IEE/09/758/SI2.558286 - MixBioPells

WP 4 / D 4.4

Constraints and drivers

Author 1: Dr. rer. nat. Annett Pollex (DBFZ)
Author 2: Thomas Zeng (DBFZ)

With support of the project partners:

BE2020 – Bioenergie 2020+
VTT - Technical Research Centre of Finland
SP – Technical Research Institut of Sweden
DTI - Danish Technological Institute
Protecma – Energia Y Media Ambiente S.L.
CTI - Italian Thermotechnical Committee

Supported by the European Commission under the EIE programme

INTELLIGENT ENERGY EUROPE

Table of contents

Context

The report provides detailed background information about the deduction of the constraints and drivers for alternative (mixed) biomass pellet production and utilisation. Furthermore, it outlines the process that lead to the classification of national conditions and the definition of the different frameworks. Thus, the report can be helpful as a guide for further similar projects. The target groups for this report are scientific readers and key actors desiring more detailed information on the approach that is the foundation for the main outcomes of this report (Initiators Handbook and Advisory Papers).

The report merges the results from the regional analysis (WP 2) on the costs of alternative (mixed) biomass pellet production and utilisation (Cost Analysis Report), on available biomass (Biomass Report and Biomass Map) and on the social acceptance (Social Acceptance Report) and information from the analysis of the technical development (WP 3) on pelletizing, combustion and flue gas cleaning technology (Critical Review on Pelletizing and Combustion Technology) and on best practise examples (Best Practise Examples about Pelletizing of Alternative Raw Materials, Best Practise Examples about Combustion of Alternative Pellets, Best Practise Examples about Production and Combustion Chains) with the outcome of the interviews (Interview Report) and the evaluation of national conditions (National Condition Report). All individual reports can be found on the project website www.mixbiopells.eu. From the whole pool of information gathered within the project constraints and drivers for alternative (mixed) biomass pellet production and utilisation are extracted using an approach that combines the appraisal of the key actors' personal view with the evaluation of the compiled factual data. Based on the constraints and drivers the main dissemination output, i.e. a guidebook for bio-business initiators (Initiators Handbook) and the Advisory Papers for legal frameworks on EU and on national level will be developed to communicate the constraints and drivers and to outline possible solutions and measures to support alternative (mixed) biomass pellet production and utilisation (Figure 1).

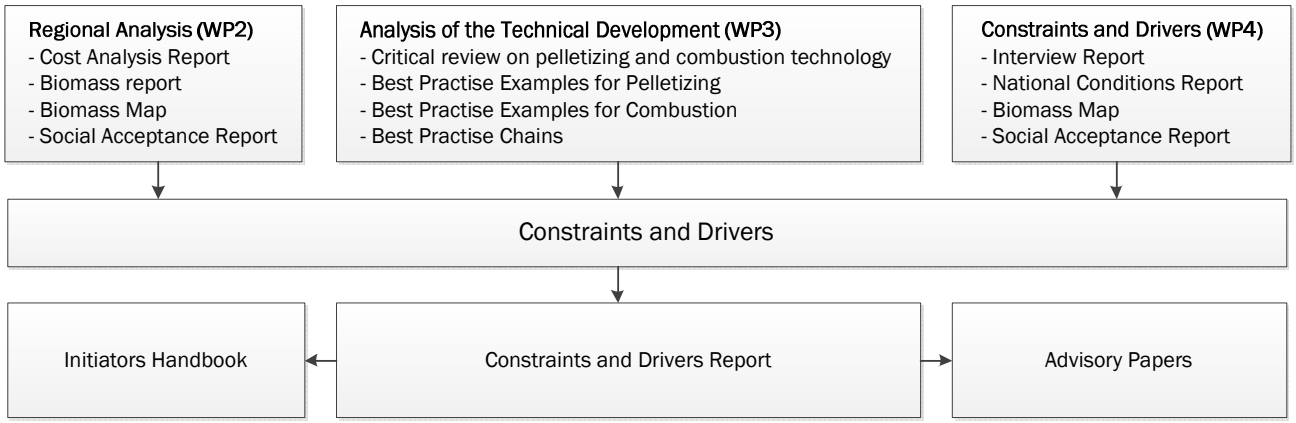


Figure 1 Context and position of the Constraints and Drivers Report

1 Method

In task 4.3.1 of the MixBioPells project the information gathered so far within the regional analysis (WP2) as well as the technical analysis (WP3) is compiled and analysed in the context of national frameworks (WP4.2). The aim of task 4.3.1 within WP 4 was to identify the most relevant constraints and drivers for the pelletizing and of alternative (mixed) biomass and the utilisation of these pellets. Within the project several key actors along the value chain of alternative (mixed) biomass pellet production and utilisation were interviewed. From these interviews the key actors view on problems and chances of alternative (mixed) biomass pellet production and utilisation could be visualised. Additionally, the partner 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 both for the pelletizing and combustion of alternative (mixed) biomass were gathered using literature research, market survey and contacts with key actors. Economic aspects have been analysed for selected case studies representing the complete value chains within each country. The value chains were developed based on existing projects and were at least partly realised. Best Practice Examples for the pelletizing of alternative (mixed) biomass pellets and their combustion 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). Furthermore, the Best Practice Chains illustrate successful realisations of combinations of pellet production and combustion. They are highly valuable to increase the market relevance of alternative mixed biomass pellets in Europe since they can be used as guideline for future projects. Information on the above topics can be found on the website of the project (www.mixbiopells.eu). 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 issues,
- Raw material issues.

For the first part of the report the information concerning the topics above was extracted from structured interviews (questionnaires) on raw material, pellet production, combustion and social acceptance. The questionnaires were sent to the key actors by mail or provided to the key actors at the occasion of National Side Workshops, National Presentations and Regional Activities. Thus, mainly a written response to the interviews was received. More than half of the partner countries (Spain, Italy, Sweden, Denmark) conducted additionally or alternatively interviews by telephone as semi-structured interviews using the questionnaire as a guideline. From the interviews, concerns and experiences of stakeholders in the different European countries as well as their expectations for the future developments are highlighted. For the report the interview part will be accentuated as it provides an insight in the personal concerns and motivating aspects that are relevant for the key actors. This part is particularly interesting since the constraints and drivers are derived directly from the experts and thus, might be in some cases different from what would be commonly assumed as a constraint or driver. It indicates how relevant certain aspects are. Additional input on the key actors view was provided

by the analysis of the regional activities. The case studies, Best Practice Examples and investigation on raw materials, pelletizing and combustion technologies provided additional input on constraints that had to be overcome during the initiation of alternative (mixed) biomass pellets projects. Additionally, the case studies underscore which conditions are helpful to boost such initiatives. In this way, it is possible to reconcile the individual perception with the factual relevance. The identified constraints and drivers will be summarised and discussed in the context of common presuppositions for each of the above fields. In this way it will be shown which conditions repeatedly hinder the market implementation of alternative (mixed) biomass pellets or, on the other hand, can support their utilisation.

According to this approach, within Chapter 2.1 (Policy and Social Acceptance) the political will to enhance alternative (mixed) biomass pellet production and utilisation will be verified on the basis of the available data. Furthermore, it will be shown how realistic the targets are when taking the actual situation and the support measures into account. Chapter 2.2 (Legal Conditions) will outline to what extent the emission thresholds and the regulations on licensed fuels reflect and support the political will. The legal conditions indicate on which capacity range the alternative raw materials should be preferably used and on which types of alternative raw materials the attention should be focused. The Chapters 2.3 and 2.4 (Economics and Technology Issues) will show constraints and drivers that are relevant on the user side (e.g. for pellet producers, fuel suppliers, manufacturers, plant operators, costumers). Within Chapter 2.5 it will be highlighted which raw materials are available that can be used within the existing legal frameworks and with the available technology.

In the second part, groups of national conditions will be defined and classified. Thus, similarities between the countries in the fields of policy, public perception, legal conditions, economics, and technological will become evident. It will be shown, which of the national conditions are the most decisive key parameters defining the national frameworks. With this context it can be shown which combination of legal conditions and policy decisions is required to overcome the most relevant constraints. The aim is to extract good and weak concepts to enhance the utilisation of alternative (mixed) biomass pellets on different scale (small, medium, industrial) and for the different national frameworks.

2 Constraints and drivers

2.1 Policy and social acceptance

Constraints and drivers with regard to policy and social acceptance are mainly derived from the social acceptance interviews with research institutes, lobbying institutions, pellet producers, raw material suppliers and technology providers (Annex 5). The number of interviewed key actors and the received feedback can be found in Annex 1. Main topics were the public perception of the energy related utilisation of biomass, possibilities to improve the social acceptance, the perception of energy crops, the impact of biomass combustion on environment and health as well as expected economic benefits on national and regional level.

Additional constraints and drivers in the field of policy and social acceptance are derived from the national conditions reports and from the analysis of the available data on targets and support options to realise the targets. Policy provides climate protection targets and targets for the use of renewable energy sources (RES). Thus, a political will is expressed with the targets. However, this political will to enhance alternative (mixed) biomass pellet production and utilisation has to be evaluated in the context of the current situation and available support options. Therefore, the actual situation in the electricity sector and in the heating and cooling sector will be described first. The aspired share of renewables and of biomass will be depicted for each country considering the two sectors individually. In the following, the available support options will be described and evaluated in order to show if the political will is reflected in appropriated support options. In summary, this analysis will indicate the realistic chances to increase alternative (mixed) biomass pellet production and utilisation.

Interview part

In general, the addressed key actors rate the overall acceptance of the energy related utilisation of biomass as fairly high. Particularly in Denmark, Finland and Sweden bioenergy is perceived as something good and important to counteract climate change. Only in some cases the energetic utilisation of biomass is seen as problematic. Main issues that raise concerns are:

- Sustainability (nutrient loss, competition with food or composting) (DE, DK, FI, SE)
- Combustion problems (ash content, chlorine content, emission, low efficiency) (DE, AT, FI, IT, ES)
- Lack of information (IT, ES, FI)
- Economics (FI, DE)

There is no alternative biomass that would not raise any concerns among the interviewed key actors and in the public perception. However, problems are seen in different fields for each of the alternative biomass types (Table 1).
The opinions how the public perception can be improved differs significantly within the partner countries. The intensification of communication and dissemination activities is assumed more important in Italy and in Spain than in the other partner countries. This might be attributed to the less developed biomass energy market in these countries. Due to the lack of experience, customers might have wrong expectations and assumptions concerning alternative biomass

use. Furthermore, awareness on possible problems connected with alternative biomass utilisation is underdeveloped. Thus, disappointment may result which could lead to bad perception and lower the interest and demand. In contrast, key actors in Austria, Germany, Denmark and Finland see the potential to improve the acceptance for combustion of alternative (mixed) biomass pellets in the improvement of existing technology. Suitability of the available technology for alternative mixed biomass pellets is a key issue. Thus, the following constraints can be divided:

- Lack of information about combustion of alternative mixed biomass pellets (IT, ES)
- Lack of appropriated technology for the combustion of alternative mixed biomass pellets (AT, DE, DK, FI)

Table 1: Concerns among the key actors and in the public perception

	Energy crops	**Residues from agriculture**	**Residues from landscape gardening**	**Residues from processing of olives or grapes**	**Residues from processing of citrus fruits**	**Residues from processing of other agricultural commodities**
Sustainability						
Competition with food production	×					
Competition with composting			×	×		×
Possible nutrient loss	×	×	×			
Combustion problems						
Chlorine content	×					
Ash content	×	×	×	×		
Emission			×			
Quality						
Heterogeneous			×			
High moisture content					×	

Source: Interview on Social Acceptance (Annex 5), for feedback rate see Annex 1
An "x" indicates that it was mentioned by at least one key actor

Currently, there are only few plantations of energy crops in Europe. The further development of this sector depends among others on the public perception. According to the interviews, the public is in general more concerned about competition with cultivation of food than about the negative influence on landscape and biodiversity. In Sweden uglifying of the landscape by short rotation coppices is an issue. Concerns against energy crops exist especially in Sweden, Germany and Finland.

Key actors in the European partner countries were asked for concerns in connection with alternative biomass utilisation. In Austria key actors are more concerned about the economics of available combustion systems. In contrast, in Germany and Denmark and to a smaler extend in Finland, Italy and Spain the state of development of combustion technology is seen most problematic. Standardisation is the most urgent topic for Spanish key actors while it appears less important for stakeholders in Italy. The topic emission is also perceived differently within the partner countries. While particulate emission is the most important issue in Germany, Austria and Italy, for key actors in Denmark and Finland it appears to be far less significant. The HCl-, NO_x- and SO_2- emissions were of less importance for the key actors. In Spain emissions from combustion of alternative pellets were not an issue at all. The available information about concerns of key actors is summarised in Table 2.

Table 2: Concerns of key actors

	AT	DK	FI	DE	IT	ES
Share of people that have concerns about safety/technical development [%]	50	50	50	55	43	100
Economics	++					
Technology not developed		++	+	++	+	+
Standardisation					+	++
Subsidies		+	+	~		
Share of people that have concern about emissions [%]	40	44	50	79	70	0
Dust emission	++	+	+	++	++	
HCl, NO_x, SO_2 emission	~	+	+	~	~	

Source: Interview on Social Acceptance (Annex 5), for feedback rate see Annex 1
++ more than 40% of the people with concerns address this topic
+ 20-40% of the people with concerns address this topic
~ less than 20% of the people with concerns address this topic

Overall there is a consensus among the stakeholders that the increased market implementation of alternative mixed biomass pellets has a positive effect on rural development and creation of jobs and can contribute to the decrease of energy imports.

Results from other investigations within the MixBioPells project

Ambitious targets are aimed to enhance the relevance of renewable energy sources. With the National Renewable Energy Action Plans [1] 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 (Table 3).

Table 3: Energy structure and the policies the targets in the partner countries

		AT	DK	FI	DE	IT	ES	SE
Population in millions		8.4	5.5	5.4	82	60	47	9.4
Gross final energy consumption [PJ]	2010	1,077	683	1,077	9,359	5,517	3,902	1,511
	2020	1,135	687	1,179	8,254	5,569	4,062	1,642
Contribution of renewables in overall energy consumption [PJ]	2010	333	150	309	946	444	531	657
	2020	387	206	448	1,614	947	923	825
Contribution of renewables in overall energy consumption [%]	2010	31	22	29	10	8.1	14	43
	2020	34	30	38	18	17	20	50
Growth in renewable energy use from 2010-2020 compared to 2010	PJ	55	56	139	668	502	392	182
	%	17	38	45	71	113	74	26

Source: National Renewable Energy Action Plans:
http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

Among the partner countries Germany has the highest gross final energy consumption. This is mainly attributed to the large industry sector in Germany and its high population. In contrast, due to the lower population Finland, Sweden, Denmark and Austria have low gross final energy consumption. The gross final energy consumption is expected to rise in all partner countries except Germany. There, efficiency measures are expected to result in reduced energy consumption particularly in the heating and cooling sector. However, the current and envisioned share of renewables in the overall energy consumption is significantly higher for these countries. Among the partner countries, Germany, Italy and Spain have the most ambitious targets considering the growth in renewable energy use. Despite these ambitious targets and the high total increase in renewable energy utilisation, these three countries cannot catch up with the other partner countries considering the share of renewables in the gross final energy consumption. The envisioned gross final energy consumption of the partner countries as well as the respective RES contribution and the targeted growth in RES consumption is illustrated in Figure 2.

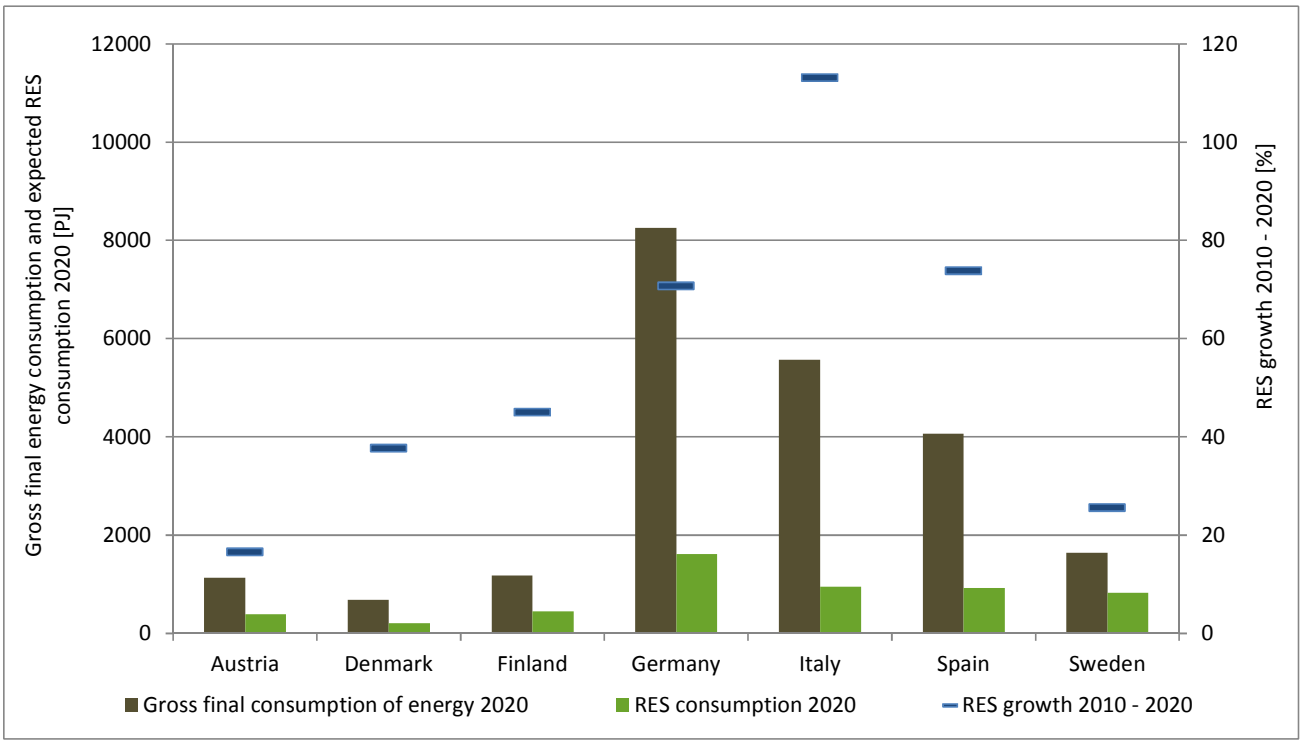


Figure 2: Gross final energy consumption of the partner countries as well as the respective RES contribution and the targeted growth in RES consumption

According to the National Renewable Energy Action Plans (NREAPs) around twice as much energy will be consumed for heating and cooling compared to electricity consumption in almost all partner countries except Spain and Sweden in 2020 (Figure 3). The share of energy for heating and cooling varies between around 45% and 54%. Spain requires only around 30% of its gross final energy consumption for heating and cooling.

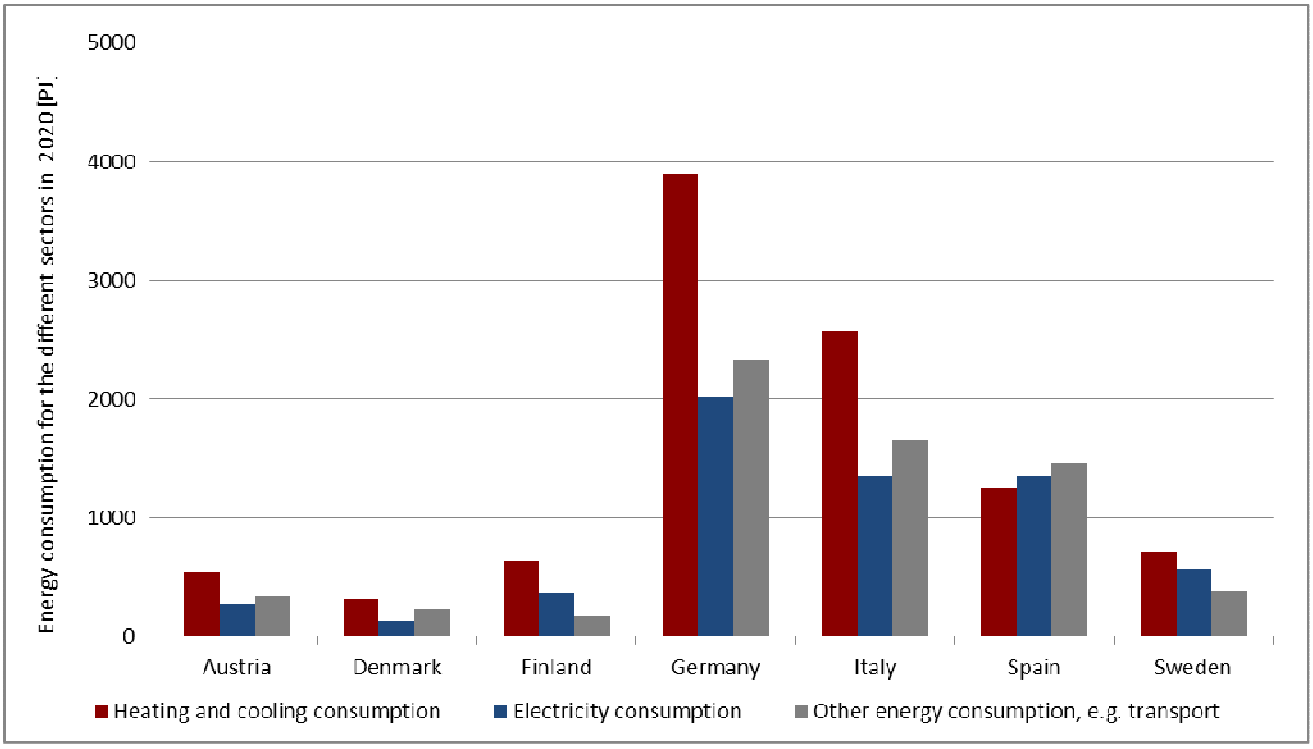


Figure 3: Energy for heating and cooling compared to other energy sectors

According to the NREAPs the targets for biomass utilisation in the heat and the electricity sector also differ quite significantly (Table 4).

