EUROPEAN COMMISSION
Research Executive Agency (REA)
Fostering Novel ideas, FET-Open

ANNEX 1 (part A)

Coordination and support action

NUMBER — 737395 — CARBOMET

Table of Contents

1.1. The project summary

Project Number [1]	737395	Project Acronym [2]	CARBOMET

One form per project

General information	
Project title [3]	Metrology of Carbohydrates for Enabling European Bioindustries
Starting date [4]	01/01/2017
Duration in months [5]	48
Call (part) identifier [6]	H2020-FETOPEN-2-2016
Topic	FETOPEN-02-2016 FET-Open Coordination and Support Actions
Fixed EC Keywords	Glycomics, Analytical chemistry, Bioproducts (products that are manufactured using biological material as feedstock) biomaterials, bioplastics, biofuels, bioderived bulk and fine chemicals, bio-derived novel materials
Free keywords	metrology carbohydrates measurements bioindustry analytics synthesis reference standards bioinformatics databases network

Abstract [7]

CarboMet will foster and drive collaboration, cross-fertilisation and communication among stakeholders to facilitate a uniform approach to the metrology and/or measurement of carbohydrates for exploitation in biopharmaceuticals, diagnosis of disease and precision medicine, food and personal care and sustainable material BioIndustries. This will be achieved through a consolidated approach towards the modification of key emerging technologies or identification of radically new technologies currently unforeseen by technology roadmaps.
Carbohydrates and glycoconjugates are especially challenging to analyse due to their high stereochemical diversity which means it is difficult to distinguish between them and fully characterise using standard techniques and methods. Current methodologies to fully solve 3-D structures include NMR and X-Ray Crystallography which are low-throughput, require large samples and have poor sensitivity. Emerging technologies are beginning to address these issues such as Ion Mobility Mass Spectrometry (IM-MS) and the combination of 3 gas phase techniques: IR spectroscopy with IM-MS in-vitro enabling high-throughput with higher sensitivity, small samples, and analysis from mixtures to provide structural detail on each component. These technologies are underpinned by advanced supporting technologies such as automated carbohydrate synthesis, bioinformatics tools and databases, and new suites of enzymes for glycan synthesis and modification. CarboMet will use a range of communication and dissemination tools (meetings, workshops, website, surveys, briefing papers) to engage key stakeholders, to establish the current emerging technologies, limitations, and barriers to implementation. Priority areas, future challenges and a wish list of capabilities will then be defined, culminating in the production of a roadmap for 2030, setting out a Europe-wide vision. These capabilities will lead to new robust metrologies for the exploitation of carbohydrates.

1.2. List of Beneficiaries

Project Number [1]	737395	Project Acronym [2]	CARBOMET

List of Beneficiaries

No	Name	Short name	Country	Project entry month[8]	Project exit month
1	THE UNIVERSITY OF MANCHESTER	UNIMAN	United Kingdom	1	48

1.3. Workplan Tables - Detailed implementation

1.3.1. WT1 List of work packages

WP Number[9]	WP Title	Lead beneficiary[10]	Person-months[11]	Start month[12]	End month[13]
WP1	Analytics & Measurements	1 - UNIMAN	5.50	1	48
WP2	Synthesis of Standards	1 - UNIMAN	5.50	1	48
WP3	Bioinformatics & Databases	1 - UNIMAN	5.50	1	48
WP4	Policy Engagement	1 - UNIMAN	5.50	1	48
WP5	Project Coordination & Management	1 - UNIMAN	8.50	1	48
WP6	Ethics requirements	1 - UNIMAN	N/A	1	48
		Total	30.50		

1.3.2. WT2 list of deliverables

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Map of existing analytical centres of expertise and facilities onto website	WP1	1 - UNIMAN	Websites, patents filling, etc.	Public	10
D1.2	Scoping workshop with key players carbohydrate analytics & measurements	WP1	1 - UNIMAN	Other	Public	16
D1.3	Online stakeholder survey to identify additional centres of expertise and facilities	WP1	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D1.4	Update website with additional centres of expertise and facilities	WP1	1 - UNIMAN	Websites, patents filling, etc.	Public	30
D1.5	Training workshop on advanced technologies in analytics & measurements	WP1	1 - UNIMAN	Other	Public	36
D2.1	Map centres of carbohydrate synthesis expertise onto website	WP2	1 - UNIMAN	Websites, patents filling, etc.	Public	10
D2.2	Scoping workshop with key players synthesis of standards	WP2	1 - UNIMAN	Other	Public	16
D2.3	Online stakeholder survey to identify additional centres of expertise and the use and availability of standards and reference materials	WP2	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D2.4	Update website with centres of carbohydrate synthesis expertise including catalogue of available standards and reference materials on website	WP2	1 - UNIMAN	Websites, patents filling, etc.	Public	30
D2.5	Training workshop on advanced technologies in synthesis of standards	WP2	1 - UNIMAN	Other	Public	36
D3.1	List of databases and bioinformatics tools on website	WP3	1 - UNIMAN	Websites, patents filling, etc.	Public	10

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D3.2	Scoping workshop with key players in Bioinformatics & Databases	WP3	1 - UNIMAN	Other	Public	16
D3.3	Online stakeholder survey to identify the use and availability of databases and bioinformatics tools	WP3	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D3.4	Update website with additional databases and bioinformatics tools	WP3	1 - UNIMAN	Websites, patents filling, etc.	Public	30
D3.5	Training workshop on advanced technologies for databases and bioinformatics tools	WP3	1 - UNIMAN	Other	Public	36
D4.1	Policy briefing papers (brief, one page) by ETA and/or BIS	WP4	1 - UNIMAN	Report	Public	26
D4.2	Successful case studies from industry and academia onto website	WP4	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D4.3	Meeting 1 with key policy makers, funding and regulatory bodies	WP4	1 - UNIMAN	Other	Confidential, only for members of the consortium (including the Commission Services)	9
D4.4	Engagement 1 with national member state glyco-initiatives	WP4	1 - UNIMAN	Other	Public	9
D4.5	Scoping meeting for roadmap input	WP4	1 - UNIMAN	Websites, patents filling, etc.	Public	36
D4.6	Production of roadmap	WP4	1 - UNIMAN	Report	Public	42
D4.7	Meeting 2 with key policy makers, funding and regulatory bodies	WP4	1 - UNIMAN	Other	Public	21
D4.8	Meeting 3 with key policy makers, funding and regulatory bodies	WP4	1 - UNIMAN	Other	Public	33
D4.9	Meeting 4 with key policy makers, funding and regulatory bodies	WP4	1 - UNIMAN	Other	Public	45
D4.10	Engagement 2 with national member state glyco-initiatives	WP4	1 - UNIMAN	Other	Public	21

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.11	Engagement 3 with national member state glyco-initiatives	WP4	1 - UNIMAN	Other	Public	33
D4.12	Engagement 4 with national member state glyco-initiatives	WP4	1 - UNIMAN	Other	Public	45
D5.1	Project Plan	WP5	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	1
D5.2	Kick off meeting with Working Group	WP5	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	2
D5.3	Dissemination & Exploitation plan	WP5	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D5.4	Data Management plan	WP5	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	6
D5.5	Industry Steering Group appointed	WP5	1 - UNIMAN	Report	Public	6
D5.6	Project website & logo	WP5	1 - UNIMAN	Websites, patents filling, etc.	Public	2
D5.7	Meetings and workshop calendar including hosts and locations on website	WP5	1 - UNIMAN	Websites, patents filling, etc.	Public	9
D5.8	Social media accounts established	WP5	1 - UNIMAN	Websites, patents filling, etc.	Public	2
D5.9	Periodic e-newsletter 1	WP5	1 - UNIMAN	Report	Public	12
D5.10	Data Management plan Y1 update	WP5	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	12
D5.11	Data Management plan Y2 update	WP5	1 - UNIMAN	ORDP: Open	Public	24

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
				Research Data Pilot		
D5.12	Data Management plan Y3 update	WP5	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	36
D5.13	Data Management plan Y4 update	WP5	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	48
D5.14	Periodic reporting RP1	WP5	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	26
D5.15	Periodic reporting RP2	WP5	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	48
D5.16	Periodic e-newsletter 2	WP5	1 - UNIMAN	Report	Public	18
D5.17	Periodic e-newsletter 3	WP5	1 - UNIMAN	Report	Public	24
D5.18	Periodic e-newsletter 4	WP5	1 - UNIMAN	Report	Public	30
D5.19	Periodic e-newsletter 5	WP5	1 - UNIMAN	Report	Public	36
D5.20	Periodic e-newsletter 6	WP5	1 - UNIMAN	Report	Public	42
D5.21	Periodic e-newsletter 7	WP5	1 - UNIMAN	Report	Public	48
D6.1	POPD - Requirement No. 2	WP6	1 - UNIMAN	Ethics	Confidential, only for members of the consortium (including the Commission Services)	9

1.3.3. WT3 Work package descriptions

Work package number [9]	WP1	**Lead beneficiary** [10]	1 - UNIMAN
Work package title	Analytics & Measurements		
Start month	1	**End month**	48

Objectives

To assess the current state of the art and technological capabilities in carbohydrate analytical and measurements capabilities in each of the 4 BioIndustry Sectors. Also to identify existing needs and future challenges.

Description of work and role of partners

WP1 - Analytics & Measurements [Months: 1-48]
UNIMAN
Define the current state of the art of carbohydrate analysis and measurements in each of the 4 BioIndustry Sectors. Map national centres of excellence and national infrastructures to show how academia can support industry. Identify scientific gaps and overlaps through a joint workshop and follow up stakeholder online survey. Education and training workshop in analytics and measurements tools, with a particular focus on any advanced technologies as is timely, to showcase capabilities to interested stakeholders.

Participation per Partner

Partner number and short name	WP1 effort
1 - UNIMAN	5.50
Total	5.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Map of existing analytical centres of expertise and facilities onto website	1 - UNIMAN	Websites, patents filling, etc.	Public	10
D1.2	Scoping workshop with key players carbohydrate analytics & measurements	1 - UNIMAN	Other	Public	16
D1.3	Online stakeholder survey to identify additional centres of expertise and facilities	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D1.4	Update website with additional centres of expertise and facilities	1 - UNIMAN	Websites, patents filling, etc.	Public	30
D1.5	Training workshop on advanced technologies	1 - UNIMAN	Other	Public	36

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	in analytics & measurements				

Description of deliverables

A map of existing analytical centres of expertise and facilities will be created and put onto the project website (D1.1). There will then be a scoping workshop with key players (D1.2). The aim of the meeting is two-fold: to identify the current state of the art, and also the future needs. Barriers to commercialisation, training needs and regulatory requirements will also be considered. The meeting will be followed up by an online survey (D1.3) to identify additional centres of expertise and facilities, and to engage stakeholders that were not able to participate in the meeting. Information from the meeting and the online survey will be used to update the website (D1.4) with additional centres of expertise and facilities. A training workshop (D1.5) will be held to showcase recent developments in advanced technologies for carbohydrate 'analytical and measurements' capabilities.

D1.1 : Map of existing analytical centres of expertise and facilities onto website [10]

Map of existing analytical centres of expertise and facilities onto website

D1.2 : Scoping workshop with key players carbohydrate analytics & measurements [16]

Scoping workshop with key players in carbohydrate analytics & measurements

D1.3 : Online stakeholder survey to identify additional centres of expertise and facilities [22]

Online stakeholder survey to identify additional centres of expertise and facilities

D1.4 : Update website with additional centres of expertise and facilities [30]

Update website with additional centres of expertise and facilities

D1.5 : Training workshop on advanced technologies in analytics & measurements [36]

Training workshop on advanced technologies in analytics & measurements

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS3	Information gathering stage 1 completed	1 - UNIMAN	18	Website update completed using input from stakeholders based on outputs from scoping workshops.
MS4	Information gathering stage 2 completed	1 - UNIMAN	30	Website update completed using input from stakeholders based on outputs from online surveys.

Work package number [9]	WP2	Lead beneficiary [10]	1 - UNIMAN
Work package title	Synthesis of Standards		
Start month	1	End month	48

Objectives

To assess the current state of the art in carbohydrate synthesis capabilities and the availability of standards and reference materials for measurements in each of the 4 BioIndustry Sectors. To also identify existing needs and future challenges.

Description of work and role of partners

WP2 - Synthesis of Standards [Months: 1-48]
UNIMAN
Define current state of the art in carbohydrate synthetic methods. Determine what reference standards and materials are used within each of the 4 BioIndustry Sectors. Identify scientific gaps and overlaps through a joint workshop and a follow up stakeholder online survey. Map national centres of excellence and expertise to show how academia can support industry. Hold an education and training workshop in synthesis and standards tools, with a particular focus on any advanced technologies as is appropriate, to showcase capabilities to interested stakeholders.

Participation per Partner

Partner number and short name	WP2 effort
1 - UNIMAN	5.50
Total	5.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.1	Map centres of carbohydrate synthesis expertise onto website	1 - UNIMAN	Websites, patents filling, etc.	Public	10
D2.2	Scoping workshop with key players synthesis of standards	1 - UNIMAN	Other	Public	16
D2.3	Online stakeholder survey to identify additional centres of expertise and the use and availability of standards and reference materials	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D2.4	Update website with centres of carbohydrate synthesis expertise including catalogue of available standards and reference materials on website	1 - UNIMAN	Websites, patents filling, etc.	Public	30

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.5	Training workshop on advanced technologies in synthesis of standards	1 - UNIMAN	Other	Public	36

Description of deliverables

A map of existing carbohydrate synthesis expertise will be created and put onto the project website (D2.1). There will then be a scoping workshop (D2.2) with key players. The aim of the meeting is two-fold: to identify the current state of the art, and also the future needs. Barriers to commercialisation, training needs and regulatory requirements will also be considered. The meeting will be followed up by an online survey (D2.3) to identify additional centres of expertise in carbohydrate synthesis, and the use and availability of standards and reference materials thus engaging stakeholders that were not able to participate in the meeting. Information from the meeting and the online survey will be used to update the website (D2.4) with carbohydrate synthesis expertise including a catalogue of available standards and reference materials. A training workshop (D2.5) will be held to showcase recent developments in advanced technologies for carbohydrate synthesis capabilities.

D2.1 : Map centres of carbohydrate synthesis expertise onto website [10]

Map centres of carbohydrate synthesis expertise onto website

D2.2 : Scoping workshop with key players synthesis of standards [16]

Scoping workshop with key players in synthesis of standards

D2.3 : Online stakeholder survey to identify additional centres of expertise and the use and availability of standards and reference materials [22]

Online stakeholder survey to identify additional centres of expertise and the use and availability of standards and reference materials

D2.4 : Update website with centres of carbohydrate synthesis expertise including catalogue of available standards and reference materials on website [30]

Update website with centres of carbohydrate synthesis expertise including catalogue of available standards and reference materials on website

D2.5 : Training workshop on advanced technologies in synthesis of standards [36]

Training workshop on advanced technologies in synthesis of standards

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS3	Information gathering stage 1 completed	1 - UNIMAN	18	Website update completed using input from stakeholders based on outputs from scoping workshops.
MS4	Information gathering stage 2 completed	1 - UNIMAN	30	Website update completed using input from stakeholders based on outputs from online surveys.

Work package number [9]	WP3	Lead beneficiary [10]	1 - UNIMAN
Work package title	Bioinformatics & Databases		
Start month	1	End month	48

Objectives

To assess the current availability of database provision and the current state of the art in bioinformatics in each of the 4 BioIndustry Sectors. Also to identify existing needs and future challenges.

Description of work and role of partners

WP3 - Bioinformatics & Databases [Months: 1-48]
UNIMAN
Define current availability of databases for carbohydrate measurements data to identify gaps and overlaps in provision. Assess the current state of the art in bioinformatics for carbohydrate-based molecules and their use in each of the 4 BioIndustry Sectors. Education and training workshop in bioinformatics and database tools, with a particular focus on any advanced technologies as is timely, to showcase capabilities to interested stakeholders.

Participation per Partner

Partner number and short name	WP3 effort
1 - UNIMAN	5.50
Total	5.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D3.1	List of databases and bioinformatics tools on website	1 - UNIMAN	Websites, patents filling, etc.	Public	10
D3.2	Scoping workshop with key players in Bioinformatics & Databases	1 - UNIMAN	Other	Public	16
D3.3	Online stakeholder survey to identify the use and availability of databases and bioinformatics tools	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D3.4	Update website with additional databases and bioinformatics tools	1 - UNIMAN	Websites, patents filling, etc.	Public	30
D3.5	Training workshop on advanced technologies for databases and bioinformatics tools	1 - UNIMAN	Other	Public	36

Description of deliverables

A list of databases and bioinformatics tools will be added to the project website (D3.1). There will then be a scoping workshop (D3.2) with key players. The aim of the meeting is two-fold: to identify the current state of the art, and also the future needs. Barriers to commercialisation, training needs and regulatory requirements will also be considered. The meeting will be followed up by an online survey (D3.3) to identify additional databases and bioinformatics tools, and to engage stakeholders that were not able to participate in the meeting. Information from the meeting and the online survey will be used to update the website (D3.4) with these additional databases and bioinformatics tools. A training workshop (D3.5) will be held to showcase recent developments in advanced technologies in databases and bioinformatics tools.

D3.1 : List of databases and bioinformatics tools on website [10]

List of databases and bioinformatics tools on website

D3.2 : Scoping workshop with key players in Bioinformatics & Databases [16]

Scoping workshop with key players in bioinformatics and databases

D3.3 : Online stakeholder survey to identify the use and availability of databases and bioinformatics tools [22]

Online stakeholder survey to identify the use and availability of databases and bioinformatics tools

D3.4 : Update website with additional databases and bioinformatics tools [30]

Update website with additional databases and bioinformatics tools

D3.5 : Training workshop on advanced technologies for databases and bioinformatics tools [36]

Training workshop on advanced technologies in databases and bioinformatics tools

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS3	Information gathering stage 1 completed	1 - UNIMAN	18	Website update completed using input from stakeholders based on outputs from scoping workshops.
MS4	Information gathering stage 2 completed	1 - UNIMAN	30	Website update completed using input from stakeholders based on outputs from online surveys.

Work package number [9]	WP4	Lead beneficiary [10]	1 - UNIMAN
Work package title	Policy Engagement		
Start month	1	End month	48

Objectives

The overall objective is to build momentum for a long term European initiative for the metrology of carbohydrates in the form of a Private Public Partnership (PPP). To influence the development of current and future EU funding initiatives. To align innovation with regulation. To strengthen links between science, policy and industry.

Description of work and role of partners

WP4 - Policy Engagement [Months: 1-48]
UNIMAN
Develop a coherent strategy for further funding to support research to address the gaps identified in WP 1- 3, from current calls and provision for future funding through lobbying. Engage with key stakeholders (e.g. instrument manufacturers, end users, manufacturers, charities, patient organizations, regulatory bodies). Host a series of meetings in each application area to establish current methods used and anticipate future regulatory challenges. Outputs from these meetings will include policy briefing papers that will form a Knowledge Platform on Glycoscience priorities and challenge areas be used to engage policy makers, and as described in Objective 4, as input to guide future EMPIR programs. The Working Group will act as a task force to acts as champion and to provide leadership for the initiative. Prepare the 'Roadmap for 2030' as described in Objective 3 which will cover actions for each enabling technology for each application area to highlight the impact and raise the profile of carbohydrate metrology and gain support for research in the same. Develop and implement communication and dissemination activities for various relevant end-users (e.g. academic researchers, industrial end users) and the general public, in particular to increase the visibility and profile of carbohydrate metrology and raise awareness about the benefits and opportunities it provides.

