

Fraunhofer ISI Discussion Papers *Innovation Systems and Policy Analysis* No. 53

ISSN 1612-1430

Karlsruhe, April 2016

Societal Grand Challenges from a technological perspective – Methods and identification of classes of the International Patent Classification IPC

Rainer Frietsch¹, Peter Neuhäusler¹, Oliver Rothengatter¹, Koen Jonkers²

This study was funded by the JRC-IPTS (Institute of Prospective Technology Studies) in the project with the title "Collection and analysis of private R&D investment and patent data in different sectors, thematic areas and societal challenges" (JRC/BRU/2014/J.6/0015/OC)

Karlsruhe, Fraunhofer ISI

© European Union, 2016

¹ Fraunhofer Institute for Systems and Innovation Research ISI

² European Commission, JRC-IPTS

The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

Contents

1 Introduction..... 1

2 Methodology 2

2.1.1 Societal Grand Challenges 2

3 Lists of IPC-classes for each of the Societal Grand Challenges..... 6

4 List of IPC classes in each of the sub-fields of the Societal Grand Challenges 9

5 References 15

Tables

Table 1: IPC classes for each of the six technology-oriented Societal Grand Challenges 7

Table 2: Detailed list of IPC classes for each of the six technologically-oriented Societal Grand Challenges 9

1 Introduction

The aim of this working paper is the provision of a list of IPC classes assigned to each of the technology-oriented Societal Grand Challenges (SGCs) of Horizon2020 and the description of the methods and workings steps that have led to this list. Patents are a vested right on the exclusive use of a certain technological solution. In consequence, patent data can only be collected for technology-driven or at least partially technology-affected areas. In terms of the Societal Grand Challenges, we see that six out of seven of them have at least in part a technology-affection, while one – namely "Europe in a changing world, inclusive, innovative and reflective societies" – can hardly be defined based on patent classes. We are fully aware of the fact that the Societal Grand Challenges have other, non-technical dimensions, which cannot be grasped on the basis of patents or patent statistics. Therefore, the aim of this paper is to provide a definition of the technological dimensions of the Societal Grand Challenges, while other dimensions will not be addressed. Next to definitions of patent classes for the six Grand Challenges, also definitions of the sub-fields of the Societal Grand Challenges will be provided.

Patents are classified according to their technological content. A very detailed and differentiated classification is currently used for this purpose, the International Patent Classification (IPC). At the national level, some additional classification systems are in use (e.g. the USPC at the USPTO). In addition, more recently, the Cooperative Patent Classification (CPC) has been created that will be used in addition to IPC and USPC and might become the most frequently used classification in the future. However, currently the IPC is still the most frequently used classification for analytical purposes and it is available in most databases. In addition, there is a considerable overlap between the IPC and CPC. It is for these reasons that we have used the IPC classification.

For the sake of this working paper, the Societal Grand Challenges were defined in terms of technologies. So far – to the best of our knowledge – no such technological definition is available. However, we took into account previous work for example at the EPO (European Patent Office (EPO) 2013), at WIPO (Schmoch 2008) and by Geerts et al. (2011) for defining the thematic fields of the Seventh Framework Programme. In addition, we were able to rely on previous work for the OECD (Grupp et al. 1996) and Eurostat/European Commission (Schmoch et al. 2003) that was done at Fraunhofer ISI.

For the definition of the content and the demarcation of the Societal Grand Challenges as such, we have relied on the Legal Base of the First Working Programme of Horizon 2020. In second instance a number of interviews were conducted with representatives of the Commission Services. These involved officials from the coordinating units of the thematic directorates of DG Research and Innovation, responsible for the parts of Hori-

zon 2020 targeting the Health, Sustainable Resources, Bioeconomy, Transport and Energy grand challenges. As the latter unit cooperates with JRC-IET in Petten in collecting among others patent and business indicator data, research staff from this institute was also involved. For the Security grand challenge we have interviewed officials from DG HOME and DG CONNECT responsible for the R&D funding programme in this field.

We agreed that we should not strictly limit our focus neither on the current working programme nor the legal basis for Horizon 2020. The latter document is not sufficiently specific for building the definitions on, whereas the first does not cover the whole programming period. In the context of this project the Societal Grand Challenges are to be seen from the challenges themselves and not only based on what is funded by the European Commission or what is part of the working programme. For example, in the SGC Health, funding is not foreseen for general pharmaceutical research, but for certain diseases and technologies/agents. The challenge as such, however, includes all pharmaceutical research with the awareness that most of that is done by industry without public funding aids. The same example could be made in the context of the SGC Transport, where only certain technologies and solutions are funded by the European Commission or national sources, but the challenge itself contains a number of technological solutions where industry conducts R&D without direct public funding support.

