Policies
to Promote
Sustainable
Consumption
Patterns

EUPOPP Work Package 4

Deliverable 4.1

Overall Approach of Material Flow Analysis and its Application to the Need Areas Food and Housing, and Hypotheses on the Impacts of SC Instruments

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SEVENTH FRAMEWORK PROGRAMME

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Overview

The EU FP7 collaborative research project "European Policies to Promote Sustainable Consumption Patterns (EUPOPP)" is carried out by several research partners throughout Europe, co-ordinated by Oeko-Institut.

Within the EUPOPP workflow, **Deliverable 4.1** (D4.1) provides results from the Work Package (WP) 4 tasks which focus on the need areas of **food and housing** in the EU 27. The paper describes the overall approach, and its application to the need areas, including the hypotheses on the impacts of SC instruments.

Key to D4.1 is **Task 4.2** in which sustainable consumption (SC) instruments are "bundled" based on a literature review and the outcomes of WP3.

Furthermore, hypotheses are formulated on how these bundled instruments effect the sustainability of the need areas of food and housing.

Deliverable 4.1 is structured as follows:

After the introductory section, the **methodological** background on material flow analysis (MFA) is presented in Section 2 – this is the key tool to model the impacts of sustainable consumption instruments and policies.

In Section 3 discusses the selection and "bundling" of SC instruments (**Task 4.2**).

In Section 4, the respective hypotheses on the "bundles" in the need area "food" is given, while in Section 5 presents the hypotheses for bundled instrument in the need area "housing".

Section 6 summarizes the hypotheses for both need areas.

The Annex gives details on SC instruments considered in Sections 4 and 5.

More information on the BAU scenario assumptions for the EU, and the SC scenarios derived from the hypotheses described here, is given in Delivery D 4.2, and the results of the scenario comparison are given in Delivery 4.3.

1 Introduction

This paper represents the methodological and data background for the material flow analysis (MFA) for food and housing within Work Package 4 of the EUPOPP project.

The need area of **food** contains a variety of products, which are consumed within the EU 27. Each country, each region has specialties, favourites, habits or other food specific characteristics. It will not be possible to model all these features, therefore system boundaries limit the need area and so the model world of the scenario analysis. Furthermore the data quality will be discussed.

The need area of **housing** is focussing buildings within the private (residential) sector, and household appliances. The section on housing describes the methodology used to calculate the energy demand for the modelled house typology. The description of environmental and economic impacts derived from MFA needs indicators. In the case of housing, the main indicator is the final end-energy demand (kWh/m²) from which then further indicators (GHG and air emissions etc.) were derived.

Impacts on sustainable consumption can be quantified, namely through assessing the improvement of economic, social and environmental performance indicators against a business as usual (BAU) scenario. A key indicator is the emission of greenhouse gases (GHG), expressed in CO_2 equivalents. The other indicators are discussed in a specific EUPOPP working paper (Fritsche et al. 2009).

BAU represents a benchmark to compare future developments in which SC strategies are assumed to be implemented. The quantification of the potential future success of those instruments uses material flow analysis. Furthermore a quantitative analysis of distributive effects is carried out to address the international dimension.

The following sections describe the upgrading of existing data and necessities for calculating material flows and scenarios within the need area of food and housing.

By means of literature research and national and international statistical databases system boundaries are described.

The new data on fish are represented in section **Fehler! Verweisquelle konnte nicht gefunden werden.** and differentiate between aquaculture and capture.

To guarantee the readability of the working paper, extensive data tables are given in the annex.

2 Material Flow Analysis: Origin of the Concept and Methodological Approach

In 1972, the report to the Club of Rome *Limits to Growth* (Meadows et al. 1972) stimulated heated debates about future resource use, and introduced scenario logics to the wider public: what *would* be the consequences *if* future economic and population growth takes a certain path? And are there physical limits to growth?

> "Limits to growth include both the material and energy that are extracted from the Earth, and the capacity of the planet to absorb the pollutants that are generated as those materials and energy are used. Streams of material and energy flow from the planetary sources through the economic system to the planetary sinks where wastes and pollutants end up.
>
> There are limits, however, to the rates at which sources can produce these materials and energy without harm to people, the economy, or the earth's processes of regeneration and regulation. Resources can be renewable, like agricultural soils, or nonrenewable, like the world's oil resources. Both have their limits." (Meadows 2004, p. 10)

In the 1980ies, the so-called *Brundtland Report*[1] "Our Common Future" linked environmental degradation to economic *and* social development, popularizing the term *sustainable development* which encompasses production *and* consumption:

> "In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development; and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations". (WCED 1987, Chapter 2 no. 15)

In the 1990ies, this view on energy and material flows and associated use of natural resources was taken up in the term *industrial metabolism* proposed by Robert Ayres who described it as

> "the whole integrated collection of physical processes that convert raw materials and energy, plus labour, into finished products and wastes..." (Ayres 1994, p. 4)

Baccini/Brunner (1991) provided the conceptual base for material flow analysis (MFA) which is a broader form of life cycle analysis (LCA)[2].

In the late 1990ies, MFA was applied on various scales and became mainstream not only in the research (Duchin/Hertwich 2003) but also quite practical for e.g., enterprises and product developers (Brunner/Rechberger 2003), and the material flows of whole nations were determined (WRI 1997; 2000).

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[1] The report was named after Gro Harlem Brundtland, the Chair of the WCED and a former Norwegian Prime Minister.

[2] MFA avoids some of the shortcomings of LCA, especially the narrow focus on a functional unit of product output, thus allowing the analytical scope to be broadened to whole systems such as factories, cities and regions, to whole countries and, ultimately, the entire planet.

MFA in combination with scenario approaches proved successfully being applicable for sustainable consumption policy analysis in various need areas[3].

Assessing of effectiveness of sustainable consumption instruments requires projections into the future. For this purpose, scenarios are an adequate means of ex-ante analysis of different demand patterns created by consumers and their influence on material flows.

2.1 Scope of MFA

Ta panta rhei (everything flows)[4] is a fundamental view on modern economies with their manifold transformations of materials, energy and natural resources into products along globalized trade patterns.

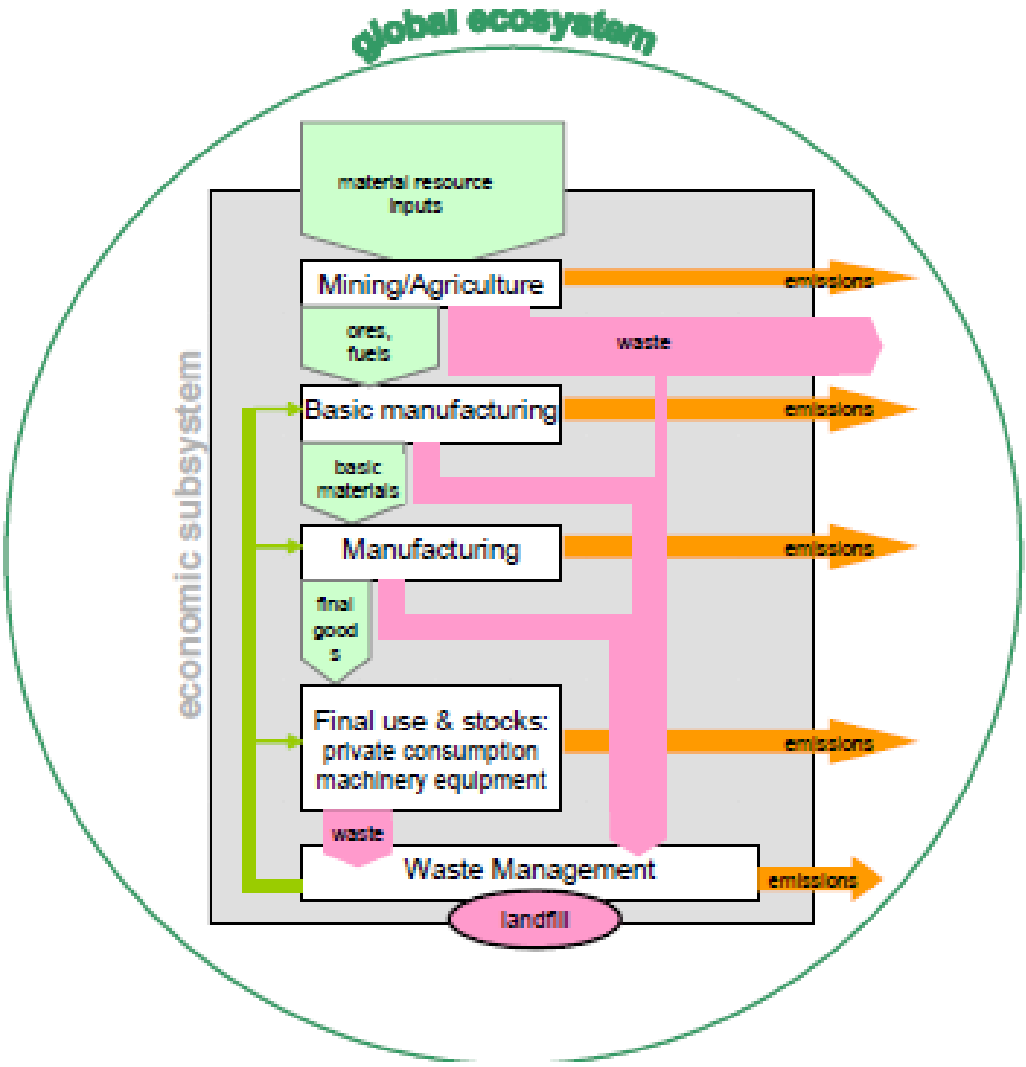
Besides the resource use and its implications for scarcity, trade etc., there are impacts of extraction and downstream processing – including transport – on energy demand and effects on air and GHG emissions, waste streams, and land use.

These impacts can occur along the whole life cycle (or value chain) of products and services associated with the resource use (see following figure).

[3] There are several examples for this from Germany (e.g., OEKO 2002; OEKO/IOER 2003; OEKO 2004; OEKO/LDR-IVT 2009).

[4] A philosophical quotation accredited to Heraclitus who lived 2,500 years before today in Greece.

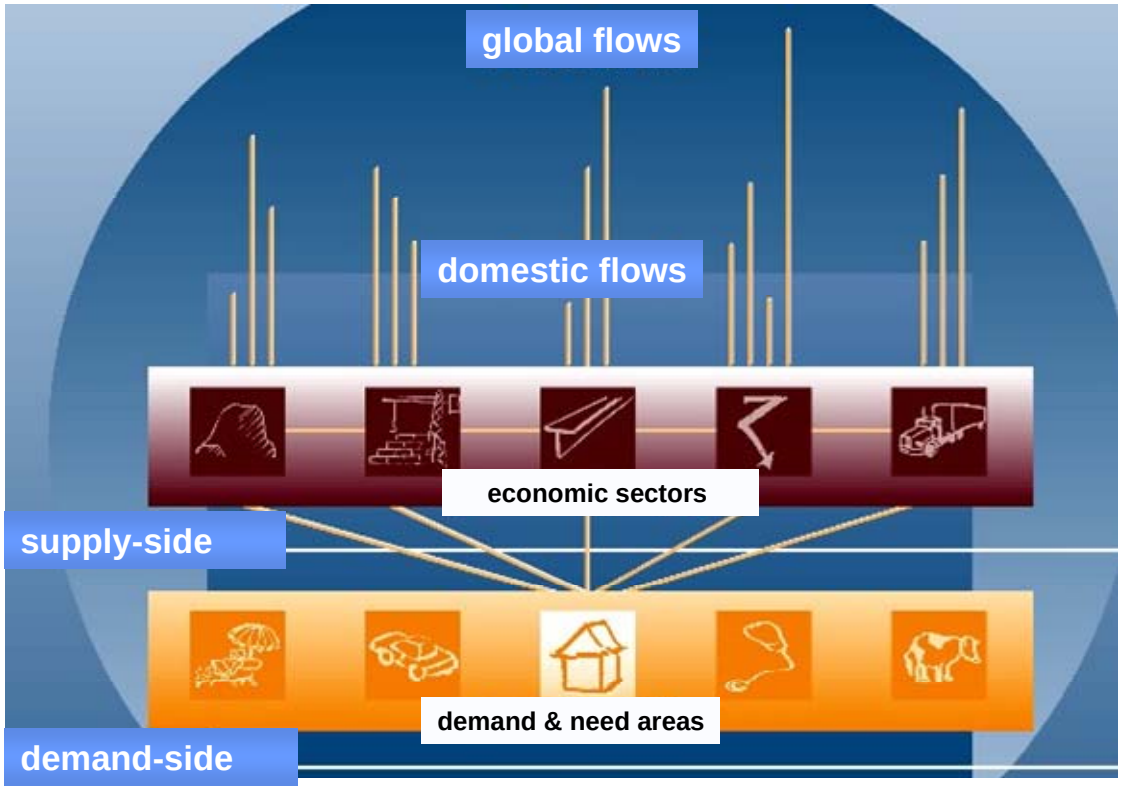
Figure 1: Resource Flows and Environmental Impacts



Source: EEA (2004)

Material flows and associated environmental and social impacts can be geographically distributed as well – due to the *transboundary* nature of resource flows in modern societies, the principal links between the demand-side (products and services), the economic sectors providing those, and their resource inputs and sustainability effects are, in principle, interrelated, as shown in the following figure.

