KTBL

Use of renewable drive energy in agricultural machinery

Catalogue of actions

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Contents

1 Introduction

In German agriculture and forestry, around 2.1 billion litres of fuel (approximately 74 PJ) are needed each year. Almost exclusively fossil diesel is used. The associated greenhouse gas emissions must be reduced to zero within the next 20 years, but no later than 2045, the target year for climate neutrality in Germany.

The KTBL working group on drive systems for agricultural machinery has carried out a description and assessment of the options for replacing diesel fuel in agriculture and identified options for action to support the transition to renewable drive energy. The results of the work were published in autumn 2023 in the KTBL special publication "Use of renewable drive energy in agricultural machinery" (Fig. 1).

Fig. 1: KTBL special publication "Use of renewable drive energy in agricultural machinery" (© KTBL)

It examines and evaluates different drive systems and drive energies for use in different types of agricultural work, e.g. yard-related and field work. The drive energies are examined in more detail: renewable electricity as well as the fuels vegetable oil, biodiesel, paraffinic diesel (HVO and Fischer-Tropsch), biomethane (CNG and LNG) and hydrogen for use in fuel cells and combustion engines.

A concise overview is given in Figure 2. In the future, there will be different options for agriculture up to 2030 and 2045. These are technically feasible to varying degrees. In addition, they should at best be cost-effective and resource-efficient, and sufficient amounts of electricity and fuel, ideally from regional supply, should be available.

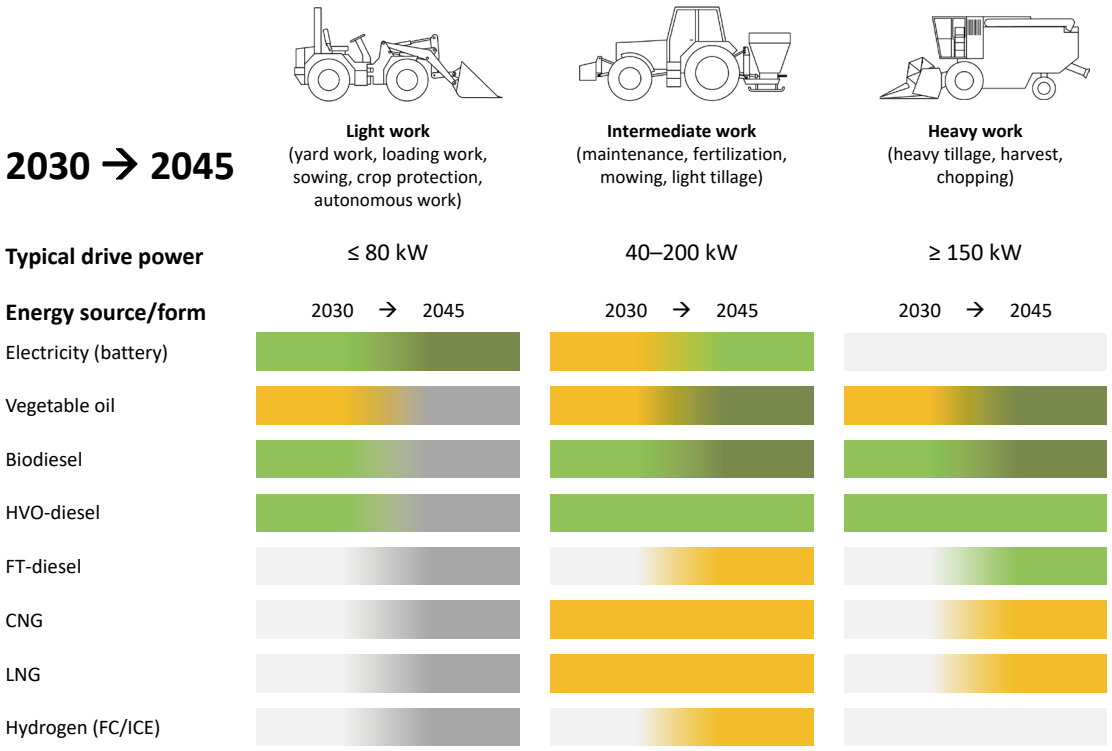

Fig. 2: Perspective 2030 and 2045 for selected renewable energy sources and drives in agricultural applications (© KTBL)

Legende:

Preferred options that can be implemented for agricultural machinery: Machine and energy sources are available on the market, are suitable for the respective agricultural work, are cost-effective and the use of resources is efficient. Regional provision of energy sources is possible.

Can be implemented for agricultural machines:
Machines and energy sources are available on the market and are suitable for the respective agricultural work.

Partially implementable for agricultural machinery: Machines and energy sources are available on the market under optimistic assumptions, the suitability for the respective agricultural work is partly given.

Can be implemented for agricultural machines: However, more suitable alternatives are available.

Suitable renewable energy sources and corresponding drives are not available.

It becomes clear that in addition to the necessary technical developments in energy sources, engines, drive systems and energy infrastructures, the legal framework, promotion, training, and communication between the actors involved play a central role in achieving the conversion goals.

Against this background, the Federal Ministry of Food and Agriculture (BMEL) has asked the KTBL to specify and classify the identified options for action to provide guidance on which steps could be expedient for a transition to renewable drive energies and which actors would have to initiate the actions.

This task was undertaken by the KTBL-working group "Roadmap - Drive Systems for Agriculture" with the participation of a large number of experts in the period from April to August 2024. The expertise of the members of the KTBL-working group and the experts involved has been incorporated into the process, without their individual assessments having to correspond to the results presented below in each individual aspect.

2 Actions to support the transition to renewable drive energy in agriculture – overview

Different stakeholder groups need to be involved in order to successfully convert agriculture to renewable drive energies:

- Politics and administration at federal and state level
- Science and education including the respective universities, colleges, research institutions and technical schools
- Agricultural equipment manufacturers, distributors and specialized service companies
- Fuel producers, distributors and electricity suppliers
- Agricultural practice

Different tasks must be assigned to the actors:

First of all, the political framework for the transformation should be created at federal level by outlining the target set, defining the framework for action, providing legal certainty and investment certainty, and sending out signals for action. Financial support from the federal and state governments can underline the seriousness of the transformation goal and accelerate its implementation in practice as well as the research and development of new technologies. Public institutions can lead by example in the operation of their own mobile machinery by using renewable drive energy; they can act as a role model and attract attention through targeted demonstration of new technologies. Universities, colleges, as well as federal and regional research institutions can support the transformation process through research and development by identifying the need for action together with industry and agricultural practice, optimizing systems and launching new technologies as well as new agricultural work methods. Education and counselling institutions have the task of imparting existing knowledge in order to enable fact-based decisions. A cross-cutting task for all actors is communication: Expectations must be communicated, problem awareness created, solutions identified, and opportunities and risks identified. The industry has the task of providing a range of new machines and solutions for existing machines for the use of renewable energies. The availability of renewable fuels and renewable electricity must also be ensured. In some cases, farmers can also increase security of supply and generate added value through biofuel production and the provision of electricity. Finally, agriculture and agricultural service providers, such as contractors, are called upon to address the implementation of the transformation of machinery.

Figure 3 shows the groups of people involved in the transformation process and their tasks as well as the required interaction and leads to the individual actions identified and processed by the Roadmap Working Group. The numbers listed in the short titles of the actions are intended to facilitate the finding of the detailed action profiles and thus the navigation in this document. The numbering of actions is not a ranking. Table 1 lists the actions with a brief classification and evaluation and an assignment to the actors addressed. From page 15, the detailed action profiles follow.

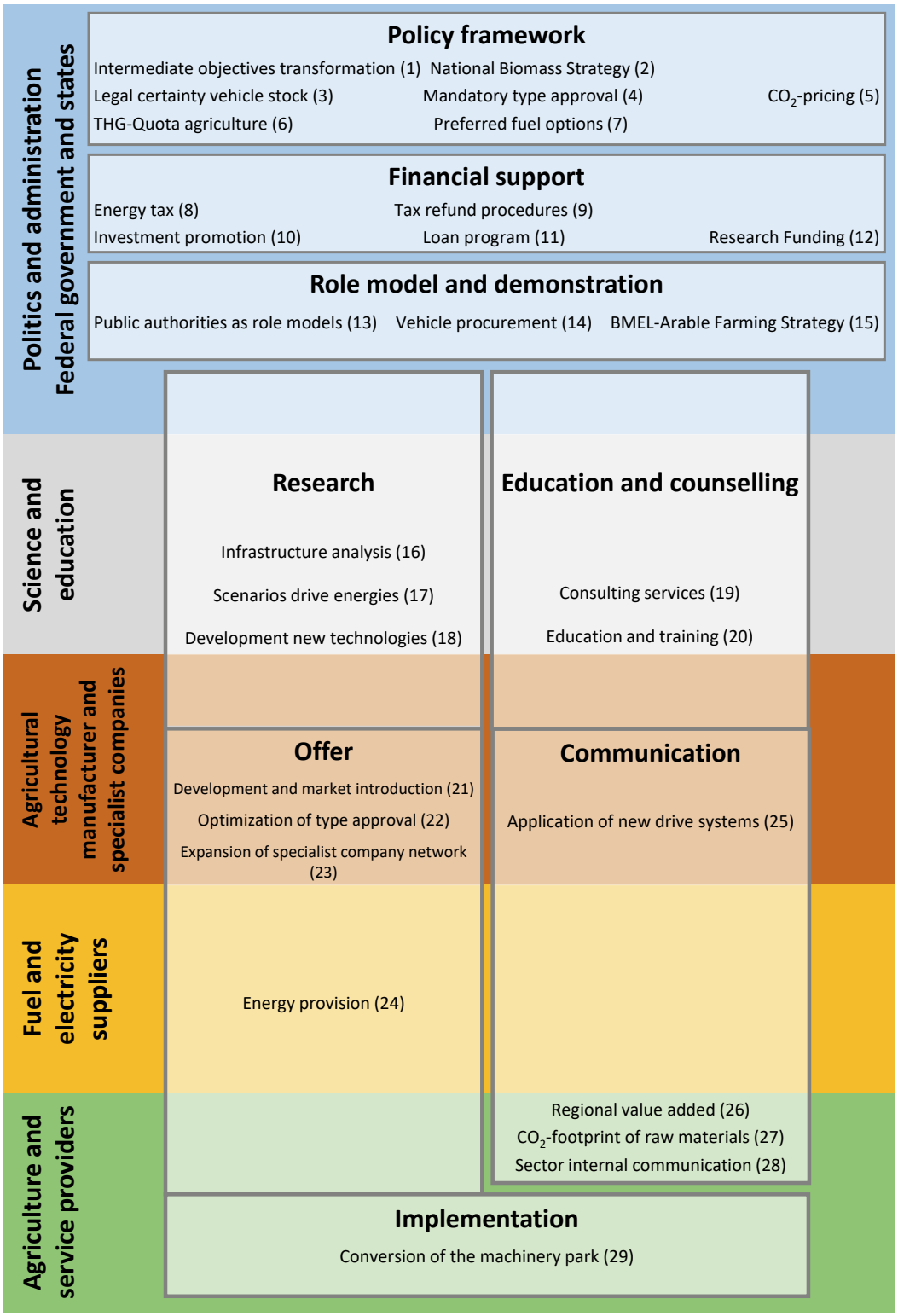

Fig. 3: Transformation process – stakeholders, key tasks, interaction (© TFZ)

Tab. 1: Transformation process – stakeholders, actions, classification of actions

Group of actors	Number Short title	Action	Classification of the action
		Policy framework	
	Action 1: Interim objectives transformation	Derivation, agreement, communication and monitoring of intermediate targets for the conversion of drive systems in agriculture for the achievement of climate protection targets by 2045	Specification of the objective and basis for monitoring
	Action 2: National Biomass Strategy	Implementing biofuels from cultivated biomass as well as from residual and waste materials for use in agriculture in the National Biomass Strategy of the Federal Government	Preservation of the possibility of using cultivated biomass for energy use as basic prerequisite for the establishment of regional value chains
	Action 3: Legal certainty vehicle fleet	Use of renewable fuels and fuel blends in existing vehicles without type approval – Ensuring legal certainty	Elimination of legal uncertainties regarding the use of renewable fuels in existing vehicles
	Action 4: Mandatory type approval	Placing type-approved machinery for renewable drive energy on the market	Creates security for users to be able to use at least one renewable fuel option
	Action 5: CO_2-pricing	Continuation of the gradual increase in the prices of emission certificates in the Fuel Emissions Trading Act	Increasing the competitiveness of renewable energy sources, here the introduction to the Emissions Trading System of the European Union (EU ETS 2), avoidance of possible price jumps when introducing them
	Action 6: GHG-quota agriculture	Introducing a sub-quota for agriculture in the greenhouse gas reduction quota for fuels in the Federal Emissions Protection Act	Incentive for fuel distributors, such as the mineral oil industry, to sell renewable electricity or renewable fuels specifically in the agricultural sector. Potential price-reducing effect for renewable fuels
	Action 7: Preferred fuel options	Preferential treatment of certain renewable fuels for the agricultural sector	Ensuring the supply of agriculture with a fuel that is also suitable for existing machinery
		Financial support	
	Action 8: Energy Tax Act	Adaption of the taxation of renewable fuels in the Energy Tax Act	Central Action – with a big signal effect – to offset the additional fuel-related costs associated with the use of renewable fuels
	Action 9: Tax refund procedure	Energy tax-free purchase of renewable fuels - abolition of the tax refund procedure	Increasing the acceptance of renewable fuels through immediately visible cost savings
	Action 10: Investment promotion	Continuation of the Federal Programme to Increase Energy Efficiency and CO2-Savings in Agriculture and Horticulture	Incentive for investment in machines with renewable drive energy and the associated infrastructure by partially offsetting the additional costs
	Action 11: Loan-programme	Loan programme for investments in renewable drive systems, as well as refuelling and recharging infrastructure	Incentive for investment in machines with renewable drive energy and the associated infrastructure by partially offsetting the additional costs
	Action 12: Research funding	Research funding for the development, testing and evaluation of alternative drive systems	Reducing development risks for engine and agriculture machinery manufacturers through government-supported research, thereby accelerating development activities

Table continued on next page

Group of actors	Number Short title	Action	Classification of the action
		Role model and demonstration	
	Action 13: Authorities as a role model	Strengthening the role model function of the public sector	Increasing the visibility of machines powered by renewable energy and strengthening the credibility of state actions Creation of an additional sales market for the agricultural machinery industry
	Action 14: Vehicle-procurement	Deletion of the exemption of agricultural and forestry vehicles from the scope of the Clean Vehicles Procurement Act	Creation of an initial market by the public sector, thereby increasing the market potential for machines powered by renewable energy
	Action 15: BMEL-arable farming strategy	Demonstration of machines with renewable drive energies on the lead farms as part of the BMEL Arable Farming Strategy 2035	Reducing barriers through perception and exchange of experience
		Research	
	Action 16: Infrastructure analysis	Analysis of infrastructures for the provision of renewable fuels and electricity in rural areas	Demonstrate the need for action for the expansion of the energy supply infrastructure
	Action 17: Scenarios drive energies	Preparation, modelling, and analysis of scenarios for the increased use of renewable drive energies in agriculture	Creation of a basis for the optimization of machinery and the further development of agricultural production processes
	Action 18: Development of new technologies	Development of new drive technologies for mobile machines	Exploiting the potential of technical possibilities in combination with new processes for the use of renewable drive energies for different applications (close to the farm / away from the farm)
		Education and counselling	
	Action 19: Advisory services	Expansion of the advisory services of the chambers of agriculture and state institutes as well as comparable institutions to include the aspect of low-greenhouse gas energy supply for mobile machines	Enabling fact-based decisions
	Action 20: Education and training	Imparting knowledge on drive systems with renewable energies in vocational and academic education and training	Enabling fact-based decisions
		Offer	
	Action 21: Development and market launch	Development and market launch of agricultural machinery for farmyard-related and field applications with renewable energy sources	Creation of a wide range of machines using renewable drive energies and provision of solutions for existing machines
	Action 22: Optimization of type approval	Optimization of homologation and type approval proceduresOptimierung der Vorgehensweisen bei der Homologation und Typgenehmigung	Saving costs when releasing renewable fuels Providing legal certainty for the use of renewable fuels in existing machinery
	Action 23: Expansion of specialist company network	Establishment of a network of agricultural machinery dealers and agricultural machinery specialists trained in renewable drive systems	Ensuring valid advice and short distances to expert machine service
	Action 24: Energy supply	Provision of sufficient quantities of fuel of the required quality, even in the event of seasonal peaks in demand, and creation of sufficient electrical connection capacity on farms	Ensuring a nationwide supply of renewable drive systems and thus increasing the readiness of agricultural farms and service providers to switch over

Table continued on next page

Group of actors	Number Short title	Action	Classification of the action
		Communication	
	Action 25: Promotion of new drive systems	Reinforcement of the promotion for machines suitable for renewable drive energies	Support the decision for machine buyers
	Action 26: Regional added value	Participation in value creation in the energy market through the provision of electricity and the production of agricultural raw materials and their processing into fuels	Exploiting the opportunities for farms arising from the regional supply of energy products
	Action 27: Carbon footprint of agricultural raw materials	Exploiting the potential of renewable drive energy in the provision of agricultural raw materials with low carbon footprint	Generate a financial advantage for agricultural holdings and ensure market access for agricultural products
	Action 28: Intra-industry communication	Strengthening intra-sector communication	Strengthening awareness of problems, knowledge of possible solutions and thus increasing readiness for change
		Implementation	
	Action 29: Conversion of machinery park	Conversion of the machinery park to renewable drive energies	Assessment of the possibilities and implementation of the procurement of new machines and conversion of existing machines, if necessary, using a checklist to support decision-making

3 Actions to support the transition to renewable drive energy in agriculture – action sheets

In order to reduce fuel-related greenhouse gas emissions in agriculture to zero by 2045, the options for action to support the transition described below may be useful.

