LIFE Project Number

LIFE12 BIO/LV/001130

FINAL NARRATIVE REPORT-PUBLIC VERSION

Covering the project activities from 01/10/2013 to 31/12/2017

Reporting Date

31/05/2018

LIFE+ PROJECT NAME or Acronym

Alternative use of biomass for maintenance of grassland biodiversity and ecosystem services

LIFE GRASSSERVICE

Project Data

Project location	Latvia
Project start date:	01/10/2013
Project end date:	31/12/2017 **Extension date**: ---
Total Project duration (in months)	51 months
Total budget	1,280,964 €
Total eligible budget	1,280,964 €
EU contribution:	640,482 €
(%) of total costs	50%
(%) of eligible costs	50%

Beneficiary Data

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1. List of contents

1.1 List of abbreviations

AB	Associated beneficiary
BEF-LV	Baltic Environmental Forum – Latvia
Bio RE	AB 2 – "Bio RE" Ltd.
c.a.	around, from Latin *Circa*
CB	Coordinating Beneficiary
cm	centimetre
EC	European Commission
ENG	English
e.g.	for example, from Latin *exempli gratia*
etc.	and the other things, from Latin *et cetera*
EU	European Union
ha	hectares
i.e.	in other words, from Latin *id Est*
JSC	Joint stock company
kg	kilogram
km	kilometer
l	liter
LAT	Latvian
LFN	AB 1 - Latvian Fund for Nature
Ludza	AB 5 - Ludza Municipality Council
Ltd.	limited company
n/a	not applicable
m	meter
m^3	cubic meter
NGO	Nongovernmental organisation
No	Number
RTU	AB 3 - Riga Technical University
Sigulda	AB 4 - Sigulda Municipality Council
Skujas	AB 6 - farm "Skujas"
t	tonne

2. Executive Summary

The main objective of the LIFE GRASSSERVICE project was to ensure maintenance of biologically valuable grasslands by enhancing alternative, economically sustainable approaches to the use of grassland biomass as well as establishing co-operation models between farmers, entrepreneurs and local authorities, which would ensure viability of grassland management and proposed technological solutions. The project activities were carried out in two local municipalities of Latvia (Sigulda and Ludza), which although representing different socio-economic situation, both (at the start of the project) were characterised by large share of non-used agriculture land and abandoned grasslands. To enhance sustainable grassland management, the project assessed biological and economic value of grasslands in the two municipalities, potentials for the use as well as developed alternative solutions for grassland management and utilisation of biomass. The project has carried out grassland restoration activities in the both municipalities, thus establishing preconditions for further grassland management, but also creating valuable experience in various grassland restoration methods and building know-how among local entrepreneurs and landowners. Furthermore, the project has demonstrated in practice the alternative technological solutions for biomass processing for production of bio-energy (i.e. biogas and biobutanol) to wide range of interested stakeholders, including entrepreneurs and researchers investigated possibilities for innovative biomass uses. The project demonstration activities, informative events as well as communication tools and materials have increased the knowledge of local community on opportunities for sustainable grassland management and facilitated contacts and co-operation among landowners, entrepreneurs, grassland management experts and researchers, thus ensuring continuity of the undertaken actions.

The main results of the project activities are summarised in the following deliverables and outputs:
- Report on grassland biomass resources in the 2 pilot areas;
- Report on technical solutions for use and processing of biomass and their cost-effectiveness;
- Internal Activity Plans on management of grassland habitats at the 2 project areas;
- Technical specification of the biogas production prototype;
- Electronic publication on alternative uses of grass biomass;
- Report on impacts of the project activities on grassland ecosystems;
- Report on socioeconomic impacts of the project activities;
- After-LIFE conservation and communication plan.

The results of the direct conservation/management measures include:
- registers of local landowners and entrepreneurs maintained by the Sigulda and Ludza municipalities;
- 14 long-term agreements with local landowners on management of restored grasslands;
- 122 ha of grassland habitats restored in the 2 project pilot areas/municipalities;
- a prototype for production of biogas from grass biomass developed;
- adaptation of the existing biobutanol production technologies to the use of grass as feedstock studied at the existing biobutanol pilot facility;
- biogas production facility demonstrated to 331 and biobutanol facility to 526 interested stakeholders.

The main information, public awareness and dissemination activities organised:
- 2 international seminars: on solutions for sustainable grassland management and dissemination of the project results;
- 4 informative seminars for local stakeholders (in total 297 participants);
- web-based information platforms established by the Sigulda and Ludza municipalities;
- brochure about project and alternative use options of grassland biomass (1000 copies in Latvian);
- 4 notice boards (two in each project pilot area);
- project home page and information at the web pages of the project partners;
- Layman's report (300 copies in Latvian and 100 copies in English).

Targets of the following two demonstration actions could not be achieved:
- *Demonstration of grass pellet production* was not possible due to drop out of the partner in charge, who had a business interest to set up a grass pelleting facility in Sigulda municipality, and lack of

other interested entrepreneurs within the project areas or vicinities, who would be willing to join the project or to provide such service. Nevertheless, the project has successfully demonstrated the other two innovative technologies for use of grass biomass - biogas and biobutanol production, whereas grass pelleting can be considered as rather conventional and available on the market.

- *Eliminating the invasive species Sosnowsky's hogweed within 25 ha* was not implemented due to change in grassland management requirements in Latvia. Since 2015 agricultural support payments were available also for grassland areas invaded by hogweed, if they are mowed before blooming of the species, thus the area of unmanaged grasslands with hogweed have considerably decreased. At the same time the owners of the still remaining grasslands with hogweed, not receiving agriculture support payments, were not interested to co-operate with the project and/or to sign the long-term agreements for continuation of grassland management.

The project management system

The project LIFE GRASSSERVICE is funded by the LIFE Nature & Biodiversity Programme under the Biodiversity strand. The project was implemented from 01.10.2013 to 31.12.2017. The project consortium initially was formed by seven partner organisations: two NGOs – CB BEF (Baltic Environmental Forum – Latvia) in charge for the project management, including financial and administrative supervision as well as technical supervision and co-ordination of all actions and AB1 LFN (Latvian Fund for Nature) in charge for assessment of grassland resources and biodiversity; two research institutions providing expertise on bioenergy production – AB2 Bio RE and AB3 RTU (Riga Technical University), and two administrations of local authorities (AB4 Sigulda and AB5 Ludza) in charge for building local cooperation networks as well as AB6 farm "Skujas", in charge for grassland restoration activities in Sigulda Municipality and demonstration of grass pellet production. AB6 "Skujas" resigned from the project partnership in November 2015, due to change of economic conditions as well as its management structure and financial capacity. For planning and co-ordination of the project activities half yearly project partners meetings were organised (10 in total) as well as more than 20 ad hoc meetings on specific topic.

Assessment of grassland biomass resources

The assessment was based on the data obtained by the Project partners (airborne and field surveys), as well on datasets and maps provided by other institutions. Overall field inspection of 1042 ha of biologically valuable grasslands and grasslands of Community importance was carried out in 2014 and 2015 concluding that 337 ha of grassland habitats in Sigulda Municipality and 585 ha in Ludza Municipality correspond to the status of Community importance or grasslands with potential to reach it, however the overall quality of habitats is rather poor. The total amount of dry grass biomass was estimated. The amounts significantly differ among habitat types (e.g. there is almost five time less biomass in Xeric sand calcareous grasslands (6120*) compared to Lowland hay meadows (6510)). At least 28% of grasslands in Sigulda Municipality and at least 48% in Ludza Municipality were assessed as unmanaged or mowed in late August when the quality of grass is not good as fodder for cattle. The amount of not used grassland biomass was calculated for both municipalities. Economic valuation of the grassland biomass resources in the project pilot areas showed that the total profit from production and realisation of hay that could be produced from the grasslands that currently are not managed or used for hay production is 1.38 million euro. The results of the assessment were summarised in the Action A1 report and maps.

Assessment of measures applicable for maintenance of grassland habitats

To obtain an overview on current experience of LIFE and other projects implemented in the Baltic States and other EU countries an international seminar „Sustainable grassland management: biodiversity conservation and alternative uses of grassland biomass" was organised on 05.-06.11.2014 in Sigulda, Latvia. The event gathered 52 participants from Latvia, Estonia, Lithuania, Poland, Germany and the United Kingdom representing various organisations, institutions and companies. Balancing nature conservation and processing of grassland biomass as a potential source of renewable energy was discussed. Experience presented in the seminar revealed that grass biomass can be used for energy production in local small-scale applications, starting from simple combustion up to modern integrated generation of solid fuels and biogas from biomass technologies. However, integrated and combined solutions bring better results than stand-alone approaches.

Testing of technological solutions for processing of grass biomass for production of biogas and biobutanol was carried out. 162 samples of grass biomass from 6 dominating grassland habitat types in Sigulda and Ludza Municipalities were collected, analysed for contents and exposed to various physical and chemical conditions at laboratory conditions. Various forms of grass biomass were treated: raw grass, hay and silage. Splitting biomass by grinding or steam explosion, thermal treatment, ozonation, enzymatic hydrolysis has been tested and optimal technologies found for each biobutanol and biogas production. The results are included in the Action A2 Report on possible technical/ technological options for use of biomass with evaluation of cost effectiveness.

Development of internal activity plans

Two internal activity plans for each Sigulda and Ludza Municipality were finalised in autumn 2015 forming the bases for demonstration activities within Action C2. The plans include assessment of the current use of grass biomass and quality of grassland with attention to biologically valuable grasslands, criteria for selecting the sites to be restored by the project (elimination of shrubs and the Sosnowsky's Hogweed), as well as description of the actions for demonstration of alternative use of grass biomass. Grassland ecological networks were proposed concentrating around 8 core areas in Sigulda Municipality and 15 core areas in Ludza Municipality. The plans delineated 67 potential grassland restoration sites of 300 ha with the aim to clear shrubs and 54 sites of 137 ha with the aim to eliminate the Sosnowsky's Hogweed in Sigulda Municipality; and one site of 25 ha to clear from trees and bushes and eliminate invasive/expansive species in Ludza Municipality.

Technical preparation for purchase and improvement of biomass processing equipment

For preparing the tendering documentation the Technical Specification for the biogas pilot facility (prototype) was developed containing description and precise parameters of the separate components of the prototype. The Technical Specification includes the technical drawings of the prototype (prepared within Action C2), which is the essential part of the prototype documentation, used for the price surveys of its assembling elements.

Establishment of local co-operation networks for grassland maintenance

Establishment of contacts with local stakeholders and facilitation of local co-operation networks was implemented by the administrations of Sigulda and Ludza municipalities. This included two rounds of interviews with landowners and grassland managers (carried out in 2014 and 2017), which provided information on grassland management and use of grassland biomass in the project areas (and was also used for the project impact assessment), but also allowed to identify landowners, who are interested to be involved in project activities, including grassland restoration. Information from the interviews was also used for development of the registers of local land owners and managers as well as registers of entrepreneurs, including information on land properties and management status of grasslands as well as contact information of landowners, who represent interest from the project implementation perspective, e.g. owners of biologically valuable grasslands. The registers served as basis for forming the local co-operation networks. The information in the registers was permanently updated. The web-based information systems were developed to facilitate exchange of information on offer/demand for grassland biomass resources, agriculture related services or land leasing. Networking of local landowners and entrepreneurs was encouraged also by the series of informative seminars and meetings with landowners and entrepreneurs for discussing the grassland management and restoration as well as opportunities for alternative use of grassland biomass. One of the results of the networking activities and negotiation with local landowners was the signing of the long-term agreements (13 in Sigulda Municipality and 1 in Ludza Municipality) on maintenance of the grasslands restored within the project.

Demonstration actions on processing of biomass

The demonstration actions consisted of two main blocs: restoration of grasslands; and demonstration of biogas and biobutanol production. In total, 122 ha of grasslands were restored: 25 ha compact site in Ludza Municipality, and 12 sites with an area of 97 ha in Sigulda Municipality. The biofuel production was demonstrated using a biobutanol pilot facility of AB3 RTU as well as launching of biogas pilot facility (prototype) developed by AB2 Bio RE. The both facilities were demonstrated since September till December 2017 in the project areas Ludza and Sigulda municipalities and actively promoted during the visitor days to various groups of interested stakeholders, including residents, entrepreneurs, researchers

and students of technical schools and universities as well as schoolchildren. The biobutanol pilot facility was available for demonstrated for a longer period – since April 2016, at premises of the Riga Technical University. In total 565 interested stakeholders have visited the biobutanol facility and 331 - biogas production prototype. During the demonstration period, 40 l of biobutanol and 200 m^3 of biogas have been produced.

Monitoring and assessment of project impacts

Impacts of the project activities were assessed in relation to the grassland ecosystems as well as to the socioeconomic situation in the two municipalities. To assess the impacts of different management regimes (including application of digestate) on grassland habitats in total 24 permanent monitoring plots were established, where samples of grass biomass and terrestrial beetles' samples were collected, and description of vegetation performed annually. For assessment of impacts of restoration activities, a questionnaire on habitats quality of the sites proposed for restoration as well as detailed overgrowth maps based on LIDAR and orthophoto data was used. The monitoring report describes the impacts of habitat restoration activities to conservation status of EU grassland habitats in Sigulda and Ludza Municipality as well as the impact of digestate application to vegetation and invertebrate fauna of semi-natural grasslands.

The assessment of socioeconomic impacts of the project activities was implemented by consulting company based on data characterising the situation in the project areas prior to implementation of the project actions and comparing that to situation at the end of the project. The data was collected by the project partners including information on grassland management from interviews with landowners, employment data from statistics as well as data on rural tourism. The collected data sets were assessed to detect the project impacts on economic diversification and employment opportunities, well-being of local population and public awareness about the value of landscape. The assessment report reveals positive impacts of the project activities regarding development of local economy and entrepreneurship related to grassland management, including increase of revenue earning possibilities, collaboration of rural entrepreneurs as well as development of new business opportunities.

Public awareness and dissemination of results

The public awareness activities of the project included a series of informative seminars for local public in the project areas (first round in 2015 and second in 2017 back to back with the visitors' days of the demonstration activities), general project visibility (e.g. information in the project web sites, production of informative materials and work with media) as well as dissemination of the project results (Layman's report in Latvian and English and closing international seminar). The project website (http://grassservice.balticgrasslands.eu) was launched during the first half year of the project and regularly updated. The project leaflet was developed in the format of booklet with extra pages for notes. Four notice boards were developed – two stationary notice boars set up at strategic places in each municipality close to restoration sites, informing about biologically valuable grasslands; and two - in roll up format, providing information about alternative uses of grass biomass explored during the project, and placed inside of premises of each municipality as well as used during the public events. Additionally, to the planed information materials, interactive posters for raising awareness and assessment of stakeholders' preferences to various ecosystem services provided by grasslands were developed for participation at the public festival "Nature Concert hall" in June 2015, and later used in various publicity and networking events.

Evaluation of Project Implementation

During implementation of the LIFE GRASSSERVICVE project transdisciplinary approach was applied, involving different expert groups and stakeholders - working together for development of innovative solutions and know-how on grassland management and potentials for alternative use of grass biomass. The methods applied for implementation of the project actions (including the field surveys and analysis of the remote sensing data; laboratory test on most suitable technological solutions for production of biogas and biobutanol; engineering work to design and construct the biogas production prototype; practical grassland restoration and demonstration of the alternative use of biomass; assessment of project actions as well as raising of public awareness and dissemination of the project results) have proved to be successful and cost effective in relation to the produced results. Most of the set objectives were achieved despite several delays and complications, in particular regarding construction of the biogas production prototype. However, some of the expected outputs could not be realised – the demonstration of the grass pellet

production was not possible due to withdrawal of the responsible partner AB6 Skujas as well as reaching the target of 25 ha for restoration of grasslands invaded by Sosnowsky hogweed was not feasible due to change in agriculture support requirements as well as low interest from the side of landowners. Nevertheless, the LIFE GRASSSERVICE project has achieved important immediately recognisable results (e.g. 122 ha of restored grasslands with established preconditions for their further management and constructed biogas production prototype) as well as significantly contributed to increasing knowledge of local community and competent authorities about the grassland quality, biomass resources, management requirements, restoration techniques and alternative use potentials. The results gained by testing of biofuel production potential from grass biomass has improved the scientific knowledge in this field and provides a basis for further development of commercialized small-scale mobile biofuel production facilities as well as industrial scale plants.

Analysis of long-term benefits

The LIFE GRASSSERVICE project was in line with the EU Biodiversity Strategy 2020, which aims at reversing biodiversity loss and speeding up the EU's transition towards a resource efficient and green economy, and its target 2, which sets that by 2020, ecosystems and their services shall be maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems. Furthermore, the project contributes to the EC strategy for smart, sustainable and inclusive growth aiming to increasing share of the renewable energy sources in the overall balance of the energy production by encouraging the use of grassland biomass in bioenergy production and EC climate and energy framework targets by 2030.

The LIFE GRASSSERVICE project activities in long-term have stimulated the maintenance of semi-natural grassland by preventing their further abandonment. Direct environmental benefits are achieved by restoration of ca. 122 ha of abandoned grassland, which has been overgrown by shrubs and trees or invaded by invasive species. This has laid bases for resuming of the grassland management and applying the Agri-environmental measures under the Rural Development Programme. The restored grasslands now are used for agriculture, including cattle breeding, as well as in some cases for rural tourism development. Project activities for restoration of the grasslands have also created remarkable experience in organisation of such works and applicable methods. Some of the demonstrated restoration methods were novel in the country’s context. The gained experience has been disseminated to other experts and projects. Furthermore, the project has demonstrated technologies for biogas and biobutanol production from grass biomass, raising interest among local entrepreneurs as well as creating important knowledge in the field of bioenergy research. Consequently, the project has both immediate and future positive impact on grassland management, on the collaboration of rural entrepreneurs, on revenue earning possibilities as well as on the development of new lines of entrepreneurship. Project has also contributed to enhancing the quality of life of society, by encouraging a discussion (involving altogether at least 5405 persons) about the topic of interaction between humans and nature and the role of maintaining natural diversity in promoting sustainable well-being.

3. Introduction

Grasslands are among the most threatened habitat groups in Europe – according to the results of the Member States' reporting on conservation status of species and habitats of European importance ca. (published by the European Commission in 2015) 80% of grassland habitats are assessed as unfavourable inadequate or bad and ca. 40% are experiencing trend of deterioration. This is also the case in Latvia where grasslands of high biological value cover only 2% of agricultural land and ca. 40% of such grasslands are not managed. Therefore, the overall objective of the project was to promote maintenance of biologically valuable grasslands by enhancing alternative, economically sustainable approaches to the use of grassland biomass as well as establishing co-operation models between farmers, entrepreneurs and local authorities.

The specific objectives of the project included: i) assessment of biological and economic value of grassland ecosystems and available amount of biomass at the project areas; ii) assessment of the use potential of the grassland biomass; iii) development of area specific technological solutions for grassland management and utilisation of biomass in economically sustainable way; iv) informing local stakeholders about alternative options for use of grassland biomass; v) establishment of the contacts and co-operation networks among land owners and entrepreneurs engaged in production of energy and various goods from grassland biomass; vi) demonstration of alternative technological solutions for biomass processing to wide range of interested stakeholders.

Project activities were carried out in two municipalities of Latvia - Sigulda and Ludza, representing different socio-economic situation. Sigulda municipality is located ca. 60 km from Riga (capital of Latvia) and has growing number of populations, although majority of people are working in Riga. Ludza municipality is located at the Eastern border of Latvia (265 km from Riga), experiencing depopulation due to high rate of unemployment. Nevertheless, at the start of the project, both municipalities were the characterised by large areas of non-used agriculture land and abandoned grasslands. In Sigulda Municipality the grassland abandonment was related to urbanisation and change to urban life style among rural population, thus giving up the farming practice. Whereas in Ludza Municipality typical process of marginalisation is still observed, when decline of land use for agriculture results of economic decline and depopulated. Considerable decrease in livestock farming in both municipalities has resulted in lack of demand of hay as fodder for animals and loss of economic motivation of grassland management. Due to lack of management grasslands are overgrowing and losing their biological value. Abandoned fields are also favouring expansion of invasive species, such as *Heracleum sosnowsky*, that has become a burning problem particularly in the rural areas around Sigulda. In 2014 17% of agricultural land and 35 % of biologically valuable grassland were not managed in Sigulda Municipality, while in Ludza Municipality it is 43% and 33 % accordingly.

According to survey carried out by the LIFE GRASSSERVICE project, in Sigulda Municipality there are 337 ha of grassland habitats of Community importance or potential grassland habitats, while in Ludza Municipality - 585 ha (including following habitat types: 6120*; 6210; 6230*; 6270*; 6410; 6450; 6510). The project activities were mostly targeting the following habitats - 6270* *Fennoscandian lowland species-rich dry to mesic grasslands*, 6510 *Lowland hay meadows* and 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates*, which cover the largest proportion of the grasslands of a high biodiversity value in the both project areas.

The project activities involved restoration of the 122 ha abandoned grasslands, substantially improving their conservation status (e.g. removed shrubs, improved vegetation structure and resumed grassland management). Furthermore, the grassland management has been encouraged by promoting co-operation between landowners and entrepreneurs involved in processing of grassland biomass as well as demonstration of opportunities for alternative use of grassland biomass. Thus, the project has stimulated the continuous maintenance of grasslands and their biodiversity within the both municipalities.

4. Administrative part

4.1 Description of the management system

The implementation of the core project actions was organised in preparatory phase and demonstration phase (see figure 4.1). The preparatory phase included four A actions, which provided conceptual and technical preparation for the demonstration actions on alternative use of grassland biomass. Action A1 assessed the biomass resources in the two project areas by carrying out field inventory, collection of airborne remote sensing data and assessment of economic value of biomass resources. Action A2 assessed the measures for grassland maintenance by learning from international experience and testing in laboratories technological solutions for processing of grassland biomass for production of biogas and biobutanol. Based on stocktaking and assessment results two internal activity plans were prepared for both municipalities within Action A3, setting the framework for implementation of demonstration actions. Preparatory phase included also action A4 on development of technical specification of the biogas production prototype and preparation of the documentation for price surveys for purchase of its components and assemblage of the prototype. Furthermore, the preparatory phase partly also involved the two concrete conservation actions – initial stage of Action C1 on establishment of local co-operation networks and preparatory work for construction of biogas pilot facility (Action C2).

The actions C1 and C2 continued in the demonstration phase by restoring the overgrown grasslands, involving the local stakeholders in demonstration of the alternative use of grassland biomass (i.e. production of grass pellets) and organising the visitors' days in two municipalities to demonstrate the pilot facilities for production of biogas and biobutanol.

