DIRECT-MAT – developing best practice on recycling or safe disposal of road materials in Europe

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DIRECT-MAT –Wiederverwendung, -verwertung und sicherere Entsorgungs-Technologien für Straßenausbaustoffe in Europa

Abstract

DIRECT-MAT is a three-year European project aiming to develop best practice on dismantling and recycling or safe disposal of road and road related materials at the European level. It was initiated within the EC 7th Framework Transport Research Program and is comprised of partners from fifteen participating countries for a budget of 1.2 million Euros. The project runs through 2009–2011 and involves building a European Web database and drafting best practice guides on DIsmantling and RECycling Techniques for road MATerials ("DIRECT-MAT"). Several materials are addressed – unbound, hydraulically bound and asphalt road materials, but also other materials related to road use but not commonly recycled in road construction. These include tyre shreds, sediment from ditches, industrial by-products and reinforcement materials. As a first project result the paper presents a summary of reuse, recycling and disposal strategies for the addressed road materials.

Inhaltsangabe

Bei Rückbau und baulicher Erneuerung von Straßenbefestigungen fallen große Mengen an Straßenausbaustoffen an. Durch deren Wiederverwertung im Straßenbau kann das Abfallaufkommen sowie der Verbrauch von neuen Baustoffkomponenten erheblich reduziert werden. Um die Wiederverwertung von Ausbaumaterialien aus Fahrbahnbefestigungen Europaweit zu fördern und vorhandene Technologien allen Mitgliedsstaaten verfügbar zu machen, wurde im 7. Rahmenprogramm der Europäischen Kommission ein mit 1,2 Mio. € gefördertes Forschungsprojekt initiiert (DISmantling and RECycling Techniques for Road MATerials – DIRECT_MAT). Seit Anfang 2009 werden zunächst die vorhandenen Technologien im Bereich des Baustoffrecyclings im Straßenbau zusammengestellt und in einer Online-Datenbank frei zugänglich gemacht.

Keywords

Recycling-Baustoffe, Straßen-Ausbaustoffe, Fahrbahnbeton, Asphalt

Recycling, road materials, road concrete, asphalt

1 Introduction

The European road network has a total length of more than 5.8 million km (ERF 2007) and it is still growing. Obviously, various pavement layers exhibit different lifetimes which makes regular maintenance work necessary. As a result, several hundred million tons of road materials are excavated each year from a number of demolished pavement layers. According to European policy (EUROPEAN PARLIAMENT, 2006), these materials can be seen as wastes, viz. “substance or object which the holder discards or intends or is required to discard”. Nevertheless, in nearly all countries, part of these road construction wastes is reused or recycled back into road infrastructure and this part may reach 100 % depending on the type of road waste. Furthermore nearly all countries have developed their own strategy to handle road material wastes in terms of characterisation, demolition, classification, handling, recycling and reuse technology. In this way even some beneficial effects of road material waste reuse were discovered, such as natural resource savings (e.g. aggregates, bitumen) as well as improved road materials behaviour. Available information is being either unpublished or published in native languages, very few countries can benefit from actual breakthrough. In order to improve the situation, a research project called DIRECT-MAT was proposed for the 7th framework research program in order to initiate the knowledge transfer between the stakeholders within the European Member states.

1.1 Background

The EU25 main road network is essential for passenger and freight transportation across Europe. However, its maintenance is costly and also responsible for detrimental impacts to the environment relative to waste production and natural resource consumption. As emphasized by ERTRAC in its Research Framework (ERTRAC, 2006), it is necessary to simultaneously optimise the quality-to-cost ratio of road infrastructure and encourage environmentally friendly road maintenance practices. A significant contribution to the ERTRAC view consists of reducing the proportion of road materials originating from natural resource extraction and increasing the recycling of locally-available road wastes into new road materials.

Over the past few years, most European countries have started to work towards this goal, by implementing national strategies for dismantling and recycling road materials back into new roads. At present, many European countries have acquired experience in dismantling and recycling road and road related materials back into roads, especially asphalt materials, either on their own or by applying European research results.