Table 4: Targets for biomass utilisation in the heat and the electricity sector

		AT	DK	FI	DE	IT	ES	SE
Share of biomass in the heating and cooling sector [%]	2010	28	28	36	8.2	3.8	11	54
	2020	28	35	43	12	9.3	17	56
Assumed share of biomass in the electricity sector in 2020 [%]	2010	7.2	10	9.2	5.4	2,4	1,6	6.9
	2020	6.9	23	13	9.2	5.4	2,7	11

Source: National Renewable Energy Action Plans: http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

All countries aim to further increase biomass utilisation for heating and cooling. For Austria only a minor increase is targeted paralleling the increase in gross final energy consumption. 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 4.

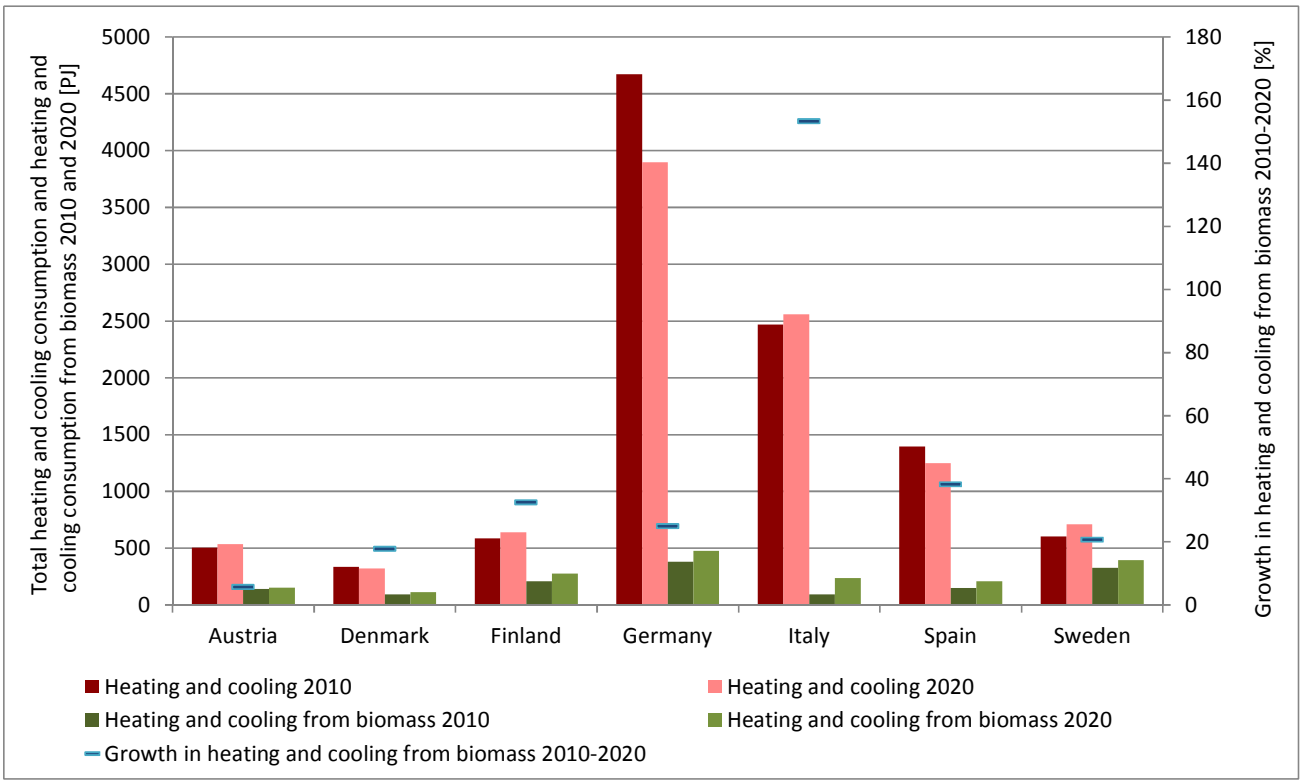


Figure 4: Total heating and cooling consumption for 2010 and 2020 as well as the targeted heating and cooling from biomass

Spain and Italy have high targets for the increase of biomass utilisation in the heating and cooling sector. However, both countries start from quite low value compared to their gross final energy consumption. In contrast, within the Scandinavian countries Finland and Sweden a large share of heating and cooling 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 5 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 and solar thermal energy is assumed.

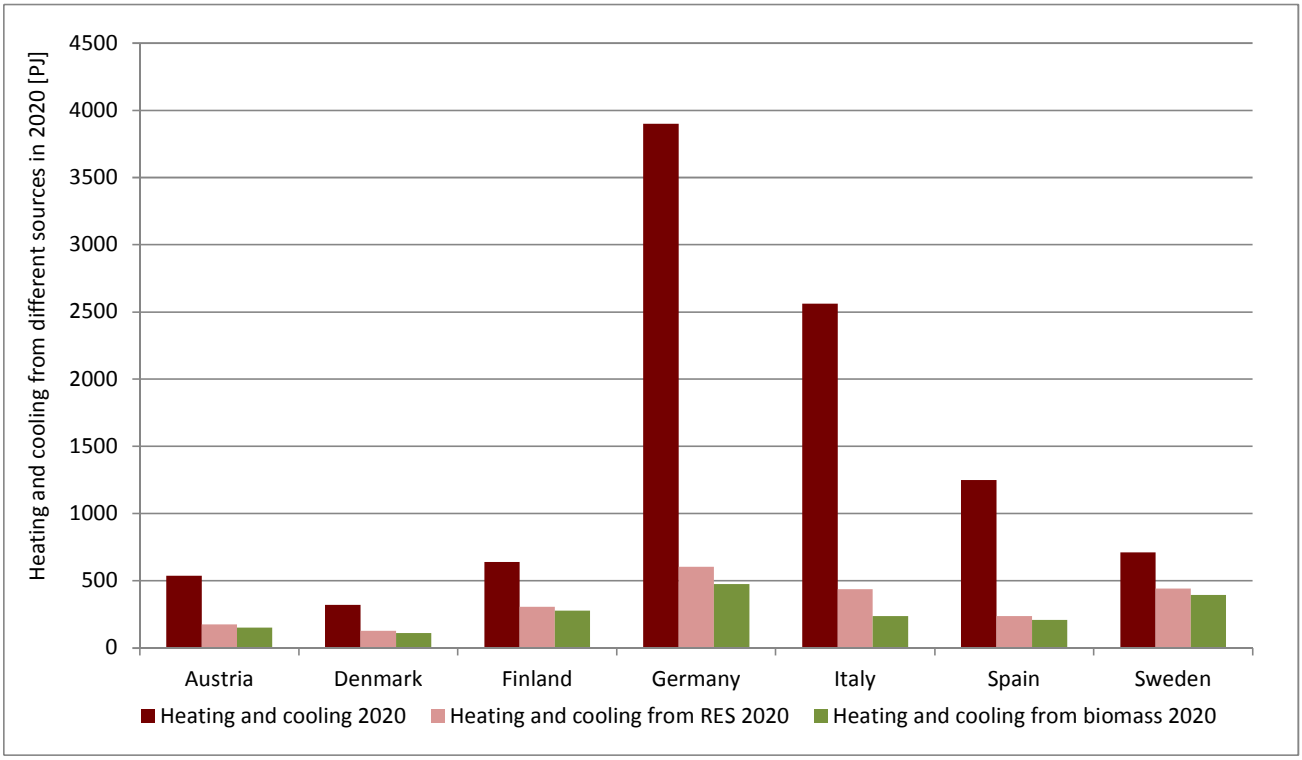


Figure 5: Contribution of heating and cooling from biomass to the total heating and cooling consumption from renewable sources

Biomass is far less used in the electricity sector for all partner countries. All countries aim to further increase biomass utilisation for electricity production (see Table 4). For Austria only a minor increase is targeted paralleling the increase in gross final energy consumption. However, due to the targeted reduction in electricity consumption the share of biomass in the electricity sector will be lower in 2020 than in 2010 in Austria. The assumed change of total electricity consumption between 2010 and 2020 as well as the targeted electricity consumption from biomass utilisation are illustrated in Figure 6.

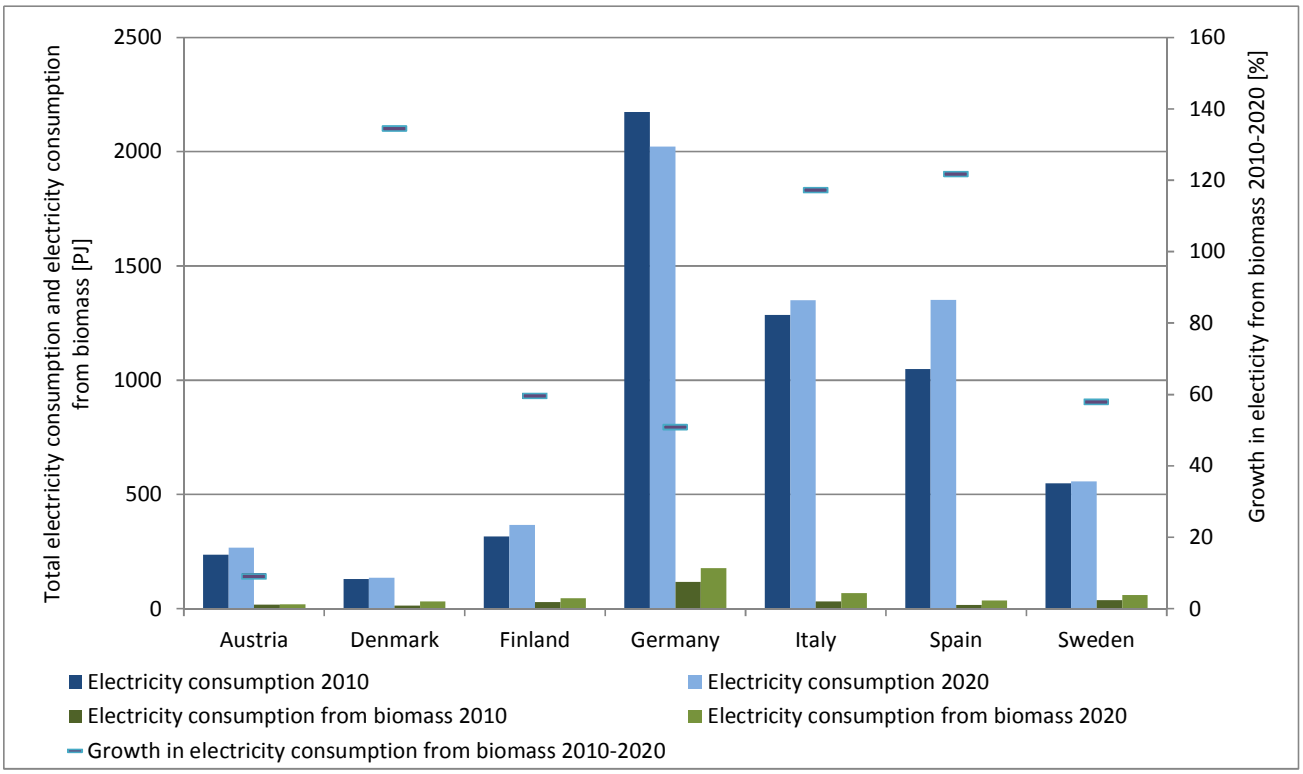


Figure 6: Total electricity consumption for 2010 and 2020 as well as the targeted electricity consumption from biomass

The highest total increase is targeted by Germany. Denmark is targeting the highest percental increase and aims to produce almost a quarter of its electricity from biomass. For Finland, Sweden and Germany an electricity production from biomass of around 10% of the total electricity production is targeted. However, in Germany a large share of almost 50% is assumed to be produced from biogas. In contrast, in Finland and Sweden more than 60% respectively 99% of electricity from biomass is assumed to be produced using solid biomass. As illustrated in Figure 7 biomass contributes only to a minor part to the total electricity consumption from renewables.

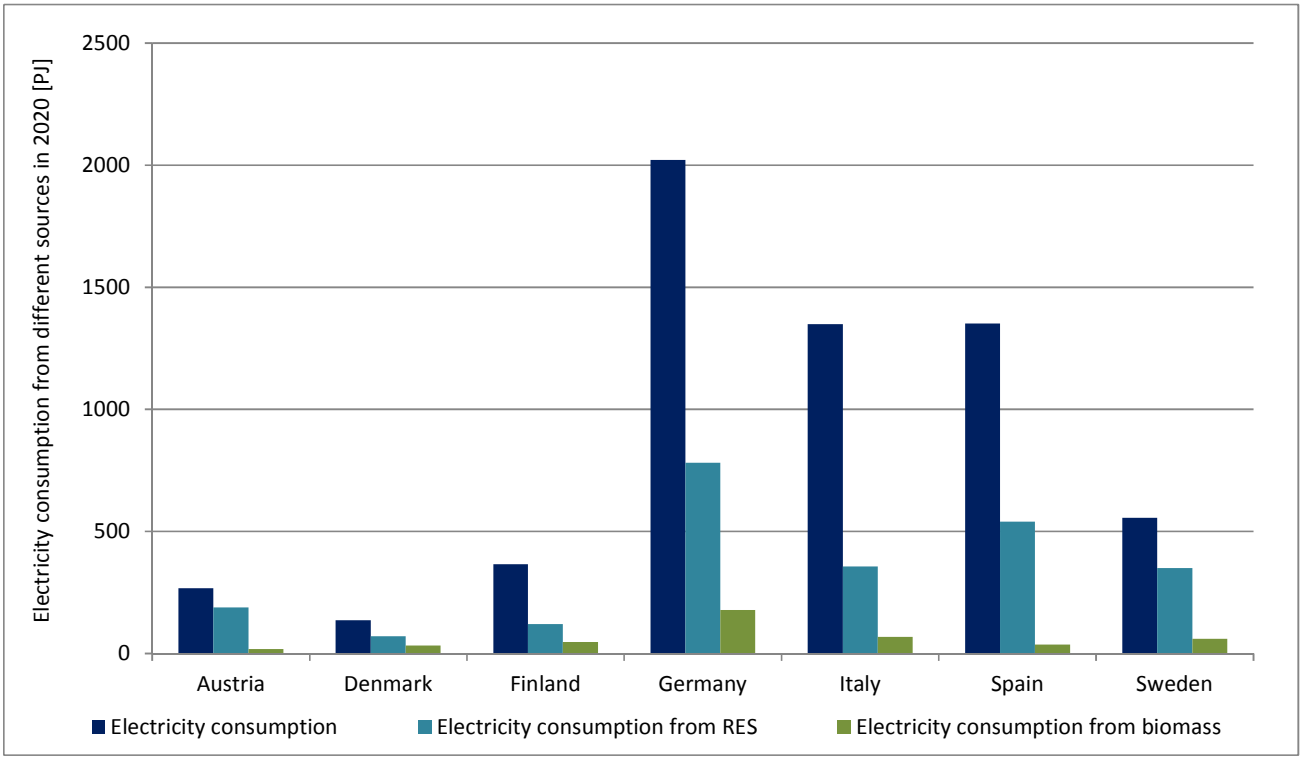


Figure 7: Contribution of electricity consumption from biomass to the total electricity consumption and the electricity consumption from renewable sources

On the policy level it appeared that not only ambitious targets are necessary but also that these targets are binding and not voluntary. The renewable energy directive of the European Union resulted in the NREAPs and spurred a development towards increased utilisation of biomass. There are different support schemes to increase biomass utilisation for energy purposes. Apparently, the most effective motivation can be realised using financial incentives. 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 5).

Table 5: 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 partner countries have implemented different measures to reach their targets. All partner countries provided information according to the available support programs within their countries. This information is summarised in the national conditions report which is available at

www.mixbiopells.eu. Further information on support options for biomass utilisation for energy production was extracted from the Renewable Energy Policy Reviews [2]-[8] and from the country reports of the EU-BioNet 3 project [17]. Support options for liquid fuel production from biomass are not taken into account. In the following, the available information is summarised separately for small and medium scale (<1MW heat production, Table 6) and for industrial scale (combined heat and power production, Table 7).

For small and medium scale the existing support measures are almost exclusively investment focused. Austria, Sweden, Finland, Germany and Italy provide financial incentives to support small and medium scale biomass use (Table 6). Investment subsidies and grants are offered in all five countries. However, in Austria the support mechanism are rather heterogeneous and complex, since each province has its own support measures for the renewable heating and cooling sector. Furthermore, low interest loans (FI, DE) and tariffs for used fuel (FI) are provided. These measures facilitate the initial decision for an investment into biomass utilisation and help to overcome economic constraints resulting from higher initial investments that are required when using alternative biomass fuels. In contrast, Denmark and Spain do not support the biomass utilisation for small and medium scale. In Spain, there is solely a RES obligation installed for the building sector, but with no particular focus on solid biofuels. In summary, the partner countries can be divided into two different groups according to their support option in small and medium scale. The used colours indicate the affiliation to the different groups within Table 6:

- Countries providing 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)

Table 6 Available support for small and medium scale biomass utilisation within the partner countries

	DK	ES	AT	SE	FI	DE	IT
Investment subsidies			x[1)]	x	x	x	x
Low interest loans					x	x	
Tariffs for used fuels					x		

An "x" indicates that the particular support is available in the respective country.
[1)] Only available on federal level.

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. The used colours indicate the affiliation to the different groups within Table 7:

- 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)

Overall, feed-in tariffs are an established measure to support biomass utilisation. It is applied by almost all partner countries. The sole exception is Sweden that relies its support scheme in the electricity sector mainly on quota obligations and green certificates. Furthermore, research activities are strongly supported in Sweden. The second type of support scheme that is applied by Austria and Spain utilises mainly feed-in tariffs but resign other support options. In Austria this may as well, at least partly, be attributed to an already quite diverse and well developed energy portfolio based on renewable energy sources as result of the prohibited nuclear power generation (since 1978). Denmark and Italy also have no own nuclear power stations. Thus, the pressure of dependency from foreign energy sources is more prominent and spurs the developments towards independent energy supply based on renewable energy sources (RES). Within the third category Denmark, Finland, Germany and Italy apply a mix of different support options. The feed-in tariffs are accompanied by priority or guaranteed access to the grid. Both measure give long time assurance for investors. Furthermore, financial incentives like tax exemptions are implemented. In Finland the support level is much lower than in the average European feed-in tariff scheme [18].

Table 7: Available support for industrial scale biomass use within the partner countries

	SE	AT	ES	DK	FI	DE	IT
Feed-in tariffs and/or premium for produced electricity		x	x	x	x	x	x
Priority/Guaranteed access to the grid				x	x	x	x
Tax exemption	x			x	x		
Green certificates	x						x
Quota obligations	x					x[2)]	x
Feed-in tariffs for heat		x[1)]					

An "x" indicates that the particular support is available in the respective country.
[1)] For CHP plants.
[2)] Only for new buildings. Obligation for RES use but not particularly for biomass use.

The previous analysis highlights that support scheme implemented to realise policies can address the economics of alternative (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 (mixed)

biomass utilisation will only be realised if it is economically feasible. The economics will be addressed in more detail in Chapter 2.3. The legal frameworks which can strongly influence the broad market implementation of alternative (mixed) biomass pellets will be analysed in Chapter 2.2. Within chapter 2.4 technology issues and the availability of appropriate technology for the production and utilisation of alternative (mixed) biomass pellets will be discussed.

The Best Practice Examples underscore the importance of public perception. Both Italian and Spanish key actors specifically mentioned the good public perception and the open-mindedness of customer towards alternative biomass fuels as important driver. Similarly, the long tradition of heating with wood as it is in Germany and Austria can result in a more positive perception of biomass combustion. In Austria, public buildings have obligations to use renewable energies in order to play an exemplary role.

Summary and Conclusion

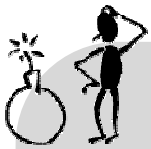
Policy and public opinion form the background and basis for the utilisation of alternative mixed biomass pellets. A good reputation can drive the demand. Thus, policy can contribute to the increase of the market relevance of alternative (mixed) biomass pellets by the improvement of the public perception. There are several possible tools. First of all, ambitious climate protection targets have to be set based on a public consent. Land use targets (energy plants vs. agricultural use) have to be considered too.