The remaining parts of this working paper are organised in the following way. The second chapter briefly describes the methodological basis of the definitions, while the third chapter provides the IPC codes for the Societal Grand Challenges and the fourth for a number of sub-fields of these Challenges, as well as the respective sources of definitions.

2 Methodology

2.1 Societal Grand Challenges

A shift in terms of application orientation is envisaged with Horizon 2020 (H2020) as part of the Innovation Strategy in European policy making. This implies a focus on pathways to technological solutions. Previous thematic priorities and research lines under FP6 and FP7 have been retained – the main change within H2020 is not the thematic priorities, but the type of projects funded. In an attempt to be less prescriptive, the Work Programmes (WP) under the Horizon 2020 Grand Challenges – which encompass previous thematic priorities to a large extent – try to indicate the areas expected to be targeted. This offers more flexibility and freedom than under FP7, but in terms of definitions and analyses, this openness is too broad or too unspecific to be

operationalized and measured. There is no clear definition of what should be covered by the Societal Grand Challenges (SGCs) in terms of included or excluded scientific or technological fields. In consequence, there are no definitions or demarcations of the SGCs which could be directly used for their definitions in terms of patent classes.

As a starting point, we held a workshop in Brussels at the end of March 2015 with a number of experts on technology classifications, data treatment, and statistical analyses from a broad array of institutions including academia, the EPO, EUROSTAT, European Commission DG JRC as well as other policy makers from the Commission Services. Two main results emerged from the workshop. First, there is continuity in policy making that makes it possible to draw on previous analyses and findings, for example, in the context of FP7. A modular definition of technologies within SGCs allowed for a sufficient level of flexibility in defining the SGCs. Second the following procedure was established to elaborate a technology definition:

- Check the (current and maybe upcoming) work programme (WP) and legal basis of H2020 for funded technologies;
- Rely on existing classifications in the definition of the modular technological fields encompassed in the SGCs as far as possible
- Hold interviews and discussions for each SGC with representatives from the respective thematic directorates of DG RTD and for the security Grand Challenge, the responsible units from DG HOME and DG CONNECT to ensure an appropriate understanding of the SGCs;
- Use the information gathered to suggest technological definitions that are then re-discussed with the representatives.

In the course of these discussions with representatives, it became clear that it was also worthwhile to examine the newer WP to obtain a more general and longer-term perspective of each SGC rather than only the current WP. This was taken into account when fine-tuning and adapting the technology definitions. In addition, the structured interviews and discussions, during which first general technology lists were provided by the contractors (based on the available WPs of the SGC), led to a common understanding of the SGCs. The Commission representatives agreed to check the precise technology definitions suggested by the contractors after the interviews. All the representatives agreed that the view of SGCs should be broader and more general than in the current WP under H2020 and go beyond what is explicitly mentioned in the WPs. In addition, several SGCs address general issues some of which might not be directly funded under H2020, but through a Joint Undertaking (JU) like the Innovative Medicines Initiative (IMI) as well as private funding and research by companies. The latter is particularly important here as the core of the project for which this definition is devel-

oped deals with business R&D expenditures (BERD) and patent applications, about 90% of which originate in the private sector. **So this definition of the SGCs is in the broad sense of the challenges and not in the narrower sense of the funding programme.** We decided, in agreement with the representatives of the respective thematic directorates, that there could be some overlap between the definitions of the Societal Grand Challenges, i.e. the patents classified in each field do not have to be mutually exclusive.

The following Grand Challenges are addressed in the course of this working paper:

- Health, demographic change and well-being [HEALTH],
- Food security, sustainable agriculture, marine and maritime research, and the bio-economy [BIOECONOMY],
- Secure, clean and efficient energy [ENERGY],
- Smart, green and integrated transport [TRANSPORT],
- Climate action, resource efficiency and raw materials [CLIMATE],
- Secure societies – protecting the freedom and security of Europe and its citizens [SECURITY].

The Grand Challenge "Europe in a changing world – inclusive, innovative and reflective societies" cannot be included as it has few direct technological components, which can be searched in patent databases. Some other elements that fall within the remit of the Societal Grand Challenges as defined in Horizon 2020 could also not be covered in this definition. This is, for example, the case for Cultural Heritage which falls under the CLIMATE Grand Challenge. While Cultural Heritage has a technological dimension, it was deemed impossible to accurately capture this output. Some finely grained IPC classes could be assigned to this field, but most relevant patents would fall within IPC classes that are considerably broader. Including this field would therefore lead to a strong over or underestimation of technological output.

As far as possible, we have relied on existing patent classifications and assign them (totally or in parts) to the respective SGC rather than creating completely new ones.