3.1 "Policy and administration" action sheets

Action 1

Derivation, agreement, communication, and monitoring of intermediate targets for the conversion of drive systems in agriculture for the achievement of climate protection targets by 2045

Action

Definition of interim targets for the conversion to renewable drive energies in agriculture for the achievement of the climate protection targets by 2045 and implementation of associated monitoring instruments. To do this, the following steps are necessary:

- Defining and communicating intermediate goals
- Establish methods for recording the use of renewable drive energies
- Propose follow-up actions in case of non-achievement
- Publish annual progress report

Background

In accordance with the objectives of the Climate Protection Act (KSG 2024), greenhouse gas emissions from fuel use must be reduced as close as possible to zero (GHG emissions from fuel combustion tank-to-wheel) by the target year 2045 at the latest. The transition to renewable drive energy will have to take place over a longer period. In order to be able to adjust, if a target is not reached, a monitoring of the transition progress is necessary.

Mode of action

The definition of intermediate objectives and monitoring are concomitant actions to guide the other actions. Harmonisation with the other actions is necessary in order to be able to set realistic objectives where appropriate. The action enables the timely detection of target deviations and enables quick interventions.

Scope

Depending on the implementation of the other actions.

Time horizon implementation

In the short term over the next two years: Development of intermediate objectives and review mechanisms.

Time horizon effect

Immediately after the establishment of the action.

Main stakeholders

- Federal Ministry of Food and Agriculture (BMEL): Development of intermediate objectives and monitoring.
- Federal Office for Agriculture and Food (BLE): Recording and evaluation of the transition progress using the figures for fuel consumption and the registration figures of the Federal Motor Transport Authority (KBA).

Costs

Personnel costs for recording and evaluating the transition progress.

Contribution to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

None

Obstacles to implementation

- Missing method for recording the quantity of drive energies prevents monitoring procedure in case the fuel quantities can no longer be recorded by the application for tax refund.
- Missing method for recording the electricity used.

Action 2

Implementing biofuels from cultivated biomass as well as from residual and waste materials for use in agriculture in the National Biomass Strategy of the Federal Government

Action

Implement the use of biofuels from cultivated biomass as well as from residual and waste materials for use in the limited sector of agriculture and forestry in the National Biomass Strategy (NABIS) of the federal government. This is to avoid an exclusion of this option of fuel use.

To ensure security of supply for food and feed production, it is necessary to use these limited renewable fuels preferably in agriculture and forestry. Agriculture can be both a producer and a user of these renewable fuels.

Background

Objective of the Biomass Strategy of the Federal Government (BMWK et al. 2022) is to contribute to the medium- and long-term sustainable use of resources as well as to climate and biodiversity protection and to create appropriate framework conditions in Germany. Thereby prioritization of biomass resources for nutrition, material use and finally energy use is carried out.

Mode of action

The action enables the further use of renewable fuels from crop biomass and residual and waste materials in agriculture and forestry.

Scope

Not quantifiable

Time horizon implementation

Depending on completion of the NABIS process including publication.

Time horizon effect

Immediately after the adoption of the National Biomass Strategy (NABIS).

Main stakeholders

Federal Ministry for Economic Affairs and Climate Protection (BMWK), Federal Ministry of Food and Agriculture (BMEL) and Federal Ministry for the Environment and Consumer Protection (BMUV): Preparation of NABIS.

Costs

None

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

The action has an impact on the other actions as it allows the use of renewable fuels.

Obstacles to implementation

- As the NABIS process has not yet been completed (as of November 2024), there are uncertainties about the possibility of a future use of renewable biofuels. This has a dampening effect on market development.
- The action can only be effective if NABIS is actually used as a guideline for policymaking on biomass.

Action 3

Use of renewable fuels and fuel blends in existing vehicles without type approval – establish legal certainty

Action

Analysis of the legal situation to use renewable fuels and fuel mixtures in existing vehicles that feature only a type approval for diesel fuel according to DIN EN 590. It is necessary to clarify what legal consequences (fines, decommissioning of the vehicle, etc.) the use of other fuels would have for the user. The aim is to remove any existing legal hurdles in a subsequent step, e.g. by developing an approach to retroactive type approval by engine and machine manufacturers together with a technical service or obtaining general type approval. By providing legal certainty, engine and machine manufacturers, farmers and contractors should be able to make legally compliant decisions.

Background

Engines used in mobile machinery must meet the requirements of the current Regulation (EU) No 2016/1628 (EU Regulation 2016/1628 2016) or the former Directive 97/68/EU (EC Directive 97/68 1997) for type approval valid throughout Europe. This ensures compliance with § 38(1) sentence 1 BImSchG at the time of approval. The vast majority of existing vehicles are homologated exclusively for diesel fuel in accordance with DIN EN 590.

The Tenth Ordinance on the Implementation of the Federal Immission Control Act (10. BImSchV 2010) 'Ordinance on the Characteristics and Labelling of the Qualities of Fuels' lists the fuels that may be placed on the market in Germany for commercial purposes or as part of commercial undertakings vis-à-vis the final consumer, namely the renewable fuels fatty acid methyl ester (biodiesel) in accordance with DIN EN 14214, rapeseed oil fuel in accordance with DIN 51605, vegetable oil fuel in accordance with DIN 51623 and paraffinic diesel fuel, e.g. HVO, in accordance with DIN EN 15940.

The use of renewable fuels is also regulated by § 47f StVZO Fuels: Motor vehicles may only be operated with other qualities of liquid, gaseous or solid fuels, provided that compliance with the requirements of § 38(1) of the BImSchG for the vehicle is ensured.

At various research centres, including the Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe (TFZ Straubing), it has been demonstrated that agricultural machines of different exhaust gas stages, which are operated with the renewable fuels HVO, biodiesel as well as rapeseed oil and vegetable oil fuel, comply with the legal limit values for air pollutant emissions. The prerequisite is that existing exhaust gas aftertreatment systems also function properly.

Mode of action

Uncertainties are eliminated and, depending on the result of the test, the operation of existing vehicles with renewable fuels is made possible or restricted.

Scope

High, affects all existing machines. In case of a positive test, the use of renewable fuels can take place in a large number of machines.

Time horizon implementation

Six months for the examination of the legal situation. If performance or emission measurements are required, an additional period of about three years is to be expected.

Time horizon effect

Immediately after completion of the action and publication of the results.

Main stakeholders

- Federal Ministry for the Environment and Consumer Protection (BMUV): Execution of the legal review.
- Manufacturers and relevant research organisations: Provision of data.

Costs

None

Contributing to de-bureaucratisation

Yes, by eliminating individual releases via technical services.

Contribution to self-supply of energy or increase of value added in rural areas

No

Other effects, interactions, and risks

The legal review concerns only the performance of the machinery in operation with renewable fuels and compliance with the limit values for air pollutant emissions and does not include the functionality of the machinery in everyday operation. For example, when changing fuel, fuel filters may clog, or leaks may occur on seal elastomers.

Obstacles to implementation

None

Action 4
Placing type-approved machinery for renewable drive energy on the market

Action
From a cut-off date, only machines that have a type approval according to the EU Directive 2016/1628 for at least one renewable fuel will be placed on the market.

- Option 1: Regulatory requirement, e. g. statutory ordinance pursuant to § 38 BImSchG
- Option 2: Commitment of the agricultural engineering industry

Background
Mobile machinery may only be operated on fuels for which it is type approved. This can be an obstacle to achieving greenhouse gas reduction targets in the future through the use of renewable energy sources. In addition, rising CO_2 pricing can lead to high burdens due to rising diesel prices. The legal basis for type approvals is Regulation (EU) 2016/1628 (EU Regulation 2016/1628 2016) and Delegated Regulation (EU) 2017/654 (EU Regulation 2017/654 2017) and BImSchG § 38 "Characteristics and operation of vehicles" (BImSchG 2024).

These fuels are based on the following standards:

- DIN EN 590: Reference diesel B7
- DIN EN 15940: paraffinic diesel fuel, e. g. HVO, e-fuels
- DIN EN 16709: B20 and B30
- DIN EN 16734: B10
- DIN EN 14214: B100
- DIN 51605: R100
- DIN 51623: P100

Compliance with the standard requirements is a prerequisite for the placing on the market of the fuels in accordance with the 10th Ordinance on the Implementation of the Federal Immission Control Act (10. BImSchV 2010).

Mode of action
The type approval requirement allows for the immediate use of renewable drive technologies and opens up the option for the future use of these fuels. This can prevent high-cost burdens that can arise from fossil fuels in the future. The additional type approval for renewable pure fuels allows these fuels to be used in any mixture with fossil diesel, provided that the requirements of the relevant fuel standards are met. This concerns e. g. B10, B20, B30 fuels.

Scope
Enables the use of renewable fuels. The scope of effects depends on the price development of fossil and renewable drive energies.

Time horizon implementation
- Option 1: 1 year for the amendment of the BImSchG.
- Option 2: Possible in the short term.

Regulatory requirements for the implementation of this action must be in line with the legal basis for type approvals at EU level.

Time horizon effect

From the effective date and price equality or price advantage of renewable drive energies over diesel fuel.

Stakeholders

- Option 1: Federal Ministry for the Environment and Consumer Protection (BMUV): Adaptation of the legal framework.
- Option 2: Engine manufacturers and agricultural engineering industry: Elaboration of the self-commitment.

Costs

- Development costs for engine manufacturers and the agricultural technology industry.
- Type approval and homologation costs.

Contributing to de-bureaucratisation

No

Contribution to self-supply of energy or increase of value added in rural areas

Yes, when using regionally generated drive energies.

Other effects, interactions, and risks

None

Obstacles to implementation

- The limit values for elemental contents laid down in the requirements standard DIN EN 14214 for biodiesel may not be sufficient for the safe operation of exhaust gas aftertreatment systems. This could be remedied by adjusting the limit values according to the proposals in the guidelines of the Working Group on Quality Management Biodiesel (AGQM 2023).
- Possible increase in the cost of machines.
- The lack of a nationwide supply of renewable drive energies prevents the effect of the action, despite the availability of machines.
- Disproportionately high effort for machines with a small market and small quantities or for special purpose machines.

Action 5

Continuation of the gradual increase in the prices of emission allowances in the Fuel Emissions Trading Act

Action

Continuation of the step-by-step increase in the prices of emission allowances in the Fuel Emissions Trading Act (BEHG) in order to increase the CO_2 levy on fossil fuels. Short-term increase of the CO_2 price in the BEHG to at least € 150 /t CO_2.

Background

The Fuel Emissions Trading Act (BEHG 2020) is the national emissions trading system for CO_2 emissions from fossil fuels in the heating and transport sectors, i.e. also for diesel use in agriculture and forestry.

Currently, the fixed price per emission allowance is set as follows:

- 2024: € 45 /t CO_2
- 2025: € 55 /t CO_2
- From 2026 corridor for auction: € 55 to € 65 /t CO_2
- From 2027 free price formation on the market is planned

From 2027 onwards, the extension of EU emissions trading to the transport and buildings sectors (ETS 2) is envisaged. Estimates of the price level in 2030 range from about € 48 to € 350 /t CO_2 (Fiedler et al. 2024). Unlike the BEHG, there is currently no provision for fuels used in agriculture and forestry to be subject to ETS 2 (EU Directive 2023/959 2023). However, it is currently unclear how, in practice, a distinction could be drawn from the fuels used in road transport at the point of delivery. Furthermore, the question remains whether the EU emissions trading scheme ETS 2 replaces the BEHG or whether the BEHG remains valid at least for sub-areas.

Mode of action

Through the CO_2 levy, the actions lead to an increase in the prices of fossil fuels, as this increases the economic competitiveness of the renewable drive energy used in agriculture and forestry.

From the experience of the years 2006 to 2008 it can be deduced that renewable fuels are in demand from a price difference to fossil fuels from about 20 ct/l. Assuming, for example, that biodiesel generates 20 ct/l higher supply costs, a CO_2 price of € 150 /t CO_2 (equivalent to 39.75 ct/l) causes a price difference when purchasing of around 20 ct/l. Consequently, below this CO_2 price, no direct incentives to increase the use of renewable drive energy are effective.

Scope

The CO_2 pricing leads to a price increase for fossil diesel of about 2.65 ct per € 10 /t CO_2.

In 2025, a CO_2 price of € 55 /t leads to a surcharge of approximately 14.58 ct/l diesel fuel; in 2026 at a CO_2 price of € 55 to € 65 /t at a price premium of approximately 14.58 to 17.20 ct/l diesel fuel. At a price of € 150 /t CO_2, the surcharge would be about 39.75 ct/l diesel fuel.

Time horizon implementation

In the short term: Amendment of the Fuel Emissions Trading Act (BEHG).

Time horizon effect

Immediately or analogously to the timeframe of the BEHG amendment and, where applicable, the introduction of the EU ETS 2. For the timetable for the e introduction of the EU ETS 2, see Kellner and Kallmann (2023).

Main stakeholders

- Federal Ministry for Economic Affairs and Climate Protection (BMWK) and Federal Ministry for the Environment and Consumer Protection (BMUV): Adaptation of the Fuel Emissions Trading Act (BEHG).
- Other actors: Federal Environment Agency (UBA)/German Emissions Trading Authority (DEHSt) and Federal Ministry of Finance (BMF) (customs supervision).

Costs

Costs are incurred by fossil fuel users due to higher fuel prices. On the part of the federal budget, additional VAT revenue is to be expected due to the price premium of, for example, 7.55 ct/l (19% based on 39.75 ct/l above) at a price of € 150 /t CO_2.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

- Yes, using renewable drive energy instead of fossil diesel fuel.
- Incentives for regional fuel production can be set.

Other effects, interactions, and risks

- The effect of the action requires that emissions from fuel consumption in agriculture and forestry continue to be taken into account, as is currently the case in the BEHG.
- Another prerequisite for the effect of the action is that biogenic fuel emissions as well as fuel emissions from liquid or gaseous renewable fuels of non-biological origin are assigned the emission factor 'zero' (see § 7(4)(2) BEHG).
- Maintaining the BEHG and the price effect of ETS 2 open, resulting in a high degree of uncertainty.
- Interactions with the design of the Energy Tax Act (Action 8) and the GHG quota (Action 6).

Obstacles to implementation

- Social acceptance for a high CO_2 price is questionable (Fiedler et al. 2024).
- Price-reducing intervention by the EU member states or the European institutions at a high price level is conceivable.

Action 6

Introduction of a sub-quota for agriculture in the greenhouse gas reduction rate for fuels in the Federal Immission Control Act

Action

Introduction of an increasing sub-quota for agriculture and forestry in the Federal Immission Control Act from 2026 and in the following years, analogous to the existing sub-quota for aviation turbine fuel that comes from renewable energies of non-biological origin. Quota obligations are imposed on the suppliers of fuels, in particular the petroleum industry, who have to meet this sub-quota additionally. In principle, the sub-quota can be met via renewable fuels in standard-compliant diesel admixtures or as pure fuels or via renewable electricity.

By designing the fulfilment options, regionally or self-produced renewable fuels (in particular biomethane, vegetable oil and biodiesel) from regionally provided raw materials or electricity can be particularly appreciated. This can be achieved by limiting compliance to certain fuels or by setting incentives for certain compliance options (e. g. by multiple crediting, possibly also in combination with a tax advantage (see Action 8)).

Background

The Federal Immission Control Act (BImSchG 2024) regulates the reduction of greenhouse gas emissions from fuels (greenhouse gas reduction rate, or GHG quota for short) and sets gradual reduction targets for greenhouse gas emissions resulting from the placing on the market of fossil petrol and fossil diesel fuels by 2030 (§ 37a). Quota holders are distributors of fuels acting commercially or on economic undertakings. An incentive to place climate-friendly energy products on the market arises from the fact that levies (penalties) are payable in the event of non-compliance with the quota.

Section 37a (4a) stipulates that distributors of fuels must ensure a minimum energy content of renewable fuels of non-biological origin over the years that replaces jet fuel (the so-called PTL sub-quota for air transport).

