, a co-ordinated use of the individual instruments, and an effective build-up of tension and intensity.

As has been shown, successful campaigns usually focus their communications concepts on strategically relevant target groups with strong synergy and multiplier potential. Bearing this in mind, a resource efficiency campaign should initially focus on three target groups, each of which offers considerable potential for disseminating resource-efficient thinking and behaviour:

- People who are open to change (for example, because they are at a turning point in their lives) and whom it is possible to target in completely new ways via new communications media like chat rooms, blogs and web 2.0 platforms such as studiVZ and Facebook – in other words, teenagers and young adults and other Internet communities. People undergoing positive life changes (whether embarking on a new stage of education, starting work, starting a family or moving in together with a partner) are those who will shape tomorrow and are therefore likely to be potential innovators with respect to resource efficiency in the medium to long term. They can be easily reached via interactive and dynamic formats (such as web 2.0 platforms, edutainment formats, guerrilla and viral marketing and popular messengers). At the request of the funding authority the concept was tailored to students as its target group.
- Politically and socially influential actors (above all key policy-makers in the private sector and in research and education, communications-oriented multipliers such as media representatives and editorial boards, or content-oriented multipliers such as trade unions, trade associations and NGOs). All of these people have ample opportunity to act and exert influence in ways that will ensure resource efficiency a permanent place on the social agenda. The best instruments for reaching this target group are those that are serious, credible and professional and have a broad exposure (e.g., conferences and congresses, trade fairs, the print media and billboards).
- People engaged in education and training (e.g., company trainers for the target group trainees and professors for the target group students) whose positions allow them to spread the resource-efficiency message to a large target group and help this group acquire the skills to put it into practice. Instruments that communicate seriousness and credibility are likewise the best ones for reaching this group.

Fundamentally, the main communications routines and channels of the respective target groups provide the best indication of which instruments are likely to be most suitable. Based on the user preferences of the target groups, instruments should be chosen that will have as broad an impact as possible. Sometimes the best effect is achieved by using a mixture of different instruments tailored to the respective target group and using them to bring the issue of resource efficiency to public attention over a long period of time in constantly changing contexts. This implies a co-ordinated communications concept that uses the different instruments in an integrative way with respect to both timing and presentation.

To do this the campaign must have a clear mission (with respect to content, finance, structure, advertising strategies etc.) and a clear organisational structure – whereby professionalism and effectiveness should be the guiding principles. A small powerful coordination team that manages to interact effectively with multiplier groups will succeeded in arousing a great deal of attention among the target groups. The campaign could therefore also be organised as a network. This would enable swift, on-the-spot responses and promotional events as well as a high degree of flexibility and mobility. Alongside permanent networking, professional PR work would also be required.

Gaining the support of various strategic partners (e.g. foundations, networks etc.) would also enhance the campaign. Media partnerships are of special significance here since they offer opportunities for a regular presence in several different formats, including a number of radio and television stations alongside the print media. These should be in a position to address the respective target groups and enjoy broad public acceptance.

3 Concepts for Successful Marketing

3.1 The Starting Point for Developing the Concepts

Taking into account the findings of Step 13.1, the campaign concepts and PR strategy as well as the educational instruments must aim to:

- inform decision-makers and motivate them to act
- reach social groups at decisive turning points in their lives
- establish resource efficiency as a theme in education

In view of funding limits to the campaign, PR strategy and educational measures must assume a leverage effect and focus their efforts. This can be done by combining certain target groups and instruments in effective ways, since the impact that different instruments of communication have on different actors varies. Tab. 1 gives an overview of strategies that can be used to good effect and which could provide a basis for developing a campaign, PR strategy and educational measures.

Tab. 1: Target Groups & Appropriate Communication Instruments

Communication Instruments			
Target groups	**Campaign**	**PR strategy**	**Education**
Decision-makers			
Politicians		✔	
Media representatives	✔	✔	
Social multipliers		✔	
Education system			
Company trainers			✔
Professors			✔
People and systems in the process of change			
Teenagers/young adults	✔		✔
Internet communities	✔		

Source: Wuppertal Institute

Resource Efficiency Paper 12.1 (Kristof / Süßbauer 2009), which deals with behavioural options for private households (including working from home), offers substantial additional material.

3.2 Campaign & PR Concept

The campaign and the PR concept are built on three **impact phases for initiating social movements** as presented in Tab. 2. These phases correspond with three central ideas derived from Step 13.1: the first concerns the attitudes and behaviour of people who can be addressed only on an emotional level. The idea of resource efficiency tends to be a rather dry, sometimes abstract and “heavy” issue, which relies on arousing curiosity to communicate its message effectively. Simply conveying information is not a very promising approach. The second phase addresses individual behaviour and hence the individual sphere of influence. The third is about conveying the idea that individual behaviour may bring benefits of various kinds. For this reason the campaign relies on strategies that activate and inspire selected target groups and trigger certain emotions.

Tab. 2: Impact Phases for the Campaign and PR Concept

Impact phase	Goals
Impact phase 1	Arouse curiosity and interest
Impact phase 2	Create understanding and awareness
Impact phase 3	Generate attitudes and commitment
	Initiate a social movement

Source: Wuppertal Institute

The campaign and the PR strategy **target the following groups**:

- students (ca. 1.8 million) as a direct target group and
- as indirect target groups:
  - policy-makers in the private sector and in research and education
  - multipliers and opinion leaders – above all the media, educational institutions, management consultants as well as environmental and one-world associations/one-world NGOs, trade unions, consumers' associations.

The **campaign design** consists of four elements: the slogan, the logo, the visual elements and the tonality of the advertising. The campaign slogan conveys the central message with every contact achieved and has an activating and motivating impact. A good campaign slogan must be self-contained, memorable and programmatic, and it must also sound good. The campaign logo stands for a clear message, gives the campaign an instantly recognisable and unmistakable identity and also communicates emotions. Logos consisting of images and words usually have a more powerful impact than image-only or word-only logos, because they are easier to remember. A good logo must be self-contained and memorable; it must also be eye-catching and of high graphic quality. Like the slogan the logo must also be programmatic. The visuals must offer a look and feel that communicates emotions at both a conscious and a subconscious level, and which conjure up images in the mind and trigger positive associations with resource efficiency. The tonality must be tailored to the target group students – in other words, it must be cool, amusing, original and entertaining.

The **campaign is divided into two phases**. The first will target selected universities and serve as a kind of “warm-up” phase. It entails positioning the theme of resource efficiency and the promotional events among the students, arousing curiosity and interest and recruiting multipliers – above all, the media. During the second phase the campaign will be extended to all universities and expanded in scope. This phase would serve to acquaint a broader public with the issue, to generate attitudes and commitment, to encourage and support local campaign activities, to establish a media presence and media partnerships, to activate a support base, to broaden the information and dialogue opportunities offered by a website, to intensify advertising activities and PR, to establish a firm bond with target groups (e.g., through competitions) and to give the issue greater prominence in the political sphere (e.g. conferences, resource efficiency report).

During the **first phase** a poster and advertising campaign will be launched in universities with more than 20,000 students and an Internet presence and brochures offering more detailed information will be developed. The initial steps and concrete measures in the first phase are:

- Important basic ideas for presenting the communications campaign:
    - Present the issue of resource efficiency in terms of the weight of the total resources consumed using images or metaphors such as the “ecological rucksack”.
    - The advertising material itself should be reusable or multi-purpose material. In order to make the idea of saving resources practical and credible, the campaign should aim to be resource efficient per se. Setting an example by using advertising material in a sparing and conservational manner already represents a message and an attitude in itself. Where possible, instead of producing new advertising material such as posters, leaflets/flyers, postcards etc. existing advertising material should be used (e.g., by printing over existing material), The main message: “This method of communication represents resource efficiency in practice” should cause people to reflect and think about what they do.
- Select pilot universities. Acquire co-operation partners and stage pilot learning events (e.g. a pilot summer school/Innovation Campus for resource-saving product design; see Chapter 4).
- Prepare press material to introduce and accompany the campaign. Prepare press information from the Federal Ministry of the Environment for the campaign launch, offer interviews at ministerial level, provide carefully formulated press releases on the subject of resource efficiency for student media and web platforms (including Unicum, studiVZ and university newspapers).