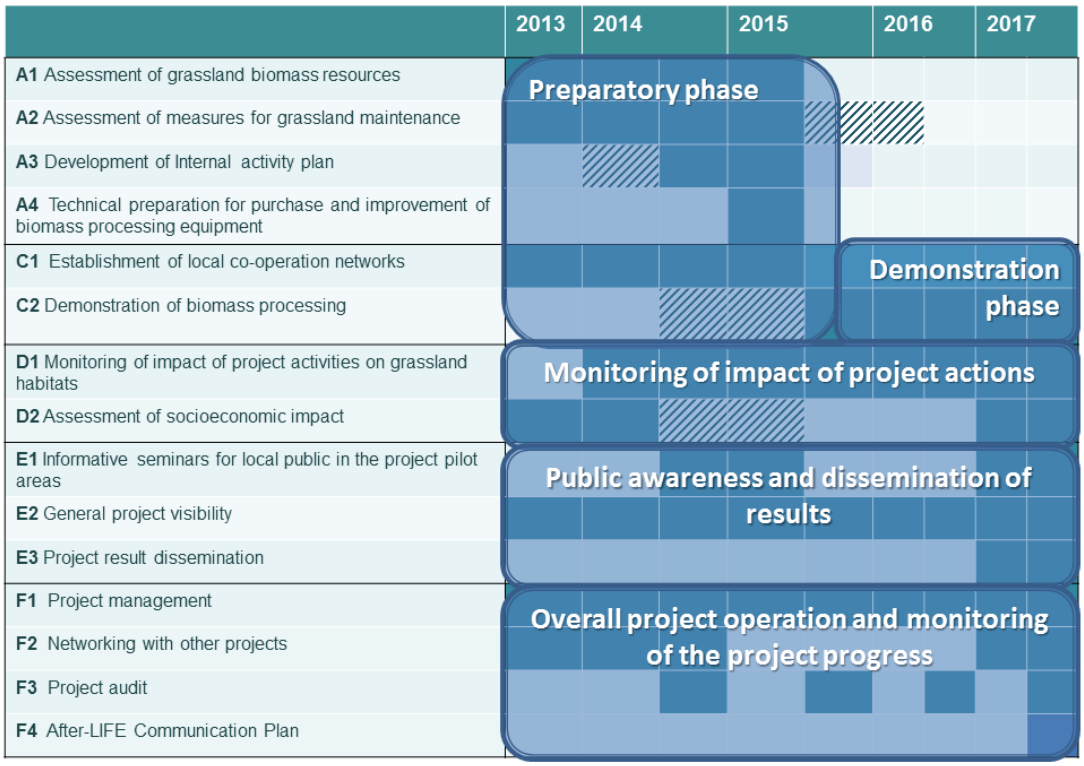
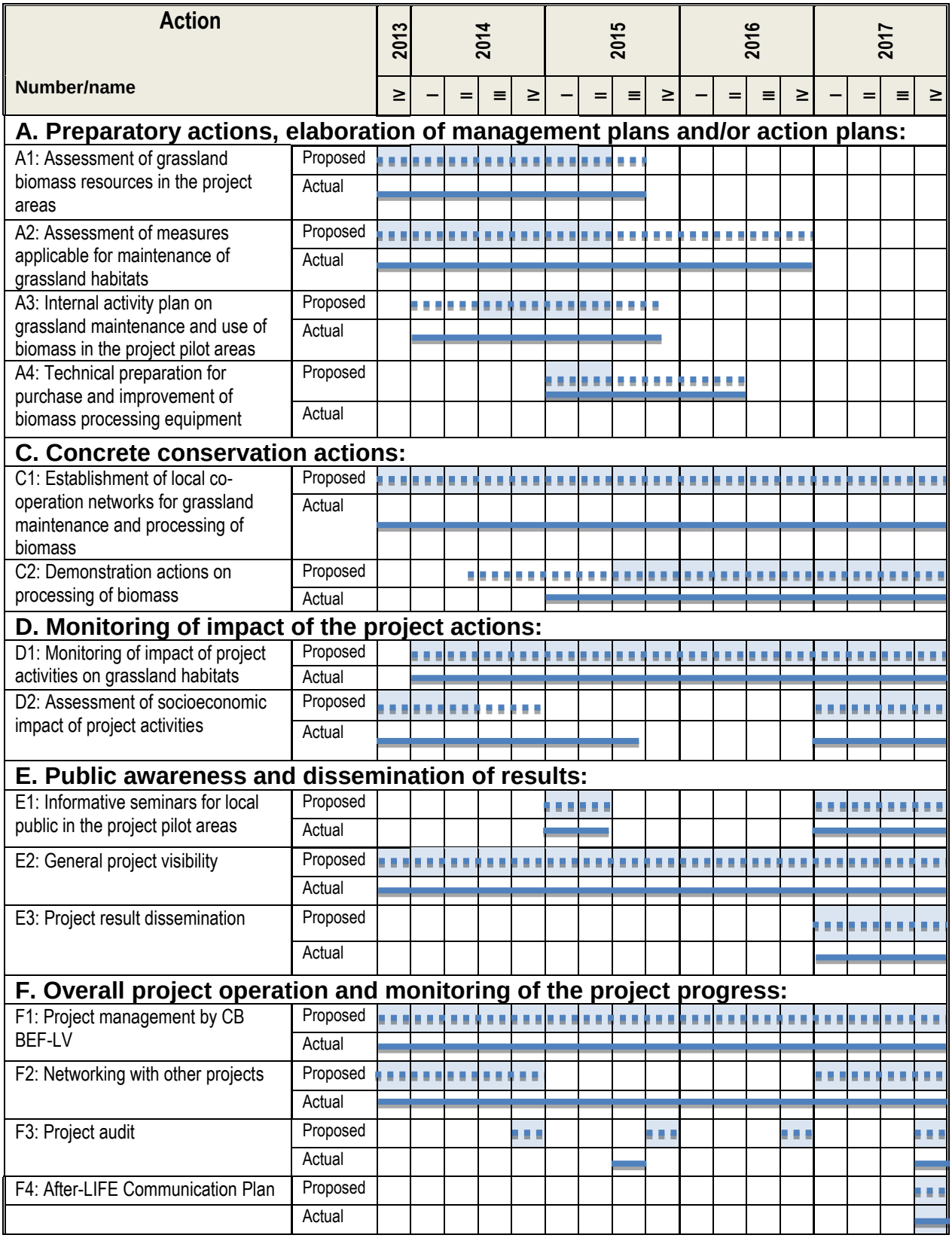


Figure 4.1: Overall project schedule and the main implementation phases

The preparatory and demonstration phase of the core actions was accompanied by the obligatory actions - monitoring of the impact of project activities on grassland habitats (action D1) as well as assessment of socioeconomic impacts (action D2); tree E actions – public awareness, including informative seminars to local public (action E1), general project visibility (action E2); project result dissemination (action E3) as well as four F actions on project management, networking, audit and after-LIFE communication plan.

Overall project schedule: proposed and actual action implementation

Blue filling of the squares represents the initially proposed implementation time of the action, dashed lines - revised time plan, and the blue lines represents the actual time of the action



The project management structure

The project management was organised in two levels - the overall management was ensured by the co-ordinating beneficiary – CB BEF-LV, while lead of the single action implementation was shared between CB and associated beneficiaries (AB). The role of each partner in implementation of the project actions is illustrated by the project management scheme (figures 4.2) and the project action scheme (figure 4.3).

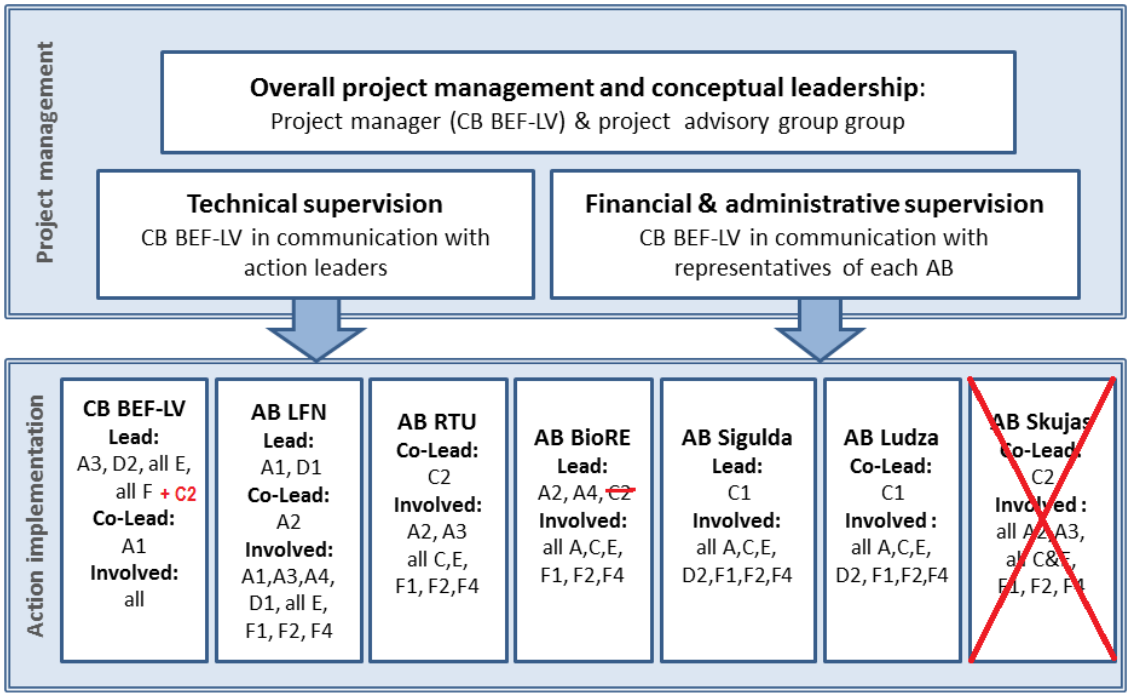


Figure 4.2.: The Project management scheme (updated)

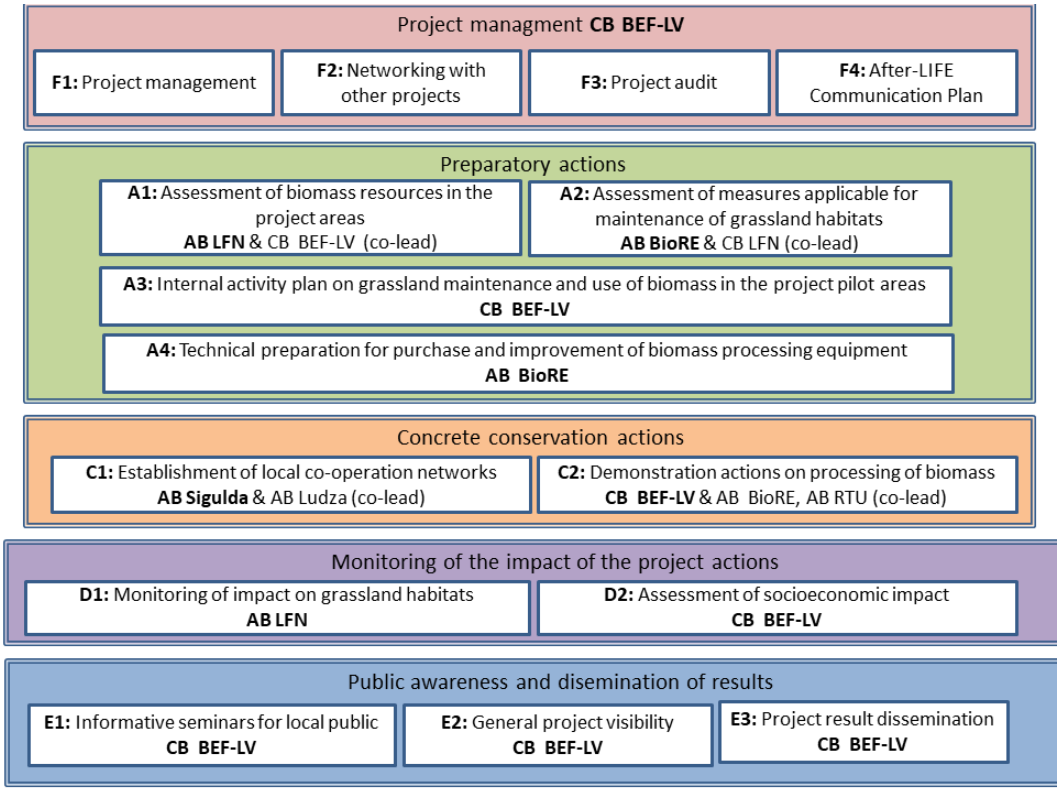


Figure 4.3: The project action scheme and leadership (updated)

The co-ordinating beneficiary BEF-LV was in charge for the **overall project management and conceptual leadership**. The technical supervision of the project activities was ensured by the project manager and co-ordinator for technical implementation of the project activities in co-operation with other action leaders assigned for actions. Project manager was also in charge for the reporting to EC on project implementation (Inception, Midterm, Progress and Final Reports), communication with EC and the external project monitoring experts, handling the decisions on change of the project partnership structure and amendments of the Grant Agreement etc. Furthermore, project manager moderated the project partners meetings, supervisory board meetings, as well as informative seminars for local public. BEF LV environmental expert was co-ordinating the direct implementation of the project actions, handling challenges related to drop out of the AB6 Skujas (e.g. search for replacement, communicating with Ltd. "Jumis" and grass pelleting service providers about possible involvement in the project) and finally taking over lead of the Action C2 on grassland restoration and demonstration of alternative use of biomass. was also in charge for leading the Action A3. Junior environmental expert joined the CB team in September 2015 (sharing the budget position of junior expert/project assistant) to support co-ordination of the grassland restoration works as well as implementation of other project actions. Communication expert was in charge for public awareness and dissemination actions as well as assistance to project manager in reporting to EC, organisation of the project meetings**,** update of the project web-site, etc. From 07.04.2014 till 31.07.2015 another environmental expert joined the CB team to support in conceptual leadership and co-ordination of A2 action and elaboration of visibility materials.

The financial and administrative supervision was ensured by the project manager, financial manager and financial and administrative supervisor in co-operation with assigned co-ordinators and bookkeepers of each associated beneficiary. Financial manager oversaw financial reporting, accounting, communication with the auditor and partners' bookkeepers about their expenditure reports as well as regular reporting to the national co-financing administration. Supervisor was in charge for contracting of the project partners and external services as well as ensures the overall financial and administrative control. Supervisor was also involved in decision making on changes in the project partnership structure and tendering procedure for the grassland restoration activities. The leading financial advisor has provided advice on financial and technical management issues as well as chaired the international seminar (Action A2).

Associated beneficiaries (AB) were actively engaged in direct implementation of the project actions. Each AB nominated a coordinator for ensuring implementation of the actions, communication with the project management, participation in the partners meetings as well as administrative and technical co-ordination of the project activates carried out by the partner. AB1 LFN was in charge for assessment of grassland biomass resources in the project areas (Action A1) as well as monitoring of impact of project activities on grassland habitats (Action D1). AB2 Bio RE in co-operation with AB3 RTU and AB1 LFN have tested the technological solutions for utilisation of biomass resources (Action A2) and lead the construction and demonstration of prototype of biogas production (Action C2). AB3 RTU has assessed the potential of different grassland habitats for bioenergy production (Action A2) and demonstrated the process of the biobutanol production (Action C2). AB4 Sigulda and AB5 Ludza were in charge for establishment and maintaining local co-operation networks (Action C1) as well as supporting the demonstration activities (Action C2) and other actions. AB6 Skujas was supposed to demonstrate the grass pellet production and to implement the grassland restauration activities, (Action C2), however due to change in the economic conditions (e.g. significant drop of the market price for the grass pellets) as well as management problems of the company, the partner officially withdraw from the project at 23.11.2015. Before the withdraw the AB6 Skujas investigated the availability of grassland biomass for demonstration activities in Sigulda Municipality as well as economic potential for grass pellet production, providing input for the project reports and publications.

The partnership agreements with all associated beneficiaries have been submitted to European Commission with the Inception report., Amendment No 1 to the partnership agreement between CB BEF-LV and AB4 Sigulda.

In total 10 project partners meetings (Action F1) were organised to report on progress in action implementation, to do the planning and co-ordination of next activities as well as to agree on the major management decisions.

Project progress was monitored by the project advisory board involving representatives of the competent authorities as well as action leaders. The project advisory board has met three times - on 06.11.2014; on 25.04.2016 and on 03.11.2017**.**

Changes in project management structure

After dropping out the AB 6 Skujas, CB BEF-LV was actively searching for the replacement of the partner, who could take over the tasks within the action C2 including grassland restoration and demonstration of the grass pellet production. As potential new partner Ltd. "Jumis" was identified - a company in charge for waste management in Sigulda municipality, with experience in and maintenance of public spaces, experience in grassland restoration and technical capacities for implementation of the required tasks. However, after the long negotiations on budgetary issues, involvement of the new partner in the project failed. Therefore, in consultation with the project external monitoring expert, CB BEF-LV decided to take over the technical and financial liabilities of the AB6 Skujas as well as the leadership of the C2 action. The long negotiation process and uncertainties about the implementation of the C2 action was reason delaying the grassland restoration works in Sigulda municipality for one year.

Changes due to amendments to the Grant Agreement

The Grant Agreement of the LIFE GRASSSERVICE project was modified twice:

- **1st amendment** was signed by the European Commission on 13.07.2015. It concerned the change of the legal status of the project partner – the AB2 BUFPI was replaced by Ltd. Bio RE, established on 26.08.2013 as result of reorganisation of BUFPI. The AB2 Bio RE took over the tasks and financial liability of the AB2 BUFPI already from the beginning of the project. The change of the associated beneficiary had no implication on fulfilment of the project tasks and the overall project budget, although it has resulted in minor budget change by shifting the AB2 financial administration from "Personnel" to "External assistance". Furthermore, a major change in budget was made by introducing a new budget position – "Prototype" for implementation of the Action C2. Instead of renting existing pilot facility for demonstration of the production of biogas from grass biomass, AB2 Bio RE decided to construct a new pilot facility that would be technically suitable for production of biogas from the grass biomass. Such pilot facility was not available as a serial/standardised product, therefore could not be purchased or rented, but had to be specifically created for the implementation of the project.
- **2nd modification** was signed by the European Commission at the very end of the project on 21.12.2017. It concerned another changes in the division of the budget positions of the AB2 Bio RE. The results of Action A2 revealed that the size of the previously planned facility was too small to demonstrate efficiently biogas production and consequently the costs estimated with the 1st modification was not enough. An increase in size of the facility as well as more advanced technical solutions has led to the increase of the Prototype costs.

4.2 Evaluation of the management system

In overall the established management system of the project, including the technical supervision of action implementation as well as financial and administrative supervision of associated beneficiaries was functioning very well. Supervision of the action implementation as well as co-ordination of mutually interdependent actions was ensured by the half yearly partners meetings, and more than 20 ad hoc meetings on specific topic between partners. The frequent (half yearly) expenditure reporting of the associated beneficiaries to the CB financial manager have ensured regular control of reporting practices and documentation of the costs.

The major challenge to the project management was caused by the drop out of the AB 6 farm "Skujas" in November 2015, which was in charge for grassland restoration action and demonstration of grass pellet production from grassland biomass. This has resulted in a complicated process for seeking of solutions on replacement of the partner and implementation of the related tasks, including long negotiations with potential new partner Ltd. "Jumis", who's involvement in the project finally failed. Finally, in summer 2016 CB BEF-LV took a decision to take over the co-ordination of the grassland restoration tasks. The

change in partnership structure had an impact on implementation of other actions, including C1 (signing of long-term agreements with landowners on maintenance of restored grasslands was not possible until June 2015 due to the fact the actual implementer of the action was not known) and action C2 (grassland restoration in Sigulda Municipality had to be postponed to 2016).

Another major management challenge was related to demonstration of the biogas production implemented by the AB2 Bio RE. Based on conclusion from the laboratory tests performed within action A2, it was decided that the renting of exiting biogas pilot facility would not ensure the demonstration needs and construction of new pilot facility (prototype) for production of biogas from grass biomass is required. This has resulted in the above described modifications of the grant agreement – first to introduce a new budget positions "prototype" and second to increase the cost of the prototype. Preparation of the necessary modifications has caused substantial administrative efforts and series of additional meetings with the partner in charge for estimation of costs and recalculation of the budget positions. The modification had also on impact on the time plan of implementation of action C2, even the partner started the construction of the enlarged prototype on its own risk before the 2nd grant agreement modification was signed.

The progress in implementation of the project actions, changes in the time plan as well as all the management challenges described above was regularly communicated with the Commission and Monitoring team. The changes in the management structure as well as modifications of the Grant Agreement were addressed in the Inception, Midterm and Progress reports as well as discussed during the visits of the external monitoring experts to the office of CB BEF LV on 24.04.2014; 09.07.2015; 29.11.2016; 22.05.2018 (after the end of the project to discuss the final report).

In addition to the formal visits and reporting project manager had a permanent contacts and consultations with the monitoring experts about eligibility of costs, possible changes and problems faced with implementation of the project actions. The communication with monitoring team has worked very well. The project team appreciates the received support and advice on project management and technical implementation of the actions.

The project has received 6 feedback letters from European Commission regarding project reports and visits of monitoring experts and replied to them. Answers to the last questions included in the feedback to the Midterm Report and Progress Report.

5. Technical part

5.1 Technical progress per task

5.1.1. Action A1: Assessment of grassland biomass resources in the project areas

Action implementation time	Action status
In the project application: 01/10/2013 – 30/06/2015 Action extended until 30/09/2015*	Completed by 30/09/2015

** The deadline is extended for 3 months, changes are acknowledged by EC letter, No. ENV.E.3 RH/TS/sp, 23.09.2015*

Name of the Deliverable	Deadline	Status
Maps on grassland biomass resources in 2 pilot areas	31/12/2014	Completed 15/08/2015
Report on assessment of grassland biomass resources in 2 pilot areas	30/06/2015	Completed 30/09/2015

Name of the Milestone	Deadline	Status
-	-	-

The action assessed the available and potential amounts of biomass, its use potential and economic value in the both project areas – Sigulda and Ludza municipalities. The results of the action were used for development of the internal project activity plans for the both project areas (Action A3) as well as served as input for monitoring of the impact of project activities on grassland habitats (Action D1) and socio-economic impact assessment of the project activities (Action D2).

The Action included the following steps: i) development of the methodology for assessment of grassland biomass resources at local level; ii) collection of data on biomass resources in the both project; iii) assessment of the results on available biomass resources; iv) economic valuation of grassland biomass resources; and iv) compilation of the report on biomass resource assessment in Sigulda and Ludza municipalities

The Action was implemented by the Latvian Fund for Nature (AB1) with support of sub-contracted external service (the Institute for Environmental Solutions) for obtaining and analysis of the remote sensing data.

Activity 1: stocktaking and biophysical mapping of available biomass resources in the two project areas

The activity started with identification of the available data sets and development of methodology for assessing grassland distribution, biomass resources and productivity (including application of the remote sensing data). Description of the methods is included in the Action 1 report on assessment of biomass resources.

In 2014-2015, data on distribution and quality of grasslands, quantity of biomass resources and management practices were collected, using existing data sets, field surveys and remote sensing methods (LiDAR data, and hyperspectral, RGB aerial images), and available radar and satellite data.

Assessment of grassland distribution and quality

In total, 1042 ha of biologically valuable grasslands were inspected by the project team until August 2015. Inspection covered the biologically valuable grasslands, that were identified before 2012, since approximately 80% of the data on these grasslands were obtained comparatively long time ago (8–15 years) with different methodology and other purposes. The survey revealed that only 64% of inspected areas still correspond to the habitats of Community importance, while the rest have lost their quality. As result 337 ha of grassland habitats of Community importance or potential grassland habitats were identified in Sigulda Municipality and 585 ha in Ludza Municipality. The questionnaire on habitat quality

was filled in each site and exact boundaries for each habitat type in each grassland patch drawn. The data have been submitted to the Nature Conservation Agency for updating the data base OZOLS on the biologically valuable grasslands. The distribution maps of the grassland habitats are added to the report on biomass resource assessment.

The overall quality of the grasslands of Community importance in the project sites was assessed as rather poor. Only 20% of the biologically valuable grasslands in Sigulda and 41% in Ludza municipality were assessed as good or medium quality; the remainder is of low quality or does not even meet the minimum quality requirements. As the number of overgrown, transformed or cultivated grasslands with no restoration potential was quite high, grasslands that could be restored without huge investments were included in the target data set.

Assessment of grassland biomass quantity and productivity

To calculate the biomass amounts produced in each habitat type, 128 biomass samples from six most common habitat types of Community importance (6120, 6210, 6270, 6410, 6450, 6510) were collected in project sites during the summers of 2014 and 2015. The analysis of collected samples showed that the average amount of the biomass in grasslands of Community importance reaches 9.1 t/ha of fresh or 3.2 t/ha of dry biomass, but the harvested one (the biomass that could be collected after mowing at 10 cm above the ground level) – 6.3 t/ha of fresh or 2.5 t/ha of dry biomass. The amounts differed significantly among various habitat types.

To assess the grassland biomass resources in the whole project area, as well as bush encroachment, the distribution of the Sosnowsky's Hogweed and the management of grasslands that are not supported by the Rural Development Programme, advanced airborne remote sensing technologies and remote sensing data assessment methods were used. For collection and processing of the remote sensing data the Institute for Environmental Solutions was subcontracted in procurement procedure. The LiDAR data, hyperspectral imagery and high resolution RGB were acquired by the Institute till the end of July of 2014. The data on the distribution of total grassland biomass resources, bush encroachment and the distribution of *the Sosnowsky's Hogweed* grows were delivered in December 2014. The final set on distribution of biomass resources was submitted on 15.08.2015. All mentioned maps are included in the Report on biomass resource assessment.

Grassland yield estimates for each grasslands patch in project sites were produced by combining the field data on grassland biomass amount in 128 sampling plots with the data sets on values of normalized difference vegetation index (NDVI), obtained from the remote sensing data. The NDVI values were calculated from high resolution RGB and Lansat-8 imagery. The bush encroachment was evaluated from normalised digital surface models (nDSM) that were developed from LiDAR data, but the distribution of the Sosnowsky's Hogweed was assessed by digital image classification techniques and high resolution RGB, nDSM species distribution data collected within field surveys. Results show that there are at least 329 ha of grasslands with the Sosnowsky's Hogweed in Sigulda Municipality and at least 104 ha in Ludza Municipality. It was estimated that at least 1498 ha of grasslands are overgrowing with bushes in Sigulda Municipality and 1521 ha in Ludza Municipality. However, it must be noted that the coverage of overgrown grasslands in the project sites is much higher, because the given numbers represent the presence of overgrown grasslands in the data set that was created for assessment of the total amount of biomass in the project sites.

