Integrated biomass policy frameworks GERMANY

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Executive Summary

The aim of the integrated policy framework for biomass in Germany is to:

"Improve social acceptance for biomass to energy and fuels by steering focus towards the use of untapped waste and residual biomass streams in biomass power plants (existing and new ones); facilitate the use of perennial crops; reinforce cogeneration and heat uptake; and ensure a clear plan is in place for biofuels in transport."

Current market uptake, policy effectiveness and challenges for 2020 & 2030 for different market segments.

Market segment	Market uptake, policy effectiveness and challenges
Heat	Share of biomass based heat remains very high with households and industry being the primary end users. The main challenge to meet the 2020 targets is to sustain the high share of biomass heat and support cogeneration and subsequent heat uptake. **Policy effectiveness**: High; The use of biomass in most of the private households use wood is attributed mostly to economic reasons and not to effective policies only. **Risks & Challenges for 2020 & 2030**: to sustain the high share of biomass heat and support cogeneration and subsequent heat uptake.
Electricity	Electricity from biomass represents a share of 7% of gross electricity production (compared to an overall renewable electricity share of 23.6%). So a modest share of 30% of renewable electricity comes from biomass. Around 27% of bio-electricity is produced from solid biomass, 61% from biogas and 11% from MSW. The main focus is on (biogas) CHP plants, the majority as main activity (feed-in tariff for electricity and selling heat). Low share of auto-producers. **Policy effectiveness**: Very high. Germany has been the largest solid and gaseous biomass electricity producer in Europe (more than 47TWh in 2014) in absolute terms. The Renewable Energy Sources Act (EEG) offers fixed payments (feed-in tariffs) for renewable electricity supplied to the national grid. Next to that, there are additional bonus payments for using wood and other renewable resources that have been specifically cultivated for energy production (the "biomass bonus"), for CHP plants ("cogeneration bonus") and for the use of innovative technologies ("innovation bonus"). **Risks & Challenges for 2020 & 2030**: to ensure FiTs for early biomass plants that end in 2021 have a follow up scheme, meet targets and sustain deployment in the bioelectricity sector it is important to further mobilise residual and waste biomass potentials, for bioelectricity and to promote high efficiency technologies (in current stock and or newly built plants). Increase the value added of bioelectricity to the energy system (providing flexible and reliable power for balancing energy etc.), to agriculture (e.g. decrease nitrate input of manure) and to cascading use of waste (e.g. anaerobic digestion before composting).
Transport	Germany has a relatively high energy consumption in transport. Biofuels implementation is higher than EU average, with a moderate role of advanced or double counting biofuels. The physical share of biodiesel (excl. double counting) is around average. There is some natural gas in transport, and also a fraction of biogas. **Policy effectiveness**: Very high **Risks & Challenges for 2020 & 2030**: to develop a clear action plan for transport biofuels up to 2020 and beyond 2020 alongside electro-mobility.

Priority value chains

Perennial crops	There is a large potential of perennial crops that could increase biodiversity on agricultural and fallow land on the one hand; on the other hand, tapping additional national wood resources could mitigate the competition between energetic and material uses of woody biomass
Organic waste	German Recycling and Waste Act (KrWG) stipulates biological wastes to be collected separately by 1st January 2015. This rule increases the amount of technical and economical viable bio- wastes which can be utilized for combined composting and digestion.
Straw	Depending on the region, straw has a large unused potential that can be tapped both economically and sustainably. As a residue it is one of the resources which are in the focus of the German renewable energy policy at the moment.

Key considerations on formation of an integrated policy framework

- In order to reduce greenhouse gas emissions by 80 to 90 % in the year 2050 in comparison to 1990 level, a fundamental change of the energy system – the so called Energiewende or energy transition - is required. But, most measures that support bioenergy phase out by the year 2020. This is especially the case for the feed-in tariffs for biomass power plants. In the case of biofuels for transportation, no Germany legislation is expected as long as there is no European goal or strategy for biofuels for the time after 2020. As there are no dedicated goals for bioenergy for the time after 2020, there is high uncertainty amongst plant operators, the financial sector and potential investors.
- In relation to bioenergy, the energy policy is driven by energy costs, competing uses of agricultural land and woody biomass as well as environmental concerns. And, within the political discussion social acceptance plays a crucial role.
- The potential to decrease the costs of bioenergy is limited as in most cases feedstock represents the lion`s share of bioenergy costs. The identification of cost reduction potentials and the communication of bioenergy's benefits towards policy and public are crucial barriers for the future deployment of bioenergy in Germany.
- The deployment of bioenergy has created a significant demand for different biomass categories from agriculture, forestry, garden and landscape management and municipal and industrial wastes and residues. Some of these potentials are developed completely, such as certain waste wood categories. For other biomass categories competition amongst different users and stakeholders has increased in recent years resulting in rising prices for biomass and agricultural land on the one hand side. On the other hand, side competition with other users has created negative impacts on the public discussion of bioenergy.

Introduction

In comparison to other European Member States the deployment of bioenergy is very advanced in Germany. Nevertheless, the German targets to decrease the GHG emissions in the time to 2030 are ambitious. From today's perspective it requires the mobilisation of additional biomass feedstocks for energy and the optimisation of the existing bioenergy capacities.

Germany's current bioenergy policy is driven by energy costs, competing uses of agricultural land and woody biomass as well as environmental concerns. Germany will have to overcome a strong reservation and unfavourable social attitude towards using biomass as fuel. In addition to this, most measures that support bioenergy phase out by the year 2020. This is especially the case for the feed-in tariffs for biomass power plants (the ones for the first biomass power plants phase out in 2021). In the Business as Usual situation, operators are likely to stop the operation of biomass power plants from that year onwards, if framework conditions don´t change. Due to more capacities could retire than added to the system; the total biomass power capacity could decline. Current legislation (EEG) creates only little incentives for new combined heat and power projects, so additional heat from biomass will be limited to the installation of new boilers and heat plants in the future. Germany is less likely to come up with strict legislation for biofuels for post 2020 if there is no principal European Union goal or strategy for biofuels.