- Prepare campaign media: Develop and launch an Internet presence; design and produce motifs for posters, newspaper advertisements and promotional postcards. Design and produce information brochures and flyers.
- The **second phase** will comprise a broad cinema, poster and newspaper advertising campaign plus indoor and outdoor promotional events and online presentations for all universities.

The second phase will comprise the following main measures:

- Important basic ideas for a communications presence:
  - Targeted and broad-ranging VIP poster campaigns at universities. These would use well-known personalities to draw more attention to the issue and to set an example, thus familiarising the public with the campaign and enhancing its image. The style of the campaign should be eye-catching and involving, its tonality “loud”, disconcerting and emotional. The key features of the concept are: the use of well-known faces to draw a lot of attention to the message, the disconcerting effect of larger-than-life images of objects, dramatised scenarios that make people curious to visit the campaign website to see the resolution and a catchy and personalised headline format such as “Why Cindy’s lipstick weighs more than you think!”. This type of presentation would give the campaign a human face.
  - Further develop the basic idea of resource-saving advertising material: e.g. use page corner ads combined with graphic highlighting of words in newspaper or magazine texts in target-group media (e.g. student magazines like Unicum and Neon or university newspapers) or fill towel dispensers in universities and student pubs with towels carrying information about resource conservation. The tonality of such information would vary.
  - Design and stage promotional events: indoor events (e.g. a sign slalom race, an on-campus art park or a poetry slam) or outdoor events (e.g. flash mobs that might take place as follows: the flash mob is announced in advance via e-mail distribution lists to universities, groups on studiVZ and via MySpace, Facebook and YouTube. On the day the flash mob is to take place the students meet at a prearranged time and place. They each tuck a newspaper under their arm and walk around the venue. At an agreed time they all suddenly stand still and begin to read the newspaper. After a certain time, as if responding to a signal, they lay the newspaper on the ground and run off in all directions. The newspapers now serve as flyers and are picked up by other students.)
  - Online: Service and update the website, adding more detailed information. Enhance activity on web 2.0 platforms (e.g. sponsored groups).
- Intensify PR work:
  - Enhance the prominence of resource efficiency as an issue in the political sphere (e.g. conferences, resource efficiency report).

- Offer research grants for young journalists. To obtain such grants journalists would be required to submit concepts for how they intend to treat the subject of resource efficiency in journalism. A specialist jury would award grants in the categories print media, radio, television and online media.
- Invite journalists to presentations of new resource-efficient products and processes at companies or research institutions. These presentations would include examples of best practice and personal success stories of people who have managed to implement good ideas
- Offer material to editorial departments that tells stories and creates images in people’s heads in order to facilitate journalistic work: provide film footage, produce features for television and radio, create information graphics and photos for print and online media.
- Build up media partnerships (specialist and general media).
- Stage Innovation Campuses and hold competitions (e.g. the “Design for resource-efficient products” competition staged by university design departments, the poster competition “Resource efficiency at home” or the competition for the best video spot promoting greater resource efficiency). Competitions could also be staged in cooperation with companies.

More concrete proposals for campaigns and PR strategies can be found in Albrecht / Baum (2009).

3.3 Educational Policy Approaches

Another way of strengthening resource competency is via educational policy. This consists of two components: basic knowledge and the skill to put that knowledge into practice, which also includes the ability to understand systems. The goal here is to enable people to translate knowledge into action, thus providing visible evidence of successful learning.

Many people contribute to the educational process. The policy proposals aim to reach the following actors: teachers at general and vocational schools, professors at relevant universities, company staff responsible for training, actors involved in teacher training and intermediary institutions that provide educational materials.

The target group of this educational strategy is mainly the 15–30 age group – i.e., school pupils, apprentices and trainees, students and people embarking on careers. This group was chosen in order to reach the decision-makers of tomorrow and to broadly increase resource competence.

Tab. 3 gives an overview of the strategies proposed for imparting basic knowledge, the instruments selected for this purpose and the goals to be achieved. Concrete proposals for the educational strategy can be found in Kristof / Liedtke (2009).

Tab. 3: An Overview of Education Policy Approaches for Resource Efficiency

Basic strategies and instruments	Goals
Impart basic knowledge	➠ **Convey resource competence**
• Internet platform teaching/learning materials for resource efficiency	➠ Ensure fast and simple access
• Study seminars	➠ Teacher training
Stage educational events	➠ **Experiment with resource efficiency**
• Innovation Campus	➠ Develop resource-efficient products/services
• Jugend forscht/Jugend gründet (Young Researchers/Young Entrepreneurs competitions)	➠ Develop innovation skills
Consolidate excellence	➠ **Strengthen resource efficiency in universities**
• Virtual resources university	➠ Network university departments
• Integrated/dual courses of study	➠ Coordinate teaching activities and open them up to new target groups

Source: Wuppertal Institute

Impart Basic Knowledge

The goal of the **Internet platform** (e.g. www.ressourceneffizienz-wissen.de) would be to provide structured teaching and learning materials on the subject of resource efficiency throughout Germany. This would make educational material readily available for teachers and vocational trainers and also for adult education programmes.

Seminars could be staged on a national scale to train teachers to teach the subject of resource efficiency. One approach would be to develop courses and training courses for the seminars to familiarise future teachers with the subject. Another would be to get future teachers – guided by their trainers – to produce their own teaching/learning materials on resource efficiency as part of their practical training. These could then be shared via an Internet platform thus utilising synergy effects.

Stage Educational Events

Students and professionals working in the field of design and product development could attend one- to six-week interdisciplinary workshops or summer schools on an innovation campus where they would develop innovative product service solutions/systems. During such activities university faculty would provide teaching input for both students and practitioners. The trans-disciplinary approach would also give them opportunities to further qualify themselves by exchanging ideas with design practitioners. Chapter 4 presents the pilot projects carried out in the framework of Task 13.

Schools pupils aged fourteen and above could develop resource efficiency innovations within the framework of special events like **Jugend forscht/Jugend gründet** (Young

Researchers/Young Entrepreneurs). To help these teenagers and young adults acquire the requisite level of knowledge quickly and effectively, both school teachers and universities and institutions active in innovation and research transfer in the field of resource efficiency could act as mentors.

Consolidate Excellence

The goal would be to build up a university network comprising university departments already engaged in resource efficiency research (including energy and energy efficiency) whose task would be to conduct interdisciplinary research into strategies for raising resource efficiency, to develop joint research projects and to apply for funding. Our vision is to create a **”virtual resources university”** that would use synergy effects to strengthen research and teaching in the area of resource efficiency**.** This would require both a network concept and joint projects to put this into practice. Shared laboratory and project facilities and joint innovation workshops and innovation campus events would help to make this a cooperative effort that would promote exchange between researchers and broaden the study programmes and material on offer.

Another possibility might be **integrated and dual courses of study** that would forge closer links between in-company training and university education. This would require such courses to be part of an overall concept for studying geared towards lifelong learning and a flexible education system.

