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MIXBIOPELLS SUMMARY OF THE MIXBIOPELLS PROJECT RESULTS

MixBioPells

MARKET IMPLEMENTATION OF ALTERNATIVE AND MIXED BIOMASS PELLETS IN EUROPE

Summary of the MixBioPells project results

mixBioPells
Market Implementation of extraordinary biomass pellets

Coordinated by: DBFZ

Partner: bioenergy2020+, protecma, VTT Danish Technological Institute, SP, Energia Ambiente CTI

Supported by INTELLIGENT ENERGY EUROPE

SUMMARY OF THE MIXBIOPELLS PROJECT RESULTS

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Date of Publication: June 2012

The authors would like to acknowledge the support and input of the project partners:

- Bioenergy 2020+
- Comitato Termotecnico Italiano (CTI)
- Danish Technological Institute (DTI)
- Energia y Medio Ambiente S.L. (Protecma)
- Technical Research Institute of Sweden (SP)
- Technical Research Centre of Finland (VTT)

This project was financed by the Intelligent Energy Europe programme. All data presented and opinions expressed remain the responsibility of the authors

Participating countries

In most European countries, the market integration of alternative biomass pellets (e.g. made of straw, agricultural or food processing residues) is still hindered by various constraints. To overcome these constraints and to strengthen the drivers, promising market introduction concepts will be identified to enhance the relevance of alternative pellets in Europe. Thus, the MixBioPells project provides up-to-date market information for alternative and mixed biomass pellets based on a comprehensive data collection for representative European countries and regions (see above) which are available at

www.mixbiopells.eu

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Market Implementation of extraordinary biomass pellets

Market implementation of alternative and mixed biomass pellets in Europe

IEE/09/758/ SI2.558286

Market implementation of alternative and mixed biomass pellets in Europe: Summary of the MixBioPells project results – Final publishable report

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Leipzig, August 2012

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PREFACE

This publication is part of the MixBioPells Project (Market Implementation of Extraordinary Biomass Pellets - IEE/09/758/ SI2.558286, www.mixbiopells.eu) funded by the European Union's Intellegent Energy Programme. MixBioPells is coordinated by the DBFZ Deutsches Biomasseforschungszentrum. Other partners involved in the project are Bioenergie 2020+, BE2020 (Austria), Technical Research Centre of Finland, VTT (Finland), Technical Research Institut of Sweden, SP (Sweden), Danish Technological Institute, DTI (Denmark), Energia Y Media Ambiente S.L., Protecma (Spain), Italian Thermotechnical Committee, CTI (Italy). The MixBioPells was performed between May 2010 and June 2012.

The main objective of the project was to identify the constraints and drivers for the market integration of alternative and mixed biomass pellets and to find promising market introduction concepts for enhancing the market relevance of these pellets in Europe. This was to be done by a comprehensive data collection, literature research as well as interviews and direct contacts with key actors. The MixBioPells project aimed at a strong support of initiatives on regional level.

With this report the main results as well as the impact of the project will be described. It will be shown how the findings were acquired, which conclusions were drawn and what has to be taken into account when applying the findings of the project to other countries and regions. Rather than being exhaustive the key outputs and their content will be highlighted which are in brief the "Initiators Handbook", the "Advisory Papers" for public authorities and policy makers both on national and European level and the draft for the labeling system developed in close cooperation with the European Pellet Council. Furthermore results and conclusions will be presented which were drawn from the support of initiatives in the course of the project.

In the long run, the MixBioPells project will amplify alternative and mixed biomass pellets production and utilization, secure the most cost effective and value adding use of biomasses that are currently not used adequately, boost the investments on best practice technologies, contribute to the creation of job opportunities particularly in rural area and lead to intensified networking activities and improved knowledge exchange between key actors along the value chain.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 General

Caused by the growing demand for material and energy related use, wood is getting scarcer nowadays. Consequently, unexplored solid biomass raw materials such as agricultural residues are experiencing growing interest as alternative fuel sources. In most European countries preliminary activities have been started to integrate these alternative solid biofuels. However, the market integration of alternative biomass pellets is still hindered by various constraints. To overcome the constraints and strengthen the drivers, the impact of national and European frameworks has been evaluated. On this basis, recommendations on favorable legal frameworks and regional concepts for the market integration of alternative pellets will be given. Furthermore, the difficulties connected to combustion of alternative pellets, especially in small scale, amplify the need for quality systems and quality assurance. Thus, a draft for a labeling system for the production and combustion of alternative and mixed biomass pellets developed in close cooperation with the European Pellet Council will be presented.

The aim of the MixBioPells project is to enhance the market relevance of alternative and mixed biomass pellets made of biomasses and biogenic residues (except wood) and mixed biomass pellets made of mixtures of raw materials from Group 1, 2 or 3 according to the definition in EN 14961. There are significant differences between the available raw materials and the national frameworks in the European countries and even between the regions within the same country. Thus, the local situations in Central Finland, East Sweden, Jutland in Denmark, Rhineland-Palatinate in Germany, Lower Austria, Lombardy in Italy and Asturias in Spain were analysed. Local bio-business activities have been supported based on a close cooperation with local key actors along the whole value chain. The objective was to develop regional case studies to gather information about successful technical developments, available raw materials, basic and economic conditions and problems during the build-up of new regional bio-business activities. The information was then set into the context of the current situation concerning technical possibilities in production and utilisation of alternative pellets in the European partner countries. As a result, recommendations on favourable legal frameworks can be given and regional concepts for the market implementation of alternative pellets with regard to the existing frameworks were developed. Dissemination of the project as well as the project results have been realised to increase the market implementation of alternative and mixed biomass pellets. A website including a database and a forum was set up and side-workshops were organised at local, national and international conferences. Based on a comprehensive data collection, the MixBioPells project provides up to date market information about alternative and mixed biomass pellets.

Within the project, several key actors along the value chain of alternative and mixed biomass pellet production and utilisation were interviewed. From these interviews the key actors view on problems and chances of alternative and mixed biomass pellet production and utilisation were visualised, also indicating the relevance of certain aspects. Additionally, the partners collected information concerning European, national and regional conditions, existing raw material sources, available amounts of alternative biomass and the fuel characteristics of these materials. Furthermore, technical solutions for both the production and the combustion of alternative and mixed biomass

pellets were gathered by means of literature research, market survey and contacts with key actors. Economic aspects were analysed for selected case studies representing the complete value chains within each country. The value chains were developed based on existing projects and were partly realised. Best Practice Examples for the production and utilisation of alternative and mixed biomass pellets as well as Best Practice Chains representing the whole value chain highlight successful strategies as well as common problems and motivations of the involved key actors in Austria (AT), Denmark (DK), Finland (FI), Germany (DE), Italy (IT), Spain (ES) and Sweden (SE). The Best Practice Chains are highly valuable to increase the market relevance of alternative and mixed biomass pellets in Europe. They can be used as guideline for future projects both on small and medium scale as well as on industrial scale. From the gathered information, common constraints and drivers became apparent. They can be allocated to the following fields:

- Policy and social acceptance,
- Legal framework,
- Economics,
- Technological and raw material issues.

Eventually, groups of national conditions were defined and classified. Thus, similarities between the countries in the fields of policy, public perception, legal conditions, economics and technology became evident. It could be shown, which of the national conditions are the most decisive key parameters defining the national frameworks. The method is illustrated in Figure 1.

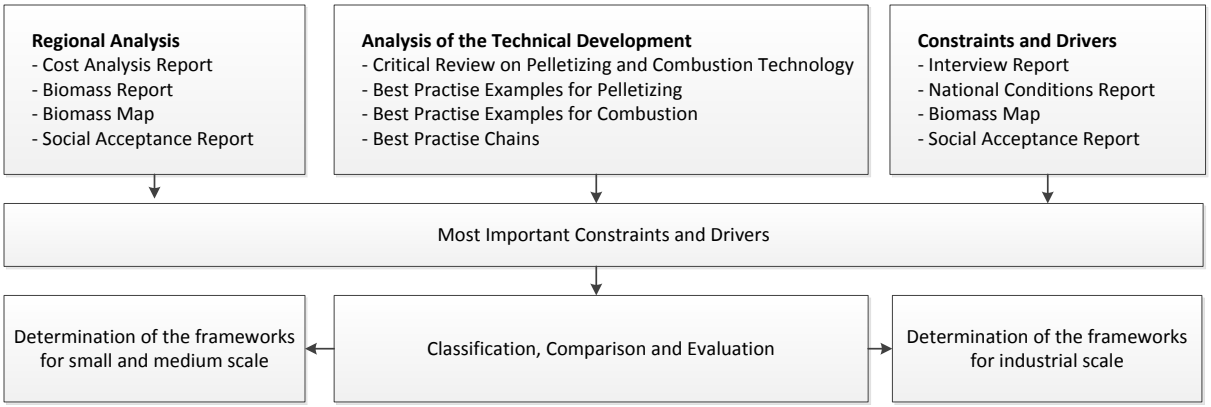


Figure 1: Method of the MixBioPells project

On this basis, recommendations were deduced both for policy makers and initiators. For the former, **Advisory Papers** are provided while for the latter an **Initiators Handbook** was developed. The Initiators Handbook is available in seven European languages (English, Finnish, Swedish, Danish, German, Italian, and Spanish). Both, the Initiators Handbooks and the Advisory Papers can be downloaded free of charge from the project website www.mixbiopells.eu. Furthermore, the **draft of a labeling system** for both the production of alternative and mixed biomass pellets and the combustion systems for these fuels was developed in close cooperation with the European pellet council.

1.2. Involved key actors

The involvement of key actors from different target groups such as raw material suppliers, pellet producers, manufacturer of production and combustion technology, associations or administration was an integral part of the project. The main key actors of the project are situated in the project regions and were involved into the regional analysis. The key actors supported the project by involving their experiences, problems and requirements, by giving information about relevant raw materials and successful regional concepts, by implicating their technical experiences with alternative raw materials and giving feedback to prospective developments. Additionally they supported the dissemination activities of the project. A selection of the involved key actors is listed in Table 1. The complete key actors list is available as D2.2 (see list of deliverables).

Table 1: Involved key actors

AUSTRIA	DENMARK	FINLAND	GERMANY	ITALY	SPAIN	SWEDEN
fex GMBH High Tech aus Natur www.adf-miscanthus.at FJ BLT WIESELBURG	VERDO ANDRITZ VATTENFALL	ARITERM BIOBOTNIA FINBIO VAPO	EnviTec Biogas PUSCH AG ENERGY COMPANY ÖKO THERM® RLP Agroscience	TERMO CABI AGE stufe centro di formazione professionale nazareno	HARGASSNER BIOMASA orientación sur visión sostenible KWB BRIEC	LATTRA GÅRD 1529 Bioprodukter Energikontoret i Mälardalen GLOMMERS MILJÖENERGI AB

2 CURRENT STATUS

2.1 Raw materials and fuels

2.1.1 General

Within the European countries there is a large variation regarding the kinds of available raw materials, accessible amounts and associated supply cost. While reed canary grass is a particularly important alternative biomass in Finland and Sweden olive and grape residues are predominantly available in the southern countries, e.g. Italy and Spain. In the context of the project the most relevant raw materials for each region had been selected based on selection criteria such as market size, relevance for the region, expert opinions, cross-border activities, already existing experiences and suitability for pelletizing. The raw materials were found to be quite heterogeneous with respect to chemical and physical properties, scattered or concentrated availability and existing experience.

For the benefit of key actors and bio-business initiators the MixBioPells project gathered and compiled information on availability, potentials and fuel characteristics of the most relevant raw materials in certain regions of seven European countries. They are summarized in the Biomass Report of the project (D2.3, see list of deliverables). For small and medium scale heating appliances only a few alternative fuels, e.g. straw, are used so far. Most of the alternative fuels are used in dedicated industrial CHP plants or for co-firing in varying fuel proportions.

2.1.2 Raw material potentials

Within the MixBioPells project the potentials of the three most relevant raw materials have been estimated for each partner country and compared with results from previous studies. The results of the comparison are shown in Figure 2.

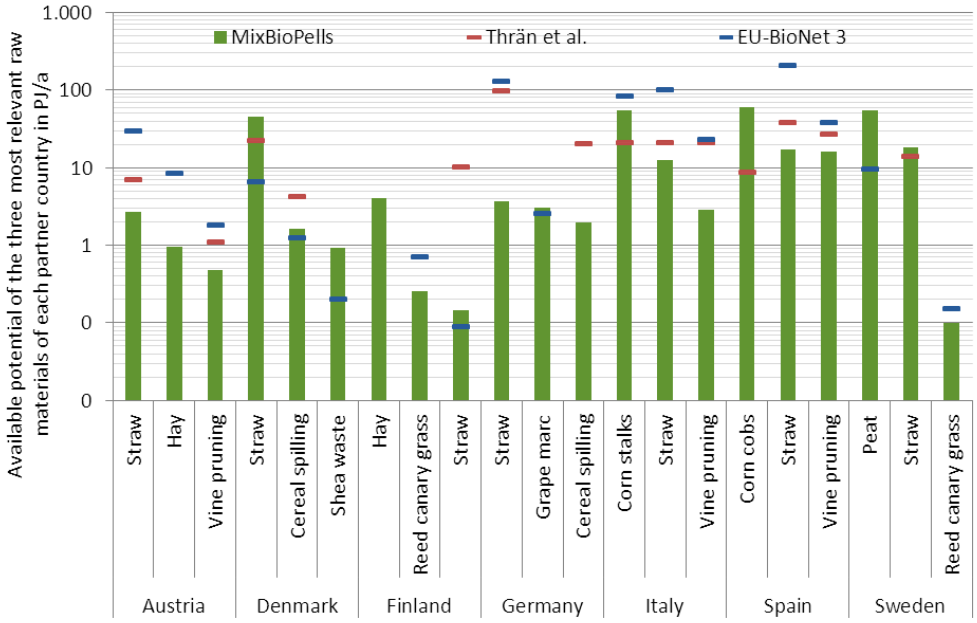


Figure 2: Comparison of the results on available potentials for selected raw materials in seven European countries with results from other studies

To get an overview about the total amounts of alternative raw materials that are available in the partner countries the potentials of the five raw materials with the highest relevance in the partner countries have been summed up (Figure 3). Several raw material types are available in too small amounts (e.g. olive cake, shea waste, mash from breweries, olive stones, almond shells, reed canary grass and rape seed press cake). Thus, their potentials are compiled and indicated as “others” in Figure 3.