For example, the OECD¹ provides definitions of selected fields, namely biotechnology, ICT, nano-technology and environmental technologies. Furthermore, several patent offices publish search strategies and technology definitions of particular fields in their

¹ Please refer to <http://www.oecd.org/innovation/inno/oecdworkonpatentstatistics.htm>.

annual reports, for example, electric and hybrid vehicle technologies, renewable energy technologies, or biotechnology.²

The EPO used to classify nano-technologies (Y01), climate mitigation technologies (Y02) and more recently also energy-saving technologies in smart grids (Y04) using their internal classification scheme, the ECLA (European Classification System) that supplemented the IPC (European Patent Office (EPO) 2013). The ECLA was then transferred to the CPC (Cooperative Patent Classification), which is jointly managed by the EPO and the USPTO. Y02 and Y04 technologies are still classified there³, while Y01 was integrated into the IPC in 2010 and is now classified as B82. The SETIS⁴ project as well as an EPO/UN⁵ report on Climate Change and Mitigation Technologies (CCMT) uses this classification so that it is well established in the field and accepted by stakeholders in the Commission Services as well as outside the Commission. In the context of these challenges – namely CLIMATE and ENERGY – we have also relied on the IPC Green Inventory by the WIPO⁶.

In a project for DG-RTD called "Measurement and analysis of knowledge and R&D exploitation flows, assessed by patent and licensing data", INCENTIM at K.U. Leuven together with KITES (Geerts et al. 2011) at the University Bocconi developed a concordance between FP7 thematic priorities and IPC classes (Patent Indicators by Thematic Priority)⁷. They based their technological definitions on Schmoch (Schmoch 2008) and assigned them to 15 thematic priorities. As they also kept a differentiation below the level of these 15 priorities, a modular definition of the thematic priorities was achieved, which were also used in this working paper to assign technologies to one of the SGCs.

² See for example the annual reports by the German Patent and Trademark Office at <http://www.dpma.de/english/service/publications/annualreports/index.html>.

³ In the call for this tender, this was mentioned as reference to the "IPC Green Inventory".

⁴ <https://setis.ec.europa.eu/archive/project-mapping>

⁵ <http://www.epo.org/news-issues/press/releases/archive/2015/20151208.html>

⁶ <http://www.wipo.int/classifications/ipc/en/est/>

⁷ Annelies Geerts, Gianluca Tarasconi, Francesca Innocenti, Xiaoyan Song, Julie Callaert, Maikel Pellens, Caro Vereyen, Cathy Lecocq, Stefano Breschi, Bart Van Looy (2011): Measurement and analysis of knowledge and R&D exploitation flows, assessed by patent and licensing data. Deliverable 1.6: Patent Indicators by Thematic Priority; Leuven, Milano.

These available classification schemes formed the basis for our definitions of the SGCs. The definitions were based on the version 2015.01 of the International Patent Classification (IPC). The IPC can be found, for example, on the website⁸ of the World Intellectual Property Organization (WIPO). More recent versions of the IPC as well as concordance tables from previous to the current version can also be found there.

3 Lists of IPC-classes for each of the Societal Grand Challenges

In Table 1 the IPC classes for each of the six technology-oriented Societal Grand Challenges can be found. Table 2 provides the same IPC classes differentiated by sub-fields of each of the challenges as well as the sources of definitions of each of the sub-fields.⁹ There were mainly four sources that were used for the definitions. These were the WIPO classification by Schmoch (2008), indicated as "WIPO" in the source column, while the green inventory¹⁰ by the WIPO is explicitly mentioned as well. EPO's (2013) climate change and mitigation technologies are indicated as "EPO" and the biotechnology definitions rely on OECD so it is indicated as "OECD". Another source was the report provided by Geerts et al. (2011), which is then indicated as "Geerts et al.". In one case we also relied on some classes that were defined in the KETs Observatory (Van de Velde et al. 2013) mentioned as "KETs Observatory". Finally, a number of definitions were newly introduced or adapted. These latter ones are then mentioned as "own".

To stress it once again, we decided to allow for some overlap between the individual definitions of the Societal Grand Challenges, i.e. the patents classified in each field do not have to be mutually exclusive. This is why also some sub-fields show up in more than one SGC (e.g. Y02T in Climate and in Transport).

⁸ <http://web2.wipo.int/classifications/ipc/ipcpub/#refresh=page>

⁹ It has to be noted that subfields can be assigned to multiple SGCs, as in the case of "biotechnology".

