PROJECT FINAL REPORT

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Support action

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1- Final publishable summary report

A- Executive summary

In order to improve the activities of the EPNOE Association, the European Commission approved the EPNOE CSA project and its three objectives, (1) expanding EPNOE activities towards health-related materials and products, (2) expanding EPNOE activities towards food-related materials and products and (3) increasing Financial Viability via industrial participation and innovation.
In order to reach these goals, EPNOE was re-structured in order to reach a better critical mass. EPNOE changed its membership. A new definition of membership has been formulated and then implemented. Three categories of members now exist in the Statute of EPNOE Association (Regular Member, Business and Industry Club Member, Affiliated Member). With the same objective, a new open network was devised with the aims to increase information flow among all persons interested in polysaccharide research and applications, called epnoe-at-large. Epnoe–at–large is a free email-based knowledge transfer platform linking individuals, on the contrary to EPNOE where members are legal entities.
These changes are further placing EPNOE at a central position in the world regarding networking in the polysaccharide area.

The enlargement towards health and food related activities was performed through a series of measures. Strategy plans were devised, including surveys of the activities in these fields within EPNOE, definition of the areas where EPNOE partners should go and list of companies which could be interested in collaborating with EPNOE Members. Approaches to companies were done in several ways including meetings, mailing of brochure and personal contacts. Research and innovation projects were prepared in confidential manner between EPNOE members and companies. Together with the coming of ten new affiliated members, more activities are presently conducted in these two areas.

Further steps were conducted to move towards innovation activities, like identifying results from EPNOE CSA partners that have the potential to be transformed into innovation in the whole polysaccharide field, including Food and Health. Another initiative called “Dormant ideas” was started. A “dormant idea” is defined as a research or application idea that will not be used by its author due to several reasons (lack of time or resources to develop it, not fully validated, missing a critical expertise, etc.). After a first phase defining the conditions for driving this activity, 11 academic/research members of EPNOE collected 170 dormant ideas since the beginning of 2013. The set of ideas and the set of resulting/combined ideas were used to create new projects and proposals. In total, more than 160 projects in connection with industry are conducted every year by EPNOE CSA partners. In addition, more than 100 projects aimed at increasing knowledge are also run.

Finally, EPNOE, on its own initiative, built formal agreements with three knowledge transfer and innovation cluster, Polintegra in Poland, Bioeconomy cluster in Germany and Céréales Vallée in France. This will form a 250 strong company and academic institution group in Europe, with a size allowing the development of effective R&D and innovation projects in the general area of bio-based products.

B- Summary description of project context and objectives

The call text (**NMP.2011.4.0-5 Support to Networks of Excellence with durable integrated structures)** specified that the Networks of Excellence (NoEs) which applies should reach two targets:

1. To prepare a realistic plan to achieve financial viability.
2. To expand their current activities by:
    - ensuring coverage of industrial technologies research relevant to one or more particular application sector(s) e.g. Healthcare, Environment, Energy, ICT, Manufacturing;
    - ensuring the extended participation of relevant industrial partners.

The expected impacts of the project should be:

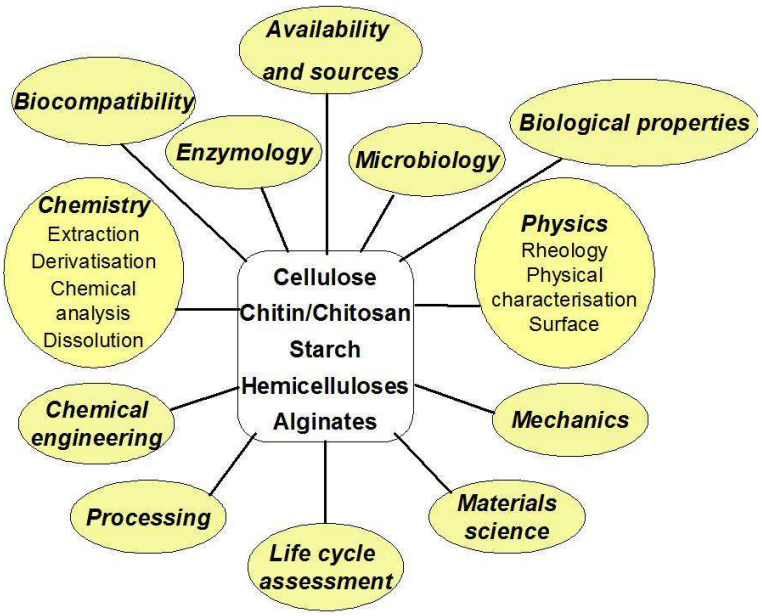
- Improved coordination in research and innovation;
- More robust critical mass of the durable integrated structure;
- Boosted dynamism of research, technological development and innovation in the field(s);
- Better structuring of the European Research Area.

The European Polysaccharide Network of Excellence (EPNOE) was granted a project under this call with the title: EPNOE CSA.

As stated in the summary of the Description of work of the EPNOE CSA contract, "the general concept of EPNOE CSA at the origin of this proposal was to participate to the improvement of competitiveness of European industry and generate new knowledge in polysaccharides through the expansion of EPNOE leadership in two new areas (Food and Health) and through increasing EPNOE participation and interactions with industry, with a special focus on SME's".

Consortium

The EPNOE CSA consortium was composed of 16 institutions complementary active in the polysaccharide area. All 16 institutions participated to the EPNOE Network of Excellence and are Regular Members of the EPNOE Association.
Together they cover all the basic technical expertise that is needed to tackle any topic related to sourcing, extraction, isolation, modification, re-combination, fabrication of structures and products and analysis of properties and life cycles.



EPNOE CSA project objectives and Work Packages

The initial objectives of the EPNOE CSA project were:

Objective 1: expanding EPNOE activities towards health-related materials and products.

Objective 2: expanding EPNOE activities towards food-related materials and products.

Objective 3: increasing Financial Viability via industrial participation and Innovation by

(1) installing the tools for increasing the financial viability of EPNOE during the three years of the EPNOE CSA project, in order to ensure long-term sustainability of EPNOE Association activities after the project and

(2) improving partnership with industry and boost innovation and knowledge transfer.