In the "Ordinance laying down further provisions for the reduction of greenhouse gas emissions from fuels", Section 13 of the 38th Federal Immission Control Ordinance (38. BImSchV 2017) sets an annual limit for the eligibility of biofuels from food and feed crops of 4.4% in terms of energy content, and Section 13a sets an upper limit for the eligibility of waste-based biofuels of 1.9%.

Mode of action

Similar to air transport, create incentives for the targeted supply of renewable fuels or electricity to the agricultural and forestry sector.

The expectation is that the prices of renewable fuels placed on the market in agriculture will fall; this is due to the levy to be imposed on fuel distributors in the event of non-compliance with the quota obligation (Section 37c (2) BImSchG). It is possible that, on the part of fuel distributors, the additional costs will be offset by price premiums for fossil fuels.

Scope

To the extent of the annual increase in the under-quota; depending on the price advantage resulting from the mechanism described above.

Time horizon implementation

A rapid implementation would in principle be possible with the upcoming adjustment of the integration of the REDII revision into the regulation on the GHG quota, which must be completed by May 2025.

Time horizon effect

From 2026 onwards, with the entry into force of the revised GHG quota system in national law.

Main stakeholders

- Federal Ministry for the Environment and Consumer Protection (BMUV) and involved departments/executive authorities/bodies: Implementation of the GHG quota.
- Fuel distributors: Implementation of quantity recording.

Costs

Where applicable, additional costs for fuel distributors (quota obligated parties) for adapted proof keeping up to a maximum of the levy for shortfalls in the greenhouse gas emissions to be reduced, e. g. € 600 /t CO_2, as currently regulated.

Costs of recording the fuel volumes for the sub-quota for agriculture and forestry, for oil companies as quota obligors, e. g. via fuel cards.

Contributing to de-bureaucratisation

No

Contribution to self-supply of energy or increase of value added in rural areas

Yes, if the quota system favours the use of regionally produced renewable drive energy.

Other effects, interactions, and risks

- Defining the sub-quota in comparison with the setting of intermediate targets for the conversion of energy supply for non-road mobile machinery in agriculture (see Action 1).
- Harmonisation required with possible actions of the National Biomass Strategy NABIS (see Action 2) and financial support for machinery suitable for renewable energy (see Action 10, Action 11).
- The energy demand for agriculture and forestry of currently around 74.4 PJ could theoretically be fully covered by conventional biofuels at all times, without exceeding the cap for the eligibility of biofuels from food and feed crops of 4.4% (energy share). The energy share of fuel used in agriculture and forestry would account for 3.4%.
- Increased regional added value would be possible if the under-quota in the GHG quota was exceeded and could be traded when self-producing and using, for example, vegetable oil or biomethane.
- The decision as to whether electricity or renewable fuels are used to meet quotas is the responsibility of the distributor of fuels and thus predominantly of the petroleum industry. By paying the penalties, the quota compliance and thus the emission reduction can be circumvented. The higher burden of proving compliance with quotas when taking into account small quantities from regional supply of electricity and fuels can be avoided by paying the penalties or by favouring large suppliers. This can have a detrimental effect on the use of regionally produced electricity and fuels.
- Possible risk that the sub-quota for agriculture and forestry will mainly be met with imported HVO100, thus discriminating against regional value chains and new drive systems.

- Unresolved: The fact of double funding if an energy tax relief is granted and at the same time the fuel quantities are counted towards the GHG quota fulfilment in the transport sector.

Obstacles to implementation

- Challenge of quantity recording: e. g. analogous to the current agricultural diesel regulation or transfer of the quantity recording to distributors (e. g. via fuel cards).
- Accompanying manufacturer approvals are required if the use of pure fuels is to be incentivised (in particular B100, P100, CNG/LNG) (see Action 4, Action 22).
- Slow capacity building, therefore accompanying evaluation of the prospects in the provision and use of the fuel options required, currently and in the short term in particular the market for HVO100, in the future also for other paraffinic diesel fuels such as BTL and PTL.

Action 7

Preferential treatment of certain renewable fuels for the agricultural sector

Action

The use of appropriate steering instruments is intended to ensure that sufficient renewable fuels, which are particularly advantageous for existing machinery and for applications that cannot be electrified, are always available for food production and the associated agricultural work. This is preceded by a political decision-making process, which criteria and with which weighting are used for the assessment of the excellence of individual fuel options. From this, a fuel strategy for agriculture can be developed, using the following steering tools. Individual aspects are also discussed in other actions listed here.

As a steering tool, for example, the following is conceivable:

- Taxation (see Action 8)
- Investment support and favourable loans for certain machinery (see Action 10 and Action 11)
- Eligibility for GHG quotas (Action 6)
- Regulatory requirements

Background

Electricity and the various renewable fuels differ in their excellence in terms of their characteristics and availability for utilisation as drive energy for machines used for various agricultural activities.

Distinctive features include, for example, fuel costs and investment costs in machinery as well as in recharging and refuelling infrastructure, chemical-physical properties such as aggregation state and energy density, compatibility for use in existing machinery, market availability, raw material potential, the possibility of regional provision and self-sufficiency, soil and water risks, greenhouse gas reduction, etc. (KTBL 2020) and (KTBL 2023).

For food production, a crisis-proof supply of drive energies must be ensured. These preferable drive energies must meet essential requirements from a technical, environmental, social, and economic point of view. The legal framework must be designed in such a way that these drive energies can be used in agriculture as a priority.

Mode of action

The preferable fuels are available to agriculture in sufficient quantities. Agricultural industry and agricultural practice receive planning certainty for investments.

Renewable fuels are primarily used in applications where battery-electric drives are not technically possible and where they provide additional benefits.

Scope

High, for a targeted transformation of drive systems in agriculture and for a comprehensive national fuel strategy.

Time horizon implementation

Immediately, if legislative changes are required: 1 year.

Time horizon effect

With the implementation of the action.

Main stakeholders

- Federal Ministry of Food and Agriculture (BMEL): Identification of preferred fuel options.
- Federal Ministry of Finance (BMF) (Tax), Federal Ministry of Food and Agriculture (BMEL) (Funding), Federal Ministry of the Environment and Consumer Protection (BMUV) (THG quota): Activation of steering instruments.

Costs

Not quantifiable: Depending on the steering instruments used.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, if regionally produced renewable drive energies are identified as preferred fuel options.

Other effects, interactions, and risks

Conflicts, in particular with the transport sector, if the same fuel options are preferred for different modes of transport, e. g. paraffinic diesel HVO, and these fuel options are not available in sufficient quantities at any given time.

Obstacles to implementation

- The assessment of the excellence of individual fuel options is not all-encompassing and represents a snapshot, as e. g. the weighting of individual assessment criteria may change depending on the political focus or technical progress. Thus, the previous political discourse on the identification of preferred fuel options is complex and time-consuming and the design of the steering actions must also be questioned again and again and, if necessary, discussed anew.
- Protracted political coordination processes on the contribution of regionally produced conventional biofuels to climate protection and their further environmental effects.

Action 8
Adaptation of the taxation of renewable fuels in the Energy Tax Act

Action
Equality, ideally better positioning of renewable drive energies in agriculture and forestry compared to fossil fuels in the calculation of the energy tax. The scheme should include all renewable energy products and be open to all technologies.

- (Re)introduce a total or partial tax relief for renewable drive systems in agriculture and forestry,
- levying the energy tax on the energy contained in the energy product instead of on the volume,
- establishment of energy tax rates for the different renewable drive energies at the same level,
- creation of long-term reliable regulations, as investment decisions in machines as well as refuelling and charging infrastructure are often associated with the use of certain drive energies.

For the energy tax refund procedure, see Action 9.

Background
The taxation of energy products and derogations are laid down at national level in the Energy Tax Act (EnergieStG 2024). The tax rate for gas oil (diesel fuel) is € 470.40/1,000 l (€ 13.44 /GJ), for natural gas in the year 2024 € 18.38/MWh (€ 5.11 /GJ), in 2025 € 22.85/MWh (€ 6.35 /GJ), in 2026 € 27.33/MWh (€7.59 / GJ) and from 01.01.2027 € 31.80/MWh (€ 8.83 /GJ).

"Other energy products" shall be taxed in the same way as the energy products to which they are most closely related in terms of their purpose of use and nature.

Paragraph 57 of the EnergieStG governs tax relief for agricultural and forestry undertakings. The Second Budget Financing Act 2024 gradually reduces the tax relief on gas oils granted on request up to 29 February 2024 from 21.480 ct/l to

- 12.888 ct/l from 01.03.2024 to 31.12.2024,
- 6.444 ct/l from 01.01.2025 to 31.12.2025 and
- from 01.01.2026 no refund will be granted

An energy tax relief on biodiesel and vegetable oil fuel was granted until 31.12.2021.

The basis for the national energy tax law is the EU Energy Tax Directive (EU Directive 2003/96/EC 2003). Article 7 sets minimum rates of taxation for motor fuels. These are:

- Gas oil: € 330 /1,000 l (€9.43 /GJ)
- Gas oil for use in agriculture and (...) forestry: € 21 /1,000 l (€ 0.6 /GJ)
- Natural gas: € 2.6 /GJ
- Natural gas for use in agriculture and [...] forestry: € 0.3 /GJ

Article 15 (3) of the Directive allows Member States to apply a zero level of taxation to energy products and electricity used for work in agriculture and horticulture, fish farming and forestry.

Article 6 regulates the granting of tax reliefs. They can be granted (a) directly, (b) via a graduated tax rate or (c) via a pro rata or full refund of the tax.

The EU is currently working on a "Directive restructuring the Union framework for the taxation of energy products and electricity" (European Union 2021). The calculation should be based on the energy content in €/GJ on the basis of the lower calorific value. The amount of the minimum tax rates takes into account the contribution to climate protection. Reduced minimum rates are granted for fuels used in agricultural, horticultural, aquaculture and forestry activities.

Conclusion:

- By the end of 2025, fossil diesel fuel will be tax-privileged, while renewable fuels will not.
- The levying of the energy tax related to a fuel volume penalises fuels with a lower energy content than diesel fuel ('gas oil').
- The level of the tax levied on energy products (electricity, gaseous and liquid fossil, and renewable fuels) used to power agricultural machinery varies greatly.

Mode of action

The energy tax can compensate for cost differences in the production of energy products and for overconsumption in case of a lower energy content, as well as the additional expenditure on the use of the new drive systems, and the level of the tax rate signals to the farmers and foresters which energy products should be preferred from a government point of view in the future.

A tax relief is a fast-acting incentive instrument to promote the use of renewable drive energies and has a signal character.

Scope

According to experts, a real incentive to buy arises from the experience of the years 2006 to 2008 only from a longer-term price difference of at least € 0.20 /l. The effect therefore depends on the amount of the energy tax relief.

Overall, however, the pricing of fossil and renewable fuels and the resulting cost-side excellence is still dependent on many other factors such as raw material prices, energy prices, carbon pricing (see Action 5), GHG ratio (see Action 6) etc.

Time horizon implementation

- Amendment to the Energy Tax Act: 1 year.
- If necessary, further time may be required for approval by the EU Commission under State aid law.

Time horizon effect

Immediate impact on technology development. Since the agricultural machinery industry is being signalled which energy sources should be used in the future, a boost is being created for the development and market launch of machines with renewable drive systems.

Effect on fuel demand from 2026. A slow increase in demand for renewable fuels is expected. Since a pro rata energy tax relief for fossil diesel fuel will be granted until the end of 2025, renewable drive energies are not yet competitive. In addition, only a few machines with renewable drive systems are currently available on the market. Therefore, no short-term burdens on the federal budget are to be expected from a tax relief.

Main stakeholders

- Federal Ministry of Finance (BMF): Amendment of the Energy Tax Act.
- Beneficiaries: Agriculture and forestry.
- Indirectly affected parties: Agricultural machinery industry, fuel manufacturer and trade.

Costs

The federal budget is losing tax revenue.

The tax losses due to a tax relief of renewable drive energies in agriculture arise from about the year 2026 and increase in small steps until the year 2045. To a small extent, the losses in the energy tax are compensated by revenues from the electricity tax.

After the complete abolition of the energy tax refund from the beginning of 2026, energy tax revenues from fuel consumption in agriculture and forestry will increase annually to around € 975 million.

Due to the increase in propulsion efficiency through proportional electrification by the year 2045, the energy consumption for the drive of machines will decrease overall and thus also the tax revenues. Revenues decrease by around € 240 million.

Electricity tax revenues will be around € 60 million in 2045, with electricity consumption of around 10 PJ; this is offset by losses of € 70 million due to the lower tax rate on electricity compared to diesel fuel.

With a full tax relief for all renewable liquid fuels still needed, revenues of a maximum of € 600 million will be lost.

This contrasts with tax revenues from regional fuel production.

Contributing to de-bureaucratisation

From 2026 (no energy tax relief for diesel fuel): No (see Action 9).

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, using renewable drive energy instead of fossil diesel fuel. Depending on the drive energy for which tax relief is granted, incentives can be set for regional fuel production.

Other effects, interactions, and risks

- Unexplained: The fact of double funding if an energy tax relief is granted and at the same time the fuel quantities are counted towards the GHG-quota fulfilment in the transport sector.
- Compliance with State aid rules, e. g. the State aid rules for climate, environment, and energy (European Commission 2022/C 80/01 2022), must be ensured.
- The tax relief is not sufficient to trigger a demand for renewable drive energy, but there will be no tax losses.

Obstacles to implementation

- The budgetary situation at the federal level is tense and may not allow tax refund to be granted.
- The renewable energy tax relief instrument may be perceived by farmers and the agricultural machinery industry as an unreliable policy instrument: The background is, for example, the negative experience with the gradual reduction of the energy tax refund to biodiesel and vegetable oil fuel in non-agricultural applications since 01.01.2007. In addition, frequent delays and ambiguities in the EU notification regarding the continuation of the tax relief on biodiesel and vegetable oil fuel in agriculture and, last but not least, the abolition of the tax relief for biodiesel and vegetable oil fuel while at the same time continuing to grant the tax relief on fossil diesel fuel on 1 January 2022 (Section 57 (5) (2) of the Energy Tax Act) have led to uncertainty and caution.
- Taxation of fuels according to their energy content is not envisaged in the EU Directive 2003/96/EC, which is still in force.

Action 9

Energy tax-free purchase of renewable fuels – abolition of the tax refund procedure

Action

Establishment of a procedure through which agricultural holdings can obtain renewable fuels with reduced energy tax - without a refund procedure - directly from the fuel distributor. The prerequisite is an energy tax reduction for renewable fuels in accordance with § 57 of the Energy Tax Act (EnergieStG 2024) (see Action 8).

Background

The basis for the national Energy Tax Act is the Energy Tax Directive of the European Union (EU Directive 2003/96/EC 2003). Article 6 of the Directive regulates the granting of tax advantages.

They can be granted directly, via a graduated tax rate or via a partial or full refund of the tax. These options, as described in Directive 2003/96/EC, will be retained in the draft amendment to the Energy Tax Directive (Article 6). Thus, there is a legal basis for the action described.

Mode of action

Directly when buying fuel, a cost saving due to the energy tax exemption becomes visible. This improves the liquidity of the company and makes it possible to simplify administration and reduce bureaucracy by eliminating the refund procedure. This leads to an increasing acceptance of renewable drive energies in agriculture.

Scope

Increase the impact of an energy tax reduction on renewable drive energies (see Action 8).

Time horizon implementation

1 year to amend the energy tax law.

Time horizon effect

With the entry into force of the amendment to the Energy Tax Act (EnergieStG).

Main stakeholders

- Federal Ministry of Finance (BMF): Amendment of the Energy Tax Act.
- Customs: Surveillance.
- Other actors: Fuel manufacturers, fuel distributors, service station operators.

Costs

Cost savings for agricultural holdings and the federal administration due to the elimination of the tax refund procedure.

Possibly additional effort in distinguishing between agricultural and non-agricultural customers for fuel distributors (identification of agricultural holdings when purchasing e. g. via the farm number, colouring of the fuel from the tax warehouse, additional storage capacity in the tax warehouse (analogous to diesel fuel and coloured heating oil).

Contributing to de-bureaucratisation

Yes, in the case of agricultural holdings and customs administration. If necessary, a higher expenditure arises in the fuel trade due to corresponding documentation obligations.

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

- By waiving the tax refund procedure, customs no longer record the quantities of fuel used in agriculture and forestry. This complicates GHG balancing in the context of inventory reporting.
- A recording of fuel volumes would still be possible, e.g. through a documentation obligation for fuel distributors or biofuel manufacturers.

Obstacles to implementation

A prerequisite for the effectiveness of the action is an energy tax reduction for renewable fuels in accordance with § 57 EnergieStG.

Action 10

Continuation of the Federal Programme to Increase Energy Efficiency and CO_2 Savings in Agriculture and Horticulture

Action

Continuation of the Federal Programme to Increase Energy Efficiency and CO_2 Savings in Agriculture and Horticulture and extension to include a new or additional funding guideline in order to be able to support not only agricultural SMEs (small and medium-sized enterprises), but also producer groups, organisations, and associations as well as machinery rings and contractors.

