

Annex B

External Experts Involved in the Bioeconomy to 2030 Project

External experts were called upon to draft papers and provide comments on the various topics addressed by the project. (Titles and affiliations are those held during the course of the project.)

Steven BLANK
Cooperative Extension Specialist
Department of Agricultural and Resource Economics
University of California, Davis
United States

Torben Vedel BORCHERT
Senior Director Protein Optimization
Novozymes
Denmark

Ann BRUCE
Research Fellow
Research Centre for Social Science
University of Edinburgh
United Kingdom

Leslie BUTLER
Department of Agricultural & Resource Economics
University of California, Davis
United States

Mark CANTLEY
Consultant
Belgium and the United Kingdom

Joanna CHATAWAY

Professor, Development Policy and Practice
Faculty of Maths, Computing and Technology
The Open University
United Kingdom

Michael CHING

Policy Analyst
Innovation and Science
Agriculture and Agri-Food Canada
Canada

Alain DEHOVE

Coordinator of the World Animal Health and Welfare Fund
World Organisation for Animal Health - (OIE)
France

M.N. Graham DUKES

Professor, Unit for International Community Health
University of Oslo
Norway

Christien ENZING

Senior Researcher
Innovation Policy Group
Netherlands Organisation for Applied Scientific Research (TNO)
Netherlands

Annelieke van der GIESSEN

Researcher
Innovation Policy Group
Netherlands Organisation for Applied Scientific Research (TNO)
Netherlands

Johan van GROENESTIJN

Senior Researcher
Microbiology Group
Netherlands Organisation for Applied Scientific Research (TNO)
Netherlands

E. Richard GOLD
Director, Centre for Intellectual Property Policy,
McGill University Faculty of Law
Canada

Matthew HERDER
Visiting Professor of Law,
Loyola University
United States

Damian HINE
Senior Lecturer
University of Queensland Business School
Australia

Michael M. HOPKINS
Research Fellow
SPRU - Science and Technology Policy Research
University of Sussex
United Kingdom

Chung-cheng LIU
General Director, Biomedical Engineering Research Lab
Industrial Technology Research Institute
Chinese Taipei

Elspeth MACRAE
Group Manager Biomaterials Research
Scion
New Zealand

Boris MANNHARDT
Managing Director
Biocom Projektmanagement GmbH
Germany

Maureen McKELVEY
Professor, School of Business, Economics & Law
Göteborg University
Sweden

Koen MEESTERS
Researcher
Microbiology Group
Netherlands Organisation for Applied Scientific Research (TNO)
Netherlands

Daryl Van MOORSEL
Economist
Innovation and Science
Agriculture and Agri-Food Canada
Canada

Angela MURPHY
Senior Policy Analyst
Innovation and Science
Agriculture and Agri-Food Canada
Canada

Miriam PODTSCHASKE
Consultant
Biocom Projektmanagement GmbH
Germany

Nicolas RIGAUD
Consultant
France

Joyce TAIT
Director
Innogen Centre
University of Edinburgh
United Kingdom

Michel TROMMETTER
Senior Researcher
Institut National de la Recherche Agronomique (INRA)
France

David WIELD
Professor, Development Policy and Practice
Faculty of Maths, Computing and Technology
The Open University
United Kingdom

Noboru YUMOTO
Research Coordinator, Life Sciences
National Institute of Advanced Industrial Science & Technology (AIST)
Japan

Abbreviations and Acronyms

ADR	adverse drug reaction
AG	agronomic trait
AIDS	acquired immunodeficiency syndrome
ALL	acute lymphoblastic leukaemia
APHIS	Animal and Plant Health Inspection Service
BP	British Petroleum
BRIC	Brazil, Russia, India and China
BSE	bovine spongiform encephalopathy
CDER	Center for Drug Evaluation and Research
CGAP	Cancer Genome Anatomy Project
CGIAR	Consultative Group on International Agricultural Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBF	dedicated biotechnology firm
DDT	dichlorodiphenyltrichloroethane
DHA	Department of Health and Aging (Australia)
DHHS	Department of Health and Human Services (United States)
DNA	deoxyribonucleic acid
DNDi	Drugs for Neglected Diseases Initiative
DOE	Department of Energy (United States)
EEC	European Economic Community
ELISA	enzyme-linked immunosorbent assay
EMA	European Medicines Agency
EU KLEMS	European Union Capital (K) Labour (L) Energy (E) Materials (M) Service Inputs (S) Database
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration (United States)
FFN	functional foods and nutraceuticals
GAO	Government Accountability Office (United States)
GBOARD	government budget outlays and appropriations for research and development