Participation per Partner

Partner number and short name	WP4 effort
1 - UNIMAN	5.50
Total	5.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.1	Policy briefing papers (brief, one page) by ETA and/or BIS	1 - UNIMAN	Report	Public	26
D4.2	Successful case studies from industry and academia onto website	1 - UNIMAN	Websites, patents filling, etc.	Public	22
D4.3	Meeting 1 with key policy makers, funding and regulatory bodies	1 - UNIMAN	Other	Confidential, only for members of the consortium (including the Commission Services)	9

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.4	Engagement 1 with national member state glyco-initiatives	1 - UNIMAN	Other	Public	9
D4.5	Scoping meeting for roadmap input	1 - UNIMAN	Websites, patents filling, etc.	Public	36
D4.6	Production of roadmap	1 - UNIMAN	Report	Public	42
D4.7	Meeting 2 with key policy makers, funding and regulatory bodies	1 - UNIMAN	Other	Public	21
D4.8	Meeting 3 with key policy makers, funding and regulatory bodies	1 - UNIMAN	Other	Public	33
D4.9	Meeting 4 with key policy makers, funding and regulatory bodies	1 - UNIMAN	Other	Public	45
D4.10	Engagement 2 with national member state glyco-initiatives	1 - UNIMAN	Other	Public	21
D4.11	Engagement 3 with national member state glyco-initiatives	1 - UNIMAN	Other	Public	33
D4.12	Engagement 4 with national member state glyco-initiatives	1 - UNIMAN	Other	Public	45

Description of deliverables

A series of policy briefing papers (brief, one page) by ETA and/or BIS will be produced as communication tools to engage with policy makers (D4.1).
Successful case studies from industry and academia that demonstrate how carbohydrate metrology tools have been used to bring products and technologies to market will be added to the website to showcase to the wider scientific and industrial community and the general public. (D4.1).
We will seek meetings with key policy makers, funding and regulatory bodies to highlight the impact and raise the profile of carbohydrate metrology and gain support. (D4.3). We will ensure engagement with national member state glyco-initiatives to ensure joint efforts in this area ensuring maximum impact (D4.4). The final task is to prepare a roadmap for 2030 (D4.6) setting out a Europe wide vision. This will be produced using inout from key stakeholders obtained by a scoping meeting for roadmap input (D4.5).

D4.1 : Policy briefing papers (brief, one page) by ETA and/or BIS [26]

Policy briefing papers (brief, one page) by ETA and/or BIS

D4.2 : Successful case studies from industry and academia onto website [22]

Successful case studies from industry and academia onto website

D4.3 : Meeting 1 with key policy makers, funding and regulatory bodies [9]

Meeting with key policy makers, funding and regulatory bodies

D4.4 : Engagement 1 with national member state glyco-initiatives [9]

Engagement with national member state glyco-initiatives

D4.5 : Scoping meeting for roadmap input [36]
Scoping meeting for roadmap input

D4.6 : Production of roadmap [42]
Production of a roadmap

D4.7 : Meeting 2 with key policy makers, funding and regulatory bodies [21]
Meeting with key policy makers, funding and regulatory bodies

D4.8 : Meeting 3 with key policy makers, funding and regulatory bodies [33]
Meeting with key policy makers, funding and regulatory bodies

D4.9 : Meeting 4 with key policy makers, funding and regulatory bodies [45]
Meeting with key policy makers, funding and regulatory bodies

D4.10 : Engagement 2 with national member state glyco-initiatives [21]
Engagement with national member state glyco-initiatives

D4.11 : Engagement 3 with national member state glyco-initiatives [33]
Engagement with national member state glyco-initiatives

D4.12 : Engagement 4 with national member state glyco-initiatives [45]
Engagement with national member state glyco-initiatives

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS5	Roadmap for 2020 established	1 - UNIMAN	42	The roadmap is published and available for dissemination and engagement with policy makers and funding bodies.

Work package number [9]	WP5	**Lead beneficiary** [10]	1 - UNIMAN
Work package title	Project Coordination & Management		
Start month	1	**End month**	48

Objectives

To manage the project to a high standard ensuring maximum cooperation and engagement is achieved for maximum outputs and value.

Description of work and role of partners

WP5 - Project Coordination & Management [Months: 1-48]
UNIMAN
Lead partner: UoM.
A dedicated CarboMet Project Manager will coordinate and deliver activities under the guidance of the Project Coordinator, Working Group (WG) and Industry Steering Group (ISG).
Task 5.1: Project establishment activities
Establish overall project plan, including timing of meetings and workshops, and a communication and dissemination plan, both of which will be updated on a regular basis. Suitable representatives from each of the BISs will be approached and invited to sit on an Industry Steering Group (ISG).
Task 5.2: Commission and maintain project website
Design, develop and maintain a dedicated project website for CarboMet that will be accessible by all stakeholders and the wider scientific research and innovation community. Regularly update the website with outputs from meetings and workshops and stakeholder surveys, and other information using input from all stakeholders.
Task 5.3: Meeting & workshop organisation
Coordinate and arrange meetings and workshops. As appropriate these may be joint meetings between BISs and/or ETAs. To ensure maximum impact and engagement additional meetings will be organised as required between Working Group members and policy makers.
Task 5.4: Online surveys
Online surveys will be created and disseminated to the wider community for input on key areas identified during workshops and by the WG and ISG.
Task 5.5: Policy documents including final Roadmap
Coordinate input from WG, ISG and other stakeholders on content for policy papers and final road map.
Task 5.6: Stakeholder Communication activities
Regularly update all stakeholders via periodic e-newsletters and social media such as Twitter and LinkedIn.
Task 5.7: Project progress reporting
Periodic project reporting including financial details as set out in and required by the grant agreement and the EC.

Participation per Partner

Partner number and short name	WP5 effort
1 - UNIMAN	8.50
Total	8.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.1	Project Plan	1 - UNIMAN	Report	Confidential, only for members of the	1

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
				consortium (including the Commission Services)	
D5.2	Kick off meeting with Working Group	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	2
D5.3	Dissemination & Exploitation plan	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D5.4	Data Management plan	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	6
D5.5	Industry Steering Group appointed	1 - UNIMAN	Report	Public	6
D5.6	Project website & logo	1 - UNIMAN	Websites, patents filling, etc.	Public	2
D5.7	Meetings and workshop calendar including hosts and locations on website	1 - UNIMAN	Websites, patents filling, etc.	Public	9
D5.8	Social media accounts established	1 - UNIMAN	Websites, patents filling, etc.	Public	2
D5.9	Periodic e-newsletter 1	1 - UNIMAN	Report	Public	12
D5.10	Data Management plan Y1 update	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	12
D5.11	Data Management plan Y2 update	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	24
D5.12	Data Management plan Y3 update	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	36
D5.13	Data Management plan Y4 update	1 - UNIMAN	ORDP: Open Research Data Pilot	Public	48
D5.14	Periodic reporting RP1	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	26

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.15	Periodic reporting RP2	1 - UNIMAN	Report	Confidential, only for members of the consortium (including the Commission Services)	48
D5.16	Periodic e-newsletter 2	1 - UNIMAN	Report	Public	18
D5.17	Periodic e-newsletter 3	1 - UNIMAN	Report	Public	24
D5.18	Periodic e-newsletter 4	1 - UNIMAN	Report	Public	30
D5.19	Periodic e-newsletter 5	1 - UNIMAN	Report	Public	36
D5.20	Periodic e-newsletter 6	1 - UNIMAN	Report	Public	42
D5.21	Periodic e-newsletter 7	1 - UNIMAN	Report	Public	48

Description of deliverables

A project plan will be produced (D5.1) followed by a kick off meeting with the working group (D5.2) to plan the details of CarboMet activities. This will include the Dissemination & Exploitation plan (D5.3) and the Data Management plan (D5.4). During the kick off meeting the Industry Steering Group will be appointed (D5.5). Project website established (D5.6) to host various deliverables and will include the meetings and workshop calendar (D5.7) including hosts and locations on website. Social media will be used as a dissemination tool and accounts will be established from the outset (D5.8). A series of periodic e-newsletters will be produced (D5.9).
Periodic project progress reporting will be carried out as required by the grant agreement including final project progress report and financial reporting.

D5.1 : Project Plan [1]

Project Plan

D5.2 : Kick off meeting with Working Group [2]

Kick off meeting with Working Group

D5.3 : Dissemination & Exploitation plan [3]

Dissemination & Exploitation plan

D5.4 : Data Management plan [6]

Data Management plan

D5.5 : Industry Steering Group appointed [6]

Industry Steering Group appointed

D5.6 : Project website & logo [2]

Project website established and logo designed

D5.7 : Meetings and workshop calendar including hosts and locations on website [9]

Meetings and workshop calendar including hosts and locations on website

D5.8 : Social media accounts established [2]

Social media accounts established

D5.9 : Periodic e-newsletter 1 [12]

Periodic e-newsletter

D5.10 : Data Management plan Y1 update [12]

Year 1 update of Data Management plan

D5.11 : Data Management plan Y2 update [24]

Year 2 update of Data Management plan

D5.12 : Data Management plan Y3 update [36]

Year 3 update of Data Management plan

D5.13 : Data Management plan Y4 update [48]

Year 4 update of Data Management plan

D5.14 : Periodic reporting RP1 [26]

Periodic reporting for period 1 (M1-24). Will include technical and financial reporting and associated action check meeting. An update on progress towards all Deliverables and Milestones in the period will be provided.

D5.15 : Periodic reporting RP2 [48]

Periodic reporting for period 2 (M25-48). Will include technical and financial reporting and associated action check meeting. An update on progress towards all Deliverables and Milestones in the period will be provided.

D5.16 : Periodic e-newsletter 2 [18]

Periodic e-newsletter

D5.17 : Periodic e-newsletter 3 [24]

Periodic e-newsletter

D5.18 : Periodic e-newsletter 4 [30]

Periodic e-newsletter

D5.19 : Periodic e-newsletter 5 [36]

Periodic e-newsletter

D5.20 : Periodic e-newsletter 6 [42]

Periodic e-newsletter

D5.21 : Periodic e-newsletter 7 [48]

Periodic e-newsletter

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS1	Project initiated	1 - UNIMAN	6	• Kick off meeting held. • ISG appointed and in place. • Press release or newsletter to announce CarboMet.
MS2	Website established	1 - UNIMAN	12	Website publicly available to view.

Work package number [9]	WP6	Lead beneficiary [10]	1 - UNIMAN
Work package title	Ethics requirements		
Start month	1	End month	48

Objectives

The objective is to ensure compliance with the 'ethics requirements' set out in this work package.

Description of work and role of partners

WP6 - Ethics requirements [Months: 1-48]
UNIMAN
This work package sets out the 'ethics requirements' that the project must comply with.

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D6.1	POPD - Requirement No. 2	1 - UNIMAN	Ethics	Confidential, only for members of the consortium (including the Commission Services)	9

Description of deliverables

The 'ethics requirements' that the project must comply with are included as deliverables in this work package.

D6.1 : POPD - Requirement No. 2 [9]

1. Copies of authorization from the Institutional Data Protection Officer or authorization by the National Data Protection Authority, depending on what is applicable in the respective country, must be obtained, in compliance with the Data Protection Directive (EC Directive 95/46) and, once entered into force by May 2018, with Regulation 2016/679. 2. In case of collection of data not publicly available, copies of authorization from the Institutional Data Protection Officer or authorization by the National Data Protection Authority, depending on what is applicable in the respective country, must be obtained, in compliance with the Data Protection Directive (EC Directive 95/46) and, once entered into force by May 2018, with Regulation 2016/679.

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification

1.3.4. WT4 List of milestones

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
MS1	Project initiated	WP5	1 - UNIMAN	6	• Kick off meeting held. • ISG appointed and in place. • Press release or newsletter to announce CarboMet.
MS2	Website established	WP5	1 - UNIMAN	12	Website publicly available to view.
MS3	Information gathering stage 1 completed	WP1, WP2, WP3	1 - UNIMAN	18	Website update completed using input from stakeholders based on outputs from scoping workshops.
MS4	Information gathering stage 2 completed	WP1, WP2, WP3	1 - UNIMAN	30	Website update completed using input from stakeholders based on outputs from online surveys.
MS5	Roadmap for 2020 established	WP4	1 - UNIMAN	42	The roadmap is published and available for dissemination and engagement with policy makers and funding bodies.

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	Member of the Working Group decides to leave the project - LOW	WP1, WP2, WP3, WP4, WP5	We have appointed 2 representatives per work package. Should a member leave we will appoint a second representative from within the network, which will grow as the project develops providing a pool of suitable candidates from which to select.
2	Unforeseen changes in the membership of the Industrial Steering Group - MEDIUM	WP1, WP2, WP3, WP4, WP5	Rotation in membership of the Industrial Steering Group will be beneficial as it will ensure a wide range of companies and industries have the opportunity to provide strong input to the project. New members will be recruited from within the network which will grow as the project progresses, or from outside the network depending on the needs of the network at the time.
3	Low participation in meetings and workshops - MEDIUM	WP1, WP2, WP3, WP4	Invitations to attend events will be widely disseminated to the community through all available channels. The meetings and workshops will be followed up with online surveys that will capture input from additional stakeholders unable to physically attend meetings and workshops in person.
4	Number of responses received from the network to online surveys are insufficient - LOW	WP1, WP2, WP3, WP4	Invitations to participate will be widely disseminated to the community through all available channels. The surveys will be made available for input for a significant duration (6 months). In the event of a low response rate, stakeholders will be contacted by follow up emails and phone calls to encourage survey completion.
5	Unforeseen delays in establishing the project website - LOW	WP5	The website will be a key dissemination tool for CarboMet. Any delays in the ability to communicate through the website will be counteracted with the use of other methods such as social media or newsletters.
6	Information gathering stage captures insufficient information - LOW	WP1, WP2, WP3	The information gathering stage has been designed to be lengthy (i.e. from establishment of website M6 to further updates in M36). In addition stakeholders will be able to make input using a number of methods. However, in the event of a low response rate, stakeholders will be contacted by follow up emails and phone calls.. The management team have been selected for their expertise and will correlate the information captured.
7	Delays in Roadmap for 2020 being established - LOW	WP4	To complement the roadmap, a series of shorter policy briefing papers (1 page) will be produced to allow engagement and communication with policy makers and funding bodies as well as other stakeholders until such time when the roadmap is available.

1.3.6. WT6 Summary of project effort in person-months

	WP1	WP2	WP3	WP4	WP5	WP6	Total Person/Months per Participant
1 - UNIMAN	5.50	5.50	5.50	5.50	8.50		30.50
Total Person/Months	5.50	5.50	5.50	5.50	8.50		30.50

1.3.7. WT7 Tentative schedule of project reviews

No project reviews indicated

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Commission). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent fillings, videos, etc.
OTHER	
ETHICS	Ethics requirement

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU	Public
CO	Confidential, only for members of the consortium (including the Commission Services)
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
EU-SEC	Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number:MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

VA	if virtual access,
TA-uc	if trans-national access with access costs declared on the basis of unit cost,
TA-ac	if trans-national access with access costs declared as actual costs, and
TA-cb	if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.

History of Changes

Part A	
Table 3.2b	Removed risk 'Lead partner makes a decision to leave due to unforeseen reasons LOW'
Section 3.3	Added line 'In the context of this project, Bio-Shape will not provide any technology but will provide an industrial perspective in the information gathering stages for WPs1-3 and Milestones 3 and 4.'
Milestone 3	Amended Milestone name to 'Information gathering stage 1' (insertion). Means of verification – deleted 'and online surveys'.
Milestone 4 / 5	'Roadmap for 2020' re-numbered from 4 to Milestone 5 / added Milestone 5
Milestone 4	Re-named Milestone 4 as 'Information gathering stage 2 completed' and; Means of Verification as 'Website update completed using input from stakeholders based on outputs from online surveys.
D1.2	Title amended to include 'carbohydrate analytics & measurements', changed from type DEC to OTHER and; Dissemination CO to PU
D1.3	Changed Dissemination from CO to PU
D1.5	Title amended to include 'analytics & measurements' and changed from type DEC to OTHER and; Dissemination CO to PU
D2.2	Title amended to include 'synthesis of standards', changed from type DEC to OTHER and; Dissemination CO to PU
D2.3	Changed Dissemination from CO to PU
D2.5	Title amended to include 'synthesis of standards' and changed from type DEC to OTHER and; Dissemination CO to PU
D3.2	Title amended to include 'bioinformatics & databases, changed from type DEC to OTHER and; Dissemination CO to PU
D3.3	Changed Dissemination from CO to PU
D3.5	Title amended to include 'bioinformatics & databases' and changed from type DEC to OTHER and; Dissemination CO to PU
D4.3	Title amended to include 'meeting 1' and changed from type DEC to OTHER and; Dissemination CO to PU.
D4.7, D4.8 and D4.9	Added as complimentary to D4.3 and correspond to meetings 2, 3, and 4 in Months 21, 33, and 45 respectively.
D4.4	Title amended to include 'engagement 1' and changed from type DEC to OTHER and; Dissemination CO to PU.
D4.10, D4.11 and D4.12	Added as complimentary to D4.4 and correspond to engagement 2, 3, and 4 in Months 21, 33, and 45 respectively.
D4.5	Changed Dissemination from CO to PU
D5.4	Changed from type R to ORDP and; Dissemination CO to PU
D5.10, D5.11, D5.12 and D5.13	Added as complimentary to D5.4 and correspond to annual updates for years 1, 2, 3, and 4 in Months 12, 24, 36, and 48 respectively.
D5.6	Changed from month 6 to 2. Title amended to include logo design
D5.9	Title amended to include '1' and changed from Dissemination CO to PU.
D5.16, D5.17, D5.18, D5.19, D5.20, D5.21	Added as complimentary to D5.9 and correspond to e-newsletters 2, 3, 4, 5, 6, and 7 in Months 18, 24, 30, 36, 42 and 48 respectively.
D5.10	'Periodic progress reporting' Removed and replaced with D5.14
D5.14	'Periodic reporting RP1' added to replace D5.10
D5.11	'Final project progress report and financial reporting' Removed and replaced with D5.15
D5.15	'Periodic reporting RP2' added to replace D5.11
Table 3.1a	Deliverable changes updated in work package descriptions
Table 3.1c	List of deliverables to include changes and additions
Table 3.4b	Training workshops deleted and replaced with advanced technologies showcase meetings
Section 4.2	Table 4.2 added
Section 5.1	Updated as requested by Ethics Summary Report 19/09/2016

Table of Contents

1 Excellence

Carbohydrates are ubiquitous. They comprise a core set of molecules, polymers and materials on which all life depends. The biological role of carbohydrates depends on context: Carbohydrates are major components of foods, they are key to modern medicine and they are a primary source of natural materials. Carbohydrates constitute the largest source of biomass on Earth and their exploitation will be crucial if we are to reduce our dependence on fossil fuels and create a Circular Economy. Produced from sunlight and carbon dioxide by plants, algae and photosynthetic bacteria, carbohydrates are a truly renewable resource and a viable sustainable alternative to fossil fuels.

