



**CASI: Public Participation in Developing a Common Framework
for Assessment and Management of Sustainable Innovation**

THEME SIS.2013.1.2-1

Mobilisation and Mutual Learning (MML) Action Plans: Mainstreaming Science in Society Actions in Research

CASI

Grant Agreement no. 612113

SUSTAINABLE INNOVATION POLICY ADVICE

**PUBLIC PARTICIPATION IN DEVELOPING A COMMON FRAMEWORK FOR THE ASSESSMENT AND
MANAGEMENT OF SUSTAINABLE INNOVATION**

DELIVERABLE 7.3, TASK 7.3

Organisation responsible for the deliverable

UNIMAN

Editors:

Rafael Popper

Guillermo Velasco

Date of delivery

March 2017

Project start date:

January 2014

Duration:

42 months

Coordinating organisation:

*ARC Fund - Applied Research and
Communications Fund, Bulgaria*

Dissemination level: **Public**



This project has received funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under grant agreement no 612113.

ISBN 978-954-9456-22-6

Applied Research and Communications Fund, Bulgaria

Printed in Bulgaria

How to cite this report

Popper, R. and Velasco, G. (eds.) (2017). *Sustainable Innovation Policy Advice*, CASI project report. Deliverable 7.2.

Corresponding editor

Rafael.Popper@manchester.ac.uk

Important note

In order to further increase the impact and outreach of the output of the methodological framework for the assessment and management of sustainable innovation (CASI-F), the editors have agreed to include in Chapter 3 several verbatim extracts from the main report of the CASI project:

- Popper, R., Velasco, G. and Popper, M. (2017). CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation, CASI project report. Deliverable 6.2.

Table of revisions

Version number	Name of partner last involved	Date of last update
1.1	UNIMAN	August 2016
1.2	UNIMAN	September 2016
1.3	UNIMAN	October 2016
1.4	UNIMAN	November 2016
1.5	UNIMAN	December 2016
1.6	UNIMAN	January 2017
1.7	UNIMAN	February 2017
1.8	UNIMAN	March 2017

Disclaimer

The information in this document is provided as is and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at his/her sole risk and liability. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of the following information.

© CASI 2017. Reproduction is authorised provided the source is acknowledged.

Contents

Figures	iii
Tables	iii
Acronyms	iv
Editors	v
Contributors	vi
Acknowledgements	vii
Foreword	viii
1. Sustainable Innovation Policy Advice: Executive Summary	1
<i>Rafael Popper and Guillermo Velasco</i>	
2. Sustainable Innovation Policy Advice: Introduction	7
<i>Rafael Popper, Guillermo Velasco, Zoya Damianova, Ventseslav Kozarev, Petteri Repo, Kaisa Matschoss and Monika Popper</i>	
2.1. Abstract	7
2.2. The CASI project in a nutshell	7
2.3. The CASI Policy Watch activities and policy reports	8
2.4. Objectives and structure of the Sustainable Innovation Policy Advice report	9
3. Assessing and managing sustainable innovation: The CASI-F methodology	11
<i>Rafael Popper, Guillermo Velasco and Monika Popper</i>	
3.1. Abstract	11
3.2. Introduction	11
3.3. CASI-F Methodology	13
3.4. The benefits of CASI-F for SI actors	23
3.5. Conclusions and recommendations	25
4. Sustainable innovation policy advice using a quadruple helix approach to ‘innovations’ mapping	27
<i>Monika Popper, Anita Tregner-Mlinaric, Rafael Popper, Guillermo Velasco, Maria Schwarz-Woelzl, Sarah Van Eynde, Monique Ramioul, Zoya Damianova, Ventseslav Kozarev, Mattia Martini, Rick Hölsgens and Jürgen Schultze</i>	
4.1. Abstract	27
4.2. Introduction	27
4.3. Methodological approach	28
4.4. Key priorities of sustainable <i>product</i> innovations	29
4.5. Key priorities of sustainable <i>service</i> innovations	30
4.6. Key priorities of sustainable <i>social</i> innovations	32
4.7. Key priorities of sustainable <i>organisational</i> innovations	34
4.8. Key priorities of sustainable <i>governance</i> innovations	36
4.9. Key priorities of sustainable <i>system</i> innovations	38
4.10. Key priorities of sustainable <i>marketing</i> innovations	40
4.11. Research and innovation policy agendas for SI	42
4.12. Conclusions and recommendations	44
5. Sustainable innovation policy advice using a policy watch approach to ‘policies’ mapping	47
<i>Petteri Repo, Kaisa Matschoss, Anita Tregner-Mlinaric, Sarah Van Eynde, Monique Ramioul, Zoya Damianova and Ventseslav Kozarev</i>	
5.1. Abstract	47
5.2. Introduction	47
5.3. Approach and objectives	48
5.4. European policies on CO ₂ emissions, energy security and resource intensity	49
5.5. The CASI Framework applied to policies of multi-level/actor relevance	49

5.6.	Challenges of applying the CASI Framework to sustainable innovation policies	54
5.7.	Added value of the CASI Framework in sustainable innovation policy analysis	54
5.8.	Conclusions and recommendations	55
6.	Sustainable innovation policy advice using a citizen-expert-citizen approach to ‘aspirations’ mapping...59 <i>Konstantin Ivanov, Ventseslav Kozarev, Zoya Damianova, Kaisa Matschoss, Petteri Repo and Bjorn Bedsted</i>	
6.1.	Abstract	59
6.2.	On the inherently normative and socio-political nature of sustainability issues	59
6.3.	Recognising the need for more socially robust SI decisions	60
6.4.	Expert vs. non-expert normative preferences	62
6.5.	The CEC engagement approach: multi-stage participation	63
6.6.	Comparative analysis of visions and priorities	64
6.7.	Discussion of results	65
6.8.	Conclusions and recommendations	68
7.	Lessons from a multi-level/stakeholder approach to sustainable innovation actions analysis.....71 <i>Rick Hölgens, Jürgen Schultze, Vilja Anttila, Ventseslav Kozarev, Soizic Linford, Lindsey Martin, Guillermo Velasco and Rafael Popper</i>	
7.1.	Abstract	71
7.2.	Introduction	71
7.3.	Methodological approach	71
7.4.	Empirical basis	73
7.5.	Meta-actions and key messages	75
7.6.	Conclusions and recommendations	78
8.	Policy priorities for climate action, environment, resource efficiency and raw materials	81
	<i>Guillermo Velasco, Rafael Popper, Monika Popper, Zoya Damianova, Ventseslav Kozarev, Petteri Repo, Kaisa Matschoss, Anita Tregner-Mlinaric and Bjorn Bedsted</i>	
8.1.	Abstract	81
8.2.	Introduction	81
8.3.	Approach and objectives	82
8.4.	On R&I policy priorities from the assessment of SI objectives	82
8.5.	On R&I policy priorities from the assessment of sustainable innovation ‘aspirations’	87
8.6.	Tentative future directions	91
8.7.	Conclusions and recommendations	93
9.	Sustainable innovation policy advice: outlooks and key messages	95
	<i>Guillermo Velasco, Rafael Popper, Monika Popper, Zoya Damianova, Ventseslav Kozarev, Petteri Repo, Kaisa Matschoss and Minna Kaarakainen</i>	
9.1.	Abstract	95
9.2.	Introduction	95
9.3.	Policy advice on sustainable innovation	95
9.4.	Sustainable innovation policy outlooks	96
9.5.	Conclusions and recommendations	101
10.	Annexes	103
10.1.	Annexe 1: CASI project work packages and tasks structure	105
10.2.	Annexe 2: List of 202 SI initiatives analysed in Chapters 3, 4, 8 and 9	107
10.3.	Annexe 3: List of policy briefs analysed in Chapter 5	114
10.4.	Annexe 4: CASI-F Glossary (Popper <i>et al.</i> , 2017)	115

Figures

Figure 1: Overview of the sustainable innovation policy advice report	10
Figure 2: CASI-F overview.....	13
Figure 3: CASI-F assessment of critical issues from the CASI Ideas Bank	16
Figure 4: CASI-F multi-perspective logics in the analysis of critical issues.....	16
Figure 5: CASI-F approach to multi-stakeholder and multiple SI management dimension mapping.....	21
Figure 6: CASI-F approach to SI management key aspect mapping.....	22
Figure 7: CASI-F approach to SI management dimension by implementation time frame.....	23
Figure 8: A quadruple helix approach to the analysis of innovators' objectives.....	28
Figure 9: A systematic process to cluster the objectives of the quadruple helix of SI stakeholders.....	83
Figure 10: Producing citizens' research priorities.....	87

Tables

Table 1: CASI-F use of EC priorities in climate action, environment, resource efficiency and raw materials	14
Table 2: CASI-F criteria for the fully-fledged assessment of sustainable innovations.....	15
Table 3: CASI-F approach to multi-level and multi-stakeholder advice.....	18
Table 4: CASI-F approach to SI management dimensions and key aspects	20
Table 5: CASI-F approach to multi-level and multi-stakeholder actions mapping from 43 innovations	21
Table 6: CASI-F benefits by type of stakeholder.....	24
Table 7: Product Innovation priorities	29
Table 8: Service Innovation priorities.....	31
Table 9: Social Innovation priorities	32
Table 10: Organisational Innovation priorities	34
Table 11: Governance Innovation priorities	36
Table 12: Governance Innovation priorities	38
Table 13: Marketing Innovation priorities.....	40
Table 14: CASI R&I Policy Agendas	43
Table 15: Key policy recommendations at the strategic level.....	51
Table 16: Key policy recommendations at the tactical level.....	52
Table 17: Key policy recommendations at the operational level.....	53
Table 18: Number of visions according to clustered topic and cluster size	65
Table 19: Selection of cluster-specific research priorities for elaboration, according to original cluster size.....	66
Table 20: Expert-elaborated priorities derived from the citizens' visions, according to overall rank.....	67
Table 21: Top 10 European research priorities against experts' corresponding overall rank.....	67
Table 22: Clustering of the meta-actions	76
Table 23: SI objectives from the analysis of CASIPEDIA.....	82
Table 24: R&I priorities from the analysis of the 4-helix of SI stakeholders' objectives	84
Table 25: Overall rating of 27 CEC-based research priorities	88
Table 26: Top 10 CEC-based research priorities	89
Table 27: Comparison of R&I Policy Agendas and CEC-based top 10 European research priorities	92
Table 28: List of 202 SI initiatives used in Chapters 3, 4, 8 and 9	107

Acronyms

4-Helix	Quadruple Helix of SI (Business, Government, Civil Society and Research/Education)
CA	Climate Action
CASI-F	CASI Framework
CASIPEDIA	State-of-the-Art of Sustainable Innovation (online database)
CEC	Citizens-Experts-Citizens
CPM1	Citizens' Panel Meeting 1
CPM2	Citizens' Panel Meeting 2
CSO	Civil Society Organisation
EFP	European Foresight Platform
EN	Environment
H2020	Horizon 2020
ICT	Information and Communication Technologies
IGO	Intergovernmental Organisation
MML	Mobilisation and Mutual Learning
NGO	Non-governmental Organisation
RE	Resource Efficiency
RES	Renewable Energy Sources
R&I	Research and Innovation
RM	Raw Material
SC5	Societal Challenge 5 on Climate Action, Environment, Resource Efficiency and Raw Materials
SI	Sustainable Innovation
SIM	Sustainable Innovation Management
SMART	Specific, Measurable, Assignable, Realistic, Time-related
SMEs	Small and Medium Enterprises

Editors

Rafael POPPER (PhD) is Principal Scientist in Foresight, Organizational Dynamics and Systemic Change at VTT Technical Research Centre of Finland, and Research Fellow at the Manchester Institute of Innovation Research (MIOIR) of the University of Manchester, where he completed his PhD on 21st Century Foresight. He is also Director of Executive Education in Foresight and Horizon Scanning at the Manchester Business School (MBS); Innovation Director and CEO of Futures Diamond in the UK and the Czech Republic; and has been Director of iKnow (an Innovation, Foresight and Horizon Scanning System) and Leader of the Mapping activities of the European Foresight Platform (EFP). His main areas of work include: ‘foresight’ as an instrument of innovation policy, the development of foresight and horizon scanning methodology, and the design of forward-looking activities and their evaluation with a focus on technological and social innovation policies. He is an economist from the Central University of Venezuela (UCV) and he has also worked as Research Fellow at the United Nations Industrial Development Organisation (UNIDO) based in the Area Science Park of Trieste in Italy. At UNIDO, Dr Popper was responsible for the Technology Foresight Programme for Latin America and the Caribbean (UNIDO TF-LAC) and for actively supporting the Technology Foresight Programme for Central and Eastern Europe and Newly Independent States (UNIDO TF-CEE/NIS). In the CASI project Dr Popper leads the work package on the ‘*State-of-the-art of Sustainable Innovation*’ and several tasks including: *Draft proposal of Common Framework for Assessment and Management of Sustainable Innovation (CASI-F)*; *Revision and finalisation of CASI-F*; *Preparation of an Annual Policy Report on SI* and the *Online training for the application of CASI-F (aka CASI Tutorial)*.

Guillermo VELASCO (PhD) works as a researcher at the Manchester Institute of Innovation Research, where he has completed his PhD in the field of Strategic Intelligence for Innovation policies. His research interests relate to future-based anticipatory methods, policy recommendations formulation and critical discourse analysis. He is currently analysing how forward-looking activities may lead to more consistent policy advice. He holds a BEng in Industrial Economics from the Technical University of Madrid (UPM), and an MPhil in Economics and Innovation Management from UPM and EU-SPRI. He has experience in the creative industries, as Director of Innovation, and has been actively involved in product innovation conception and development, IPR and brand management, and ‘design thinking’ corporate assessment. He has also worked as an Industrial Organization advisor in Spain and Sweden. He participates in several European Commission-funded projects, such as providing information on the future of ERA (VERA project), and developing a common framework for the management of sustainable innovation (CASI), as well as in other Horizon scanning initiatives, sponsored by the UK NHS, to identify new technologies and models of care. Guillermo also collaborates as a Master Executive Lecturer of Internationalisation Strategies for the European University of Madrid. In the CASI project he has contributed to numerous tasks, including: the mapping of sustainable innovations; the design and piloting of CASI-F; the editing of an Annual Policy Report and the CASI Tutorial.

Contributors

Vilja **ANTTILA**, INOVA+
Bjorn **BEDSTED**, Danish Board of Technology Foundation
Zoya **DAMIANOVA**, ARC Fund
Rick **HÖLSGENS**, Technical University of Dortmund
Konstantin **IVANOV**, ARC Fund
Minna **KAARAKAINEN**, University of Helsinki
Ventseslav **KOZAREV**, ARC Fund
Soizic **LINFORD**, Coventry University Enterprises Limited
Lindsey **MARTIN**, Coventry University Enterprises Limited
Mattia **MARTINI**, University of Milano-Bicocca
Kaisa **MATSCHOSS**, University of Helsinki
Monika **POPPER**, Futures Diamond
Rafael **POPPER**, University of Manchester
Monique **RAMIOUL**, Katholieke Universiteit Leuven
Petteri **REPO**, University of Helsinki
Jürgen **SCHULTZE**, Technical University of Dortmund
Maria **SCHWARZ-WOELZL**, Zentrum für Soziale Innovation GmbH
Anita **TREGNER-MLINARIC**, Meta Group
Sarah **VAN EYNDE**, Katholieke Universiteit Leuven
Guillermo **VELASCO**, University of Manchester

Acknowledgements

The editors of this report would like to thank the European Commission for supporting the CASI project on ‘Public Participation in Developing a Common Framework for Assessment and Management of Sustainable Innovation’, which received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under the grant agreement number 612113 (see also Annexe 1). The CASI project has benefited from the valuable support of several European Commission officials, especially *Giuseppe Borsalino* (CASI Project Officer and responsible for Public and Multi-Actor Engagement in the Directorate General for Research and Innovation - DG R&I) and *Josefina Enfedaque* (Policy Officer at the Sustainable Management of Natural Resources Unit, DG R&I).

In addition, this work is partly the result of a continuous process of mobilisation and mutual learning (MML) involving 19 partners from 12 EU countries and a network of experts (country correspondents) in the remaining 16 countries, thus ensuring a full coverage of the EU28. The editors would also like to thank the valuable contributions, feedback from colleagues from the following partnering organisations: Applied Research and Communications Fund (BG), Coventry University Enterprises (UK), Danish Board of Technology (DK), Consumer Society Research Centre at the University of Helsinki (FI), Technical University of Dortmund (DE), University of Primorska (SL), Poznan Science and Technology Park of Adam Mickiewicz University Foundation (PL), INOVA+ (PT), META Group (IT), Increase Time (PT), Municipality of Monza (IT), Espinho City Council (PT), Centre for Social Innovation (AT), University of Milano-Bicocca (IT), Cleantech Bulgaria (BG), Manchester Institute of Innovation Research of the University of Manchester (UK), Catholic University of Leuven (BE), TechnoLogica (BG) and Futures Diamond (CZ).

Equally important was the commitment and hard work of the CASI country correspondents: Marika Rošā (Latvia), Merit Tatar (Estonia), Antonis Zorpas (Cyprus), Sébastien Soleille (France), Warren Phelan (Ireland), Yuliya Voytenko (Sweden), Frans Coenen (Netherlands), Foteini Psarra (Greece), Brian Restall (Malta), Dolores Ordoñez Martínez (Spain), Olga Mala (Luxembourg), Edgaras Leichteris (Lithuania), Cristian-Marius Moisoiu (Romania), Geist Radovan (Slovakia), Erdős Katalin (Hungary) and Račić Domagoj (Croatia). Their input was particularly important for the SI assessment activities, especially for the co-creation and enrichment of the CASIPEDIA bank of SI.

We would also like to express our gratitude to Petteri Repo, Attila Havas, Claire Nauwelaers, Mahshid Sotoudeh and Zoya Damianova for their review and feedback.

Last but not least, special thanks go to Ian Miles (Professor of Technological Innovation and Social Change at the University of Manchester) for the Foreword and to Frances Brown for proofreading the report.

Foreword

According to Yuval Noah Harari's impressive history of humankind, *Sapiens* (2014)¹, it was some tens of thousands of years ago that our species underwent a 'cognitive revolution'. We could use language to envision and communicate imagined worlds, allowing us to speculate about past events and appraise future possibilities. We were able to live in new ways, in large groups, and to spread across the globe – adapting ourselves to different conditions by the use of fire, clothing, weapons, and new sorts of shelter; we changed environments (wiping out many species, including some of our close relatives) on the way. We innovated in agriculture, in making things, in using energy, in organising industry, and in communications systems. We have transformed our cultures and the wider world through agricultural, scientific, industrial and informational revolutions.

The many innovations that these revolutions produced have brought us unparalleled prosperity, though both rising prosperity and short-term decisions mean that our levels of happiness may not have expanded to anything like the same extent. And, of course, a huge number of fellow humans are still eking out lives in conditions of poverty and degradation – some of them slaving to produce the raw materials and artefacts that others consume as luxuries. But innovations have largely been undertaken with little consideration of the implications for sustainability. While sustainability has many dimensions, it is awareness of the impacts of our ways of life on the global climate that have attracted most publicity and concern in recent years. The threats to biodiversity, to the habitability of many areas of human settlement, the continuing productivity of food and other life-support systems, are well-rehearsed and scientifically attested (even if denied by some sectional interests).

So, can we avert disaster? Short of a major reduction in living standards for most of the world's population, this is only going to be possible if we are able to reorient innovation along more sustainable trajectories. Innovations must be pursued that create less damage, that can actively undo damage, that can help monitor and plan for environmental and other challenges. We have jumped into a 'bramble bush', as the nursery rhyme has it: if we have got into this mess through innovation, then we have to get out of it through innovation:

There was a man in our town and he was wondrous wise,
He jumped into a bramble bush - and scratched out both his eyes;
And when he saw what he had done, with all his might and main
He jumped into the bramble bush - and scratched them in again.

Perhaps there are deeper aspects to this metaphor – our one-sided 'wisdom' (which seems to be identified as masculine!) has blinded us to the nature we are invading through our actions. However, the metaphor has its limits. Jumping into a bramble bush is rather a simple, impetuous act. The path to successful innovation – from creation of a new idea to achieving the desired outcomes of large-scale roll-out – is complex. It typically requires alignment of multiple innovation system actors ('the quadruple helix'), located at various 'levels' of action and governance. This report complements the 'transition management' approach (cf. Geels *et al.*, 2016)², which pinpoints the need to examine ways of bringing about shifts in the pattern of technology creation and use from the micro to the macro level. The problem we confront is more like choosing how to plunge into a forest, than just choosing which bramble bush to leap into.

This report thus addresses critical questions. What is sustainable innovation and how can we determine its realisation and the ways this can be achieved? What is good practice and what is the scope for policy initiatives to promote it? What can such policies look like in practice, and how are they implemented? Many readers will start with the executive summary, which provides an overview of each chapter and its key messages. This will give an overview of the answers to these questions, but the chapters include much detail which is needed to fully absorb these points, and they outline some wider implications that may be taken into account, so a full reading is recommended. In particular, in relation to the questions posed above, it will be important to pay attention:

¹ Harari, Y. N. (2014) *Sapiens*. London: Vintage Books.

² Geels, F., Berkhout, F., van Vuuren, D.P. (2016) Bridging analytical approaches for low-carbon transitions. *Nature Climate Change* 6, pp. 576–583.

- to Chapter 3's development and presentation of a new framework to assess and manage sustainable innovation (CASI-F) – this framework informs the work in subsequent chapters, and should be seen as complementing existing sustainability assessment approaches. Existing approaches, which are typically more quantitative ones, are not to be discounted; CASI-F, which is fully described in Popper *et al.* (2017)³, is intended to be applied after the use of conventional methods;
- to Chapter 8's outline of future policy directions, developed by drawing on both innovators' objectives and the preferences expressed by citizens; and
- to the key messages and recommendations that are set out in the Executive Summary and Chapter 9.

Additionally, Chapter 4 relates sustainability priorities to the different types of innovation considered. This should be of particular interest to innovators and to researchers examining sustainable innovation, since it offers insights into 'hot' priority areas, the strategic agendas that are evident on the basis of a systematic analysis of over 200 innovations.

This report may come to be seen as part of a forward-looking 'sustainability revolution'. Homo sapiens' cognitive revolution has allowed us to create new societies and imagine ways of living and relating together that have transformed the world. Now it is time for us to be aware of the unsustainability of many of the transformations we have wrought, and to envisage – and systematically appraise – innovations that can allow us to take more sustainable directions of travel. In so doing we will realise our human potential, as well as taking more care of the world we inhabit – with its berries and thorns.



Ian Miles

Professor of Technological Innovation and Social Change
Manchester Institute of Innovation Research, Manchester Business School, The University of Manchester

³ Popper, R. Velasco G. and Popper M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.

1. Sustainable Innovation Policy Advice: Executive Summary

Rafael Popper, University of Manchester

Guillermo Velasco, University of Manchester

Sustainable innovation (SI) is a wide and multifaceted concept, the complex nature and definition of which is continuous and the subject of many questions and debates. This is probably the main reason why developing a framework for the assessment and management of SI is simultaneously a pioneering and a challenging endeavour. This report introduces the CASI Framework (CASI-F), which aims to assist in the assessment and management of SI by facilitating the identification of SI critical issues and inducing policy-oriented responses to address these issues. The report targets two different objectives. The first is to provide a critical perspective on the use of CASI-F. The second is to extract and present policy messages obtained through the varied mobilisation and mutual learning activities developed within the CASI project to conceive the framework. The framework has been developed and conceptually informed by three key sources of knowledge (or tracks), namely existing SI initiatives (as described in Chapter 4), current SI policy developments (Chapter 5) and the visions and aspirations of citizens (Chapter 6). The importance of engaging and mobilising relevant actors across these tracks is analysed and discussed in the remaining chapters. The perspectives of four key stakeholders, corresponding to government, businesses, civil society and research/education sectors, have been considered in the development and application of CASI-F.

The report recognises that the benefits of using the framework are various for each SI actor. With CASI-F **government representatives** can, for example, explore and analyse SI practices in their areas of political influence; implement policies that directly address specific SI critical issues; establish the conditions that allow the implementation of actions by innovative firms; review existing SI developments and policies and/or orientate research and innovation funding more efficiently according to the expected agendas of citizens.

The framework also aims to be a valuable instrument for SI **businesses**. By using CASI-F, firms can better identify new market opportunities; refine their innovation strategies; reinforce their SI management capabilities and effectively align their products and services to citizens' interests.

For **civil society** actors, CASI-F may help citizens to discover new products, services and social initiatives, as well as understand new research and innovation priorities. With CASI-F civil institutions may also react in a more timely and adequate manner to those policies that imply either positive or negative social consequences, thus aligning more faithfully their strategies, as institutions, to eventual changes.

The interest of **research and education** actors in using CASI-F lies in the potential of the framework to support both research and lecturing developments. The CASI database, CASIPEDIA, offers multiple possibilities for SI case study assessment and empirical analysis across countries and sectors, thus facilitating benchmarking. New policy areas and sustainability issues, for instance, can be identified through the analysis of the components of the CASI-F platform, namely ideas, policy briefs, visions, actions, and roadmap banks.

The report reflects a critical journey through the application of the framework. On the journey some relevant messages have emerged that may orientate the actions of SI policy makers.

A first message relates to the **functioning and capacities of CASI-F**. It highlights the benefits of using, in general, conceptual and methodological frameworks for assessing and managing sustainable innovation and, in particular, shows the potential of fully exploiting the versatility of CASI-F. An important feature of the CASI Framework is its ability to support the identification and prioritisation of SI critical issues. Based on these the report also encourages the co-creation of roadmaps that guide and monitor the achievement of SI objectives. The message can be summarised in the following statements:

1. *Recognise the potential of utilising methodological frameworks for assessing and managing sustainable innovation and, in particular, acknowledge the benefits of fully exploiting the versatility of CASI-F.* While the framework was fully tested and piloted with innovations, the infrastructure is also ready to systematically support the assessment and management of sustainability-related policies and aspirations.

2. *Support the use of SI frameworks, like that represented by CASI-F, to identify and prioritise SI critical issues.* CASI-F is not a substitute for conventional sustainability assessment and management frameworks; rather it complements them with critical issues analysis. Therefore it is crucial to properly identify and prioritise relevant critical issues associated with SI, taking into account the variety of critical issues, including drivers, opportunities, barriers and threats. Given the importance and urgency of critical issues, this prioritisation should be carried out together with the innovators or, if policies or aspirations are the subject, with representatives of governments and civil society.
3. *Promote the co-creation of SI roadmaps.* It is important that Action Roadmaps for addressing and managing SI critical issues are co-created together with those responsible for, or who benefit from, their practical implementation. Co-creation leads to co-ownership, which triggers sustainability-oriented decision-making at strategic, tactical and operational levels.

The report's second message refers to the **assessment of sustainable innovations** and suggests that policy makers should thoroughly analyse and interpret drivers of change affecting every type of SI stakeholder. In the analysis, they should adopt a broader conception of innovation that includes all SI modalities, rather than only focusing on the conventional ones (products and services). The report in addition recommends paying more attention to the analysis of early stages of sustainable innovation. To ensure a systematic presentation of ideas, the message is summarised below:

4. *Analyse and make sense of the drivers of change affecting each type of SI stakeholder.* Recognise the importance of the analysis and sense-making of the innovator-led drivers of change, bearing in mind that an 'innovator' can take various forms, i.e. government, business, civil society or research and education stakeholders.
5. *Adopt a broad conception of innovation in SI projects analysis.* Promote projects that develop the mapping of different types of innovation (e.g. product, service, social, organisational, system, governance, marketing) rather than focusing only on the conventional ones (product and service), and identify common priorities and R&I policy agendas related to the different types of innovations.
6. *Foster the analysis of early stages of sustainable innovation.* Promote exercises that carry out systematic mapping and analysis of sustainable innovation initiatives that are at the design/conceptual and prototype/piloting/demonstration stages of the innovation cycle. This may be done in addition to the mapping of cases that are already at the implementation and diffusion stage.

With respect to the **assessment of sustainable innovation policies**, the text basically emphasises the benefits of considering a wider variety of stakeholders in the SI policy action. In particular, the participation of civil society is recommended at specific stages of the policy process. To complement these ideas it is also suggested that policies incorporate long-term perspectives when formulating SI-oriented research and education initiatives. These recommendations can be summarised as follows:

7. *Consider the contributions of a wider variety of stakeholders to the policy action.* While many policy recommendations are aimed at governmental stakeholders, they highlight topics and actions that call for consideration of other stakeholders' interests and activities. The fact that, to be effective, public SI policies also require contributions from more than just governmental actors should be taken into account.
8. *Adopt long-term perspectives in SI-related research and education policy initiatives.* Recommendations for research and education stakeholders require longer time spans to achieve their targeted impacts. For this reason, policy recommendations for these actors need to be considered and adopted against a longer time perspective than others.
9. *Ensure the participation of civil society at appropriate stages of SI policy-making processes.* The engagement of civil society stakeholders is frequently called for in policy advising processes. This does indeed merit additional attention, as the success of sustainable innovation is reliant on social and economic acceptance. Accordingly, Civil society stakeholders must be invited into the policy process at appropriate stages.

For **citizen and expert participation** in SI, a key message is the necessity of promoting public engagement for improving SI development results at the policy and societal level. To a large extent this engagement implies recognition that a major challenge of sustainability today resides in the systemic re-orientation of society and the economy. Policies have to guarantee the systemic effectiveness of sustainable innovations and ensure they are congruent with wider socially deliberated values. The message can thus be divided into three key ideas:

10. *Promote public engagement for improving SI development results at the policy and societal levels.* The complexity, ambiguity and subjectivity that surround persistent problems of sustainability decision-making highlight the importance of wider public engagement in both knowledge generation and priority development. Societal stakeholders must be engaged in the co-creation and delivery of our common future sustainability agenda.
11. *Recognise that the major challenge of sustainability today resides in the systemic re-orientation of society and the economy.* Effective models of sustainability need to adapt to, and incorporate, contextual and experiential avenues for co-creating and co-delivering the future, providing that their central goal is to respond to some of the most complex challenges people face on a day-to-day basis. Involving a large group of societal stakeholders (citizens, experts, civil society stakeholders, policy-makers, businesses, etc.), for the purpose of arriving at integrative solutions that complement each other, can result in societal changes that are appropriate for sustainability to become a feasible and welcome option for society.
12. *Guarantee the systemic effectiveness of sustainable innovations and ensure they are congruent with wider socially deliberated (i.e. publicly reasoned) values.* If sustainability is to contribute to a better life for all, then strategic actions will need to go beyond incremental changes and begin addressing holistic issues of human development, growth, material/spiritual wealth, equality, consumption and empowerment. A comprehensive policy framework that seeks to unravel, and potentially rework in a collaborative process, some of the societal drivers and influences shaping individual desires, expectations and concerns should be encouraged.

On the topic of **sustainable innovation management** the report also puts forward practical ideas, which mainly align some broadly understood innovation concepts for the specific area of sustainability. Among these ideas we can highlight the following:

13. *Remove barriers to sustainable innovation.* Some innovation system actors can contribute to easing or removing financial and legal barriers to sustainable innovation. While investing businesses may actually contribute to improving innovators' financial capacities, policy-makers can remove regulatory obstacles, provide support infrastructures, and formulate specific programmes to reinforce the competitiveness of innovative firms.
14. *Promote SI actors collaboration.* Sustainable innovation calls for actors' collaboration across sectors. Involving civil society, business, government, and research and education actors is vital for the success of sustainable innovations. Policy action is required to promote collaboration, establish platforms and methods to foster cross-fertilization, improve knowledge exchange, and enable citizen participation.
15. *Support SI actors' empowerment.* The value of sustainable innovators' endeavour to economic growth and the future development of society should be emphasised and endorsed. Raising awareness and acceptance is an important step for sustainable innovation actors, who will thereby be empowered to progress more effectively in their respective innovation developments. Empowerment can also be achieved through human resources training and by the creation of platforms that enlarge their visibility.

Other messages that can be extracted from the report address the **definition of SI policy priorities and agendas**. A strong argument is made, for example, for pursuing a more intensive public engagement in SI research. When this research is aimed at supporting the policy action, public engagement can actually help to better match citizens' expectations with current or upcoming SI policies. Involving citizens in policy-making may also contribute efficiently to addressing social issues linked to sustainable innovation. These ideas are represented by the following recommendations:

16. *Policy makers should encourage public engagement in research initiatives that aim to support/ inform SI policy action.* Facilitate a rational, adequate and effective integration of public engagement activities in research projects. The incorporation of citizens, stakeholders and relevant experts is particularly important when research aims to inform and support the formulation of sustainable innovation policies.
17. *Matching citizens' expectations with existing SI policy priorities.* Encourage research-based advisory bodies, projects or agencies to utilise methodologies that analyse how citizens' actual aspirations and concerns really do match the rest of research evidence and empirical data. Acknowledging potential discrepancies with these methodologies would drive policy action towards more appropriate, precise, and democratic SI policy formulations.
18. *Consider the contribution of citizens to addressing social issues linked to sustainable innovation.* Strengthen the role of citizens in the elaboration of policy agendas that tackle socially relevant topics and issues. The

analysis of R&I priorities undertaken in CASI actually suggests that the social dimension is reinforced and enriched when citizens' participation is included in the agenda-setting process.

A proposal for a new policy agenda on sustainability, as conceived in Chapter 4 and summarised in Chapter 8, assumes that greater attention should be paid to eco-community and crowd-driven developments, sustainable bioeconomy, water management, renewable energy, foresight-supported governance, advancing recycling, embedding sustainability in cultural heritage, eco-local-agriculture, smart mobility and greenhouse gas emissions management.

The practical character of the 18 above-mentioned messages, which basically aim to orientate the actions of governmental actors, does not, however, exclude the identification in the report of other suggestions addressing other types of SI actors. In fact, the text presents many discussions on sustainable innovation businesses, civil society and research and education actors' objectives and actions, which have multiple implications for SI assessment and management.

Businesses, a major actor in the SI landscape, will, for instance, recognise in the report, especially in Chapter 4, numerous objectives, opportunities and threats with which they can surely identify. Some messages summarised in Chapter 9 may encourage and induce them to consider the utilisation of CASI-F in their forthcoming management plans. In this sense, the report also reveals that the framework has a very practical component, as it facilitates reflection on those technological, economic, environmental, political, social, ethical, or spatial circumstances whose relevance and transformation potential may lead SI actors to make decisions in a different manner than initially expected or planned.

The incorporation of a wider variety of stakeholders in the SI policy action, as directly and indirectly suggested in the policy messages, could also become a stimulus for businesses, which may be eventually tempted to similarly incorporate other SI actors, in particular the public, in their own innovation processes. In fact, from the perspective of innovators, as reflected in Chapter 6, the direct participation of citizens may have a disruptive potential that could eventually improve the quality of SI management decisions and promote a broader deliberation that includes more plural and strategic arguments.

The report also presents other CASI-F implications for management. Business related readers will doubtless be encouraged, for example, to explore the CASI-F platform as a source of information on SI action roadmaps, not least because the CASI database is grounded upon a solid empirical set of piloted innovation cases. Inviting these readers to this type of mutual learning process may constitute, on its own, an important achievement of this policy report. In this regard, many sections highlight how the CASIPEDIA provides a rich collection of SI cases from which innovators can extract lessons for assessment and management.

Civil society actors will find this report enlightening and provoking. In reality, presenting discussions to citizens and other civil actors about current SI management initiatives and policy developments may eventually not only support (or refute) their arguments in favour of a more intense and effective action against climate change, use of natural resources, and environmental protection but may also serve to demonstrate that, at least in terms of 'sustainability', European policies and the endeavours of innovative firms are moving forward and something is changing.

We have also described the report as thought-provoking, since it highlights important questions that deserve profound and critical reflection. Inquiries about the stage of the innovation process at which civil society participation is more (or less) appropriate, discussions that call into question the capacity of citizens to provide useful and effective advice or insights to innovators and/or policy-makers, or debates on the way proposals from citizens can be challenged and 'politely' declined, are examples of issues that can enrich and make the SI political debate more controversial. In this respect, the report may be useful in activating and promoting intellectual deliberation, discourse analysis and further social research.

Research and education actors will probably realise that some policy messages are also applicable to their scientific activities, since many suggestions and ideas actually relate to and fall under their academic scope. Helping policy makers to better understand SI drivers of change, for instance, can certainly contribute to more efficient SI policy developments.

Researchers should also continue expanding and developing those conceptual frameworks that, utilising multi-level and multi actor perspectives, try to explain and envision socio-technical transitions. These

theoretical assumptions are needed to tackle SI challenges via a systemic orientation. The combination of these conceptual frames with foresight methodologies can help academics to more effectively provide impact-oriented, long-term and sound policy advice.

The necessity of engaging and involving civil society, especially citizens, in research is recurrent throughout the whole report. Indeed, the idea that this type of engagement may make SI policy makers better and more democratically informed is implicitly and explicitly brought out. Science policies can thus be more legitimately ascertained.

Reviewing these four different SI actors' perspectives prompts a final remark that recognises the two-fold contribution of CASI-F to fostering the participation of the SI actors and to promoting knowledge-transfer processes. In fact, not only has the framework emerged through a synchronised interaction of 19 CASI partners and the involvement of numerous SI organisations, but an adequate and effective utilisation of CASI-F by innovators does actually call for interaction with other stakeholders. Thus CASI-F facilitates the generation and effective circulation of knowledge across actors who ultimately consider social, economic and environmental progress a shared and common goal.

In conclusion, this summary has briefly highlighted the benefits of using the CASI Framework and also anticipated messages and recommendations that are relevant to each type of SI actor. These messages, especially those oriented to governmental actors, reflect the extent to which the CASI Framework has been able to stimulate an inclusive process of strategic and collective intelligence. The flexibility and usefulness of CASI-F means that it is a strong candidate to become an instrument that helps European policy-makers better understand and envision those plausible directions that SI innovation practices and citizens' aspirations may eventually take at the European and global level.

2. Sustainable Innovation Policy Advice: Introduction

Rafael Popper, University of Manchester
Guillermo Velasco, University of Manchester
Zoya Damianova, ARC Fund
Ventseslav Kozarev, ARC Fund
Petteri Repo, University of Helsinki
Kaisa Matschoss, University of Helsinki
Monika Popper, Futures Diamond

2.1. Abstract

Two different rationales underpin the work behind the present policy report. The first relates to the necessity of obtaining a critical perspective that can challenge the consistency and usefulness of CASI-F, namely the framework developed during the CASI project to assess and manage sustainable innovation. The second objective is to conceive and propose a set of messages that can drive policy action in the short term towards more efficient sustainable innovation-oriented governance.

The sections included in this chapter represent a logical and hierarchical sequence that proceeds from a brief introduction of the CASI project, to the description of the Policy Watch activity (of which this policy report is a key part), and finally to the description of the report's objectives and structure.

2.2. The CASI project in a nutshell

The project 'Public Participation in Developing a Common Framework for Assessment and Management of Sustainable Innovation' (CASI) responds to one of the Societal Challenges set out in the Horizon 2020 programme of the European Union, namely Climate Action, Environment, Resource Efficiency and Raw Materials (SC5). CASI is a multi-stakeholder European partnership on innovation-related challenges and considers not only the impacts of social and technological innovation, but also the types of actors involved and their inherent interests. It effectively integrates the perspectives of civil society, government, business, and research and education actors setting up and continuously expanding a network for mutual learning, dialogue and cooperation.

At its core, CASI builds upon the concept of 'sustainable innovation' as a promising, yet under-researched policy field, which brings technological and social innovation under one novel umbrella paradigm.

As a contribution to the varied options suggested by practitioners and academics in the literature to clarify what sustainable innovation actually is, we have elaborated the following working definition:

Sustainable innovation may be conceived as 'any incremental or radical change in the social, service, product, governance, organisational, system and marketing landscape that leads to positive environmental, economic and social transformations without compromising the needs, welfare and wellbeing of current and future generations' (see Popper et al., 2016).

The two most important characteristics of this definition are its comprehensiveness and its forward-looking orientation. Part of this comprehensiveness is reflected by the process itself that gave rise to the definition, since it implied a systematic and structured mapping of 202 SI initiatives across seven different types of innovation (see Annexe 2 for a full list of the SI initiatives mapped across the EU28 and beyond). The forward-looking component refers to the prospective orientation also adopted in this process, which required the prospective assessment of every individual SI case in terms of its transformation capacity.

Through bringing sustainability into the innovation debate, one of CASI's main objectives is to develop a methodological framework for assessing and managing sustainable innovation via wider public engagement in the research and innovation (R&I) system. To that end, the project works to include the needs and concerns of a wider group of societal stakeholders in assessing the impact of innovation practices, and largely responds to demands from within policy structures and beyond for a greater level of public engagement in R&I governance.

As part of its strategic outlook, CASI facilitates partnerships with complementary perspectives, knowledge and experiences through different mechanisms, all of which contribute to incorporating ‘science with and for society’ issues into the system of research, sustainable innovation and policy-making. Embedded in its design and process is a mobilisation and mutual learning approach (MML), a holistic engagement approach that allows for outcomes and learning to support both thematic policy development and implementation in an iterative fashion.

Drawing systematically on the input of experts and ordinary citizens in a series of nationally staged meetings and workshops, one of the central objectives of the project was to promote and facilitate more societally relevant and accountable research and innovation outcomes. In establishing an inclusive multi-actor dialogue at the science/policy/society interface, CASI joined other EU-supported efforts to stimulate a wider transformation in the current ways of streamlining sustainability and development, ultimately offering a better fit to societal needs, expectations and concerns.

In addition to this successful collaboration, the CASI project’s ambition to foster mutual understanding on matters of sustainability was realised through the broader engagement of different innovators, practitioners and other relevant stakeholders, whose critical contributions were important in leading to the elaboration of an assessment framework of sustainable innovation practices. This framework, named CASI-F, is built on the analysis of more than 500 identified innovation cases from across Europe, of which just under half were mapped and explored in greater depth for the purposes of aligning innovation processes and policy agendas effective in tackling complex societal challenges.

Leaning on these pillars, CASI fosters a debate on conceptual dimensions, policy boundaries and good practices, combining innovative pursuits with sustainability objectives more widely. By attempting a more comprehensive inquiry into the balance between the social, economic and environmental impacts of innovations, the project contributes to determining the scope and directionality of national and EU policy-making in the context of the persisting challenges of climate change adaptation and resource depletion, alongside other interrelated issues. As such, its framework fits within strategic policy-level efforts in Europe and globally to facilitate a transition towards a society that assures environmental integrity, resilience and sustainability.

Reflecting the policy priorities of the Europe 2020 strategy, which identifies research and innovation as key in addressing societal challenges and generating smart, sustainable and inclusive growth within Europe (and worldwide), CASI is funded by the Seventh Framework Programme for Research and Technological Development and runs from 2014 until mid-2017.

2.3. The CASI Policy Watch activities and policy reports

CASI provides extensive policy monitoring activities – i.e. Policy Watch – to support the streamlining of European, national and organisational sustainable innovation policy related to the Horizon 2020 SC5. Key targets of these activities include: (1) reviewing the strategic priorities and policies of the European Union; (2) identifying relevant EU and national policy debates; (3) spurring new policy debates on the topic; and (4) building awareness of policy commitments to supporting sustainable innovation among key stakeholders and the public at large. While these targets are addressed in Policy Watch activities, many of them intertwine closely with other activities in the CASI project. For instance, the mapping, assessment and management of sustainable innovation initiatives form another set of major activities in the CASI project, which help to accomplish the above-mentioned targets (3) and (4) - spurring new policy debates and building awareness. Similarly, contributions from the Policy Watch have been used throughout the public engagement activities of CASI.

The Policy Watch has three types of contribution, which include *policy briefs* at the EU and national levels, an online *policy blog*, and annual *policy reports*, such as the one at hand. Together, these provide a transparent and accessible interface for stakeholders and the public to learn about strategies, priorities, policies, actions and their interconnectedness within the topic of sustainable innovation. As the CASI project is part of the MML Action Plans, its partners include government, civil society, research and business actors, who provide a multi-stakeholder knowledge pool with complementary expertise, viewpoints and insights from a variety of national and institutional settings. Furthermore, CASI’s extended network of partners and country correspondents covers all EU countries.

This CASI annual policy report is the second of its kind. The first positioned the CASI project in a wider policy context by: (1) identifying policy arenas in which CASI activities could provide substantial contributions; (2) discussing the role of innovation from the perspectives of sustainability, responsibility and ecological aspirations; (3) considering public participation and the social aspects of innovation as promising areas to explore, using examples from the energy and transport sectors; and (4) drawing attention to novel arrangements and approaches relating the SC5 to transition studies, the circular economy and sustainable development goals.

Since the first policy report was published, the CASI project has made progress in terms of generating new insights and contributing to new debates about these and broader policy contexts. For instance, the CASI Policy Watch established a common interface for easy monitoring of current EU and national policy cycles, resulting in over 100 policy briefs, each with analysis and recommendations at the EU and national levels. At the time of writing, these policy briefs have been downloaded over 21,000 times, which is a remarkable number for briefs based on a neutral and careful analysis of affiliated policies. The CASI online policy blog has also enjoyed considerable online success, with over 90,000 views in its first two years, thus showcasing the way complex policy debates can be instigated in inviting ways, and the fact that awareness is best built with a combination of analytical and critical reporting skills.

In the early stages of the project, CASI Policy Watch provided various issues to consider in other project activities. This was to the result of the project plan, which targeted a quick start and produced the first policy brief only three months into the project. However, considering the huge amount of information and empirical data generated during the state-of-the-art work (literature review and mapping activities), stakeholder mobilisation and piloting of the CASI Framework activities, this second policy report gives the stage to key findings and outcomes of the project resulting from: (1) the systematic mapping and analysis of sustainable innovations; (2) the public and expert engagement in the translation of citizens' visions into research priorities; and (3) the development and application of the CASI Framework for the assessment and management of sustainable innovation. The main results from these activities have been published in various reports, but this policy report is the first attempt to bring all their policy-relevant contributions together.

A third and final policy report will respond to the main issues raised in the CASI policy conference and highlight important policy insights from the work developed through the whole CASI project. The focus will be on key policy recommendations for public participation in the assessment and management of sustainable innovation, thus the final policy report will build on the wider policy context addressed in the first policy report, with the policy messages discussed in the present report drawing in the final results of CASI mapping and public engagement activities.

