



**EUROPEAN COMMISSION
RESEARCH EXECUTIVE AGENCY**

REA.B – Industrial Leadership and Societal Challenges
B.2 – Sustainable Resources for Food Security and Growth

GENERAL PROJECT REVIEW CONSOLIDATED REPORT

Grant agreement (GA) number:	730349
Project¹ Acronym:	RES URBIS
Project title:	REsources from URban BIo-waSte
Type of action:	RIA
Start date of the project:	01/01/2017
Duration of the project:	36
Name of primary coordinator contact and organisation:	mauro MAJONE (UNIROMA1)
Period covered by the report:	from 01/07/2018 to 31/12/2019
Periodic report/Reporting period number:	Final
Date of first submission of the periodic report (if applicable):	30/03/2020
Amendments (latest AMD concerning description of the action)²	05/04/2018 (AMD-730349-19)
Date of meeting with consortium (if applicable):	Not applicable
Name of project officer:	Pilar VIZCAINO MARTINEZ
Name(s) of monitors:	<ul style="list-style-type: none"> – Ljiljana RODIC-WIERSMA <ul style="list-style-type: none"> • Self-employed • Leiden University, Institute for Area Studies (LIAS) • Wageningen University and Research Centre, Centre for Sustainable Development & Food Security – Anna AUGUSTYN <ul style="list-style-type: none"> • Groupe de Bruges [this is my main affiliation] • Brussels • Prague

¹ ‘Project’ means the same thing as ‘action’.

² Only amendments to the description of the action (DoA; AT21) are relevant for general project reviews since they always have to be carried out against the latest version of the DoA

1. Overall assessment

1. Overall assessment
Project has fully achieved its objectives and milestones for the period.
2. Significant results linked to dissemination, exploitation and impact potential
<p>Project has delivered exceptional results with significant immediate or potential impact (even if not all objectives mentioned in the Annex 1 to the GA were achieved).</p> <p>The project delivered significant results with regard to valorisation of urban organic waste into bio-based products, using the concept of an integrated biorefinery. Different options were thoroughly studied through which organic urban waste could be converted into products for the market, while subscribing to the principles of a circular economy. A great progress is made in terms of collected data, information and knowledge on process parameters and produced materials, which emerged from the experiments performed by the team. LCA was carried out, delivering insightful views on the environmental performance of the novel technological solutions proposed by the project, in comparison to more conventional waste management options for the same waste streams. Based on the experimental and analytical project activities, a suitable portfolio of products was established in various fields of application, ranging from packaging to soil remediation to durable goods.</p>
3. General comments
<p>The project was successful in generating knowledge and advancing the state of the art in implementation of circular economy. With its focus on waste valorisation in urban context, the project addressed an area of a great concern to society and the EU policy agenda. The project activities yielded valuable insights in terms of PHA production from the three types of feedstock (organic fraction of municipal waste, wastewater sludge, fruit waste from industry) and similar. In addition to LCA of this technical option and the already existing practices, the outcomes are further strengthened by a comprehensive analysis of occupational safety issues involved with biorefinery processes, including appropriate measures of risk management.</p> <p>Furthermore, the latest pertinent EU legislation was analysed, in light of the necessary legal base to enable and advance the current state of the art. The project activities also included appropriate and comprehensive analyses of the economic feasibility. The project and its consortium involved five territorial clusters, where specific analyses of the existing and new value chains were performed to identify market opportunities for the product portfolio. The proposed technology chain was already available at the TRL5-6 and the project offered a visible advancement towards the market uptake. It is a good sign that investors showed initial interest in the project outcomes. In follow-up of the project an additional effort needs to be made in order to reach the market with the novel technologies and products.</p> <p>The project had some shortcomings in terms of exploring the social impacts (especially along the value chains), associated risks and market penetration strategies. It could have benefitted from a better tailoring of the financial and other instruments to enable a better market position of its SMEs and related IPR (for instance, patents, rights to patents, licensing).</p>
4. Recommendations concerning the period covered by the report
<p>The team continued the work planned and obtained significant results. Experimental work was very successful in terms of insights obtained. Where necessary and appropriate, tasks from different work packages built on the results of others. Notwithstanding, in some cases, sustainability considerations were not sufficiently taken into account, even though the consortium included staff with complementary disciplinary fields of expertise that could have contributed. Accordingly, revision is requested for several deliverables, mainly to increase clarity and/or appropriately expand the considerations presented.</p> <p>In addition, while the project explored the technological aspects of the novel solutions in a great detail, lesser attention was paid to the examination of the social impacts, which are, arguably, likely to occur if the results of the project reach the stakeholders along the value chains. In this respect the project was mostly focused on the discussion of the relevant literature and testing the consumer perception in a selected case study (chair) that was not clearly derived from the project results. The project could have been enhanced with a more comprehensive social impact assessment (or social LCA) and/or development of scenarios representing consumers' response once the novel products and technologies become available. Moreover, a greater attention could have been paid to the value chain creation and economic models for the commercialization. Advancements of work on the TRL would be desirable.</p> <p>Comments on individual deliverables where revision is requested:</p> <p>D2.6 only contains report from SubTask 2.4.1 executed by BIOTREND, lacking report from SubTask 2.4.2, which makes</p>

Figure 17, p. 31 in The Final Periodic Technical Report rather unclear. (The D2.3 submitted in the previous reporting period does not help here either.)

Please see the deliverable assessment for details.