Information and transparency concerning the possible problems are very important for a good reputation. Inappropriate information can result in an overestimation of the chances of biomass utilisation for energy purposes and thus could lead to disappointment and bad reputation.

As will be shown in the following chapters, alternative (mixed) biomass pellets are especially suitable on a regional level. Thus, policies to support regional utilisation (bioregion projects, demonstration and pilot plants for alternative biomass pelletizing and utilisation) can be a surplus. The support can be financially but as well counselling and guidance can be provided.

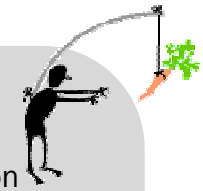
Ashes are formed in high amount during combustion of alternative biomass. Thus, ash disposal could be a problem for the key actors. At least it would result in additional costs. Interestingly, this topic had not been raised by the key actors, yet. However, increased utilisation of alternative (mixed) biomass pellets might result in an increased importance of this topic in the future. Thus, policies to render ashes which are formed during combustion of alternative (mixed) biomass a valuable resource (e.g. fertiliser) rather than a disposable waste can further promote their utilisation. The definition of waste is also an important topic on the raw material side. A policy change to address biogenic residues (e.g. from food processing) as possible raw material rather than as waste wood help to overcome uncertainties on possible fuel sources and drive the utilisation of alternative raw materials for energy purposes.

The lack of policy support (low climate protection targets or targets, no support for projects, conventionalism concerning centralised energy supply) and a low social acceptance can be considered as major constraints.



CONSTRAINTS

- Low climate protection targets or target without public consent
- Lack of land use targets
- Bad reputation driven by negative press coverage and failed or mal functioning projects
- Lack of support options and supported projects
- Conventionalism supporting centralised energy supply
- Allocation of residues from food processing as wastes



DRIVERS

- Ambitious climate protection targets based on public consent
- Clear land use targets
- Successfully realised projects (e.g. application in public buildings, supported bioregion projects)
- Available support for pilot/ demonstration projects and regional activities (financial, administrative, consultancy)
- Pioneering and inspiring national concepts for future energy supply
- Support options to ensure economics

2.2 Legal framework

Within this analysis it will be outlined to what extent the emission thresholds and the regulations on licensed fuels reflect and support the political will. Furthermore, the legal conditions indicate on which capacity range the alternative raw materials should be preferably used and on which types of alternative raw materials the attention should be focused.

Interview part

The legal framework has not been the subject of a specific questionnaire. However, the topic was frequently raised by the key actors during the regional activities, on workshop discussions and during discussions at the occasion of national and international presentations indicating the relevance of this topic for the key actors along the whole supply chain. Within the interviews on Combustion (Annex 4) key actors from Austria and Germany mentioned problems with legal conditions.

Results from other investigations within the MixBioPells project

Numerous contacts of the project partners with regional key actors and stakeholders took place on the occasion of regional activities, national presentations and workshops and during the investigations in the context of the project. Several subjects concerning the legal framework have been frequently raised and will be covered within this chapter.

The following aspects of the legal framework are of special relevance for the key actors along the alternative (mixed) biomass pellets production and utilisation chain:

- What types of biomass raw materials and residues are allowed for combustion?
- Is the utilisation of certain biomass types restricted to a specific capacity?
- What emission thresholds have to be complied with?
- What are the necessary steps of regulatory approval?

From the key actors view uncertainties concerning the allowed biomass fuels, the definition of waste in the context of biogenic residues as well as unclear regulations to receive regulatory approval have been frequently mentioned as concern, particularly by German and Austrian stake holders. Thus, strict but clear regulations are rather appreciated. However, cost intensive measurement programs and testing procedures to verify the suitability of the fuels are a major drawback. Within the MixBioPells project legal conditions for the combustion of alternative biomass pellets made of different raw materials, residues and mixtures were surveyed for the partner countries. Licensed fuels differ significantly within the partner countries. Possible solid biofuels that can be used for combustion purposes are listed in Table 8 for seven European countries.

Table 8: Solid biofuels for combustion purposes

Country	Licensed fuels
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
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"
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.

Certain alternative raw material types are residues or even wastes according to the current legal framework. For several raw materials, the boundaries between waste and biogenic residues are not clear (e.g. allocation of apple pomace in Germany). For these raw materials, the combustion

is particularly difficult since there are special regulations for waste incernation. To facilitate the use of these materials a clear regulation is required. This applies also the classification of mixtures with these raw materials.

The Scandinavian partner countries Finland and Sweden both have no general guidelines for licenced fuels. Accordingly, there is a tendency to focus on established fuels. Indeed, key actors in Finland and Sweden used only few different alternative raw materials. Preferentially, energy crops (e.g. reed canary grass RCG) were employed.

The legislative framework for emission and immission is also of high relevance for the key actors. Within the partner countries the threshold values vary significantly in the range from non-existing till highly regulated with low thresholds. In Figure 8 the threshold values of each country are classified as strict, loose and no regulation of threshold values. According to Figure 8 there are significant differences of the legal conditions for different thermal ranges and different countries. 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. In contrast, 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. Within the Scandinavian countries Finland and Sweden only few alternative raw material are used for combustion and there is no large demand for the expansion of the raw material basis. For that reason, it seems to be not necessary to control the types of alternative raw materials being used for energy purpose by the implementation of strict emission thresholds. Indeed, 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).

Country	Capacity	CO	OGC	NO_x	SO_2	HCl	Particles	Dioxine/ Furanes
Austria[1)]	< 100kW							
	100kW - 1MW							
	> 1MW							
Austria	< 100kW[2)]							
	100kW - 1MW[3)]							
	> 1MW							
Denmark	< 100kW							
	100kW - 1MW							
	> 1MW							
Finland	< 100kW							
	100kW - 1MW							
	> 1MW							
Germany	< 100kW							
	100kW - 1MW							
	> 1MW							
Italy	< 100kW[4)]							
	100kW - 1MW[5)]							
	> 1MW[6)]							
Sweden	< 100kW[7)]							
	100kW - 1MW[8)]							
	> 1MW							
Spain	< 100kW							
	100kW - 1MW							
	> 1MW							
		mg/Nm^3	mg/Nm^3	mg/Nm^3	mg/Nm^3	mg/Nm^3	mg/Nm^3	ng/Nm^3
	strict	<500	<30	<300	<250	<50	<50	<0,1
	loose	<1000	<125	<600	<400	<100	<300	<0,5
	none	-	-	-	-	-	-	-

1) Threshold values valid for non-industrial applications 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 8: 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)

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. (The influence of additional investments for flue gas cleaning on the overall viability of alternative (mixed) biomass utilisation projects has been addressed in the cost analysis report which is available at www.mixbiopells.eu). For that reason the following classification of the legal conditions can be established for small and medium scale applications. In case there are thresholds for several emissions that have to be complied with *and* the thresholds are strict then legal conditions are classified as "highly restricted". In contrast, if thresholds apply only for few of the possible emissions and the thresholds are loose then the legal conditions are classified as "low restricted". Consequently, the legal conditions influence the range of alternative fuels that can be used:

- Highly restricted legal conditions: A small range of fuels can be used due to strict emission threshold values and due to few technical possibilities to keep the threshold values, e.g. restrictions for small and medium scale combustion plants in Germany and Austria and medium scale applications in Italy (100-400 kW).
- Low restricted legal conditions: A wide range of alternative fuels could be used for combustion purposes due to loose restricted emission threshold values, e.g. restrictions for medium scale systems in Denmark as well as small scale systems in Italy and Sweden.
- No regulations: Due to a lack of emissions thresholds and/or alternative fuels not being specifically indicated as allowed fuels the utilisation of alternative fuels has to be individually approved by local authorities based on experiences, e.g. in Spain, Finland (below 1 MW) or non-industrial use in Austria (except for boilers below 400 kW in the province of "Lower Austria").

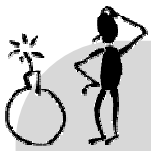
If the European Union's Framework Directive on Eco-Design of Energy-Using Products (Directive 2009/125/EC) is coming into force most national frameworks will be adjusted [9].

Clear, easy and fast procedure to get regulatory approval is another important factor to enhance alternative (mixed) biomass pellet utilisation. This aspect is a main part of the Assessment of NREAPs [18]. According to this analysis the administrative procedure and the delay that is caused by time consuming approval steps are quite different among the partner countries. The one-stop shop scheme facilitates the administrative tasks since all necessary bureaucratic steps to achieve the plant authorisation can be taken in one place. It is introduced by almost all partner countries except Finland and Spain. In Italy, the one-stop shop scheme is introduced but not well implemented. In most partner countries the regulatory approval is granted in reasonable and acceptable time. However, in Italy and Spain the lead-time to get all permits is very long and could require up to several years.

Summary and Conclusion

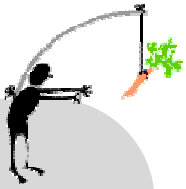
Standardised and uniform regulations European-wide would facilitate alternative mixed biomass pellet production and utilisation. Though there are some advances/positive developments (adaption of EN 303-5, product standard prEN 14961-6) the situation is still unsatisfying. Similarly, a labelling and certification system especially for small combustion units is assumed a

major driver by many key actors. The development of such a labelling and certification scheme is one of the main targets of the MixBioPells project.



CONSTRAINTS

- Varying regulations or lack of regulations concerning the allowed biomass types for combustion on national or even regional level
- Uncertain legal status for regulatory approval
- Dependency on the good-will of local authorities
- Varying national emission thresholds
- Different capacity limits for certain emissions in the different countries
- Elaborate, periodic test procedures to keep approval for operation
- Slow and complicated procedures to get regulatory approval



DRIVERS

- Clear regulations on the allowed biomass types on European level
- European labeling and certification system (esp. for small combustion units)
- Clear, easy and fast procedures for regulatory approval
- Uniform emission thresholds

2.3 Economics

This chapter will highlight economic issues that are relevant and will show economic constraints and drivers that are important on the user side (e.g. for pellet producers, fuel suppliers, manufacturers, plant operators, costumers).

Interview part

There was no specific questionnaire on economics. However, economic aspects had been the subject of the interviews on raw materials, pellet production and combustion as well as on the social acceptance questionnaire. The utilisation of alternative mixed biomass pellets is strongly influenced by the associated costs. To render the utilisation of alternative mixed biomass pellets profitable the achievable revenues have to be higher than the overall costs. The overall costs are the sum of fuel costs, the investments for the required equipment and the

maintenance and operation cost which could be higher for difficult alternative raw materials than for conventional woody or fossil fuels. Investment costs can be reduced by governmental grants and subsidies. Tax exemptions and guarantied feed-in tariffs are further instruments to render alternative biomass utilisation more profitable (Table 9).

Table 9: Factors that influence the profitability

Costs decreasing profitability	Factors increasing profitability
• Costs for raw material harvest and supply • Logistic costs • Investment costs • Maintenance costs • Operation costs	• Feed-in tariffs and premiums • Investment subsidies • Tax exemption • Subsidies on fuels • Disposal cost savings

Low costs of the raw materials straw (Italy, Sweden) and reed canary grass (Sweden) were indicated as motivation for its utilisation by the interviewed key actors. In contrast, high cost of potentially available raw materials resulting from cost intensive processing, pre-treatment or necessary drying were particularly mentioned by Swedish (hemp), Danish (pectin waste) and Spanish (wine residues) key actors.

There are different raw materials utilised within the different partner regions. This can be attributed to the availability of raw material that was estimated by the interviewed key actors (see chapter 2.4 Technology Issues). Though not specifically asked for it can be assumed, that the key actor particularly indicated those raw materials as available that can be received at an affordable/reasonable price. However, the direct relation between raw material costs and utilised raw materials for pelletizing could not be extracted from the interviews. Firstly, this is attributed to the relatively low overall feedback rate on the production questionnaires resulting from the limited experience of the interviewed key actors in this field. Moreover, due to the limited experience the questionnaire appeared to be too elaborated for the key actors and several questions could not be answered. Thus, information on the raw material cost was only provided for selected raw materials and not all of them had been consecutively used for pelletizing. Similarly, pellet production costs were provided only for selected raw materials and the according raw material costs were available only for few of these examples.

According to the interview on Pellet Production (Annex 3, for feedback rate see Annex 1) in most cases, the raw materials are provided to the pellet producers either from their own plantation (21%) or from other farmers within a radius of 50 km (49%). This indicates the importance of logistic costs. Similarly, key actors have been interviewed on the combustion of alternative (mixed) biomass pellets (Annex 4, for feedback rate see Annex 1). Apparently, customer that use alternative (mixed) biomass pellets or briquettes mainly get their fuel from the own production (42%) or from local sales and services within a 54 km radius (35%).

Economic problems due to the utilisation of alternative (mixed) biomass pellets or briquettes have been mentioned by Finish, German and Swedish key actors within the combustion questionnaire.

Results from other investigations within the MixBioPells project

In particular, economics have been investigated within the cost analysis. Each partner region established two Case Studies representing the whole value chain of alternative pellets. Based on these Case Studies a comparison of the heat supply costs of alternative heating systems with the heat supply costs of the most common fossil heating system considering the local conditions has been performed. The results of the cost analysis is summarised in the Cost Analysis Report which is available at www.mixbiopells.eu.

As described above, the fuel costs contribute significantly to the overall costs. Therefore, if prices for alternative (mixed) biomass pellets are low compared to fossil fuel prices an increased interest in alternative fuel options will result. Similarly, rising fossil fuel prices and taxation on CO_2-emission and/or on fossil fuel use can increase the interest in and the demand for cheaper alternatives.

In the following the fuel costs of different alternative (mixed) biomass pellets and briquettes from the participating countries are compared with prices for wood pellets, wood chips and fossil fuels for comparison. Figure 9 shows the fuel costs in € / MWh including costs for harvesting, transport (up to 50 km), drying and pelletizing/briquetting.

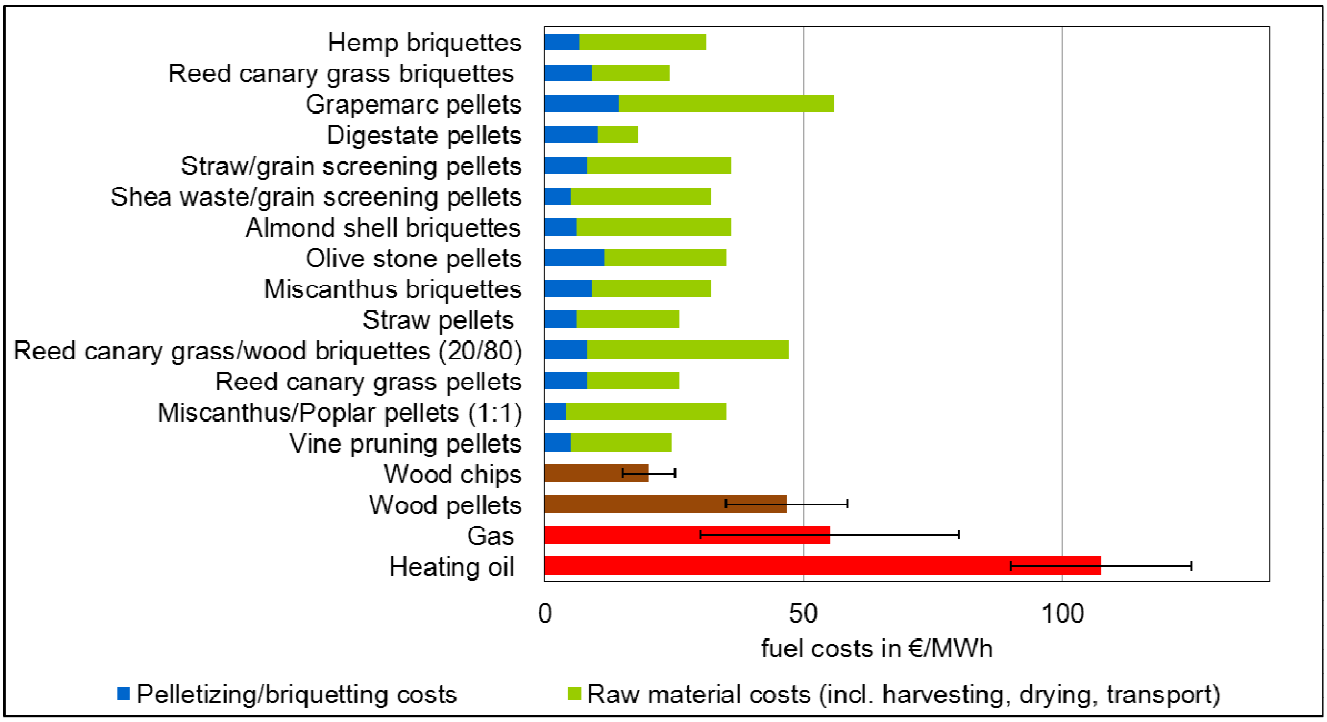


Figure 9: Fuel costs including costs of pelletizing/briquetting and fluctuation of wood and fossil fuel prices

The fuel costs amount to 18-56 € / MWh, depending on the used raw material and the pelletizing plant. Usually, the costs for pelletizing and briquetting amount to 11-32% of the whole fuel costs. Thus, optimal operation of the pelletizing/briquetting plant is important to gain cost advantages. The higher prices of grape marc pellets indicate the high drying effort for this particular raw material. Thus, the importance of high raw material quality that does not require

intensive drying is highlighted. Reed canary grass/wood pellets also have relatively high cost which can be attributed to the high proportion of the more expensive wood.

Furthermore, in Figure 9 the fluctuations of fossil fuel prices in the different partner countries are illustrated. The price for heating oil is much higher than the one for alternative pellets.

Gas as fuel can keep up with alternative pellets in regard to the price in some, especially Southern, countries (Table 10). In contrast, Scandinavian countries have particularly high fossil fuel prices which can be partially attributed to CO_2-taxation that is implemented in Denmark, Finland and Sweden. Therefore, alternative (mixed) biomass pellets are more competitive there. Within Table 10, the average fuel price for alternative (mixed) biomass pellets, the price of the most common fossil alternative (heating oil (ho), natural gas (ng) or gas oil (go)) is provided for each country.

Table 10 Comparison of actual prices for alternative pellets/briquettes and fossil reference fuels

	AT	DK	FI	DE	IT	ES	SE
Fossil fuel type	ho	ho	ho	ho	ng	go	ho
Fossil fuel price [€/MWh]	90	150	130	70	60	90	120
Average price for alternative pellets or briquettes [€/MWh]	29	34	37	37	30	36	28
Cost savings by using alternative biomass pellets/briquettes [%]	68	77	72	47	50	61	77

Source: Investigation within the project, Cost Analysis Report of the MixBioPells project

The total heat supply costs are influenced not only by the fuel cost but as well by investment, maintenance and operation costs. These aspects were addressed in the analysis of the case studies within the MixBioPells project. Exemplary, two Austrian heating systems (25 kW and 200 kW) that are fired with Miscanthus briquettes or straw pellet have been analysed and the results are depicted below.[1] The calculation of the heat supply costs of the reference fossil fuel system is based on the average price of heating oil in 2010/2011. Apparently, regarding economic aspects, alternative biomass pellets are more suitable for medium to large scale heating systems than for small boilers (Figure 10a and 10b). Using straw pellets in a 25 kW heating systems pays off not before year 10, using Miscanthus briquettes pays off after 14 years. In comparison, the 200 kW systems operated with alternative pellets or briquettes are getting favourable after 3.5 years. Thus, the lower fuel costs of alternative (mixed) biomass pellets or briquettes influence the economic efficiency of larger plants more than the one of smaller plants.

[1] A detailed description of the method used for the cost analysis can be found in the cost analysis report which is available at www.mixbiopells.eu.

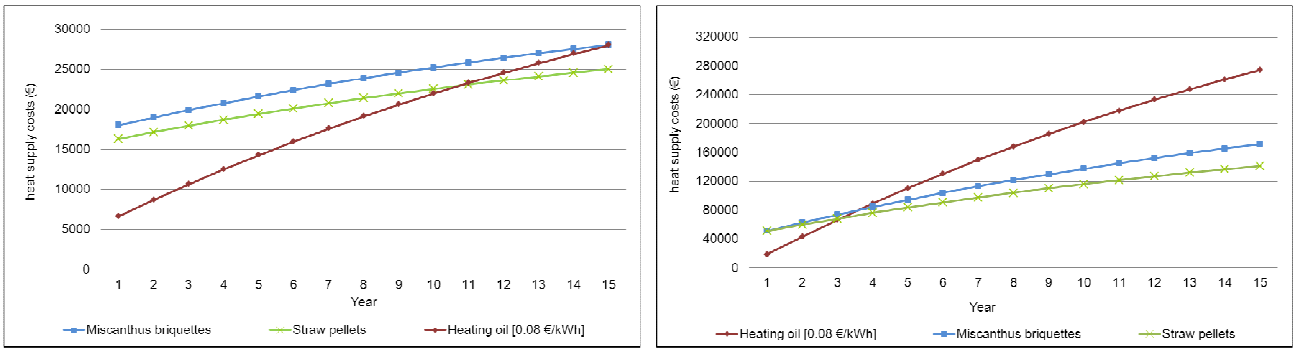


Figure 10a (left) and Figure 10b (right): Comparison of a small (25 kW) and medium scale (200 kW) heating systems in Austria fired with Miscanthus briquettes or straw pellets

The heat supply costs for heating systems of each case study are presented in Figure 11. Obviously, the heat supply costs of small plants are higher than those of large systems, despite consideration of different conditions in the partner regions. An exception is the system which is operated with vine pruning pellets. This can be explained by the exceptionally low raw material costs for vine pruning. The heat supply costs of the 200 kW system operated with reed canary grass/ wood briquettes are higher due to the high wood proportion of the briquettes which make them more expensive.