GDP	gross domestic product
GHG	greenhouse gas
GM	genetically modified <i>or</i> genetic modification
GVA	gross value added
HAS	<i>Haute Autorité de Santé</i>
HIV	human immunodeficiency virus
HR	human resources
HT	herbicide tolerance
HT-IR	combined herbicide tolerance and insect resistance
IAVI	International AIDS Vaccine Initiative
IB	industrial biotechnology
ICH	International Conference on Harmonisation
ICT	information and communication technology
IEA	International Energy Agency
IMSR	improvement of medical service rendered
IPCC	Intergovernmental Panel on Climate Change
IPO	initial public offering
ISAAA	International Service for the Acquisition of Agri-biotech Applications
ISO	International Organization for Standardization
IT	information technology
IVD	<i>in vitro</i> diagnostic
IVF	<i>in vitro</i> fertilisation
LCA	life cycle analysis
M&A	mergers and acquisitions
mAb	monoclonal antibody
MAS	market-assisted selection
MEOR	microbial enhanced oil recovery
MSR	medical service rendered
Mtoe	million tons of oil equivalent
NAFTA	North American Free Trade Agreement
NCE	new chemical entity
NGO	non-governmental organisation
NICE	National Institute for Clinical Excellence
NIH	National Institutes of Health (United States)
NMA	<i>Noordwijk</i> Medicines Agenda
NME	new molecular entity
OECD	Organisation for Economic Co-operation and Development
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
PCT	Patent Cooperation Treaty
PDO	polydioxanone

PGD	preimplementation genetic diagnosis
PHA	polyhydroxyalkanoates
PHB	polyhydroxybutyrate
PPP	purchasing power parity
PQ	product quality
PVC	polyvinyl chloride
QALY	quality adjusted life years
R&D	research and development
RFA	Renewable Fuels Association
RNA	ribonucleic acid
RNAi	RNA interference
SARS	severe acute respiratory syndrome
SM	small molecule
SME	small- and medium-sized enterprise
SNP	single nucleotide polymorphisms
Synbio	synthetic biology
TB	tuberculosis
TRIPS	Trade-Related Aspects of Intellectual Property Rights (WTO)
UN	United Nations
UNU-MERIT	United Nations University Maastricht Economic and Social Research and Training Centre on Innovation and Technology
USDA	United States Department of Agriculture
USITC	United States International Trade Commission
USPTO	United States Patent and Trademark Office
VC	venture capital
WHO	World Health Organization
WTO	World Trade Organization

Table of Contents

Abbreviations and Acronyms.....	11
Preface	14
Executive Summary	15
<i>Chapter 1. Defining the Bioeconomy</i>	19
What is a bioeconomy?	22
Foreseeing the emerging bioeconomy.....	26
Notes	28
References.....	29
<i>Chapter 2. What External Factors Will Drive the Bioeconomy to 2030?</i>	31
Population and income	33
Demographics and human resources	37
Energy consumption and climate change.....	38
Agriculture, food prices and water	40
Healthcare costs	41
Supporting and competing technologies	42
Summary of drivers.....	44
Notes	47
References.....	48
<i>Chapter 3. The State of the Bioeconomy Today.....</i>	51
Platform technologies.....	52
Biotechnology applications in primary production	55
Biotech applications in health	63
Biotech applications in industry	72
Biofuels	79
The bioeconomy today	85