Based on obtained data, it was estimated that there are more than 23 000 t of total dry grass biomass in the grasslands of Sigulda Municipality and almost 42 000 t in Ludza Municipality.

Assessment of grassland management intensity

During the preparation of the resource assessment, the problem of lack of data about the management of grasslands not supported by the Rural Development Programme was realised. Therefore, it was decided to obtain the necessary data by comparing the sets of NDVI values, calculated from open access satellite (Landsat-8 and Sentinel-1), data sets from June, July and August 2015 and airborne RGB data from August 2015. For processing of the mentioned remote sensing data, the second procurement procedure was launched on 03.08.2015. The Contract was signed with the same service provider – the Institute for

Environmental Solutions, which undertook the data analysis with the available terms and funds. The data on grassland management activity was delivered till the end of September 2015.

The tested method was successful. It was possible to estimate the management intensity for 88% of the grasslands in the project sites. The data shows that 69% of the grasslands in Sigulda Municipality and 37% of grasslands in Ludza Municipality were grazed or mowed in June or mid-July (the time when the quality of grass is highest for hay making), while at least 28% of grasslands in Sigulda Municipality and at least 48% in Ludza Municipality were unmanaged or mowed in late August. Related calculations suggest that at least 7.5 thousand t of dry grass biomass in Sigulda Municipality and 20.6 thousand t in Ludza Municipality are not used for agricultural needs.

Activity 2: Economic valuation of grassland biomass resources

The economical assessment of grassland biomass resources was prepared by Ltd. "VB LIMITED" (subcontracted for socio-economic assessment of the project impacts) till the end of September 2015. Assessment is based on direct market pricing method.

It was estimated that direct economic value generated by forages from grasslands of Sigulda and Ludza municipalities is 0.18 million euro (the profit that could be derived from sales of hay if all grasslands would be used for hay production). If the payments that farmers can receive under the European Union's Common Agricultural Policy are included in the calculation, the total profit from hay production and realisation can exceed 3.81 million euro. The total profit of production and realisation of hay that could be produced from the grasslands that currently are not managed or used for hay production is 1.38 million euro. Despite that, only 3-4% of hay productions are sold due to low demand. More detailed results as well as used methods are described in the Report on biomass resource assessment.

Activity 3: Report on biomass resource assessment in Sigulda and Ludza municipalities

The Final report on biomass resource assessment in Sigulda and Ludza Municipalities was prepared till the end of September 2015. It highlights results of the research on the distribution, quality, productivity and management activity in the grasslands of Community importance, as well as permanent and cultivated grasslands in the both municipalities. Key findings are mentioned in the description of Activity 1. It also presents the methodology to ensure that the assessment can be repeated in other territories.

Problems encountered

When assessing the remote sensing data, prepared by the Institute for Environmental Solutions, it was realised that the data on the total amount of grass biomass (including the biomass from 1-2 cm above the ground level) are not sufficient for correct assessment of biomass resource. It was concluded that the assessment on biomass resources shall be coupled with regular agricultural practice (mowing at 7–10 cm height from the ground level). For that purpose, a new data set had to be prepared, which required collection of extra field data on biomass amount 10 cm above the ground level at each habitat type during the next summer season (June -August 2015). Collection and analysis of the additional field data resulted in the need to extend the deadline of the action implementation by three months, which originally was set in 30.06.2015.

Modification of action compared to project proposal

Due to the reasons described above the action has been extended for 3 months (till 30.09.2015) as noted in the *CB letter to EC, No 15-10/30, 23.09.2015.*

Evaluation of achieved outputs and implementation of the time schedule

All the expected outputs of the action have been achieved. As described above, the stocktaking and biophysical mapping of available biomass resources (Activity 1) had to be extended to include the summer field season of 2015. This has resulted in slight delay of the two other activities – economic valuation of grassland biomass resources (Activity 2) and preparation of the report on biomass resources (Activity 3). All activities were completed in accordance to the revised schedule. The extension of the action had also an impact on implementation of the Action A3: "Internal activity plan on grassland maintenance and use of biomass in the project pilot areas", which was partly based on the results of the

action A1 and consequently had to be extended by 4 months (until 31.10.2015). This delay has slightly impacted implementation of C1 and C2, however not caused major obstacles for timely achievement of the project objectives.

Expected results	***Achieved results***
Methodology for assessment of grassland biomass resources at local level	The methodology was developed during the initial stage of the action and tested in Sigulda and Ludza Municipality. Description of the method included in the report on biomass assessment.
Data sets with information for assessment of grassland biomass resources in the 2 pilot areas	All data sets were collected by summer 2015.
Maps of grassland biomass resources in the project pilot areas	Most of the maps were prepared by 31/12/2014. The maps of the amounts of harvested biomass in grasslands of Ludza and Sigulda Municipality were finalised by 15/08/2015.
Economic value of grassland biomass resources in the project pilot areas assessed	Implemented by 30/09/2015 and included in the action report.
Report on grassland biomass sources at the 2 pilot areas	All the listed results are included in the Report on assessment of the grassland biomass

Conclusions on action implementation and obtained results:
The action has been completed and all envisaged results achieved within approved extension of the action for three months. The obtained results have provided essential input for the subsequent project activities (A3, C2, D1, D2), but also have an added value of their own. This includes the comprehensive data on distribution, quality and management of the grasslands in the two municipalities, which so far have not been available from the data registers in Latvia. The updated information on distribution of the grassland habitat types of the Community importance is of high importance for the Nature Conservation Agency (in charge for monitoring and reporting on the status of the Habitats) as well as for the Rural Support Service for calculation of the payments amounts to farmers. The assessment of the biomass productivity by the habitat types of the Community importance as well as in other permanent and seeded grasslands have scientific value, since similar studies in Latvia have not been performed since middle of the last century.

Perspectives for continuation of the action after the end of the project:
All data sets prepared within the project can be used for preparation of planning documents and analysis of agricultural situation in municipalities. The interest in the prepared data set has also been shown by consultative (e.g. Latvian Rural Advisory and Training Centre), regional development (Vidzeme Planning Region) and scientific (University of Latvia, Institute of Agricultural Resources and Economics, Institute for Environmental Solutions) institutions.

The methodology developed by the project for assessment of grass biomass resources and management, which involves application of the field sampling and analysis of the remote sensing data, already has been used by other projects and studies, for example LIFE13 ENV/LT/000189 project “Integrated planning tool to ensure viability of grasslands” (LIFE Viva Grass, Lead Partner – BEF LT) or European Space Agency PECS project “Assessment of Grassland Quality and Quantity Parameters and Management Activities Using Sentinel 1-1&2 data” (SentiGrass, Lead partner – Institute for Environmental Solutions). After the Project end it is planned that the methodology will be used by LIFE16 NAT/LV/000262 GrassLife Project “Restoring EU priority grasslands and promoting their multiple use (Lead partner – Latvian Fund for Nature).

5.1.2. Action A2: Assessment of measures applicable for maintenance of grassland habitats

Action implementation time	Action status
In the project application: 01/10/2013 – 30/06/2015 Proposed modification: 01/10/2013 – 31/12/2016*	Completed by 31/12/2016

** The proposal for modification of the action implementation time was included in the Inception report and provisionally accepted by the EC, letter No. ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014*

Name of the Deliverable	Deadline	Status
Report on possible technical/ technological options for use of biomass with evaluation of cost effectiveness	In the project application: 30/06/2015 Proposal for modification: 31/12/2016**	Completed 31/12/2016

*** The proposal for extending deadline for submission of the report was included in the Inception report and provisionally accepted by the EC, letter No. ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014*

Name of the Milestone	Deadline	Status
Experience exchange seminar on up-to-date options for sustainable grassland management and use of harvested biomass	31/12/2014	Implemented in 5-6/11/2014

The aim of the Action was to assess different measures that could be implemented for management of grassland habitats, involving traditional farming practices as well as innovative approaches and possible combinations and synergies of different measures. The results of the action were used for designing and constructing the biogas and biobutanol pilot facilities, as well as served as input for monitoring of the impact of project activities on grassland habitats (Action D1).

The Action was led by AB2 Bio RE with high involvement of AB3 RTU and AB1 LFN.

The action consisted of four main activities:

Activity 1: Experience exchange seminar on the management of grassland habitats

International seminar on „Sustainable grassland management: biodiversity conservation and alternative uses of grassland biomass" was held on 05-06.11.2014 in Sigulda. The content and logistics of the seminar was prepared by CB BEF-Latvia in close cooperation with AB1 LFN and with contributions from the other project partners. The event gathered 52 participants representing non-governmental organisations, education and research institutes, state administration, municipalities, consulting companies and enterprises from Latvia, Estonia, Lithuania, Poland, Germany and the UK. The participants shared their experiences in the protection of natural grasslands, as well as the use of grass biomass for production of heat energy, biogas and biobuthanol. Results of the experience exchange seminar were presented in the seminar report.

In addition, the action leader from AB2 Bio RE took part in the Seminar organised by company "SCHAUMANN BioEnergy Consult" about application of microelements and enzymes in production of biogas from semi-natural grassland; Gut Hülsenberg, Germany, 11.-13.02.2014.

Activity 2: Testing of various technical and technological solutions

2.1. Collection of biomass for laboratory testing

In both Sigulda and Ludza Municipality, 67 sampling plots were established for collection of biomass samples from 6 dominating grassland habitat types. Biomass samples were gathered 3 times a season instead of the planned 5 times a season – the change was communicated to the EC with the Inception report and approved by the EC, *letter ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014*. Altogether, AB1 LFN took 162 samples in 2014-2016 covering early harvest, intermediate and late harvest time. Before biomass clipping, vegetation description for each square was prepared to obtain data necessary for result

interpretation. The collected material was stored in plastic bags, weighted and brought to the laboratories of AB2 Bio RE and AB3 RTU. The experts of AB2 Bio RE analysed the contents of total solids and volatile solids, which also gives background information for calculations of biogas production potential.

2.2. Exposure of biomass to various physical, chemical and biological conditions

The laboratory works were performed to test various technological solutions (physical, chemical, biological) for biomass pre-treatment and hydrolysis. This included the set-up of optimal conditions for processing of grass biomass for further production of biobutanol and biogas. In addition, laboratory tests for treatment of digestate (the end product in the production of biogas) were performed in order to find out the treatment conditions optimal for biogas production.

AB2 Bio RE performed laboratory tests and research for obtaining biogas from grass biomass and digestate. Various technological processes and solutions have been used for optimization of this process including determining the contents of total solids and volatile solids. The results proved a great annual variability in biomass quantity and quality. The experiments showed that cutting of grass in smaller pieces is recommendable, which enlarges the external surface of the material and intensifies production of biogas. The use of steam explosion was tested in the laboratory and proved its applicability on an industrial scale.

Laboratory tests were carried out to find the optimal processing regime and parameters for production of biogas from different types of grass biomass: raw grass, hay and silage samples. It was proved that raw grass had the highest biogas yield with an optimal load of 2.8-3.0 kgVS/m^3V*day; application of larger organic loads reduces methane concentration below 50%. Adding up microelements in bioreactors at low levels of volatile solids (<4%) resulted in more optimised anaerobic fermentation process. Additionally, to biomass treatment, laboratory tests were performed to identify an optimal treatment regime to obtain biogas from digestate samples by applying thermal treatment and ozonation. The results showed that biogas thermal treatment does not influence biogas yield; however, treatment of biomass with ozone can increase the yield.

In general, laboratory experiments suggested that 1 tonne of grass biomass may produce about 70 m^3 of biogas with a methane concentration below 52%; 1 tonne of digestate may yield in about 60 m^3 of biogas with a methane concentration of 53%. The obtained results were used for planning the construction of the biogas pilot facility (prototype) for demonstration purpose (Activity C2).

AB3 RTU performed laboratory tests for grass biomass pre-treatment and hydrolysis in order to find the optimum conditions to obtain the maximum sugar yield from grass biomass samples for further production of biobutanol. The effect of biomass size on hydrolysis yields was evaluated in order to determine the optimal conditions for mechanical pre-treatment. Further evaluation of heat pre-treatment was performed to determine the lowest temperature/time treatment conditions that would be still effective and energy efficient. The results demonstrated that the highest sugar yields are obtained when the biomass is grinded into the powder. However, due to high energy consumption, it is acceptable to use biomass fractions below 0.5 cm which did not showed significantly different results ($p > 0.05$) in sugar yields when compared to powder grinded samples. Assessment of heat pre-treatment showed that it is enough to boil the biomass for 5 minutes to ensure effective neutralization of indigenous microflora.

Further enzymatic hydrolysis was compared to chemical (acid) hydrolysis. The superiority of enzymatic hydrolysis was supported by comparable sugar yields and high salt concentration formed after chemical hydrolysis. Finally, enzymatic hydrolysis was performed using grass biomass samples collected at various habitats in Sigulda and Ludza Municipalities to determine the maximum sugar yield, which is used as the feedstock for biobutanol fermentation. The results showed the highest yields in samples from Xeric sand calcareous grasslands (6120), Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210) and Lowland hay meadows (6510). There was an evident decrease in sugar yields with the vegetation period.

Activity 3: Preparation of a report on technological solutions for use of biomass with evaluation of cost effectiveness

The report was finalised in December 2016 and reported by the Progress report. It describes the results of laboratory research performed to find the optimum conditions for pre-treatment of grass biomass and shows technological possibilities and amounts of biogas that can be produced from different types of grass biomass and digestate as well as assessment of cost efficiency of production of biogas and biobutanol from grass biomass, compering that to production of grass pellets. The contents of the publication were discussed among AB2 Bio RE and AB3 RTU together with the subcontracted company *Edo Consult Ltd., which assessed the cost-effectiveness of the technologies*. The authors of the report conclude that out of all three assessed technological solutions for alternative biomass use under the existing conditions (technological parameters, prices of energy resources, operational costs, investment costs) the production of grass pellets and using them as fuel is the only solution, which is probably economically effective. Biogas production is perspective if some production costs will be reduced; biobutanol production now is the least economically viable solution, which might have future perspective in synergy with biogas production.

Activity 4: Testing application of digestate

In July and August 2014, AB1 LFN in cooperation with AB2 Bio RE, AB4 Sigulda and AB5 Ludza Municipality set 6 monitoring plots in Sigulda and Ludza Municipalities for testing the management actions, including application of digestate, mowing and removal of fresh biomass or hay. In April 2014, AB1 LFN in cooperation with AB2 Bio RE and AB4 Sigulda performed collection of soil samples and calculation of necessary amount of digestate to be applied on each management plot. Initially it was planned to complete testing of the management actions by summer 2015. However, it was realised that one season for testing of impact of digestate application would not be sufficient for estimation of its impact on grassland productivity and ecological status, including species diversity. Therefore, prolongation of the action, including one more field season was applied with the Inception report and provisionally accepted by the EC, *letter No. ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014.* In spring 2015 and 2016, AB2 Bio RE in cooperation with AB1 LFN spread digestate, and in summer in cooperation with AB4 Sigulda and AB5 Ludza Municipality harvested biomass at the monitoring plots. The Activity was completed in August 2016.

The impact of digestate application on semi-natural grasslands was assessed within Action D.1.

Problems encountered

No major problems had been identified that hindered reaching the objectives of the Action.

Modification of the action compared to the project proposal

No modification in relation of the content of the action were required. The deadline of the completion of the Action was extended for 18 months (from 30.06.2015 till 31.12.2016) for the reasons described above. The justifications for extension of the action were provided within the Inception Report and provisionally accepted by the European Commission, as indicated in the *EC letter, No. ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014.*

Evaluation of achieved outputs and implementation of the time schedule

All the expected outputs of the action were achieved within the prolonged time schedule – by 31.12.2016. In order to include on more field season, the testing of the digestate application (Activity 2.4) was extended until 30.09.2016. Accordingly, the laboratory analysis for assessing the impacts of digestate application on productivity of grass biomass (Activity 2.2.) as well as finalisation of the report on technological/technical solutions for the use of biomass (Activity 2.3) had to be extended until 31.12.2016. The prolongation of the action did not influence the other project activities and the project in general.

Expected results	***Achieved results***
International experience exchange seminar on sustainable grassland management and use of harvested	International experience exchange seminar held on 05.-06.11.2014, with 52 participants from Latvia, Estonia, Lithuania, Poland, Germany and the United Kingdom.

biomass (ca. 40 participants); report from the seminar produced summarising the main findings and experiences presented	
Possibilities for technological/technical solutions for the use of biomass with evaluation of cost effectiveness have been assessed and published in a report	The final report including evaluation of cost effectiveness was completed by 31/12/2016 and published on project web site

Conclusions on action implementation and obtained results
The action has been completed and all envisaged results achieved within approved extension of the action for 18 months. The results of laboratory experiments and tests performed within Activity 2 have fed project Action C2 by providing essential information required for a better design and construction of the biogas and biobutanol pilot facilities. The impacts on grassland biodiversity from the 3-year application of digestate at the sampling plots were monitored and assessed within Action D1.

Perspectives for continuation of the action after the end of the project
The research on optimising processes for biofuel production will be continued in the laboratories of AB2 Bio RE and AB3 RTU. For biogas production, optimisation of hydrolysis process, as well as applicability of other substrates in addition to grass biomass will be investigated. For biobutanol production, new sugar extraction methods (pre-treatment and hydrolysis) will be investigated. The biomass samples obtained during the project are stored at RTU and will be used for studies or laboratory works. About application of digestate, the results of the project shall serve for future investigations to wider application in agriculture.

5.1.3. **Action A3:** Internal activity plan on grassland maintenance and use of biomass in the project pilot areas

Action implementation time	**Action status**
In the timetable of the project application: 01/07/2014 – 30/06/2015 Initial proposal for modification: 01/01/2014 – 30/06/2015* Second proposal for modification: 01/01/2014 – 31/10/2015**	Completed by 31/10/2015

** The initial proposal for modification of the implementation time was included in the Inception report and provisionally accepted by the EC, letter No. ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014.*
*** Additional extension of the action for four months was proposed in the meeting with expert from the external monitoring team on 09.07.2015 and provisionally accepted by EC, letter No. ENV.E.3 RH/TS/sp 23.09.2015*

Name of the Deliverable	**Deadline**	**Status**
Action Plan for grassland management in Sigulda local Municipality	30/06/2015	Completed 31/10/2015
Action Plan for grassland management in Ludza local Municipality	30/06/2015	Completed 31/10/2015

Name of the Milestone	**Deadline**	**Status**
Background information (ownership structure, biodiversity valuation) gathered	30/09/2014	Completed 30/11/2014
Proposal on biodiversity supporting grassland network development	31/12/2014	Completed 30/06/2015
List of actions for grassland management developed	31/03/2015	Completed 31/10/2015

The aim of the Action was setting a clear framework for activities to be implemented within the actions C1 and C2 ensuring continuous management of biologically valuable and potentially valuable grasslands in the project target areas by developing detailed activity plans for each pilot area.

The Action was led and mostly implemented by CB BEF-LV with involvement of AB4 Sigulda Municipality, AB6 Ludza Municipality and AB1 Latvian Fund for Nature.

The Action was implemented according to the set objectives and within the agreed prolonged time schedule. Two Internal Activity Plans for grassland restoration and demonstration of the alternative use of grass biomass (for Sigulda and Ludza municipalities) were developed by the end of 2015. The plans were based on results of the stocktaking and biophysical mapping of available biomass resources in the both project areas (action A1, activity 1) as well as direct interviews with landowners and information compiled in the registers of local land owners and managers (action C1), providing information on actual management status of grasslands.

The plans cover the following issues: trends in the use of grasslands in the municipalities, extent and quality of biologically valuable grasslands, proposed ecological network of grasslands, factors threating grasslands, priority grassland areas to be restored, resources of grass biomass and possibilities of use, cooperation network for facilitating grassland management, as well as a detailed activity plan to be implemented within the project and beyond.

During the development of the plans, it was found out that only ca 70% of available grass biomass was used in Sigulda Municipality and 40% in Ludza Municipality that provides additional opportunity for either animal husbandry or alternative uses. The quality of biologically valuable grasslands showed alarming trend: in Sigulda Municipality, only 20% of biologically valuable grasslands correspond to good or average quality class, in Ludza Municipality, the situation is slightly better – 31% can be qualified as of a good or average quality; the rest belongs to a low or potential class.

Ecological networks for supporting grassland biodiversity were proposed by delineating core areas, where biologically valuable grasslands reach higher density, and connecting them by ecological corridors and stepping stones. 8 core areas in Sigulda Municipality and 15 areas in Ludza Municipality were marked. The priority grassland areas and proposed ecological networks served as the basis for further selection of restoration areas within Action C2. 67 sites of 300 ha with the aim to clear shrubs and 54 sites of 137 ha with the aim to eliminate the Sosnowsky's Hogweed were included in the Internal Activity Plan of Sigulda Municipality. Additionally, 15 areas were identified where management improvement is needed. In Ludza Municipality one site (25 ha) was selected for restoration and included in the Internal Activity Plan.

The draft plans were communicated with local stakeholder in informative meetings on 13/04/2015 in Ludza and 15/05/2015 in Sigulda. Also, possible activities were discussed in the meeting with local entrepreneurs on 22/05/2015 in Ludza. Pellet production and grassland restoration options were discussed during 3 individual meetings with entrepreneurs of Sigulda Municipality (20/04/2015, 27/06/2015).

It shall be noted that the project did not succeeded to implement the demonstration of grass pellet production and elimination of the Sosnowsky hogweed included in the Internal Activity Plans (reasons explained in Action C2).

Problems encountered

The Internal Activity Plans were based very much on the results of Action A1, which provided important information on grassland resources and quality. As development of Action A1 was delayed, it influenced also performance of Action A3, requiring shift of the deadline for few months.

Modification of action compared to project proposal

Due to delays with the implementation of Action A1, the deadline of implementation of Action A3 was prolonged till 31.10.2015. The reasons for prolongation of the action were addressed at the 2nd visit of the External Monitoring Team and noted in the in the *EC letter, No. ENV.E.3 RH/TS/sp, 23.09.2015*.

Evaluation of achieved outputs and implementation of the time schedule

All expected outputs of the action have been achieved within the prolonged time schedule. Action A3 started half a year earlier than planned - from the beginning of 2014. The Action was prolonged for four

months, from 30.06.2015 till 31.10.2015 due to later input from Action A1. This delay had no significant impact on implementation of the grassland restoration (Action C2), which were based on the Internal Activity Plans.

Expected results	***Achieved results***
The biological value of the grasslands in the project pilot areas and their management requirements assessed	Completed and included in the Internal Activity Plans of Sigulda and Ludza municipalities developed by 31/10/2015
Proposal on development of biodiversity supporting grassland network at the project pilot areas elaborated	Completed and included in the Internal Activity Plans of Sigulda and Ludza municipalities developed by 31/10/2015
List of activities (activity plans) for grassland management in Sigulda and Ludza municipalities with clearly defined action schemes have been developed	Completed and included in the Internal Activity Plans of Sigulda and Ludza municipalities developed by 31/10/2015

Conclusions on action implementation and obtained results
The action has been completed and all envisaged results achieved. The Internal Activity plans contain comprehensive information about the extent and quality of grasslands and define areas where restoration is needed providing priority categories. Ecological networks for supporting grassland biodiversity developed for Sigulda and Ludza municipalities are unique examples on Latvian scale. The plans touched also the perspective of the potentials of using grass biomass for local heat supply. The plans were essential elements for practical implementation of the restoration activities within Action C2. Although, the proposed activities for Sosnowsky's hogweed elimination and demonstration of grass pellet production could not been implemented within the project, the information provided in the activity plans provides essential input for municipalities to co-ordinate the hogweed eradication beyond the project.

Perspectives for continuation of the action after the end of the project
Although the aim of the Internal Activity Plans was planning of activities within the Project, the presented information and knowledge can well serve other needs in relation to grasslands in Sigulda and Ludza municipality. Particularly, the plans provide a good overview about the extent and quality of grasslands and priority areas for restoration that can be used in local strategic and spatial planning documents as well as support co-ordination of the hogweed eradication. The approach by prioritising restoration areas and developing biodiversity supporting networks can be used for planning grassland restoration and maintenance of biodiversity in other municipalities.