2.4. Objectives and structure of the Sustainable Innovation Policy Advice report

This report aims to fulfil two different objectives. The first is to gather critical perspectives on the use of the framework (CASI-F) developed during the CASI project for assessing and managing sustainable innovation. The second is to extract policy messages from the SI initiatives mapped and analysed during the framework's construction, from citizens' and experts' reflections obtained throughout the engagement CASI activities, and from a review of current SI policy developments.

The report is structured around nine chapters (see Figure 1).

Chapters 1 and 2 provide an executive summary and introduction to the report, respectively, placing special emphasis on **CASI Policy Watch** activities.

Chapter 3 presents *sustainable innovation concepts and frameworks*, as well as the rationales of the CASI project from the perspective of common European research and innovation governance principles. A new Triple Track approach to sustainable innovation assessment and management is also presented to highlight the importance of *tracking 'innovations'* (Track 1),⁴ *'policies'* (Track 2),⁵ and *'aspirations'* (Track 3).⁶

⁴ See the CASIPEDIA database at <http://www.casi2020.eu/casipedia/cases/>.

⁵ See the CASI Policy Briefs at <http://www.casi2020.eu/library/policy-briefs/>; and Blog at <http://www.casi2020.eu/blog/posts/>.

⁶ See the CASI Visions Bank at <http://www.casi2020.eu/visions-bank/>.

Chapter 4 focuses on the first track of CASI-F by analysing 202 cases (see Annexe 2) of seven types of sustainable **innovations**: product, service, social, organisational, governance, system and marketing. The chapter pays particular attention to R&I priorities emerging from the assessment of current and future objectives and to the strategic agendas of sustainable innovations from across the EU28.

Chapter 5 is linked to the second track of CASI-F, which analyses sustainable innovation **policies** at EU and national levels. This chapter provides a pilot of how CASI-F can be applied to assess national policy developments related to the EU's Europe 2020 Strategy from the perspective of resource efficiency (see Annexe 3). It analyses 96 policy recommendations discussed in 23 national policy briefs and shows how CASI-F helps to detect imbalances between the stakeholders targeted in the policy recommendations, or between the three main levels of policy, namely strategic, tactical and operational.

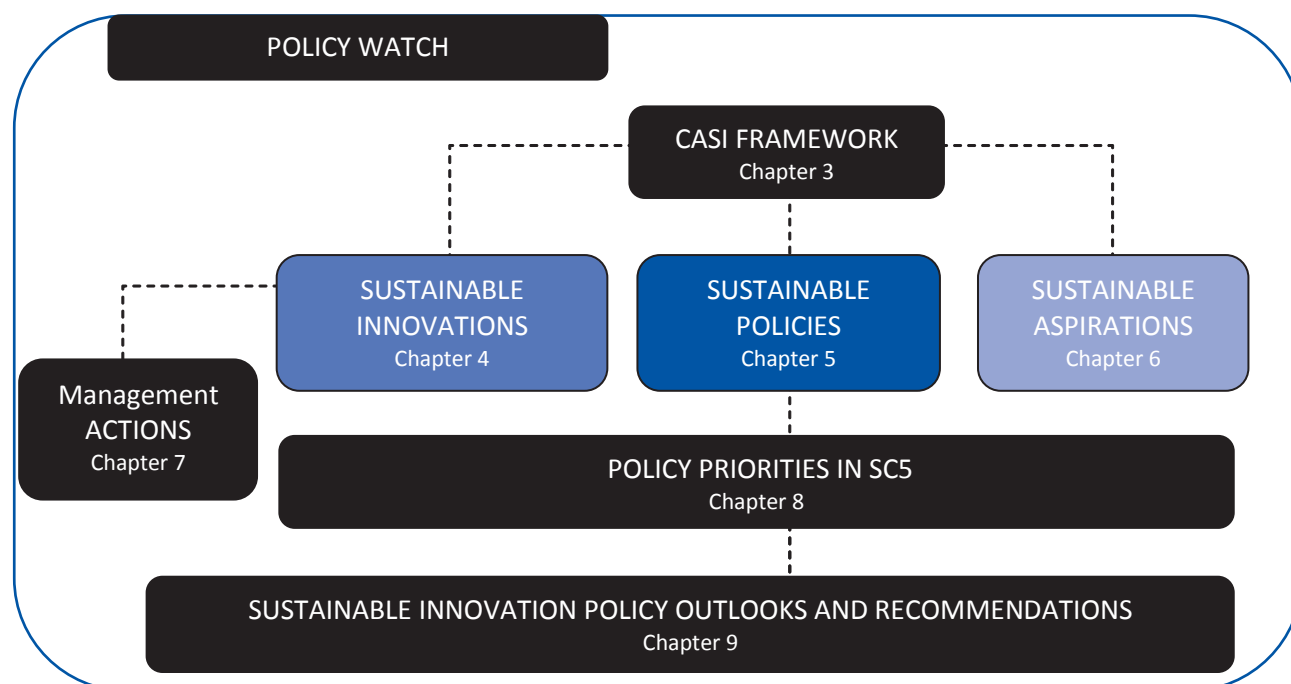
Chapter 6 relates to the third track of CASI-F, which engages 'citizens' and 'experts' in a mutual learning process aimed at identify common normative preferences (**aspirations**) for sustainable innovation. The chapter assesses the different values and motivations feeding into 50 sustainability visions, developed by non-expert communities of citizens from 12 EU countries and used by sustainability experts to identify 27 research priorities. Special emphasis is placed on the mismatch between citizens' and experts' perspectives and the need for more analytical oversight and policies for effective public engagement in sustainability debates.

Chapter 7 is focused on *Managerial aspects of SI*. It identifies meta-actions that may be considered by SI actors, as they may have a significant influence on the development of innovation processes.

Chapter 8 is related to *R&I policy priorities for climate action, environment, resource efficiency and raw materials*. It has two key sections: the first focuses on the top priorities for sustainable 'innovations' (discussed in Chapter 4), the second discusses the top priorities for sustainable 'aspirations', resulting from a citizens-experts-citizens dialogue. In the conclusions the chapter reflects on the implications of the two sets of priorities for climate action, environment, resource efficiency and raw materials policy.

Finally, *Chapter 9* presents conclusions and policy recommendations. The general objective of this chapter is to provide a critical reflection on the capacity of CASI-F to support the generation of policy advice. To this end, the chapter gathers together the policy messages emerging from previous chapters, thus presenting lessons obtained during the analysis of CASIPEDIA, citizens' visions and policy briefs/reports on sustainable innovation.

Figure 1: Overview of the sustainable innovation policy advice report



3. Assessing and managing sustainable innovation: The CASI-F methodology⁷

Rafael Popper, University of Manchester
Guillermo Velasco, University of Manchester
Monika Popper, Futures Diamond

3.1. Abstract

The importance, as well as the complex and ambiguous nature, of sustainable innovations that have the potential to address the multifaceted societal challenges of the 21st century demonstrates the urgent need and calls for the development of more effective tools and frameworks to support better assessment and management of sustainable innovations. A well-thought out and carefully designed process and flow of activities supported the development of CASI-F – a methodological framework – that considers the multi-dimensional, multi-stakeholder and innovation system perspectives and builds on hands-on experience and lessons learned from project’s mobilisation and mutual learning activities. CASI-F, therefore, evolved from within its creation, following the assessment components of the mapping of sustainable innovation initiatives and of identifying critical issues that could influence their design, implementation or diffusion. It also incorporates those management components that focused on the development and prioritisation of actions and roadmaps supporting the short-, medium- and long-term sustainability of innovations.

The potential application of CASI-F for the assessment and management of the SI-related policies and aspirations of citizens is also presented. While the framework promotes a structured process accompanied by a number of tools and protocols, it is at the same time flexible enough to stimulate reflection and confront users with the self-search and out-of-the-box thinking that is undoubtedly required to tackle the complexity of societal challenges. With this in mind, the chapter sets out to provide a detailed account of the CASI-F ‘journey’, demonstrating the processes and justifying the choices and decisions that were taken in order to develop a practical framework that was co-created and successfully applied to real social and technological innovations in Europe. Furthermore, CASI-F was designed to provide sound responses and solutions to critical issues in order to support short-, medium- and long-term decision-making.

3.2. Introduction

The prime objective of the CASI project is to develop a ‘common framework for the assessment and management of sustainable innovation’, hereinafter referred to as CASI-F (Popper *et al.*, 2017). While having such a sharp 10-word objective seems a straightforward starting point, the reality is that there is plenty of ambiguity in the terms ‘common’, ‘framework’, ‘assessment’, ‘management’, ‘sustainable’ and ‘innovation’. Let us begin this chapter with a discussion about these ambiguities, followed by a short introduction to the building blocks of the CASI-F chapter itself.

What is the meaning of ‘sustainable’, ‘innovation’ or ‘sustainable innovation’? By definition, ‘sustainable’ is an adjective for maintaining ‘something’ at a certain rate or level, while ‘innovation’ is a noun referring to the outcome or process of doing ‘new things’. Putting these two definitions together would make ‘sustainable innovation’ anything that maintains the outcome or process of doing new things at a certain rate or level. However, such a definition does not specify the kind of ‘new things’ considered or the rate and type of changes to be maintained. For this reason, and to combine both scholarly and participatory approaches to defining ‘sustainable innovation’, the CASI project undertook a systematic literature review of the use of the term across all EU28 countries and beyond, complemented by a stakeholder survey gathering more than 1500 responses and the systematic review of over 500 sustainability-oriented innovations in order to support the development of the following working definition: *Sustainable Innovation is any incremental or radical change in a socio-technical system (including social, service, product, governance, organisational, system and marketing solutions) leading to positive environmental, economic and social transformations without compromising the needs, welfare and wellbeing of current and future generations* (Popper *et al.*, 2016).

⁷ Since the CASI-F methodology have been the backbone of all the contributions in this policy report, this chapter presents several verbatim extracts from section 5 of the CASI-F report (see Popper *et al.*, 2017).

The terms ‘assessment’ and ‘management’ denote very clear sets of complementary activities. In the context of the CASI project a five-step approach was employed and focused on:

- **(Step 1) sustainability relevance and scanning:** identifying ‘innovations’, ‘policies’ and ‘aspirations’ relevant to the societal challenge of ‘climate action, environment, resource efficiency and raw materials’ at national and EU levels;
- **(Step 2) multi-criteria analysis and assessment:** selecting or prioritising nominated innovations, policies and aspirations using a set of criteria relevant to the aforementioned societal challenge and the mobilisation and mutual learning nature of CASI;
- **(Step 3) critical issue analysis and assessment:** analysing selected innovations, policies and aspirations so as to identify and prioritise critical issues, such as barriers, drivers, opportunities and threats;
- **(Step 4) multi-level advice management:** generating and prioritising multi-level and multi-stakeholder actions to manage prioritised critical issues; and
- **(Step 5) action roadmaps management:** developing roadmaps for the most important and urgent actions.

The main purpose of focusing the assessment and management on these five interconnected activities is to promote the adaptation and improve the resilience of the quadruple helix innovation ecosystems actors (business, government, civil society and research/education) to current and future incremental or radical changes in socio-technical systems.

The term ‘common’ is often understood in two different ways. It may refer to something that is ordinary, recurrent, routine, standard or typical, in which case there would be nothing new to be developed by CASI; or to something that is done or shared by two or more (groups of) actors. The latter interpretation was the obvious choice for CASI-F, which implied the mobilisation of multiple actors in its creation and wider use.

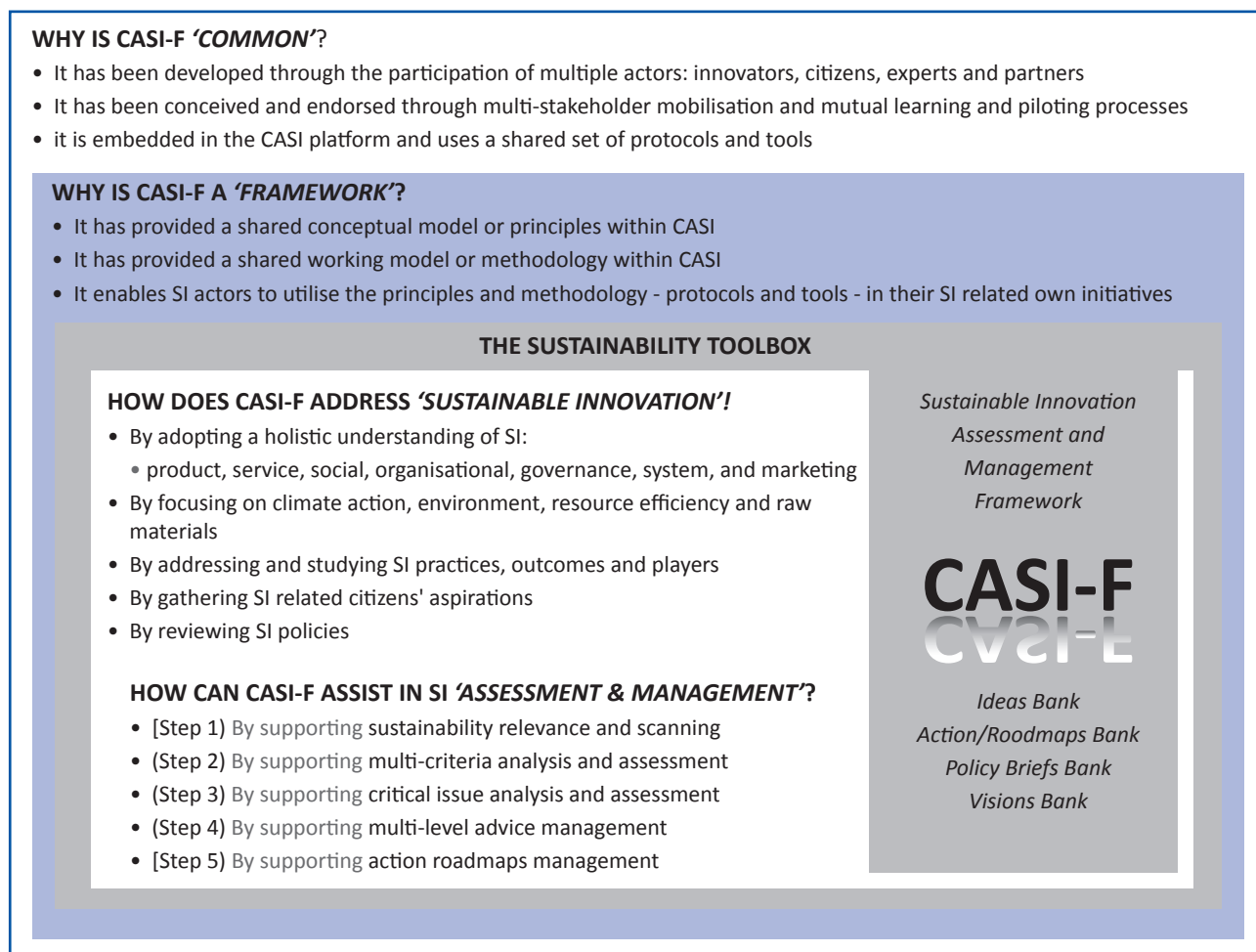
The word ‘framework’ could mean a set of physical or virtual platforms (tools) around which something is developed, or a system of ideas and procedures (protocols) to inform and support decision-making. To choose one of these options was neither possible nor suitable for CASI-F, as both sets of practical tools and guiding protocols were needed. As a result, CASI-F consists of several web-based interconnected ‘tools’ (i.e. CASIPEDIA, the Ideas Bank, Policy Briefs Bank, Visions Bank and Action/Roadmap Bank) supported by jointly produced ‘protocols’ for the assessment and management of sustainable innovation. This duality of CASI-F is similar to that of the Microsoft Office or Adobe Suite packages, which include a group of complementary applications and services (tools), each of which providing ‘templates’ or functionalities for specific data gathering, access, processing and visualisation activities (protocols). This conceptual framework is described in Figure 2.

Based on these conceptual assumptions, this chapter presents CASI-F as a tool for the assessment and management of sustainable innovation, which promotes public engagement and collective intelligence and, in particular, the participation of business, government, civil society, and research and education actors.

The general purpose of the chapter is to demonstrate that a framework of this sort is helpful for dealing with the societal challenges of climate action, environment, resource efficiency and raw materials. However, thanks to CASI-F’s high generalisation capacity, the framework could be applied to other societal challenges. CASI-F complements but does not replace other mainstream frameworks (see also Pope *et al.*, 2004; Singh *et al.*, 2011; Ness *et al.*, 2006; Gasparatos *et al.*, 2007; Hacking and Guthrie, 2007) such as life cycle assessment, eco-efficiency, eco-design, footprint analyses, etc.

More specifically, the objective of the chapter is to describe the five steps of the CASI-F methodology and to illustrate the sort of benefits that CASI-F may provide to every kind of SI actor.

Figure 2: CASI-F overview



3.3. CASI-F Methodology

3.3.1. Step 1 of CASI-F: Sustainability relevance and scanning

Since 2014, 19 CASI project partners and 16 country correspondents covering all EU28 countries have been engaged in a rigorous and systematic environmental scanning process to identify sustainable innovations achieving or aiming for positive environmental, social and economic transformations in Europe and the world. More than 500 solutions were scanned and nominated between June and December 2014. The solutions included the following seven types of innovations (see Glossary in Annexe 4):

- Product innovation, i.e. new/improved goods or technology;
- Service innovation, i.e. new/improved activity or process;
- Social innovation, i.e. new/improved solution to a social problem;
- Organisational innovation, i.e. new/improved practice, configuration or business model;
- Governance innovation, i.e. new/improved regulation, policy or form of stakeholder engagement;
- System innovation, i.e. new/improved set of interconnected innovations/socio-technical changes;
- Marketing innovation, i.e. new/improved promotion or positioning of any kind of innovation.

In addition, all nominations had to be relevant to one or more of the 22 priority areas of the Horizon 2020 SC5 (see Table 1).

Table 1: CASI-F use of EC priorities in climate action, environment, resource efficiency and raw materials

Climate action	<ol style="list-style-type: none"> 1. Climate change projections and scenarios 2. Climate change adaptation solutions 3. Climate change mitigation solutions 4. ICT to assess and predict climate actions 5. Climate action by sustainable lifestyle 6. Climate action eco-innovation policies
Environment	<ol style="list-style-type: none"> 7. Biodiversity examination and understanding 8. ICT mapping of natural resources and trends 9. Solutions for cultural heritage assets 10. Strategic intelligence and citizens' participation
Resource efficiency	<ol style="list-style-type: none"> 11. Solutions to water imbalances 12. ICT systems improving resource efficiency 13. Resource efficient sustainable lifestyles 14. Eco-innovation and green economy transition
Raw materials	<ol style="list-style-type: none"> 15. Long-term raw materials availability 16. Solutions for exploring, extracting, processing and recycling 17. Alternative raw materials 18. Awareness of raw materials shortage 19. ICT systems to map raw materials trends 20. Eco-solutions to reduce raw materials use 21. Raw materials-conscious sustainable lifestyle 22. Effective raw materials policies

Furthermore, to promote a more systematic mobilisation and mutual learning approach to sustainable innovation, CASI partners and country correspondents were encouraged to identify solutions with wider sectoral relevance. Some 15 to 22 nominations were requested from each of the EU28 country teams who were asked to cover as many of the 21 economic activities as possible from the International Standard Industrial Classification (ISIC) of All Economic Activities.

A panel of sustainability experts from within the CASI consortium reviewed and assessed all nominations in terms of their relevance to SC5.

To further focus the selection of solutions to the needs of national and European policies in the area of public engagement and sustainability, a second assessment conducted independently by three CASI team members required a 1 to 5 scale rating of nominated innovations against the following five criteria: (1) *Degree of public participation and mobilisation*; (2) *Degree of sustainability and cross-sectoral linkages*; (3) *Degree of multi-dimensional transformations*; (4) *Degree of deployment and diffusion*; (5) *Degree of novelty and originality*. The results of this multi-criteria assessment were used to create a scoring system for the nominated solutions. To achieve EU-wide coverage, the six highest scoring innovations from each EU28 country were chosen (168 solutions) together with 34 other high-scoring innovations, including some international cases. Overall, a total of 202 innovations (see Annexe 2) were selected and upgraded to a 'deep dive' assessment process, also known as fully-fledged mapping of sustainable innovation practices, outcomes and players.

3.3.2. Step 2 of CASI-F: Multi-criteria analysis and assessment

The mapping of the selected SI focused on 3 ‘deep dive’ assessments using a total of 34 criteria (Table 2):

- *SI Practices assessment*: This includes 21 criteria providing a panorama of the actual innovation, including both descriptive information and a detailed assessment of key objectives, origins, factors of success, barriers, drivers, tensions, funding and market potential, mobilisation degree, mutual learning processes, geographical and sectoral transferability and use of assessment methods.
- *SI Outcomes assessment*: This includes nine criteria exploring both current and possible future outcomes of the innovation. The first two criteria focus on the degree and status of the innovation outcomes, followed by a structured assessment of strengths and weaknesses using nine sub-criteria (Novelty; Complexity; Protection of intellectual property rights (IPR); Timing; Robust and platform design; Rewriting the rules; Reconfiguration of production, distribution and consumption; Sectoral applicability; and Geographical replicability). This is followed by a forward-looking assessment of seven types of opportunities and threats (technological, economic, environmental, political, social, ethical and spatial). Additional outcomes such as new policies, spin-offs, publications, skills and competences are also mapped. Finally, the systemic sustainability criterion includes 44 sub-criteria assessing positive contributions to five sub-systems of the broader socio-technical system.
- *SI Players assessment*: This included the mapping of role, type and contact details of innovators, funders and sponsors, supporters and brokers, as well as beneficiaries and users.

Table 2: CASI-F criteria for the fully-fledged assessment of sustainable innovations

SI Practices assessment criteria	SI Outcomes assessment criteria	SI Players assessment criteria
1. SI Name 2. SI Description 3. SI URL 4. Lead organisation 5. Lead organisation URL 6. SI Scope 7. SI Date range 8. Link to H2020 priorities 9. SI Type 10. SI Objectives 11. SI Origins 12. SI Factors of success 13. SI Barriers 14. SI Drivers 15. SI Tensions 16. Funding/market potential 17. Mobilisation degree 18. Mutual learning processes 19. SI transferability 20. Similar SI elsewhere 21. SI assessment methods	22. Degree of innovation outcomes 23. Status of innovation outcomes 24. Strengths and Weaknesses 25. Opportunities and Threats 26. Policies 27. Spin-offs 28. Publications 29. Skills and competences 30. Systemic sustainability <ul style="list-style-type: none"> • Societal Systems <ul style="list-style-type: none"> - 11 indicators • Economic Systems <ul style="list-style-type: none"> - 7 indicators • Environmental Systems <ul style="list-style-type: none"> - 6 indicators • Infrastructure Systems <ul style="list-style-type: none"> - 11 indicators • Government Systems <ul style="list-style-type: none"> - 9 indicators 	31. Innovators <ul style="list-style-type: none"> • Role • Type • Contact details 32. Funders/Sponsors <ul style="list-style-type: none"> • Role • Type • Contact details 33. Supporters/Brokers <ul style="list-style-type: none"> • Role • Type • Contact details 34. Beneficiaries/Users <ul style="list-style-type: none"> • Role • Type • Contact details

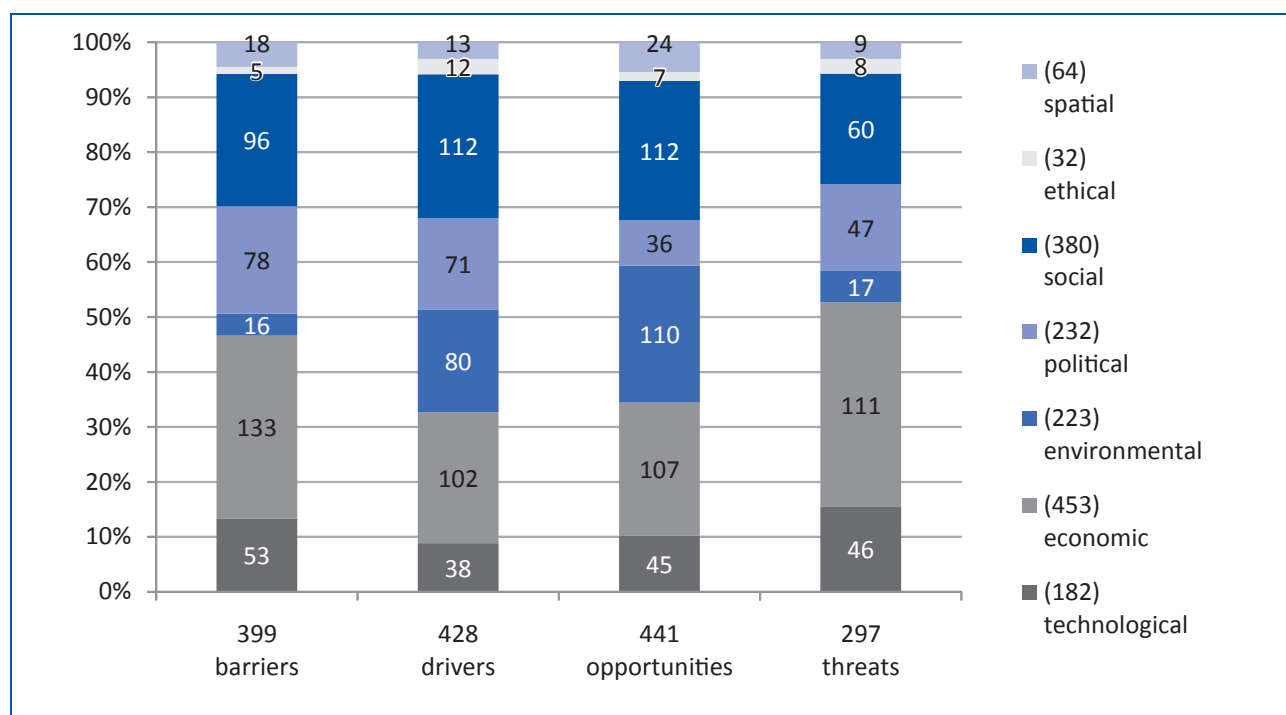
3.3.3. Step 3 of CASI-F: Critical issue analysis and assessment

The nomination of 548 cases against the first 12 SI Practices assessment criteria (see Table 2 above) and the mapping of 202 cases against all aforementioned 34 SI Practices, Outcomes and Players criteria generated a rich and unique database on the state of the art of sustainable innovation in Europe and the world, also known as CASIPEDIA and available online at <http://www.casi2020.eu/casipedia/>.

The wealth of information about sustainable innovation in CASIPEDIA is far from fully analysed but, for the purpose of developing and piloting CASI-F, a ‘targeted’ assessment of CASIPEDIA data was chosen. Thus

particular emphasis was given to the analysis of selected ‘critical issues’, i.e. key barriers, drivers, opportunities and threats that require further assessment and attention for management decisions. Some 1566 ‘critical issues’ were mapped against nominated and selected cases with the active participation and engagement of relevant stakeholders (especially the innovators, but also the funders and sponsors, supporters and brokers, and beneficiaries and users, who were given access and invited to contribute to the assessment of sustainable innovations in CASIPEDIA). Given the strategic importance and often confidential nature of the ‘critical issues’ related to a specific innovation, the mapping team, as well as the innovators, were also allowed to restrict access to sensitive issues. The final set of publicly available issues can be explored online in the CASI Ideas Bank at <http://www.casi2020.eu/ideas-bank/>.

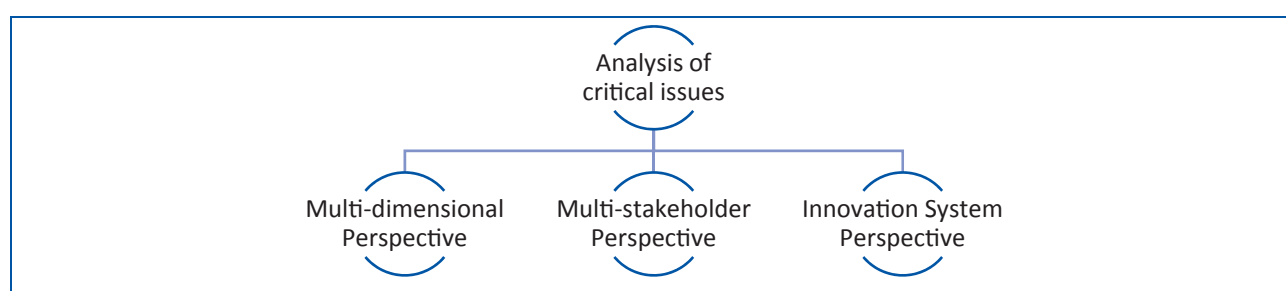
Figure 3: CASI-F assessment of critical issues from the CASI Ideas Bank



These issues were analysed following three complementary logics aiming to answer the following research questions:

- What lessons can be learned from the analysis of critical issues using seven analytical dimensions or perspectives, namely technological, economic, environmental, political, social, ethical and spatial?
- What type of actions are needed to deal with the positive and negative effects that such an extensive set of critical issues have on sustainable innovations?
- What type of action management framework can be created based on a meta-analysis of the critical issues from an innovation system perspective?
- Lessons from the analysis of critical issues using a multi-dimensional perspective.

Figure 4: CASI-F multi-perspective logics in the analysis of critical issues



From a **technological perspective**, the analysis of 182 issues led to 11 lessons, namely to: analyse possible dependency on specific technologies; develop IPR strategies; elaborate technology development plans; identify and assume protection and imitation costs; make a plan for digital and social media communication; guarantee an easy use of innovation; create maintenance and contingency plans; reinforce technical capabilities and capacities for technological anticipation; ensure an adequate level of novelty in both radical and incremental innovations; develop supporting infrastructures; and comply with technological standards while reaching the right level of complexity.

From an **economic perspective**, the analysis of 453 issues led to 12 lessons, namely to: elaborate market expansion plans; create realistic business strategies; design capacity enlargement and production adjustment plans; differentiate between mass-production and differentiation strategies; define economic benefits targets, when applicable; define cost reduction objectives, when applicable; elaborate a strategy for local development; assess the possibilities and implications of self-employment; make a clear estimation of initial investments; evaluate the availability of future resources; ensure the stability of funds during the SI process; and increase or maintain adequate efforts in R&I.

From an **environmental perspective**, the analysis of 223 issues led to six lessons, namely to: understand the potential and implications of climate change adaptation and mitigation strategies; identify those environmental elements where the SI could have a better impact; develop environmental ex-ante impact measuring tools; evaluate the potential of the SI to solve energy problems; define and communicate how the SI is contributing to promoting sustainable life styles; and evaluate potential ecological collateral effects.

From a **political perspective**, the analysis of 232 issues led to eight lessons, namely to: understand bureaucratic processes; recognise and adapt to government's political goals; analyse policy agenda opportunities; learn applicable regulation; monitor current and potential regulation changes; achieve sustainable political support; get timely access to experts and policy advisors; and assess lobbies' and competitors' reactions.

From a **social perspective**, the analysis of 380 issues led to 14 lessons, namely to: elaborate a SI communication plan; establish realistic poverty-related targets, if applicable; establish achievable social-minorities-focused objectives, if applicable; establish realistic health targets, if applicable; establish realistic welfare and security targets, if applicable; interact with social actors with impact-oriented plans; devise instruments to measure the social impact of the innovation; design and implement motivation techniques for personnel; balance the use of volunteering and professional resources; keep alive the interest of beneficiaries in the SI; coordinate the action of the actors involved; develop knowledge-transferring mechanisms and platforms; update and share objectives with partners; and establish linkages with civil society organisations.

From an **ethical perspective**, the analysis of 32 issues led to five lessons, namely to: make ex ante evaluation of the SI ethical consequences; avoid the SI bringing about the exclusion of specific user-groups; develop a communication plan based on unambiguous organisational sustainability objectives; identify and integrate all affected community members; and communicate how the innovation is aligned with social values.

From a **spatial perspective**, the analysis of 64 issues led to four lessons, namely to: establish realistic demographic objectives, if applicable; align innovation with rural and local traditions; consider heritage preservation in the innovation conception; and distinguish between the results of SI local experimentation and their application to other environments.

All in all, 60 lessons or 'critical considerations' emerged from the meta-analysis of 1566 critical issues linked to 202 SIs, where both the variety and volume of lessons required additional analytical perspectives.

3.3.4. Step 4 of CASI-F: Multi-level advice management

In addition to the multi-dimensional perspective, the same 1566 critical issues were analysed, based on their influence on the selected innovations, using a multi-stakeholder perspective. This helped us to arrive at an important managerial conclusion: ***Critical issues require a multi-level and multi-stakeholder actions-oriented approach.***

The main lesson from the analysis of the positive and negative effects that the critical issues identified had on the mapped innovations was that the actions to manage such an extensive set of barriers, drivers,

opportunities and threats might need to be implemented by multiple actors with different managerial roles and responsibilities.

Table 3: CASI-F approach to multi-level and multi-stakeholder advice

	Government actors	Business actors	Civil society actors	Research & education actors
Top-level management: Strategic actions	<i>Strategic actions</i> involve the definition of high-level aims, challenges, goals, objectives and priorities that require strategic attention or orientation from top-level decision-makers in government, business, civil society, research and education organisations.			
Mid-level management: Tactical actions	<i>Tactical actions</i> require mid-level decision-makers to translate strategic level objectives and priorities into tactical interventions, such as investment, research or knowledge-transfer programmes and calls, funding schemes or instruments, as well as development and implementation mechanisms.			
Front-line management: Operational actions	<i>Operational actions</i> require the intervention of front-line decision-makers - policy makers, civil servants, entrepreneurs, citizens, researchers and workforce - who are directly responsible for the operationalisation of day-to-day activities linked to tactical and strategic actions.			

For example, the Food Bank Network operated by Fondazione Banco Alimentare Onlus, a civil society organisation in Italy, identified the existing *regulatory and normative framework* as a critical issue for the effective implementation and wide diffusion of its business model innovation, focused on the daily recovery of surplus food from the food supply chain and its redistribution to charitable organisations helping around two million deprived people in the country. However, the management of such a critical issue or barrier requires governmental actors, at the strategic level, to: *formulate or implement new national policies on surplus food donations aimed at economically encouraging the private sector*; and, at the operational level, to: *organise and manage dialogue tables with operators, including policy-makers, businesses and not-for-profit civil society organisations – aimed at redesigning the regulatory system so as to acknowledge the needs of several stakeholders*.

Similarly, the 202 SI cases studied in CASI helped us identify a wide range of critical issues, including not only barriers but also drivers, opportunities and threats, providing good examples of the kind of managerial situations where sound responses and solutions require multi-level (strategic, tactical and operational) and multi-stakeholder interventions.

3.3.5. Step 5 of CASI-F: Action roadmaps management

The complexity of the multi-level and multi-stakeholder approach led us to another major managerial conclusion: ***Critical issues require a systemic SI management framework***. Using an innovation systems perspective a meta-analysis of the 1566 critical issues helped to identify 10 *SI management key aspects* associated with 50 *critical factors* or meta-issues affecting the ***context, people, process*** and ***impact*** of SI management dimensions (see Table 4, Glossary and Popper *et al.*, 2016).

The success of a sustainable innovation depends greatly on its ***context*** and 17 critical factors were mapped against its four dimensions: *Momentum*, reflecting the potential space for innovation, i.e. expectations of entrepreneurs and other actors, political drive from regulators or procurement, exemplars from other technological or social enterprises, and the perception of problems that call for solutions; *Foresight*, showing the capacity to anticipate, strategise and overcome gaps in the innovation curve; *Resources*, emphasising the need for healthy combinations of skills, finance, location, markets, etc.; and *Mobilisation*, including the capacity for action, as in public participation, community and institutional support, public-private partnerships, research and education engagement.

The role of **people** – especially government, business, civil society, and research and education actors – cannot be under-estimated. Many objectives remain unfulfilled when innovations fail to connect or mobilise the right people, or do not provide the right incentives or skills for key people. Some eight critical factors were clustered around two *key aspects* in the people dimension: *Aptitude*, referring to the actual skill-set or competences of people involved in the design, development, implementation and diffusion of a sustainable innovation; and *Attitude*, meaning the type of behaviour of the same people.

Innovation is widely considered a complex, participatory and multifaceted **process**. As mentioned above, the analysis of critical issues confirmed the need for a multi-level and multi-stakeholder actions-oriented approach supporting the management of the innovation process. Given the multiple possibilities of clustering some 14 process-related critical factors, these have been grouped into two broader sets of key aspects: *Catalysts*, contributing to the initiation, development and implementation of the innovation; and *Fosterers*, including factors that further consolidate and diffuse the innovation.

Finally, 11 critical factors were linked to the **impact** dimension and grouped into two corresponding key aspects: (multi-agent) *Transformation*, meaning positive changes in the quadruple helix of SI and knowledge production (see also Carayannis and Campbell, 2009; 2010); and (systemic) *Sustainability*, referring to changes in the socio-technical system where the SI operates that lead to positive environmental, social, economic, government and infrastructure transformations without compromising the needs and welfare of future generations.

Table 4 summarises the four SI management dimensions, the 10 SI management key aspects and the 50 SI critical factors that innovators need to consider in the systemic management of SI actions (see Glossary).

The lessons from the analysis of sustainable innovations were used to develop an action research methodology for piloting the CASI-F with real life sustainable innovations. The piloting process followed a critical issue approach, which required innovators to prioritise those critical issues (barriers, drivers, opportunities and threats) considered important and in need of urgent action. The most important critical issues were selected and, with the help of CASI partners, a total of 43 innovators engaged in a mutual learning, multi-level and multi-stakeholder ‘action generation’ process driven by creativity, evidence, expertise and interaction. At the time of writing this section, some 707 of these actions have been fully mapped and codified in the CASI Actions Bank, at <http://www.casi2020.eu/actions-bank/>.

Table 5 shows the overall results of the application of the CASI multi-level and multi-stakeholder actions-oriented approach to 43 sustainable innovations. More details about the actual implementation of the framework developed by the authors can be found in Chapter 6. In total, some 190 actions were generated for government actors, 186 actions for business actors, 175 actions for civil society actors and 156 actions for research and education actors. Overall, the actions were evenly distributed among actors and the three targeted SI management levels, namely strategic, tactical and operational (see also Table 3).

The subsequent application of the systemic *SI management dimension* (see Glossary in Annexe 4) framework shows that 52% of the actions addressed the context dimension, 13% the people dimension, 25% the process dimension and 10% the impact dimension. The results confirm how important the context and process dimensions are in the management of critical issues influencing sustainable innovations. An interesting finding is the limited role of the impact dimension, probably as a result of the often long-term implementation nature of such actions.

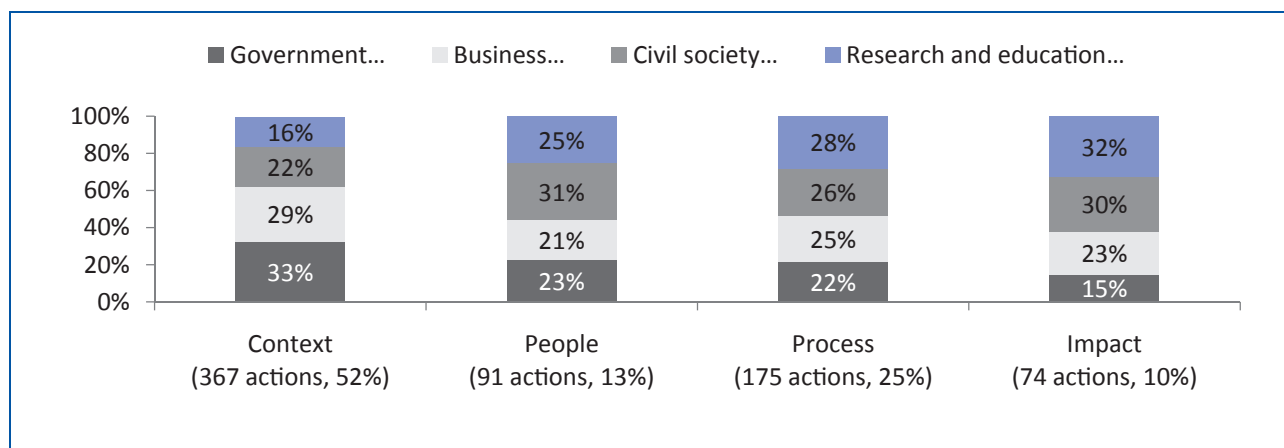
Table 4: CASI-F approach to SI management dimensions and key aspects

CONTEXT dimension	<p>Momentum refers to the force that gets a sustainable innovation moving forward. There are 3 critical factors linked to this SI key aspect: political setting (including regulations, decisions, rules, policies, guidelines, etc.); exemplars (including pioneering or leading models, standards, prototypes, examples, etc.) and problems (including challenges, complications and difficulties as drivers of change).</p>	<p>Foresight refers to the future-oriented strategic drive of a sustainable innovation. There are 3 critical factors linked to this SI key aspect: <i>horizon scanning-based approach</i> (proactive mapping of critical issues, e.g. barriers, drivers, opportunities and threats); trends-based approach (reacting to current developments); and strategic targets approach (aligning goals with STI priorities of the system).</p>	<p>Resources refer to the means that can be drawn by a sustainable innovation to be designed, developed implemented and diffused. There are 5 critical factors linked to this SI key aspect: <i>geographical setting</i> (both environmental and demographic conditions); <i>funding</i> (internal and external); <i>infrastructure</i> (physical and virtual); <i>data</i> (including hard and soft, e.g. statistics and insights) and <i>scalability</i> (potential to grow).</p>	<p>Mobilisation refers to the capacity to reach and involve key stakeholders. There are 6 critical factors linked to this SI key aspect: <i>champions and facilitators</i> (to engage stakeholders), <i>civil society engagement</i> (to promote democracy); <i>government engagement</i> (to ensure governance and regulation); <i>research and education engagement</i> (to promote evidence-based decision-making), <i>business engagement</i> (to promote <i>public-private partnerships</i> to address market issues) and <i>proactive participation</i> (to address the needs of the quadruple helix SI players).</p>
PEOPLE dimension	<p>Aptitude refers to the actual skill set or competences of people involved in the design, development, implementation and diffusion of a sustainable innovation. There are 4 critical factors linked to this SI key aspect: <i>leadership</i> (to guide the innovation team); <i>charisma</i> (to inspire and mobilise key people); <i>creativity</i> (to reach original and innovative solutions); and <i>knowledge</i> (to make sound and informed decisions).</p>		<p>Attitude refers to the type of behaviour of people responsible for the design, development, implementation and diffusion of a sustainable innovation. There are 4 critical factors linked to this SI key aspect: <i>enthusiasm</i> (to spread interest and excitement); <i>empathy</i> (to be more responsive to the needs of potential SI users and beneficiaries); <i>involvement</i> (to promote cooperation and networking); and <i>commitment</i> (to achieve shared ownership and co-create success).</p>	
PROCESS dimension	<p>Catalysts refer to critical factors enabling the design and development phases of a sustainable innovation process. There are 7 critical factors linked to this SI key aspect: <i>compressibility</i> (to offer user-friendly solutions); <i>crowd-sourcing</i> (to achieve truly bottom-up financial support); <i>learning-by-doing</i> (to promote more assertive evolution and incremental innovation); <i>supportive services</i> (to deal with specific bottlenecks of the innovation process); <i>absorptive capacity</i> (to generate and act upon valuable information or intelligence); <i>ex-ante impact evaluation</i> (to recognise and measure important benefits and possible risks); and <i>piloting and experimenting</i> (to avoid disappointments and manage expectations).</p>		<p>Fosterers refer to critical factors supporting the implementation and diffusion phases of a sustainable innovation process. There are 7 critical factors linked to this SI key aspect: <i>incentives</i> (to further position the innovation); <i>coordination</i> (to manage the relationship between the innovation team, sponsors, supporters and beneficiaries); <i>networking and synergy</i> (to better capitalise momentum-related critical factors); <i>knowledge management</i> (to reinforce the innovation capacity of the team); <i>intellectual property management</i> (to improve the competitive advantage of the innovation); <i>ex-post impact evaluation</i> (to promote improvements through learning and demonstrate the positive environmental, social and economic impacts of an innovation); and <i>communication and dissemination</i> (to increase the sectoral and geographical transferability).</p>	
IMPACT dimension	<p>(Multi-agent) Transformation refers to positive changes in the quadruple helix of SI and knowledge production. There are 6 critical factors linked to this SI key aspect: <i>stakeholder and community development</i> (to consolidate new/existing players and promote spin-offs and networking); <i>knowledge-based products and services</i> (to increase academic, cultural or scientific advances); <i>values and lifestyle changes</i> (to promote knowledge- and media-based cultural and behavioural change); <i>multi-challenge approaches</i> (to better manage the complexity of dynamically changing socio-technical systems, visions and paradigms); <i>capacities and skills</i> (to support workforce development, competences and jobs); and <i>entrepreneurship</i> (to innovate and create new business opportunities).</p>		<p>(Systemic) Sustainability refers to changes in the socio-technical system in which the SI operates that lead to positive economic, social, infrastructure, environmental and government transformations. There are 5 critical factors linked to this SI key aspect (see Section 4.5): <i>societal system sustainability</i> (to improve social cohesion/interaction, community sense, education); <i>economic system sustainability</i> (to improve consumption, production, labour conditions, trade); <i>environmental system sustainability</i> (to protect cultural/ecological heritage, species, resources, environmental protection laws and policies, etc.); <i>government system sustainability</i> (to improve public participation and democracy, etc.); and <i>infrastructure system sustainability</i> (to improve the energy, water and food supply system, waste management, settlements and cities, transportation, distribution and knowledge-transfer channels).</p>	

Table 5: CASI-F approach to multi-level and multi-stakeholder actions mapping from 43 innovations

707 Multi-level & Multi- stakeholder Actions	Government actors (190 actions)	Business actors (186 ac- tions)	Civil society actors (175 ac- tions)	Research and edu- cation actors (156 actions)
Top-level management: Strategic actions	37%	41%	31%	33%
Mid-level management: Tactical actions	35%	33%	34%	29%
Front-line management: Operational actions	28%	26%	35%	38%

Figure 5: CASI-F approach to multi-stakeholder and multiple SI management dimension mapping



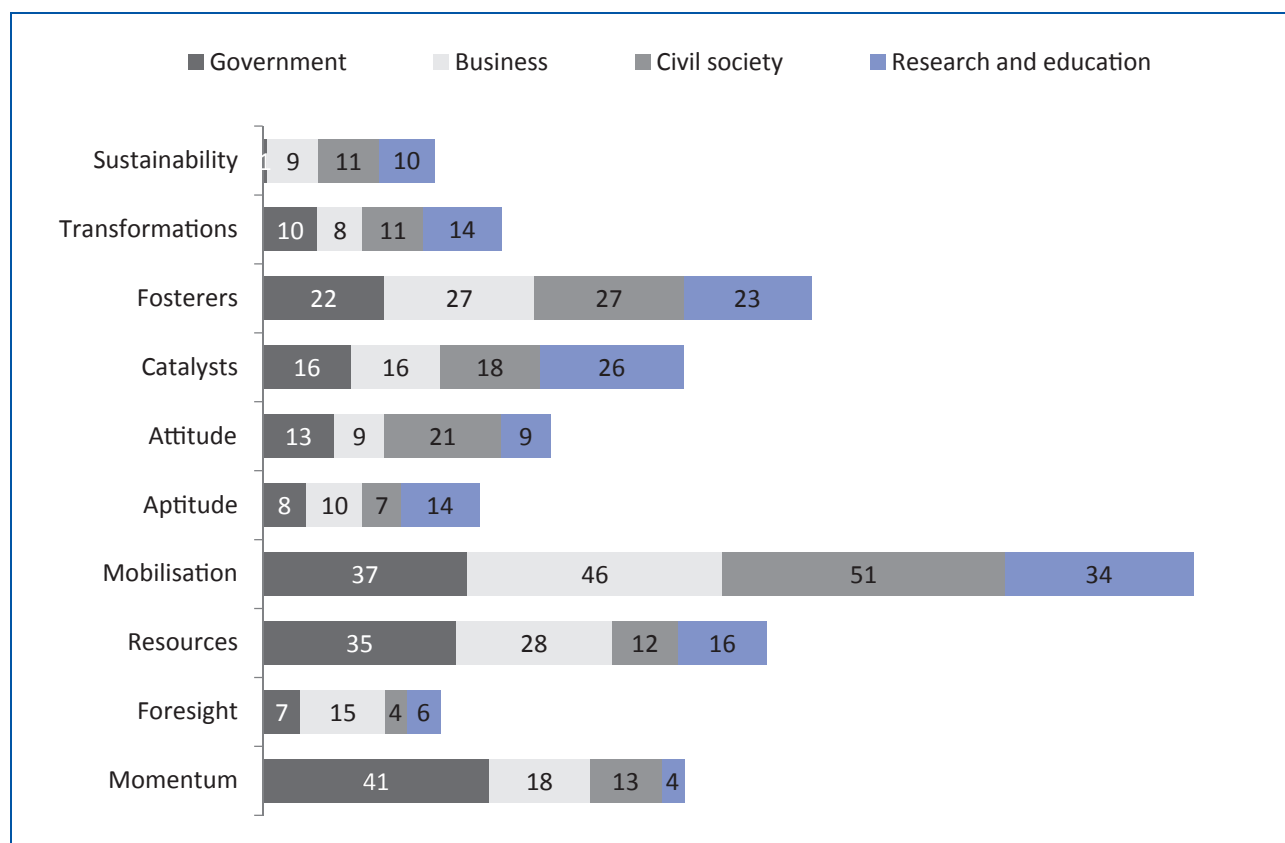
The results also show the clear differences between government, and research and education actors in the management of critical issues in each of these dimensions. While government actions are expected to focus more on the context dimension, followed by the people, process and impact dimensions, the actions of research and education actors first target issues of the impact dimension, followed by the process, people and context ones.