Figure 2: Sectoral, National and Global Flows in MFA



Source: own presentation

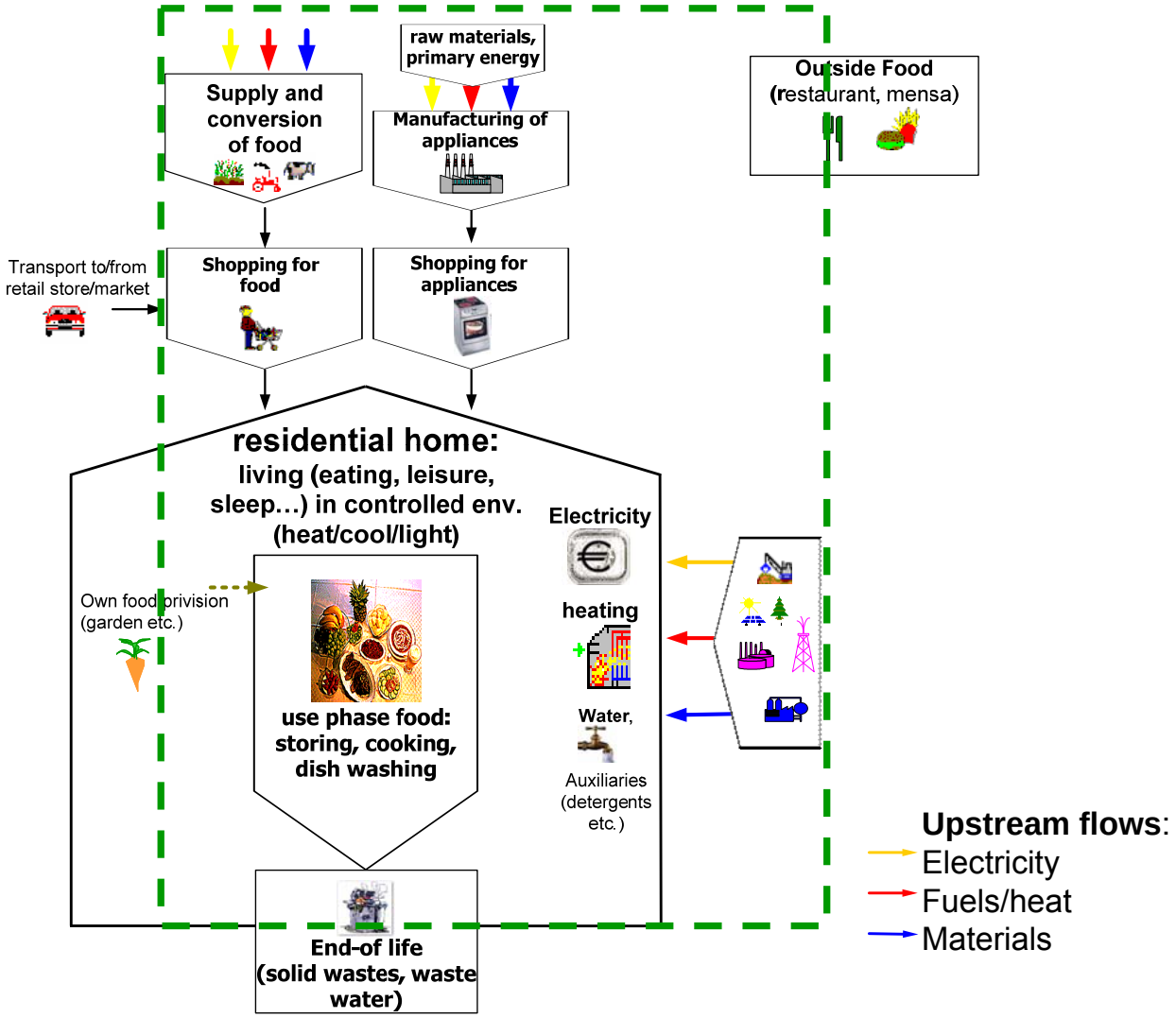
2.2 System Boundaries for Food and Housing in EUPOPP

MFA allows determining which material flows and environmental impacts are associated with current and with (modelled) future consumer demands for goods and services, taking into account "upstream" impacts which concern essential production and distribution expenditures.

MFA starts with the demand and tracks all (energy and) material flows to resource extraction (primary energy and natural resources). In the case of EUPOPP, the demand of e.g., food is taken as a starting point and all expenditures linked with energy, transport, use and processing of food is modelled until the extraction of primary energy and natural resources, respectively, is included. Effects from imports from outside of a country or a region- such as the EU 27 – are considered in the analysis, too.

On the demand-side, the system boundaries for EUPOPP are all inputs on the customer side, i.e. the various food items, but also their processing and use in the households, purchase and use of appliances, and their respective energy inputs (see following figure).

Figure 3: System Boundaries of the MFA in EUPOPP



Source: own presentation

2.3 Quantification of Sustainability Indicators

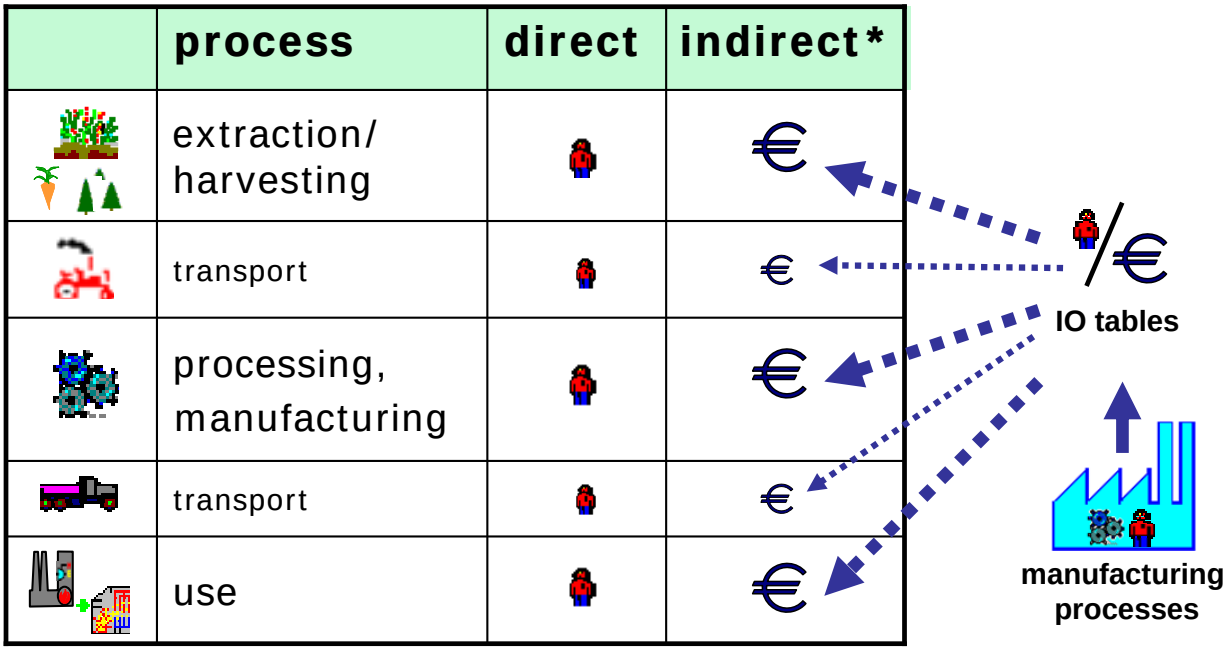
As described in an EUPOPP working paper (Fritsche et al. 2009), the MFA in EUPOPP comprises the following indicators for sustainability along the full life cycles:

- GHG and air pollutant emissions Non-Renewable Energy and raw materials as well as land use
- Costs (household expenditures)
- Employment (production side).

In contrast to the “pure” modelling of life cycles, the calculation of employment is vased on a hybrid approach which considers the “direct” jobs along the life cycles, but factors

in also the indirect employment stemming from the investment and operating expenditures for which input-output tables are used to convert monetary flows into jobs. The logic of this approach is shown in the following figure.

Figure 4: Direct and Indirect Employment in GEMIS



*** = from investitment & operating (non-fuel) costs**

Source: own presentation

2.4 Database for MFA

To determine the various sustainability impacts of material and energy flows, one has – depending on the scope of the analysis - to use MFA models and databases. Due to the restrictions in available data for both, adequate information exists only for a limited number of resource flows and product “chains”.

One model which is in the public domain and which offers a comparatively extensive database is GEMIS (Global Emission Model for Integrated Systems). GEMIS is open source software developed by Oeko-Institut and is continuously updated and extended (OEKO 2010 + 2011).

GEMIS Version 4.5 already included information regarding process chains of food on a national level (Germany), but was extended in EUPOPP to Versions 4.6 (in 2010) and 4.7 (in 2011) now covering the EU 27, and the time horizons from 2010-2030 for the BAU scenario which includes the PRIMES baseline scenario for the EU 27 energy sector.

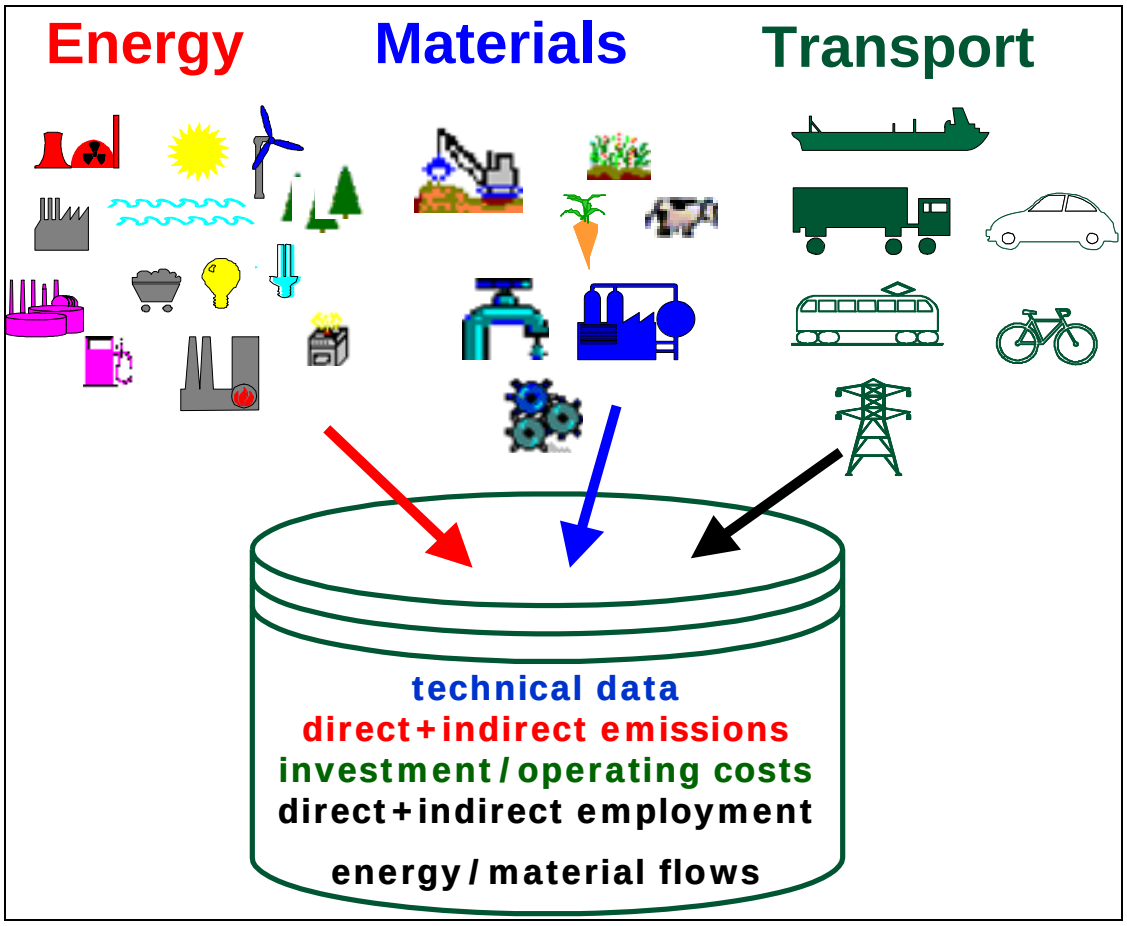
The data encompass the following steps regarding allocation of food:

- agricultural production
- industrial processing
- trade with storage
- transport.

The original base year of MFA data in GEMIS 4.5 has been 2005 which was extended in the EUPOPP work to 2010. All production and consumption data were derived from literature and official statistics.

Next to Member State-specific consumption and production data, the analysis of imports from outside of the EU 27 is necessary. GEMIS offers also country-specific data and processes for about 30 countries outside of the EU.

Figure 5: The GEMIS Database



Source: own presentation

3 Hypotheses on the Bundling of Instruments

In WP4, the formulation of "sustainable consumption" (SC) scenarios and their comparison with a reference scenario (business-as-usual = BAU) is a key issue[5].