To achieve these objectives, four Work Packages were designed:

Work Package 1 covered the project coordination, management activities and assessment of the financial viability. The main task of the Executive Board was to turn the project concept and objectives into practice (project progress, following-up budgets matters and taking care of the general communication issues). WP1 was designed to ensure a smooth relation with the current activities of EPNOE Association that will continue to run. It was also meant to define the return mechanisms.

Work Package 2 aimed at expanding EPNOE Association activities towards health-related materials and products in order to reach a critical mass as EPNOE will be seen as an important actor in this sector. WP2 had two tasks, one being the preparation of the EPNOE Association in health-related research, training, infrastructure, testing and other services and the second related to developing approaches for preparing industrial contacts in this area.

Work Package 3 aimed at expanding EPNOE Association activities towards food-related materials and products in order to reach a critical mass as EPNOE will be seen as an important actor in this sector. WP3 had two tasks, one being the preparation of the EPNOE Association in food-related research, training, infrastructure, testing, and other services and the second related to developing approaches for preparing industrial contacts in this area.

Work Package 4 specifically aimed at industrial participation and innovation. The main targets were to increase industrial participation, with a goal of having 20 new companies

members of EPNOE Association by the end of the project, half being SME's and to organize an innovation strategy for research, infrastructure, testing, LCA, EoL, education. Two other tasks were designed in order to increase interaction with industry and establish an as-efficient-as possible academia-industry knowledge transfer, one being the establishment of a regular industrial EPNOE conference as a forum for academia-industry relationship, every two years, alternating with the already existing EPNOE scientific conference, and the second dedicated to finding ways to establish formal relations with relevant European Technology Platforms. The last task was dedicated to exchanges with other CSAs on best practice on how to approach industry.

Expected progress beyond the state of the art of EPNOE CSA

As stated in the contract, the progress beyond the state of the art thought to be mainly in four areas:

Expansion of EPNOE leadership in new areas (Health and Food)

Before the start of the contract, EPNOE was a successful network focusing on Materials for Engineering based on polysaccharides that was running with an efficient organisation. However, EPNOE recognized already some time ago that two areas should benefit from its experience, Health and Food, where several EPNOE Association members are very active and leaders in their field in research, education and industry. A few activities were started within EPNOE Association before the contract but due to a lack of common resources, it was not pursued very actively, individual partners continuing their own activities without many interactions. These two areas were nevertheless studied in depth regarding future needs and the results were included in the EPNOE Association Research Road Map 2010-2020.

The full implementation of these two new application areas (Food and Health) together with the already running cross-sector Materials section within EPNOE Association addressing the underpinning key enabling technology through the present EPNOE CSA project aimed at establishing extensive exchanges between these three different communities. This meant to allow products, theories or concepts used in one community to be used and developed in another, as presented in the EPNOE Association Research Road Map.

Increasing EPNOE participation and interactions with industry, mainly towards SME's in order to ensure a financial viability

26 companies were members of EPNOE Association at the end of 2010, most of them being large, multinational organisations. Only five members are SME's. The fact that SME's are not members of EPNOE Association is not due to the level of the fees (1000€ per year) but mainly to the fact that EPNOE Association is not able to reach them and that these companies are not seeing the advantages to be members. This must be corrected for several reasons:

- Innovation, especially fast innovation, is in majority in the hands of SME's.
- SME's often need scientific help that they will find among EPNOE Association members.
- SME's will find within EPNOE Association a network of companies and research centres that are very actively building collaborative research projects they can be associated with. This is indeed what is occurring with the five SME's members of EPNOE Association. Each was associated with the building of at least one collaborative project in 2009-2010.

To be known to SME's and find ways to convince them that investing time in following EPNOE Association activities is profitable for them requires resources EPNOE Association does not have at the present time. The present Call offered the unique occasion to move

forward to help SME's benefit from EPNOE research and innovation activities and from EPNOE industrial environment.

Ensuring financial viability

The necessary activities for EPNOE Association to be active are not fully covered by the present level of fees. EPNOE CSA will give the opportunity to achieve a correct balance between expenses and revenues in order to have a stable, long term financial viability by establishing mechanisms for innovation activities.

Organisation between EPNOE activities and the present proposal

EPNOE Association was aimed at continuing to work on and improve its present activities (Research Road Map on materials, education, services to industry, communication, newsletter, organisation of conferences, etc.) with its own resources. The expansion towards Health, Food and SME's will be performed owing to the help of the European Commission through the present EPNOE CSA project.

Close interactions between EPNOE Association and the present project EPNOE CSA were easy due to the fact that the partners are the same in the two projects, and that the management structures of EPNOE Association and EPNOE CSA are similar and fully compatible.

C- Description of the main S&T results/foregrounds

C-1 Financial viability

Four Finance Viability Checks were performed in December 2012 on the financial results of 2011, in November 2013 on the financial results of 2012, in May 2014 on the financial results of 2013 and one January 2015 on the financial results of 2014. All results were showing that the situation of EPNOE Association is very good.

Although the project did not succeed in increasing its industrial membership, there was no difficulty for matching expenses and revenues (which are only coming from fees from members). This was performed by transferring some financial charges to other sources and by decreasing expenses, with no decrease of EPNOE efficiency: during the period of the EPNOE CSA project, EPNOE launched several major projects, aside running all its previous operations:

- creation of a new structure able to increase its academic membership;
- creation of a new, worldwide network call *epnoe-at-large*;
- organisation of networking with three regional and national knowledge transfer and innovation clusters.

C-2 Re-organisation of EPNOE. New structural activities

Due to various factors such as a decrease of industrial membership and a pressure from the academic community to join EPNOE, there was a need to change the structure of EPNOE. It occurred through a change of membership and the creation of a new network, dedicated to all

person interested in polysaccharides. Epnoe-at-large has an individual membership contrary to EPNOE Association which has only legal bodies as members.

Increase of expertise through the coming of new groups from inside and outside EPNOE

This increase of involved researchers will drastically extend the scope of expertise present in EPNOE and should be a critical benefit for all members, including companies. These changes were only possible with a change of EPNOE membership structure.