D2.8. It would be good to be explicit how the monetary equivalent of energy was calculated. In other words, which prices were assumed in the calculation of such a precise number 286,626 EUR/year?

Also, it would be appropriate to use a range, rather than a single number, and add a couple of sentences of discussion here, particularly because this is used in WP1 and WP5.

D3.3 presents important component of the project. Very innovative and relevant. Notwithstanding, the text lacks some discussion about the newly obtained packaging materials – composites that sandwich PET with biodegradable components – in terms of their own end-of-life in the context of sustainability and circular economy. This concerns implications for the overall material biodegradability and options for waste management once this material becomes waste (which tends to be soon after the purchase, as they serve as packaging).

Some discussion of this issue would be highly appropriate. Also see similar comment on D3.4, as well as comments on D5.3 and D5.5 where this issue propagates.

D3.4 contains extensive introductory explanations, however, it does not adequately address an important issue related to the addition of input materials that are only partly bio-based, to produce a viable material with PHA – it does not discuss implications for the overall material biodegradability and options for waste management once this material becomes waste, in the context of sustainability and circular economy. Also see similar comment on D3.3, as well as comments on D5.3 and D5.5 where this issue propagates.

D3.5 is very interesting, clear and well presented. The results are appropriately contrasted with relevant literature. Some further clarifications would be beneficial though; please see the deliverable assessment for details.

D3.6 explores an attractive application of PHA obtained from waste, for remediation of groundwater polluted by organic solvents, using a technology patented by UNIRM. The experimental set-up, execution of experiments and results are well presented. It is particularly encouraging that “raw PHA”, without further treatment, has turned out to be very effective. Some further clarifications would be beneficial though; please see the deliverable assessment for details.

D5.3 is very good, providing a comprehensive analysis of the PHA portfolio. Notwithstanding, a few remarks are made; please see the deliverable assessment for details.

D5.5 is also very good. Notwithstanding, a few remarks are made; please see the deliverable assessment for details.

5. Recommendations concerning future work, if applicable

As the project is completed, the future work needs to concentrate on the dissemination and exploitation of results. Of crucial importance is the follow up with the investors that expressed initial interest in the project results. In addition, business models and strategies for the market penetration could be expanded. Further projects, advancing the results of RES URBIS, would be also desirable as the area of concern is very important for circular economy. It would be also relevant to work with other urban clusters, both in the countries involved and not involved in this project. Social impacts in the value chain could be explored with the subsequent projects and interested stakeholders.

2. Objectives and workplan

1. Is the progress reported in line with objectives and work plan as specified in the DoA? If there are significant deviations, please comment.	Yes
<p>The project has achieved its original objectives, largely in line with the work plan as specified in the DoA. After some obstacles in the first half of the project, the work has progressed well in the remainder of the project duration.</p> <p>1/ Collection and analysis of data on urban organic waste generation, their characteristics and present management systems in five selected territorial clusters: This objective was fully achieved. The related deliverables are of high quality, comprising detailed data as well as pros and cons of the management systems in the selected municipalities / agglomerations: Province of Trento (Italy), Barcelona Metropolitan area (Spain), Lisbon Metropolitan area (Portugal), South Wales (United Kingdom) and Copenhagen Metropolitan Area (Denmark). The selected cases represent a variety of geographic and climatic European regions and socio-cultural and economic conditions, which all significantly influence not only the available waste streams but also a potential uptake of the project results.</p> <p>2/ Well-targeted experimental activity to solve a number of open technical issues, related to the conversion of the organic waste feedstock into close-to-market bio-based products, by using the appropriate combination of innovative and catalogue-proven technologies: Pertinent experiments were performed, obtaining valuable insights into optimal process parameters for production of PHA and production of derived materials. Besides that, due consideration is given to the occupational safety issues related to human health, accounting for biological, chemical and explosion risks. In addition to production aspects, experiments were conducted to ascertain relevant mechanical and barrier properties of the obtained bio-based materials, as well as presence of contaminants, taking into account and examining a range of identified potential applications, contrasted with corresponding legislation.</p> <p>3/ Market analysis within several economic scenarios and business models for full exploitation of bio-based products (including a path forward to remove regulatory barriers and constraints): Market analysis was performed and value chain oriented strategies presented. Potential investors were identified and initial contacts made to confirm their interest. However, there are some shortcomings in terms of data collection on the social impacts of the proposed novel technologies. While the analysis of the pertinent legislation lacks depth, the crucial components, the ones that have direct bearing on the project outcomes, are identified and satisfactorily addressed.</p> <p>The specific objectives SO1-SO9 of the project were achieved as expected.</p> <p>Some relatively minor deviations were noted in the planning, with regard to the following:</p> <ul style="list-style-type: none"> - WP1, Task 1.1. It was planned that the investigation of the clusters be completed by month 3. However, the duration of the task was extended, due to criticisms in the previous review. - WP2, Task 2.1. More time was needed than planned at the start to design, realize and put into operation fermentation reactors, which was recovered in the second period. - WP2, Task 2.2. Start up and operation of pilot plants for PHA production was initially more demanding than expected, both at Lisbon and Treviso sites. - WP3, Task 3.2. At the end of the project around 30 kg of PHA were produced at pilot scale, which is truly a significant amount. Although this was less than originally planned, it did not compromise WP3 activities. -WP4, Task 4.2. The investigation of social perception was planned to be completed by month 12. However, the duration of the task was extended, due to criticisms in the previous review. -WP5, Task 5.1. Among activities related to the Stakeholder Platform, a questionnaire was originally planned in the early stage of the project (D5.1, month 3). However, the questionnaire was postponed in order to better assess the outcomes of the meetings with Stakeholders, both at international and local levels. - WP6, Task 6.3. In the first reporting period, the number of scientific papers was lower than originally planned. This was recovered in the second half of the project and overall 24 scientific papers have been published. 	
2. Are the objectives of the project still scientifically and /or technologically relevant?	Yes
<p>The project objectives are fully attuned to the current state of science and technology in relation to circular economy, and waste management as one of its components. They have been successfully achieved and the results presented in numerous scientific publications, thus significantly contributing to the existing body of knowledge. At the same time, their scientific and technological relevance remain very high, as this field is in development and will continue to be so in the coming period, with many projects and initiatives. Due to strategic orientation of the EU (as well as China, Japan and other countries) toward circular economy, it is very likely that the results of the project will remain of high interest</p>	