However, to understand and ultimately exploit carbohydrates, we must be able to unambiguously elucidate carbohydrate structure. Methodology for comprehensive structural elucidation of carbohydrates has been slower to develop than for protein and nucleic acid sequencing, in part because of the relative intractability of the diverse and non-templated biological systems giving rise to them. Carbohydrates (and glycoconjugates) are especially challenging to analyse due to their high (stereo)chemical diversity which means it is difficult to distinguish between them and fully characterise using standard techniques and methods. Current methodologies to fully solve 3-D structures include: NMR and X-Ray Crystallography which are low-throughput, require mg-scale of sample and have poor sensitivity and a low dynamic range. There are a number of emerging new technologies that are beginning to address these issues such as ion mobility mass spectrometry (IM-MS) and the combination of 3 gas phase techniques: vibrational spectroscopy (IR) with Ion Mobility Mass Spectrometry (IM-MS) *in-vitro* enabling high-throughput (tens of minutes) with higher sensitivity, low levels of sample material (μM), and analysis from mixtures, minimizing pre-purification; providing structural detail on each component. These emerging technologies are also underpinned by advanced supporting technologies such as automated carbohydrate synthesis, glyco-specific bioinformatics tools and databases and within the next 5 years, a new suite of glycoenzymes for glycan synthesis and structural modification and enhancements.

This application is particularly timely because there is a pressing need for a suite of measurements and metrology tools for carbohydrates that will be essential to underpin new research and innovation for the full exploitation of carbohydrates for the benefit of European society. If you cannot fully measure something you cannot understand, or indeed control and manage it. CarboMet aims to support the development of metrology technologies which will have similar magnitudes of impact on European carbohydrate science to those of DNA sequencing and synthesis on Industrial Biotechnologies in general. Currently, the relatively disparate nature of the communities and diversity of industrial sectors in the area represent barriers to effective engagement and cross-sectorial collaboration, and the absence of pan-European coordination is a major contributory factor to this.

Through this action we will bring together key players from several BioIndustry Sectors to specify what measurements/tools are sub-standard or unattainable by the current state-of-the art and emerging technologies, through cross fertilisation of ideas and strategies between them. By facilitating communication, the current state of the art in each area will be highlighted which will lead to the consideration of cutting edge aspects in each field, radically new technologies unforeseen by current roadmaps and the application and/or major modification of existing technologies currently in practice or emerging beyond the purview of the glycoscience community.

In addition, priority areas and future challenge areas based on technological, manufacturing or regulatory aspects will lead to a ‘wish list’ of capabilities for innovators and developers to address and consider when focusing on the development of new measurements and metrology technologies.

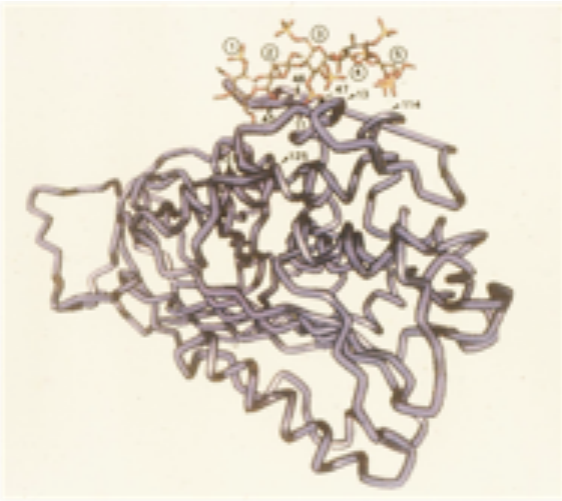
The availability of these new tools will in turn will lead to the discovery and development of novel carbohydrate-based products, processes and technologies.

CarboMet will build on world-leading technological capabilities and proven track record within Europe, essential for advancement of glycoscience. The aim is to maintain the European-lead and

translate new emerging and currently unforeseen innovative scientific discoveries in the metrology of carbohydrates and closely related areas resulting in new and improved industrial processes and practices.

The applicants are well aware of the current Horizon 2020 European Metrology Programme on Innovation and Research (EMPIR). Consultations with leading NMIs in Europe and further afield to determine the interest in an EMPIR-led initiative on Carbohydrate Metrology, probably under the Health theme, have therefore taken place. The NMIs consulted accepted that the area was of great potential importance, however, before a major investment were to be placed in this area under EMPIR it was agreed there was a need both to estimate and to project where over the next decade and beyond the great challenges were likely to be and thence to draw up an action plan following this. Consequently, in February 2016 a Workshop was held in Brussels on Future Challenges in the Metrology of Carbohydrates. This attracted a significant number of SMEs and some large companies (30 out of 58 delegates) as well as leading academics from all over Europe, all of which presented papers on where they saw the major science challenges and/or potential untapped business areas. At the end of the meeting a preliminary action plan was put together. It was agreed that a business plan needed to be developed as well as a detailed road map of future actions; all to be drawn up as a matter of urgency. Following this workshop, a Working Group was established (Serge Perez and Anne Imberty, Centre National Recherche Scientifique (FR); Paula Domann, LGC Limited (GB); Daniel Spencer, Ludger Limited (GB); Peter Seeberger, Max Planck Institute of Colloids and Interfaces (DE); Lokesh Joshi, NUI Galway (IE); Frederigue Lisacek, Swiss Institute of Bioinformatics (CH); Isabelle Compagnon, Université de Lyon Claude Bernard (FR)) building on deliberations at this workshop to develop this CSA proposal, which all participants recognise as core to carrying this endeavour forward.

Case study: The Heparin contamination crisis (2008) – an example of why carbohydrate metrology is so important



Heparin is a polysaccharide that interacts with antithrombin in blood and is widely used in the clinic as an injectable anticoagulant, isolated from natural sources.
In 2008, the use of adulterated samples of heparin caused a number of deaths and highlighted the lack analytical scrutiny of this commonly used carbohydrate based medicine. There are now enhanced safety measures in place alongside better sourcing control of the pharmaceutical supply chain in place, as well as new analytical methods for more comprehensive screening of drug and incipient identities and impurity profiles were specified.[1] This is a specific example of how advanced metrology can lead to improved product safety.

[1] Lever, R., Mulloy, B., Page, C. P., (eds) *Heparin – A Century of Progress,* Handbook of Experimental Pharmacology 207, Springer-Verlag Berlin Heidelberg 2012.

Glossary

Carbohydrates are also known as **sugars, saccharides,** and **glycans.**

Glycoconjugates are biomolecules such as proteins, lipids or metabolites linked to glycans.

Glycoscience and **Glycobiotechnology** encompass all activities related to the science and technology of carbohydrates.

Glycomics studies the structure and function of carbohydrates in cells, tissues and organisms.

1.1. Objectives

Over the course of **CarboMet** we will build up a picture of the current provision in 3 Enabling Technology Areas (ETAs) across 4 BioIndustry Sectors (BISs) as shown in Figure 1 below. CarboMet activities will facilitate engagement between key players and stakeholders in each ETA and BIS to ensure full engagement of the glycoscience community across Europe to identify the current state of the art and in particular future innovation and technological challenges in carbohydrate metrology.

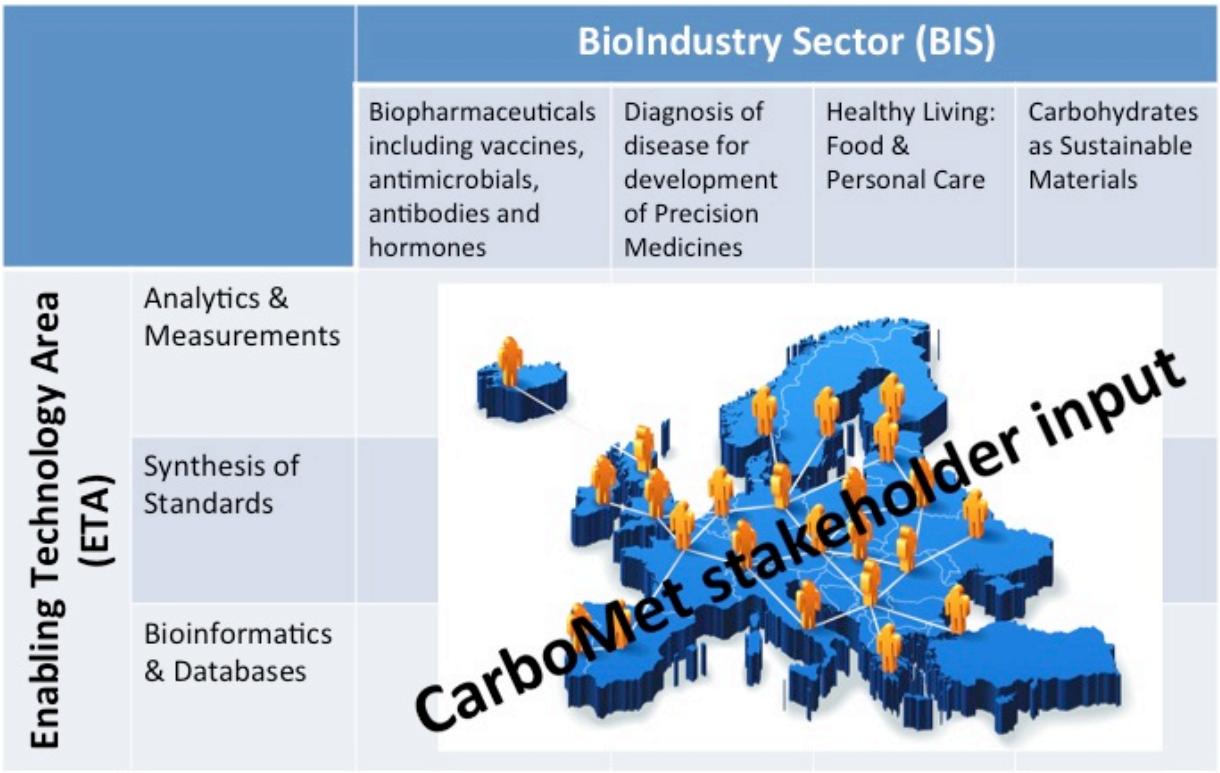


Figure 1: An overview of the **CarboMet** matrix showing the ETAs and BISs. This ETA-BIS matrix will be completed over the lifetime of project using input from stakeholders for dissemination to the wider research community.

1.1.1. Specific Objectives

The 5 key **objectives** of **CarboMet** are summarised schematically in Figure 2 below.

These objectives will be achieved by groups within the CSA working in parallel on **3 Enabling Technology Areas (ETAs)**:

1. Analytics & Measurements
2. Synthesis of Standards
3. Bioinformatics & Databases

First of all, we will carry out detailed assessments of the current state of the art and capabilities within each ETA. Following this, we will define the effort needed to progress beyond the state of the art. Below therefore, we first expand on what each objective is about and after this we explain how working on the 3 ETAs will help to achieve the 5 objectives. More details on the ETAs are under objective 2 below.

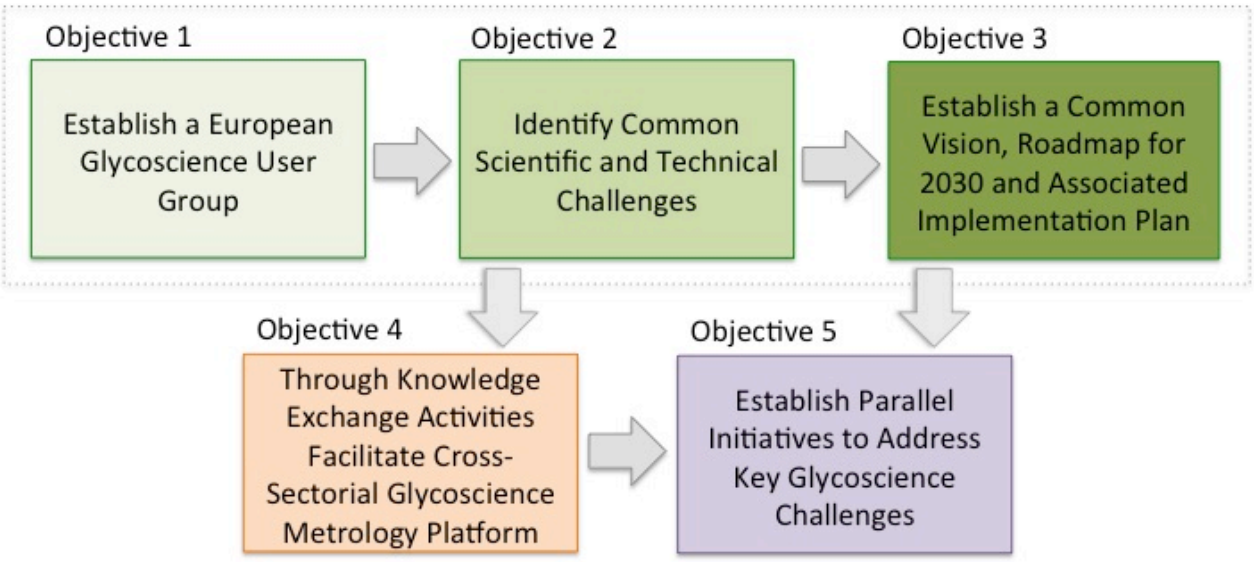


Figure 2: Schematic to show **CarboMet** Objectives.

- **Objective 1: Establish a European Glycoscience User Group (EU-GUG) –** The purpose of this Objective is to have a large group of experts drawn from all relevant disciplines and sectors that facilitates the exchange of non-competitive metrological know-how between stakeholders. In the introduction above it was emphasised that carbohydrates are ubiquitous. This very ubiquity means that the exploitation of carbohydrates has the potential for enormous impact on a number of areas that are of interest to European society and indeed worldwide. Therefore the group of experts must be fully representative of the 4 **BioIndustry Sectors (BISs),** which were identified at the recent workshop (see textbox below). **CarboMet** will drive cross-sectorial collaboration between the BISs. For example between the food and health industries, where innovative functional food products have the potential to benefit health and wellbeing.

  Success criterion – Success will be measured by the degree to which we have brought together key players from academia and industry with expertise in carbohydrates and glycoscience who have an interest in their application. Our criterion for success is therefore that the CSA should be made up of representatives from over 500 organisations, including research groups, innovators, manufacturers, end users such as patient groups, policy makers and wide involvement across all sectors will be judged as a criterion of success.

- **Objective 2: Identify Common Scientific and Technical Challenges – CarboMet** will identify common scientific and technical challenges, in each of the 4 BISs listed above using as tools the three ETAs and assess their relevance of these challenges to the other BISs. The scientific and

technical challenges will specifically relate to ETAs as follows:

- **Measurements and Analytical:** Techniques which allow quantitative, structural characterisation of different carbohydrates with a view to ensuring that technical specifications for manufacturing and regulatory requirements are met.
- **Synthesis of Standards:** Defining the range of standards and reference materials required will present major synthetic challenges in their production. Specifications of these required new standards will be determined.
- **Bioinformatics and Databases** to provide reference data, to understand the complex activity structure relationships of carbohydrates and to act as viable alternative tools for in vitro testing.

Success criteria – CarboMet will identify a minimum of 10 common strategic scientific and industrial challenges across the 3 ETAs specified above. This will include barriers the community need to jointly overcome with a consolidated effort to ensure that Europe leads future innovation of new technologies within glycoscience. Formulation of new or a number of new technology specification(s) will be compiled to enable dedicated future demonstration funding proposals. In addition, training and education opportunities and future needs will also be defined

Workshop: Metrology of Carbohydrates
The Sheraton Brussels Hotel, Brussels, 18-19th February 2016

To gauge interest for this initiative we have hosted a European-wide scoping workshop 'Metrology of Carbohydrates' comprising invited key players from academia and industry that focused on future metrology and analytical science needs over the next decade concerning both carbohydrates and glycoconjugates.
In attendance at the workshop were a number of companies, large and small, from across Europe and a variety of sectors as follows:

BASF | Bio-Shape Ltd | Covance Laboratories | Dextra UK | DSM | Elicityl | Fermentalg | Friesland Campina | Glycomix Ltd | GlycoSeLect Ltd | GSK Vaccines | Inbiose | Intellihep | LGC | Ludger Ltd | MedImmune | Nestec | Polymaris Technology | Prozomix | Sanofi | TdB Consultancy | UCB | Unilever | Waters Corporation

Through a series of industry perspectives and group discussions at the workshop, a picture began to emerge on the current state of the art and gaps in capabilities.
Four BioIndustry Sectors (BISs) *were identified as of immediate interest where the exploitation of carbohydrates will have huge impact:*

- **Biopharmaceuticals including vaccines; antimicrobials, antibodies and hormones;**
- **Diagnosis of disease at a personal level for the development of precision medicines;**
- **Healthy lifestyles from good food & personal care, including for healthy ageing;**
- **Carbohydrates as the sustainable material for the future**

The overwhelming consensus from delegates was the need for follow-on community building and networking, including through education and training activities, as well as promoting the field and highlighting potential impact in order to influence policy. In order to achieve this a business plan and a roadmap were required.

- **Objective 3: Establish a Common Vision, Roadmap for 2030 and an Associated Implementation Plan – CarboMet** will establish a comprehensive overview of the work done within Objective 2 in order to enable European Bioindustries to achieve global leadership for the delivery of standardised carbohydrate and glycoconjugate metrology methods.

Success Criteria – A fully validated strategic roadmap and implementation plan will be created and published by year 4. Validation will be achieved by having input from all **CarboMet** stakeholders

and a dedicated scoping workshop will be held to formulate an initial draft roadmap, which will then be widely circulated for further input and validation. The roadmap will be designed to fill gaps and make meaningful contributions to existing complementary roadmaps and strategic research agendas, but is intended to be a primary resource to guide leadership within the field. The BBI-PPP and IMI aspirations and strategies will in particular be kept in mind here.

- **Objective 4: Through Knowledge Exchange Activities Facilitate the Formation of a Cross-Sectorial Glycoscience Metrology Platform – CarboMet** will draw on the actions and activities described in Objective 2 and 3 to create a Knowledge Platform on Glycoscience priorities and challenge areas. These will be captured in a series of briefing papers that will form a basis for the European National Measurement Institutes (**NMI**) to construct a future set of priorities and a possible program on metrology needs for carbohydrates and glycoconjugates under EMPIR.

  Success criterion – To have a Glycoscience Knowledge Platform in place by 2018, which European NMIs own and acknowledge as being of key value in their forward planning activities.

- **Objective 5: Establish Parallel Initiatives to Address Key Glycoscience Challenges** – Establishment of **CarboMet** will allow the community to inform on the opportunities that arise during the lifetime of **CarboMet**, such as funding calls and opportunities. By having the **CarboMet** network in place, members will be able to respond quickly to take advantage of such opportunities in order to complement, inform and strengthen **CarboMet** objectives.