To derive the SC scenarios, the implementation of SC instruments and policies in the need areas of food and housing is assumed beyond BAU, i.e. the scenarios assume more instruments and possibly more "intense" formulation and implementation of the instruments. To model the effects and impacts of the SC scenario, these instruments need to be quantified in their effects and – to facilitate modelling – they should be "bundled" into aggregate policy sets for the respective need areas. Furthermore, each separate instrument might induce tradeoffs outside of the instrument scope and could individually be influenced by the overall context factors.

Therefore, a coherent set of instruments for which the **combined effects** in the need areas are considered is needed, and called "bundle".

3.1 Criteria for Bundling Instruments

The base for the selection of instruments to be "bundled" was the result of the impact assessment in EUPOPP work package 3 which analyzed the efficiency of selected instruments (Wolff/Schönherr 2011). The selection should consider possible synergies created by the combined implementation of individual instruments, and options to reduce negative tradeoffs. The variety of instruments was classified by criteria for bundling which focus on the most effective combination of instrument types regarding sustainable consumption practises:

- bundling could cover more than one consumption phase (purchase, use, disposal);
- it should include various types of instruments which reinforce each other;
- it could be focused on one group of consumers in a certain consumption "setting" (e.g. catering at school);
- it could be focused on a specific issue (e.g. less meat consumption).

Bundling should ideally be achievable at the EU level, this means the transposition of existing national/regional instrument to the EU level and a combination of these instruments with existing EU level instruments (optimisation).

Furthermore, informed estimates on EU level outcomes and impacts and on the magnitude of synergistic interaction between the instruments in one package need to be made. In particular, the role of success factors and barriers according to the instrument has to be considered.

[5] In EUPOPP Deliverable 4.2, the future trends from 2005 onwards to 2030 are presented to define the baseline (reference) scenario, see OEKO (2011).

3.2 Scope for Bundling Instruments

The instrument bundles are considered for a time horizon of 20 years, i.e. between 2010 and 2030. To allow for a "delay" caused by formulation and legal or administrative preparation, the implementation of bundled instruments is assumed to start in 2015, with full implementation by 2030. The implementation logic of the bundled instruments must also reflect time to find acceptance in the respective customer groups and need areas, i.e. they are introduced slowly.

Changing behaviour regarding food and housing is influenced by economic or political instruments which induce both short- and long-term reactions of consumers. Especially the long-term reactions can generate rebound effects, which could negatively affect e.g., GHG emission reductions. Therefore, instrument bundles also need to consider elements to "counter" rebound and improve spill-over effects.

3.3 Bundling of Instruments for the Need Area Food

Food consumption is closely related to lifestyle aspects, quality demands, food competences, health considerations, income, and especially daily routines. Therefore, more sustainable food consumption instrument bundles must target these daily activities, and – as changing of consumption and lifestyle habits need motivation and knowledge – must consider informational and motivational elements.

The selected instruments concerning changing behaviour concentrate on the following four principles (Eberle et al. 2006):

1. Sharing responsibility
2. Reinforcing competences
3. Bundling of qualities[6]
4. Establishing of structures

With regard to possible impacts on sustainability, the most promising target area concerning food is the consumption of meat and dairy products, as both product groups impose high GHG and air emissions, high impacts on (agro)biodiversity, land and water, and also have comparatively high cost implications (see EUPOPP 2009).

However, dairy products are deeply integrated in many diets and food styles, and their sustainability depends on a variety of specific factors such as fat content so that changes in dairy consumption are very hard to address. Meat consumption, on the

[6] "Qualities" here refers to issues such as affordability, environmental soundness, and adequacy for daily life as well as nutritional value. Bundling of such qualities aims to allow consumers to easily buy and prepare sustainable food, as both are essential qualities – apart from the price of a product (Eberle et al. 2006).

other hand, is a more "generic" element of diets and food styles and easier to be (partially) replaced either by cereals or vegetables, or their combination[7].

Empirical evidence of consumer reactions to meat scandals (e.g. BSE crisis in the 1990s) and increasing health awareness shows that consumers can and do react in the short-term if health is concerned (Egenolf 2004).

For this reason, the key for instrument bundling in the need area of food is meat consumption[8].

In addition, the increase of organic food shares and the reduction of food waste in households (FAO 2011) are elements of the food instrument bundle.

3.4 Bundling of Instruments for the Need Area Housing

In the need area housing, there are three different aspects regarding sustainable consumption to be considered with regard to instrument bundling:

- household **electricity** consumption due to the use of **appliances**;
- household **heating** requirements due to **building** characteristics; and
- household **energy** consumption for heating and hot water.

These three consumption aspects must be dealt with separately, as they have very different linkages to customer behaviour and respective decision making:

Appliances are closely connected to every day life which is contingent on routines and use patterns of curtailment behaviour.

"Curtailment behaviors include water and energy conservation, car use reduction, and to some extent recycling and responsible waste disposal. In this conceptualization, curtailment behaviors are made on an everyday basis, and in aggregation, they may have a substantial effect on the environment. Other characteristics of these behaviours are that they rarely cost money, involve frequent efforts, and often result in discomfort for the actor performing the behavior Curtailment behaviour focuses on behaviours that would reduce resources and energy uses" (Jansson et al. 2010).

Typically, most appliances are replaced within less than 10 years, which then is related to so-called investment behaviour with specific implications for change.

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7 Besides the GHG emission and biodiversity impacts of meat consumption, an important aspect is the associated health impact. Several medical studies show an overall increased risk of cancer and mortality due to lifestyle factors such as nutrition habits and diets as well as high levels of meat consumption (Sinah et al. 2009, Zarraga et al. 2010, Ford et al. 2009).

8 It must be noted that generic "meat" is meant as a crude proxy of unsustainable meat consumption which reflects the different GHG and air emission impacts from e.g. beef, chicken and pork, and their different animal health, (agro)biodiversity and land/water impacts in an aggregated manner.

On the other hand, the buildings' characteristics with regard to heat demand are determined mainly by the construction of the building, and major renovation cycles which typically occur within several decades.

The choice and use of heating and hot water systems lies between these two extremes, i.e. in the order of 15 to 20 years.

Therefore, the bundling of instruments for the housing need area differentiates between the three energy-related aspects.

4 Hypotheses on the Bundled Instruments for Food

In the following, the key instruments to be bundled for the need area food are presented, and "packaged" into four elements:

- The first one addresses the overall awareness of households and consumers regarding sustainable diets.
- The second instrument focuses directly on significantly shifting diets towards less meat consumption.
- The third instrument aims to increase the share of organic food.
- The fourth element is the overall reduction of food waste on the consumer side which is generic to all food consumed.

All elements of the bundle reinforce each other in influencing consumer's behaviour regarding sustainable food consumption.

4.1.1 Bundle Element A: Changing Awareness on Diets

Food consumption is influenced both by market supply (producers/distributors) and by consumers. From the consumer's perspective, issues such as product costs, comfort regarding personal lifestyle, and communication with other consumers due to change experiences, knowledge and information (e.g. inside, outside or in between social status) play an important role. Without adequate competences (knowledge and information) regarding aspects like product life cycle impacts, an adequate product use (e.g. cooking) and availability of alternatives (and their environmental and cost implications), consumers will not change their food behaviour. Besides the importance of knowledge and information there is significant inertia due to habits and (socio-economic) contexts.

To stimulate changes in diets, both realistic opportunities and incentives to change are needed. In that regard, the first element of the food instrument bundle aims to create a common social awareness of impacts of consumption, and to establish first "strongholds" in institutional structures for sustainable meal provision, particularly in public catering which is part of the daily routine for many consumers.

Therefore, the first instrument bundle particularly addresses options to institutionalise sustainability criteria in the public domain and building knowledge and capacities of private consumers through sustainable public food services.

The implementation of a regularly **vegetarian day** per week aims on public information about non-meat benefits and tastes. In 2009, the Belgian city Gent started the "Veggiday" project. Each Thursday, cafeterias, schools, restaurants and bars offer vegetarian meals instead of meat products and expect that the awareness for non- or low-meat diets rises. Associated with the Veggiday are information campaigns on advantages of regional and seasonal food, low fat diets or environmentally friendly nutrition. Both the project and the information transfer support consumer decisions regarding changing food habits in a public setting. Furthermore, increased supply of non- and low-meat

meals offered during the Veggiday contributes to the diversification of meals, and is supposed to influence consumer demands.

Since such direct intervention into the food choices of private consumers is not yet generally acceptable to private consumers and likely to be met with resistance, it is important to initiate widespread structural changes as well. The EU could take a lead in this by requiring targets and strategic action from Member States in the field of public food services.

An effective process towards more sustainable food consumption must integrate with and complement existing policies in the fields of public procurement and the promotion of public health/obesity prevention. The most promising setting to initiate activities is **public education** (schools, universities etc.). This is because of the following factors:

- Children and students spend a substantial amount of time there
- Educational buildings can offer both a learning environment and food provision services (or can be retrofitted to do so)
- Public education has the potential to reach a large share of the population through the combined introduction of food alternatives in many sites, and could create an important demand-side "driver" for better logistics, (social) infrastructures and supply-side changes
- Healthy and sustainable eating habits are influenced by the daily routines of children and the young, and eating habits are probably easiest to change early in life.

The instruments on sustainable food thus address catering and procurement, and can easily be extended to cover other (public or private) food service provision, thus institutionalise a more pronounced shift towards fresh, seasonal, and vegetarian diets.

4.1.2 Bundle Element B: Sustainable Diets

Complementary to Element A, the second element of the bundle directly addresses the food choice of all customers by changing the relative price of meat.

Consumers price elasticities for food imply that a "real" shift in demand only occurs in the case of changing prices. To influence meat consumption in the longer-term thus means to assume economic instruments targeting meat prices. Therefore, element B is a **levy on meat products** (e.g. a tax per kg) which is introduced slowly, and rises over time to allow adjustments of both consumers, and producers to changed demands.

Since March 2010, Romania collects taxes on "unhealthy" food such as soft drinks, sweets or other food with a high content of salt, fat, or sugar (IMABE 2010) to reduce unhealthy food and, hence, reduce adipositas and obesity.

Furthermore, a study regarding price elasticities and fast food consumption (Duffey et al. 2010) researched the influence of price levels on consumption behaviour in a time frame of 20 years and shows that the cheaper fast food is, the more it is eaten, and assumes that a tax on food products can change eating habits. A recent paper from the EU FP7 project CORPUS discussed policy instruments for sustainable diets with regard to the demand-side and compiled respective research results (SERI 2011).

A Finnish study estimated that an increased taxation on sweets, soft drinks and sugar will result in a significantly decrease of demand of these products. The impact of the tax on sugar is cost effective. In addition, effects of sugar taxes could be larger than average among low-income households and, therefore, the tax can reduce health inequalities (Kotakorpi 2011).

The economic literature distinguishes between short- and long-term elasticities. In general, price elasticities on food products are low in the short-term due to behavioural inertia and difficulties to find adequate substitutes (Pindyck et al. 2003)[9].

Substituting meat must - as discussed earlier (EUPOPP 2009) – consider different protein contents of the alternatives. It can be assumed that given a strong price differential, consumers will adjust their diets in the longer run by shifting towards more vegetables in combination with dairy products and fish to balance their nutrient needs.

Such changes could, however, imply negative tradeoffs due to high-fat dairy products (with a high GHG impact), and increased fish consumption (potential overfishing). Therefore, it will be important to integrate a sustainable supply criterion, especially sustainable fish production (e.g. aquaculture, quota)[10].

This could be supported with financial incentives paid from the meat levy (or tax) revenue.

4.1.3 Bundle Element C: Increasing the Organic Food Share

In addition to the diet composition, the GHG balance and other sustainability indicators (e.g. biodiversity) are also affected by the agricultural/farming approach, especially conventional versus organic.

In the more ambitious sustainability scenario an increase of the share of organic products above the 20% share of the BAU case by 2030 is assumed especially through green public procurement for catering, and through more prominent access to organic food in retail shops.

Customer acceptance of organic food is rising in the BAU case, but “mainstreaming” to an average of share of 40% of all food products consumed would take not only lifestyle changes assumed in Elements A+B, but it is hypothesized that for this level, a tax exception for organic meat and dairy products is needed.

The overall GHG reduction of this additional instrument is comparatively small, but the non-GHG impacts are very positive.

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[9] Exceptions are branded goods. They show higher price elasticity than trademarks and therefore they are interesting for short term price reduction in the case of bargain advertising (Weber 2009). For more detail, see Annex A-5

[10] In 2009, FAO and WHO published a Codex Alimentarius to assist the handling and production of fish and fishery products with the objective of protecting health of consumers and ensuring fair practices in the food trade (FAO/WHO 2009).

4.1.4 Bundle Element D: Reducing Food Waste

This element addresses the minimization of food waste within households. Food waste is composed of unused raw or cooked food materials and includes food loss before, during or after meal preparation in households (BIO 2010). The food waste stemming from trade and production are not considered here, as the consumer is in the focus of EUPOPP.

The issue of food and drink bought, prepared and served at home can be categorised into avoidable waste, possibly avoidable waste and unavoidable waste

The avoidable food and drink waste can be classified into prepared, served or cooked to much, not used in time and other reasons

For the UK it was estimated that each household produces 330 kg waste per year, equivalent to 6 kg waste per household per week (WRAP 2009). FAO estimated food waste by consumers in Europe as about 95-115 kg/cap/year (FAO 2011).