These findings become more apparent and interesting after the application of the systemic action management framework at the level of 'key aspects' (Figure 6). Here we can clearly see the significant role of the *mobilisation* key aspect, followed by the *fosterers* and *resources* as the three most important areas of intervention. Both the foresight and sustainability key aspects appear to be addressed by all actors, although business actions in the foresight key action are considerably more prominent than those of other actors, showing that more strategic behaviour is normally expected from entrepreneurs. However, these results may also reveal the general need for a more forward-looking and sustainability oriented-mentality when looking for solutions to critical issues affecting innovations.

Figure 6 presents the distribution of each type of stakeholder by key aspect. Thus it is possible to recognise that government actors are expected to address critical factors linked to the *momentum*, *mobilisation* and *resources* key aspects. Business actors play a major role in the *mobilisation* key aspect as well as in actions dealing with issues about *resources* and *fosterers*. Nearly a third of the actions of civil society actors are about *mobilisation*; the other two expected areas of intervention include the *fosterers* and the *attitude* of people involved in the innovations. Finally, the most prominent set of actions of research and education actors can be linked to the *mobilisation* key aspects, closely followed by actions in the process dimension, with an almost even distribution between *catalysts* and *fosterers*.

From the innovators' perspective, the final step in the management of identified actions required their assessment in terms of importance for the innovator, feasibility of implementation and the degree of economic, social and environmental impacts. Several interviews and interactions with the innovators were organised in order to jointly prioritise those actions that required more in-depth managerial advice. This involved the creation of 46 action roadmaps using the systemic action management framework to develop more specific sub-actions or tasks for priority actions. A total of 564 tasks was generated and allocated short-medium-to-long-term implementation time scales, thus providing innovators with more practical advice on immediate and future steps for the management of critical issues affecting the context, people, process and impacts dimensions of their innovations. Figure 7 shows how the 564 tasks identified related to the context, people, process and impact dimensions, as well as their implementation time scale.

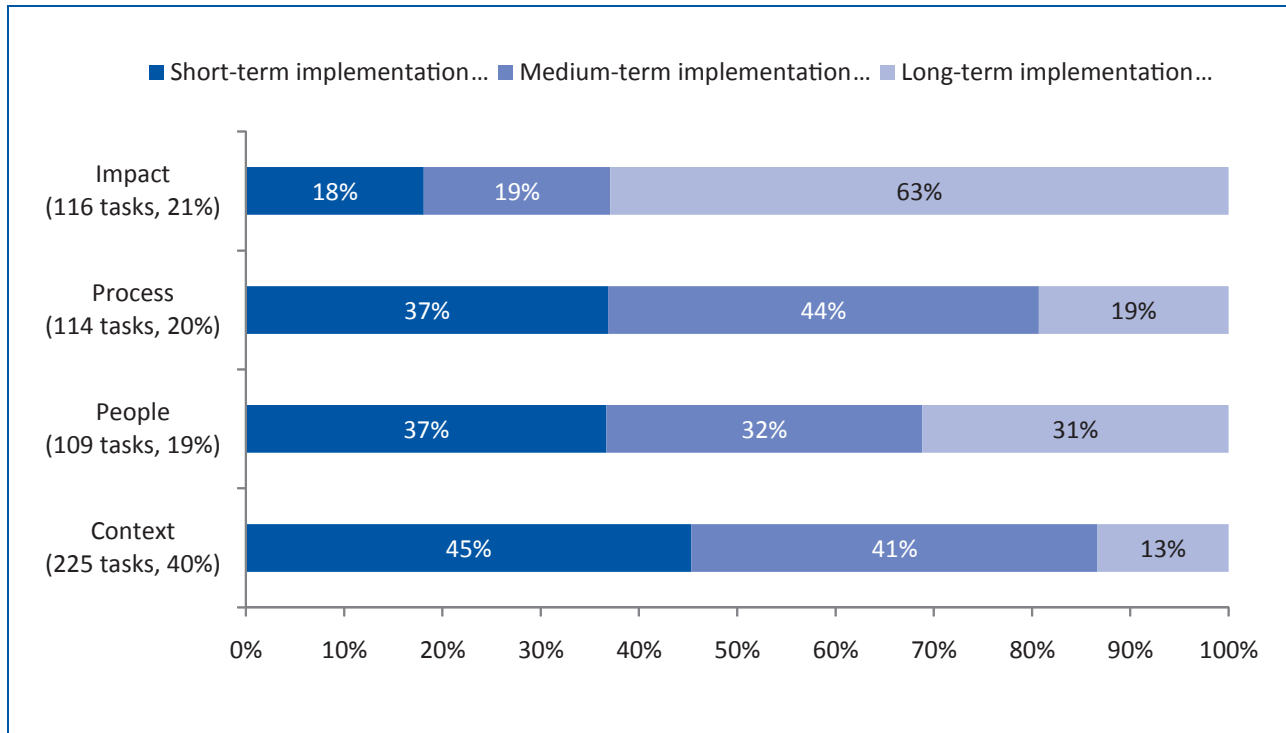
Figure 6: CASI-F approach to SI management key aspect mapping



From the CASI team perspective, the amount of strategic intelligence generated while mapping, analysing and managing selected innovations and related critical issues has a huge potential to further advance knowledge and support evidence-based policy-making in the area of sustainable innovation. Applying supplementary systematic and content-oriented meta-analysis (i.e. a structured and systematic study of a large amount of data with the aim of identifying patterns and clusters) of the actions and sub-tasks linked to the piloted innovations could further support the refinement of CASI-F and the development of recommendations on the type of mechanisms, schemes and programmes that regional, national and European policy-makers should put in place to: (1) better promote strategic sustainability agendas; and (2) promote more effective functioning of existing policy instruments.

Similarly, the meta-analysis of other SI Practices, Outcomes and Players assessment criteria would probably lead to more and equally interesting lessons. For example, Chapter 4 focuses on the meta-analysis of innovators' short-medium-to-long-term objectives and aspirations. This analysis helped to identify some 76 priority areas for *product, service, social, organisational, governance, system and marketing* innovations, which were later clustered into 10 research and innovation policy agendas (see also Chapter 8).

Figure 7: CASI-F approach to SI management dimension by implementation time frame



3.4. The benefits of CASI-F for SI actors

This section presents the benefits of CASI-F for the quadruple helix of sustainable innovation stakeholders.

The possible uses of applying CASI-F in the assessment and management of *innovations*, *policies* and *aspirations* is summarised in Table 6. However, using our systematic effort to apply CASI-F to the innovations first track, here we provide a more elaborated discussion on how government, business, civil society and research and education actors can benefit from the information, analysis and advice generated during the piloting of CASI-F.

- Government actors can use the information from the *mapping* to explore practices in the local, national or international areas of policy influence. The resulting *analysis* can support the implementation of multiple policies addressing, for example, specific technological, economic, environmental, political, social, ethical or spatial *critical issues*. The advice linked to the actions generated can help policy actors to establish the conditions that allow the implementation of SI actions by firms and include new research priorities in SI agendas.
- Business actors can use the information from the *mapping* to identify opportunities and learn from competitors. The resulting *analysis* can support the (re)definition of SI strategies and reinforcement of SI management, while the advice would on the one hand, facilitate the implementation of actions and meta-actions and, on the other hand, help to create roadmaps based on piloted SI cases.
- Civil society actors can use the information from the *mapping* to discover new products, services and social initiatives. The resulting analysis would allow civil society organisations (CSO) to recognise those SI management factors where public engagement is needed, thus increasing their participation in socially oriented business activities. The advice generated from the analysis of innovations can increase CSOs' awareness of new research and innovation agendas and priorities.
- Research and education actors can use the information from the mapping as case studies in lectures and research on sustainable innovation or to develop new SI databases and statistics. The resulting *analysis* can inform management programmes on SI critical factors in business schools, and management research on how SI critical factors compare across countries. The advice linked to the actions generated can drive research careers through new research priorities.

Table 6: CASI-F benefits by type of stakeholder

Benefits of CASI-F	CASI-F Track 1 Innovations	CASI-F Track 2 Policies	CASI-F Track 3 Aspirations
Government	Explore SI practices in the local/national/international area of policy influence. Implement policies that address specific critical issues or SI considerations. Establish the conditions that allow the implementation of actions by SI firms. Include new research priorities in the SI agenda.	Incorporate new policy insights into the policy formulation process. Cover policy gaps, develop new policies and review existing ones. Be inspired by policy briefs and blogs to formulate new SI policies.	Understand citizens' expectations and fears. Address citizens' opportunities, threats and suggestions in policy formulation. Adjust research and innovation funding to citizens' proposed agendas.
Business	Identify opportunities Learn from competitors. Refine/define SI strategies. Reinforce SI management. Implement actions, meta-actions. Create roadmaps, based on piloted SI cases.	Design contingency plans that allow the right answers to new policy plans and regulations. Identify strategic opportunities and responses to identified policy insights and gaps. Take advantage of new regulation opportunities or prevent the negative impact of new policy developments.	Align products and services to citizens' interests. Consider citizens' opportunities, threats and suggestions in corporate strategies. Increase R&I investment according to new research priorities.
Civil Society	Discover products, services, and social initiatives. Recognise those SI management factors where public engagement is needed, thus participating in socially oriented business activities. Be aware of new research and innovation agendas and priorities.	Use policy briefs and blogs to be better informed about current policy agendas. Identify and understand through the policy blog individuals' most desired policy developments, and make strategies accordingly. React to policy briefs with information on positive and negative policy changes.	Define civil society organisations' strategies to citizens' expectations. Initiate new actions related to identified citizens' opportunities, threats and suggestions. Align civil institutions' strategies to citizens' priorities.
Research and Education	Use CASIPEDIA and SI indicators to support lectures and research. Include SI critical factors in business schools' courses. Compare SI critical issues across countries and sectors in management research. Develop training courses and research careers in areas related to CASI R&I policy agendas on SI.	Include policy briefs and blog insights in policy analysis-related lectures. Use policy briefs and policy blogs to expand insights on specific areas of policy research, thus broadening research empirical data. Undertake research in those policy directions identified in policy briefs and blog.	Utilise citizens' visions in lecturing or foresight and horizon scanning projects and courses. Make further research areas in areas related to citizens' opportunities, threats and suggestions. Create new lecture areas according to citizens' interests.

3.5. Conclusions and recommendations

This chapter has presented a systematic overview of the CASI framework (CASI-F) that supports the assessment and management of sustainable innovation. Major attention has been paid to the development of SI policy advice, building upon a practical/methodological sequence that includes the scanning, selecting, mapping and analysing of (1) sustainable innovations, (2) existing SI policies, and (3) sustainability-related citizens' aspirations. This chapter gives rise to three methodological conclusions and three policy messages.

Methodological conclusions:

- Improving the quality of European *governance*, as far as multidisciplinary areas like sustainability are concerned, needs to be supported by highly participative and well-informed policy action. In this respect, the first message of this chapter is the need to consider participatory intelligence instruments, such as CASI-F represents, to assist policy makers in the conception of more *legitimate* and *democratic* decisions.
- The second message is related to the necessity of testing and challenging policy intelligence tools with well-accepted *impact*-oriented criteria. Tackling complex and multifaceted problems, like those that sustainable innovation actors have to address, requires the development of instruments such as the CASI-F to support SI policy actors in the elaboration of more *resilient* and *sounder* strategies.
- The third message builds upon the capacity of CASI-F to effectively exploit different *sources of knowledge*. In particular, SI experiences, current SI policies and citizens' visionary aspirations constitute the practical and multi-perspective evidence that policy makers should demand when commissioning SI advisory projects. Making use of these types of sources should contribute to the development of more *comprehensive* and *inclusive* SI policy formulation.

Some policy messages can also be extracted as recommendations from this chapter. They basically aim to highlight the importance of:

- *Recognising the potential of utilising methodological frameworks for assessing and managing sustainable innovation and, in particular, acknowledging the benefits of fully exploiting the versatility of CASI-F.* While the framework was fully tested and piloted with innovations, the infrastructure is also prepared to systematically support the assessment and management of sustainability-related policies and aspirations.
- *Supporting the use of SI frameworks, like that represented by CASI-F, for identifying and prioritising SI critical issues.* CASI-F is not a substitute for conventional sustainability assessment and management frameworks; rather it complements them with critical issues analysis. Therefore, it is crucial to properly identify and prioritise relevant critical issues associated with SI, taking into account the variety of critical issues, including drivers, opportunities, barriers and threats. The prioritisation, considering the importance and urgency of critical issues, should be done together with the innovators or, if policies or aspirations are the subject, with representatives of governments and civil society.
- *Promoting the co-creation of SI roadmaps.* It is important that action roadmaps, aimed at addressing and managing SI critical issues, are co-created together with those responsible for, or benefiting from, their practical implementation. Co-creation leads to co-ownership, which triggers sustainability-oriented decision-making at strategic, tactical and operational levels.

The subsequent chapters of this report describe a journey through the application of the CASI Framework. To a greater or lesser extent, these chapters will aim to stimulate and encourage readers to critically reflect on the levels of legitimacy, democracy, resilience, soundness, comprehensiveness and inclusiveness that the practice of sustainable innovation demands.

References

- Carayannis, E.G. and Campbell, D.F.J. (2009) 'Mode 3' and 'quadruple helix': toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management* 46 (3/4), pp. 201–234.
- Carayannis, E.G. and Campbell, D.F.J. (2010) Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? A proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. *International Journal of Social Ecology and Sustainable Development* 1 (1), pp. 41–69.
- Council of the European Union (2013) 'Council decision establishing the specific programme implementing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020) and repealing Decisions 2006/971/EC, 2006/972/EC, 2006/973/EC, 2006/974/EC and 2006/975/EC (15401/13)'.
- European Commission (2001) 'European Governance: a White Paper'. COM(2001) 428, 25.7.2001.
- European Commission (2009) 'Impact Assessment Guidelines'. SEC(2009) 92, 15.1.2009.
- Gasparatos, A., El-Haram, M., Horner, M. (2008) A critical review of reductionist approaches for assessing the progress towards sustainability. *Environmental Impact Assessment Review* 28, pp. 286–311.
- Hacking, T. and Guthrie, P. (2008) A framework for clarifying the meaning of triple bottom-line, integrated and sustainability assessment. *Environmental Impact Assessment Review* 28 (2–3), pp. 73–89.
- Ness, E., Piirsalu, U., Anderberg, S. and Olsson, L. (2007) Categorising tools for sustainability assessment. *Ecological Economics* 60, pp. 498–508.
- Pope, J., Annandale, D. and Morrison-Saunders, A. (2004) Conceptualising sustainability assessment. *Impact Assessment of Project Appraisal* 23 (4), pp. 293–302.
- Popper, R., Velasco G. and Popper M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.
- Popper, R. (2008) Foresight Methodology, in Georghiou, L., Cassingena H., J., Keenan, M., Miles, I., Popper, R. *The Handbook of Technology Foresight: Concepts and Practice*. Cheltenham: Edward Elgar.
- Popper, R., Velasco, G., Bleda, M., Amanatidou, E., Ravetz, J., Damianova, Z., Kozarev, V., Chonkova B., Tsin, S., Avarello, A., Martin, L. and Morris, D. (2016) Sustainable Innovation Conceptual Framework. CASI project report. Deliverable 2.2.
- Popper, R., Velasco, G. and Ravetz, J. (2016) State-of-the-art of Sustainable Innovation: climate action, environment, resource efficiency and raw materials. CASI project report. Deliverable 2.1. <http://www.casi2020.eu/library/#d8838>.
- Singh, R.K., Murty, H.R., Gupta, S.K. and Dikshit, A.K. (2009) An overview of sustainability assessment methodologies. *Ecological Indicators* 9 (2), pp. 189–212.

4. Sustainable innovation policy advice using a quadruple helix approach to ‘innovations’ mapping

Monika Popper, *Futures Diamond*
 Anita Tregner-Mlinaric, *Meta Group*
 Rafael Popper, *University of Manchester*
 Guillermo Velasco, *University of Manchester*
 Maria Schwarz-Woelzl, *Zentrum für Soziale Innovation GmbH*
 Sarah Van Eynde, *Katholieke Universiteit Leuven*
 Monique Ramioul, *Katholieke Universiteit Leuven*
 Zoya Damianova, *ARC Fund*
 Ventseslav Kozarev, *ARC Fund*
 Mattia Martini, *University of Milano-Bicocca*
 Rick Hölsgens, *Technical University of Dortmund*
 Jürgen Schultze, *Technical University of Dortmund*

4.1. Abstract

The CASI Framework (CASI-F) supporting better assessment and management of sustainable innovations (SI) was created and developed based on the results of a project’s systematic mapping activities and a pilot study of sustainable innovations (SI) led by the quadruple helix of SI actors across Europe. Over 200 fully-mapped SI initiatives (out of 548 nominated) were categorised under seven types of innovation (product, service, social, organisational, governance, system, marketing). The specific characteristics of SI types are demonstrated in this chapter, noting the research and innovation priorities pertinent to each type that emerged from the analysis and the clustering of innovators’ short-, medium- and long-term sustainability-focused objectives. These priorities were used to identify and formulate wider sustainability agendas, which revealed the complementarities of different types of innovation and their interconnections with policy issues and H2020, as well as citizens’ priorities.

4.2. Introduction

The past decade has witnessed the emergence of coordinated agendas with specific sustainability targets. In a global dimension, the United Nations has positioned 17 Sustainable Development Goals with 169 targets.⁸ While the European Union has endorsed these goals and declared its commitment to implementing them by 2030, the European Commission’s Horizon 2020 framework programme has set out its own strategy to address several societal challenges, including new initiatives to better assess and manage sustainable innovations with a focus on ‘Climate action, environment, resource efficiency and raw materials’ (SC5). It is in this context that the CASI project has launched a systematic effort to develop CASI-F (see Chapter 3 and Popper *et al.*, 2017) in order to assess sustainable innovations (SI) from across Europe that address the societal challenges of climate action, environment, resource efficiency and raw materials. The nomination of relevant SI initiatives involved the mapping of cases by the CASI partners and country correspondents, while working in close collaboration with SI innovators. This was then followed by three independent peer-review and SI-relevance assessment processes conducted by the University of Manchester, Coventry University Enterprise and the initiative nominators (including CASI partners and country correspondents covering all EU Member States). A total of 168 SI initiatives was determined through the assessment; however, innovators’ interest and self-mapping activities led to a final set of 202 initiatives (see Annexe 2), fully mapped in terms of practice, outcome and player dimensions – a scheme previously investigated in the context of the European Foresight Platform (EFP) project (Popper *et al.*, 2012). The analysis of SI initiatives by seven types of innovation (i.e. product, service, social, organisational, governance, system, marketing) and, in particular, of their specific objectives, has played a significant role in the identification of new and emerging R&I Policy Agendas within CASI. While this chapter highlights the specificities of each type of innovation, there are several cross-cutting objectives which are discussed in Chapter 8 on ‘Policy priorities for climate action,

⁸ See <http://www.un.org/sustainabledevelopment/>.

environment, resource efficiency and raw materials'. More detailed discussion is centred on the top five priorities pertinent to each type of SI, as well as on their contribution towards one or more of the four pillars of SC5, namely Climate Action, Environment, Resource Efficiency, and Raw Materials (SC5). Finally, a critical reflection on the similarities and convergence of sustainability agendas driven and stirred by seven types of SI initiatives will be provided.

4.3. Methodological approach

A review of the contemporary literature was first conducted to establish the foundation for this research, the full account of which can be found in Popper *et al.* (2016). As a result seven types of sustainable innovations emerged as important foci for further analysis through a systematic mapping exercise and direct interaction with innovators. Initially, the CASI team, which consisted of 19 partners from 12 EU countries and 16 country correspondents from the remaining Member States, each nominated 15-22 SI initiatives (totalling 548), ensuring coverage of the pre-defined seven types of SI and public participation and engagement of the quadruple helix of SI stakeholders as leaders of selected SI initiatives (see Figure 8).

Figure 8: A quadruple helix approach to the analysis of innovators' objectives

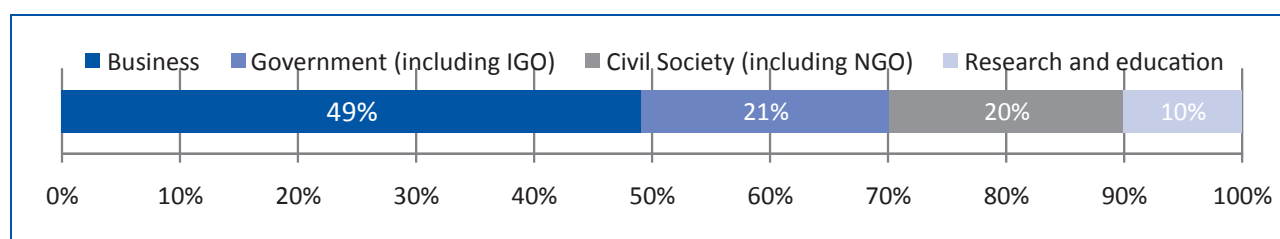


Figure 8 shows that around 49% of the nominated SI initiatives were led by business actors, 21% by government actors (including intergovernmental organisations such as the EU and the UN), 20% by civil society (including non-governmental organisations) and 10% by research and education stakeholders. The primary focus of the SI initiatives nominated was on social, economic and environmental dimensions, including relevance to one or more of the H2020 priorities related to SC5. The nomination phase included 12 questions, which were then reviewed and rated by the University of Manchester and Coventry University Enterprise teams using the following criteria to assess the SI relevance: *Public participation and mobilisation* – to assess engagement in the issues of the sustainable innovation by the public, civil society and democratic governance, with the goal of fostering independent thinking and debate, i.e. not corporate market research; *Sustainability and cross-sectoral linkages* – to assess the way further innovation or positive effects are enabled among a wide range of sectors, levels, and users; *Multi-dimensional transformations* – to assess the degree to which the sustainable innovation can produce positive change or transformation for one or more dimensions (social, economic or environmental); *Deployment and diffusion* – to assess the degree of advancement in the process of deployment or implementation; and *Novelty and originality* – to assess the degree to which a sustainable innovation represents an original or novel idea. The combined score from the assessment against these criteria was used to select and fully map six SI initiatives per EU28 country (168 initiatives), complemented by some additional 34 SI initiatives covering selected non-EU countries as well as the seven types of innovations. In total 202/548 SI initiatives were mapped/nominated: 38/194 Product SI; 48/121 Service SI; 48/75 Social SI; 22/62 Organisational SI; 25/46 Governance SI, 16/31 System SI, 5/19 Marketing SI. While both nominated and fully mapped cases are available from the CASI project online knowledge platform (CASIPEDIA), only the analysis of 202 SI initiatives (see Annexe 2) was used in the study to shape the R&I priorities discussed below. Selected SI initiatives were led by business, government, civil society or research/education actors, thus the combined results from their analysis show priorities based on CASI's quadruple helix approach to innovation mapping.

Among a number of criteria, the SI initiatives were mapped in terms of innovators' goals and objectives. In the process of defining new research and innovation (R&I) priorities, up to five main and five supporting objectives from each of the 202 fully mapped cases, were clustered by type of SI and the

seven clusters analysed using *Research Gate's* (Kapiche) text mining and analytical tool. The 1852 real short-, medium- and long-term goals and aspirations of the quadruple helix of SI stakeholders, aimed at positively contributing to the sustainability agenda, were analysed and produced a number of terms and key terms. Of the goals 494 were derived from selected product-, 416 from service-, 309 from social-, 245 from organisational-, 187 from governance-, 142 from system-, and 59 from marketing-related innovations. The key terms were carefully analysed by project partners at the University of Manchester and clustered into key SI priorities, which are presented in detail in the following sections. Several research priorities per type of SI were formulated through the clustering of text and topics but only the top five of each will be considered in this chapter, including linkages to H2020 priority areas and relevant socioeconomic sectors. It is worth noting that, while some of the innovators' objectives used in this study have already been achieved and are bringing positive environmental, economic and social transformations, they will remain as priorities driving the future developments and diffusion strategies of these, and similar, innovations. Therefore, the combined analysis of SI objectives can be seen as both the implicit and sometimes explicit ongoing and future R&I agendas of innovators.

4.4. Key priorities of sustainable *product* innovations

The analysis of 494 objectives from selected product-related SI initiatives produced 1980 terms and 88 key terms that were clustered into 15 SI priorities (see Table 7). The top five of these are discussed below and supported with examples originating from mapped SI initiatives.

Table 7: Product Innovation priorities

KEY PRODUCT INNOVATION PRIORITIES	
1.	Developing reliable equipment and saving solutions for renewable and non-renewable energy.
2.	Decreasing raw materials use through waste processing and recycling plants (e.g. biofuels, plastic).
3.	Improving society and people's health by ensuring high levels of indoor and outdoor air quality.
4.	Reducing the use of clean and drinking water in industrial processes (e.g. fracking, gas/oil drilling).
5.	Developing sustainable public transport infrastructures that promote employment and safety.
6.	Lowering the carbon footprint through effective carbon dioxide sequestration and storage.
7.	Using sustainable materials and nanotechnology in the construction of residential/office buildings.
8.	Reducing pollution (e.g. NOx) in waste incineration and combustion processes (e.g. automobiles).
9.	Supporting sustainable regional development and environmentally friendly lifestyles.
10.	Limiting the negative impact of climate change and greenhouse gas (GHG) emissions.
11.	Increasing the market share of electric vehicles and building sustainable (e.g. solar) power stations.
12.	Generating biogas resources from sustainable food production (e.g. Aquaponics plants).
13.	Using green roofs to reduce heat island effects in urban areas and gain competitive advantage.
14.	Promoting more sustainable heating and cooling devices (e.g. using wood biomass as a fuel).
15.	Developing technological solutions for the effective reuse and recycling of products.

SI product priority 1: Developing reliable equipment and saving solutions for renewable and non-renewable energy – This appears as the most important priority of the mapped Product SI. Examples of product innovations in CASIPEDIA, among many others, include: wood pellets-based local CO₂-neutral heat supply systems; quiet double bladed vertical axis wind turbines; wind and wave energy powered electric thermal space and water heating systems; near-zero-energy public buildings; sustainable wood burning boilers; integrated microclimate control systems; floating surface waste water aeration and purification technology. The importance of this priority had been highlighted by Omer (2015) in 'Renewable Energy Technologies, Sustainable Development, and Environment', especially in the context of climate change adaptation and mitigation strategies.

SI product priority 2: Decreasing raw materials use through waste processing and recycling plants (e.g. biofuels, plastic) – Conservation of raw materials using SI waste management products appears an important priority area that supports the reduction of negative environmental impacts, while increasing the efficiency of processes and the profitability of businesses. Examples of product innovations from CASIPEDIA include: an innovative and cost-effective methodology for producing second-generation biofuels using recycled waste cooking oils as the main feedstock; epichlorohydrine production from a renewable raw material resource (one of the by-products of biofuel production – glycerine); *AirCarbon* made by sequestering carbon emissions and used to replace oil in the production of plastic, biodegradable and/or recycled plastic materials made of plants or recycled paper; and *Cynar Technology's* useable liquid fluids converted from end-of-life plastics.

SI product priority 3: Improving society's and people's health by ensuring high levels of indoor and outdoor air quality – Concerns over the quality of our indoor and outdoor air standards are on the rise following continuously increasing levels of air pollution. CASIPEDIA provides examples of SI products that address the inside and outside of buildings. Among those products are flooring and furniture items that are made of alternative, eco-friendly raw materials that provide a healthier indoor environment and can be re-used at the end of their life span. With regard to outdoor emissions, the CASI database features: 'Climate Cooler Catalyst', a solar reflective roof paint, which also has a catalytic effect that converts harmful NOx particles from traffic exhaust gas into harmless salts; and 'Accura' electric bikes that are pollution-free and noise-free alternatives to conventional electric bikes.

SI product priority 4: Reducing the use of clean and drinking water in industrial processes (e.g. fracking, gas/oil drilling) – A large proportion of resource-efficiency challenges relate to clean water scarcity, which over the centuries has resulted from multiple environmental, political, economic and social forces and is negatively affecting the quality of human lives, something that is increasing statistically with each year. Therefore, it is essential that industry actors adopt innovative solutions that support reducing the use of clean and drinking water in industrial processes. Some ideas for SI products mapped by the CASI team include: Toring Turbine® - a water aerator for the introduction of purifying oxygen into wastewater; the use of nanotechnology-based solutions to eliminate water pollutants; and a number of wastewater recycling and separation systems, all of which allow recycling and re-using of wastewater, thus promoting more efficient use of clean and drinking water in industrial processes.

SI product priority 5: Developing sustainable public transport infrastructures that promote employment and safety – The demand for sustainable public transportation and supporting infrastructures is increasing over time as urban areas face growing levels of traffic and air pollution. An example of a related SI product mapped in CASIPEDIA is the Blue Shock Bike - a Latvian brand that develops electric bicycles and related ICT infrastructure. Blue Shock Bike provides solutions that are fully tailored to the needs of its customers, such as web-based applications for fleet management, GPS tracking and bikes that are charged through regular electricity grid connections and are compatible with electric car-charging infrastructure. In search of a safer and more sustainable transport system, the city of Tartu (Estonia) has explored regional development and employment opportunities from the fully integrated production and use of biogas in modern public transport vehicles.

From within the top 10 Horizon 2020 priority areas that were determined through the analysis of mapped SI initiatives, and are associated with product SI, the majority of product innovations appear to focus most on raw materials. These are followed by products to support resource efficiency and climate action-related targets associated with both the UN and EU sustainability agendas. Not surprisingly the majority (51%) of sustainability-oriented products are linked to the manufacturing sector. This reflects growing efforts to introduce both incremental and radical innovations in product design and development. Product innovations linked to the energy sector (26%) remain at the forefront, followed closely by innovations in the water (21%), construction (17%) and agricultural (11%) sectors.

4.5. Key priorities of sustainable service innovations

An important type of innovation considered within the CASI project is service innovation, or the introduction of a service that is new or significantly improved with respect to its characteristics or intended uses. Examples are efficiency or speed improvements, new functions or characteristics of existing services, or the introduction of entirely new services (OECD, 2005). Out of more than 500

mapped sustainable innovation initiatives in CASIPEDIA, service innovations account for 22% (or a total of 121 cases). Most of these initiatives appear to match a number of the Horizon 2020 priorities, with nearly half (46%) referring to resource-efficient sustainable lifestyles, a third (33%) to climate action by sustainable lifestyle and another third to ICT for improving resource efficiency, also suggesting the frequent overlap among the different priorities in sustainable service innovations. The analysis of this subset of innovations resulted in the identification of 416 different objectives, comprising 1556 unique terms. These were grouped and reduced to 87 key terms that were then clustered into 18 SI priorities (see Table 8). This section describes the top five and discusses their greater significance.

Table 8: Service Innovation priorities

KEY SERVICE INNOVATION PRIORITIES	
1.	Promoting alternative/renewable energy sources (e.g. biogas, kinetic energy) and monitoring their impact.
2.	Creating sustainable societies based on the circular economy and environmental protection principles.
3.	Preventing waste and managing the recycling/re-use of waste (including old electronic equipment).
4.	Contributing to the reduction of global CO ₂ and greenhouse gas emissions.
5.	Reducing private car ownership through effective car/bike renting and sharing services.
6.	Improving the efficiency, speed and eco-friendliness of public transport and freight services.
7.	Developing sustainable mobility networks and infrastructures supporting electric vehicles.
8.	Fostering self-sufficient rural areas through sustainable agriculture and energy production.
9.	Creating platforms/networks for information/knowledge sharing on sustainable tools and services.
10.	Analysing data on urban water use and modelling effective water management strategies.
11.	Providing timely communication of environmental hazards (e.g. floods) to citizens and authorities.
12.	Establishing and reinforcing organic food production and markets in local communities.
13.	Providing users of environmental data with real-time analysis/modelling of air/land/water quality.
14.	Preserving and consolidating cultural heritage, traditional values and sustainable lifestyles.
15.	Reducing traffic problems, fuel consumption and emissions linked to parking problems in cities.
16.	Reducing air and noise pollution from residence and cultural heritage areas.
17.	Providing advice on sustainability issues to citizens (e.g. ecological risks, floods, consumption, etc.).
18.	Improving the efficiency of retail distribution centres and goods distribution to shops.

SI service priority 1: Promoting alternative/renewable energy sources (e.g. biogas, kinetic energy) and monitoring their impact – This priority arose as a response to increased CO₂ emissions from transportation, and is linked to the production and wider availability of bio-based fuels. This is also seen as key in promoting a ‘green transition’, whereby the production of alternative energy sources is paramount for the economy and for society as a whole. Certain (regional) initiatives, for example, link alternative fuel use to transport efficiency.⁹ It would be interesting to monitor the further developments around that, also taking into consideration specific awareness-raising strategies.

SI service priority 2: Creating sustainable societies based on the circular economy and environmental protection principles – With this priority, a number of services involved in waste management are being addressed. Specifically, the emphasis is on developing a decision-support tool for public authorities and other interested stakeholders, to enable them to easily calculate the environmental benefits and financial costs of concurrent waste management options. Of special importance is the reassessment of current services and technologies dealing with collecting and packaging specific types of waste (i.e. paper, plastic, glass and metal, as well as electrical and electronic equipment). This is seen as critical to any public management strategy for the implementation of the circular economy and environmental

⁹ For example, the North-Western Skåne biogas plant, Helsingborg, Sweden.

protection. Furthermore, this priority is based on real examples of how certain aspects of sustainable development can be positively affected by service innovation practices, such as facilities and regulations that allow the rental (and re-use) of unnecessary or rarely used equipment. In addition, it also rests on the assumption that changing otherwise traditional services (such as deliveries) to use biofuels, will significantly contribute to meeting environmental targets. From a commercial point of view, this would mean fostering the paradigm of smart cities, where consumers and service providers are dynamically connected, and decision-making is based on proactive research and real-time data analysis.

SI service priority 3: Preventing waste and managing the recycling/re-use of waste (including old electronic equipment) – The issue of managing waste – not only the recycling regulations, but the actual minimisation of harmful waste residuals combined with the introduction into use of older equipment – is paramount for a sustainable society. As waste collection and management is based on a system of connected services, sustainable innovations play a big part in its further development. It is a field ripe with innovation opportunities too: by recycling hazardous waste in order to obtain secondary raw materials, such materials can be directed into new production, thus also helping to create economic activity and additional employment. The latter clearly demonstrates the powerful cascade effect in service innovation, and illustrates the economic, environmental and social potential of zero-waste-economy strategies.

SI service priority 4: Contributing to the reduction of global CO₂ and greenhouse gas emissions – This priority reflects a dominant sustainability ambition. Sustainable service innovations have already demonstrated solutions, ranging from policy goals (setting CO₂ reduction targets) to awareness raising (educating consumers on how to reduce the CO₂ emissions of their own activities) to resource planning (reduction of waste waters, minimisation, promoting energy-saving behaviour, etc.). A major objective is the lasting reduction of greenhouse gas emissions. Innovative approaches could therefore be designed to address different aspects of CO₂ emissions reduction simultaneously in order to meet the set targets.

SI service priority 5: Reducing private car ownership through effective car/bike renting and sharing services – This priority reflects a number of initiatives where it became evident that private cars were an idle resource that could be leveraged to produce social, economic and environmental benefits, while also helping optimise existing transportation services and schemes. For example, an environmentally focused mobility concept relies on fewer private cars as a precondition to a healthy environment. In addition, introducing schemes for better cooperation among car users would significantly help to reduce noise levels, CO₂ emissions and road congestion, and will contribute to an improved, healthier life style.

4.6. Key priorities of sustainable *social* innovations

Of the more than 500 sustainable innovations in CASIPEDIA, 75 (14%) are social innovations. We derived 309 objectives from the analysis of the set of social innovations, which were further delineated into 1123 terms and 45 key terms. In the next step the terms and key terms were clustered into 11 key SI priorities (see Table 9). The top five of the 11 SI priorities are further described in this section and supported by examples of SI initiatives mapped in CASIPEDIA.

Table 9: Social Innovation priorities

KEY SOCIAL INNOVATION PRIORITIES	
1.	Improving organic food production, supply chains and distribution networks.
2.	Promoting sustainable lifestyles and consumption patterns through knowledge sharing.
3.	Supporting community life and development (e.g. solidarity networks).
4.	Reducing legal and illegal construction waste (e.g. recycling of building materials).
5.	Enhancing local quality of life by promoting regional industries, products and services.
6.	Raising public awareness and participation in environmental actions and education.
7.	Developing children's interest and skills in the promotion of sustainable neighbourhoods.
8.	Understanding and improving the conscious use of resources and environmental responsibility.
9.	Promoting effective transport initiatives that reduce the impact of goods' and people's mobility.
10.	Promoting sustainable water access, distribution, management, use and treatment practices.
11.	Adopting social practices/actions for river and stream water quality improvement and monitoring.

SI social priority 1: Improving organic food production, supply chains and distribution networks – The number one priority involves the production and distribution of organic food. Consumption of organic food should be made as easy as possible, and perhaps even fun. It also involves local production of food by citizens, including in urban areas. An example is the Belgian initiative *Gaan we samenwortelsplukken* which gives children the opportunity to grow and consume their own food in a city garden. This priority also entails the following objectives: first, the reduction of food waste by helping people to think about how they can reduce waste, and what they can do with leftovers. An example is the creation of a cookbook with leftover food recipes created by the Paralimni municipality in Cyprus. Second, the setting up of sustainable supply chains, including those of shorter distance, and supplying stores with high-quality products through interaction with national and local producers. Third, motivating people to interact, strengthening the awareness of a region and strengthening social networks. Finally, reducing/eliminating food poverty. The Estonian *Food Bank* is an example of a social innovation that helps to reduce food poverty in Estonia through the distribution of food to those in need. The need for the more sustainable consumption of food is addressed by Reisch *et al.* (2013). These authors critically examine the current status of food production and consumption and address such issues as the unequal distribution of food, and emissions in production and transport. They call above all for a changing in policy instruments rather than social innovations, however.

SI social priority 2: Promoting sustainable lifestyles and consumption patterns through knowledge sharing – Social innovations, by definition, involve change in social practices. In the case of social innovations aiming to enhance sustainability this generally means promoting more sustainable lifestyles and consumption patterns; knowledge sharing is often critical to accomplish this. Cadbury Schweppes' initiative to promote sustainable livelihoods in Ghana is a nice example of how this second SI priority works in practice. To increase the livelihoods of cacao farmers (an important ingredient in Cadbury products) Cadbury Schweppes has provided free training in new sustainable farming practices to local farmers, thus promoting sustainable living through knowledge sharing. Another example is the German *Stromsparcheck*, in which long-term unemployed people are trained to become energy savings advisors who subsequently visit poor households and advise them on how they can save energy, and thereby money. Other objectives clustered under this SI priority are: the education of young people in school curricula or through extra-curricular activities, such as offered for instance by the *3D Ecobus* that visits school in Bulgaria to inform children above all on waste recycling; increasing knowledge sharing with regard to sustainable living, technologies, etc; facilitation of discussions about sustainability and sustainable consumption; and more generally increasing awareness of sustainable lifestyles.

SI social priority 3: Supporting community life and development (e.g. solidarity networks) – The third SI priority for social innovations aims to support community life. Many social innovations for sustainability have the aspect of community-building implicitly in their objectives, as they want to build up communities directed, for example, at the aforementioned sustainable lifestyles or the example of *Gaan we samenwortelsplukken* which has *samen* ('together'), central in its name. Another example of the development of a community of people around more sustainable practices is *OZONAS*, a Lithuanian open access magazine. It is open to everyone, creating opportunities to participate in the preparation of publications that bring together scientists, business people, non-governmental organisations and activists. It is published both in electronic and paper formats: as an electronic library and a free magazine distributed in public places, especially those declaring sustainable lifestyles (restaurants, events, etc). In this way, it reaches tens of thousands of people. Other objectives under this priority are: living in communities in which diversity and variety are important; self-sufficient communities and communities based on common earnings; contributing to the development of civil society by promoting active attitudes, strengthening local communities and supporting the development of local leaders; sensitising the community to promote more sustainable practices; creating employment opportunities for prisoners and their reintegration into the community; and providing the local community with the possibility to take an active role in protecting the environment and reduce negative impacts.

SI social priority 4: Reducing legal and illegal construction waste (e.g. recycling of building materials) – SI Priority 4 addresses the reduction of construction waste. More generally, it encompasses two broad objectives: the development of sustainable construction methods and techniques and the reduction of waste in general. An example is *Cog.gr*, which is concerned with natural building and bioclimatic architecture, as well as two techniques that result in the safe management of resources and energy – the

first during the construction of the building, the second in maintaining the standard living conditions. Natural building is used to describe an approach to building based on the use of local, carefully selected or recycled materials, simple tools and techniques. Bioclimatic architecture is equally – if not more – important than natural building because its benefits will last as long as the house is inhabited. Another example is the online platform *Nemsitt.hu*. This platform offers the possibility to sell, buy or exchange surplus construction materials and building components and thus aims to reduce the quantity of construction and demolition waste.

SI social priority 5: Enhancing local quality of life by promoting regional industries, products and services –

This SI priority deals with reducing environmental pressure through shorter transport distances while at the same time strengthening the local economy. Its objectives include supplying stores with local products, in partnership with (local) food industries, supermarkets and local cultivators. But its objectives also address other industries, for example through the provision of training, education and quality standards to local businesses, which in turn will increase the quality of visitor experiences. In addition, the objectives include the building of local communities, education of the local community and improving the quality of life for the disabled. Examples of community-building social innovation have already been addressed in SI Priority 3. An example of a social innovation aimed at improving the quality of life of disabled people is *SEATRAC*. *SEATRAC* was built to act as an auxiliary utility, which can be used by persons with movement disabilities or otherwise limited mobility, in order to facilitate their access to the sea. The main notion behind its creation was to give people with disabilities the opportunity to enjoy a simple leisure activity, such as swimming, completely unassisted. The social innovations analysed cover various H2020 priority areas and all four pillars of SC5. They focus almost by definition on more sustainable lifestyles. The most important pillars of SC5 are resource efficiency and climate action, both through more sustainable lifestyles. However, strategic intelligence and citizens' participation are also important in social SIs. The most important socioeconomic sector of relevance to sustainability-oriented social innovation is education. This covers the education of children, but raising awareness and informing the general public is also central in many of the SI priorities mentioned above, and in the social innovation analysed within the CASI project. The remaining top five socioeconomic sectors are: other services, agriculture, health/social services and water.

4.7. Key priorities of sustainable *organisational* innovations

Of the more than 500 sustainable innovations in CASIPEDIA, only 62 (11%) are organisational innovations. From an analysis of the set of organisational innovations, we derived 245 objectives that were further delineated into 885 terms and 42 key terms. Next, the terms and key terms were clustered into 11 key SI priorities (see Table 10). The top five of the 11 SI priorities are presented below and supported with examples of sustainable innovations mapped in CASIPEDIA.