  Success criterion – To have a dedicated **CarboMet** website by Q2 that alerts and highlights stakeholders of opportunities for funding support, in the identified scientific and industrial cross-sectorial challenge areas identified by **CarboMet** activities. Success will be measured by the number of research collaborations, to address the key glycoscience challenges identified, as a result of **CarboMet** activities.

1.1.2 Scientific Justification for the Priorities Set Out in Objectives 1-5

The Objectives described in paragraph 1.1.1. outline how **CarboMet** will foster and drive collaboration and communication among stakeholders in the field of carbohydrates and glycoscience generally, in particular on their metrology and analytical science needs with particular reference to structure determination, sequencing, modeling, databases and standards. It remains now for us to demonstrate in this section the value that will come to the community from engaging in establishing this proposed CSA.

Carbohydrates constitute the largest source of biomass on Earth and their exploitation will be crucial if we are to reduce our dependence on fossil fuels and create a Circular Economy. Produced from sunlight and carbon dioxide by plants, algae and photosynthetic bacteria, carbohydrates are a truly renewable resource and a viable sustainable alternative to fossil fuels (Figure 3).

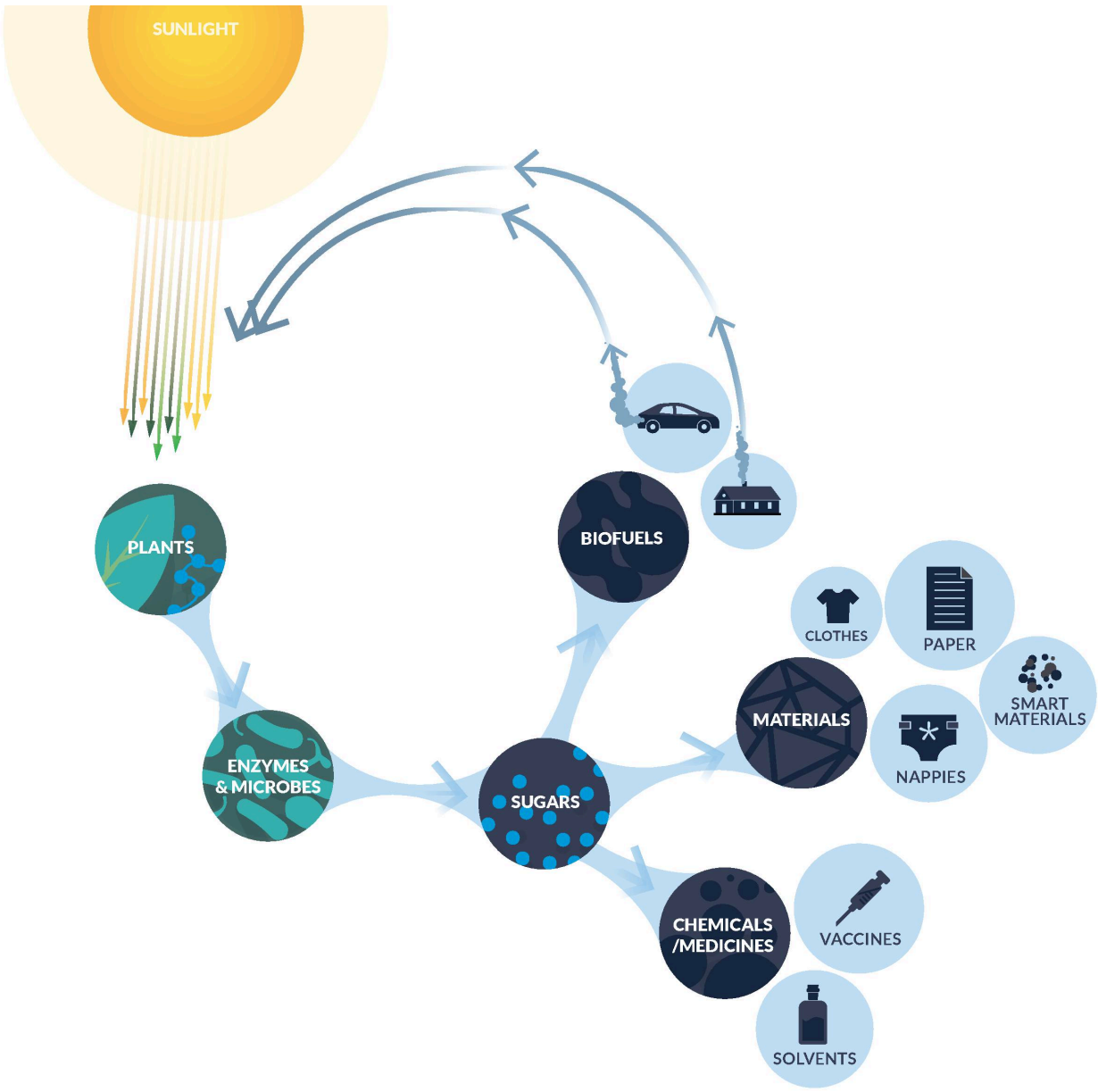


Figure 3: Carbohydrates are a truly sustainable resource, produced from sunlight using carbon dioxide and water, and thus will play a vital role in the Circular Economy for the sustainable production of chemicals, medicines, materials and biofuels.

More specifically, Carbohydrates are a large class of molecules with incredible diversity and complexity – there are over 100 known 'monosaccharides', and multiple possibilities and combinations for the assembly of these monosaccharides into larger, complex carbohydrate structures, branched or un-branched, which is not template-driven. This is in marked contrast to DNA, which is made up of just 4 nucleotide units, in un-branched chains with a template-driven biosynthesis. Figure 4 illustrates the current status of knowledge for carbohydrates, oligonucleotides, proteins and their complexes and the current status of research into them - carbohydrates are lagging behind and are at an early stage of research.

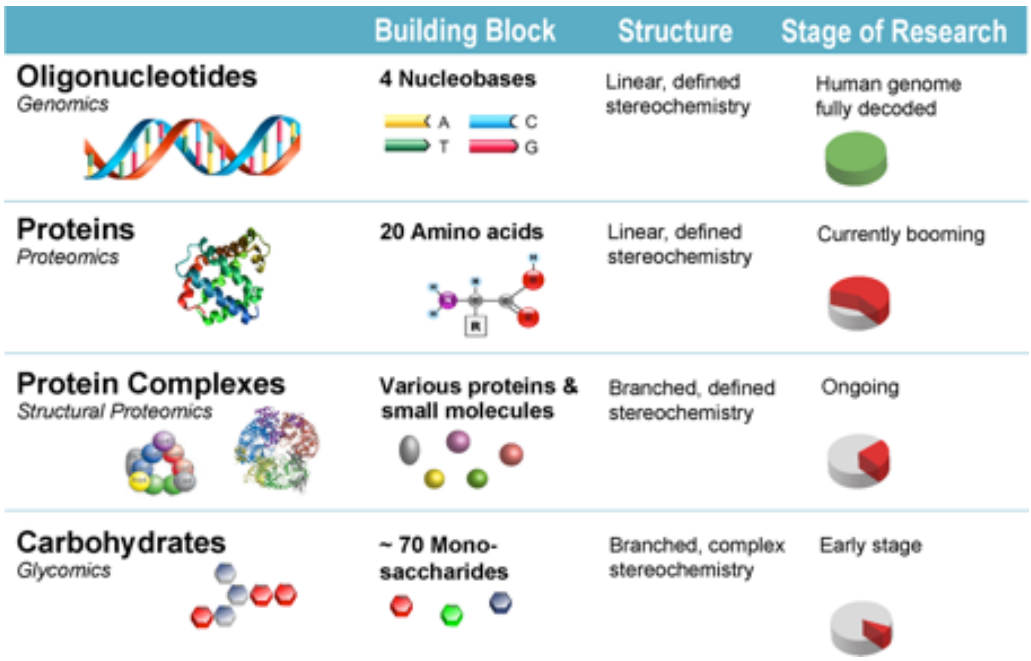


Figure 4: Carbohydrate sequencing and analysis is in the early stages of development compared with the other macromolecules important for life due to the inherent complexity and diversity in the number of monosaccharide building blocks available. (Source: Peter Seeberger, Potsdam).

Whilst carbohydrates are indeed challenging to manipulate due to this complexity, **their exploitation is a huge opportunity** and presents numerous possibilities due to this wide-ranging diversity. For example, compare starch and cellulose; both natural homo-polymers of glucose but with very different properties and roles in nature (cf. the role of starch in energy storage whilst cellulose is a structural component of plant cell walls). Note also that the aforementioned nucleotide units of DNA, which contain deoxyribose, a sugar molecule, further illustrating the diverse roles and importance of sugars in nature. Sugars can be found everywhere.

These considerations make 'glycoscience' a broad term for scientific research into carbohydrates ranging from analysis, synthesis and bioinformatics to cell biology and clinical application – an exciting frontier of modern science, that has seen dramatic developments during the past 10 years. Furthermore, European researchers have been leading internationally in particular in the areas of carbohydrate analysis, structure determination, sequencing, modeling, databases, and synthesis.

This is shown in Figure 5 below which illustrates the prolific research output of European researchers compared to the rest of the world based on research publications. This demonstrates that there is a wealth of knowledge within the European glycoscience research community that is ripe for exploitation for the benefit of Europe's bioeconomy.

Europe must maintain and even increase its lead position in this future and emerging technological opportunity. **CarboMet** will be the prime vehicle to catalyse this process and enable us to build on Europe's current world leading position by active engagement of stakeholders in the field within Europe (including research groups, innovators, manufacturers, end users such as patient groups, policy makers and the general public at large). How we intend to do this is encapsulated in the 5 objectives described in §1.1.1.

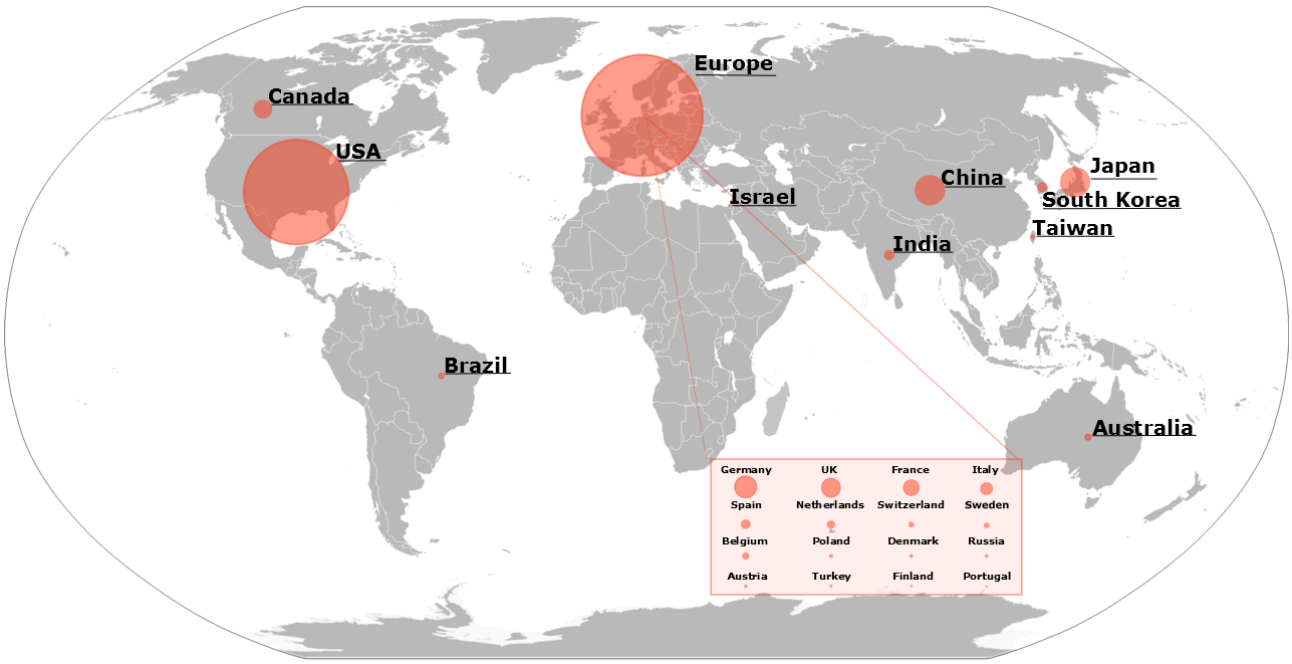


Figure 5: The publication output of European R&D glycoscientists is the highest in the world. The size of the circles represents the number of glycoscience papers published. The top performing countries are depicted.[2]

In a key policy document, which preceded the Workshop: 'Metrology of Carbohydrates '**A Roadmap for Glycoscience in Europe'**[3] a number of high impact areas for glycoscience research were highlighted including; **Pharmaceuticals, Personalised Medicines, Food & Nutrition, and, Biomaterials** for the benefit of European Bioindustries. **CarboMet** is in response to this roadmap and will bring together key players in each of these areas to address future metrology challenges in particular.

Glycoscience research has largely focused on R&D applications, and it is anticipated that this investment will drive product development in areas such as Medicine, Biomaterials and Food and the market is rapidly increasing - the glycomics R&D market includes enzymes, instruments, kits, and reagents used in research and development. Glycomics is used in diagnostics, drug discovery research, immunology, oncology, and many other applications. **The rapidly increasing global glycomics market (expected $930 million by 2019 from $510 million in 2014) is driven by investment in R&D from government and industry worldwide**.4

CarboMet intends to promote advances in carbohydrate metrology to European Bioindustries to:

- help European Bioindustries to produce innovative glyco- and carbohydrate based products and processes;
- facilitate and encourage strong engagement with the relevant EU regulatory bodies to ensure rapid delivery of innovations to market. This engagement will be crucial for successful translation of to market. For example, recent data on FDA drug approvals shows that 2015 was the most productive year for the pharmaceutical industry since 1996 with 45 new products receiving approval; the FDA attributes this success rate to better interactions with companies early on in the development process.[5]

[2] These data were produced by carrying out a Web of Science literature search on 20th January 2015 using the following search terms: *glyco*, *glyco**genom*, *glycom* and *glyco**proteom* during 2010-2015 giving a total of 1,557,961 results. The EU produced 34.6% of the total search results versus the USA (30%), which had the 2nd highest country output.

[3] Flitsch et al. (2015) *A Roadmap for Glycoscience in Europe* – a joint EGSF IBCarb publication. http://ibcarb.com/wp-content/uploads/White-Paper-amended-May-15.pdf0

[4] Glycobiology/Glycomics Market By Product [Enzymes (Glycosyltransferase, Neuraminidase, Glycosidase), Instruments (HPLC, Mass Spectrometry, MALDI-TOF), Kits, and Reagents], Application (Immunology, Oncology), End User Global Forecast to 2019, Markets and Markets

[5] C&EN, Vol. 94, Issue 5, p12-17 'The year in new drugs'

1.2 Relation to the work programme

Call: FETOPEN-02-2016: FET-Open Coordination and Support Actions (d) FET Innovation Greenhouse [2016]	
Extract from call text	**How CarboMet will address the call text**
FET Innovation Greenhouse [2016]: actions for establishing a Europe-wide capacity for innovation, exploitation and entrepreneurship stemming from the visionary, high-risk interdisciplinary science and technology research supported by FET. Greenhouse provides innovation support services to help bridging the gap between FET research and its application in industry and for society. The focus should be on enabling the earlier creative and learning stages of innovation from FET research, for which the classical path of business plans and investors is still premature, many options are still open and a more exploratory, risk-friendly and tailored support is needed. A wide technological scope, a strong specificity to FET and complementarity with existing greenhouse initiatives and innovation services are of prime importance. This subtopic also welcomes support to the actions funded under the FET Innovation Launchpad (FETOPEN-04- 2016-2017) and for networking and exchange among them.	**CarboMet** will establish a European Glycoscience User Group (EU-GUG), comprising of stakeholders from research groups (including social scientists), innovators, including starts ups and more established SMEs, manufacturers, and end users such as patient groups, and policy makers who have an interest in glycoscience based in Europe. Membership of the community will be targeted in alignment with the sectors identified in Objective 1 to bring a wide range of expertise and know-how. **CarboMet** activities will allow communication between these stakeholders to help bridge the gap between FET research and its application in industry and for society. **CarboMet** will engage the EU-GUG community to facilitate and drive information, know-how and knowledge exchange to stimulate through this cross-fertilisation of ideas, the formation of new, collaborative cross-sector initiatives. In turn these will lead to the creation of new knowledge as well as new commercialisation activities such as manufacturing processes and equipment as well as new products and services. This 'academic push – industry pull' mechanism will ensure exploratory research and innovations are developed with end applications in mind. **CarboMet** will facilitate and drive the exploitation of recent exciting developments in carbohydrate metrology from European academic laboratories to industrial applications in 4 diverse BioIndustry Sectors with different needs and challenges who will benefit from exposure to other technology areas which will undoubtedly inspire future developments. **CarboMet** will engage and coordinate activities between the various market sectors identified in order to translate academic developments into commercial reality.
Expected Impact: • Strengthening globally recognised European leadership in the early exploration of visionary, new and emerging technologies, beyond academic excellence and with a strong engagement of scientists, citizens, innovators and policy makers. • Improved long-term innovation	The prolific output of European researchers compared to the rest of the world based on research publications (Figure 5) demonstrates that there is a wealth of knowledge within the European glycoscience research community ripe for exploitation for the benefit of Europe's Bioeconomy. The development of an enabling technologies toolkit is crucial and is perhaps the most important aspect

potential in Europe both from the abundance of novel ideas and the range of actors ready to take them forward. • Improved understanding of the range of possible impact mechanisms for long-term science and technology research. • Improved readiness across Europe to engage in silo-breaking research collaboration and to take up new research and innovation practices.	required in order to exploit the possibilities carbohydrates have to offer.[6] High-throughput synthesis and sequencing technologies of DNA and proteins are seen as the key drivers of modern biotechnology and similar tools are required to realize the full potential of glyco-biotechnology. Europe has a number of leading scientists in this area who have made some significant advances in the past 10 years. Adequate provision of metrology and measurements tools for carbohydrates will be essential for new research and innovation practices in glycoscience. The tools we need are not there yet. By bringing together key players from several sectors we will specify what is needed through cross fertilisation of ideas and strategies and approaches to markets. Ensuring innovation aligns with regulation in this way will be a key activity of **CarboMet** and proactive engagement with the relevant regulatory bodies in each sector will be encouraged. Through joint events and workshops, sectors will be able to learn best practice enabling cross-sectorial strategies and approaches in areas of commonality across traditional industrial sectors. By engaging the relevant regulatory bodies at an early stage in the R&D process, we will ensure rapid delivery to market of the technologies and innovation arising from the interdisciplinary collaborations. We have witnessed a high level of interest in this initiative from several key players from industry as evidenced by a higher than anticipated attendance at an initial workshop (see textbox above -'Workshop: Metrology of Carbohydrates').