¹⁰ <http://www.wipo.int/classifications/ipc/en/est/>

Table 1: IPC classes for each of the six technology-oriented Societal Grand Challenges

CHALLENGE	IPC CLASSES
Health	G06Q050/22, G06Q050/24, A61B, A61C, A61F, A61G, A61H, A61J, A61L, A61M, A61N, H05G, H04R-025, A61K (NOT A61K-008), A61P, A01H001/00, A01H004/00, A61K038/00, A61K039/00, A61K048/00, C02F003/34, C07G011/00, C07G013/00, C07G015/00), C07K004/00, C07K014/00, C07K016/00, C07K017/00, C07K019/00, , G01N33/(53,54,55,57,68,74,76,78,88,92); (G01N27/327, C12M, C12N, C12P, C12Q, C12S) AND (A61K)
Bioeconomy	A01B, A01C, A01D, A01F, A01G, A01J, A01K, A01L, A01M, A21B, A21C, A22B, A22C, A23N, A23P, A61D, B02B, B29B, B29C, B29D, B29K, B29L, B99Z, C03B, C08J, C12L, , C13B05, C13B015, C13B025, C13B045, A01N, A01P, C05B, C05C, C05D, C05F, C05G, D21C, D21D, D21F, D21H, B31B, B31C, B31D, B31F, B41B, B41C, B41D, B41F, B41G, B41J, B41K, B41L, B41M, B41N, C14B, D01B, D01C, D01D, D01F, D01G, D01H, D02G, D02H, D02J, D03C, D03D, D03J, D04B, D04C, D04G, D04H, D05B, D05C, D06G, D06H, D06J, D06M, D06P, D06Q, D21B, D21C, D21D, D21F, D21G, D21H, D21J, D99Z, A01G023/00, A01G025/00, A01N025, A01N027, A01N029, A01N031, A01N033, A01N035, A01N037, A01N039, A01N041, A01N043, A01N045, A01N047, A01N049, A01N051, A01N055, A01N057, A01N059, A01N061, A01N063, A01N065, C09K017/00, E02D003/00, C05F, A01H 1/06, C12N 15/00, C12N 1/00, C12N 5/00, C12N 7/00, E02B-003, E02D, E02F, A01J, A01H, A21D, A23B, A23C, A23D, A23F, A23G, A23J, A23K, A23L, C12C, C12F, C12G, C12H, C12J, C13D, C13F, C13J, C13K, C13B010, C13B020, C13B025, C13B030, C13B035, C13B040, C13B050, C13B099, B67C, A21C, A22B, A22C, A21B, A21C, A22B, A22C, A23N, A23P, C07K, C10L005/40, C10L005/42, C10L005/44, C10L005/46, C10L005/48, C10B053/02, A01C3/02, C02F11/04, C05F17/02, B01D53/84, F23G7/10, C08B, C08C, C08H, C09F, C08L001, C08L003, C08L005, C08L007, C09J101, 103, 105, 107, C11B, C11C, C13B, A01H15, A61K36/02, 03, 04, 05, A01H001/00, A01H004/00, A61K038/00, A61K039/00, A61K048/00, C02F003/34, C07G011/00, C07G013/00, C07G015/00, C07K004/00, C07K014/00, C07K016/00, C07K017/00, C07K019/00, G01N33/(53, 54, 55, 57, 68, 74, 76, 78, 88, 92), (G01N27/327,C12M, C12N, C12P, C12Q, C12S, ANDNOT (A61K)), C07C029, C07D0475, C07K002, C08B003, C08B 7, C08H 1, C08L 89, C09D 11, C09D 189, C09J 189, A01K, A01M, A23N017, A22B, A61D, B62C, F25D, A21B, A47J
Energy	Y02, Y04