However, depending on available wastes and local regulations, the practice at national level differs significantly from one country to another. Thereby, a wide array of research

results on road material recycling has been produced, yet they are dispersed throughout the various Member States and not widely implemented. Furthermore, pertinent databases and available documents usually are not translated into a common language and site data are seldom available to specialists from other countries. As a result, national experience based on local site data almost never benefits other European countries, and this especially affects the newer Member States.

1.2 Objectives of DIRECT-MAT

At present, many European countries have acquired experience in dismantling and recycling road and road related materials back into roads, especially asphalt materials. However, research results are not widely implemented and national documents are not often available to specialists from other countries. In this European project, twenty partners cooperate to build a web database that will provide access to validated guidelines, national document references, harmonised literature reviews and practical application case studies based on jobsite data sets.

By gathering information on every type of road and road related material used along with local experiences, by drafting best practice guides and sharing all those elements on a website, the DIRECT-MAT project will establish a benchmark on the best practices for dismantling and recycling or safe disposal of road and road related materials. The work undertaken will also serve to identify further possible research needs for improving overall system optimisation with regard to material dismantling, manufacturing and implementation processes.

Thus DIRECT-MAT will actively contribute to generate closer cooperation between research and practice within road material recycling and also contribute to reducing the waste disposal associated with roads.

1.3 DIRECT-MAT Research Consortium

Twenty partners – research institutes, universities and private companies – from fifteen participating countries will contribute collecting, analysing and sharing international as well as national information for the benefit of Europe (Table 1).

Table 1 Partners in the DIRECT-MAT Consortium

Partner	**Country**
French Public Works Research Laboratory (LCPC), Coordinator	France
Belgian Road Research Centre (BRRC)	Belgium
Swedish Geotechnical Institute (SGI)	Sweden
Danish Road Institute (DRI)	Denmark
National Laboratory for Civil Engineering (LNEC)	Portugal
Dresden University of Technology (TUD)	Germany
Braunschweig Institute of Technology (TUBS/ISBS)	Germany
Institute for Transport Sciences (KTI)	Hungary
National Institute of Applied Science (INSA) Strasbourg	France
University College Dublin (UCD)	Ireland
Recipav/Recipneu	Portugal
Forum of European National Highway Research Laboratories (FEHRL)	-
Brancheverenigning Recycling Breken en Sorteren (BRBS)	Netherlands
The Research Institute of VÖZ	Austria
Transport Research Centre (CDV)	Czech Rep.
Swedish National Road and Transport Research Institute (VTI)	Sweden
Centro de Estudios y Experimentación de Obras Públicas (CEDEX)	Spain
Slovenian National Building and Civil Engineering Institute (ZAG)	Slovenia
The Highway Institute (IP)	Serbia
Road and Bridge Research Institute (IBDiM)	Poland

1.4 Organisation of work

The work programme is organised into seven work packages where four packages focus on the various construction materials, one is devoted to the database and the remaining two work packages to management & coordination and dissemination (comp. Figure 1).

Dissemination activities include cooperation with a Reference Group consisting of end users in several countries; presentations in national and international papers and conferences as well as the arrangement of national seminars and a European workshop for end users in 2011. Continuous project information will be available at http://direct-mat.fehrl.org. Potential end users of the DIRECT-MAT project results are road owners, standardization experts, road designers, contractors, material producers, researchers, laboratory personal, professional associations, equipment manufacturers as well as teachers in professional education.