1.3 Concept and methodology, quality of the coordination and support measures

1.3.1 The Enabling Technology Areas (ETAs)

As outlined above there are 3 ETAs that will makeup the 'toolbox' for carbohydrate metrology that will be the focus of **CarboMet,** each detailed below:

1.3.1.1 Analytics & Measurements

A range of analytical measurement tools are required for structure determination, sequencing, and modeling of carbohydrates and for probing their interactions. For example, for the analysis of glycan side chains in glycoproteins and biopharmaceuticals and great strides have been made in the high-throughput sequencing of carbohydrate polymers, in particular by means of sophisticated mass spectrometry. We see this capability as an area already ripe for transfer into the commercial sector by providing opportunities for instrument manufacturers. At the same time, there are clear gaps in the technology due to the inherent complexity (and hence ambiguity) of carbohydrate structure (i.e. isomers which are not distinguishable using mass spectrometry alone). Close interaction between

[6] Walt et al. (2012) *Transforming Glycoscience: A Roadmap for the Future*, National Academies Press http://glyco.nas.edu

academia and instrument manufacturers will be essential for formulating the specific problems and then finding solutions to these ambiguities. A major economic pull will be the biopharmaceutical sector where there is a particular need for careful analysis of protein glycosylation processes and structures.

Microarray technology has also been exploited for the study of the glycan interactions (the so called 'glycoarrays') where glycans are displayed as array on surfaces that mimic those found on the cell surfaces as part of the glycocalyx and their interactions (see Figure 6). Several European laboratories are leading globally in glycoarray technology, which will be important for future development of glyco-based diagnostics (e.g. in cancer, diabetes) and personalised medicine.

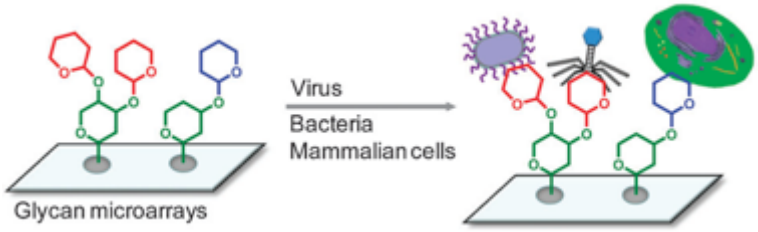


Figure 6: Glycan arrays are an important tool used to study carbohydrate interactions.[7]

1.3.1.2 Synthesis of Standards

There is a need to develop recognised methods and technologies for the standardised syntheses of carbohydrates. European scientists are at the forefront of developing such novel tools for glycan synthesis. Carbohydrate structures can be synthesized in the laboratory using combinations of traditional organic chemistry and chemoenzymatic methods. A broad range of 'glycoenzymes' are now available covering a significant amount of human carbohydrate sequence space. The latest advances include automated synthesis protocols that enable the assembly of sugar building blocks into glycans (Figure 7), in a similar manner to the programmable synthesisers that have long been used to produce DNA and amino acid sequences.[8]

Fast and efficient synthesis of carbohydrates including scale up processes (such as bacterial fermentation) have the potential to allow the production of standards for benchmarking and quality control as well as methods of production for carbohydrate based products e.g. human milk oligosaccharides. As the fields of glycoscience and glycobiotechnology progress, the need for more and more standardised synthetic methods and technologies will also increase.

Readily available standards will be required for benchmarking and quality control purposes. This is an opportunity for reagent manufacturers and suppliers. There will also be a need to ensure standards are suitable for relevant regulatory requirements as well as to increase awareness of what is available to the community. Ongoing engagement with regulatory bodies on developing and updating current and new monographs on best practice will be required. In addition, engagement with National Metrology Institutes (NMIs) and EURAMET for method and protocol standardization will also be important here.

[7] Park et al. (2013) Chem Soc Rev., 42, 4310-4326
[8] Plante et al. (2001) Science, 291, 1523-1527

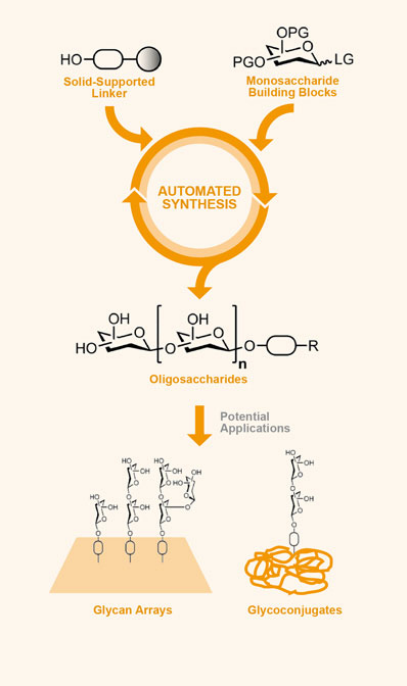


Figure 7: Schematic to show the process of automated oligosaccharide synthesis operates, in a similar fashion to the programmable synthesisers that have long been used to produce DNA and amino acid sequences.

1.3.1.3 Bioinformatics & Databases

The application of data mining techniques enhanced by high performance computing, efficient information searching and data extraction, will undoubtedly open new paths to discovery. Apart from collecting and processing raw data from published work, wealth lies in the extraction of pertinent information from any associated datasets, and their transformation into manageable and understandable sources. Recent advances in the area include the development of tools and databases for the structural analysis of carbohydrates (Glyco3D)[9].

These activities will be crucial to equip the Smart Factories of Industry 4.0 where such ICT tools will allow real-time capability and decentralisation are required to make decisions.

This data driven approach will lead to the highly efficient production of products such as glycoproteins where the correct glycosylation profile is vital to guarantee efficacy and patient safety, as just one example.

In parallel, a variety of on-line resources essentially in the form of databases covering glycan and glycoproteins structures have been developed by independent research groups world-wide (GlycomeDB[10], GlyTouCan[11], UniCarbKB[12]), enzymes responsible for their biosynthesis and degradation (CAZy[13]), glycan binding to human pathogens (SugarBindDB[14]), glyco-epitope and their antibodies (GlycoEpitope[15]), protein-glycan interactions (MatrixDB[16]). However, managed

[9] S. Pérez, A. Sarkar, A. Rivet, C. Breton & A. Imberty (2015) Glyco3D: A portal for structural glycosciences. *Meth. Mol. Biol.* 1273, 241-258
[10] http://www.glycome-db.org/About.action
[11] https://glytoucan.org
[12] http://www.unicarbkb.org
[13] http://www.cazy.org
[14] Mariethoz J, et al, SugarBindDB, a resource of glycan-mediated host-pathogen interactions Nucleic Acids Res. 2015 Nov 17. doi: 10.1093/nar/gkv1247.
[15] http://www.glycoepitope.jp/epitopes
[16] http://matrixdb.ibcp.fr

infrastructure that would contribute to the advancement of research not only on the provision of comprehensive structural, experimental and functional databases, but also on their interoperability. A managed and coordinated infrastructure is now urgently required. The concomitant expansion of stable and integrated databases, cross-referenced with popular bioinformatics resources should contribute to connecting glyco-mics with other –omics in much the same way other –omics have expanded through concomitant bioinformatics development. DNA and protein databases are now well established and invaluable resources for biotechnology. There is a critical need for carbohydrate equivalents. In addition it is important for such databases to be accessible, and contain reliable information in a searchable, format in order to be useful.

European scientists are leading MIRAGE (http://www.beilstein-institut.de/en/projects/mirage) a global effort to standardize and improve the quality of data in the literature. Existing databases are reliant on uncertain future funding and effort is required to maintain current initiatives perhaps through industry sponsorship, subscriptions or crowd funding. Stakeholders will be encouraged to contribute and make use of existing initiatives by increasing awareness and training workshops. Potential funding models will continue to be explored which will be required in order to secure the long-term future of glycomics databases.

1.3.2 Horizontal Actions

To support the 3 ETAs there is a set of horizontal actions, which will be pursued. These are listed below:

1.3.2.1 Education & Training

It will be important to educate the users of the technologies, which will include patients, healthcare professionals, scientists and policymakers, with coordinated programmes of online training as well as seminars, meetings and conferences. It will also be important to educate the public as well as raise professional awareness. Sadly, glycoscience is currently not part of the general school and higher education curriculum. This is a worldwide problem and US glycoscientists have recently highlighted the need for full integration of glycoscience into mainstream biology education.[17]

1.3.2.2 Policy Engagement

A key objective of **CarboMet** must be to raise the profile of carbohydrates as an extremely important class of biomolecules that up until now have been overlooked in terms of their importance, their exploitation potential and their innovation value. We will engage policy makers to ensure carbohydrates are included on the research and innovation agenda. We will also engage with regulators in all sectors to ensure innovation is well-aligned with regulation in order to allow rapid translation to market.

Note also that, the Coordinator of this proposed CSA, Professor Sabine Flitsch is currently participating in the MEP-Scientist Pairing Scheme, which is providing useful insight into the decision process within EU parliament.

1.3.3 National initiatives to link with the project

- **Dutch Society for Glycobiology (NL)** – A professional organisation of interdisciplinary research scientists and their industry colleagues that have an interest in carbohydrate structure and glycobiology in general, whose aim is to exchange knowledge and stimulate research.
Website: http://nvbmb.kncv.nl/sections/dutch-society-for-glycobiology

[17] *Training the next generation of biomedical investigators in glycosciences* Peter Agre ... David Walt, Irving Weissman, J Clin Invest. 2016;126(2):405-408. doi:10.1172/JCI85905

- **EGSF (EU)** – Although now completed, the ESF Euroglycoforum, promoted glycoscience within the wider academic scientific community. This is the initiative that culminated in the production of a white paper 'A roadmap for Glycoscience in Europe', a joint exercise with IBCarb (*vide supra*) that was published in 2015, and is referred to above. It is intended that the community of scientists that participated in EGSF shall be a starting point for establishing the **CarboMet** consortium.
Chair: Sabine Flitsch, Manchester Institute of Biotechnology, University of Manchester, (GB)
Vice Chair: Serge Perez, CNRS, Grenoble, (FR)
Website: www.egsf.org
Duration: Feb 2009 – Feb 2014.

- **French Glycoscience Group (CFG) (FR)** – is one of the 16 thematic groups of the French Chemical Society and one of the four Associated Groups of the French Biochemistry and Molecular Biology Society. Its objective is to promote and develop applied and basic science related to glycosciences: structural analysis, organic and chemoenzymatic synthesis, metabolism and biological functions of carbohydrates and glycoconjugates.
Website: http://gfg.univ-lyon1.fr/

- **Glycoscience Ireland (IE)** – Encourages inter-disciplinary collaboration between glycoscientists, biologists, chemists, engineers, information scientists and clinicians, interested in exploring novel glycoscience approaches to their particular research questions, to build on the wealth of expertise that is directly relevant to the biopharmaceutical and food industries in Ireland and abroad. It provides a forum for communication and interaction between Irish glycoscientists and industry representatives in Ireland and further afield that will be responsible for the translation of glycoscience discoveries into commercial and clinical realities.
Website: http://www.glycoscienceireland.ie

- **IBCarb (GB)** – Glycoscience Tools for Biotechnology & Bioenergy, is a BBSRC Network in Industrial Biotechnology & Bioenergy ('NIBB') a UK government funded initiative which aims to foster collaborations between academia, industry, policy makers and NGOs in order to find new approaches to tackle research challenges, translate research and deliver key benefits in industrial biotechnology. This network currently has ~400 members from academia and industry.
Director: Sabine Flitsch, Manchester Institute of Biotechnology, University of Manchester (GB)
Co-Director: Rob Field, John Innes Centre, Norwich (GB)
Website: www.ibcarb.com
Duration: 01/01/2014-31/12/2018.

- **International Glycophysics Network (FR)** – This has been established to accelerate the technological transfer of structural tools. It aims to foster glycoscience by informing both the glycoscience and physcis communities of the needs and existing tools and to facilitate interdisciplinary communication and collaborations in carbohydrate-orientated research in physics. Supported by the Agence Nationale de la Recherce.
Coordinator: Isabelle Compagnon, Université de Lyon 1, (FR)
Website: http://glyms.univ-lyon1.fr

- **Royal Society of Chemistry Carbohydrate Group (GB)** – The Carbohydrate Group is one of the Royal Society of Chemistry's many Interest Groups. The Interest Groups are member driven groups, which exist to benefit RSC members, and the wider chemical science community, in line with the RSC's strategy and charter.
Website: http://www.rsc.org/Membership/Networking/InterestGroups/Carbohydrate/index.asp?e=1

1.3.4 Overall Methodology

1.3.4.1 CSA Meetings and Workshops

A series of meetings will be held in each of the ETAs of interest to build on previous and existing networks and to engage key players in each area. The aims of these meetings will be two-fold: to identify the current state of the art, and also the future needs. Barriers to commercialisation, training needs and regulatory requirements will also be considered.

Where possible, these meetings will include cross-sectorial representation between the BISs to ensure cross fertilisation of ideas. It is anticipated that through these cross-sectorial meetings all participants will be able to transcend their traditional established communities and break down current 'silos' (e.g. a silo mentality that might exist between the food and health industries, where innovative functional food products have the potential to benefit health and wellbeing).

All events will provide opportunities for networking and consortia building with activities such as scientific flash presentations followed by speed dating, which we have found to be a fruitful means of generating new ideas.

Social scientists will be invited to attend these meetings as their input will be invaluable to ensure that the ethical dimensions of the proposed research priorities and challenge areas are given full consideration as these are developed.

Outputs of the meetings will include:

- Identification of gaps in measurement and metrology capability;
- Proposals for specific project funding;
- Generation of policy briefing papers for lobbying purposes;
- Requirements for market data and production of market reports in key areas as appropriate;
- Recommendations and representations to regulatory bodies for input to monographs.

A final meeting will be held at the end of year 3 to allow members to provide input to the road map which will be published in the final year. This will be a successor to the current 'Roadmap for Glycoscience in Europe', which will focus on measurement and metrology challenges and their resolution as detailed in Objective 3.

1.3.4.2 Online Surveys

Following the workshops, surveys will be used to engage additional key stakeholders who did not participate in the workshops. The aim here is to ensure that a full coverage of the areas of expertise and a full range of opinions is obtained in order to get as full a picture of the current state of the art and any gaps that exist as well as areas with scientific overlap. This information will supplement issues that identified during the workshops and will be collated into lists and/or maps to be added to the project website for dissemination purposes. The website will therefore be updated on a regular basis throughout the lifetime of the project.

1.3.4.3 Website

A key implementation tool will be the project website which will be made fully accessible to the public. Outputs from workshops and surveys will be recorded there for dissemination purposes. It is anticipated that over the lifetime of **CarboMet**, a catalogue of expertise will be built up as a vital source of information for all stakeholders, including non-experts working in other areas. Data collated and published will include centres of excellence, available tools (virtual and actual), national initiatives, funding available, training and education opportunities, market data and other resources etc. This will enhance the sharing of knowledge between developers and users through an 'academic push – industry pull' mechanism. It is emphasised again that the website will be

regularly updated using the most input from all stakeholders. Web management will therefore constitute significant component of the proposed CSA.

Current and future opportunities for European support will also be publicised on the website as potential means of supporting project proposals that will address the challenges and gaps identified by each of the ETAs. Particular attention will be paid to opportunities within the current Horizon 2020 calls, and beyond, as well as member state national initiatives.

1.3.4.4 Training Workshops in Advanced Technologies

In addition we intend that there will be education and training events to showcase recent developments and capabilities identified within each ETA to key stakeholders. Stakeholder input here will be critical for ensuring the development of analytical and measurement tools that are fit for purpose in industrial settings and for providing the information needed for regulatory approval purposes and commercial applications, including proprietary claims.

1.3.5 Production of Policy Briefing Papers & White Papers

To complement and advance the earlier 'A roadmap for Glycoscience in Europe' we will produce policy-briefing papers on key areas of relevance by ETAs and BISs, which will be used to target policy makers. This will culminate in the production of a road map in the final year with recommendations for future research activities, and as identified in the introduction to this proposal. As described in Objective 4, these challenges and projections will be of interest to the ongoing Horizon 2020 European Metrology Programme on Innovation and Research (EMPIR).

1.3.6 How Gender Analysis is taken into Consideration

Gender equality is recognised as a critical issue in research and innovation studies and specifically the under representation of women in decision-making, practices, peer review and pay. **CarboMet** is fully committed to ensuring full gender representation - 4 out of 8 Working Group members are women.

The Project Coordinator, is based at the School of Chemistry, at the University of Manchester who have been recognised for their commitment to addressing gender inequalities, and tackling the unequal representation of women in science and to improving career progression for female academics through an Athena SWAN Silver Award.

CarboMet recognises the reality of the "glass ceiling" in many areas; particularly science and policy making. The team understands it is necessary to promote diverse and representative women's participation in the Working Group and intend to take into consideration women's needs and interests when setting meeting agendas including through a sympathetic approach to the needs of those members with childcare or similar considerations. Activities such as data surveys will provide opportunities for **CarboMet** to analyse gender representation in terms of participation rates by **CarboMet** stakeholders. **CarboMet** workshops will also provide opportunity for training in Gender Awareness (using EU GenPORT resources) and Gender Development including the influence of positive female role models.

Gender differences will also be taken to into account as we identify common cross-sector challenges that need to be addressed by Industry to ensure gender differences and potential biases during evaluations are taken into consideration during the development of innovative carbohydrate based products and innovations.

2. Impact

2.1 Expected impacts

By analogy to DNA and protein sequencing technologies, which have revolutionized biological research in recent decades, we are only now at the precipice of a similar leap in glycan sequencing. Continued investment in technology and data handling drove down genome sequencing costs from ~$100m for the first genome drafts in 2000 to <$1000. Similar investment in glycan sequencing technology is essential if it is to reach its enormous potential. For example, the ability to unambiguously define glycan higher order structure will not only impact human diseases and the development of biologics, but has important connotations for food security and host/pathogen interactions, positively impacting human health, and disease diagnosis and therapy, with global societal benefit.

The following 4 BioIndustry Sectors (BISs) have been identified as of immediate interest where the exploitation of carbohydrates will have huge impact.

2.1.1. Biopharmaceuticals including vaccines, antimicrobials, antibodies and hormones

During the dynamic process of glycosylation, the simple carbohydrates from photosynthesis are converted to complex carbohydrates, glycoconjugates or glycans, which are an integral part of cell biology, and are present on the cell surface and the macromolecules contained within. Glycosylation influences the function of these molecules, playing an essential role in health and disease. This includes the development of innate and adaptive immunity, the growth and spread of cancer, responses to bacterial and viral infections, and the development of diseases such as diabetes. Understanding and exploiting glycoscience and glycomics is an essential part of modern molecular medicine.

Pharmaceutical products include small molecules, vaccines, antimicrobials and antibiotics and hormones as well as biopharmaceuticals and biosimilars. The number of therapeutics based on glycans, glycan targets and glycosylated products is rapidly increasing. Examples including heparin, cyclodextrin, carbohydrate-based vaccines, and glycosylated natural products such as the antimicrobial vancomycin have been on the market for a long time. More recent examples include Tamiflu and Relenza, which were developed to treat the ‘bird flu’ influenza virus. With the advent of biopharmaceuticals such as human erythropoietin and therapeutic antibodies, glycoconjugates will continue to increase their major market share.