to various stakeholders in the years to come. The results have a great potential to be transferred into practice, either as scale out or up. This is further supported by the keen global interest in addressing problems with plastic waste, which the materials developed in this project could help mitigate.	
3. Are the critical implementation risks and mitigation actions described in the DoA still relevant?	Not applicable
The critical implementation risks had been adequately identified. Some of the risks materialised. Adequate mitigation measures were devised and successfully applied.	
4. Have the pilots/case studies started to showcase innovative results as described in the DoA?	Yes
<p>Innovative results from the previous review period have been expanded and confirmed. Experimental research was performed to a high standard, resulting in a wealth of valuable insights and information, in different complementary domains, from production of PHA and derived materials, to materials characteristics and their potential applications.</p> <p>Regarding the case studies, the criticisms expressed in the previous review have been very well addressed. The case studies included five defined territorial clusters, namely: Province of Trento (Italy), Barcelona Metropolitan area (Spain), Lisbon Metropolitan area (Portugal), South Wales (United Kingdom) and Copenhagen Metropolitan Area (Denmark). The targeted project activities delivered insights into their individual situations regarding existing technologies and systems of municipal waste management, enriched by LCA, as well as value chains and economic potential. The techno-economic analysis was supported by a compilation of pertinent, locally valid legislation.</p>	
5. Have the ethics deliverables due for the current period been adequately addressed and approved?	Yes
<p>As commented in the previous review period, the project has an outstanding approach to managing issues related to ethics. This work has been further expanded.</p> <p>In addition, the project thoroughly examined occupational safety. The related deliverable convincingly discusses the associated risks.</p>	
6. Have the comments and recommendations from previous project reviews been taken into account?	Yes
<p>Generally, the comments and recommendations made in the previous project review have been very well addressed.</p> <p>The data from the territorial clusters were thoroughly updated and improved, resulting in a very good deliverable.</p> <p>The issues that had been raised concerning research on consumer perceptions were generally satisfactorily addressed, with research papers published in very good scientific journals. The deliverable did not demonstrate, however, that doing research based on commercially available UK and US consumer panels was appropriate to represent the consumers and other value chain actors across the involved geographies. Conducting surveys in each territorial cluster would have been more effective and more beneficial for the project objectives.</p> <p>The belated analysis of the legal framework was carried out. Now the deliverable provides a thorough and detailed critical review of the EU legislation that has bearing on the topic of project. It is laudable that the authors seized the opportunity to take into account relevant pieces of legislation that have appeared in the meantime, providing a very good and detailed analysis of the latest changes in the pertinent provisions.</p> <p>Other issues related to social impacts were updated with more detailed references to the secondary sources and interviews, and measuring the communication / dissemination performance. However, the project did not sufficiently take into consideration the social impacts of the novel technologies along the value chains.</p>	