The statute and association rules were initially prepared and registered in December 2007. They were modified in April 2009 in order to simplify several points which were not operational. The re-organisation of EPNOE made in 2014 was not anymore compatible with the Statute and Association Rules written in April 2009. A new, simplified version modifying mainly the membership structure in order to include the Affiliated Members was prepared in 2014, accepted by the Governing Board end of 2014 and officially registered end of February 2015.

EPNOE Association is now composed of three categories of members: Regular Members, Business and Industry Club Members (BIC) and Affiliated Members.

- A Regular Member must be a scientific and research organisation whether public or private entity or body, whatever its nationality and status, pursuing research in the field of polysaccharide science and any related field. Are Regular Members the sixteen founding members of EPNOE, and any other organisations proposed by the Governing Board in the future.
- A Business and Industry Club Member must be a company whatever its nationality and status, whether private or public, being interested in the production of products based on polysaccharides.
- An Affiliated Member must be an organisation, legal entity or body, whatever its nationality and status, whether private or public, being interested in the overall progress of research in the field of polysaccharide science and any related fields, but not conducting any commercial activities for marketing, producing and selling products based on polysaccharides. Affiliated members have the vocation to become Regular Members.

Launched end of December 2014, ten universities have joined EPNOE as affiliated members end of February 2015. More than 50 others indicated their wish to join.

Creation of an epnoe-at-large network

Many scientists all over the world were approached for forming a web-based network around polysaccharides. *Epnoe-at-large* was established mid-February 2015. *Epnoe–at–large* is an email-based knowledge transfer platform linking together students, scientists and researchers from academia, research centers, consulting firms or industrial companies and innovators working with and/or interested in polysaccharide science and polysaccharide-related products. Any individual student, scientist, researcher and innovator from all over the world who is interested in polysaccharide science or polysaccharide-based materials can join *epnoe–at–large*.

In order to avoid complicated log in-log out to a web site, all information provided by a member will be distributed to all the other members. To avoid undesired messages, spams and advertisements, EPNOE association will filter messages. To avoid a too large number of mails, the various pieces of information will be gathered in block messages sent once every two weeks. *epnoe-at-large* is thus an e-mail-based network and a specialized information exchange portal for carbohydrate experts.

On a voluntary basis, epnoe-at-large members will have the opportunity to up-load in the public *epnoe-at-large* web site a short page with their data and expertise.

End of February 2015, more than 250 persons already joined *epnoe-at-large*.

C-3 Participation to improvement of competitiveness of European industry and generation of new knowledge in polysaccharides

The activities of the EPNOE network towards their industrial and academic members are falling into the three following categories:

- **Innovation**
- **Information**
- **Dissemination**

Innovation

The role of EPNOE in the innovation process is to find the proper networking strategies able to generate collective ideas which may serve for understanding better existing methods or techniques, improving existing methods, techniques or products, generating new ideas or inventing new processes or products. To reach this goal, several new activities were installed in addition to the ones which were performed before:

Increasing interactions with innovation structures

The initial objective as reported in the DOW, was to establish formal interactions with the European Technology Platforms that are in total or in part of their missions dealing with polysaccharides. This turned out not to be feasible

A second, not planned in DOW, objective appeared during the project, first due to the construction of a PPP dealing with bio-based resources and then due to the possibility of building interactions with other organisations other than European Technology Platforms, but having similar aims, i.e. favouring knowledge transfer on R&D results and innovation.

All along the project, various consortia were approached or approached EPNOE. Four formal agreements were built with the following consortia:

Biobased Industries Consortium (BIC)

Initially called BRIDGE, a Public Private Partnership action was dedicated to accelerate the development and industrial deployment of several European primary sectors (agro-food, forest-based, chemical and energy industries). The main issues are detailed in the Strategic Innovation and Research Agenda (http://bridge2020.eu/our-work/). Several EPNOE companies belong to the governing board of BRIDGE PPP. EPNOE applied in 2013 to be a member of Biobased Industries Consortium (BIC) and take a role in research, development and innovation projects funded under the PPP. Since 2014, EPNOE Association is an associated member of BIC, taking part in meetings (5 February 2014 and 2 September 2014, Brussels).

Polish Innovation Centre

The Polish Innovation Center called Polish Ponadregionalne Centrum Naukowo-przemysłowe (bio)-polimery Materiały-technologie dla Gospodarki (Polintegra) proposed to have a cooperation agreement with EPNOE. After a first meeting in Warsaw on 10-11 February 2014, a letter of intention was prepared by lawyers and signed in the polish ministry of industry on 15 April 2014. A final agreement was signed on 22 December 2014 from the Polish side and on 12 January 2015 for EPNOE. It specifies the following main activities:

- Exchange of information;
- Organization of meetings;
- Brain-storming sessions;
- Establishment of projects between members of Association EPNOE and members of POLINTEGRA CENTER;
- Building of R&D proposals between members of Association EPNOE and members of POLINTEGRA CENTER;
- Common participation to stakeholder's events.

BioEconomy Cluster

The BioEconomy Cluster is an association made up of companies, research institutes and educational institutions that work in close partnership to build the foundations of a bio-based economy. Their aim is to promote the material and energetic use of biomass in the form of innovative processes used in the production of materials, platform chemicals, products and energy carriers on the basis of renewable non-food resources like beech wood. The aim is to create a bioeconomy model region for Germany and Europe. The cluster region provides excellent conditions as an established chemical location and timber region.
An agreement similar to the one of Polintegra was signed end of February 2015.

Pôle de Compétitivité "Céréales Vallée"

By innovating and pooling knowledge and skills, Céréales Vallée aims to encourage the growth and competitiveness of the national economy while developing the reputation of Auvergne region. By accentuating the international visibility of French cereal chains, the Cluster also aims to become a reference in this field.
An agreement similar to the one of Polintegra was signed mid-January 2015.