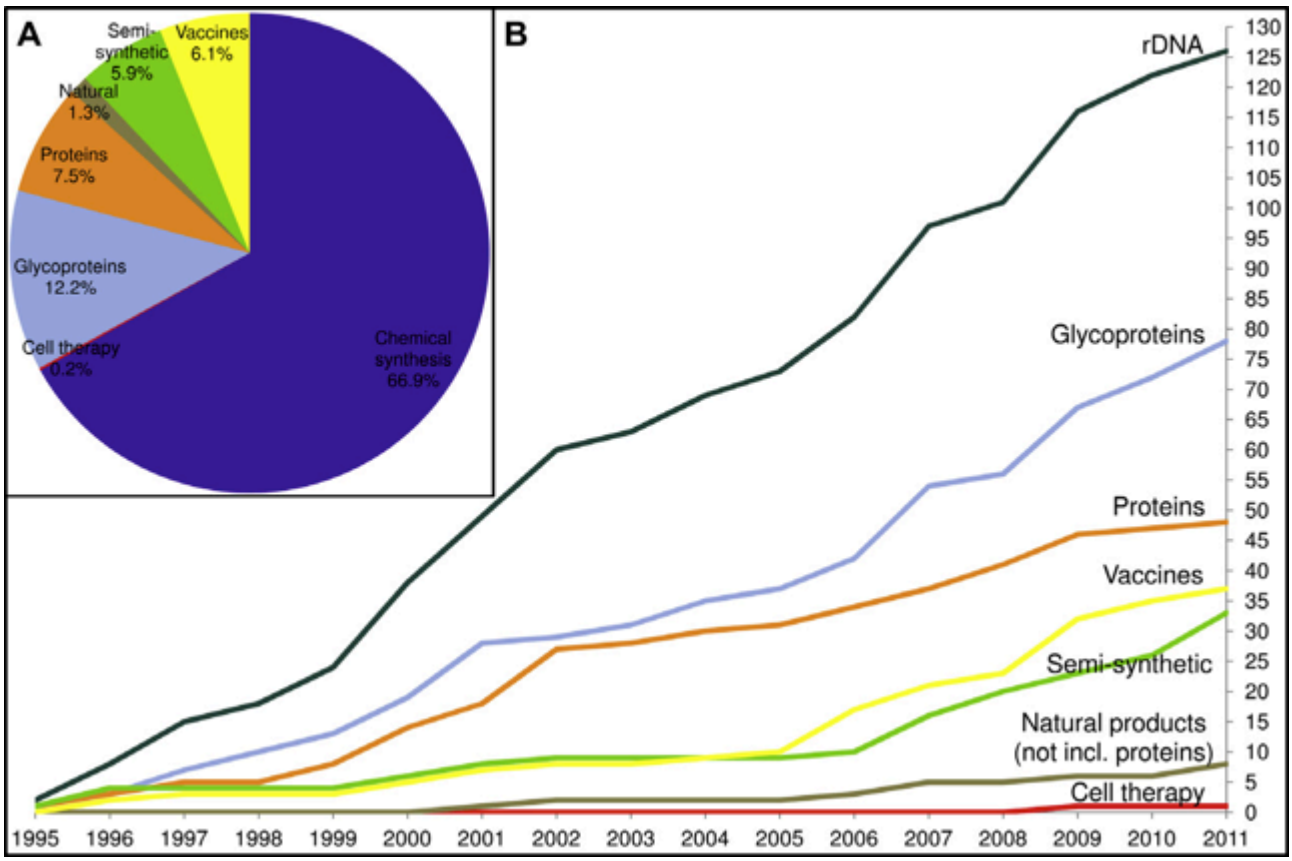


Figure 8: Shows the number of drugs the European Medicines Agency (EMA) approved during the period from its establishment in 1995 to June 2012 –glycoproteins are the second fastest growing category.[18]

From a regulatory perspective this is a challenging issue, with a size molecular range of products ranging from small molecules such as aspirin (~25atoms) to biologics such as herceptin (~25,000atoms), which is an advanced treatment for certain forms of breast cancer. As the degree of molecular complexity increases so does the range of analytical techniques required for quality control purposes. Glycosylated biopharmaceuticals such as glycoproteins provide particular challenges in terms of production and analysis for quality control (ICH guideline Q6B). With new biologics, the FDA expects the latest advances in analytics to be employed. **CarboMet** will be able to catalyse the processes that will make this feasible as **CarboMet** has at its core, activities to increase awareness of the latest analytical capabilities.

From the regulatory perspective, the engagement here will be with the European Medicines Agency (EMA) with a view to building on current links and working together to modernise current practise as well as developing new monographs as required. There also needs to be strong engagement with patient end users to ensure products and formulations are user friendly and new innovations are readily adopted in clinical settings.

[18] S. Kyriakopoulos, C. Kontoravdi (2013) '*Analysis of the landscape of biologically derived pharmaceuticals in Europe: Dominant production systems, molecule types on the rise and approval trends*' Eur. J. Pharm. Sci. 48, 428-441

Case Study - Erythropoietin (EPO)

EPO is a glycoprotein hormone that stimulates the production of red blood cells and is used as a therapeutic agent for the treatment of anaemia. Approximately 40% of its weight due to glycosylation[19]. Advances in recombinant DNA technology techniques have allowed the production of recombinant EPO for therapeutic use to treat anaemia, for which it was first approved by the FDA in 1989. Glycoscience has since played a major role in bringing improved EPO variants with modified glycosylation components to the market. One such product Aranesp® from Amgen has been found to have a significantly longer half-life in the body after injection providing improved therapy. It is anticipated that worldwide sales of EPO therapeutic products will continue to grow as even more effective variants for anaemia treatment are found. The development of improved, highly sophisticated analytical measurement techniques has been no small contributor to achieving these improvements in therapy.

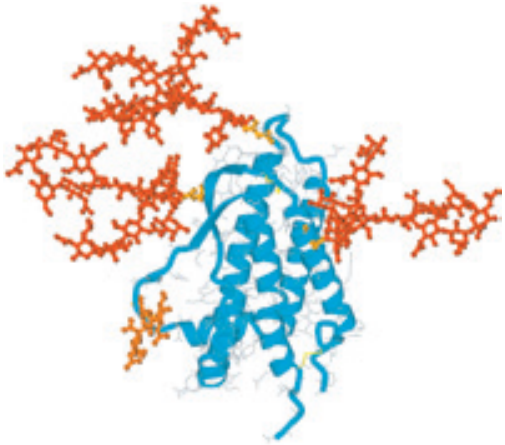


Figure 9: The glycans (red) are linked to the protein (blue) via individual amino acids (orange) that make up the protein polypeptide chain. (Source: Pauline Rudd, NIBRT).

2.1.2 Diagnosis of disease at a personal level for the development of precision medicines

All cells, including human cells, have carbohydrates on their surface, in a covering known as the glycocalyx. This coating of glycolipids and glycoproteins controls a variety of fundamental biological processes, for example helping sperm to recognize eggs during fertilization, determining blood groups, or enabling the body to identify diseased cells or infectious agents. The carbohydrates of the glycocalyx are produced through highly complex biosynthetic pathways controlled by both genes and the environment. The makeup of the glycocalyx is therefore highly sensitive to genetic mutations, changes in gene activation or silencing, or environmental and personla habit factors such as diet, alcohol consumption or smoking. This makes the glycocalyx a useful target for personalised medicine, including finding new biomarkers for diseases such as cancer, and for patient stratification during clinical trials.

As personalised medicine advances there will be a need for novel instrumentation to rapidly and accurately measure the individual patient's condition in real time. Consequently, there will be many opportunities to develop lower-cost and better targeted products for the diagnostics market such as: on-/in-body sensors; nanotechnology-based sensors for use in the field; theranostics; companion diagnostics. Identification of glycobiomarkers provides the opportunity in combination with

[19] Bunn H.F. (2013) Cold Spring Harbour Perspectives in Medicine 3:a011619 DOI: 10.1101/cshperspect.a011619

existing biomarkers to achieve significantly increased diagnosis specificity and sensitivity, which in turn contributes to the development of more effective personalised medicines.

It goes without saying that the development of fast and effective diagnostic tools for the detection of pathogens and for the monitoring of health and disease will greatly benefit society by both reducing human suffering and concomitantly cutting healthcare costs. The tools should allow governments and healthcare providers to put preventative measures into place, for example vaccination programs in infectious disease outbreaks, or targeted interventions for diseases such as cancer or diabetes.

As an example, in the EU FP7 project GlycoBioM - 'Tools for the Detection of Novel Glyco-biomarkers' high-throughput screening technologies were used to identify new glycan biomarkers for a range of diseases and the team discovered a novel biomarker for maturity-onset diabetes of the young (MODY).[20]

2.1.3 Healthy lifestyles from good food and personal care, including for healthy ageing

Sugars are important components of everyday foods and an understanding of polysaccharide production in plants is of the utmost important for improved food security and production, including crop protection. The importance of sugars as dietary components and their nutritional value and potential in functional foods is becoming more and more apparent and they are increasingly being appreciated for their health giving effects for the benefit of society, reducing the burden on health services and improving quality of life.

For example, because of the rise of obesity and diabetes in the western world there is a need to find healthier substitutes for sucrose itself. Sources include natural sugar containing sweeteners of low calorific value, such as the carbohydrate-based steviose, and high intensity sweeteners and substitutes such as sucralose (>200 times sweeter than sucrose) and xylitol.

Human milk oligosaccharides (HMO) for infant health, HMOs are significant components (up to 10%) in human milk and have been shown to provide many benefits in infant development and for developing resistance to infection. It is argued that the addition of HMOs to formula milk would have great benefit to infant health, although at present HMOs are complex to produce and purify. Further development of this field is yet another one that relies heavily on our continuing to advance concomitantly our measurement and metrology capabilities further.

Increasing in size and complexity are polysaccharides, which are sources of soluble fibre and have cholesterol lowering properties (e.g. beta-glucans). Currently these represent a set of major challenges in terms of analysis and characterization, but the possible rewards in terms of positive opportunities arising from new polysaccharides becoming available are also exciting as we seek to understand how to exploit and refine biomass, within the circular (bio)economy (a key source of polysaccharides).

Prebiotics are non-digestible food ingredients that stimulate the growth and/or activity of those bacteria found in the digestive system, which are beneficial to the health of the body. Prebiotics, usually carbohydrates such as galacto-oligosaccharides (GOS) prepared from cow milk lactose and fructo-oligosaccharides (FOS) prepared from plant inulins, support the growth of the gastrointestinal microflora. Promotion of healthy gut microflora is increasingly understood to be important for infant and adult health and for healthy ageing, as well as to prevent allergies, infection, immune disease and chronic disease. Identification and characterization of prebiotic carbohydrates and their impact on the gut flora is an ongoing research activity alongside metagenomics studies in the construction of the human microbiome, all of which depends on innovative analytical measurement techniques. The ability to produce benign and healthy gut

[20] Thanabalasingham et al. (2013) Diabetes, 62(4), 1329-37. DOI: 10.2337/ db12-0880

microflora in sufficient quantities and purity is an exciting area of opportunity for the food industries in the future, not just in terms of nutrition but also in disease prevention.

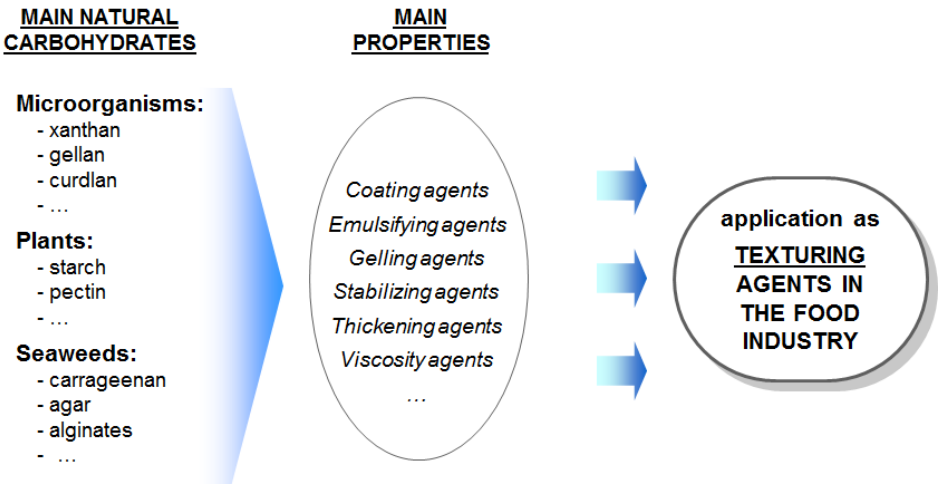
As our understanding of the role of diet and its impact on our health and well-being increases, it is anticipated that there will be increasing collaboration between the food and health sectors which will require a coordinated effort between the key players from both sectors especially policy makers and the relevant regulatory authorities. Food additives are regulated in Europe by the European Food Safety Authority (EFSA) and they are currently re-evaluating all food additives authorized for use in the EU before 2009 by 2020. This is a timely opportunity for **CarboMet** to contribute positively and innovatively.

As for health, there will also need to be strong engagement with consumers to ensure that the development of new functional food products are not only palatable and consumers are educated on the health benefits, in order to ensure that beneficial innovations are readily adopted.

Innovations in carbohydrate based products have the potential to fulfill several other needs of the personal care market. These range from stability and formulation aspects such as structurants, excipients and fillers; packaging materials; and, high performance ingredients for consumer effects with a particular emphasis on sustainable, benign and eco-friendly materials (Figure 10). Personal care products are regulated under the EU Regulation 1223/2009 with a strong focus on consumer safety; again the need for new measurement capabilities and metrology procedures will continue to grow.

2.1.4 Carbohydrates as the sustainable materials for the future

The development of sustainable biorenewables will facilitate the move from our dependence on hydrocarbons towards a more sustainable bio-based chemicals industry with a reduced carbon footprint. For example, cellulose, hemicellulose, starch, chitin, xyloglucan and other polysaccharides are all natural products and are often found in biological waste streams. They can be produced in plants that can be grown on low value or marginal land or even through bioremediation.



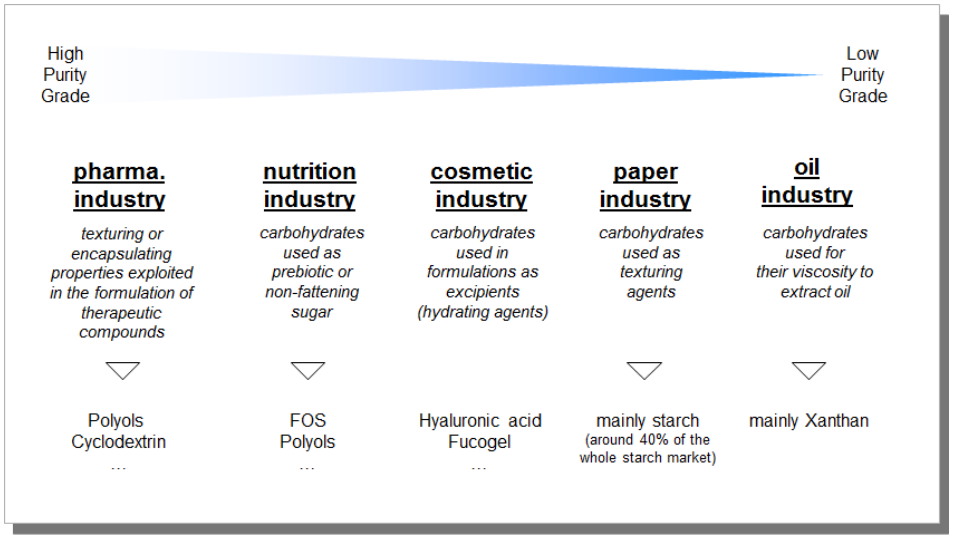


Figure 10: Natural polysaccharides have properties that make them useful for a variety of industrial applications. Their modification (chemical, mechanical, biological) can further expand their properties and functionalities for further applications. (Source: Serge Perez, CNRS).

Carbohydrates building blocks are useful compounds and their biodiversity and availability make them very attractive candidates for conversion into tailor-made carbohydrate polymers ('designer polysaccharides') with unique properties and for novel applications. By producing carbohydrate polymers from sustainable sources there is also opportunity to develop benign eco-friendly materials and processes for use in a number of consumer products, which is of interest to the wide range of sectors in anticipation of the partial demise of fossil fuel derived feedstocks. The range of sectors for potential is huge and includes but is not limited to the, chemical industries, energy companies developing advanced biorefineries, medical device companies for novel biomaterials, membrane companies, biotechnology companies, the healthcare sector, food companies (potential ingredients and innovative solutions for sustainable food packaging to reduce food waste) biodegradable materials (e.g. for nappies, packaging) and cosmetic companies.

Analytical methods based on nuclear magnetic resonance spectroscopy and mass spectrometry, together with atomic force microscopy, and optical tweezers are now used hand-in-hand with theoretical tools to elucidate structural details. However, more new instrumentation is required to accompany the development of new overarching concepts, which are at the interface between physics and biology, and to support the generation of highly-defined innovative bio-based materials.

Appropriate application of the novel carbohydrate materials yet to be invented will require careful navigation of the relevant regulatory aspects before full exploitation an be realized, for example there is specific EU legislation relating to materials that can be used in food packaging. **CarboMet** will encourage participants from various sectors to highlight opportunities within the regulatory landscape to allow a focused approach to the targeted development of suitable materials, which will in turn enable rapid delivery market of novel carbohydrate based biomaterials to market.

Education and training for all stake holders will be vital in this area in order to open up the markets for these products to justify and encourage the investment needed for this area to fully develop.

2.2 Measures to maximise impact

a) Dissemination and exploitation of results

The key dissemination tool will be the website which will be updated using information from consortium members and stakeholders using outputs from scoping workshops (D1.2, D2.2, D3.2)

and online surveys (D1.3, D2.3, D3.3) for the benefit of stakeholders including end users and the wider science community.

Engaging with national initiatives detailed in §1.3.3 (D4.4) will ensure a wide dissemination of information to relevant stakeholders. Other opportunities could include trade fairs and conferences (e.g. the EuroCarb conference which takes place in Barcelona in July 2017).

The dissemination and exploitation plan (reported initially as D5.3) will be reviewed and updated every 6 months to include these opportunities in order to achieve maximum impacts. The draft dissemination and exploitation plan is shown in Table 2.2a below.