The food and drink waste generated comprises many different groups of food and drink. The most products by weight are fresh vegetables/salad (25%), fresh fruits (13%) and bakery (10%). Meat and fish encompass 7% and dairy products 7% (WRAP 2009).

The reduction of GHG emissions associated with these avoidable food products calculated to the UK estimate a reduction about 2.4 % due to all consumption in the UK. This correlates with 20 million tonnes of CO_2 per year (WRAP 2009).

The food waste on household level within the EU 27 was estimated for 2006 in the order of 38 million tonnes with 42 % of all food waste arises from households (BIO 2010).

According to consumer targeted policies, the causes of food waste can be addressed as follows (BIO 2010):

- a lack of awareness of the quantity of food waste combining with financial benefits of using food more efficiently.
- the lack of knowledge on how to use food efficiently
- the attitudes due to efficiently use
- planning issues like buying to much food products
- labelling issues due to misinterpretation or confusion over shelf life labels
- storage.

The defined instrument bundle D on food waste comprises two elements:

1. Responsibility of the retailers to expand shelf life dates for food products provided that such measures are possible without negatively affecting food safety and consumer health (e.g., no increased use of artificial preservation).

2. Capacity building on the level of the consumer regarding labelling issues of shelf life of food products with help of information campaigns and clarification. This could include tools for daily routines via TV or radio campaigns.

We assume that due to the instrument bundle, households have a potential to reduce food waste by 10% points by 2030 (starting in 2020).

5 Hypotheses on the Bundled Instruments for Housing

5.1 Electricity Consumption (Appliances)

The instrument bundling for housing is, as discussed in Section 1.4, disaggregated with regard to electricity consumption from appliances, efficiency of buildings, and mix of heating systems. The following section discusses the instrument bundling for electric appliances.

According to different studies (Bürger 2009, JRC 2007), cooling appliances such as refrigerators and freezers and their various combinations have the largest non-thermal electricity demand in EU households, followed by other large appliances (white goods and brown ware, electronic entertainment equipment). The reduction of household electricity consumption – as opposed to total end energy use – therefore depends on two decisive elements:

- reaching an optimal level of energy efficiency for new appliances bought in Europe, and
- encouraging consumers to use existing appliances as efficiently as possible.

5.1.1 Bundle Element A: Best Appliances

The proposed element A of the instrument bundle combines successful existing approaches – i.e. the EU Energy Label for Appliances – with instruments that have not yet been applied at the EU level but appear particularly promising to address the above mentioned factors – i.e. the **top runner approach** and **price incentive schemes**.

The advantage of a toprunner regulation, which means to regularly phase out appliances below a certain energy efficiency level, is that it can relatively quickly lead to the phase out of inefficient appliances and tap into the general trend towards more efficient appliances that is present in Europe anyway. At the same time, the coupling to the long-established energy label would function as an efficient communication tool to consumers and thus encourage the creation of a respective demand for the more energy efficient appliances[11]. Additionally, the energy label could provide a simple way of implementing the top-runner approach: each year products with e.g. the two lowest energy efficiency classes could be phased-out and the levels of energy efficiency classes could be raised.

While information on energy efficiency is an aspect that EU consumers are well aware of and – to a certain extent – make use of in their purchasing decisions, existing research (knowledge-action-gap) shows that this is not enough to encourage consumers to change their appliances if there is no immediate need to do so (i.e. malfunction, breakdown).

[11] For details, see Annex A-1

This can lead to a considerable delay in realising efficiency: the quicker the replacement of existing stocks with more efficient new appliances, the higher the electricity savings. For example, a typical refrigerator has a lifetime of 15 years, so that an appliance bought in 2010 would be replaced only in 2025. The change of appliance stocks should, therefore, be encouraged to phase-out the oldest and least efficient appliances. The instrument for this is a disposal refund at the beginning of a top runner period which would help diffusing BAT appliances as quickly as possible. The disposal refund would fix a range of financial refunds for consumers buying energy efficient appliances, in accordance with category A of the EU Energy Label (top 10% on the market) based on the age/performance of their previous appliance. Consumers buying an energy efficient appliance but keeping their previous one would be excluded from the scheme, as the refund would require providing evidence for safe disposal of the “old” appliance, and its type.

5.1.2 Bundle Element B: Advanced Labelling

The European Energy Label provides for mandatory comparative energy labels for household appliances based on standard product information on the consumption of energy and other resources by household appliances. The labels indicate energy use (kWh/year) as well as performance, e.g. such as noise and cooling characteristics for refrigerators. A scale from A to G is used, where A represents the best available equipment and G the worst, thus the label ranks the appliance within the range of different energy classes. Currently, there are defined energy labels for a wide range of household appliances. The following selection of household appliances is illustrative of the total range and represents the appliances with the largest share of overall electricity consumption in the need area of housing (appliances):

- refrigerators and freezers
- washing machines, washer and tumble dryers
- dishwashers
- air conditioners and electric ovens.

In order to be compatible with a toprunner scheme and a disposal refund, the labelling scale would have to be harmonised (i.e. one scale A-G for all appliances, elimination of A+(+)(+)) and be made flexible. This means that instead of a fixed energy performance level, the categories of the label would reflect the current relative energy performance of an appliance as compared to the BAT in the market.

For example, this could mean a scale as follows:

- A = awarded to the 10% best performing appliances of one segment
- B = awarded to the following 10%
- C = awarded to the following 10 %
- … and so on

With the proposed change in the EU Energy Label, it could be efficiently combined with a top runner energy performance standard based on the BAT for each segment[12].

5.1.3 Hypotheses on the Effects of the Instrument Bundle

The average lifetime of household appliances is below the scenario horizon of EUPOPP, so that it is assumed that all existing appliances are replaced until 2030.

As household appliances with labels consume only about 40% of the total household electricity, the instrument bundle influence only this share.

In the reference case, it is assumed that by 2030, new appliances have at least a C label. This results in a reduction of 25% compared to existing appliances.

Introducing Bundle A improves the market share of appliances with higher efficiency. We assume that this leads to an average reduction of 35%. Appliances which produce heat using electricity have lower reduction rates, and cooling appliances have a higher reduction rate. Introducing Bundle B leads to a significant share of new applicance with advanced technology. This includes e.g. heat pumps for dryers, warm water tap for washing machines and dish washers, and advanced air conditioners. The expected reduction is 45%.

Compared to the reference efficiency increase of 25% by 2030, the instrument bundle would add 20 percent-points, i.e. the total efficiency gain would be 45%.

The real reduction of household electricity is somewhat lower due to decreasing average household sizes in the future. This leads to more households and, thus, more appliances which use more electricity than today, though more efficient.

The net efficiency change would, therefore, be 21% reduction for the reference, and 42% for the bundled instruments, both for the 2030 time horizon.

[12] For details, see Annex A-2

5.2 Heat Consumption (Building Efficiency)

5.2.1 Bundle Element A: Optimizing the EPBD

One key instrument is to **advance the EPBD**[13] which sets standards for new and existing buildings in its regulation on obligatory minimum performance standards for existing buildings. For new houses, the EPBD already introduced a zero-energy standard by 2020. The advanced EPBD is assumed to require all EU building owners to retrofit their buildings once the building is subject to a major renovation, e.g. renewing the building hull, or the roof.

So far, the EPBD relies on the Member States to set concrete energy performance standards for buildings. As the implementation of this framework regulation is hard to control for the EU Commission, the EUPOPP instrument design assumes integrating EU-wide standards into the EPBD. These standards should reflect, for example, requirements for percentage improvements[14] in overall thermal efficiency (kwh/m²), not concrete coefficients of heat transmission (due to regional and sectoral differences).

A challenge for this instrument is to develop innovative and cost-effective monitoring and control mechanisms to foster compliance. One possibility is to use the energy performance certification already in force which could be extended to include a **renovation registry**: energy performance certificates have to be renewed every ten years, which means renovations should be reflected in the data displayed on the certificate. An obligation to register energy performance certificates (e.g. at the land registry office) would easily allow to control the development of the energetic condition of a building – no matter how exact data are, the change over time would be obvious.

In addition, the moment of owner change can be seen as ideal point of intervention. Therefore, the EUPOPP instrument design also assumes integrating the obligation of retrofitting not only in the case of major renovations, but also in the case of owner change. This approach has several advantages:

- The new owner can easily be addressed with information by authorities
- The costs of retrofitting could enter the negotiation and therefore directly influence the market value of the building (which means reducing the price of non-renovated buildings and making renovations more cost efficient)
- As results of EUPOPP WP 3.2 (Impact Assessment and Focus Groups) have shown, exclusively voluntary instruments seem to be insufficient, because many

[13] see also the recent Energy Efficiency Plan 2011 of the Commission: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0109:FIN:EN:PDF

[14] These could decrease in proportion to the energetic condition of a building: e.g. 75% in case of very old buildings (severe energetic condition); 50% in case of old buildings; 25% in case of new buildings. The thermal efficiency should be expressed on the end-use energy level of buildings to factor in improvements of heating (control) systems, reduced heat losses, etc. and might be developed further into a GHG reduction requirement which would reflect also the “upstream” GHG balance of end-energy used.

people do not feel the necessity or have the capacity to renovate even if they are informed about their duties.

In case of non-compliance with any of the above mentioned obligations, owners should be sanctioned by a monetary penalty which should be fixed according to the estimated costs to fulfil the retrofit obligations.

However, there will be cases in which owners cannot afford to pay the upfront investment cost of the retrofits even though the measure is economic in the medium-term. Thus, a hardship clause could be included, but it would be more effective to increase the overall compliance with the standards through capacity building and financial incentives as accompanying measures to the regulatory instrument (see Element B).

As a strong additional instrument to be used in parallel with increased energy efficiency-oriented renovation and regulation, a “scrapping requirement” (possibly with an accompanying financial incentive) could be considered for the bundle. This “radical” option assumes issuing demolition decrees for buildings not retrofitted after a certain period in line with the regular (and usually cost-efficient) renovation cycle of a building (e.g. between 30-40 years), but may raise new problems, though. First, it might prove hard to achieve a political majority in favour of this instrument, as it has the potential of diminishing the chances of politicians to be re-elected due to a fall from grace among the population. Second, a demolition decree could curtail fundamental ownership rights or, as may be the case for rental homes, cause social problems. Third, the fundamental EPBD philosophy is that all measures must be cost-effective. This was already disputed with regard to minimum energy performance standards for major renovations, and it seems unlikely that scrapping very old buildings would be seen as cost-effective. Still, this instrument should be seen as a “last resort” option.

5.2.2 Bundle Element B: Incentive Programmes

The second element of the building bundle is to implement an EU-wide financial incentives scheme for major energy retrofits of buildings. One way of doing so is to make subsidies and low interest rate credits (soft loans) available to the target group, but also government-guaranteed loans and various types of financial incentives for ESCO services are important.

In large countries, the order of magnitude of such incentives is several billion € per year. The problem of the divided benefits between investors (building owners) and consumers could be solved by tax incentives for retrofitted buildings which would create a direct benefit for owners of rental homes.

The potential source for EU-wide financial support schemes should be seen in the revenue from the proposed energy (or CO_2) tax, as discussed in Section 5.4.2.

5.2.3 Hypotheses on the Effects of the Instrument Bundle

The affected housing stock in the EU is aproximately half of all houses, but the heat demand of this stock share is about 75% of the total heat consumption of all households, as in general, older buildings consume more heat.

Within the time horizon of the EUPOPP scenarios, not all houses will become subject to retrofitting[15] so that the rate of energy-oriented renovations of buidlings per year is crucial. It is assumed that the instrument bundles will result in both a higher specific reduction per building, and a higher retrofit rate. The assumptions are shown in the following table.

Assumptions for the Elements in the Bundle on Buildings Efficiency

	Reference	Element A Optimized EPBD	Element B Optimized EPBD + Incentives
Reduction heat loss windows	40%	50%	60%
Reduction heat loss roof and façade	40%	60%	70%
Retrofitting rate windows	3%/a	4%/a	4%/a
Retrofitting rate roof and façade	1%/a	2%/a	3%/a
Resulting reduction all houses	9%	21%	29%

Introducing the “scrapping requirement” which would target very old houses so that each year, 0.5% of these houses are replaced by new ones would add another 8% reduction in overall energy consumption by 2030.

The total effect of the instrument bundle for buildings would be an additional reduction of 37% of the heat demand which represents 28% more than in the reference scenario by 2030.

[15] Even a very optimistic retrofitting rate of 3% would lead only to a share of 60% of renovated houses by 2030.

5.3 Heating and Hot Water Systems

The provision of residential heat and hot water is the third area of instrument bundling for the housing sector. Given the previous discussion on the instrument to reduce the heat demand of buildings, the choice and use of residential heating and hot water systems determine the overall end-use and respective environmental and cost impacts of the thermal energy needs of the housing need area.

It is assumed that the overall efficiency improvements of heating and hot water systems are implemented already in the reference scenario, as they are very cost-effective, and the life-time of heating systems is smaller than the scenario time horizon so that all heating systems existing in 2005 will be replaced by 2030.