The aim of this integrated framework is to provide an appropriate biomass policy package for Germany and facilitate reaching the RES-Directive 2020 targets by using indigenous resource and energy efficient value chains as well as sustain biomass deployment beyond this timeline to 2030. The policy framework setting comprises three phases: 1. policy aim & justification 2. analysis & direction setting and 3. policy framework design which includes a set of financial support mechanisms for the selected indigenous value chains.

- The policy aim has been formed based on valid argumentation which has been communicated to and validated by national stakeholders in national workshops and an online consultation;
- In the analysis and direction setting current state of play is analysed, evidence for resource efficient indigenous biomass supply and efficient value chains is assessed and key principles were further validated by stakeholder engagement;
- In the framework design phase a set of options for future biomass policy are selected together with the national agencies and key quantitative indicators are being provided as regards to the costs of the respective value chains.

Whilst this approach is inherently subjective, the project team considers that it is effective both as a means of illuminating the policy process, and as a basis for critical assessment. It is also remarkably flexible and could be applied to many other policy processes.

To minimise its subjective nature, targeted workshops and consultations in the participating countries have taken place and have taken place between months 27 and 34 to:

- present the key principles that will guide the integrated policy framework, developed within the project,
- seek feedback from the stakeholders and give them a chance to provide input.

The report provided the baseline for the financial modelling and projections that were performed by the RESolve[1] model in Task 4.2.

[1]The RESolve model is an optimization model developed by ECN*. The model fulfills given demands for biofuels for transport, electricity and heating using biomass in a least cost manner with respect to fossil references. In this optimization stimulating measures can be included. The model has previously been applied to analyse the EU biofuel sector in several large project funded by the European Commission (REFUEL, etc.) and also within the Biomass Futures project to analyse the role of biomass to meet RED 2020 targets and beyond to 2030. The RESolve model has been extended with electricity and heat as compared to the model described in Lensink, S. and Londo, M. (2010): *Assessment of biofuels supporting policies using the BioTrans model, Biomass and Bioenergy 34 (2010), 218-226, 2010.*

Policy aim and justification

This section defines the key issues under consideration for biomass to meet the targets set in NREAP for 2020 and 2030, justifies the need for government intervention and shortly describes the policy objectives and intended effects.

Which are the key issues under consideration for biomass to meet the targets set in NREAP for 2020 and 2030?

- Realise more biomass for energy while at the same time leaving enough biomass for the biobased economy.
- Provide data to make decisions more informed and transparent as well as to justify decisions already made.
- Improve existing and new biomass conversion projects in economic and environmental terms.
- Providing a reliable policy framework for investors and key stakeholders.

Why is the government intervention necessary?

- Biomass is expected to make a major contribution to future low carbon energy in Germany.
- In an energy system with a high share of fluctuating renewable energies, biomass can provide important system services for a reliable and stable power supply.
- In the transport sector biomass is a crucial option to reduce GHG emissions in the future e.g. heavy-duty road-freight transport.
- Indigenous biomass is under increased demand pressure from energy and non energy sectors.
- Policy makers thus need to consider constraints to mobilising resources and how to balance competing priorities by different sectors.
- The use of residues and by-products is important, as the qualitative higher biomass is being used for food, feed and material use.

What are the policy objectives and intended effects?

The aim of the integrated policy framework for biomass in Germany is to

- Improve social acceptance for biomass to energy and fuels by steering focus towards the use of untapped waste and residual biomass streams in biomass power plants (existing and new ones).
- Facilitate the use of perennial crops.
- Reinforce cogeneration and heat uptake.
- Ensure that a clear plan is in place for biofuels in transport.

What evidence will the Biomass Policies project provide to inform the suggested future policy interventions?

- Suggestions for mobilizing additional biomass resources (especially currently unused fractions which are not used for food/feed or material uses, e.g. second generation biofuel crops, organic wastes and straw).
- Insights into the pros and cons of different utilization chains.
- Possibilities of beneficial utilization of indigenous biomass
- Sharing best practices with other countries and incorporating them in integrated policy approaches (addressing biomass competition and sustainability issues).

Policy Effectiveness

Heat

The utilization of biomass in heating devices has a long tradition in Germany. In the year 2000 the Market Incentive Programme (MAP) was introduced, providing investment for the installation of highly efficient biomass boilers. The sharp increase in fossil fuel prices from 2004 to 2008 created strong incentives to use wood for heating purposes in private households. Since the year 2009 the Renewable Energies Heat Act (EEWärmeG) regulates the obligation to use renewable energy in new buildings. Owners of newly erected buildings must cover part of their heat demand with renewable energies. The share is 50 % for solid biomass. Another key issue for the development of biomass heat in Germany is the combined heat and power production from biomass. Since the extension of the feed-in tariff with a bonus for the combined heat and power (CHP) production in 2004 (EEG), heat provision of biomass power plants is continuously increasing. Since 2012 the EEG requires newly built biomass power plants to make use of a minimum of 60 % of the waste heat. Considering yearly changing heat demand in Germany, the heat provision from biomass is stable in recent years. This is due to rising wood prices and declining fossil fuel prices that have minimized the incentives for private households to shift from fossil to biomass fuels. What increased uncertainty amongst stakeholders additionally was the fact, that when the Federal Emission Control Act (1. BImSchV) was adopted in 2010, measurement devices weren't available to observe the boilers compliance with emission thresholds.

One key issue of biomass heat in the future is the improvement of the performance of biomass boilers and stoves in terms of efficiency and emissions of particulate matter. The implementation of the Ecodesign Directive and the Energy Labelling of Products respectively will extend the requirements for energy efficiency to the majority of new heating applications in the future.

The rapidly changing energy system requires biomass heat applications to be more flexible and compatible with regard to both the heat demand and other energy technologies. In order to diminish the competition between biomass heat and the material use of biomass there are additional challenges. One is the cascading use of wood increasing the resource efficiency. Another is the mobilization and processing of non-woody biomass for wood fuels. But, existing fuel wood standards (e.g. ENplus for wood pellets) and the regulatory framework conditions of the 1. BImSchV limit these measurements to certain wood qualities (e.g. saw mill residues) and large heating applications. And, the introduction of instruments in order to improve the cascading use of wood and the mobilization of additional biomass resources needs regulatory adoptions and technical improvements for the utilization in biomass heating applications.