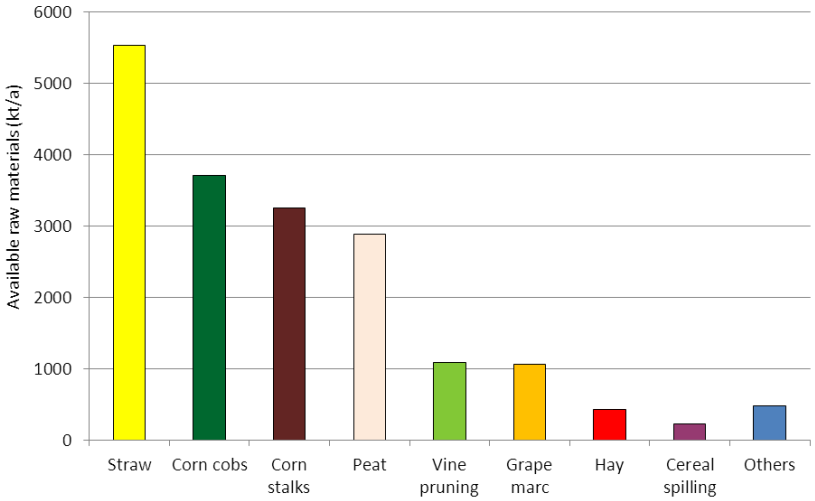


Figure 3: Most relevant raw materials according to the analysis within the MixBioPells project

From the results a biomass map (see www.mixbiopells.eu) was developed illustrating the raw material base in selected regions of the partner countries, Figure 4.

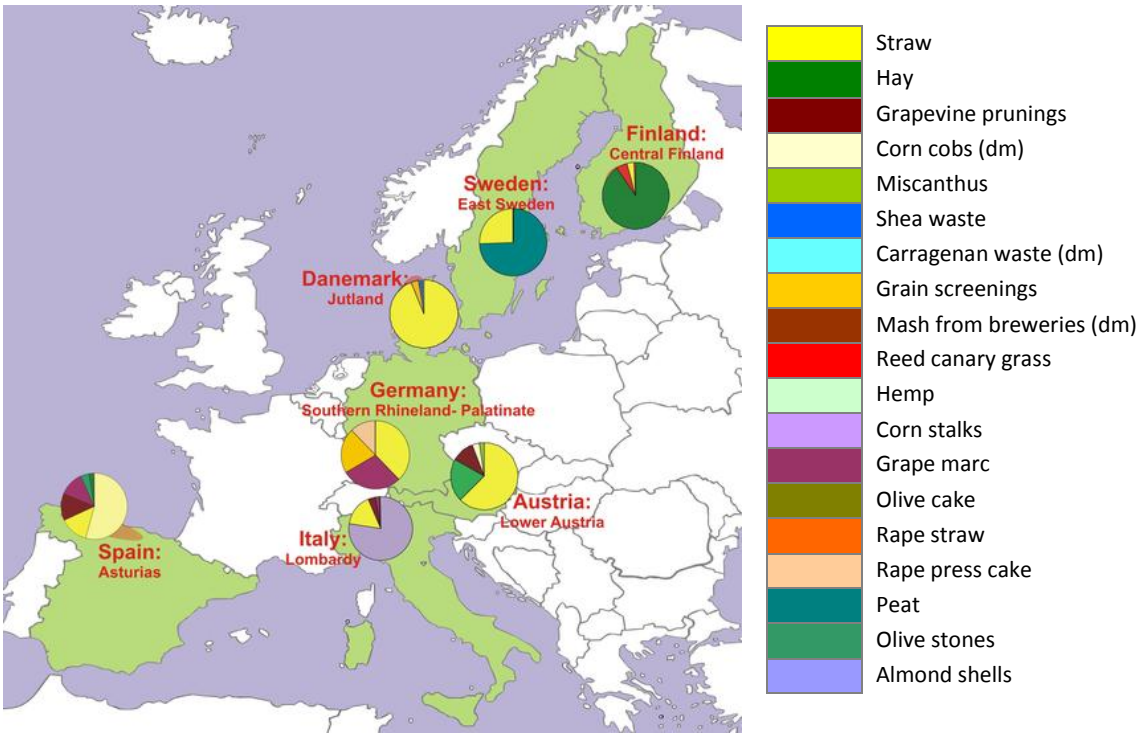


Figure 4: Biomass Map

2.1.3 Raw material properties

Raw material properties of non-woody biomasses are considerably different from the characteristics of woody biomasses. In general the ash content of non-woody biomass is higher and at the same time ash melting temperatures are found to be lower. High levels of nitrogen, sulphur, potassium and chlorine are often present in alternative biofuels. These elements can form harmful gaseous emissions like NO_x, SO_2, HCl as well as particulate emissions. Moreover, sulphur and chlorine play a major role in corrosion reactions. Table 2, Table 3 and Table 4 gives an overview about the raw material properties relevant for the standardisation and for the combustion of selected raw materials. If available, the range of the data is listed, other values are average values. Single values are especially indicated.

Table 2: Combustion-relevant fuel properties

Kind of biomass	Net calorific value	Ash content	Water content	Ash softening temperature	N	S	Cl
	MJ/kg db	% db	%	°C	% db	% db	% db
Miscanthus	17.5-17.9	1.6-3.0	7.5-14.0	820-1172	0.20-0.43	0.02-0.09	0.02-0.13
Reed canary grass	17.5-19.0	4.5-6.0	10.0-15.0	1150-1650	0.30-0.60	0.07-0.08	0.03-0.04
Hemp	19.1-19.6	1.6-2.3	56.6	1200-1250	0.30-1.40	0.06-0.10	0.02-0.30
Straw	17.0-19.0	4.4-7.0	9.0-15.0	800-900	0.30-0.80	0.06-0.12	0.03-0.05
Vine pruning	17.5-18.2	2.2-3.5	15.0	795-1200	0.50-0.75	0.02	0.05-0.07
Corn cobs	16.5	1.0-3.0	6.0-7.0	1100	0.40-0.90	0.03	0.02
Corn stalks	16.6-.17.5	11.0-17.0	15.0-18.0	1250	0.70-0.90	0.08-0.10	n.a.
Cereal spilling	16.5	9.8-10.0	10.0-12.0	1055	1.20-1.70	0.20	0.16-0.3
Hay	18.3	5.5	15.0	820-1150	1.60	0.04	0.09
Rape straw	18.5	3.4	15.0-25.0	n.a.	1.48	0.20	n.a.
Rape press cake	20.8	6.5	9.0	860-1115	5.39	0.36	0.01
Grape marc	18.4-20.8	3.5-11.0	50.0-60.0	1300	1.80-2.20	0.09-0.13	0.02-0.03
Olive residue	17.9-18.3	9.0-12.0	35.0-45.0	1310	2.50	0.15	0.06
Olive stones	16.0-19.0	<1	10.0-12.0	n.a.	<0.01	n.a.	n.a.
Almond shells	17.9-18.6	9.0-12.0	35.0-45.0	1395	0.45-2.50	0.09-0.15	0.02-0.06
Shea waste	18.5[1]	6.0[1]	13.0[1]	n.a.	2.60[1]	0.30[1]	0.10[1]
Carragenan waste	16.6[1]	10.0[1]	80.0[1]	n.a.	0.30[1]	0.70[1]	0.30[1]
Mash from breweries	20.0	4.0	80.0	n.a.	3.30	0.20	0.00
Digestate	15.4	16.5	15.0-20.0	n.a.	2.20	0.60	0.56
Peat	16.5	4.0	10.0-17.0	n.a.	1.20	0.12	0.03

[1] Single value; db…dry basis; n.a….not available

Table 3: Main ash forming elements in mg/kg (dry basis)

Kind of biomass	Al	Ca	Fe	K	Mg	Na	Si	Ti
Miscanthus	79[1]	1600-1790	92-120	3410-7200	300-600	31.5[1]	3930[1]	4-40
Reed canary grass	200-600	900-2000	13849	2300-4330	600-730	200-350	22280-22800	360
Hemp	111	13400	120	15400	2000	130	2100	0
Straw	60-130	2950-3300	120	7120-10000	630-1030	100-120	9000-19300	0
Vine pruning	140-774	4240-10900	390-625	2940-7660	820-840	180-415	4500-5350	64-66
Corn cobs	60[1]	400[1]	70[1]	8500[1]	290[1]	<50[1]	1100[1]	250[1]
Corn stalks	140	7390	680	8190	500	800	14200	70
Cereal spilling	700	2050-5000	500	5380-1340	1170-1400	300	26100	10
Hay	200	5600	60	14000	1740	1000	15000	0
Rape straw	n.a.	n.a.	n.a.	5800[1]	n.a.	170[1]	n.a.	n.a.
Rape press cake	13	3640-6500	0	8890-14100	220-4700	68	750	0
Grape marc	1330	200-6460	1140	7710-18160	60-1100	50-400	720-5260	90
Olive residue	868	7390	670	17000	353-500	46-500	2270-16620	11-80
Olive stones	410-1210	2640-7110	240-800	2550-19340	860	550	6240	90
Almond shells	293[1]	4650[1]	227[1]	7870[1]	687[1]	642[1]	2290[1]	25.7
Shea waste	710[1]	3020[1]	570[1]	38100[1]	3200[1]	100[1]	4630[1]	50000[1]
Carragenan waste	1140[1]	19940[1]	440[1]	4710[1]	4000[1]	1700[1]	5470[1]	110000[1]
Mash from breweries	20-100	4600-5530	440[1]	700-1340	2500-4780	200[1]	830-15990	0
Digestate	1940-5300	5800-28900	200-3600	3540-15000	1140-3000	3000-6550	7200-30600	1970
Peat	8000	4600	n.a.	8000-58000	1200	7000-22000	7900	0

[1] Single value; n.a….not available

Table 4: Heavy metals in mg/kg (dry basis)

Kind of biomass	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Miscanthus	<0.17	0.03-0.09	0.81-6.85	1.4-2.0	<0.03	2.0-3.3	0.16-0.95	1.0-25.5
Reed canary grass	2.10	0.30	3.40	9.1	0.03-0.10	1.0	0.10	11.7[1]
Hemp	0.86	0.11	1.21	4.9	0.03	n.a.	n.a.	2.5
Straw	0.31	0.17	6.56	2.1	0.02	2.2	0.18	1.4
Vine pruning	0.30-0.67	0.05-0.20	0.70-6.80	6.2-28.0	0.10	1.1-1.5	1.90[1]	n.a.
Corn cobs	n.a.	<1[1]	4.00[1]	<4[1]	n.a.	2.0[1]	<1[1]	11.0[1]
Corn stalks	n.a.	0.80	8.00	10.0	0.1	3.3	n.a.	n.a.
Cereal spilling	0.10	0.10	4.60	2.2	0.02	7.0	0.00	1.7
Hay	5.40	0.90	6.40	6.2	0.20	1.2	2.00	6
Rape straw	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rape press cake	0.50	0.40	3.80	4.5	0.03	0.7	0.34	6.4
Grape marc	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Olive residue	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Olive stones	0.09[1]	0.12[1]	7.70[1]	3.9[1]	0[1]	3.7[1].	1.30[1]	5.8[1]
Almond shells	0.20[1]	0.02[1]	7.17[1]	4.5[1]	0.01[1]	3.9[1]	1.18[1]	9.71[1]
Shea waste	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Carragenan waste	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Mash from breweries	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.06	n.a.
Digestate	<0.70	0.22-1.10	15.00-17.35	38.5	0.05	n.a.	0.04	n.a.
Peat	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

[1] Single value; n.a….not available

2.1.4 Fuel standards for alternative and mixed biomass pellets

In April 2012 the European standard EN 14961-6 “Non-woody pellets for non-industrial use” came into force which is or will be included in the national legal frameworks.

Pellets according to EU-standards will probably be more expensive due to certification procedures and possibly higher pre-treatment efforts as well as a more demanding pelletizing process to ensure constant quality and fulfilment of the requirements of the standard. However, these pellets are then applicable for certified combustion appliances that do not require special adaption to the fuel requirements. Thus, overall economics could be still favourable despite the higher fuel costs. In contrast, regional available alternative and mixed biomass pellets could be produced without fulfilling EU-standards. These pellets would be less expensive. However, available combustion technology would have to be adapted to the requirements of the local fuels. This strategy would be particularly suitable on regional level with local contracts for a local fuel. Thus, fuel characteristic would be though critical fairly constant. Thus, the additional costs for adapting the combustion technology could still pay off.

The availability of raw materials for different capacity ranges was evaluated (Constraints and drivers report D4.4, see list of deliverables). This has been realised according to the EN 14961-6. Thus, for small and medium scale utilisation only those raw materials that fulfil the requirements of EN 14961-6: Miscanthus, EN 14961-6: straw and EN 14961-6: reed canary grass well as EN 14961-6: class A should be used (see Table 5). Raw materials that fulfil the requirements of EN 14961-6: class B can be used for medium scale. For industrial scale applications those raw materials with even more critical characteristics should be applied.

Table 5: Comparison of the fuel characteristics of the most relevant raw materials with the thresholds given in EN14961-6 (A – requirements for ash content according to EN14961-6: Miscanthus A < 4 wt.-% d.b.; Straw A < 6 wt.-% d.b.; RCG A < 8 wt.-% d.b.)

Raw material	EN14961-6: Miscanthus				EN14961-6: Straw				EN14961-6: Reed Canary Grass			
	A	N	S	Cl	A	N	S	Cl	A	N	S	Cl
Miscanthus												
Reed canary grass												
Hemp												
Straw												
Vine pruning												
Corn cobs												
Corn stalks												
Cereal spilling												
Hay												
Rape press cake												
Grape marc												
Olive residue												
Almond shells												
Shea waste												
Carragenan waste												
Mash from breweries												
Digestate												
Peat												

requirements of the EN14961-6 can be fulfilled

requirements of the EN14961-6 can be fulfilled in some cases

requirements of the EN14961-6 can be not fulfilled

d.b. … dry basis

Table 5: (continued) Comparison of the fuel characteristics of the most relevant raw materials with the thresholds given in EN14961-6 (A – requirement for ash content according to EN14961-6: class A - A < 5 wt.-% d.b.; class B - A < 10 wt.-% d.b.)