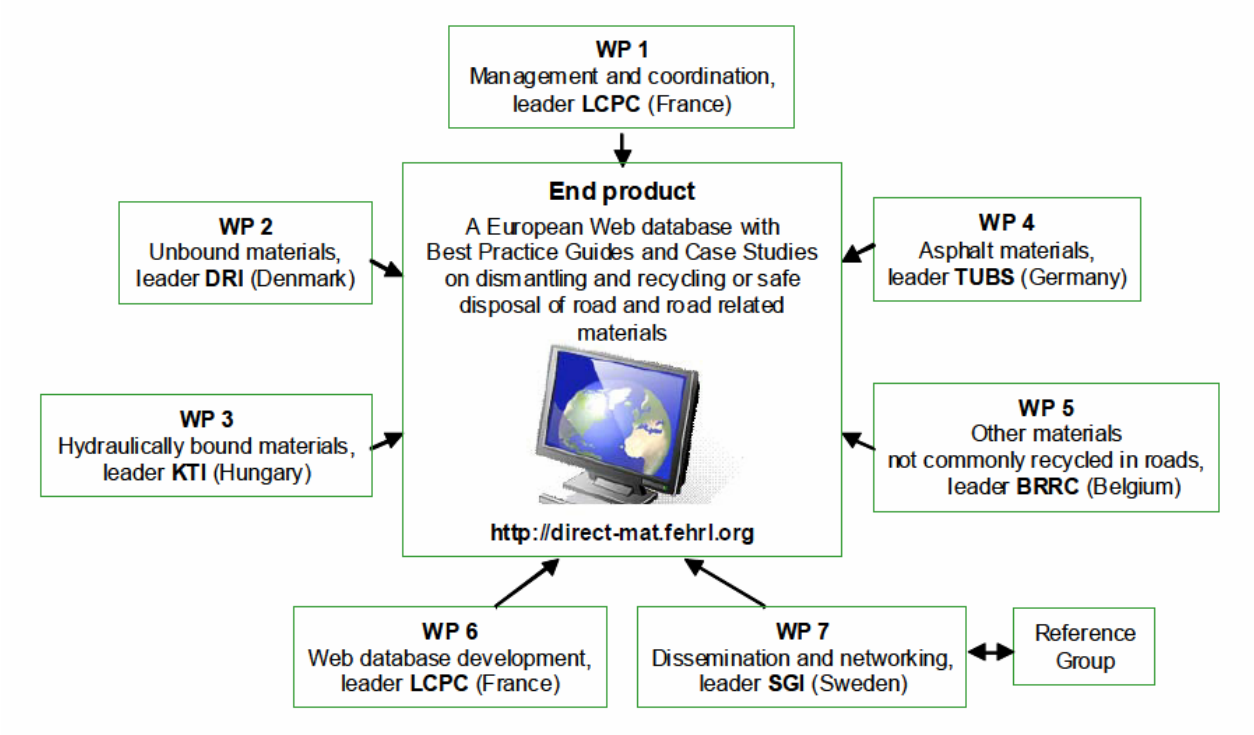

Figure 1 DIRECT-MAT work package organisation

2 Road waste materials addressed in DIRECT-MAT

In the Direct-Mat project the major road materials demolished during maintenance activity are addressed in single work packages. There the national techniques for demolition and recycling were elaborated during 2009.

2.1 Unbound materials

Unbound materials built up the base of any road. On top of the natural soil, which may be modified already with hydraulically binders, the roadbase is built up from natural aggregates (sand, gravel or crushed rock). Besides load-spreading properties the unbound base layers enable a drainability of the road structure as well as prevent frost heave especially in northern Europe. Therefore unbound road material consists of a mixture of the natural aggregates with varied grain sizes. In order to achieve the drainability the unbound material mixtures are composed specifically. Each grain itself needs high resistance against crushing to prevent the development of fines which would disturb the technical workability of the construction layer.

With thicknesses up to 50 cm the unbound materials take the highest percentage of the volume of a road structure.

As a first result of the international literature review as well as of the evaluation of the national material standards and recommendations it can be summarised that demol-

ished unbound layers can be reused in new road construction courses. Therefore the recycled material must fulfil the same technical requirements as natural aggregates in terms of single grain properties as well as the resulting grading. Therefore recycled aggregates are often mixed with virgin material to reach the needed material composition.

As new unbound layers are often drained and come in contact with groundwater several countries define environmental requirements on the recycled road material. If the recycled material contains special target pollution its use is restricted to waterproof road structures and may be prohibited in water protection areas.

2.2 Hydraulically bound materials (coming from roads)

The application of concrete pavements in road constructions is used to various extents in Europe's nations. For example, in 2008 there were only 101 km of concrete roads in use in Hungary and only 87 km in Sweden. In Austria by contrast 38 % (1420 km) of the highly trafficked motorways are made of concrete and up to 70 % of new motorways are currently built with concrete. Hydraulically bound pavement layers have been used in the form of concrete pavements and cement bound base layers in Denmark while cement stabilisation of sub-grade was never applied to any considerable extent.