3. Impact

1. Does the work carried out contribute to the expected impacts detailed in the DoA?	Yes
<p>The project activities and results have considerably contributed to the expected impacts. The visible technological innovations generated through this project are likely to enhance circular economy within the participating regions and beyond. More specifically:</p> <p>1/ To enable the creation of new value chains for higher value purposes other than just for compost or energy: The project has developed innovative technological solutions and tested them on pilot scale, obtaining positive and encouraging results. Thereby the project provided a basis for the establishment of new value chains that incorporate waste management at a higher value than the current state of the art: a portfolio of bio-based products is developed that could be put on the market and considerably diversify the waste use beyond compost or energy (biogas). The existing value chains were thoroughly studied and new directions outlined, accompanied with a tailored business strategy, which will allow the project consortium members to be actively involved into the value chains creation. In addition to technical innovation, additional efforts have been put in the second part of the project duration to address social aspects and stakeholders' interests and concerns related to this technical innovation.</p> <p>2/Contribute to new developments in strategy and policy at regional and local level for the innovative use of urban organic waste: Analysis has been carried out of the relevant EU legislation, including circular economy and other strategic documents, pertinent Directives and REACH. This is accompanied by an appropriate discussion of the possible impacts of the legislation on the exploitation of the project results, and the recommendations with regard to the progress necessary in the regulatory standards for advancing the innovative use of the organic waste. Moreover, the project consortium engaged with relevant actors at various levels to seek input and promote these ideas. Furthermore, regional and locally valid national legislation has been compiled for each territorial cluster.</p> <p>3/Boost investments in the local and regional economy supporting sustainable growth, development and employment This is clearly visible in the project, especially through participation of the interested companies and an attention paid to recognizing of commercialization opportunities, investment needs and capacities of the market to generate jobs. The economic analysis has identified other regions (from partners' other projects) and investors that may be interested in the exploitation of the PHA technology developed in the project.</p>	
2. Does the work carried out follow the plan detailed in the DoA to enhance innovation capacity, create new markets opportunities, strengthen competitiveness and growth of companies, address issues related to climate change or the environment, address industrial and/or societal needs at regional level or bring other important benefits for society? Give information on the relevant innovation activities carried out (prototypes, testing activities, standards, clinical trials) and/or new product, service, reference materials, process or method (to be) launched to the market, if any.	Yes
<p>The innovation capacity of the researchers and companies participating in the project has been significantly enhanced through the project, in accordance with the DoA. The newly developed technologies for production of PHA from urban and industrial organic waste streams open avenues toward more sustainable and more circular approaches to resources and waste management, while at the same time valorising economic value of waste materials. Experimental work conducted pointed to optimal scenarios and potential use of the developed materials. This resulted in a portfolio of products with a strong market uptake potential, taking various important aspects into account, including relevant issues from the latest EU legislation. The business plan and initial engagement allowed partners to take the project work beyond its lifetime and should lead to increase of the capacity of participating SMEs in particular. The results are in the pre-commercial stage and a business strategy was developed.</p>	
3. Does the work carried out contribute towards European policy objectives and strategies and have an impact on policy making?	Yes
<p>There is a visible impact of the project outcomes toward reaching the EU circular economy policy objectives. The legal context for the exploitation of the project outcomes is duly analysed, both at the EU and national/regional level in the countries selected as case studies. The focus was appropriately placed on the legislation with direct bearing on the materials developed in the project, such as the allowed levels of contaminants in plastic materials for different applications. The project team also engaged in a dialogue with relevant stakeholders, both internationally and regionally. Importantly, the latest changes in the pertinent waste legislation, including the end-of-waste criteria, were highlighted. As this legislation now leaves it to Member States to determine related definitions, the project team made recommendations for the next steps, which could have an impact on policy making nationally and locally.</p>	

4. Does (or will) the work carried out have an impact on SMEs?	Yes
<p>The work has already had a visible impact on participating SMEs through their engagement with researchers in developing innovative products. Furthermore, the work has a strong impact on the participating SMEs in terms of job creation and improving their market position. Clear market potential is recognised, supported by a comprehensive and well-informed economic analysis.</p>	
5. Have the beneficiaries reached gender balance at all levels of personnel assigned to the action? If not, have the reasons been explained in the periodic report?	Yes
<p>The Consortium has put active efforts to address gender balance. Namely, the project paid attention to gender aspects and a balanced number of men/women were employed. Procedures were in place to enable recruitment that did not discriminate either gender.</p>	

4. Implementation

1. Has the project been efficiently and effectively managed?	Yes
Generally, the project was managed efficiently and effectively. The allocated resources were used according to the initial plan, with only minor deviations. The deliverables were mostly submitted on time and in case of shortcomings, they were updated. Most of the milestones were also achieved as expected. In case of the delays, these were appropriately justified. There is a visible cross-referencing to other WPs in the deliverables, which clearly and logically build upon each other. This is primarily due to a solid design of the project structure, which was followed in the project management as well.	
2. Is the management of the project in line with the obligations of beneficiaries (including ethics and security requirements, risk and innovation management if applicable)?	Yes
The management of the project followed the obligations of beneficiaries. There was a specific WP dedicated to the ethics and the related deliverables provided very useful insights into this topic at the project and industry level. The risk and innovation management was also included, by paying attention to the IPR and technology readiness progress.	
3. Is the contribution of each beneficiary in line with the work committed in the DoA? (applicable only to multibeneficiary projects)	Yes
Each beneficiary appropriately contributed to the project. There were some minor deviations in terms of allocated PM resources for the tasks performed, which did not result in adverse effects on the project quality.	
4. Have the beneficiaries disseminated project results (foreground) in scientific publications as planned in the DoA (including the deposition of publications in open access repositories)? Do they include a reference to EU funding?	Yes
The project disseminated its results in the scientific publications as planned at the DoA. A considerable number of scientific papers was published in the open access (green and gold categories), including high ranking journals. They contain reference to the EU funding. Overall, there was a very good dissemination of the project findings among the scientific community.	
5. Have the beneficiaries disseminated and communicated project activities and results by other means than scientific publications (social media, press-release, the project web site, video/film, etc) as planned in the DoA? Do they include a reference to EU funding?	Yes
The project is well communicated, using multiple channels, and targeting both scientific and practitioner audiences. The project involved an intensive communication and dissemination effort. 67 technical events (110 in total including the 1st reporting period) were held, some with multiple participation and using different modalities. This included: 66 oral presentations (98 in total), 14 poster presentations (25 in total), 16 events where leaflets were left available to attendees (42 in total). The references to the EU funding were made and open access ensured in several publications. There was also an online presence including website and social media. The project evaluated its performance in detail, demonstrating that there was a significant interest of the targeted audiences in Europe and beyond.	
6. Has the plan for the exploitation and dissemination of the results (if required) been updated and implemented as described in the DoA, in particular as regards intellectual property rights? Is it appropriate?	Yes
The plan for the exploitation and dissemination of results has been updated and implemented in line with the DoA. However, the focus on IPR in the context of the business strategy and post-project activities could have been articulated more clearly.	
7. Has the data management plan (DMP) (if required) been updated and implemented? Is it appropriate?	Yes
The data management plan did not require any significant changes. The related plan defined the methodology, standards, and confidentiality level of different types of data as well as guidelines for publications (previous information to partners, IPR verification, authorship, acknowledgements, open sources).	
8. Have the proposed institutional changes been appropriately promoted?	Not applicable
No major institutional changes were needed for this project.	