5.1.4. **Action A4:** Technical preparation for purchase and improvement of biomass processing equipment

Action implementation time	**Action status**
01/01/2015- 30/06/2015 Proposed modification: 01/01/2015- 30/06/2016*	Completed by 30/06/2016

Name of the Deliverable	**Deadline**	**Status**
-	-	-

Name of the Milestone	**Deadline**	**Status**
Technical documentation for biogas pilot facility prepared	In the project application 30/06/2015 Proposal for modification: 30/06/2016*	Completed by 30/06/2016

* The proposal for extending deadline for submission of the report was included in the Midterm report and provisionally accepted by the *EC, letter No. ENV.E.3 IB/TS/nb, 04.05.2016*

The purpose of the Action was to prepare the tendering documentation (including the Technical Specification) for development of the biogas production pilot facility (Action C2), which according to Grant Agreement modifications, signed by the EC on 13.07.2015, was upgraded to the prototype.

The action was led and implemented by AB2 Bio RE.

The textual part of the Technical Specification, including description of the separate components of the prototype and list of their characterising parameters, was drafted by the action leader by March 2016 and used for the price survey of:

- the first components of the prototype, including supply of four shield elements and a central shield of the reactor for ensuring the base process (announced on 03.02.2016);
- the development of the technical design (including drawings) of the prototype (announced on 04.04.2016).

The technical design of the prototype was delivered by the company "Vega Plast" Ltd. (chosen in a price survey) within Action C2 by June 2016. The technical design was added to the **Technical Specification** and later fine-tuned along to the construction of the biogas prototype.

The full technical specification, including the technical drawings, was used for the price survey of the remaining assembling elements of the prototype:

- Purchase of thermal insulation materials (announced on 15.08.2016)
- Supply of biogas micro-cogeneration (micro CHP) equipment (announced on 07.12.2016)
- Purchase of the continuously working gas analyses equipment (announced on 09.12.2016)
- Purchase of elements for the biogas production pilot facility (announced on 17.01.2017)
- Purchase of systems and elements for the biogas production pilot facility (announced on 03.04.2017).

All the price surveys were published at the website of the AB2 Bio RE (available at www.biore.lv).

Problems encountered

By progressing with investigations on biogas production possibilities from grass biomass within Action A2 and planning project modification of Action C2 on upgrading the pilot facility to a prototype, it became clear that the planned timing for Action A4 cannot be met. The actual drafting of the Technical Specification could start after receiving acceptance from the EC on the Grant Agreement modification and obtaining the first results of the laboratory tests. This delayed the implementation of the action by one year and had an impact on Action C2, delaying the construction works of the prototype.

Modification of action compared to project proposal

The need for prolongation of the action was addressed at the 2nd visit of expert from the External Monitoring Team and noted in the in the *EC letter, No. ENV.E.3 RH/TS/sp 23.09.2015* and the deadline was prolonged till 30.09.2015.

However, also the new deadline was still not possible to meet, therefore, with the Midterm report, the Project team proposed prolongation of the Action by 30.06.2016 and restructuring it according to the following time schedule:

- Development of detailed technical specification for completing modules and the automated control system - by 30.04.2016.
- Preparation of the documentation for price survey for completing purchases - by 31.05.2016.
- Development of a technical project with detailed drawing prepared by a contracted technical designer - by 30.05.2016.
- Preparation of the documentation for price survey for assemblage of the pilot facility – by 30/06/2016.

The European Commission took a note of the proposed new deadline with *EC letter, No. ENV.E.3 IB/TS/nb on 04.05.2016.*

Evaluation of achieved outputs and implementation of the time schedule
The tendering documentation was developed a year later than planned in the project proposal. The delay was caused by the modification process of the biogas pilot facility and upgrading it to a prototype within Action C2. The expected outputs of the action have been achieved within the prolonged time schedule.

Expected results	***Achieved results***
Tendering documentation consisting of technical specification for the biogas pilot facility was prepared	The Technical Specification developed by 30/06/2016 and used for tendering the assembling elements for the prototype.

Conclusions on action implementation and obtained results
The action has been completed and all envisaged results achieved. The developed technical specification provided essential input for Activity C2 by setting clear technical requirements for the biogas facility and clear conditions for tendering companies supplying parts of the prototype.

Perspectives for continuation of the action after the end of the project
There is no specific need to continue the Action after the end of the project. However, the technical specification may later serve as a basis for replicability and further development of the biogas facility up to industrial production scale.

5.1.5. **Action C1:** Establishment of local co-operation networks for grassland maintenance and processing of biomass

Action implementation time	**Action status**
01/10/2013- 31/12/2017	Completed by 31/12/2017

Name of the Deliverable	**Deadline**	**Status**
-	-	-

Name of the Milestone	**Deadline**	**Status**
Web based information system developed	30/06/2014	Completed 30/06/2014
Register of local land owners and managers developed	31/12/2014	Completed 31/12/2014
Contracts with landowners on grassland restoration	30/06/2015 Proposed modification: In early 2016*	Completed 14/10/2016

**The proposal for extending deadline for signing agreements was included in the Midterm Report as well as noted by the EC, letter No. ENV.E.3 IB/TS/nb,04.05.2016.*

The aim of the Action was to establish stable and continuous network of landowners/land managers and entrepreneurs involved in biomass processing. The action consisted of four main activities. The information from the registers and interviews provided input for development of the Internal Activity Plan (A3), demonstration actions (C2) and socioeconomic impact assessment of the project (D2).

The Action C1 was led and implemented by the both municipalities - AB4 Sigulda and AB5 Ludza.

Activity 1: Development of register of local land owners and managers (i.e. land properties)
The registers were compiled in the both municipalities, including information on all land properties, management status (i.e. area of non-managed agricultural land; areas with invasive species) and presence of biologically valuable grasslands. The registers of local land owners and managers are non-public as containing personal information (e.g. address and phone number). The registers were set up by 31.12.2014 with 158 entries for Sigulda Municipality and 272 entries for Ludza Municipality and maintained during the project lifetime.

Two rounds of interviews with landowners were carried out by AB4 Sigulda and AB 5 Ludza in 2014 and 2017, using a common questionnaire developed by CB BEF-LV. In Sigulda 94 respondents were interviewed in 1st round and 73 in 2nd round; while in Ludza, 83 and 77 interviews were conducted, respectively. During the interview's information was collected on economic activities, status of grassland management and use of grassland biomass. For example, the interviews from 2014 reveal that 40 % respondents (n=177) did not use the grass biomass, while in 2017 this figure has reduced to only 20% (n=150), which might indicate positive impact of the project activities. In 2014 the mown grass was left on field by 28% of respondents in Sigulda municipality and 31% in Ludza municipality, while in 2017 only 1% of respondents in both municipalities reported that they leave the grass on field. Furthermore, landowners were identified, who are interested to be involved in project activities, e.g. grassland restoration. The information from the interviews was fed into the land owner and manager register and used for establishment of co-operation networks as well as providing input for development of the internal Activity plan in A3, demonstration actions within C2 and socioeconomic impact assessment of the project in D2. The final round of interviews has also demonstrated the project impact on awareness raising about grassland management and their ecosystem service value as well as growing interest in networking and co-operation among the local stakeholders. For example, 37 % of respondents in 2017 acknowledged that they have participated in the activities organised by the LIFE GRASSSERVICE and have gained the valuable knowledge, 6% have admitted that project has stimulated interest to start co-operation with other entrepreneurs and one respondent have expressed interest to introduce in his farm innovative technological solutions for use of grass biomass.

Activity 2: Development of the register of agriculture related entrepreneurs

The registers of local entrepreneurs involved in processing of biomass in the Sigulda and Ludza Municipalities were developed based on information collected by the project partners AB4 Sigulda and AB 5 Ludza. The register provides contact information of entrepreneurs, information on land properties of agriculture related enterprises (e.g. farms) and their management, number of livestock etc. In Sigulda Municipality the register includes information on 138 farms and 28 enterprises related to agricultural activity (including 13 agricultural service providing companies), while in Ludza the register includes information on 63 farms and 10 agriculture related enterprises. The registers of entrepreneurs are non-public as containing personal information (e.g. address and phone number). The registers were set up by 31.12.2014 with 166 entries for Sigulda Municipality and 61 entries for Ludza Municipality and maintained during the project lifetime.

Activity 3: Negotiations on the management and restoration of the grassland core areas

The potential land properties, where grassland restoration activities had to be carried out, were designated in the Internal Activity Plans within Action A3. In Sigulda Municipality identified areas have public and private ownership, as the activities was financed from CB BEF-LV budget. In 2016, project partner AB4 Sigulda sent letters to 90 landowners noting the problem of grassland degradation in their properties and inviting to meetings to discuss restoration opportunities provided by the project and following commitments. Altogether, three meetings with local landowners were organised in Sigulda Municipality in February 2016 gathering 36 stakeholders. The discussion raised interest from the participants to restore their grasslands; however, many of them expressed fears about signing commitment to maintain the restored grassland in a good quality for 10 years after the end of the project, as they were not sure about rural support conditions in the future or thought about selling the property**.**

In Ludza Municipality, only municipal grasslands were considered for restoration (according to Latvian legislation, municipalities cannot invest public funds in private properties), and it was not problematic to organise signing of such agreement, as the municipality itself will take care of the restored grassland.

Finally, 13 agreements for an area of 97 ha were signed in Sigulda Municipality and 1 agreement for 25 ha in Ludza Municipality that is a higher number than planned in the application.

Activity 4: Facilitation of the contacts and co-operation among the landowners and entrepreneurs involved in biomass processing

The project team used direct individual contacts, as well as various project events for facilitating contacts and co-operation of landowners and entrepreneurs. This included the following events:

- Informative seminars for residents held on 13.04.2015 in Ludza and on 15.05.2015 in Sigulda (Action E1).
- A meeting with local entrepreneurs on 22.05.2015 in Ludza.
- 3 meetings with Sigulda landowners on 25.-26.02.2016.
- A series of seminars during visitor days on 19.-20.09.2017 in Ludza; 10-12.09.2017 and 3.11.2017 (Actions C2 and E1).

Special web-based information platforms were developed in the both municipalities (to facilitate the networking of landowners who are interested to offer grassland biomass resources or land for renting with those who are interested in the use of biomass. The information platforms were placed at the web sites of the municipalities:

- Sigulda Municipality:
https://www.sigulda.lv/public/lat/uznemejdarbiba/lauku_attistiba/piedavajumi_un_pakalpojumi,
- Ludza Municipality:
http://www.ludza.lv/projekti/alternativas-biomasas-izmantosanas-iespejas-zalaju-biologiskas-daudzveidibas-un-ekosistemu-pakalpojumu-uzturesanai).

Additionally, in Sigulda, a special online map with various spatial information related to grasslands was developed (http://karte.sigulda.lv).

Problems encountered

The major problems in implementation of the Action was related to signing of the long-term agreements with landowners on maintenance of the restored grasslands. The activity delayed due to withdrawal of AB "Skujas" from the project partnership in summer 2015 that caused big uncertainty about the execution of grassland restoration activities in Sigulda Municipality. It was solved by the decision of CB BEF-LV in 2016 to take over restoration.

Another problem regarding signing of the agreements was uncertainty on interpretation of the definition "long term". The 30 years period, advised by the external project monitoring expert was recognised by the project partners as disproportionally long, considering knowledge on support conditions for grassland management under Rural Development Programme, available only end for the programming period till 2020. An agreement was reached with the European Commission on the period of 10 years *(EC letter, No. ENV.E.3 IC/TS/sp, 09.11.2015).*

However, even 10-year period seemed too long for many landowners; many of them were not ready to sign an agreement with the commitment to maintain the restored grasslands in a good quality the given time period after the end of the project. The main reasons were uncertainty about rural support payments in future, as well as possible ownership change (selling the property). Thus, during negotiations, some grassland areas of a high restoration priority dropped out of the list. However, the project team managed to reach the set target of signed commitments.

Modification of action compared to project proposal

No modification in relation of content of the action were needed. The planned signing commitments with land owners on grassland restoration was delayed compared to the planned (30.06.2015), mostly due to problems created by the withdrawal of partner AB6 Skujas. The last agreement was signed on 14.10.2016.

Evaluation of achieved outputs and implementation of the time schedule

All the expected outputs of the action have been achieved within the planned timetable, excepting signing long-term agreements with landowners. This had an impact on starting dates of restoration activities in some sites in Sigulda municipality within Action C2 – the first restoration works could start only in late autumn 2016 (see more in chapter 5.1.6).

Expected results	***Achieved results***
A register of local landowners and managers	A register has been developed in each municipality, with 158 entries on properties with biologically valuable grasslands in Sigulda Municipality, and 272 entries in

	Ludza Municipality by 31/12/2014
A register of entrepreneurs (farms and other agriculture related entrepreneurs)	A register has been developed in each municipality, with 166 entries in Sigulda Municipality and 61 entries in Ludza Municipality by 31/12/2014
Ca. 100 local stakeholders in each municipality actively approached and informed about project activities and alternative uses of biomass	Ca. 380 stakeholders in Sigulda Municipality and ca. 400 stakeholders in Ludza Municipality were directly approached and informed during the project lifetime
Ca. 10 long term agreements signed with landowners on management of grasslands that will be restored during project activities	14 long term agreements (13 in Sigulda Municipality and 1 in Ludza Municipality) have been signed by 14/10/2016, 16 months later than initially planned
1 web-based information system developed in each municipality to facilitate the management of grasslands	Information systems has been developed and launched on the websites of each Sigulda and Ludza Municipality by 30/06/2014 and actively used by residents of both municipalities

Conclusions on action implementation and obtained results
The action has achieved all envisaged results. The registers of landowners/managers and entrepreneurs was first time attempt in Latvia to compile such information in one place. The number of entries in the registers by far exceeded the planned numbers. The registers have not only served the needs of the project by providing essential information on land properties for the needs of Actions A1, A3 and C2, but also serving the needs of municipalities to communicate rural development issues. The web-based information platforms are continuously used by local people for finding information on service providers for mowing grass in their properties.

Also, the number of stakeholders informed about the project activities exceeded the planned numbers. The experience obtained within the project proved that proactive communication by approaching landowners yielded with good outcomes. Particularly, it was important for older generation, which still does not use modern communication means.

Difficulties during signing long-term contracts reflected the uncertainty of landowners about the future of their properties, which, in turn, is caused by socioeconomic situation in the countryside.

Perspectives for continuation of the action after the end of the project
The both registers will be maintained by Sigulda and Ludza Municipalities also after the end of the project providing possibility to use them by the specialists of the both municipalities, as well as on request by interested persons who might have a stake on the management of grasslands. Also, the information exchange platforms will continue to function on the public websites of the both municipalities, and residents will have possibility to insert information on land rents or demands, grass biomass offer or demand, and offers for grassland management services.

5.1.6. **Action C2:** Demonstration actions on processing of biomass

Action implementation time	Action status
In the project application: 01/07/2015 – 31/12/2017 Proposed modification: 01/07/2014 – 31/12/2017*	Completed by 31/12/2017

Name of the Deliverable	Deadline	Status
Publication on results of assessment of the alternative uses of biomass	30/06/2017	Completed by 31/12/2017

Name of the Milestone	Deadline	Status
Pilot facility for production of biogas	31/03/2016	Completed, biogas pilot facility

launched	Proposed modification: 31/12/2016**	launched by 30/06/2017
Restoration of overgrown grasslands	31/12/2016 Proposed modification: 31/07/2017***	Completed in Ludza Municipality by 31/08/2016; Completed in Sigulda Municipality by 31/08/2017
Visitor day in Ludza local Municipality	30/09/2017	Completed, organised on 19-20/09/2017
Visitor day in Sigulda local Municipality	30/09/2017	Completed, organised on 10-12/10/2017 and 3/11/2017

** The proposal for earlier start of the action implementation was included in the Inception report and noted by the EC, letter No. ENV.E3 TPM/TS/ak ARES (2014), 08.09.2014*
*** The proposal for extending deadline for launching the biogas pilot facility was included in the Progress report and provisionally accepted by the EC, letter No. Ares (2017)2427409, 12.05.2017.*
**** The proposed deadline of 31 July 2017 was acceptable by the EC, letter Ref. Ares (2017)2427409, 12.05.2017.*

The aim of the Action was to set preconditions for continuous grassland management and maintenance of the ecologically coherent grassland network through restoration of the overgrowing fields and providing opportunities for alternative uses of grassland biomass that goes beyond the traditional farming practices. The action consisted of two main activity blocks: restoration of overgrowing grasslands and demonstration of alternative uses of biomass for biofuel (biogas and biobutanol) production.

CB BEF-LV ensured the overall leadership of the Action in close co-operation with AB2 Bio RE and AB3 RTU. The demonstration of grass pellet production as well as grassland restoration in Sigulda municipality was planned to be implemented by AB6 Skujas. As noted before the AB6 Skujas withdrew from the project in November 20015 due to change in the economic conditions (e.g. significant drop of the market price for the grass pellets) as well as management problems of the company. As potential new partner Ltd. "Jumis" was identified - a company in charge for waste management in Sigulda municipality, with experience in grassland restoration and technical capacities for implementation of the required tasks. However, after the long negotiations on budgetary issues, involvement of the new partner in the project failed. Therefore, CB BEF-LV took over also this activity.

Activity 1: Restoration of the overgrowing fields in order to establish ecologically coherent grassland network

According to the project proposal, 150 ha of grasslands had to be restored, including removal of shrubs and their roots and stumps within 100 ha in Sigulda Municipality and 25 ha in Ludza Municipality as well as elimination of the invasive species Sosnowsky's hogweed within 25 ha in Sigulda Municipality. The sites were selected based on the Internal Activity Plans (Action A3), taking into account their location in the proposed grassland ecological network.

AB5 Ludza supervised grassland restoration activities within a 25 ha site between Lake Diunoklis and Mazais Ludza Lake fully reaching the restoration target for the Ludza municipality. The area includes habitat of Community importance *6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates*. Restoration was performed by the subcontractor Farm "Saulaine" from November 2015 till August 2016. The restoration activities included felling trees and bushes, removal of stumps, roots, stones and waste, elimination of the Canadian goldenrod *Solidago canadensis*, primary mowing, as well as spreading hay from high nature value parcels to the cleaned ones with the aim to distribute seeds.

CB BEF-LV supervised restoration activities in 12 areas with an area of 97 ha in Sigulda Municipality nearly reaching the target of 100 ha in the municipality: 3 in Sigulda town, 2 in Siguldas parish, 1 in Allaži parish, and 6 in More parish). The selected areas include grassland habitats of Community importance: *6120* Xeric sand calcareous grasslands; 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates; 6270* Fennoscandian lowland species-rich dry to mesic grasslands; 6450 Northern boreal alluvial meadows; 6510 Lowland hay meadows*. Restoration was performed by the subcontractor Company "Vidzemes Ekomežs" from October 2016 till August 2017. The restoration

included felling of trees and shrubs, removal of stumps and roots, milling roots, soil levelling and disking/harrowing, removal of stones, concrete slabs, poles, and waste, elimination of invasive and expansive species, controlled burning, primary mowing, application of freshly mown grass and hay to facilitate spreading seeds, as well as seeding.

Some of restoration activities are unique in the country's context. On 10.04.2017, controlled burning was organised in site "Kalna Klaukas" of Sigulda Municipality to remove old thatch and excessive organic matter in the soil. Before burning, all permits were gathered from the Nature Conservation Agency and the Fire Service. The site was specially prepared by making lanes with bare soil. The date was chosen when weather conditions were favourable to keep fire under control. Summary of the obtained experience during the restoration works are compiled in the report "Grassland restoration demonstration in Sigulda and Ludza Municipality".

On 17.07.2017, application of freshly mown grass from biologically valuable grasslands ("green hay" method) was carried out in site "Balonu pļava" and "Līcīši" in Sigulda Municipality. The grassland was constantly monitored for the right mowing time when seeds got mature, as well as appropriate weather conditions. The mown grass was immediately transported to other grasslands, where soil was uncovered during restoration activities, particularly after root and stump removal and milling. The first monitoring results suggest that the application of the "green hay" method has been successful and facilitated recolonization of grasslands with typical species.

In July 2016, a similar method – application of dry hay – was used in Ludza Municipality with the same purpose to facilitate spreading seeds from biologically valuable grasslands.

The activity of elimination of the invasive species Sosnowsky's hogweed within 25 ha in Sigulda Municipality was not implemented due to change in grassland management requirements in Latvia. Since 2015 agricultural support payments were available also for grassland areas invaded by hogweed, if they are mowed before blooming of the species, thus the area of unmanaged grasslands with hogweed have considerably decreased. At the same time the owners of the remaining grasslands with hogweed, not receiving agriculture support payments, had a low interested to participate in the project actions and/or to sign the long-term agreements for continuation of grassland management (see more details in the section **"Problems encountered"**). Only one landowner was ready to sign an agreement on implementation of hogweed elimination activities in his land lot; however, natural conditions were rather difficult for technical implementation (river floodplain). Also, inactivity of land owners in the surrounding areas made elimination meaningless, because hogweed seeds from their properties would continue to invade the restored land lot. Therefore CB BEF-LV has proposed in the Progress Report an alternative restoration activity by improvement in grassland structural quality. However, as noted in *EC letter, No. Ares (2017)2427409, 12.05.2017*, the European Commission did not consider that proposed modification of the Activity would compensate the failed eradication of Sosnowsky's hogweed.

Activity 2: Demonstration of alternative uses of the biomass

Activity 2.1: Production of grass pellets

The activity was not implemented. According to the project application, AB6 Skujas was responsible for the demonstration of production of grass pellets. The company planned to develop commercial production of pellets in Sigulda Municipality with all production costs covered by the company itself excepting preliminary investigation costs. Unfortunately, AB6 Skujas withdrew from the project as noted before and new partner, who would be interested in grass pellet production and ready to join the project was not found. Therefore, CB BEF-LV was looking for another solution how to organise the demonstration of grass pellet production. In the Midterm report, it was proposed to perform the activity in a modified way by producing a reduced number of pellets and testing their application for fodder, litter and fuel. After investigation on pellet production possibilities (potential of demonstration in the project pilot areas as well as experience of similar activities in other countries), the project team found out that the implementation of this activity was not feasible and proposed replacing it with a detailed desk study on various experiences in grass pelleting in Latvia and other countries. As noted in *EC letter, No. Ares (2017)2427409, 12.05.2017*, the European Commission did not support replacing demonstration of pellet production by a thorough desk study since it does not seem to have a direct and concrete implementation.

Activity 2.2: Production of biofuels

Based on the results of exploring usage of various types of grass biomass (raw grass, hay, silage) as feedstock and exposing it to different types of physical and chemical treatment, basic technologies to produce biogas and biobutanol were developed within the Action A2. As noted before, based on Action A2 results, it was decided to replace the renting of existing facility for demonstration of biogas production from grass biomass with construction of new facility (Prototype) and accepted with the first Grant Agreement modification, signed by the European Commission on 13.07.2015.

During the initial stage of the C2 Action (from July 2014 till June 2016) AB2 Bio RE **calculated the** technical parameters of **the biogas production prototype** based on the results of the Action A2, and the technical design of it components was prepared by the contracted company "Vega Plast" Ltd. The total volume of the reactor, its modules and a separated hydrolysis module has been calculated based on hydraulic retention time and organic loading rate. Technical solutions for biomass movement in the reactor and mixing substrate were developed, and engineering preconditions for installing the facility (needed capacity of water and electricity networks etc.) were defined. The design for methane separation device (water scrubber), gasholder and biogas burner were developed. The optimal level of automated control system for the biogas reactor was calculated.

The practical assemblage of the facility was much more complicated and time demanding than initially planned, resulting in the 2nd Grant Agreement modification for increasing the production capacity, size and accordingly costs of the prototype (see more details bellow in the section "**Problems encountered**"). Consequently, the assembling of the main parts of the prototype was finished by 30.06.2017. However, still ca. 2.5 months were needed for bringing the facility into operation. This included calibration of sensors, configuration of hydrolyses unit and optimisation of the gas-mixing system. Due to the technical complications faced during the construction of the prototype and optimisation of its operation, it was ready for the demonstration in the project sites only from mid-September 2017 (more details about the demonstration in the project sites see below). Optimization of anaerobic digestion processes and stable fermentation conditions were achieved in parallel to demonstration of the facility in the two project areas.

Assembling of the prototype, June 2017

Demonstration of the prototype in Sigulda, October 2017

Picture: biogas production prototype

During the demonstration period in the project areas, the prototype was in full operation for ca. 50 days, and the total amount produced during the life time of the project was ca. 200 m^3.