The educational policy approaches developed in Task 13 were also integrated in the policy mix of Task 4 “Innovative Resource Policy Approaches at the Micro-Level: Business-Oriented Instruments and Approaches” in the Step 4.2 detailed analysis paper “Efficiency Awareness and Performance” (Görlach / Schmidt 2010) and in the Step 4.2 milestone paper “Proposals for Resource Policy Measures in the Field of Business-oriented Instruments” (Liedtke / Kristof / Bienge / Geibler / Görlach / Knappe / Lemken / Meinel / Onischka / Schmidt / Zvezdov 2010).

4 Innovation Campus on Resource Efficiency-Oriented Industrial Design – the Pilot Projects

In two pilot projects formats were developed and tested with a view to developing a concept for an Innovation Campus on resource efficiency-oriented industrial design. One of these projects –“Sustainable Households / Nachhaltige Haushalte ”– was held parallel to general university teaching at the Folkwang University Essen in co-operation with the Department of Industrial Design during the winter semester of 2008/09. The other was the “1st Sustainable Summer School: design walks_value through less” staged by the University of Wuppertal and the Wuppertal Institute. Staged in autumn 2009 this built on the experience gathered during the sustainable households seminar as well as on other workshops and educational events organised by the participating partners. Four departments of design from Germany and Switzerland were involved in the summer school, which was attended by students from thirteen countries (Wolf / Liedtke 2010).

4.1 The Folkwang University – An Educational Event as an Pretest

In the winter of 2008/09 a preparatory seminar for the 1st Sustainable Summer School was staged at the Folkwang University led by Professor Anke Bernotat (Department of Industrial Design), Dr. Christa Liedtke and Dr. Jola Welfens (Wuppertal Institute). The subject of the seminar was sustainable households. Since the majority of the students came from Asia and Scandinavia the seminar was conducted mainly in English.

It began by giving the students a thorough grounding in the field of sustainable development and resource efficiency. Parallel to this the students chose topics for their design projects in the field of private consumption. Their first task here was to identify aspects of households that were very resource *in*efficient and that could be made more resource-efficient by means of eco-intelligent service and product design. The students then thoroughly researched the areas they had chosen (e.g., showering, cooking) and subsequently developed scenarios for at least three different development approaches. These were then evaluated in terms of their impact on sustainability and resource efficiency and, of course, whether they satisfied the consumer requirement. On this basis a scenario was chosen for the subsequent design study during which design solutions were developed and improved on in several phases of reflection and evaluation. A total of ten studies were conducted. Some of the most interesting examples were the resource-optimised use of food (Food Alarm), power socket strips, in-house information systems (Eco Racer – Conscious Consumption), resource-optimised showers (Green Romantic), a lift to transport shopping upstairs targeted at senior citizens and a resource-efficiency campaign for the university campus itself, which was implemented at Folkwang University. The results were presented at one of the major conferences of the Resource Efficiency Network (Task 10) and very positively received (www.netzwerk-ressourceneffizienz.de/to_join/netzwerkkonferenzen/vierte_konferenz: "Resource Efficiency as a Starting Point for Product Design – Concrete Findings from the Seminar at Folkwang University": Prof. Dr. Anke Bernotat / Swantje Krauß, Folkwang University). The resource efficiency campaign is aimed at students. Its goal is to raise their awareness of resource efficiency and to reach them via multiple media at a place where they spend a lot of time.

4.2 1st Sustainable Summer School: designwalks_value through less

In preparation for the 1st Sustainable Summer School the University of Wuppertal and the Wuppertal Institute approached a number of other departments of design, academies and other actors with respect to resource/eco-efficiency or sustainability. Together the following six institutions used their specific experience to develop the international profile of the 1st Sustainable Summer School: designwalks_value through less: the University of Wuppertal / Department of Industrial Design, Folkwang University Essen / Department of Industrial Design, Ecosign Academy for Design Cologne, UNEP CSCP Wuppertal and the Wuppertal Institute.

In the field of design it is usual to offer students the opportunity to attend international educational events of this kind during the summer break, so they attract a wide range of students. The vision of the participating partners is:

- to offer a top-quality educational programme in the field of sustainable and resource-efficient design
- to develop the image of Germany as an organiser and initiator in the field of sustainable and resource-efficient design
- to create a high-ranking network by giving the participating departments an international outlook
- to make it easier to implement resource-efficient design in practice by including private-sector sponsors

The 1st Sustainable Summer School was one of the first steps in this direction:

- Held in autumn 2009 the 1st Sustainable Summer School was attended by thirty-two students from thirteen countries – around half of whom had a bachelor’s or master’s degree.
- Alongside students’ fees the 1st Sustainable Summer School also received funding from private-sector sponsors.
- The 1st Sustainable Summer School received input via the active participation of practitioners from science and industry in an inter- and trans-disciplinary process.
- The first two days of the 1st Sustainable Summer School were spent attending an international conference on the subject of sustainable products and services. This enabled participants to build up networks with academics and practitioners and also to exhibit their own ideas for sustainable products and services.
- During the three days following the conference university lecturers and scientists who were engaged in research in the fields of resource efficiency and sustainability got together with the students to come up with preliminary concepts for more resource-efficient services (e.g. Slow Shopping, localfoodsfinder.de, car.munity, soop wareshare etc.) in the following four thematic workshops:
    - Rituals, habits and lifestyles
    - Lifestyle light
    - What if ... exploring alternative services
    - Luxury and sustainability

- After completing the summer school students were awarded a certificate which they could use to obtain study credits.
- The Internet platform www.designwalks.org was created as a work in progress.
- The summer school also managed to get departments of design abroad interested in participating.

4.3 Innovation Campus on Resource Efficiency-Oriented Industrial Design – Looking Ahead

In the final evaluation the students gave a very positive assessment of the 1st Sustainable Summer School and also developed their own network on Facebook. Both the 1st Sustainable Summer School concept and the results were documented in a brochure (Wolf / Liedtke 2010).

The Innovation Campus concept is currently being further developed. The goal is to actively involve further design departments from abroad in the process. A sponsorship and grants concept is also being developed with the aim of reaching potential sponsors, project funders and grant givers. In addition there are plans to use the homepage of the Sustainable Summer School as a platform for exchanging ideas. Formats suitable for this purpose currently being developed will also be accessible to interested companies and inventors, thus encouraging them to interact and exchange ideas (cf. the innovation agents and innovation laboratories approach in Task 4 “Innovative Approaches to Resource Policy at the Micro-Level: Business-Oriented Instruments and Starting Points”; Lemken / Meinel / Liedtke / Kristof 2010).

Work is also under way to implement and further develop the concepts students came up with at the1st Sustainable Summer School (e.g. Slow Shopping, CarMunity etc.). Both the advanced concepts and the next steps to be taken will be presented and further developed at future events (the next Sustainable Summer School, Design Management Forum, exhibitions etc.).

The 2nd Sustainable Summer School will take place from 29 August to 4 September 2010. The concept allocated more time to concept development with input from experts as well as a brief period of reflection each morning. The first day of the summer school was a Seniors Day to which high-calibre experts and external interested guests were invited to hold discussions.