Raw material	EN14961-6: class A				EN14961-6: class B			
	A	N	S	Cl	A	N	S	Cl
Miscanthus								
Reed canary grass								
Hemp								
Straw								
Vine pruning								
Corn cobs								
Corn stalks								
Cereal spilling								
Hay								
Rape press cake								
Grape marc								
Olive residue								
Almond shells								
Shea waste								
Carragenan waste								
Mash from breweries								
Digestate								
Peat								

requirements of the EN14961-6 can be fulfilled

requirements of the EN14961-6 can be fulfilled in some cases

requirements of the EN14961-6 can be not fulfilled

d.b. … dry basis

2.2. Production and utilization of alternative and mixed biomass pellets

2.2.1 General

The characteristics of alternative biomasses differ from woody biomasses. Thus, available technology for wood harvest, milling, compacting, handling and combustion is not always well suited for alternative raw materials. Instead, special or adapted technology might be required. In some cases, know-how from related utilisation paths can be used as basis (e.g. straw and hay pelletizing for forage or litter). However, critical fuel parameters and especially strongly varying fuel characteristic within a single biomass type afford special care and experience that is rarely available. Using mixtures of different raw materials is one possibility to achieve the required fuel properties, e.g. of product standard EN 14961-6. The mixing ratio often depends on the availability and price of the raw materials. From the investigations within the MixBioPells project it became apparent that in most cases pure alternative biomasses have been used. There is only a small number of pellet producers using mixtures of alternative raw materials.

2.2.2 Pelletizing technologies

Several properties of alternative raw materials can be problematic for their handling (Table 6).

Table 6: Properties of alternative raw materials and resulting problems

Property	**Problems that might result from the property**
higher ash content	• abrasion during the pelletizing process • reduced lifetime of the dies
structural properties (e.g. stalks)	• problems with the feeding system (e.g. blocking)
hardness of the material	• higher energy demand and wear during cutting and milling
different molecular composition	• different compacting properties requiring different dies
varying fuel characteristics and inhomogeneous structural features	• handling of these variations requires experience that is rarely available
low energy density	• higher storage and transportation effort

A good possibility to generate a solid biofuel with improved and defined transportation, storage and feeding properties is the agglomeration into pellets or briquettes. Binders can be used to reduce abrasion of dies and to lower the energy consumption during the compacting process. Based on the literature research, pelletizing of alternative biomass has gained considerable interest, recently. It could be shown that in many cases available wood pelletizing technology can be employed if suitable adaption of the pelletizing parameters (e.g. moisture content, die speed, dimension of the die) is employed. Problematic is the development effort for each raw material and the energy demand for pellet production that is often higher compared to wood for several cases. Thus, market implementation is still very limited. Therefore, the market survey had to be realized based on the data collection (Critical review on pelletizing and combustion technology D3.1, see list of

deliverables) and the interviews within the project (Summarisation of the interview D4.2, see list of deliverables). Accordingly, MixBioPells provides the most accurate data on this topic available at the moment. From the data collection and the interviews with key actors the following results were deduced. There are two different pelletizing technologies which are most commonly used for alternative raw materials:

- Pellet mills with flat dies: This technology is common for the production of animal feed pellets.
- Pellet mills with ring dies: This technology is mainly used for the industrial production of wood pellets.

According to the interviews about 50 % of the average installed pelletizing technologies for alternative raw materials are ring die presses, see Figure 5.

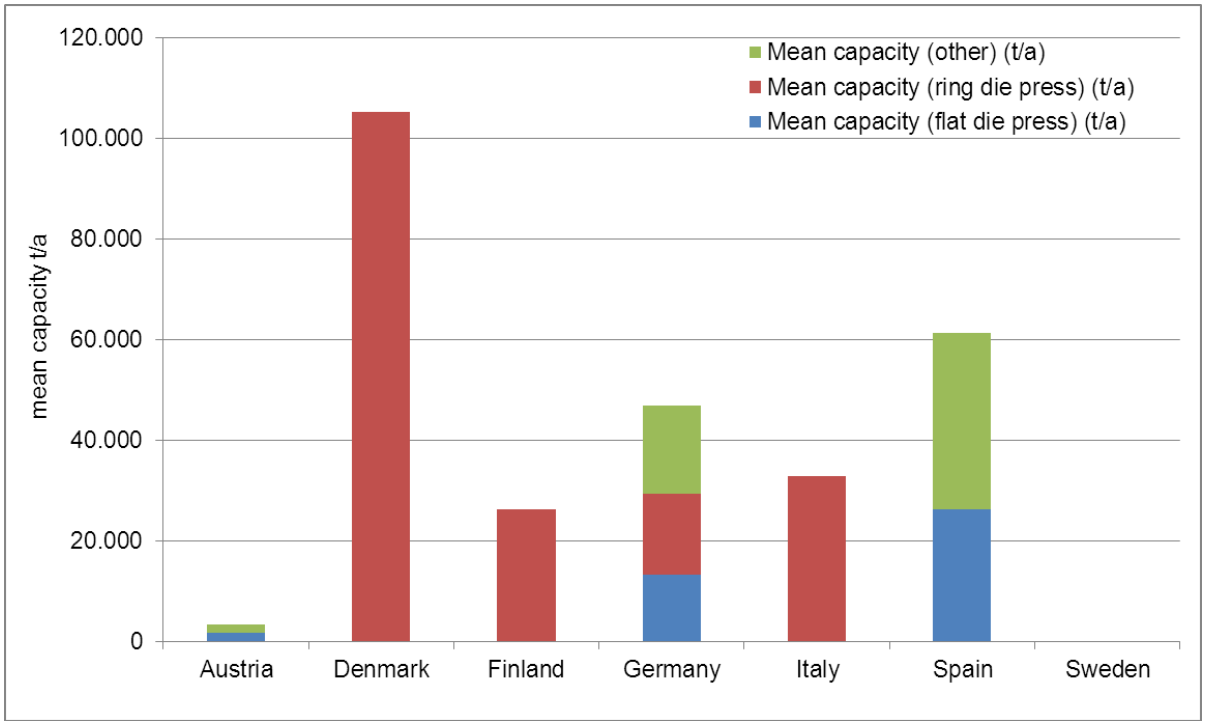


Figure 5: Average installed pelletizing technologies (others: e.g. hydraulic presses)

From the interviews it can be deduced that there is a total press capacity of about 590,000 t/a available for the production of alternative and mixed biomass pellets within the partner countries (Figure 6). The total real production of these pellets accumulates to about 373,600 t/a. Thus, capacity utilisation of about 68% is achieved. In Denmark more than 100,000 t/a straw pellets and in Sweden more than 100,000 t/a straw, peat and reed canary grass pellets are produced. Smaller pellets amounts are produced in Germany with straw, energy crops like Miscanthus and hay, Finland using peat pure and in mixtures with wood and Italy using energy crops, grape marc and agricultural residues. In Austria the production is very low using energy crops and hay. In Austria, Germany, Italy and Sweden there is still a significant share of unused capacity.

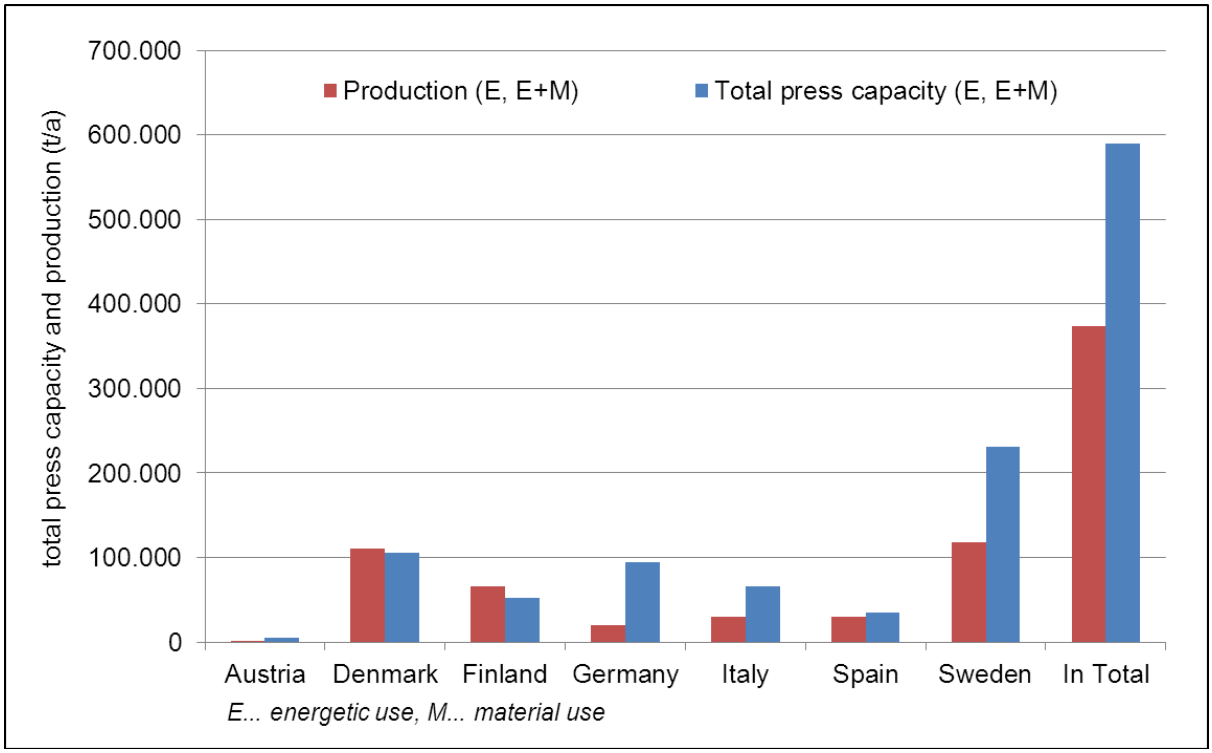


Figure 6: Total press capacity and production[1]

According to the interviews alternative and mixed biomass pellets are mainly produced from local raw materials and for local use. As main problems in the field of alternative and mixed biomass pellet production the following aspects were identified from the interviews:

- quality of the raw materials,
- difficulties with the pelletizing process,
- lack of experience.

2.2.3 Combustion technologies

The combustion of alternative and mixed biomass pellets can be more challenging than the combustion of wood pellets and possible problems have to be considered. The reasons for this can be found in the composition of alternative raw materials that is significantly different from woody biomass. The main fields of problems for the combustion of alternative and mixed biomass fuels are summarised in Table 7.

[1] Higher production in DK and FI compared to the capacities results from the different feedback rates for the respective question in the interviews.

Table 7: Main fields of problems for the combustion of alternative and mixed biomass fuels

Property	**Problems that might result from the property**
higher ash content	• problems with ash removal
varying fuel characteristics	• handling of these variations requires experience that is rarely available
higher content of critical elements (e.g. N, S, Cl, K, Na, Si)	• possibly higher emission of harmful gaseous components (e.g. HCl, SO_2, NO_x) and particulate • higher risk of fouling and corrosion on downstream tubes and surfaces • lower ash melting point with increased slagging risk

These problems can be lowered by primary and secondary measures. Reduction of harmful emissions can be obtained by either avoiding creation of such substances (primary measures) or removing the substances from the flue gas (secondary measures).

Primary measures:

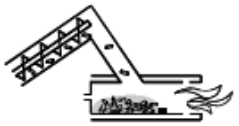
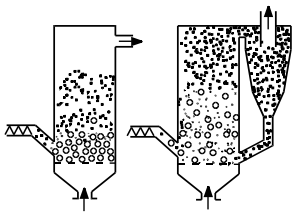
- modification of the fuel (leaching of the raw materials, blending of difficult raw materials with additives or less problematic raw materials) which can also enhance the ash related characteristics
- modification of the combustion process (flue gas recirculation to achieve reducing atmosphere and lower temperature, cooled grates to reduce slagging, automated cleaning and ash removal to prevent slagging and fouling)

Secondary measure:

- flue gas cleaning.

Similar to the pelletizing of alternative biomass, their combustion and problems correlated with ash slagging, corrosion and higher emission levels have also gained considerable interest among the scientific community in the last years. Support programmes for research and development facilitated the development of technologies. Consequently, combustion systems suitable for selected alternative raw materials have been introduced by some manufacturers. However, market implementation is still limited and prior to the project no market data were available. Therefore, the market survey had to be realized based on the data collection (Critical review on pelletizing and combustion technology D3.1, see list of deliverables) and the interviews within the project (Summarisation of the interview D4.2, see list of deliverables). Accordingly, MixBioPells provides the most accurate data on this topic available at the moment. From the data collection and the interviews with key actors the following results were deduced. There are different combustion systems which are suitable for alternative and mixed biomass pellets. Depending on the aspired capacity range one of the following different combustion systems (Table 8) may be employed.

Table 8: Combustion systems

Combustion system	Thermal range	Picture
Horizontal stoker burner	20 kW – 1 MW	
Moving grate combustion system	30 kW – 10 MW	
Water cooled combustion chamber with ash stoker	50 – 800 kW	
Underfeed rotating grate combustion systems	3 – 20 MW	Not available
Fluidised bed firing (a) bubbling fluidised bed with lower gas flow and a defined boundary between the bed and the free board or (b) circulating fluidised bed with higher gas flow and a blurred boundary between the bed and the free board.	(a) 5 – 15 MW (b) 15 – > 100 MW	

According to the interviews with key actors, sustainability and regional added value are among the issues most often mentioned as motivation for the utilization of alternative and mixed biomass pellets and briquettes. The clear majority of the interviewed key actors expect a further increase in the future.

The current use is focused on energy crops and residues from agriculture. According to the interviews only a minority of key actors employ combustion systems dedicated for alternative and mixed biomass pellets. Usually boilers for wood pellets, wood chips or wood briquettes are used. This indicates the limited number of appropriated technology available for this purpose or respectively the high costs for these technologies. Accordingly, several problems resulting from difficult fuel characteristics are not addressed and were reported:

- Dust emission
- Corrosion
- Slagging and fouling
- Ash handling

Each of the interviewed key actors had at least once a problem with the combustion. This finding highlights the importance of adapted boiler technology and the necessity of available experience with the handling of alternative fuels.