Notes	86
Annex 3.A1. USDA-Approved GM Varieties	89
Annex 3.A2. <i>Haute Autorité de Santé</i> (HAS) Therapeutic Value Classifications	90
Annex 3.A3. Analysis of <i>Prescrire</i> Therapeutic Value Evaluations	91
References.....	92
<i>Chapter 4. The Bioeconomy to 2015</i>	99
Platform technologies to 2015.....	100
Biotech applications to 2015 in primary production	103
Biotech applications to 2015 in human health	109
Biotech applications to 2015 in industry	119
Biofuels to 2015	124
The bioeconomy in 2015.....	129
Notes	130
References.....	132
<i>Chapter 5. Institutional and Social Drivers of the Bioeconomy</i>	137
Public research	138
Regulation	144
Intellectual property rights	152
Social attitudes	153
Notes	156
References.....	158
<i>Chapter 6. The Business of the Emerging Bioeconomy</i>	163
Current business models for biotechnology	164
Emerging business models in biotechnology	171
Conclusions	184
Notes	185
Annex 6.A1. R&D Expenditures by Leading Firms Active in Biotechnology	188
References.....	189

<i>Chapter 7. The Bioeconomy of 2030</i>	193
Introduction	194
The probable bioeconomy in 2030.....	194
Scenarios for the bioeconomy of 2030.....	202
Conclusions	209
Notes	210
Annex 7.A1. Fictional Scenarios to 2030	211
References.....	232
<i>Chapter 8. Policy Options for the Bioeconomy: The Way Ahead</i>	235
Primary production.....	241
Health applications.....	248
Industrial applications	258
Cross-cutting issues.....	266
The global challenge	269
Timing.....	272
The complex policy context	274
Notes	275
References.....	279
<i>Chapter 9. Conclusions: On the Road to the Bioeconomy</i>	285
Main findings	287
Concluding comments.....	293
Notes	294
<i>Annex A. Members of the Bioeconomy to 2030 Steering Group</i>	295
<i>Annex B. External Experts Involved in the Bioeconomy to 2030 Project</i>	302
<i>Glossary of Selected Scientific and Technical Terms</i>	307

List of tables

2.1. Population and per capita GDP in 2005 and 2030, by region.....	34
2.2. Population living in areas under water stress	41
2.3. Drivers for the bioeconomy.....	45
3.1. HAS evaluations of the therapeutic value of biopharmaceuticals and all other drugs.....	66
3.2. Valid FDA genomic biomarkers and genetic testing requirements, September 2008.....	70
3.3. Examples of biopolymer production facilities in use or development	74
3.4. Characteristics of new types of biorefineries	79
3.5. Percentage of all field trials in select food crops involving potential biofuel traits, 1987-2006.....	81
3.6. An overview of some current biofuel production technologies and research goals	84
3.A1.1. USDA-approved and pending GM crop varieties as of 1 May 2007.....	89
3.A3.1. <i>Prescribe</i> evaluations of the therapeutic value of biopharmaceuticals and all other drugs (January 1986–December 2007)	91
3.A3.2. Definition of <i>Prescribe</i> evaluation categories.....	91
4.1. The current status and prospects to 2015 of some important platform technologies.....	102
4.2. The current status and prospects to 2015 of some important biotechnology applications in primary production	108
4.3. Share of all biotechnology clinical trials in proven and experimental biotherapies, by phase.....	113
4.4. The current status and prospects to 2015 of some important biotechnology applications in health	118
4.5. Bio-based chemical R&D: US survey respondents' expenditures and employment, 2004-07	120
4.6. Projected value of world chemical production: 2005, 2010 and 2025	121
4.7. The current status and prospects to 2015 of some important biotechnology applications in industry	127
5.1. Indicative regulatory costs to commercialise a biotechnology product.....	146
6.1. Percentage of all GM field trials by the leading firms.....	168
6.2. Concentration of R&D in pharmaceuticals and health biotechnology	170
6.A1.1. Estimated 2006 R&D expenditures of relevance to biotechnology by leading companies in each application	188
7.1. Biotechnologies with a high probability of reaching the market by 2030.....	195
7.2. Maximum potential contribution of biotechnology to gross value added and employment	200
7.3. Current R&D expenditures versus future markets for biotechnology by application	201
8.1. Examples of incremental, disruptive and radical innovations for the bioeconomy to 2030	239