Electricity

The Renewable Energy Sources Act (EEG) is the main driver for the market uptake of biomass power. It came into force in the year 2000. The prohibition of dumping organic wastes from the year 2005 onwards pushed the use of waste wood as feedstock for biomass power plants forward. This development slowed down in 2007 when a large share of the available waste wood potential was exploited. The introduction of additional bonuses for certain biomass feedstock such as manure and energy plants triggered a biogas boom in the years between 2009 and 2012. However, the installation of new biomass power plants has become more difficult from year to year as the prices for feedstock and public resistance to biomass projects have increased. The amendment of the EEG in 2012 took these developments into account and removed some of the bonuses. Other key elements of the 2012 amendment are the market and the flexibility premium which compensate plant operators for a market orientated operation and the respective investment costs. A large share of biomass power plants receives the market premium for the market orientated power production. The most recent amendment of the EEG in 2014 contains a sharp cut back of the feed-in tariffs for biomass that creates only little incentives for the erection of new biomass power plants.

The introduction of an auction model for biomass power capacities is under discussion in Germany. In its latest discussion paper from November 2015 the Federal Ministry of Economy and Energy (BMWi) proposes a combined auctioning procedure new, extended and existing biomass power plants (BMWi 2015a). A follow-up funding for existing installations is a crucial issue as the feed-in tariffs for these plants start to

phase out in the year 2021. Without any support it is very likely that almost all of these power capacities will become economically unviable in the future. Most of the first biomass power plants are characterised by relatively low energy efficiency and low production costs. Hence, policy makers are faced with the introduction of obligations that increase the efficiency and flexibility of existing biomass power plants on the one hand side while creating higher production costs and respective higher financial support on the other hand side.

Transportation

The market uptake of biofuels for transportation started with a tax exemption. In 2004 a quota obligation was introduced that created additional demand for bioethanol. In 2007 the share of biofuels in Germany reached its peak as the phase out of the tax exemption started in 2008. From that year the biofuel quota was the main support mechanism for the utilization of biomass as transport fuel. With the introduction of double counting of certain biofuels in 2011 once more the amount of biofuels decreased that was required to fulfil the quota obligations. Although the blend wall for bioethanol was increased from 5 to 10 percent in 2010, most car holders prefer the gasoline with a maximum share of bioethanol of 5 percent only.

The greenhouse gas reduction (GHG) quota is in force since 1st of January 2015. Suppliers of gasoline and diesel fuels are obliged to reduce the GHG balance of their transportation (road only) fuels by means of liquid and gaseous biofuels. The GHG reduction is 3.5 percent in 2015, 4 percent in 2017 and will be increased to 6 percent by 2020. A first analysis of sustainable liquid and gaseous biofuels documented within the system of the Federal Office for Agriculture and Food (BLE) shows that instead of using “typical” GHG values most biofuel producers calculate their own GHG values. And, more bioethanol producers make use of carbon capture and replacement that improves the GHG balance of biofuels significantly. As an interim result the average GHG reduction potential of all sustainable liquid and gaseous biofuels is higher than in the same period in 2014 (BLE 2015). Increasing the GHG reduction potential of biofuels reduces the amount of biofuels in terms of energy that is required to fulfil the quota obligations. Therefore, it is very likely that the share of biofuels in terms of energy will not increase before the increment of the GHG quota in 2017 (4 percent) or maybe even 2020 (6 percent). Depending on the volume and availability of alternative options such like upstream emission reductions, the increment from 4 to 6 percent in 2020 could mean an sharp increase of biofuel demand from 2019 to 2020.

For the time after 2020 there is no policy goal for biofuels in the transportation sector. If there is no principal European Union goal or strategy for biofuels it is very difficult for Germany to come up with strict legislation for biofuels for post 2020. Another crucial barrier for the introduction of more efficient value chains in Germany is to overcome the social resistance against biofuels.

Taking the infrastructure for alternative fuels into account, the future development of biofuels in the transportation depends on the LNG - and to some degree CNG – infrastructure, as well. Here, biomethane could contribute significantly to improve LNG’s and CNG’s greenhouse gas reduction potential.

Analysis & direction setting

Current State of play for biomass in Germany

Biomass forms the major share in renewable energy in Germany (about 70 percent). From the total biomass use, solid biomass represents around 50% of biomass applications for energy and the share of energy from biogas is particularly high in comparison to the EU average. The electricity production from biomass contributed 30.5 percent to the renewable based electricity in 2014 (see figure 1).

In the heat and the transportation sector biomass' share is about 90 percent of all renewable energy.