5 Overview of the Products of Task 13 and Literature

Resource Efficiency Paper (Download under http://ressourcen.wupperinst.org)

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Kristof, Kora / Liedtke, Christa (2009): Erfolgreiche Kommunikation der Ressourceneffizienzidee: Bildungsstrategie; Auszug aus der Präsentation der Ergebnisse zu AS13.2 am 20.4.2009; Paper zu Arbeitspaket 13 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 13.2

Albrecht, Roland / Baum, Holger (2009): Erfolgreiche Kommunikation der Ressourceneffizienzidee: Kampagnen und PR-Strategie; Präsentation der Ergebnisse zur Kampagnenkonzeption und zur PR-Strategie aus AS13.2 am 8.7.2009; Paper zu Arbeitspaket 13 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 13.3

Wolf, Brigitte / Liedtke, Christa (Hg.) (2010): 1st Sustainable Summer School: designwalks_value through less; Wolf, Brigitte / Liedtke, Christa / Schmidt-Bleek, Friedrich / Radau, Michael / Lettenmeier, Michael / Bernotat, Anke / Gellersen, Nina / Draser, Bernd / Welfens, Maria Jolanta; Paper zu Arbeitspaket 13 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 13.4

Kristof, Kora / Liedtke, Christa (2010): Kommunikation der Ressourceneffizienz: Erfolgfaktoren und Ansätze; Kurzfassung der Ergebnisse des Arbeitspakets 13 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 13.5

Kristof, Kora / Liedtke, Christa (2010): Communication of the idea of resource efficiency: success factors and strategies; Executive Summary Task 13 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project, ResourceEfficiency Paper 13.6

Kristof, Kora / Liedtke, Christa (2010): Kommunikation der Ressourceneffizienz: Erfolgfaktoren und Ansätze; Endbericht des Arbeitspakets 13 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 13.7

Pilot projects

Sustainable Households / Nachhaltige Haushalte, Lehrveranstaltung Wintersemester 2008/09, Folkwang Hochschule Essen – Industrial Design, Prof. Anke Bernotat, Dr. Christa Liedtke, Dr. Jola Welfens

1st Sustainable Summer School 2009: designwalks_value through less, September 2009, Prof. Anke Bernotat (Folkwang Hochschule), Bernd Draser (Ecosign), Nina Gellersen (Hochschule Luzern), Michael Kuhndt (UNEP/WI CSCP), Dr. Christa Liedtke (Wuppertal Institut), Prof. Brigitte Wolf (Universität Wuppertal)

Input from other MaRess Tasks useful for Task 13:
Starting Points for Raising Resource Efficiency in Everyday Consumer Behaviour

Kristof, Kora / Süßbauer, Elisabeth (2009): Handlungsoptionen zur Steigerung der Ressourceneffizienz im Konsumalltag; Papier zu Arbeitspaket 12 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 12.2

Input from Task 13 used for other MaRess Tasks:
The Task 13 proposals for education policy and for the Innovation Campus were also included in the Task 4 Policy Mix “Innovative Approaches to Resource Policy at the Micro-Level: Business-Oriented Instruments and Starting Points”.

Liedtke, Christa / Kristof, Kora / Bienge, Katrin / Geibler, Justus von / Görlach, Stephanie / Knappe, Florian / Lemken, Thomas / Meinel, Ulrike / Onischka, Mathias / Schmidt, Mario / Zvezdov Dimitar (2010): Maßnahmenvorschläge zur Ressourcenpolitik im Bereich unternehmensnaher Instrumente; Meilensteinpaper zu Arbeitspaket 4 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 4.6

Görlach, Stephanie / Schmidt, Mario (2010): Maßnahmenvorschläge zur Ressourcenpolitik im Bereich unternehmensnaher Instrumente; Feinanalysepaper für den Bereich Public Efficiency Awareness & Performance zu Arbeitspaket 4 des Projektes „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 4.4

Lemken, Thomas / Meinel, Ulrike / Liedtke, Christa / Kristof, Kora (2010): Maßnahmenvorschläge zur Ressourcenpolitik im Bereich unternehmensnaher Instrumente; Feinanalysepaper für die Bereiche Innovation und Markteinführung zu Arbeitspaket 4 des Projekts „Materialeffizienz und Ressourcenschonung“ (MaRess), RessourceneffizienzPaper 4.5

Material Efficiency & Resource Conservation

Peter Hennicke / Kora Kristof / Thomas Götz

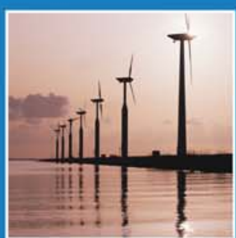
Wuppertal Institute for Climate, Environment and Energy

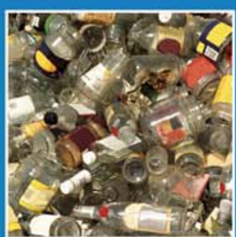
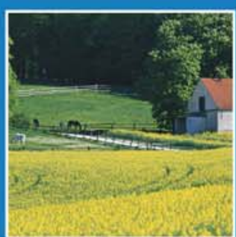
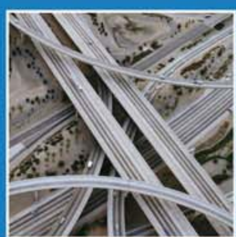
Summary of the Speeches and Discussions at the Major MaRess Conference on "Resource Efficiency – A Motor for Green Growth" on 5 October 2010 in Berlin

& Executive Summary

Summary report of the Major MaRess Conference on "Resource Efficiency – A Motor for Green Growth" (Task 8) within the framework of the „Material Efficiency and Resource Conservation" (MaRess) Project

ResourceEfficiency Paper 8.4

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"Material Efficiency and Resource Conservation" *(MaRess)* – Project on behalf of BMU I UBA

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"Material Efficiency and Resource Conservation" (MaRess)
you will find on **www.ressourcen.wupperinst.org**

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Umwelt Bundes Amt
For our Environment

Summary of the Speeches and Discussions at the Major MaRess Conference on "Resource Efficiency – A Motor for Green Growth" on 5 October 2010 in Berlin

Contents

Summary of the Speeches and Discussions at the Major MaRess Conference on "Resource Efficiency – A Motor for Green Growth" on 5 October 2010 in Berlin

1 Resource Efficiency: A Leading Policy Issue in Germany

Climate protection and anticipated long-term rises in energy prices have led to increasing public approval for measures to save energy and promote energy efficiency. A willingness in principle to use energy more efficiently can now be observed among all social groups. For many years the same could not be said, however, of the much broader issue of resource efficiency and resource conservation. Even today, many people are still unaware of the sometimes disastrous ecological and social consequences of extracting raw materials, while the effects of price developments are usually not felt directly by the general public. Even when the prices of raw materials soared to exorbitant levels prior to the global financial crisis, end users were not nearly as affected as they were by the price rises for petrol and heating oil that resulted from the increase in the price of oil. Resource efficiency was therefore an issue that for a long time received little public attention. This is now beginning to change.

For manufacturing industries the availability of raw materials (raw materials security) has always been a matter of considerable strategic importance. In many sectors – particularly hi-tech clusters (such as renewables, ICT, eMobility) – it was to be expected that the financial crisis would reduce global demand – and hence raw materials prices – only temporarily. And indeed, the prices of raw materials have now begun to rise again at a disproportionate rate – the price of non-ferrous metals, for instance, rose by approximately 25% between August 2009 and August 2010

It was against this background that the major conference on "Resource Efficiency – A Motor for Green Growth" took place in Berlin on 5 October 2010. The conference was attended by more than 400 participants.

The conference programme and the short input papers by the initiators of Forums I to V can be found in the appendix to the German version of this paper.

The following are brief summaries of the keynote speeches, the discussions in the five forums and the statements by Katherina Reiche (Parliamentary State Secretary in the Federal Environment Ministry) and Jochen Flasbarth (President of the Federal Environment Agency).

Four keynote speeches on "Green Growth – New Perspectives for the Twenty-First Century" looked at the issue from a number of different perspectives.