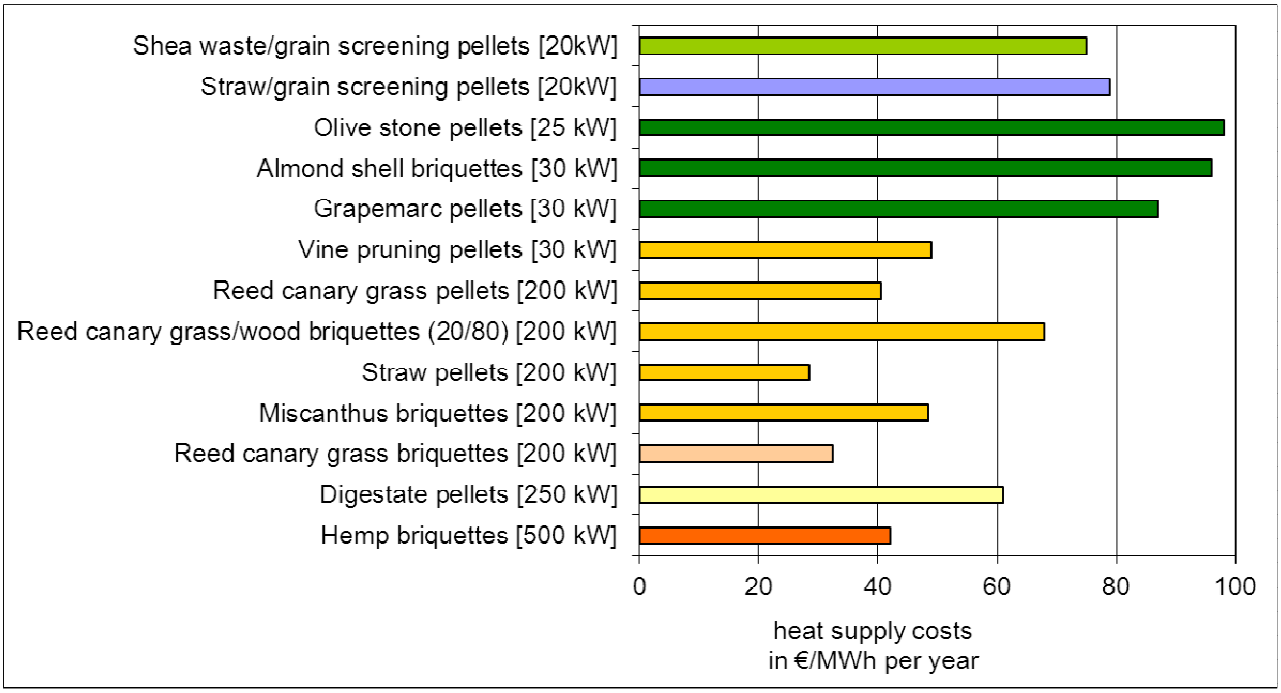


Figure 11: Heat supply costs for selected case studies in the partner countries

The analysis of the influence of the fuel costs was accomplished on the basis of the Austrian 200 kW heating systems. The fuel costs as a major part of the annual operating costs have a major influence on the economy of the heating systems. Figure 12 shows different price scenarios for the heating oil in Austria. Currently, the oil price amounts to 0.09 € / kWh and the alternative biomass heating systems are getting favourable after 3.5 years. If the oil price amounts to 0.045 € / kWh, like in the year 2005, the alternative biomass heating systems would get favourable after 4.5 years (straw pellets) respectively after six years (Miscanthus

briquettes). If the oil price doubles, like it did from 2005 to 2010, the alternative biomass systems would already get cost-effective after 1.5 years (Figure 12).

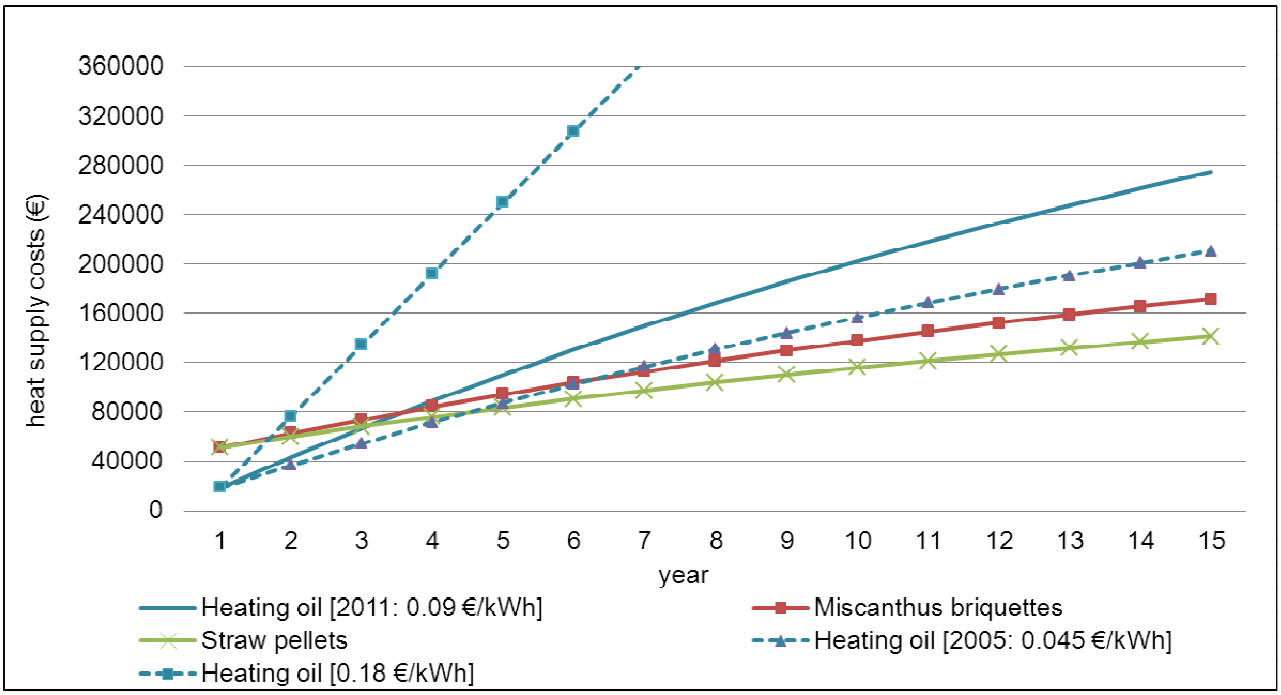


Figure 12: Influence of changing heating oil prices on the profitability of the heating systems (200 kW)

Further information on economic constraint and drivers can be extracted from the investigations on the regional conditions. The regional conditions considering legal aspects and available support options have been summarised in the Regional Conditions Report which is available at www.mixbiopells.eu. As discussed within the Chapter 2.1 Policy and Social Acceptance, policy can provide financial incentives by implementing appropriated support schemes for alternative (mixed) biomass utilisation. The following options reduce initial investments:

- Investment subsidies and grants
- Tax exemptions
- Soft loans

This support is important to overcome constraints resulting from the necessary high initial investment costs which currently hinder the broad market implementation of alternative (mixed) biomass pellet utilisation. Investment focused support schemes are mainly used for small and medium scale applications. In contrast, generation based support options are valuable measures to enhance industrial scale utilisation. The following generation based support option are implemented in the European partner countries:

- Fixed feed-in tariffs and premiums for electricity
- Green certificates and quota obligations

Fixed feed-in tariffs are important to allow and ensure profitability. Thus, they provide an incentive for alternative (mixed) biomass utilisation. In contrast, quota obligations in concert

with green certificates are an instrument to enforce the utilisation of alternative (mixed) biomass pellets. A more detailed description of the available support measures in the different partner countries is provided in Table 6 and Table 7. Table 11 summarises the main support schemes within the partner countries.

Table 11: Main support schemes within the partner countries

		SE	AT	ES	DK	FI	DE	IT
Investment focused support scheme		x	x			x	x	x
Generation based support scheme	**Feed-in tariffs for electricity**		x	x	x	x	x	x
	Green certificates and quota obligations	x						x

An "x" indicates that the particular support is available in the respective country.

Apparently, generation based support schemes are implemented in all partner countries. In contrast, support for the initial investment for small and medium scale applications is only implemented in Sweden, Finland, Germany and Italy. In Austria, investment subsidies are available for small and medium scale heat appliances on federal level and for biomass based CHP plants.

The Best Practise Examples underscore the importance of the local aspect. Most of the alternative raw materials are available on local level. The scattered and in many cases seasonal availability of small amounts render the regional utilisation more favourable. Frequently, it turned out that the commitment of regional key actors is mandatory to initiate projects with alternative raw materials. For regional key actors the economic effect of a 'grown in the region-produced for the region' concept is highly relevant.

High storage demands due to seasonal availability leading to additional cost have been a problem in some cases.

Summary and Conclusion

Economic aspects, e.g. the costs of alternative raw materials and fuels and additional investments for technical systems like precipitators and combustion technologies, are crucial for the establishment of alternative (mixed) biomass pellet production and utilisation. The investment costs for alternative heating systems are higher than for fossil fuels and often also higher than for wood fired systems. However, fuel costs as a major part of the annual operating costs have a major influence on the economy of the heating systems. Therefore, medium to large scale heating systems which are operated with alternative (mixed) pellets and that are operated with high yearly working hours are more profitable than fossil heating systems. Necessary pre-treatments of the raw material have a major impact on the pellet prices. Low drying and storage costs are essential to ensure a profitable fuel. The costs for pelletizing and briquetting of alternative raw materials amount to 11-32% of the whole fuel costs. If the raw materials are mixed, an optimal plant operation must be ensured in order to keep the

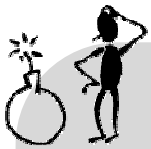
production costs low. Logistic efforts have only a minor effect on the pellet price as long as transportation distances are low (<50 km). Long transport distances only pays off for large scale appliances (>1MW).

Ashes are formed in high amounts during combustion of alternative biomass. The ash disposal could be a problem for the key actors. At least it would result in additional costs. Interestingly, this topic had not been raised by the key actors, yet. However, increased utilisation of alternative (mixed) biomass pellets might result in an increased importance of this topic in the future. Thus, policies to render ashes which are formed during combustion of alternative (mixed) biomass a valuable resource (e.g. fertilizer) rather than as disposable waste can further promote their utilisation.

One important factor for building-up a successful supply chain is the commitment of regional stakeholders. Furthermore, the policy makers are asked to set up a well-defined legal framework in order to provide assurance to potential investors.

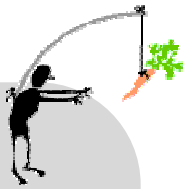
It is important to ensure planning reliability for cost and revenues. Thus, stable raw material prices would be advantageously. Furthermore, stable and reliable revenues have to be guaranteed. In general, specific investment cost decrease with increasing plant size. However, the local and scattered availability of alternative biomass results in higher logistic efforts. Thus, upscaling is only possible to a certain degree.

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 (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. In this case, the fuel characteristic would be still critical. However, since local fuels are used and there is no or little change in the source and origin of the fuel it can be expected that the fuel characteristics are fairly constant. Thus, the additional costs for adapting the combustion technology could still pay off.



CONSTRAINTS

- High and fluctuating raw material prices
- Higher investment costs resulting from critical fuel parameters
- Increased costs for maintenance and repair due to critical fuel parameters
- Low economic life-time due to critical fuel parameters
- Logistic efforts limit upscaling
- Increase of specific cost with lower capacity render small combustion unit for alternative mixed biomass pellets less profitable



DRIVERS

- Lack of alternative utilisation options for available raw materials, i.e. low raw material costs
- High costs for disposal of biomass residues from agricultural and food industry, i.e. demand for alternative utilisation options
- Financial incentives supporting alternative biomass pellets utilisation
- Higher logistic costs resulting from local and scattered availability support regional utilisation and medium scale plant size
- Quota obligations enforcing the utilisation

2.4 Technological issues

Technological issues are import at several steps along the alternative (mixed) biomass pellets production and utilisation chain. Alternative biomass types often afford adapted harvest technologies. Furthermore, sources of alternative biomass are usually more scattered. Thus, for several cases there are no established supply chains. Sometimes, additional preconditioning efforts are required for alternative biomass (e.g. higher moisture content affording drying, structural properties that require adapted feeding technology, more complicated grinding). During pelletizing, alternative biomass could require different dies and die dimensions. Certain characteristics of alternative biomass could reduce the lifetime of dies. Overall, adapted technology might be necessary for the production of alternative (mixed) biomass pellets. Similarly, alternative (mixed) biomass pellets are difficult to use with boilers developed for wood pellets. Higher ash content and lower ash melting points resulting in higher slagging tendencies have to be coped with. Thus, adapted combustion technologies have to be developed and applied. Finally, elemental composition of alternative biomass often results in higher emission of critical air-borne pollutants (e.g. HCl, NO_x, SO_2, dust emission). For that reason, flue gas cleaning technologies have to be developed and applied. Some of the emissions are not only harmful for health and environment but cause erosion within the combustion appliance.

This chapters will show constraints and drivers that are relevant on the user side (e.g. for pellet producers, fuel suppliers, manufacturers, plant operators, costumers).

Interview part

Interviews on alternative (mixed) biomass pellet production (Annex 3) and combustion (Annex 4) have been conducted. However, feedback rate was particularly low for this part (see Annex 1 for feedback rates). The low feedback rate indicates the limited experience with alternative raw materials for pelletizing and combustion.

Alternative (mixed) biomass pellet production

The interviews on raw materials highlighted that the utilisation of alternative raw materials is facilitated if it relies on an established supply and logistic chain. The key actors in the field of alternative (mixed) biomass pellets production have been interviewed using questionnaires on production (Annex 3). In all countries, most of the raw materials that were seen as available for the region (see Chapter 2.5 and Annex 2) were as well used for production (Table 12). Austrian, Danish, Italian and Swedish pellet producer used less biomass types for pellet production than raw material types were mentioned as available within their region. German and Spanish pellet producers also used raw materials which were not considered as promising raw materials within their region.

Table 12 Available vs. used raw materials for combustion

	Energy crops	Residues from agriculture	Residues from landscape gardening	Residues from the processing of rapes	Residues from the processing of olives and grapes	Residues from processing of citrus fruits	Residues from processing of other agricultural commodities	Others
Austria								
Denmark								
Finland								
Germany								
Italy								
Spain								
Sweden								

	Available raw material for combustion
	Raw material used for pellet production

Source: Interviews on Raw Material (Annex 2) and on Pellet Production (Annex 3), for feedback rate see Annex 1

Only the most essential pre-treatment is applied. None of the interviewed pellet producers used thermo-chemical processes (e.g. torrefaction) to change physical and/or chemical properties. In most cases, the interviewed key actors used solely a grinder. Several key actors indicated that drying was not required since the raw materials were supplied with sufficiently low moisture

content. Hammer mills are most commonly used to reduce the particle size. The available information on used mixers was particularly poor. The reason is probably the limited experience with mixed alternative raw materials and that the key actors hardly produce alternative (mixed) biomass pellets. Thus, for test trials manual mixing may be applied. In Italy the utilisation of a compulsory mixer has been mentioned. In Germany, a not specified mixer had been applied by one of the key actors. A mixing bin fed by different conveyor belts had been mentioned by a Finnish pellet producer. Less than 50% of the key actors used binders or additives. This might be attributed to the fact that no additives are required for the pelletizing of the used raw materials or to the lack of appropriated technology for the addition of binders or additives. According to the interviews, there is a preference for the utilisation of ring die technology for the production of alternative (mixed) biomass pellets (Table 13). Flat die presses are traditionally used for litter and fodder production. They can be more economic since less pressure is applied resulting in less abrasion and energy costs. However, pellets produced on flat die presses have often lower quality (mechanical stability, durability, bulk density). Thus, on flat die presses pellets that have sufficient quality as fodder or litter may be produced. However, high quality demand for fuel production will cause increased utilisation of ring die presses. In Austria and Germany, hydraulic pellet press technology has been used. Own developments with not specified technology are mentioned by Spanish, Austrian and Swedish key actors.

Table 13: Types of pellet presses used for alternative (mixed) biomass pellet production

	AT	DK	FI	DE	IT	ES	SE[1)]
Flat die	x			x		x	x
Ring die	x	x	x	x	x		x
Others[2)]	x			x		x	x

Source: Interview on pellet production (Annex 3), for feedback rate see Annex 1
[1)] Data from Swedish data acquisition instead of questionnaire.
[2)] Hydraulic pellet presses or own developments of the pellet producers.

According to the interviews there is a total press capacity of about 650.000 t/a available within the partner countries (Figure 13). This includes both pellet production for energetic (E) and material (M) use. Material use includes pellets used in stock breeding as bedding or fodder but as well as insulating and filling material. The total real production accumulates to about 443.000 t/a. Thus, capacity utilisation of about 68% is achieved. The deviations between the installed capacities and the real production (DK, FI) can be explained by varying feedback rates for both subjects. In Denmark, more than 100,000 t/a using mainly straw as raw material 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.

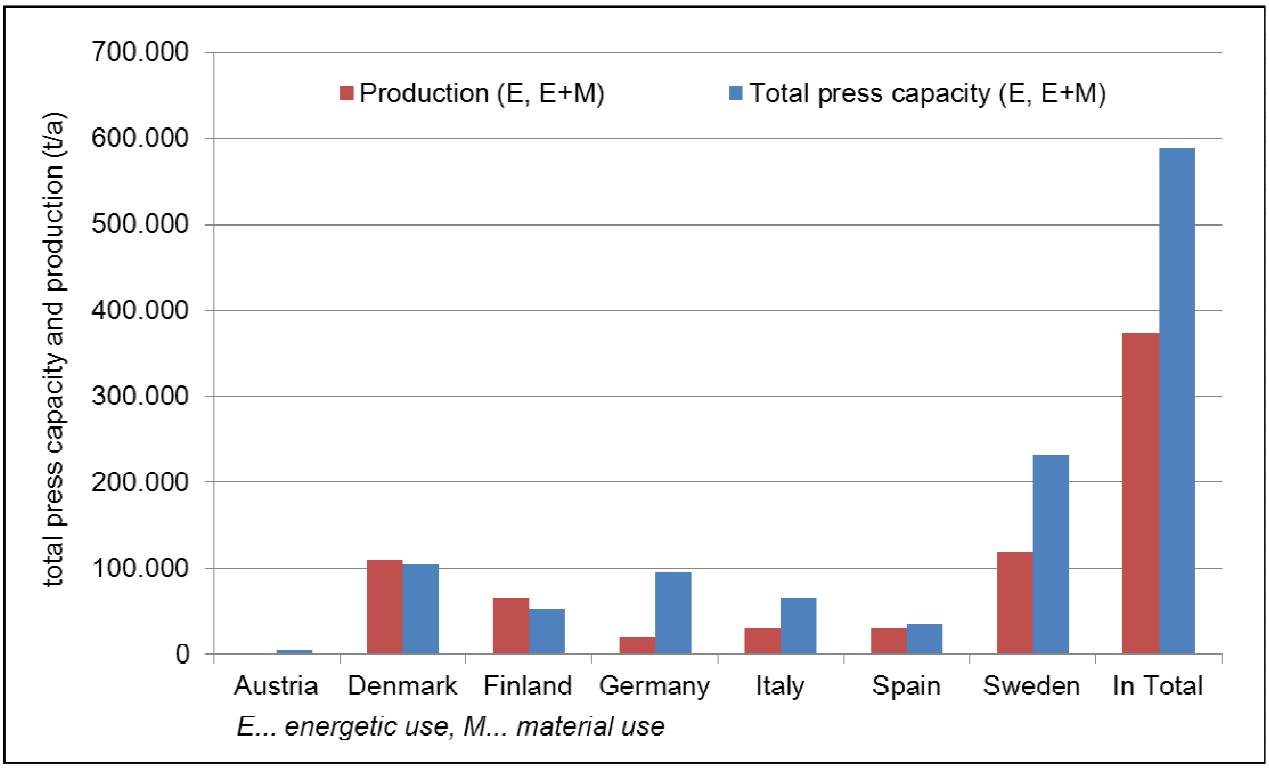


Figure 13: Pellet press capacity vs. pellet production

The production of alternative and mixed biomass pellets is mainly based on energy crops (11 of 21 key actors), residues from agriculture (10 of 21 key actors), residues from landscape gardening (5 of 21 key actors) and residues from processing of olives and grapes (3 of 21 key actors). Other raw materials such as peat or carrageenan waste are used by 10 of 21 key actors. Some of the pellet producers follow existing standards for the pellet production (Table 14). However, feedback rate on this question was very low. This may be attributed to a lack of knowledge.