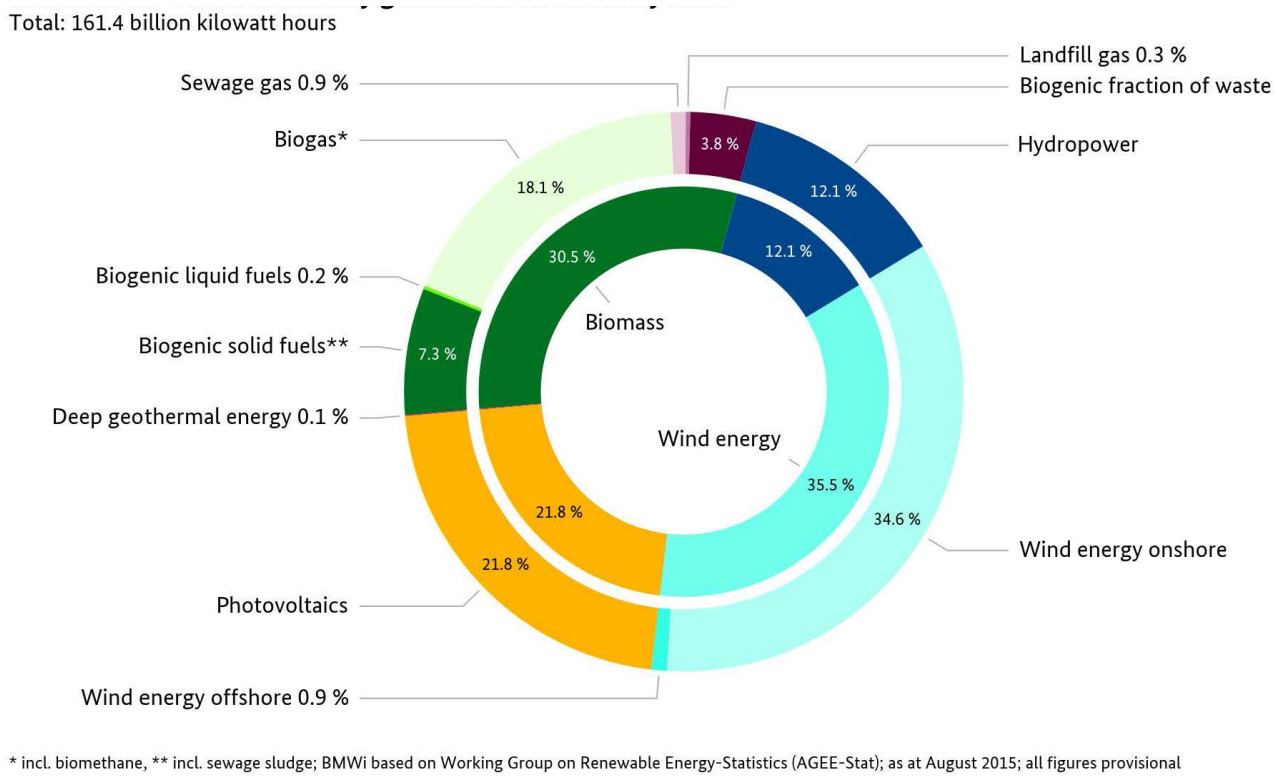

Figure 1. Renewable-based electricity generation in Germany 2014. (Source: BMWi 2015)

The current state of biomass in the heat, electricity/ combined heat and power (CHP) and biofuel sectors is analysed in detail in Deliverable 3.1 National Policy Landscape Germany[2] and summarised below in Table 1.

[2] http://www.biomasspolicies.eu/?cat=26

Table 1. Current state of biomass implementation in the heat, electricity/ CHP and biofuel sectors

Market segment	Current state of implementation
Heat	Share of biomass based heat remains very high with households and industry being the primary end users.
Electricity/ CHP	Electricity from biomass represents a share of 8% of gross electricity production (compared to an overall renewable electricity share of 27.4%). So a modest share of 30% of renewable electricity comes from biomass. Around 24% of bio-electricity is produced from solid biomass, 59% from biogas and biomethane and 12% from MSW. This indicates the importance of biogas for electricity production. The main focus is on (biogas) CHP plants (feed-in tariff for electricity and selling heat). Low share of auto-producers[3].
Transport biofuels	Germany has a relatively high energy consumption in transport. Biofuels implementation is higher than EU average, with a moderate role of advanced or double counting biofuels. The physical share of biodiesel (excl. double counting) is around average. There is some natural gas in transport, and also a fraction of biogas.

Biomass supply & selection of value chains

Germany is a country with significant biomass potentials and clearly a front runner in reaching the renewable bioenergy targets among EU Member States. Recently the renewable energy policy has changed significantly. Due to a debate about increasing costs, the feed-in tariffs for bioenergy have been reduced drastically and the additional capacity of bioenergy that can receive remuneration is capped to 100 MW annually.

The largest indigenous biomass potentials derive from forest activities, the primary and secondary forestry potentials, dedicated crop, straw and manure as shown in Figure 2.

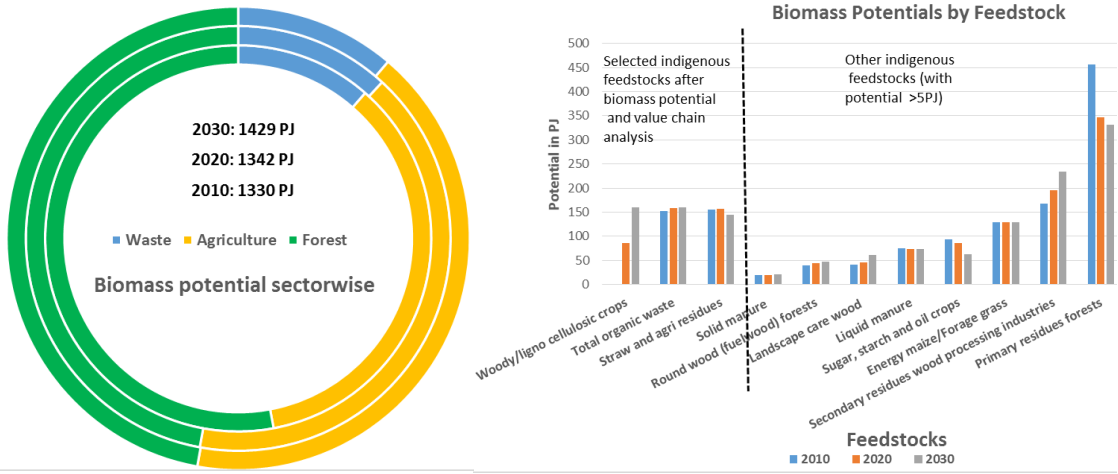

Figure 2: Biomass Policies estimated biomass potentials for Germany for 2010, 2020 and 2030 under different sector and feedstock types.

[3] Auto- producers refer to companies producing their own energy needs via CHP.

The Biomass Policies team consulted with national agencies and stakeholders at various workshops and consultations over the project period and based on it has summarized the prioritised feedstock, value chains and the key drivers for their selection.