5. Resources

1. Were the resources used as described in the DoA and were they necessary to achieve its objectives? If there are deviations from planned budget, have they been satisfactorily explained? Have they been used in a manner consistent with the principle of sound financial management (in particular economy, efficiency and effectiveness)?	Yes
<p>The resources consumed in the project were necessary to achieve its objectives. They were mostly spent in line with the planned budget, with minor deviations. These were, however, well justified. In particular the planned personnel effort exceeded original plan. 536,4 PM were used at month 36 out of initially planned 457.3 PM, giving around 117% of the total planned effort. This extra work was partially covered by the junior personnel, lowering the staff costs to keep up with the project budget.</p> <p>WP1: personnel effort in WP1 is bit higher than planned one (54 PM vs 51 PM, +6%). WP2: personnel effort in WP2 was quite higher than planned one (226 PM vs 174 PM, +30%). WP3: personnel effort in WP3 was also higher than planned one (90.8 PM vs 74 PM, +22.7%). WP4: personnel effort in WP4 was also higher than planned one (45,5 PM vs 38 PM, +20%). WP5: personnel effort in WP5 was quite well aligned to the planned one (48,3 PM vs 47 PM, +2,7%). WP6: personnel effort in WP6 was quite well aligned to the planned one (39,1 PM vs 38.5 PM, +1,6%). WP7: personnel effort in WP7 was also quite well aligned to the planned one (32,4 PM vs 34.8 PM, -7%).</p> <p>Detailed overview is also provided for each partner. The justifications indicate that the project was implemented with the respect to the sound financial management principles, i.e. economy, efficiency and effectiveness. The unforeseen contracting was not made.</p>	

Expert opinion on deliverables

Deliverable number	Deliverable name	Status	Comments
D1.1	Cluster analysis framework	Accepted	<p>The comments made in the previous assessment have been satisfactorily addressed.</p> <p>D1.1 is comprehensive and elaborated in detail. Extensive data were collected on the relevant waste streams through a survey. Attachments are provided with the detailed accounts. The report also elaborates on the methodological shortcomings.</p>
D1.3	Final LCA	Accepted	<p>D1.3 is well elaborated, with the LCA methodology presented transparently and assumptions stated clearly. Relevant data was collected, collated and analyzed using an appropriate EU reference framework. Uncertainty analysis, supported by Monte Carlo simulations, is a welcome addition. Comparison to plastic packaging consumption is very beneficial, putting things in perspective indeed.</p> <p>Some further clarifications would be beneficial though, as follows:</p> <p>(1) For an appropriate comparison and ‘perspective’, the amounts of polyurethane in comparable applications should be included in Table 24 (page 27). Also, source(s) of the information on plastic packaging consumption presented in Table 24 should be stated.</p> <p>(2) It is not completely clear how exactly the scenarios RESURBIS and RESURBIS+ were defined for each territorial cluster, namely, how the process stability restriction of max. 25% VS coming from sewage sludge, was accounted for. Is this restriction taken into account by including treatment of the remaining amounts of OFMSW / sewage sludge? Is this what yellow colour denotes in Figure 9, 11, 13, ...? A couple of sentences of additional explanation would be very appropriate. (Now the project ends with recommendations for more research to increase percentage of VS, in order to adjust to the situation in Wales and Trento, which may or may not be relevant to other places.)</p> <p>(3) As the authors discuss in Conclusions (pp. 40-41), the ratio OFMSW/sewage sludge is a very important process parameter. The discussion of the ratio on page 26 is currently focused only on benefits to production of PHA. Notwithstanding, for cities’ authorities it is equally (if not more) relevant to know, if the restriction of 25% VS coming from sludge is applied, how much waste or sludge would be a "surplus" that would have to be treated through a different process. This would</p>

Deliverable number	Deliverable name	Status	Comments
			<p>put things further in perspective and give a much clearer picture of the current possibilities.</p> <p>This requires a minimal additional effort by the authors, for example, arranging information presented in Table 22 in a different way:</p> <p>Table 22 could be split into two tables. In the first new table, using Table 22, the PHA column should be deleted, and columns with percentages inserted, showing how much waste would be used in the biorefinery (if the restriction of 25% VS coming from sludge is maintained) and how much would remain, to be processed in a different way. Then the percentages that are now cited in the text, 87% for Lisbon and 30% for Wales, become immediately visible.</p> <p>In the second new table, PHA column from Table 22 should be presented, as well as the potential numbers that are now stated in the text, namely required percentages of VS per cluster, and full amounts of PHA that could be produced in such a case.]</p> <p>Also, the numbers should be reconciled. In the text, it says, for example for Barcelona, 3.3 kg, whereas Table 22 states 3.5 kg. (BTW, in English, it should be: “instead of”, not: “instead than”.)</p>
D2.4	2nd report on upstream	Accepted	<p>D2.4 is very good, offering clear explanations and insights into methods and results of individual experiments as well as a useful summary of results, accompanied with implications for the project topic.</p> <p>Three remarks:</p> <ul style="list-style-type: none"> - Regarding USW, UB, UNIVR and INRA/UNIRM, will the stated further research be done (was done?) within this project or not? If so, where can the results be found? This should be stated in a more explicit manner in the Deliverable. - In the experiments at UNIVR, were diapers represented by clean cotton wool, or by the filling from real diapers, like HFW was represented by a synthetic formulation? Or were real, discarded after use (soiled), diapers used? This should be stated clearly. - In the work presented in Figure 2.6, is there a particular reason why VFA profile was not determined in FW batch 7 (whereas it was important enough to be included in measurements presented in Figure 2.5)?
D2.5	2nd report on PHA production	Accepted	<p>D2.5 presents results of the activities undertaken in Task 2.2, on the optimization of the biological process for production of PHA in relation to the different organic feedstock and producing the PHA to be extracted in Task 2.3 and to be delivered to WP3 partners.</p> <p>The Deliverable is well presented, including clear descriptions of the research done and links to</p>