Table 14: Pellet production according to existing standards

	AT[1)]	DK[2)]	FI	DE	IT[1)]	ES	SE
CEN	-		x	x	-	x	x
DIN	-			x	-		x
ÖNORM	-				-		
Others	-	x			-	x	x

Source: Interview on Pellet Production (Annex 3), for feedback rate see Annex 1
An "x" indicates that the particular standard has been used by at least one of the interviewed key actors in the respective country.
[1)] no answer received
[2)] only one answer received

As main constraints in the field of alternative (mixed) biomass production the following aspects were identified from the interviews:

- quality of the raw materials (DE, FI)
- difficulties with the pelletising process (DE, ES, FI)
- lack of experience (FI).

Alternative (mixed) biomass pellets combustion

Similarly, key actors in the field of alternative (mixed) biomass pellets utilisation have been interviewed using the questionnaire for combustion (see Annex 4). All of the interviewed key actors use alternative (mixed) biomass pellets regularly. However, the data base is very limited for the combustion interviews (see Annex 1). Thus, the results given below can only provide an indication. The given reasons for alternative (mixed) biomass utilisation differ within the different partner countries (Table 15).

Table 15: Most important issues for the utilisation of alternative (mixed) biomass pellets/briquettes

	AT	DK[1)]	FI	DE	IT	ES	SE
Climate protection		++	+		~		
Economics		++		~	+		+
Sustainability			+	+	+	+	~
Regional added value			+	+	~	++	~
Others[2)]	++		+				+

Source: Interview on Combustion (Annex 4), for feedback rate see Annex 1
[1)] Number of received answers: 1.
[2)] Other reasons for the utilisation of alternative (mixed) biomass pellets/briquettes are: a monitoring project (AT), the recycling of residues (AT), the use of alternative to grains (SE), the demand on the market (SE) and other not specified reasons (FI).
++ 50-100% of the mentions relating the most important issues to utilise alternative (mixed) biomass
+ 20-49% of the mentions relating the most important issues to utilise alternative (mixed) biomass
~ less than 20% of the mentions relating the most important issues to utilise alternative (mixed) biomass

Sustainability and regional added value are among the issues most often mentioned as motivation for the utilisation of alternative (mixed) biomass pellets and briquettes. According to the interviews economics and climate protection appear to be less relevant. The clear majority of the interviewed key actors expect a further increase in the future. However, there are clear regional differences (Table 16).

Table 16: Estimated future development for the energetic utilisation of alternative (mixed) biomass pellets and briquettes until 2020

	AT	DK[1)]	FI	DE	IT	ES	SE
Will increase	+	++[1]	~	+	++	++	~
Will remain on the actual level			~	~			
Will decrease			+				++

Source: Interview on Combustion (Annex 4), for feedback rate see Annex 1
[1)] Only one answer received.
++ 75-100% of the asked key actors.
+ 50-74% of the asked key actors.
~ <50% of the key actors.

The Scandinavian countries Sweden and Finland see the prospect of alternative (mixed) biomass utilisation markedly more negative. In contrast, Italy, Spain and Denmark expect a positive further development. The current use is focused on energy crops (35% of all answers concerning the used biomass for combustion) and residues from agriculture (53% of all answers concerning the used biomass for combustion). Agricultural residues (esp. straw) are already used in all partner countries. Germany, Italy and Spain use residues from olives or grapes for combustion.

According to the interviews, only a minority of key actors utilising alternative (mixed) biomass pellets is equipped with combustion systems that are licensed for alternative fuels. Usually, boilers for wood pellets, wood chips or wood briquettes are used. This indicates the limited number of appropriated technology available for this purpose. Accordingly, several problems resulting from difficult fuel characteristic were reported (Table 17). None of the interviewed key actors had no problems with the combustion.

Table 17: Problems during alternative (mixed) biomass combustion

	AT	DK	FI	DE	IT	ES	SE
Dust emission	x		x	x	x		
Corrosion			x		x		x
Slagging and fouling		x	x	x			x
Ash handling	x	x	x	x	x	x	x

Source: Interview on Combustion (Annex 4), for feedback rate see Annex 1
An “x” indicates that the problem was mentioned by at least one key actor.

Problems with ash handling were mentioned in all partner countries. However, problems with slagging and fouling were only indicated by Danish, Finnish, German and Swedish key actors. Dust emission problems were an issue for Austrian, Finnish, German and Swedish combustion plant operators and customers. Only Finnish, Italian and Swedish key actors mentioned problems with corrosion and reduced life time of the appliances.

Gaseous and particulate emissions are important issues for regulatory approval. Thus, the key actors have been asked for technical equipment to reduce emissions. Only Danish and German key actors used such equipment. According to the interviews, alternative (mixed) biomass is mainly used for heat supply and district heating, i.e. within small and medium scale applications. Within the project there are only two examples of combined heat and power supply (Denmark and Italy). A larger demand in the small and medium sector would be a driver for further technology development. In due course, technological developments will allow for an increased market relevance of alternative (mixed) biomass pellets if provided at a reasonable price.

Results from other investigations within the MixBioPells project

Further information concerning available technology for the steps along the alternative (mixed) biomass pellet production and utilisation chain was gathered within the MixBioPells Project using literature research, market survey and contacts with key actors. The information has been summarised in the report on pelletizing and combustion technology that is available at www.mixbiopells.eu. Furthermore, problems with and motivations for the pelletizing of alternative raw material could be extracted from the Best Practice Examples. Best Practice Examples from the partner countries have been compiled for alternative (mixed) biomass pellet production, for the combustion of alternative (mixed) biomass pellets and for chains of alternative (mixed) biomass pellet production and utilisation. All Best Practice Examples are available at www.mixbiopells.eu.

Pelletizing technology

In general, cereal straw and other herbaceous raw materials can be pelletized without major difficulties if a proper moisture content and pressing temperature exist. Feedstock moisture seems to have an important effect on improving the pellet density and durability. As water softens lignin, moisture can improve the durability if densification temperatures are low. Several critical fuel characteristics can be positively influenced by choosing the appropriate harvest time. Within the Best Practice Examples, usually conventional pre-treatment and pelletizing technologies are applied. Thus, hammer mill and ring die pellet presses are most often used. For herbaceous biomass (straw, reed canary grass) in some cases an additional shredder or bale braker is used before the raw material is grinded with the mill. However, there is also an example where a pellet producer developed a special pellet press particularly suitable for the critical and varying characteristics of alternative raw materials and mixtures based on a hydraulic press concept. According to the Best Practice Examples, manual mixing seems to be most often used for alternative raw materials. However, this is not an adequate solution if standardised pellets with constant quality are to be produced. Though there are some problems with the pelletizing or briquetting characteristics of certain raw materials (e.g. vine prunings, almond shells) none of them appeared to be an insurmountable obstruction to the pellet producers. The varying fuel characteristics of alternative raw materials are a major constraint. Overall, careful adaption of the pelletizing parameters has to be done for each raw material and depending on the available quality of the raw material in order to achieve pellets with good

mechanical characteristics. In summary, considerable experience is crucial to successfully perform the pelletizing of alternative raw materials.

Among the Best Practice Examples two concepts deserve special attention. Several pellet producers us mobile pelletizing machines. With this strategy they react to the scattered availability of alternative raw materials. In this way, less logistic effort is required. Furthermore, it supports a "grown in the region produced for the region" philosophy that seems to be an important motivation for the pellet producers. The other strategy that is followed by at least two pellet producers is the combination of production of alternative (mixed) biomass pellets based on local raw materials with the testing of the pellets in combustion appliances at their own premise. Doing so, they can overcome another major constraint for the utilisation of alternative (mixed) biomass pellets: the lack or limited experience. In having their own combustion test bed they can provide customers with combustion know-how for these more critical fuels and they are aware of possible problems. Thus, they have the opportunity to either adapt the fuel or the combustion appliances and they can give first hand advice and support to the customers. Furthermore, customers can be adequately informed and transparency is guaranteed. In this way disappointment and dissatisfaction can be avoided. In one case, a pellet producer gives as well support to licensed pellet producers not only on production of the licensed pellets but as well on sales and logistics.

Combustion technologies

Critical properties of alternative and mixed biomass pellets can cause problems during the combustion process, e.g. higher emissions of particles, HCl and SO_2 and ash slagging. These effects depend on several factors, e.g. the used combustion and flue gas cleaning system, the boiler size and the chemical composition of the fuel. Therefore, available combustion and flue gas cleaning systems applicable for alternative fuels were surveyed. According to Table 18 about 50 % of the boiler manufacturers are producing combustion systems within a range up to 400 kW. In the range over 400 kW (medium and industrial scale systems) there are fewer manufacturers which have long term experiences in the construction and operation of plants dealing with alternative or mixed biomass pellets or briquettes. Apparently, in Scandinavian countries the combustion of alternative and mixed biomass pellets is favoured in medium and industrial plants. In other countries e.g. in Germany and Austria the energetic utilisation in a range up to 1 MW is promoted due to economic or political constraints.

Table 18: Manufacturers of combustion appliances for alternative biomass

	AT	DK	FI	DE	IT	ES	SE	Total
Small scale (<400 kW)	5	2	3	4	14[1)]	3	2	33
Medium scale (400 kW – several MW)	3	3	3	4	4	11[1)]	2	30
Industrial scale (up to 300 MW)	3	3	5	2	2	2	0	17

Source: Investigation and market survey within the MixBioPells project

[1)] Production of boilers that are only suitable for local alternative raw materials but do not provide technology solutions to minimise maintenance efforts to a level similar to wood pellet combustion

Small and medium scale heating-systems

Small heating systems are mostly optimised for high quality wood pellets but there are innovations to use alternative pellets as well. Austrian burner and boiler manufacturers are working on solutions for alternative (mixed) biomass pellet combustion on small scale. For some Scandinavian countries the capability of the boilers to burn pellets with high ash content is claimed. Heating systems, like Guntamatic, REKA, Ökotherm or Hargassner, with capacities > 30 kW have been developed for the combustion of more problematic fuels than wood pellets and are gaining importance. Some woodchip boilers might be partly operated with alternative pellets. A main issue is the high ash content and the low melting point of several ashes from alternative raw materials resulting in slagging and ash removal problems. Boilers for alternative (mixed) pellets combustion require appropriate ash discharge systems and have to be operated with optimised conditions. Several technologies for controlling and limiting of the combustion temperature to reduce slagging tendencies in the bottom ash are available on the market e. g. air cooled grate systems with moving grates or water cooled combustion chambers with ash stoker. A powerful ash removal system combined with the possibility to control the combustion temperatures should limit problems caused by slagging hazards. Furthermore, several research results indicated that the use of additives like Kaolin or limestone as well as the production of blends can reduce slagging hazards. [10-14]

There is no system that can handle all types of alternative pellets. Therefore, the standardisation and the adaption of boilers for certain alternative fuels are of great relevance. Hence, the exact fuel specification of different boilers systems need to be known and communicated with pellet manufacturers and raw material suppliers. The existing norm EN 303-5 for boiler testing and certification is currently being adapted according to the European product standards for solid biofuels (emission thresholds, capacity range).

Furthermore, dust emission control is of particular relevance. The reduction of the dust emissions cannot be realised by the combustion technology alone. Instead, precipitators and fuel improvement can be used. Recently, the precipitator technologies gain increasing importance. However, the high investment and operation costs still limit the widespread use of this technology in small and medium scale combustion systems. In Germany, Switzerland and Austria several manufacturers of precipitators are acting on the market, see (Table 19).

Table 19: Producers of flue gas cleaning systems with focus on small scale combustion systems [15]

Type of precipitator	**Range of capacity [kW]**			**License**
	< 100	**< 1000**	**>1000**	
Electrostatic	16	4	3	2
Filter	5	3	0	0
Scrubber	3	2	0	1
Others	2	1	0	0

In the range of boiler capacities < 100 kW such technologies are already available on the market or subject of ongoing research activities. For small and medium capacity range it is important that off-the-shelf solutions are available thus guaranteeing a reasonable price. The separation efficiency depends on the particle amount, the particle size distribution and the precipitator technology. However, most of these systems are developed for the combustion of woody biomass. Wood combustion produces far less dust emission. Thus, the capacity of the available flue gas cleaning systems might be too low. At least, these flue gas cleaning systems are not certified for alternative biomass combustion. Thus the development and certification of an appropriate combination of fuel, boiler and flue gas cleaning systems is required. To implement alternative (mixed) biomass pellets, fuel quality standards are required. For these pellets problems during combustion should not occur if the specified fuel qualities are fulfilled.

Industrial scale systems

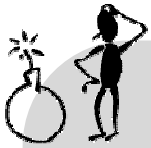
Large industrial systems for the combustion of alternative and mixed biomass pellets are relevant in certain regions of Finland, Sweden and Denmark. This development is spurred by the lower prices of the fuels and the legal framework. As an example in Sweden industry pellets are used in large CHP-plants for heat and electricity and also the CHP-plant of Avedör, Denmark combusts straw pellets. In industrial scale, there are different techniques available like reciprocating grates and bubbling fluidised bed boilers. Available flue gas cleaning solutions can be adapted according to the requirements of the plant. The increased price for these special solutions is less critical for large scale applications.

Similarly to the alternative (mixed) biomass pellet production a major constraint is the lack or limited experience available in many European regions. Initiators are reluctant to start a project if there are no other actors to compare experience, exchange knowledge and to get first hand help with possible problems. A treasure trove of experience is one of the key drivers in the field of technology aspects.

Summary and Conclusion

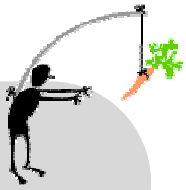
Utilisation of alternative biomass and residues requires adapted technology along the whole process chain. Raw material harvest can often but not always be achieved using established technologies. However, several alternative biomass assortments have not been used previously. Thus, new supply chains for raw material gathering and transport have to be developed. Several non-woody biomass need to be preconditioned to a certain extent. In some case, 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 only limitedly available. In many cases, the low demand in alternative mixed biomass pellets hinders or delays the necessary developments. Limited or lack of experience is a major constraint. In contrast, a treasure trove of experience on which bio-business initiators could base there project on is one of the key drivers. The constraints and drivers are listed separately for pelletizing and combustion.

PELLETISING



CONSTRAINTS

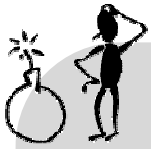
- Requirement of elaborated preconditioning
- Limited available pellet press technology adapted for critical fuel parameters of alternative biomass assortments
- Low demand for alternative (mixed) biomass pellets
- Varying raw material characteristics
- Lack of experience for pellet production from alternative raw materials with varying characteristics
- Lack of experience in the improvement of pellet characteristics by using mixtures and additives in case of critical biomass assortments
- High maintenance efforts due to increased abrasion



DRIVERS

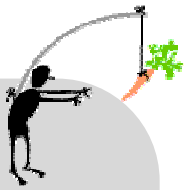
- Available technology for the production of standardised wood pellets
- Available experience from related utilisation paths (e.g. straw and hay pelletizing for animal food or litter)
- Existing contracts ensuring reliable demand for the produced pellets
- A treasure trove of experience based on preliminary experiences with production of alternative (mixed) biomass pellets
- Regional availability of practical experience with production of alternative (mixed) biomass pellets
- Security on required standards for solid biofuels (e.g. prEN 19461-6

COMBUSTION



CONSTRAINTS

- Critical fuel parameters that require adaption of available technology and special care (e.g. ash amount, slagging caused by low ash softening temperatures, fouling and corrosion caused by critical fuel components, NO_x emission, particulate emission)
- High price for adapted technology
- Technology less advanced as for fossil fuels and wood fuels (e.g. lower efficiency)
- Lack of licensed combinations of precipitors with combustion systems or fuels



DRIVERS

- Available technology to deal with all critical fuel parameters
- Availability of technology based on many different combustion principles
- (Affordable) flue gas cleaning technology
- A treasure trove of experience based on preliminary experiences with combustion of alternative (mixed) biomass pellets
- Regional availability of practical experience with combustion of alternative (mixed) biomass pellets
- Testing and certification procedures for boilers and precipitors
- Labels for alternative solid biofuels and boilers

2.5 Raw material issues

Within this chapter it will be highlighted which raw materials are available that can be used within the existing legal frameworks and with the available technology.

Interview part

Constraints and drivers in the fields of raw material issues are mainly derived from the raw material and pellet production interviews with stakeholders along the whole pellet production and utilisation chain (Annex 2 and 3). Main topics were the availability of biomass, existing competitions for raw material, the expected future potential of several biomass resources and actual trading activities. Both the recent utilisation and future prospects are seen quite differently within the partner countries indicating a differing perception on the availability of

biomass and the tendency for its extended use. According to the key actors the biomass types with the highest availability in the considered regions are:

- Residues from agriculture (especially straw) which is predominant in DK, ES and IT
- Residues from processing olives and grapes already used in DE, IT, ES and AT
- Others such as peat and reed canary grass in SE and FI

According to the interviews the following raw materials are available for combustion (Figure 14).

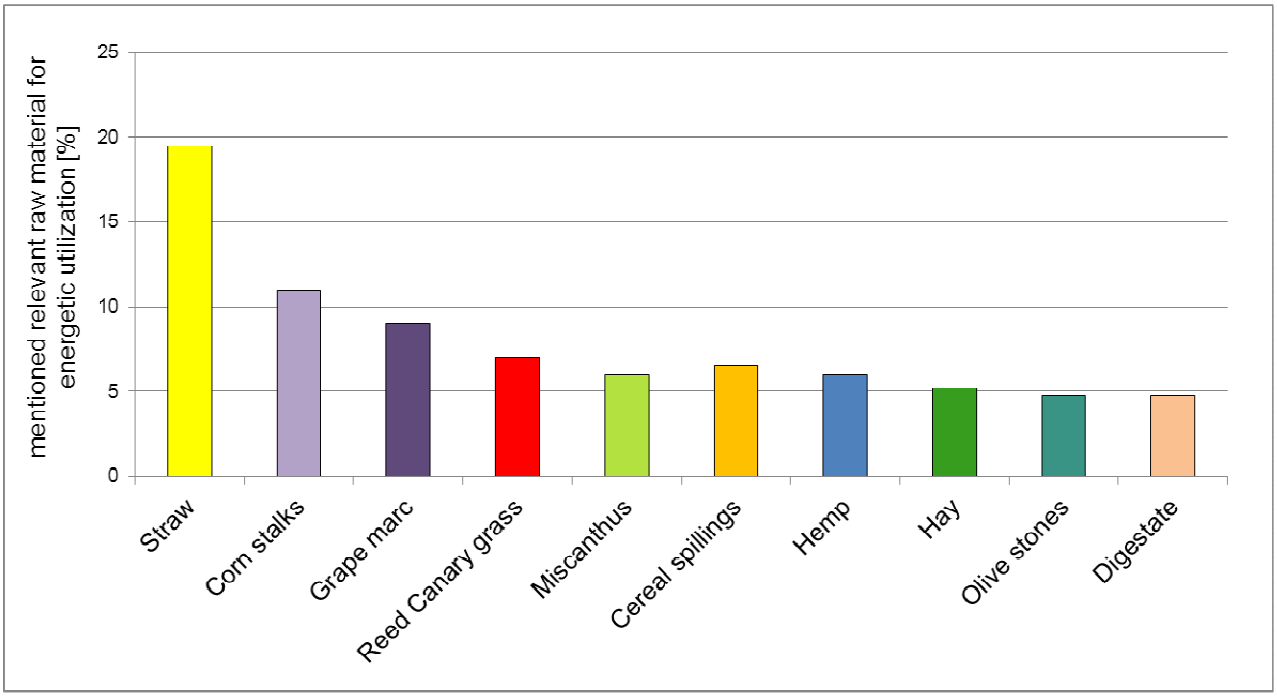


Figure 14: Raw materials, which are considered to be most relevant for the energetic utilisation by the interviewed actors in the partner countries (n=38, multiple answers were possible)

Apparently, many key actors consider straw as a promising alternative raw material. However, at the moment the production of straw pellets for energy purposes takes place predominantly in Denmark. Based on the critical fuel parameters and the resulting higher investment costs and maintenance efforts the demand for those pellets appears to be still low. Thus, a higher pressure from rising fossil fuel prices and more severe scarcity of conventional wood fuels seems to be required to spur the utilisation. Corn stalks and grape marc have also been indicated as relevant by a comparatively high number of key actors. Beside these three raw materials that seem to be more important there are several other raw materials that were less often but frequently stated as relevant. Interestingly, all these raw materials have been mentioned by a similar number of key actors. This indicates that the regional approach appears to be most promising for several reasons.

The cultivation of energy crops is not highly developed yet. However, first trials exist in Germany, Austria, Italy and Spain and most key actors are optimistic concerning its use in the next years. Thus, expectations for future potential are focused on the following biomass types:

- Agricultural residues (especially straw) with high potentials expected in AT, DK, ES and SE
- Energy crops with high potential expected in AT, DE, IT, ES and SE
- Residues from processing olives and grapes especially in major wine producing regions of AT, IT and ES.