2.2.4 Flue gas cleaning technologies

Depending on the emission thresholds secondary measures for the reduction of NO_x, SO_2 or dust may be required. Most of the available flue gas cleaning technologies contributes also to the reduction of HCl, heavy metals and PCDD/F emissions. In principle, secondary emission reduction measures are known and are available for all harmful emission components. However, particularly on small scale their utilisation is rarely cost effective. The possibilities to build-up viable combustion systems with advanced flue gas cleaning increase with the size of the biomass combustion applications.

Small and medium scale applications

For small and medium scale combustion, reduction of small particle emission will probably be most critical. There are two different approaches for the reduction of particulate emissions:

- Many boiler manufacturers focus their developments on the optimisation of the combustion chamber as well as the fuel and air supply.
- Another possibility is the use of precipitator technology.

The development of appropriate precipitator technologies is still subject of several on-going research activities. Even for wood stoves and boilers there are only few precipitators available at the market. At the moment, electrostatic precipitators are most common. However, most of the available systems have significantly lower separation efficiencies compared to the industrial applications. So far, filter precipitators are not offered for heating appliances < 100 kW. Some of the precipitator technologies are tested for the use of non-woody and mixed biomass and were adapted to some extend for higher dust concentrations and varying dust characteristics. The selection of the appropriated precipitator technology strongly depends on the characteristics of the particles. The high specific investment and operation costs prevent the widespread usage of technology and cause a low demand. Available technologies on the market have been compiled in the Critical review on pelletizing and combustion technology (D3.1, see list of deliverables).

Industrial scale applications

Emission reduction measures particularly for the removal of particles, NO_x and SO_2 are state of the art for industrial combustion systems. Other components that can also be reduced by secondary measures are HCl, heavy metals and PCDD/F. However, secondary emission reduction measures for these components will not be presented in detail because the solutions are made individually for each plant. Furthermore, information and data about construction, operation and characteristics of the mentioned secondary measures are scarcely available.

2.2.5 Best Practice Examples

In the course of the project best practice examples on the production of alternative and mixed biomass pellets (D3.2, see list of deliverables) and on their combustion (D3.3, see list of deliverables) were gathered in close cooperation with local industry partners. Furthermore best practice chains representing the whole value chain were identified (D3.4, see list of deliverables). The best practice examples are of great relevance since they provide insight in the individual motivation, problems and solutions of the key actors, see Table 9, Table 10 and Table 11. The best practice examples are

available in seven languages at the project website http://www.mixbiopells.eu/en/publications/best-practices.html.

Table 9: Overview about best practice examples “production”

Country	**Best practice example “production”**
Austria	Pelletizing straw at FEX
Denmark	Pelletizing straw & screenings at Køge Biopellet Factory
Finland	Pelletizing straw and grass at Biobotnia Oy
Germany	Pelletising of mixed biomass pellets at Pusch AG
Italy	Pelletizing straw and cornstalks at Bagioni group
Spain	Vine pruning pelletizing by Orientación Sur Consultoría S.L.
Sweden	Briquetting of reed canary grass at Låttra farm in Sweden

Table 10: Overview about best practice examples “combustion”

Country	**Best practice example “combustion”**
Austria	Combustion of hay briquettes
Denmark	Combustion with mixed biomasses at Randers CHP
Finland	Combustion of mixed pellets at Ariterm Oy
Germany	Combustion of grape marc pellets in small and medium scale combustion systems
Italy	Combustion of alternative pellet in Tomasoni farm
Spain	Combustion of vine pruning pellets at Orientación Sur
Sweden	Combustion of Reed Canary grass briquettes at Låttra Farm, Sweden

Table 11: Overview about best practice examples “production and combustion chain”

Country	**Best practice example “production and combustion chain”**
Denmark	Production & combustion of biomass pellets at Vattenfall A/S in Denmark
Germany	Production and combustion of mixed biomass pellets at Pusch AG within the “agrarSTICK®” concept
Germany	Production and combustion of grape marc pellets and blends with vine pruning in small scale appliances
Italy	Grapevine pellets production and combustion
Spain	Production and combustion of almond shell briquettes in Crevillent, Spain
Sweden	Production and combustion of Reed Canary grass briquettes in Sweden

2.3 Economics

2.3.1 General

Alternative and mixed biomass pellets production and utilisation projects are mostly accompanied by higher initial costs resulting from critical fuel parameters and characteristics of the alternative raw material as well as from the statutory requirements. However, lower raw material and fuel costs can contribute to make these investments profitable. Furthermore, support options can help to overcome constraints resulting from the high initial costs.

Within the MixBioPells project two case studies, representing the whole value chain of alternative pellets, were established for each partner region. Based on these case studies a comparison of the costs of alternative heating systems with commonly used fossil heating system considering the local conditions has been performed (Cost analysis report D2.5, see list of deliverables). Data for the cost analysis was gathered from the key actors involved in these case studies. As a result both fuel costs and heat supply cost could be compared for different raw materials and for different capacity ranges. The European and transnational aggregation of costs of alternative biomass heating systems employed for the MixBioPells project is an innovative approach and stands out from the on-going and previous projects.

2.3.2 Fuel costs

Within the MixBioPells project the fuel costs have been calculated for selected case studies. More detailed information can be found in the Cost Analysis Report of the project. Fuel costs are determined by costs for crop growing, harvesting, transport (up to 50 km), drying and pelletizing/briquetting. As a major part of the annual running costs they have a wide influence on the economy of a heating system. Figure 7 presents the fuel costs identified in the different case studies in € / MWh considering these aspects. Furthermore the fluctuations of fossil fuel prices in the different partner countries are illustrated.

The fuel costs amount to 18-56 € / MWh, depending on the used raw material and the pelletizing plant. Necessary pre-treatments of the raw material have a major impact on the pellet prices. Therefore raw materials which do not require intensive drying should be used, unless the raw material prices are extraordinary low.

→ Low drying and storage costs are in most cases essential to ensure a profitable fuel.

The costs for pelletizing and briquetting amount to 11-32 % of the whole fuel costs. Certainly, these costs strongly depend on the pelletizing/briquetting plant, but also on production parameters and fuel properties.

→ Optimising the pelletizing process in terms of suitable production parameters and raw material mixtures is a large cost advantage.

Due to the increasing prices of heating oil, the use of agricultural biomass fuels is getting more and more attractive from an economic point of view. Especially in the Nordic countries, the use of alternative biomass fuels is much cheaper than using fossil fuels. Even medium to large scale

alternative heating appliances with flue gas treatment systems are more profitable over service life despite higher investment costs.

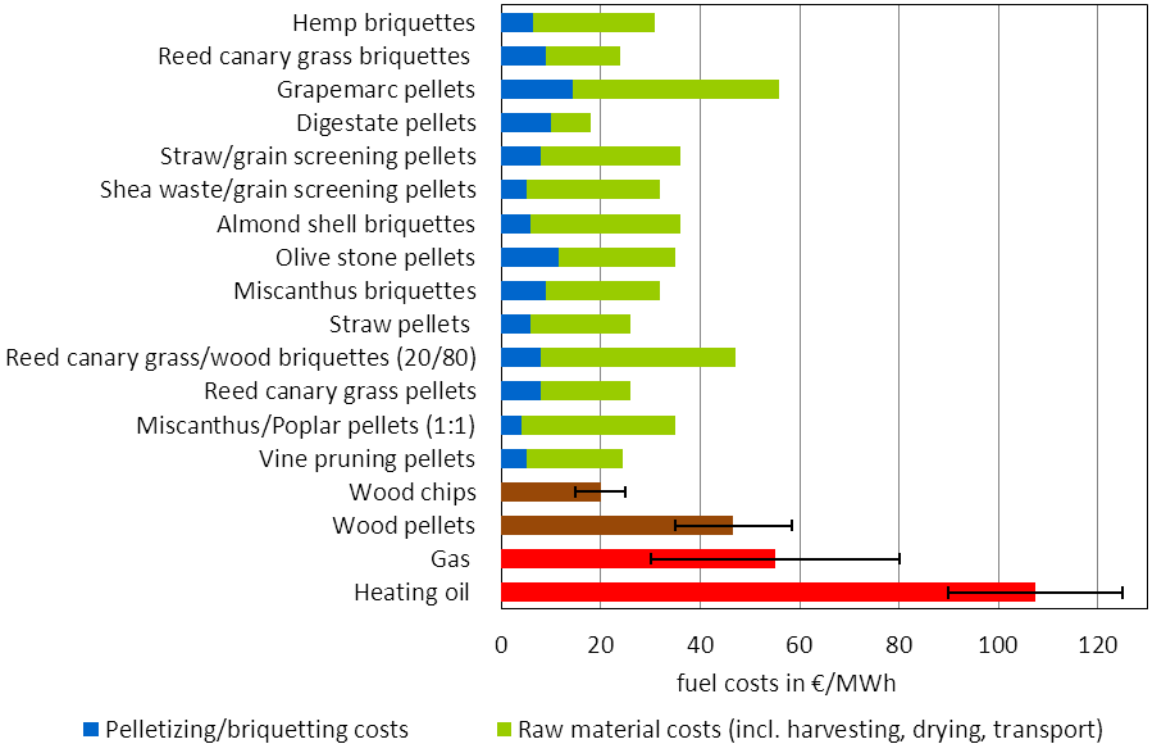


Figure 7: Fuel costs incl. costs of pelletizing and briquetting in €/MWh as well as fluctuations of wood and fossil fuel prices in the various partner countries

2.3.3 Heat supply costs

Within the MixBioPells project the heat supply costs have been calculated for selected case studies. More detailed information can be found in the Cost Analysis Report of the project. The following cost categories have been taken into account, Table 12.

Table 12: Cost categories included in the calculation of the heat supply costs

Investment costs	• boiler • storage room • construction and initial operation • flue gas treatment system • heating grid
Running costs	• fuel costs • auxiliary energy costs • filling flat rate • chimney sweeper costs • maintenance and repair

The investment costs of heating systems for alternative biomass are in general higher than for comparable fossil fuelled heating systems. However, fuel costs as a major part of the annual running costs have a wide influence on the heat supply costs and thus on the economics of heating systems (Figure 8). Due to the increased impact of fuel costs, medium to large scale heating systems which are operated with alternative pellets are more likely to be profitable than fossil fuel systems. Thus, heating systems operated with alternative and mixed biomass pellets or briquettes are getting favourable after an operation time well below the middle of the service life. For small scale profitability within the service life can only be achieved for a particularly high difference between fossil fuel price and alternative and mixed biomass pellet price.

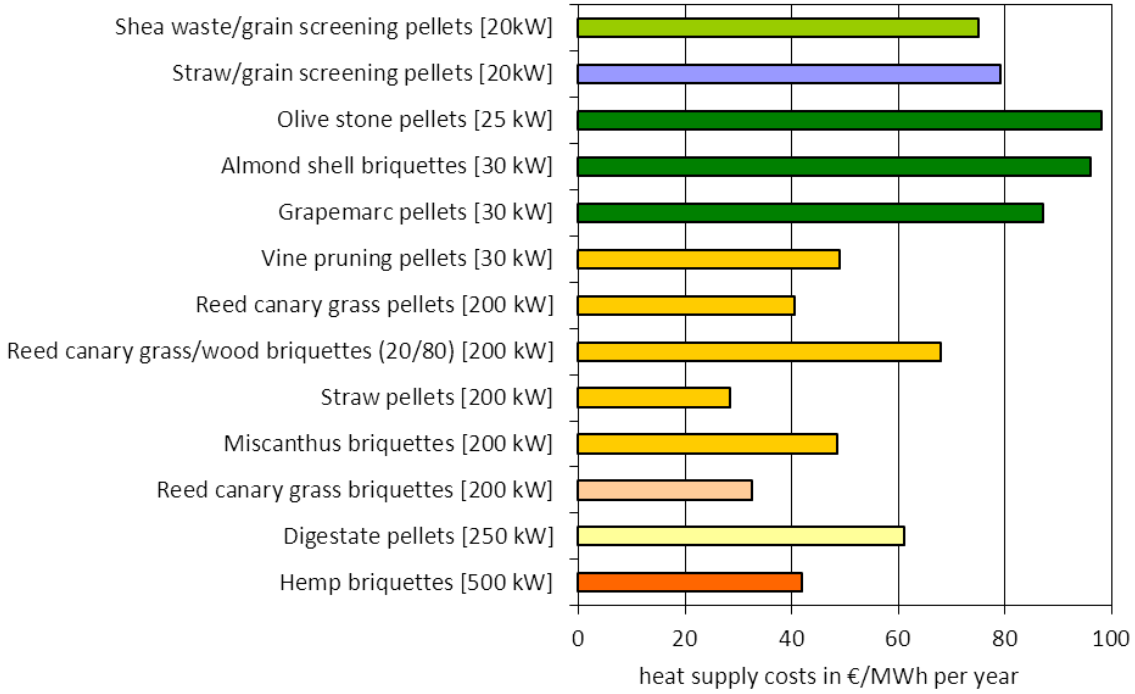


Figure 8: Comparison of heat supply costs of the alternative combustion systems of the case studies in €/MWh per year

2.4 National Conditions

2.4.1 General

The national aspects of the partner countries were surveyed and assessed to set the findings on the current market implementation of alternative and mixed biomass pellets into the right context (National conditions report D4.3, see list of deliverables). Thus the following aspects were considered:

- General political conditions for the utilisation of solid biofuels in the partner countries including the political targets and support schemes.
- Legal framework including licensed fuels, emission thresholds, rules on waste disposal and legal aspects of permission to install the boilers and to use the fuels including measurement methods.
- Social acceptance of alternative and mixed biomass pellets production and utilization.

2.4.2 Political conditions

The most important aspects of the political conditions for the utilisation of solid biofuels are:

- Political targets in the EU and for the member countries and
- Support options.

The comparison of the current biomass use with the political targets indicates if the political conditions are favourable for the enhanced biomass use. The given support schemes reflect the political will for the realisation of the political targets.

Political targets for the use of solid biomass fuels

Policy provides climate protection targets and targets for the use of renewable energy sources (RES). Ambitious targets are aimed to enhance the relevance of renewable energy sources. With the National Renewable Energy Action Plans all European countries have committed to the achievement of certain targets and measures to support the development towards the envisioned targets. Based on the present energy structure and the policies the targets are quite different in the partner countries. According to the NREAPs the targets for biomass utilisation in the heat and the electricity sector also differ quite significantly.