The conditions of the existing support programme should be made more attractive for the new efficiency-enhancing or low-emission technologies, such as the new procurement and retrofitting of machines with renewable drive energies:

- extension of the groups of applicants, in addition to primary production SMEs, to producer groups, organisations and associations, as well as machinery rings and contractors,
- raising the funding rates,
- extension of support to accompanying infrastructure actions, such as refuelling and recharging infrastructure at the farm,
- consideration of the resumption of funding facilities for the decentralised production of biofuels for use in agriculture, and
- maintaining and further developing the simple procedure for application and approval, if necessary, by introducing early start of actions for rapid implementation.

Background

The funding instrument is based on the Programme to Increase Energy Efficiency and CO_2 Savings in Agriculture and Horticulture, Part A – Primary Agricultural Production of 28 June 2023. Eligible for support of investment actions under point 3 of the programme are SMEs producing primary agricultural products.

The Directive Part B: Renewable Energy Production, of 18 August 2021, which also targeted commercial machinery rings and contractors providing services in the primary production of agricultural products for agricultural enterprises as beneficiaries, has ceased to be in force since 31.12.2023.

The areas of support in Part A are as follows:

The individual actions include, inter alia, energy efficiency actions on agricultural machinery (automatic tire pressure control systems) and alternative drive systems for agricultural machinery, in particular electrically and biofuel powered agricultural machinery or autonomously operating robots in livestock farming. Battery storage facilities for the farm's own needs are also promoted in order to store self-generated PV electricity in batteries.

The funding opportunities have been very well received so far. For certain new technologies that are only recently available on the market, demand initially developed slowly. Supported lighthouse projects and the increase of other available technology in a developing market are also constantly increasing the demand for support (e. g. electric farm loaders or the direct electrification of former diesel-powered feeders).

The maximum grant for individual actions is 20% of the net investment volume, provided that a CO_2-reduction is achieved, at least € 16,000 (pure purchase price) for new acquisitions and at least € 5,000 for retrofits.

Mode of action

The funding helps to offset the additional costs of investing in new machines or converting them to renewable drive energies. This will reduce barriers to investment and support the penetration of energy-efficient technologies in agricultural practice.

As a result of the investments made, companies in agriculture and horticulture consume less energy (increase in efficiency) and the remaining energy demand is increasingly covered by renewable sources. This not only protects the climate and thus the essential production basis of agriculture (primary target), but the sector also becomes less vulnerable to energy crises resulting from the lack of availability and global market distortions in fossil fuels. This strengthens crisis resilience, competitiveness and supports the sustainable production of domestic food.

Scope

- Direct – each supported action contributes immediately to CO_2 savings by using renewable energy sources and improving energy efficiency by renewing the machinery park over the technical lifetime.
- The subsidies are significantly increased by the beneficiaries' own resources – up to 80% depending on the funding action.
- The impact may be reinforced by a combination with the launch of a loan programme (see Action 11).

Time horizon implementation

- Immediately implementable.
- 1 year for supplementing the programme in the way described above.

Time horizon effect

Immediately with the use of the support action.

Main stakeholders

- Federal Ministry of Food and Agriculture (BMEL) and Federal Ministry of Finance (BMF): Design of the programme.
- Federal Office for Agriculture and Food (BLE): Implementation of the support programme.
- Agricultural machinery industry: Provision of mobile machinery suitable for renewable drive energies.

Costs

The necessary funding has already been approved in the 2024 federal budget, including the proposals for the financial years 2025, 2026 and 2027. Additional funds may have to be earmarked for an extension of the funding objects.

Contributing to de-bureaucratisation

No, but extensive actions have been taken in recent years to establish a streamlined application procedure for agricultural SMEs.

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, depending on the object of support, electrified drive systems with renewable electricity produced on farms and the use of regionally produced biofuels.

Other effects, interactions, and risks

- When determining the level of support, the EU State aid rules must be observed.
- The modernisation of mobile machinery reduces the emission of air pollutants, irrespective of the use of renewable energies.
- The actions represent an economic promotion of the agricultural machinery industry.
- There is a risk of the subsidy being absorbed by artificially increased market prices.

Obstacles to implementation

- A lack of sufficient longer-term funding prevents the necessary certainty for the generally significant investment decisions that must be made in companies in the agriculture and in the agricultural machinery industry.
- The action does not have any effect if the costs for the machines, fuels or electricity are too high and thus no overall economic operation of the respective machines is possible.
- Actions can only be effective if the agricultural machinery industry provides corresponding machines in all relevant performance ranges.

Action 11

Loan programme for investments in renewable drive systems as well as refuelling and recharging infrastructure

Action

Establishment of a temporary loan programme with low-interest conditions to incentivise investment in mobile machinery with renewable drive energies.

- Option 1: Isolated loan programme
- Option 2: Loan programme in conjunction with the Federal Programme to Increase Energy Efficiency and CO_2 Savings in Agriculture and Horticulture (see Action 10).

Funding should include the following elements:

Electrified machines and charging infrastructure for use close to the yard and for light transport and field work:

- New acquisition of machines with electric drives (tractors, farm loaders, wheel loaders, feed mixers, other electrically operated machines).
- Charging infrastructure for electrically powered machines.

Machinery and infrastructure for operation with renewable fuels:

- New purchases of machinery suitable for renewable fuels (e. g. vegetable oil fuels, biodiesel, CNG) in accordance with the Biofuel Sustainability Ordinance (Biokraft-NachV 2021).
- Conversion of existing machines to the use of renewable fuels.
- Refuelling infrastructure (storage and refuelling) for renewable fuels.

Beneficiaries:

- Agricultural SMEs (small and medium-sized enterprises) of primary production.
- Producer groups, organisations, and associations as well as machinery rings and contractors.

The involvement of commercial enterprises providing services to farms regarding the production of primary products (e. g. contractors) is an important factor for the rapid market uptake of innovative technologies. This is due to the high proportion of work carried out by contractors, which applies in particular for energy-intensive harvesting operations.

Background

Manufacturers of type-approved machines for renewable drive energies or retrofitting of existing machines usually call for higher prices compared to diesel-powered machines. For electric skid steers, a surcharge of about 50% on the price of the diesel machine is to be expected, for electric telehandlers an increase of about 30% and for battery electric small tractors a surcharge of about 60% arises. For brand new tractors powered by vegetable oil, additional costs of approximately € 10,000 may be incurred; this also applies to retrofitting of existing machines. From the truck sector, costs for biodiesel equipment of up to about € 2,000 are known. A tractor certified for methane (CNG) is about € 20,000 more expensive than the diesel counterpart. For machines with a certification for paraffinic diesel fuel HVO, no higher costs are usually called. In addition, there are expenses for alternating current and direct current charging stations as well as for extra on-yard filling stations for renewable fuels.

Investments in mobile machinery are supported by the Federal Programme to Increase Energy Efficiency and CO_2 Savings in Agriculture and Horticulture. Farming SMEs are eligible to apply.

In 2023, the share of alternatively driven tractors (excluding lorries) in new registrations of all holder groups in this vehicle category was only 0.3% (KBA 2024b).

Mode of action

The interest rate subsidies provide direct support to farms, machinery rings and contractors and compensate for part of the investment costs currently incurred in the procurement of vehicles with alternative drive systems. This accelerates the market penetration of machines with alternative drive energies.

In option 2, the loan programme is intended to increase the incentive effect of the Federal Energy Efficiency Programme (Action 10) (innovation booster). This option could then be advertised as a funding combination.

The loan programme should be implemented through the Landwirtschaftliche Rentenbank (Agricultural Pension Bank), as its rapid procedures for coordination with the house banks are well known in agricultural practice and enjoy a high level of acceptance.

Scope

Direct: Any agricultural machinery placed on the market or retrofitted by means of the subsidy thus makes an ongoing contribution to CO_2 savings (Tab. 2). For the excellence of various renewable energy sources, see (KTBL 2020) and (KTBL 2023).

Indirect: Economic development of the agricultural machinery industry.

Tab. 2: Reduction of emissions over the service life of a new machine (estimate based on the KTBL standard values for the scope of use) (KTBL 2022).

Type of machine	Power class kW	CO_2 savings over machine lifetime (tank-to-wheel)[1)] t CO_2e
Standard tractor	138 (130-147)	430
Skid steer loaders	30 (26-33)	84
Wheel loaders	102 (93-111)	326
Forage harvesters	400 (376-425)	560
Combine harvesters	300 (288-312)	419

[1)] Corresponds to emissions from diesel use (emission factor 74.5 g CO_2e/MJ) over the service life of the machine.

Time horizon implementation

Implementable in the short term: Structuring of the loan programme in 2024, implementation in 2025.

Time horizon effect

Immediately after the start-up of the investment action.

Main stakeholders

- Federal Ministry of Food and Agriculture (BMEL) and Federal Agency for Agriculture and Food (BLE): Revision of the regulatory framework.
- Rentenbank: Implementation.
- Chambers of agriculture and other advisory bodies: Information on funding opportunities in practice.

Costs

- Costs of funding.
- Administrative costs e. g. for the BLE.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, depending on the object of support in the case of electrified drive systems with renewable electricity from agricultural holdings and in the case of the use of regionally produced biofuels.

Other effects, interactions, and risks

- Supporting an accelerated modernisation of the vehicle fleet, possibly resulting in efficiency gains, reduction of air pollutant emissions, through the use of modern drive technologies, also independent of the use of renewable energies.
- Economic development of the agricultural machinery industry.

Obstacles to implementation

- The action does not have any effect if the costs for the machines, fuels or electricity are too high and thus no overall economic operation of the respective machines is possible.
- Actions can only be effective if the agricultural machinery industry provides corresponding machines in all relevant performance ranges.
- Possible state aid restrictions on the combination of subsidised loans and investment support through the Energy Efficiency Programme.

Action 12
Research funding for the development, testing and evaluation of alternative drive systems

Action
Launch of a programme to promote research, development and testing of alternative drive systems as well as accompanying research for use in field tests. Cooperative research and product development with the participation of manufacturers, agriculture and science is to be promoted with public funds and participation from industry. The results will be evaluated in the context of demonstration projects in practical use and critically discussed. Contents of the research and development funding programme:

- Technical development and adaptation of available technologies to agricultural applications (drive technology, fuels and fuel quality, air pollutant emissions, battery technology, charging/refuelling operations, etc.).
- Agricultural practices using alternative drive technologies.
- Optimised energy supply and use concepts on farms.
- Local and regional energy supply concepts linked to agriculture.
- Accompanying research on the role of agriculture as a producer and user of biomass within the framework of bioeconomy concepts, on aspects of value creation in rural areas and on acceptance by the actors involved as well as in society.

No restrictions should be imposed on the materials used in the production of fuels, e.g. no exclusion of renewable raw materials.

Background
The product range of agricultural and forestry machinery with renewable drive energy is currently limited to individual vehicle types, with almost every manufacturer having at least one vehicle in the portfolio. The technology readiness level (TRL), for drive technologies not yet available on the market, varies depending on the drive technology or energy source and is in the range of TRL 5 to 8. Since the market for machines with renewable drive systems is so far very small, the development effort of manufacturers usually does not increase.

The variety of structures and requirements of farms for drive technology is large. Various renewable drive energies, which differ in their properties, are available. They are suitable for different types of agricultural work. Particularly large differences occur in farm-related work compared to heavy field work (KTBL 2023). Machine concepts have so far been largely geared towards diesel fuel, and the variety of energy source options is not reflected in the range of machines on offer (see Action 18).

The future energy supply for farms will not be one-fits-all, but multi-layered. It is therefore necessary to ensure that sufficient quantities of different energy sources are available seasonally in the right place (see also Action 16, Action 24, and Action 7).

The "Renewable Resources" funding programme (since January 2024, the "Sustainable Renewable Resources" funding programme), implemented through the FNR, has already been in high demand in the past and has led to pioneering technical solutions.

Mode of action
The reduction of development risks for manufacturers of agricultural machinery indirectly increases the supply of available machine types and provides incentives for agriculture and forestry in the form of lower

prices and greater choice of machine types. In addition, the developed technical solutions will enable the practical use of previously unavailable technologies in the future.

An R&D funding programme attracts the interest of agricultural machinery manufacturers and research institutions with dedicated calls for funding.

Scope

A high level of impact is to be expected if the programme is used well, as additional funds are mobilised from industry and the results are generally available to the public.

Time horizon implementation

Once funds have been made available, a funding guideline can be drawn up within about 6 months and the action can therefore be implemented very quickly. If integration into the existing programme "Sustainable Renewable Resources" takes the form of calls for funding, the action can be implemented almost immediately.

Time horizon effect

Realistic periods in research and development range from 3 to 6 years. Depending on the initial situation at the respective manufacturers, however, relevant findings and effects on the supply side of the agricultural machinery market can also be expected earlier.

Main stakeholders

- Federal Ministry of Food and Agriculture (BMEL), Fachagentur Nachwachsende Rohstoffe e.V. (FNR): Conceptual design of the funding programme.
- Fachagentur Nachwachsende Rohstoffe e.V. (FNR): Implementation of the funding programme (project management institution).

Costs

- Required funding for research funding: € 20 million over 5 years.
- Administrative costs for the project management.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

A range of practical machines increases acceptance for the use of machines with renewable drive energies. In addition, Germany as a technology and research location will be maintained and expanded.

Obstacles to implementation

Lack of funding from the federal budget.

Action 13
Strengthening the role model function of the public sector

Action
At state, federal state and municipal level, in future only agricultural and forestry vehicles with renewable drive systems will be procured and existing machines will only be operated with renewable fuels. In this way, the role model function of the public sector is exercised. Appropriate financial resources for the procurement and operation of vehicles should be allocated to public budgets so that corresponding tender criteria can be taken into account in procurement processes. To this end, the "Regulation on Public Procurement" (VgV 2024), the "Rules of Procedure for the Award of Public Supply and Service Contracts below the EU Thresholds" (UVgO 2017), the "Regulation on the award of public contracts in the transport, drinking water and energy sectors" (SektVO 2016) or the "Clean Vehicles Procurement Act" (SaubFahrzeugBeschG 2021) (see Action 14) may need to be adapted. It should also be examined whether further legal provisions run counter to the objectives and whether they need to be revised.

Background
Section 5 of the Federal Climate Protection Act (KSG 2024) calls for the role model function of the public sector. Section 15 "Climate-neutral Federal Administration" describes the objective that the federal administration is to be organised in a climate-neutral manner by 2030. The implementation of this goal is monitored by the German Federal Office for Climate-neutral Administration at the Federal Ministry for Economic Affairs and Climate Protection (BMWK). A programme of actions to implement the targets has been drawn up (Federal Government 2022).

Similar objectives can be found in state climate protection laws, climate protection targets of municipalities and self-commitments of public institutions.

Mode of action
The action may create an additional sales market for machines with renewable drive technologies and thus increase planning certainty for the agricultural machinery industry, which in turn leads to falling prices (scale effects) and increased supply for agriculture and forestry.

Scope
Creation of a limited but secure market for renewable drive machinery outside the agricultural sector.
In particular, implementation is expected to depend heavily on existing federal, state, and municipal funds, as the procurement of vehicles with renewable drive energies is associated with higher costs than conventional drive systems.

In the holder group 'Public administration, defence, social security', 1,846 new agricultural tractors were registered in 2023 (KBA 2024a). On 1 January 2023, the stock consisted of 31,555 tractors (KBA 2023).

Time horizon implementation
1 year for the adjustment of the legal regulations if necessary. Commitments can be implemented in the short-term.

Time horizon effect

Depending on the existing financial situation or prioritisation on the part of the public authorities.

Main stakeholders

- Coordinating Body for Climate-neutral Federal Administration at the Federal Ministry for Economic Affairs and Energy (BMWK): Formulation of actions and monitoring.
- Institutions of the state, the federal states, and local authorities: Procurement of machinery.
- Federal Ministry of Digital Affairs and Transport: Adjustment of the Clean Vehicle Procurement Regulation.
- The beneficiaries of these actions are manufacturers and dealers of vehicles, as well as fuel distributors and electricity suppliers.

Costs

Public bodies will have to reckon with additional costs due to (premature) procurement of machines with renewable drive energies: For electric skid steers, a surcharge of about 50% on the price of the diesel machine is to be expected, for electric telehandlers an increase of about 30% and for battery electric small tractors a surcharge of about 60% is estimated. For tractors that can be operated with vegetable oil fuel or for retrofits, additional costs of approximately € 10,000 are incurred. From the truck sector, costs for biodiesel equipment of up to around 2,000 € are known. A tractor certified for methane (CNG) is about € 20,000 more expensive than the diesel counterpart.

Depending on the energy source, costs are also incurred by investing in storage and refuelling infrastructure as well as connection and charging infrastructure (fast charging stations).

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

The contribution to climate protection by the public sector will be increased.

Obstacles to implementation

- Lack of availability of corresponding mobile machines.
- Lack of financial resources in public budgets to procure machinery and energy.
- Lack of awareness among procuring entities.