The availability of selected biomass types with high relevance, the current use for pelletizing and the assumed potential for the future are summarised in (Table 20) for the partner countries.

Table 20: Availability, current use and future potential of selected raw materials

	Agricultural residues	Energy crops			Residues from processing olives and grapes	
	Straw	Miscanthus	Reed canary grass	Paulownia	Olives	Vine pruning and grape
Availability[1]	AT, DK, FI, DE, SE, IT	AT, DE, IT, ES	SE, FI	ES	ES	AT, DE, IT, ES
Current use[2]	AT, DK, FI, DE, ES, SE	AT, DE	SE	ES	ES	ES, DE
Future high potential	AT, DK, FI, ES, SE	AT, D, I	SE	ES, SE	ES	AT, ES
Future medium potential	FI, DE, ES	ES	SE			DE
Future low potential		DE				

Source: Interviews on Raw Materials (Annex 2), for feedback rate see Annex 1
[1] Indicates that the availability of the respective raw material is assumed as high.
[2] Use for pelletizing in pelletizing companies. Does not indicate the produced amount of pellets.

Apparently, the availability of a certain biomass is prerequisite for its utilisation. However, the availability of a biomass does not automatically spur its utilisation. For example, Italian key actors affirm a high amount of straw available for combustion. However, straw is rarely used in Italy for energetic purposes. Similarly, highly available residues from winegrowing did not yet result in its utilisation but resulted in the perception of a high potential in the future. The largest variety of different biomass types used for the production of alternative mixed biomass pellets is found in Germany. The main reasons for the utilisation of alternative biomass for the production of mixed pellets are summarised in Table 21:

Table 21: Main reasons for the utilisation of alternative biomass for the pellet production

	Agricultural residues	Energy crops		Residues from processing olives and grapes		Others		
	Straw	Mis-can-thus	Reed canary grass	Olives	Grapes	Almond shells	Salix	Digestate
General availability	DK, IT, ES	AT, DE, IT, ES	SE	ES	DE, IT, ES	ES	SE	DE
Low price	IT, SE		SE					
Homogeneity								DE
Good fuel properties							SE	
Grows with low maintenance		IT, SE	SE					
High productivity		IT						
Available harvest technology			FI					

Source: Interviews on Raw Materials (Annex 2), for feedback rate see Annex 1

While the general availability of appropriated biomass is important to the key actors in all partner countries, the low costs were mentioned only in Italy and Sweden. The low demand for soil quality of energy crops and the little agricultural maintenance effort seemed to be important in Italy, Sweden and Spain all having preliminary experience with those plants.

- Availability of a certain biomass (AT, D, DK, I, ES, FI, SE)
- Need for disposal of residues (D, I, ES)
- Low costs of available Biomass (I, SE)
- Low demand on soil and agricultural maintenance for energy crops (ES, I, SE)
- Good fuel properties (SE, D)

From the interviews several objections against the use of certain biomass types became apparent. They can be grouped to the following headlines:

- Economic objections (cost, processing effort to transform residues to fuels)
- Objections on availability (overall amount, temporary availability, competitive use, harvest technology)
- Objections on raw material characteristics (moisture content, protein content, ash content)

Table 22: Objections against the use of certain biomass types

	Agricultural residues	Energy crops			Others				
	Straw	Mis-can-thus	Reed canary grass	Hemp	Vine pruning	Pomace of grapes	Citrus fruit residues	Rape press cake	Digestate
Costs	AT			SE					
Availability			SE		ES			DE	
Competitive use		DE						SE	
Technology						ES			DE
Moisture content			FI				DK		
Ash content	DE, SE				ES				
Protein content						DK		SE	

Source: Interviews on Raw Materials (Annex 2), for feedback rate see Annex 1

Results from other investigations within the MixBioPells project

Within the MixBioPells project information on available raw materials was gathered from literature review as well as previous and ongoing projects. For each partner region the three most relevant raw materials have been selected based on the evaluation done in WP2, task 2.2. The selection is based on selection criteria such as market size, relevance for the region, expert opinions, cross-border trading activities, already existing experience and suitability for pelletizing. For each of these raw materials the available potential has been estimated within the project. If the same raw material type is considered as most relevant in different regions, the estimation was performed for each region individually. The information on the raw material selection and the estimation of the potentials can be found within the Biomass Report which is available at www.mixbiopells.eu. Afterwards, the results could be compared with results from a previous study [16] and from the EU-BioNet 3 project [17]. Most of the raw materials that have been indicated as most relevant for the considered European regions are also covered in the two projects. However, selected biomasses are not considered in the two projects. In particular, the information on peat, hay, grape marc, cereal spilling, shea waste, cereal spilling and corn residues is not complete. The results of the comparison are shown in Figure 15.

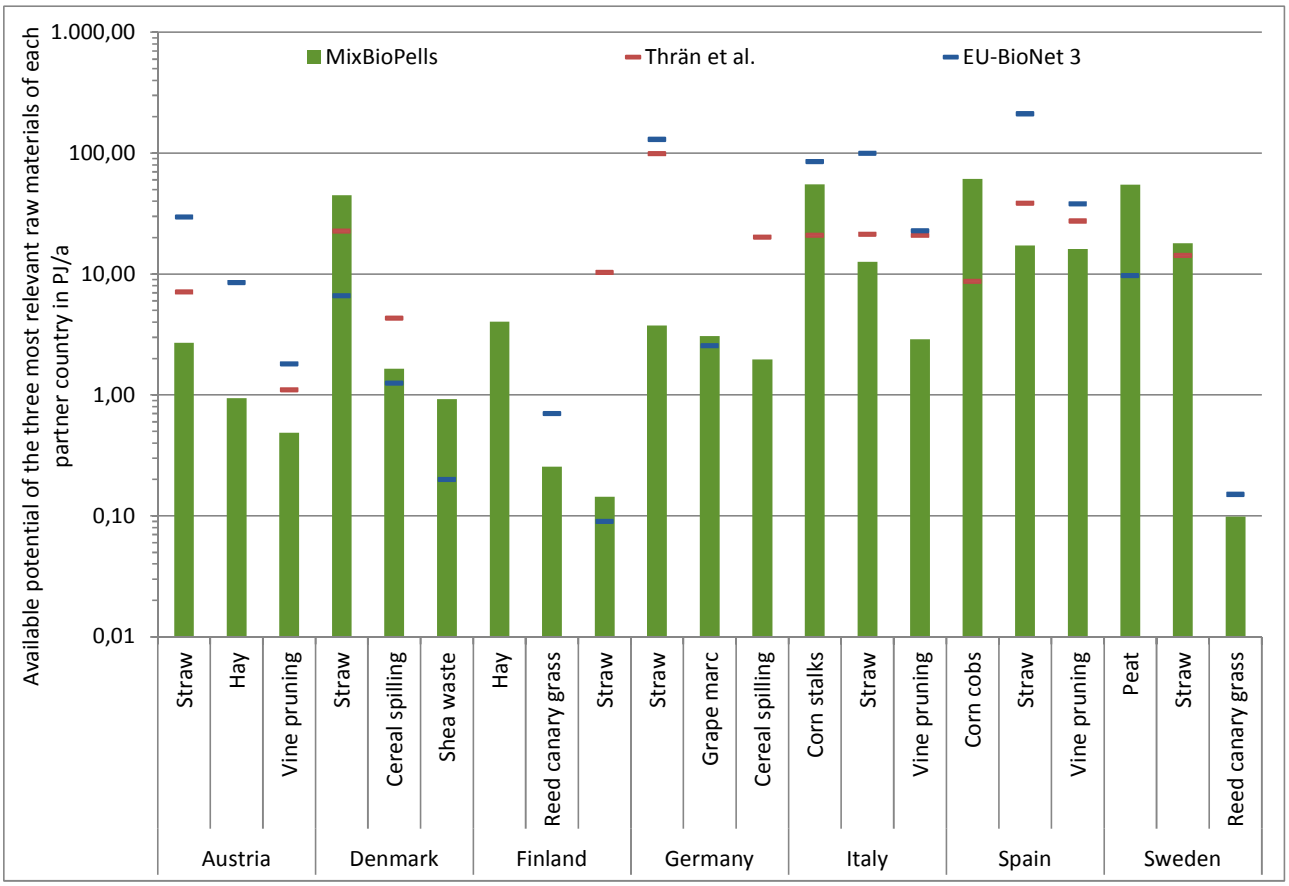


Figure 15 Comparison of the results on available potentials for selected raw materials in seven European countries with results from other studies [16], [17]

Usually, the potentials that have been estimated by the project partners are lower than the estimated values in the studies. In most cases, this can be attributed to the focus on selected regions within the MixBioPells project rather than the whole country. Furthermore, the data base is different and for some of the potentials more recent data could be used for the estimation. In Denmark, the potentials for shea waste and straw were estimated significantly higher by the project partner compared to the results from the other studies. Similarly, for straw in Finland and Sweden, grape marc in Germany, corn residues in Spain and peat in Sweden higher potentials were estimated by the project partners than by the previous 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 16). 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 16.

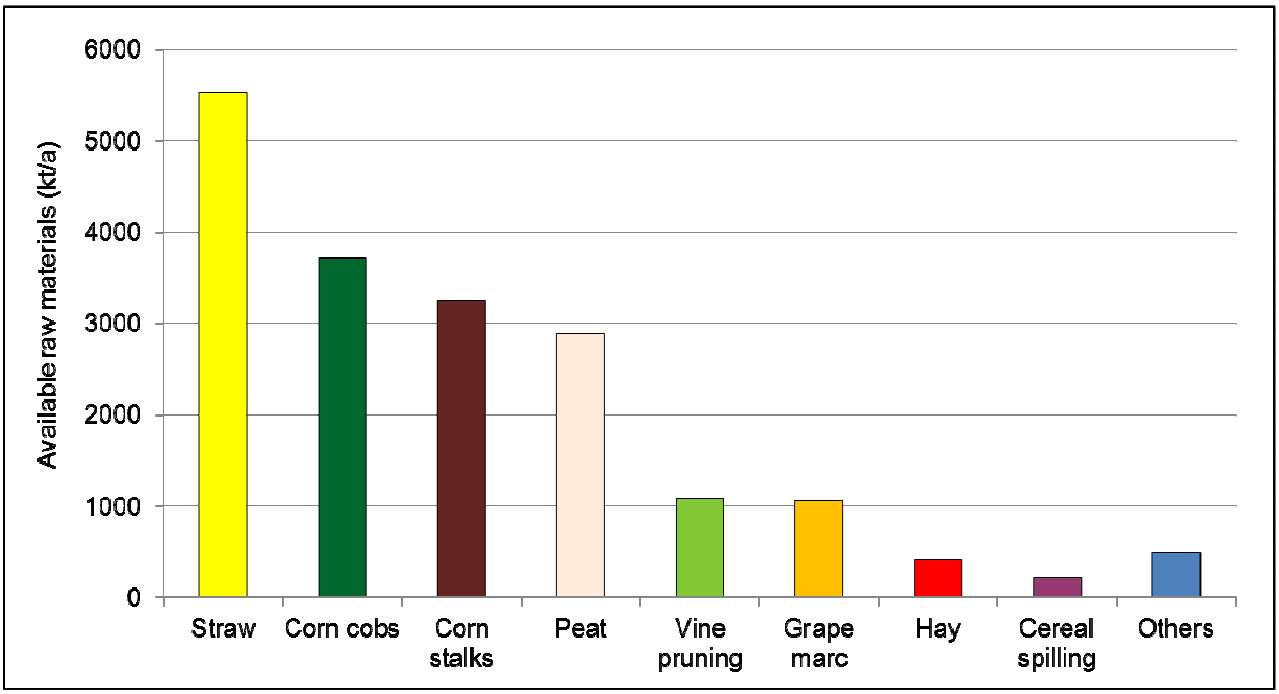


Figure 16: Sum of the potentials of the most relevant raw materials according to the analysis within the MixBioPells project

For the raw materials with the highest relevance available potentials, agricultural aspects and fuel characteristics were collected. This information can be found within the Biomass Report which is available at www.mixbiopells.eu. The fuel characteristics can be compared with the demands of prEN14961-6 (Table 23). Within the table, different colours indicate if the raw material can fulfil all requirements of the standard (green colour), can fulfil the requirement of the standard in certain cases (yellow colour) or cannot fulfil the requirements of the standard (red colour). Those raw materials for which only incomplete fuel characteristics are available are indicated with white. According to Table 23, even Miscanthus and straw cannot always fulfil the requirements of prEN 14961-6. Some of the analysis of selected raw material samples indicated sulphur, nitrogen and chlorine contents not in accordance with the standard. Overall, the majority of the most relevant raw materials can fulfil at least the requirements of prEN 14961-6 class B. These materials may be well suitable for medium scale applications. For small scale applications only raw materials and mixtures that fulfil at least the requirement of class A, Miscanthus, Straw and reed canary grass (RCG) should be used. However, adequate measures to cope with the high ash content and the slagging risks have to be employed. Raw materials that cannot even fulfil the requirements of prEN 14961-6 class B should only be used in industrial scale applications.

Table 23: Comparison of the fuel characteristics of the most relevant raw materials with the thresholds given in prEN14961-6

Raw material	prEN14961-6: Miscanthus				prEN14961-6: Straw				prEN14961-6: RCG				prEN14961-6: class A				prEN14961-6: class B			
	Ash content < 4 wt.-% d.b.	N	S	Cl	Ash content < 6 wt.-% d.b.	N	S	Cl	Ash content < 8 wt.-% d.b.	N	S	Cl	Ash content < 5 wt.-% d.b.	N	S	Cl	Ash content < 10 wt.-% d.b.	N	S	Cl
Miscanthus	x	x	~	~	x	x	x	~	x	x	x	~	x	x	x	x	x	x	x	x
Reed canary grass	o	x	o	x	x	x	x	x	x	x	x	x	~	x	x	x	x	x	x	x
Hemp	x	o	o	~	x	~	x	~	x	x	x	~	x	x	x	~	x	x	x	x
Straw	~	~	o	x	~	~	~	x	x	x	x	x	~	x	x	x	x	x	x	x
Vine pruning	x	o	x	x	x	~	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Corn cobs	x	o	x	x	x	~	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Corn stalks	o	o	o		o	~	x		o	x	x		o	x	x		o	x	x	
Cereal spilling	o	o	o	o	o	o	o	o	o	x	x	o	o	~	x	~	x	x	x	x
Hay	o	o	x	o	x	o	x	x	x	x	x	x	o	o	x	x	x	x	x	x
Rape straw	x	o	o		x	o	o		x	x	x		x	x	x		x	x	x	
Rape press cake	o	o	o	x	o	o	o	x	x	o	o	x	o	o	o	x	x	o	o	x
Grape marc	~	o	o	x	~	o	~	x	~	~	x	x	~	o	x	x	~	~	x	x
Olive residue	o	o	o	x	o	o	o	x	x	o	x	x	o	o	x	x	~	o	x	x
Olive stones	x	x			x	x			x	x			x	x			x	x		
Almond shells	o	o	o	x	o	o	o	x	o	o	x	x	o	o	x	x	~	o	x	x
Shea waste	o	o	o	o	x	o	o	x	x	o	o	x	o	o	o	x	x	o	o	x
Carragenan waste	o	x	o	o	o	x	o	o	o	x	o	o	o	x	o	o	x	x	o	x
Mash from breweries	x	o	o	x	x	o	o	x	x	o	x	x	x	o	x	x	x	o	x	x
Digestate	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Peat	x	o	o	x	x	o	o	x	x	x	x	x	x	x	x	x	x	x	x	x

x - requirements of the prEN can be fulfilled

~ - requirements of prEN can be fulfilled in some cases

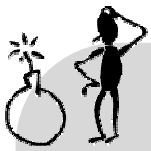
o - requirements of prEN can not be fulfilled

White filling, if database is not complete enough for final decission

Conclusion

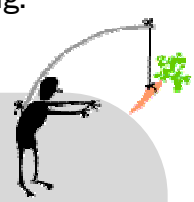
The availability of unused biomass raw materials or residues is important to allow the initiation of any project along the alternative biomass pellets production and utilisation chain. Main issues are the potential (i.e. the total amount of biomass that is available), the effort for the cultivation, harvest, collection and supply, the achievable price compared to the costs and the required quality (e.g. moisture content, constant fuel characteristics). Rising fossil fuel prices, increasing scarcity of wood fuels and resulting demand are drivers for the amplified utilisation of alternative biomass and residues.

Local and scattered availability is a constraint for its utilisation. However, it seems to be not an insurmountable constraint. Instead, it sometimes spurs creative solution to overcome this problem, e.g. development of mobile pelletizing machinery or formation of cooperatives to allow shared use of machinery ring. Similarly, the necessity of adapted harvesting technology for alternative biomass seems to be only a minor constraint. Apparently, the availability of biomass at a cheap price creates solution development to make them available for pelletizing.



CONSTRAINTS

- Requirement, that fuel characteristics have to comply with standards and remain constant
- Higher effort for harvest, collection and supply
- Necessity of adapted/specialised harvesting technology
- Local and scattered availability of alternative biomass
- Low potential of the alternative biomass assortments

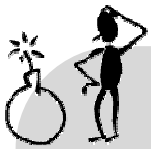


DRIVERS

- Availability of unused raw materials
- Availability of machinery rings
- Demand for alternative (mixed) biomass pellets

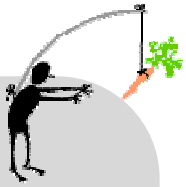
2.6 Most relevant constraints and drivers

In the fields policy and social acceptance, legal framework, economics, technology issues, and raw material issues a comprehensive analysis of the results of the project was performed with special focus on constraint and drivers of the alternative (mixed) biomass pellets production and utilisation. The extracted constraints and drivers can be evaluated 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 cost when using alternative raw materials. On the other hand the demand is highly important. Only if there is demand for alternative (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.

3 Classification, Comparison, Evaluation

Within this part a classification of the different national conditions will be developed. The possible classification will be discussed for each of the above fields (policy and social acceptance, legal framework, economics, technology issues, raw material issues). Based on this, the countries can be allocated according to their national conditions. The discussion will be done separately for the biomass utilisation in the heating and cooling sector and for the biomass utilisation for electricity generation. This differentiation is based on the different scales that are applied for the sectors. Heating and cooling is performed using small and medium scale applications. In contrast, electricity supply is usually realised using large industrial scale applications. Thus, different legal frameworks apply for biomass utilisation for heating and cooling and biomass utilisation for electricity production.

Small and medium scale applications for heating and cooling

Policy: Policy could be classified as highly ambitious and less ambitious. According to the NREAPs the growth in biomass use for heating and cooling is quite different for the partner countries (Table 24). Germany and Italy target the highest total growth in biomass use in the heat sector. However, these countries start from a comparatively low share of biomass use in the heat sector. A little bit lower but still high total increase is targeted by Finland, Spain and Sweden. Among those three countries, Finland and Sweden already have a very high share of biomass in the heat sector of around 50%. In contrast, Spain starts from a low share. Austria and Denmark target a comparatively low total increase in biomass use for heating and cooling. However, both countries have already a higher share of biomass use for heating and cooling. To evaluate how ambitious the targets are the specific total growth compared to the population is calculated (Table 24). Furthermore, the available potential of the three most relevant alternative raw materials is used for the evaluation. Within the MixBioPells project in several cases only the available potential on regional level was estimated. Thus, for the calculation in Table 24 is based on raw material potentials estimated in [16] and [17]. Then, the specific growth of biomass use for heating and cooling in relation to the available potential indicates what amount of the available alternative raw materials would have to be used to fulfil the targets.

Table 24 Targeted growth of biomass use in the heating and cooling sector

		AT	DK	FI	DE	IT	ES	SE
Population in millions		8.4	5.5	5.4	82	60	47	9.4
Share of biomass in the heating and cooling sector [%]	2010	28	28	36	8.2	3.8	11	54
	2020	28	35	43	12	9.3	17	56
Growth in biomass use for heating and cooling from 2010-2020 compared to 2010	PJ	8.0	16.7	68	95	144	57	67
	%	5.6	18	32	26	153	38	21
Specific growth of biomass use for heating and cooling from 2010-2020 [PJ/Mio inhabitants]		1.0	3.0	12.6	1.2	2.4	1.2	7.2
Available potential of the three most relevant alternative raw materials of each country [PJ/a][1)]		28,3	17,6	9,9	137,1	135,3	166,2	24,1
Specific growth of biomass use for heating and cooling from 2010-2020 in relation to the available potential [%]		2	10	33	2	11	2	9

Source: National Renewable Energy Action Plans:
http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm
[1)] Calculated as the sum of the mean value from the two studies [16] and [17]

According to this analysis, Finland and Sweden aim at the highest total increase of biomass use for heating and cooling per inhabitant. Denmark and Italy aim at a considerably lower specific total increase in biomass use for heating and cooling. The lowest specific total increases are targeted by Germany, Austria and Spain. Similarly, a significant amount of the available alternative raw materials (33%) would have to be used in Finland to fulfil the targeted growth. Denmark, Sweden and Italy would follow with around 10%. In Austria, Germany and Spain only 2% of the available alternative raw materials would have to be used to fulfil the targeted growth in biomass use for heating and cooling. In summary, according to the targeted specific total increases Finland and Sweden can be classified as highly ambitious since both values for the specific growth are among the highest of the partner countries, while the other countries would be classified as little ambitious for the targeted utilisation of alternative raw materials in the heating and cooling sector.