A) Heating and cooling sector

The assumed change of total energy consumption for heating and cooling between 2010 and 2020 as well as the targeted biomass utilisation are illustrated in Figure 9. All countries aim to further increase biomass utilisation for heating and cooling. The largest increase is targeted by Italy. However, Italy starts from a quite low value compared to the total heating and cooling consumption. In contrast, in Finland and Sweden a large share of heating energy is already provided by biomass fuels. Efficiency measures are assumed to lead to a decreased heat demand in Germany, Spain and Denmark. As illustrated in Figure 10 heating and cooling from renewable sources is almost exclusively provided from biomass for all partner countries except Germany and Italy. There, significant contribution of geothermal energy as well as heat pumps is assumed.

B) Electricity sector

Biomass is far less used for the production of electricity for all partner countries. All countries aim to further increase biomass utilisation for electricity production. The assumed change of total energy consumption for electricity production between 2010 and 2020 as well as the targeted biomass utilisation are illustrated in Figure 11. The highest total increase is targeted by Germany. Denmark is targeting the highest percentile increase and aims to produce almost a quarter of its electricity from biomass. As illustrated in Figure 12 biomass contributes only to a minor part to the total electricity production from renewables.

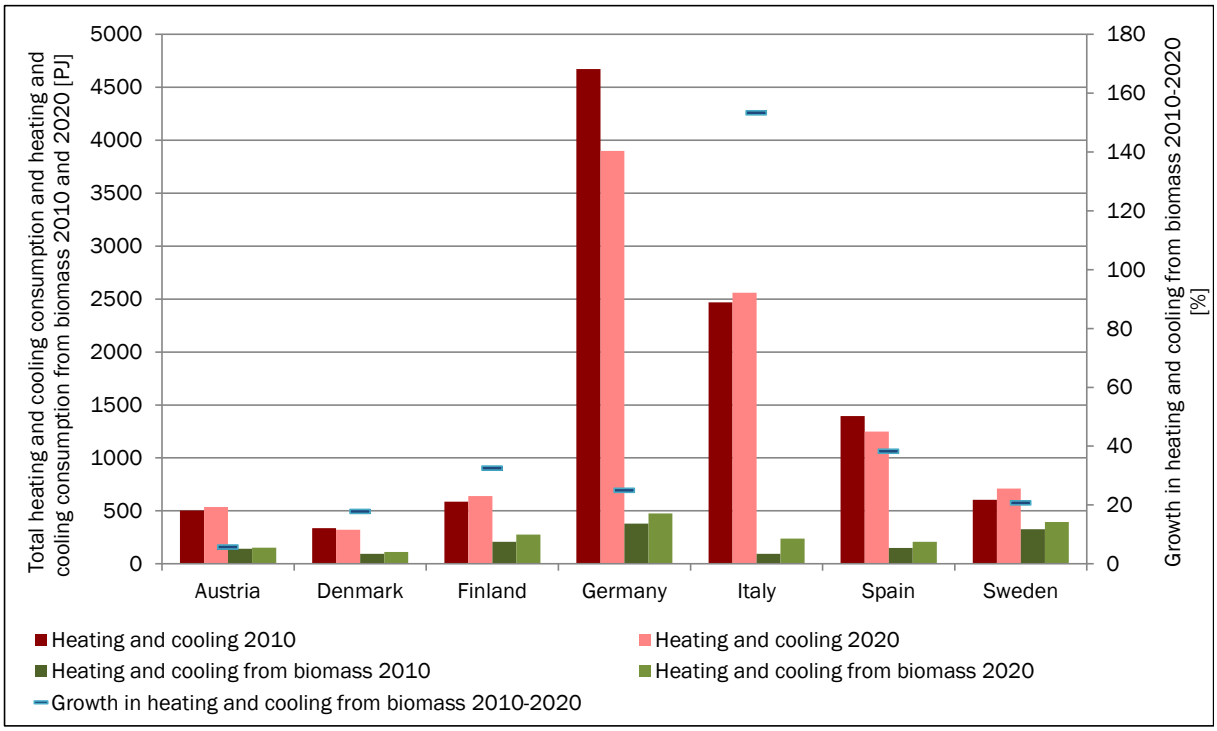


Figure 9: Total heating and cooling consumption for 2010 and 2020 as well as the targeted heating and cooling from biomass

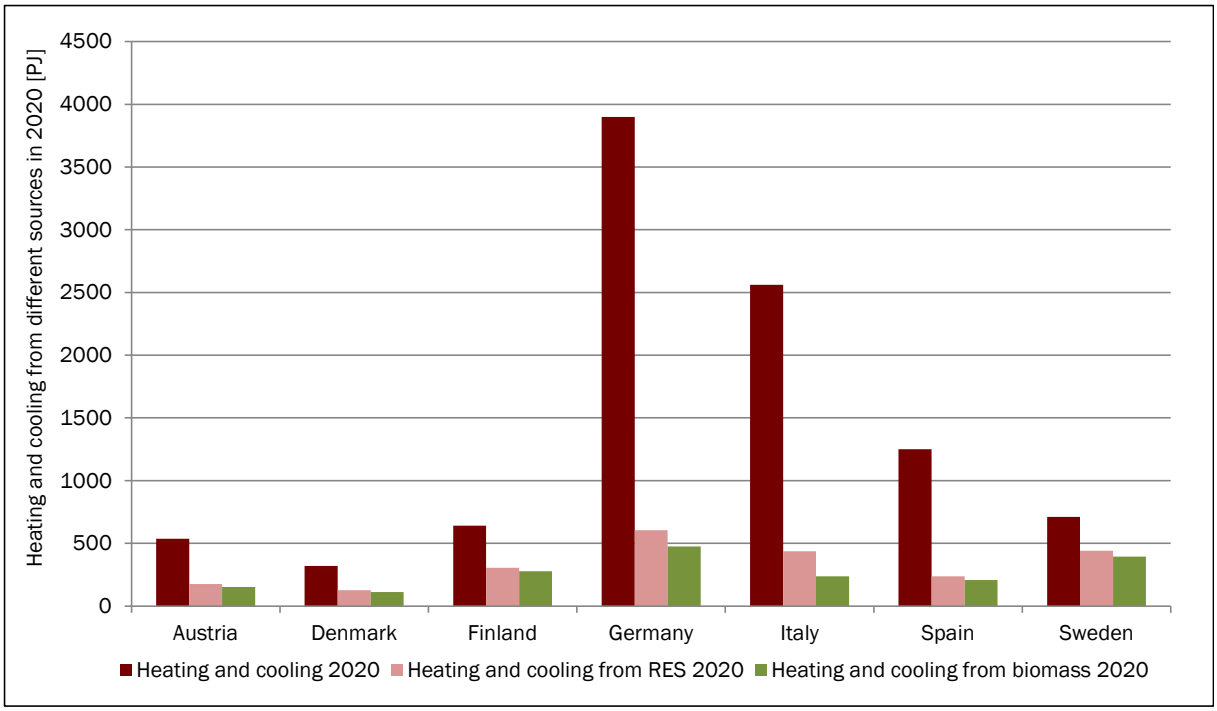


Figure 10: Contribution of heating and cooling from biomass to the total heating and cooling consumption from renewable sources

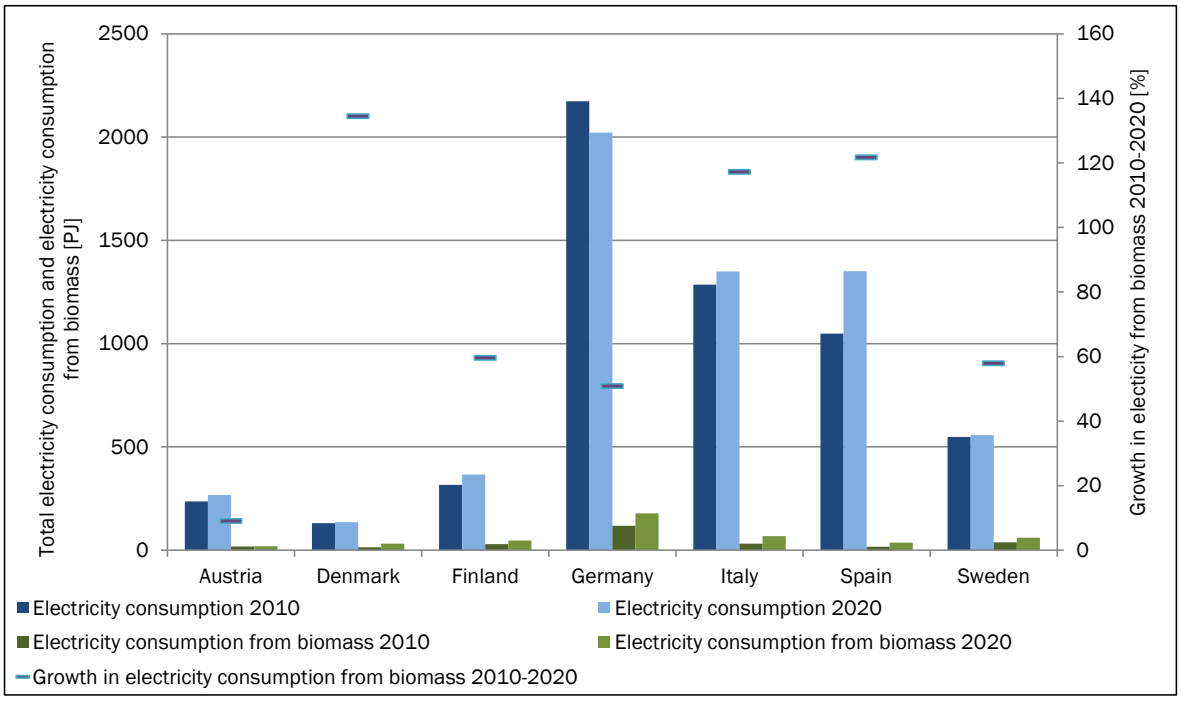


Figure 11: Total electricity consumption for 2010 and 2020 as well as the targeted electricity consumption from biomass

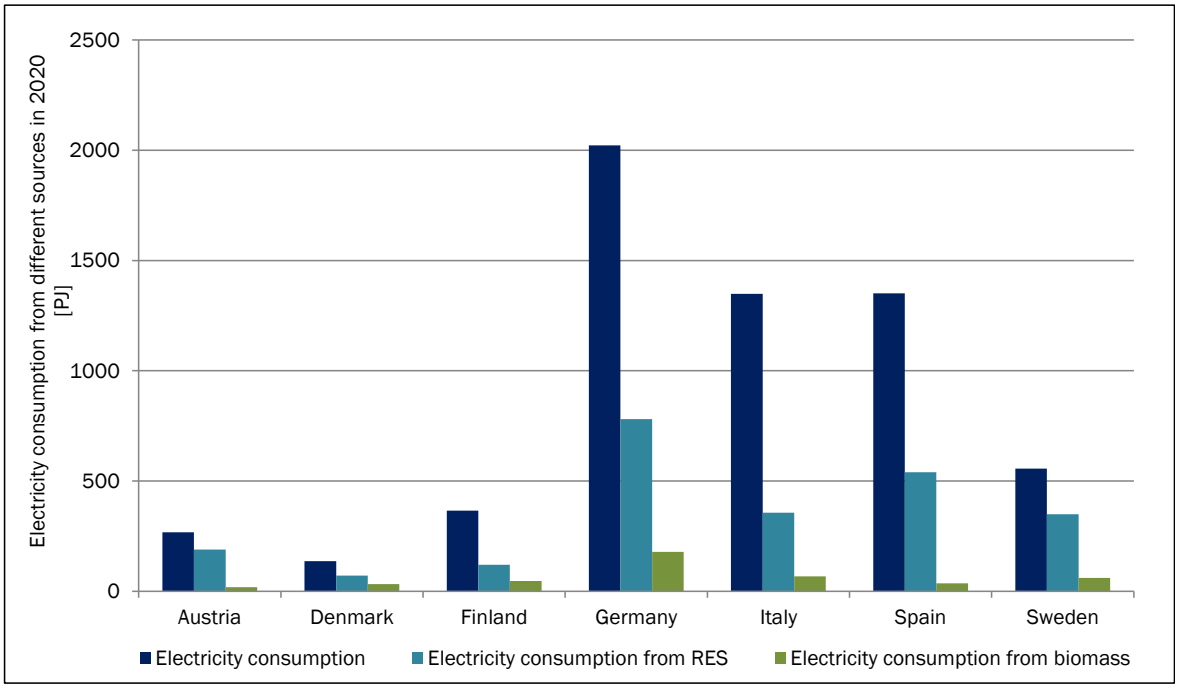


Figure 12: Contribution of electricity from biomass to the total electricity consumption from renewable sources

Support schemes

There are direct and indirect support schemes to increase biomass utilisation for energy purposes. Indirect methods increase the price of fossil fuel options, e.g. by environmental taxes, greenhouse gas emission trading or the removal of subsidies for coal or nuclear power. CO_2-taxation as indirect support is implemented in Sweden, Finland and Denmark. Among the direct methods there are different options (Table 13).

Table 13: Direct support schemes to increase biomass utilisation for energy purposes

	Price driven	**Quantity driven**
Investment focused	Investment subsidies Tax credits Soft loans	Tendering
Generation based	Fixed feed-in tariffs Fixed premium systems	Green certificates Quota obligations

The support options are different in the MixBioPells partner countries. Furthermore, different support schemes are employed for small and medium scale as well as industrial utilisation, see Table 14.

Table 14: Support schemes for small and medium scale as well as industrial utilisation

Scale	**Support scheme**
Small and medium	Investment focussed
industrial	Generation based

For small and medium scale the existing support measures are almost exclusively investment focused. The partner countries can be divided into two different groups according to their support option in small and medium scale:

- Countries providing very little or no support options for small and medium scale biomass utilisation (Denmark, Spain)
- Countries providing support options for small and medium scale biomass utilisation (Austria, Sweden, Finland, Germany, Italy)

On industrial scale the support measures are predominantly generation based. The partner countries can be divided into three groups according to their major support strategy.