Table 10: Organisational Innovation priorities

KEY ORGANISATIONAL INNOVATION PRIORITIES	
1.	Implementing energy- and water-saving practices in schools and working environments.
2.	Developing future-oriented sustainable strategies for businesses and society.
3.	Engaging customers in the improvement of the quality and sustainability of business operations.
4.	Reducing CO ₂ emissions by promoting responsible procurement and consumption.
5.	Promoting easier and more efficient waste management practices and procedures.
6.	Fostering cooperative business models and collaboration in local communities.
7.	Exchanging information on and managing the surplus of resources in the public sector.
8.	Optimising the food supply chain for producers and consumers by decreasing intermediaries.
9.	Gaining access to smart grid projects and technologies stimulating renewable energy production.
10.	Implementing international e-waste recycling practices, especially in developing countries.
11.	Encouraging business practices (e.g. teleworking) that reduce traffic/congestion-related pollution.

SI organisational priority 1: Implementing energy and water saving practices in schools and working environments – The top priority is reflected in a number of organisational innovations' objectives. In particular this priority entails promoting and realising energy and water savings at schools. Other examples include education about saving energy with the goal of having more efficient energy use in the children's homes. A concrete example is the '*Fifty/Fifty School Program*'. Schools that participate receive 50% of the energy costs saved at their discretion. Schools use the programme not only to engage their own pupils in energy-saving activities but also to educate and raise awareness. Examples of this number one priority in working environments are: (1) helping customers to become more energy-independent by advising on energy consumption and saving in their building and/or creating their own energy using software tools, advisers and specialised (installation) suppliers; (2) promoting energy saving; (3) benefiting from green certification for producing energy from biomass; (4) providing local-to-local biomass energy production; and (5) reducing the use of energy and water. A concrete example is the case of BAS, a company that tries to sell as little energy as possible to customers.

SI organisational priority 2: Developing future-oriented sustainable strategies for businesses and society – There are many organisational innovation cases whose objectives recognise the importance of incorporating a sustainability strategy in order to be resilient in the future, and thus to ensure their role and place in society as a (for-profit) business. A concrete example is the Bulgarian brewer *Zagorka AD* (Heineken Zagorka Brewery). The brewery makes a serious attempt to reduce water use and CO₂ emissions, in addition to promoting responsible consumption. The company's employees are ambassadors of 'Create a better future', a platform united for sustainable development. Sometimes the organisational innovation cases do not only talk about a strategy but also give themselves a place in a (future) sustainable system such as the mobility system. An example of such a case is *Move About*, the world's first and largest car sharing fleet exclusively using electric vehicles. Similar to *Move About* is the case of *Worldloop*: it has not just a strategy that targets sustainable development, its entire business model is based upon transforming a system into a sustainable one. *Worldloop* connects businesses from the developed world with e-waste recycling plants in the developing world.

SI organisational priority 3: Engaging customers and employees in the improvement of the quality and sustainability of business operations – Organisational innovations try to engage customers and suppliers in multiple ways in order to improve the sustainability and quality of business operations and society. Examples are Carlsberg's engagement with global suppliers to develop upcycling packaging solutions based on the Cradle-to-Cradle concept, and *Worldloop's* engagement with companies in developed countries to ensure the creation of accessible, environmentally sound, socially responsible and sustainable e-waste recycling solutions. In the case of *Renner Italia*, a company that produces wood coating systems, the organisational innovation entails engaging its own employees in the improvement of the quality and sustainability of business operations. It does so by distributing 50% of the savings made on energy bills among its employees, thus rewarding the savings achieved by the employees.

SI organisational priority 4: Reducing CO₂ emissions by promoting responsible procurement and consumption – An example of responsible procurement and, simultaneously, of promoting sustainable consumption is the case of the district heating company *SalaspilsSiltums*, which is owned by a Swedish municipality. The objective of the heating company is to raise public awareness by providing transparent and accessible data about the heat energy consumption of individual buildings to its customers. Another example of a new business model in district heating that is leading to a reduction of emissions is the case of the wood-based district heating system installed by *RindiEnergiAB* in Sweden. Other examples of organisational innovations that have the objective of reducing CO₂ emissions are local food communities such as *LokalnePotravineKomunity* and local stores like 'Content', which aim to connect small farmers with local end-use customers or car sharing initiatives like 'Move About' in Scandinavia.

SI organisational priority 5: Promoting easier and more efficient waste management practices and procedures – The fifth-ranked priority of organisational innovations targets more efficient waste management. A first example entails the co-processing of waste, as in the case of cement producer *Holcim* Romania. The residual industrial waste is used to produce thermal energy that is in its turn used again in the process of cement production. Another example that indicates that waste can be turned into a resource is the district cooling innovation in Helsinki. Extra heat produced during a warm season from renewable energy sources such as the sun is used for heating in cooler seasons. Investing in a waste management strategy also targets the

production of energy in the case of *Pilz-Nagl LTD*. The company produces biogas from organic agricultural material. The company started its incineration with the aim of developing ecological methods for mushroom production.

The organisational innovations analysed cover many H2020 priority areas and all four pillars of SC5. Most innovations seem to focus on climate action and resource efficiency, followed by raw materials and the environment. Reducing CO₂ emissions by switching from fossil fuels to alternatives or by turning waste into an alternative resource, and simultaneously engaging consumers, suppliers and employees in companies' effort to implement sustainable strategies or new sustainable business models touches upon all four pillars. Moreover, these strategies and business models aim, in the longer term, to contribute to a reduction in the pressure current societal systems place on natural resources and ecosystems.

As the examples given in the paragraphs above indicate, the majority of the organisational innovations mapped operate in the energy sector. Other sectors covered are the manufacturing, transport, agriculture and retail sectors.

4.8. Key priorities of sustainable *governance* innovations

Of the more than 500 sustainable initiatives in CASIPEDIA, some 46 (8%) are governance innovations. The analysis of 187 objectives from selected SI initiatives produced 700 terms and 33 key terms, which were then clustered into nine SI priorities (see Table 11) of governance innovations, out of which five are presented below and supported with examples of sustainable innovations mapped in CASIPEDIA. In 2015 the European Commission published a Communication regarding the Energy Union package, which set a Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy. The nine key SI priorities match the priorities and objectives underlined in this strategy paper. The paper emphasises, in particular, the role of citizens in the Energy Union and considers their engagement as the core, with citizens taking ownership of the energy transition, benefiting from new technologies to reduce their bills and participating actively in the market, and where vulnerable consumers are protected. This is aligned with the principle of governance innovation, which implies new forms of citizen engagement, new democratic institutions, new public and user participation in service design and delivery, and the use of public boards to govern particular choices.

Table 11: Governance Innovation priorities

KEY GOVERNANCE INNOVATION PRIORITIES	
1.	Enforcing energy saving policies promoting the transition towards a post-carbon society.
2.	Promoting multi-stakeholder engagement in sustainable development actions for the future.
3.	Assessing and mapping business adaptation and innovative responses to climate change.
4.	Engaging citizens in the creation of sustainable municipal strategies and initiatives.
5.	Developing public transport networks and municipality plans promoting sustainable mobility.
6.	Formulating and implementing policies aimed at decreasing CO ₂ emissions.
7.	Supporting innovative ways of assessing and improving the quality of air and life.
8.	Securing resources to establish and support renewable energy and water networks.
9.	Mapping and monitoring reliable data and information on environmental problems and solutions.

SI governance priority 1: Enforcing energy saving policies promoting the transition towards a post-carbon society – The top 10 objectives that constitute this priority underline the importance of finding the most appropriate energy-saving solutions for the reduction of CO₂ emissions by choosing the optimal energy-supply scenario, reasonably priced. Citizens also have a particular focus here and their engagement is crucial in the process. It is also noted that the relevant government authorities should be aligned with delivery policies and instruments that will fully support the above noted transition process. In order to secure sustainability of the objectives, it was found that capacity-building actions are necessary, which would require the engagement of all relevant actors in the chain – from local government associations to network of energy agencies working

with municipalities – and would include raising awareness and the promotion of renewable energy and energy efficiency in order to mitigate climate change and achieve sustainable development objectives, as well as conservation of natural resources for future generations. At the global scale, the best collaborative governance models are found in Scandinavian countries and the Netherlands, followed by China, Turkey and New Zealand. CASIPEDIA provides great examples of such models as well. The *Energybook* from Belgium, for example, is showcasing a co-operative investment system in which parents and people from the neighbourhood invest in making school buildings more energy efficient. The innovative aspect of this initiative is co-creation. Citizens, together with coaches from *Energybook*, local administration, owners of school buildings or other buildings co-create a more sustainable environment.

SI governance priority 2: Promoting multi-stakeholder engagement in sustainable development actions for the future – The plethora of existing multi-stakeholder platforms confirms the need for this type of engagement and suggests that such an approach provides relevant input into the process and helps build a more sustainable future through five focus areas: raising awareness, increasing engagement, empowering stakeholders, coordinating advocacy and strengthening governance. In the case of the multi-stakeholder alliance formed in the city of Tilburg in 2009 under the working title *Klimaatschap*, the aim was to work together on innovations in order to speed up the process and stimulate the local energy projects. The engagement of the network resulted in a so-called Roadmap Tilburg Climate, which noted trends in local energy saving and sustainable energy production with concrete actions for decades to come. These ranged from neighbourhood development aimed at energy saving to large-scale wind power. The *Klimaatschap* played a central role in a local arrangement thanks to which various organisations have signed Green Deals with the support of the municipality of Tilburg. The municipality formed a special unit in order to support the initiative with the goal of stimulating local initiatives by giving companies, civil society organisations and citizens co-responsibility based on commitments to green deals for the sustainable and low-carbon future of Tilburg. In order to secure the sustainability of the actions and building of the foundations for the future, strategic planning is crucial. Moreover, the action plans must be developed based on the realistic resources and careful planning of resources that will be needed in the future (human, financial, sectoral, etc.). Here public consultations can provide relevant input. Such an approach was used in the development of a Local Sustainable Development strategy for Gozo Island in Malta, which envisions that Gozo will become an eco-island by 2020. Eco-Gozo is a declared government objective for the island – one of the seven strategic targets set for the country in the ambitious ‘Vision 2015 for the Maltese Islands’. The aim of the Eco-Gozo vision is to improve economic development and employment and to enhance skills among the local population.

SI governance priority 3: Assessing and mapping business adaptation and innovative responses to climate change – SI Priority 3 assesses and maps businesses adaptation and innovative responses to climate change. Adaptation and mitigation are closely linked; adaptation efforts will be more difficult, costly and less likely to succeed if significant mitigation actions are not taken. Uncertainties about future socioeconomic conditions, as well as future climate changes, can make it difficult to arrive at adaptation decisions now. However, the pace and magnitude of projected changes emphasise the need to be prepared for a wide range and intensity of climate impacts in the future. It is important to develop, refine, and deploy tools and approaches that enable iterative decision-making and increase the flexibility and robustness of climate change responses. The *Armhoede* sustainable energy landscape (ADEL) project in the Netherlands led with the question of the possibilities for the generation of renewable energy in a rural area where sustainability, landscape development, a thriving agriculture and a good quality of life could go hand in hand. The ADEL interest group was investigating how, with today’s knowledge, the area can (as far as possible) become climate neutral in 2030. Using a baseline measurement, a number of themes were defined (design of the landscape, energy, water and agricultural enterprises). These theme groups of residents and businesses have formulated measures with the help of experts. The municipality had trust in the competences of the interest group and gave them great freedom. Social cohesion in the area played a positive role, as did the support they got from independent (process) consultants.

SI governance priority 4: Engaging citizens in the creation of sustainable municipal strategies and initiatives – The SI Priority 4 addresses the issue of engaging citizens in the creation of sustainable municipal strategies and initiatives or, more generally, ensuring citizens’ participation in decisions related to municipal investments, so that these represent a correspondence between the real needs and aspirations of the population. Partnerships help make the municipal development process more transparent and accountable, thereby increasing the likelihood that the municipal development strategy will deliver the expected results and contribute to

the improved quality of citizens' life. *Step2Save* is an innovative programme in the Netherlands in which municipalities, housing corporations and the energy company *Nuon* joined forces. Amsterdam municipality's environmental policy plan had the idea to give up to 3000 poor inhabitants free energy advice. It then became apparent that *Nuon* had similar plans and in addition was already pursuing a project in which it gave young unemployed people job training. Therefore, it was decided to run the project together and also to extend it to 10,000 households. After the pilot in Amsterdam other municipalities started their own projects together with *Nuon* and their own housing co-operatives. *Innovation Fur* is a development project launched by the island of Fur, Skive municipality, and *EnergiMidt* in Denmark. It represents a new means of regional development where the municipal authorities engage with citizens and energy companies in a 'Living Lab' model. The objective of the project is to transform Fur into a miniature model of the sustainable society of the future, where modern technology is utilised to achieve a green profile.

SI governance priority 5: Developing public transport networks and municipality plans promoting sustainable mobility – The SI Priority 5 addresses the issue of developing public transport networks and municipality plans promoting sustainable mobility. European local authorities face increasing problems of congestion and pollution thanks to the continuous growth of urban motorised traffic. As a result of bad environmental conditions and traffic volumes, European citizens are reallocating to the suburbs. Apart from making an impact on citizens, transport is also a challenge in terms of climate protection, as it is the largest single contributor to greenhouse gas emissions. Therefore, sustainable mobility patterns call for consolidated strategies by local policy-makers around measures and specific examples that can pave the way to sustainable mobility policies. Priority must be given to more sustainable modes of transport, which must become more efficient, innovative, attractive and energy- and environmentally friendly. A good example of successful cooperation among local authorities with the joint aim of confronting the current transport challenges for the benefit of citizens and the environment is showcased in CASIPEDIA and relates to the Lund municipality in Sweden. At the end of the 1990s Lund politicians agreed upon the *LundaMaTs* strategy, which has now been used for over a decade across the entire administration in order to achieve economic and social sustainability, while monitoring any negative effects on the environment. The strategy, which aims to have a sustainable transportation system in Lund municipality by 2030, has been in place since 1999 and is constantly updated and improved to address the main challenges of the transport system. *LundaMaTs* structured its work around six focus areas, comprising village development, living city centre, commercial transport, regional commuting, growing Lund and innovative Lund.

4.9. Key priorities of sustainable system innovations

While the analysis of 142 objectives from selected SI initiatives produced 791 terms and 23 key terms, we clustered them into seven SI priorities (see Table 12) of system innovations, the top five of which are further described in this section.

Table 12: System Innovation priorities

KEY SYSTEM INNOVATION PRIORITIES	
1.	Implementing more systemic and efficient solutions in the production of renewable energy.
2.	Developing sustainable platforms and policies to protect natural resources in urban and rural areas.
3.	Reinforcing services and practices that reduce the negative environmental impacts of food waste.
4.	Introducing standard criteria and practices to assess and improve the quality of life, water and air.
5.	Protecting the populations and habitats of endangered species from anthropogenic and other influences.
6.	Ending the negative impact of animal agriculture and the food industry (e.g. emissions, water use).
7.	Developing integrated applications, systems and content-promoting resource efficiency.

SI system priority 1: Implementing more systemic and efficient solutions in the production of renewable energy – The most important priority of the system SI initiatives focuses on the development of solutions to support the production of renewable energy. Examples include an environmentally friendly façade

ventilation system with integrated air conditioning of buildings, utilising solar energy; an interactive energy city map that brings together data on energy saving, consumption and opportunities for possible energy sources in the city, per neighbourhood, area and even street; an ex-industrial site in the heart of the city that wishes to become an eco-district; and creation of an integrated system for the collection and processing of milk. The literature review conducted by Negro et.al (2012) strongly confirms that more systemic approaches are required for the faster development and diffusion of renewable energy technology; thus innovative solutions supporting this are in demand.

SI system priority 2: Developing sustainable platforms and policies to protect natural resources in urban and rural areas – The importance of platforms for the protection of natural resources is emphasised by a number of relevant EU initiatives; the EU Business @Biodiversity Platform – a forum for sustained and strategic dialogue at the EU level – is one example among others. Supporting examples from the CASI mapping database include: (1) partnerships among not-for-profit housing associations, local councils, charities and expert consultants for the development of a sustainable new community with a significant number of zero carbon houses and associated facilities, e.g. infrastructure; (2) a cluster bringing together players from industry, research and public administration to boost technological development and innovation in the construction sector and to enhance systemic innovation at policy and legislation levels; (3) a network of cities and municipalities actively supporting sustainable development; (4) a network that establishes, monitors and manages five plant micro-reserves; (5) an effective way of combining forestry policy with R&D strategy and education; (6) combination of systems to improve the next generation of offshore platforms, which can be used for multiple purposes, including energy extraction, aquaculture and platform-related transport.

SI system priority 3: Reinforcing services and practices that reduce the negative environmental impacts of food waste – This is the third most important priority of the mapped System SI, which most commonly refers to designing ways of reducing food waste at every stage of the food chain and includes electronic systems for the exchange of data and information, and monitoring the international transfer of waste, among other solutions. Not surprisingly, food waste prevention is an important part of the new circular economy package of the EU, which promotes the establishment of a multi-stakeholder platform dedicated to the avoidance of food waste. The outcomes of the FP7 project EU FUSIONS (EU FUSIONS, 2016) suggest that a coordinated policy response, including policies regarding waste, food safety and food information, but also ‘aspects of economic, research and innovation, environment, agriculture, education and social policy’, should be embraced by food waste SI. As in the focus of this priority, it is crucial to continuously support and reinforce such initiatives (services and practices) in order to reduce the damaging impact of food waste.

SI system priority 4: Introducing standard criteria and practices to assess and improve the quality of life, water and air – The quality of water and of air has major influences on quality of life. For example, air pollution poses the single largest environmental health risk in Europe today (European Environmental Agency, 2015). Hence, the strong need to introduce standard criteria and practices to improve the quality of air and water is evident. The priority is supported by examples of SI initiatives from CASIPEDIA, which focus mainly on developing energy-efficiency strategies in low-income housing; monitoring, modelling and management of particulate matters; innovative methods and tools for the preservation of the good ecological status of water bodies; and raising public awareness of the subject.

SI system priority 5: Protecting the populations and habitats of endangered species from anthropogenic and other influences – The importance of this priority is specifically reflected in the EU Habitats Directive (European Commission, 2016), which aims to ensure the conservation of a wide range of animal and plant species. Examples found in the System SI are: (1) a methodology for the long-term monitoring of new micro-habitats for selected endangered species; (2) improvement of the conservation status of selected fauna species and their habitats; and (3) a control system to maintain biodiversity.

The top 10 SI system-related priority areas that match those of H2020 priorities tend to focus most on resource efficiency, including eco-innovation and green economy transition, resource-efficient sustainable lifestyle, followed by systems aimed at supporting climate actions, for example, climate change mitigation solutions, and eco-solutions to reduce the use of raw materials and promote a raw materials-conscious sustainable lifestyle. Most system-related SI are linked to the energy sector (32%), which reflects the need for growing efforts to produce more systemic and efficient solutions in the

renewable energy sector. The construction (26%) and ICT (26%) sectors are also important areas of system-related SI, followed by the agriculture sector (23%).

4.10. Key priorities of sustainable *marketing* innovations

From the more than 500 sustainable innovations in CASIPEDIA, only 19 (3.5%) are marketing innovations. This result is not surprising, as the selection of SI cases avoided initiatives that only included changes in communication strategy. Rather it considered those projects with changes in product and service design, development, packaging, dissemination or pricing, as marketing innovations, than approaching the marketing concept to that of a business model.

From an analysis of the set of marketing innovations, we derived 59 objectives that were further delineated into 267 terms and 19 key terms. Next the terms and key terms were clustered into five SI priorities (see Table 13), which are presented below and supported with examples of sustainable innovations mapped in CASIPEDIA.

Table 13: Marketing Innovation priorities

KEY MARKETING INNOVATION PRIORITIES	
1.	Promoting organic food products and healthy lifestyles.
2.	Increasing consumer awareness of sustainable shopping practices.
3.	Developing eco-labels and applications for sustainable businesses (e.g. mapping location, services).
4.	Sharing information on sustainable communities, lifestyles and initiatives (e.g. helping refugees).
5.	Reducing the waste stream to landfills to a minimum by certifying sustainable packaging and recycling.

SI marketing priority 1: Promoting organic food products and healthy lifestyles – Marketing innovations are mainly aimed at promoting organic food products and connected healthy lifestyles. In particular, several cases of SI in the agri-food cluster are characterised by the development of new forms of marketing strategies and tools aimed at raising awareness among consumers and producers of the consumption and production of organic products. A small private company in Poland, for example, has developed a new way of marketing eco-food, inventing *the Cud Miod Box*, a subscription box containing organic food products (delivered once a month), where the contents of the box are kept secret from subscribers. There are also initiatives targeted at businesses to promote and facilitate the production of organic food. Two particularly interesting examples were mapped in CASIPEDIA. *Friendly Food* is a project where a social enterprise works together with gastronomic businesses and helps them to create menu plans featuring less meat and a larger variety of vegetarian meals. Another example is the *Green Idea*, through which the Croatian Association of Communications Agency facilitates the market access of small organic food producers by informing and training small businesses about new and innovative marketing methods for promoting their products.

SI marketing priority 2: Increasing consumer awareness of sustainable shopping practices – Increasing the awareness of individuals – consumers and citizens – of sustainable shopping practices and behaviour is another important priority of marketing innovations. This does not seem to be just a public or social concern, as private companies are also proving sensitive to the issue. *Green Office*, for example, a provider of office products, certifies its ‘green products’ and informs its clients whether and to what extent these products have been manufactured from recycled materials, whether they are biodegradable, fair-trade, etc. It offers consulting services to its clients on how to decrease their environmental impact/footprint. Those most engaged in the development of projects designed to change attitudes and the behaviour of consumers to more sustainable ones, however, are mainly public and non-profit organisations. *Pedibus* is an initiative of an Austrian local authority, offering primary school students the opportunity to walk to school in guided groups, instead of using cars, which has dramatically reduced school traffic. In the same country, a non-state actor has launched a campaign called *RadeltzurArbeit* (Bike to work), which aims to motivate workers to take their bikes to go to work and to increase the bicycle traffic in Austria. Those who are interested can register through

a website and create or be part of a team that collectively tries to reach the goal of going to work by bike for at least half their working days.

SI marketing priority 3: Developing eco-labels and applications for sustainable businesses (e.g. mapping location services) – In recent years initiatives in the field of social responsibility oriented towards the development of models, certification and guidelines used by companies to enhance their reputation among their stakeholders have been on the rise. Many examples of marketing innovations exist, most of which aim to develop eco-labels and applications for sustainable business in different sectors. In the tourism sector, the *Green Certificate* is an environmental quality eco-label certifying operators engaged in eco-activities and strategies (e.g. protecting nature and landscape, using water and energy resources rationally, offering environmentally friendly tourist activities, etc.). *ECOverified* is another eco-label, established by a research institution, to certify products and services, which provide a complete ecological package in the tourism industry. If these initiatives have an important role in turning companies' choices towards greater social responsibility, environment-awareness and ethics, then innovative marketing strategies and tools are also needed to help businesses in increasing the economic return of social responsibility actions. An interesting innovation in this field is the *Green Earn Loyalty Card* – a strategic alliance supporting the marketing strategies of socially responsible companies by helping its partners (mainly businesses) to promote and communicate their social and environmental programmes innovatively (e.g. mobile applications).

SI marketing priority 4: Sharing information on sustainable communities, lifestyles and initiatives (e.g. helping refugees) – There are marketing innovations that not only try to increase consumer awareness of sustainable products but also to provide them with relevant and extensive information on how and where they can apply conscious sustainable consumption. *Buy Aware* is an example of a web portal for sustainable consumption in Austria. With information on over 200 labels, 62 shopping guides and over 2000 sustainable products, the platform provides consumers with information about current sustainability topics, projects and innovations, and offers comprehensive information to support consumers in making sustainable decisions when shopping. A similar project has been developed in Poland (by Poznan 2.0), creating a 'local community' that provides marketing, promotion and rebranding services for local shops, cafes, bars and restaurants at city level. The internet and the virtual space are not the only means of developing sustainable communities and sharing information about sustainable food consumption. In Poland, *Breakfast Market* is a market organised in public spaces, where people can eat, buy organic foods and products, as well as take part in thematic workshops to learn more about organic food. This is an example of using an ancient tool in a new way that favours people's access to healthy food and facilitates learning about sustainable lifestyles.

SI marketing priority 5: Reducing the waste stream to landfills to a minimum by certifying sustainable packaging and recycling – Very frequent, and also quite similar in terms of aims and processes, are marketing innovations that involve changes in the packaging of their products, while reducing the overall waste and the negative impact of their activities. These initiatives are obviously common among companies in the agri-food cluster, but their presence is also extending to other trade sectors. One important innovation is that of Carlsberg, which has launched the Carlsberg Group's work on *Sustainable Packaging*, where the multinational company and its selected global suppliers have joined forces to rethink the design and production of packaging material. The particular focus was to develop the next generation of packaging products, optimised for recycling and re-use, while at the same time retaining or improving their quality and value. Other large companies in the beverage industry have introduced innovations to reduce the environmental impact of their packaging. As part of a global initiative, Coca-Cola in Romania has changed the design of its plastic water holders, introducing the new *PlantBottleTM*, which contains 30% plants in its composition and is 100% recyclable. The operators and distributors of the retail sector are heading in the same direction. In Belgium, for example, a waste-free, local cooperative grocery store has been created, where people can find a variety of products for daily needs, such as vegetables, fruits, bread, drinks and cereals, without any kind of plastic packaging. Marketing innovations for more sustainable packaging are finally diffusing across other industries. *Madara Cosmetics* encourages its customers to return empty and/or expired Madara-brand product packaging to its shops, giving a small discount on the next product purchase and recycling the returned packaging.

The marketing innovations analysed cover various H2020 priority areas, focusing mainly on resource efficiency and climate action, followed by changes in product and service design, development, packaging, dissemination or pricing, all with the intention of supporting raw materials-related targets associated with both the UN and EU sustainability agendas. The majority (42%) of marketing innovations are linked to the

manufacturing sector, followed by innovations in the retail (32%), agriculture (26%), accommodation and food (26%) and Health/Social services (21%) sectors.

4.11. Research and innovation policy agendas for SI

The individual analysis of the seven types of innovation discussed above shows that there are multiple sources for innovation (e.g. product, service, governance) across different actors and levels of management (strategic, tactical and operational). Systematic assessment of these innovations, by type, was useful to enhance understanding of the rationales and objectives behind each type and explore their roles in formulating wider sustainability agendas. The common patterns that emerged from interconnecting the findings on SI priorities of the more than 500 SI case studies led to the identification of 76 priority areas, which were clustered to reveal 10 emerging R&I Policy Agendas. A brief description of the process is presented in Chapter 8. Thirty-five of 76 priorities (i.e. the top five for each type of innovation) were discussed in more detail. While the 35 objectives were analysed here in isolation, per type of innovation, the cross-cutting objectives are considered in Chapter 8: 'On R&I policy priorities for climate action, environment, resource efficiency and raw materials'.

While a more detailed account of the 10 R&I Agendas is provided in Popper *et al.* (2016) and reproduced in Chapter 8, it is worth noting the distribution of the 35 priorities within those agendas. The number of priorities that fall within each of the 10 agendas are:

- 5 in Agenda 1: *Strengthening eco-community empathy and crowd-funded development.*
- 2 in Agenda 2: *Developing sustainable urban and rural infrastructures for the bioeconomy.*
- 5 in Agenda 3: *Deploying responsible environmental and resource-efficiency strategies.*
- 4 in Agenda 4: *Creating sustainable bio-fuel and renewable energy solutions.*
- 4 in Agenda 5: *Promoting foresight for sustainability governance and intelligence.*
- 6 in Agenda 6: *Advancing recycling and circular use of waste and raw materials.*
- 2 in Agenda 7: *Embedding sustainability in cultural and holistic education models.*
- 2 in Agenda 8: *Fostering eco-local-agriculture and bio-resources efficiency.*
- 3 in Agenda 9: *Implementing sustainable transport and smart mobility innovations.*
- 2 in Agenda 10: *Dealing with climate issues and managing greenhouse gas emissions.*

While a more even distribution would have been achieved taking into consideration all 76 priorities, it is interesting to see how the 35 priorities, comprised of the five priorities of highest significance for each type of innovation, relate to CASI R&I Policy Agendas. Six of 35 priorities are focused on Agenda 6: *Advancing recycling and circular use of waste and raw materials*, followed by five priorities each in Agenda 1: *Strengthening eco-community empathy and crowd-driven development* and Agenda 3: *Deploying responsible environmental and water management strategies*. These represent the areas of major focus and highest concern among SI innovators, with potential implications for research and policy-making.

These findings also confirm that wider R&I agendas are shaped by the complementarities of different types of SI rather than their individual characteristics. The objectives are cross-cutting to better respond to complex societal challenges that different types of innovations try to address. Furthermore, social innovation can, for example, simultaneously be a product, process or organisational model, while organisational/governance innovations can help further position and diffuse product/service innovation. This was considered by the CASI project during the nomination phase of the SI mapping activities, assessing SI initiatives based on the leading and supporting type of innovation, thus allowing the identification of cross-cutting themes/agendas relevant across the multiple objectives and goals of different types of innovations. The findings and the importance of CASI R&I Policy Agendas can be further validated through their linkages to Horizon 2020 priorities listed in section 8.3 of Chapter 8, and to the policy issues described in Chapter 5 and the research priorities that emerged from citizen visions through a citizens-experts-citizens (CEC) process, which are discussed in section 8.5 of Chapter 8.

While Agenda 1, 3 and 6 were among the most highly ranked in terms of their alignments with SI priorities distilled from SI innovators' objectives, they are only to some extent aligned and reflected in visions, H2020 priorities and policy issues identified by the CASI project, as presented in Table 14. Agenda 1 is strongly aligned with CEC-based research priorities (15 out of 27), with two climate action and three resource-efficiency-related priorities of H2020 and with three (out of 11) policy briefs. Agenda 3 aligns with 11 out of 22 H2020 priorities, evenly distributed among the four main pillars, with reference to four CEC-based priorities and four policy briefs. Finally, the cross-cutting priorities of Agenda 6 can be found in eight out of 22 H2020 priorities (four of which are focused on raw materials) and four policy briefs, while reference to CEC priorities is limited to three out of 27.

Table 14: CASI R&I Policy Agendas

CASI 4-Helix-based R&I Policy Agendas for SI		H2020 priorities			CEC Process	Policy Briefs
1	Strengthening eco-community empathy and crowd-funded development	2 CA	3 RE	5	15	3
		0 RM	0 EN			
2	Developing sustainable urban and rural infrastructures for the bioeconomy	3 CA	2 RE	5	13	4
		0 RM	0 EN			
3	Deploying responsible environmental and resource-efficiency strategies	3 CA	3 RE	11	4	4
		3 RM	2 EN			
4	Creating sustainable bio-fuel and renewable energy solutions	1 CA	2 RE	9	5	5
		6 RM	1 EN			
5	Promoting foresight for sustainability governance and intelligence	5 CA	1 RE	12	4	7
		2 RM	4 EN			
6	Advancing recycling and circular use of waste and raw materials	2 CA	2 RE	8	3	4
		4 RM	0 EN			
7	Embedding sustainability in cultural and holistic education models	3 CA	1 RE	6	4	4
		1 RM	1 EN			
8	Fostering eco-local-agriculture and bio-resources efficiency	2 CA	2 RE	5	5	4
		0 RM	1 EN			
9	Implementing sustainable transport and smart mobility innovations	2 CA	2 RE	4	3	5
		0 RM	0 EN			
10	Dealing with climate issues and managing greenhouse gas emissions	4 CA	0 RE	4	2	2
		0 RM	0 EN			
Total		39% CA	26% RE	22	27	11
		23% RM	13% EN			

Note: H2020 related priority areas are indicated as follow: Climate Action (CA); Resource Efficiency (RE); Raw Materials (RM) and Environment (EN).

The mapping of R&I Policy Agendas against H2020 priorities, CEC process and policy briefs, presented in Table 14, demonstrates the linkages between the 10 R&I Policy Agendas, that stem from the study of innovators' long-term aspirations and objectives, mapped against H2020 priorities related to the four pillars of SC5 and CASI project's foci (i.e. climate action, environment, resource efficiency and raw materials), from 27 research priorities developed in CASI through the CEC process, and from 11 EU-level policy briefs produced by the CASI team so far. The results clearly suggest the importance of public engagement in the establishment of the top two priorities, both of which have been less emphasised in policy-relevant priorities. Furthermore, CEC-based priorities are strongly reflected in CASI 4-Helix-based

R&I Policy Agendas. This shows that the innovators are working hard to meet the aspirations of citizens and targeting the needs of society. With regard to H2020 priorities, these are most strongly reflected in Agenda 3, Agenda 4: *Creating sustainable bio-fuel and renewable energy solutions* and Agenda 5: *Promoting foresight for sustainability governance and intelligence*, thus also targeting relevant ambitions of the EC and confirming the relevance and importance of the H2020 priorities in sustainability-oriented innovations.

4.12. Conclusions and recommendations

The transition to a sustainable, innovation-oriented society is required in order to successfully meet societal challenges, including those of SC5. Improved understanding of the complex and cross-cutting nature of the different types of SI can facilitate the transition by supporting relevant decision-making processes. Mapping activities that unfold the complex reality and elements of an innovation ecosystem, including those of SI practices, outcomes and players, should be maintained in order to provide a stream of genuine insights that policy-makers, businesses and communities can use to enhance their understanding and to be able to better assess and manage sustainable innovations. This is particularly valuable in identifying priorities that can support the shaping and formulation of wider sustainability agendas and reveal other policy-relevant themes emerging from ongoing developments in the SI field.

Although clear similarities and differences between the seven types of innovations, as well as their objectives and priorities, can be distinguished, these should be observed as complementarities that can further promote sustainability and innovation, and more effectively address contemporary societal challenges. The exploration of the priorities and agendas driven by the analysis of different types of sustainable innovations revealed that all seven types of SI work complementarily to address all four pillars of SC5, with slightly more weight on the challenges of climate action and resource efficiency.

The assessment of the short-, medium- and long-term objectives of the quadruple helix of SI stakeholders provided useful insights into the different, and often interconnected, types of sustainable innovation, which through collective analysis can play a significant role in the identification and development of wider R&I policy agendas with specific sustainability targets. The agendas can be used to reveal the extent to which innovators' objectives and undertakings align with those of researchers and policy makers, as well as society at large, in order to better coordinate actions aimed at addressing societal challenges.

Furthermore, R&I priorities, which strongly support and shape wider policy agendas, but also align with citizens' visions, policy issues and H2020 priorities, should continue to receive attention and support from policy-makers and research actors, which would be best facilitated by launching collaborative calls for projects in these areas. Multi-stakeholder mobilisation, mutual learning and engagement, as promoted by CASI-F (see Chapter 3), is crucial to ensure sound responses to innovators' goals and objectives and to offer solutions to critical issues that can potentially affect their innovation. Thus the existing successful models highlighted in some of the above-mentioned examples of sustainable innovations could be used as case studies for promoting such an approach at the European level and, moreover, as an input for creating future European policies.

As a complement to the above-mentioned insights, the following should be highlighted as practical suggestions for enhancing future SI policy actions:

1. *SI policy formulation should analyse and make sense of the drivers of change affecting each type of SI stakeholder.* Recognise the importance of the analysis and sense-making of the innovator-led drivers of change, bearing in mind that an 'innovator' can take various forms, i.e. government, business, civil society or research and education stakeholders.
2. *A broad conception of innovation is necessary in SI projects analysis.* Promote projects that develop the mapping of different types of innovation (e.g. product, service, social, organisational, system, governance, marketing) rather than focusing only on the conventional ones (product and service), and identify common priorities and R&I policy agendas related to the different types of innovations.
3. *SI policy action needs to support/foster analysis of early stages of sustainable innovation.* Promote exercises that carry out systematic mapping and analysis of sustainable innovation initiatives that are at the design/conceptual and prototype/piloting/demonstration stages of the innovation cycle.

This may be done in addition to the mapping of cases that are already at the implementation and diffusion stage.

While this chapter has focused on the assessment of sustainable innovations (Track 1 of CASI-F) with the mobilisation and engagement of innovators, representing all the quadruple helix of SI stakeholders (business, government, civil society and research/education actors), Chapter 6 discusses the assessment of sustainable visions/aspirations (Track 3 of CASI-F) with the participation of citizens and experts, also known as the citizens-experts-citizens (CEC) engagement process.

References

- CASIPEDIA (2017) State-of-the-art of Sustainable Innovation Database. [Online]. CASI Work Package 2 led by the University of Manchester, CASI project. <http://www.casi2020.eu/casipedia/>.
- European Commission (2015) 'A Framework Strategy for a Resilient Energy Union with a Forward-looking Climate Change Policy', COM(2015) 80 final.
- European Commission. Internet portal dedicated to Energy. <https://ec.europa.eu/energy/en/topics/energy-efficiency>.
- European Commission. Internet portal dedicated to Mobility and Transport in Europe. http://ec.europa.eu/dgs/transport/index_en.htm.
- European Commission (2016) 'The Habitats Directive'. http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm.
- European Environmental Agency (2015) 'Air Quality in Europe – 2015 Report'. No. 5/2015. <http://www.eea.europa.eu/publications/air-quality-in-europe-2015/download>.
- EU FUSIONS (2016) <http://www.eu-fusions.org/index.php>.
- Negro, S.O., Alkemade, F., Hekkert, M. (2012) Why does renewable energy diffuse so slowly? A review of innovation system problems'. *Renewable and Sustainable Energy Reviews* 16 (6), pp. 3836–3846. doi:10.1016/j.rser.2012.03.043.
- OECD (2005) *Guidelines for Collecting and Interpreting Innovation Data*. Oslo Manual 3rd Edition. Paris: Organisation for Economic Co-operation and Development.
- Omer, A.M. (2015) Renewable Energy Technologies, Sustainable Development, and Environment, in Thomas, K.D., (ed) *Handbook of Research on Sustainable Development and Economics*. Hershey, PA: Business Science Reference.
- Popper, R., Amanatidou, E. and Teichler, T. (2012) 'Reach and Impact of FLA Mapping: Towards a Fully-Fledged Futures Mapping Environment', in Giessecke, S., Gießen, A. and Elkins, S. (eds) *The role of forward-looking activities for the governance of Grand Challenges: Insights from the European Foresight Platform*, Final publication of the European Foresight Platform project. Vienna: Austria Institute of Technology.
- Popper, R., Velasco, G., Bleda, M., Amanatidou, E., Ravetz, J., Damianova, Z., Kozarev, V., Chonkova B., Tsin, S., Avarello, A., Martin, L. and Morris, D. (2016) Sustainable Innovation Conceptual Framework. CASI project report. Deliverable 2.2.
- Popper, R., Velasco, G. and Ravetz, J. (2016) State-of-the-art of Sustainable Innovation: Climate action, environment, resource efficiency and raw materials. CASI project report. Deliverable 2.1. <http://www.casi2020.eu/library/#d8838>.
- Popper, R., Velasco G. and Popper M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.
- Reisch, L., Eberle, U. and Lorek, S. (2013) Sustainable food consumption: an overview of contemporary issues and policies. *Sustainability: Science, Practice & Policy* 9 (2), pp. 1–19.

5. Sustainable innovation policy advice using a policy watch approach to ‘policies’ mapping

Petteri Repo, University of Helsinki

Kaisa Matschoss, University of Helsinki

Anita Tregner-Mlinaric, Meta Group

Sarah Van Eynde, Katholieke Universiteit Leuven

Monique Ramioul, Katholieke Universiteit Leuven

Zoya Damianova, ARC Fund

Ventseslav Kozarev, ARC Fund

5.1. Abstract

This chapter illustrates via a piloted application how one of the five steps of the CASI Framework (CASI-F), which is designed for the management and assessment of sustainable innovation, can be applied to monitor policy developments. To this end, we reviewed 96 policy recommendations from CASI policy briefs concerning the Europe 2020 strategy, with a special focus on resource efficiency. The results show that CASI-F can provide a useful additional tool for analysing and reflecting on the outcomes of a policy watch. In particular, CASI-F provides opportunities to review how policy recommendations relate to policy levels and types of stakeholder.

5.2. Introduction

Policies concerning sustainable innovation that consider public participation are developing at different paces and with varying targets in European countries. The CASI project has developed an extensive procedure – the CASI Policy Watch – to follow up on policy developments across a large number of European countries. Key policy developments are first identified at the European level and then linked to corresponding developments at the national level. At the time of writing, the project has published over 100 policy briefs on sustainable innovation and public participation, with themes ranging from smart cities to energy poverty, public procurement to crowd-funding, and eco-innovation to sustainable lifestyles. These briefs form a valuable information base, against which sustainable innovation initiatives and public participation can be reviewed and promoted. They contribute to a policy dialogue between the European Commission and the Member States of the European Union.

Alongside this, the CASI project has developed a framework for the assessment and management of sustainable innovation – CASI-F (see Chapter 3 and Popper *et al.*, 2017). This chapter reviews whether, and how, CASI-F can assist in policy watch activities. CASI-F holds the potential to make policy watch more efficient and standardised, which facilitates the undertaking of similar activities with a larger scope in the future. For the CASI project and beyond, it also provides additional insights on how sustainable innovation and public participation are approached in policy.

The chapter describes a piloted application of CASI-F in an analysis of policy developments using data from a set of policy briefs that reviewed the European Union’s Europe 2020 strategy from the perspective of resource efficiency (see Annexe 3 for a full list of references to the policy briefs of the 23 countries). These policy briefs revealed that the differences in Europe-wide responses to CO₂ emission reduction could be explained by maturity of policy context, that energy security was interlinked to a variety of parallel policy targets, and that market-related policy instruments were frequent when addressing resource intensity. Public participation, in turn, emerged differently in the three policy domains.

The piloting data consists of policy recommendations for 23 European countries, which are re-analysed using the CASI-F approach. These recommendations have been analytically developed by CASI partners and country correspondents for their respective countries and are based on comparative analyses of national, transnational and European policy developments. The recommendations address policy makers at the national level, and a comparison of the recommendations provides a glimpse at how the policy

topic could progress in the near future. The character of the chapter is explorative and analytical, and it aims to identify the added value of applying the framework and to reveal new opportunities in its application.

The subsequent sections of this chapter discuss how CASI-F can be applied to policy watch. Results from the established CASI Policy Watch process are presented as a foundation against which a comparative analysis of policy recommendations is performed. The added value of applying CASI-F to policy watch activities is further discussed in the concluding sections of the chapter.

5.3. Approach and objectives

The Member States of the European Union are facing a series of challenges, which require comprehensive long-term strategy tools for sustainable transition as a solution to low growth, insufficient innovation and environmental and social challenges. The Europe 2020 strategy recognises these challenges and provides the Horizon 2020 programme a pivotal role when addressing them. Particular emphasis is placed on evidence-based policy, programme evaluation and the monitoring of activities.

Despite awareness and a common understanding of major societal challenges and the profound effects they have on EU countries, weak and uncoordinated responses at regional and national levels result in missed opportunities, untimely responses and limitations in desired actions. The CASI Policy Watch addresses the above-noted shortcomings by spurring new policy debates on issues integral to Societal Challenge 5 (SC5, on climate action, environment, resource efficiency and raw materials) and by building awareness among a wide group of stakeholders with an outreach to all European Member States. Moreover, interlinkages with CASI-F enable CASI Policy Watch to provide timely and relevant input into European sustainable innovation policy agenda-setting and to identify the groups of relevant actors that should be engaged in the process. Piloting CASI-F also provides an opportunity to consider utilisation of its concept for diverse kinds of evidence-based policy analysis.

‘Policy watch’, or more specifically the procedure of following up on policy developments across a number of countries, has its academic tradition in comparative politics. Comparative politics provides the comparative methodology (vs. experimental and statistical methodology), which includes the idea of reviewing a limited number of comparable cases, i.e. similar policies (see Lijphart, 1971; Wiarda and Skelley, 2007). Identifying and comparing key policies in the Member States of the European Union provides insights into how far, and in which ways, Europe is progressing policy-wise in order to meet SC5.

This chapter explores whether applying CASI-F to policy watch activities can provide added analytical value. A number of CASI-F features are of generic and content-independent nature for SI assessment and management. A detailed description of CASI-F is presented in Chapter 3 of this report. Other features of CASI-F are more apt to provide new policy insights. One relates to the balanced structure of potential actions according to policy level (strategic, tactical or operational) and stakeholder types (government, business, civil society, research and education). The Policy Watch provides a solid set of actionable data (i.e. policy recommendations), which can be structured in accordance with CASI-F. This structured and action-oriented feature of CASI-F is explored here as it may provide added value to policy analysis, and there is appropriate data for carrying out a pilot of it. In essence, policy recommendations relating to the Europe 2020 strategy in general, and to resource efficiency in particular, are analysed by using the CASI-F approach.

Another feature of CASI-F, which could also provide new policy insights but currently lacks data for piloting, relates to creating action roadmaps for key actions. In the policy context, this would encompass converting specific policy recommendations into an implementation strategy. As the CASI Policy Watch has not developed such implementation strategies, nor actively reviewed ‘best policy practices’, this particular feature of CASI-F is not discussed here. Nevertheless, this feature should be seen as an additional opportunity in future policy watch endeavours.

It should be noted that the policy recommendations examined are not descriptions of policy developments, but instead represent CASI project partners’ and country correspondents’ assessments of how to foster, improve or challenge existing policies. Accordingly, they represent responses to key observations in the policy field rather than attempting to present a thorough description of all activities in that field. The

recommendations are prescriptive or normative by character rather than descriptive or interpretive. Corresponding to the aims of CASI-F, the outcome of this pilot targets the assessment and management of sustainable innovation policies and public participation in them.

Another issue to consider when applying CASI-F for policy watch is that the framework has been designed for innovation activities. While innovation activities normally do not proceed in a straightforward manner, the innovation process can nevertheless be considered to include stages that relate to research and development, manufacturing and marketing (Trott, 2008; Merrill, 2015). The innovator, whether an individual or organisation, 'owns' the innovation and then attempts to promote it. In contrast, public policy processes or cycles comprising agenda-setting, policy formulation, implementation and evaluation (Hill, 2014; Berry and Berry, 1999) may resemble a chain-linked innovation process (Kline and Rosenberg, 1986). In terms of agenda-setting and policy formulation, the idea of political pluralism (Dahl, 1978) highlights the need to consider varying and even conflicting interests. Liberal corporatism (Siaroff, 1999), in turn, acknowledges that some interests may be better served by states, but even then acknowledges a competition between interests. Accordingly, public policy processes, which are at the stages of implementation or evaluation, may indeed resemble sustainable innovations at agenda-setting and formulation stages, and correspondingly make it meaningful to use CASI-F for policy analysis.