Action 14

Deletion of the exemption of agricultural and forestry vehicles from the scope of the Clean Vehicles Procurement Act

Action

Deletion of the exemption of agricultural and forestry vehicles from the scope of application of the Clean Vehicles Procurement Act with regard to the reduction of CO_2 emissions. Corresponding CO_2-reduction targets should be set for these vehicles through the use of renewable electricity or renewable fuels.

The aim is to create additional demand for agricultural machinery with renewable energy from the public sector.

Background

The Clean Vehicles Procurement Act (SaubFahrzeugBeschG 2021) (underlying Directive (EU) 2019/1161 of 20 June 2019 amending Directive 2009/33/EC) (EU Directive 2019/1161 2019) is aimed at contracting authorities and sector contracting authorities in order to ensure a minimum reduction in CO_2-emissions and air pollutant emissions through the procurement of low-emission vehicles. However, pursuant to section 4 (1) (1), agricultural and forestry vehicles within the meaning of Regulation (EU) No 167/2013 (EU Regulation 167/2013 2013) are excluded.

Mode of action

The abolition of this exemption creates a demand for climate-friendly agricultural and forestry vehicles on the part of the public authorities (state, federal state, and local authorities), which can help to solve the "hen-egg problem" - no demand is conditional on no supply. In the best case, this could create an initiative market that can contribute to planning security in the agricultural machinery industry.

Scope

Creation of a limited but secure market for renewable drive machinery outside the agricultural sector. In the holder group "Public administration, defence, social security", 1,846 new agricultural tractors were registered in 2023 (KBA 2024a), with a stock of 31,555 (KBA 2023). The desired supply of newly developed machines is also open to customers from the agricultural sector.

Time horizon implementation

1 year for the legislative amendment.

Time horizon effect

3 years after the adoption of the amendment.

Main stakeholders

- Federal Ministry of Digital Affairs and Transport (BMDV): Adaptation of the Clean Vehicles Employment Act.
- Other actors: State, federal state and local institutions, agricultural machinery industry, fuel trade.

Costs

- State, federal state and local institutions: Where applicable, higher procurement costs for machinery and lower to higher operating costs for machinery, where applicable, additional costs for additional refuelling and recharging infrastructure.
- Agricultural machinery industry: Development costs for machines with renewable drive energies, costs for market introduction, costs for training of sales and workshop personnel, spare parts management, etc.
- Fuel trade: Costs for the additional provision of renewable fuels.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions and risks

A positive effect is created by the role model function of the public sector. The reduction of GHG emissions at the level of public institutions will be accelerated. This supports the achievement of legal climate protection targets and self-commitments.

Obstacles to implementation

- Political discussion processes, which can take a lot of time, precede a decision.
- The cost-benefit ratio may be low due to the small number of new machines to be procured annually.

Action 15

Demonstration of machines with renewable drive energies on the lead farms as part of the BMEL Arable Farming Strategy 2035

Action

Use machines with renewable drive energies on the demonstration farms in practical use as part of the BMEL Arable Farming Strategy 2035 and share the findings. Regional and practical demonstration of different options for GHG-reduction through drive systems with alternative power sources and renewable electricity.

Background

The Arable Farming Strategy 2035 of August 2021 comprises 12 fields of action, including fields of action 9. "Strengthening Climate Protection in Arable Farming and Exploiting Synergies" and 10. "Strengthening Education and Advice" (BMEL 2021). Currently, 98 leading companies are listed in the network nationwide. The demonstration of new drive energies has not been the focus so far.

Mode of action

The action has an impact on reducing barriers for farmers through demonstration and exchange of experience. By using the demonstration farms as a real laboratory in conjunction with accompanying research, a further gain in knowledge could be generated.

Scope

Not quantifiable.

Time horizon implementation

Immediately possible – the "Demonstration Farm Project" has started with around 100 companies, and an expansion network has already been established. Delay, in case of necessary investments in the machinery.

Time horizon effect

From the moment of dissemination of the findings of the demonstration.

Main stakeholders

- BMEL demonstration farms: Demonstration of technologies.
- Federal Agency for Food and Agriculture (BLE) with the Coordination Office for Demonstration farms: Organizational framework.
- Partners to be involved: Agricultural machinery industry, regional farm machinery workshops, chambers of agriculture and agricultural offices, associations.

Costs

- Public budgets: Compensation for the additional costs for the demonstration of machines with renewable drive energies.
- Agricultural holdings: Costs for new machinery procurement, machine conversion, storage and refuelling infrastructure and renewable fuels.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, when using electrified drive systems with renewable electricity produced on farms and when using regionally produced biofuels.

Other effects, interactions, and risks

- "Showcases" for the agricultural machinery industry.
- Improving acceptance (public) – traceable value chains/classification in the energy system of arable farming and illustrating the contribution to GHG-reduction also through exemplary GHG balance sheet calculations.
- Real-world laboratories for implementation in other countries, especially with little reliable fuel supply.

Obstacles to implementation

- Low interest on the part of the companies within the existing network. Remedy could be the recruitment of additional demonstration farms explicitly for this demonstration and communication goal.
- Lack of federal and state funds to compensate for the additional costs for the conversion of machines and the procurement of energy sources.

3.2 "Science and education" action sheets

Action 16

Analysis of infrastructures for the provision of renewable fuels and electricity in rural areas

Action

Analysis of the infrastructure and its capacity to provide renewable drive energies in rural areas in the context of research. Account must be taken of the provision of electricity and renewable fuels by agricultural holdings for their own operational supply and, in addition, for use by other agricultural holdings or demanders in the immediate vicinity or for feeding into public distribution networks.

- Analysis of technical options for improving the energy supply of agricultural holdings at regional and supra-regional level.
- Analysis of energy supply requirements at the farm level depending on the farm's type and structure.
- Analysis of the possibilities of operational self-sufficiency and community energy supply, e.g. through cooperative models.

See also Action 24.

Background

The future energy supply for farms will not be a one-fits-all solution, but multi-layered. It is therefore necessary to ensure that the availability of different energy sources (electrical energy, fuels, etc.) is ensured seasonally in sufficient quantities in the right place (where appropriate close to the field).

For example, the electrical power for the electricity supply is limited in many regions, so that solutions have to be created that enable unrestricted and efficient charging of the batteries and operation of electrified machines.

On the other hand, high investments can be required for the on-farm storage of fuels and safety standards must be adhered to. Against this background, inter alia, regional inter-company supply concepts must also be developed. In connection with trade, these must be able to cover different company-specific preferences of individual energy sources in sufficient quantities and suitable container forms.

Mode of action

The analysis of the current situation and the development of new concepts for energy supply shows the need for action with regard to necessary infrastructure actions and the actors involved in the implementation.

Scope

The concepts developed are transferable and thus offer a blueprint for other regions and farms.

Time horizon implementation

Analyses of the type described can be carried out in classical research formats with a duration of about 2 years.

Time horizon effect

The implementation of the different concepts depends on the underlying business model and should be possible within a timeframe of about 5 to 7 years.

Main stakeholders

- Research organisations with relevant experience in cooperation with farmers, consultants, retailers and energy suppliers: Research
- Ministries: In particular the Federal Ministry of Food and Agriculture (BMEL), the Federal Ministry of Economics and Climate Protection (BMWK), the Federal Ministry of Education and Research (BMBF) and their project management institutions: Funding.

Costs

Costs for public research funding approx. € 1 million (see Action 12).

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

The action can act as a boost to innovation in the region beyond agriculture.

Obstacles to implementation

- Lack of funding for research.
- Missing or incomplete data on the status quo of energy supply.

Action 17

Preparation, modelling, and analysis of scenarios for the increased use of renewable drive energies in agriculture

Action

In research works, scenarios are to be developed and investigated that differ according to agricultural production methods in different agricultural structures as well as agricultural machinery with different drive systems and energy sources.

- In particular, electrical concepts (battery/fuel cell) as well as combustion engine concepts with various alternative liquid energy sources (plant oil fuel, biodiesel, HVO, etc.) and gaseous energy sources (biomethane, hydrogen, etc.) will be considered. A systematic analysis should be carried out, including, where appropriate, farm-related production (e. g. biogas plant, oil extraction plant) and provision.
- Due to the different agricultural structures (soil-climate regions, arable/livestock farming regions, etc.), adapted solutions need to be developed. For different farm operational constellations and thus possibly for typical regions advantageous, exemplary mechanization solutions must be determined.
- Methodologically, the various excellences must be worked out with contribution of the parties involved. From this, the available energy quantities, and the possible demand for energy carriers and, if necessary, for various drive systems must be analysed.
- The interim objectives of the transition to renewable drive energy should be taken into account (see Action 1).

Background

Today, agricultural processes are essentially aligned with the use of standard tractors and harvesters with diesel fuel. In the future, agricultural machines can have different drive systems depending on the performance and usage requirements. It is to be expected that advantageous constellations of working methods and used machines allow a more extensive use of renewable drive energies.

Mode of action

The developed scenarios provide the basis for the optimization of machines and the further development of agricultural production processes. In addition, the scenarios provide a basis for agricultural advice.

Due to the availability of the information and data developed, the use of machines with alternative energy sources is increased by appropriate purchases and, if necessary, conversions in the operating modes.

The results will primarily support decision-making by agricultural holdings. Regarding the prioritisation of drive systems, the action has an impact on machine manufacturers and, with regard to quantity estimation, on the providers of energy carriers.

Scope

The scenarios developed are transferable and thus provide a blueprint for other farms.

Time horizon implementation

Studies of this kind can be conducted in classical research formats with a duration of 2 to 3 years.

Time horizon effect

The results of the work can be useful for the conversion over a time horizon of about 10 years.

Main stakeholders

- Research institutions: Development of scenarios by research institutions with extensive experience in process analyses in cooperation with machine manufacturers, farmers, and agricultural enterprises (consultants), consulting institutions (chambers) and associations (VDMA, German Agricultural Society (DLG), Association of German Engineers (VDI), etc.).
- Ministries: in particular the Federal Ministry of Food and Agriculture (BMEL), the Federal Ministry of Economics and Climate Protection (BMWK), the Federal Ministry of Education and Research (BMBF) and their project management institutions: Funding.

Costs

Depending on the number and scope of differentiated studies, funding should be less than € 2 million (see Action 12).

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

None

Obstacles to implementation

Lack of funding for research.

Action 18
Development of new drive technologies for mobile machines

Action
Together with agricultural research, the agricultural engineering industry is developing new technical solutions for process-, energy- and drive technology – namely:

- new and adapted machine concepts with suitable drive technology (yard related/field related) for different purposes and for new agricultural processes,
- easily electrifiable, automated, and networked machine and process solutions, as well as
- tank and loading concepts.

See also Action 17 and Action 21.

Background
So far, the range of mobile machinery suitable for the use of renewable drive systems is heavily limited. The exception is the largely possible use of HVO100, especially in new machines.

The variety of structures and requirements of agricultural holdings for drive technology is large. Various renewable drive energies are available. They are suitable for different types of agricultural work. Particularly large differences occur in farm-related work compared to heavy field work (KTBL 2023).

Machine concepts have so far been largely geared towards diesel fuel; the variety of energy carrier options is not reflected in the range of machines on offer.

Mode of action
The developed practical solutions are available for wide use in agriculture and, if necessary, beyond. As a result, further energy savings and emission reductions are achieved.

Scope
The extent of the impact depends on the willingness of the industry to invest in the development and acceptance of the market for machines with renewable drive energies.

Time horizon implementation

The time horizon for implementation depends on the content and scope of the respective developments. Optimisation usually take 2 to 4 years, new developments 3 to 6 years.

Time horizon effect
The market launch takes place after product development. Subsequent market penetration depends on demand and, where appropriate, on supporting factors.

Main stakeholders
- Machine manufacturers and research institutes: Technology development.
- Cooperation with farmers, consultants where appropriate and other institutions such as chambers of agriculture and experimental goods: Development support and testing.

Costs

Expenditure on product developments is mainly attributable to machine manufacturers. Depending on the content and scope, these can amount to high double-digit millions. Research funding may be required (see Action 12).

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, depending on the energy source and machine type.

Other effects, interactions, and risks

Technology development is being driven forward by manufacturers and suppliers with extensive product offerings. Therefore, the action may have an impact on other machinery or sectors (construction machinery, commercial vehicles).

Obstacles to implementation

- A lack of cost-effectiveness of product development among manufacturers.
- High cost of use by agricultural enterprises.
- Possible overburdening of individual farms due to too many different energy sources.

Action 19

Expansion of the advisory services of the chambers of agriculture and state institutes as well as comparable institutions to include the aspect of low-greenhouse gas energy supply for mobile machines

Action

Extension of the range of advisory services offered by regional advisory bodies to include the use of renewable drive energies and the creation of contact points for farmers.

Against the background of the different conditions on farms and the manyfold of possible technical solutions, the action should include:

- higher-level specialist information on machine concepts and drive energies,
- integration of energy and material cycles into economic considerations,
- company analysis, company-specific basic consulting,
- development of a basic concept for the use of renewable drive energy,
- fundamentals of greenhouse gas accounting and the necessary data collection,
- economic consideration of possible returns from potential GHG quota trading,
- funding advice and
- excursions to demonstration farms.

The advisory services are to be integrated into existing advisory structures and the effectiveness is to be increased through an additional support programme.

Background

The use of renewable drive technologies in farms is still a niche and there is a correspondingly large need for information on technological options, fuel properties and handling, GHG-quota trading, economic backgrounds. Consulting services on energy efficiency and energy production are currently being expanded to include the assessment of the carbon footprint of individual products (current focus in dairy farming). Advice on optimizing CO_2-emissions in the production process in connection with health protection (noise, exhaust gases) and sustainability is already in demand by farmers and cannot be adequately served.

Similar advisory programmes, such as the "Biofuel and Bioenergy Advisory Service in Agriculture" supervised by the Fachagentur Nachwachsende Rohstoffe e.V. (FNR), have in the past been characterised by great demand from farmers and have therefore been successful.

Within the framework of the GAK, the Federal Government contributes to the costs of advisory services through the 'Funding of agricultural enterprises (2 B consultancy)'. Consulting services for the improvement of resource and energy efficiency, environmental protection and nature conservation are up to 100% eligible (BMEL 2024).

Mode of action

The action will, on the one hand, reduce barriers to acceptance and, on the other hand, provide technical and economic know-how so that well-founded decisions can be made regarding the application of new drive technologies on farms. This reduces the risk of misinvestment.

The expansion of the consulting as described above leads to the integration of alternative drives into existing production optimization approaches. A rather exotic topic becomes a building block for optimizing the operation.

Scope
High, as lack of advice is currently a major obstacle to the use of renewable drive technologies.

Time horizon implementation
- 1 year for the conception of the advisory offer and integration into the existing advisory structure of the federal states and the federal governments.
- 1 year for the preparation of a funding guideline for the expansion of regional advisory services.

Time horizon effect
- 2 years with regard to options that can be implemented at short notice with existing machinery and energy supply.
- Longer than 2 years for the long-term options associated with new acquisitions of previously unavailable technology or drive energy.

Main stakeholders
- Federal Ministry of Food and Agriculture (BMEL), line ministries at federal state level: Conception and funding.
- Fachagentur Nachwachsende Rohstoffe e.V. (FNR): Funding programme as a project management institution.
- Research institutions and specialised authorities: Provision of expertise.
- Advice centres at state level (covering the whole of Germany) such as chambers and offices of agriculture, state institutions and similar institutions: Development of practical advice and implementation of the advice, because these facilities are already used by the primary producers.

Costs
Staff costs for the expansion of the advisory services in the existing advisory institutions – costs are borne by the budgets of the institutions.

Expenses for an additional advisory service with funding through a support programme: € 2.5 million /a (10 to 12 counselling centres (1 per federal state, excluding ctiy-states), 2 positions per country; 2 positions at the FNR for the implementation of higher-level actions and coordination of the country's wide counselling centres.

Contributing to de-bureaucratisation
No

Contribution to self-sufficiency with energy or increase of value added in rural areas
The action indirectly supports the procurement of machines with renewable drive technologies, so that a contribution to self-supply and added value (plant oil fuel, biomethane, renewable electricity in self-consumption) can be expected.

Other effects, interactions, and risks
Positive effects are to be expected in the market ramp-up of new technologies by reducing barriers to growth. This implicitly supports all other actions. A strengthening effect can be achieved in combination

with actions to promote investment and intra-industry communication (see Action 10, Action 11, and Action 28).

Indirect support for an accelerated modernisation of the vehicle fleet, possibly resulting in efficiency gains, reduction of air pollutant emissions by using modern drive technologies, also irrespective of the use of renewable energies.

Obstacles to implementation

- Lack of funding of advisory services by the Federal Government (support programme) and the federal states.
- Lack of readiness to implement by the line ministries of the federal states.
- Incentives for the use of renewable drives must be provided, otherwise there will be no effect of this action due to a lack of economic options.
- Lack of adequate and available staff at the counselling centres. As a rule, jobs are temporary, so they may not be attractive.
- Lack of advisory services as regional focal points.