Thus, the instrument bundles for heating and hot water address two other aspects:

- Adjusting for effective actual heat consumption of residents
- Substituting heating systems with “greener” options, i.e. renewables and high-efficient cogeneration.

5.3.1 Bundle Element A: Adjusting for Effective Heat Consumption

High-rise residential building stock is estimated to cover some 36 million European households (Guertler/Smith, 2006). So far, energy saving potential has mainly been attributed to implementation of technical measures with additional insulation, changing of windows and improved efficiency of heating systems (installation of thermostatic radiator valves and balancing valves).

In our research we focus on options for alteration of consumer behaviour to taking actions for a voluntary reduction of heat energy consumption by individuals living in high rise residential buildings. A good potential for energy savings at the residential buildings connected to the central heating provides the individual metering and heat cost allocation that is technically supported by metering devices, automated data collection and individual billing based on apportioning heat costs (fixed part and consumption based part). Penetration of individual metering and heat cost allocation will largely relate to the success factors:

- Motivation to search for additional possibilities for energy and cost savings by households due to increasing relevance of energy prices for consumers. Saving the heat energy consumption, e.g., by adjusting the temperature to affordable comfort level, night and weekend lowering of temperature, adjusting the room airing practice are among easy measures employed by consumers.
- The fairness of energy bills where the cost allocation is based on actual consumption safeguards the commensurability of costs and benefits for decisions taken by a consumer. Higher heat energy consumption, e.g., due to increased temperature in rooms, careless attitude towards energy saving results in higher costs to be paid. The appropriate tariff model is critical to the acceptance of metering by consumers. Change in the approach from the flat rate tariffs to the individual metering and heat cost allocation is seen as a strong argument in many countries.

- Acceptance from consumers to the tool on providing feedback to their heat energy consumption while allowing to take the own decisions on heat comfort level, savings and energy bills to be paid. Here the crucial factors will be consumers' information and education about the system, its operation principles and potential benefits to the users from their behaviour change towards reduction of energy consumption.

Recent studies in CEE countries indicate the energy cost savings in range of 20% up to 35% per heating season at residential multi-flat houses with individual metering and heat cost allocation (Lukss 2008; MUNEE). In Denmark, the transition from joint to individual metering has been ensuring savings (Gullev/Poulsen 2006), whereas in Sweden, a higher cost for heat meters has been found when compared to the cost reduction from individual metering (Jönsson 2007a). The heat cost allocation for a consumer inevitably involves fixed and variable costs – the latter of which are based on individual consumption costs – and the ratio between these two parts can play an important role. While in Sweden a high share of fixed costs 60-80% with 20-40% of variable costs is used (Jönsson 2007b), the ratio of 40:60 or 30:70 is applied in other countries.

Measuring of heat consumption is ensured by accepted technical standards (Sperber, 2010) and development of adequate technical devices is on-going (Nordlander, 2007).

When the individual metering and heat cost allocation system is installed, it provides a possibility for consumers to adjust their heat consumption and receive the energy bill based on the cost allocation (i.e., a bill for the heat energy is divided to residents of multi-flat building according to their own consumption and higher energy bills are paid by those consumers that have higher heat energy consumption).

Application of the cost allocation principle is illustrated by an example from Latvia (see figure below) where the cost share range from 0.5 to 2.2 by different consumers at one house.

Indications are that majority of consumers are intended to save the energy (cost share <1) when the heat cost allocation is applied.

Thus, the energy savings can be achieved (on a house by house basis) by altering the consumer behaviour in favour of adjusting and reducing the heat consumption.

Figure 1: Heat energy consumption by flats and cost share per m2 flat area

Flat Nr.	13	14	15	28	29	30	43	44	45
Cost share	1.3	1.0	0.5	0.6	0.6	0.7	0.6	0.9	0.7
Flat Nr.	10	11	12	25	26	27	40	41	42
Cost share	1.7	0.8	0.7	0.9	0.6	0.9	0.7	1.5	1.0
Flat Nr.	7	8	9	22	23	24	37	38	39
Cost share	1.2	1.1	2.0	1.1	0.7	0.7	0.7	0.6	1.4
Flat Nr.	4	5	6	19	20	21	34	35	36
Cost share	0.8	0.6	0.8	0.6	0.7	1.3	1.2	0.8	0.7
Flat Nr.	1	2	3	16	17	18	31	32	33
Cost share	1.7	0.7	1.3	0.6	0.7	0.8	1.1	2.2	1.8

Source: Data from a building: Kurzemes prospect 14, Riga, Latvia; period: December, 2009). Red – cost above the average, yellow – cost at the average, green – cost below the average

By providing feedback on consumption the individual metering and heat cost allocation triggers the consumer to strive for savings; while the feedback is found to bringing about 10% of reduced consumption (Darby 2001). On the consumption side, indications are that a majority of consumers are intended to save the energy when the heat cost allocation is applied. Results from pilot cases indicate that the resulting effect may bring about energy savings of 9% (Lordache 2007), although higher savings are often reported. Such higher reported savings mainly result from the combination of consumers' behavioural change and investments for technical measures and are, therefore, not presented here. Inefficient residential energy behaviour (Linden 2006), a rather sceptical attitude to the heat cost allocation due to an unfavourable macro-economic environment (Jönsson 2007a), distrust of residents in the fairness of the system and lack of information (Siggelsten/Olander 2010) was observed in Sweden.

Potential for transferability is estimated for EU countries where high-rise residential building stock is in place and the building-based central heating systems are applied. High potential is seen for CEEC countries where the building stock shows a high share of high-rise buildings.

For some countries, a provision for the individual metering and heat cost allocation is incorporated in the 1st National Energy Efficiency Action Plans. In Slovenia, the benefit is estimated at 3.5% of 2016 target (Boza-Kiss 2009). A success for implementation of individual heat metering has been reported for Bulgaria (MUNEE). Lower potential is probable for other EU countries.

5.3.2 Bundle Element B: Heat System Substitution

To increase the share of "green" heating and hot water systems in the EU beyond the reference, the introduction of an obligatory minimum quota of "green" heating for **newly** installed[16] systems is assumed which must be met by home owners.

To allow for adjustment of consumers and suppliers, the quota system should be introduced with a low share which increases gradually over time, i.e., the later the replacement of a heating system occurs, the higher the required "green" share.

To account for regional differences, flexibility should be allowed for the Member States both in terms of the quota levels[17], and in determining the "greenness" of respective heating systems.

5.3.3 Bundle Element C: High-Efficient Air Conditioning

On the European level, not only heating systems are relevant for residential energy consumption, but also air-conditioning which is more relevant in Southern Europe than heating – and is becoming more relevant also in central Europe[18].

The way to save energy for air-conditioning is to implement minimum energy performance standards for those systems in addition to the minimum energy performance standards for buildings. To be more dynamic over time, a toprunner model is assumed.

[16] "Newly installed" does relate to system installed in newly built houses as well as when systems are replaced, or substituted.

[17] This reflects the flexibility the Renewable Energy Directive (RED) gives to reach the overall 20% renewables target for the EU as a whole.

[18] Ventilation – which will become more relevant after 2020 due to the introduction of zero-energy houses is assumed to be regulated as part of the reference scenario in an evolution of the EPBD and is not included in the instrument bundle.

5.4 Hypotheses on the Bundled Instruments for Housing: Cross-Cutting Instruments

The implementation of the instrument bundles in the housing need area must be accompanied by two "cross-cutting" instruments to assure minimised rebound and maximised spill-over effects:

- Instruments to increase awareness on sustainable energy in housing, supplying information through campaigns and offering energy advisory services and auditing schemes
- Economic instruments such as an energy (or CO_2) tax on the end-use level.

5.4.1 Awareness, Training and Capacity Building

General information instruments, such as campaigns, raise awareness on global issues, e.g., climate protection or healthy food. Furthermore, they might provide additional information on selected aspects of, e.g., reducing energy use in private households. In a more elaborate and specifically targeted communication concept, also educational aspects can be addressed and influence consumer behaviour in the longer-term. Through the combination with measures of feedback and evaluation, the outcome of information campaigns can be improved.

Feedback systems in general are seen as a very successful instrument to promote sustainable consumption. While for home care products and food, different models of giving feedback are still at the experimental level, feedback systems have a long tradition in the energy sector. Here, the instruments of metering and feedback encompass different fields of application. One can distinguish between various instruments such as informative billing (mostly on electricity, in some cases on gas or district heating), feedback by energy audits or advice programmes, single measurement (e.g. of electric power consumption) and smart metering (home automation).

Abrahamse et al. (2005) point to the finding that information instruments alone are not effective, but were found to be successful in combination with more specific informational instruments or implementation tools.

In order to reach deep cuts in energy use, the end-users' capacity to make/accept investments and to modify their usage behavior needs to be enhanced. Additionally, capacity building is needed for the various types of personnel dealing with buildings (property owners, facility managers, maintenance staff, renovating contractors).

Capacity building, i.e., intensive communications, training and education, audit and advice services and quality certification of building services and the provision of appropriate financial services, is needed for three reasons:

1. To support investment decisions: In particular, the renovation and appropriate maintenance of owner-occupied homes requires that consumers (especially as building owners) have the appropriate capacities to make the right decisions and have access to appropriate advice and services (including financial services).

2. To support the right investment decisions and make sure they are correctly implemented: As the most important measures to improve energy efficiency depend on building type, age and characteristics (e.g. Nemry et al. 2008), on-site knowledge is needed to select the most appropriate measures. Additionally, skills are needed both on the provider and the customer side to ensure top-quality implementation. If this is not ensured, the theoretical potential of the investments is not achieved.
3. To capture a 5% potential to further reduce energy consumption as compared to the Building Efficiency basic scenario through appropriate usage behaviour, operations and maintenance. This estimate is based on several studies finding that user behaviour accounts for 4-20% of heat energy use (Owens & Wilhite 1988; Guerra-Santin et al. 2009: Airaksinen and Matilainen 2010) and arguing for a potential for reducing heat and hot water consumption (through, e.g., thermostat settings, changed use of hot water, low-flow showerheads, etc.) by 4-15% using a package of diverse instruments (Becky et al. 2002; Dietz et al. 2009). Based on a meta-analysis of several studies, Ürge-Votsatz et al. (2009) argue that non-technological measures can be as important as technological ones to reduce CO_2 emissions.

The package of instruments is thus necessary to ensure the effectiveness of other instruments in the instrument bundle for housing to promote energy investments. At the same time, it can deepen their effect by capturing an additional 5% potential for savings through operational or very low-cost measures such as water-saving fittings.

The package should be tailored to national and local conditions and local actors such as local government and local energy agencies should be involved in delivery of these services. The package should include:

- Intensive communications: Communication campaigns alone are not effective in changing energy behaviour, but they are necessary to support other measures (IEA 2008; Dietz et al. 2009). Communication campaigns should utilize diverse media.
- Training and education: Training is needed for building owners, managers and maintenance staff, as well as for renovation contractors. In addition to professional training, building owners and users can benefit from peer-to-peer training and advice schemes (Heiskanen and Aalto 2010).
- Audit and advice services: A network of audit and advice services has gradually built up in Europe thanks to support by European programmes such as SAVE II and Intelligent Energy Europe. This network is not, however, comprehensive and suffers from funding deficits (Hodson et al. 2009). Best-practice energy advice services are estimated to be both effective and cost-effective in reducing CO_2 emissions (e.g. Koppel et al. 2007; IEA 2008).
- Quality control and certification of building services: The risks of undertaking renovations are a significant deterrent for building owners (Golove/Eto 1996; Sorrell et al. 2004; IEA 2008). Moreover, if efficiency investments are implemented poorly, their theoretical potential will not be reached. Hence, this instrument package needs to include measures to ensure top-quality services, such as certification, quality labels and warranties.

5.4.2 Energy (or CO_2) Taxation

The massive increase in energy efficiency of both appliances and heating could imply rebound effects which – as it is well known in all areas related to consumer behaviour – could offset at least some of the energy savings.

To avoid this, an economic instrument is needed which would let people save energy but not money, which could be achieved by an energy tax on the end-use level, i.e., an increase in prices customers pay for a unit of energy.

The overall calculation of the tax level would have to reflect the savings of energy units, and increase the price so that the "net" (undiscounted) spending of the residential customers for their energy services remains **at least** constant.

A slight net increase of, e.g., 2 percent per year could incentivise home owners to speed up replacing inefficient appliances, renovating their buildings, and shifting to "green" heat sources.

The tax would have to differentiate between fossil fuels (especially oil and natural gas), electricity, and (district) heat, and would have to be adjusted over time.

Alternatively to or in combination with the energy tax, a carbon levy could be used which would be calculated according to the carbon footprint of the consumed energy mix.

The overall revenue of the economic instrument could be re-distributed to the customers so that financial support elements of the instrument bundle can be covered.