Dormant ideas

This is a new initiative which turned out to be profitable, although it was difficult to be implemented. A "dormant idea" is defined as a research or application idea that will not be used by its author due to several reasons (lack of time or resources to develop it, not fully validated, missing a critical expertise, not properly tested, not applicable to the area it was devised for, outside the main strategic areas of the member, having no idea what to do with it, etc.). These dormant ideas will:

- develop more intense collaboration between partners
- offer opportunity to bring into existing research projects ideas from another group or scientific discipline.
- create by combination new, applicable projects or products.

After a first phase defining the conditions for driving this activity, 11 academic/research members of EPNOE collected 170 dormant ideas since the beginning of 2013. The set of ideas and the set of resulting/combined ideas were used to create new projects and proposals. Despite confidentiality issues, four such projects were disclosed to EC.

Membership to Bio-based Industries Consortium (BIC)

The Bio-based Industries Consortium is a Public Private Partnership action dedicated to accelerate the development and industrial deployment of several European primary sectors (agro-food, forest-based, chemical and energy industries). EPNOE is an associated member of Bio-based Industries Consortium and it actively participates to the Bio-based Industries Initiative (Public-Private Partnership (PPP) between the European Commission and the Bio-based Industries Consortium).

This allows all members of EPNOE to be aware of the main aspects of this important action and to participate to R&D projects. A presentation of BIC and BBI was done at the meeting of the American Chemical Society in Denver Colorado in March 2015, co-authored by EPNOE.

Information

It is very important that all EPNOE members know well what the other members are doing. The actions made during the EPNOE CSA project were around up-dating and improving the web site.

New member web site

An up-dated, simplified version of the member web site comprises:

- Description of all PhD's on-going within EPNOE.
- Experimental Facility Tool Box. The initial concept of the Tool Box was excellent, but it turned out to be difficult to implement it, mainly by lack of time of Members. A new tool box including equipment of the newly associated research was created and implemented.

Dissemination

Circulation of pertinent information in the polysaccharide community is essential for its development. EPNOE has an important role in information dissemination. The actions made during the EPNOE CSA project are:

EPNOE Newsletter

- EPNOE Newsletter is presently sent to about 500 subscribers

Construction of databases

- Company database: list of about 1500 companies working in the polysaccharide sector or having connections with polysaccharide-based products.
- List of about 12 000 academic researchers working in the polysaccharide sector or having connections with polysaccharide-based products, classified by country and in each country by institution.
- Database of about 300 scientific and industrial societies in the world.

Epnoe-at-large

- epnoe-at-large, described above, is a very efficient vector for disseminating information.

C-4 Expanding EPNOE activities towards health-related materials and products

This topic was treated in Work Package 2 which aimed at expanding EPNOE Association activities towards health-related materials and products in order to reach a critical mass such as EPNOE will be seen as an important actor in this sector. WP2 has two tasks, one being the (1) preparation of the EPNOE strategy plan in health-related research, training, infrastructure,

testing and other services and the second related to (2) developing approaches for preparing industrial contacts in this area.

(1) Definition of the EPNOE association health-related industrial strategy plan

The first part was a survey of EPNOE in the health-related field.

SWOT analysis
A SWOT analysis was performed during the first year of the project.

The results of the inventory of partners organisation resources, and the opinion expressed by each partner about the most promising areas of research in the future have been critically analysed and used for the SWOT analysis of the EPNOE .
Results of the SWOT analysis are given in the table below.

Strength (internal)	**Weakness (internal)**
• Concentration of knowledge & expertise • High potential for innovation • Wide variety of techniques & essential infrastructure • Network • Collaborations with academic groups & industry • Experience with collaborative projects & projects with industry	• Insufficient coordination of activities • Health research is not core activity • Focus on fundamental research, less on application • Low efficiency in technology transfer to industry, marketing and commercialization • Limited network with partners from medical technology and clinical applications
Opportunities (internal)	**Threats (External)**
• Developments in therapies $\Rightarrow$ need for new competitive materials • Orientation to innovations in Europe (EU policies) • Prosperous sector of the world market • Extension of the human life duration	• Competitiveness among pharma companies and their R&D • Global economic crisis • High-risk research (medical trials failure) • Competitiveness among academic groups (EU, worldwide)

Inventory of partners organization resources (personnel, facilities, RTD infrastructures, finances, equipment, research activities)

Identification of EPNOE member's know-how

Topic & expertise	**Partner**
PS/Biopolymers for controlled release of drugs & bioactives. PS nanoparticles • starch, cellulose, chitosan, bacterial cellulose, inulin, etc.	Abo, Boku, Fraunhofer, IBWCh, Jena , WUR-FBR

Bioactive PS (antioxidant, antimicrobial, antithrombotic, blood compatible additives, AM textiles, AM fibers, PS vaccines) • sulfated PS as heparin substitutes, heparosan, hyaluronan, chitosan, functionalized PS, etc.	Boku, Fraunhofer, IBWCh, Jena, UIBK, Univ. Maribor, WUR-FBR
PS-based materials for wound healing, Intelligent textiles (AM, pH control, etc), non- woven composites.	Boku, IBWCh, UIBK
PS based scaffolds for (stem) cell culture, gene therapy, bone implants, vascular grafts, cellulose and cellulose derivatives, chitosan, hemicelluoses, heparin, dextran sulphate, fucoidan	Boku, Fraunhofer, IBWCh, Jena, U. Maribor
Others: Functional clothing (sport, recreation) Textiles for an aging society	UIBK
PS modification • sulfation, alkylation, arylation, oxidation, amination, crosslinking, etc. • surface modification of PS cellulose, chitosan, hemicelluoses (GM, xylans), inulin, starch, pectin, dextran, etc	Fraunhofer, Jena, WUR-FBR
Characterization of PS, PS-derivatives, PS-derived materials	Abo, Armines, Boku, Fraunhofer, IBWCh, Jena, UM, UIBK, WUR-FBR, Armines
Biosynthesis of PS • microbial (bacterial cellulose, GAGs) enzymatic (GAGs	IBWCh, WUR-FBR
Processing	Abo, Armines, Boku, Fraunhofer, IBWCh, Jena, UIBK, WUR-FBR