CHALLENGE	IPC CLASSES
Transport	B64, B60, B61, B62, B63, B25J, B65, B66, B67, G06Q-010/08, G06Q-050/28, G06Q-050/30, G05D-001/00, G08G-001/123, G08C, G08G, G06F017/00, G06F019/00, G01S, G01C, E01B, E01C, E01D, E01F, H01M, C07C-067/00, C07C-069/00; C10B-053/02; C10G, C10L-001/02, C10L-001/14, C10L-001/19, C10L-003/00, C10L-005/00, C10L-005/40, C10L-005/42, C10L-005/44, C10L-005/46, C10L-005/48, C10L-009/00; C11C-003/10, C12M-001/107, C12N-001/13, C12N-001/15, C12N-001/21, C12N-005/10, C12N-009/24, C12N-015/00; C12P-005/02, C12P-007/06-7/14, C12P-007/64, Y02E50, Y02E70/20; Y02E70/30, F16H003, F16H048, H02K029/08, H02K049/10, F02B043, F02M021/02, F02M027/02, H02J007/00, Y02T
Climate	A43B 1/12, 21/14; A61L 11/00; A62D 3/00, 101/00; B01D 45/00-53/96; B03B 9/06; B03C 3/00; B09B; B09C; B22F 8/00; B29B 17/00; B62D 67/00; B63B 35/32; B63J 4/00; B65F; B65G 5/00; C01B 31/20; C02F; C04B 7/24-130, 18/04-18/10; C05F; C08J 11/00-11/28; C09K 3/22, 3/32, 11/01; C10B 21/18; C10G 1/10; C10L 5/46, 5/48, 10/02, 10/06; C11B 11/00, 13/00-13/04; C14C 3/32; C21B 3/04; C21C 5/38; C22B 7/00-7/04, 19/30, 25/06; C25C 1/00; D01F 13/00-13/04; D01G 11/00; D21B 1/08, 1/32; D21C 5/02; E02B 15/04, 15/08; E03C 1/12; E03F, E21B 41/00, 43/16; E21F 17/16; F01N 3/00-3/38, 9/00; F02B 75/10; F23B 80/02; F23C 9/00; F23J; F25J 3/02; G08B 21/12; G21F 9/00; H01J 9/50, 9/52; H01M 6/52, 10/54; Y02E20/12, Y02C, B23D 25/14, D21C 11/00 B03B, B07B, B63B-035/32, B63J-004, C02F, C05F-007, C09K-003/32, E02B-015/04, E03C-001/12, E03F, G21C-013/10, E03B, B01D-045, B01D-046, B01D-047, B01D-049, B01D-050, B01D-051, B01D-053, B03C-003, C10K, C10L-010/02, C21B-007/22, C21C-005/38, C21C-005/40, F01N-003, F01N-009, F02M-027, F23C-009/06, B01D045, B01D046, B01D047, B01D049, B01D050, B01D051, B01D053, B03C003/00, C09K003/22, C10B021/18, C10L010/02, C10L010/06, C21B007/22, C21C0005/38, C21C005/38, F01N003/00, F01N009/00, F02B075/10, F23B080/02, F23C009/00, F23G007/06, F23J007/00, F23J015/00, F27B001/18, F27B015/12, G08B021/12, C09K017/00, E02D003/00, C05F, B09C, B25D-017/11, B25D-017/12, B60R-013/08, B64C 1/40, B64F-001/26, E01B-019, E01C-001, E01F-008, E04B 1/74, E04B-001/80, 82, 84, 86, 88, 90, E04F-015/20, E06B-005/20, F01B-031/16, F01N-001, F01N-013/02, F01N-013/04, F02B-077/13, F02C-007/045, F02C-007/24, F02K-001/34, F02K-001/44, F02K-001/46, F02M-035/12, F02M-035/14, F16L 55/02, F41A 21/30, G10K-011/16, A01G-023, A01K 67/00, A01H, E03B-003, B64G-001/10, C08B, C08C, C08H, C09F, C08L001, C08L003, C08L005, C08L007, C09J101, 103, 105, 107, C11B, C11C, C13B
Security	G01B 9/02, G01J 3/45, G01J 5/02, G01N 29/00, G01N 33/22, G01N 33/569,

CHALLENGE	IPC CLASSES
	G01N 33/94, G01R 27/00, G01V, G03B 42/02, G21K 1/00, A61B 5/117, G01N033, G06M 11/02, B63G 8/39, G01S 13/00, G01S 5/00, G08B 13/00, G08B 15/00, G08B 17/00, G08B 19/00, G08B 21/00, G08B 23/00, G08B 25/00, G08B 26/00, G08B 27/00, G08B 29/00, G08B 31/00, B60R 25/00, A61B 5/117, E05B 39/00, E05B 45/00, E05B 75/00, G06F 21/00, G06F 7/04, G06K 5/00, G06K 7/00, G06K 9/00, G07C 9/00, H04L 9, H04L 9/00, H04W 12/00, A62, F42D-005, E04H009, H05K009, B60R 21/12, A41B 9/12, A41D 13/00, B63C 9/08, B63C 11/00, B64G 6/00, G21F 3/00, A61B 5/00, A61N 1/39, A62B, A62D, A63B 29/02, B63C 9/00, E04H 9/00, E21F, A62C, A62D 1/00, A62D 3/00, B09C, G01J 5/00, G01T 1/00, H04K, H04L 9/00, B61L 23/04, B61L 29/02, C04B 111/20, E01F 13/00, E01F 15/00, E02B 3/04, E04H009, E06B 5/10, F41H 5/00, G08B 13/00, G08B 15/00, G08B 17/00, G08B 19/00, G08B 21/00, G08B 23/00, G08B 25/00, G08B 26/00, G08B 27/00, G08B 29/00, G08B 31/00, G21F 7/00, H02J 9/00, H05C, G06F012/14, G06F021/00, H04L009, G07F007/08, G07F007/10, G07F007/12, G06F 13/362, G06Q020/40, G06K009/00, H05K 9/00