6 Summary of Impacts of the Instrument Bundles

The instrument bundles for the need area "food" can be summarised as follows:

1. Introduction of a vegatarian day per week
2. Implementation of information and motivation campaigns, with "social feedback"
3. Introduction sustainable (low-meat) meals in catering for public educational institutions through procurement rules
4. Implementing of a consumer tax on meat products
5. Extending the shelf life of food in retail, and increasing customer awareness regarding best-use-before labels.
6. Raising the share of organic food through a combination of public procurements, better access in retail, and tax exception
7. Adjusting framework conditions to prevent rebound and increase spill-over effects, especially information campaigns, and capacity building

The instrument bundles address both food consumption of residential customers ("in-house"), and food consumption through public catering. They could, in principle, be extended to private catering, though.

The instrument bundles in the need area "housing" consist of the following key elements:

1. Introducing a toprunner scheme for BAT appliances combined with advanced labelling
2. Optimising the EPBD with minimum performance standards for existing buildings in combination with a "scrapping requirement" for very old non-retrofitted buildings, and a respective financial incentive scheme
3. Implementing individual metering for heat consumption, and "green" heating quotas for new systems
4. Implementing minimum energy performance standards for air-conditioning through a toprunner model
5. Implementing large-scale information campaigns to raise awareness, and increase energy advisory and audit services for residential customers
6. Implementing an energy (or CO_2) tax on end-energy to prevent rebound effects, and use revenue to finance economic support schemes.

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Abbreviations and Acronyms

BAT	best available technology
BAU	business-as-usual
BEF	Baltic Environment Forum
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktor-sicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMELV	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (Federal Ministry of Food, Agriculture and Consumer Protection)
BSE	bovine spongiform encephalopathy
CEE	Central and Eastern Europe
ECOI	Eco-Institut Barcelona
EEA	European Environment Agency
EPBD	Energy Performance of Buildings Directive (of the EU)
EU	European Union
EUPOPP	European Policies to Promote Sustainable Consumption Patterns (EU FP 7 collaborative research project)
EUROSTAT	European Statistical Office
FAO	Food and Agriculture Organization of the United Nations
FiBL	Forschungsinstitut für biologischen Landbau
GHG	greenhouse gas(es)
LCA	life-cycle analysis (or assessment)
MFA	material flow analysis
NCRC	National Consumer Research Council (of Finland)
OEKO	Oeko-Institut (Institute for appliec Ecology)
PRIMES	Partial equilibrium model for the European energy system
RED	EU Directive for the Promotion of Renewable Energy Sources
SC	sustainable consumption
UBA	Umweltbundesamt (German Federal Environmental Agency)

UCL	University College London
UNEP	United Nations Environment Programme
WHO	World Health Organization of the United Nations

Annex

A-1 Top Runner Air Conditioning Model

In nearly all European countries, a strong increase in the demand for building cooling and air-conditioning is predicted and detected for the following decades (by a factor of 4 in 2020). The reasons for this general increase are manifold, such as an increase in comfort habits, currently still low energy costs, architectural trends like an increased fraction of glazed areas in buildings and last but not least slowly changing climate conditions. The rising demand for cooling and air-conditioning in buildings involves unfavourable fossil fuel consumptions as well as upcoming stability problems in the electricity supply in the Mediterranean countries, which in turn demands for costly upgrading of the grids to handle electricity peak power demand situations (SOLAIR, 2008).

On this account it is of utmost importance to develop top runner air-conditioning models aiming at high energy efficiency, fulfilling minimum energy efficiency standards and introducing alternative energy resources or new actions such as metering. There are several studies, reports and web sites on the topic which are briefly summarized below.

Eco-design and Energy Labelling

Electricity Consumption and Efficiency Trends in European Union – Status report 2009 (Paolo Bertoldi, Bogdan Atanasiu)

With the introduction of energy labels for **air-conditioning**, the EU market has seen a positive transformation into a more efficient one with “A” class systems’ sales growing by 361% from 2005 to 2008 on the main EU markets. There is no energy efficiency EU policy for air-conditioning systems. Subsequent to the finalisation of the Eco-design preparatory study in 2009, an EC Regulation is expected to impose minimum energy efficiency performance requirements and additional requirements on noise, energy use in standby, off mode and other relevant modes.

Annex II: Working document on possible eco-design and energy labelling requirement for room air-conditioning appliances, local air coolers and comfort fans (2009/06/22)

This working document pursuant to 2005/32/EC and 92/75/EEC Directives establishes eco-design and energy labelling requirements related to room air-conditioning appliances, local air coolers and comfort fans based on Lot 10 Eco-design preparatory study.

The document shows a chapter on *Voluntary agreements*: *Eurovent* started a certification scheme for air-conditioners and local air coolers up to 12 kW cooling capacity in 2004. In the scheme, room air-conditioners in Class G, as defined in the Energy Labelling Directive 31/EC/2002, were eliminated from Eurovent Certification. Since then, no further action has been taken despite of the initial intention to eliminate further classes from the Scheme. No further voluntary actions have been proposed to date.

Concerning market structure, total sales of room air-conditioners (RACs) for domestic use are estimated at 5 million units in 2007. Local air coolers (LACs) stand for another 1,5 annual unit sales. Both for RACs and LACs, unit sales in Europe have doubled over the last 7 years with an average growth rate of over 8-10% (compared to the 4%-5% growth rate for the rest of the world) and market penetration much higher than the rest of the world. Two thirds of all room air-conditioners and local air coolers are sold in four Member States, Spain, Italy, Greece and France.

Product cases report. Methodology Study Eco-design of Energy-using Products (MEEUP) Final Report (2005/11/28)

There is a section concerning *Extra EU legislation and initiatives*. All major RAC markets (USA, Japan, "Australasia", China) but the EU have imposed minimum efficiency standards, many of which so stringent that the average product sold in the EU could not be sold in that particular market.

The EERAC study (Adnot, J. et al, Energy efficiency of Room Air-Conditioners (EERAC)-final report, ADEME for the EC (SAVE programme), May 1999) remarks on the subject: "The principal conclusion of this comparative work is that there has been considerable legislative activity to improve air conditioner efficiency and that a large proportion of RACs currently available for sale in the EU would not satisfy efficiency requirements in many other countries around the world. This suggests that there is significant scope to improve RAC energy performance in the EU and to do so requires not technological innovation but merely implementation of well-established higher efficiency design options. European or national efforts reported previously in this report appear very limited when compared with the schemes being applied in any country or group of countries considered here".

The study presents an overview of international minimum efficiency standards, including the proposal for EU standards by the EERAC study group. A higher EER value means a more energy efficient appliance. (Energy Consult, Comparison of International MEPS: Room Air Conditioners, report for Australian Greenhouse Office, January 2005).

Regarding *Labelling initiatives,* most countries that have introduced minimum energy efficiency requirements also run labelling programs in parallel, both in mandatory (like the EU Energy Label) and/or voluntary format (like the Energy Star, Energy Guide , miscellaneous Ecolabels).

Eco-design of room air-conditioning appliances (http://ecoaircon.eu/index.php?id=144): This is a website for the preparatory study on eco-design requirements for room air conditioning appliances (air-conditioners and ventilation) to prepare the implementation of the EuP Directive 2005/32/EC.

The website presents several reports on Room Air-Conditioners; the most recent one is the Draft final report for **Task 8: Policy, Impact and Sensitivity analysis** (updated 17th March 2009). (This task was coordinated by Philippe Riviere, from Armines, France. Other participant countries were Belgium, Portugal, Austria, UK and Greece).

This task summarises and totals the outcomes of all previous tasks. It looks at suitable policy means to achieve the potential, e.g., implementing LLCC as a minimum and BAT as a promotional target, using legislative or voluntary agreements, labelling and promotion. It draws up scenarios 1990-2020 quantifying the improvements that can be achieved vs. a Business-as-Usual scenario and compares the outcomes with EU environmental targets, the societal costs, if the environmental impact reduction would have to be achieved in another way, etc. It suggests an estimate of the impact on consumers (purchasing power, societal costs) and industry (employment, profitability, competitiveness, investment level, etc.), explicitly describing and taking into account the typical design cycle (platform change) in a product sector. Finally, in a sensitivity analysis of the main parameters it studies the robustness of the outcomes.

Regarding energy efficiency, it is concluded that the present EU label (31/EC/2002) energy classes need to be revised and a large potential seems to exist for improvement for all product types in cooling and in heating mode.

The French Centre for Energy and Processes (MINES ParisTech) has a Research Theme dedicated to High Efficiency and Low Environmental Impact Air-Conditioning systems with Dominique Marchio as the team leader. The works of CEP Paris contribute to increase the energetic performance of the air-conditioning plants and to promote alternative air-conditioning techniques.

http://www-cep.ensmp.fr/english/themes/mde/index-2.html

Figure 21: Evolution of the air-conditioning sales in Italy and Spain by energy classes ([STO2009])

Top Runner Program Japan

The "Top runner" standard was introduced in Japan in 1999. The program established energy efficiency standards for 23 categories of products, air-conditioning being one of the 11 initial ones. The Top Runner Program is prescribed under the Energy Conservation Law.

Manufacturers are required to ensure that future appliances have to be more efficient than the best performing products currently on the market.

The improvement of energy efficiency of air-conditioners has been **67.8%** between 1997 and 2004 (Energy Conservation Center Japan, 2010).

Examples of financial instruments

Some of the measures of the **Estrategia de Ahorro y Eficiencia Energetica en España 2004-2012, Plan de Acción 2008-2012, IDAE, Julio de 2007** (Spanish Strategy for Energy Saving and Efficiency 2004-2012, Action Plan 2008-2012) are:

- The improvement of the energy efficiency of thermal installations in existing buildings.
- The replacement of heating and cooling equipment, the incorporation of free cooling systems and the thermal recovery in existing climatic installations.

Public funds subsidize rebates (243.315.000 €), a total inversion of 3.719.205.000€ is expected until 2012.

In order to support the "Plan Renove" initiatives **IDAE (Energy Diversification and Saving Institute** http://www.idae.es**)** also provides a database on efficient domestic air-conditioning appliances, with a selection of domestic equipment up to 12 kW, with "A" energy classification; thus the most efficient appliances are included in catalogues available in the Spanish market.

In Spain the Autonomous Communities have included air-conditioning appliances within the **"Plan Renove"** Initiatives:

The aim in all the cases is to give an incentive for the acquisition and installation of high energy efficient air-conditioning appliances labelled as "A" class (including A+ and A++), replacing those appliances that offer the same functions but do not comply with energy efficiency requirements.

More information about the actual funding of the Renove Plans can be found at the homepage of AFEC (Spanish Air Conditioning Equipment Manufacturers Association): http://www.afec.es/en/plan-renove-andalucia.asp.

Examples of Renove Plan in the Autonomous Regions of Spain

Andalucia

The Department of Innovation, Science and Business, through the Andalusian Agency of the Energy, has placed in motion the new assembly of the **Plan Renove for Electric Appliances (2009-2010), that includes air conditioning equipments**.

Castilla La Mancha

The Department of Industry, Energy and Environment, by means of Order of 14/05/2010, calls for the ***Plan Renove for domestic air conditioning appliances***.

Cataluña

The Department of Economy and Finances of the Generalitat, through the Catalonian Institute of the Energy (ICAEN), by means of the Order ECF/362/2010, made public the assembly for the year 2010, setting the regulating bases of the **Electrical Appliances Renove *Plan, boilers and air conditioning equipments in Catalonia***.

Extremadura

The Department of Industry, Energy and Environment of Extremadura, published the Decree 81/2010, of 26 of March, by which the bases of the **Plan Renove of air conditioning equipments and of electrical appliances** were settled.

Galicia

The Department of Economy and Industry, through the Energy Institute of Galicia, has placed in motion the **Plan Renove of air conditioning equipments** (Campaign 2009).

Valencia

The Valencian Agency of the Energy by means of Resolution of February 21, 2010, calls for the ***Plan Renove of air conditioning 2010***, destined to the domestic air conditioning equipments' replacement by other highly energy efficient ones

A-2 Future Potential of Solar Cooling

As for the use of renewable energy sources for air conditioning appliances, the **SOLAIR Project (Increasing the Market Implementation of Solar Air Conditioning Systems for Small and Medium Applications in Residential and Commercial Buildings)** presented an Analysis of Market Potential.

The use of solar thermal energy for air-conditioning has a huge unexploited potential. This can become a significant contributing factor in the acceleration of the growth of the European solar market, particularly in the southern countries like Spain and Italy (which are the most appropriate countries for using solar energy for cooling).

The potential for environmental impact is considerable since the housing sector stands for more than one third of all CO_2 emissions. Thus, improved building concepts, and the use of alternatives in coverage of the remaining cooling demands, are of interest. Solar driven or assisted cooling is one of the possibilities to actively provide cold.

The European Commission within the Strategic Energy Technology Plan Information System (SETIS) also refers to Solar Heating and Cooling http://setis.ec.europa.eu/mapping-overview/technology-map/technologies/solar-heating-and-cooling

The potential for the penetration of solar heating and cooling technology in Europe, especially in the building sector, is large. Solar heating and cooling systems will be complementing other RES technologies and energy efficiency measures in the future.