- Countries supporting biomass utilisation preferably with quota obligations and green certificates (Sweden)
- Countries supporting biomass utilisation preferably with feed-in tariffs and/or premiums (Austria, Spain)
- Countries supporting biomass utilisation with a potpourri of supporting measures (Denmark, Finland, Germany, Italy)

The support schemes implemented to realise policies can address the economics of alternative and mixed biomass utilisation. It has to be ensured that the incentives and support options enable the utilisation of the technology that is required to fulfil legal requirements. This is of particular relevance because any project for alternative and mixed biomass utilisation will only be realised if it is economically feasible.

2.4.3 Legal conditions

The main legislatory issues regulated in the partner countries concern the allowed fuels, the regulations on waste disposal and the emission thresholds for biomass combustion.

Licensed fuels

Licensed fuels differ significantly within the partner countries. Possible solid biofuels that can be used for combustion purposes are listed in Table 15.

Table 15: Solid biofuels for combustion purposes

Country	Licensed fuels
Austria	Private sector (valid only in Lower Austria): • > 400 kW: no general legislative framework – individual permission by local authorities • < 400 kW: · in Lower Austria: standardised non-wood biomass up to a Cl-content of 1500 mg/kg (so far standards are available for straw, Miscanthus and energy grain) · Other federal states: no general legislative framework – individual permission by local authorities required Public/industrial sector: • Standardised fuels made of other solid and herbal raw materials from forestry and agriculture such as cereal whole plant, grasses and Miscanthus
Denmark	According to the Danish Act no. 638 on biomass waste: • raw wood, straw, kernels and seeds from fruits, fruit residues, nut and seed shells, untreated cork, grain and seeds, malt, tobacco waste • fuel pellets or fuel briquettes produced exclusively from these raw materials
Finland	No general guideline: • common solid biofuels are wood logs, wood chips and wood pellets • non-woody must be handled individually by the authority as a “special fuel”

Table 15: Solid biofuels for combustion purposes (continued)

Country	Licensed fuels
Germany	According to Federal Immission Control Regulation No. 4 (> 100 kW): • Straw and other herbal raw materials (e.g. cereal whole plant, grasses, Miscanthus) According to Federal Immission Control Regulation No. 1 (< 100 kW): • straw, whole plants (also pellets), grains (also pellets), energy grain processing residues, husks, culms residues and similar herbaceous biomass substances (like Miscanthus or hay)" • other renewable sources
Italy	According to the environment protection act (D.lgs 152/2006): • biomass is considered as a fuel only if it has not been submitted to any chemical treatment According to legislation on renewable energy promotion (implementation decree of Directive 2009/28): • any biogenic matter, regardless its origin or quality (any biomass from agriculture, forestry or agro-industry, which has been submitted only to a mechanical treatment, can be considered as a fuel)
Spain	According to the "Plan de Energías Renovables": • biomass from forests, woody agricultural residues (pruning of olive trees, fruit trees and vineyards), • grass agricultural residues (mainly straw and corn maize stover), • residues from agricultural industries (olive stones, almond shells,…), • energy crops (mainly cardoon, sorghum and Ethiopian Canola)
Sweden	No general guideline: • Solid fuels are divided in groups with respect to their origin: forest fuels, peat, agricultural fuels, fuels derived from waste etc.

There are several uncertainties on the allocation of certain biogenic residues as waste or as fuel. These questions have been frequently raised by the key actors during regional networking activities.

Emission thresholds

Within the partner countries the threshold values vary significantly in the range from non-existing till highly regulated with low thresholds. There are significant differences of the legal conditions for different thermal ranges and different countries, see Figure 13. Emissions of carbon monoxide (CO), nitrogen oxides (NO_x) and particles are commonly limited in medium and industrial scale combustion plants. Emission threshold values for small scale combustion plants up to 100 kW mainly exist in Germany and Austria. Emission threshold values of hydrogen chloride and dioxins/furanes exist only in Germany. If there are no regulations in the respective thermal range existing, legal authorities will set the permission and the threshold values at their sole discretion. Finland and Sweden have relatively low emission thresholds particularly for small and medium scale. However, based on the experience with alternative raw material combustion, only selected raw materials are actually used in these countries. Restrictions are rather set at the bottom end (raw material quality) than at the top end (flue gas emission thresholds). The classification of the threshold values indicates whether

the use of alternative biomass pellets can be problematic ("strict thresholds") or in some cases problematic ("loose thresholds"). However, the realisation strongly depends on available combustion and flue gas cleaning systems and the properties of the used fuel. Clearly, emission thresholds are more easily complied with for industrial scale applications for which appropriated flue gas cleaning system are commonly available. However, for small and medium scale applications the situation is different. Though there are a few systems available an adaption for specific fuels is often required and the additional investments are more severe drawback for small and medium scale systems. If the European Union's Framework Directive on Eco-Design of Energy-Using Products (Directive 2009/125/EC) is coming into force most national frameworks will be adjusted.

Country	Capacity	CO	OGC	NO_x	SO_2	HCl	Particles	Dioxine/ Furanes
Austria[1)] private sector	< 100kW	loose	loose	strict	none	none	loose	none
	100kW - 1MW							
	> 1MW	none	none	none			none	
Austria public and industrial sector	< 100kW[2)]	loose	loose	loose	loose	strict	loose	none
	100kW - 1MW[3)]		strict					
	> 1MW							
Denmark	< 100kW	none	none	none	none	none	none	none
	100kW - 1MW	loose					loose	
	> 1MW	strict		strict	loose		strict	
Finland	< 100kW	none	none	none	none	none	none	none
	100kW - 1MW							
	> 1MW						loose	
Germany	< 100kW	loose	none	loose	none	none	loose	strict
	100kW - 1MW	strict	strict		loose	strict	strict	
	> 1MW							
Italy	< 100kW[4)]	none	none	none	none	none	loose	none
	100kW - 1MW[5)]	strict		loose	strict			
	> 1MW[6)]		strict				strict	
Sweden	< 100kW[7)]	none	loose	none	none	none	none	none
	100kW - 1MW[8)]			strict	strict		loose	
	> 1MW		none					
Spain	< 100kW	none	none	none	none	none	none	none
	100kW - 1MW							
	> 1MW							
		mg/Nm³	mg/Nm³	mg/Nm³	mg/Nm³	mg/Nm³	mg/Nm³	ng/Nm³
	strict	<500	<30	<300	<250	<50	<50	<0.1
	loose	<1000	<125	<600	<400	<100	<300	<0.5
	none	-	-	-	-	-	-	-

[1)] Threshold values valid in Lower Austria up to 400 kW, [2)] Threshold values valid for <400 kW, [3)] Threshold values valid for 0.4-1 MW, [4)] Threshold values valid for 35-150 kW, [5)] Threshold values valid for 0.15-3 MW, [6)] Threshold values valid for >3 MW, [7)] Threshold values valid up to 300 kW, [8)] Threshold values valid for 0.3-1 MW

Figure 13: Classification of existing emission threshold values for the use of non woody biomass up to 50 MW in different European countries (based on 13 Vol.-% O_2)

2.4.4 Social acceptance

Overall the social acceptance of alternative and mixed biomass pellet production and utilisation appeared to be good (Social acceptance report D2.6, see list of deliverables). The social acceptance of alternative pellets is essential for enlarging the user groups and utilisation.

The results of the investigation within the MixBioPells project show that there are regional differences regarding the social acceptance of the energetic utilisation of biomass. In none of the countries an intense ethic debate about the energetic utilisation of alternative biomass could be identified. The main problems regarding the social acceptance are summarised in Table 16.

Table 16: Main problems regarding the social acceptance in the partner countries

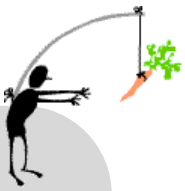
Country	**Problems**
Sweden, Denmark, Finland	• Low confidence in technology • Concerns about the sustainability • Nutrition losses • Negative impacts on the landscape
Austria, Germany	• Uncertainty about legal framework • Concerns about negative impacts on the landscape
Italy, Spain	• Lack of information and knowledge • Concerns about health issues

2.5 Constraints and Drivers

To develop recommendations on favourable frameworks the most important constraints and drivers as well as successful national strategies were identified by comparing the situation of different countries (Constraints and drivers report D4.4, see list of deliverables). The extracted constraints and drivers were evaluated in the field policy and social acceptance, legal framework, economics, technology issues, and raw material issues concerning to their relevance. For the evaluation the following criteria have been set: frequence of mentioning, influence on the feasibility and viability of a project, tractability with policy decisions. In total, the most important constraints and drivers can be summarised as following:

CONSTRAINTS

- Low demand
- Lack of or insufficient financial support
- Uncertainty what biomass can be used and if it is waste or not
- Uncertain legal status and complicated procedure to get regulatory approval
- Critical and varying fuel parameters causing additional costs along the whole chain
- Insecure raw material supply and availability
- Lack of or too high price of technology to fulfil emission thresholds



DRIVERS

- Binding targets creating demand
- Secure support options to ensure economic viability
- Clear regulation on usable biomass, emission thresholds and regulatory approval
- Availability of unused raw material at a low price
- Availability of appropriate technology
- A treasure trove of technological experience with alternative raw material utilisation within the region

Apparently, unused raw materials on the one hand can spur the utilisation if the key actors can rely on clear regulations and have an economic perspective despite the higher initial costs when using alternative raw materials. On the other hand the demand is highly important. Only if there is demand for alternative and mixed biomass pellets they can be marketed. To enhance the demand transparency and profound knowledge on the problems connected with the utilisation of alternative biomass is required. To reach this goal experience is crucial. Furthermore, dissemination of the know-how, of possible obstacles and possibilities to resolve the problems is important. Ideally, first-hand experience with the specific raw materials of each region together with experienced key actors in close proximity should be available.

As a result of the analysis a classification of the national frameworks was suggested. It concentrates on the availability of support options and on the allocation of the legal conditions as favourable or less favourable. As a result there are four different possible combinations, Table 17.

Table 17: Possible combinations of legal conditions and support options as a basis for the classification of the frameworks in different countries

Favourable legal conditions	Support options available	Description
		This combination indicates that unfavorable legal conditions apply and there are no support options available.
		In this case unfavorable legal conditions are accompanied by support options to overcome financial hurdles.
		Under this framework there are favorable legal conditions. However, there is also no support option available.
		This combination indicates the combination of favorable legal conditions with available support options.

Based on this specific advices for alternative pellet utilization were given for different target groups, e.g. in advisory papers for politicians and stakeholders as well as the initiators handbook.

3 SUPPORT FOR ENHANCED MARKET INTEGRATION

To enhance the market relevance of alternative and mixed biomass pellets various dissemination activities are integral part of the MixBioPells project. With the accomplished dissemination activities different target groups were addressed with tailor made information material. The main outcomes of the project are the Advisory Papers (D4.6, see list of deliverables) developed for the support of stakeholders and politicians, the Initiators Handbook (D4.5, see list of deliverables) which addresses the needs of bio business initiators particular on regional level and the labelling system (D5.1, see list of deliverables) which is an important tool to improve the acceptance of alternative and mixed biomass pellets and to facilitate their utilisation. Knowledge transfer was realised by extensive communication and publication including creation of a website with an online library and a forum. Furthermore, various networking support was provided.

3.1 Advisory Papers

The Advisory Papers were developed for each partner country as well as on European level indicating which combinations of legal conditions and policy decisions are required to overcome the most relevant constraints, Figure 14. Each Advisory Paper summarizes in brief the current situation of each country, the envisioned targets for increased biomass use, available support schemes, legal conditions and available raw materials. Based on this, important constraints are highlighted and recommendations deduced. Thus, the Advisory Papers support enhanced market integration of alternative and mixed biomass pellets by:

- Giving a brief overview of the most important facts and the current situation,
- Facilitating decisions towards improved support of this topic.

The Advisory Papers were provided to relevant decision makers and stakeholders aiming at the support of promising developments and the sensitising for necessary changes. The advisory paper is available at the project website www.mixbiopells.eu.

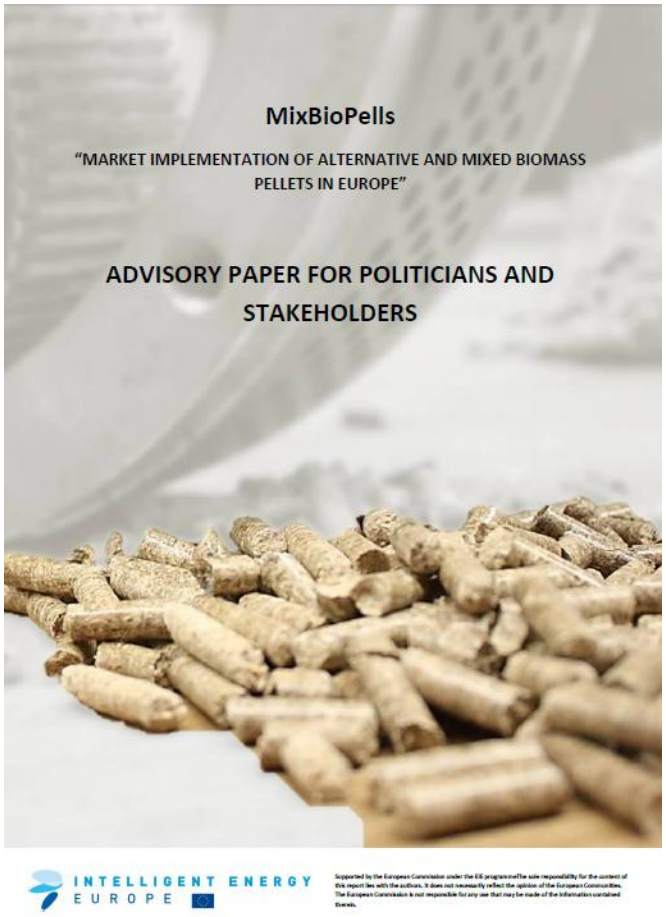


Figure 14: Advisory Paper

3.2 Initiators Handbook

The Initiators Handbook was developed to help bio-business initiators on the decision in favour of projects for alternative and mixed biomass pellet production and utilisation, Figure 15. Furthermore, it supports initiators during project planning and build-up with flow sheets for different initial situations, information on raw material availability and characteristics, detailed descriptions of available technology with key actor lists, information on legal conditions, economic considerations and many useful links for further information. Within the second part of the handbook, Best Practice Examples for alternative and mixed biomass pellet production and utilisation as well as Best Practise Chains are presented reflecting the different frameworks present in the partner countries. Furthermore, a system to classify the national conditions is explained which enables the initiators to easily assess their own national conditions. Based on this, related Best Practice Examples and Best Practice Chains from countries with similar frameworks can be found in the Annex of the Initiators Handbook.