4 List of IPC classes in each of the sub-fields of the Societal Grand Challenges

Table 2: Detailed list of IPC classes for each of the six technologically-oriented Societal Grand Challenges

1) Health

FIELD TITLE	IPC CLASSES	SOURCE
E-health	G06Q050/22, G06Q050/24	own definition
Medical instruments	A61B, A61C, A61F, A61G, A61H, A61J, A61L, A61M, A61N, H05G, H04R-025	WIPO, 13 own definition
Pharmaceuticals	A61K (NOT A61K-008), A61P	WIPO, 16
Biotech definition	A01H001/00, A01H004/00, A61K038/00, A61K039/00, A61K048/00, C02F003/34, C07G011/00, C07G013/00, C07G015/00), C07K004/00, C07K014/00, C07K016/00, C07K017/00, C07K019/00, , G01N33/(53,54,55,57,68,74,76,78,88,92); (G01N27/327, C12M, C12N, C12P, C12Q, C12S) AND (A61K)	OECD

2) Bioeconomy

FIELD TITLE	IPC CLASSES	SOURCE
Agriculture/forestry	A01B, A01C, A01D, A01F, A01G, A01J, A01K, A01L, A01M, A21B, A21C, A22B, A22C, A23N, A23P, A61D, B02B, B29B, B29C, B29D, B29K, B29L, B99Z, C03B, C08J, C12L, , C13B05, C13B015, C13B025, C13B045	WIPO, 29
	A01N, A01P, C05B, C05C, C05D, C05F, C05G,	parts of WIPO, 19
Pulp and paper	D21C, D, F, H	own definition based on WIPO
Machines (cartons, boxes, printing)	B31B, B31C, B31D, B31F, B41B, B41C, B41D, B41F, B41G, B41J, B41K, B41L, B41M, B41N, C14B, D01B, D01C, D01D, D01F, D01G, D01H, D02G, D02H, D02J, D03C, D03D, D03J, D04B, D04C, D04G, D04H, D05B, D05C, D06G, D06H, D06J, D06M, D06P, D06Q, D21B, D21C, D21D, D21F, D21G, D21H, D21J, D99Z	WIPO, 28, excl. textile machines
	A01G023/00, A01G025/00, A01N025, A01N027, A01N029, A01N031, A01N033, A01N035, A01N037, A01N039, A01N041, A01N043, A01N045, A01N047, A01N049, A01N051, A01N055, A01N057, A01N059, A01N061, A01N063, A01N065, C09K017/00, E02D003/00, C05F	WIPO, green inventory ¹¹
Genetic engineering	A01H 1/06, C12N 15/00, C12N 1/00, C12N 5/00, C12N 7/00	own definition
Landscape management	E02B-003, E02D, E02F	own definition
Food	A01J, A01H, A21D, A23B, A23C, A23D, A23F, A23G, A23J, A23K, A23L, C12C, C12F, C12G, C12H, C12J, C13D, C13F, C13J, C13K, C13B010, C13B020, C13B025, C13B030, C13B035, C13B040, C13B050, C13B099	WIPO, 18
	B67C, A21C, A22B, A22C	own definition
	A21B, A21C, A22B, A22C, A23N, A23P	Geerts et al.

¹¹ <http://www.wipo.int/classifications/ipc/en/est/>

FIELD TITLE	IPC CLASSES	SOURCE
(Future) Proteins	C07K	own definition
Biomass	C10L005/40, C10L005/42, C10L005/44, C10L005/46, C10L005/48, C10B053/02	WIPO, green inventory
Bio fuels	A01C3/02, C02F11/04, C05F17/02, B01D53/84, F23G7/10	own definition
Bio-materials	C08B, C08C, C08H, C09F, C08L001, C08L003, C08L005, C08L007, C09J101, 103, 105, 107, C11B, C11C, C13B	own definition
Marine	A01H15, A61K36/02, 03, 04, 05	own definition
Biotech	A01H001/00, A01H004/00, A61K038/00, A61K039/00, A61K048/00, C02F003/34, C07G011/00, C07G013/00, C07G015/00, C07K004/00, C07K014/00, C07K016/00, C07K017/00, C07K019/00, G01N33/(53, 54, 55, 57, 68, 74, 76, 78, 88, 92); G01N27/327, C12M, C12N, C12P, C12Q, C12S, ANDNOT (A61K)	OECD OECD, Euro-stat
	C07C029, C07D0475, C07K002, C08B003, C08B 7, C08H 1, C08L 89, C09D 11, C09D 189, C09J 189	additional codes from KETs Observatory
Animals/livestock management	A01K, A01M, A23N017, A22B, A61D, B62C	own definition
Household appliances (food-related)	F25D, A21B, A47J	own definition