These examples show the wide range of application of concrete pavements in Europe. Similar disparities can be noticed in the field of concrete recycling.

Recycling of materials has become normal practice in countries like Austria and Belgium where concrete pavements are used in a high percentage of the road system. In these nations (Austria, Belgium and the Czech Republic) special organisations are dealing with this technique and representing the national recycling companies. The use of recycled road materials in cement concrete pavements can not be considered as a common technology in other countries like Hungary. However there are several valid specifications in this field available. In Slovenia research on recycling of concrete roads was mainly focused on the use of industrial by-products like steel slag, fly ash and crushed concrete from building demolition in new concrete. Hydraulically-bound waste from road construction has not been targeted in European research works by now; the main reason can be that this waste usually utilized at least as material for embankment.

2.3 Asphalt materials

Throughout Europe about 333 million tonnes of hot mix asphalt (HMA) were produced in 2008 by more than 3.000 asphalt companies (EAPA 2008). At the same time more than 51 million tonnes of reclaimed asphalt were made available for recycling due to road maintenance or demolition.

The DIRECT_MAT participating countries look back on different developments concerning the road industry determined by natural circumstances (size of country, population, traffic density and natural recourses). These differences cause various answers concerning the development of recycling techniques for road materials.

An overview about various recycling techniques is given in Figure 2. Before the old flexible pavement is demolished the material is characterised. If it contains substances involving a danger for health or the environment (e.g. tar) special recycling techniques are necessary which are addressed in WP 5.

Generally two techniques can be applied on asphalt pavements:

- in-situ recycling where the old pavement material remains on site after being processed using mobile equipments and
- plant recycling where the dismantled road material is transported to mixing plants.

Demolition of the old pavement can be done using 2 methods: milling or cracking to blocks. In situ recycling generally requires milling. After demolition further manufacturing steps are applied to reach reclaimed asphalt which can be used in new pavement layers. The application in unbound layers is further addressed in WP 2.

With both recycling techniques, the reuse of the reclaimed asphalt (RA) in situ or in plant can be divided into:

- hot recycling where RA is mixed with new aggregates and hot bitumen, laid and compacted as usual hot mix asphalt at temperatures around 150°C (HMA),
- warm recycling where RA is mixed with new aggregates and hot bitumen with the addition of additives which enable the reduction of the mixing, laying and compaction temperature (~100°C),
- cold recycling where RA is mixed with new aggregates and bitumen emulsion or foamed bitumen with the possible further addition of hydraulically binder if required (~20°C).