Due date	**Type of activity**	**Dissemination route**	**Type/size of audience (Countries addressed)**	**Details**
Press releases and non-specialist dissemination				
M6	Press release	EU Media, UoM website and public relations channels; third party dissemination by knowledge transfer networks, professional associations, scientific societies/SIG, trade bodies	Civil society, Scientific, Technology Providers, Social Scientists and Ethicists, Policy Makers, End Users, ALL STAKEHOLDERS (Global)	Press release to launch CarboMet, including dissemination of scope and aims and Network website address, highlighting EU FET activities and glycoscience.
M2-6	CarboMet website	Online	ALL STAKEHOLDERS (Global)	Website domain secured and holding page published in Month 2, full website content online by end of Month 6
Ongoing	Public engagement events		Civil society (EU)	
Network dissemination				
Ongoing	Advertisement of meetings and workshops	Network website (calendar); social media alerts; targeted communications by email to key stakeholders; third party dissemination by knowledge transfer networks, professional associations, scientific societies/SIG, trade bodies	Scientific, Technology Providers, Social Scientists and Ethicists, Policy Makers, End Users (EU/Global)	
Ongoing	Documented workshop and	Network website	Scientific, Technology	

	meeting outputs		Providers, Social Scientists and Ethicists, Policy Makers, End Users (EU)	
Year 1, Q4; then, biannual	Electronic Newsletters	Network website; social media alerts; targeted communications by email to key stakeholders; third party dissemination by knowledge transfer networks, professional associations, scientific societies/SIG, trade bodies	Scientific, Technology Providers, Social Scientists and Ethicists, Policy Makers, End Users, [Civil Society] (EU/Global)	
M12	Network website updated with databases and bioinformatics tools	Online	Scientific, Technology Providers, Social Scientists and Ethicists, Policy Makers, End Users (Primarily EU; Global)	
M24	Results of Stakeholder survey	Network website	Scientific, Technology Providers, Social Scientists and Ethicists, Policy Makers, End Users (EU)	
Research strategy papers and roadmap publications				
M26	Policy Briefing Papers	Targeted communications with EU, Commission, National Policy Makers, and available to other Stakeholders	Policy Makers , [Scientific, Technology Providers, Social Scientists and Ethicists] (EU)	
M42	Roadmap for 2030	Targeted communications with EU, Commission, National Policy Makers; Network website, social media alerts; targeted communications by email to key Network members; third party dissemination by knowledge transfer networks, professional associations, scientific societies/SIG, trade bodies; SUCCESSOR/PARALLEL ACTIONS	Scientific, Technology Providers, Social Scientists and Ethicists, Policy Makers, End Users, SUCCESSOR/ PARALLEL ACTORS, [Civil Society] (EU/Global)	Roadmap to promote development of carbohydrate metrology, with particular focus on FET development, supporting strategies, collaboration, and leadership up to 2030. This will include engagement with parallel and/or successor actors with

				shared or overlapping remits to ensure ongoing impact beyond the initial lifespan of CarboMet.
Policy Maker and Other high-level engagement				
Annual	Meetings with national member state glyco-initiatives	Targeted communications, virtual and physical meetings including key stakeholders	Successor/ parallel actors (EU)	Ensure coordination between actors with shared or overlapping remits, maximise routes to exploitation of Network outputs through related initiatives.
Annual	Meetings with Policy Makers, Funding Bodies	Targeted communications, virtual and physical meetings including key stakeholders	Policy Makers, Funding Organisations, Network (EU)	Ensure CarboMet has a working dialogue with relevant actors; identify and engage with funding and exploitation routes to support FET development from CarboMet and maximise broader impacts of the Network; ensure that Roadmap for 2030 is fit for purpose and secure succession and legacy of CarboMet.

Table 2.2a: Draft Dissemination and Exploitation Plan.

Data Management Plan - UoM and the EU-GUG fully support the Open Research Data Pilot in Horizon 2020. This compliments the UoM's own policies, procedures and professional support

services. The Project Manager will ensure that all data generated from **CarboMet** will be made available to stakeholders in a timely and responsible manner with as few restrictions as possible. **CarboMet** welcomes and will actively promote the use of the data generated by this project to influence EU policy and practices as well as benefit future scientific innovation and actions. **Data Description**. Data will comprise: personal details of **CarboMet** members within a members directory/database, website and social media contents, market data, market reports, policy briefing papers/roadmaps, regulatory data, online surveys and case studies. To enable long term implementation and accessibility; data will be stored and in formats that are open-access, non-proprietary and made easily available. **Data Management**. The Project Manager will oversee the accessibility, distribution, archiving and preservation of the data in accordance with the EU guidelines (D5.4 by M6). The project will make use of UoM's Research Data Management Service (RDMS), which provides robust, managed, secure, replicated storage. Electronic data will be stored and backed up daily on secure servers. **Data Sharing and Access**. All data generated by the Project will be archived by the Project Manager and made available to the EU and **CarboMet** User Group during the lifetime of the Project and for a further 10 years after completion of the Project. The data will be stored in suitable accessible formats i.e. PDF files. A summary of the project will be published on the project website, along with contact details for the Project Manager/User Group and links to publications such as the policy briefing papers. Data generated will be made available through specially designated meetings and through publication. Author accepted manuscripts will be submitted to Open Access 'green repositories' via The University of Manchester's Library Service to ensure they will have the widest possible readership. UoM uses the newly launched Pure repository for deposition of all publications. UoM also provides funding through the Gold Open Access Scheme to make research articles freely available through the publisher's website. A statement regarding our data sharing policy will be included in any publications arising from this work. Requests for additional data can be made to the Project Manager who will arrange for an appropriate secure method of transfer. Links to Bioinformatics tools and Databases provided by third parties will be made available through the **CarboMet** website, and the Project Manager will work with the providers to ensure that the relevant permissions are in place. **Timeframes:** It is very important that the data generated during this project will be released in a timely manner to ensure that new future technologies remain innovative. **Ethics and Data Protection**. Special consideration has been made towards data protection on personal data such as identifiable individuals participating in the Working Group held in a secure directory/database. Security measures are in place to protect all personal data under the obligations of the Data Protection Act. Furthermore, implications of interactions with patient groups have been considered. Divulging data on early stage technology to vulnerable people without raising expectations and hopes is a sensitive matter, therefore all communication will be extensively reviewed by the PM and designated experts from the User Group to ensure that data can be disseminated openly but also sympathetically.

b) Communication activities

The main communication activities covered by specific deliverables are workshops and meetings, including training workshops, and the production of policy briefing papers, as follows:

D1.5, D2.5 & D3.5 Training workshops in advanced technologies | M36

D4.2 Successful case studies from industry and academia on website | M22

D4.1 Policy briefing papers | M26

D4.5 Production of a roadmap | M42

In addition we will:

- Design, develop and maintain a dedicated project website for **CarboMet** that will be accessible not only to all immediate stakeholders but also to the wider scientific research and innovation community
- Produce a periodic project newsletter that will be distributed to parties registering their interest
- Establish and monitor social media sites on Twitter and LinkedIn for dissemination of outputs and case studies
- Advertise in industrial and technical printed journals to promote activities
- Disseminate outputs via third party multipliers such as the Enterprise Europe Network (EEN); relevant ETPs, JTIs and PPPs; and relevant industrial associations as well as the national initiatives already highlighted in section 1.3.3 as well as others yet to be identified.
- Participate in targeted EU conferences and events to promote **CarboMet** and disseminate output via presentations, posters and project flyers. The consortium will participate in 6 to 10 conferences. One of these will be selected for a final dissemination event.

3. Implementation

3.1 Work plan – Work packages and deliverables

a) Brief presentation of the overall structure of the work plan

Over the course of **CarboMet** we will build up a picture of the current state of the art and future needs for each of the BioIndustry Sectors (BISs) by Enabling Technology Area (ETA) (**WP1** Analytics & Measurements; **WP2** Synthesis & Standards; **WP3** Bioinformatics & Databases. Outputs from WP1-3 activities will be fed into **WP4** Policy Engagement. **WP5** Will coordinate all activies, allowing identification of any cross-cutting activities between BISs versus ETAs in a matrix of activities (see Table 1) for maximum impact and engagement as shown below in Figure 11.

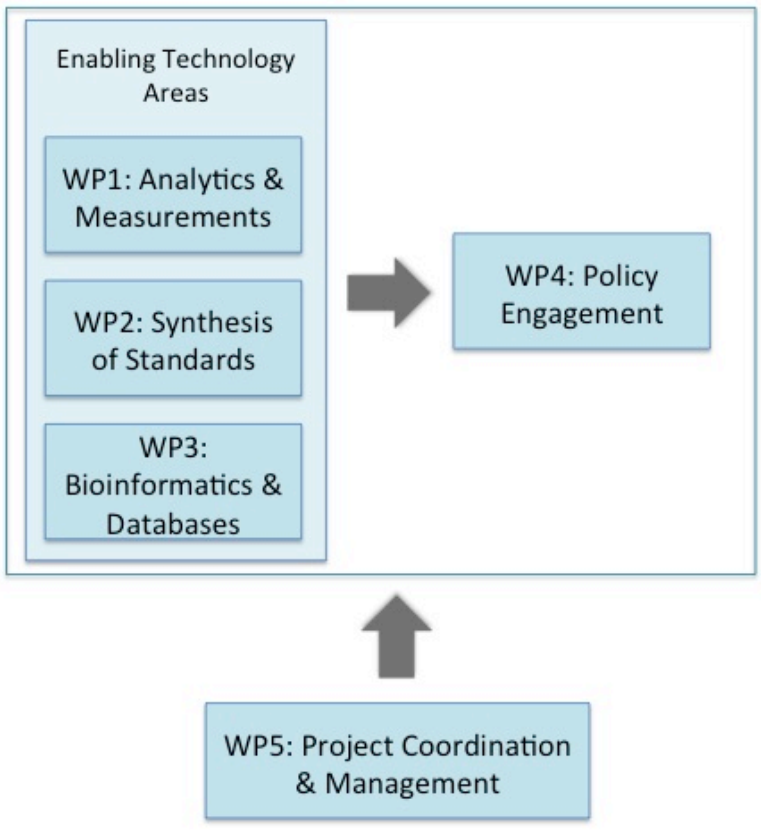


Figure 11: An overview of the overall **CarboMet** structure and the 5 work packages.

WP5 is dedicated to the overall project management, administration and co-ordination of **CarboMet**. It will ensure effective communication and interaction across all activities between all work packages. Key to this will be a dedicated project manager (PM) who will act as crucial support for the Working Group. Under their direction, the PM will manage the activities of the **CarboMet**. This will include coordinating and promoting activities as well as engaging industry, academia and regulatory bodies and other stakeholders, as well as practical assistance such as managing the website, organising meetings and workshops, and delivering the communication plan as required by the work plan. Matrix management of the ETA-BIS matrix (shown in Matrix 1 below) will also be a key responsibility of the PM.
Communication and dissemination are the core activities of **CarboMet**, and these goals are implicit in the **CarboMet** work package structure and plan.

Dissemination and exploitation. The PM will be responsible for collating and modifying the Plan for Dissemination and Exploitation (2.2a), both in order to monitor the progress of the project against the plan of work, and in order to ensure that dissemination and exploitation of the Network outputs is maximised. The PM will identify dissemination routes and partners, building positive relationships with organisations and individuals in order to maximise the reach and impact of Network dissemination activities. They will also make the membership aware of key routes and contacts, to enable members to directly engage with these, as well as mediating dissemination through the website and social media and providing support to access high impact dissemination routes on behalf of **CarboMet**. The PM will also monitor and provide guidance on **communication activities** (as discussed in 2.2b), developing processes to mediate good quality communication between members, but also effective and high-impact outward facing communications**.** Tools, templates, and standards will be made available during events and via the website to ensure effective communication of **CarboMet** aims, remit, and outputs. The PM will provide guidance to ensure that the Network can effectively promote itself, collaborate to develop new technologies of in the area, and highlight role of the EU in supporting FET.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">BioIndustry Sector (BIS)</td></tr>
<tr><td>Biopharmaceuticals including vaccines, antimicrobials, antibodies and hormones</td><td>Diagnosis of disease for development of Precision Medicines</td><td>Healthy Lifestyles: Food & Personal Care</td><td>Carbohydrates as Sustainable Materials</td></tr>
<tr><td rowspan="3">Enabling Technology Area (ETA)</td><td>Analytics & Measurements</td><td colspan="4" rowspan="3">To be completed with stakeholder input through CarboMet activities</td></tr>
<tr><td>Synthesis of Standards</td></tr>
<tr><td>Bioinformatics & Databases</td></tr>
</table>

Matrix 1: ETA-BIS matrix that will be completed over the lifetime of project using input from stakeholders for dissemination to the wider research community. **CarboMet** will facilitate cross-fertilisation of ideas within each ETA across each BIS.

b) Work plan to show timing of Deliverables

Deliverables	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
D1.1: Map of existing centres of expertise and facilities onto website																
D1.2: Scoping workshop with key players carbohydrate analytics & measurements																
D1.3: Online Stakeholder survey to identify additional areas of expertise and facilities																
D1.4: Update website with additional centres of expertise and facilities																
D1.5: Training workshop on advanced technologies carbohydrate analytics & measurements																
D2.1: Map centres of carbohydrate synthesis expertise onto website																
D2.2 Scoping workshop with key players synthesis of standards																
D2.3 Online stakeholder survey to identify additional centres of expertise and the use and availability of standards and reference materials																
D2.4 Update website with centres of carbohydrate synthesis expertise including catalogue of available standards and reference materials on website																
D2.5: Training workshop on advanced technologies in synthesis of standards																
D3.1: List of databases and bioinformatics tools on website																
D3.2: Scoping workshop with key players in databases and bioinformatics																
D3.3: Online survey to identify the use of databases and bioinformatics tools																
D3.4: Update website with additional databases and bioinformatics tools																
D3.5: Training workshop on advanced technologies in databases and bioinformatics																
D4.1: Policy briefing papers (brief, one page) by BIS and/or ETA																
D4.2: Successful case studies from industry and academia onto website																
D4.3; 4.7; 4.8; 4.9 : Meeting 1, 2, 3, 4 with key policy makers, funding bodies																
D4.4; 4.10; 4.11; 4.12: Engagement 1, 2, 3, 4 with national glyco-initiatives																
D4.5: Scoping meeting for roadmap input																
D4.6: Production of a roadmap																
D5.1: Project Plan																
D5.2: Kick off meeting with Working Group																
D5.3: Dissemination & Exploitation plan																
D5.4; 5.10; 5.11; 5.12; 5.13: Data Management plan and updates Y1, Y2, Y3 and Y4																
D5.5: Industry Steering Group appointed																
D5.6: Project website & logo																
D5.7: Meetings & workshop calendar including hosts and locations on website																
D5.8: Social media accounts established																
D5.9; 5.16; 5.17; 5.18; 5.19; 5.20; 5.21: Periodic e-newsletters 1, 2, 3, 4, 5, 6, 7,																
D5.14: Periodic project reporting (technical, financial & action check meeting) RP1																
D5.15: Final project report (technical, financial & action check meetings) RP2																

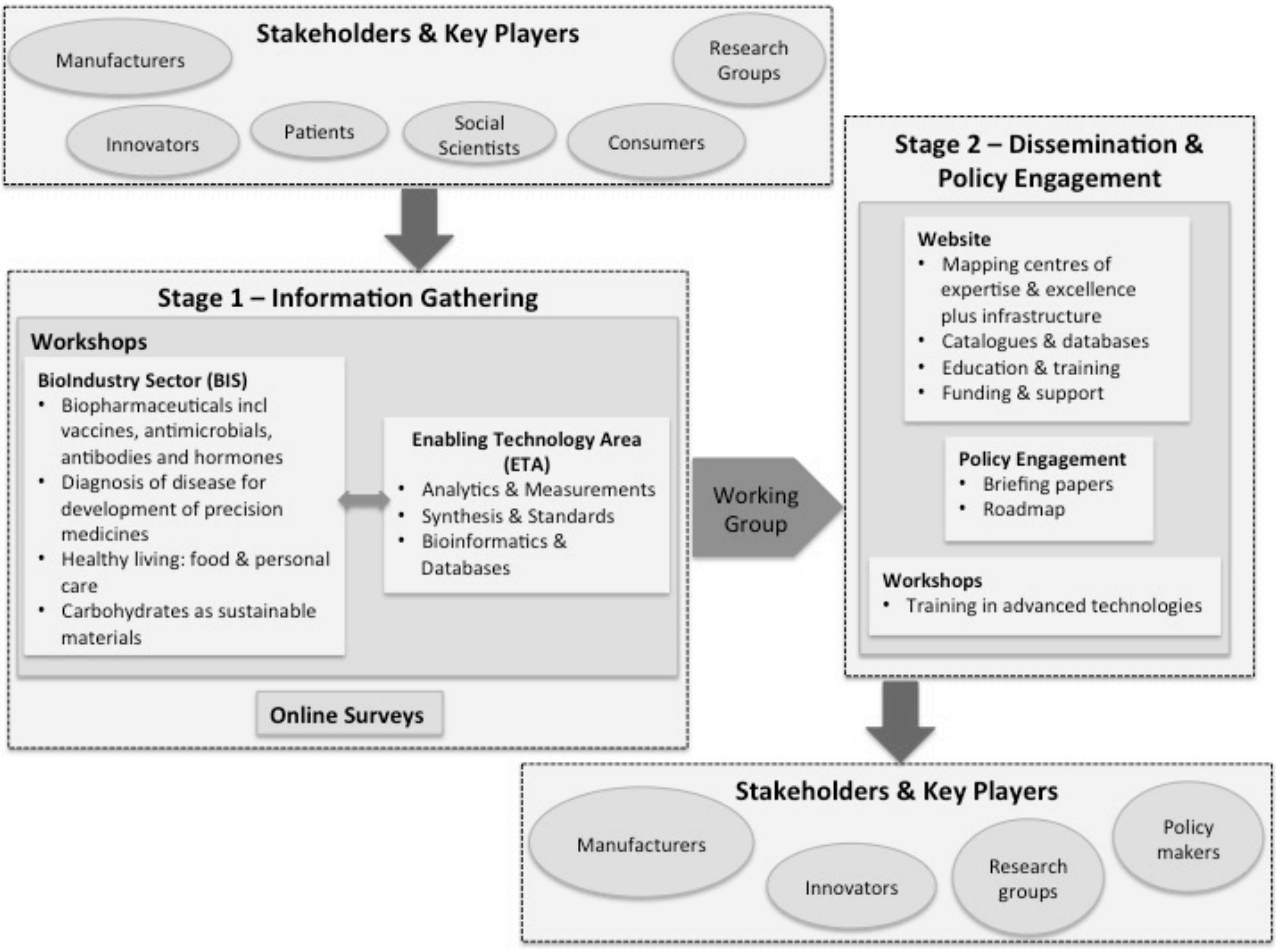


Figure 12: Pert chart to show inter-relation of **CarboMet** activities.

3.2 Management structure and procedures

a) Organisational Structure and Decision Making

The **CarboMet** management team will comprise a Working Group and an Industry Steering Group as shown in Figure 13 below.

The Working Group will be made up of representatives from each work package and will have been selected firstly by their expertise in the Enabling Technology Areas (ETAs), and secondly on a strategic basis for their links to industry and policy makers.

The Working Group's activities will be overseen by an Industry Steering Group, made up of representatives from each of the 4 BioIndustry Sectors (BISs). These will be nominated by the Working Group during the kick off meeting in Q1.