EPNOE Member's infrastructure & resources

Infrastructure	**Partner**
Analytical SEM, TEM, AFM, RDX, goniometer, zeta potential FTIR, FTIT-Raman, NMR, MS, MaldiTOF, UVVIS, TOF SIMS, TOC/TN, XPS Rheology, mechanical testing Tensiometers, nephelometers, PL-PSDA, DSC, TGA, electrophoresis (+ capillary) SEC, IEC, HPLC, GC, GCMS, LC-MS, UPLC-	Abo, Armines, Boku, Fraunhofer, IBWCh, Jena, UIBK, UG, UM, WUR-FBR

MS, UPLC, amperometry, voltammetry	
Processing Plasma reactors, microwave reactor, Flow reactors, sonoreactors Extruders, lab/pilot scale film blower Pilot scale spray drier, freeze dryer, turbulent air dryer	Fraunhofer, IBWCh, UM, WUR-FBR

Identification of hot topics

In recent years, huge advances have been made in the development of novel Polysaccharide-based biomedical materials. Over the last three years the EPNOE activity, scientists have generated considerable knowledge on the current trends in polysaccharides application in the pharmaceutical, medical and well-being area. The identification of such “hot” topics was the result of many discussions among EPNOE research partners during brainstorming meetings. Based on their contribution, "hot" topics have been determined that meet the following criteria: a special interest in the subject, the relative novelty and great potential for further research. While some topics remain still “hot” like: engineered biomedical materials, targeted drug delivery, micro- and nano-encapsulation, use of natural compounds for therapies/ healing/ prevention, biosensing and new diagnostic methods, in the meantime other new topics emerged.

The most prominent and promising topics according to EPNOE members are:

- Extraction and Use of Polysaccharides from Plants;
- Preparation of Chitosan/Chitin and/or Alginates Micro/nanoparticles;
- Hollow Chitosan Fibres for Medical Applications (non-woven fabrics, immobilizing enzymes or cells);
- Composite Micro- and Nanofibres via Electrospinning;
- Self-Healing Polymer Nanocomposites using Halloysite Nanotubes;
- Modified Hyaluronan and Chitosan-Hyaluronan Composites;
- Bioactive Properties of Common and Therapeutic Polysaccharides;
- Polysaccharide-Protein Conjugates for Health Applications;
- Thermoreversible Hydrogels based on Cellulose Ethers;
- Soft Implants based on Polysaccharides;
- Photoactive Polysaccharide-based Nanoparticles;
- Cellulose Material Functionalised with Bacterial Exopolysaccharides;
- Wound Dressing with Incorporated Keratinocytes and Fibroblasts;
- Poly-functional Personal Care Textile Materials (slimming and anti-cellulite);
- Multilayered PS-structures;
- 3D Printing as means for Tailor-made Patient Treatment;
- Textiles and Dressings with Analgesic Activity;
- Antimicrobial Dressing and Antibacterial Polysaccharide Coatings;
- Functional Oligosaccharides for Biomaterials applications.

Building of EPNOE IT-collaboration platforms

A common IT collaboration platform was implemented for sharing equipment (adapted from toolbox), methodologies, competencies and resources (extracted from surveys among partners and tool box).

A database technology offer was also prepared, as an extension of the present IT platform on the Private web site. This offer was built around the following items:

i. EXPERTS- containing information about EPNOE researchers with experience in the implementation of expertise for industry, areas in which experts operate as well as reference lists of expertise made.
ii. TECHNOLOGY OFFER - contains information about the results of some research projects carried out by EPNOE partners which may find application in the industry linked to health, including a description of the offered technology (ready to implementation), the current stage of advancement of research and industrial sectors in which the results can be applied.

Attracting new industrial members specialized on health related issues (medicine, pharmacy, bioengineering)

An Information package was prepared and sent to companies:

- The brochure prepared for SME's which includes information on Affiliated Member and epnoe-at-large.
- The Newsletter of November 2014 which has a specific section on Affiliated Members.
- A one-page leaflet describing the activities of EPNOE in the area of Health-related products.
- A one-page leaflets describing the hot topics identified by EPNOE.
- A one page information leaflet about epnoe-at-large, showing the advantage of being a member of EPNOE.

(2) Action plan: approach to industry in health-related areas

Several actions were initiated in order to approach industry:

Induce companies to join EPNOE as Business and Industry Club members

a. Identification of companies in Europe involved in polysaccharide research in health and well-being;
b. Search of companies (mainly SME's) working in the health area all over the world;
c. Preparation of brochure to be sent to SME;
d. Initiating contacts with companies, particularly with SMEs, to identify mutual interests, the opportunities for collaboration and the relation to EPNOE-BIC.

Organisation of a coordinated action to respond to Horizon 2020

Due to the importance of the Horizon2020 program for promoting and supporting industrial-driven research in Europe, special attention has been given to transfer information on the program and on specific calls to the companies and to initiate collaborative research & innovation projects. Three meetings were organised by EPNOE-CSA, to discuss the strategy to be adopted by the consortium (meeting of 25 October 2013) and to build consortia with industry for specific topics and calls (meetings of 28-29 January 2014 and 22 January 2015).

Proactive contacts with a selection of companies listed in the new EPNOE databases.

A database with companies with activities in the pharmaceutical, cosmetic, medical and well-being sector was created. A number of these companies use polysaccharides in their

applications and have been identified as potential partners for EPNOE-CSA. The following activities have been conducted:

- A folder promoting EPNOE association has been sent to the companies on the list.
- Further contacts were initiated with selected companies from the list by partners, addressing both the potential for joining EPNOE-BIC and future collaborations. The outcomes of this activity are:
    - A raised interest of a number companies in the activities of the EPNOE association; further discussions will be carried out regarding the potential joining of EPNOE-BIC by the interested companies. The activity was expanded in the 3rd year of the project, by (i) intensifying the direct contact with the already contacted companies and (ii) promoting EPNOE association to other companies that will be identified these months in WP4 and independently by partners.
    - Direct discussions with companies contributed significantly to the identification of common research interests and in a high number of applied research projects and project proposals submitted at national and European level. Information on the market trends has been gathered.