A-3 Top Runner BAT Appliances and Advanced Labelling

Energy and electricity consumption trends over 2004-2007 seem to indicate that residential energy efficiency policies and measures start to take hold. Nevertheless, it is too early to conclude this positively due to the impact of warm winters in those years that influence heating energy consumption. There is still a huge saving potential that could be exploited. EU energy efficiency policies were significantly reinforced from 2005 on, with new important legislation coming into force or under assessment. The 2007-2012 Action Plan for Energy Efficiency "Realising the Potential" sets the new reinforced energy efficiency policy. The main objective of the Action Plan is to control and reduce energy demand and to take targeted action on consumption and supply, in order to save 20% of annual consumption of primary energy by 2020 (Bertoldi, P., Bogdan, A., 2009).

European Policies

Electricity Consumption and Efficiency Trends in European Union – Status report 2009 (Paolo Bertoldi, Bogdan Atanasiu)

One of the aims of the report is to show the present status of electricity consumption of the main appliances and equipment, the energy efficiency progress and estimates of the saving potential in the EU-27 electricity sector. The report summarises the policy actions introduced at EU level and some of the national policies for the building sector and for the electric motor systems.

Conclusions:

The **white appliances** show a success story for improving energy efficiency. This is mainly due to the combined effects of EU legislation (energy labels, minimum energy performance standards), national programmes (tax incentives in Italy, price rebate schemes in Spain, awareness raising campaigns in UK and Hungary, supplier obligations and white certificate schemes in France, Italy and the UK) and voluntary agreements (CECED) of the industry.

Compact Fluorescent Lamps (CFLs) represent one of the most efficient solutions available today for improving energy efficiency in residential lighting. In March 2009 the European Commission adopted an Eco-Design Regulation to improve the energy efficiency of household lamps, which stipulates the progressive phasing out of incandescent bulbs starting in 2009 and finishing at the end of 2012 (COM2008b).

Information and Communication Technologies (ICTs): If the proposed Eco-design Regulation for minimum performance and labelling requirements for TV sets and monitors is adopted, savings can be achieved, when the proposed energy labelling and performance requirements for televisions will reach their full impact.

To summarise, energy efficiency policies and programmes such as minimum energy performance standards and energy labels at EU level, unilateral agreement with manufacturer trade associations, utility DSM programmes, incentives, tax rebates, supplier obligations and white certificates, implemented at EU and national level over the last decade, have resulted in market transformation. The EU energy efficiency policies

have been significantly reinforced since 2005, new important legislation has come into force, is under assessment or under revision, in order to contribute to the achievement of the 20-20-20 target by 2020. The measures already adopted by the EU should achieve energy saving of about 13% by 2020 if properly implemented by Member States. In the light of the need to counterweigh the risk of falling short in achieving the 2020 target, the EU Commission has proposed a new energy efficiency package under the Second Energy Review from November 2008. The Eco-design of the energy-using products Framework Directive 32/2005/EC (Eco-design Directive), the End-use Energy Efficiency and Energy Services Directive 32/2006/EC (ESD), the re-cast of the Energy Performance of Buildings Directive (EPBD) and the re-cast of Labelling Directive will contribute significantly to realising the energy saving potential in European Union.

The Labelling Directive has been an important policy for promoting the energy efficiency measures, contributing substantially to the market transformation for domestic appliances. It has been shown that this measure has lived up to the expectations, and revision of the energy classes is now needed, as for many appliances types the large majority of the market models are in the A energy class. A recast of the Labelling Directive is expected to happen soon.

The voluntary initiatives of the industry, including the EU Codes of Conduct, have also made a very important contribution to improving the efficiency by the reduction of stand-by energy consumption of certain products, such as external power supplies, set-top boxes, and broadband equipment.

Under the EU Directive of Eco-design of the Energy-Using Products, mandatory standards for 25 product lots are already under assessment.

The **estimates for remaining energy saving potential** for the white appliances are very low compared to lighting, television and electronics, and this is because policies were successfully developed for white appliances rather than for the other consumers. The reduction of the stand-by consumption of electric and electronic equipment will be another important driver for achieving important savings by 2020.

EMEEES bottom up case application 5: Energy-efficient cold appliances and washing machines (Pascal Larsonneur, Robert Angioletti, Sarah Dukhan) 30 April 2009

Types of Energy Efficiency Improvement (EEI) facilitating measures

Regulation: Minimum Equipment Energy Performance Standards

Information:

- Focused information campaigns
- Labelling
- Training and Education
- Metering and information billing

Financial instruments for energy savings:

- Cash rebates
- Tax rebates and other taxes reducing energy end-use consumption
- Third party financing
- Loans

Voluntary agreements:

- Industrial companies (appliance manufacturers)
- Commercial (appliance trade) or industrial organisations

Given the complexity of harmonisation of the method for all types of measures, the document deals with measures most likely to be implemented at national scale which are, in general, measures facilitating or encouraging the purchase of the most efficient solution. Facilitating measures must target the best available technology: A++ appliances for cold appliances and below 0.17 kWh/kg for washing machines, and should not be restricted to a category of end users.

General specifications: The EU labelling policy is usually considered as a success in that it helped shape the market by informing the consumers and raising their awareness to efficiency issues. However, although the market shares of "A" class appliances have significantly increased since the implementation of the Labelling Directive throughout the EU, in many countries the share of the most efficient ones struggle to take off. Financial measures such as the Dutch rebate on topmost classes have proved effective in this regard.

Country specific initiatives

Spain (Plan Renove)

- **Estrategia de Ahorro y Eficiencia Energetica en España 2004-2012, Plan de Acción 2008-2012, IDAE, Julio de 2007**
- **SPA 22 Action Plan 2008-2012: "Renove" Plan for electrical appliances, February 2008 (Mure)**

Thanks to the new Action Plan 2008-2012 under the Energy Saving and Efficiency Strategy in Spain 2004-2012, approved in July 2007, the effort carried out by the Action Plan 2005-2007 becomes consolidated. It is a relevant fact that the new Action Plan is integrated within the European Energy Efficiency Action Plan demanded by the Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services, having established even more ambitious annual energy saving objectives, around 2% versus 1% established by the mentioned Directive.

"Plan Renove" on electric appliances is aimed at giving an incentive for the removal of existing electric appliances with high energy consumption, replacing them with others with A class or higher. These plans organized by the Autonomous Communities

cover the following appliances: refrigerators, freezers, washing machines and dish washers. The 2006 and 2007 Renove Plans have achieved the commercialization of mostly “A” and “B” labelled appliances, a trend that will further move towards “A” class appliances during the 2008-2012 Action Plan. It is considered convenient to maintain replacement plans to accelerate the introduction of more efficient equipment. These plans would be more efficient if complemented by information, training and awareness campaigns for consumers and suppliers.

It is proposed to keep on with the implementation of Renove Plans, already implemented in the frame of the Action Plan 2005/2007, so as to enhance the substitution of appliances in each Autonomous Community. The ultimate goal of this measure is that the purchaser will not find appliances other than Class “A” ones.

It is deemed that the proposed energy saving objective can be achieved by providing an economic incentive that may encourage the buyer to decide to acquire more energy-efficient equipment with these Renove Plans. This action takes into account the effect these plans have on the market, leading to a technological improvement in the equipment, and therefore, a concentration of Class A appliances on offer at the end of 2012. Information and training campaigns are included in the measure, both for appliance buyers and suppliers.

The potential beneficiary of this measure will be any individual or legal entity of a public or private kind that will replace an electrical appliance included in this support line. The bodies in charge of this measure shall be the Autonomous Communities whereas Ministry of Industry, Tourism and Trade, through IDAE, will act as collaborating institutions.

For further information on the functioning and results of Plan Renove:

http://www.odyssee-indicators.org/publications/workshops/spain/spanish_energy_efficiency_plan.pdf

Italy

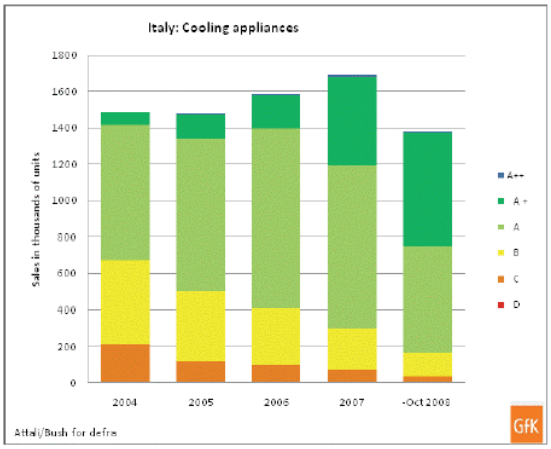
Fiscal incentives for energy savings in the household sector, October 2008 (MURE)

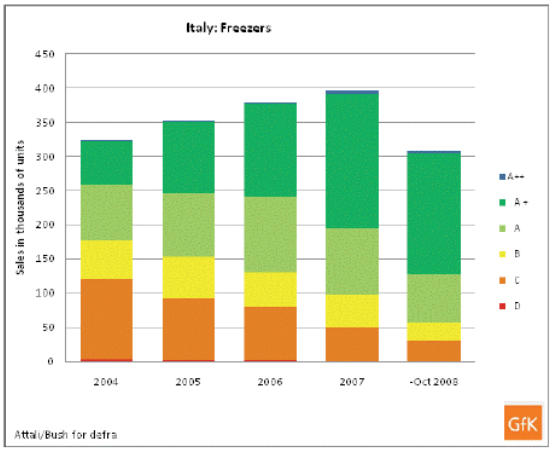
The law’s approval on energy performance of buildings has been accompanied by the implementation of measures directed to financially support building renovations and to promote energy efficiency for electrical appliances.

The Budget law 2007 has foreseen among other things: the tax incentive up to 200€ for any A+ refrigerator and freezer purchased by 31.12.2007.

The Budget law 2008 has created a “Fund for energy and efficiency savings” with 1 million € of budget to support among other things: awareness-raising for electrical appliances equipped with stand-by functions when not in use.

Factors influencing the penetration of energy efficient electrical appliances into national markets in Europe, Market Transformation Programme (Sophie Attali, Eric Bush, Anette Michel) June 2009





The market share of A+ cold appliances is increasing steadily on most European countries. However, the market share of A+ appliances shows a sudden increase for 2007 in Italy, illustrating the success of the nationwide rebate programme that began in this year.

The Italian on-going rebate for consumers is a tax deduction for A+ and A++ cooling appliances (2007-2009).

Denmark

The Danish Energy Saving Trust

http://www.savingtrust.dk/consumer/understand-your-energy-consumption/energy-labelling/about-the-energy-saving-label

Denmark has developed its own Energy Saving Label “EL”, and presents it as the easy route to energy saving products. When buying products displaying the Energy Saving Label consumers can be sure that electricity consumption will be at the low end.

The Trust’s Energy Saving Label was launched in Autumn 2006 and by the beginning of 2009 its scope has been expanded to cover:

A-rated energy saving bulbs, air to air heat pumps, central heating circulator pumps, computers, computer monitors, copiers printers and scanners, digital decoders, energy saving equipment, external power supplies, fridges and freezers, professional fridges and freezers, tumble dryers, washing machines and wireless devices.

UK

UK13 Market Transformation Programme (including implementation of minimum standards and labelling for appliances) MURE January 2008

The Market Transformation Programme (MTP) is an initiative that aims to develop products, systems and services which do less harm to the environment, using less energy, water, and other resources. Formally launched in 1998, the MTP evolved from the Energy Efficiency Best Practice Programme. This programme is responsible for delivering the appliance standards and labelling given in the Climate Change Programme and confirmed in the 2003 Energy White Paper. The Market Transformation Programme (www.mtprog.com) supports the development and implementation of UK Government policy on sustainable products. MTP works with policy makers, business and other experts at national, European and International levels to determine the scope to reduce environmental impacts through better product design.

The UK's energy efficiency action plan estimates that by raising product standards annual emissions could be reduced by between 1-3 Mt C by 2020. To do this will require a range of measures and approaches, including: international agreements; European and domestic legislation; and voluntary action through the supply chain to enhance markets for more cost-effective energy efficient goods and services.

The UK Government is working closely with UK manufacturers, retailers and trade associations to be the first European country to phase out inefficient GLS bulbs for the majority of domestic use, where an efficient alternative exists by 2011. This will reduce annual UK carbon emissions by up to 1.2 Mt C by 2020 and lead to a saving of around 30 pounds on the average household energy bill.

The UK Climate Change Programme estimated that energy labels and minimum energy efficiency standards for appliances introduced since 1995 will result in savings of 0.2 to 0.4 Mt C (0.730 to 1.470 Mt CO_2) per year by 2010.

Other measures from various countries

EEDAL '09, Energy Efficiency in Domestic Appliances and Lighting (Gunnar Pautzke, CECED)

Voluntary agreements to influence the demand side

1997: washing machines

1999: dishwashers/electric storage water heaters

2002: refrigerators, freezers/washing machines (updated for 2002-2010)

2004: refrigerators, freezers (updated for 2002-2010)

Results: worst energy consuming products were phased out and 17 Mt CO_2 were no longer discharged into the atmosphere.

Market based Instruments

Awareness raising campaigns (e.g. Hungary and UK): Hungary uses the following campaign tools

- sales promotion (20€ reduction for buying energy efficient refrigerator or washing machine and returning the old one
- contest to find the oldest working appliance
- drawing competition for children
- on-line energy calculator
- media events and TV spot.

The conclusion here is that without financial benefit given to consumers market transformation is less efficient. Long term activity involving financial support from the government should be introduced.