Social Acceptance: The classification of the social acceptance could be realised in accordance with the evaluation of the social acceptance results of the MixBioPells project. Thus, the countries would be allocated to the group “little concerned” if the public perception is in general positive. In contrast, if there are various concerns in connection with alternative biomass use for heating and cooling the countries are allocated to the group “highly concerned”. Thus, Austria, Germany and Italy would be allocated to the group “highly concerned” while Denmark, Finland, Sweden and Spain are allocated to the group “little concerned”.

Legal framework: For the legal framework a threefold classification of the national conditions is applied. From the information in Figure 8 a classification of the legal conditions can be established. For that reason the following classification of the legal conditions can be established for small and medium scale applications. In case there are thresholds for several emissions that have to be complied with *and* the thresholds are strict then legal conditions are classified as "highly restricted". In contrast, if thresholds apply only for few of the possible emissions and the thresholds are loose then the legal conditions are classified as "low restricted". Consequently, the legal conditions influence the range of alternative fuels that can be used:

- Highly restricted legal conditions: A small range of fuels can be used due to strict emission threshold values and due to few technical possibilities to keep the threshold values, e.g. restrictions for small and medium scale combustion plants in Germany, Austria and medium scale applications in Italy (150-400 kW).
- Low restricted legal conditions: A wide range of alternative fuels could be used for combustion purposes due to loose emission threshold values, e.g. restrictions for medium scale systems in Denmark as well as small scale systems in Italy and Sweden.
- No regulations: Due to a lack of emissions thresholds and/or alternative fuels not being specifically indicated as allowed fuels the utilisation of alternative fuels has to be individually approved by local authorities based on experiences, e.g. in Spain, Finland (below 1 MW) or non-industrial use in Austria (except for boilers below 400 kW in the province of "Lower Austria").

However, the realisation strongly depends on available combustion and flue gas cleaning systems for small and medium scale application and the properties of the used fuel.

Economics: Available support options can help to ensure the economic viability of the alternative (mixed) biomass utilisation. For the heating and cooling sector in general only an investment focused support scheme exist (e.g. investment subsidies, low interest loans). Generation based support is not available for small and medium scale heat appliances and heating plants. According to the national conditions it can be differentiated between countries having support options for the heating and cooling sector (Sweden, Finland, Germany, Italy) and countries without support options for the heating and cooling sector (Denmark, Spain, Austria).

Technology issues: The countries could be classified according to the availability manufacturers that provide adapted technologies for the alternative (mixed) biomass pellets production and utilisation. Indeed, there is some concentration of manufactures for alternative (mixed) biomass pellets production and utilisation for small scale in Germany, Austria and Denmark. Manufacturers for medium scale heating plants are more prominent in Finland and Sweden. However, technology is tradable on European level. Thus, the availability of experience with the alternative (mixed) biomass pellets production and utilisation should be rather used for the classification. Thus, the classification "beginners" is applied for countries with limited experience with small and medium scale alternative (mixed) biomass pellets production and utilisation (Finland, Italy, Spain, Sweden) and those countries with some experience in this field (Austria, Denmark, Germany).

Raw material issues: The classification within raw material issues could be realised using the availability of raw materials suitable for small and medium scale heat application as an indicator. According to the prEN 14961-6 this would be those raw materials that are classified as and can fulfil the requirements of prEN 14961-6: Miscanthus, prEN 14961-6: straw and

prEN 14961-6: RGC as well as prEN 14961-6: class A (see Table 25). According to the results of the MixBioPells project all partner countries have considerable amounts of those raw materials. However, the types of available raw material differ considerably. There are no significant amounts of Miscanthus available yet. In contrast, straw and hay are available in all countries in certain amounts. Peat and the energy crop reed canary grass are available in Finland and Sweden. Vine prunings are a possible raw material in Germany, Italy and Spain. Italy and Spain have significant amounts of corn cobs. In conclusion, because there are raw materials for small and medium scale use available in all partner countries this criterion is not used for classification. Table 25 summarises the classifications that are used for small and medium scale heating plants and applications with the respective allocation of the partner countries within this classification.

Table 25 Classification of the countries for small and medium scale biomass use

Issue	Classification	Countries
Policy	Highly ambitious	FI, SE
	Little ambitious	AT, DK, DE, IT, ES
Social acceptance	Little concerned	DK, FI, ES, SE
	Highly concerned	AT, DE, IT
Legal conditions	Highly restricted	AT, DE, IT (>150 kW)
	Low restricted	DK, IT (<150 kW), SE
	No regulations	FI, ES
Economics	Support available	SE, FI, DE, IT
	No support available	DK, ES, AT
Technology issues	Beginners	FI, IT, ES, SE
	Advanced	AT, DK, DE

Large scale applications for combined heat and power production

Policy: Policy could be classified as highly ambitious and less ambitious. According to the NREAPs the growth in biomass use for electricity is quite different for the partner countries (Table 26). Germany and Italy target the highest total growth in biomass use in the electricity sector. However, these countries start from a comparatively low share of biomass use in the electricity sector. Furthermore, in Germany a large share of electricity from biomass is assumed to be produced from biogas instead of solid biomass in 2020. A little bit lower but still high total increase is targeted by Denmark, Finland, Spain and Sweden. Among those four countries, Denmark, Finland and Sweden already have a comparatively high share of biomass in the

electricity sector of around 10%. In contrast, Spain starts from a low share of 1,6%. Austria targets a low total increase in biomass use for electricity production. To evaluate how ambitious the targets are the specific total growth compared to the population is calculated (Table 26). Furthermore, the available potential of the three most relevant alternative raw materials is used for the evaluation. Within the MixBioPells project in several cases only the available potential on regional level was estimated. Thus, for the calculation in Table 26 is based on raw material potentials estimated in [16] and [17]. Then, the specific growth of biomass use in the electricity sector in relation to the available potential indicates what amount of the available alternative raw materials would have to be used to fulfil the targets. Thus, Denmark, Finland and Sweden aim at the highest total increase of biomass use for electricity per inhabitant. Denmark, Germany and Italy aim at a considerably lower specific total increase in biomass use for electricity. The lowest specific total increase is targeted by Austria. Similarly, a significant amount of the available alternative raw materials would have to be used in Denmark (77%) and Finland (60%) to fulfil the targeted growth. In Austria, Germany, Italy and Spain less than 10% of the available alternative raw materials would have to be used to fulfil the targeted growth in biomass use for electricity. In summary, according to the targeted specific total increases Denmark, Finland and Sweden can be classified as highly ambitious since both values for the specific growth are among the highest of the partner countries, while the other countries would be classified as little ambitious for the targeted utilisation of alternative raw materials in the electricity sector.

Table 26 Targeted growth in biomass utilisation in the electricity sector

		AT	DK	FI	DE	IT	ES	SE
Population in millions		8.4	5.5	5.4	82	60	47	9.4
Assumed share of biomass in the electricity sector in 2020 [%]	2010	7.2	10	9.2	5.4	2.4	1.6	7
	2020	6.9	23	13	9.2	5.4	2.7	11
Growth in biomass use for electricity from 2010-2020 compared to 2010	PJ	1,5	18	17	60	36	20	22
	%	9,0	135	60	51	117	122	58
Specific growth of biomass use for electricity from 2010-2020 [PJ/Mio inhabitants]		0.2	3.3	3.2	0.7	0.6	0.4	2.3
Available potential of the three most relevant alternative raw materials of each country [PJ/a][1)]		28,3	17,6	9,9	137,1	135,3	166,2	24,1
Specific growth of biomass use for heating and cooling from 2010-2020 in relation to the available potential [%]		3	77	60	4	9	7	24

Source: National Renewable Energy Action Plans: http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

[1)] Calculated as the sum of the mean value from the two studies [16] and [17]

Social Acceptance: The classification of the social acceptance could be realised in accordance with the evaluation of the social acceptance results of the MixBioPells project. Thus, the countries would be allocated to the group "little concerned" if the public perception is in general positive. In contrast, if there are various concerns in connection with alternative biomass use for heating and cooling the countries are allocated to the group "highly concerned". Thus, Austria, Germany and Italy would be allocated to the group "highly concerned" while Denmark, Finland, Sweden and Spain are allocated to the group "little concerned".

Legal framework: Large scale applications are only installed if the legal framework is favourable. The most important topics are: emission thresholds that can be complied with under reasonable effort, clear and reasonable procedures to get regulatory approval and legal conditions that enable the cost effective operation of plants fired with alternative (mixed) biomass pellets (e.g. adequate feed-in tariffs to cover additional cost for difficult alternative fuels). Thus, the legal framework indicates the political will for alternative (mixed) biomass pellet utilisation on industrial scale. Therefore, it can be differentiated between legal frameworks that are favourable for alternative (mixed) biomass utilisation and those frameworks that are not favourable for alternative (mixed) biomass utilisation. A good indicator for this is if there are already industrial scale plants installed for alternative (mixed) biomass utilisation. Thus, installed plants in Denmark, Finland and Sweden indicate favourable conditions. In contrast, the lack of industrial scale plants for alternative (mixed) biomass utilisation in Austria, Germany, Italy and Spain indicate unfavourable conditions.

Economics: Available support options can help to ensure the economic viability of the alternative (mixed) biomass utilisation. For the electricity sector a generation based support scheme is applied (e.g. feed-in tariffs, premiums, quota regulations and green certificates). Investment focused support options are uncommon in this capacity range. According to the national conditions it can be differentiated between countries supporting biomass utilisation preferably with quota obligations and green certificates (Sweden), countries supporting biomass utilisation preferably with feed-in tariffs and premiums (Austria, Spain) and countries supporting biomass utilisation with a potpourri of supporting measures (Denmark, Finland, Germany, Italy).

Technology issues: The countries could be classified according to the manufacturers that provide adapted technologies for the alternative (mixed) biomass pellets production and utilisation. However, technology is tradable on European level. Thus, the availability of experience with the alternative (mixed) biomass pellets production and utilisation should be rather used for the classification. Thus, the classification "beginners" is applied for countries with limited experience with large scale alternative (mixed) biomass pellets production and utilisation (Austria, Germany, Italy, Spain) and those countries with some experience in this field (Denmark, Finland, Sweden).

Raw material issues: The classification within raw material issues could be realised using the availability of raw materials suitable for industrial scale application as an indicator. According to the prEN 14961-6 raw materials that are classified as and can fulfil the requirements of prEN 14961-6: Miscanthus, prEN 14961-6: straw and prEN 14961-6: RGC as well as prEN 14961-6: class A (see Table 27) would be rather used for small and medium scale applications. For industrial scale applications raw materials classified as prEN 14961-6 class B or those raw materials with even more critical characteristics should be applied. According to the results of the MixBioPells project all partner countries have considerable amounts of alternative raw materials for this purpose. However, the types of available raw material differ considerably.

Straw and hay are available in all countries in certain amounts. Peat and the energy crop reed canary grass are available in Finland and Sweden. Vine prunings are a possible raw material in Germany, Italy and Spain. Italy and Spain have considerable amounts of corn cobs. In conclusion, because there are raw materials for industrial scale use available in all partner countries this criterion is not used for classification.

Table 27 Classification of the countries for industrial scale biomass use

Issue	Classification	Countries
Policy	Highly ambitious	DK, FI, SE
	Little ambitious	AT, DE, IT, ES
Social acceptance	Little concerned	DK, FI, ES, SE
	Highly concerned	AT, DE, IT
Legal conditions	Favourable	DK, FI, SE
	Unfavourable	AT, DE, IT, ES
Economics	Quota obligations/green certificates	SE
	Feed-in tariffs and premiums	AT, ES
	Potpourri	DK, FI, DE, IT
Technology issues	Beginners	AT, DE, IT, SE
	Advanced	DK, FI, SE

Selection of the key parameters

To allow bio-business initiators of different countries which are not part of the project to allocate their country according to the respective national conditions the classification is concentrated on the most decisive key parameters. In this way, an easy and comprehensible procedure will be provided to guide the initiators towards the countries with similar conditions. Thus, most suitable Best Practice Examples and chains are easily accessible. For the selection of the key parameters the following criteria are applied:

- Key parameters have to be specific for a country.
- Key parameters have to be crucial for the feasibility and economic viablility.

The selection process leading to the most decisive key parameters is described below.

Political targets are strongly influenced by EU-directives. In case of alternative (mixed) biomass pellets production and utilisation the RES directive is the most important EU directive. Thus a binding target of 20% final energy consumption from renewable energy by 2020 was implemented. However, the individual share of each renewable energy source has not been specified. Thus, within this context and depending on the already achieved values each country

can set its own focus. Ambitious targets can increase the overall demand for alternative (mixed) biomass pellets. However, since it does not directly influence feasibility of a project and its economic viability it will not be included in the key parameters. Similarly, the social acceptance mainly influences the demand and the overall perception of these kinds of fuel. In contrast, legal conditions are essential for the feasibility of alternative (mixed) biomass utilisation projects. A project will only be realised if it is possible within the legal conditions. Highly restricted legal conditions limit the technological options to fulfil the requirements for legal approval. In contrast, low restricted legal conditions facilitate the realisation of a project. Thus, legal conditions can be assumed as key parameter.

If legal approval is possible, i.e. the projects feasibility is ensured, realisation then depends on the economic viability. Alternative (mixed) biomass pellets production and utilisation projects are mostly accompanied by higher costs resulting from critical fuel parameters and characteristics of the alternative raw material. The situation becomes more sever under highly restricted legal conditions. They limit the technological options. Furthermore, costs are often higher since increased efforts and additionally investments are required to comply with statutory requirements. Support options are a useful measure to overcome constraints resulting from the high costs. Therefore, the availability of financial incentives and support options is appointed as second key parameter. Availability of technological options to comply with the legal restrictions is also crucial. However, technology is tradable on European level. Thus, it is not country specific. Therefore, it is not included as key parameter.

In summary, the legal conditions and availability of support options are identified as the key parameters for the following definition of the national frameworks. For the two parameters a digital discrimination is chosen, i.e. initiators have to select if for their country a “yes-option” (indicated by the number 1) or a “no-option” (indicated by the number 0) applies. In this context, the number 1 will be used for conditions that support alternative (mixed) biomass pellet production and utilisation. In contrast, the number 0 indicates conditions that are more likely to hinder alternative (mixed) biomass pellet production and utilisation. As a result there are four different possible combinations

0-0: This combination indicates that highly restricted legal conditions apply and there are no support options available.

0-1: In this case highly restricted legal conditions are accompanied by support options to overcome financial hurdles.

1-0: Under this framework there are only low restricted legal conditions. However, there is also no support option available.

1-1: This combination indicates the combination of low legal restrictions with available support options.

Thus, to find out to which legal framework the country of a potential initiators belongs to only two questions have to be answered:

- Do low restricted legal conditions apply for our country?
- Are there support options for the utilisation of (alternative) biomass?

According to the results of this project the thresholds for particulate emission are a good indicator for the legal conditions on small and medium scale. If strict limits for dust emission apply there are usually limits for other emissions as well. Furthermore, dust emission thresholds are in general most difficult to comply with for alternative raw material combustion. Thus, low thresholds for particulate emission limit the possible fuel options as well for most cases.

➔ *We define the limit to indicate legal conditions for small and medium scale application as strict if emission thresholds for particulate emission of ≤100 mg/Nm³ apply.*

For industrial scale application the indicator of favourable legal conditions is the existence and operation of industrial scale plants for alternative (mixed) biomass pellet utilisation, as well as the construction and installation of further plants.

➔ *Thus, if there are industrial scale plants running on alternative (mixed) biomass pellets and further plans are planned or being build the legal conditions for industrial scale use can be appointed as favourable.*

For the second question it is only relevant if there are support options or not.

Determination of the frameworks for small and medium scale

The procedure described above is now applied for small and medium scale. The results are summarised in Table 28.

Table 28 Determination of the national frameworks for small and medium scale

Small and medium scale (<1MW)	AT	DK	FI	DE	IT	ES	SE
Low restricted legal conditions	0	1	1	0	0	1	1[1)]/0[2)]
Support options available for small and medium scale	0[3)]/1[4)]	0	1	1	1	0	1

[1)] Small and medium scale up to 300 kW.
[2)] Medium scale >300 kW.
[3)] If no federal support is available for small and medium scale.
[4)] If federal support is available for small and medium scale.

According to Table 28 all four distinct frameworks for alternative (mixed) biomass pellets production and utilisation in small and medium scale applications can be found among the partner countries:

0-0: This framework applies to certain regions in Austria where no federal support options are available for small and medium scale use. Highly restricted legal conditions are accompanied by a lack of support options for alternative (mixed) biomass pellet utilisation.

This framework is particularly difficult for the initiation of projects based on alternative (mixed) biomass pellets. It is based on public concerns. Thus, high legal restrictions are implemented increasing the costs for alternative (mixed) biomass pellet utilisation. Furthermore, caused by the lack of support there is a low demand for technologies capable to handle more difficult alternative raw materials. The best practice examples reflect the difficult situation. Straw pellets

are produced in Austria with a production capacity of 5000 t/a. However, there is no demand for the pellets. In another project, based on the commitment of a local farmer a micro heating network with an annual demand of 45 t of hay briquettes has been started and is operated without major problems.

0-1: Germany and Italy as well as those regions in Austria where federal support for small and medium scale applications are available belong to this category. Furthermore, Sweden can be allocated to this framework for small and medium scale applications larger than 300 kW. The national conditions within these countries are characterised by highly restricted legal conditions and available support options for small and medium scale applications.

This framework exists in the context of policies particularly supporting small and medium scale use. Similar to Austria, in Germany the alternative (mixed) biomass pellet utilisation has to be realised under highly restricted legal conditions resulting from public concerns. However, support options are implemented to spur the utilisation nevertheless. The result of this framework is reflected by the Best Practice Examples available for these countries. In Germany mixtures of grape marc with vine pruning as well as mixtures of Miscanthus, grape marc, digestate and wood have been pelletized on 3000 t/a and 5000 t/a scale. Italian pellet producers successfully realised vine pruning pelletizing on 15000 t/a scale but as well works on mobile pelletizing units. The increased utilisation of alternative raw materials can help to overcome or avoid scarcity of the most common solid biofuel wood. An additional political target is the reduced dependency on fossil fuels. In Sweden, reed canary grass briquettes are produced with a capacity of 3500 t/a, and are provided to local heating plants.

1-0: Among this group there are Denmark and Spain. These three countries have low restricted legal conditions but no support options for small and medium scale applications.

Among these countries the small and medium scale utilisation of alternative (mixed) biomass pellets is not politically favoured (DK, ES). Instead, policy seems to prefer larger scale use. Therefore, there are no support options available to overcome the problem of higher cost due to alternative (mixed) pellet utilisation in small and medium scale. Thus, these fuels are rather used on large scale where higher costs affiliated with alternative (mixed) biomass utilisation are less problematic. The result of this framework is reflected by the Best Practice Examples available for these countries. Industrial scale pellet production is realised in Denmark based on straw. The current capacity of the Spanish pellet producer is 20000 t/a using vine pruning as raw material. However, both the capacity and the variety of used raw materials are going to be expanded.

1-1: Finland and Sweden have national conditions where low restricted legal conditions are accompanied by support options for small and medium scale applications.

This framework provides the strongest support for alternative (mixed) biomass utilisation in small and medium scale. At first sight, this might appear surprising since in Finland and Sweden a large share of heating and cooling is already provided from biomass. However, biomass use in these countries is currently focused on logged and chipped wood. Alternative raw materials are rarely used. Furthermore, despite the large share of biomass in the heating and cooling sector, the Scandinavian countries have ambitious targets requiring enhanced biomass use. Thus, a framework is required to facilitate alternative (mixed) biomass utilisation. The still limited use of alternative raw materials is reflected in the Best Practice Examples. Some experience is available for pelletizing of herbaceous biomass using a mobile pelletizing machine in Finland.

The pellets are used as fuel by the farmers or sold as fuel or litter. In Sweden, reed canary grass briquettes are produced with a capacity of 3500 t/a and are provided to local heating plants.

Determination of the frameworks for industrial scale

The procedure described above is now applied for industrial scale. The indication of favourable legal conditions for industrial scale use of alternative (mixed) biomass pellets is based on the existence and operation of industrial scale plants for alternative (mixed) biomass pellet utilisation, as well as the construction and installation of further plants. The results are summarised in Table 29.

Table 29 Determination of the national frameworks for industrial scale

Industrial scale (>1MW)	AU	DK	FI	DE	IT	ES	SE
Favourable legal conditions	0	1	1	0	0	0	1
Support options to secure long term economics	1	1	1	1	1	1	1

According to Table 29 only two distinct frameworks for alternative (mixed) biomass pellets production and utilisation in industrial scale applications can be found among the partner countries:

0-1: Austria, Germany, Spain and Italy belong to this category. The national conditions within these countries are characterised by highly restricted legal conditions and available support options for industrial scale applications.