Action 20

Imparting knowledge on drive systems with renewable energies in vocational and academic education and training

Action

Drive systems with renewable energies are to be part of the teaching content at technical schools, technical colleges, and universities. In engineering faculties, this must be done in a basic and application-oriented manner, in agricultural faculties at least in an application-oriented manner. At most universities with agricultural technology in training, this has already been implemented in an individual way. The topic of drive systems must be integrated into training at vocational and technical schools. The greatest need for action lies in teacher training and further education for vocational and technical schools (technical schools and master schools).

In this context, inter-company training institutions (agricultural machinery schools, DEULA) play a key role. Machines with alternative drive systems that are fit for use in practice must be available to these institutions, since, as a rule, new technology will initially not be available in operational practice for cost reasons (see Action 13).

Background

The content of the training is defined in the respective vocational training regulations and is primarily based on the needs of the labour market and the ideas of the social partners. The Federal Ordinances are issued by the relevant Federal Ministry of Education in cooperation with the Federal Ministry of Education. The curricula of the vocational and technical schools are also based on the respective job profile but can be subjected to changes flexibly and more quickly. The federal states have the power to act here. What is common, however, to all curricula is that they are formulated in an open and procedurally neutral manner and consider the necessary scope for change in professional practice.

For example, in the profession of "farmer", the job title "environmental protection and landscape maintenance; rational use of energy and materials" is formulated in such a general way that new drive systems with renewable energies can be easily integrated into school and company training – without necessarily changing the respective regulations and curricula.

Mode of action

Practical vocational training has a high degree of efficiency. Exemplary content that leads to advantages in professional reality is well received. Thus, the positive procedures and technical solutions in the training company or in intercompany training facilities and universities are regularly the basis for later investment decisions in agricultural enterprises.

Scope

The provision of training content on alternative drive systems in the context of vocational education and training can have a direct effect only on the participants. For example, according to Bavaria's current agricultural structure survey, around 40% of farm managers do not have any professional qualifications. However, it can be assumed that trained specialists and managers have an indirect effect on less well-trained managers.

Time horizon implementation

The implementation of the actions does not necessarily require the creation of new legal bases, as they are formulated in an open and procedurally neutral manner. To be able to provide exemplary technology in intercompany training, it must first be practical. Only then it can be meaningfully worked on in vocational education and training. In the meantime, the awareness of necessary changes in the field of energy use can be heightened by communicating basic knowledge.

Time horizon effect

Actions in vocational education and training usually have no short-term effects, but only come into effect when the trained specialists come into professional responsibility. But education has the most lasting effect.

Main stakeholders

- Employer and employee organisations (here: Deutscher Bauernverband (DBV)), Industriegewerkschaft Bauen-Agrar-Umwelt (IG BAU), LandBauTechnik, IG Metall, chambers of crafts, ministries at federal level (here: Federal Ministry of Food and Agriculture (BMEL), Federal Ministry of Education and Research (BMBF)): Changes to training regulations.
- Ministries of Education of the federal states (Kultusministerkonferenz (KMK)): Curricula of vocational schools based on the Federal Framework Curricula.
- Chambers of Agriculture, ministries of the federal states: Framework plans for intercompany training actions, e. g. at agricultural machinery schools, based on decisions taken by the respective vocational training committees.
- Ministries of the federal states: Curriculum of state technical schools.
- Training organisations: Training of trainers.

Costs

No additional costs are expected for normative changes. Although the training required for teaching staff is costly, it will probably not be possible to extend it beyond the current timeframe. The main factor will be the cost of providing appropriate exemplary technology in intercompany training. If alternative drive systems based on renewable energies are established in operational practice, the training is a benefit that does not incur any additional costs.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

Consideration of drive systems with renewable drive energies in training, further education, and studies can lead to a better fact-based assessment of these technologies.

Obstacles to implementation

Intercompany training facilities (agricultural machinery schools, DEULA) often do not have machines with the new drive systems available, as they are even more expensive to purchase than conventional systems.

3.3 Actions "Agricultural technology manufacturers and specialist companies"

Action 21

Development and market launch of agricultural machinery for farmyard-related and field applications with renewable energy sources

Action

Machine manufacturers develop engines and machines that are suitable for use with renewable drive energies.

- New development of engines and machinery for use with renewable drive energies (see Action 18, "development of new drive technologies").
- Development of solutions for the use of renewable fuels in existing machinery. This includes the passing on of type approvals by the agricultural machinery manufacturer for the use of pure fuels or standardised fuel blends or conversion solutions for the fuel system, as well as engine control updates.
- Organisation of spare parts supply.
- Establishment of a network of trained workshops (see Action 23).
- Communication and marketing activities (see Action 25).

Background

So far, the range of mobile machinery suitable for the use of renewable drive systems has been severely limited. Approvals for new machines are currently usually limited to paraffinic diesel fuel HVO. Electrification plays a particularly important role for work in animal husbandry and in the low performance range.

Existing engines are occasionally approved for alternative fuels, in particular engines up to emission level IIIA.

Due to the long holding period of the machines on farms, the development of solutions for existing machines without approval for renewable fuels is of particular importance.

Mode of action

The expansion of the range of new or existing machinery suitable for the use of renewable drive energies facilitates the transition of agricultural holdings. The competition among the manufacturers as well as the increase in the number of units lead to a cost degression.

Scope

Potentially high, especially due to the inclusion of existing machines.

Time horizon implementation

Partially long research and development cycles for new machines. Further developments usually take 2 to 4 years, new developments 3 to 6 years. Implementation for existing machines is possible in the short term.

Time horizon effect

Immediately with the use of the machine with renewable drive energies.

Main stakeholders

Engine and agricultural machinery manufacturers: Development of new machines and concepts as well as approval procedures.

Costs

There are costs for the development of new machines and for the development of solutions for the vehicle. Costs for the development of electrical concepts and new drive concepts can be high. Costs for setting up spare parts supply, workshops, training courses.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, for electrified drive systems with renewable electricity produced on farms and for the use of regionally produced biofuels.

Other effects, interactions, and risks

Amortization of development costs cannot be achieved due to a lack of demand. Fuels are not available at competitive prices and in sufficient quantities.

Obstacles to implementation

- Lack of long-term legal regulations and policy objectives that make the sales market for new machinery difficult to assess.
- Lack of planning certainty regarding the availability of renewable energy sources.
- Complex licensing procedures, some of which entail extensive emission certifications.
- Depending on the age of the engines, liability issues due to a lack of continuous running experience must be clarified.
- The issue of replacing diesel fuel is not receiving sufficient international attention, so sales market for new developments is too small.

Action 22
Optimisation of homologation and type approval procedures

Action
Optimise the homologation and type approval process on the part of the authorities in cooperation with engine and machine manufacturers and technical services, which could result in a wider variety of applications for renewable fuels due to savings in effort and thus costs.

- Optimisation of the test scope within the type approval procedure based on studies and assessment by designated technical services. Coordination of the procedure with the competent type approval authority in trilogue with manufacturers and technical services. The aim is to reduce as much as possible the burden of carrying out separate tests on individual renewable fuels and fuel-blends.
- Creation of a possibility for machinery with engines approved under Regulation (EU) 2016/1628 (EU Regulation 2016/1628 2016) for diesel fuel, to extend the type approval to include additional renewable fuels. A guarantee of emission conformity by a technical service for each machine could therefore be omitted, provided that the manufacturer has released it.

Background
Type approvals for renewable fuels are currently often not applied for due to the high expenditure and high costs involved.

The legal basis for current type approvals is Regulation (EU) 2016/1628, in particular Article 25 "Carrying out measurements and tests for EU type approval paragraph 2". Previously, Directive 97/68/EU applied. Further details are laid down in Delegated Regulation (EU) 2017/654 (EU Regulation 2017/654 2017), e. g. with regard to the "requirements for other specified fuels, fuel mixtures or fuel emulsions" in Article 2 and Annex I. At national level, Section 47f StVZO "Fuels" is relevant in connection with the use of renewable fuels (StVZO 2024). It is stipulated that a motor vehicle (here: agricultural or forestry tractor/mobile working machine) with other qualities of liquid, gaseous or solid fuels may only be used if compliance with the requirements of § 38(1) of the BImSchG for the vehicle is ensured. However, proof of this requires a great deal of effort, e. g. measurements by a technical service.

Existing engines cannot be retroactively type-approved for other fuels. The manufacturers can issue approvals for renewable fuels on their own responsibility. Emission compliance shall be ensured based on individual responsibility, where appropriate in conjunction with a technical service.

Various measurements of mobile machines with renewable fuels such as paraffinic diesel fuel HVO, fatty acid methyl ester (biodiesel) as well as rapeseed oil and vegetable oil fuel have shown that the exhaust emission limits are complied with if exhaust gas aftertreatment is working properly.

Mode of action
An optimisation of the type approval procedure leads to more frequent additional approval of machinery by manufacturers for use with renewable fuels. For users of existing machines, legal certainty is created by the retroactive release.

Unlimited and widely available renewable fuels are released by engine and machine manufacturers to enable users to adopt them.

By transferring to other engine families via equality certificate, effort and costs could be reduced.

Scope
Potentially large, depending on the availability of approved machinery and renewable fuels.

Time horizon implementation
1 year for the change of requirements at national level. A longer period should be planned for adjustments at European level.

Time horizon effect
Immediately after approvals for the existing machines or type approvals for the new machines.

Main stakeholders
- Federal Ministry for the Environment and Consumer Protection (BMUV): Necessary legal adjustments.
- Engine and agricultural machinery manufacturers and technical services: Responsible for implementation.
- Federal Motor Transport Authority (Kraftfahrt-Bundesamt): Type approvals.

Costs
Additional type approvals or homologation with emission certifications are very complex and require measurements on certified test benches with extensive test procedures. These efforts require planning security.

Contributing to de-bureaucratisation
Yes, due to the dispensability of many individual reports of technical services for the respective machines.

Contribution to self-sufficiency with energy or increase of value added in rural areas
Yes, when using regionally produced biofuels.

Other effects, interactions, and risks
Any damage to machinery by customers and workshops is unfoundedly attributed primarily to the use of renewable fuels.

Obstacles to implementation
Possibly emissions concerns of the Federal Ministry for the Environment and Consumer Protection (BMUV).

Action 23

Establishment of a network of agricultural machinery dealers and specialists trained in renewable drive systems

Action

Specialist companies and their employees in trade and service must be made fit for a future with alternative drive systems. This should enable them to recognise agriculture as customer on the one hand and also master the service of the new technologies on the other. A new understanding of the system must be incorporated into the corporate culture and built up among the service staff, beyond a training course with punctual immediate actions. For this it is necessary

- to invest in vocational education and training,
- to qualify teachers in companies, trade, and schools accordingly, and
- to develop and implement concepts to motivate and qualify a workforce, for a long-time familiar with combustion engines, for the shift towards renewable liquid and gaseous fuels and electrified drive systems, including digitalisation and automation.

See also Action 20.

Background

The approximately 4,000 specialist companies for agricultural machinery trade and service are an elementary link between manufacturer and users for every type of technology in use here. Without specialist companies, the spread of new technologies cannot be implemented. This applies to livestock farming and crop production, agricultural technology, construction machinery, material handling technology, municipal technology, forestry technology and horticulture as well as outdoor cleaning technology. At most in sales, a decentralized, manufacturer-owned structure would be conceivable. In the service area, this is not economically realistic for agricultural machinery manufacturers, regardless of their size. Surveys of users show that an efficient service is more important to them than the brand. Especially since it usually concerns much higher investment volumina than in the passenger car sector. The specialized companies and their employees are necessary for agriculture because they are the technological trustees. The link is between user/agriculture and specialist trade/service, not industry. This requires a reliable, well-trained decentralized service for every innovation.

Mode of action

Qualified employees in sales, repair and service create the prerequisite that mobile machines with alternative drive systems can be brought into the market, high service availability is given, and investments can be made to the intended extent.

Scope

The scope of impact is potentially very large, as the intermediaries of the new technology are enabled to motivate for the new technologies and to supervise them sustainably.

Time horizon implementation

Reorganization of the profession by 2028.

Development of further training in crafts can be implemented at any time within one year if appropriate funding is made available for conception, "train-the-trainer" and course implementation.

The availability of specialist companies in the market will increase with the market penetration of the above-mentioned machines. Availability of staff will be the bottleneck.

Time horizon effect

- In the short term: Individual training offers.
- In the medium term: Further training courses according to the Crafts Regulations (HWO) or the Vocational Training Act (BBiG).
- In the long term: Reorganization procedure.

Main stakeholders

- Federal Ministry of Labour and Social Affairs (BMAS), Federal Ministry for Economic Affairs and Climate Protection (BMWK), Federal Ministry of Education and Research (BMBF), Federal Institute for Vocational Training (BIBB): Promotion.
- Agricultural machinery manufacturers with their own workshops, manufacturer-independent craft businesses: Expansion of service and concept development for further training and motivation of employees.

Costs

Not quantifiable

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

The challenge is how to incorporate new and existing skills requirements into an already extensive job profile.

The actions also affect technologically related machine groups, such as construction machinery technology, forestry machinery technology, horticulture and municipal technology, industrial trucks and machines used in livestock farming.

If technological training is left to industry alone, instead of integrating it into the state education system, there is a risk of gaps between the larger companies, which are already closely tied to the supplier, and which can then still maintain and repair these machines. The small workshops, without close links to the technology leaders on the supplier side, could then be quickly left behind, with corresponding consequences for competitiveness.

Obstacles to implementation

- Lack of commitment to integrating new content into education and training.
- Different regional regulations and approaches and redundancies.
- Uncertainty about the future technical concepts and thus no clear guideline on what a professional reorientation should focus on technologically.
- Low motivation, also for own further training, of trainers in the company, crafts, and teaching staff in the school.
- Lack of time for necessary training in the field of renewable drive energies, as the time account has already been used up by necessary training on digital technology and automation.
- Lack of flexibility in curricula and implementation in vocational education and training.
- Lack of monitoring of the implementation of actions in the field of vocational training.

3.4 "Fuel and electricity suppliers" action sheets

Action 24

Provision of sufficient quantities of fuel in the required quality, even in the event of seasonal peaks in demand, and creation of sufficient electrical connection capacity on farms

Action

Renewable fuels are to be offered by the fuel manufacturers and distributors at public filling stations or delivered to farm filling stations, even in small quantities and in the event of seasonal demand. Renewable electricity is to be provided covering daytime-dependent consumption peaks by generating the corresponding connection services or by self-generation and storage.

- To this end, the refuelling infrastructure for biodiesel, rapeseed oil fuel, vegetable oil fuel, HVO, Bio-CNG, Bio-LNG must be expanded at decentralised locations in rural areas in order to achieve comprehensive spatial proximity to agricultural customers. This also includes mobile refuelling systems in the harvest season.
- Gaps in the public petrol station network in rural areas must be closed on a case-by-case basis.
- Appropriate tank vehicles must be kept ready.
- Where appropriate, a quality assurance system must be established to ensure the standard quality of the fuels at the point of delivery. In addition, and a correct labelling of the fuels must be carried out to meet the requirements of the 10. Federal Immission Control Ordinance (10. BImSchV 2010).
- Standards for renewable fuels shall be continuously reviewed and test parameters, limit values and determination methods updated in accordance with requirements.
- Summer and winter qualities of the fuels must be offered. Operational safety must be ensured by appropriate raw material selection and additives.
- On the farm, care must be taken to ensure that the seasonally adapted fuel qualities are used.
- The capacity of the fuel stockpile must be sufficiently dimensioned, both at the farm and in the trade and in filling stations, to be able to cover the seasonal peaks in demand.
- Sufficient electrical connected load for fast charging of one or more vehicles on farms must be ensured by the energy suppliers.
- Charging facilities for electrified agricultural machinery and, where appropriate, battery packs must be installed.

Background

Petrol stations are already often available at agricultural sites (e.g. warehouses, cooperatives). Almost all farms are equipped with farm tank systems, which can also be used for the storage of HVO100, biodiesel, rapeseed oil or vegetable oil fuels, on short notice. For other types of fuel such as Bio-CNG/-LNG, a comprehensive infrastructure must be created.

In agriculture, different amounts of drive energy are needed over the year. Demand peaks occur during the harvest period. Comparatively easy to store are liquid fuels. Gaseous fuels require significantly higher storage capacities due to the lower energy density. In addition, gaseous fuels must be provided at the required pressure level, e.g. 200 bar for CNG. Storage of LNG for an extended period of time requires active cooling of the fuel to avoid losses.

On farms, fuels are sometimes stored over a longer period of time. A quality assurance system must ensure that fuel quality is always standardised at the time of fuel use.

For the sale and delivery of various fuels, e. g. with a tanker vehicle, the measuring instruments must be approved and calibrated for quantity determination (MessEG 2024).

