

Deliverable report

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Introduction

The main objective of **LignoCOST** is to jointly establish a network in which relevant information packages are produced with a focus on sustainable lignin production and valorisation at industrial level (<https://LignoCOST.eu/>).

The **LignoCOST** action has been structured in 5 working groups (WG) of which WG1 is dedicated to the development of a search tool, which should be available on the internet, dedicated to lignin information (nicknamed Wiki-Lignin). This web tool should including information on lignin sources, lignin availability, lignin demand, lignin properties, available literature on lignin and a repository of state-of-the-art analytical methodologies and turnkey methods for the industry and academia.

WG1 has been organized into four tasks:

Task 1.1: Inventory of relevant information on lignin sources, availability, physicochemical and molecular composition, properties in the form of factsheets based on the input from participants.

Task 1.2: Overview and standardization of state-of-the-art analytical methodologies for characterization of lignin. Development of novel analysis techniques to contribute to fundamental knowledge of lignin.

Task 1.3: Mapping / analysis existing lignin production / valorization research infrastructure.

Task 1.4: Selection of relevant information to set up a repository of lignin data and designing / building a web tool called WikiLignin, including intellectual property and web hosting issues.

In the time line of **LignoCOST**, task 1.3 has to deliver after 24 months an overview of existing lignin production/valorisation research infrastructure (**Deliverable 1.3**).

The report on deliverable D1.3 will include:

- Description of the strategy used to identify the lignin structures
- Brief analysis of the scientific and technical key points revealed by the recovered data on lignin production sites
- Describing the limits of the approach of such survey and the way to overcome them, in order to anticipate to the other deliverables of WG1 due at month 30 and 42

Summary

WG1 is dedicated to the development of a web tool-based lignin information portal on the internet (Nick named Wiki-Lignin). This web tool should include information on lignin sources, lignin availability, lignin demand, lignin properties, available literature on lignin and a repository of state-of-the-art analytical methodologies and turnkey methods for the industry and academia.

The results are as such:

A first mapping of the existing lignin production / valorisation research infrastructures on lignin has been accomplished. At least 89 activities have been identified within 19 European countries, North America (USA, Canada), South America (Brazil), and Asia (India/Japan).

About 30% of the activities can be classified as developing breakthrough processes distinct from classic pulp and paper biorefineries, historically sustaining technical lignin production and processes aimed at valorisation lignin. Also it was revealed that the amount of data existing within scientific papers are less visible on the web. Therefore the **LignoCOST** database, which will be constructed in this work package, has to be continuously updated with validated information supplied by the experts of **LignoCOST** consortium, as well as by the care takers of the database.

Strategy used to recover the information for the overview

The operational deliverable is presented by an excel sheet, available at the teamsite <https://sharepoint.wur.nl/sites/lignocost> under WG1 folder (hosted by the grant holder Wageningen Food & Biobased Research) for **LignoCOST** members only, at this stage. The excel sheet combines the following information:

The name of the lignin producer, its country/city location, the technologies/key reactions by which biomass is processed to recover lignin and/or lignin derived products, the feedstock used, the maturity level of the production (lab-scale, pilot-scale or pre-industrial demo scale/ commercial availability), the brand name of lignin and/or lignin derivatives, if any, and several updated references pointing to checked web resources.

The template of this survey comes from a study performed by the DOE (USA) in 2016 (<https://www.energy.gov/eere/bioenergy/cellulosic-sugar-and-lignin-production-capabilities-rfi-responses>) as well as from a 2018 EEC reports on biorefineries (https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113216/online_biorefineries_research_brief).

The excel sheet was uploaded on the teamsite of **LignoCOST** in a share point available to all official **LignoCOST** members for further completion, corrections and improvement.

The activity resulted in a combination/aggregation of information available (companies web sites, patents and publication on google scholar, on Research-gate; on the Clarivate web of science; on blogs, etc.) and of expertise shared by the **LignoCOST** members.

In total 89 producers were identified at the date of October 2020. It has to be noted that, even if all information have been checked and updated, the overview is not complete and exhaustive and will be subject to change in the future. This point will be discussed in the next sections, but it illustrates the need to update regularly this overview in a continuous way during and after the **LignoCOST** action.