The pilot facility for biobutanol production of AB3 RTU was used to test the biobutanol production from grass biomass. Pilot system for biobutanol production consists of the following main parts: mechanical milling system, heating/hydrolysis reactor, filtration system consisting of rough filters, ultra and nanofiltration units, bioreactor, foam separator, cooler, product condensate separator, and collector. By 31.03.2016 AB3 RTU carried out performance testing of the pilot facility and adjusting parameters for further demonstration. Since April 2016, the pilot facility was available for demonstration in the premises of Riga Technical University, and ca 234 interested people have attended the facility till the end of the

Project and got acquainted with its work. During the demonstration of the pilot facility, 40 litres of biobutanol were produced.

Based on the results obtained during the demonstration, an electronic publication on alternative uses of grass biomass was developed. It covers the technological processes and design of facilities to produce biogas and biobutanol, as well as pellet and other compacted grass products.

Activity 2.3: Operation of pilot facilities in the pilot areas

The pilot facilities for biobutanol and biogas production were demonstrated in Ludza and Sigulda municipalities. The demonstration took place in the premises of Ludza and Sigulda municipal wastewater treatment facilities, which offered the required area, electricity and water supply, as well as wastewater discharge possibilities.

The biogas pilot facility was demonstrated from 17.09.2017 till 07.10.2017 7 in Ludza municipality and from 09.10.2017 till 31.12.2017 in Sigulda municipality. The demonstration period of biogas facility was considerably shorter than planned in the project proposal (4 instead of 15 month), however it was compensated with more intensive demonstration activities during the visitors' days targeted to different groups of stakeholders (see description below). The biobutanol pilot facility was demonstrated during the visitors' days (18.-22.09.2017 in Ludza; on 09.-13.10.2017 and on 03.11.2017 in Sigulda). Since the whole pilot facility was not transportable, most essential components were brought to the visitors' days helping to explain main functioning principles. In a full extent, the facility was demonstrated in the premises of Riga Technical University since April 2016 till December 2017.

The pilot facilities were introduced to various stakeholders' groups during the series of events organised within the visitors' days, including seminars targeted to entrepreneurs and students of technical colleges and universities (Action C2) as well as informative seminars for local public (Action E1),

- 19.09.2017 in Ludza for local entrepreneurs (31 participant)
- 19.09.2017 in Ludza for students from Rēzekne Academy of Technologies (32 participants)
- 20.09.2017 in Ludza for residents and schoolchildren (54 participants), organised in frame of action E1
- 10.10.2017 in Sigulda for schoolchildren (86 participants), organised in frame of action E1
- 11.10.2017 in Sigulda for students from Riga Technical University, University of Latvia, University of Agriculture of Latvia, Riga State Technical School, Mechanics and Technology College of Olaine (82 participants)
- 12.10.2017 in Sigulda for residents (47 participants), organised in frame of action E1
- 3.11.2017 in Sigulda for local entrepreneurs (42 participants)

Furthermore, the pilot facilities were visited also by the participants of the closing international seminar on 30.11.2017 organised within Action E3 (47 participants).

Problems encountered

The main problems in implementation of the Action C2 were related to restoration of grasslands in Sigulda Municipality and demonstration of the production of grass pellets, caused by the withdrawal of the AB6 Skujas and failure to involve Company "Jumis", due to the company's insecurity in the conditions for implementation of EU LIFE Programme projects. The difficulties were partly solved by the decision of CB BEF-LV to take a lead over the restoration activities, whereas production of grass pellets could not be succeeded as planned in the project application.

Due to withdrawal of AB6 Skujas and difficult negation process with landowners, the grassland restoration started later in Sigulda Municipality and was finished 8 months later compared to the planned timeline; however, the target of restoration by elimination of shrubs was reached.

The elimination activities of the Sosnowsky's hogweed were not implemented. The main reason was changes in the existing management requirements of the areas invaded by the Sosnowsky's hogweed. Since 2015, Regulations of the Cabinet of Ministers No 126 are in force, which sets the condition that the

land block, where hogweeds are found, but do not reach blooming conditions, are accepted for receiving agricultural support payments (previously, such areas were excluded from agriculture support). As the result, share of non-managed grasslands invaded by Sosnowsky's hogweed is constantly decreasing. From the 137 ha of the area identified in the Internal Activity Plan (Action A3) for elimination of the invasive species, owners of 9 grassland plots (60 ha in total) were interested to eliminate the species. However, most of them applied for agriculture support payments and were obliged to keep the land in a good quality, including eradication of Sosnowsky's hogweed. Finally, 17.5 ha were identified belonging to two owners, which would be suitable for restoration in respect to the project objectives and the Internal Activity Plan and at the same time not receiving agricultural support. The communication to the owners discovered that only one of them is interested in maintaining the grassland for future agricultural activities. The other recently decided to afforest a part of the grassland and does not plan any agricultural activities on the site. Also, wet conditions of the area (floodplains of the Mergupe River) make restoration extremely difficult, and the restoration results might be under risk due to dispersal of the hogweed from invaded plots surrounding the restored site. Therefore, CB BEF-LV decided not to invest in hogweed elimination from the project budget.

Also, demonstration of grass pellet production could not be implemented. After the withdrawal of AB6 Farm "Skujas", the CB-BEF looked for various options to perform the activity. The project discovered that there were only few grass pelleting facilities in the whole country, the nearest being a facility in Sigulda Municipality and one in a 40 km distance from Sigulda. During communication with the managers of the facilities, they showed no interest to take part in the demonstration activities of the project. It was not economically and technically feasible to use services of more distant facilities than those two mentioned.

The development of the biogas pilot facility was more complex and time consuming compared to the planned. After two-time modification of the time plan, the demonstration of biogas production was planned to start by 31.12.2016. However, due to the complexity of prototype development, including revisions in the technical design and more time demanding procurement procedure, it was impossible to launch the facility as planned. A new deadline for launching the biogas facility was set for 01.03.2017, accepted by the *EC, letter No. Ares (2017)2427409, 12.05.2017*. Due to delays in the delivery of the parts of the prototype, as well as problems faced during construction phase and adjustment of the technological processes, the prototype was launched in June 2017 and after adjustment of biogas production processes ready for demonstration in project sites only from mid-September 2017. Although the biogas facility demonstration was ensured, there were technical problems that could not be solved during the project lifetime. According to findings from laboratory tests, a 5 m^3/day biogas production with the prototype, but in practice it was a bit smaller. It means that the potential biogas production capacity of the prototype was not fully reached, and AB2 Bio RE continues to optimise the work of hydrolysis equipment (also, after the end of the project with own resources).

Modification of action compared to project proposal

Two major changes in the execution of Action C2 in relation to grassland restoration and the development of the biogas pilot facility took place in the project.

As described above, actual grassland restoration in Sigulda Municipality started only in October 2016 due to the withdrawal of the Associated Beneficiary "Skujas". A formal project modification was not required as the same activities were taken over by the Coordination Beneficiary BEF-LV. The overtaking process caused delays in restoration activities, and the new proposed deadline of 31.07.2017 was accepted by the EC, *letter No Ares (2017)2427409, 12.05.2017.*

The most significant modification of the project was related to the demonstration of biogas production. During the project lifetime, two following modifications took place:

- **Construction of a prototype instead of renting existing facility.** Based on the results of Action A2, the project team concluded that the existing biogas construction facilities available for renting were not enough for introduction technical solutions developed during the project. Therefore, a proposal for budget change from the budget position "external service" to "prototype" was submitted with the 1st request for grant agreement modifications. Accordingly, On 13 July 2015, Amendment No 1 to

Grant Agreement for the Project was signed approving the proposed changes and new budget for the biogas facility.

- **Upgrading the planned prototype to a larger facility.** During the phase of designing the facility, it was discovered that the capacity of the reactor must be enlarged, as well as a combined heat and power equipment added to fully demonstrate and evaluate biogas production. Thus, initial calculation about the size of several components the facility and related costs were underestimated. The proposed changes resulted Amendment No 2 to Grant Agreement signed on 21.12.2017 with a significant increase of the budget for biogas production prototype within the limits of existing project budget.

Evaluation of achieved outputs and implementation of the time schedule

As described above, the grassland restoration activities by elimination of shrubs started later in Sigulda Municipality due to withdrawal of the responsible beneficiary Farm "Skujas" from the project, and the Activity was completed by 31.08.2017 (8 months later that initially planned); however, it did not have further influence on other project activities and reaching the related targets.

Launching the biogas pilot facility took a significantly longer time as planned in the application, which is grounded by two times project modification as describe above. As the consequence, the biogas pilot facility (prototype) was launched by 30.06.2017, which was 15 months later than planned in the application. Accordingly, the demonstration in the municipalities also was much shorter than planned by the application (4 month instead of 15 months), starting from 17.09.2017 till 31.12.2017. Due to late launching the biogas facility, also visitor days were organised a bit later – in September in Ludza Municipality and in October-November in Sigulda Municipality - compared to the planned (by 31.08.2017). Although the demonstration of the biogas pilot facility was rather short, it was compensated by the dense programme of targeted events that covered a wide stakeholder spectrum.

Expected results	***Achieved results***
Grasslands overgrown with bushes restored in an area of 125 ha	122 ha of grasslands restored (25 ha in Ludza municipality and 97 ha in Sigulda Municipality) by 15/08/2017
Grasslands invaded with Sosnowsky's Hogweeds restored in an area of 25 ha	Not achieved; the activity was deleted due to withdrawal of the responsible partner and changes in the state support system (explained above)
Biomass for testing its alternative uses harvested in an area of 300 ha	Not achieved. The area was related to the planned grass pellet production. The activity was deleted due to withdrawal of the responsible partner (explained above)
Various options to produce biogas and biobutanol from grass biomass have been investigated and assessed	In laboratories, different types of grass biomass (raw grass, hay, silage) have been exposed to physical and chemical treatments, and best technologies to produce biogas and biobutanol developed
1 pilot facility for biogas production from grass biomass has been launched with planned production of 200 m^3 during the project duration	The pilot facility constructed and launched for demonstration by 30/06/2017; 200 m^3 of biogas produced during the demonstration time that corresponds to the planned in the application.
1 pilot facility for biobutanol production from grass biomass has been launched with planned production of 40 l during the project duration	The pilot facility constructed and launched for demonstration by 31/03/2016; 40 l of biobutanol produced during the demonstration time
Grass pellets from biomass have been produced in the pilot areas with planned production of 750 tonnes during the project duration	Not achieved. The activity was deleted due to withdrawal of the responsible partner (explained above)
1 publication on results of assessment of the alternative uses of biomass prepared in pdf format	The publication reflecting experiences obtained in the demonstration of biogas and biobutanol production within the project, as well as providing insight on grass pellet production technologies and their application produced by 31.12.2017 and available for download as a pdf file on the

	project website
Visitor days for demonstrating biomass processing methods have been organised: 2 one-day events, with ca. 50-100 participants at each	Visitor days organised on 19.-20.09.2017 in Ludza municipality and on 10.-12.10.2017, 03.11.2017 in Sigulda municipality. 8 seminars organised during visitor days: 2 seminars with 63 participants within Action C2 and 2 seminars with 55 participants within Action E2 in Ludza municipality; and 2 seminars with 124 participants within Action C2 and 2 seminars with 133 participants within Action E2 in Sigulda municipality

Conclusions on action implementation and obtained results

Despite several technical constrains and delays in the schedule the main targets in relation to establishment of preconditions for continuous grassland management and maintenance of the ecologically coherent grassland network through restoration of the overgrowing fields as well as demonstration of alternative uses of grassland biomass have been achieved. 122 ha of grasslands were restored by eliminating overgrowth by shrubs out of ca.125 ha provisionally planned in the project proposal. The restoration activities turned out much more complicated than initially planned due to several factors: additional activities that were necessary to reach objectives (like removal of wastes, controlled burning), wet weather conditions during last two years, as well as difficulties to find appropriate machinery for fulfilling certain tasks. Nevertheless, very good results have been achieved (i.e. the first observations performed within monitoring action D1 shows improvements in vegetation structure) and valuable experience gained in methods for grassland restoration. The activity may serve as a good practice example in grassland restoration, because new methods for Latvia have been tested, like green grass and hay application for seed spreading, as well as controlled burning to eliminate old thatch and excessive amount of nutrients in the soil. Though not all the targets were achieved, since Elimination of Sosnowsky's hogweed in 25 ha of Sigulda municipality was not implemented due to the reasons described above.

Also, the demonstration of the alternative use of grass biomass for production of biogas and biobutanol was successfully implemented - technological possibilities were investigated and demonstrated to large group of various stakeholders. The objectives in relation to demonstration of the two more innovative alternatives of grass biomass use - biogas and biobutanol production were achieved, although the demonstration of the more conventional technology – grass pellet production was not performed. Nevertheless, demonstration of grass pelleting technology within the Project would have least added value compared to biogas and biobutanol production, since it does not have an innovative character. Grass pellets and other compacted grass products are used for energy production in North America and Europe (closest examples in Estonia, Lithuania and Poland). A Latvian company is producing grass pellets for pets. Meanwhile, the Latvian Rural Advisory and Training Centre carried out research on the use of grass pellets for feeding domestic animals. Though, even not producing pellets in practice, the Project helped spreading the information about grass pelleting in various meetings and seminars.

The assemblage and demonstration of the biobutanol pilot facility went smoothly, while development of the biogas production prototype required technically more complex and costly solutions than initially planned. Nevertheless, the both tested technologies have proved to be technically viable to demonstrate biogas and biobutanol production. Though, the analysis of present situation shows that higher market demand and economic viability would be in case of larger scale facility with approbated technologies to process larger amounts and various type of biomass, thus to produce larger amount of biogas. The knowledge and results obtained within the LIFE GRASSSERVICE project shall enable further development in biofuel production technologies and use of grass biomass as feedstock, potentially in combination with other substrates.

In relation to the request of the European Commission "to prove that the amended format for the demonstration of alternative uses of biomass has still allowed the objectives of this action to be reached" (*EC letter, No. ENV.E.3 IB/TS/nb, 04.05.2016),* we can state that the project has mostly achieved the set demonstration objectives (except for non-implemented grass pellet production). It was estimated that altogether ca 565 stakeholders representing various groups got acquainted with the technological options

for biobutanol production and 331 for biogas, which is a high number in Latvian conditions. The demonstration of the biobutanol facility for extended time took place also outside the pilot areas, at Riga Technical University. A shorter demonstration period for biogas production was fully compensated by a more proactive way by organising specially targeted seminars and approaching students of engineering sciences and entrepreneurs. Higher numbers could be achieved only in case of transporting the facilities outside project areas, which was not in the scope of the project application. Also, no interest from local visitors arose in the last months of the demonstration in Sigulda Municipality.

Perspectives for continuation of the action after the end of the project
The restored grasslands in the both municipalities provide precondition for further management by mowing or grazing. However, they cover only part of large grassland areas defined by the project that require restoration in order to halt in decline in the status of biodiversity in future. Therefore, continuation of the restoration work within other projects or by landowners is highly welcome, and the project team is ready to share the vast obtained experience.

The pilot facilities for biogas and biobutanol production will be continued to demonstrate at the premises of AB2 Bio RE and Riga Technical University for interested stakeholders. Investigations of technologies to produce biogas and biobutanol from grass biomass shall be continued to polish the developed technologies and construct production facilities for industrial use. However, the political and economic context must be highly considered. Recently, political support for biogas production has seized in Latvia. RTU is planning to develop a mobile biobutanol production facility based on the project results. AB2 Bio RE will work on upgrading the biogas pilot facility towards an industrial facility by adopting the developed technologies for commercial production.

5.1.7. **Action D1:** Monitoring of impact of project activities on grassland habitats

Action implementation time	Action status
01/01/2014 – 31/12/2017	Completed by 31/12/2017

Name of the Deliverable	Deadline	Status
Report on impact of project activities on grassland habitats	30/09/2017	Completed 31/12/2017

Name of the Milestone	Deadline	Status
Methodology for assessment developed	30/06/2014	Completed 30/06/2014

The Action was performed to assess the impacts of two grassland management measures (restoration of overgrown habitats (Action C2) and application of digestate (Action A2)) on the ecological status of the grassland habitats.

The action included the following steps: i) development of the monitoring methodology; ii) establishment of the permanent monitoring plots and collecting the field data (vegetation and invertebrates) for assessment the impact of selected management regimes; iii) collection of field data from habitat restoration sites; iv) preparation of the monitoring report.

The Action was implemented by the Latvian Fund for Nature (AB1).

Activity 1: development of the monitoring methodology
Methodology for monitoring the impacts of different management regimes applied by the project were performed by 30.06.2014.
The methodology includes the following parts:
1. Description of methods for assessing the quantity and quality of grassland biomass.
2. Description of methods for assessing grassland structure and herbaceous vegetation.
3. Description of methods for invertebrate monitoring.

Activity 2: establishment of the permanent monitoring plots and collection of field data for assessment the impact of selected management regimes

According the monitoring methodology four 10x10 m permanent monitoring plots (24 monitoring plots in total) were installed in each site selected for testing of different management regimes (application of digestate, Action A2) at the beginning of July 2014. In each permanent monitoring plot one biomass sample were collected (24 in total) and detail vegetation descriptions – prepared for randomly selected 25 1x1m squares (600 in total) in July and June 2014–2017. To assess the impact of digestate application to invertebrate fauna, 10 traps for terrestrial beetles were installed in each monitoring site (60 traps in total) and their content collected and examined in August 2014 and June, July 2015–2017.

Activity 3: collection of field data from habitat restoration sites

For all sites proposed for restoration (Action C2) the questionnaire on habitat's quality were filled and detail overgrowth maps from LIDAR and orthophoto data were prepared in July, August and September 2015. To assess the changes in conservation status of the restored grassland habitats, the same questionnaires were repeatedly filled in June–September 2017. Additionally, vegetation descriptions of 10–25 1x1m squares along three monitoring transects in Ludza Municipality and along 7 monitoring transects in Sigulda Municipality were prepared in June and July 2016 and 2017. Additional data were collected to get the possibility to assess the success of habitat restoration after the project ends.

Activity 4: preparing the report on monitoring results

The monitoring report was prepared till the end of December 2017. It highlights the impact of habitat restoration activities to conservation status of EU grassland habitats in Sigulda and Ludza Municipality as well as the impact of digestate application to vegetation and invertebrate fauna of semi-natural grasslands.

Problems encountered

As indicated in the Midterm report it was not possible to make the monitoring of rain worms (*Lumbicidae*) within the monitoring in sites, established for assessing impacts of digestate application within Action A2, because there is only one rain worm expert in Latvia and due to his time constraints, he was not ready to engage in this task. Nevertheless, it did not have significant impact on achievement of the main goal of the action – determine the impact of digestate application on semi-natural grassland habitats – as the monitoring of the beetle fauna were done in full scope. Beetles from the *Carabidae* family are considered as the best indicators for vegetation changes because their distribution and species composition are directly dependent on the vegetation of the hosting habitat while the distribution and species composition of rain worms indicate the quality of the soil and its changes.

Modification of action compared to project proposal

The scope of the parameters of the annual monitoring was slightly narrowed by excluding the rain worms due to the reasons described above. This modification was provisionally accepted by the European Commission, *as noted in the EC letter, No ENV.E.3 IB/TS/nb, 04.05.2016.*

Furthermore, the establishment of the permanent monitoring plots as well as performance of the monitoring activities in the field had to be extended in within the vegetation season of 2017, due to latter start of grassland restoration activities in Sigulda municipality. Since the final decision on the restoration sites in the Sigulda municipality was taken only in September 2016, the description of the vegetation along the monitoring transects within the restored sites were rescheduled to June and July of 2017 and *accepted by the EC, letter, No ENV-D-4 IB/TS/vi, 12.05.2017*. Though the monitoring of few sites were completed only by September 2017, because restoration works turned out more complicated than expected and continued until August 2017.

Evaluation of achieved outputs and implementation of the time schedule

Despite slight revision of the schedule for the monitoring field works the action has been completed within agreed time frame. Changes in the schedule of the filed works did not have any impact on implementation of other actions and achievement of the expected results and overall objectives.

Expected results	***Achieved result***
Methodology for monitoring of the	Completed by 30.06.2014

impact of project activities on grassland biodiversity developed	
Regular monitoring carried out at the selected sampling plots	- 24 permanent monitoring plots for assessment the impact of selected management regimes to semi-natural grasslands (Action A2) installed in July 2014. - Vegetation descriptions for 600 1x1 m squares prepared and contents of 240 traps for terrestrial beetles collected in 2014, 2015, 2016 and 2017. - The overgrowth maps and questionnaire on habitat's quality filled for all restoration sites (Action C2) in 2014 and 2017 and 10–25 vegetation descripts along monitoring transects on 10 restoration sites prepared in 2016 and 2017.
Report on monitoring results prepared and presented at the project web site	Report on monitoring results prepared by 31.12.2017 and presented at the project website

Conclusions on action implementation and obtained results:
The action has been successfully implemented by establishing permanent monitoring plots and demonstrating the first impacts of the project activities on grassland biodiversity. The monitoring results revealed that thanks to habitat restoration activities (Actions C2) the average area of the restored grassland patches has increased from 3 to 4 ha, the overgrows with trees and shrubs within restored grasslands has decreased from 27% to 4% and there is no longer a dense layer of litter that interfered with seed germination and decreased the occurrence of less competitive species. As green hay method for improvement of the species saturation was applied only in July 2017, it was not possible to make a detail assessment of its effectiveness within the project. However, the vegetation descriptions, that were prepared along the monitoring transects, provides bases for studying the impacts of this new method after the project ends.

The monitoring data on application of digestate (implemented within Action A2) shows that even relatively small doses of digestate (9–30 kg N/ha - the dose of fertilizer necessary to compensate the loss of nutrients removed with grass biomass to maintain the productivity of grasslands) increases productivity and reduces the diversity of plant species, but it has little effect on the diversity of the beetle fauna. In all plots where digestate were applied the productivity increased by 2–13% while in all control plots it dropped by 11–30%. The saturation of plant species (number of species per square meter) in control plots increased by 7 species an average, while in the digestate application sites it increased or even decreased by 1–2 species. Besides, the increase of the species saturation in some digestate application plots is more likely attributed to the changes in grassland management practices rather than digestate application. All grasslands that were used for the valuation of grassland management methods were not managed, mulched or managed with late mowing before the project started, while during the project they were mown and harvested in July. At the same time there were no statistically significant differences in the diversity of beetle fauna between the digestate application and control plots. In some management sites the highest diversity was observed in the plots with digestate application while in other ones – in the control plots. The effect of the digestate application on beetle fauna might be more pronounced over the longer term, but during the project it was not observed.

Perspectives for continuation of the action after the end of the project:
Three of the restored grasslands are included in the sites where habitats monitoring of Natura 2000 sites are going on. That means that it will be possible to assess the long-term success of restoration activities in these sites by analysing the data of the national monitoring programme.

Habitat assessment questionnaires and vegetation descriptions along the long-term monitoring transect will make it possible to evaluate the long-term habitat restoration effect within scientific projects, citizen science or other initiatives after the project ends. Since it was the first time when some of the restoration methods were applied in Latvia, assessment of their long-term effects is expected to be of high interest among vegetation experts and specialists who are engaged in habitat restoration activities in Latvia.

5.1.8. **Action D2:** Assessment of socioeconomic impact of project activities

Action implementation time	Action status
01/10/2013-31/12/2017	Completed by 31/12/2017

Name of the Deliverable	Deadline	Status
Report on socioeconomic impacts of the project activities (part 1 and part 2)	30/09/2017	Completed 15/12/2017

Name of the Milestone	Deadline	Status
-	-	-

The Action was performed to assess the impacts of the project activities on local economy and society, including diversification of local economy and employment opportunities, social developments and well-being, improvement of landscape aesthetic quality etc.

The implementation of the action was organised in the following steps: i) preparatory phase - defining the scope of the assessment and contracting of the external assistance; ii) initial data collection for describing the baseline scenario - socio-economic situation in project areas before implementation of the project activities; iii) repeated data collection at the last year of the project for assessment of the project impacts; iv) development of the impact assessment report.

The Action was lead by CB BEF-LV, who co-ordinated the assessment and organised the data collection with support of AB 4 Sigulda and AB 5 Ludza. The assessment was performed by subcontracted company Ltd. "VB LIMITED".

Preparatory phase

The action has started with identification of information needs and approach for socio-economic impact assessment of the project activities. A meeting between CB and AB 1 LFN and AB2 Bio RE was organised on 05.12.2013 for clarification of the information needs and tasks for economists to be contracted for the economic valuation of grassland biomass (Action A1), evaluation of cost-effectiveness of different technological solutions for use of grassland biomass (Action A2) and assessment of impacts of project activities on local economy and society (Action D2).