Biodiesel B100, rapeseed oil and vegetable oil fuel are niche products for the use in agricultural machinery, which are not or only rarely offered at public petrol stations. Agricultural machines are supplied with these fuels almost exclusively via on-farm filling stations.

Farms which themselves produce fuels for the operation of agricultural machinery occupy a special position. Here, the provision of storage capacities on site, quality assurance, sustainability certification and, if necessary, the operation of a tax warehouse pose a particular challenge.

Battery electric machines, especially in the higher power range, require high charging speeds for a fast-charging process. Only in this way a practical use of the machines can be guaranteed.

Biodiesel (pure B100 fuel), vegetable oil fuel and **rapeseed oil fuel** comply with the standard DIN EN 14214 (biodiesel), DIN 51623 (plant oil fuel) and DIN 51605 (rapeseed oil fuel).

The supply of biodiesel or/and rapeseed oil fuel (R100) or vegetable oil fuel (P100) to agriculture is more than sufficiently secured in view of the national production capacities in the oil mills and conversion plants. Biodiesel and rapeseed oil fuel can theoretically be covered 100% by domestic rapeseed compared to the total agricultural and forestry demand of around 1.7 million tons of diesel fuel.

Biodiesel can be used as pure fuel (B100) in some existing machines up to exhaust gas level IIIA if manufacturer approvals exist. New machines for B100 are currently not offered. Newer tractors can partly be operated with biodiesel content of 20% (B20) or 30% (B30) in diesel fuel. There are currently no series machines available for the use of rapeseed oil/plant oil fuel. Conversion kits are available.

HVO100 (hydrotreated vegetable oil) is a paraffinic fuel produced from raw materials or residues of biogenic origin. The quality requirements for HVO100 are defined in DIN EN 15940. Paraffinic diesel fuels according to DIN EN 15940 have been approved for free sale at public petrol stations since 29.05.2024 (10. BImSchV 2010). Germany currently does not have its own HVO production capacity. The fuels are imported.

As a diesel substitute, the use of HVO100 in agriculture would be possible without further ado, after testing by the manufacturers.

Bio-CNG/-LNG (compressed natural gas from biogenic sources/liquefied natural gas from biogenic sources): Bio-CNG is provided by decentralized biogas plants with processing to methane and compression. Further processing to LNG is possible, but so far hardly realized. The refuelling can be carried out directly at the plant location. Alternatively, the transport of methane via the natural gas grid is possible. The quality requirement for methane as fuel is set out in DIN EN 16723-2. Bio-CNG/-LNG can be used as a substitute for fossil methane in gas engines.

Public filling stations for renewable fuels:

- HVO: approx. 240 filling stations in Germany (as of 08/2024) (eFuelsNow e. V. 2024).
- CNG: approx. 700 filling stations in Germany (as of 02/2024) (gibgas 2024) (tends to decline).
- LNG: 158 public LNG filling stations (as of 08/2024) (DENA 2024).
- Public petrol stations for biodiesel, rapeseed oil and vegetable oil fuel are currently unknown.

Electricity from renewable sources: Battery electric machines are charged with alternating current up to 22 kW or with direct current from 50 kW charging power. This requires corresponding connected power on the farms, which has so far only been partially implemented. Integration of the charging infrastructure into the operational energy management system can help to avoid peak loads.

Mode of action

The action ensures the reliable supply of electricity to agriculture with sufficient power and renewable fuels with short distances and in standard-compliant quality. Ensuring supply is the precondition for the transition to renewable drive systems and could thus increase the readiness for conversion.

For further characteristics of renewable drive energies and the effects of their use, see (KTBL 2023).

Scope

High impact because the action allows for straightforward, local procurement of fuels and the secure supply of electricity for agricultural enterprises. The stockpiling and distribution of liquid fuels is much easier to realize than that of gaseous fuels, with a corresponding effect on the scope of the action.

Time horizon implementation

The following shall be considered:

HVO100: Today, imports are already available in the German market and can also be used for agriculture at short notice. Depending on market developments, larger storage capacities are required (approximately 1 to 5 years).

Medium- to long-term availability depends, inter alia, on demand from other sectors (e.g. cars, commercial vehicles, sustainable aviation fuel quota).

Bio-CNG/-LNG: Development of sufficient refuelling infrastructure in rural areas. Time horizon 2026 and following. Locally possible much earlier.

Biodiesel (pure B100 fuel), vegetable oil fuel and rapeseed oil fuel: Biodiesel, rapeseed oil and vegetable oil fuel are sufficiently available on the market. As these fuels are mainly used via on-farm filling stations, the implementation of the action is possible in the short term. If necessary, the setting up of a tax warehouse requires a lead time.

Electricity: An energy management is quickly realisable, if necessary, in combination with the implementation of battery storage to reduce load peaks and thus the electrical connected load. The reinforcement of connected load depends on the regional grid situation and can take several years.

Time horizon effect

Immediately after implementation of the action and availability of the corresponding vehicles.

Main stakeholders

- Specialist companies: Construction and retrofitting of filling stations and on-farm filling stations as well as construction of loading points.
- Fuel producers, fuel importers, storage tank operators, fuel trading, logistics/freight forwarders: Fuel supply.
- Agricultural holdings: Storage and refuelling at the farm.
- Standardisation committees in the Technical Committee for Mineral Oil and Fuel Standardisation – FAM in the DIN Standards Committee for Materials Testing (NMP): Standardisation.
- Fuel manufacturer and fuel distributors, AGQM Biodiesel: Quality assurance.
- Electricity grid operators: Grid expansion.

Costs

- Provision of additional storage capacity by storage tank operators and fuel trade. The costs for refuelling systems for gaseous fuels are significantly higher than those for liquid fuels.
- Conversion of the delivery systems for delivery vehicles (tanker trucks) and for filling stations, for fuels with properties that deviate significantly from the diesel standard.
- Procurement of on-farm tanks and conversion of refuelling stations for liquid fuels: Approx. € 3,000 to € 120,000.
- Liquid fuels: New filling station (automatic filling station) approx. € 150,000 to € 450,000.
- CNG: New filling station (automatic filling station) approx. € 300,000 to € 500,000.
- LNG: New filling station (automatic filling station) from approx. € 1 million to 1.5 million.
- AC-Wallbox TYPE 2 up to 22 kW: Approx. € 2,000.
- DC-charging column 50 kW: Approx. € 25,000.
- Marketing actions in sales.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, in the case of the use of self-generated electricity and regionally produced biofuels or petrol station operations by agricultural cooperatives.

Other effects, interactions, and risks

- Longer service time of the vehicles due to slow refuelling at CNG/LNG or slow battery charging process.
- The fuel trade can use renewable fuels to expand its product portfolio and, if necessary, compensate for a decline in sales of fossil diesel.
- Indirect: Acceptance in agriculture increases attention in other sectors (e. g. construction, freight forwarding, trade).
- Competition among distributors can lead to price reductions.
- Renewable fuels and renewable electricity are fulfilment options for the annually increasing GHG-reduction rate in the transport sector.
- Rural areas benefit from job creation.
- Provision of protein feed as a co-product of the processing of oilseeds or high-quality fertilisers from the digestate.
- The use of CNG/LNG in agriculture opens a sales channel for the products of decentralised biogas plants derived from regional resources.
- The decline in demand for CNG from the freight forwarding industry due to the elimination of the toll reduction has a negative impact on the availability of CNG at public service stations. This also reduces the availability for agriculture.
- Linking the supply of rapeseed oil vegetable oil fuel and pro rata biodiesel with the production of protein feed.
- With bidirectional charging, battery-electric vehicles can contribute to grid stabilization.

Obstacles to implementation

- New filling station construction: Limited availability of land and effort for the permit procedure (development plan, nature reserves, etc.).
- Refurbishment of filling stations: Limited possibility to accommodate additional types of fuel (storage capacity utilised with predefined types of protection).
- Obstacles are mainly the additional costs for storage and refuelling infrastructure as well as additional costs for the stockpiling and delivery of small quantities. Costs for the calibration of measuring instruments for quantity determination, equipment of the tanker vehicles, cleaning costs for the tanker vehicles in case of product change are also obstacles.
- At public filling stations, only a limited number of storage tanks and dispensers for different fuels are available. An expansion of the product range increases the effort involved in equipping the tanker vehicles and refuelling systems.
- Lack of policy guidance and planning certainty or low carbon pricing could hamper the demand for regenerative fuels and thus the effectiveness of the actions.
- For imported fuels, there is a major barrier to uncertainty about the long-term availability of fuels. Another obstacle is competition between different sectors that want to use these fuels (mainly commercial vehicles and aviation).
- Possible reservations on the part of farmers regarding the new drive technology and the quality of the fuels.
- Slow grid expansion is an obstacle to the provision of high charging capacities.

Action 25

Reinforcement of the promotion for machines suitable for renewable drive energies

Action

Increased communication between farmers, agricultural machinery manufacturers and dealers as well as associations regarding machines with renewable drive energies and consistent concepts for energy supply and refuelling/loading. Opportunities as well as the necessary operational adjustments and limits should be communicated comprehensively. Communication channels can be machine demonstration, lecture events, information days in trade, social media, or explanatory videos. In addition, personal discussions and advice in the agricultural machinery trade are of particular importance.

Background

Renewable fuels and drive systems have an image problem in parts of agriculture. The reason for this is the partly negative experiences made using non-standardised fuels and machines not approved for biofuels in the early 2000s. Despite the technical challenges solved in the meantime (fuel standardization, type approvals up to exhaust gas stage V, functionality of exhaust gas aftertreatment, durability of injection systems), the use of renewable fuels is often viewed with scepticism. Battery electric drive systems are often critically questioned regarding their usability in daily practice.

Mode of action

A comprehensive communication strategy helps to convey the current state of play and thus reduce reservations. This gives farmers and forest managers the opportunity to select drive systems that are suitable for company specific operations.

It makes sense for the agricultural machinery industry and trade to communicate only machinery and fuels that are available at the time. For example, the fuel methane, HVO or electrified machines could be used immediately in the yard area. The same applies to the use of biodiesel in existing machines approved for this purpose. On the other hand, the corresponding machines are missing for the use of vegetable oil fuels and LNG, for example. E-fuels are currently not available in significant quantities.

Scope

Successful communication is a key lever for the transition to renewable energy and has a direct impact on final customers (farmers, contractors) (see Action 23).

Time horizon implementation

Immediately possible, provided the availability of the corresponding machines and fuels. In addition, training of sales and workshop personnel must be guaranteed.

Time horizon effect

Phased over time according to the availability of the machines and fuels. Communication needs to be continuously managed to be effective - opinion-forming takes time.

Main stakeholders

- Manufacturers, retailers, workshops: Development of a communication strategy (see Action 23).
- Other actors: Professional representatives (Deutscher Bauernverband (DBV), Deutsche Landwirtschaftsgesellschaft (DLG), LandBauTechnik, etc.).
- Representatives of fuel manufacturers (Union zur Förderung der Oel- und Proteinpflanzen e.V. (UFOP), Verband der Biokraftstoffindustrie (VDB), Fachverband Biogas (FvB), Bundesverband dezentraler Ölmühlen und Pflanzenöltechnik (BdOel), Mittelstandsverband abfallbasierter Kraftstoffe (MVaK), Verband der ölsaatenververarbeitenden Industrie in Deutschland (OVID) etc.).

Costs

Manufacturers, agricultural machinery trade and service and associations: Costs of communication activities and human resources.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

No

Other effects, interactions, and risks

- Risk that communicated content is no longer applicable due to changing framework conditions. This makes misinvestment conceivable.
- The effectiveness of communication is hampered by the adherence of stakeholders to the use of diesel fuel.
- Effectiveness of communication is hampered by conflicting messages.

Obstacles to implementation

- The action does not have any effect if the costs for the machines, fuels or electricity are too high and thus no overall economic operation of the respective machines is possible.
- Lack of provision of corresponding machines in all relevant performance ranges by the agricultural machinery industry.

3.5 Actions "Agriculture and service providers"

Action 26

Participation in value creation in the energy market through the provision of electricity and the production of agricultural raw materials and their processing into fuels

Action

Farms should participate in value creation

- through the production of agricultural raw materials,
- through the processing of agricultural raw materials into biofuels and co-products such as food and feed, e. g. decentralised oilseed processing; and
- by providing electricity, e. g. through PV or biogas plants.

Background

The value added from the provision of diesel fuel for agriculture currently only benefits the petroleum-producing states and the petroleum industry. Around € 1.6 billion (2.1 billion litres, 0.75 ct/l each excluding taxes) is spent annually on diesel fuel from agriculture and forestry. Part of this sum could be diverted into regional value creation strategies.

In 2023, 583,000 hectares of oilseeds, in particular rapeseed, were grown in Germany for fuel use. Rape cultivation promotes biodiversity (flowering plant/root crop) due to crop rotation (every four years), improves field hygiene (crop rotation diseases) and its preceding crop effect reduces the N-requirement for winter wheat. Plants to produce biogas were grown on 1,370,000 hectares (FNR 2024). In addition, farm manure and residues from agriculture are available for biogas production.

On farms, rapeseed oil and vegetable oil fuel can be produced in decentralised oil mills. Small biodiesel production plants have been tested in the past but have not prevailed. Biogas is usually produced in the agricultural environment and can be converted into electricity or biomethane, also for use as fuel. Existing or upgradeable PV-systems can help to ensure a seasonal energy supply for the operation of electric drives for building units, e. g. livestock housing ventilation, or for the electrification of drives. The large-scale oil mills in Germany have an oilseed processing capacity of approximately 9 million tonnes. The processing capacity of the biodiesel plants is more than 4 million tonnes of vegetable oil (UFOP 2023). Methane production from biogas plants in Germany is around 84 TWh per year (FvB 2023).

In the production of biofuels from cultivated biomass, non-GMO protein feed is produced as a co-product. These replace expensive soybean imports from overseas and thus reduce the land-use pressure in the soybean exporting countries.

Mode of action

The production of agricultural raw materials and the provision of fuels and electricity for use in agriculture increases regional added value for the benefit of agricultural operators and rural areas and contributes to the creation and safeguarding of jobs in agriculture and specialised service companies. The domestic availability of renewable drive energies increases the independence and thus the resilience of food production.

Scope

A complete replacement of fossil diesel with renewable drive energy reduces capital outflows by up to € 1.6 billion. No figures are available on job effects.

Time horizon implementation

- Raw material production: Possible in the short term.
- Provision of fuels: 1 year for (re-)commissioning of decentralized oil mills, 2 years for the construction of decentralized biodiesel plants.
- Provision of renewable electricity: 1 year for the installation of PV-systems.
- Provision of biogas/biomethane: Several years for the approval and construction of a biogas plant, where appropriate with biogas upgrading.

Time horizon effect

Immediately after implementation of the action.

Main stakeholders

- Agricultural holdings: Producers of raw materials.
- Agricultural holdings and cooperative associations: Operation of fuel producing and power generating installations.
- Specialist companies: Construction of fuel production installations and power generation installations.
- Federal Ministry of Food and Agriculture (BMEL), Federal Ministry for Economic Affairs and Climate Protection (BMWK), Federal Ministry of Education and Research (BMBF): Adaptation of the framework conditions.
- Associations, e. g. Deutscher Bauernverband (DBV), Federal agricultural associations, Verband der Landwirtschaftskammern (VLK), Deutscher Raiffeisenverband (DRV) (see Action 19, Action 20, and Action 28): Communication.

Costs

- Costs to produce raw materials.
- Costs of sustainability certification.
- Costs of installation and operation of the equipment.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, important for the sector and rural areas as a whole.

Other effects, interactions, and risks

- Improvement of acceptance for the use of sustainable renewable energies.
- Contribution to the closure of energy and material cycles.
- Contribution to sectoral climate protection and offsetting under the Climate Protection Act.
- Buffering effect through the cultivation of multi-purpose plants, such as rapeseed, with regard to food security and energy provision even in the event of a crisis.

Obstacles to implementation

- Lack of a comprehensive communication strategy.
- Excluding the energy recovery of renewable raw materials in the National Biomass Strategy (NABIS) would limit the implementation of the action.

Action 27

Exploiting the potential of renewable drive energy in the provision of agricultural raw materials with low carbon footprint

Action

Clarification of the potential to reduce GHG emissions using renewable drive energies in the provision of agricultural raw materials and integration of the emission source drive energies into the requirements of the Product Carbon Footprint (PCF).

Background

The PCF (Product Carbon Footprint) is steadily gaining in importance because of the required sustainability reporting across the entire supply chain, laid down in the EU-Directive on corporate sustainability reporting (EU-Directive 2022/2464 2022). The agricultural commodity trade, the processing industry and the food retail trade increasingly demand the reduction of GHG-emissions in the production of agricultural commodities and corresponding documentation. Farmers are therefore called upon to make a contribution for reducing GHG-emissions. If 90 litres of diesel are consumed per hectare, this corresponds to approximately 240 kg of CO_2e, plus emissions from petroleum production, processing, and transport. By switching to alternative low-emission drive energies, a tangible and easily documented contribution can be made to reducing product-specific GHG-emissions during management on all farm areas. So far, this easy-to-implement action has not been sufficiently considered.