Deliverable number	Deliverable name	Status	Comments
			relevant literature, and, importantly, discussing implications for the project and its objectives.
D2.6	2nd report on PHA extraction	Request for revision	<p>D2.6 only contains report from SubTask 2.4.1 executed by BIOTREND, lacking report from SubTask 2.4.2. This makes Figure 17, p. 31 in The Final Periodic Technical Report rather unclear. (The D2.3 submitted in the previous reporting period does not help here either.)</p> <p>20PR_CORE_2, Figure 17, p 31: This Figure and the accompanying text are not clear enough to be of full value. The presented bar chart does not really illustrate the stated superiority of the scCO₂+Trypsine+H₂O₂ extraction, as H₂O₂ seems very close in terms of achieved purity and recovery rate. As the experiments that led to some of the columns presented in Figure 17 are not sufficiently elaborated in D2.6, it remains unclear why this particular extraction method is favoured. It is also not clear whether enzymes pre-treatment is applied in all cases, as these are not mentioned with each column in Figure 17.</p>
D2.7	Report on biosolvents	Accepted	<p>D2.7 presents findings of the successfully performed production and isolation of the pure bio-solvents, derived from the effluent of fermentation of organic waste. In addition to the main focus on bio-solvents, the work done includes an important component, namely substitution of sulfuric acid as a catalyst, by more environmentally friendly – but equally or better performing – alternatives. Here, a synergetic link is made to the authors' previous work. The deliverable is clear, well presented and convincing.</p>
D2.8	Report on process integration	Request for revision	<p>Based on successfully performed experimental research, D2.8 addresses optimisation of biorefineries (for PHA production) through integration of anaerobic co-digestion (for biogas production) into the technology chain.</p> <p>One remark: In the final analysis, how was the monetary equivalent of energy calculated? In other words, which prices are assumed in the calculation of such a precise number 286,626 EUR/year? It would be good to be explicit about that.</p> <p>Also, it would be appropriate to use a range, rather than a single number, and add a couple of sentences of discussion here, particularly because this is used in WP1 and WP5.</p>
D3.2	Contaminant fate	Accepted	<p>D3.2 is clear and well presented, providing detailed findings of the analyses carried out to measure presence of specific contaminants in the produced materials. This work is essentially important for the exploitation of the materials developed in the project, as it concerns safety for use in intended applications. The results are appropriately compared to the pertinent legal requirements. They</p>

Deliverable number	Deliverable name	Status	Comments
			are very promising in relation to the potential uses of PHA-based plastics developed in the project. The experiments referred to as ‘future work’ are also reported, in the Final project report.
D3.3	PHA electro-hydrodynamic processing	Request for revision	<p>The work presented in D3.3, focusing on ‘electrospinning’ as a method to produce materials, is another very innovative component of the project.</p> <p>Notwithstanding, the text lacks some discussion about the newly obtained packaging materials – composites that sandwich PET with biodegradable components – in terms of their own end-of-life in the context of sustainability and circular economy. Concretely, what can be done with these composite materials, which combine biodegradable and non-biodegradable substances, once they are used and become waste (which tends to be soon after the purchase, as they serve as packaging)? It seems from the text that they cannot be taken apart, so by necessity the only option is incineration, isn’t it? Whereas incineration is close to the bottom of the hierarchy of waste management options (listed in D4.1.) In literature on sustainability and circularity, such materials are sometimes referred to as ‘monstrous hybrids’.</p> <p>Some discussion of this issue should be included. Also see related comment on D5.3.</p>
D3.4	Biodegradable commodity films	Request for revision	<p>D3.4 elaborates on obtaining of biodegradable commodity films for packaging and mulch film for agriculture. The deliverable contains extensive introductory explanations. Also, specific parameters for the process and compounds are presented and initial results discussed. However, the report is missing a clear indication of the optimal solutions in the light of available options. Concretely, it does not adequately address an important issue related to the addition of input materials that are only partly bio-based, to produce a viable material with PHA – it does not discuss implications for the overall material biodegradability and options for waste management once this material becomes waste. It would be very appropriate to include a few sentences of discussion of this issue within the context of sustainability and circular economy. This comment is similar in nature to the comment made on D3.3.</p>
D3.5	Thermoplastic durables	Request for revision	<p>D3.5 is very interesting, clear and well presented, providing details of the technical activities aimed at obtaining engineered thermoplastics on the one hand and fillers on the other hand. Based on measurements carried out on appropriate samples, the report presents detailed data on relevant functional properties of several options that were</p>