1.1 Dr. Norbert Röttgen, Federal Minister of the Environment

For Federal Environment Minister Röttgen resource efficiency is not just “a motor for an ecological modernisation and growth policy” but also a matter of responsibility to future generations; in order to preserve the basis for life, growth in quality of life must be decoupled from consumption of natural resources. Minister Röttgen made it abundantly clear that up till now economic growth and prosperity have been based on the unsustainable use of finite resources. Not only the earth’s resources but also the ability of the atmosphere to absorb gases that have an effect on climate are reaching their limits, he said. For this reason resource conservation and climate protection are two inseparable issues.

The growth concept of the twentieth century no longer offers any perspective for the twenty-first century. A transformation to methods of producing and consuming that preserve natural resources is now essential. At the centre of this “new intelligent growth principle,” he said, were technological innovations that were being developed in global competition and seeking to establish themselves in a world undergoing geostrategic shifts, yet at the same time they needed to be embedded in a process of global cultural change in the direction of more sustainable forms of consumption, which meant not so much doing without a new quality of growth and prosperity but rather redefining it as “growth in quality of life”.

No other country in the world, he added, was in such a globally competitive position to increase resource efficiency as Germany. This would, however, require breaking with the habit of “excessive short-sightedness”, which had brought the world to the brink of disaster during the financial and economic crisis and instead adopting a long-term strategy to raise resource efficiency. In keeping with this view Minister Röttgen proclaimed the government’s intention to make Germany “the most resource-efficient country in the world” and to make the issue of resource efficiency alongside energy policy “one of the main issues of this legislative term”.

1.2 Karl Falkenberg, Director-General of Environment at the European Commission

Karl Falkenberg, Director-General of Environment at the European Commission, likewise emphasized: “There can be no global sustainability without resource efficiency”. He expressed the EU’s view that a set of indicators was needed to record progress in resource efficiency as well as the internalisation of external costs in prices. In addition, he identified two special challenges for the EU: firstly, overcoming the differential in resource efficiency within Europe (the United Kingdom is seventeen times more resource efficient than Bulgaria, for example) and, secondly, securing access to strategically important raw materials (e.g. rare earths) via free trade links.

1.3 Prof. Dr. Meinhard Miegel

While concurring with the policy of raising resource efficiency Prof. Miegel's speech "Prosperity without Growth: How We Can Live Better" skilfully made the point that it would not be sufficient to rely solely on increasing efficiency, because this would always be more than compensated for by what he termed growth and luxury effects. Moreover, it had become apparent that "only much lower growth than we allow ourselves" would be viable for the future. Therefore it was the job of policy-makers to communicate more clearly where "accelerated growth" was permissible (e.g., in immaterial services in the social sector and in education and culture), and also which areas must be "slowed down" because they are not viable for the future.

1.4 Dr. Werner Schnappauf, President of the Federation of German Industries

Dr. Schnappauf, President of the Federation of German Industries, spoke on the subject of "Resources and Green Growth: The New Point of Orientation for Industry". Referring to the theory of "long waves" or long economic cycles expounded by the Russian economist Nikolai Kondratiev, he said resource efficiency may have the potential to trigger a new "Kondratiev cycle". He emphasized, however, that green growth – the accelerated expansion of wind energy, for instance – would actually require products from sectors of the old economy, like the steel industry, and from new high-tech industries. A low-carbon society wishing to expand renewables and increase energy efficiency would be heavily reliant on innovations from the manufacturing industries. He criticised the state for being a "lousy commodity buyer" with respect to resource efficiency and concurred with the MaRess assessment that state procurement should set an example in raising resource efficiency.

2 Podium Discussion

In the following podium discussion between the keynote speakers the question of limits and the possibility of a new "green quality" of growth were once again taken up and policy-makers were urged to take a much more differentiated approach to the growth issue.

3 Forums

In the five forums held in the afternoon the results of the project "Material Efficiency and Resource Conservation" (MaRess) were presented in detail and commented on by representatives from science, politics and the economy as well as being discussed with conference participants.

3.1 Forum I: "Core Strategies: How Can Resource Efficiency Policy Successfully Promote Green Growth?"

- Prof. Dr. Peter Hennicke/Dr. Kora Kristof, Wuppertal Institute (moderation & input)
- Katherina Reiche, Parliamentary State Secretary in the Federal Ministry of the Environment
- Werner Ressing, Head of the Department of Industry Policy at the Federal Ministry of Economics and Technology (BMWi)
- Wilfried Kraus, Deputy Director of the Department of Sustainability, Climate, and Energy at the Federal Ministry of Education and Research (BMBF)
- Jörg-Andreas Krüger, Deputy Director of the German Nature Protection Society (NABU)

In Forum I the six core strategies developed in the MaRess project (see Input paper to Forum I in the appendix to the German version of this paper or the English summary of Task 7 – AP7 – of the MaRess project) for the promotion of green growth were presented and commented on by representatives of the relevant departments of the BMU, BMWi and BMBF and by a representative of NABU. In order to make it easier for policy-makers to scale up (and bundle) the large number of activities already running, the comprehensive Policy Mix developed by the MaRess project in three Tasks (concerning framework conditions and enterprise- and consumer-related instruments) focused on priorities, target groups and budgetary impact in core strategies. The project leaders, Dr. Kora Kristof and Prof. Dr. Peter Hennicke, outlined how the proposed core strategies could be financed (total annual volume of financing required: ca. EUR 1.3 billion) via revenues obtained by introducing a tax on natural construction materials or via a restructuring of programmes already running. The model calculations carried out under the auspices of the MaRess project (see Forum III) showed that an integrated resource and climate protection programme could have a positive impact.

Katherina Reiche, Parliamentary State Secretary in the Federal Ministry of the Environment, stressed that policy-makers were prepared to actively assume the task of shaping a resource efficiency policy. Frau Reiche stated that particularly for a country like Germany with few natural resources of its own, running the economy in a resource-efficient way was imperative. The federal government would therefore launch a national resource-efficiency programme. In the words of Frau Reiche: "Many efforts are already being made to tap the great potential identified for increasing resource efficiency. These should be brought together in a national resource efficiency programme proposed by the government for next autumn (the European Commission Drive for a Thematic Strategy for Resource Efficiency). This plan should specifically include ways to achieve a sustainable raw materials policy, raising resource efficiency in production and consumption, a strengthening of recycling management and generally a greater R&D effort and greater attempts to increase public awareness".

The BMWi and BMBF representatives said the two ministries were currently examining the programmes running in the fields of sustainability, climate and energy to see how the issue of resource efficiency had already been successfully integrated into research activities and industry policy.

The spokesman for NABU emphasised that natural resources policy should be given a great deal more attention and that additional quantifiable targets were required in order to increase awareness and encourage action at all levels.

3.2 Forum II "Future Markets for Green Growth: Where Is the Greatest Potential for Increasing Resource Efficiency?"

- Holger Rohn, Trifolium/Nico Pastewski, FhG-IAO (moderation & input)
- Prof. Dr. Ulrich Buller, Senior Vice President Research Planning, Legal Affairs for the Fraunhofer Society
- Prof. Dr.-Ing. Heinz Voggenreiter, Association of German Engineers, Materials Engineering, Director of the DLR Institute of Structures and Design and Material Research and Chairman of the Advisory Board of the Centre for Resource Efficiency and Climate Protection
- Wolfgang Rhode, Member of the Board of the trade union IG Metall

The results of Forum II can be summarised in seven points:

- Increasing resource efficiency requires a focus on central fields of action. Seven such principal fields of action were expounded in Task 1 of the MaRess project and must now be pursued and implemented.
- Potential analyses must also be carried out for other sectors and other issues. As a basis for this the data basis should be harmonised and improved and suitable standards established.
- Research on resource efficiency needs to assume an important role in scientific and research institutions so as to make progress on this issue. The requisite research funding for research projects on production and consumption must be better focussed and budgets made available.
- In practice resource efficiency considerations must be put on a par with economic viability and functionality when developing and producing products and services. The goal of increasing resource efficiency can only be achieved if this principle is applied consistently along the entire value chain, including consumption.
- Resource efficiency must be made an obligatory component of training programmes, in particular for technicians and engineers as soon as possible. To achieve further progress in resource efficiency in practice will require specialists; one example would be to train special "resource efficiency angels" to carry out resource efficiency analyses.