To ensure appropriate expertise in assessment of socio-economic impacts CB BEF-LV arranged the bit-of-there procedure and contracted a consultant company Ltd. "VB LIMITED" in May 2014. The consultant in cooperation with project partners has identified the data needs and elaborated a list of indicators to be used in the assessment to compare the baseline situation at the project beginning with the situation at the project end.

According to the elaborated set of indicators data from the following data sources were required:

- direct interviews with local land owners of Sigulda and Ludza Municipalities on current management practices of grasslands, use of grassland biomass, number of people involved in grassland management, income generated/ costs related to grassland management as well as on perception of people about value of grasslands for maintenance of landscape and various ecosystem services;
- official statistical data from the State Revenue Service on:
    - number of employers and employees as well as average income per employee;
    - number of employers and employees as well as average income per employee in agriculture sec
- data on number rural tourism providers and visitors available at local authorities and tourism information centres.

Data on employment and rural tourism were required for the both project areas (Sigulda and Ludza municipalities) as well as for two additional municipalities comparative to the project areas from socio-

economic perspective – Ogre (to compare with Sigulda Municipality) and Krāslava (to compare with Ludza Municipality). Such approach was proposed by consultant to distinguish effects of the project from general developments in the country.

Initial data collection for describing the baseline scenario
The data collection for assessment of the baseline scenario has been performed by CB BEF, AB4 Sigulda and AB5 Ludza. Both municipalities carried out the first round of interviews with local land owners within Action C1 from April-September 2014. The employment data about the period from 2011-2013 for the two project areas were requested from the State Revenue Service by AB4 Sigulda and AB5 Ludza and collected by the end of 2014, while collection of the data for the two comparative municipalities (Ogre and Krāslava) took longer time then initially planned and were obtained only in August 2015. Data on number of tourism service providers and visitors in the project areas for 2013-2014 were collected by AB4 Sigulda and AB5 Ludza, while in Ludza and Ogre Municipalities this information was collected by CB BEF, by contacting tourism information centres as well as direct telephone interviews with rural tourism service providers. After the initial check of the data, the consulting company has revealed several inconsistencies in the provided data sets, therefore additional data search (particularly concerning rural tourism was necessary).

All necessary data for assessment of the baseline scenario were collected by September 2015 and handed over to the consultant. The consultant has prepared the report on the 1st phase of the socio-economic impact assessment, including description of the methodology, overview on information collected for characterisation of the present situation in two project areas as well as data on the two municipalities to be used for comparison.

Repeated data collection for assessment of the project impacts
The same data sets were collected during the last year of the project to assess the change of the socio-economic situation and the possible impacts of the project activities. The second round of interviews were carried out by AB4 Sigulda and AB5 Ludza from April 2017 - September 2017. Data on employment for the period from 2014-2016 and rural tourism four 2015-2016 were collected by CB BEF-LV by August 2017. All the data sets were submitted to consultant in October 2017 for further analysis and development of the assessment report.

The report on Assessment of socioeconomic impact of project activities was completed by the end of the project. The report presents an overview on assessed data, description of the applied methodology and data analysis, including general characterisation of the socio-economic situation in the both project areas as well as assessment of the potential project impacts on economic diversification and employment possibilities, social well-being and perception of landscape values. The impacts on economic diversification and employment opportunities was assessed by analysing indicators that characterise: i) collaboration of entrepreneurs; ii) maintenance of grasslands and possibilities to generate revenue; iii) possibilities to develop entrepreneurship. Potential impacts on well-being of local population were assessed based on following indicators: i) income level and satisfaction with the environment for living in the pilot areas; ii) social activity, engagement in the project and dissemination of knowledge. Public awareness about the value of landscape was assessed based on indicators characterizing: i) the availability of rural tourism services; ii) public awareness about natural diversity; iii) the effect of the landscape factor on evaluation of real estate market value.

The report has demonstrated positive impacts of the project activities about development of local economy and entrepreneurship related to grassland management, including increase of revenue earning possibilities, collaboration of rural entrepreneurs as well as development of new business opportunities. Furthermore, the project has contributed to increase of the quality of living environment in project areas and public awareness about the grasslands ecosystem and their role in well-being for the society (see more details bellow within "**obtained results**".

Problems encountered
No major problems were experienced with implementation of the Action D2, except the delay of the initial data collection for assessment of the baseline scenario, also noted *in the EC letter, ENV.E.3 RH/TS/sp, 23.09.2015*. The first phase of the data collection took longer time than initially planned,

because the scope of data collection was extended by including the two additional municipalities for comparison. CB BEF has contacted Krāslava and Ogre Municipalities to obtain data on employment and rural tourism. However, co-operation with municipalities in the data acquisition was not successful and finally the employment data were obtained directly from the State Revenue Service. Information on number of rural tourism providers and visitors in Ludza and Ogre Municipalities was collected by CB BEF by telephone interviews with tourism information centres and rural tourism service providers. However, this delay did not cause implications on achievement of the expected results, since assessment of impacts was performed only in the last year of the project.

Modification of action compared to project proposal
No modification of the action was required.

Evaluation of achieved outputs and implementation of the time schedule
The first phase of the data collection was delayed for more than one year due to the reasons described above. According to the time plan of the project proposal the initial phases of data collection had to be performed by the end of June 2014, though all the data sets were obtained and submitted to consultant only in by September 2015. Also, the second round of data collection (interviews with local land owners) took slightly longer than initially planned. The obtained interview results were submitted to consultant in October 2017. Consequently, the assessment report was finalised only by the end of the project. Nevertheless, the delays in data collection did not had implications on achievement of the expected results.

Expected results	***Achieved results***
Socio-economic data collected from the two pilot areas about the situation prior to implementation of the project actions;	Socio-economic data collected from the two pilot areas about the situation prior to implementation of the project actions by September 2105.
The project impacts identified and assessed, applying monetary valuation methods were appropriate	The project impacts identified and assessed, based on methods applicable for socioeconomic impact studies, including surveys, expert interviews as well as analysis and grouping of statistical data
Report on socioeconomic impacts of the project activities	Report on socioeconomic impacts of the project activities developed by 31.12.2017

Conclusions on action implementation and obtained results:
The action has been completed and all envisaged results achieved. The delays in data collection were partly related to extended methodological approach and scope of the data collection, which was essential to improve reliability of the assessment results.

The assessment of socioeconomic impact of project activities reveals the major socio-economic development trends in the both municipalities during the project implementation period. Sigulda municipality has experienced increase of population as well as certain economic growth - economic activity has increased by 19.4% as well as the number of people employed (including in agriculture sector), while in Ludza quite opposite trends were observed, including continuing of depopulation and high unemployment rate, although the number of registered employments in agriculture has somewhat increased. Though, during the project implementation no statistically significant disparity to socio-economic development trends was observed in the project areas.

Nevertheless, the assessment indicates both immediate and future positive impact of the project activities on grassland management in pilot areas, on collaboration of rural entrepreneurs, on revenue earning possibilities as well as on the development of new lines of entrepreneurship. For example, based on interview results with local stakeholders, the number of respondents who do not use the grass biomass has decreased from 40 % in 2014 to 20 % in 2017, which might indicate positive impact of the project activities. The project has restored 122 ha of degraded grasslands (including ca. 107 ha non-managed), where grassland management has been resumed, mainly for livestock farming as well as in few sites – for providing tourism services. Still the main source of income from grassland management is the agriculture payments. The data on restored grasslands have been submitted to the competent authorities, thus the amount of available payments for these grasslands (including agro-environmental measures for

maintenance of biologically valuable grasslands) have reached 25 545 € annually. The management of these grasslands will increase demand for grassland maintenance services, thus stimulating local economy. At the same time 6% of the respondents at the 2nd interview round in 2017 (n=150) stated that project has encouraged their willingness to start collaboration with other entrepreneurs and one respondent have expressed interest to introduce in his farm some innovative technological solutions for use of grass biomass.

Project activities has also positive impact on quality of living environment in pilot areas and on knowledge and understanding about grasslands as an ecosystem, their landscape value and role in assuring sustainable well-being for the society. For example, the respondents of the 2nd round of interviews gave higher evaluation both to well-kempt landscape and to grassland management in their municipality (the average rate of the subjective landscape assessment comparing to the 1st round of interviews has increased from 3.48 to 3.75 in Sigulda municipality and from 3.10 to 3.50 in Ludza municipality; assessment on scale from 1-5, where 5 is the highest landscape value). In the 2nd round of interviews the respondents have also given higher scores to all the ecosystem services provided by grasslands, which were included in the survey (i.e. fodder, biomass for energy, medical plants; habitat maintenance; landscape; tourism end recreation). The highest scores were given to fodder (4.54) and landscape (4.13).

The socio-economic impact assessment included also calculation of the dead-weight of the project activities related to diversification of economy, well-being of population and awareness about the landscape value. According to this estimation the dead weight of the project activities related to diversification of economy is 8% (this means that 92% of results would not realize at the base scenario); 9% - for activities related to well-being of population and 1% - for activities related to awareness about the value of a landscape.

Perspectives for continuation of the action after the end of the project:
The repeated assessment of the socioeconomic impacts of project activities is not foreseen, nevertheless the obtained results can be used by the local authorities of the Sigulda and Ludza municipalities in elaboration of the municipality development programmes and other strategic planning documents. Furthermore, the applied methodology can be used for socioeconomic impact assessment of other projects.

5.2 Dissemination actions

5.2.1 Objectives

The LIFE Grassservice project contained several public awareness and dissemination actions within the E and F section of the proposal: Action E1 “Informative seminars for local public in the project pilot areas”, Action E2 “General project visibility”, Action E3 “Project results dissemination”, Action F2 “Networking with other projects”, and Action F4 “After-LIFE communication plan”. Action E1 aimed at informing residents of the pilot areas about project activities, as well as raising their knowledge on grassland ecosystems and services they provide, actions needed to maintain grassland biodiversity, and different alternative options for the use of grassland biomass. Action E2 aimed at facilitating the overall visibility of the project from its beginning till the end – development of a project corporate identity, website, leaflet, notice boards and media attendance were the main activities. Action E3 aimed at presenting the activities and results of the project to a wider audience, both international and national. Action F2 aimed to ensure experience exchange with other projects, including those within the LIFE Programme, working on issues related to grassland biodiversity management and the use of grassland biomass. Action F4 is an obligatory action to guarantee the dissemination and communication of project results after the end of the project.

CB BEF-LV was responsible for the implementation of all five dissemination actions.

5.2.2 Dissemination: overview per activity

Action E1 – Informative seminars for local public in the project pilot areas

Informing residents

Activity aimed at informing residents of the project pilot areas – Sigulda un Ludza municipality – about the LIFE GRASSSERVICE project and its activities through publications in local newspapers and informative seminars (Action E2), direct interviews (Action C1) and meetings, as well as by the project leaflet and notice boards (Action E2) to raise their knowledge on the grassland ecosystem and services they provide, actions needed to maintain grassland biodiversity and different alternative options for use of grassland biomass.

Informative seminars

The 1st set of seminars –was held with the aim to introduce with the project, its aims and activities; to inform residents about biodiversity value and ecosystem services provided by grasslands; explaining management requirements and outlining different opportunities for use of grassland biomass. The informative seminar in Ludza Municipality was held on 13.04.2015; in Sigulda Municipality - on 15.05.2015. In the both seminars, a structured discussion session was organised after the informative part for establishment of local co-operation networks for grassland maintenance and processing of biomass. Interest and conditions for the supply and demand of grass biomass was clarified and opportunities of alternative use of biomass discussed. The participants of the events were informed about the envisaged project activities in the respective municipality and encouraged to be involved.

The 2nd set of the seminars was held with the aim to present the project achievements and results obtained within Action C2 on demonstration of collection and processing of grassland biomass. The seminars were held in the frame of the visitors’ days (Action C2) thus giving an opportunity for a larger number of people to take part in the demonstration activities. The informative seminar in Ludza Municipality was held on 20.09.2017. The informative seminar in Sigulda Municipality was held as event with 2 parts on 10.10.2017 (seminar for schoolchildren where attractive and creative participation was foreseen by involving them into “imaginary” planning of a local meadow by challenging them to offer long term, sustainable and innovative solutions) and 12.10.2017 (seminar for residents).

Action is implemented according to set objectives and within the agreed time schedule except slight delay for 2nd informative seminar in Sigulda municipality (initially planned until 30.09.2017, held on October 2017).

Evaluation of Action E1

Activity/ output	Foreseen in the application	Achieved	Quantifiable terms	Reaction and feedback
Informing local residents	Local residents are well informed about project activities, importance of grasslands in maintaining biodiversity and possibilities of alternative use of biomass harvested in grasslands	Residents were informed about the project and its activities through publications in local newspapers, direct interviews, websites and during the informative seminars in Ludza and Sigulda. Participants were informed about the project activities, as well as introduced to the status of grasslands in both project areas and alternative technologies for the use of grass biomass	107 participants of informative seminars in Ludza 190 participants of informative seminars in Sigulda Readers of local newspapers, interview respondents, website visitors	Perception of the provided information was ensured by adapting the information, choosing the information media and form, accordingly; the project leaflet in the form of booklet had particularly positive feedback
Informative seminars	4 seminars for local residents have been organised (2 in Sigulda Municipality and 2 in Ludza Municipality) with ca. 40-50 participants at each	1st Informative seminar in Ludza Municipality was held on 13.04.2015	53 participants representing project partners, land owners, entrepreneurs, and local inhabitants	The 1st set of seminars served not only for public awareness raising and information distribution, but also for successful contact building, networking, knowledge mapping and involvement participants into discussions. The 2nd set of informative seminars was merged with the demonstration activities not only to provide more specific and targeted information and present the results obtained within other activities of the project, but also stressing the demonstration of the biofuel pilot facilities and related technologies.
		1st Informative seminar in Sigulda Municipality was held on 15.05.2015	57 participants representing project partners, land owners, entrepreneurs, and local inhabitants	
		2nd Informative seminar in Ludza Municipality was held on 20.09.2017	In total 54 participants representing project partners, land owners, schoolchildren and local inhabitants	
		2nd Informative seminar in Sigulda Municipality was held on 10.10.2017 for schoolchildren and 12.10.2017 for residents	In total 133 participants representing project partners, land owners, schoolchildren and local inhabitants	

Action E2 – General project visibility

General visibility

The action has started from the beginning of the project with development of the project logo, which serves as a recognizable symbol. The project logo together with the LIFE logo was used in project related documents, reports, deliverables etc., as well as in publicity materials (presentations, interviews, press releases, and websites). For printed and electronic materials, project website, notice boards, posters and other needs, a common design was used to promote the project. Project team also presented project in various events on the topic.

Information at the websites of project partners and the project website
General information about the project (in Latvian and English) was placed on the websites of the project lead partner and other project partners by 31.12.2013. The project website http://grassservice.balticgrasslands.eu/ (in Latvian and English) was launched in March 2014 to present the project, its actions and results. The upper row (chapters *"News", "Project sites", "Project partners", "Reports and publications", "Events", "Other projects"*) aims to illustrate the project in general – a short description about the project, consortium, outcomes, relevant links, news etc. The main part of the website aims to present the project content – description of the activities' outcomes and progress of the implementation).

4 notice boards
Set up until 30.06.2016 – 2 in Sigulda Municipality and 2 in Ludza Municipality –at strategic places accessible for the public. One notice board in a roll up format is placed inside of the premises of each municipality (Zinātnes Street 7, Sigulda and Raiņa Street 16, Ludza). Therefore, locals and visitors can get the information about alternative possibilities of biomass use explored during the project. The second notice board in each municipality – outdoor terrestrial – is placed in a strategic place in each project pilot area informing about semi-natural grassland resources and biologically valuable grasslands (a parking place at Gūtmaņa cave, Turaidas steet 2, Sigulda municipality, and between Dunākļu Lake and Mazais Ludzas Lake, Ludza municipality. All notice boards include general information about the project**.**

The project leaflets
Prepared in the format of a booklet with pages for notes and attached pen; printed (in Latvian, March 2015) not only to supplement project visibility, but also provide a brief information about the project and its partners, shortly describe the importance of maintenance of grassland biodiversity and ecosystem services, as well as outline possible management solutions and options for the use of grassland biomass to be tested by the project. Additionally, there are 3 calendar spreads with the main activities of the project for each relevant year and information about the possibilities to join the local co-operation networks for grassland maintenance and processing of biomass. By the end of the project, all booklets were distributed.

To support the main idea of the project leaflet and inform a wide range of the public about the ecosystem services and the importance of grassland maintenance, it was decided to participate in the annual "Nature Concert Hall" in June 2015. The theme of the event was natural grassland, its biological value and why they must be kept and maintained. An introductory interactive lecture, as well as attractive info posters were prepared by the CB BEF-LV, and the project team organised a workshop with emphasis on grassland ecosystem services in the very well attended events. Later, the posters were used in various publicity and networking events, more than 1600 people voted for the grassland provided ecosystem services.

Work with media
Thanks to a great support of the project partners from Sigulda and Ludza Municipalities, the cooperation with local newspapers was very successfully. During the project, 13 articles in local newspapers and 1 article in regional media were published – not only reflecting the executed activities and events, but also informing the public about the importance of the maintenance of grassland biodiversity.

Additionally, the knowledge obtained within the project and conclusions resulted in two **scientific articles**: 1) "Production of fermentation feedstock from lignocellulosic biomass: applications of membrane separation" (prepared by project partner Riga Technical University, published in Agronomy Research, 2015) and 2) "Evaluation of the economic potential of grasslands" (prepared by a sub-contractor, published in Papers SGEM2017, 2017).

Evaluation of Action E2

Activity/ output	Foreseen in the application	Achieved	Quantifiable terms	Reaction and feedback
General visibility	The project is well known and visible to local stakeholders and public	Various design elements and project logo related to projects theme were elaborated at the very beginning of the project to serve as a recognizable symbol/ brand	n/a	The project logo and design elements were successfully used by all project partners during the project life time (and after) and served as a good tool not only to recognize the project, but also ensure its uniform visibility and performance
Information on the websites of the project partners and the main project website	The project website has been regularly updated	General information about the project was placed on the websites of the lead partner and project partners' by 31.12.2013 The project website **http://grassservice.balticgrasslands.eu** (in Latvian and English) was launched in March 2014 and regularly updated to inform about project activities and achieved results	5 project partners websites include info about the project 1 project website	Project website launched successfully and timely, basic information about the project is available, the news and events chapters updated respectively, the content chapters include the overview of implementation and respective accomplishments
Notice boards	Notice boards have been installed at four strategic places, two per local municipality	Notice boards at strategic places accessible for public were set up in Sigulda municipality and in Ludza municipality One notice board in roll up format provides opportunity for locals and visitors of the municipality to obtain information about alternative uses of grass biomass explored during the project Another notice board in each municipality (outdoor terrestrial) was placed in a strategic place close to restoration sites of each municipality. It informs about biologically valuable grasslands and ways how to protect them	2 in Sigulda municipality 2 in Ludza municipality	This approach – to choose 2 forms and different in content messages for the notice boards allows a reaching wider audience and spreading more information not only to the residents, but also for other visitors and tourists of the municipalities Alongside, roll up posters are easy to fold and transport for related events for promotion needs

The project leaflets	The project leaflet printed in 1000 copies and distributed to local residents of the pilot areas	A leaflet in the format of a booklet with pages for notes has been elaborated and printed in Latvian, in March 2015. All booklets already distributed during the informative seminars and other meetings with residents, as well as provided to project partners for distribution within their networks	1000 copies in LAT	The booklet not only provided brief information about the project and gave content messages, but also served as an attractive visibility element of the project and was highly valued not only by the project partners, but also receivers
Work with media	Six articles on project relevant issues prepared and submitted to local newspapers	Articles published in Sigulda and Ludza local newspapers, as well in the regional press; scientific articles published. The articles brought attention to project activities and events, as well as to the importance of maintenance of grassland biodiversity.	14 articles in newspapers (7 in Ludza and 6 in Sigulda, 1 regional) 2 scientific articles	The articles published in local regional newspapers ensured a wider spread of the information and served as important communication tool with local public, since access to information via internet is not sufficient, especially in Ludza Municipality

E3: Project result dissemination

Layman's report

A Layman's report has been produced, printed and distributed for non-expert readers (in Latvian and English, November 2017). The Layman's report summarizes the main project achievements, it is structured according to the implemented actions, and appropriate language chosen to avoid specific terms and project slang. Also, it was decided to use characteristic pictures for better understanding and illustration. The report is designed in the common stylistic of the project to support the visibility and publicity.

International seminar on results and lessons learnt

The seminar was organised in Riga on 29.-30.11.2017. The agenda of the seminar included presentations of project results, related experience from other countries, as well as discussions on potential for the use of grass biomass for bioenergy and related policy aspects. The first day (29.11.2017) of the seminar consisted of a plenary with 2 sessions: grass as biodiversity and resource, and grass for bioenergy production, concluded with a discussion panel session. On the second day (30.11.2017), participants visited the biobutanol pilot facility at the premises of Riga Technical University and, afterwards, the biogas pilot facility in Sigulda.

Evaluation of Action E3.

Activity/ output	Foreseen in the application	Achieved	Quantifiable terms	Reaction and feedback
Layman's report	The layman's report has been elaborated and published in a paper form in Latvian and English languages, as well as available for download as PDF files	The report prepared and published in LAT and ENG, it shortly summarizes the main activities and results of the project. Also, a PDF document is available on project's website	A5 size 300 copies in LAT 100 copies in ENG 1 PDF in LAT and 1 PDF in ENG	The Layman's report distributed in the international final event, to project partners, various project related events; PDF version is downloadable on the project website
International seminar	The international seminar has	The closing event held one month before the end of the project; project partners,	43 participants (29.011.2017)	To ensure effective use of time and cover the content interests of

	been organised to present the results of the project and discuss options for using them in future	representatives from various institutions, organisations and other LIFE projects participated; the invited lectors and participants of the panel discussion gave a very important overview of various aspects of grasslands maintenance, use of grass biomass and policy perspective: future of semi-natural grasslands in relation to biodiversity, agriculture & rural development, renewable energy and bio-economy targets; biofuel pilot facilities demonstrated	24 participants (30.11.2017)	participants, the event was organised in 2 parts and this approach was assessed as very time efficient and useful. Positive feedback received also about the invited lectors, held discussions, well-structured panel session, as well as the visit to the biofuel pilot facilities

F2: Networking with other projects

Contacts established with at least 3 projects working in the same field

The project during the implementation had permanent and successful communication, meetings, joint events and information exchange with other LIEF projects working in the field (LIFE Viva Grass, LIFE13 ENV/LT/000189; LIFE EcosystemServices, LIFE LIFE13 ENV/LV/000839; CAP LIFE LAT, LIFE14 CAP/LV/000002; Meadow Birds, LIFE10/NAT/DE011; GrassLIFE, LIFE16 NAT/LV/000262; LIFE to alvars, LIFE13 NAT/EE/000082). Networking activities also performed by participation in the events organised by other projects and organisations.

Representatives of other projects have participated at the international seminars organised by the project

Representatives of 6 projects working on grassland management and development of solutions for the use of grassland biomass participated at the international seminar held 05-06.11.2014 in Sigulda, Latvia.
Representatives of 5 other related projects participated to share their project results and discuss future possibilities and conditions for alternative use of grassland biomass at the final seminar held 29-30.11.2017 in Riga, Latvia.

Study visit

A study visit to Lower Saxony, Germany was organised on 07.-11.09.2014 to learn about natural grassland management and practical solutions for sustainable use of grass biomass. 11 project team members participated in the study visit. It provided experience how the conservation of natural grasslands is organised in Germany, and what management instruments (involvement of farmers in grass collection, regulating water regime, setting mowing and grazing times favourable for species and habitats) are being used. The participants had possibility to visit a biogas production facility, which works on grass biomass as feedstock.