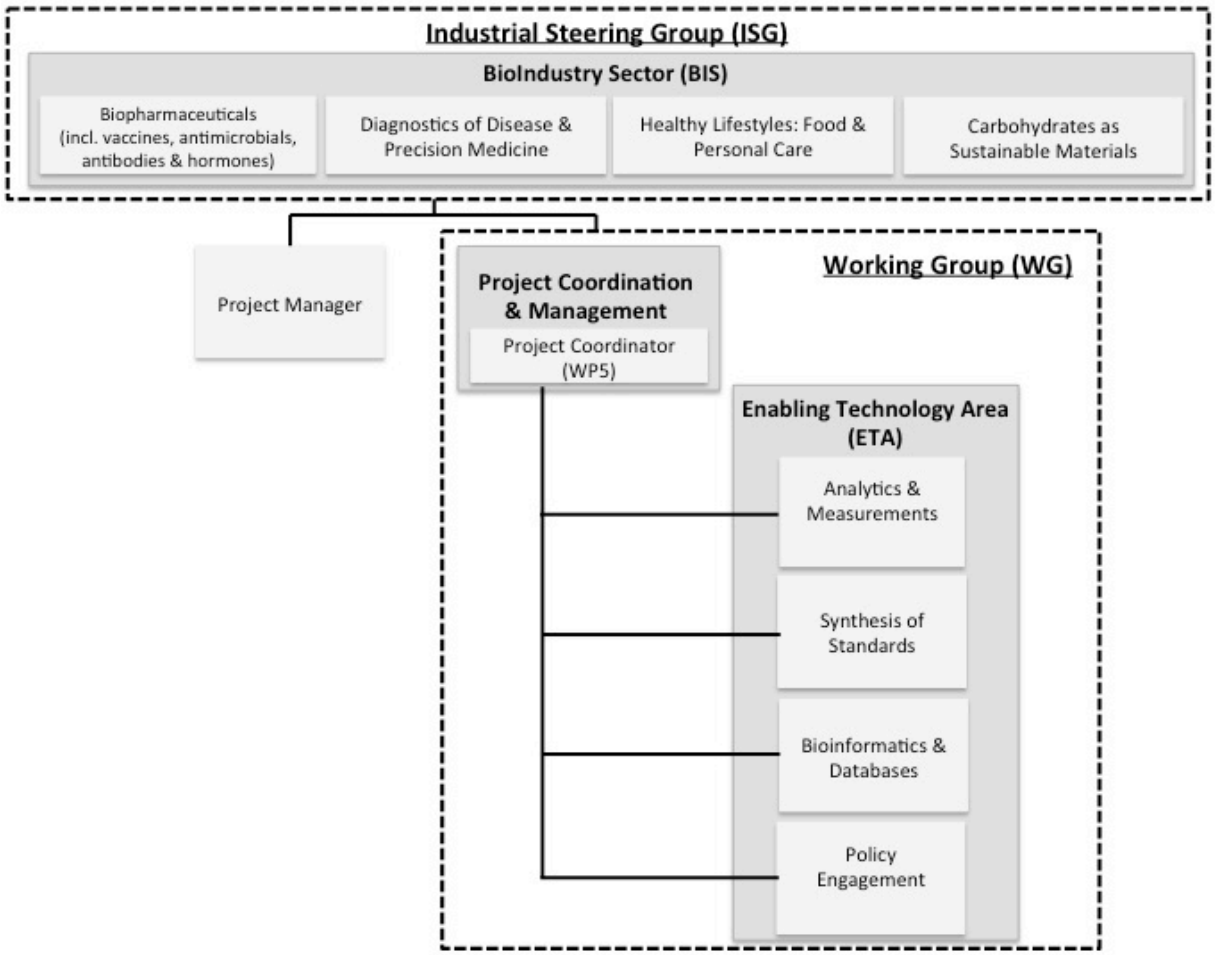


Figure 13: CarboMet management structure.

The Project Coordinator will manage the project in its administrative and financial activities with the support of the Project Manager. The Project Coordinator's tasks include acting as a contact with the European Commission (EC), monitoring the progress of the work plan, developing future strategies and taking responsibility for internal project communications.

Centralised management and delivery of the project is key for the successful delivery of **CarboMet**. This will ensure that any overlaps in strategic scientific and industrial challenges as well as any cross cutting activities and outputs can all be exploited for maximum participation and value for money. For example, where possible, workshops will be coordinated so that sessions where there are overlaps in ETAs or BISs can be held so that interested stakeholders can jointly participate as appropriate.

The activities of **CarboMet** will be supported and organised by a project manager (PM). The PM will work closely with the Project Coordinator and Working Group to deliver the objectives, deliverables and milestones. This will include coordinating and promoting activities as well as engaging industry, academia and policy bodies and other stakeholders.

The distribution of votes within the management team will be equal, i.e. one per member. As the body which represents corporately the overall **CarboMet** network, the Working Group will be responsible for ensuring the overall strategy and direction of **CarboMet** yields optimal outcomes and benefits for all stakeholders. In addition, they will ratify members as well as changes to the structure and / or composition of the management team as required.

The Working Group will audit progress across the organisation on a regular basis and in a structured manner that ensures comprehensive cover of activities and that it will take appropriate action where things seem to be going wrong.

The Working Group are shown in Table 3.2. below. They have been selected firstly based on their world leading expertise in the ETAs, and secondly strategically for their links to industry and policy makers. 4 out of 8 consortium members are female. The Working Group are highly committed to the goals and ambitions of the project and provide an excellent stating point of key players on which to further build the **CarboMet** network.

Enabling Technology Area (ETA) (WP#)	**Working Group Member**
Analytics and Measurements (WP1)	**Isabelle Compagnon (Université de Lyon Claude Bernard, FR)** specializes in the development of analytical methods based on the coupling of mass spectrometry techniques with laser spectroscopy for the structural characterization of saccharides, in particular the separation and structural characterization of isobaric carbohydrate compounds. In addition she coordinates the International Glycophysics network (§1.3.3). In recognition of her interdisciplinary approaches to glycoscience she was distinguished as a "Membre Junior de l'Institut Universitaire de France" by the French Academy of Sciences. **Paula Domann (LGC Limited, GB)** is based at the LGC, the UKs National Measurements Institute and will provide invaluable insight on all aspects of metrology, as well as engaging other NMIs for and participating in EMPIR funded programs as outlined in Objective 4.
Synthesis of Standards (WP2)	**Peter Seeberger (Max Planck Institute of Colloids and Interfaces, DE)** is a world-leading expert in carbohydrate synthesis. His research in this area has led to the successful commercialisation of automated synthesis in the form of the spin out company, GlycoUniverse and Vaxxilon, a spin out company using synths to create fully synthetic vaccines. **Daniel Spencer (Ludger Limited, GB)** - Ludger are a bioscience company that provide expert glycoprofiling services and technologies for the biopharmaceutical industry, this includes the provision of glycan standards for use in glycan analysis.
Bioinformatics & Databases (WP3)	**Serge Perez (CNRS, FR)** expertise area is structural and conformation analysis of carbohydrates using molecular modelling tools. He was the co-chair of the EGSF network (2009-2014) (§1.3.3). In addition, he is the founder of Glycopedia, an online reference source for glycoscience, which will be a useful dissemination tool for CarboMet. http://www.glycopedia.eu **Frederique Lisacek (Swiss Institute of Bioinformatics (ISB), S)** is based at ISB which provides bioinformatics services and infrastructure to the national and international community. Her research is involved with software and database development for the benefit of the proteomics and glycomics communities.
Policy Engagement (WP4)	**Lokesh Joshi (National University of Ireland- Galway, Ireland)** research focuses on developing technologies for high-throughput

	biomimic discovery and microarray based glycomics studies for clinical and industrial applications including infectious and chronic diseases and biopharmaceuticals. He is Science Foundation Ireland appointed Stokes Professor of Glycoscience since 2008 and the Vice President for Research at National University of Ireland Galway in January 2013. His research has been funded by US, Irish and EU funding agencies and industries. In 2003, he co-founded a successful biotechnology start-up, Arizona Engineered Therapeutics (AzERx) developing engineered peptides for vascular applications which was acquired in Capstone Therapeutics. In Ireland, Prof. Joshi has co-founded a biotechnology company; Aquila Bioscience developing glycoscience based solutions for society. It is funded by private sector, EU and European Defence Agency. Prof. Joshi is a member of the Research Policy Working Group of European Universities Association. **Anne Imberty (CERMAV, CNRS, France)** is the Research Director at the Centre de Recherches sur les Macromolécules Végétales (CERMAV), which is a fundamental research centre devoted to Glycosciences, with strong and multidisciplinary expertise that spans from chemistry, physical-chemistry, biology to material sciences. Her research interests are in the field of structural glycobiology, with main interest on biologically active oligosaccharides and their interaction with lectins and glycosyltransferases. She solved several crystal structures of oligosaccharides and of lectin/carbohydrate complexes. A world wide recognized glycoscientist she has received many international and national awards, including the prestigious CNRS Silver Medal.

Table 3.2: The Working Group.

b) Industrial & commercial involvement in the project

Industrial involvement in the project will be initially established by appointment of the ISB in Q1, who will be selected on the basis of their expertise in each of the BISs to ensure full representation of all the sectors **CarboMet** will address. We will also build on the industries who participated and engaged in the previous workshop 'Metrology of Carbohydrates' (see textbox §1.1.1). Objective 1 of **CarboMet** is to build a glycoscience user group made up of representatives from over 500 organisations, including research groups, innovators, manufacturers, end users such as patient groups, policy makers and wide involvement across all sectors.

3.3 Consortium as a whole

Professor Sabine Flitsch (UoM) will coordinate the project and has previous experience in leading large European projects (GlycoBioM FP7 January 2011 – December 2015). Her research expertise is in the areas of carbohydrate synthesis, mass spectrometry techniques for glycan analysis and glycan array technology, which will provide input to WP1 on Analytics & Measurements, as well as WP3 on Synthesis of Standards. She has recently established a spin out company Bio-Shape Ltd, which provides cutting edge technology for the analysis of carbohydrates based on mass spectrometry techniques. In the context of this project, Bio-Shape will not provide any technology but will provide an industrial perspective in the information gathering stages for WPs1-3 and Milestones 3 and 4. Particularly relevant for **CarboMet** is her track record in setting up such network initiatives (§1.3.3); she was the chair of the EGSF

network (2009-2014) and is the Director of IBCarb network, (2014-2019). In addition, she is currently participating in the MEP-Scientist Pairing Scheme, which is providing useful insight into the decision-making process at the EU parliament, which will be relevant to WP4.

3.4 Resources to be committed

Table 3.4 b 'Other direct cost' items (travel, equipment, infrastructure, goods and services, large research infrastructure)

1. UoM	Cost (€)	Justification
Travel	16,000	Travel budget for members of the management team (Working Group and Industrial Steering Group) to attend CSA meetings & policy engagement meetings.
Equipment	0	-
Other goods and services	150,000	€120,000 - Scoping meetings, advanced technologies showcase meetings & roadmap scoping meeting €7,000 – CarboMet website €7,000 – Literature & Printing costs including graphic design €12,000 - Consumables for Project Manager (€3K p.a.) €4,000 – Audit fees
Total	166,000	

Large Research Infrastructure

- There are no large research infrastructure costs associated with this proposal.

Section 4: Members of the consortium

4.1. Participants (applicants)

Please provide, for each participant, the following (if available):

Participant Organisation – The University of Manchester (UoM)
The University of Manchester is a world-renowned centre for scholarship and research and one of the world's leading centres for biomedical and biotechnology research that sits at the forefront of new discoveries in science and engineering. The University exhibits a higher education brand synonymous with the finest international standards of academic excellence matching the world's leading universities in attracting the highest calibre of researchers, innovators and scholars. Research is at the heart of The University of Manchester and the scale, diversity and quality of its research activity is unrivalled in the UK. UMIP, The University of Manchester IP company, is located on the campus and will provide assistance and advice in terms of protecting and exploiting IP issues. The main campus also houses a full complement of services, both physical and pastoral.
Work package participant

WP1 | Analytics & Measurements

WP2 | Synthesis of Standards

WP3 | Bioinformatics and Databases

WP4 | Policy Engagement

WP5 | Project Coordination & Management

Key Persons

Professor Sabine Flitsch (female) is a Professor of Chemical Biology (since 2004) at the University of Manchester (UoM) and an honorary member of the Oxford Glycobiology Institute. She is PI of IBCarb, a BBSRC network (www.ibcarb.com; 2014-2018) which promotes the application of Glycoscience tools in bioindustries and has led a number of Glycoscience networks such as EuroGlycosciences Forum (www.egsf.org) and the UK and European Glycoarray consortia. She has contributed to a number of international strategic papers on the future of glycosciences, e.g. the US National Academies Roadmap and A Roadmap for Glycoscience in Europe. Her interests lie primarily in the development of novel tools for the synthesis and analysis of carbohydrates and glycoconjugates and their application in Biotechnology. In the last 5 years she has been PI on grant income of over £5M and Co-I on additional grant income of over £20M. She has received a BBSRC fellowship (2001-2004), the Wolfson Merit Award (2007-2012) and the 2014 RSC Interdisciplinary Prize for her work in glycosciences. She has chaired and served on a number of bodies, including the RSC carbohydrate group (Chair) and the last two research evaluation panels for Chemistry (RAE2008 | RAF2014). Her >25 years expertise at the forefront of glycoscience and extensive networking links with glycoscientists worldwide will guide the direction of the project in terms of choice of standards/biological samples and bioinformatics capabilities.

Relevant Publications and/or products, services and achievements

[1] P. Both, A. P. Green, C. Gray, R. Šardzík, J. Voglmeir, C. Fontana, M. Austeri, M. Rejzek, D. Richardson, R. A. Field, G. Widmalm, S. L. Flitsch and C. E. Eyers. Discrimination of epimeric glycans and glycopeptides using IM-MS and its potential for carbohydrate sequencing. Nature Chemistry, 2013; 6(1): 65.

[2] G. T. Noble, F. L. Craven, J. Voglmeir, R.Šardzík, S. L. Flitsch and S. J. Webb. Accelerated Enzymatic Galactosylation of N-Acetylglucosaminolipids in Lipid Microdomains. JACS, 2012; 134(31): 13010-13017.

[3] R. Šardzík, A. P. Green, N. Laurent, P. Both, C. Fontana, J. Voglmeir, M. J. Weissenborn, R. Haddoub, P. Grassi, S. M. Haslam, G.Widmalm, and S. L. Flitsch. Chemoenzymatic Synthesis of O-Mannosylpeptides in Solution and on Solid Phase. JACS, 2012; 134(10): 4521-4524.

[4] R. Castangia, M. Austeri, S. L. Flitsch. Enzymatic Amine Acyl Exchange in Peptides on Gold Surfaces. Angewandte Chemie, 2012; 51(52):13016-13018.

[5] J. Rannes, A. Ioannou, S. Willies, G. Grogan, C. Behrens, S.L. Flitsch, N.J.Turner, Glycoprotein labelling using engineered variants of galactose oxidase obtained by directed evolution. JACS, 2011; 133(22): 8436-8439.

Participation in relevant previous projects or activities

Sabine Flitsch has a strong record of accomplishment in participating in successful research and training projects within the Framework Programmes. Previous EU research projects include:

- DCC - EU FP6 RTN (1st Sep 2006 – 31st August 2010) Project partner
- AQUA(GLYCERO)PORINS - EU FP6 RTN (1st Dec 2006 – 30th November 2010) Project partner
- MALARIAPORIN EU FP6 (1st Jan 2005 – 31st Mar 2007) Project partner
- GlycoBioM EU FP7 (1st Jan 2011 – 31st Dec 2015) Project coordinator
- hiPAD EU FP7 (1st Jan 2012 – 31st Dec 2015) Project partner
- P4FIFTY EU FP7 ITN (1st Jan 2012 to 31st Dec 2015) Project partner
- Chem21 IMI EU (1st Oct 2012 – 31st Oct 2014) Project Partner

Current EU research projects include:

- BIOOX EU FP7 (1st Oct 2013 – 30th Sep 2017) Project partner
- TINTIN EU FP7 ITN (1st Oct 2013 – 30th Sep 2017) Project partner
- IMMUNOSHAPE ITN (1st January 2015 – 31st December 2017) Project partner

Significant infrastructure and/or major items of technical equipment

The Flitsch lab are located in the Manchester Institute of Biotechnology (MIB). The MIB was the first university-based, purpose built interdisciplinary research institute of its kind in the UK. MIB houses over 60 research groups, including >300 postgraduate students from across the Faculties of Life Sciences, Engineering and Physical Sciences, and Medical and Human Sciences, making MIB at The University of Manchester (UoM) a truly dynamic and open research environment. The establishment of multi-skilled interdisciplinary teams with critical mass generates unique capabilities that cannot be realised through virtual associations between PIs or research units to develop regional, national and international partnerships in biotechnology research, which proves an ideal environment for the training and transfer of knowledge to individuals working there. In addition, the MIB has a range of state of the art facilities, which are available to us such as NMR (800 and 500MHz), mass spectrometers including SIMS and FT-ICR, a biophysics facility with full bionanotechnology capability, high level protein expression and scale-up facilities, protein structure and crystallography capability and a transcriptomics facility.

4.2. Third parties involved in the project (including use of third party resources)

Does the participant plan to subcontract certain tasks (please note that core tasks of the action should not be sub-contracted)	No
If yes, please describe and justify the tasks to be subcontracted Not applicable	
Does the participant envisage that part of its work is performed by linked third parties[1]	No
If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party Not applicable	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	No
If yes, please describe the third party and their contributions Not applicable	

Section 5: Ethics and security

5.1 Ethics

Key stakeholders will be selected and identified from the professional contacts and networks of the working group and industrial steering group. They will be invited to participate in the workshops and online surveys in order to help identify the technical capabilities and needs in their respective areas for carbohydrate metrology. No political opinions will be sought. No outcomes or outputs will be published without participants consent with a lengthy period for review of any draft outputs produced prior to publication. Personal data will not be made publicly available or shared without consent. Sensitive data will be anonymised.

The procedures that will be implemented for data collection, storage, protection, retention and destruction will comply with national EU legislation on Data Protection (EC Directive 95/46 and, once entered into force by May 2018, with Regulation 2016/679. In addition, the University of Manchester requires all its staff to complete compulsory data protection training which provides an understanding of the UK's Data Protection Act 1998 which controls how personal information can be used so as to protect the rights and privacy of individuals when handling personal data.

5.2 Security[21]

[21] Article 37.1 of the Model Grant Agreement: *Before disclosing results of activities raising security issues to a third party (including affiliated entities), a beneficiary must inform the coordinator — which must request written*

Please indicate if your project will involve:

- activities or results raising security issues: **NO**
- 'EU-classified information' as background or results: **NO**

approval from the Commission/Agency. Article 37.2: *Activities related to 'classified deliverables' must comply with the 'security requirements' until they are declassified. Action tasks related to classified deliverables may not be subcontracted without prior explicit written approval from the Commission/Agency. The beneficiaries must inform the coordinator — which must immediately inform the Commission/Agency — of any changes in the security context and — if necessary —request for Annex 1 to be amended (see Article 55*