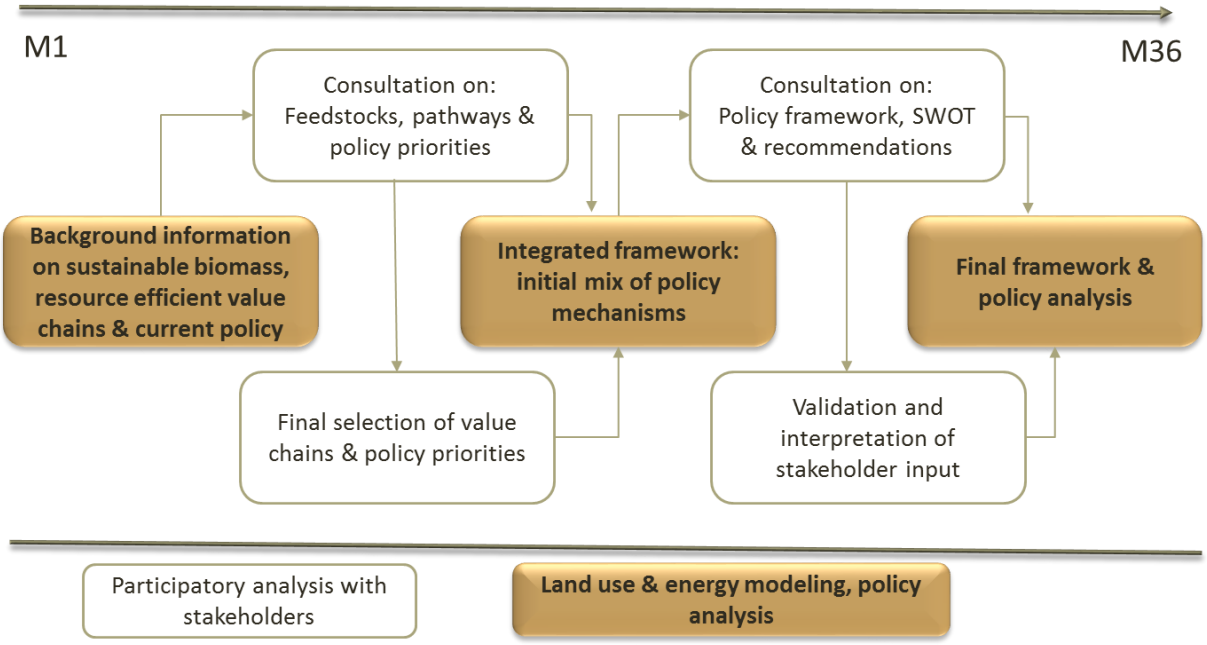

Figure 3 Structure of the Biomass Policies Consultation Process

Perennial Crops: There is a large potential of perennial crops that could increase biodiversity on agricultural and fallow land, sourced and exploited under sustainable practices. The potential of perennial crops is 1,850 PJ in 2030.

Organic waste: German Recycling and Waste Act (KrWG) stipulates biological wastes to be collected separately since 1st January 2015. This rule increases the amount of technical and economically viable bio-wastes which can be utilized for combined composting and digestion. The household waste´s potential is 473 PJ in 2030.

Straw: Depending on the region, straw still has a significant unused potential that can be tapped economically and sustainably. As a residue it is one of the resources which are in the focus of the German renewable energy policy at the moment. The biomass potential of straw is 1,064 PJ in 2030.

Policy framework design

This section defines the key issues under consideration for biomass to meet the targets set in NREAP for 2020 and 2030, justifies the need for government intervention and shortly describes the policy objectives and intended effects. Following it presents the recommended policy framework and the financial support mechanisms which will be further analysed with the RESolve model (see footnote 1).

National policies[4]

Based on the detail analysis of the existing German national policies related to biomass[5], this section provides an outlook of the main gaps and issues reflected in their policies and provides explanation how they could be improved in the future.

Table 3. Key policy related issues involved in the integrated framework setting in Germany

	Gaps and Issues related to biomass reflected in national policy	**How the selected value chains can be affected?**
How to manage with competition for the biomass feedstocks? Is high competition with other markets appropriately addressed in national policy?	From a current point of view policies in force will not stipulate a large volume of new bioenergy projects. The risk of competition seems to be limited to markets where high fossil fuel or carbon dioxide prices create an additional biomass demand. This could be an issue for the utilization of woody biomass in private households. Measures that could improve the situation are • financial support for the replacement of old inefficient biomass boilers, • requirements for boiler and stove efficiency and • support for the mobilisation of additional biomass resources. Biomass fuels cannot count towards the GHG quota obligations if the biomass contains animal fats and/or oils. Exemptions should be permitted in the 36. BImSchV if used animal fats and oils do not create competition with other uses.	**Perennial crops** are one option to increase the wood availability and to diminish competition in the markets for wood. Additionally, they can be grown on marginalized lands, which aren't used otherwise. **Straw** prices are high where there is a large demand from animal bedding and from other material uses. It is unlikely that the use of straw in heating plants and biomass boilers creates competition with other uses. As many municipalities collect **vegetable and animal wastes** together the suggestions increase the waste potential available for the production of biomethane for the transport sector.

[4] http://www.biomasspolicies.eu/wp-content/uploads/2013/09/National-Policy-Landscape-Germany.pdf
[5] http://www.biomasspolicies.eu/wp-content/uploads/2015/06/D3.2-DE_Annex-Benchmark-1.pdf