Evaluation of Action F2

Activity/ output	Foreseen in the application	Achieved	Quantifiable terms	Reaction and feedback
Contacts with other projects	Established contacts with at least 3 projects working in the same field	Regular information and experience exchange provided with other projects. The LIFE Grassservice project presented in various LIFE Platform events, as well as conferences, seminars and congresses (24 in total) organised by other projects	6 LIFE projects	The maintenance of those contacts and participation in events served as regular knowledge transfer and sustainable spread of the project results and messages and ensured information exchange
Representatives of other	Representatives of other projects	6 representatives of other projects working on	11 representatives	This was an important networking activity,

projects have participated at the international seminars organised by the project	working on grassland management and development of solutions for use of grassland biomass have participated at the international seminars organised by the project	grassland management and development of solutions for use of grassland biomass participated at the international seminar held 05.-06.11.2014 in Sigulda, Latvia 5 representatives of other projects working on grassland restoration, biogas and biobutanol production participated at the international seminar on the results and lessons learnt organised on 29-30.11.2017 in Riga	in total	experience and knowledge exchange also positively assessed by representatives of other projects
Study visit	Study visit to at least one project on grassland management and use of grassland biomass has been organised and project team has observed in practice solutions for sustainable use of biomass	Study visit to Lower Saxony, Germany was organised on 07-11.09.2014 to learn about practice solutions for grassland conservation and sustainable use of grass biomass. 11 project team members participated in the study visit	1 study visit	Study visit evaluated as a very good chance for participants to learn about practical solutions for natural grassland conservation and management, as well as sustainable use of grass biomass

F4: After LIFE Communication Plan

The **After-LIFE communication plan** (ALCP) has been developed by the leading coordinators of each partner during the elaboration of the Final report. During the last partners meeting (21.09.2017) in Ludza, the ideas for the ALCP were brainstormed among the partners and then further developed by the CB BEF-LV with inputs from all partners.

The ALCP contains the following chapters:

- Summary of project activities and results;
- After LIFE conservation plan: maintenance of the restored grasslands, monitoring of restored grasslands;
- After LIFE communication plan: assessment of grassland quality and grass biomass, grassland restoration methods, technological solutions for biofuels production; cooperation networks, public awareness.

Implementation progress compared to planned outputs and time schedule

The Action is implemented according to the set objectives and within the agreed time schedule.

5.3 Evaluation of Project Implementation

5.3.1. Evaluation of the applied methodology

The implementation of the LIFE GRASSSERVICVE project was based on transdisciplinary approach, involving various disciplines and related methods as well as different expert groups and stakeholders, working together for assessing the grassland biodiversity and biomass resources, management perspectives and potentials for alternative use of grassland biomass as well as assessing environmental and socio-economic impacts of the project activities. The collaboration between the different teams – nature conservation and grassland management experts, researchers on bio-energy technologies, economist and administrations of the local municipalities, has proved to be an effective way for development of innovative solutions and know-how.

Assessment of grassland quality and biomass resources:
The assessment was carried out by a biodiversity expert from AB1 LFN based on the data collected from existing data sources on distribution of biologically valuable grasslands as well as field surveys carried out by the project team members and remote sensing methods, combined with available radar and satellite data. The biomass amounts per habitat types were calculated using samples from the fields. For assessing the management intensity of the grasslands in the two municipalities the available data from the Rural Support Service were overlaid and intersected with the airborne data sets. This has allowed to estimate the management intensity for 88% of the grasslands in the project sites. The economic value of grass biomass resources was assessed based on direct economic value generated by forages from grasslands of the both municipalities (if all grasslands would be used for hay production), including in the calculation also payments that farmers can receive for grassland management. Furthermore, the potential economic value of the alternative use of grasslands for bioenergy production was calculated based on potential for production of biomethane. The applied methods have proved to be successful and cost effective in relation to the produced results and can be applied for similar studies elsewhere.

Activity planning for grassland restoration and alternative use of grass biomass
The Internal Activity Plans were developed by the CB BEF-LV team members with competence ecology and grassland management in co-operation with biodiversity expert from AB1 LFN. The plans were based on results of the assessment of available biomass resources in the both project areas as well as direct interviews with landowners and information compiled in the registers of local land owners and managers. For selection of the priority areas of the grassland restoration, an innovative approach for Latvia was developed by designing of ecological networks for supporting grassland biodiversity - delineating core areas, where biologically valuable grasslands reach higher density, and connecting them by ecological corridors and stepping stones. The planning of the alternative use of grass biomass (e.g. grass pellet production) was based on discussions with local entrepreneurs and experts in bioenergy production. The applied methodology and results were successfully used for organisation of the demonstration actions in relation to the grassland restoration.

Laboratory testing and development of technical and technological solutions for processing of biomass for production of biogas and biobutanol from grass
Laboratory tests of technological solutions were performed by the researchers of AB3 RTU for biobutanol production and AB2 Bio RE for biogas production. Various technological processes and conditions (physical, chemical, biological) were tested for biomass pre-treatment and hydrolysis. AB3 RTU has conducted study on adapting the existing biobutanol production technologies to the use of grass as feedstock – laboratory tests were performed to find the optimum conditions to obtain the maximum sugar yield from grass biomass samples. A methodology was designed for grass biomass pre-treatment with milling to fractions of ~ 0.5 cm and 5 minutes boiling and subsequent enzymatic hydrolysis with in-house made enzymes. The methodology has proved to be efficient, generating around 70 – 85 % of sugar from the overall available amounts. In co-operation with biodiversity experts from AB1 LFN the possible sugar yields by different habitat types were assessed. AB2 Bio RE performed laboratory tests for obtaining biogas from grass biomass and digestate. The experts of AB2 Bio RE analysed the contents of total solids and volatile solids, which, among other, gave background information for calculations of biogas production potential. The optimal processing regime and parameters for production of biogas from different types of grass biomass: raw grass, hay and silage samples were investigated. The results of

laboratory experiments provided essential information for a better design and construction of the biogas prototype and adjustments of the biobutanol pilot facilities, thus were assessed as successful and cost effective.

Demonstration of the grassland restoration

Grasslands restoration was successfully implemented within 12 areas (97 ha) in Sigulda Municipality and 1 area (25 ha) in Ludza municipality. The restoration works included felling of trees and shrubs, removal of stumps and roots, milling roots, soil levelling and disking/harrowing, removal of stones, concrete slabs, poles, and waste, elimination of invasive and expansive species, controlled burning, primary mowing, application of freshly mown grass and hay to facilitate spreading seeds, as well as seeding. Part of the applied methods (e.g. distribution of freshly mown grass and hay for spreading the seeds from biologically valuable grasslands) were innovative for Latvia and can serve as a good practice example in grassland restoration. One of the preconditions for successful implementation of the action was well established co-operation between CB BEF-LV, who co-ordinated the restoration works, implementers and land-owners, which allowed to find solutions in unexpected situations, e.g. complications due to weather conditions or problems with machinery. Our experience shows that flexibility in organisation of the restoration works is essential to guarantee achievement of the expected results. We assume that the restoration works were cost effective – the costs of the works did not exceed the planned budget, even the actual implementation was much more complicated than initially planned.

Demonstration of alternative use of the grass biomass

For demonstration of the biobutanol production from grass biomass AB3 RTU have used an existing pilot facility, thus the main results were depending on intellectual work and capacities for of the involved researchers and their engagement to demonstrate achieved results. For demonstration of the biogas production AB2 Bio RE constructed a prototype with innovative reactor design, allowing biogas production with methane concentration 13-15% higher compared to the biogas plants, which are operating in Latvia and using agricultural biomass as feedstock. Thus, even the costs of prototype increased substantially during the project implementation, the developed facility corresponds better to the concept of prototype for demonstration of close-to real-life small mobile unit for biogas production and thus higher costs are reasonable. Demonstration activities involved a series of events and seminars targeted to specific groups of stakeholders, including residents, entrepreneurs, researchers and students of technical schools and universities as well as school children. During these events the technologies for bioenergy production and construction of pilot facilities were explained.

Assessment of the project impacts on grassland habitats

The impacts of grassland restoration measures and application of digestate on the ecological status of the grassland habitats were assessed by the biodiversity expert from AB1 LFN. The methodology included establishment of the 10x10 m permanent monitoring plots, where field data were collected during the project implementation to assessment the impact of selected management regimes. In total 24 monitoring plots were established (four in each site selected for testing of different management regimes). At each monitoring plot the quantity and quality of grassland biomass as well as grassland structure and herbaceous vegetation. Furthermore, invertebrate monitoring was carried out by 10 traps for terrestrial beetles were installed in each monitoring site. The designed monitoring methods was successfully implemented, setting basis for assessment of the project impacts also after the end of the project.

Assessment of socioeconomic impact of project activities

The socioeconomic impact assessment was carried out by the contracted company, involving experienced economists, while data collection was organised by CB BEF-LV with involvement of AB4 Sigulda and AB5 Ludza. Assessment was based on comparing the baseline - socio-economic situation in project areas before implementation of the project activities - with the situation at the end of the project. The data were collected twice, including interviews with local landowners on grassland management practices and use of grassland biomass, generated income, telephone interviews with rural tourism service providers as well as collection of statistical data from the State Revenue Service employment and incomes. The data sets were analysed by economists according to a developed set of indicators for assessment of the project impacts on economic diversification and employment opportunities, well-being of local population and public awareness about the value of landscape. Furthermore, the dead-weight of the project activities was calculated in relation to the above-mentioned impact categories, showing most of the results would not be

achieved without implementation of the project activities. The assessment has demonstrated positive impacts of the project activities on grassland maintenance and income possibilities from agriculture support payments as well as increasing demand from grassland maintenance services. The developed methodology for socioeconomic impact assessment was acknowledged as efficient and cost effective.

Project visibility and dissemination of the results

The project visibility and dissemination actions were organised by CB BEF LV, applying standard (informative seminars, brochures, project website, web-based information exchange platforms, media, information boards, posters scientific articles, etc.) as well as innovative methods. The latest ones included development of interactive posters for raising awareness and assessment of stakeholders' preferences to various ecosystem services provided by grasslands, which were actively used in different public events, festivals and the project stakeholders' meetings. Furthermore, stakeholder engagement was facilitated by direct contacts and visits to landowners. All the visibility and dissemination activities were successfully implemented and cost effective – the project is well recognised among the local stakeholders as well as experts in grassland management and bioenergy production.

5.3.2. Comparison of results achieved against objectives

Table 5.15: Comparison of results achieved against objectives

Foreseen results in the revised proposal	Achieved	Evaluation
A1: Assessment of grassland biomass resources in the project areas		
Methodology for assessment of grassland biomass resources at local level	Methodology for assessment of grassland biomass resources of different habitat types is developed and included in the final report of the action.	Methodology was successfully used for assessment in Sigulda and Ludza Municipalities. It has good potential to be applied by other projects or similar studies.
Data sets with information for assessment of grassland biomass resources in the 2 pilot areas	Data sets on the grassland biomass resources including the quality and productivity of grasslands were obtained.	High quality detailed scale airborne and field research verified data, which were used for project needs, as well as can be applied for future needs (e.g. grassland related projects, spatial planning).
Maps of grassland biomass resources in the project pilot areas	Maps on the grassland biomass resources, including distribution of grasslands, biomass amounts, management intensity and quality of grasslands were developed and included in the report.	High quality maps that are being used for project needs, as well as can be applied for future needs (e.g. grassland related projects, spatial planning).
Economic value of grassland biomass resources in the project pilot areas assessed	Assessment of economic value of grasslands included in the Report on grassland biomass sources. The direct economic value generated by forages from grasslands of Sigulda and Ludza municipalities is 0.18 million euro or 3.81 million euro with Common Agricultural Policy payments.	Transforming biomass information into economic value adds addition angle for understanding economic significance of grass on the municipal scale. Assessment results can be used for calculation of grassland economical value in other areas.
Report on grassland biomass sources at the 2 pilot areas	The reports are developed assessing the grassland biomass resources, including the distribution, productivity and quality of grasslands.	Reports have been used for project needs (development of Inner Activity Plans, planning grassland restoration sites). Since the report includes the description of the applied methods, it can be used to

Foreseen results in the revised proposal	Achieved	Evaluation
		support similar studies.
A2: Assessment of measures applicable for maintenance of grassland habitats		
International experience exchange seminar on sustainable grassland management and use of harvested biomass (ca. 40 participants); report from the seminar produced summarising the main findings and experiences presented	International experience exchange seminar „Sustainable grassland management: biodiversity conservation and alternative uses of grassland biomass" was held on 05.-06.11.2014, with 52 participants from Latvia, Estonia, Lithuania, Poland, Germany and the United Kingdom.	The seminar has reached the target to exchange information on conservation of grassland biodiversity and application of alternative grass biomass uses showing not only theoretical possibilities, but also practical existing cases. Outcomes of the seminar helped to outline future perspectives for grassland management in Sigulda and Ludza Municipalities as well as potentials of alternative uses of grass biomass.
Possibilities for technological solutions for the use of biomass with evaluation of cost effectiveness have been assessed and published in a report	The report is developed reflecting the results of laboratory tests on the potential of biogas and biobutanol production from grass biomass and most suitable technologies depending on different biomass pre-treatment options. The report includes assessment of cost-efficiency assessment of biobutanol, biogas and grass pellet production, based on the technical parameters of the biogas and biobutanol pilot facilities tested by the project.	The obtained results served as bases for further development of production technologies and construction of pilot facilities for biobutanol and biogas production.
A3: Internal activity plan on grassland maintenance and use of biomass in the project pilot areas		
The biological value of the grasslands in the project pilot areas and their management requirements assessed	Areas of biologically valuable grasslands assessed and information on the distribution and quality updated. 337 ha of grasslands in Sigulda and 585 ha in Ludza were recognised as biologically valuable or potentially to become valuable. The quality was evaluated according to five classes showing alarming message: only 20% of biologically valuable grasslands in Sigulda Municipality and 31% in Ludza Municipality correspond to good or average quality class.	Updated quality information on biologically valuable grasslands obtained, which was used for delineating the core areas for biodiversity supporting grassland ecological network and selecting and prioritising restoration areas. The data are submitted to the Nature Conservation Board for updating the national database "OZOLS" on biologically valuable grasslands.
Proposal on development of biodiversity supporting grassland network at the project pilot areas elaborated	8 core areas in Sigulda Municipality and 15 core areas in Ludza Municipality were marked for biodiversity supporting grassland network and their connectivity assessed.	Design of biodiversity supporting grassland network provided input for selection and prioritisation of grassland restoration sites. The methodology applied for designing the grassland network can be applied in similar studies.
Activity plans for grassland management in Sigulda and Ludza Counties with clearly defined action schemes have been developed	Activity plans for grassland management in Sigulda and Ludza municipalities developed, including identification of priority areas with particular restoration needs (more than 330 ha in Sigulda and 25 ha in Ludza) and preselected areas to be restored by the project as well as proposal on grass pellet production and testing for agricultural and heating needs (32 t) and functioning of biomass information exchange	The restoration activities by removal of shrubs have been implemented within the areas identified in the Activity plans (97 ha in Sigulda municipality and 25 ha in Ludza municipality). The elimination of the invasive species Sosnowsky's Hogweed as

Foreseen results in the revised proposal	Achieved	Evaluation
	platforms in Sigulda and Ludza Municipalities.	well as grass pellet production was not possible to implement by the project due to the reasons described in the C2 action description. The areas marked in the Activity Plans not restored within the project may serve as target areas for planning nature conservation in the municipalities and restoration activities within other projects.
Local stakeholders actively involved in the development of the Activity Plans.	The information collected by interviews with landowners as well as direct communication with local stakeholders was applied in development of the Activity plans. Information on the development of the Activity Plans were presented to local stakeholder in informative meetings on 13/04/2015 in Ludza and 15/05/2015 in Sigulda. Possible activities were discussed in the meeting with local entrepreneurs on 22/05/2015 in Ludza. Pellet production and grassland restoration options discussed within 3 individual meetings with entrepreneurs of Sigulda Municipality (20/04/2015, 27/06/2015).	The local knowledge and ideas of the stakeholders as well as the date collected from landowners have provided considerable input for development of the Activity Plans and ensured that the planned activities are based on real needs and possibilities within the both project areas.
A4: Technical preparation for purchase and improvement of biomass processing equipment		
Tendering documentation for biogas pilot facility will be prepared and public procurement organised	Technical specification and detailed drawings of the biogas prototype have been developed.	The prepared documentation was essential for tendering purchase of parts and construction of the biogas prototype. They also can serve as bases for construction of new biogas production facilities.
C1: Establishment of local co-operation networks for grassland maintenance and processing of biomass		
A register of local landowners and managers as well as entrepreneurs involved in processing of biomass in the Sigulda and Ludza Municipalities has been developed: 1 data file with ca.100 entries in each municipality	The registers developed in Sigulda and Ludza Municipality. The register of landowners and managers in Sigulda the register includes 158 entries on properties with biologically valuable grasslands, while in Ludza there are entries on 272 land properties, including information of owners of biologically valuable grasslands. The register of entrepreneurs includes information on farms and other agriculture related entrepreneurs - 166 entries in Sigulda and 61 in Ludza.	The registers store updated information, which was used during the preparation of the Internal Activity Plans, as well as for contacting grass biomass related stakeholders.
Local stakeholders have actively been approached and informed about project activities and alternative uses of biomass: ca. 100 stakeholders in each municipality	In total ca. 380 stakeholders in Sigulda and ca. 400 stakeholders in Ludza municipalities have been directly approached and informed about project activities.	The number of the stakeholders approached and informed about the project activities is 4 times higher than initially planned. Thus, project has achieved high visibility in the two municipalities and interest in obtained results.
Long term agreements achieved with landowners on management of	14 long term agreements are signed with landowners on grassland restoration activities in Sigulda Municipality and Ludza Municipality	Reaching long-term agreements with landowners turned out to be a difficult

Foreseen results in the revised proposal	Achieved	Evaluation
grasslands that will be restored during project activities: ca.10 agreements signed	for shrub elimination.	task, because of uncertainty among most of the landowners on their future land management possibilities. Thus, the commitment on maintaining of the grasslands for 10 years was a limiting factor for many landowners to get involved in the project activities. This has resulted in reduced choice options for grassland restoration sites as well as practically no options of sites for Sosnowsky's Hogweed elimination by the project. Nevertheless, the target for signed agreements has been achieved and maintenance of the restored grasslands secured.
A web-based information system with the aim to facilitate the management of grasslands has been developed: 1 in each Sigulda and Ludza Municipality	The web-based information system was launched in June 2014. In Sigulda Municipality, the system operates through web-based map and a webpage with actual information for land owners and biomass service providers. The web based map is available at http://karte.sigulda.lv, the information exchange platform for grass biomass offer/demand, lease of land and land management services can be found at http://sigulda.lv/public/lat/uznemejdarbiba/lauku_attistiba/piedavajumi_un_pakalpojumi/. At Ludza Municipality, information exchange platform is located at http://www.ludza.lv/projekti/alternativas-biomasas-izmantosanas-iespejas-zalaju-biologiskas-daudzveidibas-un-ekosistemu-pakalpojumu-uzturesanai/	During local meetings, stakeholders have admitted that they lack grass biomass and grassland management related information. The established information exchange platforms provide unique opportunity to fill the information gap. The web-based platform is actively used in both municipalities for sharing information on leased agriculture land and offers and demand for land management services (722 users accounted in Sigulda and – 804 in Ludza).
C2: Demonstration actions on processing of biomass		
Grasslands overgrown with bushes or Sosnowsky's Hogweeds have been restored in an area of 150 ha.	25 ha of grasslands in Ludza Municipality (1 site) and 96.6 ha (12 sites) in Sigulda Municipality have been restored by bush and tree cutting, stump and root removal and/or milling, soil planning and processing, controlled burning, reseeding, spreading freshly cut grass or hay for seed dispersal, waste and stone removal.	Restoration of grasslands overgrown by bushes was successfully implemented. The project team has gained valuable experience, unique to Latvia, in different restoration methods and organisation of the restoration works, which can be shared to other similar projects and interested landowners. Though, the elimination of the invasive species Sosnowsky's hogweed within area of 25 ha could not performed due to lack of interest from landowners to participate in the project actions and to ensure maintenance of the grasslands at the restored

Foreseen results in the revised proposal	Achieved	Evaluation
		condition 10 years after the project.
Biomass for testing its alternative uses harvested in an area of 300 ha.	The project partner Farm "Skujas", who was responsible for grass harvesting and following pellet production, has left the project. All the taken efforts to find another partner or subcontractor, interested in the grass pellet production, finally were not successful. Thus, the Activity on grass pellet production was excluded from the project and the expected result on harvested biomass was not achieved.	As the harvest target was planned to ensure grass biomass for pellet production, with the withdrawal of the partner CB "Skujas" and excluding pellet production component the projects direct contribution to harvesting of grass biomass for alternative uses have diminished. The amount of grass needed for demonstration purposes of the biogas and biobutanol facilities was very small.
Various options for the production of biogas and biobutanol from grass biomass have been investigated and assessed.	In laboratories, different types of grass biomass (raw grass, hay, silage) have been exposed to physical and chemical treatments, and best technologies to produce biogas and biobutanol developed.	The tested technologies were used in developing the technological design of the pilot facilities and calculations of technical parameters.
1 pilot facility for biogas production from grass biomass has been launched with planned production of 200 m^3 during the project duration.	The pilot facility (prototype) was constructed including innovative reactor design of 600 l volume, capable to produce ca. 5 m^3 of biogas per day. The prototype was launched for demonstration in September 2017 and during its operation time by the end of the project produced ca. 200 m^3 of biogas. Facility was demonstrated to 156 people in Ludza municipality and 311 in Sigulda.	The prototype proved that technologies developed within the project are appropriate for biogas production. Further work is needed to adopt the prototype for larger scale industrial production. However, economic and political aspects of production must be carefully assessed in future. Recently, political support for biogas production has seized.
1 pilot facility for biobutanol production from grass biomass has been launched with planned production of 40 l during the project duration.	The existing pilot facility of RTU was adapted for use of grass as feedstock and during its operation the target of 40 l of produced biobutanol was achieved. In premises of RTU the facility was demonstrated to 261 visitors. During visors days in 2017 the parts of the pilot facility were demonstrated to 118 people in Ludza municipality and 257 in Sigulda.	The pilot facility proved that technologies developed within the project are appropriate for biobutanol production. Further work is needed to adopt the processes and construction of the pilot facility for larger scale production in parallel to detailed economic feasibility study of such production facilities.
Grass pellets from biomass have been produced in the pilot areas with planned production of 750 tonnes during the project duration.	Demonstration of the grass pellet production was not performed due to withdrawal of the project partner in charge of the activity and lack of alternative facilities in the project areas and vicinities. With the deletion of the Activity on grass pellet production, the expected result was not achieved.	Withdrawal of the AB "Skujas", responsible for implementation of the activity, as well as failure to attract another project partner, who could take over the activity, has demonstrated the low economic interest in grass pellet production during the project period.
1 publication on results of assessment of the alternative uses of biomass prepared in pdf format.	The publication on results of assessment of the alternative uses of biomass is produced	The publication reflects information on project experience in biogas and biobutanol production, as well as more theoretical insight in

Foreseen results in the revised proposal	Achieved	Evaluation
		grass pellet production technologies, uses and perspectives.
Visitor days for demonstrating biomass processing methods have been organised: 2 one-day events, with ca. 50-100 participants at each.	Visitors day were organised on 18.-22.09.2017 in Ludza and 09.-13.10.2017 and 03.11.2017 in Sigulda. During these days, besides individual visits to pilot facilities, specialised seminars on biomass processing technologies were organised for two target groups – entrepreneurs and students of environmental technologies and engineering: Ludza on 19.09.2017 for entrepreneurs (31 participants); Ludza on 20.09.2017 for students (32 participants); Sigulda on 11.09.2017 for students (86 participants); Sigulda on 3.11.2017 for entrepreneurs (42 participants)	The seminars and study visits to biofuel production facilities provided insight on production technologies and perspectives for important stakeholder groups: entrepreneurs who might be interested in production of biofuels, as well as technical students who will be dealing with the given technologies and their development in future.
D1: Monitoring of impact of project activities on grassland habitats		
Methodology for monitoring of the impact of project activities on grassland biodiversity developed	Methodology completed by 30.06.2014.	The methodology is successfully used in the regular monitoring Activities within the Project.
Regular monitoring carried out at the selected sampling plots	24 permanent monitoring plots for assessment the impact of selected management regimes to semi-natural grasslands (Action A2) installed in July 2014. Vegetation descriptions for 600 1x1 m squares prepared and contents of 240 traps for terrestrial beetles collected in 2014, 2015, 2016 and 2017. The overgrowth maps and questionnaire on habitat's quality filled for all restoration sites (Action C2) in 2014 and 2017.	The regular monitoring according to approved methodology is continuously gathering data. Although the planned monitoring of earth-worms was not implemented due to unavailability of experts, the vegetation and beetle monitoring proved to be sufficient to show the impact of project activities on grassland habitats.
Report on monitoring results prepared and presented at the project web site	Report on monitoring results was prepared by the end of the project	The monitoring report have revealed improvement of the vegetation structure within the sites restored by the project, although the impacts of grassland biodiversity would be possible to assess only in the next years. Part of the restored sites are included habitats monitoring of Natura 2000 sites, which will allow to assess the long-term impacts of the restoration activities.
D2: Assessment of socioeconomic impact of project activities		
Socio-economic data collected from the two pilot areas about the situation prior to implementation of the project actions	Socio-economic data were collected for the Sigulda and Ludza Municipalities as well as two reference municipalities (Ogre and Krāslava). Data about the situation prior to implementation of the project actions were collected from the end of 2014 till September 2015, while the update of the situation was collected by October 2017.	The data collected have provided the information on level of involvement of local residents in grassland management and related benefits prior to implementation of the project activities.
The project impacts identified and assessed, applying monetary valuation methods were	The project impacts assessed applying the following indicators: - impacts on economic diversification and employment opportunities: i) collaboration of	The assessment shows positive impacts of the project activities with regard to development of local economy