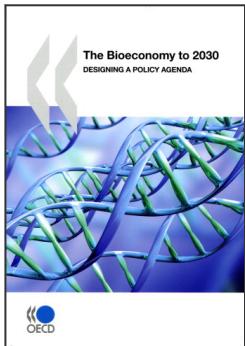
List of figures

1.1. Current and expected integration across biotechnology applications	25
2.1. World land mass by expected population in 2030	35
2.2. Expected world primary energy demand (Mtoe)	39
3.1. USDA approved GM varieties as of May 2007, by trait.....	56
3.2. Approved GM crop plantings, 2007	58
3.3. Share of biopharmaceutical NMEs out of all pharmaceutical NMEs (three-year moving average), by year of first registration for market approval, 1989-2007	64
3.4. Number of diseases for which genetic testing is available as reported to GeneTests, by year	69
3.5. Number of GM field trials for trees and grasses for lignin modification and for all other traits.....	82
4.1. Observed (to 2005) and forecast (2006-15) GM share of global area cultivated, by crop	104
4.2. Number of biopharmaceutical NMEs expected to obtain marketing approval, by year	111
4.3. Number of identified gene-drug relationships, three-year moving average, by year of first publication	114
4.4. World ethanol and biodiesel production: projections to 2017	124
5.1. Percentage of all field trials by type of applicant for agronomic traits (three-year moving average).....	140
5.2. Public R&D expenditures for bioenergy and the share of total energy R&D in IEA countries	142
5.3. Doctoral degrees awarded in the physical, biological and agricultural sciences	143
5.4. Multiple futures for health regulation	151
6.1. Value-added market structure in biotechnology	165
6.2. Number of SMEs with one or more GM field trials in the OECD.....	168
6.3. Emerging business models in biotechnology	185

List of boxes

1.1. Demand for grains in 2030	21
1.2. The bioeconomy and sustainable development.....	22
1.3. Research spillovers	24
2.1. The global economic crisis	36
3.1. Ocean and marine applications	62
4.1. Predictive and preventive medicine	110
5.1. Biosecurity	145
5.2. Regulation and competitiveness: the <i>de facto</i> European moratorium on GM.....	149
5.3. Ethics and the bioeconomy	154

6.1. Mergers and acquisitions in the seed sector	167
6.2. Collaborative business models	172
6.3. Identification and validation of biomarkers	177
6.4. Life cycle analysis (LCA)	183
8.1. Types of innovations	237
8.2. Some policy approaches and tools for the emerging bioeconomy	240
8.3. Managing incremental biotechnologies for primary production	245
8.4. Managing disruptive and radical biotechnologies for primary production	246
8.5. Managing key uncertainties for primary production biotechnologies	248
8.6. Managing incremental biotechnologies for health	253
8.7. Managing disruptive and radical biotechnologies for health	255
8.8. Managing key uncertainties for health biotechnology	258
8.9. Managing incremental biotechnologies for industry	260
8.10. Managing disruptive and radical biotechnologies for industry	265
8.11. Managing key uncertainties for industrial biotechnology	266
8.12. Managing intellectual property for the bioeconomy	268
8.13. Managing knowledge spillovers and integration	269
8.14. Managing challenges at the global level	271



From:
The Bioeconomy to 2030
Designing a Policy Agenda

Access the complete publication at:
<https://doi.org/10.1787/9789264056886-en>

Please cite this chapter as:

OECD (2009), "Annex B: External Experts Involved in the Bioeconomy to 2030 Project", in *The Bioeconomy to 2030: Designing a Policy Agenda*, OECD Publishing, Paris.

DOI: <https://doi.org/10.1787/9789264056886-13-en>

This work is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and arguments employed herein do not necessarily reflect the official views of OECD member countries.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for public or commercial use and translation rights should be submitted to rights@oecd.org. Requests for permission to photocopy portions of this material for public or commercial use shall be addressed directly to the Copyright Clearance Center (CCC) at info@copyright.com or the Centre français d'exploitation du droit de copie (CFC) at contact@cfcopies.com.