	Such waste categories are separately collected municipal wastes and the waste codes 020204, 020502, 020603, 070199, 190809, 200108, 200125, 200302 and 020601. And, vegetable waste fractions should count towards GHG quota obligation even if they are processed together with animal fats and oils.	
How to address resource efficiency in policy?	**Renewabe Energy Sources Act (EEG):** The latest requirements for energy efficiency should be applied to existing biomass power plants in case they get a follow-up funding under a new scheme e.g. auction model within the EEG. **EEWärmeG / MAP** The replacement of old and inefficient biomass boilers and stoves with new and highly efficient biomass installations should be incentivized by the MAP.	Especially for **organic waste and straw** the efficiency is high, as in most cases they do not have any other use. In the case of organic wastes cascading use can increase resource efficiency. Anaerobic digestion of straw is another way to increase resource efficiency. The energetic utilization of **perennial crops** could benefit indirectly from the replacement of old and inefficient boilers.
Are sustainability rules adopted and applied? How to optimise with various national sustainability rules?	First experience with the implementation of the **GHG reduction quota in the transport sector** shows an improvement of the biofuels` GHG performance. If more experience about the GHG mechanisms is available, it could be considered to apply it other support mechanisms as well. **1. BImSchV and TA-Luft**: Solid biomass boilers need to comply with certain emission thresholds (e.g. particulate matter, carbon monoxide and nitrogen oxide).	**GHG reduction quota** and sustainability rules can stimulate the use of organic waste and residues from agriculture and forestry for energetic use avoiding competition with other value chains. The strict **emission thresholds** for the energetic utilization of straw creates barriers for the market uptake straw use in heating plants and small scale heating applications.
How to support mobilization of important indigenous biomass resources and for which value chains?	**Inform public about the advantages and the requirements** of waste separation. More organic wastes could be separated from private households and made available for anaerobic digestion. Permit **exemptions for animal wastes and fats to count towards the GHG quota obligations** if there is no competition with material utilization. **Financial support could be provided to the cultivation of**	For the mobilisation of new biomass resources from perennials or straw there need to be some incentives, good practices, help with investments i.e. Perennials take a while to grow until they can be harvested – therefore the investors and/or farmers need some security regarding policies and government reliability. For straw heating in particularly some incentives for buying the necessary burners and equipment would be useful and more appropriate regulation in terms of emission thresholds for small scale installations.

	perennial crops on fallow land, set-aside and for measurements that increase biodiversity in agriculture. The 300,000 ha voluntarily set-aside arable land in Germany could receive a financial support for the cultivation of SRC if they are suitable for such crops. Prior to a support scheme an assessment of the suitability for SRC on set-aside land would help to identify the technical potential.	In addition, awareness raising on the benefits, appropriate fields of application and best practices of the use of straw for heating should be continuously carried out.
Are the various scales of applications addressed in a sufficient manner within support and legislation (e.g. FiTs, etc.)	FIT for biomass power plants are limited to a maximum capacity of 20MW. Considering that power plants larger than 20MW are subject to the emission trading and taking concerns of competition into account, such a limitation seems reasonable. Biogas is not eligible under the EEWärmeG for newly built houses. Where no other renewable technologies or insulation measures are economically reasonable, biogas should be supported as well e.g. in apartment buildings. Emission thresholds for the burning of straw in small scale installations are stricter than for other solid biomass.	Emission thresholds for the burning of straw in small scale installations need to be reconsidered.
Is there sufficient support for advanced and efficient technologies?	There are different programmes in place that support research and development of biomass technologies and concepts. But, current framework conditions (e.g. EEG 2014) do not favour market demand for advanced and innovative biomass technologies. First experience with GHG quota shows that double counting is a more effective instrument to support the development of advanced biofuels. This is due to the fact that the GHG reduction potential of advanced biofuels is less than twice the GHG reduction potential of biofuels from oil crops, sugars and cereals and other starch-rich crops that have been reported to German authorities in 2015. The volume of advanced biofuels is very likely	The introduction of a sub-quota for advanced biofuels that is increasing to 0.25% in 2020. The sub-quota is in accordance with the target to achieve a minimum consumption of 0.5% of biofuels produced from feedstocks listed in part A of Annex IX of EC 2015/1513. The sub-quota creates a defined market demand for advanced biofuels that cannot compete with already established biofuels. It could incentivize existing biogas plants to invest in upgrading technologies in order to provide biomethane from wastes and residues counting towards the sub-quota.

	to decrease in the period of 2015 to 2019.	
Are there immediate plans for future support schemes?	Auction scheme for biomass is under discussion that could replace FIT for combined heat and power production under EEG.	The impact of an auction scheme for biomass is difficult to assess without detailed information of the design of such an auction.
How can future biomass power capacities be sustained, if feed-in tariffs expire?	Include existing biomass power plants in the planned **auction procedure** (EEG 2016) if they comply with efficiency and flexibility requirements. In addition to that a **follow-up feed-in tariff for biomass power plants** that contribute to environmental aims by utilizing feedstocks such as municipal wastes or manure.	The level of municipal wastes and manure that is used for anaerobic digestion could be sustained and increased respectively.
Are cooperation mechanisms already exploited?	No, the cooperation mechanism could be an interesting option if there is no or no sufficient follow-up scheme for bioelectricity in Germany.	

The Biomass Policies project conducted consultation involving stakeholders from policy, science, industry associations and environmental organisations to receive views and evidence to support the project recommendations (dena 2015). These consultations aimed to gather evidence to identify and prioritise:

- indigenous biomass sources
- efficient value chains for conversion to energy & fuels
- key principles for integrated cross- sector German biomass policy

Following a consultation process with national stakeholders, the following key principles were prioritised for consideration into future policy formation (see figure 4). Considering the cost debate on biomass in recent months, the stakeholders give costs surprisingly little importance.

- Potential to reduce GHG: GHG reduction is a key driver in Germany's energy policy and a key concern for most of the participating institutions. The use of CO2 neutral fuels in the mobility sector is mentioned, prior to the use in stationary energy purposes, to mitigate climate change and global warming effects.