Foreseen results in the revised proposal	Achieved	Evaluation
appropriate	entrepreneurs; ii) maintenance of grasslands and possibilities to generate revenue; iii) possibilities to develop entrepreneurship. - impacts on well-being of local population: i) income level and satisfaction with the environment for living in the pilot areas; ii) social activity, engagement in the project and dissemination of knowledge. - public awareness about the value of landscape: i) the availability of rural tourism services; ii) public awareness about natural diversity; iii) the effect of the landscape factor on evaluation of real estate market value.	and entrepreneurship related to grassland management, including increase of revenue earning possibilities, collaboration of rural entrepreneurs as well as development of new business opportunities. Furthermore, the project has contributed to increase of the quality of living environment in project areas and public awareness about the grassland's ecosystem and their role in well-being for the society.
Report on socioeconomic impacts of the project activities	Report on monitoring results was prepared by the end of the project and available at the project web-site.	The report demonstrates the positive impact of the project activities to local economy and society as well as provides valuable socio-economic data analysis for both municipalities, which can be used for future development planning.
E.1: Informative seminars for local public in the project pilot areas		
Local residents are well informed about project activities, importance of grasslands in maintaining biodiversity and possibilities of alternative use of biomass harvested in grasslands	Residents were informed about the project and its activities through publications in local newspapers (action E2), direct interviews (action C1), as well as during the informative seminars, which have gathered 107 participants in Ludza and 190 in Sigulda. Participants were informed about the project activities, as well as introduced to the status of grasslands in the both project areas and technologies for alternative use of grass biomass.	Residents and entrepreneurs in Sigulda and Ludza municipality have received the information through various media. Information about the importance of grasslands for maintaining biodiversity and possibilities of alternative use of grass biomass was adapted to the audience to ensure better perception.
4 seminars for local residents have been organised (2 in Sigulda Municipality and 2 in Ludza Municipality) with ca. 40-50 participants at each	The 1st set of the informative seminars was organised on 13.04.2015 in Ludza (53 participants) and 15.05.2015 in Sigulda (57 participants) introducing the project, grassland assessment results and options for alternative use of grass biomass. The 2nd set of seminars was organised in autumn 2017 back to back with the visitors' days (C2 action), focusing on the project results and included the following events: - Ludza: 20.09.2017 for schoolchildren and residents (54 participants); - Sigulda: 10.10.2017 for schoolchildren (86 participants) and 12.10.2017 for residents (47 participants)	The 1st set of the informative seminars was not only a good chance to inform residents about the project, it's aims and activities, but also map their knowledge about the importance of grassland maintenance and its biodiversity, as well involve participants into discussions on grassland management options and co-operation possibilities for the use of biomass. The 2nd set of the informative seminars aimed to present the results obtained within project, particularly regarding grassland restoration and demonstration of the biofuel pilot facilities and related technologies. The seminars served not only

Foreseen results in the revised proposal	Achieved	Evaluation
		for public awareness and information distribution, but also for contact building and networking.
E2: General project visibility		
The project is well known and visible to local stakeholders and general public	Popularisation of the project among local stakeholders and public was achieved by developing of visual identity, including the project logo and publication design, placing information about the project at the partners' web sites and local newspapers. The project logo was elaborated at the very beginning of the project and served as a recognizable symbol. General information about the project was placed on the websites of lead partner and project partners by 31.12.2013.	The project has reached recognition among local stakeholders and public at the project areas, thanks to its visibility on partners' web-sites, media, various dissemination materials, notice boards and signs at the restored grasslands. Information about the project was placed on the partners' websites very timely, some partners published it in two languages – LAT and ENG.
The project website has been regularly updated	The project website http://grassservice.balticgrasslands.eu/ (in Latvian and English) was launched in March 2014 and regularly updated to inform about project activities and achieved results	Website was launched successfully and timely, providing basic information about the project, news and events. The content chapters include an overview of the action implementation and achieved results.
Notice boards have been installed at four strategic places, two per local municipality	Four notice boards were developed and set up until 30.06.2016, providing information about the project, grassland biodiversity, management requirements and options for alternative uses. At each municipality two notice boards were placed at strategic places accessible for public: - one notice board was installed close to restoration sites, informing about biologically valuable grasslands and ways how to protect them - the second notice board was prepared in a roll up format, providing information about alternative uses of grass biomass explored during the project, and placed inside of premises of each municipality as well as used during the public events.	The chosen approach of developing two different - permanent and transportable notice boards, with the content messages targeted to each municipality, allowed reaching wider audience and spreading information about the project as well as grassland biodiversity and use potential.
The project leaflet printed in 1000 copies and distributed to the local residents of the pilot areas	Leaflet in the format of booklet with extra pages for notes has been elaborated and 1000 copies printed in Latvian, in March 2015. By the end of the project 995 booklets were distributed during the informative seminars and other meetings with residents as well as provided to project partners for distribution within their networks.	The booklet not only supplements the project visibility, but also provides brief information about the project and its partners, shortly describes the importance of maintenance of grassland biodiversity and ecosystem services, as well as outline possible management solutions and options for use of grassland biomass to be tested by the project. The format of the leaflet (booklet) ensures its attractiveness and durability.

Foreseen results in the revised proposal	Achieved	Evaluation
Six articles on project relevant issues prepared and submitted to local newspapers	In total 14 articles were published, including 6 articles in Sigulda local newspapers, 7 articles in Ludza local newspaper and 1 article in the regional newspaper.	During the project, successful cooperation with the local newspapers was established. The articles brought attention to project activities and events, as well as importance of maintenance of grassland biodiversity. In addition, the article in regional newspaper provided a wider spread of the information. The information in printed press serves as important communication tool with local public, since access to information via internet is not sufficient, especially in Ludza Municipality.
E3: Project result dissemination		
Layman's report in Latvian and English language produced and distributed	Layman's report consisting of eight A5 size pages was printed in 300 copies in Latvian and 100 copies in English. It shortly summarizes the main activities and results of the project. It was distributed in the final seminar and various meetings. Project partners are distributing the report within their networks.	To summarize the main project achievements, it was decided to structure the Layman's report accordingly the implemented actions and choose the language by avoiding the specific terms and project slang. Also, it was decided to use characteristic pictures for the better understanding and illustration. Report is designed in the corporate style of the project to support the visibility and publicity.
International seminar on results and lessons learnt organised	The closing event of the project -international seminar "Grass for biodiversity and bioenergy: experience and future perspectives" was organised in Riga on 29-30.11.2017. The agenda of the seminar included presentations of project results, related experience from other countries, as well as discussions on potential for use of grass biomass for bioenergy and related policy aspects.	The seminar provided an opportunity to share the project results to national as well as international audience, including experts in grassland management and bioenergy production. At the same time, it gave an inside about similar projects and developments in other countries as well as outlined general conclusions on sustainability of grassland management and potential of use grass biomass resources for bioenergy.
F2: Networking with other projects		
Established contacts with at least 3 projects working in the same field	Regular information and experience exchange provided with 6 other projects. The LIFE GRASSSERVICE project was presented in the LIFE Platform meetings, as well as other international and national seminars, conferences and public events (24 in total).	The project has permanent and successful cooperation with other projects by regular communication, meetings and information exchange on evaluation of grassland biomass resources and ecosystem services, as well as possible solutions for alternative use of grassland

Foreseen results in the revised proposal	Achieved	Evaluation
		biomass. The maintenance of those contacts also served as regular knowledge transfer and sustainable spread of the project results and messages.
Representatives of other projects working on grassland management and development of solutions for use of grassland biomass have participated at the international seminars organised by the project.	- Representatives of 6 projects related to grassland management and solutions for use of grassland biomass participated at the International seminar held 05.-06.11.2014 in Sigulda, Latvia. - Representatives of 5 projects working on grassland restoration, biogas and biobutanol production participated in the project closing seminar on 29. -30.11.2017 in Riga.	Both events were an important networking activity, where representatives of other related projects were invited to learn about the project results as well as share their experience and discuss grassland management practices and opportunities for alternative use of grassland biomass.
Study visit to at least one project on grassland management and use of grassland biomass has been organised and project team has observed in practice solutions for sustainable use of biomass	Study visit to Lower Saxony, Germany was organised on 07.-11.09.2014 to learn about practice solutions for grassland conservation and sustainable use of grass biomass. 11 project team members participated in the study visit.	The study visit provided experience how conservation of natural grasslands is organised in Germany, and what management instruments (involvement of farmers in grass collection, regulating water regime, setting mowing and grazing times favourable for species and habitats) are being used. The participants had possibility to visit a biogas production facility, which works on grass biomass as feedstock.

The immediately visible results of the project include 122 ha of restored grasslands with established preconditions for their further management, the tested technological solutions for production of biogas and biobutanol from grass biomass as well as the constructed biogas production prototype available for further demonstration and research on technologies for biofuel production. Also, the assessment of grassland quality and grass biomass in the two project areas provide valuable results to competent authorities and municipalities for planning, co-ordination and supporting grassland management. As immediate result can be mentioned also the web-based information exchange platforms established by the two municipalities, which has facilitated the grassland management and use of agricultural land.

Improved knowledge of local community and competent authorities about the grassland quality, biomass resources, management requirements, restoration techniques and alternative use potentials as well as established contacts and co-operation networks in long-term shall in improve maintenance of grasslands and their biodiversity within the two municipalities. Moreover, the elaborated methodologies for assessment of grassland biomass resources and planning of grassland ecological network as well as the gained experience in grassland restoration shall contribute to implementation of similar projects and studies elsewhere, thus promoting maintenance of grassland biodiversity.

The results gained by testing of biofuel production potential from grass biomass by exposing the grass feedstock to different physical-chemical processes and conditions as well as depending on grassland habitat types as well as has improved the scientific knowledge on the most efficient technological solutions for production of biogas and biobutanol. Furthermore, the experience gained through construction of biogas prototype as well as experimenting with biobutanol facility will be used for development of commercialized small-scale mobile biofuel production facilities as well as industrial scale plants.

The results achieved by demonstration of the biogas production (e.g. constructed prototype with innovative reactor design as well as knowledge gained on operation of the facility) would not be possible without the two modifications of the gran agreement – the 1st on the change from renting of the existing facility to construction of the prototype, since existing facility would not ensure efficient demonstration of the biogas production from grass biomass, and the 2nd on increasing the size and consequently the costs of the prototype, which allowed to ensure the demonstration needs as well as more objective evaluation of the economic and technological feasibility of the facility.

The project dissemination actions were assessed as very effective, reaching high number of the targeted stakeholder groups. Ca. 250 stakeholders in Sigulda Municipality and ca. 350 stakeholders in Ludza Municipality have been directly approached and informed about project activities. The informative seminars for local stakeholders in Sigulda and Ludza were attended by 297 participants in total. The two international seminars have brought together ca. 80 experts in grassland management and bioenergy production from several countries and different related projects. 1000 copies of the project brochures were distributed at various events organised by the project as well as within the networks of the project partners. Furthermore, the interactive posters for raising awareness and assessment of stakeholders' preferences to various ecosystem services provided by grasslands, which was developed for participation at the public festival "Nature Concert hall" in June 2015, were later used in various publicity and networking events, collecting votes for the grassland provided ecosystem services from more than 1600 people.

5.4 Analysis of long-term benefits

1. Environmental benefits
    a. Direct / quantitative environmental benefits:

By stimulating more active, economically viable grassland management the LIFE GRASSSERVICE project is promoting maintenance of grassland ecosystems, including the habitat types listed in Annex I of the Habitats Directive: 6120*; 6210; 6270*; 6410; 6450; 6510. Direct environmental benefits have achieved by restoration of ca. 122 ha of abandoned grassland, which has been overgrown by shrubs and trees or invaded by invasive species. Long-term management is ensured by 14 agreements from grassland owners. The restoration of the grasslands had created preconditions for resuming grassland management and applying the Agri-environmental measures under the Rural Development Programme. Thus, we expect that in the coming years the nature value as well as landscape quality of the restored grasslands will continue to increase.

    b. Relevance for environmentally significant issues or policy areas

The LIFE GRASSSERVICE project was in line with the EU Biodiversity Strategy 2020, which aims at reversing biodiversity loss and speeding up the EU's transition towards a resource efficient and green economy, and its target 2, which sets that by 2020, ecosystems and their services shall be maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems. The project has promoted implementation of the above-mentioned targets through the knowledge building and gaining practical experience in mapping, assessment and valuation of grassland biomass resources as part of ecosystem services at the local level as well as by restoration of the degraded grassland ecosystems. Also, at the project time several other projects (SentiGrass, Viva Grass, GrassLIFE etc.) and state authorities (Rural Support Service etc) have started to use similar methodologies for assessment of grass biomass and grassland management by remote sensing, satellite data. The project results in future will help municipalities on development of local planning issues and co-operation with residents.

Furthermore, the project contributes to the EC strategy for smart, sustainable and inclusive growth aiming to increasing share of the renewable energy sources in the overall balance of the energy production by encouraging the use of grassland biomass in bioenergy production. Targeting at non-used grasslands for energy production needs will avoid competition for land with food production, at the same time maintaining the biodiversity characteristic for traditional grasslands. The project results were relevant for energy, climate and transport policy sectors by promotion on the use of energy from renewable sources. The alternative technological solutions for production of bio-energy (i.e. biogas and biobutanol) were demonstrated in practice to wide range of stakeholders. The developed technologies and gained knowledge will support achievement of the EC climate and energy framework targets for 2030.

2. Long-term benefits and sustainability
    a. Long-term / qualitative environmental benefits

The project activities in long term will stimulate the maintenance of semi-natural grassland by preventing their further abandonment or transforming into intensively used agricultural land or planning of fast-growing bio-energy crops. It is expected that land owners or managers of the restored grasslands will continue extensive grassland management also in the cases when they’re not engaged in active agriculture practice based on long term agreements with them. This will be stimulated by available Agri-environmental support schemes within the Rural Development Programme. Maintenance of grasslands will prevent loss of their biodiversity value, ensuring favourable conservation status of the Annex I habitat types as well as help also to prevent changes in soil properties (acidification, leaching of nutrients from topsoil, soil erosion), eutrophication of water bodies as well as increasing soil organic matter and carbon sequestration. Consequently, project activities have both an immediate as well as expected future positive impact on the biodiversity and environmental quality in pilot areas.

    b. Long-term / qualitative economic benefits

The direct impacts on the local economy have measured by the Action D2 based on direct interviews with land owners from the two municipalities (Sigulda and Ludza) as well as official statistical data. Project activities have direct impact on grassland management and related revenue earning possibilities. Grassland has been restored in the Sigulda and Ludza municipalities at total area of 122 ha and further on their owners will be eligible to support payments from RDP 2014-2020 "Agri-environment and climate"

for biodiversity preservation in grasslands, which are higher than those under single area payments for which the restored areas could qualify up to now. As result of the project activities, the amount of available payments for the restored grasslands have reached 25 545 € annually. The grassland restoration has also a direct positive impact on the landscape value, which has potential positive impact on the market value of real estate in close vicinity to the restored grasslands.

Project activities are expected to have a direct positive impact in the future on the development of entrepreneurship. With the increase of managed grassland areas in the pilot areas, there has been a growing demand for area maintenance services; it is possible to develop tourism services in the restored grassland areas; also, rural entrepreneurs have an enhanced awareness about alternative use (non-related to agriculture) of grass biomass and technological solutions. Project activities have helped to develop livestock farming in both pilot areas. Consequently, project activities have both immediate and future positive impact on the collaboration of rural entrepreneurs in pilot areas, on grassland management, on revenue earning possibilities as well as on the development of new lines of entrepreneurship.

The economic assessment of grass biomass resources, performed within the Action A1, has demonstrated rather high economic value of grassland in Sigulda and Ludza municipalities. The heat energy potential of grass per hectare is comparable to the average heat and electric energy consumption of a household in Latvia. The results of the estimates suggest that develop industrial scale technologies would be needed to utilize the economic potential of grasslands better.

c. Long-term / qualitative social benefits

The social benefits to local communities are closely related to the economic benefits described above. Project activities have potential impact on the improvement of the quality of living environment and the possibility to get aesthetic pleasure from a well-kempt landscape in the Sigulda and Ludza municipalities. Project activities have a positive impact on enhancing the quality of life for the society, which has been attained by encouraging a discussion and involving altogether at least 5405 persons about the topic of interaction between humans and nature and the role of maintaining natural diversity in promoting sustainable well-being. In long-term we expect an impact on the development of new business directions, e.g. small-scale energy supply technologies, which can serve as a local solution for farms that do not use grass for livestock breeding.

Project have promoted collaboration between entrepreneurs in the pilot areas. In the 2017 farm survey 6% (n=150) of respondents acknowledged that participation in the project has encouraged their willingness to start collaboration with other entrepreneurs. The web-based information platforms, developed as part of the project for exchanging with grassland related service offers, will continue to facilitate the collaboration between entrepreneurs in the future. Project activities have also positive impact on promoting of society's involvement and active participation in solving systemic issues. Over the project implementation period at least 2013 participants representing entrepreneurs, young people, officials from municipalities, researchers and other interested parties – have been involved in the project activities and 1684 had raised awareness on grassland ecosystem services.

d. Continuation of the project actions by the beneficiary or by other stakeholders.

After the end of the project, most of the activities will be continued. The restored grasslands will be maintained by the landowners or managers, ensured by the long-term agreements. AB4 Sigulda and AB5 Ludza Municipalities will maintain web-based information exchange platforms to regularly place information about demand of agricultural land, including grasslands, and agricultural related service offers. A specially appointed person will be responsible for contacts with local stakeholders and placing information on the website. The pilot facilities for biogas and biobutanol production will be continued to demonstrate at the premises of AB2 Bio RE and AB3 Riga Technical University for interested stakeholders. The both organisations - AB2 Bio RE and AB3 Riga Technical University will continue research in the field of biogas and biobutanol production, respectively, and are open for consulting interested parties in relation to installing biogas and biobutanol production facilities. AB2 Latvian Fund Nature will evaluate the long-term habitat restoration effect within scientific projects, citizen science and widely disseminate methods which can be used to assess the amount, quality, management of grassland biomass and previous evaluated results. Baltic Environmental Forum will disseminate all project results and ensure project succession. More details about the continuation of project activities are provided in the After-LIFE plan.

3. Replicability, demonstration, transferability, cooperation: potential for technical and commercial application.

Project actions, implementation principles and the methodologies for evaluation of grassland biomass resources, their quality, distribution and management, ecological network principle and habitat restoration, stakeholder involvement and awareness raising on grassland ecosystem services are replicable and transferable to other projects and regions in Latvia.

Essential focus of the project was on demonstration of the opportunities for alternative use of grassland biomass that would complement the traditional farming practices and encourage more effective and economically viable grassland management. This includes use of grassland biomass for production of biogas and biobutanol. The technologies developed for biogas and biobutanol production will have potential to be transferred or used for further development. Biogas production technologies are well developed worldwide, but the Project had emphasis on using grass as feedstock and has developed technologies with higher efficiency applicable for the small-scale solution for farms and households. Biobutanol production technologies are still being developed elsewhere, and the Project had invested its share in this field of investigations. The both pilot facilities have potential in future for development of commercial solutions.

Market conditions is very important factor in the development of the alternative use of grass biomass. Now, market factors are rather unfavourable for the competitiveness biogas and biobutanol with other source of energy, but more favourable for grass pellets. Also, use of pellets as fodder for animal can be economically viable. Market for biogas production is based on agricultural crops and another agricultural feedstock. Although currently facing lack of political support, the biogas facilities have been successfully operating in Latvia for many years. Thus, if the operational costs of the prototype constructed within the LIFE GRASSSERVICE project are not higher compared to the working facilities, such small-scale grass-fed biogas plants can be successfully incorporated in the biogas production network. There is no market for biobutanol yet in Latvia, as the whole technology of the production is still being developed. It will be very difficult to compete with petrol, as production costs currently are much higher. But with improvement of technologies and political support, biobutanol may successfully supplement the fuel market.

4. Best Practice lessons:

Several grassland restoration methods ("green hay" method and "dry hay" method, prescribed burning) have been tested for the first time in Latvia, and significant experience in the organization of restoration work has been obtained. Principles for creating of grassland ecological network, tested in Sigulda and Ludza municipalities, have a potential to use in the green infrastructure planning and maintenance of ecosystems and their services.

Development of grass biomass information exchange platforms in the both municipalities are supposed to be a best practice procedure that highly facilitates exchange of information. Local land owners have possibility to place information on the websites of local municipalities about grass biomass, advertisement of agricultural land and providers of agricultural services. However, it shall be noted that the older generation hardly uses modern technologies, also internet connections are not available everywhere, as it has been experienced in the Ludza Municipality, therefore more individual approach shall be implemented by personally contacting elderly people by phone or post and widely using traditional media (radio, local TV, newspapers and magazines) to inform about the functions of the information exchange platforms and offered services.

5. Innovation and demonstration value:

The project has tried to bring grassland biodiversity protection on a higher level looking at it in an integrative approach and going beyond traditional nature conservation and agricultural practice level. The project provided Sigulda and Ludza Municipalities with comprehensive maps and information on grass biomass resources, the quality of grasslands, as well as extent of threating factors (overgrowing with shrubs and invasive Sosnowsky's Hogweed). This was the one of first cases in Latvia when such amount of remote sensing data was used for assessment of the grassland resources. The obtained information can be used not only for project needs, but also serve for further activities, particularly related to spatial planning in the municipalities and cooperation with residents. The acquisition of remote sensing data for

Sigulda and Ludza Municipalities has also a demonstrative character for application of the methodology in other areas. The experience is already taken over by another LIFE projects, e.g. LIFE Viva Grass and GrassLIFE, and by the European Space Agency project - SentiGrass.

Technologies for production of biogas and biobutanol, developed by the project, offers innovation for the supply of energy resources in countryside households. The inventory done within the project proves that there is grass potential for non-agricultural needs. At present, most household energy systems in the countryside are based on wood. The project offers small scale energy production options for those having grasslands, but not doing agriculture by demonstrating biogas production for cooking and heating needs and biobutanol production for vehicles. While some of the existing biogas production facilities are already using grass in limited extent, biobutanol production can really be called innovative, as it is still in laboratories and only the LIFE GRASSSERVICE project had tested grass as the feedstock. Looking from the international perspective, the project has created important knowledge in the field of the bioenergy research, especially by construction of the biogas production prototype. In 2016 and 2017, the project had demonstrated the pilot facilities for biogas and biobutanol production in to the stakeholders of both municipalities as well as interested researchers and students of engineering sciences. In total 565 people have visited the pilot facilities and learned about the technological solutions.

Project activities for restoration of the grasslands have also created remarkable experience in organisation of such works and applicable methods. Some of the demonstrated restoration methods were novel in the country's context. The gained experience has been disseminated to other experts and projects.

6. Long term indicators of the project success:

The project is focusing on improving the quality of grasslands towards biologically valuable status, as well as facilitating introduction of alternative biomass processing where agricultural activities do not fulfil this objective. Following indicators will be used to measure success of the project within 10-year period after the end of the project.

Indicator	**Target value**
The restored grassland areas are continuously managed after the end of the project	97 ha in Sigulda Municipality 25 ha in Ludza Municipality
The quality of the restored grasslands reaches at least a "low quality class" of biologically valuable grassland	97 ha in Sigulda Municipality 25 ha in Ludza Municipality
Technology of biogas production from grass biomass is taken over by business and/or households	1 facility launched in Latvia
Technology of biobutanol production from grass biomass is taken over by business and/or households	1 facility launched in Latvia
Cooperation network of landowners and local entrepreneurs	3 municipalities