Thus, the Initiators Handbook:

- Supports the project planning process with detailed flow sheets
- Helps during decision making with detailed information and links
- Facilitates network formation between initiators with key actors lists and Best Practise Examples
- Provides a guideline for initiatives with the Best Practice Examples and Best Practice Chains allocated to different frameworks
- Enhances the knowledge base and thereby reduces uncertainties.

The Initiators Handbook is available in seven European languages, i.e. English, Finnish, Swedish, Danish, German, Italian, and Spanish and can be downloaded at the project website www.mixbiopells.eu. The Initiators Handbook turned out to be a great success and a highly valuable tool to enhance the market relevance of alternative and mixed biomass pellets. The English and the German version had to be reprinted in a second edition to fulfil the demand.

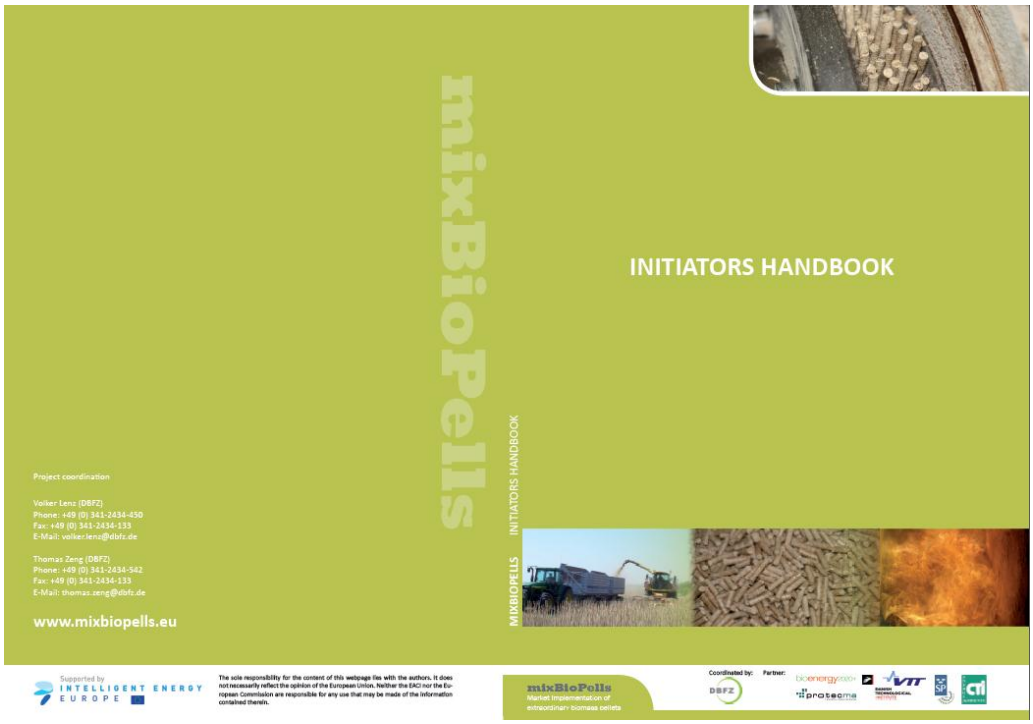


Figure 15: Initiators Handbook

With the Initiators Handbook a tool was developed that allows for the transfer of the knowledge and the experiences gathered from the partner countries to third countries not involved in the project. The classification of the frameworks enables interested bio business initiators to identify best practice examples from countries with similar frameworks. Thus, the initiators can profit from the lessons learned, deduce helpful recommendations for their own situation and use the provided contact data for the build-up of networks.

3.3 Labelling system

Difficulties connected with the combustion of alternative pellets amplify the need for quality systems and quality assurance. A well-designed labelling and certification system could allocate alternative pellets to the appropriate combustion appliances. This would help to reduce hazardous emissions, to avoid operational disturbances and to limit high maintenance costs. Consequently, a labelling system is highly important in order to facilitate the use of alternative pellets especially on small and medium scale.

At the beginning of the project, standards for alternative pellets were implemented to some extend on national level, in particular in Austria. However, different national standards rather complicate the market integration of alternative pellets on the common European market. Consequently, the European standard EN 14961-6 for non-woody pellets for non-industrial use was developed and came into force in April 2012. It is crucial to develop and implement a European labelling system for alternative and mixed biomass pellets based on this standard that gains a high acceptance among the key actors. Thus the development of such a labelling system was attempted together with the European Pellet Council EPC that is already conducting the European wide certification of wood pellet (ENPlus). Both associations and key actors were continuously informed on the development progress to receive their input and feedback on this topic.

The draft of the ENagro labelling and certification system for the production of alternative and mixed biomass pellets was developed in close cooperation with the European Pellet Council. The certification of the production would guarantee consistently homogeneous quality of delivered pellets. The classes of ENagro are based on the specifications of the European standard EN 14961-6. Thus, five different classes are defined, i.e. for cereal straw pellets, Miscanthus pellets, Reed canary grass pellets, mixed pellets class A and mixed pellets class B. The possible labels are displayed in Figure 16. The labelling and certification system contains requirements for:

- Production and quality assurance (EN 15234-6),
- Product characteristics (EN 14961-6),
- Labelling, logistics and intermediate storage and
- Delivery to the end customers.

Specifications for internal quality management guarantee that the product requirements are maintained. It provides requirements for technical facilities, operation procedures and documentation, which make the operation processes transparent and should lead to a rapid tracking down and solving of problems. The formulation of these specifications was carried out on the basis of ISO 9001 and EN 15234-6.

During networking meetings and the 2nd advisory board meeting the draft was presented and discussed with the key actor. Valuable input was received from these discussions that were integrated in the draft. After the end of the project duration, the partners will continue to contribute to the further development of the labelling and certification system participating in the Technical Committee of European Pellet Council.

Today, voluntary certification systems for combustion systems are available for wood pellets utilisation taking into account combustion related criterions such as emissions and efficiency. Additionally, the labels address other aspects such as function and surveillance inspections, environmentally responsible product design or auxiliary power demand. The draft of a labelling system suitable for alternative and mixed biomass pellets includes the following requirements:

- Fuel or range of fuels that can be used in the boiler. The boiler manufacturers should use the classification of the ENagro label in their boiler sign.
- A clear statement of what efficiencies are reached and what emission levels (or classes) of CO and particles are reached with the specified fuel or range of fuel.
- Long term performance should be included.

However, to be relevant and successful, a labelling and certification system for combustion units must be developed in close collaboration with the producers of equipment. Systematic combustion tests with different fuels in different combustion units are not available. It is also highly probable that increased use of alternative fuels will be accompanied by improved technical solutions adapted for these fuels. Today the use of alternative pellets is still not far developed. Consequently, the demand for a boiler certification system for alternative and mixed biomass pellets developed just recently.

One possible approach would be a two-step testing procedure using ENagro fuels. In the first step the boilers should by type tested with the ENagro labelled fuel. The labels are displayed in Figure 16. Since the product standard of the EN14961-6 includes only upper limits for normative fuel properties the type test should be done with the worst fuel of each product class. According to the prEN303-5 the boiler and safety requirements as well as the production documentation are proofed. Additionally, a long term test (e.g. 48 hours) following the prEN303-5 test criteria must be carried out with the ENagro labelled fuel to evaluate slagging, ash removal and corrosion. Since the product standard of the EN14961-6 includes only upper limits for normative fuel properties, the type test should be done with the worst fuel of each product class.

The harmonization of requirements within ECO Design Directive (LOT 15), e.g. for emission thresholds and efficiency is still under development. Until now, the requirements of the ECO Design Directive (LOT 15) are orientated on the prEN303-5. If the European Union's Framework Directive on Eco-Design of Energy-Using Products (Directive 2009/125/EC) is coming into force most national frameworks will be adjusted and will therefore replace existing national regulations. Thus, European wide uniform requirements will result in a validity of the type test according to the EN303-5 in all EU member countries.

Figure 16: Possible ENagro labels

3.4 Knowledge transfer and networking support

As the main tool for the knowledge transfer a website was created. The project website provides information on the main actions and achieved results of the project in an easy and user friendly way. It includes a searchable online library with previously gathered information from research projects, demonstration projects and success stories. The collected information on raw material, available pelletizing and combustion technologies, constraints and drivers, social acceptance and others are is provided as reports. The website includes an interactive raw material map, key actors lists and newsletters. Furthermore, reports on completed events (e.g. regional network meetings, side workshops and advisory committee meetings) are available on the website including presentations and participant lists, Table 18.

Table 18: Events organized during the MixBioPells project

Event	**Place, Date**
National Side Workshops	Fachtagung Energie, Graz, Austria, 03.02.2012
	Glentevej, Esjberg, Denmark, 19.04.2012
	VTT, Jyväskylä, Finland, 08.04.2011
	International Biomass Conference, Leipzig, Germany, 25.05.2011
	Bioenergy Italy, Cremona, Italy, 19.03.2011
	Agrofer Exhibition, Cesana, Italy, 31.03.2012
	Expobioenergia 2010, Valladolid, Spain, 29.10.2010
	Öknaskolan, Tystberga, Sweden, 02.04.2012
International side workshop	World Bioenergy Conference, Jönköping / Sweden, 31.05.2012
1st advisory committee meeting	European Pellet conference in Wels/Austria, 03.03.2011
2nd advisory committee meeting	Pellets 2012 Conference in Stockholm/Sweden, 31.01.2012

On the website an open forum is provided where people can share information from own experiments and experiences as well as ask questions and discuss everything from maintenance issues to possible improvements. In addition to this a communication platform and networking activities are supported. Four regional networking meetings were organised in each partner country to support for example the build-up of new regional bio-business initiatives, Table 19. In total 320 stakeholders participated in 28 regional networking meetings in the MixBioPells partner regions.

Table 19: Projects supported within the regional networking activities

Case study	**Raw material**	**Pelletization/ Briquetting**	**Customers**
ESP 1	Olive stones from the food industry	One pelletizing experiment has been carried out.	Possible end users are private pellet stove/boiler owners as well as small district heating systems (e.g. hospitals).
ESP 2	Almond shells from the food industry	The pelletizing company has studied and tested different processes in order to obtain physically stabile briquettes. The final formula has been patented.	Possible end users are the industry, farms, industrial bread ovens (restaurants and supermarkets).
FIN 1	Reed canary grass from local farmers	The pelletizing company owns a mobile pellet machine with ring die technology.	The customers are usually local farmers with boilers from 100 up to 500 kW.

Table 19: Projects supported within the regional networking activities (continued)

Case study	Raw material	Pelletization/ Briquetting	Customers
FIN 2	Reed canary grass mixed with wood (20/80)	The pelletizing company sells wood and mixed briquettes in big bags or loose (ring die technology).	Main customers are the farmers of the region and the local district heating plants (from 200 to 2000 kW boilers).
SWE 1	Reed canary grass	Any agricultural company running a small commercial briquetting plant.	Heating plants, public buildings as well as households.
SWE 2	Reed canary grass	Any agricultural company running a small commercial briquetting plant.	Heating plants, public buildings as well as households.
ESP 1	Olive stones from the food industry	One pelletizing experiment has been carried out.	Possible end users are private pellet stove/boiler owners as well as small district heating systems (e.g. hospitals).
ESP 2	Almond shells from the food industry	The pelletizing company has studied and tested different processes in order to obtain physically stabile briquettes. The final formula has been patented.	Possible end users are the industry, farms, industrial bread ovens (restaurants and supermarkets).
FIN 1	Reed canary grass from local farmers	The pelletizing company owns a mobile pellet machine with ring die technology.	The customers are usually local farmers with boilers from 100 up to 500 kW.
FIN 2	Reed canary grass mixed with wood (20/80)	The pelletizing company sells wood and mixed briquettes in big bags or loose (ring die technology).	Main customers are the farmers of the region and the local district heating plants (from 200 to 2000 kW boilers).
SWE 1	Reed canary grass	Any agricultural company running a small commercial briquetting plant.	Heating plants, public buildings as well as households.
SWE 2	Reed canary grass	Any agricultural company running a small commercial briquetting plant.	Heating plants, public buildings as well as households.

Table 19: Projects supported within the regional networking activities (continued)

Case study	Raw material	Pelletization/ Briquetting	Customers
DNK 1	Shea waste, rape waste, potato and beet pulp, grain screenings	The energy utility who is the operator of the CHP plant also intends to own the pelletizing plant.	CHP plant (Electrical output: 52 MW_{el}. Heat output: 112 MJ/s).
DNK 2	Straw, grain screenings, peanut shells and corn cobs	A former wood pellet factory which is rebuild.	District Heating plants or schools in the countryside and minor industries with biomass boilers. Size of plant is typical from 50 kW to 10 MW.
ITA 1	Miscanthus and poplar	The pellets are produced (vertical die) and consumed directly in the power plant.	Power plant or district heating systems are possible customers.
ITA 2	Vine pruning	The pellets production company uses a vertical die technology.	The customers are mainly household heating systems.
AUT 1	Straw from regional farmers	The pellets production company uses a ring die technology.	The customers are the farmers who are the straw suppliers.
AUT 2	Miscanthus	The raw material supplier owns a private mechanical briquetting machine.	Customers have usually a heating capacity between 50 and 500 kW.
GER 1	Grape marc	The pelletizing company owns a pelletizing plant with a modular design.	Small scale heat plants up to large scale plants.
GER 2	Dried digestate	The pelletizing company owns a pelletizing plant with a modular design.	These pellets should be used for the combustion in a power range of 300 kW.

The networking activities highlighted different approaches for alternative and mixed biomass pellets production and utilisation (e.g. special raw materials, adapted pelletizing technology, and appropriated boiler). Each partner country provided valuable examples and individual solutions for the problem connected with alternative raw materials. The main advantage of the European approach was that these experiences could be spread among all the partner countries. In this way, a mutual progress and advance was stimulated. In all partner countries the networking support resulted in enhanced activities.

3.5 Dissemination platform and networking activities

The project and the project results were disseminated during national and international events. In total 17 national and 9 international presentations were done during the project period, **Table 20**. The topic of alternative and mixed biomass pellet utilization gained rising interest as reflected by publications in national and international journals(Table 20, Table 21), the great success of the final regional network meetings (particularly in Austria, Germany and Italy) and the demand for a second national side workshop in Italy.