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			<p>chosen. The results are appropriately contrasted with relevant literature.</p> <p>Two comments:</p> <ul style="list-style-type: none"> - Why was park and garden waste from Copenhagen used? Why did not INRA obtain such materials locally, in France, rather than having them shipped from Denmark? A couple of explanatory sentences need to be added. - A few sentences would be beneficial to place the obtained results in the context of possible applications, indicating which existing plastic (or other) materials could be replaced.
D3.6	C-releasing PHA	Request for revision	<p>D3.6 explores an attractive application of PHA obtained from waste, for remediation of groundwater polluted by organic solvents, using a technology patented by UNIRM. The experimental set-up, execution of experiments and results are well presented. It is particularly encouraging that “raw PHA”, without further treatment, has turned out to be very effective.</p> <p>Comments:</p> <ul style="list-style-type: none"> - While everything else is so well explained and argued, the purpose of experiments with only commercial PHA (Figure 8) is not explained. A brief explanation should be added. - Also, a couple of sentences should be added regarding the possible (heavy) metals content of “raw PHA”, as their solubilisation is mentioned as a possible disadvantage of in-situ remediation.
D4.1	Legal framework	Accepted	<p>D4.1 is a resubmission. The report has been considerably improved. Now the deliverable provides a thorough and detailed critical review of the EU legislation that has any bearing on the topic of project, production and marketable use of biodegradable materials produced from selected organic waste streams. It is laudable that the authors seized the opportunity to take into account relevant pieces of legislation that have appeared in the meantime, providing a very good and detailed analysis of the latest changes in the pertinent provisions.</p> <p>Notwithstanding, a few remarks are made:</p> <p>(A) Potentially, Environmental Impact Assessment Directive and Water Framework Directive could be relevant. These should be checked as well, for licensing of biorefinery facilities and for issues related to discharge of wastewater, respectively.</p> <p>(B) The authors of the deliverable may find it useful to consider the following comments specifically related to legislation in the field of solid waste management:</p> <p>On page 8, it is not appropriate to call command-and-control instruments “traditional” and economic instruments “innovative” in the</p>

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			<p>domain of environmental legislation (and other domains relevant to solid waste management). Some countries, for example the U.S.A., have TRADITIONALLY preferred economic instruments (and self-regulation) over direct regulation, which is popularly known as command-and-control. Also the example given in the text of the command-and-control approach is somewhat naïve, as it ignores the ensuing costs and practical problems of implementation and enforcement. (It is indeed these costs and difficulties that have prompted authorities in many EU countries to introduce various economic and ‘social’ instruments.) So, this statement should be rephrased.</p> <p>For a succinct and popularly written introduction into policy/legal instruments used in solid waste management, the authors may wish to consult UNEP (2015) Global Waste Management Outlook, Figure 4.1 and sections 4.3, 4.5, and 4.6, https://www.unenvironment.org/resources/report/global-waste-management-outlook</p> <p>(C) Understandably, the authors, who clearly have expertise in the field of legislation, are not familiar with the operational activities and practices of waste management. This means that the terminology is not used correctly. The main issues are listed below.</p> <ul style="list-style-type: none"> - The terms “waste separation” and “waste sorting” have distinct meanings in waste management, and they cannot be used interchangeably. <p>Waste SEPARATION is done by people at the source where waste is generated, for example a household, BEFORE waste collection service. If people don’t separate their waste at home, waste is mixed together. Therefore, waste SORTING needs to be done in a waste facility, AFTER collection and transport of waste from its source to the facility.</p> <ul style="list-style-type: none"> - Expression “differentiation at source” is not used in English literature. This should be: waste separation at source. (“La raccolta differenziata” translates into English as SEPARATE collection.) - The terms “separate collection” and “waste separation” have distinct meanings in waste management and they cannot be used interchangeably. <p>Separate collection is a SERVICE provided to waste generators (for example households) by various types of service providers (for example private waste companies). Waste separation is an activity that people do themselves, BEFORE collection service, as explained above.</p> <p>(D) On pages 16, 17 and 18, the text cites documents with opinions from 2015 and 2016</p>

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			<p>(Ronzon et al, 2016; Carus et al, 2015; KBBPPS, 2015, respectively), without comparison with the 2018 legislation, and without conclusions about whether the criticisms expressed in 2015 and 2016 still hold.</p> <p>(E) The report would benefit from a clearer articulation of the comparative advantages of the solutions at the national / regional level, both in terms of legislation and in terms of allocation of responsibilities to the designated administrative bodies.</p>
D4.2	Social aspects	Accepted	<p>D4.2 is a resubmission. The report has been partially improved from the previous version.</p> <p>The work reported in the deliverable is research concerning consumers' perception, which resulted in scientific papers published in good journals. While scientifically sound, the research reported in the papers was done based on a purchased access to panels of UK and U.S. consumer respondents. The deliverable did not adequately demonstrate that this decision was appropriate to represent the consumers and other value chain actors across the geographies involved in this project. Conducting surveys in each territorial cluster would have been more effective and more beneficial for the project objectives.</p> <p>While devoting ample space to retelling a few literature sources, the deliverable remains vague in terms of sampling methodology applied in Spain and Poland. In addition, the findings largely remain focused on the consumers' perception (with a limited addition of citizens' willingness to separate their organic waste at source), neglecting the complexity of the value chains. Finally, the regional differences are not clearly articulated.</p>
D4.3	Relevant contaminants	Accepted	<p>D4.3 is a resubmission. The deliverable highlights the contaminants of concern when using urban bio-waste as a renewable resource to produce bioplastics, thus expanding on other applications of organic waste, beyond production of PHAs. It is evident that the authors have taken comments made in the previous review on board and have produced an excellent new version, using highly relevant literature including relevant regulatory frameworks, where applicable. The material is very well structured and well presented, providing the available information on risks that the three defined groups of contaminants pose to human health. The information served as input into several other project tasks. The contaminants in composting and anaerobic digestion are also discussed, which will be relevant information for municipal authorities that may be interested in biorefineries integrated with other processes.</p>