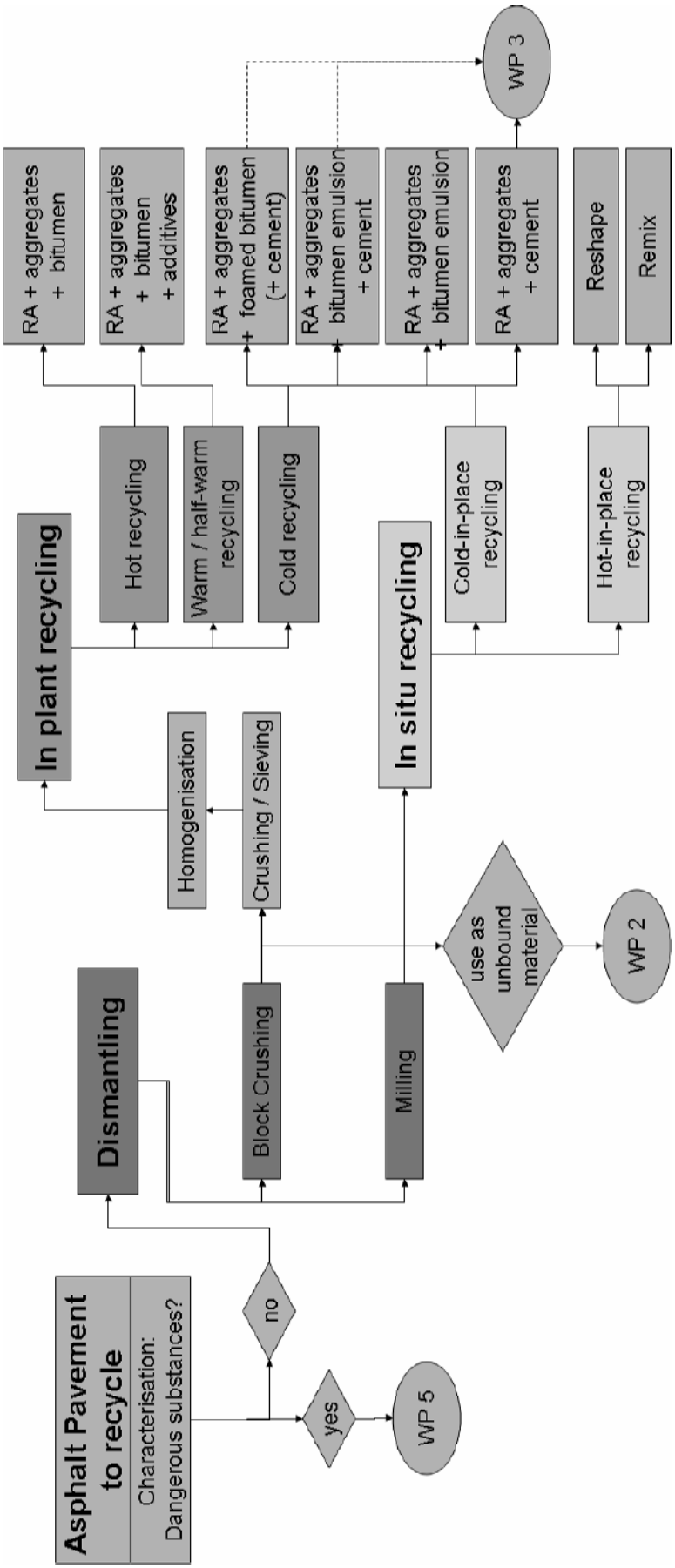

Figure 2: Techniques for recycling of reclaimed asphalt

Figure 3 shows the differences in the applied techniques for the end-of-life strategies for asphalt roads. Whereas some countries focus on the recycling of reclaimed asphalt as unbound material in road base layers, others specialised in the reuse of the old bituminous bound material in new hot mixed asphalt. In both cases the material from roads having reached the end of their service life is recycled in new road structures and high recycling rates are reached.

The causes of these differences can be found in differences of the general infrastructure in the various countries. Some countries have a high population density more or less homogeneously spread whereas others have wide areas with low population. Therefore some countries have a high number of stationary mixing plants which enables the plant-recycling by avoiding long-distance transportation of material. In these countries the percentage of plant-recycling is comparably high. Countries with areas of low population-density have a road network with less heavy trafficked roads which enables the application of in-situ recycling techniques where long-distance material transportation is avoided.