- Resource efficiency must be made an issue in companies. Companies must recognise the importance of resource efficiency as a **strategic** issue so that they can take appropriate action. Only in this way can resource efficiency potential be tapped that goes beyond one-off solutions. (Putting resource efficiency on the corporate agenda would also have an impact on employees and Works Councils, which could use their professional competence to influence processes and promote resource efficiency.)
- From the perspective of technology particular attention should be focused on the following:
  - Goods with a long life
  - Materials savings
  - Recycling
  - Energy efficiency

3.3 Forum III "Resource Efficiency: What Are the Goals and What Impact Do the Policies Have?"

- Dr. Stefan Bringezu, Wuppertal Institut/Prof. Dr. Bernd Meyer, GWS (moderation & input)
- Dr. Peter Viebahn, Wuppertal Institute
- Klaus Brunsmeier, Vice President of BUND (Friends of the Earth Germany)
- Dr. Harry Lehmann, Division Director Federal Environment Agency

Owing to the illness of Harry Lehmann and the fact that Stefan Bringezu was unable to attend the conference, Forum III produced only three inputs:

- Professor Meyer presented the results of the simulation calculations performed using the economic-environmental model PANTA RHEI of the GWS. The main points were:
  A committed climate policy combined with a policy for increasing material efficiency could achieve a complete decoupling of economic growth and resource consumption with a positive impact on GDP and a clear absolute reduction in resource consumption. The goal of doubling resource productivity in the next twenty years is achievable. An information and consultation programme to harvest the "low hanging fruit" (i.e. reach the easier targets) would be very effective in the medium term. In the long term resource-saving technical advances must be realised: in Germany the particular importance of metals means that recycling is an important option (also for building materials). Economic instruments are important because they create the right incentives in all sectors of the economy. Negative side effects can be avoided through compensation.

- Peter Viebahn reported on simulation calculations with the bottom-up model of the Wuppertal Institute and made the following recommendations for policy-makers: Implement the energy saving and efficiency strategies laid out in the BMU's 2008 reference scenario and confirmed in MaRess scenarios. Use industrial policy initiatives to avoid production of fluorinated hydrocarbons (particularly in the production of insulation materials) and evaluate other building materials and alternatives from a resources perspective. Launch research policy initiatives to develop a standardised environmental life-cycle accounting approach with up-to-date and reviewed data (where appropriate in conjunction with the German Life Cycle Data Network) and to evaluate the scaling up of renewables from the perspective of resources and land requirements as well as a trade-off analysis. Integrate resource criteria in measures to promote energy saving or climate protection.
- In a brief speech Mr Brunsmeier (BUND) commented on environmental policy over the past ten years and called on the government to shoulder more responsibility. In particular he called for environmental targets to be pursued more systematically according to an annual timetable and not just for a distant future.

Approval for these statements was expressed in the ensuing discussion, which focused on the lecture given by Professor Meyer and specifically the strength of the rebound effect and its significance for an absolute reduction in resource consumption and CO_2 emissions. Discussion participants also asked to what extent international competition had been taken into account in the simulations.

3.4 Forum IV "Routes to Successful Implementation: The Success of the Network"

Resource efficiency and the current roadmapping process

- Dr. Siegfried Behrendt, Institute for Future Studies and Technology Evaluation (IZT)/Prof. Dr. Klaus Fichter, Borderstep Institute (moderation & input)
- Reinhard Kaiser, BMU, Deputy Head of the Resource Efficiency Department
- Dr. Peter Jahns, Director of the NRW Efficiency Agency/Resource Efficiency Network
- Dr. Eric Maiser, German Engineering Federation (VDMA) Director of the Forum Means of Production in Photovoltaics
- Jürgen Graf, Federal Association of Information Management, Telecommunication and New Media (BITKOM) Working Group Thin Client & Server-Based Computing
- Ralf Baron, Director Arthur D. Little GmbH and a member of the MaRess Advisory Committee

Mr Kaiser (BMU) stressed that in the Resource Efficiency Network regional conferences also had an important role to play alongside national conferences as a way of reaching enterprises and other actors locally. In addition sector-related dialogues, as for example in the metal industry, were of central significance in the Resource Efficiency Network, as indeed were roadmapping projects of the kind implemented under the auspices of MaRess for the fields of photovoltaics and work station computers.

Dr. Behrendt (IZT) presented the roadmap “Resource-Efficient Photovoltaics 2020+” developed under the auspices of Task 9 (AP9) of the MaRess project. This showed the high ecological and economic potential that still exists in the value chain, especially in the production and recycling of PV products, and how it could be tapped in practice. The roadmap formulates concrete measures and milestones for tapping this potential.

Dr. Maser (VDMA) emphasised the major role played by mechanical engineering in the manufacture of photovoltaics products and expressed his great satisfaction with the results of the roadmapping project in which the VDMA and many companies from the photovoltaics value chain participated. He said this project had led to the formulation of clear machinery requirements that would need to be taken into account in the future. He also pointed out that the VDMA had already taken some concrete steps towards implementing the roadmap “Resource-Efficient Photovoltaics 2020+” and that the effects were already beginning to be felt.

Prof. Fichter (Borderstep) presented the roadmap “Resource-Efficient Work Station Computer Solutions 2020”, likewise developed under the auspices of Task 9 (AP9) of the MaRess project together with BITKOM, IT providers and users, research institutes and the Federal Environment Agency. The great potential for saving energy, materials and costs should be tapped via the thirty-nine measures contained in the roadmap, he said, adding that a central next step for implementing the roadmap would be the founding of a “Green Office Computing” initiative.

In his speech Dr. Jahns (NRW Efficiency Agency) highlighted the importance of addressing companies at the regional level. Alongside information tailored to the target group and motivating best practice examples, he said, good advice was important particularly in small and medium-sized enterprises (SMEs) for tapping existing resource efficiency potential. A central task was therefore to build up powerful networks of consultants in the regions. Here there were still some “blank spots” in certain regions of Germany.

In his commentary Mr Baron (ADL) described the MaRess roadmapping projects and the method of cooperative roadmapping as a very important “mechanism” for jointly tapping resource efficiency potential. He said he was impressed by the results and said the long-term perspective, the identification of obstacles that needed to be overcome and the concrete measures conceived for the roadmaps were a particularly valuable contribution.

The subsequent discussion addressed a number of important aspects concerning tapping resource efficiency potential, particularly with respect to SMEs. These included addressing SMEs at the regional level, the role of “intermediaries” (e.g., efficiency agencies, efficiency consultants) and securing continuous support.

3.5 Forum V "Resource Efficiency and Critical Metals: Shortages in a Few Years Time? Challenges and Policy Responses"

- Prof. Dr. Raimund Bleischwitz, Wuppertal Institute/Dr. Klaus Jacob, Free University Berlin (moderation & input)
- Prof. Dr. Armin Reller, Chair of Resources Strategy at the University of Augsburg
- Dr. Michael Angrick, Department Head, Federal Environment Agency
- Dr. Benjamin Bongardt, Consultant for Environment Policy at NABU

Certain critical metals of great importance for future technologies (including information and communications technologies, renewable energy technologies) are likely to be in short supply in the medium term. Rising or highly volatile prices have been recorded, even for metals with plentiful reserves. The environmental impact of critical metals along the value chain is enormous. Too little is known about the eco-toxicological impact of critical metals, which have only been dispersed into the biosphere in the past few years or decades via man-induced or dissipative use. So far there are no generally recognised criteria for what constitutes a critical metal and no generally recognised list of critical metals. In this context, critical means either in short supply or environmentally risky.