5.4. European policies on CO₂ emissions, energy security and resource intensity

The national-level Policy Watch process considered the European Union's Europe 2020 strategy from the perspective of resource efficiency in 23 Member States. Slow growth in the European economies was identified as forming a background against which to consider sustainable innovation and public participation in it. It was noted that challenges relating to CO₂ emission reductions, energy security and resource intensity had been responded to quite differently in the European countries studied.

Varying developments in CO₂ policies were explained at strategic, tactical and operational levels. It was recognised that in many European countries policies concerning CO₂ emissions were being discussed at the strategy level. Several countries were seen to have progressed to programme activities, such as the establishment of funding arrangements and incentives. Operational activities were identified especially in the transport sector. Public participation was considered lacking at all three levels. By contrast, energy security was interlinked with established energy policy targets such as energy efficiency, resource intensity and clean energy production. It was recognised that public participation in energy security issues usually takes place through a representative democratic procedure, which is connected to public acceptance or lack thereof. Policies have reached established operational activities in terms of energy terminals and reserves providing diversification of fuel sources. Resource intensity policies were seen to be directed towards business. Recognised cases included market-based policy instruments such as joint purchases and offerings. Other sectors of interest included waste management, and energy and building efficiency. Public participation then emerged as consumer and citizen activities.

The next section pilots CASI-F with policy recommendations from the 23 Member States. The policy recommendations are first placed in the CASI-F and the outcomes of this placement then discussed. The key objective of this procedure is to review whether CASI-F can reveal new thematic and sectoral observations and, accordingly, added value to the established policy watch process.

5.5. The CASI Framework applied to policies of multi-level/actor relevance

This section discusses the pilot of CASI-F with the recommendations from CASI national-level policy briefs that reviewed the European Union's Europe 2020 strategy from the perspective of resource efficiency. The recommendations were formulated by project partners and country correspondents in 23 European countries, and are based on their professional expertise and assessment. The recommendations addressed policies at strategic, tactical and operational levels, which also form the basic and balanced structure of CASI-F. This section follows the same structure.

The full policy recommendations were first placed in the CASI-F tables by authors at the University of Helsinki; then other authors of this chapter reviewed the placing of the recommendations concerning their validity and, when necessary, suggested changes. The tables in this section summarise the

recommendations to improve readability and show recommendations from all 23 countries. In other words, the tables present the key ideas of selected recommendations, but their analysis has also accounted for contexts and objectives for all recommendations.

In this section, the recommendations are first analysed by policy level and then reflected against stakeholder-relevant discussion in the literature. Some recommendations were not applicable to CASI-F and were therefore omitted from the analysis, although they can be found in the policy briefs. Altogether, 96 policy recommendations in 23 national policy briefs were analysed, with an average of four recommendations per brief. The briefs include 34 strategic, 50 tactical and 12 operational recommendations. A majority of the recommendations has, accordingly, focused on the tactical level (52% of all recommendations). The majority of the recommendations for policy makers in the national policy briefs at the *strategic level* focus on the governmental sector (56%), some on the business (15%) and civil society (21%) sectors, and only a few on research and education (9%). The recommendations at the strategic level are listed in Table 15.

The strategic level recommendations targeting *government actors* are focused on the creation of strategies on long-term policy developments, mostly regarding energy supply and low-carbon strategies, but also on governance approaches relating to efficient use of resources. The recommendations call for the implementation, integration and co-ordination of national strategies related to climate change, resource efficiency and energy supply. The need for policies for a sustainable transport sector is also emphasised in several recommendations that call for less traffic and for long-term strategies for fossil free transportation, in order to address the CO₂ reduction targets of the Europe 2020 strategy. When the topic of resource efficiency emerges separately from other Europe2020 topics (such as CO₂ reduction or energy security), the focus shifts towards legislative issues and increased resource efficiency. *Business actor*-oriented recommendations reveal energy issues as a key topic. The need for a long-term commitment to support renewable energy as well as sufficient electricity and energy supply is highlighted and considered important in targeting CO₂ emissions. *Civil society*-related recommendations concern the engagement of a wide range of stakeholders and the public in strategy developments and their implementation, but without specifying topics or industrial sectors. In *research and education*, strategic recommendations deal with long-term vision development and policy-relevant research.

While most recommendations at the tactical level focus on government actors (44%), there is a number of recommendations addressing the business sector (32%). The topics are rather diverse, however often repeated at the strategic level following their alignment with the Europe 2020 strategy. Table 16 summarises the policy recommendations at the tactical level. As a general note, the tactical level recommendations focus more on the CO₂ emissions reduction (through the call for more renewable energy) and resource intensity (through waste management) objectives of the Europe 2020 strategy rather than on energy security as such. While the tactical-level recommendations, in general, do not suggest any specific approaches to improve energy security, more concrete actions emerge at the strategic and operational levels.

For the *government actors*, energy appears the most important topic relating to CO₂ emissions reduction, followed by waste and innovation, which are more related to the resource-intensity aspect of the strategy. At the tactical level, the recommendations focus on following the implementation of existing strategies while, at the strategic level, the main focus is on their design. In addition, a stronger connection between the strategic orientation and implementation of strategies is called for. In terms of renewable energy sources (RES), the recommendations include suggestions to promote investor confidence by stabilising the regulatory framework for private investments in RES, including also fiscal support and market-based incentive programmes. In innovation-focused recommendations, a more innovative approach to resource use was emphasised. For waste, more holistic waste-management policies, incentives and public-scale programmes, as well as informational initiatives, were highlighted. Recycling and re-use were seen as significant objectives. The topics of water and traffic were also given importance and call for increased attention from government actors.

Table 15: Key policy recommendations at the strategic level.

Stakeholder Policy level	Government	Business	Civil society	Research and education
Strategic	<p>Consider energy security, energy intensity and CO₂ reduction as key parts of future policy-making and strategy-planning (EE)</p> <p>... integrate and co-ordinate national policy, strategies and plans to tackle climate change, resource efficiency and energy supply (IR)</p> <p>...design a clearly formulated and consequently implemented energy supply strategy. ... provide a response to the increasing energy demand of the growing economy and answer social doubts linked to alternative solutions to coal and lignite power plants (PL)</p> <p>Focus on long-term energy efficiency-targeted policies and initiatives (CZ)</p> <p>...provide legislation to address and govern resource efficiency and in particular climate change action (IR)</p> <p>Assess existing policy and estimate necessary amendments to ensure greater resource efficiency (LAT)</p>	<p>Austria could take the lead in becoming the EU member state with by far the most sustainable transport sector (AT)</p> <p>... with the improvement in renewables' performance and cost-effectiveness, it seems to be advisable to simultaneously put a higher emphasis on them at the strategic level too, since these are also great means of energy security (HU)</p> <p>... plan now for the next generation of renewable energy technologies ... to encourage industry to make the kind of long-term investment needed to develop renewable sources (UK)</p> <p>Promote eco-innovation in all kinds of SMEs (ES)</p> <p>Develop a sustainable energy policy with a long-term vision to ensure sufficient electricity generation capacity (BE)</p>	<p>Encourage the participation of the general public in designing and implementing policy measures (BE, UK)</p> <p>Strengthen public participation in the design and evaluation of national strategies and programmes in the field of energy and use of resources to achieve successful implementation and desired impacts (BG)</p> <p>Ensure the participation of a wide range of stakeholders and citizens in strategy development and implementation (CR)</p> <p>...Public participation is essential when taking decisions, especially when sustainability and the future are in question... (ITA)</p> <p>...The role of citizens ...should get more attention in the whole policy framework... (NL)</p> <p>... enhance the public participation process in the design and implementation of resource efficiency policies in Sweden (SWE)</p>	<p>Development of sustainable strategy studies among the main stakeholders with specific measurable targets (CY)</p> <p>...Policy-makers should ensure that Italy keeps taking a leading role in the development of European policies on research, and in reaching national-level objectives and targets even more ambitious than those settled at EU level... (ITA)</p> <p>Support the transition towards a circular economy through long-term vision development, policy-relevant research and concrete actions (POR)</p>

For the *business actors*, most recommendations relate to implementing different kinds of support schemes and instruments that target investments in clean energy production and energy efficiency linked to CO₂ emission targets of the Europe 2020 strategy. Supporting the development of public-private partnership and providing financial incentives and subsidies to increase public and business participation in sustainability efforts also emerged as a reoccurring theme within the recommendations. Overall, the recommendations encourage investments in a secure, low-carbon energy sector and the improvement of the security of energy supply.

In recommendations that relate to *civil society*, there is a call for the increased engagement of citizens and local businesses as co-developers of the thematic programmes and strategies in general, and in material and waste management through the application of participatory methods, in particular. Overall, the recommendations reflect the need for more public participation and suggestions for the provision of opportunities and tools for public engagement.

With regard to *research and education* actors, the recommendations indicate a strengthening of the development of human resources, skills and R&D and innovation capacities, as well as a need to educate the workforce adequately to facilitate a transition towards an inclusive low-carbon economy. Support for

activities that increase general awareness of the topic as well as areas for further investment in research, development and education are suggested.

Table 16: Key policy recommendations at the tactical level

Stakeholder Policy level	Government	Business	Civil society	Research and education
Tactical	<p>Implement with consistent strength the designated programme of the energy and climate strategy (GER)</p> <p>...creating a stronger connection between strategic orientation and implementation of strategies is needed (SLO)</p> <p>Set clear short-term and long-term national climate targets in all sectors (LAT)</p> <p>Intensive focus on the introduction of incentive programmes for improvement of energy efficiency in industry, transport, homes and public buildings (GR)</p> <p>Facilitate green innovation and public procurement (CR)</p> <p>Greater coordination among the different regions so that the development and implementation of eco-innovation is more equal (ES)</p> <p>Support for energy production from waste ... focus on sustainable technological solutions, aiming for maximum limitation of emissions of GHGs (SVK)</p>	<p>Include other focuses than resource efficiency when designing infrastructure (DK)</p> <p>Focus on clean and environmentally friendly transport technologies (EE)</p> <p>Release of the gas market for households and small businesses (GR)</p> <p>Supporting all forms of low-carbon generation across the UK can give the UK much more security and a greater degree of energy independence – helping to shield it from global fossil fuel price fluctuations (UK)</p> <p>Enhance and support innovative financial instruments to foster private funding for energy-efficiency measures in buildings and also in other sectors (LAT)</p>	<p>Continue the participation of government, industry, centres of expertise and civil society to achieve the transition towards sustainable materials management (BE)</p> <p>Engage citizens in more conscious and aware handling and recycling of waste to support the country's energy security based on increased consumption of energy obtained from secondary raw materials (CZ)</p> <p>Ensure public participation in the evaluation of implementation of the Climate Act. Provide opportunities and tools for the public to take part in these actions (FI)</p> <p>Public consultation is undertaken as part of the preparation of national strategies and plans; however, the current approach to consultation should be reviewed to consider whether citizens, communities and stakeholders are fully engaged in nationally important strategies from the earliest stage possible (IR)</p>	<p>Austria would be well advised to share its green-tech building know-how with other EU member states (AT)</p> <p>Strengthen the development of human resources, skills, and R&D and innovation capacities. Build up a suitably educated work force to facilitate the transition towards an inclusive low-carbon economy (BG)</p> <p>...support general awareness and the embedding into curricula as a useful tool for increasing sustainability (HU)</p> <p>... include further investments in R&D and education, strengthening exports and encouraging a reduction in the consumption of animal products (SWE)</p>

At the operational level most of the recommendations focus around the business sector (50%). Equal shares (25%) of recommendations focus on government and civil society actors. There are no recommendations for research and education actors at the operational level. Table 17 provides a summary of relevant recommendations. At the operational level, the different aspects of the Europe 2020 strategy focusing on resource efficiency are presented in quite a balanced way, with the topic of energy security being more prevalent than at the tactical level.

For *business actors* at the operational level, the recommendations are concrete and context-related, for example the connection of islands to the mainland power network, and the promotion of electricity

production and consumption metering, accompanied by adoption of flexible eligibility criteria for its effective application. The recommendations call for tools to support the public and companies in their choices. There is also a call for funding measures and instruments to support the development of technical improvements in materials management, and development of business models for the integration of efficiency targets. In addition, support for projects involving public–private partnerships is recommended.

The few recommendations for *government actors* include the promotion of market-related policy tools to provide clean-tech innovations and participation, the development of new financing models that promote a socially balanced and intergenerational approach to avoid energy poverty, and the introduction of a national monitoring system of climate actions and waste management.

For *civil society* at the operational level, a number of recommendations include more political support for the creation of energy efficiency networks and the creation of better measures to get the general public involved in the efficient use of natural resources. In addition, citizens’ fears of decreasing air quality, of transport intensity and about the quality of life in general should be addressed early in the planning processes via public participation.

Table 17: Key policy recommendations at the operational level

Stakeholder Policy level	Government	Business	Civil society
Operational	<p>Promote market-related policy tools to provide clean-tech innovations and participation (FI)</p> <p>To avoid energy poverty, develop new financing models that promote a socially balanced and intergenerational approach. The target should be to share the costs within society and between the generations, so that the future profiteers participate with their contribution (GER)</p> <p>Introduce a national monitoring system of climate actions, including in waste management, to assess, e.g. return on investment of the EU Structural Funds in 2014-2020 (LAT)</p>	<p>Create and monitor projects where public–private partnerships can be productive (DK)</p> <p>Connection of islands to the mainland power network (GR)</p> <p>Promotion of net metering and adoption of more flexible eligibility criteria for its effective application (GR)</p> <p>Establish funding measures and instruments to support the development of technical improvements that decrease the quantity of materials used to produce a good or service, or enhance the substitution of new materials with more desirable properties for older materials (POR)</p> <p>Create efficient tools to help people and companies think and act more environmentally sustainably. (ES)</p> <p>Continue to integrate the efficiency targets into business models and develop extended businesses (GER)</p>	<p>The network approach to create 500 energy-efficiency networks needs more political support and has to be linked with the German institutional system of chambers, unions and civil engagement (GER)</p> <p>Some projects, especially in waste management and waste-water treatment could stir negative reactions in communities where they are to be located. Fears of decreased air quality, increased transport intensity, and lower quality of life in general should be addressed early in the planning process via public consultations and other forms of public participation (SVK)</p> <p>Create better measures to get the general public involved in an efficient use of natural resources (ES)</p>

As a conclusion, the CASI Framework provides a useful tool for observing policy recommendations according to policy level (strategic, tactical or operational) and to stakeholder group, as shown above. The European analysis stemming from the policy briefs and their relationship to the Europe 2020 strategy provided a content comparison of policy initiatives to which the recommendations piloted here all relate. This section also shows that CASI-F does not provide tools for conducting content-wise conclusions across countries, as its aim is neither to aggregate across topics nor to provide opportunities for country comparisons. Nevertheless, the lack of a content-wise comparison should not be seen as a deficiency of the framework. Rather, it should be seen as a further opportunity to use CASI-F as one tool among a set of complementary policy analysis tools.

5.6. Challenges of applying the CASI Framework to sustainable innovation policies

Interestingly, CASI-F helps to identify a recurring pattern across policy levels and stakeholder types in the policy recommendations. The role of governmental stakeholders is highlighted in strategic concerns, while business stakeholders are seen as important players in the implementation of sustainable innovation policies. Civil society stakeholders, in turn, are called on when there is a need to involve the general public. Research and education are for their part seen to improve the knowledge base of sustainable innovation, both in terms of creating new knowledge and in its diffusion. This recurring pattern can be considered conservative, albeit government-centred, in that it repeats established stakeholder typologies and stereotypes. Accordingly, it can be argued that the CASI policy recommendations studied support incremental and constructive, rather than radical or disruptive, sustainable innovations in the realm of the Europe 2020 strategy and resource efficiency. Whether conservatism is an embedded feature of the CASI Policy Watch, of CASI-F or simply a pattern recognised in the particular pilot data is a question which requires further studies.

The policy recommendations examined, especially those at the tactical and operational levels, include actions that have been identified as imperative for a particular stakeholder or group of stakeholders to carry out. These actions also represent expectations towards stakeholders in sustainable innovation management.

In fact, different stakeholders, including local, national and regional authorities, non-governmental organisations, citizens' groups, private businesses, industry organisations, interest groups and even independent individuals, can all represent important roles in the management of sustainable innovation (Kemp *et al.*, 1998). The policy recommendations suggest roles that government actors can carry out, sometimes depending on the phase in the transition process (see Kemp and Rotmans, 2005; Smith and Raven, 2012; Van Eynde and Bachus, 2015). For instance, similar policies may remain at the strategic level in some countries after progressing to the tactical and operational level in others. Furthermore, transition may itself take place differently across countries, depending on economic constraints or the political atmosphere. Roles for government actors identified in the literature (e.g. mobilising actors, promoting participative discussions, shielding innovations from mainstream selection pressures, steering innovations by building stakeholder networks, etc.) could also be carried out by other types of stakeholders, such as businesses, research and education organisations, or civil society actors. This variety of roles and expectations among the different stakeholders identified in the literature can also be identified in the set of policy recommendations examined in this chapter. Stakeholder roles can be placed on a continuum ranging from a facilitating role to an active regulating role, which sets the playing field. When taking the role of a facilitator, for instance, the stakeholder aims to enable a process for learning and networking, which is reflected in the recommendations that call for public-private partnerships and for the development of tools and measures that engage multiple stakeholders. In turn, the role of an active regulator, represented by the governmental stakeholder, which is prevalent in the majority of the recommendations examined, emphasises the need to provide fiscal support, market-based incentive programmes, financial incentives and subsidies or the need to establish a stable regulatory framework. Future analysis of the type of roles for the different stakeholders, through an analysis of the policy recommendations, could serve as a basis to develop implementation strategies.

As a conclusion, CASI-F provides insights that emerge from an analysis of recommendations by policy level. Most recommendations for policy-makers at the strategic level focus on the creation of strategies on long-term policy developments that particularly target energy-supply and low-carbon strategies. Also at the tactical level, most recommendations focus on those government actors calling for the efficient implementation of existing strategies, especially with regard to energy-related issues. At the operational policy level, in contrast, most of them focus on the business sector and are quite often concrete and context-related. An analysis of the expectations and roles of targeted stakeholders provides opportunities for additional reflection.

5.7. Added value of the CASI Framework in sustainable innovation policy analysis

Piloting CASI-F with policy recommendations provided in CASI policy briefs offers an opportunity to look for novel insights as well as to reflect on the established policy watch process. In particular, CASI-F

provides added value to established CASI policy watch activities by drawing attention to stakeholders and by providing opportunities for procedural reflection. In particular, mapping policies, assessing their outcomes, and providing advice form a coherent process that can well be applied in policy watch activities.

Thematically, applying CASI-F to policy recommendations does not provide novel insights. This can be considered a reasonable outcome, as policy recommendations are expected to relate to the themes that they emerge from. Perhaps surprisingly, however, the three core topics of the Europe 2020 strategy in the national level policy briefs (CO₂ emission reductions, energy security and resource intensity), have a downplayed role in the policy recommendations. This might demonstrate that European and national policy targets need to be translated to fit other political contexts and stakeholder settings (see Clarke *et al.*, 2015). Energy, not from the perspective of security, but relating to the CO₂ emissions-reduction target of the Europe 2020 strategy, in turn, is highlighted as a recommendation topic.

The greatest benefit of applying CASI-F to policy watch relates to the consideration of stakeholders in their respective policy settings. Government actors, in particular, are prevalent in the recommendations. Considering the idea of disruption as a force for innovative change (see Bower and Christensen, 1995), it might still be worthwhile to focus more on other stakeholders. Similarly, the application of CASI-F shows that research and education stakeholders are not prevalent targets of recommendations, which could reflect the lengthy time spans of their expected impacts and a perceived requirement of special expertise for making recommendations for research. Both examples show that it is good for any policy watch to reflect not only on the subject of study but also on the outcomes of any analysis conducted. CASI-F provides a good tool for such reflection and additional analysis.

Applying CASI-F to policy recommendations shows that the operational policy level receives limited attention. It is uncertain whether this is an embedded feature of the CASI policy watch process, whether it results from the complexity and short time span of operational activities, or whether it is simply an outcome related to the piloted topic (the Europe 2020 strategy from the perspective of resource efficiency). Nevertheless, CASI-F demonstrates that it is valuable to reflect on targeted policy levels, too.

In conclusion, applying CASI-F in policy watch activities has two major benefits. First, it provides a useful tool for analysing and reflecting on the outcomes of a policy watch. Second, and as a logical outcome of the first benefit, CASI-F provides an opportunity for identifying gaps which merit additional reflection and analysis. This is a result of the balanced design of CASI-F, which makes any imbalances between stakeholders and policy levels easily recognisable.

5.8. Conclusions and recommendations

This chapter has illustrated how CASI-F (see Chapter 3 and Popper *et al.*, 2017) can be applied to policy monitoring activities. In a pilot effort, a comparative analysis of policy recommendations relating to the Europe 2020 strategy was performed. After analysing 96 recommendations from 23 CASI countries against CASI-F, observations and the added value of CASI-F in policy analysis were discussed. The aim was to discover whether, and how, using CASI-F could create novel insights into or additional reflection on the policy watch process designed and applied in the CASI project.

The piloting of CASI-F showed that using the framework could prompt a more balanced, yet conservative, set of recommendations on different stakeholder types. It can be seen that the application of CASI-F could direct additional attention to the different levels of policies and kinds of stakeholders. The added value of CASI-F in policy analysis would lie in a more systematic reflection of outcomes and in an identification of emerging issues.

The piloting has shown that CASI-F can be applied to the assessment and management of policy initiatives. In particular, CASI-F is useful for detecting imbalances among the stakeholders targeted in policy recommendations, or between different levels of policy. CASI-F can thus be used to review policy fields that are already balanced, or when aiming to identify gaps in policy implementation across policy levels or stakeholder types.

Three additional messages can ultimately be derived from this analytical chapter; they highlight the need for a more participative SI policy action:

- *SI policy formulation has to consider the contributions of a wider variety of stakeholders.* While many policy recommendations are aimed at governmental stakeholders, they highlight topics and actions that call for the consideration of other stakeholders' interests and activities. The fact that, to be effective, public SI policies also require contributions from more than just governmental actors should be taken into account.
- *A long-term perspective has to be adopted in relation to research and education policy initiatives.* Recommendations for research and education stakeholders require longer time spans to achieve their targeted impacts. For this reason, policy recommendations for these actors need to be considered and adopted against a longer time perspective than others.
- *It is important to ensure the participation of civil society at appropriate stages of SI policy-making processes.* The engagement of civil society stakeholders is frequently called for in policy-advice processes. This does indeed merit additional attention, as the success of sustainable innovation is reliant on social and economic acceptance. Accordingly, civil society stakeholders must be invited into the policy process at appropriate stages.

References

- Berry, F.S. and Berry, W.D. (1999) Innovation and Diffusion Models in Policy Research, in Sabatier, P.A. (ed) *Theories of the Policy Process*, pp. 169-200.
- Bower, J.L. and Christensen, C.M. (1995) Disruptive technologies: catching the wave. *Harvard Business Review*, January-February 1995, pp. 506-520.
- Clarke, J., Bainton, D., Lendvai, N., Stubbs, P. (2015) *Making Policy Move: Towards a Politics of Translation and Assemblage*. Bristol: Policy Press.
- Dahl, R.A. (1978) Pluralism revisited. *Comparative Politics* 10 (2), pp. 191–203.
- Hill, M., Varone, F. (2014) *The Public Policy Process*. London: Routledge.
- Kemp, R. and Rotmans, J. (2005) The Management of the Co-evolution of Technical, Environmental and Social Systems, in Weber, M. & Hemmelskamp, J. (eds) *Towards Environmental Innovation Systems*. Springer: Berlin Heidelberg, pp. 33-35.
- Kemp, R., Schot, J., Hoogma, R. (1998) Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. *Technology Analysis & Strategic Management* 10 (2), pp. 175–198.
- Kline, S.J. and Rosenberg, N. (1986) An Overview of Innovation, in Landau, R. & Rosenberg, N. (eds) *The Positive Sum Strategy: Harnessing Technology for Economic Growth*. Washington, DC: National Academy Press, pp. 275–306.
- Lijphart, A. (1971) Comparative politics and the comparative method. *American Political Science Review* 65 (3), pp. 682–693.
- Merrill, P. (2015) *Innovation Never Stops: Innovation Generation—The Culture, Process, and Strategy*. Milwaukee: ASQ Quality Press.
- Popper, R., Velasco G. and Popper M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.
- Siaroff, A. (1999) Corporatism in 24 industrial democracies: meaning and measurement. *European Journal of Political Research* 36 (2), pp. 175–205.
- Smith, A. and Raven, R. (2012) What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy* 41 (6), pp. 1025–1036.
- Trott, P. (2008) *Innovation Management and New Product Development*. Harlow: Pearson Education.
- Van Eynde, S. and Bachus, K. (2015) Non-state participation in sustainable materials management: the case of Fairphone. Research paper written under the 2012-2015 Policy Research Centre Programme of the Flemish Government. SuMMa Research Paper 19, 30 June 2016.
- Wiarda, H.J. (2006) *Comparative Politics: Approaches and Issues*. Lanham, MD: Rowman & Littlefield.

6. Sustainable innovation policy advice using a citizen-expert-citizen approach to ‘aspirations’ mapping

Konstantin Ivanov, ARC Fund
 Ventseslav Kozarev, ARC Fund
 Zoya Damianova, ARC Fund
 Kaisa Matschoss, University of Helsinki
 Petteri Repo, University of Helsinki
 Bjorn Bedsted, Danish Board of Technology Foundation

6.1. Abstract

Building upon a general conceptual debate about the nature and production of knowledge, this chapter traces the manner in which different norms, visions and experiences are mobilised when framing future sustainability outcomes, with a view to promoting the effective design of strategic public engagement mechanisms. As demonstrated, whereas citizens tend to emphasise the importance of multi-dimensional and holistic development, in which ecological, social and economic components interact in a complex manner, experts focus on the elaboration of narrower and more specific questions and challenges. The normative tension between perspectives is illustrative of the broader need for more inclusive, sustained and continuous cooperation between science and society at different stages of the policy-making and innovation processes. At the same time, it calls for the careful and proactive forging of public engagement methodologies that allow complementary (or indeed diverging) values, norms, and propositions to be acknowledged and put into context, so as to ensure greater accountability among a larger group of participants and societal stakeholders.

6.2. On the inherently normative and socio-political nature of sustainability issues

Based on a multi-criteria comparative analysis of citizen-developed visions against expert-elaborated outcomes and priorities, *this chapter charts the value differences (i.e. broad normative preferences) displayed by actors when it comes to grasping and making sense of the end goals of sustainability and sustainable innovations (SI).* Given CASI’s ambition to produce a set of research priorities based on citizens’ concerns and desires for a sustainable future and, eventually, to enhance mutual learning among project partners by building capacity for the future use and understanding of the applied methodology, the chapter seeks to expand on some of the deep-lying concerns shared by participants when formulating future development choices. The main focus is upon tracing the value systems informing decisions, as supplied by citizens’ and technical experts’ communities. However, it is beyond the current scope to conduct parallels between the processes of meaning-making underlying public views that belong to practitioners and policy-makers.

In particular, the complexity, ambiguity and subjectivity that surround persistent problems of sustainability decisions highlight *the importance of wider public engagement in both knowledge generation and priority development.* In fact, one of the most striking characteristics of sustainability to have emerged from the Citizen-Expert-Citizen (CEC) engagement process conducted in CASI is that the concept tends to convey a plurality of meanings to different groups and members of society. Anchored in real-world problems and diverse sets of values and socio-ethical commitments, SI presents itself as a fluid and deeply contingent category, expressive of different normative preferences, assumptions and beliefs. Indeed, what counts as ‘desirable’ or ‘conductive’ in sustainable development appears to be highly dependent on the specific social context within which relevant issues are being discussed and elaborated. In this way, the inherent political essence of sustainability and sustainable innovation comes to light, making tangible some of the most prevalent tensions and dilemmas entailed in understanding and evaluating pertinent questions of SI content or form.

Crudely put, whereas specialised expertise has seemed to establish more operational and technically oriented SI goals, lay sustainability assessments have been notably more amorphous and multi-layered

expressions of situational knowledge, embedded not in techno-scientific reasoning but in lived experiences. It follows from here that, rather than being an isolated and unequivocally ‘knowable’ entity, SI could perhaps act more fittingly as a proxy for the dynamic interlacing of broader societal challenges, incorporating an expansive set of various value judgments. In fact, as substantiated by our findings, sustainability emerges as a multifaceted construct that is comprised of, and informed by, various concerns and capabilities suggestive of the different conceptual and moral propositions at work when making choices about the future. As sustainability appears to be framed by different perspectives, taken by actors who position themselves differently in relation to sustainability/scientific discourses, the need arises for an interactive and continuous elaboration, examination and contestation of visions,¹⁰ and of the normative (ideational) structures that appear to underwrite them. To this end, effective models that allow for, and reinforce, social learning and integration of multiple propositions over time should be encouraged.

In view of the above generic points, this chapter sets out to:

- Sketch the different values, aspirations and motivations that feed into framing sustainability visions and priorities, as deployed by groups of experts and citizens;
- Demonstrate the need for greater public engagement and participation of society in sustainability research, innovation and policy-making;
- Broaden the scope of SI analysis and participation so as to consider a continuum of complementary knowledge and value propositions for genuinely effective innovative actions;
- Suggest options for more effective applications of SI engagement practices.

6.3. Recognising the need for more socially robust SI decisions

It has often been said that recognising the social context of sustainable development is key to developing targeted policy action. Yet major inputs to SI have mainly come from insights and ideas pertaining to conservation science, environmental/climate science, engineering and economics, among other more technical fields. Indeed, the politics of sustainability, as it occurs under the domain of conventional policy development, can be seen to frame the category of SI primarily through the means of science and technology, often to the detriment of the normative and much broader imaginations that societal stakeholders invest in their relationship with the world (Brand and Karvonen, 2007; Jasanoff, 2010; van Egmond and de Vries, 2011). Defined as such, the global transition towards a more sustainable future has (in general) neglected the goals and aspirations of societies that, in fact, happen to be the ones shaping and enacting its principles in their daily lives. Broadly speaking, the current policy-making process would benefit from the nuanced perspectives of civil society and the public at large, as they tend to view sustainability in complex and multi-dimensional ways. Prevalent in their holistic view is the idea that ecosystems, the biosphere and socioeconomic systems are intrinsically related to one another, offering fertile ground for a collective rethinking of matters of sustainable development and inviting a constructive reassessment of the conventional policy-making approaches used for the end goals of sustainability.

Further, against people’s pressing and more immediate concerns, it becomes increasingly apparent that the major challenge of sustainability today resides not in the implementation of technologically-driven solutions that clash with popular sensibilities, but rather in the systemic re-orientation of society, and the economy, more widely (Rogers *et al.*, 2012; de Vries and Petersen, 2009). Effective models of SI, in this sense, would thus need to adapt to, and incorporate, contextual and experiential avenues for co-creating and co-delivering the future, providing their central goal is to respond to some of the most complex challenges people face on a day-to-day basis.

Having said that, there seems to be a growing consensus about the urgent need for a paradigmatic shift to wider public engagement practices, which could deliver a much better balance between ecological, economic and social aspects than the one that exists today, thus offering a better fit with broader societal needs, expectations and concerns (Pytlikzillig and Tomkins, 2011; Robinson, 2004). Strengthening

¹⁰ A vision within the CEC engagement method, which builds upon the method devised within the FP7-supported CIVISTI project, refers to a citizen-elaborated description of a possible desirable future.

engagement activities between governments, the private sector and citizens at the national, regional, local, or sectoral level is therefore seen as a necessary strategic response in Europe and beyond, given engagement approaches' systemic commitment to making accessible various types of perspectives and aligning different knowledge, values and experiences in support of policy formulation (World Bank Group, 2014). Indeed, as a strategic tool, public engagement could act as a valuable means of providing wide-ranging societal perspectives concerning the various impacts of scientific and technological research underpinning SI. In this way, dynamic public involvement mechanisms - which appear most suited to the job of realigning socially shared values with institutionalised (expert) forms of knowledge - could help reframe appraisals of sustainability, such as to open up the possibility for re-imagining the concept as spanning different fields, sectors and scales, and effectively re-embedding it in more appropriate, situational realities. Involving a large group of societal stakeholders (namely, citizens, experts, civil society stakeholders, policy-makers, businesses, etc.), for the purpose of arriving at integrative solutions that complement each other, can together result in societal changes that are appropriate for ensuring sustainability becomes a feasible and welcome option for all members of society. Affecting participation as much as analysis, effective engagement models could therefore 're-equip' sustainability by way of turning it into a matter of open-ended civic deliberation that seeks to inform socially acceptable and desired futures.

That said, engaging creatively with SI will require re-linking larger scales of scientific representation with smaller scales of social meaning. At all levels of enquiry there is a need to reframe public involvement as a continuous process and, by doing so, to rethink some of the wide-ranging implications of different sustainable innovations and initiatives in a way that gives rise to an emergent, co-produced understanding of possibilities and preferred outcomes. In particular, what stands out from the literature on sustainability and SI (for an overview see Robinson, 2004 and Rogers *et al.*, 2012) is that the socioeconomic dimensions of sustainable development ought to be reconciled with the all-important biophysical features, if any efforts to deliver effective SI initiatives are to succeed in the long run. In practice, this involves the development of new agendas, methods or tools that are integrative and dynamic, i.e. that bridge expert and public knowledge in a systemic and methodical fashion for the goal of managing the often-competing demands of sustainable development. Such instruments and models would at the same time need to actively provide opportunities for synergies and sustained deliberation, and leave open the ground for the free communication of ideas, values and concerns.

To be sure, the principle advantage of sustainability (and, by extension, SI) seems to be its pluralistic and holistic approach to addressing interdependent issues, as opposed to specific elements that overlook certain unimagined and/or unintended consequences of development (McClean and Shaw, 2005; Su *et al.*, 2015). Specifically, the recognition that sustainability is not a static concept also highlights the overlapping of diverse issues across the ecological, social and economic spectrums. A key implication of seeing sustainability multi-dimensionally is not just that it tends to centre on the holistic nature of intricate problems, but also that it assumes a stronger commensurability of values between different domains of social activity.

What this means on a more practical level is that any strategic decision-making efforts in the field of sustainability or SI should begin by recognising the various tensions among the generative values that arise in different domains of social life, for the end purpose of arriving at a more complete understanding of the key forces driving human aspirations. To be more precise, given the variety of factors determining the state and quality of people's lives, it is proposed that, instead of treating domains of social practice, such as the economy or the environment, separately from the social, efforts must seek to guarantee the systemic effectiveness of sustainable innovations and ensure they are congruent with wider socially deliberated (i.e. publicly reasoned) values. By the same token, existing normative trade-offs between human needs and ecological limits, which seem to influence how sustainability is 'lived' and/or 'enacted' on ecological and economic terms, provide an opportunity for a renewed focus on the contextualisation and (re)examination of issues within the methodology of public engagement practices. On the broader (policy) level, what this signals is that, if sustainability is to contribute to a better life for all, then strategic actions will need to go beyond incremental changes and begin addressing holistic issues of human development, growth, material/spiritual wealth, equality, consumption and empowerment, to name but a few.

Warranted in this regard are effective forms of social learning that heed the different values, interests and preferences of a wider group of publics and stakeholders, and which ultimately take advantage of their experiential knowledge(s) to inform a broader socio-technological transition to SI. A further necessity, in that sense, is an improved approach to sustainable development and human wellbeing that simultaneously exposes and addresses the underlying issues and root causes of suboptimal quality of living within the context of economic and environmental constraints. To this end, a comprehensive policy debate that seeks to unravel, and potentially rework in a collaborative process, some of the societal drivers and influences shaping individual desires, expectations and concerns should be encouraged.

6.4. Expert vs. non-expert normative preferences

The above questions raise important issues about the social and political governance of sustainable innovations, and the way in which they are principally derived. Generally, the way innovations are framed as desirable or undesirable in novel/deliberative SI decision-making processes depends to a large extent on the norms, values and principles of participating experts and non-experts. In this sense, differences in views about the meaning and value of sustainability could be seen as rooted partly in different ontological and normative propositions concerning the most appropriate ways to go about defining and making sense of the relationship between society, nature and the economy.

Indeed, there is a growing consensus in the literature about the constitutively social nature of normative preferences about innovations (Lehoux *et al.*, 2009). As is often the case, participant communities in SI engagement processes (be they expert or non-expert) often come to share very specific criteria for appraising sustainability innovations (Lidskog, 2008; Lehoux *et al.*, 2009). These criteria, we argue, are normative assumptions that embody ways of reasoning about future actions or scenarios, and as such could be understood as grounded in some form of qualified assessment of the plausibility or directionality of the expected effects (i.e. outcomes) of concrete developments. As will be discussed below, the perceived desirability of innovations seems to be anchored in knowledge and experience that co-shape each other in ways which tend to inform normative trade-offs and interconnections between different aspects of sustainability actions.

Yet, while it is now well-established that successful sustainable innovations need to resonate with a system of norms related to society, economy and the environment, it is significantly less clear how those norms come to affect individuals with regard to constructing their respective knowledge about, and criteria for weighing, sustainable innovations. Essentially, the sustainability debate connects to a larger set of issues about science, knowledge and epistemological values. To put that into perspective, implicit in many decision-making processes concerned with establishing a strategic sustainability agenda is a dichotomy opposing formal/technocratic expertise against informal/soft public understanding. In the traditional purview, scientific expertise is said to reveal universal truths (or facts), identified closely with evidence-based methods of analysis, thus creating context-free/objective guidance to SI, while public/ordinary knowledge is reported as bringing a context-sensitive model, embedded in social relations and dynamics (Lehoux *et al.*, 2012; McClean and Shaw, 2005; Beck, 2011).

That citizens seem to be more concerned with societal issues than are expert stakeholders is visible from the concrete engagement results in CASI CEC process, discussed in more detail below. Suffice it to say here that the citizen-elaborated research priorities, focused on issues of more immediate societal relevance (such as education, innovative agriculture, urban greening, etc.), are indicative of the multiple cross-sectoral opportunities for strengthening sustainability debates in a systemic manner. A case in point for the cross-cutting nature of sustainability challenges as emergent in the eyes of citizens is the issue of environmental pollution, which is defined, described and understood in a non-discrete way: rather, it is intermingled with, indeed often embedded within, other important social/holistic issues, such as transport, employment, health, wellbeing, community, cohesion, and so forth.

Conversely, the research topics elaborated by the experts consulted in the CEC engagement process seem to highlight the application of currently dominant sustainability approaches associated more closely with technological innovation, production and system resources, rather than with broader issues of holistic development. Their decisions can be seen as ends-driven sustainability trajectories that seek to

meet specific technological and environmental targets (such as renewable energy, green infrastructures and new technologies, among others).

As it happens, giving higher priority to efficiency outcomes and goals often points clearly to the normative orientations influencing the views and decisions of experts, who tend to assign greater importance to technologically-driven innovative solutions, as informed by specialised perspectives. On the other hand, the relatively higher ranking of socially oriented themes by citizens and other civil society stakeholders reveals their own normative preferences, which tend to be primarily concerned with improving current quality of life, thus mirroring people's holistic socio-ethical commitments. In this regard, setting up the necessary conditions for delivering complementary advice on sustainability related challenges that provide for the systemic appraisal of the priorities and ideas produced by various participants in the engagement process needs to be streamlined.

Ultimately, as sustainability is an issue of constant (re)negotiation over preferred outcomes, developing more socially robust methods of deliberation that provide for the sustained examination of some of the key value judgements and forms of understanding of both experts and ordinary citizens is an important step for opening up the analytic and participatory appraisal of SI and public policy alike. Applying a trans-disciplinary and multifaceted approach to engagement models should thus provide for the breadth and depth of issues to be examined in relation to generally shared concerns such as human well-being, or the environment, in a way which seeks to integrate various assumptions and attitudes, and helps build collective responses to complex sustainability challenges.

6.5. The CEC engagement approach: multi-stage participation

Overall, the results and consultative process completed through the CEC engagement approach within CASI illustrates the need for and benefits of including citizens in an SI research priority setting. Besides providing new input, it is clear that broader citizen participation can lead to more socially robust research and innovation results. The applied multi-stage '*citizens-experts-citizens*' process (CEC-process) proved successful in fulfilling its overall objective, namely generating a number of citizen-informed visions, translating them into interim expert-elaborated research priorities, before submitting them for wider validation by the citizens once more, for the purpose of ensuring a uniform process in all countries. Eventually, this allowed for the strategic comparability of results and for systemic conclusions to be drawn across the sustainability policy domain. By abiding by certain common guidelines for the planning and execution of citizens' panels and expert workshops, the method provided a sense of enhanced consistency and integrity of the aggregated data.

Sketched above, the citizen participation method in CASI builds on the CIVISTI method,¹¹ which combines lay public and expert involvement in and control over the elaboration of relevant topics as part of the engagement process. The CIVISTI method is based upon the idea that the process of defining relevant and proactive research agendas could in many respects gain from consultation with citizens (i.e. ordinary people), as carriers of concerns and expectations for the future. At the same time, the process relies on the facilitatory intervention of experts and other professionals, who extract novel ideas and future priorities from the visions of the citizens. In CASI, in particular, the expert-elaborated issues relate to scientific disciplines and technological development, and/or to complex trans-disciplinary challenges. As such they provide additional direct input to EU science and research policy in the field of sustainability and SI.

Going one step further, the CEC engagement approach sought to reconcile the sometimes diverging viewpoints employed by participants in the multi-actor involvement setting through a mechanism of 'outcome verification', the main objective of which was to align the different ways of rendering and reasoning about the future. By making apparent the goals and interests of experts and citizens in the multi-stage engagement process, the method allowed both sets of actors to reflect on, validate and prioritise policy-relevant research agendas, without compromising the normative justifications guiding their input. The importance of this should not be underestimated, given that the 'public' often tends to incorporate broader issues into their sustainability assessments, focusing on the continuities between different domains of social practice, whereas the expert community may seem to be more preoccupied

¹¹ <http://www.civisti.org/>

with drafting condensed and concrete visions for the effective deployment of sustainability responses (Petts and Brooks, 2006; Scerri and James, 2010).

On the face of it, the expert–lay discrepancy described above invites further extension of the strategic applicability of the public engagement methodology in policy formulation, as it poses critical questions about the importance of ontological and epistemological problems, the associated power issues, as well as practical differences regarding expertise, citizen knowledge and sustainability, more widely. Apparent misalignments between criteria deployed for appraising SI call for models that acknowledge deep-lying normative assumptions and motivations, as these often guide the practice of envisioning the relationship between human well-being and the natural world, more generally. In this regard, efforts are needed both to understand and to affect progressive change and bring about more socially robust policy options, shifting attention away from stylised analysis and participation when it comes to formulating the future goals of SI.

On a broader level, therefore, the CEC engagement approach offers significant lessons to policy-makers and researchers alike in terms of deconstructing the ontological predispositions of expert and non-expert groups partaking in public engagement. Mobilising forms of both techno-scientific and ordinary/public knowledge, the model complements perspectives and contributes to the co-development of responses that optimally fit broader social goals of sustainable development. In increasing the quality of decision-making by integrating, not so much different knowledge claims and modes of understanding, but rather diverse sets of values and commitments, CEC ensures wider accountability to society for the outcomes of the deliberation activities. A key lesson in this regard is the importance of making more explicit the ways in which sustainability is variously conceived, as well as of exposing the guiding value principles that fuel different visions about the future on the part of experts and the general public.

Building on these broader reflections and experiences in relation to the CEC method, two suggestions can be made for new approaches to be explored in future SI-related public engagement activities, one practical and one academic:

- New models can be explored for clarifying the normative assumptions of citizens in SI engagement/ mutual learning activities and making their articulation with specialist knowledge a matter of discussion and verification.
- Supplementing the technical phase of (multi-stage) public engagement mechanisms with academic analysis would be helpful in determining normative actions that could be seen as widely undesirable, as well as in promoting critical reflection about implicit commitments, values or ideas that may otherwise remain under-acknowledged as a supplement to the outcomes of the engagement process.

The following section explores in more detail some of the policy-wide implications that arise out of the CEC method, so as to offer substantive points for future strategic engagement actions.

6.6. Comparative analysis of visions and priorities

In light of the generic points raised above, the purpose of this section is to present the normative/ comparative basis upon which a substantial part of the conclusions in this chapter were drawn. Significantly, they raise critical questions for the process of building effective R&I consultation programmes more widely.

In this regard, a procedural breakdown of the CEC methodology used within CASI allows us to trace the development of outcomes in a more comprehensive fashion, starting from the first citizen panel, through to the intermediary expert workshops, to close at the second citizen panel meeting. As visions concerning the sustainable future were initially formulated with the unmediated participation of citizens, experts worked subsequently to organise thematic clusters into which to incorporate the perspectives generated, so as to eventually produce at least one research priority for each of the visions in the agreed generic clusters. Following a rigorous selection process the experts then narrowed down the list of research topics to a total of 27 draft priorities, having to essentially rate the former in accordance with three central criteria: (1) Novelty ('Is the research priority innovative according to your knowledge?');

(2) Essentiality ('How important is the research priority for reaching a more sustainable future?'); and (3) Timeliness ('How acute is the research for us to reach a more sustainable future?'). Involving a separate voting (verification) procedure, citizens at the second panel meetings in each of the participating countries produced a top 10 out of the entire list of 27 expert-elaborated research priorities, before eventually the results were merged into an aggregated European top 10 list. Importantly, therefore, it should be noted at this point that it is these finalised (transnational) lists of expert- vs. citizen-derived research topics and priorities, along with the supporting/preparatory work and materials feeding into their development, that inform the bulk of the current analysis.

6.7. Discussion of results

As described above, following the initial citizen panels, research priorities on sustainable innovation were developed with the participation of a wide group of technical experts following the first round of citizen panels. At a specially designed workshop, invited experts clustered the citizens' visions generated from all 12 countries into thematic areas. A total of eight topic clusters emerged: 'Local needs and support'; 'Energy and production'; 'Urban life'; 'System resources'; 'Living and spaces'; 'Change for the future'; 'Values and politics'; and 'Social development and people'. It is noteworthy that the latter cluster of visions, tentatively entitled 'Social development and people', formed the largest thematic cluster, containing 10 visions altogether (out of the 50 in total). These visions were humanistically and/or socially oriented and differed somewhat thematically from other, more technologically and economically oriented clusters of visions. Having said that, most clusters prepared by the experts on the basis of the citizens' visions tend to cut across several research areas and involve both technical and social elements, which were considered and analysed against their problem framing 'progression' in the engagement process. Only partial reference is made to these topics in the current analysis, which focuses on comparative normative orientations and how they may be linked to SI policy debates more generally. An outline of the number of citizens' visions according to clustered topics is presented in Table 18.