European Commission Joint Research Centre, Institute for Energy

Proceedings of the 5th International Conference on Energy Efficiency in Domestic Appliances and Lighting EEDAL 2009 (Paolo Bertoldi, Rita Werle)

http://re.jrc.ec.europa.eu/energyefficiency/events.htm

Policies and Programmes

Japanese example: Demonstration of the new promotion scheme for high-efficiency home appliances and evaluation of its energy saving effect *(Shinichi Kishida, Jyukankyo Research Institute, Japan)*

In Japan, the energy conservation regulation called "Top runner" standard was introduced in 1998 to reduce the energy consumption in households. The Top runner program requires that the energy consumption performance of future appliances (target products) should be more efficient than the best performance of the product currently in the market. According to this program, the apparent efficiency of appliances has been significantly improved.

Metering and smart appliances

Italian example: A residential electric load simulator to support demand management strategies in competitive electricity markets (*Alberto Prudenzi, University of L'Alquila)*

The residential load simulator implements a psychological model of the domestic customer's electric energy usage. The model aims at reproducing the daily electric load shape of a residential area by aggregating contributions of individual households. The individual household's daily load shape, on its turn, is the result of the elemental contributions of electric appliances demand being part of its typical mix. Thus the model provides a constructive approach to the load shaping problem by following a bottom-up

mechanism based upon interaction between the two elemental units of the demand: household's member and individual appliance.

Labelling and standards

The example from the Netherlands: The impact of eco-design measures on household electricity consumption in the Netherlands: even more savings are possible *(Hans-Paul Siderius, SenterNovem, the Netherlands)*

The Eco-design Directive (2005/32/EC) provides a framework for – amongst others – setting minimum efficiency standards for a large number of energy-using products. The justification for and potential impacts of these measures (often including energy labelling) are described in the preparatory studies, which are carried out on EU level only. Since for many EU member states minimum efficiency standards for appliances are an important instrument to achieve (national) energy efficiency targets, assessment of the impact of Eco-design measures on national level is desirable.

This paper describes a methodology that has been developed to calculate the impact of proposed measures for eco-design and energy labelling on household electricity consumption in the Netherlands up to the year 2020, based upon what is available through the preparatory studies.

The results show that for the Netherlands eco-design measures can reduce household electricity consumption (kWh/yr*hh) with 8% compared to a Business As Usual (BAU) scenario. Labelling measures alone show a reduction of 7% and the combined effect of eco-design and labelling is calculated at 11% reduction compared to a BAU scenario. Best Available Technology would result in a reduction of 34% compared to a BAU scenario. The paper concludes with a recommendation of national policy options for certain product groups to decrease the gap between the savings from EU measures (11%) and the (theoretical) savings from Best Available Technology (34%).

Beyond A: the future of the energy label. CECED examines options for improving the EU energy label for household appliances making the case for new labelling system (Paolo Falcioni, CECED, Belgium)

The energy label is a tool that was introduced in 1992 as a way to communicate the energy efficiency of an appliance to the consumer. The household appliance industry was the first to use the energy label and has recorded major successes in the area of innovation that have been communicated with the use of the label.

Today the energy efficiency of some appliances has surpassed the capability of the existing label and discussion has been ongoing for over a year on ways to update the label.

CECED, the European Household Appliances Manufacturers Association, supports a new scale that fosters innovation. The energy label is a tool that must evolve along with the energy efficient successes that have already been achieved with its help over the

past 15 years. This paper will explain the industry's point-of-view on why the energy label tool needs improving as we work toward the goal set by the Kyoto agreements.

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Bertoldi, P., Atanasiu, B. 2009: Electricity Consumption and Efficiency Trends in European Union –Status Report 2009; EU Commission Joint Research Centre

Bertoldi, P., Werle. R. 2010: Energy Efficiency in Domestic Appliances and Lighting: Proceedings of the 5th International Conference EEDAL '09 Vol. 1 and Vol. 2, EU Commission Joint Research Centre
http://re.jrc.ec.europa.eu/energyefficiency/events.htm

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Larsonneur, P., Angioletti, R., Dukhan, S. 2009: EMEEES bottom-up case application 5: Energy-efficient cold appliances and washing machines; Wuppertal Institute for Climate, Environment and Energy

MURE measure database 2008 (http://www.mure2.com):

- SPA 22 Action Plan 2008-2012: "Renove" Plan for electrical appliances

- Fiscal incentives for energy savings in the household sector

- UK13 Market Transformation Programme (including implementation of minimum standards and labelling for appliances)

Pautzke, G. 2009: National Campaigns transforming the market, EEDAL '09; CECED

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ENERGI, The Danish Energy Saving trust:

http://www.savingtrust.dk/consumer/understand-your-energy-consumption/energy-labelling/about-the-energy-saving-label

A-4 Energy (or CO_2) Tax - Revenue for Support Schemes

An energy or carbon/CO_2 tax on consumers is a tax applied to certain activities or purchases of goods that use energy. One way to apply an energy tax is to charge a fee for using electricity, such as in the workplace or the home. There are multiple reasons for charging a carbon tax; one of them is to discourage people from using excess energy or from buying products that require high amounts of energy for production. Another is to provide revenue for schemes to reduce energy use. In this way, energy reduction programmes can be funded by energy use.

The EU currently has the Energy Taxation Directive (2003/96/EC)[19], which tries to level current rates of tax on energy products between Member States, increase incentives to use energy more efficiently, and allows Member States to offer tax incentives to companies that try to reduce emissions. There is currently debate over whether an EU-wide tax should be added to this directive, and in March 2010, the EC announced plans for an EU-wide minimum tax on carbon[20].

Several countries in the EU already have some form of carbon tax. One example of this is the Carbon Emissions Reduction Target (CERT) programme in the UK. This programme requires industry to fund and make improvements on energy efficiency. CERT requires oil and gas companies to spend more than £3bn over three years to fund energy-saving measures in customer households. These oil/gas companies are mainly funding their CERT obligation through an increase in customer bills.

A Markandya et al, "Analysis of tax incentives for energy-efficient durables in the EU" (2009) *Energy Policy* Vol 37 Issue 12, 5662-74

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-4X5BP32-3&_user=125795&_coverDate=12%2F31%2F2009&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1464637234&_rerunOrigin=scholar.google&_acct=C000010182&_version=1&_urlVersion=0&_userid=125795&md5=c745ffa0c5548d281b4d96e690ca85bc&searchtype=a

This paper discusses the cost-effectiveness of many potential policies that could encourage the consumption of energy-efficient appliances in the EU. Research shows that the promotion of energy-efficient appliances has the potential to be cost-effective, but this largely depends on the specific country and other relevant factors. It examines case studies, and also concludes that an energy tax is more cost-effective than a subsidy.

[19] http://ec.europa.eu/taxation_customs/taxation/excise_duties/energy_products/legislation/index_en.htm

[20] http://www.inforse.org/europe/eu_e-tax.htm

B Saveyn, S Proost, "Energy-tax reform with vertical tax externalities" (2008) *FinanzArchiv: Public Finance Analysis* Vol 64 No 1, 63-86

http://www.ingentaconnect.com/content/mohr/fa/2008/00000064/00000001/art00004

This paper measures the welfare effects and vertical tax externalities involved with having an energy tax in a country. It discusses how the magnitude of the vertical externality can depend on environmental goals, local vs. federal shares, tax-recycling, and the size of the federation. It conducts simulations to show the effect of an energy tax on different sized countries, such as Belgium and the US.

B Wittneben, "Exxon is right: Let us re-examine our choice for a cap-and-trade system over a carbon tax" (2009) *Energy Policy* Vol 37 Issue 6, 2462-4

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-4VX0BMX-1&_user=125795&_coverDate=06%2F30%2F2009&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1464702958&_rerunOrigin=scholar.google&_acct=C000010182&_version=1&_urlVersion=0&_userid=125795&md5=873ba452ff05f53509782f151df06b8d&searchtype=a

This paper looks at the impact of the EU ETS on emission reductions, and also the cost to the general public. It discusses the fact that a cap-and-trade system is not necessarily the most cost-effective way to reduce GHG emissions. The main differences between the cap-and-trade system and a carbon tax are also examined, and the paper shows how a carbon tax on an international scale may be quicker and cheaper at reducing GHG emissions.

DM Newbery, 'Why Tax Energy? Towards a More Rational Policy' (2005) *Cambridge Working Papers in Economics* 0631, Faculty of Economics, University of Cambridge http://www.iaee.org/documents/vol26_3.pdf

This paper examines a tax theory perspective to energy taxes. It looks at optimal tariff arguments, the necessity of preventing global warming, and the possibility of taxing transport fuels and road charges. It also discusses the relationship between EU energy tax harmonisation and Kyoto, and argues that energy taxation should be changed.

M Andersen, P Ekins eds, *Carbon Energy Taxation: Lessons from Europe*, (Oxford, Oxford University Press, 2009)

This book examines whether it is beneficial to the environment and economy to use revenue from a carbon/energy tax to reduce other taxes. It discusses case studies in EU countries who have introduced carbon taxes.

T Callan et al, " The distributional implications of a carbon tax in Ireland" (2009) *Energy Policy* Vol 37 Issue 2, 407-12

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-4TTNCJ7-1&_user=125795&_coverDate=02%2F28%2F2009&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1464715869&_rerunOrigin=scholar.google&_acct=C000010182&_version=1&_urlVersion=0&_userid=125795&md5=6a75886daa3dcf5e091b572993ec99a3&searchtype=a

This paper examines the impact of a carbon tax and revenue recycling in Ireland, with a focus on the effects across the income distribution of the population. It finds that a carbon tax would be regressive; it would cost the richest households more than €4 a week, and would cost the poorest households less than €3 a week. Some of the carbon tax revenue can be used to increase tax credits and social benefits, even without using all of the funds. In this situation, households across the spectrum will benefit from the carbon tax.

A-5 Effects of Consumer Tax on Meat

There is currently a debate over whether a reduction in meat consumption, particularly red meat, would help reduce GHG emissions. A number of solutions and ideas to encourage a reduction in meat consumption have been proposed, including a consumer tax on meat products. This means that consumers would be taxed for meat products according to the GHG emissions associated with production of that particular meat.

B Jackson et al, 'Strategies for reducing the climate impacts of red meat/dairy consumption in the UK', March 2009

http://assets.wwf.org.uk/downloads/imperialwwf_report.pdf

This paper discusses possible solutions to reduce meat/dairy consumption. It focuses on the farming, retailing, and consumer sides of the issue, with a particular focus on grocery chains. One of the solutions they discuss is a tax on high-GHG food to encourage people to eat sustainable food. They suggest a new taxation scheme to incentivise a healthy and sustainable diet that tackles both obesity and climate change.

Climate change; sustainable diet; health: The connection and the solution, *Report for Government*, September 2009

http://vegclimatealliance.org/wp-content/uploads/2009/09/CLIMATE_CHANGE-SUSTAINABLE_DIET-HEALTH-The_Connection_and_the_Solution-Gov-opt.pdf

This paper, written by an organisation that promotes a vegetarian lifestyle to avoid environmental disaster, describes the impact of meat consumption. As part of its solution, it suggests taxing meat to reflect the detrimental effect it has on the environment.

CL Weber, HS Matthews, 'Food-miles and the Relative Climate Impacts of Food Choices in the United States', (2008) *Environ Sci Technol* 42 (10), 3508-13

http://pubs.acs.org/doi/full/10.1021/es702969f

This paper mainly focuses on 'food miles' and the GHG emissions associated with different types of food, especially red meat. It includes a discussion of how red meat is 1.5 times more GHG-intensive than chicken or fish, and it suggests that consumers should shift their diets to reduce their food-related climate footprint by eating less red meat. It also states that reducing red meat consumption by less than one day per week- to chicken, fish, eggs, or a vegetarian diet- is more effective at reducing GHG emissions than buying 'local' food.

R Durrant, T MacMillan, *Livestock consumption and climate change: a framework for dialogue*, 2009

http://assets.wwf.org.uk/downloads/fec_report_.pdf

This paper outlines different policy recommendations that could help reduce consumption of livestock products. It provides an outline to promote discussion and education among policy makers and consumers, and has a variety of suggestions to tackle the livestock consumption issue. Ideas range from government regulation to consumer knowledge. It discusses how a wide range of initiatives must be established to effectively reduce livestock consumption.

R Goodland, 'Environmental sustainability in agriculture: diet matters' (1997) *Ecological Economics* 23 189-200

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VDY-3SWR6DR-1&_user=125795&_coverDate=12%2F05%2F1997&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1470051470&_rerunOrigin=scholar.google&_acct=C000010182&_version=1&_urlVersion=0&_userid=125795&md5=fc39fb5f42b77ef3a4cfd1e7c4498efa&searchtype=a

This article links the efficiency of a food source (i.e. how much waste and pollution it creates) with the need to be taxed; the idea is to force those who consume the least efficient foods to pay a bigger price. In addition, less efficient foods tend to be less healthy, more sentient (as in mammals), and have the highest impact on the environment. The paper argues that taxing less efficient foods would have the greatest impact on the rich, and that such a tax will allow more time to implement other measures to combat environmental damage. It also compares taxing low-efficiency food with a tax on inefficient cars.