This framework exists in the context of policies particularly supporting small and medium scale use but try to limit large scale use as a result of public concerns (AT, DE) or in countries for which the bioenergy sector is less developed (IT, ES). Though there are support options available the legal condition and the apparent political will hinder the use of alternative (mixed) biomass pellets in large scale. Under this framework, large scale utilisation is not favourable at the moment. The development in the bioenergy sector might change the situation in Italy and Spain in the future. Nevertheless, the current situation results in the lack of Best Practice Examples for large scale from Austria, Germany and Italy. The current capacity of the Spanish pellet producer is 20000 t/a using vine pruning as raw material. However, both the capacity and the variety of used raw materials are going to be expanded.

1-1: Denmark, Finland and Sweden have national conditions where favourable legal conditions are accompanied by support options for industrial scale applications.

In these countries the framework supports large scale utilisation of alternative mixed biomass pellets. This is reflected by the Best Practice Examples. Industrial scale pellet production is realised in Denmark based on straw. In Sweden reed canary grass briquettes are provided to district heating plants within the region.

References

[1] http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

[2] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/SPAIN_RES__Policy_review__09_Final.pdf

[3] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/SWEDEN_RES_Policy_Review_Final.pdf

[4] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/ITALY_RES_Policy_Review_09_Final.pdf

[5] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/GERMANY_RES_Policy_Review_09_Final.pdf

[6] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/FINLAND_RES_Policy_Review__09_Final.pdf

[7] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/DENMARK_RES_Policy_Review__09_Final.pdf

[8] http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/AUSTRIA_RES_Policy_Review_09_Final.pdf

[9] Directive 2009/125/EC

[10] M. Rönnbäck, L. Johansson, F. Claesson, M. Johansson, C. Tullin, Emissions from small-scale combustion of energy grain and use of additives to reduce particle emissions, Proceedings of the 16th European Biomass Conference & Exhibition, Valencia / Spain, (2008)

[11] L.S. Bäfver, M. Rönnbäck, B. Leckner, F. Claesson, C. Tullin, Particle emissions from combustion of oat grain and its potential reduction by addition of limestone or kaolin, Fuel Processing Technology 90, (2009), pag. 353-359

[12] T. Zeng, V. Lenz, Einsatz von Additiven bei der Verbrennung von Miscanthuspellets in einer Kleinfeuerungsanlage < 100 kWNWL – Untersuchung des Abbrand- und EmissionsverhaltensMiscanthus, Proceedings of the 4th Rostocker Bioenergieforum, Rostock / Germany, (2010)

[13] N. Weller, T. Zeng, V. Lenz, Combustion behaviour of straw pellets and its potential optimisation by fuel improvement, Proceedings of the 18th European Biomass Conference & Exhibition, Lyon / France, (2010)

[14] L. Nikolaisen et al., Quality characteristics of biofuel pellets, Report of PSO project no. 1996, (2002)

[15] U. Seyfert, K. Bunzel, D. Thrän, E. Mauky, B. Fritsche, A. Schreiber, J. Liebetrau, T. Schmidt, T. Ulbricht, V. Lenz: Abscheider für biogene Kleinfeuerungsanlagen, DBFZ Report 8, Leipzig, (2011)

[16] D. Thrän et al.: Sustainable Strategies for Biomass Use in the European Context, Institut für Energetik und Umwelt gemeinnützige GmbH, Leipzig, (2006)

[17] http://www.eubionet.net/default.asp?SivuID=25484

[18] http://www.repap2020.eu/fileadmin/user_upload/Roadmaps/Assessment_of_NREAPs__REPAP_report_-_interim_status_.pdf

Annex

1 Amount of asked key actors and received feedback for each questionnaire

	raw material		production		combustion		social acceptance		total		feedback rate [%]
	asked	received	asked	received	asked	received	asked	received	asked	received	
Germany	17	5	44	7	29	3	81	10	171	25	14,6
Italy	6	4	5	3	2	2	7	7	20	16	80,0
Sweden[2)]	13	7	3	0	10	4	0	0	26	11	42,3
Denmark[2)]	1	1	1	1	2	1	7	6	11	9	81,8
Austria	20	7	19	7	24	4	20	5	83	23	27,7
Finland[1)]	5	5	6	3	5	4	6	6	22	18	81,8
Spain	7	2	4	4	2	2	4	3	17	11	64,7
Total	**69**	**31**	**82**	**25**	**74**	**20**	**125**	**37**	**350**	**113**	**32,3**

[1)] Interviews mainly done on regional level, [2)] Interviews has been done via direct contact

2 Questions about relevant raw material

Contact member
Name:
Address:
Phone: E-mail:
Webpage:

Kind of biomass	What non wood biomass is grown successfully in your region? [in ha]	How would you asses the available quantity for combustion? [in t/a]	What biomass would you consider for this region to be relevant for combustion and why?
Energy crops: o miscanthus, o red canary grass, o cereals, o … o …			
Residues from agriculture: o straw o corn cobs o … o …			
Residues from landscape gardening: o grass o hay o …			
Residues from the processing of rapes: o rape press cake or o extraction goat o …			
Residues from the processing of olives and grapes: o Olive press cake, o Pomace of grapes o …			
Residues from processing of citrus fruits: o pressings from oranges o … o …			
Residues from processing of other agricultural commodities (such as Coffee and tobacco)			
Others – please specify o … o … o …			

Kind of biomass	When and how often the mentioned biomass is harvested and available for the combustion?	Are there any problems regarding the cultivation and the harvest?	Are there any approved transport and logistic systems for the mentioned biomass?
Energy crops: o miscanthus, o red canary grass, o cereals, o ... o ...			
Residues from agriculture: o straw o corn cobs o ... o ...			
Residues from landscape gardening: o grass o hay o ...			
Residues from the processing of rapes: o rape press cake or o extraction goat o ...			
Residues from the processing of olives and grapes: o Olive press cake, o Pomace of grapes o ...			
Residues from processing of citrus fruits: o pressings from oranges o ... o ...			
Residues from processing of other agricultural commodities (such as Coffee and tobacco)			
Others – please specify o ... o ... o ...			

Kind of biomass	Is there any business competition regarding the use of the biomass?	How would you asses the future potential? If yes, why and in which extent [in %]?	Who are the potential regional customers?
Energy crops: o miscanthus, o red canary grass, o cereals, o … o …			
Residues from agriculture: o straw o corn cobs o … o …			
Residues from landscape gardening: o grass o hay o …			
Residues from the processing of rapes: o rape press cake or o extraction goat o …			
Residues from the processing of olives and grapes: o Olive press cake, o Pomace of grapes o …			
Residues from processing of citrus fruits: o pressings from oranges o … o …			
Residues from processing of other agricultural commodities (such as Coffee and tobacco)			
Others – please specify o … o … o …			

Kind of biomass	Are there already any cross-boarder trading activities in the region? If yes, which countries and which quantity [in t/a]?	Are you aware of experiences regarding the combustion of the mentioned biomass (e.g. special incidents) ?
Energy crops: o miscanthus, o red canary grass, o cereals, o ... o ...		
Residues from agriculture: o straw o corn cobs o ... o ...		
Residues from landscape gardening: o grass o hay o ...		
Residues from the processing of rapes: o rape press cake or o extraction goat o ...		
Residues from the processing of olives and grapes: o Olive press cake, o Pomace of grapes o ...		
Residues from processing of citrus fruits: o pressings from oranges o ... o ...		
Residues from processing of other agricultural commodities (such as Coffee and tobacco)		
Others – please specify o ... o ... o ...		

Kind of biomass	Content of			Lower heating value in MJ/kg db	Moisture content in Ma.-%	bulk density in kg/m³	Ash melting temperature in °C
	N in Ma.- % db	S in Ma.-% db	Cl in Ma.-% db				
Energy crops: o miscanthus, o red canary grass, o cereals, o ... o ...							
Residues from agriculture: o straw o corn cobs o ... o ...							
Residues from landscape gardening: o grass o hay o ...							
Residues from the processing of rapes: o rape press cake or o extraction goat o ...							
Residues from the processing of olives and grapes: o Olive press cake, o Pomace of grapes o ...							
Residues from processing of citrus fruits: o pressings from oranges o ... o ...							
Residues from processing of other agricultural commodities (such as Coffee and tobacco)							
Others – please specify o ... o ... o ...							

db... dry basis
N... Nitrogen
S... Sulphur
Cl... Chlorine

3 Questions about production of alternative and mixed pellets

Alternative pellets: *Every raw material apart from the chemical and combustion related properties of wood pellet according to prEN 14961-2 (June 2010) is relevant → excluding pellets from 100 % woody biomass and mixtures.*

Mixed pellets: *Mixtures of raw materials from Group 1, 2 or 3 according to the definition in prEN 14961 (woody biomass, herbaceous biomass, biomass from fruits).*

Contact member

Name:
Address:
Phone: E-mail:
Webpage:

Background

(1) Do you produce for exclusively or for
□ alternative pellet, □ mixed pellet or □ neither of them
□ material or □ energetic use
□ both, ____% for material and ____% for energetic use?

(2) Do you produce alternative/mixed pellets regularly? □ yes □ no
If yes, which production capacity do you have _____t/a and with how many pellets production lines do you realise it ____?

(3) Which ratios are used for the production of mixed pellets (weight-%)?

(4) What are the prices for these pellets (only production costs)?
Minimum costs _____€/t and maximum costs_____€/t

(5) Distribution of the produced pellets

Own distribution	□ regional □ not regional (national/international)	By partner	□ Regional □ Not regional (national/international)

Raw materials

(6) Which raw materials are mostly used?
□ Energy crops (e.g. miscanthus, reed canary grass, cereals)_____
□ Residues from agriculture (e.g. straw, but also corn cobs)_____
□ Residues from landscape gardening (e.g. grass, hay)_____
□ Residues from the processing of olives or grapes (e.g. Olive press cake, Pomace of grapes)_____

☐ Residues from processing of citrus fruits (e.g. the pressings from oranges)_____

☐ Residues from processing of other agricultural commodities (such as coffee and tobacco)_____

☐ Others – please specify

_____

_____

_____

(7) From where do you get the raw materials?

☐ own plantation

☐ other farmers in maximum distance of _____km

☐ biomass use industry like_____

☐ other industry like_____

(8) What are the costs for the raw materials? ☐ Minimum _____€/t

☐ Maximum _____€/t

(9) Are there costs for the delivery of raw material? ☐ yes

☐ no, we take it.

(10) Are any other substances added to the raw material(s)?

☐ yes, binder like _____ in weight-%

☐ yes, additives like _____ in weight-%

☐ yes, others _____ in weight-%

☐ no.

(11) Are the physical and/or chemical properties of the raw material(s) changed by thermo-chemical processes, e.g. torrefaction?

☐ yes, like _____

☐ no:

Pelletizing process

(12) Do you have a bale breaker?

☐ yes, please add technical dates like

type_____

capacity _____kg/h

reduction ratio _____mm

(13) Do you have a mill?

☐ yes a ☐ cutting mill or a ☐ hammer mill or an other mill _____

Please add the technical dates like

capacity _____kg/h

reduction ratio _____mm

(14) Do you use a dryer for the reduction of moisture?

☐ yes, please add technical dates like

drying method _____

temperature _____ °C

capacity _____kg/h

moisture content in/out _____weight-%

☐ no because

_____

☐ no because

_____

☐ no, because

_____

(15) If two (or more) raw materials are used, how is the mixing process proceeded?

☐ gravity mixer

☐ compulsory mixer

☐ or other mixer

_____

(16) Do you have a

☐ flat die press with the capacity _____kg/h

☐ ring die press with the capacity _____kg/h

☐ both,

☐ others _____ with the capacity _____kg/h

(17) Do you have a cooling system for the produced pellets?

☐ yes, please add the technical dates

cooling method_____

temperature _____ °C

capacity _____kg/h

☐ no, because

_____

(18) Do you have a screening system to sieve up the fines?

☐ yes _____ mm

☐ no, because

_____

(19) How are the pellets stored?

☐ silo

☐ bagged cargo

☐ big bags

☐ others

_____

(20) Are there any problems with long term storage?

☐ no

☐ yes, please add what kind of problems you had and with which materials.

_____

_____

(21) Do you produce pellets according existing pellet standards like

☐ CEN _____

☐ DIN _____

☐ ÖNorm _____

☐ others _____

Please give some information about the tree mostly produce alternative or mixed pellets.

alternative or mixed pellets	charge 1:	charge 2:	charge 3:
for material or energetic use in %			
properties of the raw materials at delivery (bale or bulk commodity)			
bulk density of the raw material before pelletizing in kg/m³			
moisture before pelletizing in weight-%			
add on binder in weight-%			
add on additives in weight-%			
Kind of sieve and sieve opening of grinder in mm			
measures of die for pelletizing (L/D)			
problems during pelletizing			
comments			

4 Questions about combustion of alternative and mixed pellets and briquettes

Alternative pellets/briquettes: *Every raw material apart from the chemical and combustion related properties of wood pellet according to prEN 14961-2 (June 2010) is relevant → excluding pellets from 100 % woody biomass and mixtures.*

Mixed pellets/briquettes: *Mixtures of raw materials from Group 1, 2 or 3 according to the definition in prEN 14961 (woody biomass, herbaceous biomass, biomass from fruits).*

Contact member

Name:
Address:

E-mail:
Phone:
Webpage:

Background

(22) Please state your field of activity (multiple answers possible).

- ☐ Producer of combustion systems
- ☐ Producer of flue gas cleaning systems
- ☐ Lobbying institutions/ representative of professional association
- ☐ Engineers and consultants designing heating systems
- ☐ Plant operator/contractor
- ☐ Other

_____

(23) Which range of thermal input do the combustion systems have you are using with alternative / mixed biomass pellets or briquettes?

Range1:
From _____to _____ kW (thermal input)
Electrical power generation _____kW_{el}
Number of installed plants _____
Type of combustion system _____

Range2:
From _____to _____ kW (thermal input)
Electrical power generation _____ kW_{el}
Number of installed plants _____
Type of combustion system _____

(24) How many years do you have experience in the field of the energetic utilisation of alternative and mixed biomass pellets or briquettes?

☐ no experience ☐ 0-2 years ☐ 2-5 years ☐ 5-10 years
☐ more than 10 years

(25) Which are the two most important issues for you to use of alternative or mixed biomass pellets or briquettes?

☐ Climate protection ☐ Economics ☐ Sustainability ☐ Regional added value ☐ Others (e.g. conviction, etc.)_____

(26) Please state your estimation about the future development for the energetic utilisation of alternative and mixed biomass pellets or briquettes until 2020.

☐ will increase ☐ will remain on the actual level ☐ will decrease

Fuels

(27) Do you use alternative/mixed pellets or briquettes regularly? ☐ yes ☐ no

If yes, which amounts are used for the combustion annually?

Fuel 1: _____ (ton/year)
Fuel 2: _____ (ton/year)
Fuel 3: _____ (ton/year)

If yes, please specify the used raw materials. If mixtures are used, please specify also the ratios in weight-%.

Raw materials	fuel 1	fuel 2	fuel 3
Energy crops (e.g. miscanthus, reed canary grass, cereals)			
Residues from agriculture (e.g. straw, but also corn cobs)			
Residues from landscape gardening (e.g. grass, hay)			
Residues from the processing of olives or grapes (e.g. Olive press cake, pomace of grapes)			
Residues from processing of citrus fruits (e.g. the pressings from oranges)			
Residues from processing of other agricultural commodities (such as coffee and tobacco)			
Others raw materials (e.g. woody biomass, etc), please specify: o ... o ...			
Others substances (e.g. binders or additives, etc), please specify: o ... o ...			
Are the pellets in accordance with existing pellet standards (e.g. CEN, DIN, ÖNORM)? Please specify.			

(28) If known, please specify the fuels characteristics.

	Content of			Lower heating value in MJ/kg db	Moisture content in Ma.-%	Bulk density in kg/m³	Ash melting temperature in °C
	N in Ma.- % db	S in Ma.-% db	Cl in Ma.-% db				
Fuel 1							
Fuel 2							
Fuel 3							

db... dry basis, N... Nitrogen, S... Sulphur, Cl... Chlorine

(29) From where do you get the fuels?

□ own production
□ local sales and service in maximum distance of _____km
□ biomass use industry like _____
□ other industry like_____

(30) What are the costs for the fuels mentioned above?

□ Minimum _____€/t for the fuel_____
□ Maximum_____€/t for the fuel_____

Storage

(31) Are there any problems within the storage?

□ no
□ yes, dust emissions_____
□ yes, odour_____
□ yes, feeding problems_____
□ yes, others_____ _____

(32) How are the pellets fed into the boiler?

□ feeding screw, or □ pneumatic feeding system
□ others _____

Combustion system

(33) The combustion systems are licensed for

□ Wood pellets □ Wood chips □ Wood briquettes
□ Alternative fuels, please specify _____
□ Others (e. g. Scrap wood, fossil fuel, waste), please specify _____

(34) Do you have problems with high emission levels, e.g. total dust, CO, NO_x, HCl or SO_2? If known, please specify the emissions and their level.

_____
_____

(35) Are there any problems with the combustion of alternative or mixed biomass pellets (multiple answers possible)?

☐ no

☐ dust emissions ☐ corrosion ☐ slagging tendencies in bottom ash

☐ ash handling ☐ fouling ☐ economics

☐ legal framework ☐ others (e.g. boiler efficiency, etc) _____

(36) Do you have technical equipment for the reduction of gaseous or particulate emissions?

☐ no

☐ yes, please specify the technical equipment regarding the range of thermal input:

Range for thermal input [kW]	Reduction of dust emissions		Reduction of SO_2 emissions		Reduction of HCl emissions		Reduction of NO_x emissions	
	Y/N	Process technology	Y/N	Process technology	Y/N	Process technology	Y/N	Process technology
20-100								
100-400								
400-3000								
> 3000, specify range: o ... o ...								

Y...Yes, N...No

(37) Do you have any problems with the technical equipment for the reduction of gaseous or particulate emissions?

☐ no ☐ separation efficiency ☐ maintenance time and costs

☐ others _____

(38) If you are operating a plant, for which purposes is the energy generated?

☐ Self supply ☐ District heating ☐ District heating and power supply

(39) General comments:

5 Questions about social acceptance of the combustion of alternative (mixed) biomass pellets

Alternative pellets/briquettes: *Every raw material apart from the chemical and combustion related properties of wood pellet according to prEN 14961-2 (June 2010) is relevant → excluding from 100 % woody biomass and mixtures.*

pellets

Mixed pellets/briquettes: *Mixtures of raw materials from Group 1, 2 or 3 according to the definition in prEN 14961 (woody biomass, herbaceous biomass, biomass from fruits).*

Contact member

Name:
Address: E-mail:
Phone: Webpage:

1. Background

How would you assess the overall acceptance of the energetic utilisation of biomass?

- ☐ high or
- ☐ in some cases problematic, because _____

or

- ☐ problematic, because _____

Which raw materials can be problematic for combustion purposes?

- ☐ Energy crops (e.g. miscanthus, reed canary grass, cereals), because _____
- ☐ Residues from agriculture (e.g. straw, but also corn cobs), because _____
- ☐ Residues from landscape gardening (e.g. grass, hay), because _____
- ☐ Residues from the processing of olives or grapes (e.g. Olive press cake, Pomace of grapes), because _____
- ☐ Residues from processing of citrus fruits (e.g. the pressings from oranges), because _____
- ☐ Residues from the processing of other agricultural commodities (such as coffee and tobacco), because _____
- ☐ Others – please specify, _____ _____

Do you think the acceptance for the combustion of alternative (mixed) biomass can be increased?

- ☐ no, because _____
- ☐ yes, by intensifying communication and dissemination activities or
- ☐ yes, by improving technical systems such as combustion and precipitator technologies and fuels or
- ☐ others, like _____

2. Cultivation

Do you expect negative influences of the cultivation of alternative biomass such as energy crops on the landscape and biodiversity?

- ☐ no, because _____or
- ☐ yes, because _____

Do you expect competitions between the cultivation of alternative biomass such as energy crops and food?

- ☐ no, because _____or
- ☐ yes, because _____

3. Combustion

Do you have any concerns about the safety and technical development of the available combustion systems for alternative (mixed) biofuels?

- ☐ no, because _____ or
- ☐ yes, because _____

Do you have concerns about emissions from the combustion of alternative (mixed) biomass and possible effects on the human health?

- ☐ no, because _____or
- ☐ yes, on dust emissions
- ☐ yes, on NO_x emissions
- ☐ yes, on SO_2 emissions
- ☐ yes, on HCl emissions
- ☐ yes, on noise emissions

4. Economic effects

Do you think the combustion of alternative (mixed) biomass plays an important role for rural development and securing of jobs?

- ☐ no, because _____or
- ☐ yes, because _____

Do you think the combustion of alternative (mixed) biomass contributes to a decrease on energy imports and an equal distribution of energetic resources?

- ☐ no, because _____or
- ☐ yes, because _____

Do you think there is a strong linkage between fossil and biomass fuel prices?

- ☐ no, because _____or
- ☐ yes, because _____

5. Others

Please make short prospects of further trends for social effects on the combustion of alternative (mixed) biomass fuels:

_____

_____

_____

_____

_____