Table 18: Number of visions according to clustered topic and cluster size

Clustered Topic	Number of Citizens' Visions
Social development and people	10
Change for the future	8
System resources	8
Values and politics	7
Energy and production	6
Living and spaces	5
Urban life	4
Local needs and support	2

Experts at the workshop had to select visions to be further developed into drafts and elaborated research priorities (see Table 19). In a nutshell, a total of 27 of the 49 draft research priorities (55%) was selected for elaboration in a two-phase selection process, principally aimed at ensuring a wide variety and translatability of citizen visions, as they made up the building blocks for the expert-drawn research agenda.

Table 19: Selection of cluster-specific research priorities for elaboration, according to original cluster size

Clustered Topic	Draft Research Priorities	Elaborated CEC Research Priorities	Share of Elaborated Priorities, %
<i>Social development and people</i>	10	2	20
<i>Change for the future</i>	7	4	57
<i>System resources</i>	8	5	63
<i>Values and politics</i>	7	3	43
<i>Energy and production</i>	6	5	83
<i>Living and spaces</i>	5	3	60
<i>Urban life</i>	4	3	75
<i>Local needs and support</i>	2	2	100

Despite the relative weight public views assigned them, however, only two of the 10 (20%) citizens' visions under the topic of 'Social development and people' were selected by the experts to be used in the development of research priorities. In contrast, a higher number of more technologically oriented clusters of visions were selected for further development ('Energy and production' 83%, 'Urban life' 75%, and 'System resources' 63%). It is worth pointing out that in the cases where the experts did give socially relevant concerns and visions a higher priority (such as in the case of the vision '*Food for all*', which contributed to the formulation of the research priority 'A new European food culture', and the vision '*Recognition, rethinking and responsible governance/action*', which contributed to the research priority 'Sustainable economics'), the experts mostly picked formulations belonging more closely to the realms of production, resource management and technology. A more concrete example lies in their elaboration of citizens' visions relating to urban planning and life. Visible in the sustainability appraisals of the experts is a focus on developing green transport technologies and road/green infrastructures. While surfacing in the accounts of the citizens, these themes are accompanied by an evaluation of the effects on urban liveability and living conditions, and by a voiced support for the development of more comprehensive instruments that highlight the role of citizens' participation in exploring urban planning options (such as how to make space for pedestrians, safe green corridors and recreation areas). This offers significant opportunities for expert knowledge to build on and advance the nuanced citizens' perspectives in fields such as transport/urban planning (and beyond), by way of integrating otherwise narrow approaches to addressing issues of broader social relevance in a more concrete/goal-oriented manner, which nonetheless harnesses normative differences in sustainability framings.

Again, in order to throw more light on the value predispositions guiding experts' and citizens' decisions we need look no further than the processes of knowledge generation shaping respective stances. Whereas the lay public actively create forms of meaning and understanding as they negotiate the conditions of everyday life, seeking to define problems in a non-discrete/holistic way, experts describe important issues from the viewpoint of technical reason and objectivity. Specifically, 'novelty' concerns seem to be driving expert assessments of sustainability, as framing desirable outcomes in terms of 'originality' and 'innovativeness' tends to prevail.

Considering the last phase of the citizen panel methodology, namely the ranking/validating of the expert-formulated research priorities by the citizens, our analysis re-affirms the view that researchers and citizens often place a different emphasis on the same issues. Many priorities, which were highly ranked by the experts, seem to have attracted less attention from the citizens and vice versa (see Tables 20 and 21. This again demonstrates that citizens and experts may assess priorities (mostly relating to socially laden issues) quite differently. Again, while the citizens tend to give a higher priority to research themes in search of socially oriented solutions and changes, the experts tend to be more supportive of more narrowly framed (i.e. often technological) solutions. This divergence in perspectives once again illustrates that there are multiple valuable ways of evaluating the same issues, which can nevertheless be successfully reconciled through a well-designed and constructive engagement approach that goes beyond simple consensus-seeking and acknowledges differing norms and value orientations.

Table 20: Expert-elaborated priorities derived from the citizens' visions, according to overall rank¹²

Overall Expert Rank	Elaborated CEC Research Priority	Originating Citizens' Visions (by Country Panels ¹³)
1	Improvement of European electricity transmission to increase renewable energy production	'Sharengy – Sharing renewable energy sources' (Slovenia)
2	Research on business models and changing institutions related to sustainable energy economy	'New sustainable energy economy' (Germany)
3	Sustainable living environment	'Sustainable living environment, sustainable values' (Finland)
=4	Holistic education for a sustainable future	'Education - a path to spiritual and sustainable future' (Bulgaria) and 'Education=aware citizen=aware society=sustainability' (Poland)
=4	A new European food culture	'Food for all' (UK)
6	Access to natural resources as a human right	'Distributive justice of essential resources' (Austria)
7	Co-developing green technology	'Development of new technologies and improvements of the existing harmony with nature and society' (Slovenia)
=8	Sustainable economics	'Recognition, rethinking and responsible governance/action' (Germany)
=8	Unified ecological grading system	'Ecocredits' (UK)
10	Sustainable transformation of existing traffic infrastructure in cities	'Reducing traffic congestion through the creation of green transport corridors and the protection and development of open and recreational space' (UK)

Table 21: Top 10 European research priorities against experts' corresponding overall rank

European Citizens' Rank	Name of CEC Research Priority	Overall Expert Priority Evaluation
1	Supporting local/regional agricultural production, distribution and consumption system	=19
2	Holistic education for a sustainable future	=4
3	Supporting people to become producers of renewable energy	11
4	Sustainable construction of buildings	=14
5	Sustainable transformation of existing traffic infrastructure in cities	10
6	New working models – new economic models	13
7	Innovating agriculture: the sustainability option	=16
8	More green in cities	26
9	Understanding and implementing sustainable electronics	=16
10	Fair and participatory access to limited resources	=14

¹² The list of research priorities elaborated by the participating experts in CASI workshops includes a total of 27 draft research themes, narrowed down from an initial list of 50. In this section, we present and analyse only the top 10 priorities, as ranked by the experts, alongside the top 10 research priorities, as ranked by the participants in the 12 citizens' panels, organised in individual countries.

¹³ CASI's detailed catalogue on the '50 Citizen Visions On Sustainable Futures' is available online at: <http://www.casi2020.eu/library/citizen-panels/>.

In short, systemic differences in the value orientations and knowledge perspectives of experts and citizens may be at the heart of the difference in SI goal formulation and prioritisation. There is significant added value in combining these perspectives into an input to sustainability policy-making, rather than relying on each as a single source of legitimacy.

6.8. Conclusions and recommendations

When carefully designed, public engagement has the potential to contribute to improved development results at the policy and societal level. The differences traced in the way citizens and experts tend to frame and assess sustainability issues within CASI lends solid support to the claim that a large group of societal stakeholders must be engaged in the co-creation and delivery of our common future sustainability agenda. The various normative assumptions, notions and propositions that seem to underpin the citizens' and experts' inputs within the CEC engagement setting of CASI carry important policy implications and point to the need for a continuous process of articulation between different knowledge types and value orientations. Academic studies and reflection on public engagement activities can help uncover such knowledge types and value orientations and thereby help to point out the need for new procedures.

To be sure, sustainability and SI resonate with a range of norms related to society, economy and the environment. These norms often affect the way members of the public construct their knowledge about and appraise sustainability-related problems and questions. Thus, while the lay public actively create forms of understanding and knowledge as they negotiate the conditions of everyday life, expert knowledge is often institutionalised and focused on end-effect relationships between sustainability components. In this sense, any strategic public engagement methodology in support of defining relevant sustainability research and policy agendas could gain considerably from the combined participation of citizens and experts, given the nuanced perspectives applied to assessing the general plausibility and/or directionality of the expected effects of SI. As evident from CASI, co-constituting knowledge in such a manner is bound to enrich the policy consultation process and result in the recognition of co-benefits of proposed topics and ideas, ultimately leading to a deeper understanding of the complex interrelationships of sustainability systems. Involving citizens in the formulation of research priorities, moreover, is further able to add novel topics to the research agenda that can successfully complement (or even unsettle) established forms of expert-based development of research priorities. This disruptive potential of citizen participation is an important aspect of engagement in that it can challenge incumbent stakeholder arrangements, goals and expertise and eventually improve the quality of decisions, by culminating in the deliberation of a wide range of arguments and plural rationalities, as seen within CASI.

In short, presenting a broad array of views may shift the direction of the discussion from problem-solving around technical issues to values and normative goals. Establishing a strong science base and co-operation with researchers can promote innovation pathways in many important areas (energy, materials, transport, etc.), which may have to be linked to the value choices implicit in policy debates surrounding SI. This deliberation of underlying normative dimensions can be a benefit of wider public engagement that aims for transformative change and socially robust innovation trajectories. Indeed, the differences, as revealed in CASI, between experts' and citizens' normative preferences point not only to the importance of allowing citizens a role in setting priorities for EU sustainability policies and research agendas, but also to the need for the establishment of new platforms and procedures that allow for continued and institutionalised deliberation – and even negotiation – between citizens and experts in order to bring about more systemic solutions and the transition to a more sustainable future.

In conclusion, we can summarise recommendations in the following three policy messages:

- *It is necessary to promote public engagement to improve SI development results at the policy and societal level.* The complexity, ambiguity and subjectivity that surround the persistent problems in sustainability decisions highlight the importance of wider public engagement in both knowledge generation and priority development. Societal stakeholders must be engaged in the co-creation and delivery of our common future sustainability agenda.
- *We have to recognise that the major challenge of sustainability today resides in the systemic re-orientation of society and the economy.* Effective models of sustainability need to adapt to, and incorporate, contextual and experiential avenues for co-creating and co-delivering the future,

providing that their central goal is to respond to some of the most complex challenges people face on a day-to-day basis. Involving a large group of societal stakeholders (citizens, experts, civil society stakeholders, policy makers, businesses, etc.), for the purpose of arriving at integrative solutions that complement each other, can result in societal changes that are appropriate for sustainability to become a feasible and welcome option for society.

- *SI policy action should guarantee the systemic effectiveness of sustainable innovations and ensure they are congruent with wider socially deliberated (i.e. publicly reasoned) values.* If sustainability is to contribute to a better life for all, then strategic actions will need to go beyond incremental changes and begin addressing holistic issues of human development, growth, material/spiritual wealth, equality, consumption and empowerment. A comprehensive policy debate that seeks to unravel, and potentially rework in a collaborative process, some of the societal drivers and influences shaping individual desires, expectations and concerns should be encouraged.

References

- Beck, S. (2011) Moving beyond the linear model of expertise? IPCC and the test of adaptation. *Regional Environmental Change* 11 (2), pp. 297–306.
- Bedsted, B., Ibsen-Jensen, J., Kloppenborg, E., Kyhn, B., Kaarakainen, M., Matschoss, K., Repo, P. (2016) *European Citizens' Visions for a Sustainable EU Future: Research Priorities and Policy Advice*. CASI Deliverable 3.3, Danish Board of Technology Foundation. <http://www.casi2020.eu/library/citizen-panels/> (accessed 20 Aug 2016).
- Brand, R. and Karvonen, A. (2007) The ecosystem of expertise: complementary knowledges for sustainable development. *Sustainability: Science, Practice, & Policy* 3 (1), pp. 21–31.
- van Egmond, N.D. and de Vries, H.J.M. (2011) Sustainability: the search for the integral worldview. *Futures* 43 (8), pp. 853–867.
- Jasanoff, S. (2010) A New Climate for Society. *Theory, Culture & Society* 27 (2–3), pp. 233–253.
- Lehoux, P., Daudelin, G., Demers-Payette, O., Boivin, A. (2009) Fostering deliberations about health innovation: What do we want to know from publics? *Social Science and Medicine* 68(11), pp. 2002–2009.
- Lehoux, P., Daudelin, G. and Abelson, J. (2012) The unbearable lightness of citizens within public deliberation processes. *Social Science and Medicine* 74 (12), pp. 1843–1850.
- Lidskog, R. (2008) Scientised citizens and democratised science: re-assessing the expert–lay divide. *Journal of Risk Research* 11 (1), pp. 69–86.
- Matschoss, K., Repo, P., Kaarakainen, M., Kloppenborg, E., Ibsen-Jensen, J. and Kyhn, B. (2015) *Citizen Assessment of Priorities for European Research: Report on the second citizen panel meeting*. University of Helsinki, CASI Internal Report.
- McClean, S. and Shaw, A. (2005) From schism to continuum? The problematic relationship between expert and lay knowledge - an exploratory conceptual synthesis of two qualitative studies. *Qualitative Health Research* 15 (6), pp. 729–749.
- Petts, J. and Brooks, C. (2006) Expert conceptualisations of the role of lay knowledge in environmental decision-making: challenges for deliberative democracy. *Environment and Planning A* 38 (6), pp. 1045–1059.
- Pytlikzillig, L.M. and Tomkins, A.J. (2011) Public engagement for informing science and technology policy: what do we know, what do we need to know, and how will we get there? *Review of Policy Research* 28 (2), pp. 197–217.
- Ratner, B.D. (2004) 'Sustainability' as a dialogue of values: challenges to the sociology of development. *Sociological Inquiry* 74 (1), pp. 50–69.
- Repo P., Kaarakainen M. and Matschoss K. (2015) *European research priorities based on citizen visions: Report on the CASI expert workshop held in Copenhagen*. University of Helsinki, CASI Internal Report. <http://www.casi2020.eu/library/citizen-panels/> (accessed 20 Aug 2016)
- Robinson, J. (2004) Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological Economics* 48 (4), pp. 369–384.
- Rogers, D.S., Duraipappah, A. K., Antons, D. C., Munoz, P., Bai, X., Fragkias, M. and Gutscher, H. (2012) A vision for human well-being: Transition to social sustainability. *Current Opinion in Environmental Sustainability* 4(1), pp.61–73.
- Scerri, A. and James, P. (2010) Communities of citizens and 'indicators' of sustainability. *Community Development* 45 (2), pp. 219–236.
- Su, L.Y.-F., Cacciatore, M. A., Brossard, D., Corley, E. A., Scheufele, D. A., Xenos, M. A. (2015) Attitudinal gaps: How experts and lay audiences form policy attitudes toward controversial science. *Science and Public Policy* 43 (2), pp. 196–206.
- de Vries, B.J.M. and Petersen, A.C. (2009) Conceptualizing sustainable development: an assessment methodology connecting values, knowledge, worldviews and scenarios. *Ecological Economics* 68 (4), pp. 1006–1019.
- World Bank Group (2014) *Strategic Framework for Mainstreaming Citizen Engagement in World Bank Group Operations*. Washington, D.C.: World Bank. <https://openknowledge.worldbank.org/handle/10986/21113> (accessed 20 Aug 2016).

7. Lessons from a multi-level/stakeholder approach to sustainable innovation actions analysis

Rick Hölsgens, Technical University of Dortmund
 Jürgen Schultze, Technical University of Dortmund
 Vilja Anttila, INOVA+
 Ventseslav Kozarev, ARC Fund
 Soizic Linford, Coventry University Enterprises Limited
 Lindsey Martin, Coventry University Enterprises Limited
 Guillermo Velasco, University of Manchester
 Rafael Popper, University of Manchester

7.1. Abstract

This chapter focuses on managerial aspects of sustainable innovation. The objective is to identify generalised actions (i.e. meta-actions) that SI actors can undertake for the management of sustainable innovations, and to make them instrumental in innovation practice by offering key messages for sustainable innovation policies. Such actions would empower and guide SI innovators in their efforts to improve their innovation processes. These meta-actions were developed on the basis of three independent analyses of CASI's work.

Whereas some meta-actions target certain stakeholders more than others, the meta-actions aim to support all four individual stakeholder groups identified in the CASI-F management framework: government, business, civil society, and research and education actors. Policy-makers, when framing and enabling SI, can use these as orientation marks from innovation practice. Sustainable innovation actors from each of the four stakeholder groups can use these key messages and meta-actions as general advice in their daily practice, as they build upon the findings on the trends and experiences of sustainable innovators participating in the CASI project. Overall, CASI research has shown that the visibility of SI is crucial, and awareness about it needs to be generated among all stakeholders. Furthermore, SI actors need to develop a deep understanding of the context in which they operate and to aim for collaboration with other stakeholder groups.

7.2. Introduction

In the context of sustainable innovation, learning from existing sustainable innovations and adapting exemplary projects considered good practice to new contexts are important components of management. In this chapter we present 55 meta-actions or lessons, developed in three consultation rounds with SI actors within the CASI project. The meta-actions are based on the experiences gained in practice by sustainable innovators; they are generalised actions that may support and inspire SI actors to take further steps to develop and promote their innovations (e.g. product or service). This chapter is structured as follows. First, the methodology used for the development of the meta-actions will be briefly outlined. This section explains how results drawn from the pilots, roadmaps and the development of SI management considerations eventually resulted in the generation of 55 meta-actions. In the subsequent sections, the main findings per empirical database will be summarised. In section 7.4, the key messages for SI actors are then brought together. This section ends by providing a list of the most important meta-actions. A concluding chapter will outline the main findings for different sustainable innovation actors and make final remarks.

7.3. Methodological approach

Having addressed sustainable innovation initiatives, relevant SI policies and citizens' aspirations in the previous chapters, this chapter turns to the concrete actions SI actors can take to further develop their sustainable innovations. The chapter presents generalised meta-actions based on analytical results drawn from three empirical databases developed within the CASI project. The database structures follow the CASI Framework; the methodologies behind the three analyses are described in the following paragraphs.

7.3.1. Piloting CASI-F

The first database resulted from the testing of the CASI-F management framework (Popper *et al.*, 2017) in 43 pilot cases.¹⁴ The pilots were chosen from among the mapped cases in CASIPEDIA (2017) in two phases (see Popper *et al.*, 2016a).¹⁵ In the first phase, partners reviewed CASIPEDIA cases and nominated 107 of them. In the second phase, the nominated cases went through a ranking process to provide: (1) an even geographical distribution; (2) the inclusion of different types of innovation (i.e. social, technological and social-and-technological cases); and (3) the inclusion of cases with different scales of innovation. Ultimately, 43 cases were chosen for pilot testing.

The CASI partners collaborated with the innovators between November and December 2015 in order to complete the first phase of the pilots. In this phase they identified actions based on the three management levels (strategic, tactical and operational) and four stakeholder perspectives (governmental, business, civil society, and research and education), as laid out in the CASI-F management framework (see Chapter 3). The purpose of this exercise was to support the management of sustainable innovation versus the critical issues and the overall assessment of sustainable innovation practice. The innovators rated each action by importance (on a scale from 1 to 5), feasibility and sustainability impact. Finally, the innovators were asked to identify two to four actions that they felt were the most important and feasible to carry forward. After the selection was made, partners submitted them, along with their feedback on lessons learned, for detailed analysis.

The piloting process showed the results of sustainable innovation on the basis of the pilots using the CASI-F management framework (six cases tested the CASI-F tool twice: once from a technological perspective and once from a social perspective; one case contained both perspectives). The actions were listed and clustered and on each management level the actions were summarised within the different stakeholder groups. More than 1000 actions identified through the pilot exercise fed the CASI Actions Bank.¹⁶ The Actions Bank was the empirical database used in the development of meta-actions, and based on the most prominent types of actions, as documented in Schultze *et al.* (2016) and Martin *et al.* (2016).

7.3.2. Action Roadmaps

The second input for the meta-actions presented here resulted from the final stage of the CASI-F methodology: **development of an Action Roadmap**. Innovators involved in the pilot were asked to choose one or more of the previously formulated actions, and to produce a more detailed Action Roadmap (see Anttila, 2016, and Chapter 3 of this report) to support the implementation of the actions selected.

Furthermore, the roadmaps focused on the implementation of action(s) from a management perspective, taking into consideration the following four management dimensions and 10 aspects (see Table 4 in Chapter 3 for a detailed description of these dimensions and aspects):

- Context (momentum/foresight/resources/mobilisation);
- People (aptitude/attitude);
- Process (catalysts/fosterers); and
- Impact (transformation/sustainability).

Developing an Action Roadmap allows innovators to gain specific, customised advice and recommendations on how to better address specific challenges. The roadmap identifies 10 different tasks that together cover all major aspects of managing a sustainable innovation, and assigns an appropriate time frame for the implementation of each of these tasks. In total, 46 Action Roadmaps were developed during the one-to-one sessions between innovators and CASI partners in March-April 2016. The roadmaps were initially analysed based on the type of action (determined by the management level and stakeholder group of the action), followed by a vertical analysis comparing the commonalities and differences between the

¹⁴ CASI Pilots – <http://www.casi2020.eu/casipedia/si-pilots/>

¹⁵ CASIPEDIA – <http://www.casi2020.eu/casipedia/>

¹⁶ Actions Bank – <http://www.casi2020.eu/actions-bank/>

Action Roadmaps developed for different stakeholder groups. The roadmaps with the specific actions formed the second empirical database for the meta-actions, documented in Anttila (2016).

7.3.3. SI management considerations

The third input for the meta-actions originates from **management considerations** derived from the analysis of: (a) CASIPEDIA mapped initiatives (Popper *et al.*, 2016a); (b) a stakeholder survey analysis; and (c) the sustainable innovation literature (see Popper *et al.*, 2016b).

The analysis considered *SI factors of success*, i.e. those aspects that facilitate the conception and launch of SI projects; *SI barriers* (elements that usually make the launch phase difficult), *SI opportunities* and *strengths* (elements that contribute to keeping up the SI process); *SI threats* and *weaknesses*, (aspects that hinder the innovation process), and *SI drivers* (those trends or circumstances that foster innovation processes). Drawing upon this information, a set of considerations across all cases was formulated. These considerations respond to questions such as: *how can innovators take advantage of identified factors of success? How can innovators overcome SI barriers? How can innovators capture the opportunities that the innovation process offers? How can SI threats be avoided? How should innovators' strengths and weaknesses be analysed and considered? How should SI innovators understand the influence of SI drivers and align them with their own SI objectives?*

The main findings of the three analyses (1000+ actions from 43 pilots, 46 Action Roadmaps and 11 management considerations), and their interpretation for the meta-actions, are introduced in the following section. Section 7.3.5 presents the complete set of meta-actions, clustered around six themes.

7.4. Empirical basis

7.4.1. Pilot projects on testing and validating CASI-F

The first empirical database contains the results of the pilot projects on testing and validating the CASI-F. The project conducted pilots of innovations that were distinctly social or technological, and also those innovation cases that included both these aspects. Once the SI initiatives were mapped in CASIPEDIA and critical issues assessed and identified, the innovators were able to use CASI-F to identify actions that would help them to better manage their innovation by capitalising on opportunities arising or by overcoming recurrent barriers and challenges. As a result, the CASI Actions Bank was populated with over 1000 actions that can improve SI management. The innovators employed CASI-F as a tool to support the management of sustainable innovations from the perspective of four different stakeholder groups, and then, for each stakeholder group considered the implications for the innovation of three levels of management (strategic, tactical, operational). The actions identified were grouped into meta-actions. A more detailed account of the actions is presented in project reports (Schultze *et al.*, 2016; Martin *et al.*, 2016); here the actions are summarised and described in more generic terms.

While actions produced by the innovators were found to vary greatly in complexity and detail, it could be determined that they fell into clusters of meta-actions; these actually transcend specific stakeholder groups and can be applied to several or all of them. Likewise, the meta-actions usually covered all three management levels. Thus they can be often seen as having 'moved through' the different levels of management; that is to say, most of the actions have a strategic origin, which has to be implemented on the tactical level and operationalised at the operational or front-line level. The most important areas for action to emerge from the technological and social innovations related to: (1) the establishment of contacts and raising of SI awareness; (2) development of business and marketing strategies; and (3) political action in support of SI (for instance through changes in the regulatory or tax system (These are listed and described in Table 22).

7.4.2. Management of sustainable innovation

The second database comprises Action Roadmaps developed in the context of improving the management of sustainable innovations (see Anttila, 2016). In total, 46 action roadmaps were created during the one-to-one sessions with the CASI partners in March-April 2016. After identifying the main themes for

each type of roadmap, a comparison was conducted between different types of Action Roadmaps, thus highlighting what kind of tasks were considered most relevant to each of the four stakeholder groups.

Almost half the roadmaps were related to **business actors (48%)**. The largest number was created for strategic actions, but tactical and operational action-related roadmaps also provided valuable inputs for analysis. In comparison with the others, the roadmaps designed for business actors were particularly focused on tasks related to economic impact and business model design. However, they also addressed the development of personnel and capacities, providing infrastructure and implementation of monitoring and/or certification systems. All the meta-actions were addressed on more than one management level. In general, in comparison to other roadmaps, it could be said that business actors roadmaps were more focused on the *how* rather than the *what*. In other words, whereas other roadmaps were focused on highlighting their impact and objectives, business actor roadmaps suggested more concrete and precise steps. It could also be said that these roadmaps focused more on internal development than on other aspects, e.g. by building strong and justified practices and measuring their success.

The second most frequent type of roadmaps were **Action Roadmaps for civil society actors (28%)**, which were relatively evenly distributed between the three management levels, the tactical level being slightly better represented. In comparison to other types of roadmaps, these roadmaps emphasised tasks related to citizen engagement, knowledge-exchange between decision-makers, and the analysis of existing structures, regulations, decision-making actors and political environments.

The findings show that each of the meta-actions was always addressed, either directly or indirectly, on more than one management level. Ultimately, the findings from civil society-oriented roadmaps indicate that innovators see great value in making an impact at the grass-roots level and with bottom-up approaches, by direct interaction with citizens but also via intermediaries. Simultaneously, innovators considered it important to collaborate with politicians to reflect on any limitations and obstacles that sustainable innovation currently has.

Research and education oriented action roadmaps (20%) were evenly spread across each of the three management levels. These roadmaps emphasised, in particular, tasks related to cross-sectoral collaboration and the adjustment of innovations to specific circumstances (for instance by adjusting the terminology for a specific audience, or by adapting to geographical differences).

The findings from **Action Roadmaps for government actors (4%)** were limited because of the low percentage of available roadmaps. These roadmaps emphasised that actions should address incremental changes, rather than disruptive activities, such as replacing old solutions abruptly. Additionally, there were several tasks focused on engaging with people, e.g. dissemination, expansion and education initiatives. Furthermore, it was emphasised that future product development should cohabit in harmony with existing structures, solutions and SI objectives.

7.4.3. SI management considerations

The third input for this chapter came from (technological) sustainable innovation management considerations as described in the CASI project report by Popper *et al.* (2016a), and the meta-actions identified through the analysis of CASI pilots, explained in more detail in Schultze *et al.* (2016). CASI partners used the steps from mapping SI cases to produce SI evidence-based recommendations for management. This resulted in practical considerations to support SI management strategies (Popper *et al.*, 2016a). As an example, and from a purely technological perspective, these considerations assume that SI innovators should: (a) analyse dependence on other technologies; (b) develop a precise IPR strategy; (c) elaborate technology development plans; (d) identify and assume protection and imitation costs; (e) make a plan for digital and social media communication; (f) guarantee the easy and 'friendly' use of sustainable innovation; (g) create maintenance and contingency plans (h) reinforce staff's technical capabilities and capacities to facilitate technological anticipation; (i) ensure an adequate level of novelty and creativity in both their radical and incremental innovations; (j) develop supporting infrastructures; and (k) comply with technical standards and achieve the right level of complexity.

Other important themes (non-technological) in these management considerations centred on business and marketing plans, for instance with regard to the use of social media for marketing purposes. The

involvement of citizens in open innovation and the development of foresight plans were also recurrent considerations. One other finding refers to the visibility of SI, which can take various forms, for example through lobbying to reach political spheres, or through the organisation of fora or events to foster knowledge transfer and cross-fertilisation. While the technological considerations have been inductively inferred through a bottom-up process that included in-depth study of CASIPEDIA mapped initiatives, a CASI stakeholder analysis and a sustainable innovation literature review, SI meta-actions emerged as top-down analysis of the messages coming from the piloted innovators. The combination of both approaches was taken into account in the construction of meta-actions.

7.5. Meta-actions and key messages

The three approaches described above resulted in 55 meta-actions. These meta-actions can be clustered around six key messages. Table 22 illustrates how meta-actions illustrate these messages. The clusters of meta-actions provide orientation marks for all the actors involved in the development of sustainable innovations. However, they hold particular relevance for SI policies as they highlight those areas that are crucial for successful SI management.

1. *Business and government can jointly remove barriers to sustainable innovation:* innovators often encounter legal or financial barriers that are difficult to overcome on their own. Support from other stakeholders is therefore needed. Investing businesses may actually improve the innovators' financial capacities. In addition, policy-makers can alter or remove legal and regulatory obstacles. These larger, and generally more powerful, stakeholders can also provide financial backing for the development of support infrastructures. They may, for example, encourage sustainable innovators through the creation of specific SI competitions, development of strategies and programmes, or the provision of relevant SI certificates.
2. *Every sustainable innovation needs contacts and collaboration across sectors:* Involving civil society, business, government, and research and education is a key factor in the success of sustainable innovations. This message shows up regularly in the meta-actions. Methods to foster cross-fertilisation and knowledge exchange beyond sectors may include the organisation of fora or events to bring different stakeholders together. A key role in this cross-sectoral collaboration is held by citizens, who are simultaneously the users in many cases. In this respect, open innovation can be useful to better align the innovators' views with users' demands.
3. *Raise awareness and empower the innovations/innovators:* Sustainable innovations need to reach out to the various stakeholder groups so that people become aware of their potential. Raising awareness and acceptance is an important step for sustainable innovation actors, as it will empower them in their further innovation developments. Lobbying and getting your message across is crucial, especially in the early stages of the innovation. Innovators and their outcomes need to be empowered by having greater visibility, but also through human resource development or training and education programmes.
4. *Understand the context and adjust to it:* innovators should be sensitive to the context in which their innovation emerges. To this end they should analyse the contextual circumstances and use evaluation methods to assess their function. The innovation needs to fit in with its context; thus it might have to be adjusted to target the right audience (jargon), geographical location and/or changing trends. Analysing the context will result in learning about opportunities for further development, but will also illuminate potential bottlenecks; once these obstacles are understood, the innovator can work on their reduction or elimination.
5. *Develop appropriate business models and marketing plans:* to ensure that sustainable innovations come to fruition and endure, it is necessary to develop appropriate business models and/or marketing strategies. Such strategies may involve promotional activities and/or the inclusion and participation of other stakeholders (most prominently from business and civil society) as mentioned above. They may also be consistent with intellectual property rights (IPR) plans. Finally, it is important for sustainable innovators to reconcile their innovative solutions with broader socioeconomic issues, thus thinking beyond market-based rationales.

6. *Engage in research and education*: staff training is vital not only to keep people updated regarding relevant activities in the areas of interest, but also to find new innovation opportunities. Innovators should therefore consider the importance and relevance of cooperating with research and education actors in research activities. In this respect, joint research and innovation initiatives with these actors should also be encouraged at the global level as a strategy to leverage innovators' international activities.

Table 22: Clustering of the meta-actions

1. Business and government should provide support and remove barriers to sustainable innovators
Provide economic support to SI firms that organise foresight staff education plans
The stakeholder group's government has the power and possibility to change the regulatory and tax system in favour of SI
The stakeholder group's government should adjust/make easier the legal and administrative processes
Achieve a greater harmonisation of SI-related IP regulation throughout Europe
Government should develop support infrastructure: programmes, funding, etc.
Government, but also the stakeholder group research and education, should provide infrastructures for different purposes (e.g. information, training and digital work)
Create government plans and strategies to further the development of SI
Create a competition for the best technological innovation dissemination plans, emphasising effective firm–society communication
Gain business-related certificates and success metrics
Develop concepts, strategies and programmes
2. Establish contacts and collaboration across sectors
Establish contacts, collaboration/co-operation, and partnerships across sectors (eco-systems approach)
Create, foster and extend cross-sectoral partnerships
Involve citizens through top-down methods (e.g. dissemination, expansion and education)
Organise fora/events to promote cross-fertilisation; thus SI firms can interact, exchange experiences and eventually create joint development plans
Make use of funding opportunities as a potential outcome of cross-sectoral partnerships (e.g. with politicians or industry partners)
Encourage open innovation strategies that guarantee a better alignment between the innovation and user demand, i.e. reducing the complexity of a solution where applicable
Engage in knowledge exchange between strategic decision-makers (e.g. politicians, heads of schools, industries, networks), via mutual learning and by testing new methods
Encourage civil engagement
Concentrate on citizen engagement, maximum impact and large-scale reach with direct and indirect engagement tasks
Encourage customised citizen engagement management, e.g. segmenting, profiling and designing a customised communication strategy
3. Raise awareness and empower the innovations/innovators
Raise awareness and acceptance through various channels, using leaflets, events, talks, activities
Guarantee that the voice of the SI firms is heard in relation to any standards and regulations that usually hinder innovation, and review these standards when appropriate
Lobby the stakeholder group's government
Empowerment: work on human resource development, exchange of knowledge, and practices
Promote social activities, including virtual meetings based on social media, that connect innovative firms with potential SI users

4. Analyse the context and adjust to it
Analyse the existing structures, regulations, decision-makers and political environment in the context of the innovation
Adjust innovation with regard to terminology, language, implementation process or even at a conceptual level
Adapt innovation to geographical location, target audience or changing trends
Promote the creation of contingency plans by innovative firms, thus changing their perception of the potential risks of innovation
Identify, implement and monitor evaluation systems (e.g. management commitment, employee engagement, business opportunities and workload)
Eliminate existing bottlenecks related to critical infrastructures, i.e. invest in facilities/ structures that allow/facilitate a fluent development of technological innovation processes
Analyse and understand changes in culture, policies or processes
Improve and develop large and complex systems instead of disrupting them
Review regulatory aspects with regard to the action of lobbies and think tanks, to eliminate bad practices and achieve positive synergies with influential actors
Conduct systematic stakeholder management (identifying, profiling, engaging, fostering) to increase stakeholder engagement (e.g. crowd-sourcing, workshops, competitions); and initiate new forms of collaboration with stakeholders (training, ambassador programmes, campaigning)
Conduct pilots (planning, conducting, measuring)
5. Develop appropriate business models and marketing plans
Develop business strategies, including modelling, changes or improvements to processes and use/creation of tools, etc.
Develop business models and transfer them to market applications
Create, modify, develop and diversify new business models at both the strategic and tactical levels
Develop market strategies: incorporating market research, new markets, trends and systems
Provide incentives for creating marketing plans that incorporate social media communication
Encourage firms to engage their marketing activities with consumers as a way to promote user-friendly innovation
Assess and develop the relevance of tasks related to economic impact
Promote the consideration of IPR aspects in firms' SI strategies
Create incentives for social innovators through investment in, and funding for, social SI
Provide funds for consistent IPR strategy developments
Focus on imitation and the transfer/diffusion of the SI
6. Engage in research and education
Provide training and development possibilities for personnel at all management levels
Provide funds for IPR staff education programmes
Design programmes that help SI firms to develop a culture of anticipation and foresight in technological innovation processes
Inform SI firms on the state of the art of SI technology initiatives, thus avoiding/reducing potential duplication of SI efforts
Improve the public financial support to those research initiatives whose objectives centre on supporting technological development strategies, e.g. horizon scanning initiatives and road-mapping
Research being undertaken locally should also be used to leverage international research
Training and education programmes should be provided
Explore student engagement (within curricula and via campaigns)

7.6. Conclusions and recommendations

The piloting project, SI roadmaps and management considerations addressed in this chapter took different approaches but all resulted in meta-actions that can support sustainable innovators in directing their efforts more effectively to strengthen their innovation management processes. Some of the meta-actions apply to all four stakeholder groups, while others are actor-specific. These meta-actions are clustered around six key messages that provide orientation marks for all actors involved in SI development. They are particularly relevant for SI policies, as they highlight those areas that are crucial to successful SI management; policy-makers can actually formulate policies and programmes that support other SI actor groups in this process. The findings also show that, while the three different levels of management utilised in the CASI Framework proved useful to structure the most concrete actions, meta-actions transcend these levels as they are – by definition – more abstract, i.e. strategic. Many take place at all three levels; that is to say, most of the actions have a strategic rationale, which must be implemented at the tactical level and operationalised at the front-line level.

There are nonetheless *three main overarching themes* that can be identified.

First of all, *innovators need to thoroughly understand the context in which they operate*. They should aim to understand the various actors' perspectives across different stakeholder groups and accordingly identify the relevant actions to put in place. Every stakeholder group has its own strengths and potential to further develop its innovation. CASI-F supports these innovators in the conception of their management actions while helping them to think about all relevant and influential actors.

Second, *raising awareness and acceptance of sustainable innovations* has emerged as a recurrent theme during all consultation rounds. Visibility, awareness and acceptance of the innovation among most stakeholders are all important and necessary achievements as they form the basis upon which other SI-process-related actions need to be built and implemented.

The third overarching issue is the *interaction between different SI stakeholder groups*. Cross-sectoral collaboration can bring new insights and strengthen sustainable innovation processes; as noted above, all stakeholder groups have their respective strengths, and the innovation can benefit from them. Understanding others' views, achieving a common understanding of SI critical issues, and acknowledging shared targets can make the innovation process smoother and make SI diffusion easier and more effective.

CASI-F can be used to support sustainable innovators in thinking about the sort of actions they could undertake, at which managerial level these actions would be most effective, and which stakeholder groups are most relevant for each action. Although the 55 meta-actions identified in this chapter are broad, they can be also useful guides for sustainable innovators, allowing them to consider actions and approaches they may not otherwise have considered. Meta-actions can actually enlighten innovators and help them to take into account the kind of initiatives that could be carried out to further develop, implement and diffuse their SI initiatives.

In addition to the aforementioned messages, we suggest three recommendations to support the SI management-oriented policy action:

- *SI policies should focus on removing barriers to sustainable innovation*. Some innovation system actors can contribute to easing or removing financial and legal barriers to sustainable innovation. While investing businesses may actually contribute to improving innovators' financial capacities, policy-makers can remove regulatory obstacles, provide support infrastructures, and formulate specific programmes to reinforce the competitiveness of innovative firms.
- *SI policies must promote SI actors' collaboration more intensively*. Sustainable innovation calls for actor collaborations across sectors. Involving civil society, business, government, and research and education actors is vital for the success of sustainable innovations. Policy action is required to promote collaboration, establish platforms and methods to foster cross-fertilisation, improve knowledge exchange, and enable citizen participation.

- *More effective policy initiatives are needed to support the empowerment of SI actors.* The value of sustainable innovators' endeavours to economic growth and the future development of society should be emphasised and endorsed. Raising awareness and acceptance is an important step for sustainable innovation actors, who will thereby be empowered to progress more effectively in their respective innovation developments. Empowerment can also be achieved through human resources training and by the creation of platforms that increase their visibility.

References

- Anttila, V. (2016) Report on CASI-F implementation. CASI project report. Deliverable 6.1.
- CASIPEDIA (2017) State-of-the-art of Sustainable Innovation Database. [Online]. CASI Work Package 2 led by the University of Manchester, CASI project. <http://www.casi2020.eu/casipedia/>
- Martin, L. and Avarello, A. (2016) Report on the pilot application of CASI-F for assessing sustainable technology innovation. CASI project report. Deliverable 5.1.
- Popper, R., Velasco, G. and Popper, M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.
- Popper, R., Velasco, G. and Ravetz, J. (2016a) State-of-the-art of Sustainable Innovation: Climate action, environment, resource efficiency and raw materials. CASI project report. Deliverable 2.1. <http://www.casi2020.eu/library/#d8838>
- Popper, R., Velasco, G., Bleda, M., Amanatidou, E., Ravetz, J., Damianova, Z., Kozarev, V., Chonkova B., Tsin, S., Avarello, A., Martin, L. and Morris, D. (2016b) Sustainable Innovation Conceptual Framework. CASI project report. Deliverable 2.2.
- Schultze, J., Schröder, A. and Hölsgens, R. (2016) Report on the pilot application of CASI-F for assessing sustainable social innovation. CASI project report. Deliverable 5.2.

8. Policy priorities for climate action, environment, resource efficiency and raw materials

Guillermo Velasco, University of Manchester
Rafael Popper, University of Manchester
Monika Popper, Futures Diamond
Zoya Damianova, ARC Fund
Ventseslav Kozarev, ARC Fund
Petteri Repo, University of Helsinki
Kaisa Matschoss, University of Helsinki
Anita Tregner-Mlinaric, Meta Group
Bjorn Bedsted, Danish Board of Technology Foundation

8.1. Abstract

This chapter takes into consideration two distinct processes utilised in CASI to develop new sets of sustainable research and innovation (R&I) agendas. The first process is based on European sustainable innovators' objectives, as gathered and analysed from more than 500 SI initiatives mapped in CASIPEDIA and led by the quadruple helix of SI stakeholders. The second draws on citizens' preferences, as identified in two rounds (citizens-experts-citizens) of participatory workshops carried out in 12 European countries. Some mismatches are identified and the chapter reveals that gaps exist between what is currently taking place in research and innovation, and what citizens wish for. Furthermore, the analysis demonstrates the potential of cross-disciplinary approaches to make cross-comparisons of data from multiple and diverse sources.

8.2. Introduction

The past decade has placed Europe at the forefront of numerous challenges. The changing world order was the trigger for a fast-track innovation process that Europe was unready for. The growing innovation gap in Europe is an obstacle to any increase in productivity and growth, which needs to be generated through future technologies and further translated into innovations in the field of new products, services and processes for the benefit of the economy as a whole. Moreover, a diverse set of social and environmental challenges means that Europe must urgently transform itself into a more sustainable entity and requires an R&I evidence-based policy agenda and programme-setting. The European Union recognised the urgency of the situation and that solutions to the above-noted challenges are interlinked. It became evident that, if these environmental and social challenges are addressed, Europe will be able to boost productivity, generate long-term growth and secure its place in the new world order, i.e. reach the required level of competitiveness. It is notable that the quest for sustainability has already started to transform the competitive landscape, forcing all relevant actors to change the way they think about products, technologies, processes and business models.

CASI recognises these challenges and, as a response, has developed two different sets of research and innovation agendas aiming to provide an input to the European Commission on the formulation of forthcoming sustainability-related policies within a framework of the next-generation expenditure programme for research and innovation. In addition to the evidence-based analysis, the R&I agendas have emerged from a wider stakeholder engagement with an outreach to all European Member States. Therefore, CASI has successfully addressed the structural weaknesses related to the weak cross-border cooperation, coordination and engagement of all relevant stakeholders (including citizens) in the process.

The following sections provide an overview and analysis of the overall methodology concerning the development of the CASI R&I agendas and the resulting research priorities, including those of citizens. CASI provides new and original contributions to sustainability research and innovations agendas, as well as on citizens' priorities for research. The concluding section builds links between both sets of priorities and tentatively suggests that citizen support for social research and innovation topics is prevalent, and

that there are opportunities for cross-cutting citizen-supported priorities across a wide range of Horizon 2020 Societal Challenge 5 (SC5) priorities related to sustainable innovation.

8.3. Approach and objectives

The CASI project has developed two different sets of research and innovation agendas. These aim to inform the European Commission on the formulation of forthcoming sustainability-related policies. A first set of 10 R&I priorities was developed through the analysis of more than 1800 SI innovators' objectives (gathered in CASIPEDIA), and from the insights generated in 12 citizens' panels held in different European countries. The first objective of this chapter is to provide a short description of these priorities and to explain how they have been identified. The second objective is to make a comparative analysis of both sets and to analyse how these priorities could give rise to new R&I directions in the area of sustainability, thus helping to detect R&I agendas that are currently insufficiently addressed in the SC5 priorities of Horizon 2020. Since its inception the CASI project has placed a strong emphasis on the core aspects of sustainable innovation – the mutual reinforcement of social, economic and environmental factors in the innovation process, as well as on the added value of social, economic and environmental impacts resulting from the implementation of successful innovations. Thus, at the core of its methodology CASI placed the cross-cutting analyses of actual sustainable innovations (backed up by a robust conceptual framework of sustainable innovation), carefully prepared stakeholder consultations, and reaching out to citizens in order to get their day-to-day perspectives on sustainability-related challenges. The project was able to deliver results that provided a structured supporting framework, CASI-F (Popper *et al.*, 2017), which may be applied in the assessment of sustainable innovation and the provision of strategic, tactical and operational actions to complete a thorough organisational strategy for innovation management, whereby sustainability remains a focal point.

The chapter also presents a critical analysis aimed at finding similarities and differences between the two sets of above-mentioned priorities, and at reflecting on the potential implications that unveiled R&I gaps may have for the future direction of sustainable innovation in Europe.

8.4. On R&I policy priorities from the assessment of SI objectives

The identification of R&I priorities based on SI initiatives mapped in CASIPEDIA involved the analysis of 1852 objectives from the quadruple helix of SI stakeholders, as described in Chapter 4 of this report. The objectives were clustered by type of innovation (Table 23) and through further filtering, clustering and analysis led to the identification of 76 R&I priorities (Popper *et al.*, 2016). These priorities represent topics and areas explicitly mentioned by innovators as relevant and strategic for the future of SI.

Table 23: SI objectives from the analysis of CASIPEDIA

Type of innovation	Number of objectives analysed
Product	494
Service	416
Social	309
Organisational	245
Governance	187
System	142
Marketing	59
TOTAL	1852

A second round of content analysis, which merged research and innovation priorities from all types of innovation led by a wide range of actors representing the quadruple helix of SI stakeholders, facilitated the identification of 10 broader research and innovation policy agendas (Table 24). The identification process is illustrated in Figure 9.