Using a policy mix resource policy can help both to alleviate shortages in the supply of critical metals and to limit their environmental impact while at the same time encouraging the ecological modernisation of the economy. Suitable instruments for a resource policy include obligations to provide information about material flows, dynamic production standards to raise the proportion of recyclable components in a given product, taxation of raw materials use and international agreements based in private law for better recycling (Metals Covenant). Critical metals is an area where there is a particularly wide gulf between the geographical and temporal positive effects (high-tech products sold on the market in industrialised countries) and the negative consequences (polluting the environment in developing countries through the extraction of raw materials and depositing electronic waste). This is one of the special challenges that resource policy instruments face. In the case of metals and minerals, which have global value chains and externalities, a resources policy that focuses only on domestic use or domestic efficiency potential is decidedly too short-sighted.

Resources policy has yet to become part of the day-to-day political agenda. One way to change this would be to optimise existing instruments – e.g. in waste disposal law. New instruments limiting products' access to the market would need to be introduced at the European level, although much discussion and time would be required to reach agreement. Furthermore resource policy should not be solely technology-oriented but should also include lifestyles.

For an effective recycling of critical metals political incentives are required. These should not, however, like for example the WEEE directive, aim to achieve volume-based recycling goals, but instead should encourage recycling “with a fine-tooth comb”. In addition design for recycling must also be more strongly promoted by policy. For some critical metals such as rare earths, shortages can already be predicted for the near future and not just in the medium term. One promising approach that would facilitate the recovery of critical metals by manufacturers would be leasing models, for instance for mobile phones or electric cars or bicycles. Resource policy measures should also aim to keep raw materials recovered from old products within the EU. Here the establishment of an effective recycling system would have a central role to play. With respect to electro-mobility it should also be noted that no satisfactory recycling concept for lithium has yet been found.

3.6 Highlights from the Forums

In conclusion State Secretary Frau Reiche summarised what she considered to be the highlights from the lectures and discussions.

She emphasised that the German government would be devoting itself intensively to a resource policy concept over the next year. A consensus existed that additional incentives and stronger promotion of resource efficiency activities were necessary. As the model calculation in the MaRess project showed, government impetus programmes for promoting resource efficiency are expected to have a positive effect on innovation and growth. Frau Reiche made it clear that further long-term scenarios with concrete intermediate steps concerning the economic and environmental impact of increased resource efficiency would be necessary.

Frau Reiche stated: “We see resource efficiency as a classic win-win strategy”. She therefore welcomed the concerted effort being made by the ministries of the environment, economics and research, which, she said, was also an important factor in the success of the “national resource-efficiency programme” announced by the government. She said the MaRess project and the conference had provided many valuable ideas for the new policy mix required to develop this programme.

4 Perspectives for a Successful Resources Policy

The event ended with a look at the perspectives for a successful resources policy by President of the Federal Environment Agency Jochen Flasbarth. The MaRess project had been put out to tender and funded jointly with the Federal Ministry of the Environment because material efficiency and resource conservation had been a high priority in the Federal Environment Agency for a long time. He added that the results of the MaRess project could provide a starting point for other open questions, including those at the European level. The issue of resource efficiency was “right at the top of the agenda for the future” of the Federal Environment Agency.

In his speech on future perspectives Mr Flasbarth focused primarily on the core strategies developed by the MaRess project. He said it was now time to move on from the phase of the aforementioned “low hanging fruits” to strategies straddling several different policy areas, because the issue of resource efficiency was “essential for all national economies”. Although Germany has increased its raw materials productivity by around 47% since 1994, it is still a long way from meeting the government’s target of doubling raw materials productivity by 2020. Therefore new targets (e.g., recycling quotas) need to be set at the macro level as well as the micro level. Mr Flasbarth recalled that energy and climate policy had begun two decades ago with “baby steps” and that back then no one would have imagined it possible that by 2050 almost 100% of electricity could be supplied by renewables. Mr Flasbarth expressly stressed the necessity of involving the financial sector in the core strategies and said that resource efficiency parameters could be used to make a contribution to the long-term stabilisation of the financial sector. Particular attention should also be paid to global aspects: “We must think internationally with respect to resource efficiency”. Mr Flasbarth emphasised here that this was not primarily a foreign trade issue but rather a matter of bridging the gaps at a national level and increasing resource efficiency in order to reduce the resource dependency of the German economy.

Last, but not least, Jochen Flasbarth recalled the fact that resource efficiency was still an “unwieldy issue” for the general public. All the more important, therefore, to implement offensive communications strategies and to use well-known environmental symbols like the Blue Angel.

Finally the President of the Federal Environment Agency thanked all the experts in the MaRess consortium as well as the Wuppertal Institute for coordinating the project and putting in valuable work.

A reader distributed at the conference contains the summaries of the MaRess Tasks (see www.netzwerk-ressourceneffizienz.de/to_join/maress_grosskonferenz/index.html).

Material Efficiency & Resource Conservation

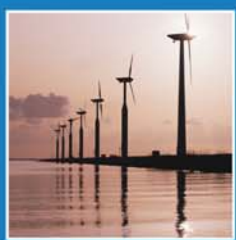
Thomas Götz / Kora Kristof / Peter Hennicke

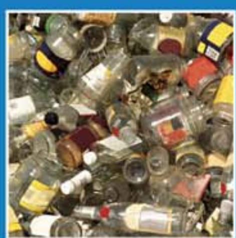
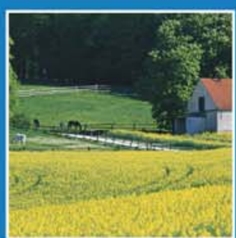
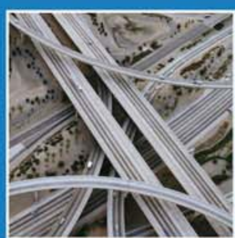
Wuppertal Institute for Climate, Environment and Energy

Advisory Committee

Executive Summary

Summary report of Task 11 within the framework of the „Material Efficiency and Resource Conservation“ (MaRess) Project

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"Material Efficiency and Resource Conservation"
(MaRess) – Project on behalf of BMU I UBA

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Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

Umwelt
Bundes
Amt
For our Environment

Task 11 „Advisory Committee“
Executive Summary

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1 Tasks and Goals of the MaRess Advisory Committee

The MaRess project was accompanied by an Advisory Committee whose task was to promote scientific, social and political discussion of the project’s findings, including those pertaining to the different fields of actors.

The Advisory Committee comprised people with proven expertise in both the scientific and political aspects of the resource efficiency discussion. Its composition reflects the areas most central to putting material efficiency and resource conservation into practice. This enabled important and broad channels of communication to be utilized for the project and important multipliers to be reached directly and indirectly. The members of the committee represented:

- politics – representing the Federal Environment Ministry, the Federal Environment Agency and any other departments active in the field of resource efficiency,
- science,
- the private sector via a consulting company,
- social actors via a relevant foundation.

Discussion with the Advisory Committee was conducted at the level of the MaRess control group. This embraced – seen over the entire duration of the project:

- Representatives from the Federal Ministry of the Environment: Reinhard Kaiser, Udo Paschedag, Uwe Nestle, Dr. Stefanie Pfahl, Dr. Torsten Bischoff, Dr. Ulf Jaeckel, Peter Stutz,
- From the Federal Environment Agency: Judit Kanthak, Matthias Koller, Dr. Michael Angrick, Dr. Inge Paulini, Peter Stutz,
- The project management: Dr. Kora Kristof and Prof. Dr. Peter Hennicke.