3) Energy

FIELD TITLE	IPC CLASSES	SOURCE
CCMT	Y02, Y04	EPO

4) Transport:

FIELD TITLE	IPC CLASSES	SOURCE
Aeronautics	B64	WIPO, 32
Automobiles (cars and trucks)	B60	WIPO, 32
Trains	B61	WIPO, 32
Trailer and other wheelers	B62	WIPO, 32

FIELD TITLE	IPC CLASSES	SOURCE
Ships	B63	WIPO, 32
Logistics/handling:	B25J, B65, B66, B67	WIPO, 25
Safety	included in B60-B64	
Intelligent transport/navigation	G06Q-010/08, G06Q-050/28, G06Q-050/30, G05D-001/00, G08G-001/123, G08C, G08G, G06F017/00, G06F019/00, G01S, G01C	own definition
Infrastructure	E01B, E01C, E01D, E01F	WIPO, parts of 35
New power train	H01M	own definition
Bio fuels for transport	C07C-067/00, C07C-069/00; C10B-053/02; C10G, C10L-001/02, C10L-001/14, C10L-001/19, C10L-003/00, C10L-005/00, C10L-005/40, C10L-005/42, C10L-005/44, C10L-005/46, C10L-005/48, C10L-009/00; C11C-003/10, C12M-001/107, C12N-001/13, C12N-001/15, C12N-001/21, C12N-005/10, C12N-009/24, C12N-015/00; C12P-005/02, C12P-007/06-7/14, C12P-007/64, Y02E50, Y02E70/20; Y02E70/30	Geerts et al., based on green inventory
Characteristics of vehicles	F16H003, F16H048, H02K029/08, H02K049/10, F02B043, F02M021/02, F02M027/02, H02J007/00	WIPO, green inventory not covered by the classes used above
CCMTs in transportation	Y02T	EPO: Finding sustainable technologies in patents

5) Climate

FIELD TITLE	IPC CLASSES	SOURCE
Waste management and recycling	A43B 1/12, 21/14; A61L 11/00; A62D 3/00, 101/00; B01D 45/00-53/96; B03B 9/06; B03C 3/00; B09B; B09C; B22F 8/00; B29B 17/00; B62D 67/00; B63B 35/32; B63J 4/00; B65F; B65G 5/00; C01B 31/20; C02F; C04B 7/24-/30, 18/04-18/10; C05F; C08J 11/00-11/28; C09K 3/22, 3/32, 11/01; C10B 21/18; C10G 1/10; C10L 5/46, 5/48, 10/02, 10,06; C11B 11/00, 13/00-13/04; C14C 3/32; C21B 3/04; C21C	Geerts et al., based on WIPO, green inventory own definition

FIELD TITLE	IPC CLASSES	SOURCE
	5/38; C22B 7/00-7/04, 19/30, 25/06; C25C 1/00; D01F 13/00-13/04; D01G 11/00; D21B 1/08, 1/32; D21C 5/02; E02B 15/04, 15/08; E03C 1/12; E03F, E21B 41/00, 43/16; E21F 17/16; F01N 3/00-3/38, 9/00; F02B 75/10; F23B 80/02; F23C 9/00; F23J; F25J 3/02; G08B 21/12; G21F 9/00; H01J 9/50, 9/52; H01M 6/52, 10/54; Y02E20/12, Y02C, B23D 25/14, D21C 11/00 B03B, B07B	
Water and wastewater	B63B-035/32, B63J-004, C02F, C05F-007, C09K-003/32, E02B-015/04, E03C-001/12, E03F, G21C-013/10, E03B	WIPO, green inventory own definition
Air	B01D-045, B01D-046, B01D-047, B01D-049, B01D-050, B01D-051, B01D-053, B03C-003, C10K, C10L-010/02, C21B-007/22, C21C-005/38, C21C-005/40, F01N-003, F01N-009, F02M-027, F23C-009/06	own definition
Air quality management	B01D045, B01D046, B01D047, B01D049, B01D050, B01D051, B01D053, B03C003/00, C09K003/22, C10B021/18, C10L010/02, C10L010/06, C21B007/22, C21C0005/38, C21C005/38, F01N003/00, F01N009/00, F02B075/10, F23B080/02, F23C009/00, F23G007/06, F23J007/00, F23J015/00, F27B001/18, F27B015/12, G08B021/12	WIPO, green inventory
Soil	C09K017/00, E02D003/00, C05F, B09C	WIPO, green inventory own definition
Noise	B25D-017/11, B25D-017/12, B60R-013/08, B64C 1/40, B64F-001/26, E01B-019, E01C-001, E01F-008, E04B 1/74, E04B-001/80, 82, 84, 86, 88, 90, E04F-015/20, E06B-005/20, F01B-031/16, F01N-001, F01N-013/02, F01N-013/04, F02B-077/13, F02C-007/045, F02C-007/24, F02K-001/34, F02K-001/44, F02K-001/46, F02M-035/12, F02M-035/14, F16L 55/02, F41A 21/30, G10K-011/16	own definition
Forests, flora, fauna	A01G-023, A01K 67/00, A01H	own definition
Other	E03B-003, B64G-001/10	own definition
Bio-materials:	C08B, C08C, C08H, C09F, C08L001, C08L003, C08L005, C08L007, C09J101, 103, 105, 107, C11B, C11C, C13B	own definition