Determination of new research areas in the field of PS towards health–related materials (Dormant Ideas)

The Dormant Idea list is including several topics in the pharmaceutical, medical and well-being area. 63 ideas have been presented by partners that are directly related to health applications of polysaccharides and materials derived upon them. Several were continued in a confidential manner. Representative ideas were selected to build collaborative projects for the Horizon 2020 calls.

Organising courses/training sessions dealing with Health and well-being, bringing together academia and industry

EPNOE organized training courses for students, researchers and/or industrial scientists:

2013

A first seminar/workshop on the topic "*Challenges and perspectives in making materials from polysaccharides*" in Nice on October 20, 2013. It was a one day course with industrial scientist participation where applications in health were described.

2015

Polysaccharides in health and well-being

January 2015 in Wageningen (the Netherlands)

Organizers: Carmen Boeriu, Karin Stana-Kleinschek, Jan van Dam

2015

Physics and Chemistry in Polysaccharide Research: From Molecules to Materials

18 October 2015 in Warsaw (Poland)

Pre-EPNOE 2015 conference course.

Organizers: Danuta Ciechanska, Patrick Navard

Besides these activities coordinated by EPNOE-CSA, partners are involved in the organisation of courses, summer schools, seminars and workshops, with participation of industry.

Building confidential R&D projects

A list of about 60 projects per year, all with companies, were listed for 2013 and 2014.

Search for innovative ideas with high market potential in order to build projects between partners and companies, with the aim to attract companies to join EPNOE
The research directions for EPNOE-CSA in the health area have been identified and defined in the 1st year of the project, by an interview of partners and discussions during dedicated meetings and the association meetings. In the past years, several partners have carried out market studies to identify market trends in different areas relevant for our activity, like engineered biomedical materials, targeted drug delivery, micro- and nano-encapsulation, use of natural compounds for therapies/ healing/ prevention, biosensing and new diagnostic methods. Based on this analysis, biosensing and 3D-printing were included in the research strategy, supported by the expertise available within three EPNOE members. The information obtained was summarised in a common document which contains the outcome of the analysis and the offer of the EPNOE-association to respond to the market trends, which was presented to companies, aiming to attract them to join EPNOE.

Organization of research-industrial consortia for realization of common projects
WP2 has been active in the organization of research-industry consortia. Meetings were organised to mediate and prepare this action. The emphasis of the discussion was on the integration of EPNOE ideas with industry needs and identify partners (academic and industrial) for future funding calls e.g. H2020, and BIC. Opportunities arising in H2020 was followed up and synchronised actions were taken to value them. EPNOE members have been very active in building consortia at the level of Europe next to building up national projects and bilateral projects with the industry. Particular attention was given to the collaboration with SMEs, that covers multiple forms of implementation: consultancy, applied projects answering direct questions of the companies and involving SMEs in collaborative projects and consortia for national and European programs. This is well documented with the examples of projects and project proposals built up from 2013 to 2015. In 2013, for example, 56 projects were submitted and/or started, with the participation of 103 SMEs, 38 large companies and 4 associations.

The possibilities of building research-industry consortia were explored in three major European programmes and in all of them, proposals were built or will be built when the calls will be opened. The programmes are:

1. Horizon 2020 where EPNOE members are involved in confidential proposals.
2. Bio-based Industries Consortium
   EPNOE association and six EPNOE members (P2, P4, P5, P7, P10, P16) are associate members of the Bio-based Industries Consortium. They participated to the stakeholder meeting held in Brussels on February 5, 2014 where they presented their ideas for project building in the parallel sessions and participated to the speed dating meetings.

C-5 Expanding EPNOE activities towards food-related materials and products

This topic was treated in Work Package 3 which aimed at expanding EPNOE Association activities towards food-related materials and products in order to reach a critical mass as EPNOE will be seen as an important actor in this sector. WP2 has two tasks, one being the (1) preparation of the EPNOE strategy plan in health-related research, training, infrastructure, testing and other services and the second related to (2) developing approaches for preparing industrial contacts in this area.

(1) Definition of the EPNOE food-related industrial strategy plan

This first part comprised several actions:

Building of a list of food companies and research groups (involving the details of contact person)
A first list of food companies using polysaccharides was collected Year 1. The list was further improved Year 2 and placed in the Private web site.

Survey of competences of EPNOE academic/research partners in order to map the expertises/knowledge that can be useful in both Food and Health areas. Analysis of the obtained response and classification (Action Plan Year 1)
A full survey of expertise present in EPNOE was performed Year 1. For each partner, a table was prepared with the following items.

INPUTS		USE FOR EXPANSION OF EPNOE TOWARDS FOOD						
		Research contracts	**Education**	**LCA[1]**	**EoL[2]**	**Testing**	**Use of Infra-structure**	**Consultancy**
Infrastructure	xxxxxx	X				X	X	X

The results is a full picture of the capacities of EPNOE members in the area of food and food-related topics.

Building of a common IT-collaboration platform
We built a common IT collaboration platform for sharing equipment (adapted from toolbox), methodologies, competencies and resources which is implemented in the private EPNOE website.

Search for innovative ideas with high market potential in order to build projects between partners and companies, with the aim to attract companies to join EPNOE.
A first EPNOE CSA workshop was organised in Year 1 on September 4th 2012, in Erfurt, Germany. The borders of the food polysaccharide research strategy of EPNOE CSA partners were described. Food polysaccharide research should develop processing technologies enabling sustainable and efficient use of agro raw materials to provide better nutritional profiles. Novel processes need to be developed for enhanced structure and in turn in vivo functionality.
The participants indicated six focus areas for the future of food polysaccharide research of which were:

1. Recovery
    a. Biomass refinery / waste re-use
    b. Bioprocessing (enzymatic/chemical/mechanical)
2. Functionality
    a. Coping with heterogeneity
    b. Shining light in the black box of fermentation (Nutrition)
3. Structures
    a. Structures determining taste and flavor / new
    b. Edible films / Bioplastics in packaging
4. Process technologies
5. Health effects of polysaccharides

Based on this information, on results reported in the best recent scientific papers (reported in Deliverable 2.3), on discussions with major industrial food companies and on work performed in FoodBest, and considering the research potential of EPNOE members, the major five research topics EPNOE could move on were identified:

1. Recovery and use of new sources
    - Biomass refinery / waste re-use;
    - Applying novel separation processes to side streams;
    - Extraction of bioactive compounds to act as functional ingredients and pharmaceuticals in value-added foods, drinks and non-foods, or even in edible and/ or bio-degradable packaging materials.
2. Functionality
    - Coping with heterogeneity;
    - Shining light in the black box of fermentation (Nutrition);
    - Structure-function relationship.
3. Structures
    - Structures determining taste and flavour;
    - Edible films;
    - Bioplastics in packaging.
4. Sustainable process technologies
    - Efficient utilisation of raw materials;
    - Bioprocessing;
    - Gentler processing procedures.
5. Health effects of polysaccharides
    - Improve gastrointestinal health.
    - Develop high quality and innovative ingredients from known and alternative sources in order to optimize the functionality, taste and health promoting effects of ingredients.
    - Develop products to provide the consumer with tasty, healthy, safe and nutritious food as part of a weight control regime.
    - Develop multifunctional and palatable foods with beneficial health properties for specific target groups to prevent and/or treat diseases and other health conditions.

Tools to attract new full and affiliated members

Two sets of documents were prepared, one set in Year 1, one set in Year 3.

- Year 1: participation to the preparation of the brochure Partners identified national targets to become EPNOE industry club members.
- Year 3, a more complete information set was prepared, taking into account the new EPNOE organisation (*epnoe-at-large* and affiliated members), comprising:
    - A brochure which including Affiliated Member and epnoe-at-large information.
    - The Newsletter of November 2014 which has a specific section on Affiliated Members.
    - A one-page leaflet describing the activities of EPNOE in the area of Food-related products.
    - A one-page leaflet describing the hot topics identified by EPNOE.
    - A one page information leaflet about epnoe-at-large, showing the advantage of being a member of EPNOE.

(2) Action plan: approach to industry in food-related areas

Building confidential R&D projects
All the R&D projects in the food area that partners accepted to disclose were reported in two confidential deliverables. Despite the confidential issues regarding such a request, EPNOE partners were able to report about R&D projects in the Food sector with companies.

Organisation of a coordinated action to respond to Horizon 2020
The following meetings were organized:

- Meeting for preparing EPNOE Horizon 2020 strategy in 24 October 2013, after the EPNOE meeting in Nice.
- 28 & 29 January 2014 in Wageningen to coordinate an EPNOE answer to Horizon 2020 calls. Five companies involved in food participated to the meeting. One potential proposal emerged from the discussion in the food area.

The outcomes of these meetings were the inform EPNOE partners of the various possibilities for financing and to start organizing call.

Determination of new research areas in the field of PS towards food-related materials (Dormant Ideas)
The Dormant Idea list included several topics in the Food area. Several were continued in a confidential manner.

Organizing seminars and workshops dedicated to companies in the food area.
Two seminars were organized:

- A national seminar was organised at VTT on February 12th, 2013 with the title "Future food factory: Utilisation of new technologies in processing and products". Covered topics were bioeconomy, new processing, measurement and packaging technologies, food safety and traceability, 3D-printing, automation. The seminar had about 90 participants, 30% of them from food processing companies.
- A second seminar was done on the topic "*Challenges and perspectives in making materials from polysaccharides*" in Nice on October 20, 2013. It was a one day course with industrial scientist participation where applications in food were described.

Organization of research-industrial consortia for realization of common projects.
This was done during the January 28-29, 2013 meeting. The possibilities of building research-industry consortia were explored in three major European programmes and in all of them, proposal projects were built The three programmes are:

- Horizon 2020;
- EIT KIC;
- Bio-based Industries Consortium.

Align EPNOE with food conferences and journals
A list of food conferences and journals was disseminated among partners in order to increase their awareness and identify new opportunities.

C-6 Preparing industrial participation and innovation

These activities were run in Work Package 4, with two main objectives:
Objective 1: to boost innovation in all sectors where polysaccharides can be used and **Objective 2:** to favour an extended participation of companies active in the polysaccharide-related sectors into EPNOE activities and to attract them to be members of the Durable Integrated Structure "EPNOE Association".

Industry survey and contact with potential industrial partners

1- Building databases

To reach the task objectives, we had to build a database listing companies working in the polysaccharide area, in order during the second period to approach them for disseminating EPNOE information, in order to organize knowledge transfer and attract industrial membership.
Three databases were prepared:

1. A first database of about 12 000 names of academic researchers working in the polysaccharide field over the world. This database is a tool for our industrial members to find competences and information and a tool for EPNOE for disseminating information.
2. A second database listing most academic and industrial societies in the polysaccharide field. This database contains about 300 entries, with for example 33 entries for Food and Drink associations
3. A third database listing companies interested in polysaccharides with about 1500 entries.

2-Identifying companies of interest

In addition to searching companies dealing with polysaccharides in all areas, a specific effort was made to identify companies where EPNOE members had a special link with or where EPNOE CSA partners thought they are of special interest. This task was specifically performed in the Health and Food areas.

3- Disseminating EPNOE offers to companies

These data bases were used to disseminate EPNOE offers in terms of scientific expertise, through several mailings where information sets were prepared but also in terms of networking. When asked about how companies are seeing the main interest of EPNOE, the major answer is its capacity to network researchers from different areas and from academic and industrial worlds. When asked about their industrial needs which EPNOE could tackle, the vast majority of companies are refusing to answer. They are however treating these needs with EPNOE partners in confidential projects. Most of these projects are confidential. However, EPNOE partners were able to disclose some of them. In 2013 and 2014, there was more than 150 R&D projects running within the EPNOE partners, linking companies and academia. In addition, about 100 more projects were running without direct industrial support or involvement.

Identification of innovation potential

The objective of this activity was to identify results from EPNOE CSA partners that have the potential to be transformed into innovation in the whole polysaccharide field, including Food and Health. Within each partner's institution, an innovation correspondent was in charge of identifying results with an innovation potential.
The following actions were made:

1- Results from EPNOE CSA partners that have the potential to be transformed into innovation in the whole polysaccharide field, including Food and Health.