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D4.4	End of Waste	Accepted	<p>D4.4 is a valuable deliverable for the future production and applications of PHAs from various waste streams. It convincingly synthesises insights from previous work in the project.</p> <p>The deliverable presents a good overview and analysis of the relevant regulatory context concerning the End-of-Waste criteria, particularly as they apply to the products based on the RES URBIS research. The report concludes that the latest changes in legal provisions are not expected to pose any major problems. However, the report would benefit from a clearer articulation of the possible obstacles in implementation of the new legislation at national/regional level on case-by-case basis, which is a new - and thus somewhat unfamiliar - situation for the actors in the system, including responsible authorities.</p>
D4.5	Occupational safety	Accepted	<p>D4.5 is very good, addressing this important topic comprehensively, based on related expertise of the authors and literature. The deliverable examines in detail the occupational health risks for the workers who are involved in the production process of PHA from bio-waste. Regulatory framework is referred to and relevant risks are identified. Rather than engaging in speculative quantification of risks, realising the complexity of such an endeavour for a novel technological process, the authors focus on risk prevention and elaboration of various precautionary measures to reduce / eliminate exposure as an effective mitigation strategy.</p>
D5.3	RES URBIS integrated portfolio	Request for revision	<p>D5.3 is very good, providing a comprehensive analysis of the PHA portfolio. There is a good consideration of the main opportunities for the market uptake of the project innovative outcomes. Notwithstanding, the initial assessment of the market potential would benefit from the following elements: an improved competitors analysis, timeline and scale of the projected market expansion, necessary financial investments from external sources, risks and reasons for possible market price fluctuations, and the necessary conditions for the value chain creation.</p> <p>Furthermore, the comments made on D3.3 and D3.4 should be taken into account. For example, regarding D3.3, the use of PHA as an interlayer between layers of conventional plastics poses a problem to waste management options at the end of its use period (which tends to be short, as it is used as packaging), as it is a combination of biodegradable and non-biodegradable substances. In literature on sustainability and circularity, such materials are sometimes referred to as 'monstrous hybrids'. Some discussion of this issue and its impact on the marketing strategy and the interest from potential customers would be highly</p>

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			appropriate. Analogously for the comment made on D3.4.
D5.4	Cost-benefit Model simulations	Accepted	D5.4 is valuable as input information for the exploitation of the project outcomes, especially in the territorial clusters involved. The deliverable presents modeling of costs-and-benefits in the various scenarios from the RES URBIS case studies. The report is very well elaborated, presenting most relevant data and findings from the project, relevant for the economic insights. It could, however, benefit from improvement in the replication section, which presents rather generic statements. Some specific options could be highlighted, e.g. licensing, capitalization.
D5.5	Integrated strategic roadmap	Request for revision	D5.5 is very good. The report elaborates a strategic roadmap for implementing RES URBIS at cluster level. The results of the project are consolidated and supported with the cost-benefit analysis performed and presented in the previous deliverable. An attractive portfolio of products is presented. Potential partners and investors from the value chain for the future activities are identified and initial arrangements in place. Notwithstanding, the same comment holds as in D5.3 in reference to D3.3 and D3.4.

Expert opinion on milestones

Milestone number	Milestone name	Achieved	Comments
MS1	PMP and DMP	Yes	The milestone was successfully achieved.
MS2	Dissemination plan and website	Yes	The milestone was successfully achieved.
MS3	1st ethics	Yes	The milestone was successfully achieved.
MS4	Preliminary cluster analysis	Yes	The milestone was successfully achieved, although with a (minor) delay.
MS5	Plant start up	Yes	The milestone was successfully achieved.
MS6	Regulatory gaps	Yes	The milestone was successfully achieved, although with a significant delay.
MS7	Preliminary LCA check	Yes	The milestone was successfully achieved.
MS8	1st PHA delivery	Yes	The milestone was successfully achieved.
MS9	1st PHA generation properties	Yes	The milestone was successfully achieved.
MS10	2nd dissemination	Yes	The milestone was successfully achieved.
MS11	Project advancement	Yes	The milestone was successfully achieved, although with a significant delay.
MS12	2nd ethics	Yes	The milestone was successfully achieved, although with a significant delay.
MS13	2nd PHA delivery	Yes	The milestone was successfully achieved, although with a (minor) delay.
MS14	2nd PHA generation properties	Yes	The milestone was successfully achieved, although with a significant delay.
MS15	“End of Waste”	Yes	The milestone was successfully achieved, although with a significant delay.
MS16	Final LCA check	Yes	The milestone was successfully achieved, although with a significant delay.
MS17	Sample products	Yes	The milestone was successfully achieved, although with a significant delay.
MS18	Occupationally safety	Yes	The milestone was successfully achieved.
MS19	Strategic Roadmap	Yes	The milestone was successfully achieved.
MS20	3rd dissemination	Yes	The milestone was successfully achieved.