6) Security:

FIELD TITLE	IPC CLASSES	SOURCE
Detection	G01B 9/02, G01J 3/45, G01J 5/02, G01N 29/00, G01N 33/22, G01N 33/569, G01N 33/94, G01R 27/00, G01V, G03B 42/02, G21K 1/00	Geerts et al. own definition
Forensics	A61B 5/117, G01N033, G06M 11/02	own definition
Monitoring/Navigation	B63G 8/39, G01S 13/00, G01S 5/00, G08B 13/00, G08B 15/00, G08B 17/00, G08B 19/00, G08B 21/00, G08B 23/00, G08B 25/00, G08B 26/00, G08B 27/00, G08B 29/00, G08B 31/00, B60R 25/00	own definition
Access control	A61B 5/117, E05B 39/00, E05B 45/00, E05B 75/00, G06F 21/00, G06F 7/04, G06K 5/00, G06K 7/00, G06K 9/00, G07C 9/00, H04L 9, H04L 9/00, H04W 12/00	own definition
Protection	A62, F42D-005, E04H009, H05K009, B60R 21/12	own definition
Protective clothing	A41B 9/12, A41D 13/00, B63C 9/08, B63C 11/00, B64G 6/00, G21F 3/00	own definition
Equipment	A61B 5/00, A61N 1/39, A62B, A62D, A63B 29/02, B63C 9/00, E04H 9/00, E21F	from HTS
Catastrophe fighting	A62C, A62D 1/00, A62D 3/00, B09C, G01J 5/00, G01T 1/00	own definition
Public communication	H04K, H04L 9/00	own definition
Critical infrastructure	B61L 23/04, B61L 29/02, C04B 111/20, E01F 13/00, E01F 15/00, E02B 3/04, E04H009, E06B 5/10, F41H 5/00, G08B 13/00, G08B 15/00, G08B 17/00, G08B 19/00, G08B 21/00, G08B 23/00, G08B 25/00, G08B 26/00, G08B 27/00, G08B 29/00, G08B 31/00, G21F 7/00, H02J 9/00, H05C	own definition
Digital security	G06F012/14, G06F021/00, H04L009, G07F007/08, G07F007/10, G07F007/12, G06F 13/362, G06Q020/40, G06K009/00, H05K 9/00, G09C	own definition

5 References

- European Patent Office (EPO) (2013): *Finding sustainable technologies in patents*: European Patent Office.
- Geerts, A.; Tarasconi, G.; Innocenti, F.; Song, X.; Callaert, J.; Pellens, M.; Vereyen, C.; Lecocq, C.; Breschi, S. and van Looy, B. (2011): *Measurement and analysis of knowledge and R&D exploitation flows, assessed by patent and licensing data. Deliverable 1.6: Patent Indicators by Thematic Priority*. Leuven and Milano.
- Grupp, H.; Münt, G. and Schmoch, U. (Eds.) (1996): *Assessing Different Types of Patent Data for Describing High-Technology Export Performance*, OECD.
- Schmoch, U. (2008): *Concept of a Technology Classification for Country Comparisons: Final Report to the World Intellectual Property Organisation (WIPO)*. Geneva: World Intellectual Property Organization.
- Schmoch, U.; Laville, F.; Patel, P. and Frietsch, R. (2003): *Linking Technology Areas to Industrial Sectors, Final Report to the European Commission, DG Research*. Karlsruhe: Fraunhofer ISI.
- Van de Velde, E.; Debergh, P.; Verbeek, A.; Rammer, C.; Cremers, K.; Schliessler, P. and Gehrke, B. (2013): *Production and Trade in KETs-based Products: The EU Position in Global Value Chains and Specialization Patterns Within the EU*. Brussels: European Commission, DG Enterprise.