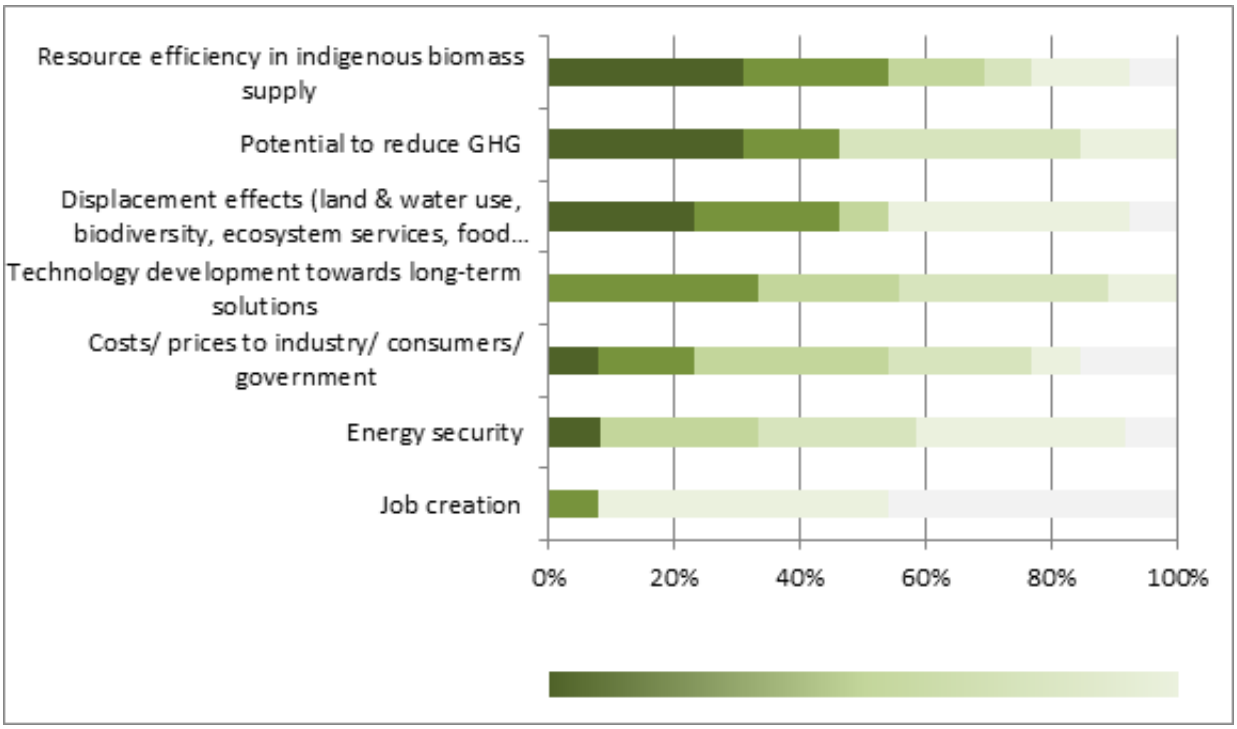

Figure 5 Key principles for future biomass policy in Germany

Resource efficiency in indigenous biomass supply:

- Resource efficiency is considered one of the most important key principles on the way to a predominant renewable energy system. Cascading of biomass resources is the most practical way to reach an efficient use of biomass, reach high GHG-savings and prevent environmental damage
- Displacement effects (land & water use, biodiversity, ecosystem services, food prices, etc.): The development of strategies to avoid or cope with displacement effects and seek to strengthen resilience are more and more important. It is meanwhile one of the key political concerns of the German Federal Government.

Recommended future policy framework

Biomass Policies suggested policy framework for biomass in Germany aims to provide equal opportunity for resource and energy efficiency improvement across sectors, technologies and applications. However, there are certain issues which may hinder the country's fulfilment of targets and future sustainable market development which should be reflected in future policy formation.

Table 4 provides an outline of the suggested policy interventions that address the issues for future biomass policy in Germany and Table 5 gives an indication for the cost benefit indicators for impact assessment of the selected value chains in Germany.

Table 4 Suggested policy interventions to facilitate the deployment of biomass value chains in Germany

Value Chain	Current Policy/ measure	Market uptake	Suggested policy interventions for the future	Barriers(from D3.2 report)	Sustainability risks (high- red; moderate- yellow; low- green)			
					Land use (iLUC risk)	Biodiversity	Soil & Carbon stock	Water
Perennial crops small scale heating (household level)	i)Act to Promote Renewable Energy for Heating Purposes (EEWärmeG) puts the obligation of 50% of energy usage from renewable sources[6] (in the case of solid biomass). Under MAP (Market Incentive Programme) framework BAFA's and KfW's Renewable Energy Programme provide support in the form of loans and financial support for biomass plants of varying sizes. ii) "Gemeinschaftsaufgabe Agrarstruktur und Küstenschutz" programme provides farmers with financial support for the cultivation of short rotation coppices.	Very low[7]	i) Investment subsidy for heating applications and loans for district heating (MAP). ii) Feedstock bonus for CHP < 100kW (EEG). iii) Assessment of suitability for the cultivation of perennial crops on voluntarily set aside land	i)Strict environmental thresholds and approval standards can restrict the deployment of new projects and the operation of existing projects. For e.g High-yield boilers that comply with air quality legislation are only eligible for incentives under MAP. ii)Support for bioenergy in the form of the feed-in tariffs for biomass power plants will phase out by the year 2020 iii) EEG creating only little incentives for new combined heat and power projects, additional heat from biomass is limited to the installation of new boilers and heat plants in the future. iv)"Gemeinschaftsaufgabe Agrarstruktur und Küstenschutz" expires after 2018.	[8]	[9]	[10]	[11]
Perennial crops medium scale heat driven (apartment building, district heating, public buildings)		Low						
Perennial crops medium scale CHP (residential district or industry; heat driven)		Very low						

[6] Always depending on the technology /measurement that is applied

[7] About 6,000 ha of energy crops are used for heating

[8] Higher land productivity when marginal lands used; in case of agricultural lands potential (indirect) land use change;

[9] Can provide winter shelter; birds nesting inside plants; may, however, destroy sensitive habitats (e.g. steppic habitats, High Nature Value farmland, biodiversity rich grasslands) when introduced.

[10] Potential use of marginal lands, which can increase soil quality and soil carbon stock; Can damage soil structure (e.g. harvesting, root removal after 20 years),

[11] In arid circumstances ground water abstraction and depletion possible because of deep roots; Some use of fertilisers / pesticides which can be leached to ground water and pollute habitats, but effect is very limited.