Figure 9: A systematic process to cluster the objectives of the quadruple helix of SI stakeholders

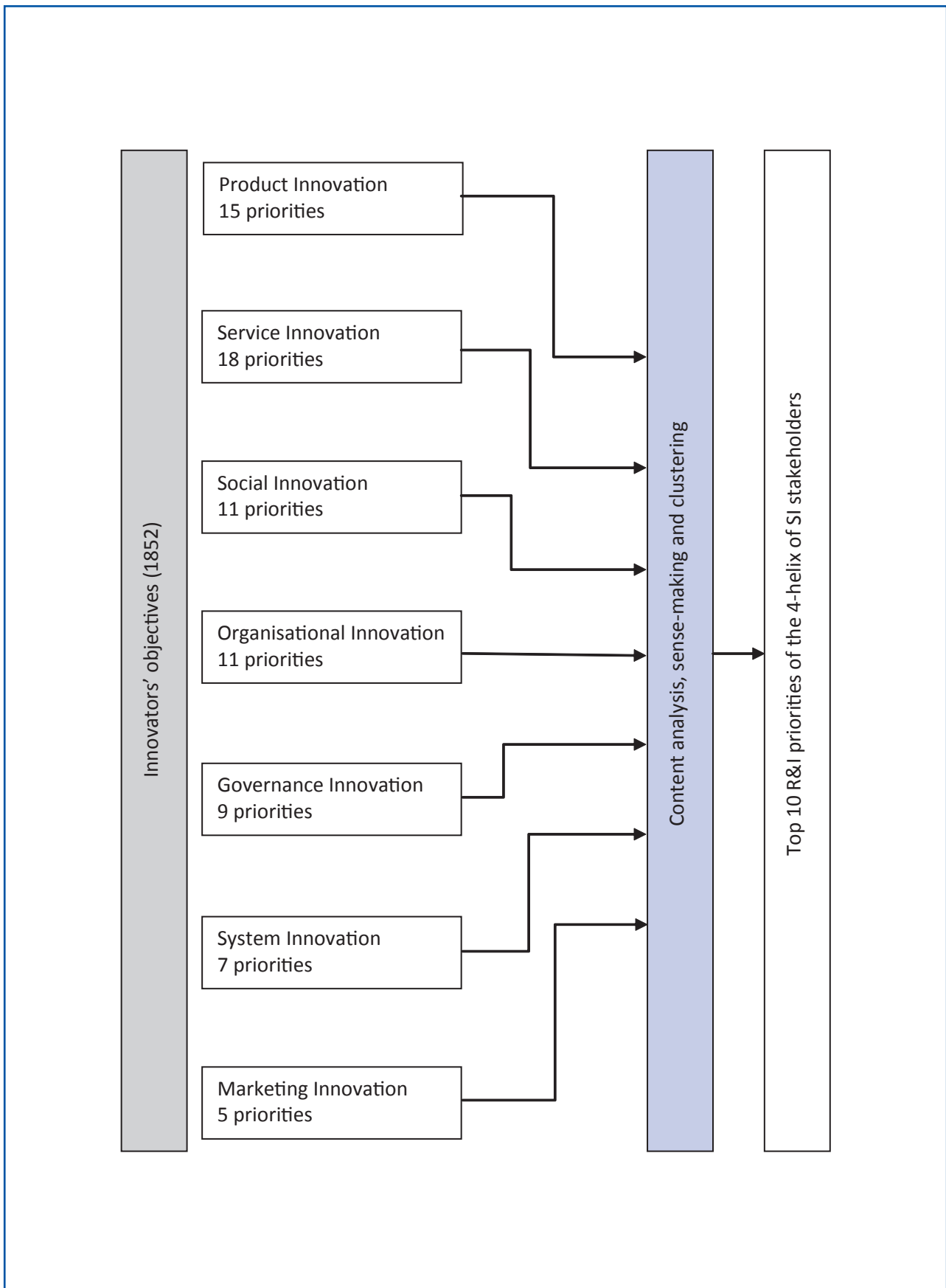


Table 24: R&I priorities from the analysis of the 4-helix of SI stakeholders' objectives

Rank	Top-10 R&I priorities of the quadruple helix of SI stakeholders
1	Strengthening eco-community empathy and crowd-funded development
2	Developing sustainable urban and rural infrastructures for the bioeconomy
3	Deploying responsible environmental and resource-efficiency strategies
4	Creating sustainable bio-fuel and renewable energy solutions
5	Promoting foresight for sustainability governance and intelligence
6	Advancing recycling and circular use of waste and raw materials
7	Embedding sustainability in cultural and holistic education models
8	Fostering eco-local-agriculture and bio-resources efficiency
9	Implementing sustainable transport and smart mobility innovations
10	Dealing with climate issues and managing greenhouse gas emissions

Source: Popper *et al.* (2016).

The 10 R&I priorities of the 4-helix of SI stakeholders are presented as 10 SI Policy Agendas below:

1. *Strengthening eco-community empathy and crowd-funded development*

"The agenda for 'community empathy', or the wider notion of 'sustainable communities', needs to balance aspirations with reality in a fragmented and often unequal world. At its roots the notion of empathy is about interdependency, and the building of reciprocity, solidarity and mutual aid. All this cuts across the conventional boundaries of 'economy' and 'society', therefore the responses to this agenda are likely to include all seven types of SI. There is an economic dimension of SI types that seeks to engage stakeholders in sustainable business, including building local and regional economic prosperity and resilience, as well as cooperative business models that can re-invest in local communities and endogenous regional development. A governance dimension looks for new models of multi-stakeholder engagement in long-term sustainable development actions, such as multi-sector public services that can address interconnected problems and new models for citizen empowerment, gender and ethnic equality. An ecological dimension looks for policies, programmes, partnerships and networks to protect natural resources in urban and rural areas, where ICT innovation can help mobilise social innovation, and vice versa. Each of these feeds into a social, cultural and psychological agenda, where 'empathy' is a driver for behavioural change and a building block for more sustainable institutions" (ibid.).

2. *Developing sustainable urban and rural infrastructures for the bioeconomy*

"A sustainable economy means different things to different stakeholders, but a good place to start is with its infrastructures. Buildings and the built environment have huge potential for greening and material efficiency, where the logistics and distribution systems of a complex economy can be tuned and restructured. Industrial supply chains can be managed using the concepts of 'service' and the 'sharing economy', while consumption patterns can be reshaped in the light of 'community empathy'. However, all this goes far beyond technical issues, into the deeper waters of policy, behaviours, institutions, cultures, and so on. The SI types, as identified by CASI, cover many angles of this; some are specific product solutions to specific problems, such as the technology of a green roof, while others address the system-

level interconnections with service, organisational, governance, social and system SI types. Future R&I agendas should continue exploring this more systematically, and look at how SI and sustainability R&I can develop new socioeconomic, connected-economy or foundational-economy models, which enable technology and other product innovations to reach their potential” (ibid.).

3. Deploying responsible environmental and resource-efficiency strategies

“The environmental management agenda often raises conflicts between health and economic activity, between different social groups, or between costs and benefits. Neither public policy nor markets are well suited to the scale of the problem, thus the possible responses are found in many types of SI. For example, governance innovations seek new regulations, trading schemes, charging schemes and public information systems, as partial solutions. Product innovations focus more on the upstream issues of emissions control and monitoring, while many service innovations address whole systems such as transport or industrial supply chains, and the hotspots of residential areas and cultural assets. Water is a cross-cutting issue, calling for new models of economic, social and informational exchange and interdependency. Meanwhile, addressing the fundamentals of an urbanised society with widespread air and noise problems calls for systemic solutions for sustainable consumption, low-impact living and education for behavioural change. Similar directions apply to water resource management, where system-level concepts such as ‘integrated catchment management’ set the challenge of interdependency and collaboration in a multi-level and multi-sector governance situation” (ibid.).

4. Creating sustainable bio-fuel and renewable energy solutions

“Energy is the basis of a complex industrial society, and the SI agenda refers equally to the supply, distribution and demand sides. Many of the SI types look at specific technologies such as biogas or anaerobic digestion, others explore the potential for socioeconomic and governance models, such as community energy or eco-schools to enable and encourage renewable energies on the supply side, or rapid efficiency improvements on the demand side. As for future R&I agendas, there is potential for energy system transformation in the sense of zero carbon supplies. More complex is the notion of energy cascades, both in technical terms such as industrial ecology and design, and behavioural terms in the usage of buildings, appliances and mobility” (ibid.).

5. Promoting foresight for sustainability governance and intelligence

“The institutions of governance were developed for a 20th century model of industrial society. Now, the sustainability agenda in a highly interconnected world calls not only for marginal improvements but also for new models of governance. Some of the CASI SI priorities call for citizen engagement or new levels of policy integration, while others focus on the resources in the public sector at the time of resource shortages. The potential and importance of ICT and ‘datafication’ is also strongly emphasised. For the future, new models of governance need to be explored more systematically and applied in every sector where governance has a role. The SI cases from CASIPEDIA are a good demonstration of the current state of the art. Some of them, though experimental, point towards alternative models and institutions for decision-making, representation and participation, to the active engagement of all sectors, sustainable resource management, and to public services which can ‘do more with less’” (ibid.).

6. Advancing recycling and circular use of waste and raw materials

“In terms of aspirations to a circular economy, waste is simply a resource in the wrong place, but in current realities, the pressures on businesses and organisations (both large firms and SMEs) seem to produce waste that then needs to be managed. Some waste streams are more viable than others for re-use, re-engineering or recycling. The CASIPEDIA initiatives show a wide range of approaches, from the small scale of social enterprises that train the unemployed in repair skills, to the large scale of national schemes for industrial symbiosis. These cover the full range not just of products, but also of social, services, governance, and organisational innovations. Overall, while the principles of a circular zero-waste economy are accepted on all sides, the practice depends on many challenges that are yet to be addressed. The R&I efforts should focus systematically on issues regarding circular business and finance models; circular consumption systems in

households and communities; the implications of the sharing/experience economy, and the implications of globalised business and lifestyles" (ibid.).

7. *Embedding sustainability in cultural and holistic education models*

"Clearly a sustainable future is in the hands of the young and the education system which surrounds the theme, but it is also in the hands of citizens, workers and policy-makers (at all levels), whose skill-base and knowledge-base can shape the world as it is. In this light, the CASI evidence-base as drawn from the citizens' panels is particularly relevant. There seemed to be the foundations of an alternative and sustainable model underlying the conventional traps of a modern consumerist, high-mobility, and high-impact society. This is visible in the CASIPEDIA cases, where not only the design of school curricula but alternative notions of 'what is a school' are explored. For the agenda in prospect, there are many trends and pressures, including: on-line education and gamification; use of big data or social media in eco-feedback for citizens and businesses; pressure on education for 'results' and 'impacts'; and, generally, a growing culture of globalised consumerism and distrust of governance. While the SI cases demonstrate some degree of these, the next R&I programmes should systematically explore the potential for and also the barriers to education for sustainability" (ibid.).

8. *Fostering eco-local-agriculture and bio-resources efficiency*

"Food and farming systems underpin almost every sector and community. On the supply side, farming and fisheries are deeply embedded in rural and coastal economies and societies, and implicated in environment and climate issues. On the distribution and demand side, food is a deeply cultural and psychological issue, at the same time raising huge challenges for public health and education. A wide range of CASIPEDIA SI cases demonstrate this interconnectedness (though with fewer types of SI products than elsewhere). Many focus on the local community level and aim for more feedback and circularity between producers and consumers. Some look at industrial ecology and alternative cultivation, such as aeroponics or aquaculture. Are there transformational innovations or systems in prospect, beyond small-scale experiments and community social innovations? Some ideas have come directly from citizens themselves, e.g. 'insect food' or 'edible towns'. Future R&I should explore multi-scale questions more systematically, i.e. how to scale up the micro-innovations, and also how to influence global food systems for a post-oil sustainable food transition" (ibid.).

9. *Implementing sustainable transport and smart mobility innovations*

"Achieving a sustainable mobility, accessibility and/or transport modal shift is a well-worn path of R&I in technology, behaviour and governance. The SI cases in CASIPEDIA demonstrate the state of the art with many new opportunities arising through smart cities and the use of big data and mobile technology. Other opportunities on the demand side or in modal shift are in social innovation and 'community empathy'. Vehicle technology continues to progress, but in some cases is meeting a system-level barrier, as with deployment of electric or hydrogen-based vehicles. Urban design has made some progress towards pedestrian zones and accessibility planning, but there is much more to be done. The outlook suggests several challenges. One is that of technology determinism (as in smart city systems), versus wider debates on 'the right to the city' (as in the reshaping of local communities, housing markets, and local economies), while another is about the question of unlimited mobility as the foundation of a fluid, outsourced, globalised economy and society. Future R&I agendas should explore these tensions as an essential underpinning to practical initiatives on transport supply and demand" (ibid.).

10. *Dealing with climate issues and managing greenhouse gas emissions*

"Despite the agreement on aspirations at the Paris COP, effective solutions to climate change and related environmental challenges are not expected in the near future. There is a context of uncertainties on costs and benefits, controversies on resources and restructuring of economies and infrastructure, and a continuing campaign of scepticism and denial, not only from lobby groups but also as a result of disconnections in the public mind and psychology. The SI cases in CASIPEDIA demonstrate this wide range of issues and possibilities, from practical technologies or business models to national infrastructures.

Many also focus on the human side of education, feedback, ‘community empathy’ and cultures of interdependency and responsibility, as well as on practical social-finance business models or land-use regimes. Future R&I agendas could take such initiatives and many others as a starting point, especially where climate solutions are not only a technocratic top-down type of ‘problem’, but are more about opportunities, which are distributed across many sectors and many levels. If we can systematically explore these wider interconnections between multi-level and multi-sectoral opportunities, there is a better chance of shifting climate change from problem to opportunity, while engaging all actors in society in a common aim” (ibid.).

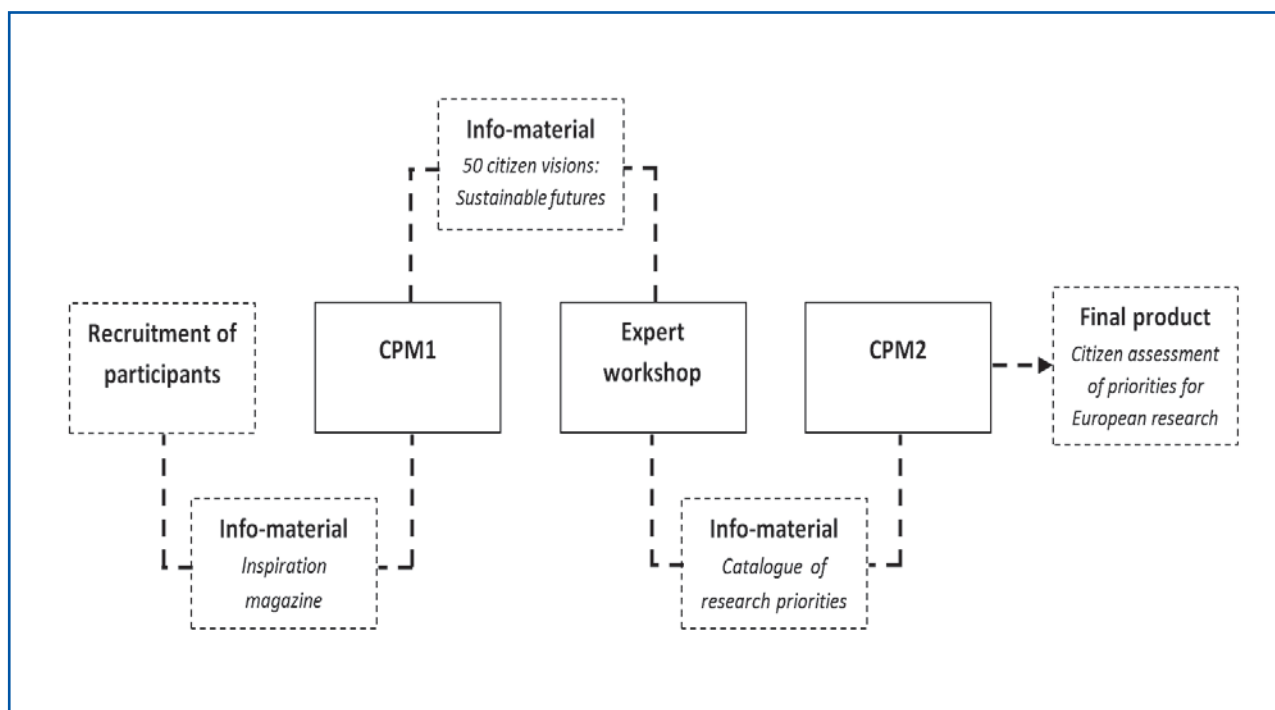
8.5. On R&I policy priorities from the assessment of sustainable innovation ‘aspirations’

There are several reasons why efforts should be made to find ways of allowing citizens a say over the way in which research funding is spent, including the robustness and accountability of the outcomes. Especially when it comes to applied and challenge-driven research, it is democratically fair to offer citizens the opportunity to influence the kind of knowledge and solutions requested from scientists in order to meet societal challenges. The outcome of this research is likely to affect and shape their future, so why shouldn’t they be invited to influence the way in which this future is shaped?

Different participatory methods are available to involve citizens and stakeholders in research and research policy development. This section explores ways in which citizens can be involved in a particular phase in the research decision-making process, namely the definition of research priorities, and what insights the results offer in comparison to other ways of setting R&I priorities. The citizen participation method used in CASI involved three key steps and activities (Figure 10):

- First Citizen Panel Meetings (CPM1), which produced 50 citizen visions for a more sustainable future;
- Expert workshop during which experts formulated visions into research priorities and ranked them;
- Second Citizen Panel Meetings (CPM2), where citizens validated and ranked the research priorities produced at the expert workshop.

Figure 10: Producing citizens’ research priorities



Both rounds of citizen panel meetings (CPMs) were organised in 12 European countries partnering in the CASI project: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, Germany, Italy, Poland, Portugal, Slovenia and the United Kingdom. All partners followed the method, training and guidelines

developed by the Danish Board of Technology, which ensured a uniform process across all 12 countries, and allowed for better comparison of results. In all countries, citizens were recruited with the purpose of reflecting the demographic diversity of their country with regard to age, gender, education, occupation and geographical zone of residency.

An inspiration magazine was produced in order to inspire, motivate, inform and support participating citizens, and to prepare them for the production of their own visions for a sustainable future.¹⁷ Each vision included a short and long description of the citizens' vision; longer and more detailed description of the vision included both benefits and possible negative consequences of the vision, as well as information on the resources and actions necessary for the potential realisation of the vision. Twenty-three experts from different scientific and organisational backgrounds were then gathered at a two-day workshop in Copenhagen to 'translate' the visions into 27 concrete research priorities (Table 25). As part of the process they were also asked to give each of them a score, indicating how novel, essential and timely they thought the visions were.

Table 25: Overall rating of 27 CEC-based research priorities

Overall rank	Research priority
1	Improvement of European electricity transmission to increase renewable energy production
2	Research on business models and changing institutions related to sustainable energy economy
3	Sustainable living environment
=4	Holistic education for a sustainable future
=4	A new European food culture
6	Access to natural resources as a human right
7	Co-developing green technology
=8	Sustainable economics
=8	Unified ecological grading system
10	Sustainable transformation of existing traffic infrastructure in cities
11	Supporting people to become producers of renewable energy
12	Supporting an active civil society for sustainable development
13	New working models – new economic models
=14	Sustainable construction of buildings
=14	Fair and participatory access to limited resources
=16	Understanding and implementing sustainable electronics
=16	Innovating agriculture: the sustainability option
=16	New spaces for public discourse
=19	Supporting local/regional agricultural production, distribution and consumption systems
=19	Supporting eco-preneurship

¹⁷ <http://www.casi2020.eu/library/citizen-panels/>

21	Collaboration through shared space
22	Impact of virtual communities in behaviour change
23	Ensuring inclusive and dynamic city centres
24	Enhanced physical activity for better quality of life and energy efficiency
25	Exploring the introduction of insect food
26	More green in cities
27	Research on individual urban farming

Note: '=' indicates that at least two research priorities have received the same rating.

Source: Repo, Kaarakainen and Matschoss (2015)

At the second Citizen Panel Meeting, citizens discussed and assessed the extent to which the research priorities elaborated by the experts were sufficiently 'faithful' to the original visions from CPM1 and how important they were to achieve a desired, sustainable future. The confirmed citizen-expert-citizen (CEC) based research priorities were ranked by the citizens to reveal the top 10 priorities, which, in their opinion, were most important for their country. Results from the 12 citizen panels were then merged, resulting in a transnational top 10 list of the citizens' preferred research priorities (Table 26), as formulated in the engagement process.

Table 26: Top 10 CEC-based research priorities

Rank	Top 10 Citizens-Experts-Citizens (CEC)-based research priorities
1	Support local/regional agricultural production, distribution and consumption systems
2	Holistic education for a sustainable future
3	Support people to become producers of renewable energy
4	Sustainable construction of buildings
5	Sustainable transformation of existing traffic infrastructures in cities
6	New working models – new economic models
7	Innovate agriculture: the sustainability option
8	More green in cities
9	Understand and implement sustainable electronics
10	Fair and participatory access to limited resources

Source: Repo *et al.* (2015)

These top 10 CEC-based European priorities are described in more detail below:

1. *Support local/regional agricultural production, distribution and consumption systems*

“Research should be done on how to encourage local community producers and suppliers to support each other, how to reduce the levels of pollution, as well as issues related to local and regional alternative market production, distribution and consumption. Furthermore, research should examine how to ensure that local production is prioritised, how it could substitute part of the supermarket supply, how to

encourage local communities to identify their local ethnic, traditional and seasonal products and dishes, and, finally, how to develop tools to create functioning business models, quality and labelling” (ibid.).

2. *Holistic education for a sustainable future*

“This research priority focuses on how to identify and elaborate the skill-set that is needed for ‘eco-citizenship’. Further research should be directed at exploring the differences between types of educational systems and whether, and how, they promote eco-citizenship. Research should also focus on the relevant characteristics of educational systems, on how educational systems can adapt to a more holistic mind-set and, finally, on how educational systems are perceived and valued in different countries” (ibid.).

3. *Support people to become producers of renewable energy*

“This research priority focuses on how to support people to become producers of renewable energy. Further research should be carried out with regard to mechanisms that can increase the bargaining power of small-scale energy producers, and give them more market power” (ibid.).

4. *Sustainable construction of buildings*

“This research priority focuses on how to build and retrofit in innovative carbon-neutral ways. To this end, research should be done to identify materials that last longer, or are made of recyclable materials. There is a need for business models, incentives and understanding of the things that can ensure large-scale changes in the building sector. Furthermore, there is a strong need for continued development of new technologies and materials. Research should be directed at how public procurement can be a driver in the process, what kind of new innovative service designs can spur further dissemination, and how to minimise all environmental costs” (ibid.).

5. *Sustainable transformation of existing traffic infrastructures in cities*

“Research priorities should ensure comparative studies of local cases of city planning targeting traffic planning, infrastructures and mobility modes. Key questions include ‘How can a city accomplish changes in this field’, and ‘Do ideas for a transformation of traffic infrastructure exist’? Solutions exist; however, their implementation will depend on political will” (ibid.).

6. *New working models – new economic models*

“This research priority focuses on new economic models of value creation as well as formal and informal economies. One could look at existing companies or cases with reduced working time, and look at their social, economic and environmental impacts and their transferability. Interactions between regulators, the labour market, social infrastructure and the public sector should be examined. Similarly, there should be exploration of whether the general public would be interested in half-day labour. Development of alternative economic models and a better understanding of their dynamics and underlying discourses are required” (ibid.).

7. *Innovate agriculture: the sustainability option*

“Research priorities should focus on a comparative study of experiences with public regulation to increase organic food production and consumption and, furthermore, on experiences with changes in household diets that focus on a lower consumption of animal products. Research should be directed towards the question of how to create new green jobs. Increasing the share of organic farms in the EU is also important, alongside the subsidies that are reforming the CAP” (ibid.).

8. *More green in cities*

“Additional research should be done on best practices to make cities greener, and on their effects on urban liveability and living conditions. Moreover, research should focus on creating comprehensive planning instruments to increase the share of urban green areas, and in this respect build on analysis of best cases or practices” (ibid.).

9. *Understand and implement sustainable electronics*

“This research priority focuses on the application of the concept of the circular economy to the electronics industry. For instance, there is growing interest in how leasing as a new consumption model, and new supply-chain monitoring systems, can be set up to assess the social and environmental impact of production. Research should focus on new models for the application of a circular economy and the different value chains in the production of electronics” (ibid.).

10. *Fair and participatory access to limited resources*

“Research should focus on the excuses of different actors for not acting on the problems of limited resources. Participatory scenario-building activities should be promoted and implemented. Concept analysis should be conducted and all major intended and unintended consequences should be studied. Information about the gatekeepers of change and drivers with veto powers could be useful” (ibid.).

8.6. Tentative future directions

The CASI project has provided new and original contributions to sustainability research and innovations agendas, as well as citizens’ priorities for research. This concluding section builds links between both sets of priorities and tentatively suggests that citizen support for social research and innovation topics is prevalent, and that there are opportunities for cross-cutting citizen-supported priorities across a wide range of Horizon 2020 SC5 priorities on sustainable innovation.

As described previously in this chapter and Chapter 4, the CASIPEDIA-based R&I Policy Agendas for SI have been developed through an analysis of the quadruple helix of SI stakeholders’ objectives. This analysis represents a state-of-the-art perspective on the agendas prevalent in 28 European countries. In contrast, the citizen-based research priorities (though developed and facilitated by experts in the sustainability and participation field) and their internal ranking originate from citizen panels in 12 European countries.

While the methodological bases, the geographical scope and the analytical levels of these two sources of data are vastly distinct, it may be worthwhile to compare them in order to provide a tentative reflection on future and potentially disruptive issues of concern (see Christensen *et al.*, 2015 on disruptive innovation).

The following reflections are based on an analysis that the University of Manchester has carried out and presented in greater detail in a project report (see Popper *et al.*, 2016). Table 27 summarises the links between the two sets of SI priorities.

A notable observation is that socially oriented R&I agendas correspond most frequently to citizens’ priorities. This comes as no surprise, as citizens tended to prefer socially relevant topics throughout their involvement process (Bedsted *et al.*, 2015; Repo *et al.*, 2015; Matschoss *et al.*, 2015). The agenda focusing on ‘*Strengthening eco-community empathy and crowd-driven development*’ corresponds to four of the CEC-based top 10 priorities, while the agenda focused on ‘*Developing sustainable urban and rural infrastructures for the bioeconomy*’ corresponds to six of the CEC-based priorities. Although the frequencies cannot be considered significant for assessing the relative importance of these two agendas, they certainly demonstrate that public support could provide opportunities for a citizen-heeding reallocation of research and innovation resources, and thus facilitate development of the Horizon 2020 research agenda, in particular concerning SC5. Another supporting argument for allocating R&I resources to these policy agendas based on evidence found in CASIPEDIA is that they correspond best to the SC5 priorities in Horizon 2020 (see also Table 14 of Chapter 4) and the fact that the studied 202 cases included a wide range of SI initiatives led by business, government, civil society and research/education stakeholders, thus offering a real quadruple helix approach to R&I agenda setting.

Other CASIPEDIA-based R&I Policy Agendas appear more specific and differentiated from the citizen perspective. Two agendas correspond to two citizen priorities: ‘*Fostering eco-local-agriculture and bio-resources efficiency*’ links to the CEC-based priority of ‘*Supporting local/regional agricultural production, distribution and consumption systems*’ and ‘*Innovating agriculture: the sustainability option*’, while ‘*Implementing sustainable transport and smart mobility innovations*’ corresponds with the CEC-based

priorities of ‘Sustainable transformation of existing traffic infrastructure in cities’ and ‘New working models - new economic models’. Furthermore, both these agendas rank low against the background of SC5 in Horizon 2020.

All other six CASIPEDIA R&I Policy Agendas correspond to only one of the CEC-based top 10 research priorities, thus indicating that there could be a discrepancy between what is currently taking place in research and innovation, and what citizens wish for.

Table 27: Comparison of R&I Policy Agendas and CEC-based top 10 European research priorities

4-Helix-based R&I priorities (CASIPEDIA) (numbers in brackets show respective CEC-based priority)		CEC R&I priorities (As voted by citizens in 12 countries)	
4-Helix R&I 1	Strengthening eco-community empathy and crowd-funded development (CEC 1, 3, 6, 10)	CEC R&I 1	Supporting local/regional agricultural production, distribution and consumption systems
4-Helix R&I 2	Developing sustainable urban and rural infrastructures for the bioeconomy (CEC 1, 3, 4, 6, 8, 9)	CEC R&I 2	Holistic education for a sustainable future
4-Helix R&I 3	Deploying responsible environmental and resource-efficiency strategies (CEC 10)	CEC R&I 3	Supporting people to become producers of renewable energy
4-Helix R&I 4	Creating sustainable bio-fuel and renewable energy solutions (CEC 3)	CEC R&I 4	Sustainable construction of buildings
4-Helix R&I 5	Promoting foresight for sustainability governance and intelligence (CEC 10)	CEC R&I 5	Sustainable transformation of existing traffic infrastructure in cities
4-Helix R&I 6	Advancing recycling and circular use of waste and raw materials (CEC 4)	CEC R&I 6	New working models - new economic models
4-Helix R&I 7	Embedding sustainability in cultural and holistic education models (CEC2)	CEC R&I 7	Innovating agriculture: the sustainability option
4-Helix R&I 8	Fostering eco-local-agriculture and bio-resources efficiency (CEC 1, 7)	CEC R&I 8	More green in cities
4-Helix R&I 9	Implementing sustainable transport and smart mobility innovations (CEC 5, 6)	CEC R&I 9	Understanding and implementing sustainable electronics
4-Helix R&I 10	Dealing with climate issues and managing greenhouse gas emissions (CEC 1)	CEC R&I 10	Fair and participatory access to limited resources

While the socially oriented agendas appear cross-cutting, the following four citizen priorities link to only one CASIPEDIA-derived R&I Policy Agenda:

- *Holistic education for a sustainable future;*
- *Sustainable transformation of existing traffic infrastructure in cities;*
- *More green in cities; and*
- *Understanding and implementing sustainable electronics.*

As these CEC-based top 10 priorities appear to be of a rather general and extensive character, it would seem worth further investigating how they could be better incorporated into established research agendas.

In sum, a comparison of the CEC-based top 10 research priorities against the CASIPEDIA-based R&I Policy Agendas, which were also reviewed against the SC5 priorities of Horizon 2020, reveals useful opportunities to further develop a truly shared European research and innovation agenda. In short, there appears to be support for social research topics and opportunities to promote cross-cutting citizen-supported topics across a wide range of Horizon 2020 SC5-related priorities on sustainable innovation. As mentioned above, because of the constraints of the data compared, these are tentative insights that merit further analysis.

8.7. Conclusions and recommendations

The CASI project has demonstrated an innovative and viable approach to aggregating intelligence which is meaningful for a large pool of sustainability stakeholders. In particular, matching analyses of citizen priorities with the actual evidence from sustainable innovation initiatives, then putting these analyses within a coherent policy awareness framework, proved to be a powerful knowledge-generation instrument. In addition, integrating citizen aspirations is a challenging exercise that not only contributes to enhancing democratic participation and legitimacy, but also – and very importantly – strengthens researchers', scientists' and even decision-makers' capacity to more precisely identify issues that can hinder progress, and to deliver relevant results.

CASI has also aptly demonstrated the potential of cross-disciplinary approaches, whereby data from multiple and diverse sources is cross-compared and taken into consideration, even though it seems to contradict established paradigms. The added value of engagement approaches is still underexplored, however – not only in terms of frequency of applying engagement methods, but also in terms of integrating these as part of larger research methodologies seeking to explore experiential and knowledge sources.

Finally, three final messages can be added which summarise some key insights presented throughout the chapter. They represent a final set of recommendations that may influence and enhance sustainability-oriented policy action:

- *Policy makers should encourage public engagement in research initiatives that aim to support/inform SI policy action.* Facilitate a rational, adequate and effective integration of public engagement activities in research projects. The incorporation of citizens, stakeholders and relevant experts is particularly important when research aims to inform and support the formulation of sustainable innovation policies.
- *It is necessary to match citizens' expectations with existing SI policy priorities.* Encourage research-based advisory bodies, projects or agencies to utilise methodologies that analyse how citizens' actual aspirations and concerns really do match the rest of research evidence and empirical data. Acknowledging potential discrepancies with these methodologies would drive policy action towards more appropriate, precise and democratic SI policy formulations.
- *SI policy action needs to consider the contribution of citizens to addressing social issues linked to sustainable innovation.* Strengthen the role of citizens in the elaboration of policy agendas that tackle socially relevant topics and issues. The analysis of R&I priorities undertaken in CASI actually suggests that the social dimension is reinforced and enriched when citizens' participation is included in the agenda-setting process.

References

- Bedsted, B., Ibsen-Jensen, J., Kloppenborg, E., Kyhn, B., Kaarakainen, M., Matschoss, K., Repo, P. (2016) European Citizens' Visions for a Sustainable EU Future - Research Priorities and Policy Advice. www.casi2020.eu.
- CASIPEDIA (2017) State-of-the-art of Sustainable Innovation Database. [Online]. CASI Work Package 2 led by the University of Manchester, CASI project. <http://www.casi2020.eu/casipedia/>.
- Christensen, C.M., Raynor, M.E. and McDonald, R. (2015) What is disruptive innovation? *Harvard Business Review*, December, pp. 44–53.
- Kaarakainen, M., Repo P., Matschoss K., Bedsted B., Damianova Z., Popper R. and Rask, M. (2015) 50 Citizen Visions on Sustainable Futures. www.casi2020.eu.
- Matschoss, K., Repo, P., Kaarakainen, M., Kloppenborg, E., Ibsen-Jensen, J., Kyhn, B. (2015) Citizen Assessment of Priorities for European Research. Report on the second citizen panel meetings (WP 3, Task 3.4). CASI project. www.casi2020.eu.
- Popper, R., Velasco G. and Popper M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.
- Popper, R., Velasco, G. and Ravetz, J. (2016) State-of-the-art of Sustainable Innovation: climate action, environment, resource efficiency and raw materials. CASI project report. Deliverable 2.1. <http://www.casi2020.eu/library/#d8838>.
- Repo, P., Kaarakainen, M. and Matschoss, K. (2015) European research priorities based on citizen visions. Report on the CASI expert workshop held in Copenhagen. www.casi2020.eu.

9. Sustainable innovation policy advice: outlooks and key messages

Guillermo Velasco, University of Manchester

Rafael Popper, University of Manchester

Monika Popper, Futures Diamond

Zoya Damianova, ARC Fund

Ventseslav Kozarev, ARC Fund

Petteri Repo, University of Helsinki

Kaisa Matschoss, University of Helsinki

Minna Kaarakainen, University of Helsinki

9.1. Abstract

Grounded in theoretical assumptions on evidence-based policy-making and participatory advice research, this chapter presents a critical reflection on and discussion of different advisory activities carried out in the CASI project, namely the assessment of sustainable innovation initiatives, policy developments and citizens' visions.

9.2. Introduction

The general objective of this chapter is to present a critical reflection on the capacity of CASI-F (Popper *et al.*, 2017) to support the generation of policy advice. To this end, three distinct outlooks are debated, drawing on the outcomes of the three CASI-F tracks described in Chapter 3.

After introductory and theoretical sections (9.2 and 9.3) section 9.4 is focused on the analysis of the first CASI-F track, supported by CASIPEDIA (2017). Drawing on SI practical evidence, the analysis emphasises the importance of inferring managerial aspects and recommendations from the observation of *sustainable innovation* initiatives. Next policy developments are discussed, based on the available *policy* evidence gathered in CASI, i.e. analysis of CASI policy briefs. Finally, some policy implications are inferred from the third approach of CASI-F, i.e. the analysis of *citizens' visions* and *aspirations*. Based on the results of citizens' panel meetings, this analysis emphasises the relevance that *participation* and *interaction* have in the construction of policy advice.

The final section (9.5) draws on policy messages presented in previous chapters and on the policy outlooks discussed to highlight the relevance that mobilisation, participation, interaction, knowledge transfer and multi-perspective approaches have in sustainability-oriented policy-making processes.

9.3. Policy advice on sustainable innovation

9.3.1. The character of evidence-based policy advice

Evidence-based information and existing knowledge are key elements of informed policy discussions and policy development. Evidence-based policy is often described as a function that provides reliable information for policy discussion, policy development, decision-making and policy action. The aim is to formulate policies addressing real problems, and which rely on evidence rather than on short-term policy pressures (European Commission, 2016; Majcen, 2016).

Evidence-based policy and policy-making have been the European Union's cross-cutting theme since 2001 and its importance has grown in recent years. The thinking behind evidence-based policy is based on the political, scientific and practical implementation of knowledge. Moreover, the influence and importance of knowledge for policy-making can be seen as significant, as opposed to doing 'what works', which was a common approach to policy-making in the past (see, e.g., Lee and Kirkpatrick, 2012; Sharman and Holmes, 2010; Head, 2008; Parsons, 2002; Sanderson, 2002).

When data is ‘translated’ into information and usable knowledge, evidence-based approaches can bring new ideas to the innovation value chains. Some authors have also discussed the amount of resources, especially time, that these sorts of evidence-based policy-making processes usually demand (Head, 2008; Sanderson, 2002). In practice, evidence-based policy-making is often based on statistics, large data sets of practices, and other accurate information that can assist in the development of effective policies.

European Commission evidence-based policy-making is based on information originating in institutional practices (e.g. EU institutions and scientific advisory structures), and from EU-funded research and scientific communities. In this sense, one of the European Commission’s roles with respect to evidence-based policies is to establish a reliable body of statistical information that contributes to policy-making, and to support related investments (European Commission, 2016; Majcen, 2016).

The CASI project has developed a sustainable innovation knowledge platform, CASIPEDIA, which gathers real SI experiences from more than 500 SI initiatives (including practices, outcomes and players) from across Europe, and beyond. Its structure facilitates the identification and analysis of critical issues, as well as the development of actions and more specific Action Roadmaps, all of which can provide useful insights into the formulation of more effective and evidence-based sustainable innovation policies, and into the definition of more solid SI corporate strategies.

9.3.2. The character of SI participatory policy advice

There are very few studies that propose rules or guidelines to support policy advice. Some objectives of the policy advice practice are the selection of alternative policy options, the identification (or design) of policy instruments, and the assessment of impacts and potential implications of policy choices. There is, however, a considerable consensus on the benefits of relying on *expert opinion* during participatory advice processes, in order to increase the (cognitive) legitimacy of policy actions. It is also widely assumed that the participation of *citizens* in policy advice processes makes policy decisions more democratic and improves the quality of participatory governance. Experts’ and citizens’ participation influences the accuracy of policy decisions, inasmuch as advice is more likely to be correct when multiple actors are involved in the advisory process, especially when they utilise multiple information sources (Yaniv, 2004a; 2004b). During the advisory process a variety of recommendations needs to be averaged and synthesised, thereby identifying consensus and reducing the variations between individuals’ opinions, and consequently decreasing the possibility of error (*ibid*).

Another beneficial aspect of participation is based on its capacity to foster interaction among individuals, which gives people the opportunity to explain to others their personal choices, beliefs and ideas, thus increasing the confidence of their positions (Heath and Gonzalez, 1995). In this respect, group thinking may be more efficient than individual thinking when a group shares a similar conceptualisation of systems and the challenges to be addressed. Many studies also indicate that groups perform better and create more efficient solutions when their members acknowledge the function they represent in the innovation system and the role they assume in the discussions (Mathieu *et al.*, 2000).

9.4. Sustainable innovation policy outlooks

9.4.1. Policy outlook based on SI evidence

The benefits of using sound evidence in policy-making are often undervalued in comparison with other options, which, in contrast, encourage the utilisation of participatory processes. While admitting the great potential of participative and interactive mechanisms to devise practical solutions to systemic and complex problems, it seems important to acknowledge the capacity that a deliberative and reflective analysis of evidence may have in the formulation of these problems.

In a context that gradually incorporates citizens’ participation in the practice of policy advice the utilisation of insufficiently structured instruments for interpreting a large volume of information may give rise to generic or imprecise conclusions and recommendations. Effective organisation of available evidence and utilisation of systematic methodologies are necessary to synthesise and understand important amounts

of data and to generate meaningful action alternatives with the right level of specificity, thus avoiding vagueness.

Different approaches have been used in this report (see Chapters 4 and 7) to analyse practical evidence of sustainable innovation and to produce recommendations for SI assessment and management. They both relied on real SI experiences. The utilisation of practical evidence guarantees, in general, a high degree of *legitimacy* in the advice and conclusions. In fact, recommendations arising from the analysis of other innovators' experiences may be well accepted, insofar as the SI innovator (as a receptor of advice) will recognise patterns of barriers to and problems with their innovations that are analogous to those experienced in their own practice. Using evidence also increases the *credibility* of the recommendations, since advice is normally better assimilated by the receptor if the evidence used to generate such advice is factual and demonstrable. Finally, the in-depth analysis of evidence brings about higher levels of *responsibility* in the advice. Recommendations are also better accepted if innovation actors are able to find similarities between the objectives of the cases used to create the advice and their own innovation rationales.

It is then reasonable to admit that the volume of data and the transparency of evidence-based methodologies can affect the quality of policy recommendations, especially when quality is understood as a combination of legitimacy, credibility and responsibility.

One example of an evidence-based approach is described in Chapter 7 of this report. The exercise drew upon the piloting of 43 SI initiatives in order to generate a set of 55 meta-actions for SI management. While these actions are valid in confirming that innovation management, in the area of sustainability, demands similar measures to the practice of innovation in many other areas (e.g. actions inviting people to 'provide training and development possibilities for personnel at all management levels' or to 'analyse and understand changes in culture, policies or processes' are generic enough to be applicable to activities ranging from medical practice to purely financial activities), the usefulness of meta-actions confirms the prevalence of traditionally well accepted innovation paradigms, such as the relevance of research and education, the importance of getting funds, the benefits of partnerships and collaboration, and so on. As part of a mutual learning process, meta-actions may serve to bring some widely recognised innovation principles into the CASI debate, while casting some light on technological and social innovation assessment and management.

Beyond the above-mentioned insights, methodological conclusions may also be extracted by comparing the results presented in Chapters 4 and 7. These illustrate how a structured methodology can reduce vagueness and develop more precise or specific advice, despite dealing with a larger amount of analysed evidence. Using data gathered from more than 200 SI initiatives, Chapter 4 analysed over 1800 objectives from SI innovators. As a next step, a strategy for data analysis was designed, as described in Chapter 8, in order to better deal with a large quantity of practical SI evidence. The process gave rise to 10 research and innovation policy agendas for SI. Some important features that give particular legitimacy to such a systematic approach include: (1) the level of specificity of final conclusions (e.g. 'Providing users of environmental data with real-time analysis/modelling of air, land and water quality', 'Exchanging information on and managing the surplus of resources in the public sector'); (2) the exclusive focus on sustainability aspects (e.g. 'Lowering the carbon footprint through effective carbon dioxide sequestration and storage'); (3) the classification of priorities by seven types of innovation; and (4) the possibility of tracking and replicating the process of generating full advice to other areas of innovation.

The analysis of the two approaches allows us to propose three methodological suggestions and three content-related conclusions:

Methodological suggestions for developing SI advice:

- Providing advice on innovation assessment and management is a complex process that calls for the combination of participatory processes and the analysis of practical evidence.
- The amount and details of practical evidence considered during the advisory analytical process can influence the quality of results, especially with regard to the levels of legitimacy, credibility and responsibility of the final recommendations.

- The methodology used to generate advice has to be transparent enough to demonstrate the robustness of the inference process and to avoid subjectivity.

Sustainable innovation-oriented conclusions:

- Sustainable innovation is a broad and cross-cutting area that covers numerous dimensions. Specific recommendations are therefore required to address different and specific types of innovation.
- To deal with the broad concept of sustainable innovation, SI advisors need to narrow the policy problem by proposing actions from technological, social, economic, ethical, political, spatial or environmental perspectives (Popper *et al.*, 2016).
- Sustainable innovation has some intrinsic characteristics that to some extent make a difference with respect to other areas of innovation. In particular, SI management is an activity that normally deals with well-identified problems, the solutions to which demand multiple actors' agreement. In terms of the Stacey model of decision-making, SI problems are located in an area of 'political debate' (e.g. decisions related to the utilisation of nuclear energy). The difficulties associated with SI policy processes thus call for the development of instruments that foster the interaction of key actors and open discussions.

9.4.2. Policy outlook based on SI policies

The CASI project has developed a Policy Watch process to follow up on policy developments across European countries. The core of the policy watch process is to identify key policy developments at the European level and link them to corresponding developments at the national level, in order to provide insights on how Europe is progressing, policy-wise, towards meeting H2020 objectives related to SC5 on climate action, environment, raw materials and resource efficiency.

The CASI project has also designed a framework for the assessment and management of sustainable innovation – the CASI Framework (CASI-F). Chapter 5 of this report explores, if and how, CASI-F may assist in policy watch activities by adding analytical value. Corresponding to the aims of CASI-F, the outcome of this pilot activity is targeted at the assessment and management of sustainable innovation policies and the role of public participation in their formulation.

The pilot data consisted of policy recommendations from Issue 3 of the CASI national-level policy briefs, which reviewed the European Union's Europe 2020 strategy from the perspective of resource efficiency. The recommendations were formulated by project partners and country correspondents in 23 European countries, and are based on their professional expertise. The recommendations are not descriptions of existing policy developments, but instead represent CASI project partners' and country correspondents' assessments of how to foster, improve or challenge existing policies.

In the pilot, the policy recommendations were considered within CASI-F and the outcomes of this exercise discussed. The key objective of this procedure was to review whether CASI-F can reveal new thematic and sectoral observations, and accordingly add value to the established policy watch process. At the strategic level, most recommendations targeted government actors and focused on the creation of long-term policy development strategies for energy supply and a low-carbon future, whereas most recommendations at the tactical level tended to focus on government actors and to call for the efficient implementation of existing strategies on energy-related issues. Recommendations at the operational policy level were less prevalent, focusing mainly on the business actor; they tended to be concrete and context-related.

An important finding of the CASI-F pilot was that it helps to identify recurring patterns across policy levels and stakeholder types in the policy recommendations studied. The strategic-level policies emphasised the role of government stakeholders, whereas business stakeholders were highlighted in the implementation of policies. Civil society stakeholders were considered important when the general public needed to be involved and policy recommendations for research and education aimed at improving the knowledge base of sustainable innovation policies. This pattern's emphasis on government stakeholders can be considered conservative and government-centred, as it enforces established stakeholder typologies and stereotypes.

The analysis suggests that CASI policy recommendations support incremental and constructive, rather than radical or disruptive, sustainable innovation policies in the field of the Europe 2020 strategy and resource efficiency. A significant benefit of applying CASI-F to a policy watch lies in the consideration of stakeholders in their respective policy settings. Government stakeholders are prevalent in the recommendations in the realm of Europe 2020 strategy and resource efficiency, while research and education stakeholders are not, which could reflect the long time spans and a perceived requirement for specific expertise. Both examples show that it is beneficial for any policy watch to reflect on and analyse not only the subject of study but also the outcomes. The CASI Framework provides a useful tool for this. In addition, applying CASI-F to policy recommendations reveals that the operational policy level receives limited attention. Therefore, reflection on targeted policy levels could also be useful.