Mode of action

The achievable revenues for agricultural raw materials are also likely to depend on the level of the CO_2-footprint in the future. The action contributes to operational GHG-optimisation within the framework of the actions (fertilisation, fertiliser type, etc.) and allows farms to generate a financial advantage and secure market access.

Scope

The incentive effect depends on the producer price advantage through a "carbon reduction bonus" on the product.

Time horizon implementation

The provision of data to calculate the carbon footprint can be done immediately. A consolidation process can begin at short notice.

The establishment of a calculation tool between the actors involved, considering international regulations and in agreement, including the obligations to provide certified proof, has a several-year lead time.

Time horizon effect

Immediately with the integration of the drive energies into the calculation methodology.

Main stakeholders

- Research institutions: Coordination of the coordination process and validation by institutions such as Thünen-Institut, Kuratorium für Technik und Bauwesen in der Landwirtschaft (KTBL), Technologie- und Förderzentrum (TFZ).
- Professional representations of agriculture, agricultural research, chambers of agriculture, agricultural commodity trade, processing industry, food retail trade: Coordinating standards.

Costs

- Personnel costs for the development of the standards and the implementation of the tools.
- The implementation entails costs for data collection and data storage, including certification.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, higher revenues are possible through "CO_2-reduction bonus" on the products.

Other effects, interactions, and risks

- The designation of the PCF on food may give rise to purchase incentives for climate-friendly products.
- Positive image for agriculture if successfully bringing the discussion about the advantageousness of renewable drive energies into society.

Obstacles to implementation

- Lack of acceptance in agriculture.
- Costs for audits/expertise, if necessary.

Action 28
Strengthening intra-sector communication

Action
Establishment of a dialogue between farmers, fuel manufacturers and dealers, agricultural technology industry and agricultural technology specialist companies as well as associations. Use of existing and establishment of new communication channels of the actors involved:

- Newsletter, websites, social media
- Public relations
- Product videos, data sheets
- Explainer videos,
- Influencer channels
- Meetings, lectures, and webinars
- Fair appearances, field days, best-practice demonstration farms
- "Renewable Drive Energy Platform for Agriculture" (www.erneuerbar-tanken.de)

Communication content:

- Raising awareness (GHG-reduction targets for agriculture, cost development for fossil fuels)
- Encourage acceptance (entrepreneurial opportunities)
- Technical information
- Legal provisions
- Environmental impacts
- Economics
- Possible applications on the farm

The communication strategies must be structured in time according to the technical and economic feasibility in practice, so as not to arouse false expectations, avoid false investments and do not tire the addressees with the communication.

Background
Farmers must increasingly deal with more cost-effective measures from an entrepreneurial point of view, considering climate protection and the end of the tax refund for agricultural diesel. The awareness of the importance of diesel use for greenhouse gas emissions and the need for reduction is not sufficiently pronounced. Communication on this topic and the opportunities and risks of switching to renewable drive energies between all actors involved is insufficient. This results in uncertainties for all stakeholders and low acceptance for new solutions.

It is important to involve agricultural engineering specialists (specialist workshops) as they contribute significantly to the adoption or rejection of a technique (see Action 23 and Action 25).

The prerequisite for the use of technology is the availability of the technology as well as the basic technical understanding of the users. Communication is therefore the basis for acceptance and progress. Without successful communication, financial incentives are not very effective. In the 2000s, biofuels were already used in agriculture, but due to some negative experiences, there are still reservations about new technologies.

Mode of action

The networking and communication of operational experiences with the use of alternative fuels and drive systems within agriculture and all actors involved promotes awareness of the problem and thus the readiness to switch (see Action 15 and Action 19).

Scope

High, as lack of communication is currently a major obstacle to the use of renewable drive energies.

Time horizon implementation

In the short term, as no or hardly any technical and administrative structures need to be set up to expand communication. Only personnel must be provided for certain actions.

Communication content on problem awareness, environmental impacts and legal requirements can be conveyed immediately. The technical information and other content must be communicated, adapted to the availability of the corresponding solutions.

Time horizon effect

Communication on problem awareness, environmental impacts and legal requirements can be successful in the short term. With the increasing networking of the actors, a strongly growing effect is expected over time.

Main stakeholders

- Various actors: Communication activities.
- Trade press: Strengthening the impact.
- Research institutions and specialised authorities: Provision of expertise.

Costs

Costs related to the outreach activities of the actors involved.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, for electrified drive systems with renewable electricity produced on farms and for the use of regionally produced biofuels.

Other effects, interactions, and risks

- Positive image for agriculture if successfully bringing the discussion about the advantageousness of renewable drive energies into society.
- One risk is the overlapping of communication on renewable drive energy with issues perceived as more important, e. g. animal welfare, biodiversity.
- A continued discussion on a return to tax relief for fossil diesel fuel in agriculture undermines communication on renewable drive energies.

Obstacles to implementation

- Continuation of the discussion about negative experiences in the past.
- Not very motivated actors.
- Uncoordinated approach to knowledge communication.
- Low planning reliability due to a lack of or frequently changing legal and economic framework conditions.

Action 29
Conversion of the machinery park to renewable drive energies

Action
The machinery of agricultural enterprises and contractors is to be converted to motorized vehicles with alternative drive technologies and corresponding fossil-free energy sources.

The implementation of the action described above involves investments that will vary in scope and timing depending on the type of drive technology and energy source used. It concerns new machines, the retrofitting of existing machines and, where appropriate, the supply infrastructure. An influence on other elements of the operational mechanisation scheme is not excluded and must be considered.

There are several criteria for investment in non-road mobile machinery (see Annex), which agricultural companies and contractors must first assess and match with their operational capabilities to make decisions. The following three areas require further analysis:

1. Analysis of the availability of new machines with alternative drive technologies and conversion or retrofit kits for existing machines.
2. Analysis of the availability of renewable electricity and renewable fuels for use in
   a) new machines with alternative drive technologies, in particular electric drive technologies,
   b) Existing engines with internal combustion engines,
   c) Existing machinery with or without conversion or retrofit kits, where technically possible, for internal combustion engines.
3. Analysis of operating costs or procedural costs when using
   a) new machines with alternative drive technologies, in particular electric drive technologies,
   b) Existing engines with internal combustion engines,
   c) Existing machinery with or without conversion or retrofit kits, where technically possible, for combustion engines.

Similarly to the machines, the analysis and evaluation of the supply infrastructure is also part of the tasks, as stated in the decision criteria.

Based on these analyses, the conversion to renewable drive energy should take place on farms and at agricultural service providers.

Background
The existing mechanization in agriculture is based on the use of fossil diesel fuel for use in internal combustion engines. Machine concepts with renewable drive energies have been presented in the past, but due to economic and technical concerns, they have only been accepted to a very limited extent. The possibilities of switching to renewable drive energies depend on various framework conditions (technical, logistical, and legal), which are still unclear in many respects.

Due to the tightening of the time window to meet the climate protection targets by 2045, the conversion of existing machines must be increasingly taken into account.

The offers of new machines with alternative drive technologies are carried out by the manufacturers in the sense of a phase-out / phase-in strategy. This means: Simultaneous change of all products or product lines in companies' product portfolios will not be realistic for a variety of reasons. Therefore, if farms and contractors need to develop a conversion strategy, the type and extent of incentive systems to be provided will have to be considered when investing in alternative drive technologies.

The willingness and possibility of farmers and contractors to convert the machinery park to alternative drive technologies depends largely on the available technological solutions and offers (alternative drive technologies and energy sources) as well as their respective properties.

The investment decision is made based on objective criteria and subjective assessments. By applying criteria, barriers can be specifically assessed and, if necessary, appropriate funding instruments developed. A list of exemplary decision-making criteria is set out in the annex.

Mode of action

The implementation of the action will lead to compliance with greenhouse gas reduction commitments in the field of fuel use in the agricultural sector. A rapid changeover leads to the securing of a future-proof machine park without burdens due to a machine stock that can only be operated with diesel fuel. Expected price increases for fossil fuels under the Fuel Emissions Trading Act (BEHG 2020) and the EU-Emissions Trading System ETS 2 (EU-Directive 2023/959 2023) can thus be cushioned.

The results of the analysis help to identify the obstacles to the transition to alternative drive technologies, to assess their impact and to reduce or completely remove them with suitable incentive systems and framework conditions.

Scope

High

Time horizon implementation

From a technical point of view, the conversion in the area close to the farm (farm loaders, wheel loaders, feed mixers, etc.) can start immediately, as well as the operation of existing machines with renewable fuels, provided that appropriate approvals are available, and the supply of fuels is guaranteed (see Action 24). In addition, new machines with type approval for CNG and HVO can be purchased in the short term, which are already offered by agricultural machinery manufacturers today. Experience has shown that the new development of machines requires 3 to 6 years. The start of development depends on a recognisable market perspective for manufacturers. The conversion of machinery will be delayed if the application of the above criteria leads to a negative assessment, in particular of economic viability.

Time horizon effect

Immediately after implementation of the action.

Main stakeholders

- Decision-makers on farms and in agricultural service providers: Procurement of machines.
- Service facilities, machine manufacturers: Machine offer and service.
- Fuel manufacturers and distributors, electricity providers and grid operators: Provision of energy.

Costs

For electric skid steers, a surcharge of about 50% on the price of the diesel machine is to be expected, for electric telehandlers an increase of about 30% and for battery electric small tractors a surcharge of about 60%. For tractors that are operated with vegetable oil fuel, or for conversions, additional costs of about € 10,000 can be incurred. From the truck sector, costs for biodiesel equipment of up to around € 2,000 are known. A tractor certified for methane (CNG) is about € 20,000 more expensive as compared to the diesel counterpart. For machines with a certification for HVO, no higher costs are due. In addition,

there are expenses for AC and DC charging stations as well as for additional on-farm filling stations for renewable fuels.

Contributing to de-bureaucratisation

No

Contribution to self-sufficiency with energy or increase of value added in rural areas

Yes, for electrified drive systems with renewable electricity produced on farms and for the use of regionally produced biofuels.

Other effects, interactions, and risks

- In the case of the procurement of new machines, efficiency gains if applicable, reduction of air pollution emissions using modern drive technologies, also independent of the use of renewable energy.
- Enables the use of locally produced raw materials and derived fuels and the use of self-generated electricity, thus reducing the need for energy imports.
- The sustainability of agricultural production processes and the products produced is significantly improved within supply and value chains and leads to greater competitiveness. This is especially true for early adopters.

Obstacles to implementation

- Incomplete decision-making criteria not yet sufficiently agreed with the relevant stakeholders.
- Lack of information and data bases for assessing fuel options according to the decision criteria slows down and hinders purchasing decisions.
- Increased costs for machinery and fuel.
- Lack of availability of machinery and energy sources.
- Lack of communication on the requirements for the handling of machinery and energy sources, e. g. regarding housing, storage and labelling.
- Further barriers may arise from the outcome of the assessment in accordance with the criteria set out below.

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Appendix

Exemplary decision criteria for investments in mobile machines

I Procurement of machinery

Manufacturer/brand

Which manufacturer can supply machines that match the application profile of the company's processes?
Which drive technology is offered or which energy sources are required for this?
Which technical design distinguishes the machines (design, dimensions, and weights)?
Are the machines reliable and easy to operate?
What operating costs can be expected?
Where does competent advice (experience, trust) for possible investments come from?
What image and brand value does the manufacturer have (attractiveness for the customer or for the driver)?
Investment security I: Consistency of value and resale value?
Investment security II: Dynamics of legal framework conditions?
Which market ramp-up scenarios (unit costs, product operational safety, etc.) are to be expected for the relevant products as a whole?

Sales partner/distributor:

Is there a suitable sales partner nearby who ensures availability and competent service of these machines?
Possibilities and level of self-service?
Do I get competent advice from the dealer?
Is there a replacement possible on short notice?
What share does the dealer, and his brands have in my machine park?

II Procurement of equipment

Manufacturer/supplier

How should the sufficient and short-term availability of energy sources be assessed?
Charging infrastructure on site or in the field (duration, costs, logistics, etc.)? Is the timely, quantitative, and close-to-operation supply of required energy sources ensured?

III Process engineering (agricultural production)

Crop production

Compatibility (hardware and software) with existing or future implements and trailers to carry out the field work?
Power requirement (power requirement, continuous power, management of peak loads, automatic or future autonomous work)?
Effects on agronomic processes?

Ensuring that work is carried out on time (season, impact, etc.)?
Effect on the environment in normal operation (soil, plant)?
Impact on the environment in the event of an accident?
Effects of alternative drive technologies on semi-automated, automated, or autonomous work?
What should be taken into account when parking the vehicles on the field or indoor?

Livestock farming

Compatibility (hardware and software) with existing or future attachments and trailers to carry out work in the building (warehouse) or livestock houses?
Power requirement (power requirement, continuous power, management of peak loads, automatic or future autonomous work)?
Effects on agronomic processes?
Effect on the environment in normal operation (soil, plant, animal)?
Impact on the environment in the event of an accident?
What should be considered when parking the vehicles (indoor or outdoor)?

III Labour Economics

What is the supply infrastructure for the respective energy sources?
How should the handling of the respective energy sources be assessed (safety aspects, certificates of competence, tests, etc.)?
Duration of the refuelling or charging process?
What workload can be expected for procurement and storage before and during the use of machines?
Impact on workflows (quality, time, costs)?

IV Economic efficiency

What purchase and investment costs for machinery and infrastructure are to be expected?
What operating and maintenance costs can be expected?
Will farming practices ((a) production and (b) mechanisation) change in the future and what significance does this have for operational success and competitiveness?
Does the transformation affect the complexity of operational mechanization and the associated indirect costs?
Does the effort required to work with different dealers and workshops and to ensure the necessary know-how for operation and maintenance increase, especially in machine-intensive structures such as contractors, which must provide a broad range of technical solutions for different customer requirements?
Are there any support actions (investment grants, tax concessions) for the purchase of the machine?
Are there any support actions (grants, tax concessions) for the use of self-generated renewable energy sources?
How should value stability and resale value be assessed (investment security)?
If the economic viability in an overall view (investment and operating costs, added value, for example in the context of EU-taxonomy or sustainable finance) is given in the long term compared to established systems, a changeover is more likely to be considered.

List of abbreviations

€	euros
AC	Alternating current
AGQM	Association for Quality Management Biodiesel e.V.
B100	Pure biodiesel fuel
BBiG	Vocational training law
BdOel	Federal Association of Decentralized Oil Mills and Vegetable Oil Technology
BEHG	Fuel Emissions Trading Act
BImSchG	Federal Immission Control Act
BImSchV	Federal Immission Control Ordinance
Bio-CNG	Compressed Natural Gas from biological sources
BiokraftNachV	Biofuel Sustainability Regulation
Bio-LNG	Liquified natural gas from biological sources
BLE	Federal Institute for Agriculture and Food
BMAS	Federal Ministry of Labour and Social Affairs
BMBF	Federal Ministry of Education and Research
BMDV	Federal Ministry of Digital Affairs and Transport
BMEL	Federal Ministry of Food and Agriculture
BMF	Federal Ministry of Finance
BMUV	Federal Ministry for the Environment and Consumer Protection
BMWK	Federal Ministry for Economic Affairs and Climate Protection
BTL	Biomass-to-liquid
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalents
Ct	cent
DBV	German Farmers' Association
DC	Direct current
DIN	German Institute for Standardization
DLG	German Agricultural Society
DRV	German Raiffeisen Association
E-fuel	Electricity-based fuels
EnergyStG	Energy tax law
EU	European Union
EU-ETS 2	Emission trading scheme 2
R&D	Research and development

FC	Fuel cell
FT-diesel	Fischer-Tropsch diesel fuel
FvB	Association of Biogas
GAK	Joint task "Improvement of the agricultural structure and coastal protection"
GJ	Gigajoules
ha	Hectares
HVO	Hydrotreated vegetable oils
HVO100	HVO pure fuel
HWO	Craft regulations
ICE	Internal combustion engine
KBA	Federal Motor Transport Authority
Kg	Kilograms
KMK	Conference of Ministers of Education and Cultural Affairs
SME	Small and medium-sized enterprises
kW	Kilowatts
l	Liters
LNG	Liquified natural gas
MJ	Megajoule
MVaK	Association of Waste-Based Fuels
NABIS	National Biomass Strategy
OVID	Association of the Oilseed Processing Industry in Germany
P100	Vegetable oil pure fuel
PCF	Product Carbon Footprint
PJ	Petajoule
PTL	Power-to-liquid
PV	Photovoltaics
R100	Rapeseed oil pure fuel
t	Ton
TFZ	Technologie- und Förderzentrum im Kompetenzzentrum für Nachwachsende Rohstoffe
GHG	Greenhouse gas
TRL	Technology readiness level
UFOP	Union for the Promotion of Oil and Protein Plants
VDB	Association of the Biofuel Industry
VDMA	Association of Machine and Plant Manufacturers
VLK	Association of Chambers of Agriculture

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