Analysis of the scientific and technical key points revealed by the overview

The overview is only a snapshot and will need regular updates, as explained in section 3 below. Only preliminary analysis can be made based on the current status, taking into account the uneven availability of data in the reviewed websites; online publications lists; patents survey, etc.:

- There is an major representation of USA located biorefineries (20%), not only related to selective search and information available, from pilot to industry. Data on Canada are reinforcing this perception.
- For Europe, the Nordic countries (Finland, Norway, Sweden, Latvia, etc...) are accounting for about 15% of the total companies identified.
- 19 European sites out of 89 were identified, where lignin valorisation / lignin-first approach is developed.
- Underrepresentation of Asian structures (Japan and India, only). More information is needed.
- No African countries were identified developing new approaches. Major pulp and paper industry is nevertheless present in South Africa. More information is needed.
- About 25% of the companies have commercial branded products.
- About 30% have developed techniques that are non-conventional (organosolv; enzymes based; new catalysts; combination of different solvents; etc.), as far as information is available, compared to the pulp and paper biorefinery concepts, using Kraft and sulphite processes.
- About 50% of the structures have been clearly identified as "in operation", but it can be considered that, when a website is updated, the company continues to run. Consultation of other websites indicates that some companies announced in 2018 are finally not operational today, and some have gone into bankruptcy (<https://biorrefineria.blogspot.com/p/listado-de-biorrefiern.html?m=1>). Other were merged with sister or bigger companies. This indicates the existence of quickly changing business dynamic within 2 years, that can be sometime difficult to trace on the short run.
- The universities/research institutes are clearly underrepresented in the overview, but EU projects enhance greatly their visibility, comparable to that of companies on the web (see discussion below).

Limits of the overview/mapping and improvement forecasted

We initially propose to “make a mapping / analysis (*of the*) existing lignin production / valorisation research infrastructure”. Several limits on the proposed action were revealed during the implementation process of the survey and overview. They can be analysed as follow with some improvements to follow up.

Existing data bases can be found quite easily, but a more extensive research using published scientific paper would be interesting, in order to consolidate some of the data collected. Indeed, as much as 2400 communications papers/scientific publications/patents were found in google scholar for an “organosolv lignin” query, only in year 2020. When the keywords “lignin-first approach” is used, 14400 items were sorted! This indicates the strong research dynamic currently existing in the lignin field, and that information need to be completed in our survey. The **LignoCOST** collective expertise can be mobilized to sort out the most important scientific papers from this ocean of knowledge.

The overview for universities is incomplete, as well as for national, regional private research institutes. This could be corrected through analysis of peer reviewed publications and patents. Again, mobilization of the network is needed. A connection with the Wiki-Lignin webtool action will be done.

Companies and research consortia (national and/or EU) have very good web supports, but it is difficult sometimes to know if they are producing volumes such as g, kg or tons of lignin which are indeed available for industry purposes. Confidentiality is probably a limiting point that cannot be solved by **LignoCOST**. However, direct personal inquiries to companies/research consortia if always possible, by consulting the websites reported in the overview (some companies are giving contacts point for that). Structures like the Lignin-Club (Pöyry Management Consulting Oy) and the historical ILI could also be solicited for that (<https://www.ili-lignin.com/>).

These bullet points on the limits of our approach of the overview points out the necessity to have a continuous process of data collection within **LignoCOST** to consolidate and enrich the survey.

Conclusions and perspectives

The overview constructed identifies the companies producing and transforming lignin into valuable products, as updated by October 2020. The publication research and analysis, part of the Wiki-Lignin web tool action of WG1, shows that even more information could be collected by a targeted and critical review of scientific papers, particularly for universities, less visible on the web (= to identify weak signals, new trends on lignin research).

The first version of the web tool will be available online for **LignoCOST** members only as a *beta* version, in order to have an continuous filling and updated of information, for those already listed, but also more importantly, the new ones coming. Also the beta will be used in order to collect user information from the **LignoCOST** community in order to improve the web tool according to the suggestions made by the community.

A more comprehensive approach of data collection will be implemented in order to incorporate the knowledge of this overview within the Wiki-Lignin webtool, which will be delivered at the end of **LignoCOST** action.

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