Results from EPNOE CSA partners that have the potential to be transformed into innovation in the whole polysaccharide field, including Food and Health were identified. They lead to confidential projects.

2- Dormant ideas

Another, more challenging activity was tested, called the Dormant Idea initiative.
A "dormant idea" was defined as a research or application idea that will not be used by its author due to several reasons (lack of time or resources to develop it, not fully validated, missing a critical expertise, not properly tested, not applicable to the area it was devised for, outside the main strategic areas of the member, having no idea what to do with it, etc.). These dormant ideas were supposed to:

- develop more intense collaboration between partners;
- offer opportunity to bring into existing research projects ideas from another group or scientific discipline;
- create by combination new, applicable projects or products.

After a first phase defining the conditions for driving this activity, 11 academic/research members of EPNOE collected 170 dormant ideas. The set of ideas and the set of resulting/combined ideas were used to create new projects and proposals following a session April 24, 2013 in Sophia Antipolis, where 160 requests for face to face meeting were asked to be organized. This dormant knowledge was proposed to selected companies identified in order for them to exploit it, the exploitation details being agreed on by the involved partners. About 15 projects were started (five were disclosed).

Increasing interactions with SMEs and increase EPNOE industrial membership

A dedicated EPNOE information set was prepared in collaboration with the present SME members of EPNOE Association in order to present the advantages of being an EPNOE member for SME's. The Information set was composed of three:

1. Selection of Newsletter, able to give a feeling about EPNOE;
2. A three-page document entitled "Activities for EPNOE Companies" describing EPNOE activities in four areas:
    - Innovation;
    - Expending the expertise of EPNOE;
    - Information;
    - Dissemination.
3. A brochure.

This brochure was prepared together with five companies members of EPNOE. This set was widely disseminated to:

- All the events organised by EPNOE;
- List of SME's coming from the industrial data base;
- To all companies listed in databases. It was sent or directly distributed to about one thousand companies.
- Organised consortia of SME's as National or local contact points in EU countries.
- Participants to conferences in Europe and in the USA.

D- Potential impact and the main dissemination activities and exploitation of results

The call text (**NMP.2011.4.0-5 Support to Networks of Excellence with durable integrated structures)** specified that the Networks of Excellence (NoEs) had the following expected impacts:

- Improved coordination in research and innovation;
- More robust critical mass of the durable integrated structure;
- Boosted dynamism of research, technological development and innovation in the field(s);
- Better structuring of the European Research Area.

The EPNOE CSA project reached the following results concerning these expected impact:

1. **Improved coordination in polysaccharide research and innovation**

EPNOE is seen by the polysaccharide community as a very efficient and attractive network. This is due to the solid organisation which has been built, with a structure of management which has been adapted to the new organisation established during the course of the EPNOE CSA project.

The many information activities (meetings, brain-storming, building of expertise tables), in large parts established during the EPNOE CSA project, is improving research coordination within EPNOE. Official meetings between EPNOE members are occurring at regular intervals during the year but there are many more occasions for EPNOE members to meet (conferences, meetings for EU projects, COST meetings, etc.).

All EPNOE members are well aware of what is going on in other than their own field though these very frequent contacts.

EPNOE members, due to these very active and diverse activities, are at the core of the research in the World. We can take two examples at two sides of the World. The American Chemical society, the largest scientific organisation in the World, is taking EPNOE as its partner in Europe in the area of cellulose and renewable materials. EPNOE is deeply involved in the running of the ACS meeting in the USA, and ACS is co-organizing with EPNOE the EPNOE conferences. In Asia, the Japanese-Europe conferences held every two years are organised on the side of Europe by EPNOE members.

The fact that EPNOE is now belonging to or associated with several other organisations dedicated to knowledge transfer and innovation like Biobased Industries Consortium, BioEconomy Cluster, Céréales Vallée or Polintegra is generating knowledge and information which are circulated within the EPNOE community.

The contribution of epnoe-at-large, this new informal network which has the ambition to unite all scientists in the World working on polysaccharides, will also be important in the information exchange between EPNOE members.

2. **More robust critical mass of the durable integrated structure**

EPNOE had reached before the EPNOE CSA project a critical mass, but it was already clear that the membership had to be extended for bringing new persons, new institutes and new companies in order to enlarge the panel of possibilities and generate new ideas.

This expansion took place in two ways.

First, research groups or university departments which were not previously involved in EPNOE were invited to join.

Second, we changed the structure of EPNOE to include a new class of academic members, called Affiliated members. These new members will bring new perspectives in the everyday activities of EPNOE. The target of having 10 new Affiliated Members is reached at the end of the project, some from countries not represented in EPNOE (Sweden, UK, Portugal, for example).

The informal network epnoe-at-large, where its members are not formally members of EPNOE, but are very close, is expected to strongly contribute to increase the critical mass of EPNOE.

3. Boosted dynamism of research, technological development and innovation in the polysaccharide field

The expected result is that several circles of innovation and knowledge transfers will be around EPNOE, boosting research, knowledge transfer and ultimately innovation.
This will help companies working in the polysaccharide field to have a simpler access to a wide range of results and expertise, some of them without having to be members of EPNOE. Membership to EPNOE is of course enlarging the panel of available information.

Several initiatives like brain-storming sessions or the Dormant Idea initiative were organized to boost the first innovation steps.

The many R&D projects conducted by EPNOE partners with industry (more than 160 running each year) are the sign of this involvement in research, technological development and innovation in the polysaccharide field.

4. Better structuring of the European Research Area

The following activities are participating to a better organization the whole polysaccharide field and significantly contributing to structure research in Europe:

- Organization of academic and industrial research projects implying all EPNOE members (Regular Members, Associate Members and Business and Industry Club;
- Implication of EPNOE scientists in many actions like European technology Platforms, PPP's, COST or Eranet's;
- Organisation of scientific conferences;
- Organisation of training courses;

- Organisation of information transfer on polysaccharide science and technology all over the World, from a European base (epnoe-at-large).

E- Address of the project public website

The address of the project website is:

- http://www.epnoe.eu/EPNOE-CSA/Overview

The project site is part of the general EPNOE public site which address is:

- http://www.epnoe.eu