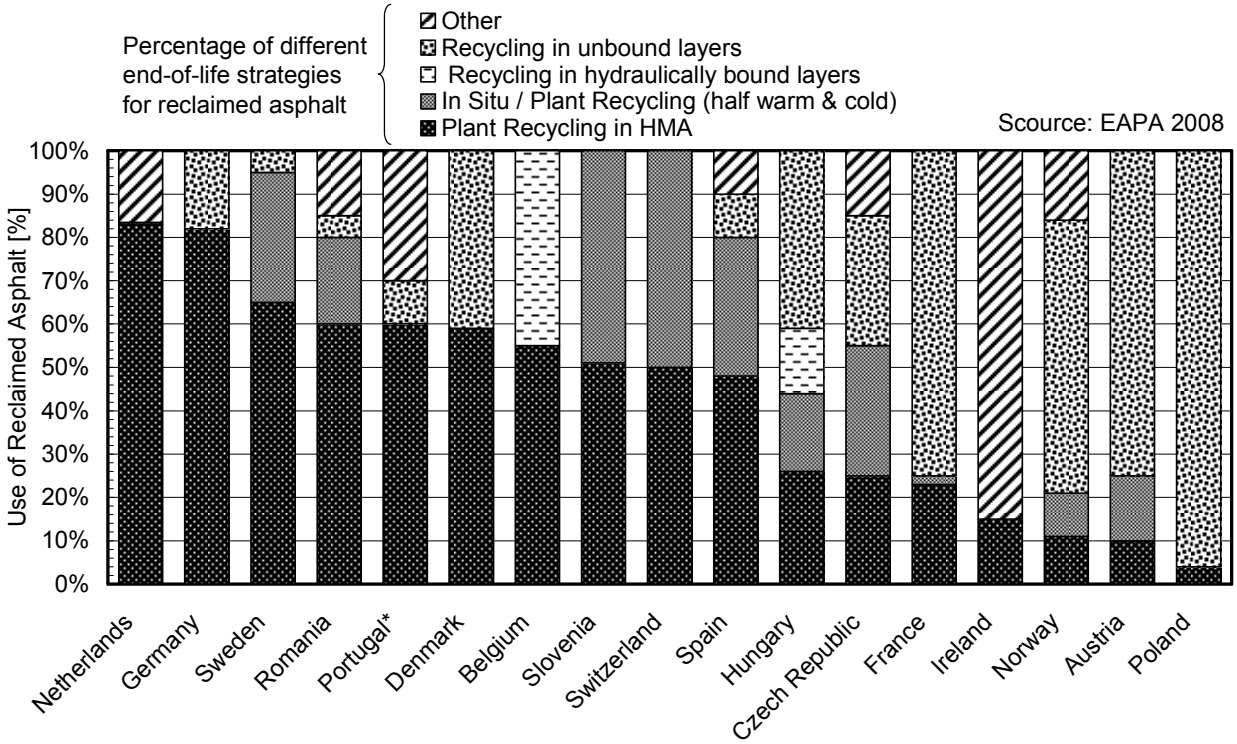

*Figure 3: Use of reclaimed asphalt material in road recycling (EAPA 2008 / *2007)*

2.4 Other road waste materials

Besides the major 3 groups of road construction materials (unbound, hydraulically bound and asphalt) there are some other materials used in road constructions which are not bulk goods or may need special consideration during road maintenance work.

Reinforcement materials (steel anchors, geosynthetic grids, etc.) and road markings interfere with common milling procedures and their residues may have to be removed from the reclaimed material.

In the past some road materials were used which were found to contain hazardous substances (as tar or asbestos). Other materials are subjected to traffic pollutants during their lifecycle (road shoulder materials). For both types of material their unrestricted reuse in the road construction is prevented due to health and safety or environmental issues.

The various end-of-life strategies for these materials vary considerably. One specific example is the handling of tar-bonded road materials. In several countries tar made of coal was used as asphalt binder until its carcinogenic hazards were discovered. Many road pavements still contain tar in some of their layers. When demolished nearly all countries developed special treatments for characterising the road waste and moreover for the recycling of these materials. In Germany, tar-containing material can be used as new cold-bound road construction material if it is ensured that leaching is prohibited (e.g. below waterproof road layers) (FGSV 2007). Other strategies range from the deposition in special landfills up to the incineration. This technique is applied in the Netherlands whereby the heated and “clean” aggregates are used directly for the hot-mix asphalt production.

A further road-related material is addressed in WP 5. Several countries benefit from the use of tyre shreds as constituent material in asphalt were found. By the recycling of this material countries will benefit by the reduction of other end-of-life strategies with higher environmental impact (as the energetic recycling in cement plants) as well as by extended service-lifetimes of new roads.

3 Summary

The on-going European research work on the demolition and recycling of road materials is following a systematised programme for its final output, the compilation of a Best Practice Guide in the topic. Not only the synergic experiences of the 20 partners from 15 European countries are utilized but further information coming from other European and non-European countries. The project partners are convinced on the basic advantages of the future outcome of DIRECT-MAT project in attaining a more and more sustainable European highway network.

4 Acknowledgement

This project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no 218656. The presented results are based on the project-internal national reports of all participating beneficiaries.

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