9.4.3. Policy outlook based on SI aspirations

The impetus for addressing today's global challenges is real and present, and requires an extended network of cooperation with all stakeholders within society. Efforts at effective dialogue need to go beyond the business and academic sectors, and involve the nuanced perspectives of citizens and civil society at large, since they tend to pay greater attention to the role of socially grounded solutions. The transition to higher levels of 'sustainability engagement' provides an opportunity for transformative social change to demonstrate its potential as an effective approach to addressing some of the most enduring challenges that people face globally, as well as showing the multitude of benefits that can result for both citizens and scientific programming. Aligning R&I policies with broader societal values through meaningful citizen engagement offers ways to bring about the genuine co-production, co-governance and co-delivery of common sustainability responses. By actively engaging citizens, policy-makers have been able to broaden the scope of available policy alternatives and provide additional criteria for selection between potential solutions, for the purpose of addressing complex contemporary issues. Apart from science, technology and innovation (STI) policy and decision-making, citizens' and other stakeholders' inputs have also been shown to contribute to R&I programme development, project conceptualisation and activities. Owen *et al.* (2013) aptly describe the following benefits of engaging citizens and stakeholders in the field of R&I: (1) it mobilises science to solve societal challenges and makes sure innovators consider the environmental, economic and social impacts of their products and services, thus improving the quality and sustainability of R&I outcomes; and (2) it modulates the direction science takes so as to be responsive to societal needs, concerns and aspirations, and reduces the ethical, legal and social concerns that come with scientific advances. Public participation in R&I activities also improves public confidence in science and innovation as a result of better societal understanding of the rapidly advancing scientific developments and discoveries, and social acceptability of the R&I outcomes. Citizens are an indispensable part of the public engagement landscape and nowadays more actively demand to be involved in the processes of evaluating and co-developing public services and policy instruments, rather than being mere observers or a group affected by decisions that have a direct bearing on their lives. Crucially, by shaping and 'enacting' the principles of sustainable development in their daily contexts, ordinary people tend to carry nuanced knowledge, understanding and experience linked to interdependent social, economic and ecological aspects of sustainability, which require systemic collaboration.

In this sense, the analysis of the CASI dialogue and participation activities has revealed a number of important implications for sustainability, research and innovation policy. Rather than envisaging the sustainable future in straightforward terms, citizens approach sustainability in a compound manner, exploring opportunities for targeted policy interventions that bridge a number of societal challenges. More specifically, their inputs contribute to a conceptual framework for the design of complex (holistic) solutions that simultaneously address imperatives as diverse as the environment, individual and societal wellbeing, resource use, health, human development, and the economy, among others. Importantly, as perceived by citizens, sustainability emerges as a long-term societal goal entailing important socioeconomic requirements for wider social transformation as a complementary and integral element to technological responses.

Indeed, as people make multiple references to a number of socially and culturally relevant themes, such as building social cohesion, reducing pressures on natural resources, encouraging cooperation and peaceful coexistence, improving working conditions, introducing holistic education, and so forth, it is

increasingly apparent that fundamental, rather than merely incremental, changes in our interaction with the external environment are necessary for sustaining human survival. This carries important lessons for policy-makers and practitioners alike, as what is emerging from the perspectives of citizens is the notion that effective sustainability actions ought to simultaneously address topics as diverse as the natural world, public wellbeing, health, human development, resource efficiency, and the economy. Effectively, a qualitatively new state of organising and going about daily activities is proposed to turn sustainability and sustainable innovation into a practice-based concept, which prioritises people's pressing needs, aspirations and concerns. Thus, instead of being envisioned or imagined as some abstract development taking place outside of society's involvement, citizen engagement adds emphasis to the issues that are of relevance to people's lives (health, food security, agriculture, and so on), and offers solutions that can integrate otherwise insufficient, linear approaches dealing with different sustainability elements in isolation. In doing so, citizens are pushing for sustainability policies operating within coupled natural and socioeconomic systems, insisting on the co-delivery of social and technological change for strategic long-term development.

One way to appreciate the need for joint resolutions to complex problems, as advocated by the citizens, is to look at the transition towards sustainable economic models, consisting of several sustainability-oriented system innovations. Radical changes to present production and consumption patterns are seen as necessary to achieve a sustainable future. Taking this perspective, the goal of unlimited economic growth has gradually given way to immediate human needs, values and orientations. Guaranteeing the sustainability of consumer culture and doing away with business-as-usual development models are considered, along with a fairer distribution of wealth. As such, an alternative to the 'silo' approach of sustainability decision-making is taking shape in the bringing together of different types of transformations that enhance the complexity and build-up of potential responses.

In the same vein, encouraging eco-efficiency and environmental improvement is seen as insufficient to steer sustainability, although it appears to be an indispensable element of efforts to this end. Instead, citizens emphasise the importance of the socioeconomic aspects of sustainability, which they consider an integral part of the eco-capacity objectives for the future. In this regard, less emphasis is being placed upon technology as the main agent for sustainable innovation, and more on an alignment of technology, user demands and complex sustainability issues, as key to an effective policy strategy. By weaving technological and non-technological changes, citizens acknowledge different topics they consider critical, giving importance to social experimentation as a key element of sustainability.

Against the above-discussed background, a number of concrete policy recommendations can be developed as guidelines for SI actors, policy-makers and practitioners. These are intended to inform the development of more comprehensive models of sustainability and SI, and to complement other findings and conclusions within CASI. In fact, if attention is to be devoted to citizens' aspirations and ideas about sustainable futures, as we think necessary, different factors of positive change will need to be established and/or fostered in order to cope with today's complex challenges. They include:

- Working towards a more balanced fulfilment of societal needs, which would probably require enhanced SI offerings that are context-sensitive and aimed at maximising the systemic effectiveness of delivered outcomes.
- An intensification of the business–society dialogue through effective processes of value co-creation or consumer co-production of sustainable goods and services. Involving the larger public in the governance of areas of significance to sustainable innovation has to be highlighted at all - strategic, tactical and operational - levels.
- Reconciling broader socioeconomic issues/effects with technological ones in order to fully address people's expectations regarding sustainability. Among other things, a strong emphasis should be placed on how best to bring eco-efficiency considerations into the social economy, and use the latter to advance environmental and equity concerns within sustainability.
- Shifting away from unidirectional technological innovations as sufficient to inform sustainable development. Though fundamentally integral to SI, the technological aspects of sustainability need to be viewed in relation to alternative/systemic solutions.

- Focusing more directly on issues of broader social change and providing the means to empower citizens as drivers of a sustainable future. Greater attention should be paid both to the role of the public as a major agent of change and to its ability to give rise to alternative socio-technical spaces where new ideas and practices can be developed. Embracing a participatory citizen-based model of broader change is bound to contribute to the development of comprehensive SI solutions.

As a horizontal theme, the analysis identified multidisciplinary and cross-sectoral research into SI planning and development as a central theme in innovation policy. Discussing sustainability implies taking into account behavioural, social, cultural and economic aspects, as well as physical and systemic elements, and requires the combination of different disciplinary domains, methodologies and levels of analysis. A truly interdisciplinary approach would provide a deeper understanding of the complex interrelationships between sustainability systems.

9.5. Conclusions and recommendations

This chapter has deliberately adopted a practical orientation and presented a critical perspective of the CASI experience. It provides three reflections based on the CASI-F triple analysis approach focused on SI evidence, SI policies and SI aspirations.

Overall, the different sections of the chapter have recognised the capacity of CASI-F to foster and deploy its underlying principles, i.e. the mobilisation and mutual learning of SI actors. The combination of various elements - namely the understanding, mapping and analysis of 202 SI initiatives, as presented in section 9.3.1; the debate around actual policies to acknowledge current initiatives configuring the SI policy landscape at national and European levels, as described in section 9.3.2; and the sequential dialogue established between citizens and experts to capture civil society aspirations, as discussed in section 9.3.3 - reveals the extent to which the CASI project has accomplished its stakeholder mobilisation and mutual learning rationales.

The mobilisation, participation and interaction processes promoted within CASI have also facilitated the generation of knowledge and its effective circulation and transfer between the actors involved. Innovators', policy makers' and citizens' points of view have been systematically analysed, which also served to reflect on the necessity of adopting and fostering multi-perspective approaches in SI policy formulation. The policy messages listed in section 9.4 reflect, to greater or lesser extent, the relevance of these mobilising, participative, interactive, knowledge-transferring and multi-perspective aspects.

In practice CASI-F has proved useful in supporting the development of these aspects, which makes it a strong candidate to become an instrument of intelligence for the elaboration of forthcoming SI policies and programmes, and to assist in envisioning the direction that SI practices, policies and sustainability aspirations could take at the European level.

Further discussion will now be necessary to identify what type of contributions, achieved throughout the implementation of these mobilisation and mutual learning processes within CASI, have been most useful and enlightening for the actors involved in CASI, as well as to recognise what sort of insights and outcomes, produced through collaboration with these actors, will be most beneficial for the future practice of European SI assessment and management.

References

- CASIPEDIA (2017). State-of-the-art of Sustainable Innovation Database. [Online]. CASI Work Package 2 led by the University of Manchester, CASI project. <http://www.casi2020.eu/casipedia/>.
- European Commission (2016) Evidence based policy making in European Commission. <https://ec.europa.eu/jrc/en/publication/evidence-based-policy-making-european-commission>.
- Head, B. W. (2008) Three lenses of evidence-based policy. *Australian Journal of Public Administration* 67 (1), pp. 1–11.
- Heath, C. and Gonzalez, R. (1995) Interaction with others increases decision confidence but not decision quality: evidence against information collection views of interactive decision-making. *Organizational Behavior and Human Decision Processes* 61, pp. 305–326.
- Lee, N. and Kirkpatrick, C. (2006) Evidence-based policy-making in Europe: an evaluation of European Commission integrated impact assessments. *Impact Assessment and Project Appraisal* 24 (1), pp. 23–33.
- Majcen, Š. (2016) Evidence based policy making in the European Union: the role of the scientific community. *Environmental Science and Pollution Research*, pp. 1-3.
- Mathieu, J.E., Heffner, T.S., Goodwin, G.F., Salas, E. and Cannon-Bowers, J.A. (2000) The influence of shared mental models on team process and performance. *Journal of Applied Psychology* 85, pp. 273–283.
- Owen, R., Bessant, J. and Heintz, M. (2013) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester: Wiley.
- Parsons, W. (2002) From muddling through to muddling up: evidence based policy making and the modernisation of British Government. *Public Policy and Administration* 17 (3), pp. 43–60.
- Popper, R., Velasco G. and Popper, M. (2017) CASI-F: Common Framework for the Assessment and Management of Sustainable Innovation. CASI project report. Deliverable 6.2.
- Popper, R., Velasco, G. and Ravetz, J. (2016) State-of-the-art of Sustainable Innovation: Climate Action, Environment, Resource Efficiency and Raw Materials. CASI project report. Deliverable 2.1. <http://www.casi2020.eu/library/#d8838>.
- Sanderson, I. (2002) Evaluation, policy learning and evidence-based policy making. *Public Administration* 80 (1), pp. 1–22.
- Sharman, A. and Holmes, J. (2010) Evidence-based policy or policy-based evidence gathering: biofuels, the EU and the 10% target. *Environmental Policy and Governance* 20 (5), pp. 309–321.
- Weller P. and Stevens, B. (1998) Evaluating policy advice: the Australian experience. *Public Administration* 76 (3), pp. 579–589.
- Yaniv, I. (2004a) The benefit of additional opinions. *Current Directions in Psychological Science* 13, pp. 75–78.
- Yaniv, I. (2004b) Receiving other people's advice: influence and benefit. *Organizational Behavior and Human Decision Processes* 93, pp. 1–13.

Annexes

10. Annexes

10.1. Annexe 1: CASI project work packages and tasks structure

The work plan spanned a period of 42 months (3.5 years) and was structured into 11 work packages.

WP1: Management. This work package established the management structure and internal management procedures. A Steering Committee was established as an oversight mechanism for the project, and an Advisory Committee and Network of country correspondents were set up to expand the geographical outreach of the project.

- Task 1.1. Technical management
- Task 1.2. Financial management
- Task 1.3. Management procedures
- Task 1.4. Action Networks
- Task 1.5. Sustainability of the project

WP2: State-of-the-art. WP2 laid the foundation for the rest of the project. It involved a state-of-the-art report on research and innovation related to the Grand Challenge 'Climate action, resource efficiency and raw materials' (SC5). Review, analysis and mapping of sustainable innovation initiatives were carried out to establish a conceptual theoretical framework, complemented by empirical cases gathered across Europe, and to provide a section on working definitions and approaches to sustainable innovations. This WP is closely linked to WP3, WP4, WP5 and WP6.

- Task 2.1. To systematically identify and review key sustainable innovation (SI) case studies
- Task 2.2. To map key practices in SI case studies
- Task 2.3. To map key players in SI case studies
- Task 2.4. To map key outcomes in SI case studies
- Task 2.5. To develop robust SI conceptual and methodological frameworks

WP3: Dialogue and Participation. WP3 ran in parallel with WP2 and went beyond it, aiming to build a common understanding of sustainable technological and social innovation, as well as a common approach to SC5 among the CASI partners and country correspondents. It enhanced the dialogue among consortium partners, country correspondents and relevant stakeholders across Europe on sustainable innovation and environment-related issues through the involvement of citizens in research and innovation policy-making, and by identifying topics for future research.

- Task 3.1. Capacity-building for the consortium partners and the country correspondents
- Task 3.2. Stakeholder Mutual Learning Seminars (MLS)
- Task 3.3. Webinar for wider societal learning and participation
- Task 3.4. Citizens and experts meetings

WP4: Common Framework for Assessment and Management of Sustainable Innovations (CASI-F). The objective here was to develop a common framework for assessing the sustainability of innovations, i.e. their advantages, disadvantages, relevance, benefits and risks, particularly their social, environmental

and economic dimensions, taking into account general public concerns. For this purpose, an online survey was launched, and consultations were held with relevant stakeholders in the 12 participating countries.

- Task 4.1. Online survey on the characteristics of SI
- Task 4.2. Draft proposal of CASI-F
- Task 4.3. Stakeholder workshops on the draft proposal of CASI-F

WP5: Pilot projects on testing and validating CASI-F. In order to avoid collecting irrelevant and useless data, the CASI partners conducted a pilot testing of CASI-F. CASI-F was applied to a number of technological and social innovation cases gathered in WP2, so as to (i) identify shortfalls and (ii) propose adjustments/corrective changes to the assessment methodology.

- Task 5.1. Technology innovation cases to be assessed via the CASI-F
- Task 5.2. Social innovation cases to be assessed via the CASI-F

WP6: Management of sustainable innovation. WP6 ran in parallel with WP5. The partners worked with the case study actors involved in WP5 (technology or social innovators) in order to verify and include the changes requested or suggested in the final version of CASI-F.

- Task 6.1. Interviews/working meetings with the developers of innovation cases
- Task 6.2. Revision and finalisation of CFAMSI

WP7: Policy Watch. This WP has established a common interface for easy monitoring of EU and national policy cycles in order to enable the streamlining of sustainable innovation measures into organisational, national and European strategic and policy planning processes. Throughout this WP, partners have been engaged in producing policy briefs. The immediate output of this WP has served as an input for the elaboration and advancement of policy recommendations within WP8. A natural outcome is the European Network on Sustainable Innovation Policy Watch.

- Task 7.1. EU-level policy debates monitoring
- Task 7.2. National policy debates monitoring
- Task 7.3. Reports on policy developments and initiatives
- Task 7.4. Online policy blog

WP8: Policy Recommendations. Activities were focused on developing specific policy recommendations for stimulating wider societal engagement in sustainable innovation activities, for their assessment and improved public management, targeting different levels of governance.

- Task 8.1. Policy dialogues among relevant stakeholders on a national level
- Task 8.2. European-level policy conference on identifying common European priorities
- Task 8.3. Final report on national and European-level policy recommendations

WP9: Heritage. The main challenge was to ensure that stakeholders in Europe, both within and without the consortium would benefit from CASI's outcomes. Several approaches were employed so that the overall sustainability would be ensured beyond CASI's formal duration.

- Task 9.1. Online training for the application of CASI-F
- Task 9.2. Promotion of CASI results and SI
- Task 9.3. Strategy to ensure the sustainability of the project and its results

WP10: Communication and dissemination. All communication and dissemination approaches applied during the project were listed in a communication strategy aiming both to raise awareness among all groups of stakeholders as to why it is necessary for them to interact, exchange ideas and participate in the process of sustainable innovations assessment, and to reach all targeted audiences.

- Task 10.1. Project web portal, homepage widgets, main modules and CMS access
- Task 10.2. CASI Knowledge platform – Online platform for internal exchange of knowledge
- Task 10.3. CASI Library – dissemination database
- Task 10.4. CASI Community – with social networking interfaces
- Task 10.5. CASI Communication Strategy
- Task 10.6. CASI Tutorials –Joint activities and education materials
- Task 10.7. Final national promotional events
- Task 10.8. Participation in EU-level events

WP11: Evaluation. This WP responded to the requirement of the call to establish systems for internal and external evaluation to ensure that project progress and results were in accordance with the work plan and met the objectives of the Science in Society programme.

- Task 11.1. External evaluation, made by independent experts
- Task 11.2. Internal observer
- Task 11.3. Internal evaluation by consortium partners

10.2. Annexe 2: List of 202 SI initiatives analysed in Chapters 3, 4, 8 and 9

The following 202 SI initiatives and more than 500 cases are available online in CASIPEDIA resulting from the systematic mapping of SI practices, outcomes and players led by the University of Manchester as part of the ‘State-of-the-art of Sustainable Innovation’ Work Package of the CASI project (see also Annexe 1 and <http://www.casi2020.eu/casipedia>). The selection of SI initiatives ensured the coverage of the seven types of SI and the public participation of the quadruple helix of SI stakeholders (see Figure 8 in Chapter 4).

Table 28: List of 202 SI initiatives used in Chapters 3, 4, 8 and 9

ID	Country	SI Initiative
1	Australia	Aircarbon
2	Australia	Novacem Technology for Carbon Negative Building Materials
3	Austria	Arche Noah - Diversity of Cultural Plants
4	Austria	Austria Bike to Work
5	Austria	Reparatur- Und Service-Zentrum R.U.S.Z
6	Austria	Solar Taxi Heidenreichstein
7	Austria	The Social Festival Keep the Ball Rolling
8	Austria	Wiener Tafel - Initiative Against the Throwaway Society
9	Belgium	Biom Project

10	Belgium	Content
11	Belgium	Energybook
12	Belgium	Freecycle (Leuven)
13	Belgium	Gaan We Samen Wortels Plukken
14	Belgium	Repair Café
15	Bulgaria	3d Ecobus: Mobile Education Center
16	Bulgaria	Building The First Passive House Kindergarten in Bulgaria
17	Bulgaria	M Cube
18	Bulgaria	Green Hero
19	Bulgaria	Carpool
20	Bulgaria	Green Finance
21	Croatia	Green Energy Cooperative
22	Croatia	Humana Nova: A Social Enterprise that Facilitates Sustainability
23	Croatia	KRK Island: Towards Energy Independence and Zero CO2 Emissions
24	Croatia	The Green Idea: Facilitating Organic Food Production through Marketing
25	Croatia	Using Crowdfunding To Create an Energy Independent School
26	Cyprus	WASP: A Waste Prevention Support Tool for Local Authorities
27	Cyprus	Food Prevention Through Public Awareness Using Leftovers Recipes
28	Cyprus	QuaResE: Quarry Resource Efficiency Demonstration Project
29	Czech Republic	Čez Group Smart Region Project
30	Czech Republic	EWA Aerobic Fermenter
31	Czech Republic	KOKOZA - More Green In Cities
32	Czech Republic	Let's Clean Up Czech Republic
33	Czech Republic	Producing Epichlorhydrine from Renewable Resources
34	Czech Republic	Rekola - Bike Sharing
35	Czech Republic	Skanska's Project City Green Court
36	Czech Republic	Škoda Battery-Powered Electric Bus
37	Czech Republic	Using CNG in DHL'S EXPRESS Transportation Services
38	Denmark	Biotrans System
39	Denmark	Biovalue Spir
40	Denmark	CITIES: Center for IT-Intelligent Energy Systems in Cities
41	Denmark	Innovation Fur

42	Denmark	Transition Now
43	Estonia	Estonian Energy Sector Development Plan: Enmak 2030+
44	Estonia	ELMO: Estonian Electro-Mobility Programme
45	Estonia	Estonian Food Bank
46	Estonia	Estonian Re-Use Centre
47	Estonia	Let's Do It!
48	Estonia	Tallinn: Capital of Free Transport
49	European Union	Med-Algae
50	European Union	Rife 2
147	European Union	I-SCOPE
51	Finland	Climate Doctor
52	Finland	District Cooling
53	Finland	Klemmari: Webportal for Welfare Service Advising and Funding
54	Finland	Kutsuplus: Customised Public Transport
55	Finland	National Cleaning Day
56	Finland	Vegetarian Day in Public Schools
57	France	Andes
58	France	Autolib
59	France	Blablacar
60	France	Compte Epargne CO2
61	France	Enercoop
62	France	Energies POSIT'IF
63	Germany	BINSE: Berchumer Initiative Für Solare Energien E.V.
64	Germany	Dorf Ist Energie(Klug): Village in Energy(Clever)
65	Germany	ELIH-Med: Energy Efficiency in Low Income Housing in the Mediterranean
66	Germany	Fifty/Fifty School
67	Germany	Mobil4You
68	Germany	Stromsparcheck
69	Ghana	Promoting Sustainable Livelihoods in Ghana: Cadbury Schweppes
70	Greece	Device For The Autonomous Access Of Disabled People to the Sea
71	Greece	REPT: Environmental Policy Support Tool for Recycling in Islands
72	Greece	Natural Building and Bioclimatic Architecture

73	Greece	New Guinea Collective
74	Greece	Olive Pits Barbeque Briquettes
75	Greece	Producing Second-Generation Biofuels Using Recycled Waste Cooking Oils
76	Greece	Recycling@Home
77	Greece	Solar Lift: An Energy Autonomous Machine as a City Eco Tool
78	Hungary	Balkantango - Accessories Made of Recycled Materials
79	Hungary	Bioszentandrás: Ecological Farming
80	Hungary	Eco-Partnership Community in Herencsény
81	Hungary	Pannonpower: Biomass Energy Heat Plant
82	Hungary	Real Pearl Foundation: Against Fuel Poverty with Biomass Briquettes
83	Hungary	Sustainability Information Centre
84	International	Global Forest Watch
85	Ireland	Cycle To Work Scheme
86	Ireland	Freetrade Ireland
87	Ireland	Obeo
88	Ireland	Quantum Storage System
89	Ireland	Rdc: Rediscovery Centre
90	Ireland	Smile Resource Exchange
91	Italy	Area C: Congestion Charge In Milan
92	Italy	Cisalpina Green - Sustainable Management of Business Travels
93	Italy	Food Bank Network: Fondazione Banco Alimentare Onlus
94	Italy	Mealup
95	Italy	Monza Bike Friendly
96	Italy	Sharing Torino
97	Italy	Tempo Al Tempo
98	Latvia	Blue Shock Bike: Sustainable City Transportation
99	Latvia	Energy Consumption Data Availability
100	Latvia	Energy Efficiency Services
101	Latvia	Energy Efficient Municipality
102	Latvia	Mobilly
103	Latvia	Social Innovation In Outright Purchases
104	Lithuania	Eco-Recommendations: Awareness-Raising Blog Ekorekomendacijos

105	Lithuania	ICISEM: Integrated Computerised Information System for Environmental Management
106	Lithuania	Optimised Complex Technology of Cleaning Soil Contaminated by Oil Pollutants
107	Lithuania	OZONAS
108	Lithuania	RUBBEE: Electric Drive For Bicycles
109	Lithuania	Care!: Social Movement “Rūpi”
110	Luxembourg	Lorry Rail
111	Luxembourg	Neischmelz Diddeleng: Live2gether – Schmelz2gether
112	Luxembourg	SDK: SuperdrecksKëscht
113	Luxembourg	The Hollerich Village
114	Malta	ALTER AQUA: Non Conventional Water Resources Programme
115	Malta	Demo Ev
116	Malta	Eco Gozo
117	Malta	Ekoskola Malta
118	Malta	HOTER - Wastewater Recycling in the Hospitality Sector
119	Malta	Smart Grid Island
120	Netherlands	Acceleration of the Establishment of Local Renewable Energy Companies by Society
121	Netherlands	Cargohopper: Electrical City Shuttles
122	Netherlands	Fairphone
123	Netherlands	Interactive Energy City Map
124	Netherlands	Local Green Deals
125	Netherlands	Step2save: Making Work with Energy Saving
126	Netherlands	Sustainable Energy Landscape
127	Poland	Dinosaur’s Park
128	Poland	Eko Ants
129	Poland	Individual Company Supports Cycling Employees
130	Poland	Innovative Public Space In Gdynia, Changing the City in Dialogue with Citizens
131	Poland	PEKA: Poznan Electronic Agglomeration Card
132	Poland	Promotional Forest Complex
133	Portugal	Bussaco Digital
134	Portugal	Hydro Efficiency for Buildings and Public Spaces Project
135	Portugal	Keepcare®PRO
136	Portugal	Lighting Living Lab Project

137	Portugal	Participatory Budgeting
138	Portugal	Projeto Rios: Rivers Project
139	Portugal	Sustainability Observatory South of Porto Metropolitan Area
140	Portugal	Wayenergy
141	Romania	ECOH2O: Ecologic Lagoon for Water Purge System
142	Romania	ELSYS: Electronic System for International Transfer of Waste
143	Romania	Greenhouse Building Subsidies
144	Romania	Less Plastics for Bottled Water
145	Romania	Letsdoit Romania: The National Clean-Up Day
146	Romania	The Expandable Building
148	Slovakia	Community Gardens
149	Slovakia	Farmama
150	Slovakia	GA Drilling
151	Slovakia	Greenway Operator
152	Slovakia	Local Food Communities: Lokalne Potraviny Komunity
153	Slovakia	Participatory Budget
154	Slovakia	Trashout
155	Slovenia	Ponnod Prime: Aquaponics Food Production Utilising Waste Heat
156	Slovenia	Eco-Schools
157	Slovenia	Goopti Platform
158	Slovenia	Innovative and Environmental Friendly Façade Ventilation System
159	Slovenia	Innovative Parking System
160	Slovenia	Toring Turbine®
161	Spain	Actyva
162	Spain	AV Symbiosis
163	Spain	Itestit
164	Spain	LIFE Reusing Posidonia
165	Spain	Mermaid
166	Spain	Redes 2025
167	Spain	SIPAID: Comprehensive Flood Alarm and Prevention Management System
168	Spain	Technological Innovation for The Urban Waste Management
169	Spain	WAI

170	Sweden	A Living Lab Stapeln
171	Sweden	Biomass-Fired Combined Heat and Power Plant
172	Sweden	Blocket
173	Sweden	Klädoteket
174	Sweden	Lundamats: A Strategy for Sustainable Transportation System in Lund Municipality
175	Sweden	Myecocost
176	Sweden	Ubigo Mobility Service
177	United Kingdom	Appliances Energy Rating and Market Transformation
178	United Kingdom	Bath and West Community Energy
179	United Kingdom	Circular Economy 100
180	United Kingdom	Community Shop
181	United Kingdom	Earthship Brighton
182	United Kingdom	Ecoflo Biodegradable Loose Fill
183	United Kingdom	Ecoverified
184	United Kingdom	ECB: Engineering and Computing Building
185	United Kingdom	Freecycle Network
186	United Kingdom	GT-VET: Greening Technical Skills
187	United Kingdom	LIW: Location Independent Working
188	United Kingdom	M&S Sustainable Building And Learning
189	United Kingdom	National Industrial Symbiosis Programme
190	United Kingdom	North West Bicester Eco-Town
191	United Kingdom	Oxford Photovoltaics
192	United Kingdom	Rebus: Re-Engineering Business for Sustainability
193	United Kingdom	Sagemcom
194	United Kingdom	SCAP2020
195	United Kingdom	Smart Motorways
196	United Kingdom	Smarter Working West Midlands
197	United Kingdom	Sustainable Citizenship
198	United Kingdom	The Goldfinger Factory
199	United Kingdom	V-Feather Vehicle
200	United Kingdom	X-Wind Power Turbine
201	USA	Artificial Trees
202	USA	Clean Air Make More Initiative

10.3. Annexe 3: List of policy briefs analysed in Chapter 5

All briefs published in the third issue focus on ‘**Europe 2020: Towards Growth and Resource Efficiency**’ and available at <http://www.casi2020.eu/library/policy-briefs/>

- Barsby, S., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for the **United Kingdom**. *CASI Policy Brief*, Issue 3.
- Chonkova, B., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Bulgaria**. *CASI Policy Brief*, Issue 3.
- Coenen, F., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for the **Netherlands**. *CASI Policy Brief*, Issue 3.
- Erdős, K., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Hungary**. *CASI Policy Brief*, Issue 3.
- Ferrara, A., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Italy**. *CASI Policy Brief*, Issue 3.
- Garefi, I., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015). Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Greece**. *CASI Policy Brief*, Issue 3.
- Ibsen-Jensen, J., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015). Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Denmark**. *CASI Policy Brief*, Issue 3.
- Lipnik, A., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Slovenia**. *CASI Policy Brief*, Issue 3.
- Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Finland**. *CASI Policy Brief*, Issue 3.
- Ordóñez, D., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Spain**. *CASI Policy Brief*, Issue 3.
- Piotrowicz, M., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Poland**. *CASI Policy Brief*, Issue 3.
- Popper, M., Fatun, M., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for the **Czech Republic**. *CASI Policy Brief*, Issue 3.
- Racic, D., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Croatia**. *CASI Policy Brief*, Issue 3.
- Rosa, M., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015). Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Latvia**. *CASI Policy Brief*, Issue 3.
- Schultze, J., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Germany**. *CASI Policy Brief*, Issue 3.
- Tatar, M., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Estonia**. *CASI Policy Brief*, Issue 3.
- Van Eynde, S., Ramioul, M., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Belgium**. *CASI Policy Brief*, Issue 3.
- Voukkali, I., Repo, P., Matschoss, K., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Cyprus**. *CASI Policy Brief*, Issue 3.
- Wollner, M., Matschoss, K., Repo, P., Tregner-Mlinaric, A. (2015) Europe 2020: Towards Growth and Resource Efficiency - Insights from and for **Austria**. *CASI Policy Brief*, Issue 3.

10.4. Annexe 4: CASI-F Glossary (Popper *et al.*, 2017)

CASI Actions Bank: An action or advice co-creation tool that explores ways in which critical issues may be managed at strategic, tactical and operational levels, and develops policy roadmaps for prioritised actions. The Actions Bank promotes more systematic and multi-level advice management for SI initiatives. The tool is available for all registered CASI community members and can be accessed through the navigation menu of the CASI portal on the main page of the CASI Actions Bank or by going to the following URL: <http://www.casi2020.eu/actions-bank/>. While most actions in the Actions Bank are automatically extracted from CASIPEDIA results, users can also access a separate input form and add actions by clicking on the 'add action' button without mapping a case. The management of advice is structured around the three most common management levels of advice: strategic (top-level management); tactical (mid-level management); and operational (front-line management). In addition, during the fourth step of CASI-F methodology, actions are targeted at the following four actors representing the quadruple helix of sustainable innovation: (1) government; (2) business; (3) civil society; and (4) research and education. The mapping of these actions can be conducted individually by the innovator (self-assessment), a trained mapper (CASI team member or country correspondent) or collectively by a group of experts or CASI community members invited to contribute to a given SI initiative.

CASI Ideas Bank: An idea (aka critical issue) co-creation and management tool, which draws on over 500 Sustainable Innovation cases from across Europe and the world. Of these, the 202 most CASI-relevant cases were selected for further analysis, which helped gather a wide range of ideas that contributed to the co-creation of the CASI Ideas Bank. These ideas or critical issues represent existing and potential barriers, drivers, opportunities and threats that can influence the success (i.e. uptake, implementation or diffusion) of sustainable innovation. The tool is available for all registered CASI community members and can be accessed through the main navigation menu of the CASI portal, by clicking on the 'add an idea' button on the main page of the CASI Ideas Bank. The mapping of these critical issues can be conducted individually by the innovator (self-assessment), a trained mapper (CASI team member or country correspondent) or collectively by a group of experts or CASI community members invited to contribute to a given SI initiative. The following seven categories of ideas are considered in CASI-F: technological, economic, environmental, political, social, ethical and spatial.

CASI Visions Bank: A vision is a picture or imagination of a desirable future, which may be based upon hopes and dreams - but also upon concerns and fears in relation to problems or imagined threats that are not desirable. The aim of the Visions Bank is twofold: (1) to openly share the results of a highly participatory citizens engagement process resulting in 50 visions on sustainable futures, with a time span of 30-40 years from now, developed during CASI citizen panels in the following 12 EU countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, Germany, Italy, Poland, Portugal, Slovenia and the United Kingdom; and (2) to activate the vision-based track of the CASI framework for the assessment and management of sustainable innovation (CASI-F) so as to allow for a systematic mapping of critical issues (barriers, drivers, opportunities and threats) associated with SI visions, and to promote a more public assessment and management of possible actions linked to such issues. The Visions Bank allows for further exploration of the original 50 visions created in CASI citizen panels, but it also allows CASI community members to add their own vision to the Visions Bank and to share their views about the most critical issues associated with that vision.

- CASIPEDIA:** A unique bank of sustainable innovation initiatives mapped by the CASI project, where activists, experts and supporters of sustainability agendas can find various initiatives combining the environmental, economic and social dimensions of sustainability. CASIPEDIA supports the mapping of practices, outcomes and players related to seven types of SI, namely product, service, social, organisational, governance, system or marketing innovations.
- Common:** This refers to something that is done or shared by two or more (groups of) actors. In the context of CASI-F, 'common' indicates that the framework for the assessment and management of SI could be used by the quadruple helix of SI stakeholders in multiple contexts.
- Framework:** This refers to both the physical or virtual platforms (tools) around which something is developed, and the system of ontologies, methods and procedures (protocols) to inform and support decision-making.
- SI Action Roadmap:** This refers to the generation of a portfolio of sub-actions supporting the transition management related to the implementation of a given 'SI Management Action' (see below).
- SI Assessment:** This involves two complementary analyses: on the one hand, the identification, analysis and prioritisation of 'SI critical issues' (see below) associated with sustainability-oriented aspirations, policies and innovations and, on the other hand, the generation, analysis and prioritisation of 'SI actions' addressing prioritised critical issues.
- SI Critical Factor:** This refers to the 50 factors (clustered around 10 SI Management Key Aspects) influencing the sustainability of innovations.
- SI Critical Issue:** This refers to technological, economic, environmental, political, social, ethical and spatial (TEEPSES) issues shaping the present and/or future of a given sustainable innovation.
- SI Critical Issue Type 1: Barrier** – This refers to any kind of existing limitation or obstacle – whether technological, economic, environmental, political, social, ethical or spatial - of a given sustainable innovation initiative.
- SI Critical Issue Type 2: Driver** – This refers to any kind of existing force, trend or enabler – whether technological, economic, environmental, political, social, ethical or spatial – that fosters a given sustainable innovation initiative.
- SI Critical Issue Type 3: Opportunity** – This refers to any kind of future possibility for a given sustainable innovation initiative to achieve something desirable, such as a technological, economic, environmental, political, social, ethical or spatial goal.
- SI Critical Issue Type 4: Threat** – This refers to any kind of future possibility for a given sustainable innovation initiative to be affected by something undesirable, such as a technological, economic, environmental, political, social, ethical or spatial risk.
- SI Management:** This refers to the process of generating multi-level and multi-stakeholder actions responding to multiple types of critical issues.
- SI Management Action:** This refers to any kind of managerial activity of a sustainable innovation at strategic, tactical or operational level.
- SI Management Action Type 1: Strategic level** – This action involves the definition of high-level aims, challenges, goals, objectives and priorities that require strategic attention or orientation from top-level decision-makers in government, business, civil society, research and education organisations.

SI Management Action Type 2: Tactical level – This refers to actions from mid-level decision-makers aiming to translate strategic level objectives and priorities into tactical interventions, such as investment, research or knowledge-transfer programmes and calls, funding schemes or instruments as well as development and implementation mechanisms.

SI Management Action Type 3: Operational level – This action requires the intervention of front-line decision-makers - policy makers, civil servants, entrepreneurs, citizens, researchers and workforce - who are directly responsible for the operationalisation of day-to-day activities linked to tactical and strategic actions.

SI Management Dimension: This refers to any of the following four specific areas where managerial actions are almost certainly required for sustainable innovations: context, people, process and impact. A total of 50 critical factors were identified in these four dimensions.

SI Management Dimension 1: Context – This dimension consists of 17 critical factors clustered around four key aspects: *Momentum*, reflecting the potential space for innovation, i.e. expectations of entrepreneurs and other actors, political drive from regulators or procurement, exemplars from other technological or social enterprises, and the perception of problems that call for solutions; *Foresight*, showing the capacity to anticipate, strategise and overcome gaps in the innovation curve; *Resources*, emphasising the need for healthy combinations of skills, finance, location, markets, etc; and *Mobilisation*, including champions and facilitators, civil society engagement, government engagement, research and education engagement, business engagement and proactive participation.

SI Management Dimension 2: People – This dimension consists of eight critical factors clustered around two key aspects (i.e. aptitude and attitude) shaping the activities of the quadruple helix actors involved in sustainable innovation. Many objectives remain unfulfilled when innovations fail to connect or mobilise the right people, or do not provide the right incentives or skills for key people. ‘Aptitude’, refers to the actual skillset or competences of people involved in the design, development, implementation and diffusion of a sustainable innovation; ‘attitude’, means the type of behaviour of the same people.

SI Management Dimension 3: Process – This dimension consists of 14 critical factors clustered around two key aspects: ‘Catalysts’, contributing to initiate, develop and implement the innovation; and ‘Fosterers’, including factors that further consolidate and diffuse the innovation.

SI Management Dimension 4: Impact – This dimension consists of 11 critical factors clustered around two key aspects: ‘Transformation’, meaning the capacity to make positive changes in the quadruple helix of SI and knowledge production; and ‘Sustainability’, referring to changes in the socio-technical system where the SI operates that lead to positive environmental, social, economic, government and infrastructure transformations without compromising the needs and welfare of future generations.

SI Management Key Aspects: This refers to 10 types of building blocs (momentum, foresight, resources, mobilisation, aptitude, attitude, catalysts, fosterers, transformations and sustainability) related to the four SI management dimensions (context, people, process and impact).

SI Management Key Aspect 1: Momentum – This refers to the force that gets a sustainable innovation moving forward. There are three critical factors linked to this SI key aspect: political setting (including regulations, decisions, rules, policies, guidelines, etc); exemplars (including pioneering or leading models, standards, prototypes, examples, etc); and problems (including challenges, complications and difficulties as drivers of change).

- SI Management Key Aspect 2: Foresight** – This refers to the future-oriented strategic driver of a sustainable innovation. There are three critical factors linked to this SI key aspect: horizon scanning-based approach (proactive mapping of critical issues, e.g. barriers, drivers, opportunities and threats); trends-based approach (reacting to current developments); and strategic targets approach (aligning goals with STI priorities of the system).
- SI Management Key Aspect 3: Resources** – This refers to the means that can be drawn on by a sustainable innovation in its design, development, implementation and diffusion. There are five critical factors linked to this SI key aspect: geographical setting (both environmental and demographic conditions); funding (internal and external); infrastructure (physical and virtual); data (including hard and soft, e.g. statistics and insights); and scalability (potential to grow).
- SI Management Key Aspect 4: Mobilisation** – This refers to the capacity of a sustainable innovation to reach and involve key stakeholders. There are six critical factors linked to this SI key aspect: champions and facilitators (to engage stakeholders); civil society engagement (to promote democracy); government engagement (to ensure governance and regulation); research and education engagement (to promote evidence-based decision-making); business engagement (to promote public-private partnerships to address market issues); and proactive participation (to address the needs of the quadruple helix SI players).
- SI Management Key Aspect 5: Aptitude** – This refers to the actual skillset or competences of people involved in the design, development, implementation and diffusion of a sustainable innovation. There are four critical factors linked to this SI key aspect: leadership (to guide the innovation team); charisma (to inspire and mobilise key people); creativity (to reach original and innovative solutions); and knowledge (to make sound and informed decisions).
- SI Management Key Aspect 6: Attitude** – This refers to the type of behaviour of people responsible for the design, development, implementation and diffusion of a sustainable innovation. There are four critical factors linked to this SI key aspect: enthusiasm (to spread interest and excitement); empathy (to be more responsive to the needs of potential SI users and beneficiaries); involvement (to promote cooperation and networking); and commitment (to achieve shared ownership and co-create success).
- SI Management Key Aspect 7: Catalysts** – This refers to critical factors enabling the design and development phases of a SI process. There are seven critical factors linked to this SI key aspect: compressibility (to offer user-friendly solutions); crowd-sourcing (to achieve truly bottom-up financial support); learning-by-doing (to promote more assertive evolution and incremental innovation); supportive services (to deal with specific bottlenecks in the innovation process); absorptive capacity (to generate and act upon valuable information or intelligence); ex-ante impact evaluation (to recognise and measure important benefits and possible risks) and piloting and experimenting (to avoid disappointments and manage expectations).
- SI Management Key Aspect 8: Fosterers** – This refers to critical factors supporting the implementation and diffusion phases of a sustainable innovation process. There are seven critical factors linked to this SI key aspect: incentives (to further position the innovation); coordination (to manage the relationship between the innovation team, sponsors, supporters and beneficiaries); networking and synergy (to better capitalise momentum-related critical factors); knowledge management (to reinforce the innovation capacity of the team); intellectual property management (to improve the competitive advantage of the innovation); ex-post impact evaluation (to promote improvements through learning and demonstrate the positive environmental, social and economic impacts of an innovation); and communication and dissemination (to increase the sectoral and geographical transferability).

SI Management Key Aspect 9: (multi-agent) Transformation – This refers to positive changes in the quadruple helix of SI and knowledge production. There are six critical factors linked to this SI key aspect: stakeholder and community development (to consolidate new/existing players and promote spin-offs and networking); knowledge-based products and services (to increase academic, cultural or scientific advances); values and lifestyle changes (to promote knowledge- and media-based cultural and behavioural change); multi-challenge approaches (to better manage the complexity of dynamically changing socio-technical systems, visions and paradigms); capacities and skills (to support workforce development, competences and jobs); and entrepreneurship (to innovate and create new business opportunities).

SI Management Key Aspect 10: (systemic) Sustainability – This refers to changes in the socio-technical system in which the SI operates that lead to positive economic, societal, infrastructure, environmental and government transformations. There are five critical factors linked to this SI key aspect: societal system sustainability (to improve social cohesion/interaction, community sense, education); economic system sustainability (to improve consumption, production, labour conditions, trade); environmental system sustainability (to protect cultural and ecological heritage, species, resources, environmental protection laws and policies, etc.); government system sustainability (to improve public participation and democracy) and infrastructure system sustainability (to improve the energy, water and food supply system, waste management, settlements and cities, transportation, distribution and knowledge-transfer channels)

SI Mapping: This refers to the systematic process of nominating and assessing sustainable innovations in terms of their practices, outcomes and players.

SI Mobilisation: This refers to the process of seeking the engagement and commitment of the quadruple helix of stakeholders in the systematic process of scoping, anticipating, recommending or transforming sustainability-oriented transition and futures.

SI Mutual Learning: This refers to the participatory multi-stakeholder process of mapping, assessing and/or managing sustainability-oriented aspirations, policies and innovations.

SI Public Participation or Public Engagement: This refers to the process of engaging the quadruple helix of SI stakeholders (i.e. government, business, civil society and research/education actors).

Sustainable Innovation (short definition) is ‘any incremental or radical change in a socio-technical system leading to positive environmental, economic and social transformations without compromising the needs, welfare and wellbeing of current and future generations’.

Sustainable Innovation (long definition) is ‘any incremental or radical change in the social, service, product, governance, organisational, system or marketing landscape that leads to positive environmental, economic and social transformation without compromising the needs, welfare and wellbeing of current and future generations’.

SI Type 1: Product innovation – This refers to the introduction of a good that is new or significantly improved with respect to its characteristics or intended uses (OECD, 2005). Product innovations include: scientific advances with innovation potential, industrial innovations with deployment potential, and new products on the market with sustainability potential.

SI Type 2: Service innovation – This refers to the introduction of a service that is new or significantly improved with respect to its characteristics or intended uses. For example, efficiency or speed improvements, new functions or characteristics of existing services, or the introduction of entirely new services (OECD, 2005).

- SI Type 3: Social innovation** – This refers to new solutions (including products, services, models, markets, processes, etc.) that simultaneously meet a social need (more effectively than existing solutions) and lead to new or improved capabilities and relationships and better use of assets and resources. In other words, social innovations are both good for society and enhance society's capacity to act (Caulier-Grice *et al.*, 2012).
- SI Type 4: Organisational innovation** – This refers to the implementation of a new method in business practices, workplace organisation or external relations to increase performance by: reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (e.g. non-codified external knowledge) or reducing costs of supplies (OECD, 2005). This includes business model innovations such as: new business/financial/infrastructure models, e.g. car/bike sharing or crowd-funded solutions.
- SI Type 5: Governance innovation** – This refers to new forms of citizen engagement, new democratic institutions, new public and user participation in service design and delivery, and the use of public boards to govern particular choices. It includes new political arrangements in local and national governments as well as changes in the organisational form and arrangements for the planning and delivery of public services (Hartley, 2005). Governance innovations may also include: local policy innovation, i.e. policy transfer from other places, or public service reform.
- SI Type 6: System innovation** – This refers to a set of interconnected innovations, where each is dependent on the other, with innovation both in the parts of the system and in the ways that they interact (Caulier-Grice *et al.*, 2012). This normally involves a complex interaction of public policy and reforms to legislation, changes to business cultures and practices, as well as shifts in consumer attitudes and behaviour. System innovations also include combinations of two or more types of innovations but such cases are not always labelled 'systems'.
- SI Type 7: Marketing innovation** – This refers to the implementation of a new marketing method involving significant changes in product or service design or packaging, placement, promotion or pricing (OECD, 2005). Sustainable marketing innovations are aimed at better positioning the social, economic and environmental benefits of new/improved products, services and processes.