Tab. 1 gives an overview of the members of the MaRess Advisory Committee.

Tab. 1: Members of the MaRess Advisory Committee

Dr. Renate Loskill	Federal Ministry of Education and Research (BMBF)	until 31.05.2010
Dr. Lothar Mennicken	Federal Ministry of Education and Research (BMBF)	since 01.06.2010
MinR Thomas Zuleger	Federal Ministry of Economics and Technology (BMWi)	
Dr. Matthias Buchert	Öko-Institut e.V.	
Prof. Dr. Rolf Kümmel	Fraunhofer UMSICHT	
Ralf Baron	Arthur D. Little, Germany	
Klaus Dosch	Aachener Stiftung Kathy Beys / Aachen Foundation	

Advisory Committee meetings were held to make sure the committee was properly informed before participating in scientific and political discussions and to allow it to perform a multiplier function. In addition, Advisory Committee members were kept abreast of the project’s progress via quarterly reports, relevant Policy Papers and the main findings from the various Tasks (e.g. milestone papers from each of the Tasks).

2 Who Are the MaRess Advisory Committee Members?

Ralf Baron, Arthur D. Little GmbH, Germany

Ralf Baron is Director of the Travel & Transportation and Public Sector & Administration Divisions and a member of the management team of Arthur D. Little GmbH, Central Europe (DACH). His assignments are chiefly in the areas of corporate strategy and organisation, performance improvement, post-merger integration, change management, project management and innovation management.

After studying political science with a focus on international economic relations and empirical social research at the Ludwig Maximilian University in Munich, he worked for the Secretariat-General of the United Nations in New York from 1989 to 1994 in the United Nations Centre for Science and Technology for Development, specialising in technology management, technology impact assessment and environmentally friendly technologies. Ralf Baron joined the Management Consultancy Arthur D. Little in January 1994.

Further information: http://www.adlittle.de

Dr. Matthias Buchert, Öko-Institut e.V.

Dr. Matthias Buchert’s special research focus at the Öko-Institut is the sustainable resources sector, including resource efficiency, recycling management, building and living, land management and rare metals. As a research associate or project manager he has been involved in various national and European projects in the fields of resource efficiency and recycling, including projects on substance flows in platinum group metals or “Sustainable Materials Management – Important Potentials in Germany.”

After studying chemistry (1982 to 1988), Dr. Buchert did a doctorate in organic chemistry at the Technical University Darmstadt (1989 to 1992). In 1992 he joined the Öko-Institut as a research associate specialising in infrastructure and enterprises. He became Director of the Infrastructure and Enterprises Division at the Öko-Institut’s Darmstadt office in 1998.

Further information: http://www.oeko.de

Klaus Dosch, Kathy Beys Foundation Aachen

Klaus Dosch has been a research project manager at the Kathy Beys Foundation in Aachen since mid-1999. His special fields include resource productivity/resource efficiency, “Factor X” (using resources more intelligently) and future scenarios and dematerialisation methods. In 2004 he became jury spokesman for the German Material Efficiency Award of the Federal Ministry of Economics and Technology (BMWi).

After studying geosciences in Bonn, Kiel and Aachen and graduating with a degree in geology, Klaus Dosch pursued further studies in industrial engineering and also took a degree in this subject. From 1988 to 1992 he was a project engineer with a research and environmental consulting company. From 1993 until mid-1999 he helped to found ECOS Umwelt GmbH (an environmental engineering company) as a managing partner.

Further information: http://www.aachener-stiftung.de

Prof. Rolf Kümmel, Fraunhofer UMSICHT

From 1992 to 1995 Prof. Rolf Kümmel was Director of Environmental Technology and Institute Director at the Fraunhofer Institute for Environment, Safety and Energy Technology (UMSICHT) in Oberhausen. His work focuses chiefly on technical chemistry, environmental chemistry and environmental technology.

Prof. Kümmel is the author of many scientific publications devoted to sustainability, research into eco systems, and environmental and resource conservation. As a member or chairperson of many boards and committees concerned with technology and the environment he has made a significant contribution to applied and interdisciplinary environmental research.

After studying chemistry at the Martin Luther University in Halle-Wittenberg, Prof. Kümmel did a doctorate (1967) and a post-doctoral lecturing qualification (1975) in applied physical chemistry. From 1983 to 1992 he was Professor for Technical Chemistry at the Technical University Merseburg.

Further information: http://www.umsicht.fraunhofer.de/

Dr. Renate Loskill, Federal Ministry for Education and Research (BMBF; member of the Advisory Committee until the end of May 2010)

Dr. Renate Loskill has worked for the German Federal Ministry of Education and Research (BMBF) since 1994 and was active in research policy for sustainability for several years. Here she was responsible for the BMBF funding programmes “Innovative Technologies for Resource Efficiency – Raw Materials-Intensive Production Processes” and “SME-Innovative – Resources and Energy Efficiency”, both of which aimed to realise the government’s high-tech strategy in the innovation field environmental technologies. She has also worked in formulating European research policy and in the BMBF’s funding focus “Sustainable Forest Management”.

Renate Loskill has a doctorate in biology and currently works in Department 112 “New Instruments and Programmes for Innovation Funding”.

Further information: http://www.bmbf.de/

Priv.-Doz. (Private lecturer) Dr. Lothar Mennicken, Federal Ministry of Education and Research (BMBF; member of the MaRess Advisory Committee since June 2010)

Dr. Lothar Mennicken was appointed Head of the Department of Sustainability in Production and Services at the Federal Ministry of Education and Research (BMBF) in June 2010. Prior to that Dr. Mennicken performed various functions at the International Office of the BMBF at the German Aviation and Space Centre (DLR). From 2009 until February 2010 he was coordinator of the BMBF Initiative “Dialog für Nachhaltigkeit – Dialogue for Sustainability (D4S)” with Brazil, Russia, India, China and South Africa. From 2001 to 2008 he supported scientific and technical cooperation (WTZ) between Germany and Asia (Vietnam, Singapur, Mongolia, Malaysia, India) on behalf of the BMBF. From 1995 to 2001 he was a teaching assistant at the University of Bonn.

After studying agrarian sciences (Dipl.-Ing. agr.) at the University of Bonn, Dr. Mennicken spent two years doing research in Malaysia before embarking on a doctorate 1995 (Dr. sc. agr.) at the Technical University Berlin and the Humboldt University Berlin in 1995. In 2005 he acquired a post-doctoral lecturing qualification at the University of Bonn.

Further information: http://www.bmbf.de/

MinR Thomas Zuleger, Federal Ministry of Economics and Technology (BMWi)

Ministerial Councillor Thomas Zuleger was appointed Head of Department VII A 5, Research Infrastructure and Consulting; Industrial Community Research at the Federal Ministry of Economics and Technology (BMWi) in 2009. His work includes funding programmes for innovative SMEs, regional aspects of technology and innovation policy and the German Material Efficiency Agency (demea).

Thomas Zuleger studied in Karlsruhe and Cologne specialising in labour market and social policy and graduated with a degree in economics. In 1981 he joined the Federal Ministry of Labour working in the fields of employment and economic policy. From 1992 until 2004 he was the SPD parliamentary group’s spokesman on employment, social and economic policy. He subsequently took over the portfolio “Funding Innovative Engines of Growth: Patent Policy” in the former Ministry of Economics and Labour. From June 2006 until the end of 2008 he held the portfolio “Industrial Community Research, Innovative Engines of Growth; Innovative Networks”.

Further information: http://www.bmwi.de/