Table 20: National and international presentations

Presentation	**Country**	**Event, Year, Place / Country**
National	Austria 1	Central European Biomass Conference, 2011, Graz / Austria
	Austria 2	European Pellet Conference, 2012, Wels / Austria
	Denmark 1	Forskningscenter Foulum, 2011, Viborg / Denmark
	Denmark 2	Dansk Træpillekonference, 2012, Randers / Denmark
	Finland 1	FINBIO Bioenergy days, 2011, Helsiniki / Finland
	Finland 2	Nordic Bioenergy Conference, 2011, Jyväskylä / Finland Workshop
	Germany 1	1st C.A.R.M.E.N.- Forschungs-Kolloquium „Nachwachsende Rohstoffe“, 2010, Straubing / Germany
	Germany 2	5th Rostocker Bioenergieforum, 2011, Rostock / Germany
	Germany 3	Workshop Compound solid fuel pellets, 2011, Gera / Germany
	Germany 4	6th Rostocker Bioenergieforum, 2012, Rostock / Germany
	Italy 1	EIMA, 2011, Bologna / Italy
	Italy 2	Agrofer Exhibition, 2011, Cesena / Italy
	Spain 1	Protecma Headquarters, 2011, Langreo / Spain
	Spain 2	Expobioenergia, 2011, Valladolid / Spain
	Sweden 1	Energiting Sydost, 2011, Ronneby / Sweden
	Sweden 2	SP, 2011, Falkenberg / Sweden
	Sweden 3	Nordic Energy Outlook, 2011 / Sweden
International	Presentation 1	19th European Biomass Conference and Exhibition / Berlin 2011
	Presentation 2	International Biomass Conference / Leipzig 2011
	Presentation 3	European Pellet Conference / Wels 2011
	Presentation 4	Poleko Exhibition / Poznan 2011

Table 20: National and international presentations (continued)

International	Presentation 5	11th Pellets Industry Forum / Stuttgart 2011
	Presentation 6	South-East European Congress on Energy Efficiency and Renewable Energy / Sofia 2012:
	Presentation 7	World Bioenergy Conference / Jönköping 2012
	Presentation 8	20th European Biomass Conference / Milan 2012
	Presentation 9	Pellcert Workshop / Brussels 2012
	Presentation 10	Venice Symposium on Biomass and Waste, 2012

Table 21: Publications on national and international level

Publication	**Specification**
National	DBFZ Annual Report 2011
	Erneuerbare Energien, March 2012
	Pellets, September 2012
	Scheibs Tips, February 2012
	Maaseudun tulevaisuus, August 2011
	Bioenergia, February 2011
	Macchine Agricole, November 2011
	Pellet News Magazine, June 2011
	Energi och Miljö, 2012
International	Government Gazette, February 2012
	European Energy Innovation, Spring 2012
	Bioenergy International, October 2012

4 SUCCESS STORIES

1. A **handbook for alternative and mixed biomass pellets certification** was developed for the first time in close cooperation with the European Pellet Council. The system is based on the ENplus handbook and standard EN 14961-6 and provides important requirements for the use of these fuels in small and medium combustion systems. Further development between the project consortium and the EPC is planned after the project end.
2. The last **Austrian regional networking meeting** was a real success. Almost 70 key actors participated in the meeting and could benefit from the networking activities. BE2020+ intends to continue the arrangement of such networking meetings after the MixBioPells project, because a number of stakeholders were interested in participating in further events.

3. In **Finland**, Biobotnia Oy produces reed canary grass pellets for the use at Jalasjärven Lämpö Oy. Jalajärven Lämpö Oy and its CEO Aarno Alaluusua are interested in the use of alternative fuels. In spring 2011, 100 t of reed canary grass pellets were produced with the mobile pelletizer of Biobotnia Oy for the combustion with sod peat to produce heat for a public district heat network. In spring 2012, the **production is more than trippled**.
4. In **Italy**, key actors awareness for the production and utilisation of alternative pellets could be significantly increased by conducting the regional network meetings and national side workshops. Furthermore, local industry partners involved in the project **increased their investments or the advertisement** of their activities in this sector:
5. MAREV as the most significant key actor of the project in Italy provided a **new solution of a harvester** which stimulated the production and the use of vine pruning pellets. Within the project MAREV organised together with CTI machinery exhibitions and network meetings. In these events and meetings interesting contacts were established.
6. The cooperative ISPARO gave their collaboration to the project by hosting some regional meetings and collaborating in other activities, e.g. combustion tests at ISPARO. The project results convinced **ISPARO to use straw, wood and vine pruning pellets as a fuel in their boiler**.
7. The first side workshop in Italy was a great success. **More than 100 persons participated**. Based on the high interest the Italian project partner organised a second workshop within the project duration.
8. The project results convinced **Tommasoni farm** in Italy to **replace their oil burner by a pellet boiler using alternative biomass pellets**. The technical and economic benefits of the operation are demonstrated in their region to other interested key actors.
9. A **Spanish key actor** could be encouraged to **install a 12 kW pellet boiler using alternative fuels**. Since there is only limited experience available in Spain, the collaboration with Protecma provides initial experiences by gathering data from long term operation. The company expects reliable information which will be provided to further interested Spanish key actors. This activity is currently being supported by the University of Cordoba. Several combustion tests are planned in 2012 to investigate gaseous emissions, fuel characteristics and efficiency.
10. Another **key actor in Spain intents to use straw pellets in a Hargassner Agrofire (30 kW)** in the following season. Flue gas emissions and efficiency will be analysed too.
11. **The State Secretary of the Federal Ministry of Food, Agriculture and Consumer Protection in Germany, Dr. Robert Kloos confirmed the usefulness of the MixBioPells advisory papers.**
12. The MixBioPells project provided sufficient support to the German demonstration project “Energetische Verwertung von Rückständen aus der Weinbereitung”. Based on this further development for the energetic utilization of **grape marc pellets is planned together with the legal authorities in Rhineland-Palatinate**.

5. FINAL SUMMARY AND CONCLUSION

The MixBioPells project underscored that the market integration of alternative and mixed biomass pellets is still limited but comprises a high potential for the next years. There is a large interest among the key actors and a significant growth in the development activities for appropriated production and combustion technologies. Alternative and mixed biomass pellets provide many opportunities for regional added value and rural development. Below, the main findings of the project are summarized including challenges for further development and possible solutions.

- Despite the low market integration of alternative and mixed biomass pellets and the sometimes difficult frameworks promising best practice examples were available for all partner countries. This underscores the high interest and great expectations connected with these pellets.
- Alternative raw materials are available in significant quantities in all partner countries. However, the type and characteristics show large variations creating uncertainties among the final users. Thus, more research in and development of appropriate technology to handle these variations is required.
- Currently, alternative and mixed biomass pellets are particularly suitable for regional use in medium scale and to some extend in industrial scale. Most of the best practice examples can be found in medium scale. For small scale utilisation the technology is less developed and less cost effective. Appropriate support schemes can facilitate the enhanced utilisation.
- Networking support and regional activities boost the interest in alternative and mixed biomass pellet production and utilisation. New bio business activities profit largely from regional available experience. Close contact with experienced key actors facilitates the start of initiatives and projects. Accordingly, the lack of or limited experience with alternative raw materials is a major constraint. Thus, knowledge transfer is highly important to increase the number of bio business activities in this sector.
- The networking activities as part of the European approach stimulated a mutual progress and advance since each partner country provided valuable examples and individual solutions for the problem connected with alternative raw materials (e.g. special raw materials, adapted pelletizing technology, and appropriated boiler).
- With the Initiators Handbook a tool was developed that allows for the transfer of the knowledge and the experiences gathered for seven European countries to other countries not involved in the project. The classification of the frameworks enables bio business initiators to identify best practice examples from countries with similar frameworks and deduce helpful recommendations for their own situation.
- Though alternative and mixed biomass pellets have been found to be particular important on regional level with highly diverse conditions (legal framework, available raw material, knowledge base) comparable problems and similar questions arose for all involved regions. However, networks spanning different European countries are rarely available for small key actors being highly important initiators in this field. Thus, the continuation of the networking activities which were started during the project period should be encouraged and supported.

- Alternative and mixed biomass pellets are mainly used in the heating sector. Very high reductions of greenhouse gas emissions can be realized compared to fossil fuels. Furthermore, only marginal competitive use is expected, since alternative raw materials are predominantly residues for which there is only limited alternative use. Thus, alternative and mixed biomass pellets have high potential as sustainable fuel creating little social acceptance problems.
- The capacity range where alternative and mixed biomass pellets are most likely to be used is strongly influenced by the national frameworks (political targets, allowed biofuels, emission thresholds, support options).
- A well accepted labelling system for alternative and mixed biomass pellets is considered a highly important tool to improve the acceptance among final users.
- Within the project duration an increasing interest in the topic alternative and mixed biomass pellets production and utilisation was observed. The project consortium received several inquiries for cooperation on this topic and for a subsequent project with other countries especially from Eastern Europe (e.g. Bulgaria, Latvia, Hungary, Estonia) and Mediterranean countries (Greek, Malta, Italy, Spain).
- In the context of the rising debate on bioenergy, available biomass potentials and their sustainable use, the project provided an important contribution to promote alternative and mixed biomass pellet production and utilisation. It highlights the chances for the partner countries. At the same time it clearly illustrates that there are still numerous hurdles to overcome particularly when it comes to the integration of third countries (e.g. Eastern Europe or Mediterranean countries). The debate on sustainability is expected to intensify in the next years. Accordingly, the topic alternative and mixed biomass pellets can provide important input for the public discussion. Thus, we will follow and support the current developments and intend to continue working on this topic after a year of monitoring with an ensuing project.

LIST OF DELIVERABLES

Del. N°	WP N°	Deliverable name	Deliverable uploaded at website?
D1.1	1	Minute of the 1st project meeting	No
D1.1	1	Minute of the 2nd project meeting	No
D1.1	1	Minute of the 3rd project meeting	No
D1.1	1	Minute of the 4th project meeting	No
D1.1	1	Minute of the 1st advisory committee meeting	Yes
D1.1	1	Minute of the 2nd advisory committee meeting	Yes
D1.2	1	Final publishable report	Yes
D2.1	2	Summary review of regional workshop with presentations	Yes
D2.2	2	List of key actors	Yes
D2.3	2	Report on the relevant biomasses including the selection criteria for the most relevant ones	Yes
D2.4	2	Map of most relevant biomasses in the considered regions including averaged chemical and physical properties	Yes
D2.5	2	Report on results of cost analysis of at least 2 case studies for each region compared to most used (fossil) heating systems	Yes
D2.6	2	Summary of crucial aspects for the social acceptance of alternative pellets	Yes
D 3.1	3	Critical review on pelletizing technology, combustion technology and industrial-scale systems	Yes
D3.2	3	“Best practice examples” for pelletizing of alternative raw material (incl. translations)	Yes
D3.3	3	“Best practice examples” for combustion of alternative pellets (incl. translations)	Yes
D3.4	3	“Best practice examples” about production and combustion chain (incl. translations)	Yes
D4.1	4	Questionnaires (incl. translations)	Yes
D4.2	4	Summarisation of interviews (incl. translations)	Yes

Del. N°	WP N°	Deliverable name	Deliverable uploaded at website?
D4.3	4	Overview about national conditions (incl. translations)	Yes
D4.4	4	Report about constraints and drivers	Yes
D4.5	4	Handbook for Initiators (incl. translations)	Yes
D4.6	4	Advisory paper for legal framework on EU level and for all partner countries	Yes
D5.1	5	Report on the labelling concept and preparation of documentation for CEN TS 335	Yes
D5.2	5	Dissemination platform on Website including Database and communication platform & update at the end of the project	Yes
D5.3	5	Report about the regional networking activities	Yes
D6.1	6	Set up of website	-
D6.2	6	Integration of database on the website	Yes
D6.3	6	Leaflets about project and project objectives	Yes
D6.4	6	Summary review of national workshops	Yes
D6.5	6	Summary review of international workshop	Yes
D6.6	6	Article in specialised publication	Yes

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Title of the Report Market implementation of alternative and mixed biomass pellets in Europe – Summary of the MixBioPells project results	
Customer, contact person, address EACI agency, Silvia Vivarelli, European Commission	**Order reference** IEE/09/758/ SI2.558286
Project name/short name MixBioPells	**Total funding** 977.751 €
Author(s) Annett Pollex, Thomas Zeng	**Pages** 58 p.
Keywords Alternative biomass pellets, mixed biomass pellets, market integration, labelling system, pelletizing, combustion	**Project duration** 26 months

Summary

The MixBioPells project has identified constraints and drivers for the market integration of alternative and mixed biomass pellets and found promising market introduction concepts for enhancing the market relevance of these pellets in Europe. With the execution of the project, the knowledge base was expanded, information exchange was supported and networking possibilities for interested stakeholders were created by the implementation of a dissemination platform providing an exhaustive database and presenting all gathered data compiled within reports, graphics and brochures including numerous "Best Practice Examples" for alternative and mixed biomass pellet production and utilization and the "Initiators Handbook". Furthermore, local network set-ups and networking activities have been support with regional workshop, side events and the initiation of further projects in the field of alternative and mixed biomass pellet production and utilization. Overall, a greater awareness of public authorities and policy makers for the opportunities and benefits of regional bio-business as well as for possibilities to support successful strategies by changing legal frameworks and developing support programs was achieved by intense dissemination of the project results and supported with "Advisory Papers" for public authorities and policy makers both on national and European level. A draft for a labeling system for alternative and mixed biomass pellets production and utilization was developed in close cooperation with the European Pellet Council.

The MixBioPells project underscored that the market integration of alternative and mixed biomass pellets is still limited but comprises a high potential for the next years. There is a large interest among the key actors and a significant growth in the development activities for appropriated production and combustion technologies could be identified and spurred. Alternative and mixed biomass pellets provide many opportunities for regional added value and rural development. Within the project duration an increasing interest in the topic alternative and mixed biomass pellets production and utilisation was observed.

Confidentiality	Public	
Written by Annett Pollex, senior scientist	**Reviewed by** Thomas Zeng, project coordinator	**Accepted by** Volker Lenz, divisional head

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Distribution (customer and DBFZ)

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