Table 4 (cont.) Suggested policy interventions to facilitate the deployment of biomass value chains in Germany

Value Chain	Current Policy/ measure	Market uptake	Suggested policy interventions for the future	Barriers(from D3.2 report)	Sustainability risks (high- red; moderate- yellow; low- green)			
					Land use (iLUC risk)	Biodiversity	Soil & Carbon stock	Water
Organic wastes Anaerobic digestion (medium scale) & local CHP	i) EEWärmeG, KfW, BAFA all supports the use of organic wastes (solid biomass) for the production of heat and biogas. ii) GasNZV provides different means of support- under this scheme grid operators are obliged to provide the grid connection priority to the renewable energy providers. iii) BioAbfV (bio-waste), AbfKlärV (sewage sludge) and KrWG (Closed Cycle and Waste Management) are all other laws in place to support the use of organic waste.	Low but with growing importance (140 of 7800 AD)	Follow-up feed-in tariff for existing biogas plants < 100kW that use organic wastes.			[12]	[13]	[14]
Organic wastes Anaerobic digestion (medium scale) & upgrading to SNG		Medium with growing importance (21 of 184 biomethane plants)	i) GHG reduction quota of 6% in combination with a sub-quota for advanced biofuels (according to Annex IX part A of RED) of 0.25% in 2020. ii) Allow biofuels from organic wastes to be counted towards quota obligations when they are produced together with used animal fats and/or oils (36. BImSchV and BImSchG).					
Organic wastes Production of chemical building blocks (e.g. bio-naphta, bio-methane)		Low, but a number of chemical products are produced from biomethane						
Straw household level (pellets)	i) EEWärmeG, KfW, KWKG, BAFA all supports the usage of straw		Investment subsidy for boilers and heating plants. More appropriate emission thresholds for small scale straw boilers <100kW (1. BImSchV) and heating plants <1MW (TA-Luft) GHG reduction quota of 6% in combination with a sub-quota for advanced biofuels (according to Annex IX part A of RED) of 0.25% in 2020..	the requirements for the utilization of straw in boilers larger than 100kW are relatively strict in comparison to woody feedstock. High straw prices in combination with relatively high investment costs		[15]	[16]	
Straw in CHP: district heating, public buildings								

[12] Positive in regions where it avoids landfill
[1313] Positive in regions where it avoids landfill; Digested organic waste is a source of soil improving material.
[14] Lower risk of water pollution in regions where it avoids landfill
[15] Biodiversity loss when harvesting too many crop residues. This may also have adverse effect on soil biodiversity.
[16] Risk to loose soil organic carbon when overharvesting crop residues; risk to loose nutrients when overharvesting

Table 5. Cost benefit indicators for impact assessment of the selected value chains in Germany

Value chains	Competing uses	Feedstock supply potentials (PJ)		Current feedstock price/ cost		Investment cost (€2015/kW) (€/ MWh, lt)	Fixed O&M costs (€2015/ (kW*yr)	Estimated cost of CO2 saving (€/ tCO2)	GHG savings[17] (%)	Baseline comparison
	Current	**2020**	**2030**	**(€/t)**	**(€/GJ)**					
Perennial crops small scale heating (household level)	Landscape recreation Biobased materials	86	160	70-160	4.6- 8,3	671	25	140	87	Heating oil
Perennial crops medium scale heat driven (apartment building, district heating, public buildings)						704	21	341	87	Heating oil
Perennial crops medium scale CHP (residential district or industry; heat driven)						513	22	110	87 for heat 82 for electricity	Natural gas
Organic wastes Anaerobic digestion (medium scale) & local CHP	Food compost Disposal	79	79	-56	-9	685	25	140	65 for heat 70 for electricity	Natural gas
Organic wastes Anaerobic digestion (medium scale) & upgrading to SNG						698	21	-194	75[18]	Natural gas
Organic wastes Production of chemical building blocks (e.g.bio-methane)						35 – 45 €/MWh[19]				Natural gas
Straw household level (pellets)	Animal bedding Heat and power Incorporation to soil	157	147	55-90	4.6- 6	671	25	156	85	Heating oil
Straw in CHP: district heating, public buildings						704	21	307	85 for heat 79 for electricity	Natural gas

[17] JRC, 2014. Solid and gaseous bioenergy pathways: input values and GHG emissions; https://ec.europa.eu/jrc/sites/default/files/eur26696_online_final_v3.pdf ; No land use emissions are included in these results nor are CO2 emissions from the combustion of biomass or other indirect effects.

[18] RED typical value for MSW biomethane

[19] Costs for replacing 1 MWh natural gas by biomethane in chemical industry.

Conclusions

Bioenergy has achieved a significant share of renewable energies in Germany in all sectors: transportation, heat and power. Nowhere else in Europe are more biomass installations. As a front runner Germany is also amongst the first countries which need to find ways how to sustain and optimise the existing biomass capacities regarding social acceptance, resource efficiency, sustainability and costs.

In recent years a number of sustainability requirements were implemented for liquid and gaseous biofuels in the transportation sector. Receiving financial support according to EEG and MAP requires plant operators to comply with certain criteria regarding sustainability and efficiency. The installation of biomass boilers is generally due to strict thresholds for emissions and efficiency. However, many older installations do not fulfil the latest technical and environmental standards. The MAP is a good example how the removal of old an inefficient boilers and stoves can be incentivized.

Existing biomass power capacities can play a crucial role achieving the renewable energy goals in the heat and power sector. Without the development of a follow-up support (auction scheme or feed-in tariff) for existing biomass power capacities the volume of biomass power capacities is very likely to decrease in the years to come. Such a follow-up support should consider the technical and environmental improvements of recent years as well as the political debate to decrease the costs that EEG support causes.

In the transportation sector biofuels are still the most important renewable source. One of the results of the introduction of the GHG reduction quota is an increasing GHG reduction potential of the biofuels that count towards the quota obligations. That way biofuels could prove that their environmental performance is better than in the public perception. But, in comparison to the double counting rules in the former biofuels quota, the advantages of advanced fuels have become smaller. A continuous increase of the quota obligations from 2016 (3.5%) to 2020 (6%) could improve their situation. A continuous market uptake of advanced biofuels – not only small amounts that are already available – requires stable framework conditions for a period of more than 5 years. The introduction of a sub-quota for advanced biofuels that last beyond the year 2020 is one measurement to start a market development.

The biomass potential in Germany is already well exploited. Nevertheless, there are some feedstock categories that are barely tapped, yet. The three categories that were chosen within the project are straw, perennials and municipal organic wastes. In sum their biomass potential is 3.387 PJ in 2030.

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